A C R I S

Reporting Change

IN THE RANGELANDS

Australian Collaborative Rangeland Information System, Reporting Change in the Rangelands – 2007

NT Information for the National Report

Rangelands 2007 – Taking the Pulse

October 2007

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SUMMARY

This document integrates reports provided by the Northern Territory Department of Natural Resources, Environment and the Arts (NRETA) that contribute to the NT's reporting of change in Australia's rangelands for the period 1992 to 2005. A national synthesis (*Rangelands 2007 – Taking the Pulse*) has been compiled from relevant jurisdictional and national data by the Australian Collaborative Rangeland Information System (ACRIS). *Taking the Pulse* will be printed by the National Land and Water Resources Audit and will be released in the early part of 2008.

Information in this (NT) report relates to:

- Change in landscape function, as Attachment 1 to this report (pages 111 to 226). This attachment is also available as the separate Word document, *NT ACRIS Theme 1 - Landscape Function.doc*.
- Change in critical stock forage, as Attachment 2 to this report (pages 227 to 284) and also in the separate Word document, *NT ACRIS Theme 2 - Sustainable Management.doc*.
- Other components of the sustainable pastoral management theme, i.e. change in woody cover and distance from water (refer to table of contents at the start of this report).
- Change in unimproved pastoral land values.
- Landscape photos from Tier 1 and Tier 2 monitoring sites showing typical changes.

Reporting is mainly at bioregion level (version 6.1 of the Interim Biogeographic Regionalisation of Australia, IBRA). Where available data are limited spatially, reporting is confined to relevant sub IBRAs of bioregions.

The ACRIS Biodiversity Working Group has compiled data and information for the 2007 report based on ten indicators. NRETA, and particularly Alaric Fisher, has contributed biodiversity information for the NT (but that information is not included in this report).

ACKNOWLEDGEMENTS

Cameron Yates as the former NT representative on the ACRIS Management Committee initiated this work. Graeme Fagan provided oversight and support to the reporting of NRETA staff. We thank both for their input and support.

Vanessa Chewings produced the site seasonal quality scores and provided general GIS support and advice. Again, our thanks to Vanessa for her valuable contribution.

Members of the ACRIS Management Committee provided more general direction and guidance with jurisdictional contributions to the 2007 national report.

NT reporting was supported by Natural Heritage Trust funding administered by the Desert Knowledge CRC. We thank the DK-CRC Secretariat, and Ange Vincent in particular, for their contribution by way of implementing and managing contractual arrangements.

INTRODUCTION

The Australian Collaborative Rangeland Information System (ACRIS) is in the final stages of compiling its national report of change in the rangelands for the period 1992 to 2005. This report will be published by the National Land and Water Resources Audit in the early part of 2008. The national report has been compiled from available jurisdictional and national datasets and this document consolidates the various reports contributed by the NT Department of Natural Resources, Environment & the Arts (NRETA) to assist ACRIS reporting. Reporting is by bioregion (IBRA v 6.1, Fig. 1).

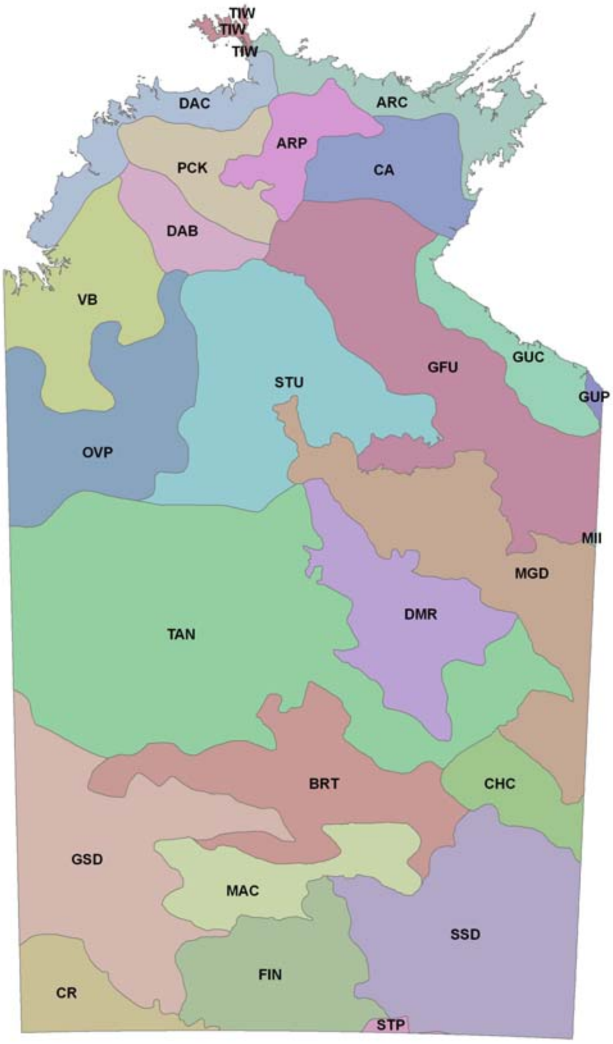


Figure 1. Bioregions in the NT.

ARC	Arnhem Coast	ARP	Arnhem Plateau	BRT	Burt Plain
CA	Central Arnhem	CHC	Channel Country	CR	Central Ranges
DAB	Daly Basin	DAC	Darwin Coastal	DMR	Davenport Murchison Ranges
FIN	Finke	GFU	Gulf Fall & Uplands	GSD	Great Sandy Desert
GUC	Gulf Coastal	GUP	Gulf Plains	MAC	MacDonnell Ranges
MGD	Mitchell Grass Downs	MII	Mount Isa Inlier	OVP	Ord Victoria Plain
PCK	Pine Creek	STP	Stony Plains	STU	Sturt Plateau
TAN	Tanami	TIW	Tiwi Cobourg	VB	Victoria Bonaparte
SSD	Simpson Strzelecki Desert				

The national report is based on a number of biophysical and socio-economic themes and related products. The Northern Territory's contribution to these themes includes:

Theme	Product	Datasets
Landscape function	Landscape function *NT ACRIS Theme 1 - Landscape Function.doc*	Tier 1 (site-based) monitoring data change in index of landscape function compiled from composition & cover of perennial grasses Tier 2 (satellite-based) monitoring that supplements Tier 1 reporting for some bioregions (grazing gradient analysis in the south and land cover change in the Sturt Plateau and Victoria River District)
Sustainable management	Critical stock forage *NT ACRIS Theme 2 - Sustainable Management.doc*	Tier 1 monitoring data change in composition of palatable perennial (2P) grasses
	Waterpoints	Distance from water percentage sub IBRA area in different distance classes from sources of stock water
	Woody cover	Classification of Landsat TM imagery to map recent clearing of woody vegetation for selected northern bioregions
Socio-economic	Land values	Unimproved value of pastoral land change in land values
Supporting information	Photos	Time-series photos of selected rangeland monitoring sites

The ACRIS Biodiversity Working Group has compiled data and information for the 2007 report based on ten indicators. NRETA, and particularly Alaric Fisher, has contributed biodiversity information for the NT (but that information is not included in this report).

Reporting Area

The NT is reporting principally on the grazed rangelands where Tier 1 monitoring sites exist. Reporting is by bioregion in the main but results are restricted to relevant sub IBRAs where site data are restricted in their spatial distribution. A location map (that also shows Tier 1 sites) is included with the theme results reported for each bioregion.

Report Contents

This report provides additional context for the separate theme reports provided by NT Government and ACRIS Management Unit staff (i.e. the Word documents listed in italicised font in the table above). This report also contains additional data and information provided by NRETA to assist ACRIS reporting (i.e. clearing and land values).

SEASONAL QUALITY AS CONTEXT FOR REPORTING CHANGE

Rainfall (amount, timing and follow-up) is the principal driver of vegetation change. In northern Australia, frequent and extensive fire also affects the vegetation. It is necessary that ACRIS filters the effect of prior seasonal conditions on change recorded at monitoring sites (to the extent possible) so that the effects of grazing management are better understood. ACRIS is using the phrase 'seasonal quality' to represent seasonal conditions.

Seasonal quality is defined as the relative value of recent climate (principally, rainfall) on biological functioning. Relative value (quality) is judged with reference to the available longer term record. 'Biological functioning' is a wide-ranging term but for the purpose of ACRIS reporting themes, broadly means vegetation growth as the basic resource for livestock production, for the maintenance or improvement of ecosystem / landscape function and as an important component of biodiversity.

Method

ACRIS partners, assisted by the Management Unit, have used the following procedure to produce an index of seasonal quality to assist interpretation of change:

1. Monthly SILO gridded rainfall was used as the input data set (see http://www.bom.gov.au/silo/). Rainfall data were extracted for the 0.05 degree grid cell (~5-km by ~5-km) corresponding with the location of each relevant monitoring site.

2. Monthly rainfall data were summed into seasonal totals. Summer (northern wet season) months are nominally November to April inclusive and winter (southern wet season) months are nominally May to October inclusive. Note that there is some latitude amongst jurisdictions in assigning months to seasons. For example, in WA winter is defined as April to September and summer as October to March.

3. Seasonal totals were then ranked as a tercile (upper, middle or lower third) against the long term record (1890 to 2005). This equates with a particular site having experienced above-average, average or below-average rainfall for a particular season, compared with the long-term record.

Depending on jurisdictional requirements, seasonally ranked rainfalls were then further weighted and combined prior to calculating a final seasonal quality score for each site.

- For the WA Rangeland Monitoring System (WARMS), sites in the northern grasslands (Kimberley and Pilbara) are reassessed on a three-year cycle and southern shrubland sites on a five-year cycle. WARMS sites use the most elaborate weighting (or ranking) system to arrive at a final seasonal quality score (and it is through the efforts of Ian Watson and Paul Novelly in developing these methods that ACRIS has been able to implement some national consistency in assigning site seasonal-quality scores). For grassland sites, the WA procedure is:

  (i) Summer rainfall is considered more important than winter rainfall and for each winter/summer pair making up a year, winter rainfall is considered to precede summer rainfall.

(ii) Individual tercile categories for winter and summer rainfall are used to derive a combined score for each year. The combined scores for each year over the interval between site reassessments are aggregated to produce a single score for each site over the interval. Tercile categories are derived from this aggregate score to provide a final ranking for each site of above average, average or below average seasonal quality.

(iii) The following weights are used to derive a combined score based on tercile ranks of summer and winter rainfall in the three-year period between assessments.

	Winter tercile 1	Winter tercile 2	Winter tercile 3
Summer tercile 1	100	90	90
Summer tercile 2	70	60	55
Summer tercile 3	30	25	20

A similar procedure is used for shrubland sites but winter rainfall is considered more important than summer rainfall and weights are adjusted as per the following table.

	Winter tercile 1	Winter tercile 2	Winter tercile 3
Summer tercile 1	9	7	3
Summer tercile 2	8	5	2
Summer tercile 3	6	4	1

- A similar procedure to that developed for WARMS shrubland sites was applied to each South Australian Quantitative Site to determine a seasonal quality rank for interpreting vegetation change. (Quantitative sites are those where a Jessup transect is used to collect shrub density data, and other quantitative data are collected.)

- In NSW where Range Assessment Program (RAP) sites are assessed annually, the separate summer and winter terciles within each 12-month period were weighted and then used to calculate a (final) combined tercile score (based on similar weightings applied to all years of data in the rainfall record). In northern NSW, summer rainfall is more beneficial for plant growth than winter rain and summer rainfall was thus weighted preferentially. In southern NSW, the reverse applies and winter rainfall was weighted above summer rainfall.

- In the northern and central parts of the NT, summer (wet season) rainfall contributes almost exclusively to vegetation growth. Tier 1 site reassessments are generally separated by three years (or so) and for each site, the most recent wet season tercile was weighted above that of preceding terciles in the period between sites assessments. As for WA, SA and NSW, the summed weights for a site was then ranked against all similarly weighted combinations in the long-term record to produce a final tercile score of seasonal quality.

  In the southern NT, winter rainfall can affect plant growth and where significant falls occurred, the winter tercile score was weighted as secondary to summer rainfall terciles in the period between site assessments. As for further north, the tercile score associated with more recent seasonal rainfall was weighted above the terciles of previous seasons. Summed weights were then used to calculate an overall seasonal quality tercile against the long-term record.

Assigning Causality to Change

ACRIS is using a 'quality of preceding seasons' by 'direction of change' matrix (see Fig. 2) to filter shorter-term seasonal influences from possible changes due to grazing management. (Wildfire must also be considered as a cause of change, particularly in northern Australia.)

Seasonal quality is based on the ranked amount of rainfall in the growth season(s) prior to the monitoring period compared with the long-term record and is calculated as described above.

Columns report the percentage of monitoring sites where reported attributes of vegetation (or landscape) declined, were unchanged or improved.

Seasonal Quality	Change in Reported Attribute		
	Decline	No change	Improvement
Above average	XX	X	~
Average	X	~	√
Below average	~	√	√√

Figure 2. Matrix for filtering seasonal effects on change.

√√ shows improvement although seasonal conditions were below average. XX is of concern because sites declined when seasonal conditions indicated no change or improvement.

The value of this matrix for reporting change is increased where vegetation data are selected that either enhance management effects or further dampen seasonal influences. For example, focussing on longer-lived perennial species filters many ephemeral species that are directly affected by timing of rainfall. Grazing effects, both positive and negative, are sharpened by reporting change for those species known to decline with heavy and prolonged grazing. This assumes that seasonal conditions alone have the same impact on species that decrease, increase or are unaffected by grazing.

PASTORAL MONITORING ACTIVITY

The NT has a two-tiered program for monitoring its pastoral lands (Karfs and Trueman 2005). Tier 1 sites are located on all pastoral leases. These sites are periodically monitored by way of a site photograph and visual estimates of pasture composition (by biomass) and cover. Information is also collected about woody species density, presence of noxious weeds and erosion. Tier 2 monitoring provides more rigorous quantitative data, mainly through remote sensing supplemented with validation data at some fixed ground sites (Karfs *et al.* 2001). Land cover change analysis is used in the northern tropical savanna and grazing gradient methods in the Barkly Tableland and southern NT.

LANDSCAPE FUNCTION

Landscape function describes the capacity of landscapes to regulate (i.e. capture and retain, not leak) rainwater and nutrients, the vital resources for plant growth (Ludwig *et al*. 1997). Functional landscapes have a good cover and arrangement of persistent vegetation patches (typically perennial vegetation) for their type. This means that much of the rain that falls soaks into the soil and is available for plant growth. There is generally minimal runoff and so there is limited loss of plant nutrients in transported sediment. Reduced overland flow also limits loss of organic matter (litter) and seeds. Similarly, a good cover and arrangement of vegetation patches minimises wind erosion and loss of nutrients in dust.

Change in the functionality of landscapes provides a sound basis from which to judge the effects of management on the rangelands. Functional landscapes are likely to recover quickly from disturbance (e.g. grazing, fire or drought), and to maintain a consistent vegetation cover through variable seasonal conditions. Dysfunctional landscapes may not recover, take longer to recover or change to a less desirable vegetation state.

Information relevant to reporting change in landscape function in the NT was compiled by Debbie Mullin (NRETA) and is contained in the separate report *NT ACRIS Theme 1 - Landscape Function.doc*. This separate report:

- Describes landscape function and explains how Tier 1 and Tier 2 monitoring data are used to report change by way of indices of landscape function.
- Presents Tier 1 results by bioregion. A map is included showing the location of each bioregion within the NT and the distribution of Tier 1 sites within the bioregion. For each bioregion, changes in the mean score (accompanied by the standard error) of the landscape function index over time are graphed. Seasonally interpreted change in landscape function for the 1992-2005 period is also reported.
- Presents results from available Tier 2 sites (Victoria River District and Sturt Plateau).
- Includes the results obtained from grazing gradient analyses in the Barkly Tableland and central Australia.

The ACRIS Management Unit has used the Tier 1 data and grazing gradient results to report change in landscape function for the NT in the 2007 national synthesis. Examples of this reporting can be seen in the bioregional summaries for NT IBRAs included later in this report.

SUSTAINABLE MANAGEMENT

Grazing of native pastures is the most extensive commercial land use in the NT rangelands. The landscape function results above indicate that the ability of some rangeland environments to regulate resources (rain water, plant nutrients, litter, seeds etc) has been altered. It is important that current grazing management practices are sustainable (and remain so) because:

1. We shouldn't degrade natural systems (as a matter of principle).
2. Repairing degraded ecosystems is expensive and where degradation has occurred, restoration is often not economically viable or sensible on a large scale.
3. That will assist future marketing of meat and wool by maintaining the image of Australia's rangeland products as "clean" and "green".
4. It will prevent further loss of biodiversity, particularly those components vulnerable to standard agricultural practices.

ACRIS is reporting a number of components under 'sustainable management'. These include critical stock forage, plant species richness (where suitable data are available), woody cover change and distance from stock water. Allied reporting covers components of total grazing pressure (domestic stock, kangaroos and feral herbivores), fire and dust.

The NT is contributing data to the national reporting of change in critical stock forage, distance from water (for the Barkly Tableland and southern NT) and woody cover.

Critical stock forage

Critical stock forage refers to those pasture species within broad regions (e.g. group of bioregions), that underpin or support longer-term livestock production. In the NT pastoral lands these are the palatable and perennial (2P) grasses, with these being more abundant in the Barkly Tableland and northern savanna regions.

Pasture species composition data collected at Tier 1 sites have been used to report change in critical stock forage for the NT. Results are contained in the separate report *NT ACRIS Theme 2 - Sustainable Management.doc* compiled by Debbie Mullin (NRETA). Bioregion reporting is similar to that of landscape function: a map that shows Tier 1 sites, graphed mean and standard error of change in 2P grass composition and seasonally interpreted change for the 1992-2005 period.

Woody Cover

The NT updates its estimates of land clearing using Landsat satellite imagery. Mapping has an accuracy scale of 1:100,000 on the ground. A range of band ratio techniques including NDVI and difference imaging are used to highlight areas of cleared land.

The estimated percentage of bioregion area cleared in 2004 and 2005 (to September 2005) was:

- Daly Basin; 10.9%, largely for agriculture and horticulture,

- Darwin Coastal; 4.36%, mostly for infrastructure purposes,
- Pine Creek; 2.74%, due to mining, and
- Tiwi Coburg; 2.12%, for plantation forestry.

  Bioregions in the semi-arid and arid rangelands had very little total clearing (usually <0.5%).

The percentage area cleared in each of 2004 and 2005 is shown in Fig. 3.

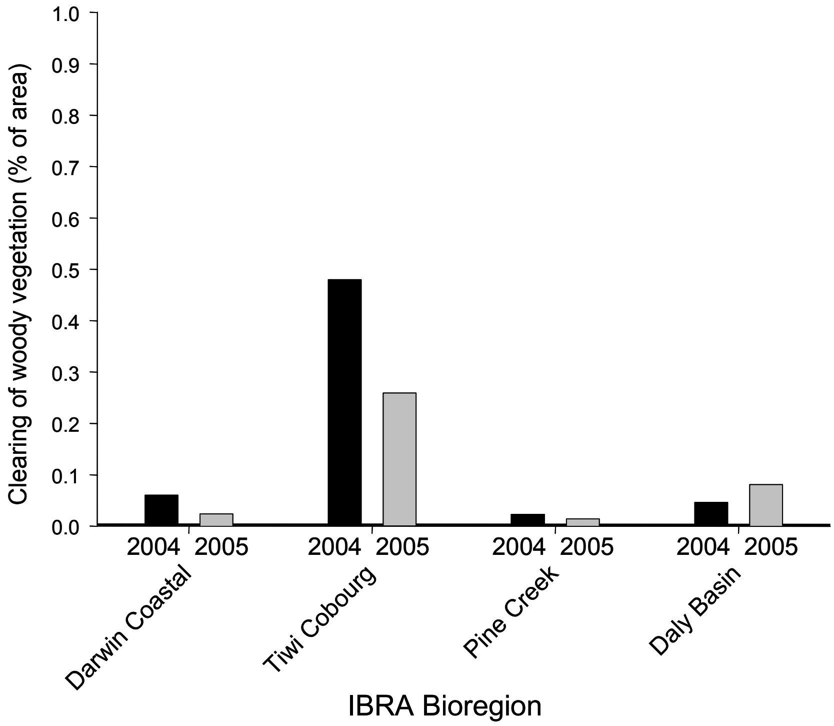


Figure 3. Rate of clearing (%) in 'Top End' bioregions of the Northern Territory for 2004 and 2005.

Distance from Water

Distance from water is used as a surrogate of grazing pressure imposed by herbivore species dependant on water. Essentially, areas closer to water are presumed to be more impacted (disturbed) by grazing while (relatively) water-remote areas are presumed to be largely intact. Stock waterpoints can also have an adverse impact on biodiversity. This component is being reported separately by the Biodiversity Working Group as part of the biodiversity theme in the 2007 ACRIS report.

Distance from water (as a raster layer) is required for grazing gradient analysis and CSIRO staff (in Alice Springs) have worked cooperatively with NRETA over several years to compile distance from water data for pastoral leases in the Barkly Tableland and southern NT. Information derived from GIS analyses of this dataset is presented in Appendix 1.

LAND VALUES

ACRIS is reporting change in pastoral land values as one of the indicators for its socio-economic theme. The following information has been compiled from data provided by the NT Valuer General's Office.

Areas within each IBRA that are under pastoral leasehold and subject to rental appraisals were used in the analysis. Bioregions that had less than 50% pastoral tenure and/or five or less stations were excluded from the analysis. Remaining bioregions (i.e. with suitable data for reporting) are listed in Table 1.

Table 1. Number of cattle stations and percentage area of pastoral lease tenure for bioregions where land values are being reported.

IBRA Name	# Stations	% Pastoral
Burt Plain	28	77
Channel Country	6	82
Daly Basin	10	50
Finke	17	89
Gulf Fall and Uplands	27	50
Mitchell Grass Downs	26	88
Ord Victoria Plain	18	71
Sturt Plateau	37	60

There are few stations that fall entirely within a single bioregion. Thus the column headed '# Stations' in the above table shows stations that have the majority of their property within one IBRA, but doesn't represent the whole station.

The total unimproved value for each station was divided by its area to give a value per square kilometre. The area of each station within the respective IBRAs was then calculated, multiplied by its value per square kilometre and summed. The total value per IBRA was then divided by the total area under pastoral lease within that IBRA to provide an average value per square kilometre. The values were then CPI-adjusted to reflect 2005 dollar values (Table 2).

The average unimproved value of pastoral land increased in all bioregions between 1991 and 2003.

- The Daly Basin and Sturt Plateau bioregions had the greatest increase in value. This is consistent with the recent intensification and development of the Sturt Plateau region and the further subdivision of pastoral leases in the Daly Basin IBRA.
- Finke IBRA has the lowest valuation. This is consistent with the low carrying capacity of the arid sand plains, the major land type within the IBRA.
- The higher valued IBRAs are generally located in the more northern areas of the NT, consistent with their more reliable seasonal conditions.

Table 2. Change in average unimproved value of pastoral land by bioregion. Values are CPI adjusted to 2005 dollar values.

IBRA	1991	2003
Burt Plain	$142.17	$161.98
Channel Country	$106.64	$111.60
Daly Basin	$410.38	$622.80
Finke	$81.72	$89.36
Gulf Fall and Uplands	$154.90	$203.24
Mitchell Grass Downs	$521.78	$544.09
Ord Victoria Plain	$536.55	$569.02
Sturt Plateau	$220.25	$319.28

PHOTOS SHOWING CHANGE

Site photos from Tier 1 and Tier 2 pastoral monitoring sites across the NT are presented here to illustrate landscape changes.

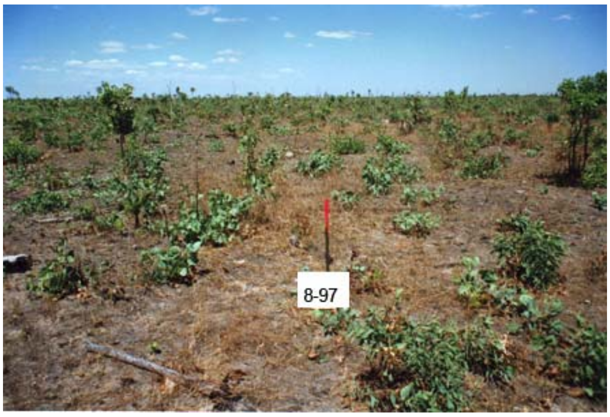
Tier 1 monitoring sites are located across the NT, covering the majority of IBRAs. The Tier 1 monitoring program aims to visit each site across the NT every three years.

Tier 2 monitoring sites are located across two IBRA regions: the Ord Victoria Plain and Sturt Plateau. This monitoring program was established in 1995 in the Ord Victoria Plain and in 2000 for the Sturt Plateau.

Below are examples of change captured by photographs over the last ten year period.

Darwin Coastal IBRA

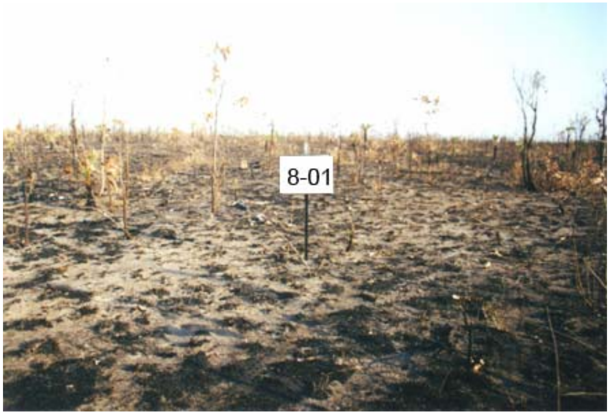
Tier 1 monitoring site



1997

1999

2000



2001

The photo monitoring point depicts changes in the landscape. Pastoral officers from the region have report the main influences upon sites in the Darwin Coastal IBRA are fire, weeds and feral animals.

This site in particular demonstrates changes in biomass and cover levels and the response the land has when affected by fire.

Darwin Coastal IBRA

Tier 1 monitoring site

1988

1988

2001

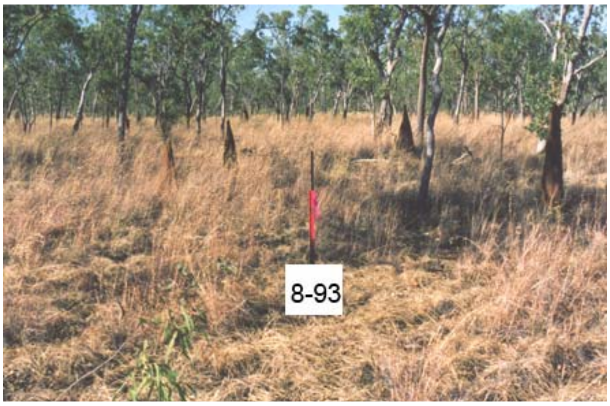
2001

Over the last 13 years of monitoring, this site has undergone a dramatic change from productive pasture lands to unusable country overrun by the weed *Mimosa pigra*.

The site is now part of a weed control area which is regularly burnt and chained as part of a regime to reclaim the pasture.

Sturt Plateau IBRA

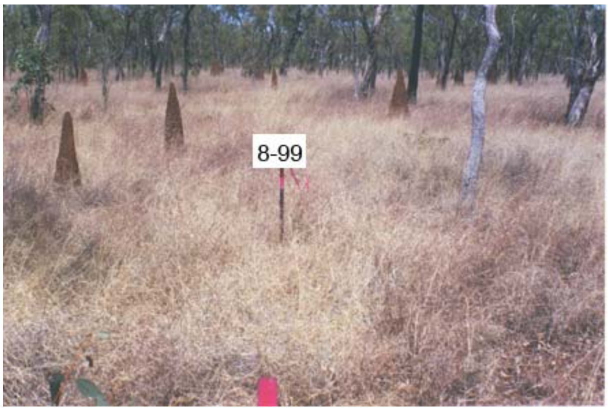
Tier 1 monitoring site



1993

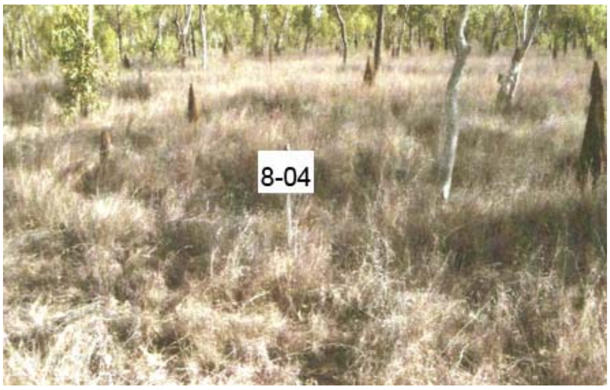
1995

1996



1999

2000



2004

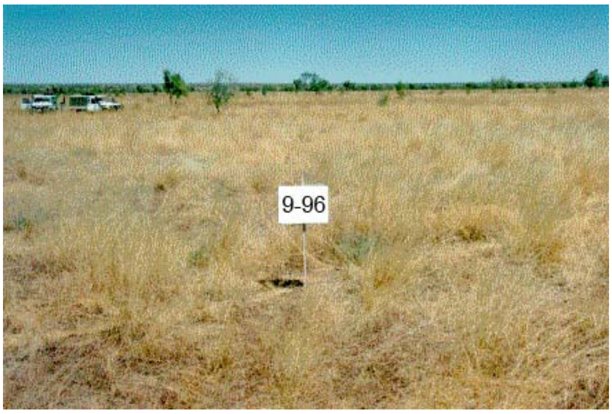
Over the last 10 years of monitoring the Sturt Plateau, the condition of sites has remained stable with an increasing level of cover and biomass.

Discussions with pastoral officers that regularly visit these sites confirmed that the sites are, to date, resilient to the effects of fire when fire is managed effectively (i.e. adequate infrastructure for control of fire and stock numbers) and data collected supports these visual assessments also.

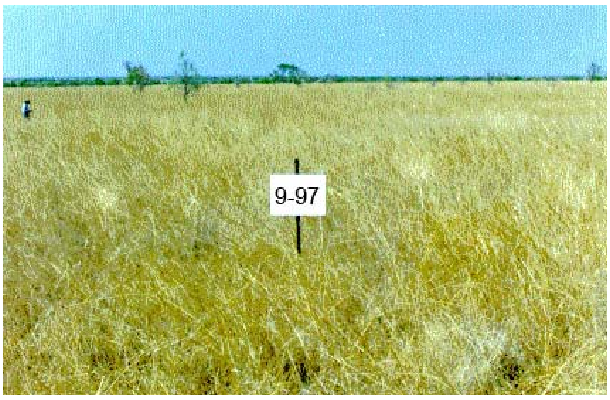
Ord Victoria Plain IBRA

Tier 2 monitoring site

1995



1996



1997

1998

1999

2003

During the period 1995 to 2003, the Ord Victoria Plain bioregion experienced a run of unprecedented high rainfall and good seasons of growth. This resulted in high levels of both perennial and annual cover, and biomass levels. This period also recorded increased levels of recruitment of perennial and annual species, indicating that the majority of sites within the IBRA had increased in condition and cover levels.

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APPENDIX ONE: GIS ANALYSIS OF DISTANCE FROM WATER

This section was compiled by Melissa Schliebs (CSIRO & ACRIS Management Unit) to assist NRETA staff with their reporting to ACRIS themes.

Rationale

The distance from water data provide information for the 'indicators of biodiversity change' theme for the ACRIS 2007 reporting. The data were created as a necessary layer for grazing gradient analysis as part of Tier 2 monitoring. The data layer has relevance as a biodiversity 'pressure' layer from the Biograze research (James *et al*. 1999) research which outlines how distance from water impacts on the distribution and abundance of certain plants and animals. Generally, grazing pressure decreases as distance from any water point increases. While many plants and animals are not affected by well-managed grazing, some plants and animals increase in abundance closer to waterpoints where grazing pressure is highest (increaser species). There is evidence that others, decreaser species, are only found in lightly grazed areas remote from water points. As a general rule (and particularly in more preferred grazing areas), there is only a small proportion of land in the rangelands that is far enough from water points to sustain these decreaser species.

Datasets

The distance from water dataset is a secondary benefit of the grazing gradient analysis. The grazing gradient dataset was created from infrastructure data (permanent and semi-permanent sources of stock water and fences) supplied in a digital format by the Department of Natural Resources, Environment and the Arts. The area analysed is restricted to commercially operated pastoral leases within UTM zone 53 in the southern Northern Territory.

Mountain ranges were digitized from satellite imagery as they form barriers to cattle movement. This was combined with the infrastructure data to produce the paddock boundaries where grazing can occur. Waterpoints that crossed fence lines were duplicated. The distance from water was calculated and mapped (see Fig. 4).

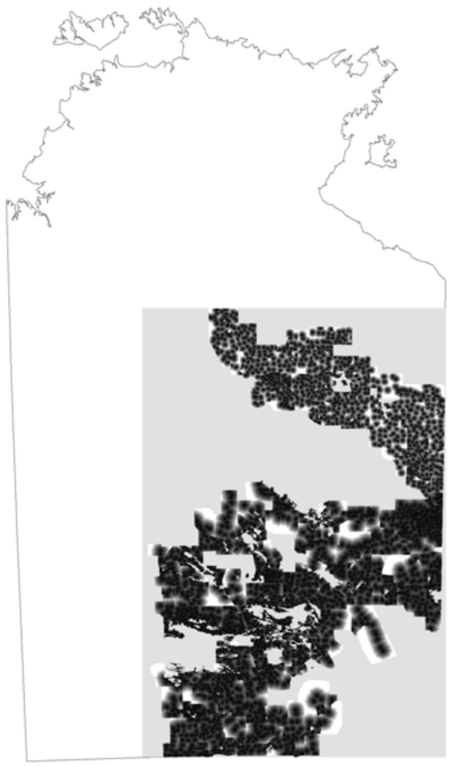

Figure 4. Geographical extent of the distance from water layer available for the NT.

Data Analysis

The distance from water data were broken into four classes (following table): The first three classes are arbitrary but, in the main, represent zones of more intensive, light to moderate and much less intensive grazing by cattle. Class 4 (>8 km) has been set by 'conventional wisdom' to be sufficiently far from water that these areas are only grazed occasionally (i.e. water remote).

Class	Distance from water
1	0-3 km
2	3-6 km
3	6-8 km
4	>8 km

These classes were created using spatial analyst in ArcInfo.

The distance from water classes were spatially intersected with the v6.1 sub-IBRAs to get the area of each distance from water class in each sub-IBRA.

Results

Proportion of sub-IBRA analysed

The study area crossed through several sub-IBRAs to varying degrees. The proportion of each sub-IBRA that was analysed was calculated so that over extrapolation for a poorly sampled sub-IBRA could be avoided. It should be noted that there is a higher percentage of 'Mountain' sub-IBRA's covered by the dataset than is shown in this table, but the distance from water layer is confined to valleys, footslopes etc that cattle (and water dependent herbivores) can access. The results are shown in Table 3.

Proportion of land in each distance from water class

The proportion of pastoral land that each distance from water class occupies was calculated as a percentage of the area of land per sub-IBRA analysed. The results are shown in Table 4.

Comments:

From these results it is possible to infer the level of development of each sub-IBRA from the percentage of land in each distance from water class. Land in Class 1 (0-3 km from permanent and semi-permanent sources of stock waterpoints) will be the most intensively developed land and therefore likely to indicate the greatest impact on grazing-sensitive species. Class 4 (>8 km from waterpoint) is used as the cut-off point to indicate the outer limit of grazing. Outside this zone, grazing is minimal and intermittent and therefore land in this class is considered less developed. Sub-IBRAs with greater than 50% of their area analysed are considered to be sufficiently covered by the analysis to be commented on.

Most developed sub-IBRAs:

- The most intensively watered sub-IBRA is Burt Plain P3 (Burt Plain bioregion) with 90.7% of its area within 3 km of a water point.

- Other sub-IBRAs that have a high density of permanent and semi-permanent sources of water for stock are Breakaways (Stony Plains), Burt Plain P2 (Burt Plain), Finke P2 (Finke) and Macumba (Stony Plains). This is indicated by >50% of their land area being within 3 km of a waterpoint and <10% which is remote from a water point.

Table 3. Percentage area of each sub-IBRA covered by the distance-from-water layer.

Percentages are based on the area of the NT portion of each sub-IBRA intersected by the distance-from-water layer. Bolded figures show those sub IBRAs with >50% of their area covered by the distance-from-water layer.

Sub-IBRA No	Sub-IBRA name	IBRA name	Sub IBRA area in NT (sq km)	% analysed
58	Burt Plain P1	Burt Plain	29310.61	49.9
59	Burt Plain P2	Burt Plain	35311.11	**81.4**
60	Burt Plain P3	Burt Plain	3909.81	**73.8**
61	Burt Plain P4	Burt Plain	5265.67	**70.4**
66	Toko Plains	Channel Country	23277.34	**92.7**
93	Mann-Musgrave Block	Central Ranges	25806.55	0.5
112	Davenport Murchison Range P1	Davenport Murchison Ranges	12186.21	26.8
113	Davenport Murchison Range P2	Davenport Murchison Ranges	15895.90	24.9
114	Davenport Murchison Range P3	Davenport Murchison Ranges	29968.97	14.4
138	Finke P1	Finke	22570.63	**81.8**
139	Finke P2	Finke	15202.83	**87.7**
140	Tieyon, Finke P3	Finke	16484.18	**81.7**
159	McArthur - South Nicholson Basins	Gulf Fall and Uplands	87417.35	3.9
160	Gulf Fall and Uplands P2	Gulf Fall and Uplands	25169.71	17.5
165	Mackay	Great Sandy Desert	85145.04	6.8
168	Great Sandy Desert P5	Great Sandy Desert	2895.41	22.8
169	Great Sandy Desert P6	Great Sandy Desert	829.32	**99.2**
196	MacDonnell Ranges P1	MacDonnell Ranges	14839.59	17.2
197	MacDonnell Ranges P2	MacDonnell Ranges	10927.82	26.7
198	MacDonnell Ranges P3	MacDonnell Ranges	13527.02	46.5
207	Mitchell Grass Downs P1	Mitchell Grass Downs	11532.83	**94.2**
208	Barkly Tableland	Mitchell Grass Downs	72450.74	**87.1**
209	Georgina Limestone	Mitchell Grass Downs	9089.97	**97.2**
270	Thorntonia	Mount Isa Inlier	225.82	**98.0**
307	Simpson-Strzelecki Dunefields P1	Simpson Strzelecki Dunefields	13551.95	**57.3**
308	Simpson Desert	Simpson Strzelecki Dunefields	91329.82	29.2
314	Breakaways, Stony Plains	Stony Plains	1310.93	**100.0**
318	Macumba	Stony Plains	385.97	**70.8**
319	Sturt Plateau P1	Sturt Plateau	19389.59	2.7
320	Sturt Plateau P2	Sturt Plateau	43338.36	5.6
324	Tanami P1	Tanami	177530.11	2.5
325	Tanami P2	Tanami	16008.93	25.7
326	Tanami P3	Tanami	36272.34	**58.1**

Least developed sub-IBRAs include:

- Thorntonia sub-IBRA of the Mount Isa Inlier is the least intensively watered sub-IBRA with 96% of its area being >8 km from a water point. However, it is also one of the smallest sub-IBRAs analysed, with only 3% of its area being in the NT (the rest is in Queensland).

- There are no other sub-IBRA's that were sufficiently analysed that had more than 50% of their land >8 km from a water point.
- Other less developed sub-IBRA's are Tanami P3 (Tanami bioregion), Great Sandy Desert P6 (Great Sandy Desert Bioregion), Simpson-Strzelecki Dunefields P1 (Simpson-Strzelecki Bioregion) and Mitchell Grass Downs P1 (Mitchell Grass Downs Bioregion). These sub-IBRAs have between 20-30% of their land >8 km from water, and less than 50% of their land within 0-3 km of water.

Water remoteness index:

The ACRIS Management Unit has defined water-remote areas as land that is >8 km from permanent and semi-permanent sources of stock water. This area is mapped using Class 4 from the distance to water analysis. It is based on the water remoteness index calculated by Amanda Brook of DLWBC in South Australia who conducted a similar distance-from-water analysis in the SA Stony Plains bioregion. The percentage of land >8 km from water was categorised and mapped per sub-IBRA (see Fig. 5). The categories are <5%, 5-10%, 10-20% and >20% of area that is >8 km from permanent and semi-permanent sources of stock water.

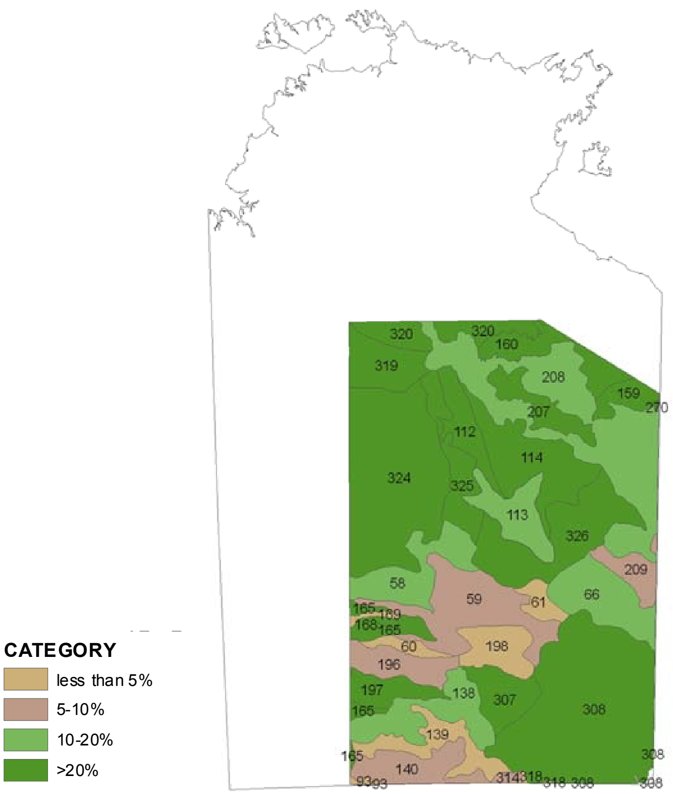

Figure 5. Mapped remoteness-index values based on the percentage of sub-IBRA area that is >8 km from permanent and semi-permanent sources of stock water.

The map is labelled according to the sub-IBRA number. The percentages are based on the proportion of area analysed in the NT.

Comments

The area covered in the map (Fig. 5) includes the whole study area, not just those areas that were given a distance from water value. The proportion of land area that has greater than 20% as water-remote (i.e. >8 km from water) may be misrepresented by this map. However, it is clear that of the area that was given distance from water values, the majority is in the three lower water remoteness categories. This suggests that the overall level of development in the study area is high, with most of the area being within 8 km of a water point. This is certainly the case for the pastorally more productive sub IBRAs.

Table 4. The percentage of land per sub-IBRA in each distance from water class. The percentages are based on the proportion of area that was analysed in the NT.

Sub-IBRA No	Sub-IBRA name	IBRA name	0-3 km	3-6 km	6-8 km	>8 km
58	Burt Plain P1	Burt Plain	45.7	31.0	9.4	13.9
59	Burt Plain P2	Burt Plain	55.4	31.1	6.9	6.7
60	Burt Plain P3	Burt Plain	90.7	8.6	0.4	0.2
61	Burt Plain P4	Burt Plain	48.0	40.3	6.9	4.7
66	Toko Plains	Channel Country	52.0	32.6	5.2	10.1
93	Mann-Musgrave Block	Central Ranges	99.5	0.5	0.0	0.0
112	Davenport Murchison Range P1	Davenport Murchison Ranges	17.3	29.6	19.4	33.7
113	Davenport Murchison Range P2	Davenport Murchison Ranges	37.3	38.6	9.2	14.8
114	Davenport Murchison Range P3	Davenport Murchison Ranges	18.8	32.6	16.4	32.2
138	Finke P1	Finke	49.2	28.9	8.5	13.3
139	Finke P2	Finke	58.3	32.8	5.0	3.9
140	Tieyon, Finke P3	Finke	49.0	36.3	7.7	6.9
159	McArthur - South Nicholson Basins	Gulf Fall and Uplands	7.8	19.0	14.6	58.6
160	Gulf Fall and Uplands P2	Gulf Fall and Uplands	12.8	26.3	19.2	41.6
165	Mackay	Great Sandy Desert	39.4	30.0	9.5	21.1
168	Great Sandy Desert P5	Great Sandy Desert	73.1	24.7	2.0	0.2
169	Great Sandy Desert P6	Great Sandy Desert	13.9	39.8	21.0	25.3
196	MacDonnell Ranges P1	MacDonnell Ranges	63.0	26.0	3.5	7.5
197	MacDonnell Ranges P2	MacDonnell Ranges	33.5	19.8	7.2	39.5
198	MacDonnell Ranges P3	MacDonnell Ranges	69.4	26.1	3.6	0.9
207	Mitchell Grass Downs P1	Mitchell Grass Downs	22.0	38.7	18.7	20.6
208	Barkly Tableland	Mitchell Grass Downs	32.3	38.0	17.0	12.7
209	Georgina Limestone	Mitchell Grass Downs	46.7	36.5	8.5	8.3
270	Thorntonia	Mount Isa Inlier	0.0	0.5	3.6	96.0
307	Simpson-Strzelecki Dunefields P1	Simpson Strzelecki Dunefields	40.0	27.4	9.3	23.3
308	Simpson Desert	Simpson Strzelecki Dunefields	20.4	28.2	11.8	39.6
314	Breakaways, Stony Plains	Stony Plains	52.3	31.6	8.7	7.3
318	Macumba	Stony Plains	63.7	34.0	2.3	0.0
319	Sturt Plateau P1	Sturt Plateau	22.7	39.1	17.9	20.3
320	Sturt Plateau P2	Sturt Plateau	19.3	33.2	17.2	30.3
324	Tanami P1	Tanami	27.9	28.7	10.9	32.5
325	Tanami P2	Tanami	21.8	27.0	15.8	35.4
326	Tanami P3	Tanami	27.7	28.6	13.4	30.2

ACRIS Reporting – Northern Territory

Theme 1 – Change in Landscape Function

Reporting of change in Landscape Function from Tier 1 monitoring sites follows as Attachment 1. Attachment 2 starts at page 143 and reports change in Sustainable Grazing Management.

Results were compiled by Debbie Mullin and Kate Richardson, NT Department of Natural Resources, Environment and the Arts (NRETA).

Attachment One

ACRIS Reporting – Northern Territory

Theme 1 – Change in Landscape Function

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Landscape Function

Landscape function describes the capacity of landscapes to regulate (i.e. capture and retain, not leak) rainwater and nutrients, the vital resources for plant growth (Ludwig et al. 1997). Functional landscapes have a good cover and arrangement of persistent vegetation patches (typically perennial vegetation) such that much of the rainfall is retained and is able to infiltrate the soil. Because there is little runoff, there is limited movement of sediment and loss of entrained nutrients, organic matter (litter) and seeds. Similarly, the good cover and arrangement of vegetation patches minimises wind erosion and loss of nutrients in dust. As patch cover decreases and patches become more distant, runoff increases resulting in lower infiltration and increased nutrient loss in transported sediments (i.e. erosion). Landscapes with lower cover are also exposed to a greater risk of wind erosion and nutrient loss in dust. These eroding landscapes become progressively more dysfunctional, i.e. have reduced landscape function.

Landscape function encapsulates fine-scale processes of resource (water and nutrient) redistribution but the concept also applies at broader scales of rangeland management and monitoring. At water point and paddock scale, landscapes with a low cover of perennial vegetation and widely spaced vegetation patches will be more leaky than the same land type with a higher and more even cover of perennial vegetation patches. Similarly, landscapes with perennial-dominant vegetation typically have more stable cover and are more resource conserving than equivalent landscapes with predominantly annual or ephemeral vegetation. This means that landscape function can be monitored and reported at a range of scales using either ground-based or remote sensing methods. While the results from various monitoring methods provide different levels of information about actual landscape and vegetation processes, each indicates (at varying scale) the degree to which landscapes are resource conserving or leaky, albeit with varying precision.

NT Reporting: Data Sources Available

Tier 1 monitoring

The composition of species contributing to pasture biomass (dry weight basis) is estimated at Tier 1 sites. Estimates are adjusted for any grazing that has occurred. The percentage area of bare ground is also estimated meaning that % ground cover can be calculated as 100 - % bare ground. These two data types have been combined to produce an index of landscape function, as a modified form of the Richards-Green Functionality Index (Appendix 2). This allows the NT to report change in landscape function for most of the bioregions under pastoral land tenure.

Tier 2 monitoring

Tier 2 monitoring is essentially based on analysis of remotely sensed data and is supplement by some ground-based monitoring (as ground truth) in the Ord Victoria Plains and Sturt Plateau bioregions.

Landscape function analysis at ground sites

Data collected through formal landscape function analysis (LFA) at 33 sites in the Ord Victoria Plains bioregion were processed to calculate a resource capture index and soil stability index. These two indices allow the most rigorous reporting of change in landscape function over time at site level. (The Sturt Plateau data have not been included because they were collected over two consecutive years in the late 1990s and do not provide an adequate representation of change over the ACRIS reporting period, 1992 to 2005.)

The *Resource Capture Index* (RCI) indicates the proportion of the measured transect that is able to capture and regulate nutrient and water flow. It is the proportion of the transect length that is occupied by resource capturing patches (i.e. sum of patch lengths down the transect).

The *Stability Index* is derived from a subset of soil surface condition indicators (Tongway and Hindley 2004) assessed as part of formal LFA. It represents the ability of the soil to withstand erosive forces and to reform after disturbance. Analysis of LFA data collected as part of the WA Rangeland Monitoring System (WARMS) has shown that the Stability Index is relatively independent of shorter-term seasonal variability (Holm 2001).

Remote sensing

Land Cover Change Analysis

Land Cover Change Analysis (LCCA) combines ecological understanding gained through ground-based monitoring with the capacity of remote sensing to provide regional-scale assessment of land condition at required time intervals. The LCCA method uses the statistical brightness and trend of a cover index through time, derived from multi-temporal Landsat data, to indicate the dominance of annual or perennial vegetation. Generally, ground cover comprised of predominantly annual species equates with poor land condition in the grazed savannas of northern Australia. These landscapes have a signature of generally low, but seasonally variable, cover values through time (i.e. low stability of the cover index). Areas with good perennial cover (i.e. good condition) have higher and more stable cover index values through time. From ground-based data, we know that perennial-dominant sites are less leaky (i.e. have better landscape function) than similar areas in the landscape that are dominated by ephemeral species. Ground data and expanding ecological knowledge are thus used to infer relative landscape function over larger areas using time traces derived from satellite data.

In practice, a region is first stratified into broadly similar land types (e.g. land systems) that have characteristic vegetation responses to grazing. Fire effects on cover dynamics must also be accounted for, e.g. by excluding recently burnt areas from the analysis of cover trends. Grazing effects on the vegetation (and for reporting purposes here, inferred landscape function) are then identified by comparing the average cover trend of a target area (e.g. the area surrounding a water point or the larger paddock) with that of the larger regional area that the target area is part of. This benchmarking procedure ranks the target area as having similar, above, or below average cover with regard to the regional average and also identifies if its trajectory of cover (i.e. trend) is different to that of the larger region over a specified time period. The cover response is also assessed in relation to infrastructure to see if results 'make sense' against mapped fences, roads and distances from water.

At LCCA ground monitoring sites (such as the Tier 2 sites above where formal LFA data are available), detailed measurements are needed to define condition based on ecological principles at discrete places in the landscape and understand change in ground cover as it relates to condition (for reporting purposes here, landscape function). Sites were selected to represent the range of conditions (landscape leakiness) expected for the land types involved so as to fully describe relationships between temporal remotely sensed cover response and that of condition. When sufficient confidence has been gained in using remote sensing to discriminate known differences in ground condition (equal inferred landscape function), it is then possible to predict the condition of other areas within the same land type based on their pattern of cover change through time. Ground truthing is then required to verify or explain results. This new information further enhances understanding of ground cover change as it relates to condition over wide areas. Causes of current vegetation conditions can often be determined with some knowledge of past (and present) grazing management practices.

In summary, LCCA allows relative change in landscape function to be inferred from the pattern of cover change over time. For the same land type, more leaky areas (i.e. poorer condition and reduced landscape function) have lower and more dynamic levels of average cover through time. More conserving (better functioning) landscapes are in better condition with a higher cover of perennial grasses. These areas are characterised by higher and more stable cover over time.

Remote Sensing: Grazing Gradient Analysis

Grazing gradients, from a remote sensing perspective, describe the pattern of average cover levels with increasing distance from water. Average cover, for various land types, typically increases with increasing distance from water due to a combination of both decreasing utilisation and cumulative long term grazing effects (i.e. degradation). The extent to which vegetation cover increases after good wet periods when the vegetation has an ideal opportunity to recover is used to filter the effects of short term utilisation from long term grazing impact .

Lack of complete vegetation recovery in the vicinity of watering points under conditions of good wet season rainfall indicates reduced rainfall use efficiency. That is, the landscape, at hectare scale and larger, is not able to capture available rainfall and utilise it for pasture growth to the same extent that similar areas more distant from water are able too. On some landscapes and soil types, this is probably directly associated with leakage of water (increased runoff) and loss of plant nutrients in sediments transported by flowing water. That is, there is a direct (although inferred) relationship between persistence of a wet-period grazing gradient and decline in landscape function. In other land types (e.g. grey cracking clays of the Mitchell Grass Downs bioregion), the interactions between soil, vegetation and geomorphology may be more subtle and perhaps related to a decline in site quality through loss of organic matter and seeds transported by water (i.e. a decline in ecosystem function) rather than a direct loss of landscape function.

The % Cover Production Loss (%CPL; Fig. 1, Appendix 4) can be used to quantify the extent to which a grazing gradient persists after good rainfall, and thereby provide an inferred value of loss of landscape function. The index is explained in Bastin *et al*. (1993).

Note that the response of vegetation cover to rainfall in arid (central Australia) and semi-arid (Barkly Tableland) regions is critically dependent on the amount of wet-period rainfall. (It is also dependent on the timing and duration of rainfall.) Rainfall that is less than ideal for maximum vegetation growth will result in incomplete recovery (for fully functioning landscapes that are in good condition) and result in inflated (and misleading) %CPL values. Thus %CPL values should be interpreted carefully when inferring loss or change in landscape function.

Data Analysis and Results

Tier 1 Data

To calculate the Landscape Function Index (modified Richards-Green Functionality Index, Appendix 2) all Tier 1 data that had recorded both % bare ground and % pasture biomass were used. Grass species were defined as either annuals (includes short lived perennials) and perennial.

The Index requires both % perennial grass biomass and % perennial grass cover. The cover was calculated as an inverse of % bare ground and then used to calculate the % perennial grass cover with the assumption that all cover were plants as other forms of cover are not recorded as part of the Tier 1 data.

The Landscape Function Index for each site assessment was calculated by summing the Perenniality Index and Cover Index (Appendix 2). Using only the first and most recent (last) assessment for each site, the change in the Landscape Function Index was calculated. Using all change in Landscape Function Index values (not just first and last comparison), the mean and standard variation were used to select the + or – 3 tolerance for 'no change'. To separate seasonal conditions from grazing and management effects, each Tier 1 site had the preceding seasonal conditions calculated using wet season terciles; 'Above Average', 'Average' and 'Below Average'.

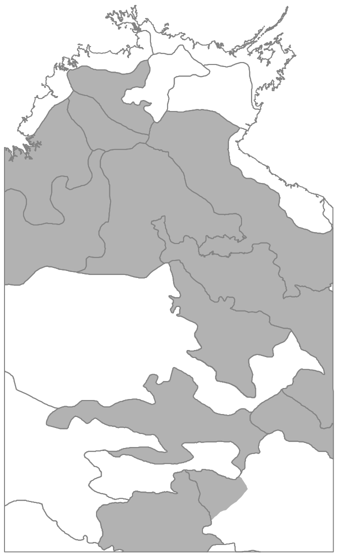
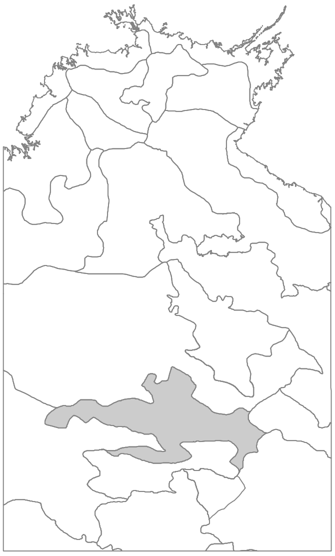


Figure 1: Northern Territory bioregions analysed with Landscape Function Index.

Burt Plain



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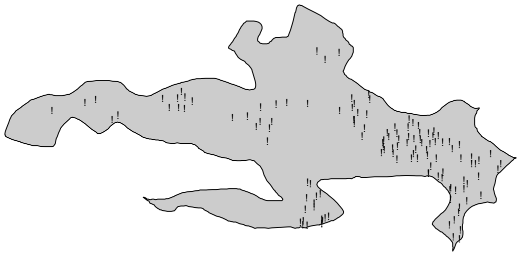


(b)

Figure 2: (a) Location of Burt Plain bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed by landscape function index within Burt Plain bioregion.

Table 1: Areas, number of Tier 1 sites and density of sites per 1000 km2 within Burt Plain bioregion.

Bioregion		Pastoral Estate within bioregion	Analysed with Landscape Function Index
Area (km^2)	73797	60280	60280
Tier 1 sites	305	282	130
Site density per 1000 km^2	4.13	4.68	2.16

Environment Australia (2000) description of Burt Plain bioregion:

Plains and low rocky ranges of Pre-Cambrian granites with mulga and other acacia woodlands on red earths. (Environment Australia, 2000)

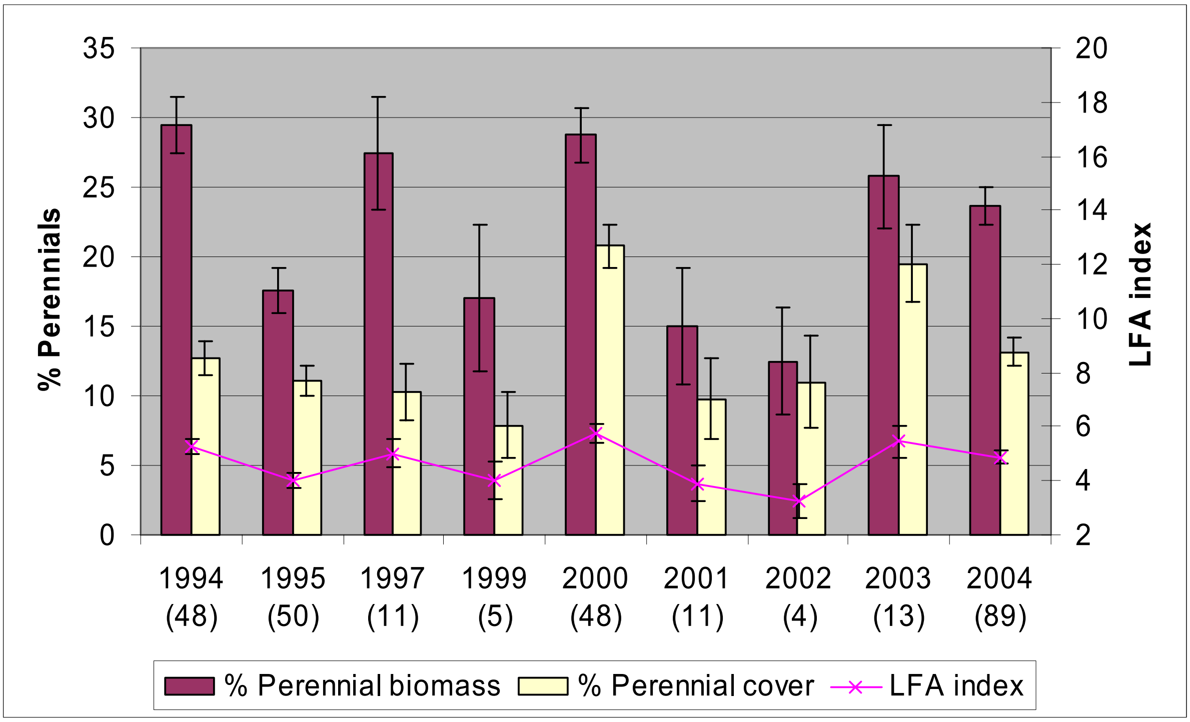


Figure 3: Burt Plain - Mean % perennial grass biomass, mean % perennial grass cover and mean LF index between 1994 and 2004.

Perennial grasses have a low mean percentage contribution within this bioregion.

Perennial grasses appear to fluctuate within 15%, up to half of their % biomass, with rainfall most likely the major influence.

The lower % biomass and cover of perennial grasses in 2001 and 2002 was influenced by the sites reassessed as all except one from each year did not change from previous assessment, i.e. they already had low perennial grass biomass and cover.

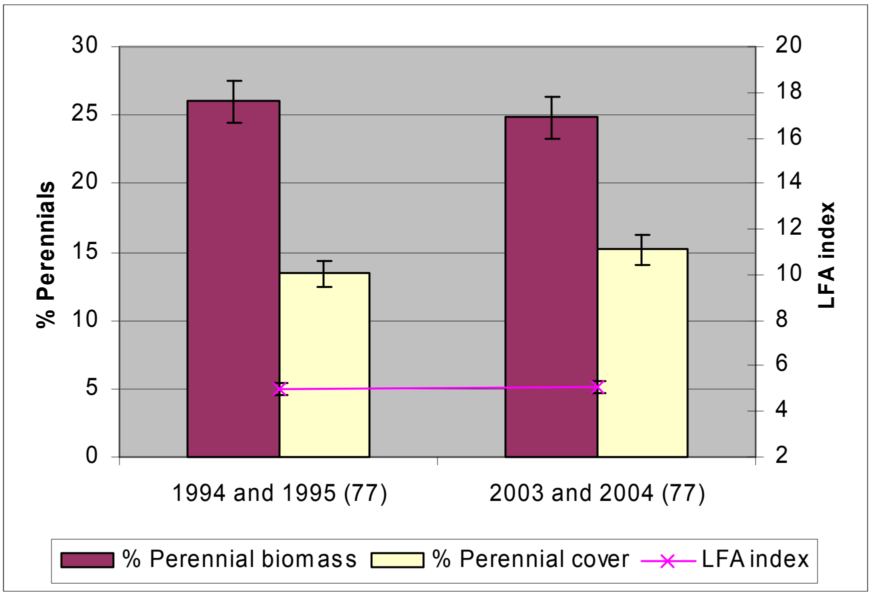


Figure 4: Burt Plain - Mean % perennial grass biomass, mean % perennial grass cover and mean LF index between 1994-1995 and 2003-2004.

Majority of sites initially assessed in 1994 and 1995 were reassessed in 2003 and 2004, showing that over this 9 or 10 year period there was an insignificant change in perennial grasses.

Majority of Figure 3 sites experienced Average seasonal effects at both assessment dates.

In summary, Burt Plain has fluctuated through out the reporting period between 1994 and 2004, however these fluctuations are most likely the result of both rainfall and site choice with the majority of the bioregion having low perennial grasses that has generally remained unchanged.

Table 2: Burt Plain - Change in Landscape Function Index from initial to most recent Tier 1 site assessment.

Seasonal Condition	Number of Assessments	Percentage of reassessments		
		Decline	No Change	Improvement
Above Average	31	6	74	19
Average	67	10	73	16
Below Average	32	31	63	6

A Tolerance of + or - 3 'no change'

Initial assessments for the 130 sites suitable for LF Index analysis where from 1994 to 2000, with the most recent assessments ranging from 2000 to 2004, giving a reporting period of 10 years from 1994 to 2004 (Appendix 1).

Two sites declined after experiencing Above Average seasonal conditions, both initially had low cover which increased, however the majority of this new cover was annual grasses while perennial grasses declined.

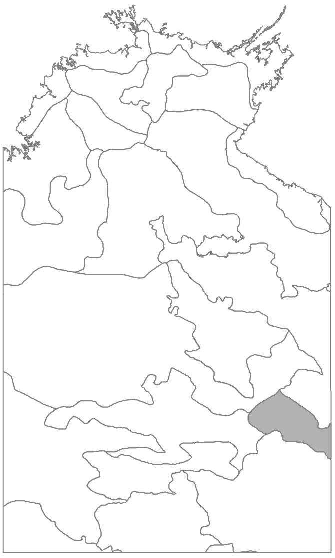
Two sites improved after experiencing Below Average seasonal conditions, one with very low cover and the other with very high cover, both still had an increase in perennials, therefore experienced improvement in Landscape Function.

74% of sites experienced no change in landscape function after Above Average seasonal conditions, this is of some concern as Burt Plain experienced two consecutive good years in 2000 and 2001, therefore allowing a good improvement in landscape function, however the majority of sites remained unchanged.

Highest improvement (19%) experienced after Above Average seasonal conditions and majority of declines (31%) experience after Below Average seasonal conditions, indicating that some of the bioregion is influenced by seasonal conditions.

In summary, two thirds of Burt Plain bioregion appears to have stable landscape function over the reporting period as a majority of sites were considered unchanged, with less than a third of sites appeared to have responded to seasonal conditions.

Channel Country



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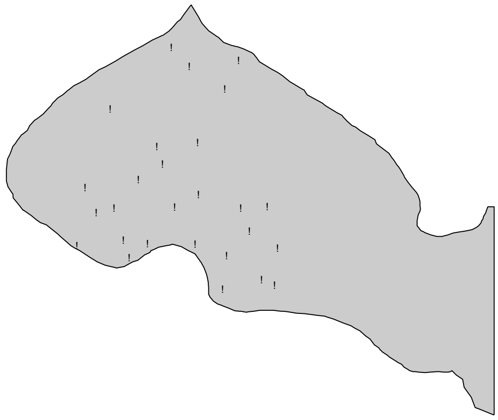


(b)

Figure 5: (a) Location of Channel Country bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed by landscape function index within Channel Country bioregion.

Table 3: Areas, number of Tier 1 sites and density of sites per 1000 km2 within Channel Country bioregion.

Bioregion		Pastoral Estate within bioregion	Analysed with Landscape Function Index
Area (km^2)	23277	22893	22893
Tier 1 sites	77	77	27
Site density per 1000 km^2	3.31	3.36	1.18

Environment Australia (2000) description of Channel Country bioregion:

Low hills on Cretaceous sediments; forbfields and Mitchell grass downs, and intervening braided river systems of coolibah *E.coolibah* woodlands and lignum/saltbush *Muehlenbeckia sp./Chenopodium sp*. shrublands. (Includes small areas of sand plains.)

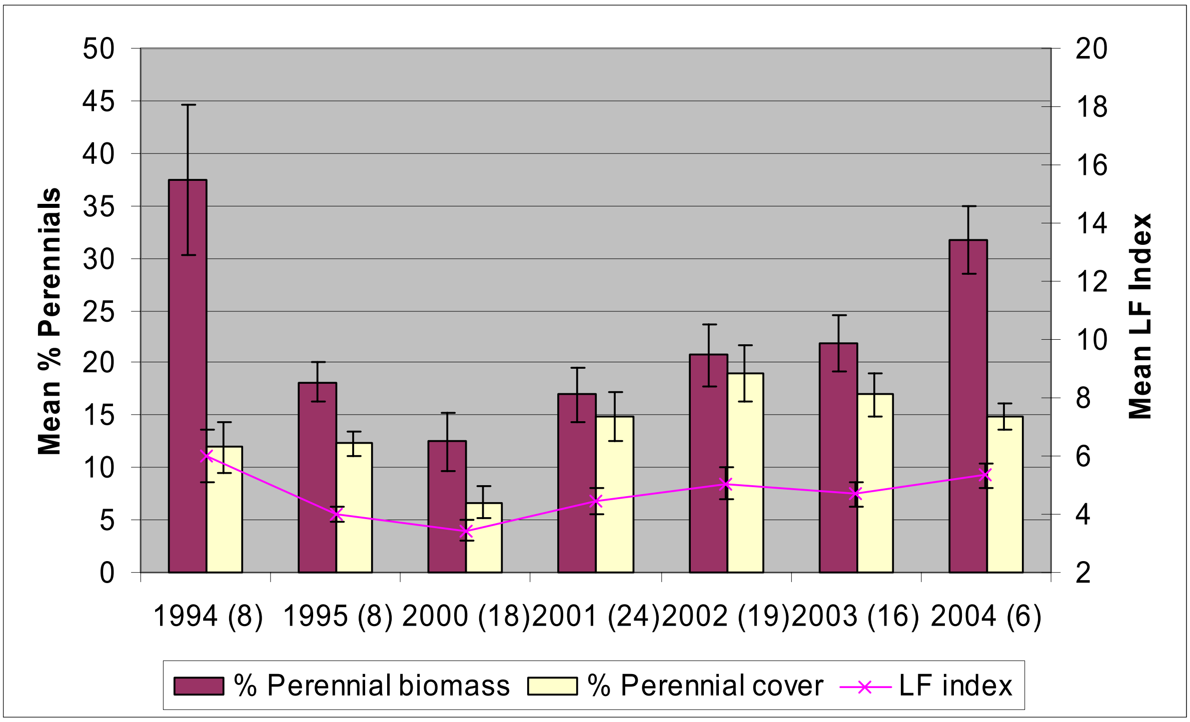


Figure 6: Channel Country - Mean % perennial grass biomass, mean % perennial grass cover and mean LF index between 1994 and 2004.

Channel Country has low to very low perennial grass cover, with majority less than 25% perennial grass biomass and approximately 15% perennial grass cover.

Between 1994 and 2004 there was only 4 rainfall event that were over 100 mm, these were January 2006, February and December 2001, and February 2003, with the December 2001 rainfall over 250 mm.

All sites in 2000 were reassessed in 2001 (includes 6 new sites), the LF Index shows a slight response to the rainfall with an increase of 1 point. Only 8 of the 19 sites in 2002 had been previously assessed in 2001, however there was small increase in the LF Index (0.5 points), which is a very poor response to the significant rainfall event the area experienced in December 2001.

Three consistent site trends are displayed in Figure 7 It shows sites that were assessed twice between 1994 and 2004 have no change in their mean landscape function.

Eight sites were assessed in three consecutive years between 2000 and 2002, their landscape function appears to be unchanged, however there was a very small increase of their LF Index of 0.4 points between 2000 and 2001 after experiencing Above Average seasonal conditions, indicating a very small response to the 100 mm rainfall, with no change between 2001 and 2002 after experiencing 250 mm of rain.

Ten sites were assessed in two consecutive years between 2000 and 2001, their landscape function also appears not to have changed, however there was a extremely small response to the Above Average rainfall in 2001 with the LF Index increasing by 0.2 points, indicating a very poor response to improved seasonal conditions.

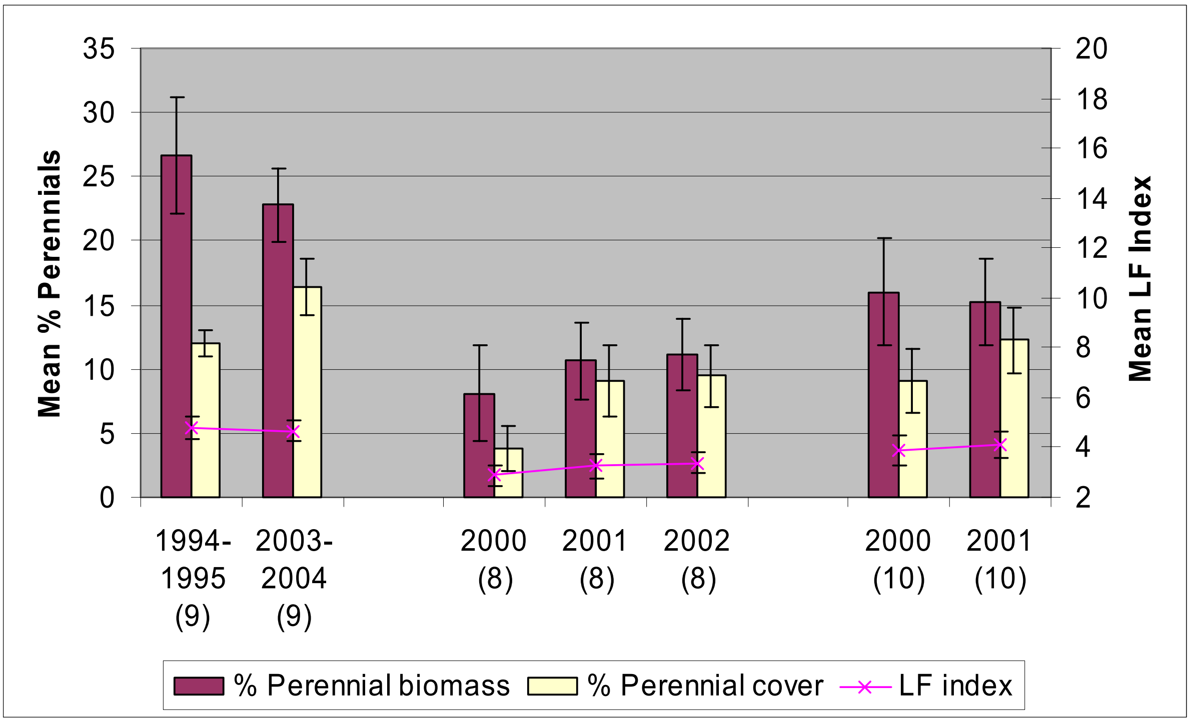


Figure 7: Channel Country - Mean % perennial grass biomass, mean % perennial grass cover and mean LF Index of consistent site trends between 1994 and 2004.

In summary, majority of Channel Country bioregion has low to very low perennial grasses which is generally unchanged between 1994 and 2004, and there appeared to be a very poor response to two high rainfall events in 2001 and 2002, indicating landscape function has been degraded prior to the reporting period and is unable to recover despite high rainfall.

Table 4: Channel Country - Change in Landscape Function Index from initial to most recent Tier 1 site assessment.

Seasonal Condition	Number of Assessments	Percentage of reassessments		
		Decline	No Change	Improvement
Above Average	10	0	90	10
Average	13	15	77	8
Below Average	4	0	75	25

A Tolerance of + or - 3 'no change'

First assessments of the 27 sites suitable for LF Index analysis where from 1994 to 2001, with the most recent assessments ranging from 2001 to 2004, giving a reporting period of 10 years from 1994 to 2004 (Appendix 1).

A large proportion (77%) of the Average seasonal condition assessed sites experienced ‘no change’, with 69% of these having no perennials in either of their assessments, 30% of Above Average sites also had no perennials present during assessments, with all below average sites having perennials.

All sites that experience Below Average in their last assessment (2004) also experience the same seasonal condition in their first assessment (1995), with the site that improved only just categorised into ‘improvement’. This indicates that these sites have been stable through out the reporting period.

The 2 sites that declined in Average seasonal conditions both had low perennial biomass and cover in their initial assessments (1994 and 1995), by their last assessment (2003) they had disappeared.

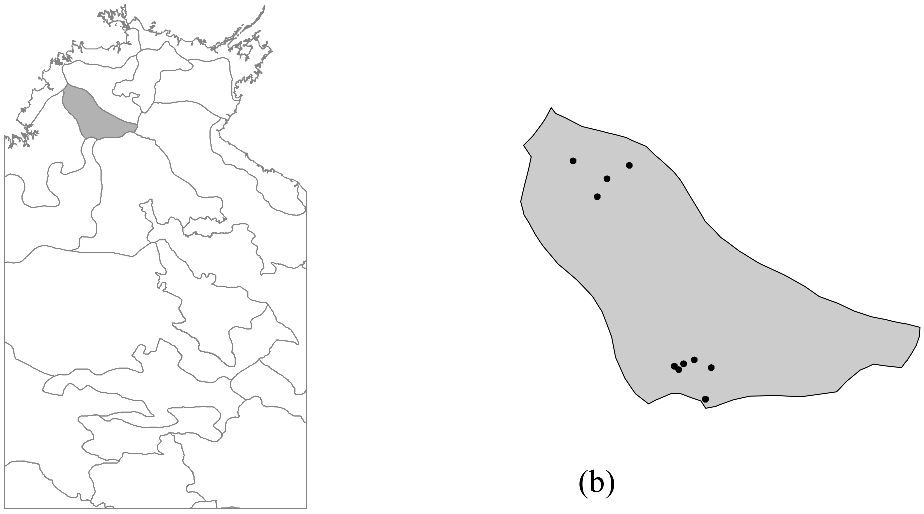
The modified RGFI values range from 2 (lowest) to 20 (highest), Channel Country has 52% in both first and last assessments with RGFI value of 2, with 19% value of 4, 7.4% for values of 3 and 7.4% of value 6. This indicates that the majority of this bioregion has low to very low perennial grasses (30% no perennials at either assessment), with majority unchanged through the reporting period with a slight improvement in a few sites.

This bioregion experiences long periods with no to low rainfall, with seed banks being vital for majority of species survival.

Short lived perennial grasses maybe as important for landscape function health in this bioregion as perennial grasses, the exclusion of short lived perennial grasses from LF Index analysis and the timing of assessments in relation to rainfall events may have given a harsher assessment of this bioregion.

In Summary, Channel Country has areas of low to no perennial grasses, therefore poor landscape function, with majority unchanged between 1994 and 2004. However with the exclusion of short lived perennial grasses the resulting assessment of landscape function within this bioregion maybe harsh.

Daly Basin



(a) (b)

Figure 8: (a) Location of Daly Basin bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed by landscape function index within Daly Basin bioregion.

Table 5: Areas, number of Tier 1 sites and density of sites per 1000 km2 within Daly Basin bioregion.

Bioregion		Pastoral Estate within bioregion	Analysed with Landscape Function Index
Area (km^2)	20922	10822	10822
Tier 1 sites	42	40	11
Site density per 1000 km^2	2.01	3.7	1.02

Environment Australia (2000) description of Daly Basin bioregion:

Gently undulating plains and scattered low plateau remnants on Palaeozoic sandstones, siltstones and limestones; neutral loamy and sandy red earths; Darwin Stringybark and Darwin Woollybutt open forest with perennial and annual grass understorey.

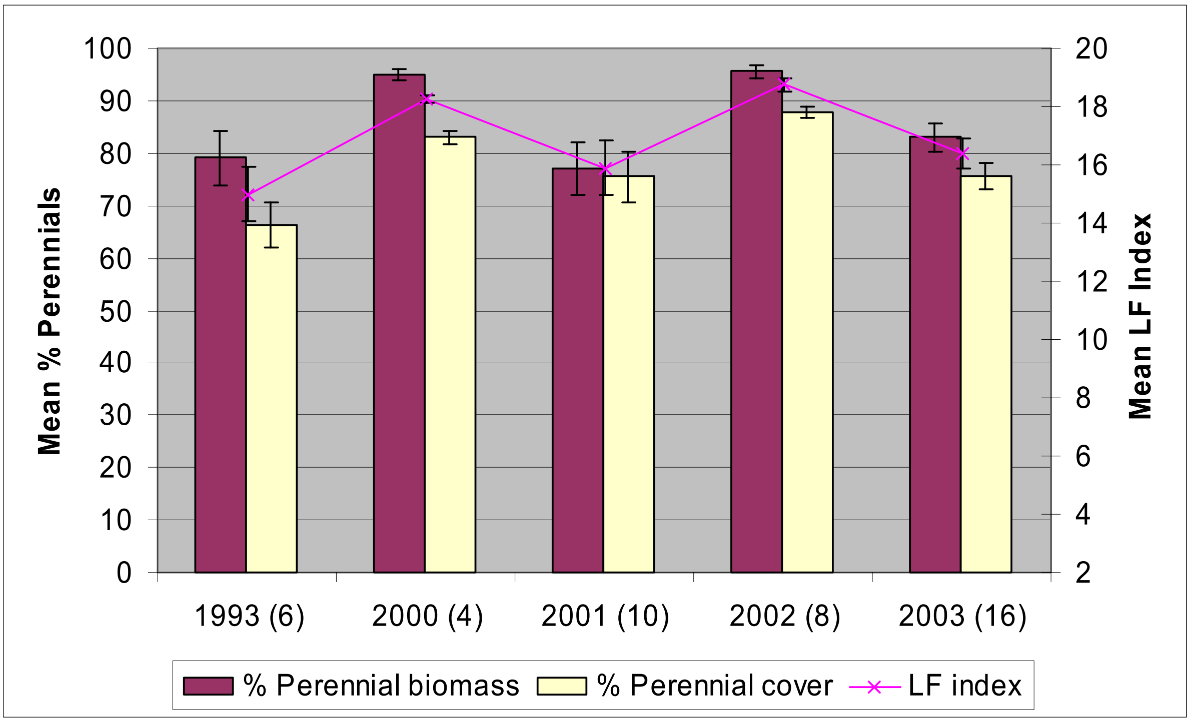


Figure 9: Daly Basin - Mean % perennial grass biomass, mean % perennial grass cover and mean LF index between 1993 and 2003.

Daly Basin appears to fluctuate through the reporting period (1993 – 2003), however this trend is not followed when comparing consistent site trends (see Figure 9).

All ten sites suitable for LF Index analysis in 2001 are new, with only 4 reassessed in 2003, and 4 sites in 1993 were reassessed in 2000 and 2003.

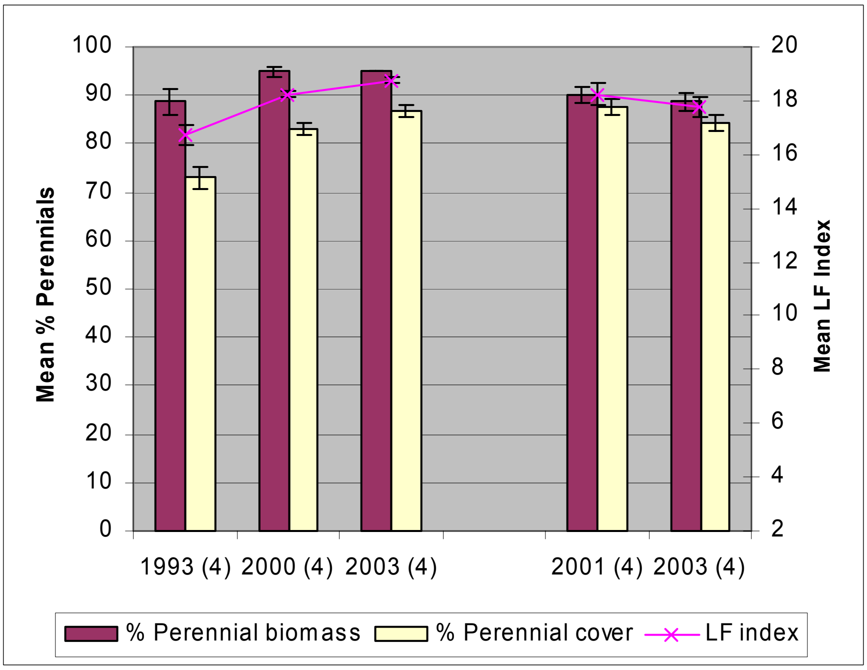


Figure 10: Daly Basin - Mean % perennial grass biomass, mean % perennial grass cover and mean LF Index of consistent site trends between 1994 and 2004.

The four sites assessed three times from 1993 to 2003 showed a slightly increasing landscape function trend, indicating some minor improvement over a ten year period.

Four sites assessed in 2001 and then reassessed in 2003 showed a slight decreasing trend in landscape function, although this decrease is so small that landscape function is considered to be stable.

In summary, the Daly Basin bioregion generally has a very high landscape function which has been mostly stable through a ten year period from 1993 and 2003.

Table 6: Daly Basin - Change in Landscape Function Index from initial to most recent Tier 1 site assessment.

Seasonal Condition	Number of Assessments	Percentage of reassessments		
		Decline	No Change	Improvement
Above Average	3	0	67	33
Average	7	0	86	14
Below Average	1	0	100	0

A Tolerance of + or - 3 'no change'

First assessments of the 11 sites suitable for LF Index analysis where from 1993 to 2002, with the most recent assessments in 2003, giving a reporting period of 10 years from 1993 to 2003 (Appendix 1).

Majority of this bioregion has high to very high perennial biomass and cover (63% of sites with 95% perennial grass biomass and 73% with > 80% perennial grass cover), with most unchanged and a few sites improving at their last reassessment in 2003.

Majority of sites (90%) have high to very high landscape function, with LF Index of 16 to 19 points.

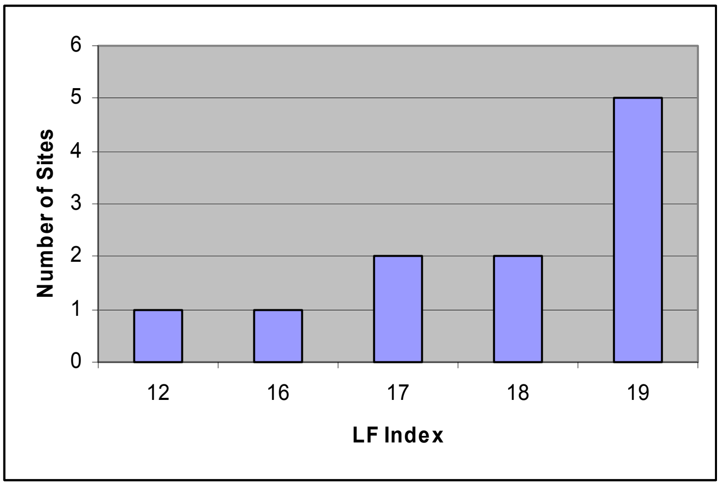
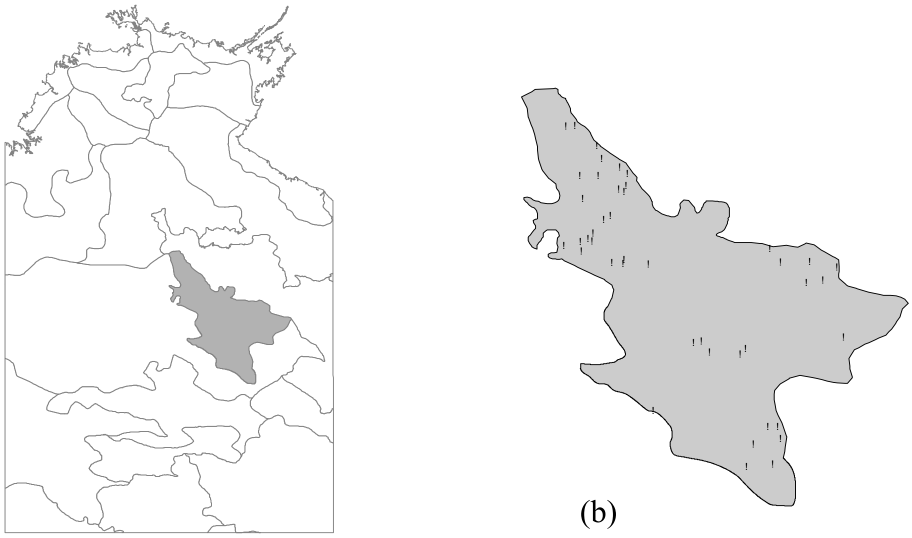


Figure 11: Number of Daly Basin sites with their respective LF Index value at reassessments.

In summary, the Daly Basin has high to very high stable landscape function over a ten year period from 1993 to 2003.

Davenport Murchison Ranges



(b)

(a)

Figure 12: (a) Location of Davenport Murchison Ranges bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed by landscape function index within Davenport Murchison Ranges bioregion.

Table 7: Areas, number of Tier 1 sites and density of sites per 1000 km2 within Davenport Murchison Ranges bioregion.

Bioregion		Pastoral Estate within bioregion	Analysed with Landscape Function Index
Area (km^2)	58051	31009	31009
Tier 1 sites	69	66	43
Site density per 1000 km^2	1.19	2.13	1.39

Environment Australia (2000) description of Davenport Murchison Ranges bioregion:

Low but rugged rocky hills, formed from folded volcanics and sandstone, siltstone and conglomerates, which contrast starkly with the generally flat sandplain surrounds of the Tanami bioregion. Vegetation includes hummock grasslands and low open woodlands dominated by eucalypt and *Acacia* species.

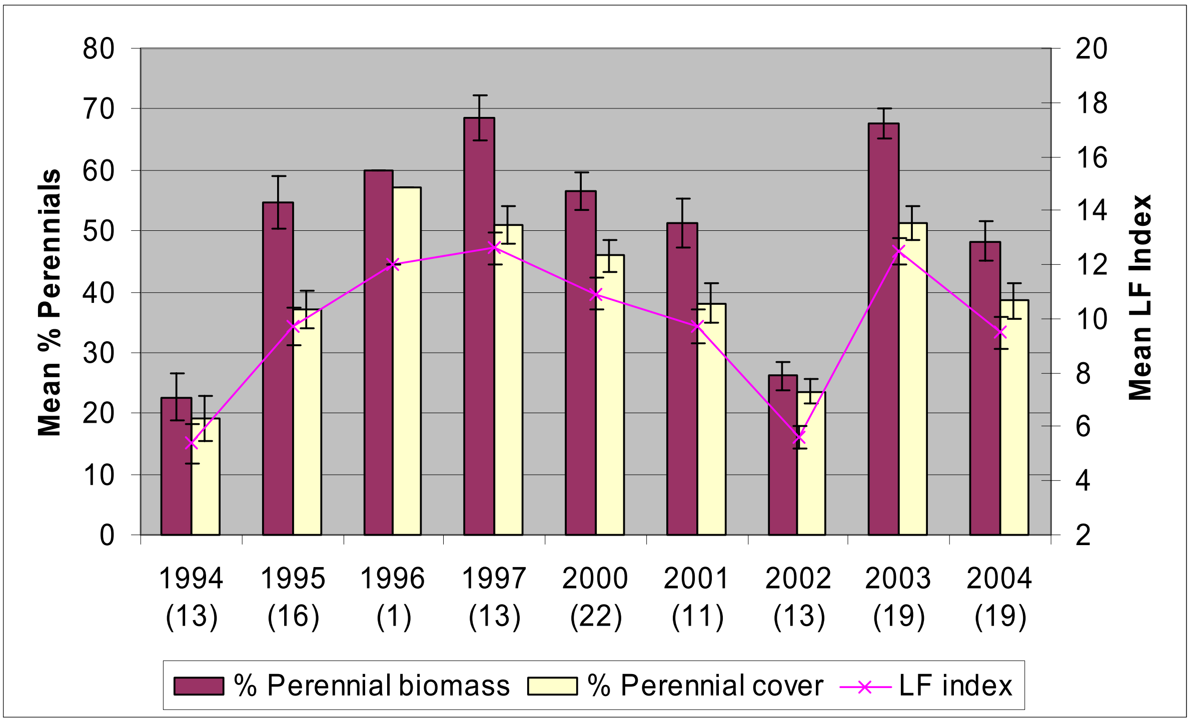


Figure 13: Davenport Murchison Ranges - Mean % perennial grass biomass, mean % perennial grass cover and mean LF index between 1994 and 2004.

Landscape function appears to fluctuate from 1994 to 2004 with 1997 and 2003 having the highest landscape function within the ten years, however the majority of the changes are due to site selection and the timing of assessment.

Of the 13 sites assessed in 2002, 12 were new and the one site that was reassessed had not changed from it's pervious very low perennial grasses levels. The two high LF Index sites had 10 and 11 points, indicating that majority of these new sites had low landscape function, therefore the drop of LF Index and perennial grasses in 2002 were most likely only due to site selection.

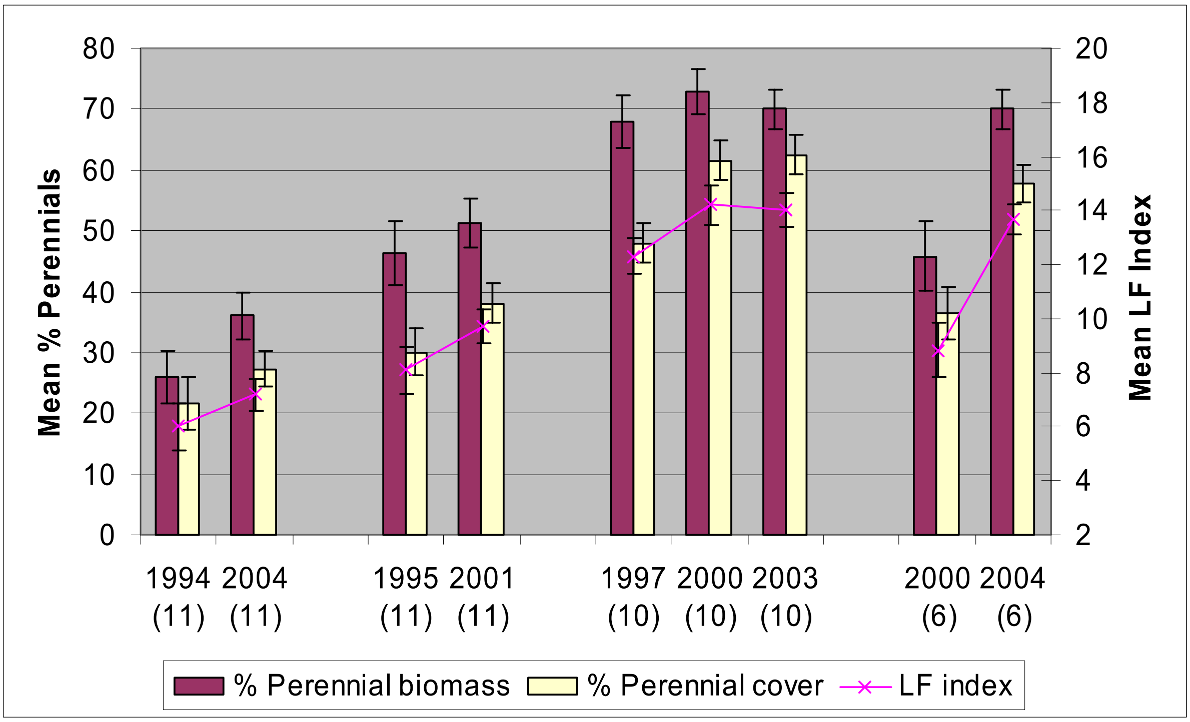


Figure 14: Davenport Murchison Ranges - Mean % perennial grass biomass, mean % perennial grass cover and mean LF Index of consistent site trends between 1994 and 2004.

Eleven sites that were established in 1994 and reassessed 10 years later had the lowest landscape function of the bioregion, however they were showing signs of some improvement.

All sites included in the consistent site trends in Figure 13 appear to be improving their landscape function with those sites initially assessed in 1997 and 2000 appear to have moderate landscape function levels.

Table 8: Davenport Murchison Ranges - Change in Landscape Function Index from initial to most recent Tier 1 site assessment.

Seasonal Condition	Number of Assessments	Percentage of reassessments		
		Decline	No Change	Improvement
Above Average	29	10	59	31
Average	8	0	75	25
Below Average	6	17	33	50

A Tolerance of + or - 3 'no change'

First assessments for the 43 sites suitable for LF Index analysis where from 1994 to 2000, with the most recent assessments ranged from 2000 to 2004, giving a reporting period of 10 years from 1994 to 2004 (Appendix 1).

3 sites declined during Above Average seasonal conditions.

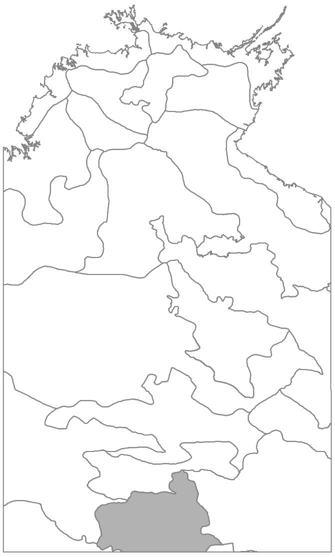
One site that declined in Above Average seasonal conditions experienced a very hot fire and the majority of shrubs were killed. The RGFI value dropped from 19 to 16, the dominate species went from unpalatable hard spinifex to the moderately palatable Eulalia aurea, landscape function may have decreased for this site but the grazing condition has gone from poor to good.

The one site that decline in Below Average seasonal conditions had at initial assessment (Above Average seasonal condition) 100% cover, 85% perennial cover with 60% comprising high to moderate palatable desirable perennial grasses. In 2004 cover slightly decreased to 90%, perennial cover dropped by half (site photo shows that majority of cover is litter, therefore perennial cover is more likely to be significantly lower), and most desirable perennial grass species has disappeared, while others had decreased. This site had been burnt in the pervious 18 months, therefore the decline in landscape function is possibly due a combination of factors, including; fire, low rainfall and grazing.

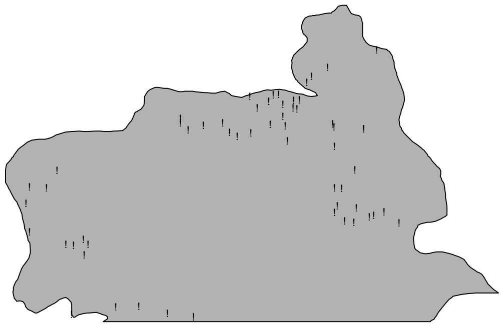
At initial assessment 72% of sites have a RGFI value of 8 to 10, with 10 being the greatest for this bioregion. This increased to 77% at last assessments, with 10 still the highest RGFI value.

This bioregion has low grazing productivity, i.e. mostly low to unpalatable grasses, the stability of landscape function maybe due to the species present. The site that lost it's 3P grass is of great concern.

Finke



(a)



(b)

Figure 15: (a) Location of Finke bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed by landscape function index within Finke bioregion.

Table 9: Areas, number of Tier 1 sites and density of sites per 1000 km2 within Finke bioregion

Bioregion		Pastoral Estate within bioregion	Analysed with Landscape Function Index
Area (km^2)	54258	51966	51966
Tier 1 sites	158	154	58
Site density per 1000 km^2	2.91	2.96	1.12

Environment Australia (2000) description of Finke bioregion:
Arid sandplains, dissected uplands and valleys formed from Pre-Cambrian volcanics with spinifex hummock grasslands (Plate 1) and acacia shrublands (Plate 2) on red earths and shallow sands.

Plate 2: Spinifex hummock grassland within Finke bioregion.

Plate 1: Acacia shrublands within Finke bioregion.

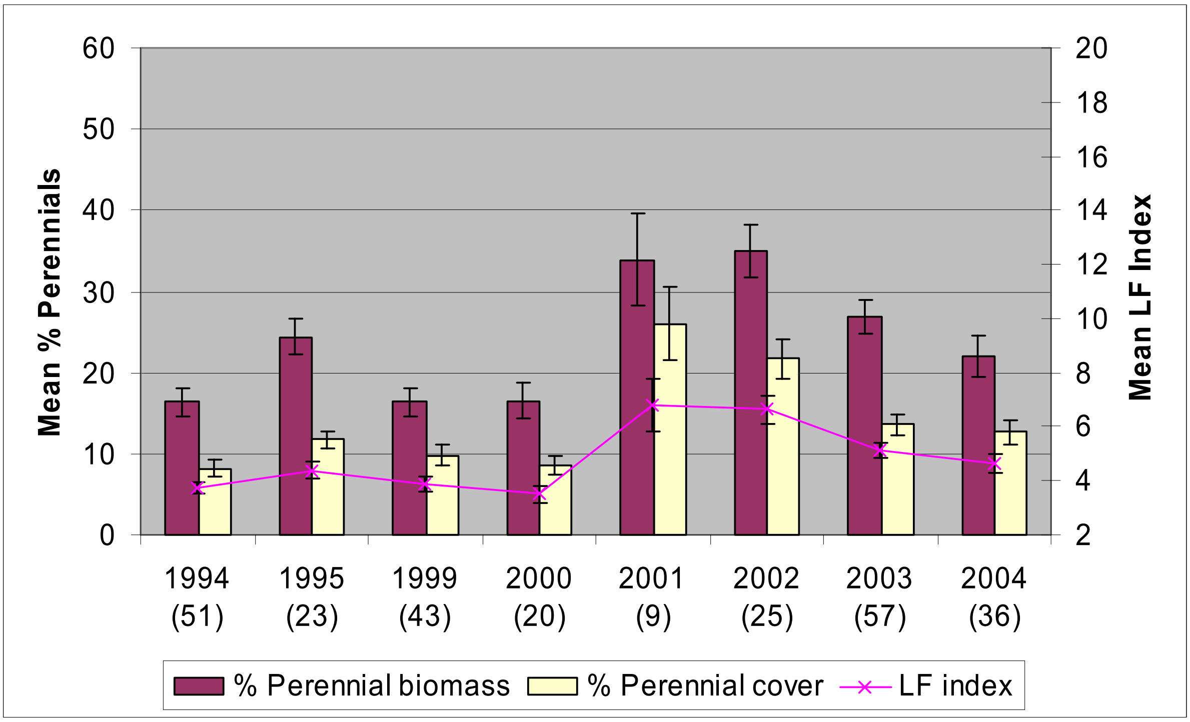


Figure 16: Finke - Mean % perennial grass biomass, mean % perennial grass cover and mean LF index between 1994 and 2004.

Finke bioregion generally has low to very low perennial grasses, short lived perennial have a higher importance in this central Australian bioregion and as they have been excluded from this analysis, conclusions made about landscape function within the Finke bioregion maybe harsh.

Finke generally experienced below average rainfall prior to the reporting period with average rainfall from 1994 to 2000, above average rainfall in 2001 and 2002 followed by very low rainfall in 2003 and average rainfall in 2004.

The perennial grass trend appears to follow this general rainfall pattern, however consistent site perennial grass trend indecates an increasing trend in landscape function.

Figure 16 below shows five consistent site trends between 1994 and 2004, with all expect 13 sites assessed in 1995 and 1999 showing an increasing landscape function trend.

37 sites initially assessed in 1994 all showed some recovery of their landscape function in response to more favourable rainfall, 10 sites initially assessed in 1995 improved their landscape function the most with an increase of their mean LF Index by 3.5 points.

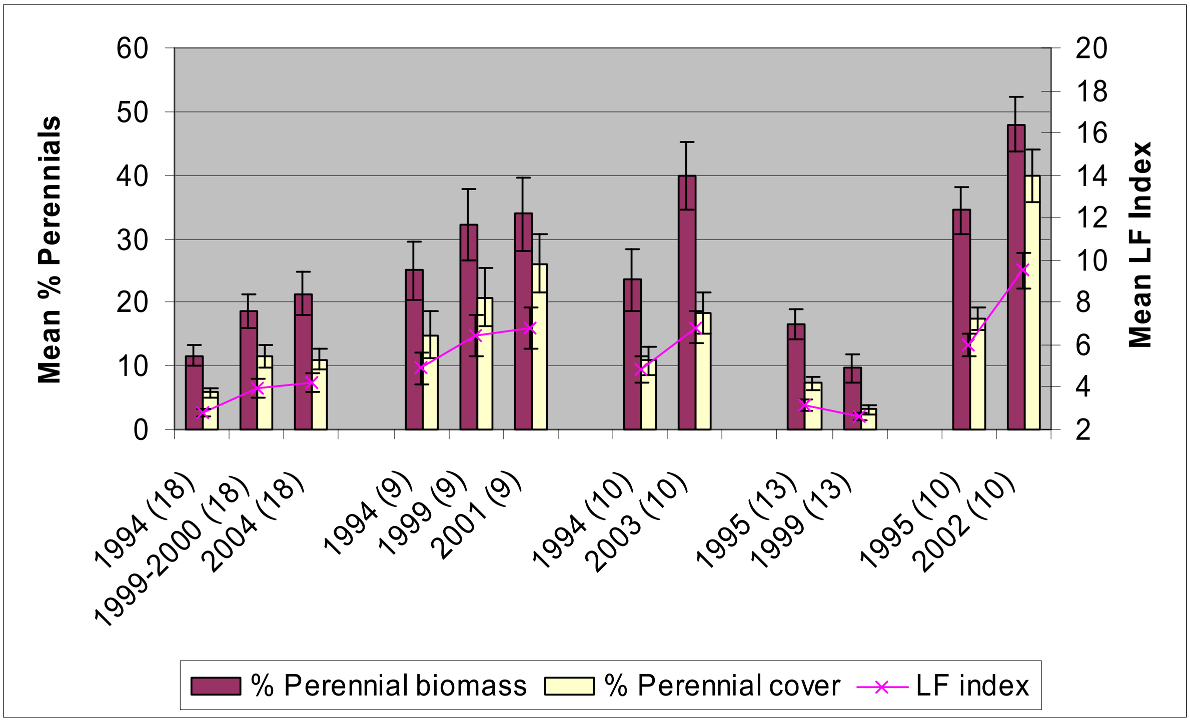


Figure 17: Finke - Mean % perennial grass biomass, mean % perennial grass cover and mean LF Index of consistent site trends between 1994 and 2004.

In summary, the Finke bioregion appears to mostly influenced by seasonal conditions with clear signs of perennial grasses fluctuating in direct response to rainfall levels, with landscape function generally recovering after experienced a long period prior to the reporting period of below average seasonal conditions. Perennial grass levels appear to be initially very low but improved to generally low levels.

Table 10: Finke - Change in Landscape Function Index from initial to most recent Tier 1 site assessment.

Seasonal Condition	Number of Assessments	Percentage of reassessments		
		Decline	No Change	Improvement
Above Average	24	0	71	29
Average	34	3	65	32
Below Average	na	na	na	na

A Tolerance of + or - 3 'no change'

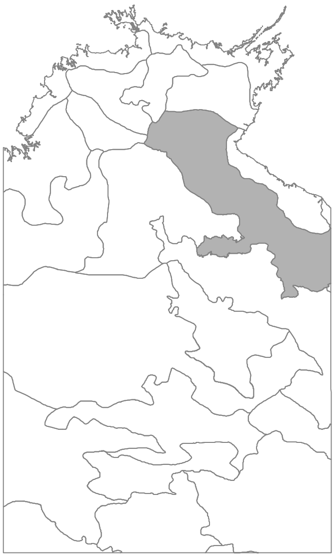
First assessments of the 58 sites suitable for LF Index analysis where from 1994 to 2000, with the most recent assessments ranging from 1999 to 2004, giving a reporting period of 10 years from 1994 to 2004 (Appendix 1).

The one site that declined went from 32% perennial cover to 0 as the one perennial grass species (*Eriachne helmsii*) disappears between its initial assessment in 1999 to last assessment in 2004. However this decline is harsh as the high rainfall in 2000 and 2001 germinated a short lived perennial (Aristida holathera) resulting in 64% cover of this species (total site cover 80%).

A third of sites are improving indicating some recovery of landscape function with more favourable seasonal conditions.

In summary, Finke bioregion is generally considered to have low landscape function with two thirds stable (67%) and a third (31%) improving, however the majority of the area that has been assessed as stable do still have an increasing landscape function trend. Without the inclusion of short lived perennials in this analysis, the resulting low landscape function assessment of the Finke bioregion maybe harsh as these grasses are believed to play an important role in Finke's overall landscape health.

Gulf Fall and Uplands



(a)

(b)

Figure 18: (a) Location of Gulf Fall and Uplands bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed by landscape function index within Gulf Fall and Uplands bioregion.

Table 11: Areas, number of Tier 1 sites and density of sites per 1000 km2 within Gulf Fall and Uplands bioregion.

Bioregion		Pastoral Estate within bioregion	Analysed with Landscape Function Index
Area (km^2)	112587	64090	64090
Tier 1 sites	173	148	79
Site density per 1000 km^2	1.54	2.31	1.23

Environment Australia (2000) description of Gulf Fall and Uplands bioregion:

Undulating terrain with scattered low, steep hills on Proterozoic and Palaeozoic sedimentary rocks, often overlain by lateritised Tertiary material; skeletal soils and shallow sands; Darwin Boxwood and Variable-barked Bloodwood woodland to low open woodland with spinifex understorey. (Environment Australia, 2000)

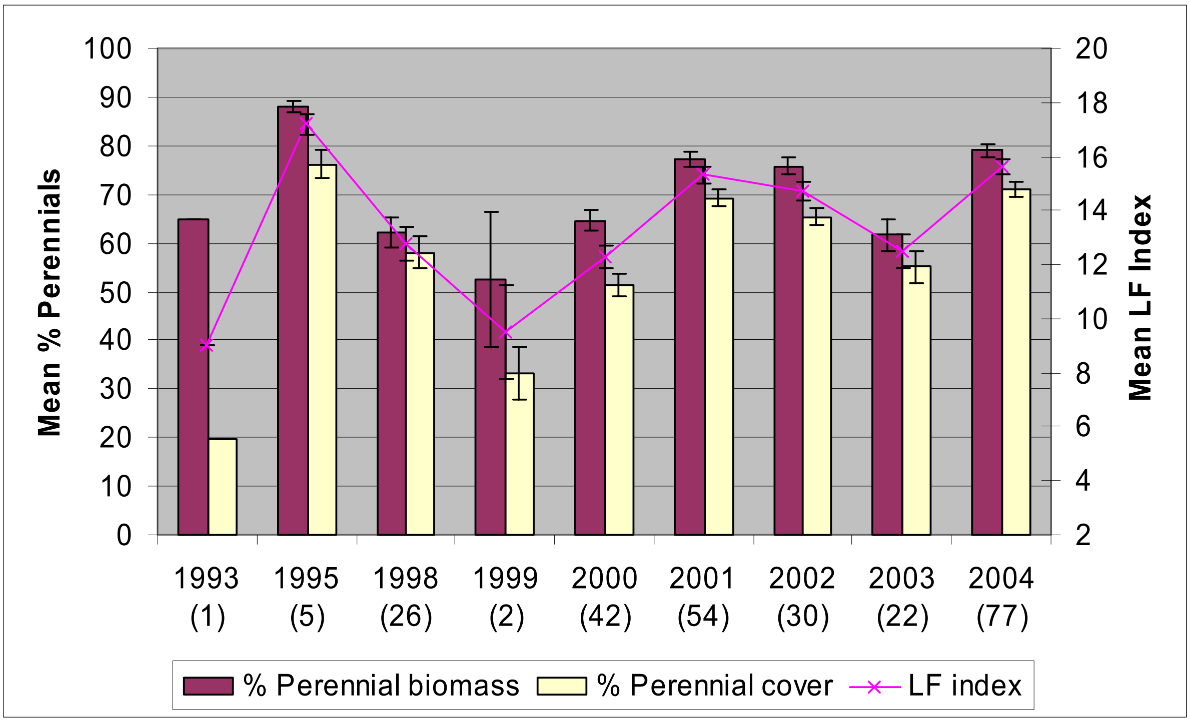


Figure 19: Gulf Fall and Uplands - Mean % perennial grass biomass, mean % perennial grass cover and mean LF Index between 1993 and 2004.

18 sites were assessed 3 times through the reporting period, 30 sites assessed twice between the first half (1993-1999) of the reporting period and second in the later (2000-2004), and there was 48 sites assessed twice in the later part of the reporting period (2000-2001 and 2003-2004), these were analysed separately below in Figure 14.

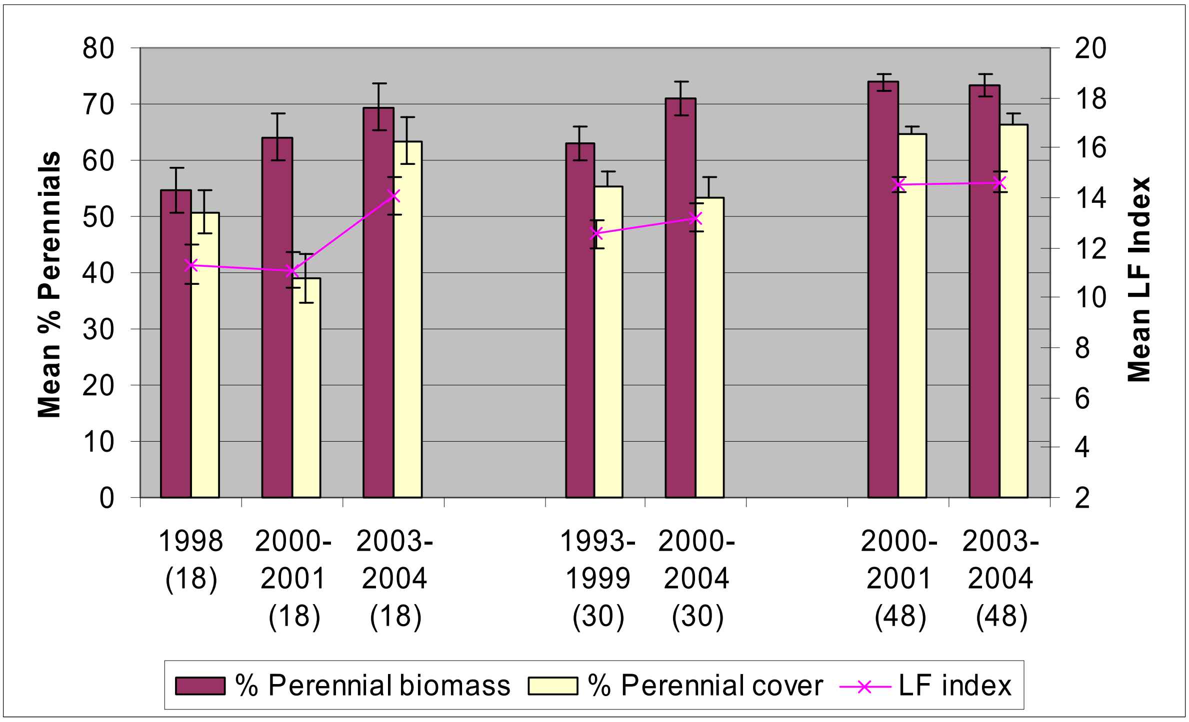


Figure 20: Gulf Fall and Uplands - Mean % perennial grass biomass, mean % perennial grass cover and mean LF Index of consistent site trends between 1998 and 2004.

Following the mean perennial grass history of 18 sites from 1998 to 2003-2004, there was little change from 1998 to 2000-2001 with a mean increase of LF Index by 3 points.

30 sites assessed first in the early reporting period and then later in the reporting period showed a slight increase (less then 1 LF Index points).

48 sites that were assessed twice in the later reporting period showed not change with a 0.1 LF Index point increase.

In summary, Gulf Fall and Uplands landscape function had slightly increased in the earlier portion of the reporting period, with stabilization between 2000 and 2004. A few areas showed the opposite with no change between 1998 and 2001 with an increase by 2003-2004.

Table 12: Gulf Fall and Uplands - Change in Landscape Function Index from initial to most recent Tier 1 site assessment.

Seasonal Condition	Number of Assessments	Percentage of reassessments		
		Decline	No Change	Improvement
Above Average	37	8	68	24
Average	42	26	64	10
Below Average	na	na	na	na

A Tolerance of + or - 3 'no change'

Initial assessments of the 79 sites suitable for LF Index analysis were from 1993 to 2002, with the most recent assessments ranging from 2001 to 2004, giving a reporting period of 11 years from 1993 to 2004 (Appendix 1).

Three sites declined after experiencing Above Average seasonal conditions, all three had their perennial grasses reduced to just presence (<5% biomass, therefore % biomass not recorded) or had completely disappeared. Two sites had high cover in both assessments, with the perennials replaced by either annual sorghum or a sedge species. The remaining site had low cover in both assessments, with perennials replaced by an annual grass (Kimberley Couch).

11 sites declined in Average seasonal conditions, of these 8 are experiencing landscape function decline. The remaining three have slightly lower biomass and cover but still appear to have very high frequency of perennials, with one of these a direct result of fire.

9 sites improved with Above Average seasonal conditions, two experienced annual sorghum decline and perennials increase. Some were de-stocked or had low cattle numbers for long periods during the reporting period.

4 sites improved with Average seasonal conditions, with previous overstocking, fire and flooding, feral animals and weed invasion causing low perennial coverage (pre 1998). With de-stocking or low stock numbers and control of feral animals, sites have recovered and perennials have returned after annual sorghum (2 sites), Kimberley Couch (1 site) and Sida weed (1 site) reduced or disappeared.

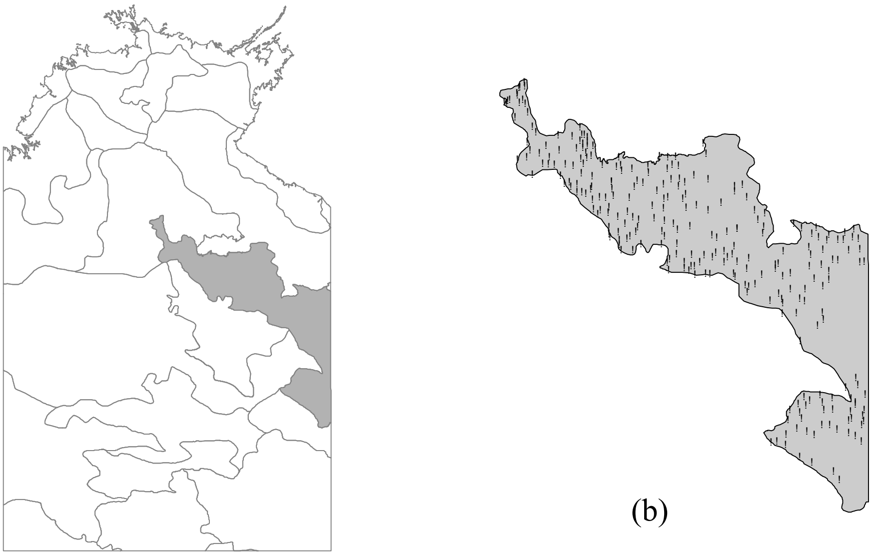
Majority of this bioregion's landscape function has been unchanged (66%), however those that are declining (18%) appear to be the result of over utilization of perennials and replacement by Kimberley Couch, annual sorghum or sedges. Improvement was experienced by 16% of sites and these appear to be the direct result of changed management, ie destocking or reduce numbers allowing perennials to increase and then compete with other ground species.

Two of the three sites that declined in Above Average seasonal conditions had some perennials (25-30% biomass) in their initial assessment (1998-2000) both following a year of spelling, these perennials however disappeared completely by last assessment (2003-2004) as stock were possibly reintroduced before sufficient recovery of perennials and/or at numbers higher then the area could sustain.

Recovery of perennial grasses to good levels for this bioregion appears to take an average of 3.5 years in Above Average seasonal conditions and 5 years in Average seasonal conditions for this bioregion.

In summary, Gulf Fall and Uplands bioregion appears to have some areas of fluctuating perennial grasses through the reporting period (1993 and 2004), some areas improving from poorer conditions due to pre reporting period stocking rates in small areas and uncontrolled feral animals over larger unfenced areas. The majority however appears to have good stable landscape function throughout the reporting period.

Mitchell Grass Downs



(b)

(a)

Figure 21: (a) Location of Mitchell Grass Downs bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed by landscape function index within Mitchell Grass Downs bioregion.

Table 13: Areas, number of Tier 1 sites and density of sites per 1000 km2 within Mitchell Grass Downs bioregion.

Bioregion		Pastoral Estate within bioregion	Analysed with Landscape Function Index
Area (km^2)	93073	90474	90474
Tier 1 sites	410	396	277
Site density per 1000 km^2	4.41	4.38	3.06

Environment Australia (2000) description of Mitchell Grass Downs bioregion:

Undulating downs on shales and limestones; *Astrebla spp.* grasslands and *Acacia* low woodlands. Grey and brown cracking clays.

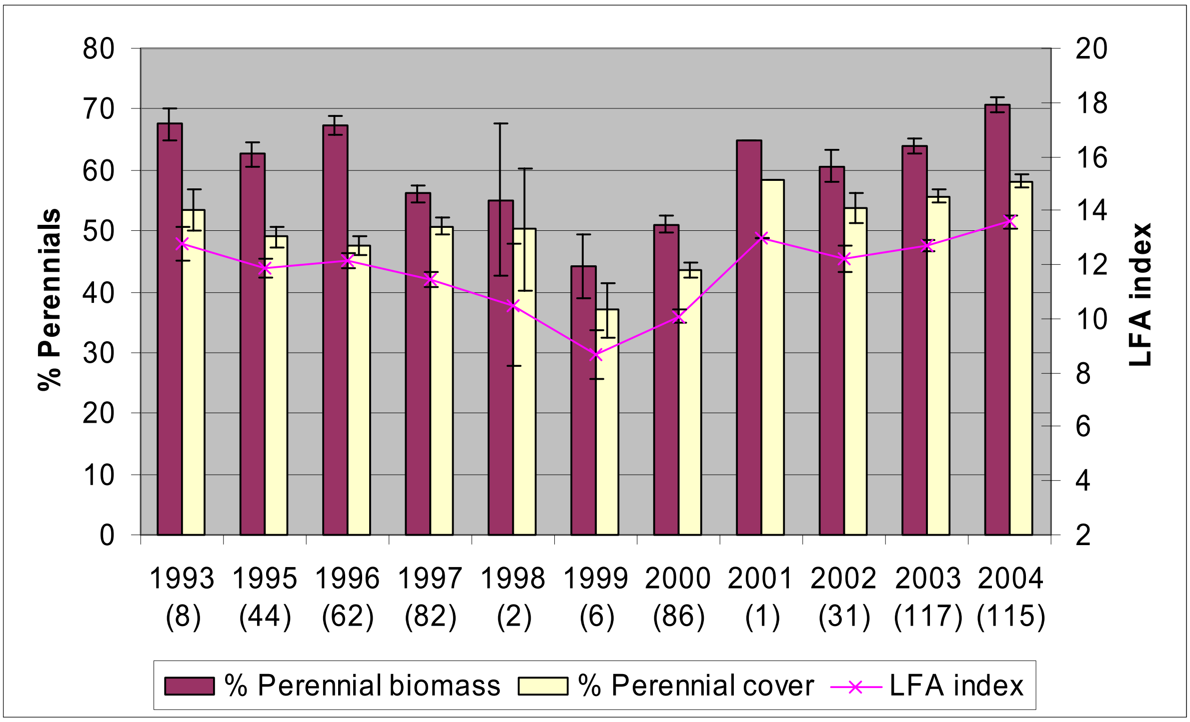


Figure 22: Mitchell Grass Downs - Mean % perennial grass biomass, mean % perennial grass cover and mean LF index between 1994 and 2004.

The LF index was stable between 1995 and 1997 (approx. 12), with a very small drop to 10 in 2000, by 2002 the index had increased back to 12 with a continued slight increase to 13.5 by 2004.

Perennial grass % biomass has followed a similar trend as the LF index with a decrease between 1997 and 2000 followed by recovery to original levels by 2004.

Perennial grass % cover slightly declined in 1995 and 1996, with a slight increase in 1997. Years 1999 and 2000 had the lowest cover, with recovery to 1993 levels by 2002, and by 2003 and 2004 perennial grass cover had increasing to slightly higher levels then recorded in 1993.

All 6 sites in 1999 were new, half with high LF index and half with low LF index.

In summary, landscape function slowly declined between 1993 and 2000, with full recovery to original 1993 levels by 2004.

Table 14: Mitchell Grass Downs - Change in Landscape Function Index from initial to most recent Tier 1 site assessment.

Seasonal Condition	Number of Assessments	Percentage of reassessments		
		Decline	No Change	Improvement
Above Average	175	13	58	30
Average	63	10	48	43
Below Average	39	21	44	36

A Tolerance of + or - 3 'no change'

First assessments of the 277 sites suitable for LF Index analysis where from 1993 to 2000, with the most recent assessments ranging from 2000 to 2004, giving a reporting period of 11 years from 1993 to 2004 (Appendix 1).

Of the 22 sites that decline after experiencing Above Average seasonal conditions, 14 sites did have a reduction in perennials, 8 sites had stable perennial grasses with a significant seasonal flush of annuals (eg Flinders, Sorghum) created by high rainfall.

Of the 6 sites declining in Average seasonal conditions, 3 were experiencing a decline in perennial grasses and 3 were stable with 2 of these experiencing a Flinders flush.

Of the 8 sites declining in Below Average seasonal conditions, 6 are stable with significant increases in Flinders and/or Annual Sorghum, and 2 had experienced a decline in perennial grasses.

All 14 sites that improved and all 17 sites that were unchanged in Below Average seasonal conditions, indicating that the modified RGFI is working for stable and improving sites, but is very harsh to the sites that have stable perennials but significant fluctuations in their annuals (eg Flinders and sorghum). As a result a new table was created using manual reclassification of the sites classified as declining by the modified RGFI method.

Table 15: Mitchell Grass Downs – Using manual reclassification of sites classified as declined by RGFI, from initial to most recent Tier 1 site assessment.

Seasonal Condition	Number of Assessments	Percentage of reassessments		
		Decline	No Change	Improvement
Above Average	175	9	62	30
Average	63	5	52	43
Below Average	39	5	59	36

A Tolerance of + or - 3 'no change', RGFI decline sites manually reassessed as decline or no change.

Using Table 15 (manually assessed decline sites), majority of Mitchell Grass Downs bioregion perennial grasses are unchanged with approximately a third improving.

In summary, two thirds of Mitchell Grass Downs landscape function is at similar levels between their initial and most recent assessment, with a third to improve.

Ord Victoria Plain

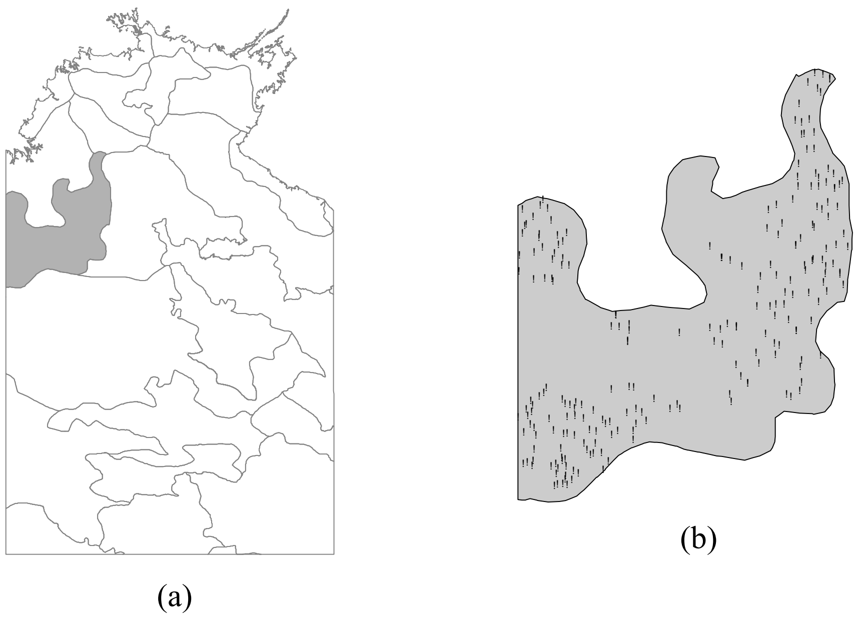


Figure 23: (a) Location of Ord Victoria Plain bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed by landscape function index within Ord Victoria Plain bioregion.

Table 16: Areas, number of Tier 1 sites and density of sites per 1000 km2 within Ord Victoria Plains bioregion.

Bioregion		Pastoral Estate within bioregion	Analysed with Landscape Function Index
Area (km^2)	70428	52560	52560
Tier 1 sites	274	263	229
Site density per 1000 km^2	3.89	5.00	4.36

Environment Australia (2000) description of Ord Victoria Plains bioregion:
Level to gently undulating plains with scattered hills on Cambrian volcanics and Proterozoic sedimentary rocks; vertosols on plains and predominantly skeletal soils on hills; grassland with scattered Bloodwood and Snappy Gum with spinifex and annual grasses. Dry hot tropical, semi-arid summer rainfall. The lithological mosaic has three main components:
(1) Abrupt Proterozoic and Phanerozoic ranges and scattered hills mantled by shallow sand and loam soils supporting *Triodia* hummock grasslands with sparse low trees.
(2) Cambrian volcanics and limestones form extensive plains with short grass (*Enneapogon* spp.) on dry calcareous soils and medium-height grassland communities (*Astrebla* and *Dichanthium*) on cracking clays. Riparian forests of River Gums fringe drainage lines.
(3) In the south-west, Phanerozoic strata expressed as often lateritised upland sandplains with sparse trees. This component recurs as the Sturt Plateau Region in central Northern Territory.

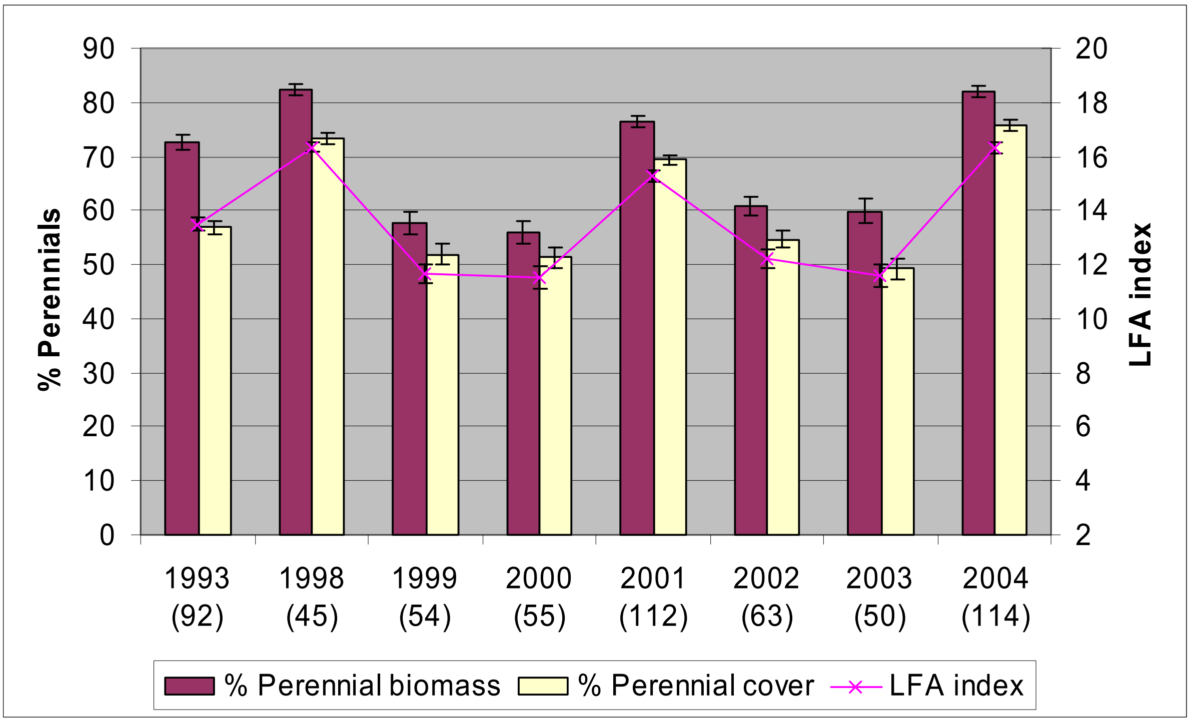


Figure 24: Ord Victoria Plain - Mean % perennial grass biomass, mean % perennial grass cover and mean LF index between 1994 and 2004.

84% (38) of sites assessed in 1998 were previously assessed in 1993, suggesting that perennial grasses increased over the 5 year period between 1993 and 1998.

76% (41) of sites assessed in 1999 and 80% (44) in 2000 were new sites, suggesting that the decrease in perennial grasses could be from site selection rather than a decrease across the bioregion.

65% (33) of sites assessed in 2000 were reassessed in 2003, majority were unchanged indicating that the lower perennial grasses in these two year are most likely due to site selection.

Of the 112 sites assessed in 2001, 20% (22) were initially assessed in 1993, 38% (42) in 1998 and 43% (48) were new, therefore it is difficult to determine if the perennial grasses in 2001 assessment had experienced changes or the new site selections had influenced the high perennial grass result.

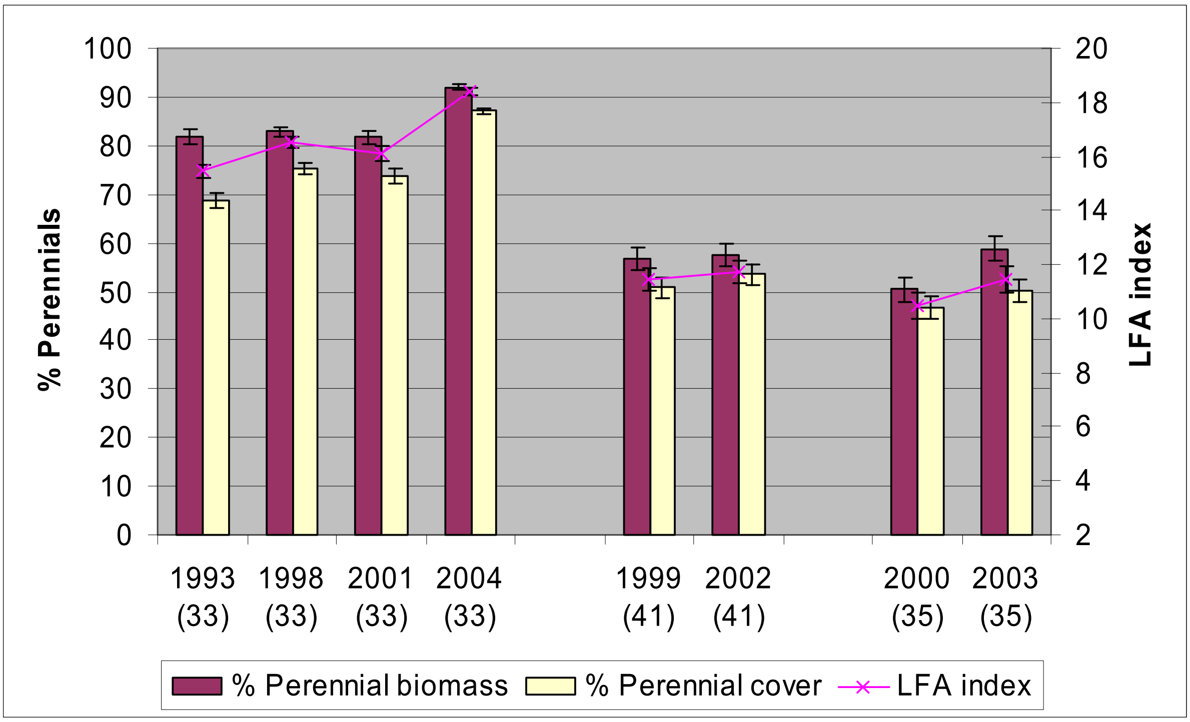


Figure 25: Ord Victoria Plain - Mean % perennial grass biomass, % perennial grass cover and LF index of consistent site trends between 1994 and 2004.

The 33 sites that were assessed in 1993, 1995, 2001 and 2004 did increase by 3 LF Index points, suggesting some minor improvement of these sites over an eleven year period.

Sites initially assessed in 1999 and 2000did show some very minor improvement over a 3 year period.

In summary, overall Ord Victoria bioregion has seen a majority of unchanged to slight improvement in landscape function over an eleven year period between 1993 and 2004.

Table 17: Ord Victoria Plain - Change in Landscape Function Index from initial to most recent Tier 1 site assessment.

Seasonal Condition	Number of Assessments	Percentage of reassessments		
		Decline	No Change	Improvement
Above Average	154	12	66	22
Average	70	0	81	19
Below Average	5	0	80	20

A Tolerance of + or - 3 'no change'

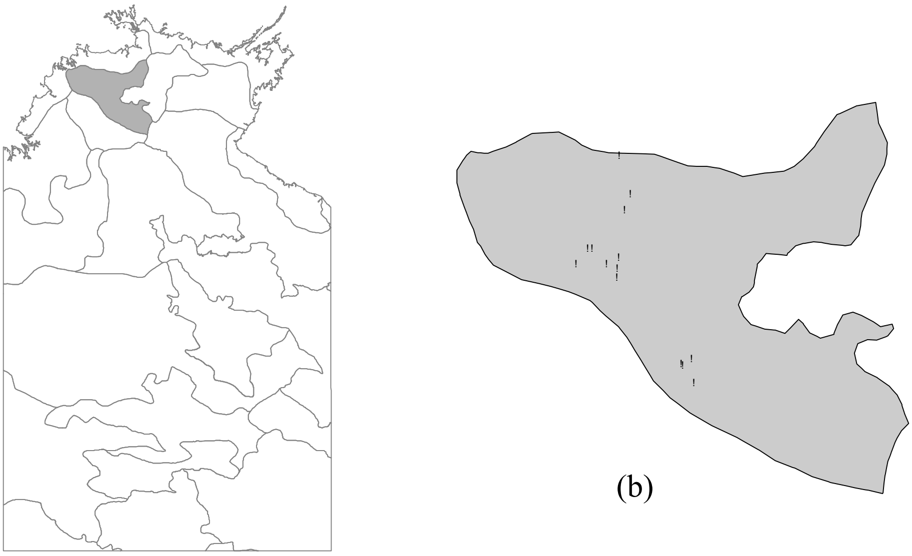
First assessments of the 229 sites suitable for LF Index analysis where from 1993 to 2001, with the most recent assessments ranging from 2001 to 2004, giving a reporting period of 11 years from 1993 to 2004 (Appendix 1).

The 19 sites that declined in Above Average seasonal conditions are concerning at the local level, especially as half of were from only two stations, however at a bioregional level this equates to only 8% declined.

Overall 71% experienced unchanged landscape function, 21% improved and 8% declined.

In summary, the Ord Victoria Plain bioregion experienced mostly stable landscape function with more areas improving than declining over an eleven year period from 1993 to 2004.

Pine Creek



(a) (b)

Figure 26: (a) Location of Pine Creek bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed by landscape function index within Pine Creek bioregion.

Table 18: Areas, number of Tier 1 sites and density of sites per 1000 km2 within Pine Creek bioregion.

Bioregion		Pastoral Estate within bioregion	Analysed with Landscape Function Index
Area (km^2)	28518	7358	7358
Tier 1 sites	51	49	14
Site density per 1000 km^2	1.79	6.66	1.90

Environment Australia (2000) description of Pine Creek bioregion:
Foothill environments below and to the west of the western Arnhem Land sandstone massif. Its main defining feature is the highly mineraliferous Pine Creek Geosyncline, comprising Archaean granite and gneiss overlain by Palaeoprotozoic sediments. The major vegetation types are eucalypt tall open forests, typically dominated by Darwin woollybutt (*Eucalyptus miniata*) and Darwin stringybark (*E. tetrodonta*), and woodlands (dominated by a range of species including *E. grandifolia, E. latifolia, E. tintinnans, E. confertiflora* and *E. tectifica*), with smaller areas of monsoon rainforest patches, *Melaleuca* woodlands, riparian vegetation and tussock grasslands. Characteristic species include the granivorous birds Gouldian finch *Erythrura goudlii*, hooded parrot *Psephotus dissimilis* and partridge pigeon *Geophaps smithii*.

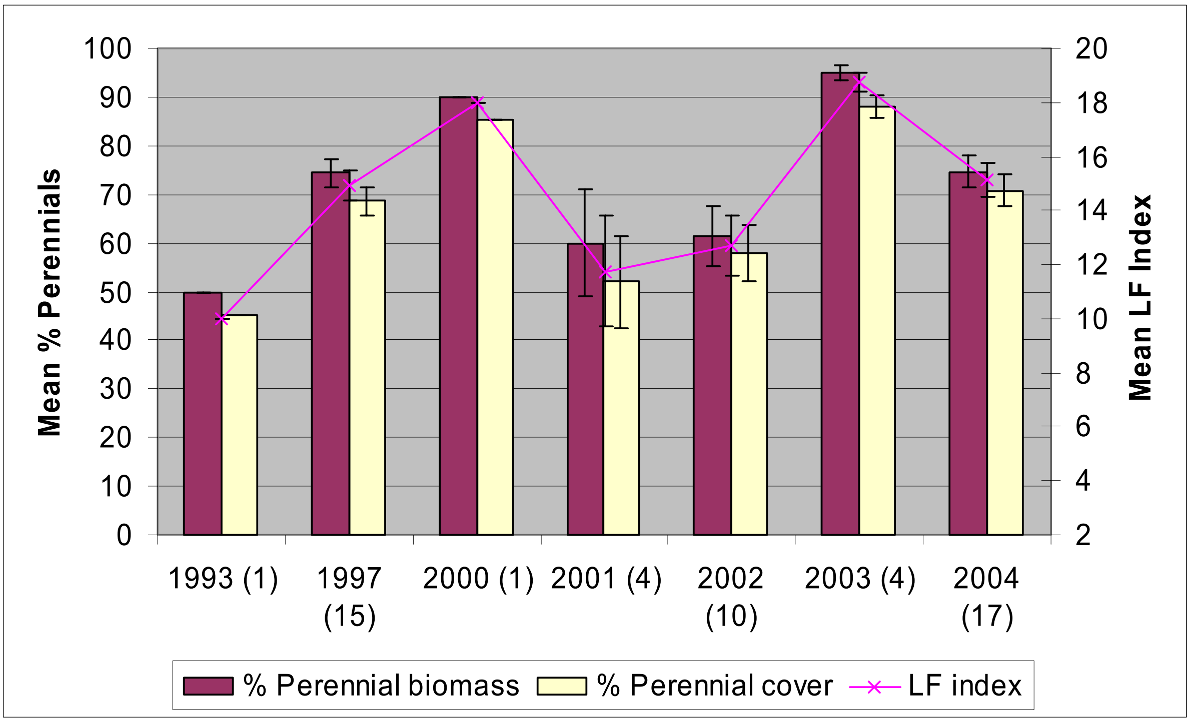


Figure 27: Pine Creek - Mean % perennial grass biomass, mean % perennial grass cover and mean LF index between 1994 and 2004.

All 2001 sites and the majority of 2002 sites are new, therefore suggesting that the drop in perennial grasses for these two years are most likely due to site selection.

As there are few sites within this bioregion that were suitable for LF Index analysis, with 52 individual analysis (34 sites), of these 20 (59% of sites) had only been analysed once, 10 (29% of sites) twice and 4 (12% of sites) three times.

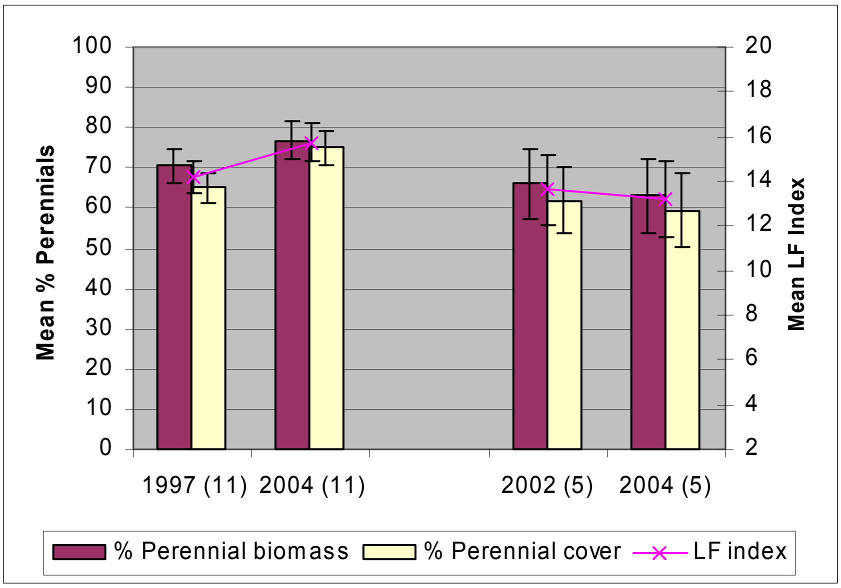


Figure 28: Pine Creek - Mean % perennial grass biomass, mean % perennial grass cover and mean LF index of consistent site trends between 1997 and 2004.

Eleven sites were assessed in both 1997 and 2004, with their mean perennial grasses showing a slight increase in their mean LF Index by 1.5 points.

Five sites were assessed in both 2002 and 2004, showing a slight decrease in their mean LF Index by 0.4 points.

In summary, Pine Creek has experienced minimal change to landscape function through the reporting period, with majority showing small improvements between 1997 and 2004

Table 19: Pine Creek - Change in Landscape Function Index from initial to most recent Tier 1 site assessment.

Seasonal Condition	Number of Assessments	Percentage of reassessments		
		Decline	No Change	Improvement
Above Average	1	0	0	100
Average	6	17	33	50
Below Average	7	0	100	0

A Tolerance of + or - 3 'no change'

First assessments of the 14 sites suitable for LF Index analysis were from 1993 to 2001, with the most recent assessments ranging from 2003 to 2004, giving a reporting period of 11 years from 1993 to 2004 (Appendix 1).

Only one site was classified as declining, however it is just declining (modified RGFI value of -4), looking at the site it has gone from 2 species of perennial grasses to 1, which has increased resulting in out competing the other perennial grass.

Of the 14 sites, 1 (7%) is declining, 9 (64%) are unchanged and 4 (29%) improving.

Of the 14 sites 9 experienced fire, which appeared to have minimal to no effect on long term landscape function within the Pine Creek bioregion as majority recovering to pre fire perennial grass levels when reassessed.

In summary, despite majority of Pine Creek bioregion experiencing fire during the reporting period, landscape function remained stable with a few areas showing some improvement.

Sturt Plateau

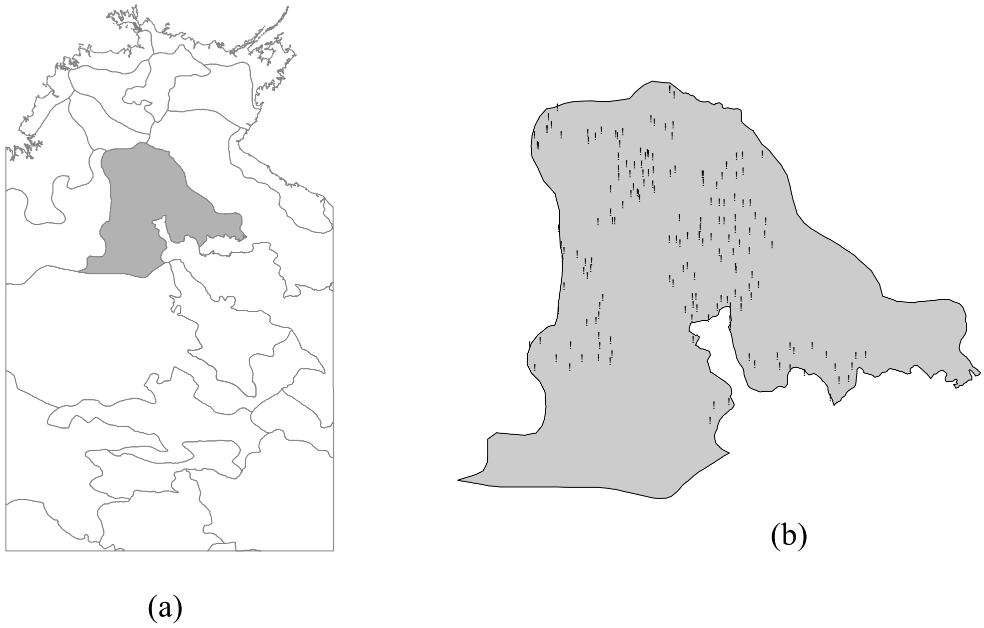


Figure 29: (a) Location of Sturt Plateau bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed by landscape function index within Sturt Plateau bioregion.

Table 20: Areas, number of Tier 1 sites and density of sites per 1000 km2 within Burt Plain bioregion.

Bioregion		Pastoral Estate within bioregion	Analysed with Landscape Function Index
Area (km^2)	98575	69534	69534
Tier 1 sites	218	200	179
Site density per 1000 km^2	2.21	2.88	2.57

Environment Australia (2000) description of Sturt Plateau bioregion:
Gently undulating plains on lateritised Cretaceous sandstones; neutral sandy red and yellow earths; variable-barked Bloodwood woodland with spinifex understorey.

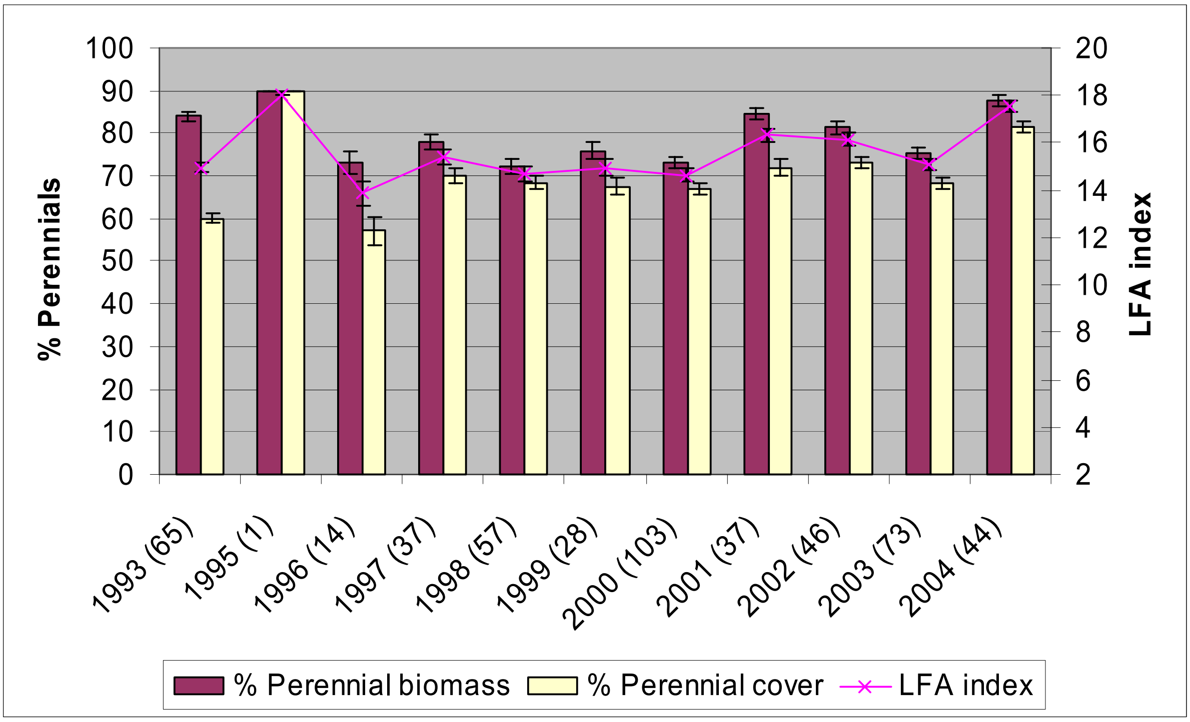


Figure 30: Sturt Plateau - Mean % perennial grass biomass, mean % perennial grass cover and mean LF index between 1993 and 2004.

Landscape function has been high throughout the reporting period, with Average seasonal conditions experience by majority of sites in 1993, 1997 and 1998, and Above Average seasonal conditions experienced by the majority from 1999 to 2004.

Landscape function index varied between 1993 and 2004 from 13.8 to 17.5, indicating mean changes of the sites are relatively minor.

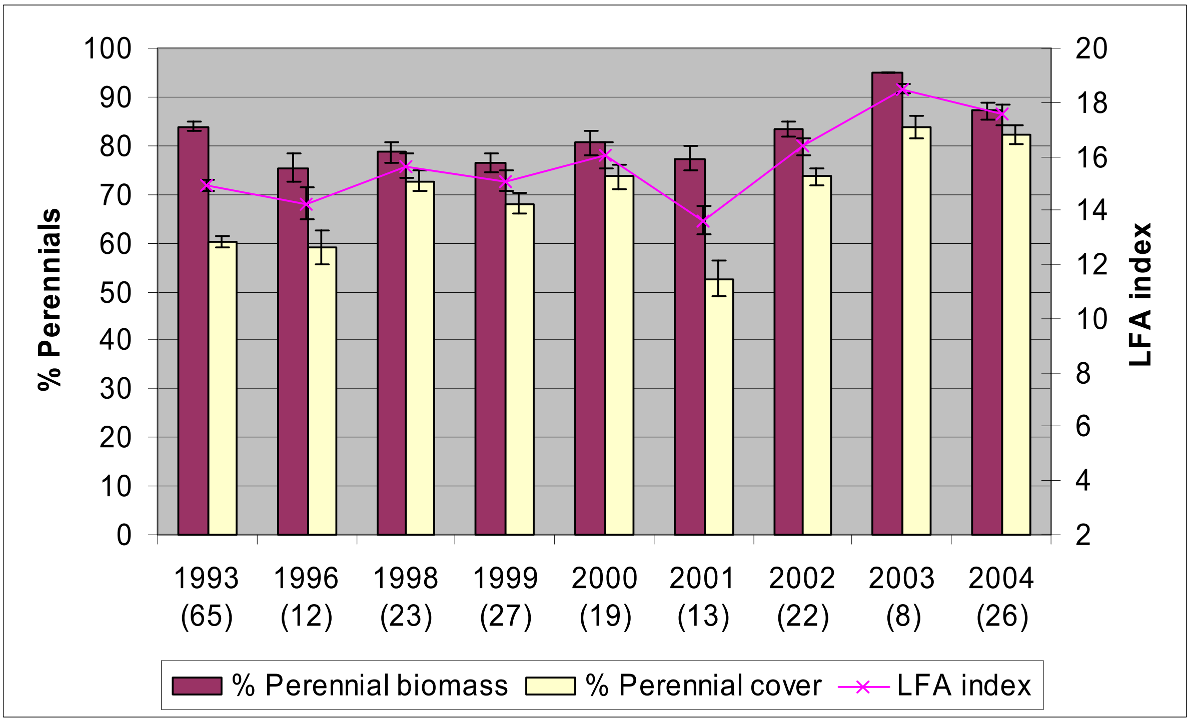


Figure 31: Sturt Plateau – Mean perennial grass history of all 65 sites initially assessed in 1993 throughout the eleven years reporting period (1993 to 2004).

Following all 65 sites assessed in 1993, Figure 31 shows that landscape function was stable from 1993 to 2000, with a decrease in 2001 followed by an increase from 2002 to 2004 of perennial grass levels above those earlier in the reporting period.

The 13 sites assessed with lower mean perennial grass in 2001 had the same levels in 1993, increased in 1998 with highest perennial grasses levels in 2004.

In summary, majority of Sturt Plateau has stable high perennial grasses from 1993 to 2004, with a slight decline in some areas in 1996, 1999 to 2001, with recovery to higher perennial grass levels between 2002 and 2004.

Table 21: Sturt Plateau - Change in Landscape Function Index from initial to most recent Tier 1 site assessment.

Seasonal Condition	Number of Assessments	Percentage of reassessments		
		Decline	No Change	Improvement
Above Average	167	6	75	19
Average	12	17	75	8
Below Average	na	na	na	na

A Tolerance of + or - 3 'no change'

First assessments of the 179 sites suitable for LF Index analysis were conducted between 1993 to 2001, with the most recent assessments ranging from 1998 to 2004, giving a reporting period of 11 years from 1993 to 2004 (Appendix 1).

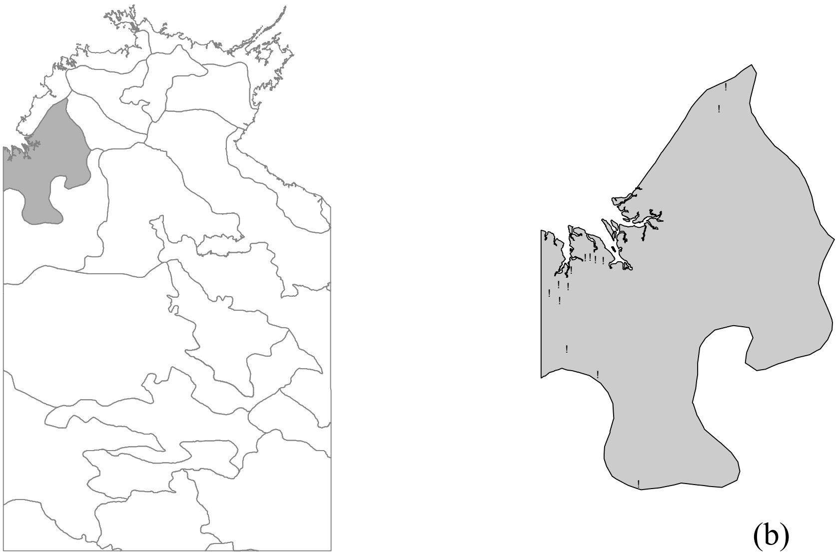
Fires in the Sturt Plateau were widespread and common before the reporting period. With increased infrastructure developments, in particular fire breaks and fence-lines, the number and intensity of wildfires have decreased dramatically.

In 2001 a large hot fire moved across the Sturt Plateau burning out large areas of stations across the plateau. Annual sorghum, after this event increased and the cover from well established perennials was also reduced. The majority of the perennials regrew the following wet season and fully recovered, however in a few areas perennials were reduced significantly as little feed was available after the fire and cattle were attracted to the green pick.

Rainfall over most of the reporting period has been above average and this has been reflected in the perennial growth even though utilization has increased with the increased development over the past 10-15 years.

In summary, the Sturt Plateau bioregion landscape function has been stable and majority is in good condition despite increased utilization between 1993 and 2004.

Victoria Bonaparte



(a) (b)

Figure 32: (a) Location of Victoria Bonaparte bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed by landscape function index within Victoria Bonaparte bioregion.

Table 22: Areas, number of Tier 1 sites and density of sites per 1000 km2 within Victoria Bonaparte bioregion.

Bioregion		Pastoral Estate within bioregion	Analysed with Landscape Function Index
Area (km^2)	54098	18148	18148
Tier 1 sites	73	54	14
Site density per 1000 km^2	1.35	2.98	0.77

Environment Australia (2000) description of Victoria Bonaparte bioregion:
Phanerozoic strata of the Bonaparte Basin in the north-western part are mantled by Quaternary marine sediments supporting Samphire - *Sporobolus* grasslands and mangal, and by red earth plains and black soil plains with an open savanna of high grasses. Outcrops of Devonian limestone karst in the west support tree steppe and vine thicket. Plateaux and abrupt ranges of Proterozoic sandstone, known as the Victoria Plateau, occur in the south and east, and are partially mantled by skeletal sandy soils with low tree savannas and hummock grasslands. In the south east are limited areas of gently undulating terrain on a variety of sedimentary rocks supporting low Snappy Gum over hummock grasslands and also of gently sloping floodplains supporting *Melaleuca minutifolia* low woodland over annual sorghums. Dry hot tropical, semi-arid summer rainfall.

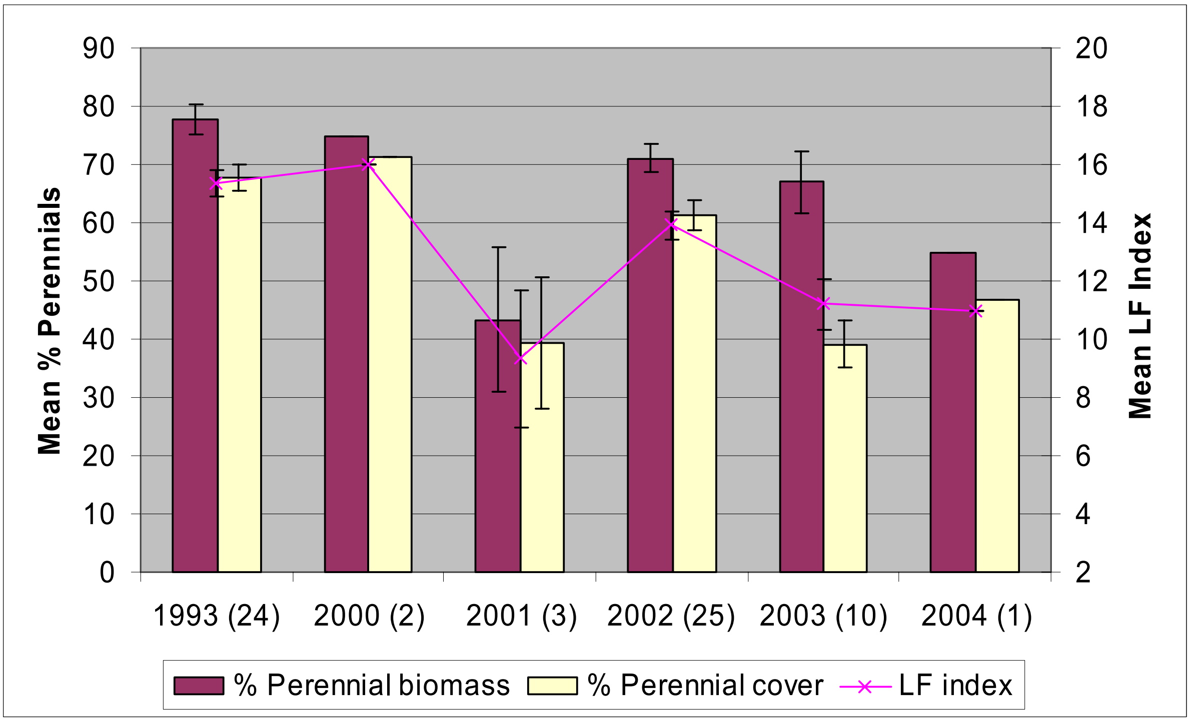


Figure 33: Victoria Bonaparte - Mean % perennial grass biomass, mean % perennial grass cover and mean LF index between 1993 and 2004.

Of the51 sites suitable for LF Index analysis 37 were only assessed once and 14 twice through the reporting period, 9 in 1993 and 2002, and 5 in 2000-2001 and 2003-2004.

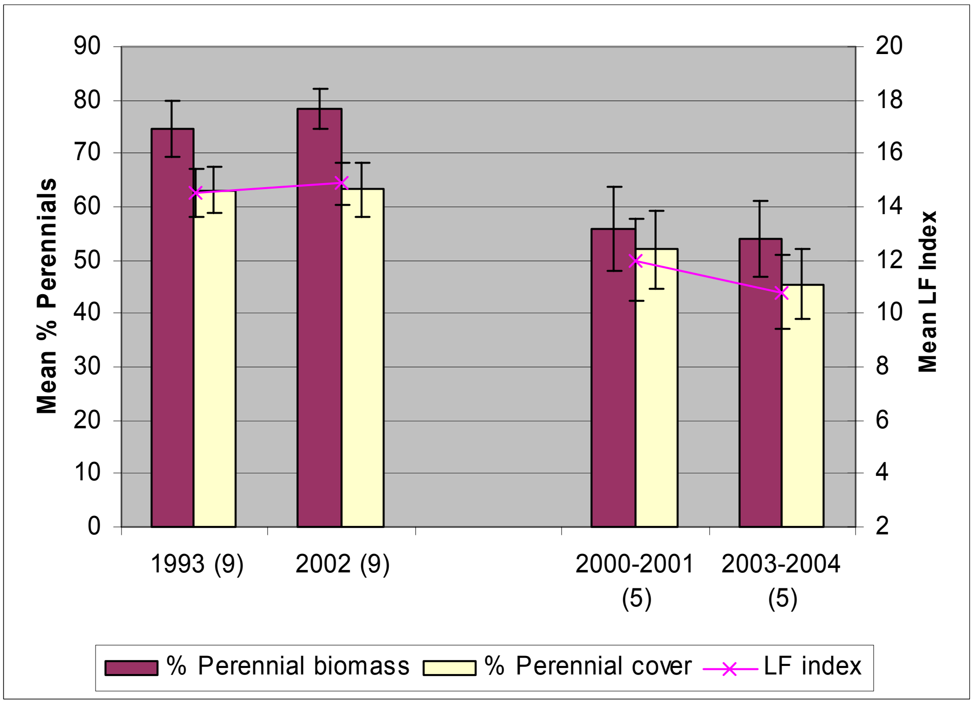


Figure 34: Victoria Bonaparte - Mean % perennial grass biomass, mean % perennial grass cover and mean LF index between 1993 and 2004.

The 9 sites that were assessed in 1993 and 2002 showed a very small mean improvement were as the 5 sites assessed between 2000-2001 and 2003-2004 showed a small mean decline in landscape function by 1.2 points.

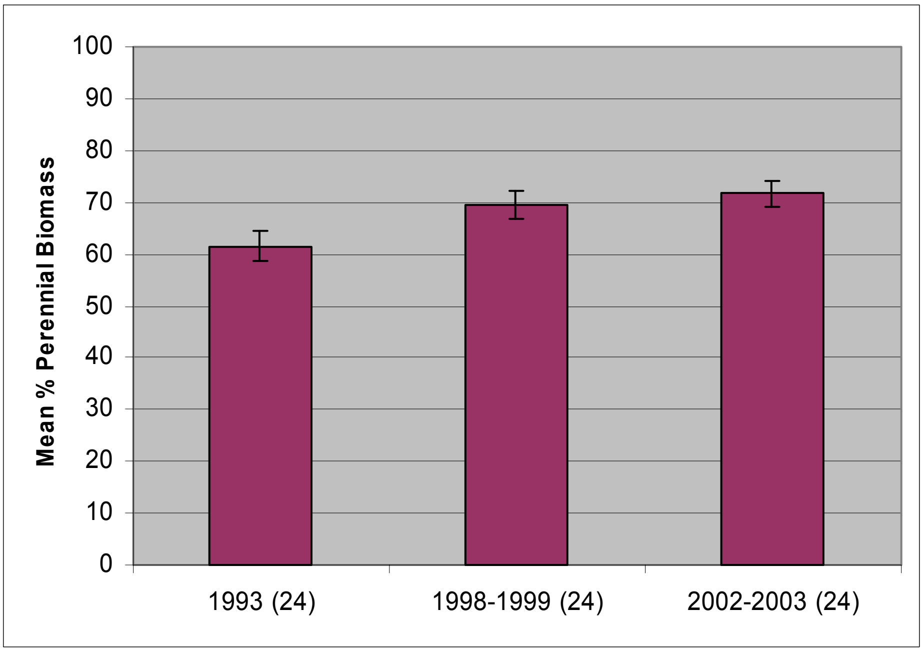


Figure 35: Victoria Bonaparte - Mean % perennial grass biomass history of 24 sites initially assessed in 1993 through a ten year period to 2003.

24 sites were assessed three times during the reporting period from 1993 to 2003.

In summary, the majority of the Victoria Bonaparte bioregion has increasing levels of landscape function, with a few recently established sites to monitor problematic areas with declining levels.

Table 23: Victoria Bonaparte- Change in Landscape Function Index from initial to most recent Tier 1 site assessment.

Seasonal Condition	Number of Assessments	Percentage of reassessments		
		Decline	No Change	Improvement
Above Average	3	67	33	0
Average	11	36	36	27
Below Average	na	na	na	na

A Tolerance of + or - 3 'no change'

First assessments of the 14 sites suitable for LF Index analysis are from the period 1993 to 2001, with the most recent assessments ranging from 2002 to 2004, giving a reporting period of 11 years from 1993 to 2004 (Appendix 1).

Six sites (2 Above Average, 4 Average) declined using the modified RGFI. Four sites were burnt, 2 fully recovered by 2005, and 1 site changed in composition to be fully dominated by annual sorghum, .

Table 24: Victoria Bonaparte- Using manual reclassification burnt sites classified as declined by RGFI to 'no change' from initial to most recent Tier 1 site assessment.

Seasonal Condition	Number of Assessments	Percentage of reassessments		
		Decline	No Change	Improvement
Above Average	3	33	67	0
Average	11	9	64	27
Below Average	na	na	na	na

Removing burnt sites assessed as declining by the modified Richards-Green LF Index to 'no change', the majority of Victoria Bonaparte bioregion is unchanged, with 2 sites(14%) declining, 3 sites (21%) improving and 9 sites (64%) unchanged.

Fire appears to have had minimal effect upon landscape function within the reporting period, Mimosa pigra continues to be an on going issue in some areas, with control measures also having long term effects.

In summary, majority of Victoria Bonaparte bioregion landscape function is unchanged through the reporting period with fire appearing to have little long term effect on landscape function and weed invasion and control activities having some localised declining effects on landscape function.

Simpson-Strzelecki Dunefields P1

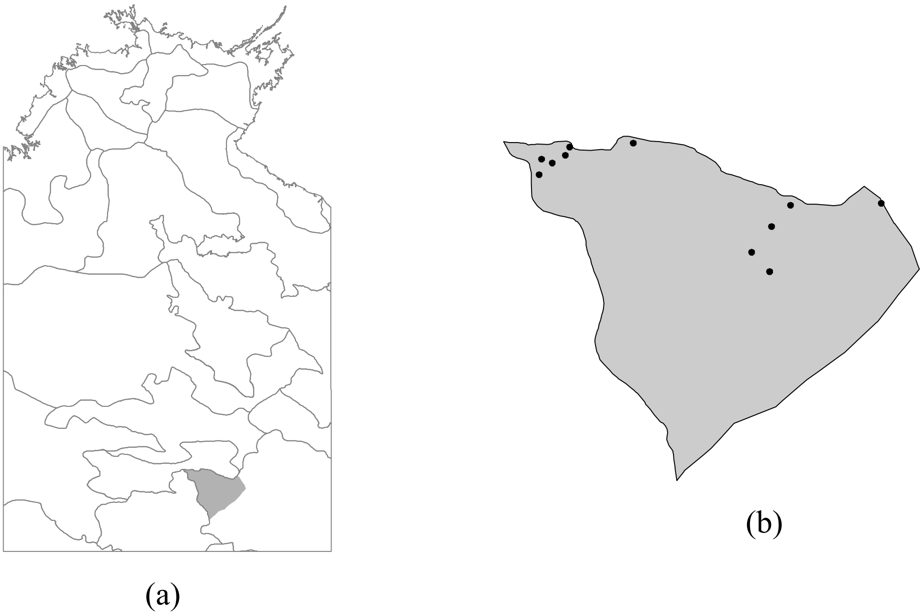


Figure 36: (a) Location of Simpson-Strzelecki Dunefields P1 bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed by landscape function index within Simpson-Strzelecki Dunefields P1 bioregion.

Table 25: Areas, number of Tier 1 sites and density of sites per 1000 km2 within Simpson-Strelecki Dunefields bioregion.

Bioregion		Pastoral Estate within bioregion	Analysed with Landscape Function Index
Area (km^2)	13552	10331	10331
Tier 1 sites	35	34	12
Site density per 1000 km^2	2.58	3.29	1.16

Environment Australia (2000) description of Simpson-Strzelecki Dunefields bioregion: Arid dunefields and sandplains with sparse shrubland and spinifex hummock grassland, and cane grass on deep sands along dune crests. Large salt lakes, notably Lake Eyre and many clay pans are dispersed amongst the dunes. Several significant arid rivers terminate at Lake Eyre, Cooper Creek and Warburton River. They are fringed with coolibah and redgum woodlands.
(Note: description of whole IBRA, not sub IBRA)

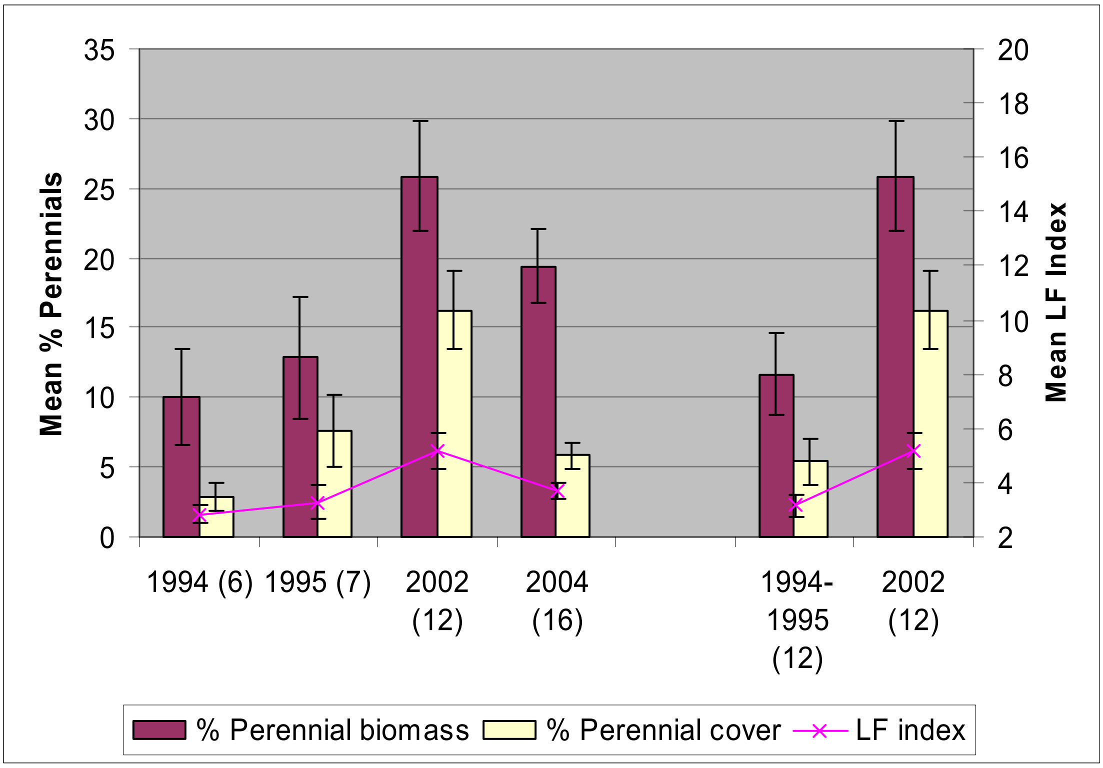


Figure 37: Simpson-Strzelecki Dunefields P1 - Mean % perennial grass biomass, mean % perennial grass cover and mean LF index between 1994 and 2004 and of consistent site trends between 1994-1995 and 2002.

28 sites were suitable for LF Index analysis, with 12 assessed twice (1994-1995 & 2002) and 16 sites assessed once in 2004.

Comparing the 12 sites assessed initially in 1994-1995 and reassessed in 2002, there was an increase in landscape function of 2 points, which indicates an improving trend over the eight year period between 1994 and 2002.

The new sites in 2004 had a LF Index between the 1994-1995 and 2002 levels, indicating that the bioregion may be slightly declining between 2002 and 2004.

In summary, Simpson-Strzelecki Dunefields P1 sub bioregion generally has a low landscape function that remained stable through the reporting period (1994 to 2004).

Table 26: Simpson-Strzelecki Dunefields P1 - Change in Landscape Function Index from initial to most recent Tier 1 site assessment.

Seasonal Condition	Number of Assessments	Percentage of reassessments		
		Decline	No Change	Improvement
Above Average	8	0	75	25
Average	4	25	50	25
Below Average	na	na	na	na

A Tolerance of + or - 3 'no change'

First assessments for the 12 sites suitable for LF Index analysis were from 1994 to 1995, with the most recent assessments in 2002, giving a reporting period of 8 years from 1994 to 2002 (Appendix 1).

Throughout the reporting period, one site declined, 3 improved and 8 sites were unchanged, indicating majority of the sub bioregion landscape is stable based on only perennial grasses between 1994 and 2002.

Table 26 uses only perennial grasses in its analysis, however this is believed to be potentially a harsh assessment as the bioregion also naturally relies on short lived perennials for its landscape function.

Table 27: Simpson-Strzelecki Dunefields P1 - Change in Landscape Function Index including short lived perennial grasses from initial to most recent Tier 1 site assessment.

Seasonal Condition	Number of Assessments	Percentage of reassessments		
		Decline	No Change	Improvement
Above Average	8	0	25	75
Average	4	0	50	50
Below Average	na	na	na	na

A Tolerance of + or - 3 'no change'

Including short lived perennial grasses as part of the analysis, highlighted that 67% of Simpson-Strzelecki Dunefields P1 sub bioregion has improving landscape function, with the remaining 33% with unchanged landscape function.

The sub bioregion responded well to Above Average seasonal conditions with 75% of sites that experienced this good rainfall improved their landscape function.

Five sites (42%) increased their LF Index by 10 to 13 points, which a very large improvement in landscape function.

In summary, Simpson-Strzelecki Dunefields P1 sub bioregion has responded extremely well to high rainfall with 75% of the area improving their landscape function, 42% improving by a considerable amount between 1994-1995 and 2002.

Tier 2 land cover change analysis

Inferred change in Landscape Function (Cover trends)

The management of rangelands is very diverse and complex. Vastness, sparse populations and harsh conditions are major factors that contribute to the lack of data and information, which consequently affects the monitoring of rangeland condition. Satellite based monitoring techniques have been developed and utilized extensively throughout the rangelands of Australia (Bastin et al. 1993, Ludwig et al. 2000).

Within the Northern Territory, satellite based monitoring techniques are being used to assess the conditions of rangeland utilised by the pastoral industry in the Victoria River District (VRD) and Sturt Plateau regions. Landsat Multi Spectral Scanner (MSS) and Thematic Mapper (TM) data are combined with ground based data to provide information on landscape cover change and processes.

Methods developed by Wallace et al. (1994) and Wallace and Thomas (1998), to detect rangeland changes through a series of Landsat scenes has resulted in the application and further development by Karfs et al. (2000) to implement a government directed satellite based monitoring program.

Data

A combination of MSS and TM data ranging from 1987 to 2005 was used for the time traces and trend imagery products. The imagery was registered, rectified (GDA94 and MGA52) and calibrated to a base image using techniques described by Furby and Campbell (2000), which calculates the regression coefficients from a set of invariant targets in each scene. The imagery was re-sampled to 50m.

Late dry season imagery (August to October) was acquired, as the ground vegetative cover is normally senescent, which enables distinctions to be made between the soil and vegetative cover.

Stratification

Stratification is an important step for the assessment of satellite data for rangeland monitoring and validation with ground data (Pickup, *et al*., 1998).

The IBRA's were stratified into pastorally important landtypes based upon lithology and landform characteristics. Stratification of the IBRA's was also based upon previous works (Karfs et al, 2000) which had determined that darker coloured soils were associated with basaltic soils and lighter coloured soils were associated with the red soil types.

To provide clearer understandings of land condition, further stratification of the data was conducted and included

Rugged landscapes with slopes greater than 10% and relief greater than 90m were cut from the satellite data, as cattle don't readily utilise these areas.

Rivers and creeks were removed. In riparian areas, the mix of tree density, sand, outcrop and water generally show different reflectance than the broader landscapes, as these are difficult to interpret. Buffers of 200m and 300m were applied to the creeks and rivers respectively.

The remaining area, the relatively flat country, was used for the time series analysis to determine the condition of the potentially grazed rangelands.

The spectral responses for the Landsat data over time were plotted for the major pastorally significant land types within each IBRA. These values were seasonally adjusted to provide a gross adjustment for differences in seasonal responses over time allowing interpretation of changes in indices related to differences in management and not seasonal variability.

Time trace analysis

Sturt Plateau IBRA

An analysis of the three main landtypes (that make up more than 10% each of the mapped IBRA region) occurring within the mapping of the Sturt Plateau IBRA was conducted and shown in figure 1.

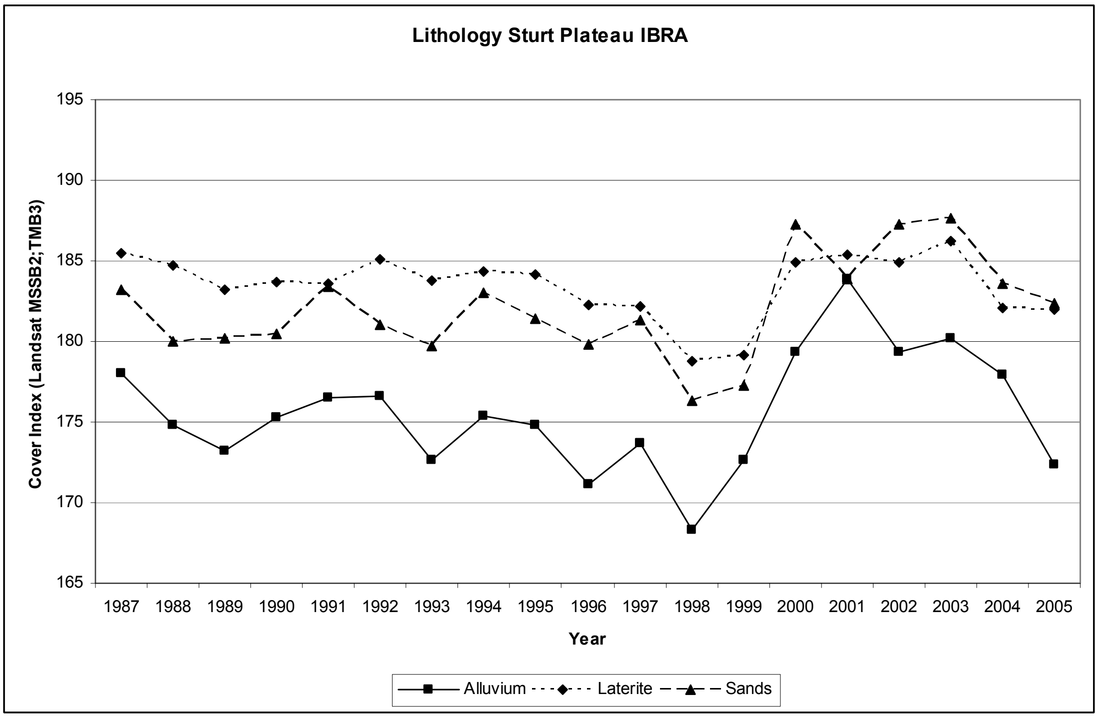


Figure 38: Time traces spanning the period 1987 to 2005 for the three land types occurring in the Sturt Plateau IBRA. Vegetation cover levels through the later part of the 1990's and early 2000's is shown to be at historical highs when compared to the 1980's. The alluvium land types have a distinctively lower cover index values when compared to the sands and laterite land types.

For the three land types, the following can be observed:

- Increasing cover trend for the later part of the 1990's and early 2000's, a response to a series of 'good' wet seasons
- Stability in the cover indices is evident from the mid 1980's to the mid 1990's
- Decreasing cover level trend from 2002 to 2005, which can be explained by increase in fire activity in the region due to large amounts of biomass

- Even though cover level trends are decreasing, the indexes have returned to levels similar to pre ‘good’ wet seasons

Land types within the Sturt Plateau IBRA have remained relatively stable with good levels of cover. In terms of condition, the remotely sensed data are consistent with results from Tier 2 site data and field observations that tracked increases in perennial plant cover and frequency during a two period from 2000 to 2001. This outcome is indicative of functioning landscapes where there is a cause and effect relationship between rainfall, the amount of cover and resource capture for promoting growth of long-lived plants. Hence it is a reasonable assertion that the sustained cover levels detected by satellites data can be regarded as an indicator of current good condition across the Sturt Plateau IBRA at the land type scale.

ORD Victoria Plain IBRA

An analysis of the main landtypes (that make up more than 10% each of the mapped IBRA region) occurring within the mapping of the ORD Victoria Plain IBRA was conducted and shown in figure 2.

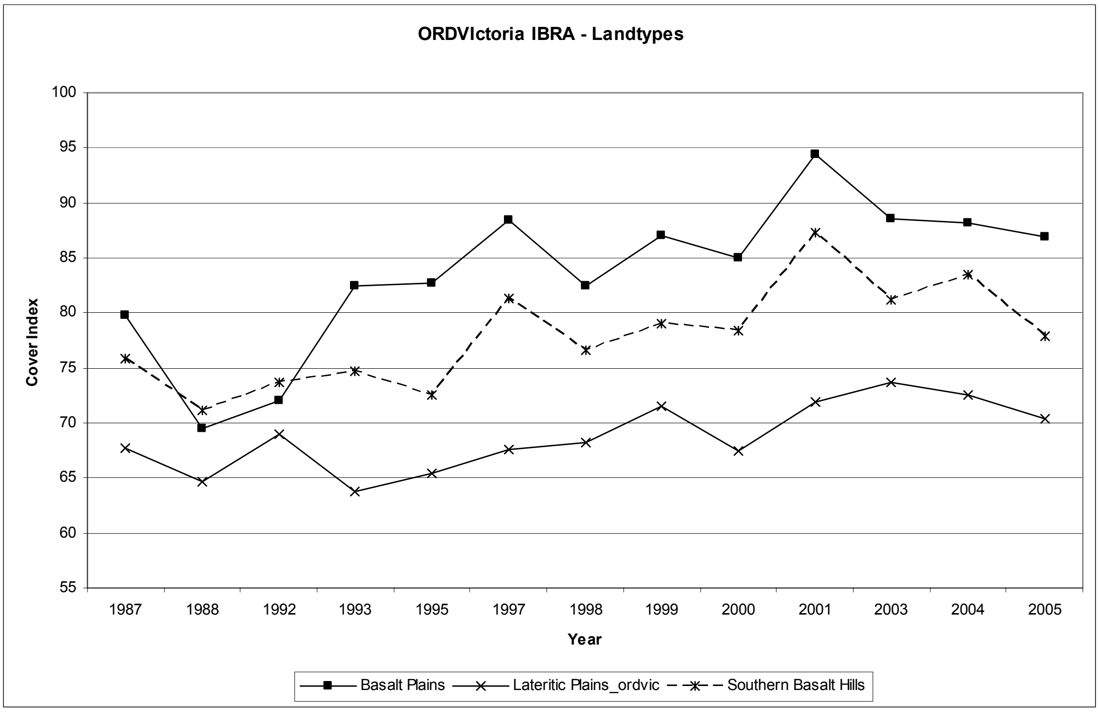


Figure 39: Time traces spanning the period 1987 to 2005 for the main land types occurring in the ORD Victoria Plain IBRA. Vegetation cover level from the mid 1990’s through to the early 2000’s are highlighting an increasing trend. Cover level indices values for all landtypes are at a higher level in 2005 than in 1987.

For the land types, the following can be observed:

- Land types through the period 1987 to 2005 have sustained an increasing trend in cover levels
- Cover level indices values for all landtypes are at a higher level in 2005 than in 1987

Victoria Bonaparte IBRA

An analysis of the main landtypes (that make up more than 10% of the mapped IBRA region) occurring within the mapping of the Victoria Bonaparte IBRA was conducted and shown in figure 3.

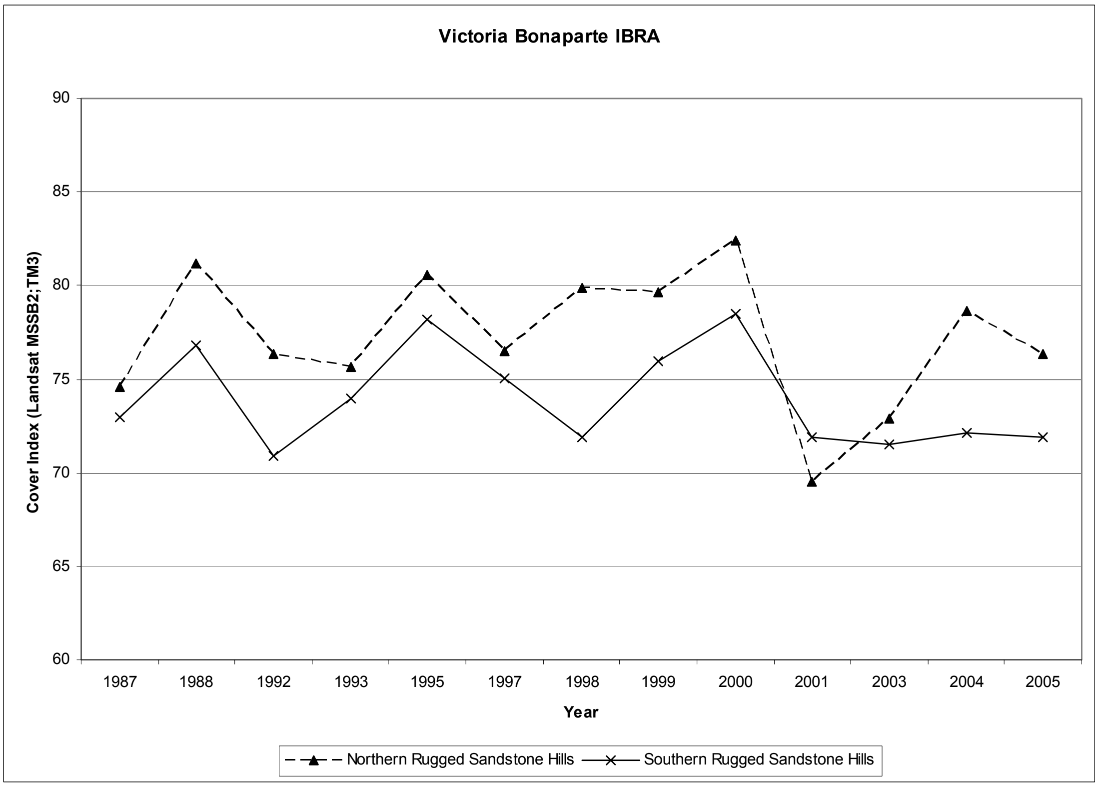


Figure 40: Time traces spanning the period 1987 to 2005 for the main land types occurring in the Victoria Bonaparte IBRA. Vegetation cover levels from the mid 1980's through to the early 2000's have a stable response with an increasing cover level trends. Cover levels decreased in 2001 and began to recover in 2003. This decrease is greatly due to the increased fire activity upon these land types, which are particularly prone to fire.

For the land types, the following can be observed:

- Stable cover levels were observed from 1987 through to early 2000's.
- Fire activity greatly influenced cover levels of all landtypes in the early 2000's
- Land types were able to recover from decreased cover levels

Note that only small parts of this bioregion are grazed.

Tier 2 - Grazing Gradient Analysis

Barkly Tableland

Methods and results are presented in Appendix 5. Inferred changes in landscape function, by sub IBRA, are summarised below (Table 28).

Table 28. %CPL values derived from dry- and wet-period image sequences.

Wet period	Sub IBRA							
	MGD1		MGD2		DMR3		GFU1	
	Infl Dist	%CPL	Infl Dist	%CPL	Infl Dist	%CPL	Infl Dist	%CPL
1995	n/a [a]	n/a [a]	9.2	19.8	8.2	n/a [b]	1.0	0.1
1997	n/a [a]	n/a [a]	7.2	24.7	13.0	n/a [c]	1.0	n/a [c]
2000	0.8	0.1	11.8	5.9	3.2	0.5	0.8	0.1
2003	n/a [a]	n/a [a]	n/a [a]	n/a [a]	2.2	1.2	1.2	0.1

[a] higher average cover closer to waterpoints in 2003 – no inflexion point and %CPL not appropriate
[b] not possible to calculate because 1995 (wet period) cover lower than 1994 (dry period) cover
[c] not possible to calculate because 1997 (wet period) cover lower than 1996 (dry period) cover.

These results show that:

- There are no deleterious effects of grazing, nor inferred loss of landscape function, on the MGD1 sub IBRA throughout the reporting period. It was not possible to calculate a %CPL value at three of the four occasions because there was no persistent wet-period grazing gradient (cover was highest, on average, at waterpoints and decreased slightly to 1-2 km from water in 1995, 1997 and 2003). The %CPL value for 2000 is very small and largely insignificant.

- In comparison, there were large %CPL values for the MGD2 sub IBRA in 1995 and 1997 (resulting from persistent wet-period grazing gradients extending to a considerable distance from water). The significance of this gradient declined in 2000 (resulting in a much smaller %CPL value) and disappeared in 2003 (not feasible to calculate %CPL). These results suggest improving grazing management of this sub IBRA but this is not proven (further monitoring required). Because of the stable nature of the grey cracking clays of this land type, it is doubtful that declining %CPL has much indicator value for landscape function (landscape stable and quite resilient).

- Fire effects probably confound interpretation of cover trends for the DMR3 sub IBRA. However, persistent gradients to ~2 km from water in the 2000 and 2003 wet-period images probably implicate grazing. The %CPL values are small and suggest a small loss of landscape function in the vicinity of waterpoints. Their relative stability between 2000 and 2003 suggest only minor changes in landscape function over time, and in reality, probable stability given seasonal variability and fire effects.

- Similar comments apply to GFU1. Persistent wet-period grazing gradients are minor, derived %CPL values are small and stable through the reporting period. This infers minimal loss of landscape function with little change through the reporting period.

Central Australia

Methods and results are presented in Appendix 6. Inferred changes in landscape function, by sub IBRA, are summarised below (Table 29).

%CPL (Cover Production Loss)

% CPL (Cover Production Loss) values were calculated by comparing good wet-period images to pervious dry-period images grazing gradients. The inflexion point and distance of the inflexion point to water of the wet-period to the dry-period. Table 3 shows the 2002 %CPL in descending values, with <3 %CPL seen as full recovery as low %CPL is considered part of the 'sacrifice' area experienced close to water. Values highlighted green have been calculated with rainfall expected to result in full recovery, where as yellow has less confidence in comparing to the green %CPL values as they had experienced less rainfall that would mostly likely not result in full recovery. Higher %CPL values of good wet-period grazing gradient are an indication of loss of landscape function and therefore less than ideal grazing management practices.

Table 29: Pastoral Productive with Inflection Distance and resulting CPL% values.

Sub IBRA	Pastoral Productivity	2002 Infl Dist	2002 CPL%	1989 Infl Dist	1989 CPL%	1992 Infl Dist	1992 CPL%	1995 Infl Dist	1995 CPL%	1998 Infl Dist	1998 CPL%
MacDonnell Range P3 (198)	Low	6.4	11	10.4	16.9						
Breakaways, Stony Plains (314)	Moderate	7.2	9								
MacDonnell Range P1 (196)	Low	6.8	7.4								
MacDonnell Range P2 (197)* **	Low	6.4	5.3	9	26.5						
Burt Plain P3 (60)	Moderate	3.6	3.7	4.8	5.9			2.4	2.9		
Burt Plain P2 (59)	Moderate	5	3.6	10.2	10.7					10.6	46.8
Simpson-Strzelecki Dunefields P1 (307)	Low	5.4	3.6	5.4	10						
Finke P1 (138)	Low	3.8	1.8	10.8	19.1						
Toko Plains (66)	Moderate	4.4	1.1	11.8	30.2	10.2	13.3				
Tieyon, Finke P3 (140)	Low-Moderate	4	1.1	5.2	3.4						
Finke P2 (139)	Moderate	2.6	1	15.6	40.3						
Burt Plain P1 (58)* **	Moderate	5	1	9.2	8.8					9	16.7
Simpson Desert (308)	Very Low	3.8	0.8	6.2	0.6						
Tanami P3 (326)	Very Low	1.8	0.2	4.8	8.8					4.8	9.7
Burt Plain P4 (61)	Moderate	1.4	0.1	7	2.3	0.8	0.2			1.2	0
Davenport Murchison Range P2 (113)	Very Low	0.4	0	2.4	2.1					2.4	2.6
Tanami P2 (325)* **	Very Low	0.4	0	3	6.6					5.2	5

Green – Confidence in assessment, Yellow – Less confident in assessment (comparing to 2002 probably unsuitable)

All show improvement, however care should be taken in inferring changes in landscape function from %CPL values prior to 2002. There was maximum opportunity for vegetation recovery after two successive years of good rainfall prior to 2002 in most areas within southern NT. Wetter years in the 1990s were not as effective.

The %CPL shows that the MacDonnell Range IBRA and Breakaways, Stony Plains sub IBRA have the lowest landscape function in southern NT. These areas would require further assessment at a finer scale to help determine areas requiring a more intensive review of grazing management practices to ensure landscape health does not continue to decline and improvement possible.
Burt Plain P2, P3 and Simpson-Strelecki Dunefields P1 sub IBRAs have also reduced landscape function, however they are fairly close to the 3 %CPL, indicating that with improved management practices full recovery could be possible.
The remaining 10 sub IBRAs all appear to have very good landscape function, with majority showing improvement through the reporting period.

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Appendix 1: Tier 1 Site Assessment Years

Assessment dates have varied over the life of program, some sites can't be fully assessed due to different factors such as fire, flooding access, removal of pickets, and recording of all Tier 1 data fields, especially bare ground has not been consistent, therefore the number of sites available for analysis that have both biomass and cover (inverse of bare ground) are less then the number of Tier 1 sites within a bioregion. Using the first and last assessment data where both biomass and cover data are available for analysis using the modified Richard-Green Functionality Index, summarised site assessments are shown in Table 30.

Table 30: Number of Tier 1 sites used per year in the modified Richard-Green Functionality Index analysis for assessing change in Landscape Function within the Northern Territory Rangelands.

IBRA or sub IBRA	Visit	Year Range	# Sites	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Burt Plain	First	1994 to 2000	130		48	50		11		1	20				
	Last	2000 to 2004	130								13	11	4	13	89
Burt Plain Total					**48**	**50**		**11**		**1**	**33**	**11**	**4**	**13**	**89**
Burt Plain Reassessments											**13**	**11**	**4**	**13**	**89**
Channel Country	First	1994 to 2001	27		1	8					17	1			
	Last	2001 to 2004	27									10	8	5	4
Channel Country Total					**1**	**8**					**17**	**11**	**8**	**5**	**4**
Channel Country Reassessments												**10**	**8**	**5**	**4**
Daly Basin	First	1993 to 2002	11	6								5			
	Last	2003	11											11	
Daly Basin Total				**6**								**5**		**11**	
Daly Basin Reassessments														**11**	
Davenport Murchison Ranges	First	1994 to 2000	43		12	12	1	12			6				
	Last	2000 to 2004	43								2	8		16	17
Davenport Murchison Ranges Total					**12**	**12**	**1**	**12**			**8**	**8**		**16**	**17**
Davenport Murchison Ranges Reassessments											**2**	**8**		**16**	**17**
Finke	First	1994 to 2000	58		34	21				2	1				
	Last	1999 to 2004	58							7	6	8	11	5	21
Finke Total					**34**	**21**				**9**	**7**	**8**	**11**	**5**	**21**
Finke Reassessments										**7**	**6**	**8**	**11**	**5**	**21**

IBRA or sub IBRA	Visit	Year Range	# Sites	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Gulf Fall and Uplands	First	1993 to 2002	79	1		5			22	2	23	25	1		
	Last	2001 to 2004	79									4	4	15	56
Gulf Fall and Uplands Total				**1**		**5**			**22**	**2**	**23**	**29**	**5**	**15**	**56**
Gulf Fall and Uplands Reassessments												**4**	**4**	**15**	**56**
Mitchell Grass Downs	First	1993 to 2000	277	8		44	62	82	2	6	73				
	Last	2000 to 2004	277								13	1	31	117	115
Mitchell Grass Downs Total				**8**		**44**	**62**	**82**	**2**	**6**	**86**	**1**	**31**	**117**	**115**
Mitchell Grass Downs Reassessments											**13**	**1**	**31**	**117**	**115**
Ord Victoria Plain	First	1993 to 2001	229	92					7	40	42	48			
	Last	2001 to 2004	229									5	61	49	114
Ord Victoria Plain Total				**92**					**7**	**40**	**42**	**53**	**61**	**49**	**114**
Ord Victoria Plain Reassessments												**5**	**61**	**49**	**114**
Pine Creek	First	1993 to 2001	14	1				11					2		
	Last	2003 to 2004	14											1	13
Pine Creek Total				**1**				**11**					**2**	**1**	**13**
Pine Creek Reassessments														**1**	**13**
Sturt Plateau	First	1993 to 2001	179	65		1	2	35	33	1	29	13			
	Last	1998 to 2004	179						1	3	13	6	45	67	44
Sturt Plateau Total				**65**		**1**	**2**	**35**	**34**	**4**	**42**	**19**	**45**	**67**	**44**
Sturt Plateau Reassessments									**1**	**3**	**13**	**6**	**45**	**67**	**44**
Victoria Bonaparte	First	1993 to 2001	14	9							2	3			
	Last	2002 to 2004	14										9	4	1
Victoria Bonaparte Total				**9**							**2**	**3**	**9**	**4**	**1**
Victoria Bonaparte Reassessments													**9**	**4**	**1**
Simpson-Strzelecki Dunefields P1	First	1994 to 1995	8		6	6									
	Last	2002	8										12		
Simpson-Strzelecki Dunefields P1 Total					**6**	**6**							**12**		
Simpson-Strzelecki Dunefields P1 Reassessments													**12**		

Appendix 2: Modified Richards-Green Functionality Index

The Richards-Green Functionality Index (RGFI) is a procedure for deriving an index of landscape functionality from data collected at monitoring sites, in the absence of more robust data collected through formal landscape function analysis. The index is based on vegetation and soil attributes that, in combination, contribute to increased retention of rainwater and nutrients as resources for the growth and persistence of plants. These attributes include perennial grass density, vegetation cover and soil surface conditions favourable to water infiltration and retention, nutrient cycling and surface soil stability.

The original index (Appendix 3) was adapted for reporting change in landscape function in the Darling Riverine Plains and Gawler bioregions as part of pilot reporting activity by ACRIS (see Grant 2005 and Della Torre 2005 respectively).

The method used here is a slightly modified version of that used by Grant (2005) for the Darling Riverine Plains. This adaptation was necessary because:

The composition of herbage species by biomass is estimated at Tier 1 sites rather than species frequency (as used by Grant, 2005).

Estimated ground cover has been weighted by the proportion of perennial grasses present (i.e. cover comprised of a high proportion of perennial grasses is assumed to contribute more to improved landscape function than a site with an equivalent cover of annual or ephemeral species).

Percentage biomass of perennial herbage species

The percent contribution of the main pasture species (by dry weight) is estimated at Tier 1 sites (i.e. those species contributing 10% or more to total biomass). Because perennial species (and dominantly, grasses) contribute most to maintaining landscape function, I have weighted the contribution of perennial grasses with the codes listed in Table 31.

Table 31: Categories of perennial biomass used to assign perenniality values to the Richards-Green Functionality Index.

% Perennial Biomass	Perenniality Biomass Index
0-10	1
11-20	2
21-30	3
31-40	4
41-50	5
51-60	6
61-70	7

71-80	8
81-90	9
91-100	10

Note that Tier 1 estimates of species composition are adjusted for any grazing (utilisation). This means that the more palatable perennial grasses are not discriminated against because they may have been grazed. These species will likely contribute less to actual pasture biomass if assessed late in the dry season compared with shortly after good rains, simply because they have been more heavily grazed later in the dry season. This adjustment provides the adapted functionality index with necessary robustness to compensate for short-term grazing effects on the biomass of perennial species, and importantly, allows us to include a measure of perenniality in the calculation of landscape function.

Weighting of estimated cover

The cover of bare ground has been estimated at most Tier 1 sites. By corollary, the cover of herbage (pasture) is 100 minus % bare ground. The contribution of perennial ground cover to landscape function has been weighted according to its presence (Table 32). That is, estimated ground cover was multiplied by the proportion of perennial species (based on biomass from above) and then coded with the lookup values in Table 2.

Table 32: Categories of perennial ground cover used to calculate the site-based Richards-Green Functionality Index.

% Perennial Cover	Perenniality Cover Index
0-10	1
11-20	2
21-30	3
31-40	4
41-50	5
51-60	6
61-70	7
71-80	8
81-90	9
91-100	10

Richards-Green Functionality Index – an example

A modified RGFI index was calculated for each Tier 1 site assessment where sufficient data allowed (note that cover was not assessed at all sites or their reassessments). The index value for the site is simply the sum of coded values – see the example in Table 33.

Table 33: Change in RGFI values for a monitoring site.

Component	*Time 1*		*Time 2*	
	Value	Code	Value	Code
% composition perennial grasses	25	3	70	7
% ground cover	40		55	
% perennial cover	25 * 0.4 = 10	1	70 * 0.55 = 38.5	4
RGFI	3 + 1	**4**	7 + 4	**11**

Changes in RGFI values at each site were then interpreted with regard to seasonal conditions prevailing prior to each re-assessment.

Appendix 3 – Richards-Green Functionality Index

Australian Collaborative Rangeland Information System
Fundamental product 3b: Change in landscape function [1]
PROPOSED REPORTING CONCEPT

DERIVED PRODUCT [2]

Reporting scale	Reporting media	**RICHARDS/GREEN FUNCTIONALITY INDEX**			
		Functionality		Trend	
IBRA	ACRIS	1	**Highly functional:** Low number of invasive species. 'Ideal' species list. Relevant crypto cover. Low soil erosion. High perenniality. Landscape patches undisturbed. Bare soil areas restricted.	1	**Improving:** Increasing size/frequency of patches; number of "ideal" species; relevant cryptogam cover; perenniality. Decreasing: soil erosion; bare soil areas. Stable or increasing: number of obstructions.
		2	**Functional:** Some invasive species, average no. of 'ideal' species. Relevant cryptogam cover not to full potential. Some: soil erosion, perennials, undisturbed landscape patches, bare soil areas.	2	**Stable:** Maintenance of stability or near stability of the above.
		3	**Poorly functioning:** Many invasive species present. Much soil erosion. Few undisturbed patches, few perennials, large areas of bare soil, few obstructions.	3	**Declining:** Decreasing: size/frequency of patches; perennials; 'ideal' species; relevant crypto cover; obstructions. Increasing soil erosion, bare areas and number of invasive species.

Notes: [1] Landscape function is defined as the ability of the landscape to effectively trap and utilise moisture and nutrients varying over space and time.

[2] Product produced by the States and NT through expert interpretation of supporting field data.

Appendix 4: %CPL Index

Grazing gradient analysis based on remotely sensed (Landsat) data provides a means for monitoring grazing impact in the arid and semi-arid rangelands. The %CPL (Cover Production Loss) Index (Figure 32) allows numerical ranking of the extent to which a grazing gradient persists after good rainfall.

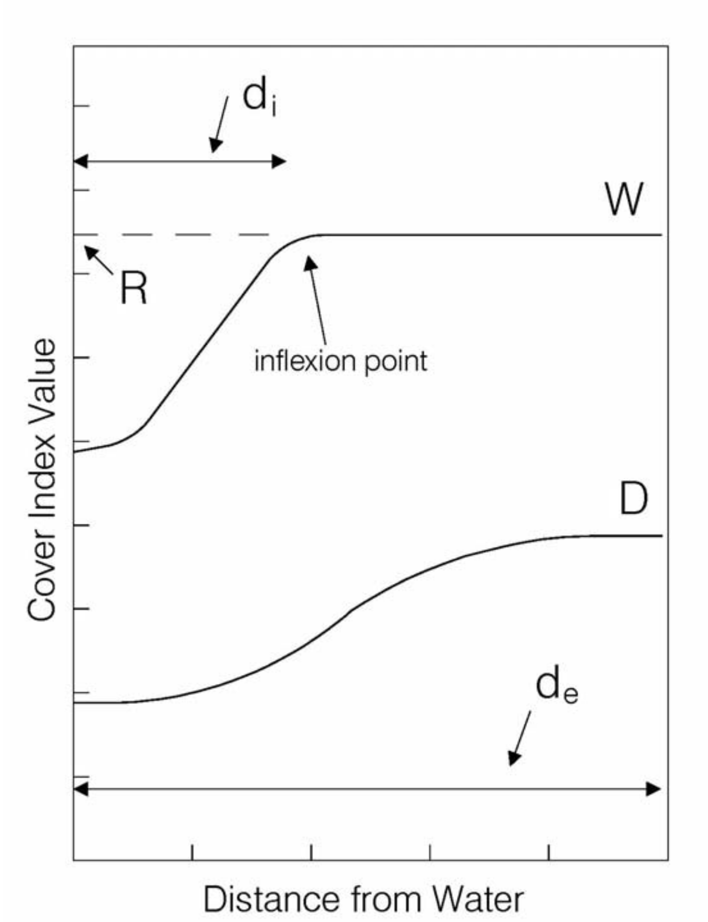


Figure 41: Procedure for calculating the %CPL Index.

The lower solid line (D) represents dry period cover, the upper solid line (W) shows wet period cover and the dashed line (R) expected cover if the vegetation fully recovered. d_i is the number of distance classes to the inflexion point from water while d_e is the number of distance classes over which the %CPL index is to be calculated.

The %CPL Index is calculated as:

$$\%CPL = A/(A+B) * 100$$

where:

$$A = \sum_{k=1}^{d_i}(R-W_k)n_k$$

$$B = \sum_{k=1}^{d_e}(W_k-D_k)n_k$$

In these equations:

- R is the cover index value expected if the vegetation fully recovered in a wet period;
- W_k is the observed wet period cover index value in distance class k;
- D_k is the observed dry period cover index value in distance class k;
- d_i is the number of distance classes to the inflexion point from water. The inflexion point is the distance, when approaching water, beyond which wet-period average cover values markedly decrease;
- d_e is the number of distance classes over which the recovery index is to be calculated;
- n_k is the number of pixels in distance class k.

Appendix 5: Grazing Gradient Results for the Barkly Tableland

General area

Version 6.1 sub IBRAs were used for landscape stratification. The general area of the Barkly Tableland is shown by the red box superimposed on the sub IBRA boundaries in Figure 33. (Box area is 525 km E-W and 423 km N-S.)

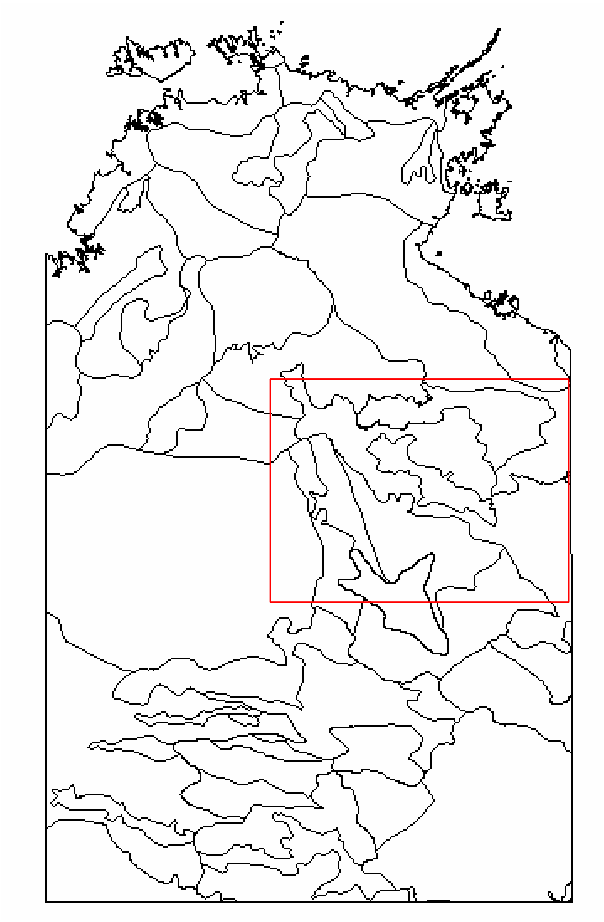


Figure 42: Barkly Tableland region superimposed on v6.1 sub IBRAs of the Northern Territory.

Landsat imagery

There are two analysis areas (Figure 34) – extensive coverage for the 2000 wet period and a "core" area of two Landsat scenes (Paths 101 & 102, Row 73) centred on the productive grey cracking clays.

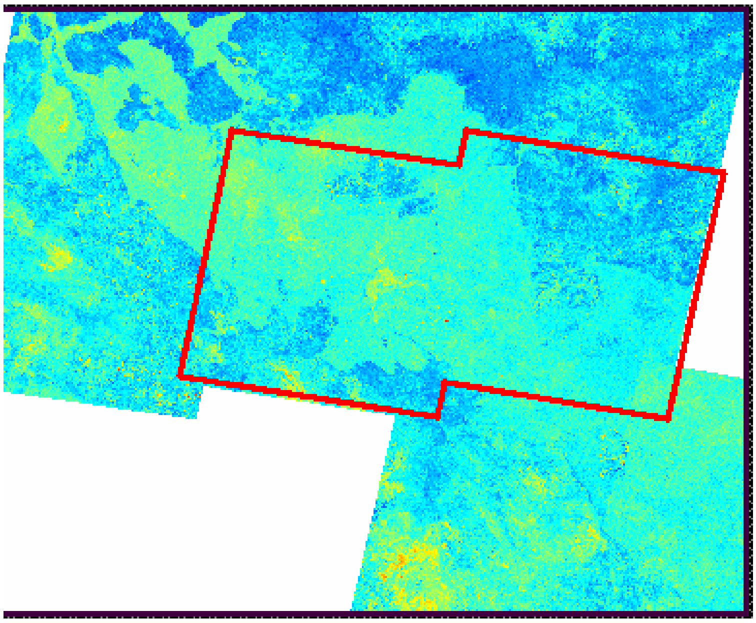


Figure 43: Barkly region showing extent of Landsat imagery, as a vegetation index, for the 2000 wet period and the core area (outlined in red).

Image dates

Available image dates are summarised in Table 34 according to whether they represent dry-period (end of dry season) or wet-period (end of wet season) conditions.

Table 34: Image dates, categorised as dry period or wet period.

Extent	Year	Representing
Core area	1994	Dry period
	1995	Wet period
	1996	Dry period
	1997	Wet period
	2002	Dry period
	2003	Wet period
Larger area	2000	Wet period

Procedure

1. Re-project v6.1 sub IBRAs (shape file) to UTM zone 53 (GDA 94). Code sub IBRAs as numbers and export as float file with same geographic extent as Landsat images used for grazing gradient analysis – north west = (295000, 8108000), south east = (820000, 7685000).

2. Conduct grazing gradient analyses using:
   - cover images derived from available Landsat dates (as per Fig. 2 and Table 1 – PD12 index for black soil, PD54 index for red soil),
   - sub IBRA codes as stratification layer (i.e. land type) and
   - distance from water.

3. Graph grazing gradients and calculate %CPL values where appropriate.

4. Interpret results in terms of inferred change in landscape function.

Seasonal Conditions

Wet season rainfall (November-April) for the reporting period (1992-2004) for Brunette Downs and Alroy Downs (extracted from *Rainman*) are listed in Table 6. Also shown is the rank of each wet season total against the long term record (1891-2004 for Brunette Downs, 113 years and 1951-2004 for Alroy Downs, 53 years). Wet season totals are also colour-coded at three levels to indicate seasonal quality where:

red = driest 1/3rd of wet season totals

green = middle 1/3rd of wet season totals

blue = wettest 1/3rd of wet season totals

Table 35: Wet season (November-April) rainfall for Alroy Downs and Brunette Downs.

Wet season	Alroy Downs		Brunette Downs	
	Rainfall (mm)	Rank	Rainfall (mm)	Rank
1991-92	166	5	125	5
1992-93	494	44	531	95
1993-94	208	11	185	18
1994-95	284	25	412	84
1995-96	280	23	318	59
1996-97	369	37	383	75
1997-98	372	38	490	91
1998-99	280	24	470	90
1999-00	597	48	814	109
2000-01	850	51	751	108
2001-02	533	45	271	43
2002-03	351	34	463	89
2003-04	348	33	596	98

Based on wet-season rainfall recorded at Brunette Downs and Alroy Downs Homesteads, the core area has experienced generally average to above average seasons through the reporting period (1992-2004). There were two below-average wet seasons in the early part of the reporting period (1991-92 and 1993-94) but since then, all wet seasons have been average or above average.

Results

Sub IBRA description and areas

Sub IBRAs wholly or partly present on the Barkly Tableland are described in Table 7. This table also shows various areas covered by Landsat imagery, and hence amenable to analysis, to help judge the importance of each sub IBRA to pastoral production. Notes following the table summarise key results.

Based on coverage of Landsat imagery within the core area, grazing gradient (and derived) results are presented for the Mitchell Grass Downs (MGD1 & MGD2), Davenport Murchison Range (DMR3) and Gulf Fall & Uplands (GFU1) bioregions.

Table 36. Description and areas of sub IBRAs on the Barkly Tableland.

sub IBRA code	IBRA	sub IBRA	Description	sub IBRA #	Area (km^2)	Area (km^2) in 2000 Landsat coverage	Area (km^2) in 1994 Landsat coverage	Area as % of 2000 Landsat coverage	Area as % of 1994 Landsat coverage	Area 2000 coverage within 8km of water	% of area within 8km of water
DMR1	Davenport Murchison Range	Davenport Murchison Range P1	Characterised by a chain of ranges and includes areas of sand plains, rocky outcrops in central Northern Territory. Eucalypt low open woodland and acacia sparse shrubland over hummock grassland	4	12,179	3,290	0	27	0	2,509	76
DMR2		Davenport Murchison Range P2		5	9,644	0	0	0	0	0	
DMR3		Davenport Murchison Range P3		6	29,490	3,861	2,090	13	7	2,805	73
GFU1	Gulf Fall & Uplands	Gulf Fall & Uplands P1	Spectacular gorges, water holes and dissected sandstone plateaux. Eucalyptus woodlands over hummock or tussock grasses are the dominant vegetation type, although monsoon forests and vine thickets occur along rivers in the sandstone country.	7	16,297	3,088	3,187	19	20	1,547	50
GFU2		Gulf Fall & Uplands P2		8	25,161	4,426	597	18	2	3,099	70
GUC1	Gulf Coastal	Gulf Coastal P1	Gently undulating plains with meandering rivers and coastal swamps.	9	1,015	0	0	0	0	0	
MGD1	Mitchell Grass Downs	Mitchell Grass Downs P1	Treeless rolling plains, dominated by Mitchell grass tussock grasslands.	11	11,525	10,963	10,885	95	94	9,589	87

sub IBRA code	IBRA	sub IBRA	Description	sub IBRA #	Area (km^2)	Area (km^2) in 2000 Landsat coverage	Area (km^2) in 1994 Landsat coverage	Area as % of 2000 Landsat coverage	Area as % of 1994 Landsat coverage	Area 2000 coverage within 8km of water	% of area within 8km of water
MGD2		Mitchell Grass Downs P2, Barkly		12	65,797	53,986	27,001	82	41	50,230	93
STU1	Sturt Plateau	Sturt Plateau P1	Flat to gently undulating plains with little local relief. Dominant vegetation communities are woodlands of Eucalypts and other species over an open grassland understorey. Mitchell grasslands occur in parts of the region.	16	1,395	522	0	37	0	454	87
STU2	Sturt Plateau	Sturt Plateau P2		17	8,787	2,256	0	26	0	1,816	80
TAN1	Tanami	Tanami P1	Mainly spinifex (hummock grassland) sand plains.	19	14,938	0	0	0	0		
TAN2		Tanami P2		20	14,232	528	0	4	0	366	69
TAN3		Tanami P3		21	11,259	946	0	8	0	602	64

This table shows that:

1. There is good Landsat coverage of the Mitchell Grass Downs MGD1 sub IBRA, both for the core area and 2000, to allow comprehensive reporting. 87% of the area of MGD1 covered by the 2000 imagery is within 8 km of water.

2. Much (82%) of MGD2 is covered by the 2000 imagery but only half this area falls within the core area so the results for 1994/95, 1995/96 and 2002/03 may not adequately represent this sub IBRA. Again, most of the sub IBRA is within grazing range of cattle (at 8 km).

3. DMR3 (Davenport Murchison Range) and GFU1 (Gulf Fall & Uplands) have reasonable coverage within the core area (>2000 km^2) although only a small proportion of the area of each on the broader Barkly Tableland is covered by the majority of image dates. I present grazing gradient results for these two sub IBRAs but these results may not adequately represent the true situation.

Grazing gradient analysis

MGD1 (Mitchell Grass Downs)

Grazing gradient results are shown in Figure 35. Brief comments on their significance follow.

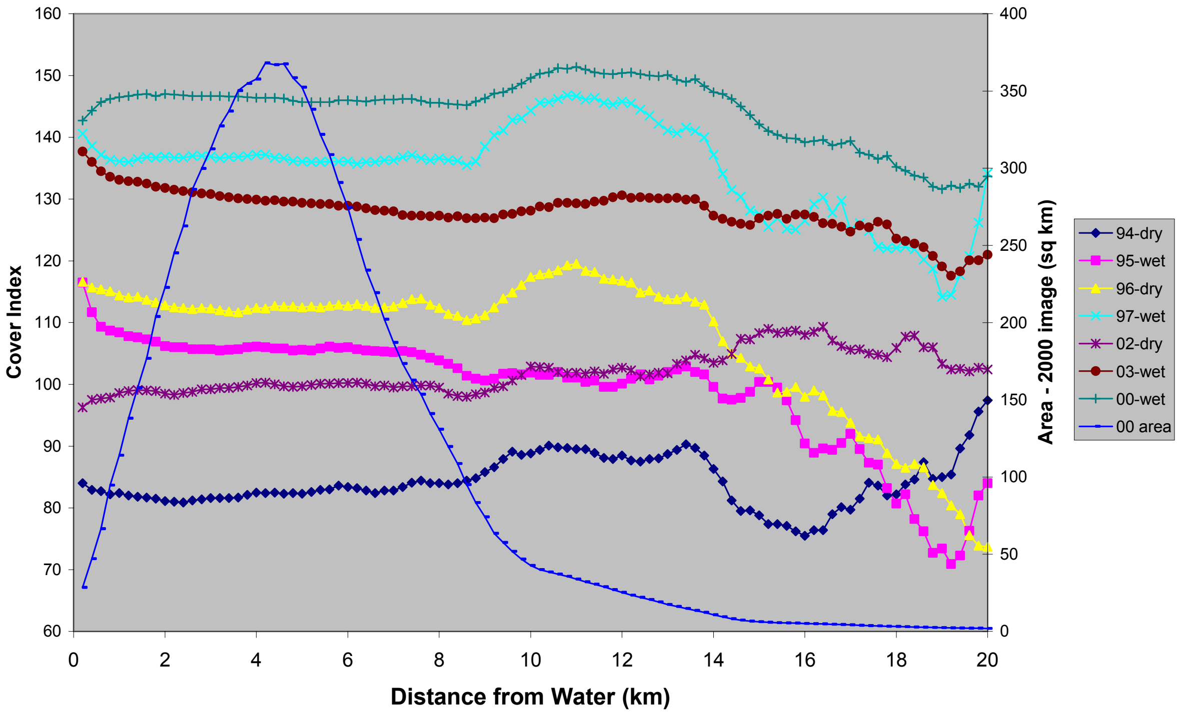


Figure 44. Grazing gradient results for the MGD1 (Mitchell Grass Downs) sub IBRA.

- The graph of watered area (blue line) shows that most of the sub IBRA is within 10 km of permanent water.
- Cover index values (left hand Y axis) below 60 represent very low cover. Values above ~140 represent high cover.
- Due to the generally very small areas in paddocks beyond about 14 km from water, cover levels and trends are unreliable (i.e. ignore, or at least discount, these areas when interpreting the graphs of mean cover in Figure 35).
- Average cover increased with wet season rainfall (to be expected). Cover was lowest (on average) in 1994 and increased to a moderate level in 1995 (end of 1994/95 wet period). Average cover at the end of 1996 was slightly higher than that present in 1995 (at the end of the 1994/95 growing period). This seems anomalous but may have been due to good growing conditions through the 1995/95 wet season and persistence of cover throughout 1996. Cover increased further over the 1996/97 summer. Cover increased appreciably over the 2002/03 summer (growing season) with 2003 cover a little below that present in 1997. Cover was highest in 2000 after the very good 1999/2000 wet season.

- There is no evidence of appreciable persistent wet-period grazing gradients (i.e. lack of recovery of vegetation cover due to damage from past grazing). There is a slight gradient of increasing cover in 2000 (to about 800 m from water). For other wet periods (1995, 1997 and 2003), cover was slightly higher (on average) at the waterpoint and declined over the first kilometre or so. This may have resulted from prolific growth of ephemeral (and perhaps mainly unpalatable) grass and herbage species closer to water.

- Correspondingly, there are no strong grazing gradients in the dry period imagery. It appeared that cattle were grazing more-or-less uniformly with increasing distance from water (averaged over the area at each distance increment from water). The Brahman and Brahman-infused cattle of the region are renowned as "good walkers".

In summary, there is no evidence of detrimental grazing effects on the MGD1 sub IBRA. My assessment is that this land type continues to be sustainably grazed.

MGD2 (Mitchell Grass Downs)

Grazing gradient results are shown in Fig. 5. Brief comments on their significance follow.

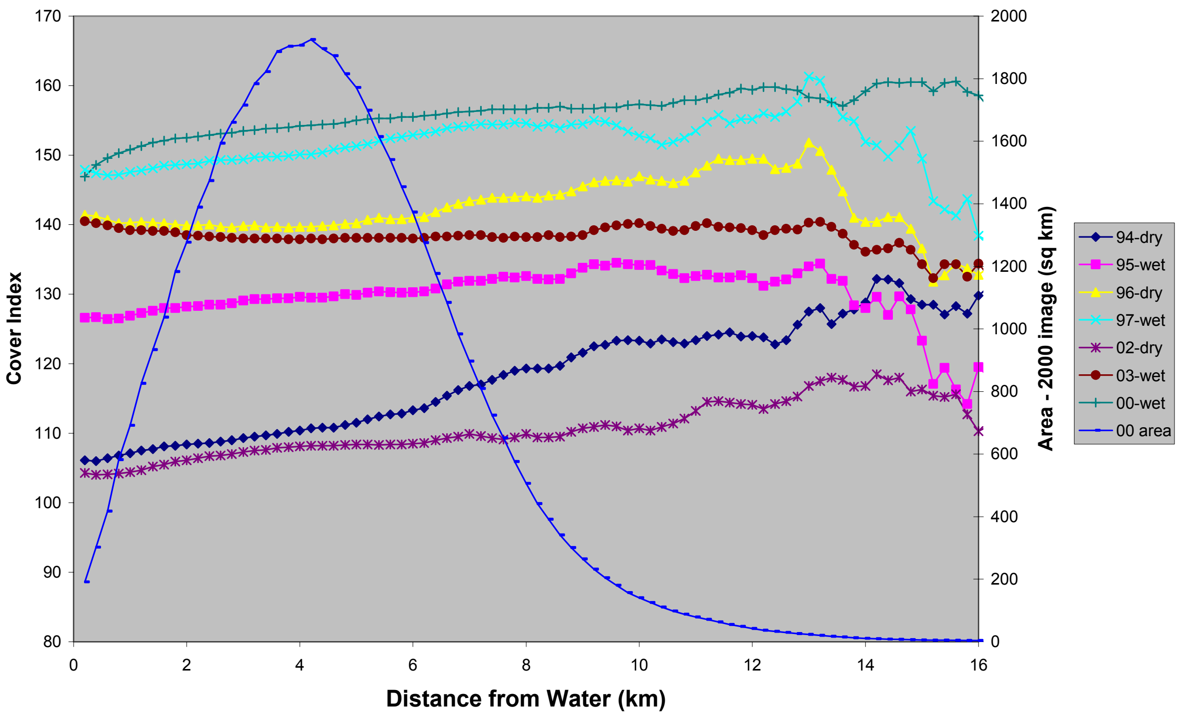


Figure 45. Grazing gradient results for the MGD2 (Mitchell Grass Downs) sub IBRA.

- Most of the land type is within 8 km of permanent water reflecting its very productive nature for cattle grazing. Levels of average cover beyond about 12 km from water are probably unreliable because of the small areas analysed in a few of the larger and less intensively watered paddocks.

- There are distinct dry-period grazing gradients and although these flatten off following wet-season rainfall, grazing gradients persist indicating apparent past damage due to grazing. The nature of wet-period grazing gradients do not appear to have changed through the reporting period indicating no change in landscape function or sustainability of grazing management.

- To elaborate:

  Average cover levels were lowest in 1994 and 2002. There was quite a distinct gradient of increasing cover to ~10 km from water in 1994.

  Average cover increased to a moderate level after the 1994/95 wet and there was a gradual increase in cover to ~9 km from water.

  As for MGD1, cover at the end of the 1996 dry season was, on average, higher than that present 16-18 months earlier (end of 1994/95 wet season). Cover levels were fairly uniform to ~6 km from water and then gradually increased to 10 km. Average cover increased a little over the 1996/97 wet period with cover gradually increasing to ~7 km from water.

  Cover was low and fairly uniform with increasing distance from water at the end of the 2002 dry season. Cover increased through the 2002/03 wet season and there was no evidence of a persistent grazing gradient in 2003 (cover fairly uniform to ~9 km from water).

  The best wet season (1999/2000) produced cover levels similar to those present in 1997. Cover increased most sharply over the first kilometre from water and then more gradually to ~12 km form water.

In summary, grazing effects in the MGD2 sub IBRA persist through the wet season to partially suppress complete recovery of vegetation cover in the vicinity of watering points. There was complete recovery (no persistent grazing effect) at the most recent assessment (2003) but this is considered insufficient evidence that grazing management has markedly improved towards the end of the reporting period.

Note:

- These grazing gradients are less steep than those detected in parts of the Alice Springs district and their impact on sustainable management is considered fairly benign.

- The MGD2 sub IBRA includes the ephemerally flooded lakes on Brunette Downs (and neighbouring stations). The distance-from-water layer used for grazing gradient analysis is based on permanent watering points. Thus presence of surface water in the lakes will affect actual distance from water – much of the area analysed will at times be closer to water than the graph (Fig. 5) indicates. Additionally, the brighter "ashy" soils of this "dry lake / dry-bog" country may adversely affect the PD12 cover index meaning that index values may not accurately represent actual cover levels present.

DMR3 (Davenport Murchison Range)

Grazing gradient results are shown in Fig. 6. Brief comments on their significance follow.

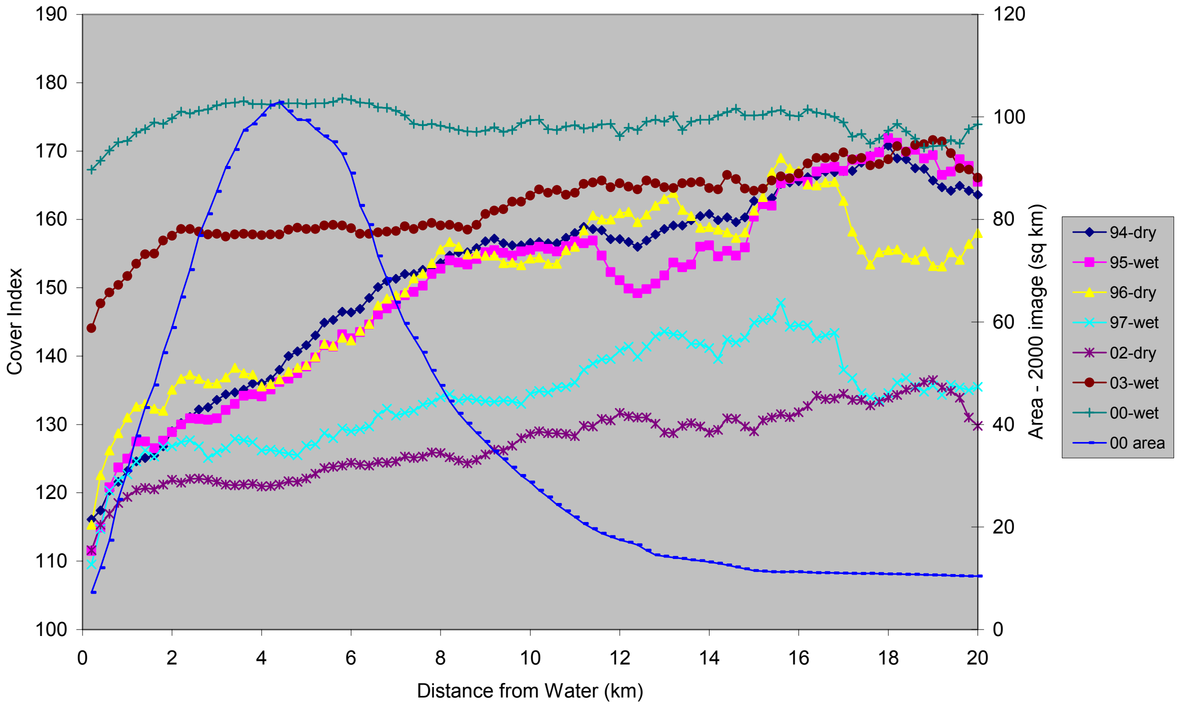


Figure 46. Grazing gradient results for the DMR3 (Davenport Murchison Range) sub IBRA.

- For the area of this sub IBRA analysed, small areas extend beyond 12 km from water (the reverse situation to the much more productive MGD1 and MGD2 sub IBRAs).
- There were steep gradients of increasing cover to 8 km from water in 1994, 1996 (end of dry period) and 1995 (end of wet period). These apparent grazing gradients may have been enhanced by fire (burning of spinifex) and thus not entirely due to grazing.
- As further evidence of possible fire effects, the 1994 and 1995 average cover levels were similar (i.e. no apparent increase in cover through the 1994/95 wet season) and the 1997 cover (end of 1996/97 wet season) was considerably less than that present in 1996 (end of dry season).
- There was appreciable increase in cover through the 2002/03 wet season (i.e. compare 2002 and 2003 average cover levels). There was a distinct gradient of increasing cover in 2003 to ~2 km from water indicating a probable persistent grazing effect.
- Cover levels were highest (on average) following the very good 2000 wet season. Cover levels increased gradually to ~3 km from water – further evidence of a probable small persistent grazing effect in this predominantly spinifex dominated country that is of limited value for cattle production.

My assessment is that because this sub IBRA is periodically burnt, fire effects probably compound the interpretation of grazing impact from grazing gradient analysis. The presence of increasing cover to between 2-3 km from water following the 1999/2000 and 2002/03 wet seasons probably indicates some grazing impact (possible small loss of landscape function). Because much of the cover has low pastoral productivity and is actually enhanced by fire (i.e. regrowth often of higher quality for grazing), it is difficult to be definitive about sustainability of management, and even less so about change through the analysis period.

GFU1 (Gulf Fall & Uplands)

Grazing gradient results are shown in Fig. 7. Brief comments on their significance follow.

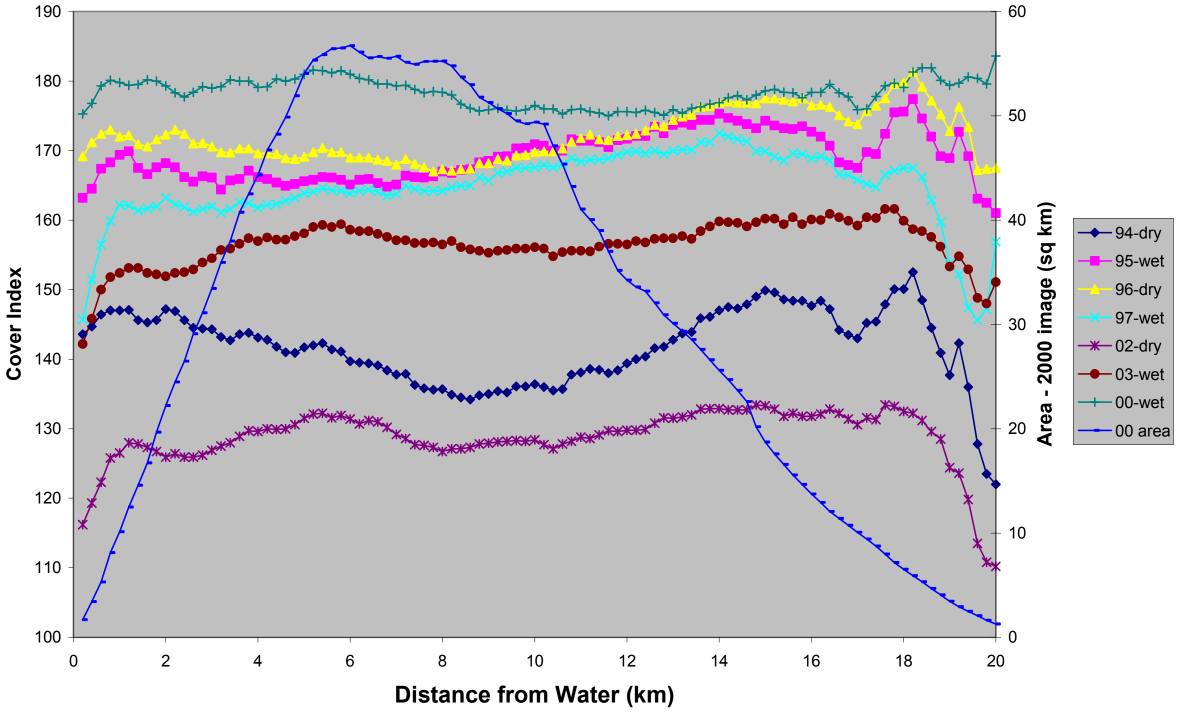


Figure 47. Grazing gradient results for the GFU1 (Gulf Fall & Uplands) sub IBRA.

- Compared to MGD1 and MGD2 sub IBRAs, there are substantial areas within the area covered by the 2000 Landsat image that are beyond the area potentially grazed by cattle (>8 km from water).

- This land type has a significant component of woody cover. Index values are higher than for MGD1 and MGD2 suggesting higher cover – although this is not really a valid comparison because the two land types use different indices to indicate cover (PD54 for GFU1 and PD12 for MGD1 & MGD2 – neither index has been calibrated to actual cover levels). Correspondingly, woody cover may have masked some effects of grazing on ground cover.

- Average cover increased to variable distances from water indicating variable grazing impacts. Generally however, these effects appear to be relatively minor.

- Average cover was lowest in 2002. Following the 2002/03 wet season, cover increased, on average, quite substantially. 2003 cover increased quite steeply over the first kilometre from water and then more gradually to 5.4 km.

- There was some increase in cover over the 1994/95 wet season with a small gradient of increasing cover to ~1 km in the wet-period image (1995). Persistent grazing effects beyond this distance appeared to be negligible, although average cover levels increased further between ~8 and 14 km from water.

- Cover was highest in 2000 and there was no evidence of any significant permanent grazing effect.

- For some reason, cover levels at the end of the 1996/97 growing season (i.e. 1997) to ~8 km from water were lower than those present in late 1996. This is counter to that expected and may have resulted from a poor wet season over much of the area covered by available imagery for this sub IBRA (not supported by rainfall records examined), or compounding effects of fire.

To summarise, the 1995, 2000 and 2003 wet-period Landsat images indicated a small persistent effect of grazing close to water (to about 1 km). This indicates a small loss of landscape function and a possible small decline in forage available for grazing. There is no evidence of any significant change in landscape function or sustainability of grazing management over the analysis period (1994/95 to 2002/03).

%CPL

%CPL values (to indicate change over time in landscape function) are shown in Table 8. To calculate legitimate values, each wet-period image needs a corresponding prior dry-period image. No immediately prior image was available for the 2000 wet-period image so I have substituted the 1996 image for the dry-period.

Note that higher %CPL values mean a more persistent wet-period grazing gradient and are interpreted to mean a loss of landscape function on red soils (DMR3, GFU1) and less so on grey cracking clays (MGD1 & MGD2).

This, and change in %CPL values over time for each sub IBRA, should indicate trend in these two indicators.

"Infl Dist" in Table 4 is the distance (km) to which wet period grazing gradients are judged to persist.

Table 37. %CPL values (derived from dry- and wet-period image sequences) as the basis for inferring change in landscape function..

Wet period	Sub IBRA							
	MGD1		MGD2		DMR3		GFU1	
	Infl Dist	%CPL	Infl Dist	%CPL	Infl Dist	%CPL	Infl Dist	%CPL
1995	n/a [a]	n/a [a]	9.2	19.8	8.2	n/a [b]	1.0	0.1
1997	n/a [a]	n/a [a]	7.2	24.7	13.0	n/a [c]	1.0	n/a [c]
2000	0.8	0.1	11.8	5.9	3.2	0.5	0.8	0.1
2003	n/a [a]	n/a [a]	n/a [a]	n/a [a]	2.2	1.2	1.2	0.1

[a] higher average cover closer to waterpoints in 2003 – no inflexion point and %CPL not appropriate
[b] not possible to calculate because 1995 (wet period) cover lower than 1994 (dry period) cover
[c] not possible to calculate because 1997 (wet period) cover lower than 1996 (dry period) cover.

These results show that:

- There are no deleterious effects of grazing on the MGD1 sub IBRA throughout the reporting period. It was not possible to calculate a %CPL value at three of the four occasions because there was no persistent wet-period grazing gradient (cover was highest, on average, at waterpoints and decreased slightly to 1-2 km from water in 1995, 1997 and 2003). The %CPL value for 2000 is very small and largely insignificant.

- In comparison, there were large %CPL values for the MGD2 sub IBRA in 1995 and 1997 (resulting from persistent wet-period grazing gradients extending to a considerable distance from water). The significance of this gradient declined in 2000 (resulting in a much smaller %CPL value) and disappeared in 2003 (not feasible to calculate %CPL). These results suggest improving grazing management of this sub IBRA but this is not proven (further monitoring required). Because of the stable nature of the grey cracking clays of this land type, it is doubtful that declining %CPL has much indicator value for landscape function (landscape stable and quite resilient).

- Fire effects probably confound interpretation of cover trends for the DMR3 sub IBRA. However, persistent gradients to ~2 km from water in the 2000 and 2003 wet-period images probably implicate grazing. The %CPL values are small and suggest a small loss of landscape function in the vicinity of waterpoints. Their relative stability between 2000 and 2003 suggest only minor changes in landscape function over time, and in reality, probable stability given seasonal variability and fire effects.

- Similar comments apply to GFU1. Persistent wet-period grazing gradients are minor, derived %CPL values are small and stable through the reporting period. This infers minimal loss of landscape function with little change through the reporting period.

Concluding Remarks

The results reported here provide inferences for ACRIS in reporting change in landscape function for some sub IBRAs on the Barkly Tableland. The results are based on cover indices derived from Landsat data and grazing gradient analysis. In interpreting results and drawing conclusions, the following caveats apply:

- The PD12 cover index applied to the downs country (grey cracking clays, MGD1 & MGD2 sub IBRAs) is somewhat problematic. Thus changes in landscape function inferred from grazing gradient analysis are probably more indicative than absolute.

- The lake country included in the MGD2 sub IBRA is seasonally inundated. At these times, considerable areas are much closer to water than the distance-from-water layer used for grazing gradient analysis indicates. This could generate spurious results for average cover at actual distance from water. This may partly account for grazing gradients (particularly those following wet-season rainfall) extending much further from permanent water for the MGD2 sub IBRA compared with MGD1 (compare Figs 4 & 5). A further complicating factor is that the PD12 index may not be adequately indicating cover levels on the brighter "ashy" soils of this dry lake / dry-bog country (the index has not been adequately ground-truthed here).

- Fire effects confound grazing gradient analysis in the DMR3 sub IBRA. Recent fires would seem to be the most obvious explanation for mean cover at various distances from water on this sub IBRA being higher at the end of the 1996 dry season compared with the end of the ensuing 1996-97 wet season.

- The validity of grazing gradient analysis for inferring changes in landscape function on the MGD1 and MGD2 sub IBRAs may be questionable (but has been used because of the absence of other broad scale monitoring data).

- Conversely, persistent wet-period grazing gradients would seem to infer information about landscape function on the predominantly red-soil DMR3 and GFU1 sub IBRAs.

Appendix 6: Grazing Gradient Results for Central Australia

General Area

The general area of the southern NT zone 53 analysed by grazing gradient methodology is shown by the blue hatch 2002 image bounding box on the version 6.1 sub IBRAs located within the NT.

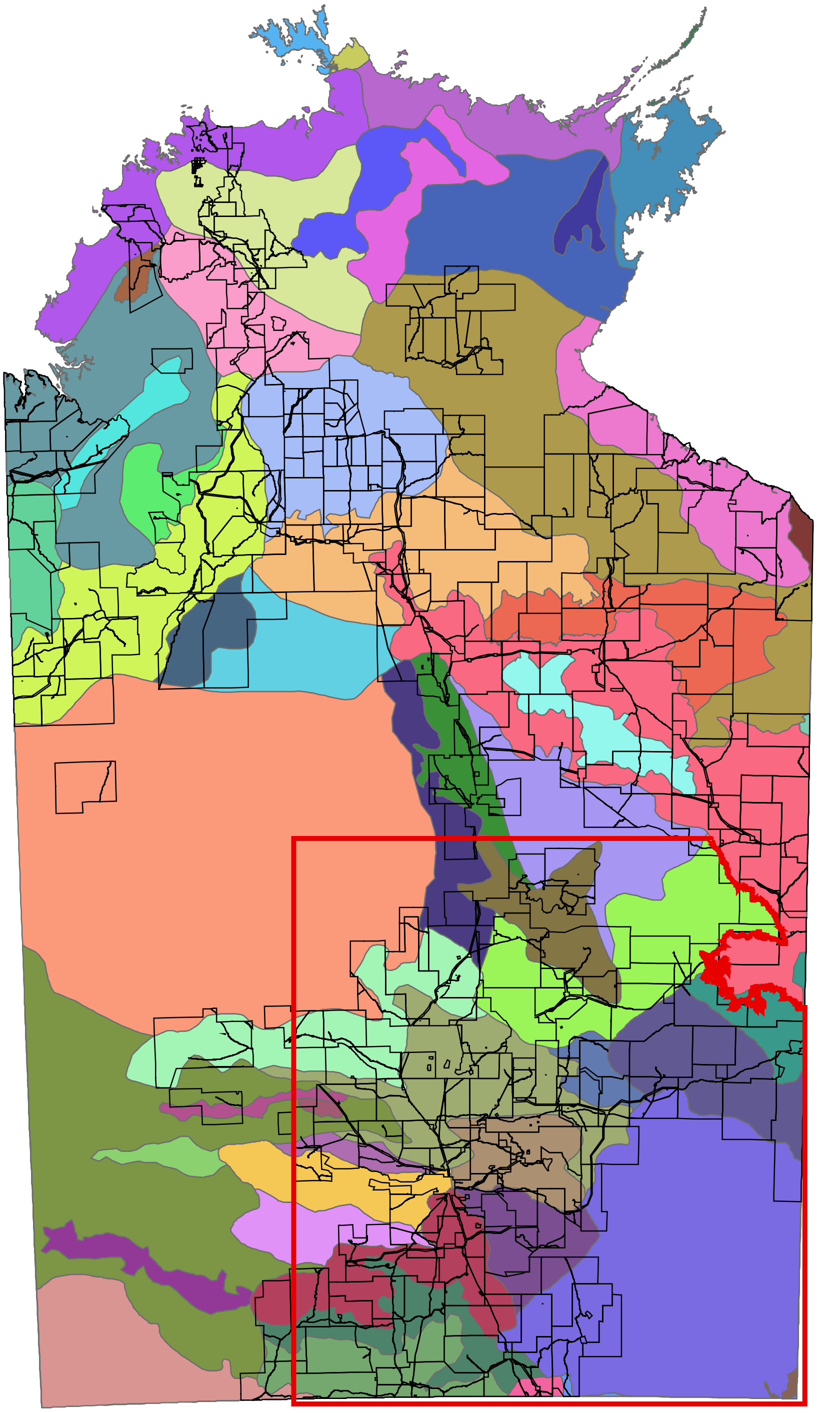


Figure 48: Version 6.1 sub IBRAs within the NT with pastoral estate and 2002 image boundary.

Landsat Imagery and Image Dates

Eight varying image years and extents were used as dry/wet paired years during the grazing gradient anaylsis. These wet/dry paired years were 1988 (dry) 1989 (wet), 1991 (dry) 1992 (wet), 1995 (dry) 1998 (wet), and 2000 (dry) 2002 (wet). The extents for each were the result of available imagery. These years were calibrated and mosaic with Figure 2 showing their resulting extents.

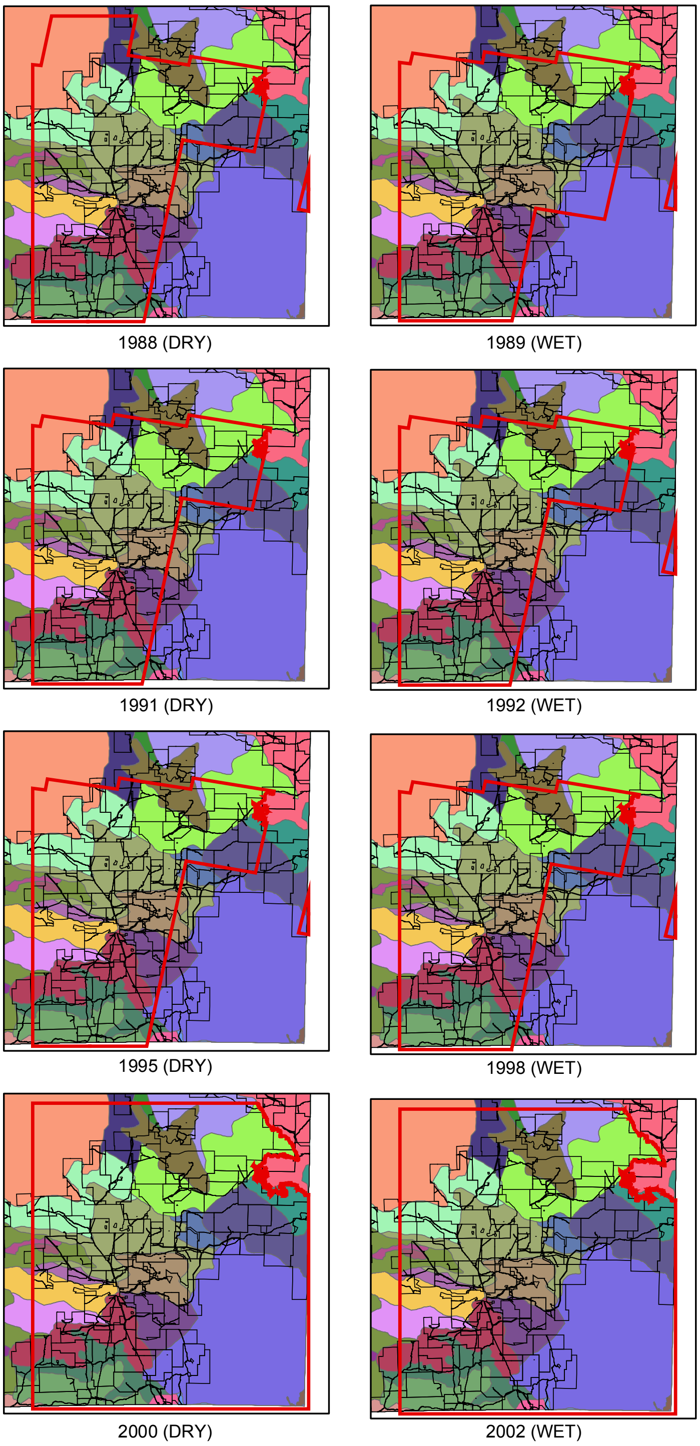


Figure 49: Southern NT (zone 53) showing Landsat coverage for dry-periods 1988, 1991, 1995 & 2000, and wet-periods 1989, 1992, 1998, 2002, over sub IBRAs and pastoral estate.

Analysed Sub IBRAs

Table 1 shows the percent of NT sub IBRA within 2002 coverage area and the percent of accessible grazing country (eg mountain ranges removed). Reporting on sub IBRAs with 70% or more coverage (highlighted green) will be analysed by grazing gradient methodology to assess their condition and the two ARCIS themes - landscape function and sustainable management.
The three sub IBRAs highlighted yellow have greater the 50% coverage and will be assessed also to give an understanding of how they compare to their related sub IBRAs, however noting portion of coverage (eg eastern portion).
Six sub IBRAs have low percent coverage (highlighted red) and will not be assessed by grazing gradient.

Table 38: Percentage of NT sub IBRA within coverage area and within grazing accessible country analysed.

Sub IBRA	% NT sub IBRA in coverage area	% NT sub IBRA analysed (grazing accessible country)	To be Assessed by Grazing Gradient Methodology
Burt Plain P1 (58)	65	46	Yes
Burt Plain P2 (59)	99	80	Yes
Burt Plain P3 (60)	94	76	Yes
Burt Plain P4 (61)	100	70	Yes
Toko Plains (66)	100	58	Yes
Mann-Musgrave Block (93)	1	0	No – Low Coverage
Davenport Murchison Range P1 (112)	8	0	No – Low Coverage
Davenport Murchison Range P2 (113)	100	24	Yes
Davenport Murchison Range P3 (114)	38	2	No – Low Coverage
Finke P1 (138)	84	74	Yes
Finke P2 (139)	93	88	Yes
Tieyon, Finke P3 (140)	99	81	Yes
Mackay (165)	6	5	No – Low coverage
Great Sandy Desert P5 (168)	24	22	No – Low Coverage
Great Sandy Desert P6 (169)	100	99	No – Inverse Gradient
MacDonnell Range P1 (196)	70	16	Yes
MacDonnell Range P2 (197)	62	16	Yes
MacDonnell Range P3 (198)	100	48	Yes
Simpson-Strzelecki Dunefields P1 (307)	100	50	Yes
Simpson Desert (308)	100	23	Yes
Breakaways, Stony Plains (314)	100	100	Yes
Macumba (318)	100	71	No – Inverse Gradient
Tanami P1 (324)	16	2	No – Low Coverage
Tanami P2 (325)	52	19	Yes
Tanami P3 (326)	99	48	Yes

Green – Over 70% accessible country analysed of NT sub IBRA and/or coverage of NT sub IBRA.
Yellow – Over 50% coverage of NT sub IBRA.
Red – Very low % coverage of NT sub IBRA or Inverse Gradient.

Procedure

1. Conduct grazing gradient analyses using:
   - cover images derived from available Landsat dates,
   - sub IBRA codes as stratification layer and,
   - distance from water.

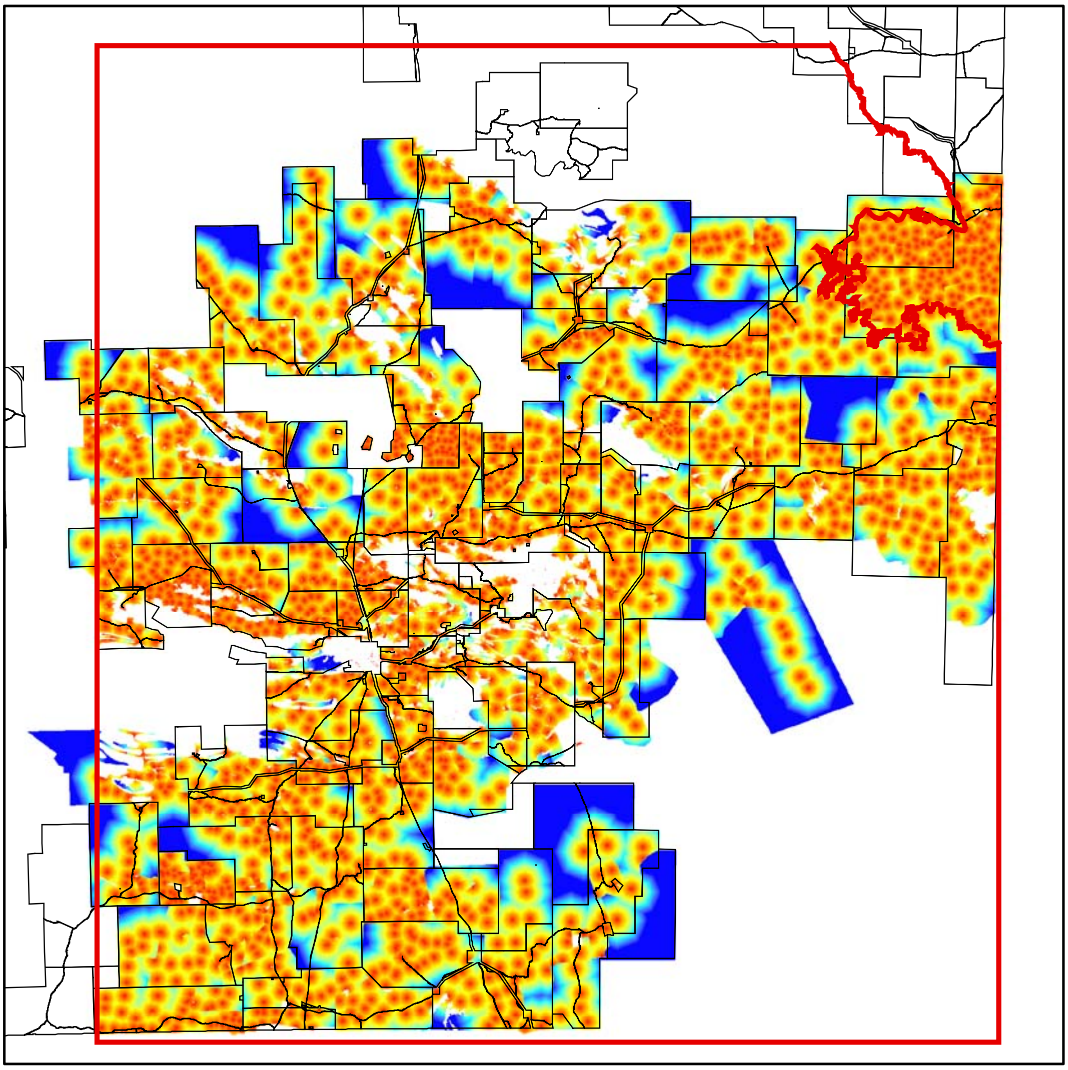


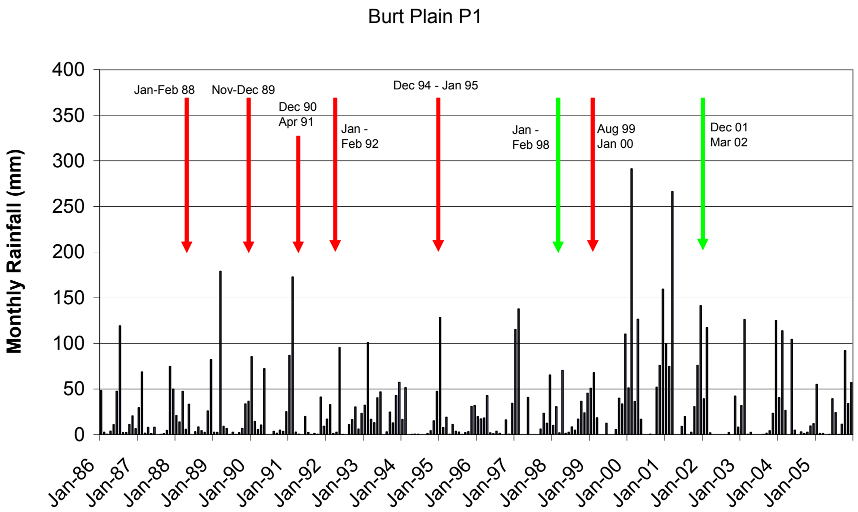
Figure 50: Distance from water points and their distance classes with NT sub IBRAs and pastoral estate within 2002 image coverage (blue polygon).

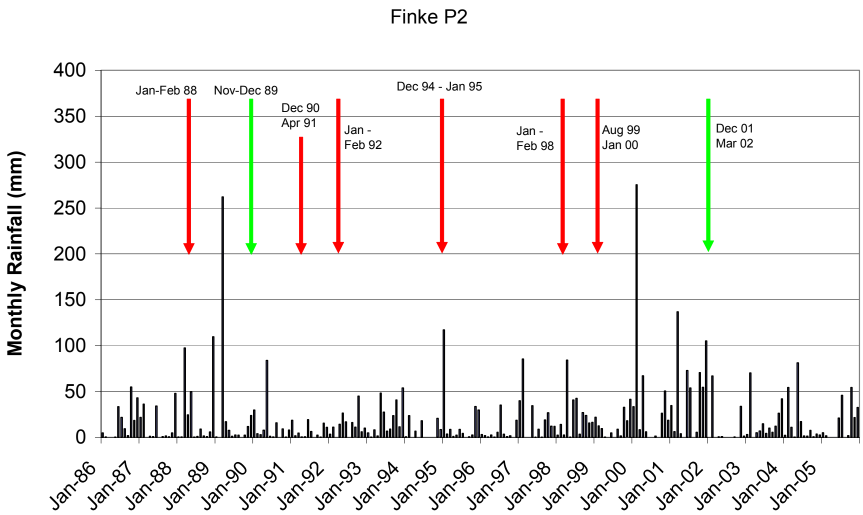
2. Graph grazing gradients and calculate %CPL values where appropriate.

3. Calculate mean levels of cover at different distance classes from water within sub IBRAs.

Seasonal Conditions

Gridded monthly rainfall spatially averaged across sub IBRAs is shown for selected sub IBRAs in Fig. 10. (Annual, monthly and daily surfaces of interpolated rainfall for Australia at 0.05 degree resolution (~5-km by ~5-km) are available for Australia by subscription or data license agreement (see http://www.bom.gov.au/silo/). CSIRO Sustainable Ecosystems has access to these data and have provided summaries to the states and NT to assist them with their reporting to ACRIS.) The approximate acquisition dates of available Landsat imagery are shown with coloured arrows, dry period images with red arrows and wet period images with green arrows. These examples show that rainfall prior to acquisition of the 2002 imagery was very high, high in the south (Finke P2 sub IBRA) prior to acquiring the 1989 imagery and more variable at other times and for other sub IBRAs.





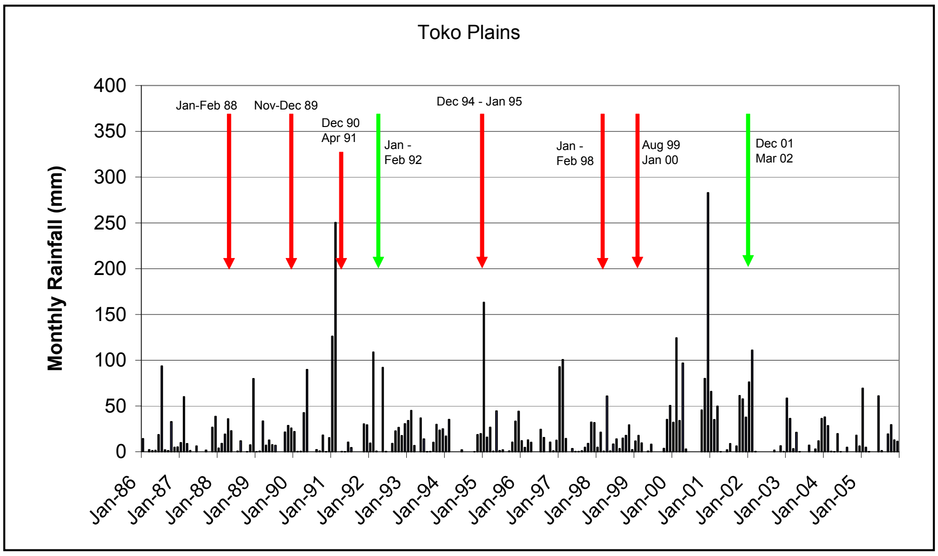


Figure 51. Gridded monthly rainfall spatially averaged across three sub IBRAs. Green arrows indicate the dates of available wet-period Landsat imagery for that sub IBRA. Red arrows show the acquisition dates of other available imagery.

Results

Sub IBRA description and areas

The sub IBRA descriptions within southern NT zone 53 are based on the Alice Springs CSIRO land system descriptions shown in Table 1. The table also shows the total area (km^2) of each sub IBRA within the study area, the coverage area within each sub IBRA of the Landsat images after good wet periods; 2002, 1989, 1998. The 2002 coverage has the largest extent of the wet images, therefore this image coverage was used to calculate the coverage within 8 km from water and its resulting percentage of its area within 8 km of water.

Table 39: Description and areas of v6.1 sub IBRAs in the southern NT (UTM Zone 53).

sub IBRA	IBRA	Description	Area (km^2)	Area (km^2) in 2002 Landsat coverage	Area (km^2) in 1989 Landsat coverage	Area (km^2) in 1998 Landsat coverage	1989 area as % of 2002 Landsat coverage	Area 2002 coverage within 8km of water	% of area within 8km of water
Burt Plain P1	Burt Plain	Metamorphic and sandstone ranges and plateaux, mostly inaccessible to stock. Accessible areas generally have low grazing value (~20%). Lower hills, foothills and valley floors with moderate grazing value (~5%). Extensive red-earth plains with mulga shrublands of low to moderate grazing value (~35%). Sandy alluvial fans and plains and contributing creek systems growing short grasses and forbs – generally high grazing value (~10%). Sandplain with predominantly spinifex – very low grazing value (~20%). Several other diverse land types including open woodland plains. Most land types have moderate to high grazing value (~10%).	29311	13587	13587	13587	100	9386	69
Burt Plain P2		Hills, foothills and valley floors with low to moderate grazing value (~5%). Extensive red-earth plains with mulga shrublands of low to moderate grazing value (~35%). Open woodland plains with mixed acacia species and short grasses and forbs of moderate to high grazing value (~20%). Alluvial fans and plains fringing creeks and rivers – mixed acacia species and short grasses and forbs of high grazing value (~15%). Sandplain growing mainly spinifex – very low pastoral value (~25%)	35311	28408	28408	23687	100	22598	80

sub IBRA	IBRA	Description	Area (km^2)	Area (km^2) in 2002 Landsat coverage	Area (km^2) in 1989 Landsat coverage	Area (km^2) in 1998 Landsat coverage	1989 area as % of 2002 Landsat coverage	Area 2002 coverage within 8km of water	% of area within 8km of water
Burt Plain P3		Metamorphic and granite mountains of the Chewings Range, generally inaccessible to stock (~20%). Alluvial fans and plains below the Chewings Range carrying mixed acacia woodlands and short grasses and forbs of high pastoral value (~35%). Red-earth plains with mulga shrublands of low to moderate grazing value (~35%). Sandplain growing mainly spinifex – very low pastoral value (~10%)	3910	2978	2978	2978	100	2918	98
Burt Plain P4		Sandstone and limestone ranges and plateaux. Some areas inaccessible to stock with lower hills, slopes and valleys having low to moderate grazing value (~45%). Undulating to flatter country with mixed acacia woodlands and short grasses and forbs of moderate to high grazing value (~40%). Sandplain growing mainly spinifex – very low pastoral value (~10%). Alluvial plains adjacent to major creeks – short grasses and forbs of high pastoral value (~5%).	5266	3704	3704	1290	100	2862	77
Toko Plains	Channel Country	Only small area in western part described. Ranges, uplands and hills. Some grazing on lower parts. Generally low to very low pastoral value (~15%). Gidyea woodlands with short grasses and forbs on undulating to flat limestone and dolomite terrain. Moderate grazing value (~60%). Open woodlands with short grasses and forbs on alluvial and other plains – high grazing value (~10%). Spinifex sandplain – nil to very low pastoral value (~15%)	23277	13587	13587	13587	100	9386	69

sub IBRA	IBRA	Description	Area (km^2)	Area (km^2) in 2002 Landsat coverage	Area (km^2) in 1989 Landsat coverage	Area (km^2) in 1998 Landsat coverage	1989 area as % of 2002 Landsat coverage	Area 2002 coverage within 8km of water	% of area within 8km of water
DMR P2	Daven-port Murch-ison Range	Quartzite and sandstone ranges. Largely inaccessible to stock. Areas that are accessible have very low grazing value (~65%). Sandy or partly stony plains with predominantly spinifex or other generally unpalatable grasses – very low grazing value (~20%). Low limestone plateaux and lower areas with mixed grasses and forbs of low to moderate pastoral value (~10%). Very small areas of floodout, alluvial plains or other mixed land types that have high pastoral value (~5%).	15896	3769 (24%)	3513	3500	93	2536	67
Finke P1	Finke	Limestone ridges, slopes and plains growing mixed short grasses and forbs of moderate grazing value (~5%). Sandstone ranges, mesas, breakaways and undulating stony plains of low to moderate grazing value (~15%). Extensive sand dunes and some sandplain with spinifex or other grasses of low-palatability – low grazing value (~70%). Several additional, but minor, land types of variable grazing value (~10%)	22571	16810	17706	17706	105	12352	73
Finke P2		Extensive calcareous plains with short grasses and forbs (~30%). These areas provide preferred grazing country. Large areas of sandplain and sand dunes growing predominantly spinifex – very low grazing value (~45%). Alluvial plains of the Finks and other major rivers (~5%). Salt lakes and fringing saline and sandy country (~5%). Mesas, low ranges and breakaway country (~15%)	15203	13453	12332	12295	92	11248	84

sub IBRA	IBRA	Description	Area (km^2)	Area (km^2) in 2002 Landsat coverage	Area (km^2) in 1989 Landsat coverage	Area (km^2) in 1998 Landsat coverage	1989 area as % of 2002 Landsat coverage	Area 2002 coverage within 8km of water	% of area within 8km of water
Tieyon Finke P3		Granite plains with mixed Acacia shrubs and short grasses and forbs (~15%) – good grazing country. Undulating calcareous and stony country of moderate grazing value (~15%). Mulga shrublands on red earth plains – low to moderate grazing value (~15%). Extensive sand dunes and minor sandplain of very low grazing value – mainly spinifex (~45%). Small areas of hills, mesas, and low ranges (~10%)	16484	13319	13264	13295	100	10221	77
MAC P1	Mac-Donnell Ranges	Prominent ranges of the western MacDonnell Ranges – nil to very low grazing value and mostly not included in grazing gradient analysis because these ranges form barriers to stock movement (~50%). Hills, foothills and narrow valleys of low grazing value (~20%). Acacia shrublands on red-earth and calcareous plains – low to moderate grazing value (~10%). Sand dunes and sandplain growing mainly inferior grasses for grazing (including spinifex) – low pastoral value (~20%)	14840	2442 (16%)	2470	2470	101	2133	87
MAC P2		Prominent ranges of the western MacDonnell Ranges – nil to very low grazing value and mostly not included in grazing gradient analysis because these ranges form barriers to stock movement (~80%). Lower hills, foothills and narrow valleys with low grazing value (~5%). Fringing areas of sand dune and sandplain growing spinifex and other grasses of low grazing value (~10%). Several other minor land types with low to moderate grazing value (~5%)	10928	1758 (16%)	1758	1759	100	1346	77

sub IBRA	IBRA	Description	Area (km^2)	Area (km^2) in 2002 Landsat coverage	Area (km^2) in 1989 Landsat coverage	Area (km^2) in 1998 Landsat coverage	1989 area as % of 2002 Landsat coverage	Area 2002 coverage within 8km of water	% of area within 8km of water
MAC P3		Prominent ranges of the eastern MacDonnell Ranges – nil to very low grazing value and mostly not included in grazing gradient analysis because these ranges form barriers to stock movement (~65%). Lower hills, foothills and narrow valleys with low grazing value (~20%). Limestone ridges and calcareous slopes with short grasses and forbs of moderate to high grazing value (~5%). Sandy alluvial plains fringing creeks and rivers – high grazing value (~5%). Several other minor land types including small areas of cracking clay plains with sparse Mitchell grass – moderate to high grazing value (~5%)	13527	6432 (48%)	5984	4482	93	5749	89
SSD P1	Simpson-Strzelecki Dunefields	Bold quartzite ranges – inaccessible to stock (~5%). Sandstone and limestone ranges with some (low to moderate) grazing value on foothill slopes and valley floors (~15%). Low limestone ridges grading to sandy calcareous plains with gidyea over short grasses and forbs – moderate to high grazing value (~15%). Extensive sand dunes and minor sandplain with spinifex and some better short grasses and forbs contributing generally low pastoral value (~60%). Small areas of alluvial plain and floodout, and mixed other land types of moderate to high grazing value (~5%)	13552	6804	5123	5097	75	4615	68
SD									
Breakaway	Stony Plains	Stony tablelands and plains with sparse short grasses and forbs. Low to moderate grazing value (~10%). Calcareous and stony plains with chenopods, short grasses and forbs – moderate grazing value (~35%), Alluvial plains and floodout of the Finke River – moderate pastoral value (~30%). Sand dunes with spinifex and other inferior grasses for grazing – very low pastoral value (~25%)	1311	1327	0	0	0	1007	76

sub IBRA	IBRA	Description	Area (km^2)	Area (km^2) in 2002 Landsat coverage	Area (km^2) in 1989 Landsat coverage	Area (km^2) in 1998 Landsat coverage	1989 area as % of 2002 Landsat coverage	Area 2002 coverage within 8km of water	% of area within 8km of water
TAN2	Tanami	Spinifex sandplain – nil or very low grazing value (>90%). Very small areas of limestone plains with witchetty bush and short grasses and forbs – moderate grazing value (3%). Very small areas of alluvial plains adjacent to larger creeks – some grazing value (~3%).	16009	3011	2300	2237	76	1418	47
TAN3		Spinifex sandplain – nil or very low grazing value (~90%). Red earth plains with mulga over harder grasses including spinifex – low pastoral value (~5%). Stony and gravely plains (including laterite) with mainly inferior grasses for grazing (including spinifex) (~5%)	36272	17503	16613	16596	95	9417	54

Grazing gradient Analysis

Burt Plain P1 (sub IBRA 58)

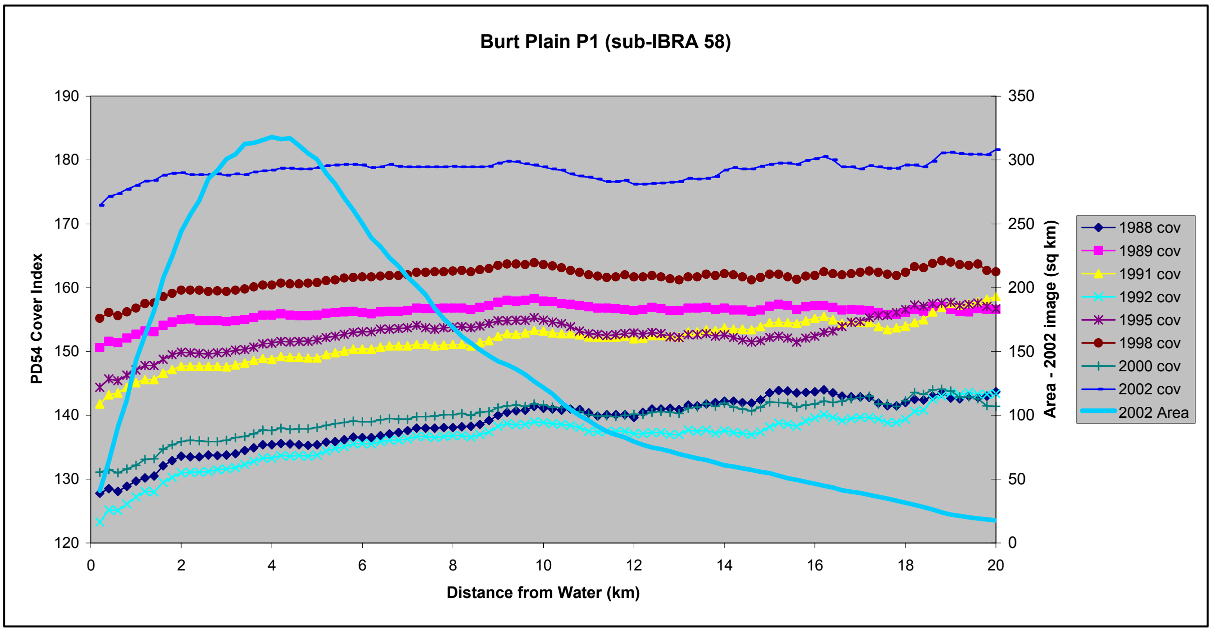


Figure 52: Grazing gradient results for Burt Plain P1 sub IBRA.

Although only 46% of NT sub IBRA was analysed, this eastern half received sufficient rainfall in 2000 and 2001 for potential full recovery by 2002 image capture. The 2000 cover is in the lower cover trend for this eastern portion sub IBRA.

All years appear to have except 2002 an initial sharper rise in cover to approximately 2 km from water followed by a slower longer rise to about 10 km. The 2002 cover has a slightly sharper rise in cover to approximately 1.8 km, followed by a very low rising gradient to 5 km, finally levelling off indicating that full recovery >5 km from water.

The persistent well defined grazing gradient <1.8 km from water indicates consistent landscape function decrease within this eastern half of Burt Plain P1 sub IBRA, and potential more landscape function loss between 1.8 to 5 km. The loss of function further out is of greater concern, it appears this area has seen long term unsustainable management.

In summary, based on similar gradient trends of all years suggest that both landscape function and grazing management has been unchanged over the reporting period. However the persistent grazing gradient suggests landscape function loss and unsustainable management practices during and prior to the reporting period.

Burt Plain P2 (sub IBRA 59)

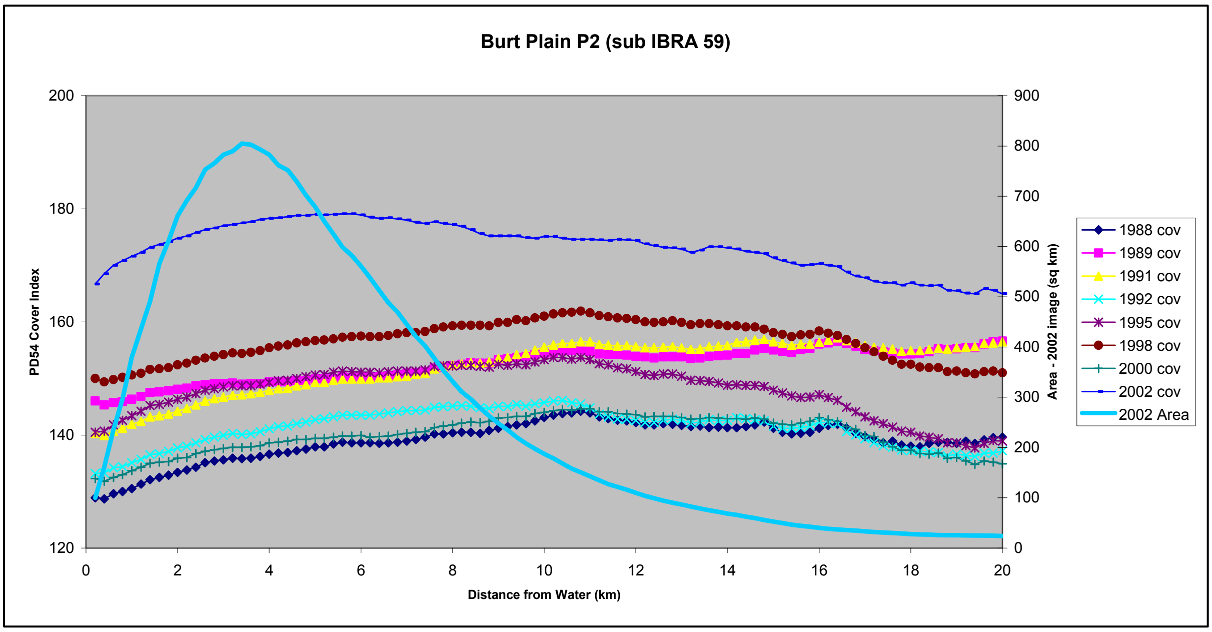


Figure 53: Grazing gradient results for Burt Plain P2 sub IBRA.

Almost all (99%) of this sub IBRA is within assessment area, with 80% accessible for grazing and therefore analysed with grazing gradient methodology. Burt Plain P2 received sufficient rainfall between the 2000 and 2002 image capture dates to compare a dry cover to a potentially full recoverable wet cover trend. There was insufficient rainfall between pervious years for potential full recovery to allow meaningful analysis.

All years except 2002 show a similar grazing gradient trend to approximately 11 km, which has a small portion of the sub IBRA therefore trend at this distance it is probably misleading, indicating that the grazing gradient could continue further out.

The 2002 cover has a grazing gradient to 5 km followed by a slow decreasing cover trend. The majority of the area is about the 4 km range, dropping quicker then most other sub IBRA's, indicating that paddock sizes are possibly smaller in size, therefore increasing potential grazing pressure closer to water, with further out tending to be more unfavourable country with less cover.

Only approximately 35% of sub IBRA is of possible high grazing potential, therefore making these areas at greater risk of landscape function loss. The loss of landscape function of this sub IBRA is possibly the result from unsustainable management on this varied grazing potential country, and those more favourable land types need to be more carefully managed in the future.

In Summary, same as with Burt Plain P1, the similar grazing gradient trends indicate unchanged landscape function and grazing management, with the change in 2002 more like dur to the higher rainfall response then to grazing pressure. The consistent landscape function loss is mostly like due to long term unsustainable management experienced on this sub IBRA.

Burt Plain P3 (sub IBRA 60)

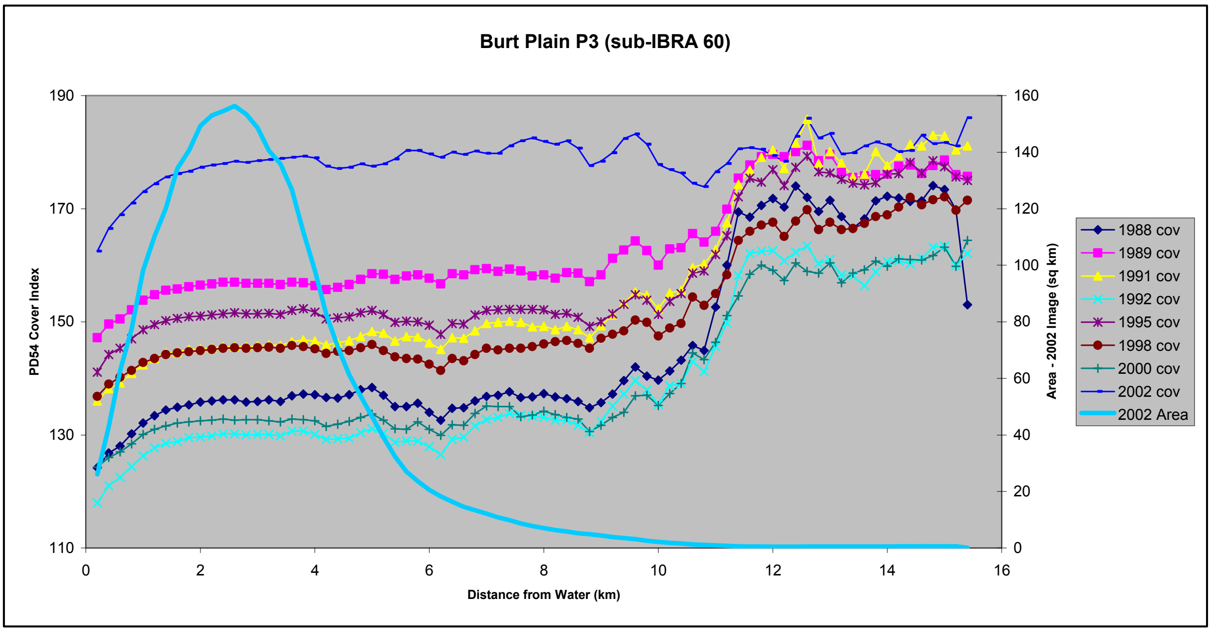


Figure 54: Grazing gradient results for Burt Plain P3 sub IBRA.

This sub IBRA contains inaccessible mountain ranges (20%) with associated high grazing alluvial (35%), low to moderate grazing red earth (35%) and very low grazing sandy (10%) plains. The eastern 94% of this sub IBRA was within the coverage area, once the mountain ranges had been removed 76% of the sub IBRA was assessed.

The majority of the area assessed is <5 km from water with greatest area approximately 3 km from water. This indicates the area has smaller grazing distances therefore greater potential for cover loss if grazing is not carefully managed especially on the more favourable alluvial plains.

All dates including 2002 shows a similar grazing gradient, indicating that the persistent well defined grazing gradient clearly shows landscape function loss for this sub IBRA.

In summary, landscape function and therefore possibly grazing management appears to be unchanged over the reporting period, with the slight change in 2002 grazing gradient mostly likely due to rainfall response. There has been a loss in landscape function most likely resulting from unsustainable grazing management practices within these smaller more productive southern NT paddocks.

Burt Plain P4 (sub IBRA 61)

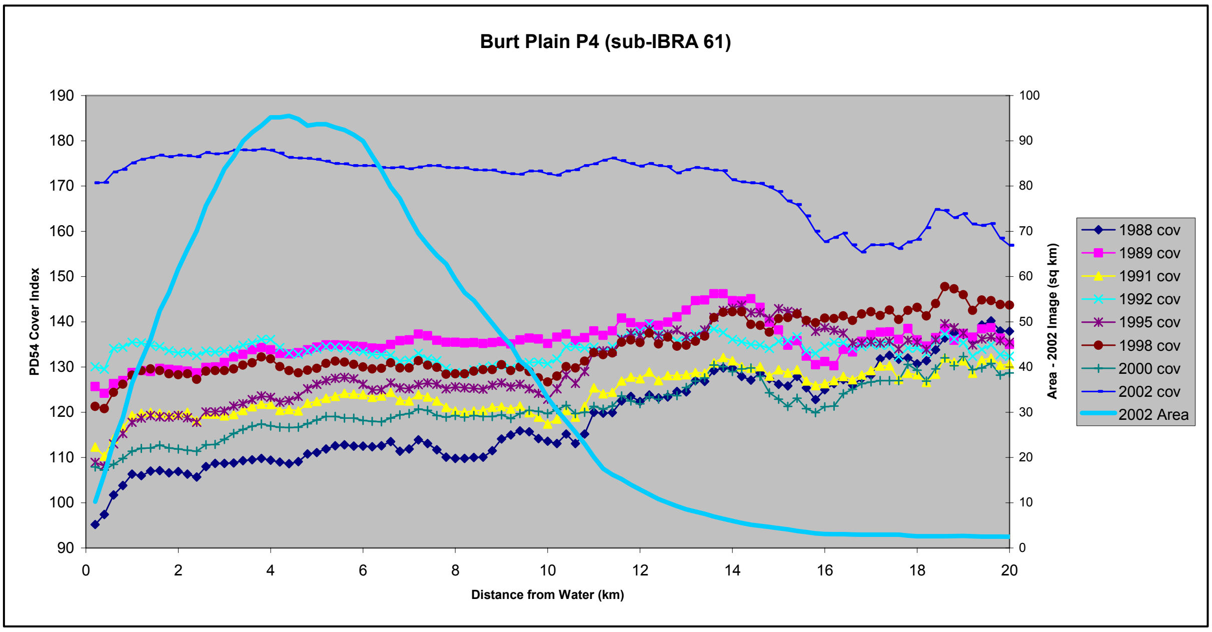


Figure 55: Grazing gradient results for Burt Plain P4 sub IBRA.

- This sub IBRA contains some areas inaccessible to stock within the low to moderate grazing lower hills, slopes and valleys (45%), moderate to higher grazing value of undulating to flatter country (40%), very low grazing valued sand plain (10%) and high grazing valued alluvial plains (5%). This sub IBRA was 100% within coverage area with 70% accessed after inaccessible areas where removed.
- The area received good rainfall in early 1991, just before the 1991 image capture and twice between the 2000 and 2002 image dates, allowing two dry/wet comparisons between the 1991-1992 and 2000-2002 cover trends.
- The difference between 2000 and 2002 cover is of greater significance, with the 2002 cover indicating the potential response should result in full recovery. There is still a small grazing gradient, but only to 1.4 km. The 1991 and 1992 cover response is less significant then the 2002 response, however the grazing gradient was only to 0.8 km indicating recovery was still possible after only one good rainfall within this sub IBRA.

In summary, it appears that landscape function is stable suggesting stable grazing management. There is a small landscape function loss close to water, therefore sustainable grazing management is most likely the cause.

Toko Plains (sub IBRA 66)

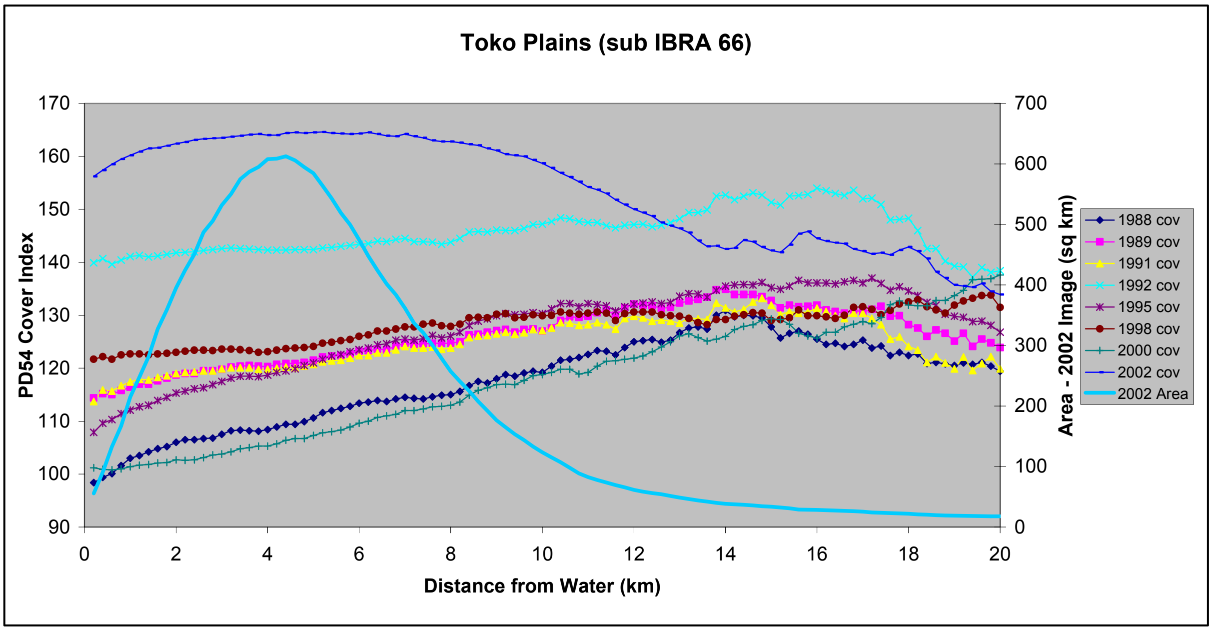


Figure 56: Grazing gradient results for Toko Plains sub IBRA.

- This sub IBRA contains some areas inaccessible to stock within the low to moderate grazing lower hills, slopes and valleys (45%), moderate to higher grazing value of undulating to flatter country (40%), very low grazing valued sand plain (10%) and high grazing valued alluvial plains (5%). This sub IBRA was 100% within coverage area in 2000 and 2002 with 70% accessed after inaccessible areas where removed.
- Two significant rainfall events over reporting years, these were in early 1991 and late 2001, both resulting in cover increases in the 1992 and 2002 images as shown in Figure 9.
- All years except 2002 have a similar gradient trend, a defined slow grazing gradient, including 1992, to approximately 16 km out from water. As this is further out then the marjory of the coverage area, <12 km from water, therefore indicating that grazing has effected the whole sub IBRA.
- The 2002 covers the whole sub IBRA, and comparing it the 2000 cover the grazing gradient shows that full recovery would have been possible. However there is still a grazing gradient to about 4 km from water.

In summary, there has been a small landscape function loss on this sub IBRA, indicating some issues with grazing management. The gradient trends indicates that both landscape function and management practices were likely to be unchanged during the reporting period, and that the response in the 2002 cover was most likely from rainfall response then grazing management practices changing.

Davenport Murchison Range P2 (sub IBRA 113)

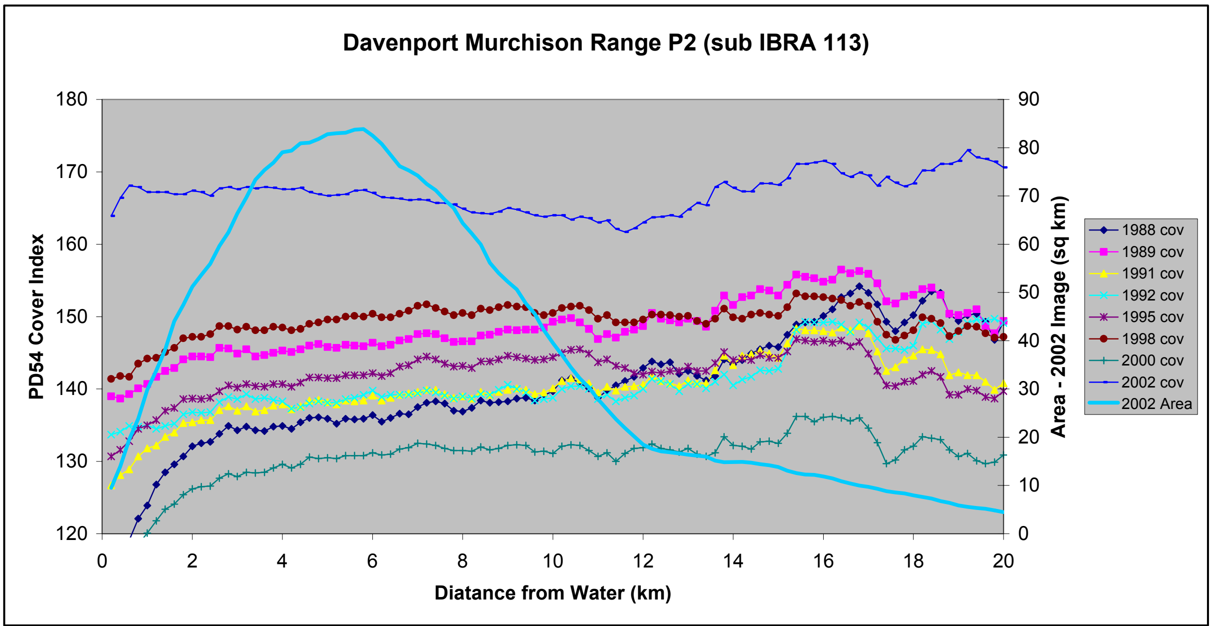


Figure 57: Grazing gradient results for Davenport Murchison Range P2 sub IBRA.

- This sub IBRA has a very small grazing gradient to 0.4 km from water, followed by a period of stable cover to approximately 5 km from water and then a slow declining gradient to 12 km from water.
- This sub IBRA has a majority of inaccessible uplands dominated by Spinifex, with the accessible areas having mostly low grazing potential.
- 2000 showed a continuous grazing gradient to approximately 7 km from water as well as the lowest PD54 cover index compared to other assessed years, where as 2002 has a very small grazing gradient and the highest cover.

In Summary Davenport Murchison Range P2 sub IBRA cover has fully recovered in 2002, suggesting that landscape function has also recovered.

Finke P1 (sub IBRA 138)

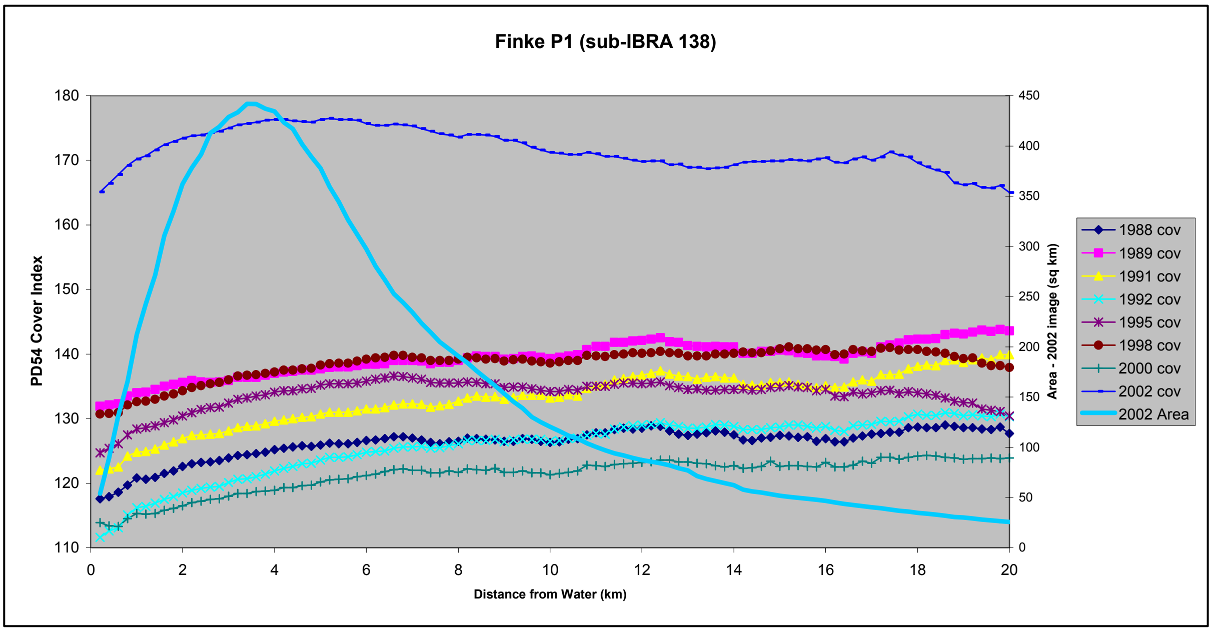


Figure 58: Grazing gradient results for Finke P1 sub IBRA

Using the 2002 Area distance from water (light blue thick line) shows that the majority of Finke P1 sub IBRA is less then 10 km from watering points.

The PD54 Cover Index clearly shows the high cover response to the high rainfall in 2001 (2002 image) compared to previous years. 2000 cover is the lowest, therefore suggesting the potential for full recovery from good seasonal conditions.

All previous years have similar low rising grazing gradients to approximately 12 km from water, where as the 2002 cover shows a more defined shorter grazing gradient to 3.8 km. Suggesting that full recovery > 4 km from water, with a persistent grazing gradient < 4 km from water, indicating potential decreased condition within this sub IBRA.

This sub IBRA appears to have a decreased Landscape Function < 3.8 km from water, indicating unsustainable grazing management practices within this sub IBRA over the reporting period and probably earlier.

Finke P2 (sub IBRA 139)

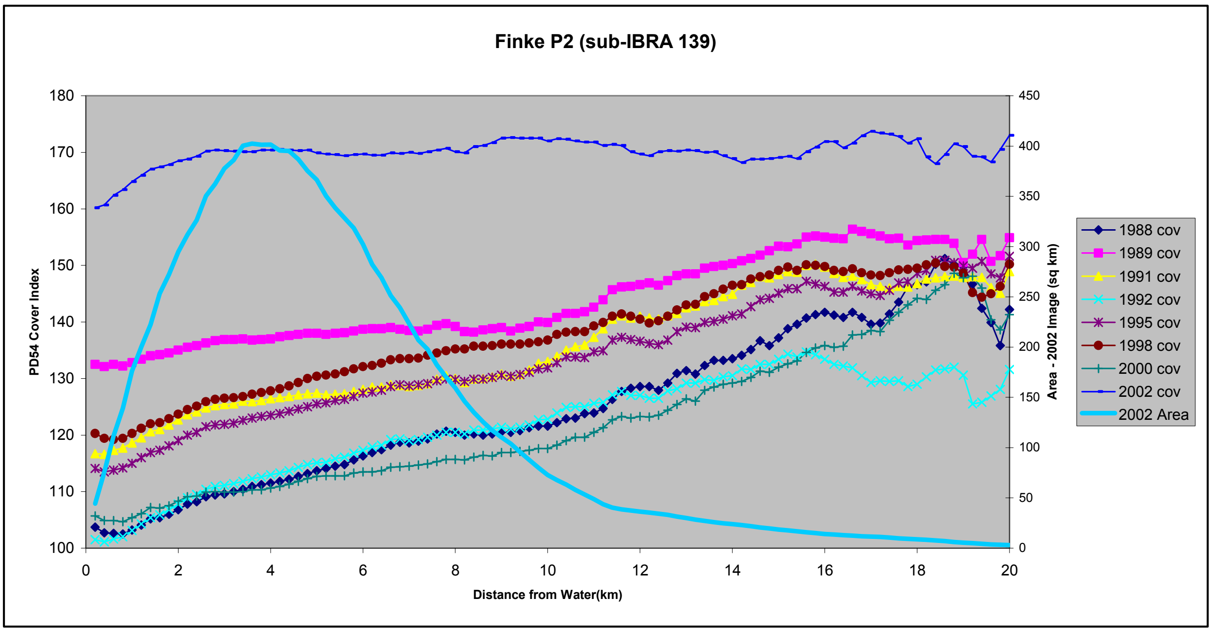


Figure 59: Grazing gradient results for Finke P2 sub IBRA.

From the 2002 coverage used in the grazing gradient analysis the majority of this sub IBRA is less then 11 km from water, with 4 km distance potentially the most area available.

Same as with Finke P1, 2000 cover lowest and 2002 significantly higher then other years cover. Suggesting that these two years would be an ideal comparison of dry and wet cover responses for grazing gradient analysis.

All grazing gradients trends except 2002 appear very similar, with a more pronounced grazing gradient compared to Finke P1 sub IBRA. The grazing gradients are to approximately 16 km from water, where as the 2002 appears to have a grazing gradient 10 approximately 2.6 km followed by consistent high cover, suggesting full recovery >2.6 km and a persistent cover loss < 2.6 km from water.

From the 2002 coverage used in the grazing gradient analysis the majority of this sub IBRA is less then 11 km from water, with 4 km distance potentially the largest distance from water area available for grazing, and from the 2002 cover has fully recovered at this distance.

The other possible comparison dry/wet cover is 1988 (dry) and 1989 (wet), however there may have been not enough rainfall between the two image dates to allow a potential for full recovery. The similar grazing gradient trend of all dates except 2002 shows that the use of other comparisons maybe of little value, if not misleading.

There is a decreased landscape function within 2.6 km from water, showing that the sub IBRA has probably experienced unsustainable grazing management practices over the reporting period.

Tieyon, Finke P3 (sub IBRA 140)

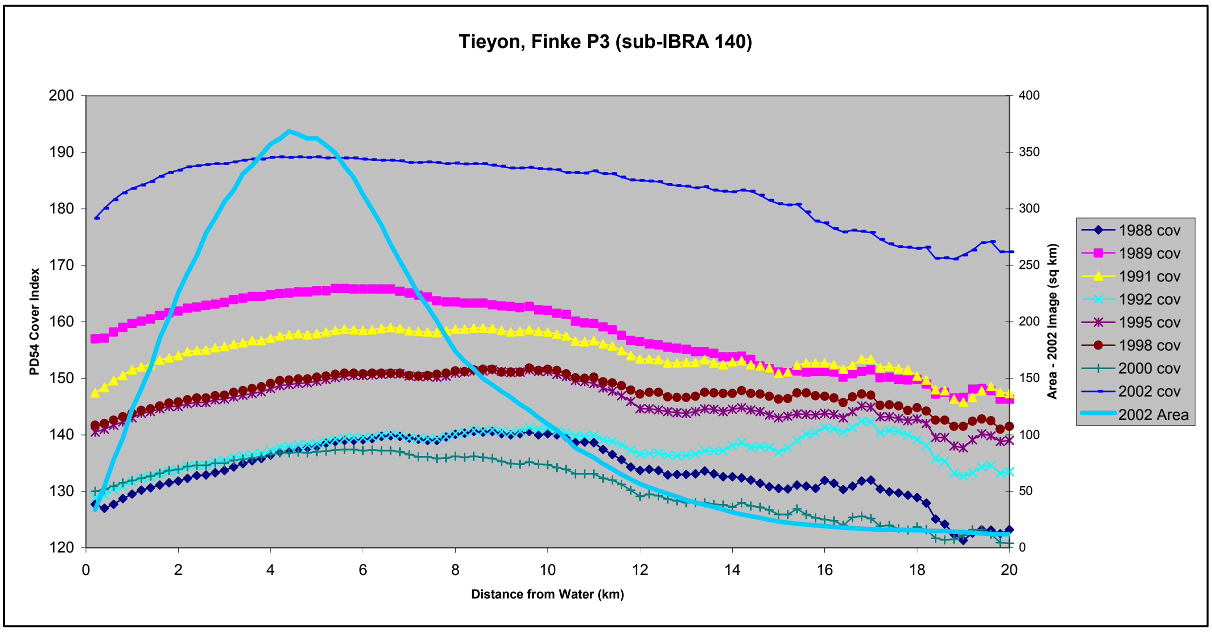


Figure 60: Grazing gradient results for Tieyon, Finke P3 sub IBRA.

Same as with Finke P1 and P2, 2000 cover is the lowest and 2002 cover the highest compared with the previous years analysed.

In all years there appears to be an increase in cover to 6 to 10 km from water, followed by a steady decrease of cover. 2002 cover appears more stable closer to water with the grazing gradient ending at 4 km out from water, followed by level cover for a few km and then the decreasing cover trend from approximately the same distance as the previous years. This could suggest a different land type with less cover present further out in this sub IBRA, rather then increased grazing pressure > 6-10 km from water.

The 2002 grazing gradient to 4 km may indicate that this sub IBRA is more degraded then the other 2 Finke sub IBRAs, as full recovery should have been possible with the level of rainfall over the 2 preceding years.

From the persist long grazing gradient (4km), the landscape function has continued to be lower then unutilised areas, indicating the sub IBRA has been under unsustainable grazing management for some time, probably longer then the reporting period.

MacDonnell Range P1 (sub IBRA 196)

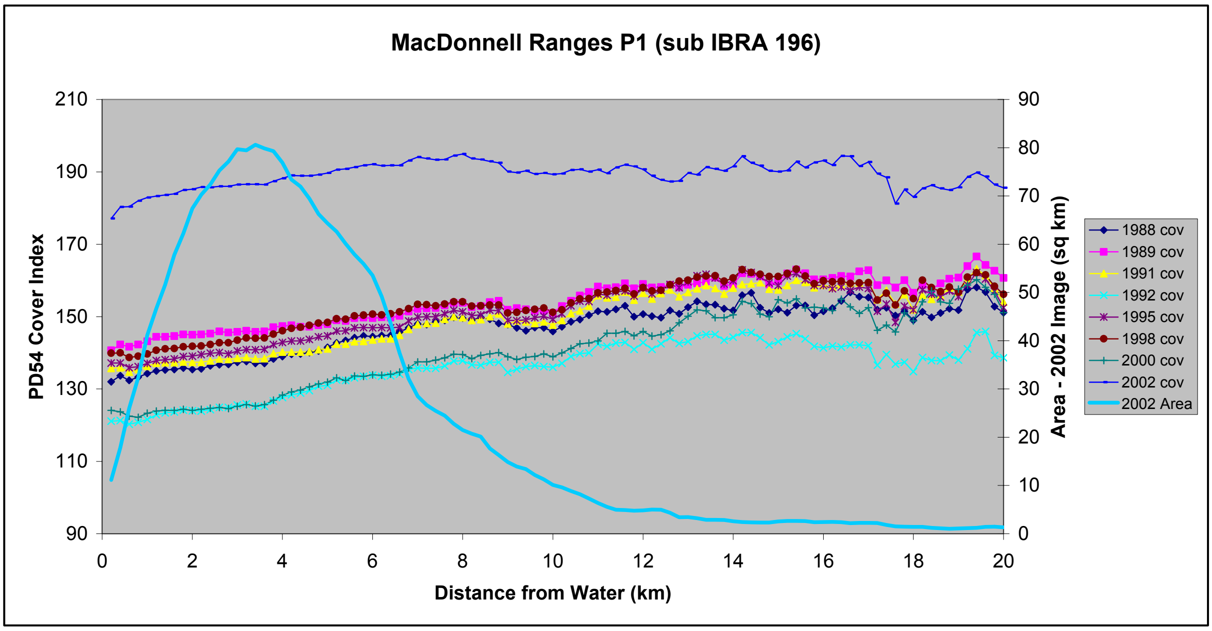


Figure 61: Grazing gradient results for MacDonnell Range P1 sub IBRA.

This sub IBRA has mostly Ranges, their associated slopes, depositional surfaces and plains. Only 16% of sub IBRA was assessed on accessible country, which are the drainage floors, alluvial flats/plans, valley floors, floodplains of the surrounding Harts and MacDonnell Ranges.

Cover significantly increased between 2000 to 2002, however the grazing gradient persisted to approximately 8 km from water in 2002 despite two years of above average rainfall.

Majority of paddocks sizes are less then 7 km from water, therefore the 8 km grazing gradient in 2002 suggest that this sub IBRA has a significant loss of potential cover and therefore landscape function.

There was no other significant rainfall period to compare 2002 result to for assessing change.

In summary, MacDonnell Ranges P1 sub IBRA has most likely a low and decreasing landscape function.

MacDonnell Range P2 (sub IBRA 197)

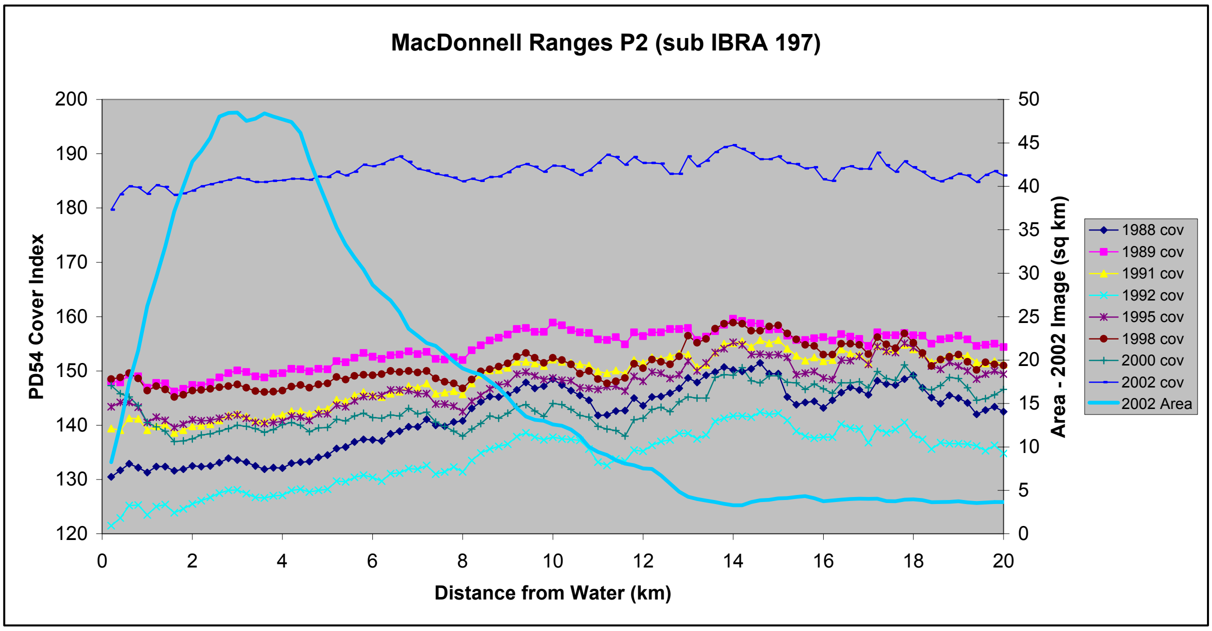


Figure 62: Grazing gradient results for MacDonnell Range P2 sub IBRA.

Majority of accessible land (16%) within this sub IBRA are valley floors, alluvial fans and channels between inaccessible mountain ranges. Shrubs and forbs are common and grazing productivity is low.

There is a grazing grained to approximately 6 km from water and a significant increase in cover in 2002 compared to pervious years.

The grazing gradient shows signs of influence from shrubs and forbs close to water, however there is still a defined gradient indicating landscape function loss.

In 1989 there was some higher rainfall, however it was not considered enough to allow potential full recovery, however compared to other sub IBRA that year it still appeared to have one of the lowest landscape function.

In summary, MacDonnell Ranges P2 has in the past had low landscape function with poor results in 1989 and 2002, showing that landscape function appears poor and unchanged during the reporting period.

MacDonnell Range P3 (sub IBRA 198)

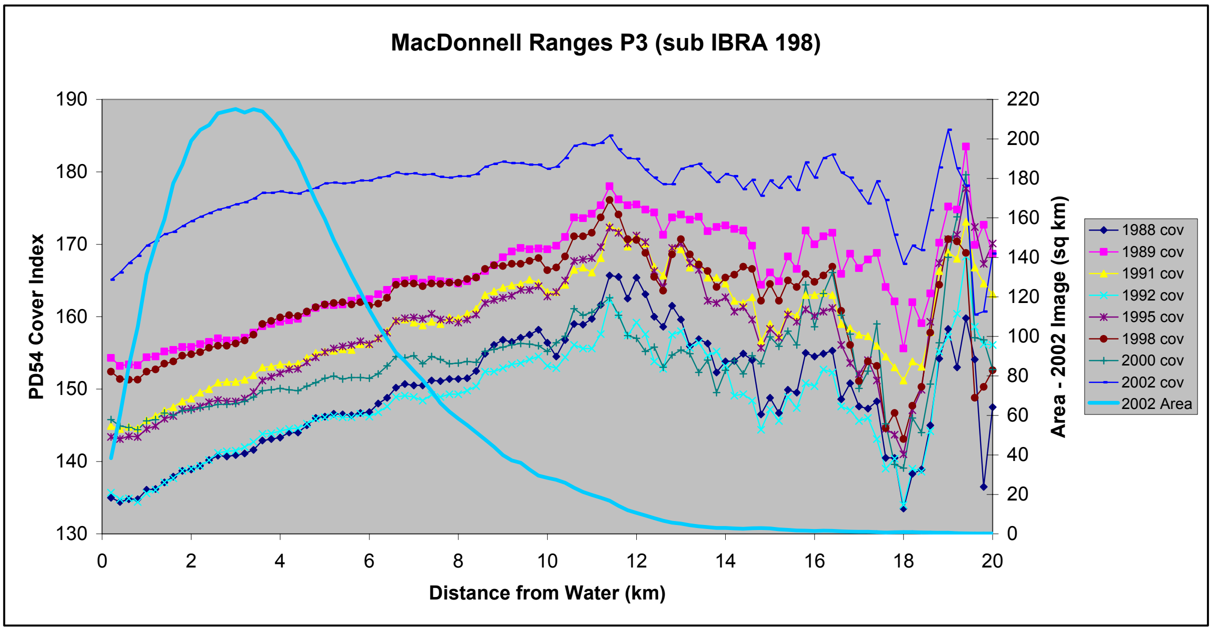


Figure 63: Grazing gradient results for MacDonnell Range P3 sub IBRA.

Majority of area assessed is erosional slopes, drainage flats/floor/valleys and minor areas of floodplains, sandy/Spinifex plains and channels, with 46% of area assessed after inaccessible areas were removed.

There was a cover response (increase by approximately 20 PD54 index) to significant rainfall events in 1989 and 2002, with less confidence that the 1989 rainfall was significant enough to allow full recovery.

Grazing gradient persisted in both 1989 and 2002, resulting in the 4th worst CPL% in 1989 and the worst in 2002.

Based on comparing between sub IBRA responses, MacDonnell Range P3 appears to continue to decline in cover and therefore landscape function through the reporting period.

In Summary, MacDonnell Range P3 has the poorest landscape function within southern NT, which has continued to decline through the reporting period.

Simpson-Strezelecki Dunefields P1 (sub IBRA 307)

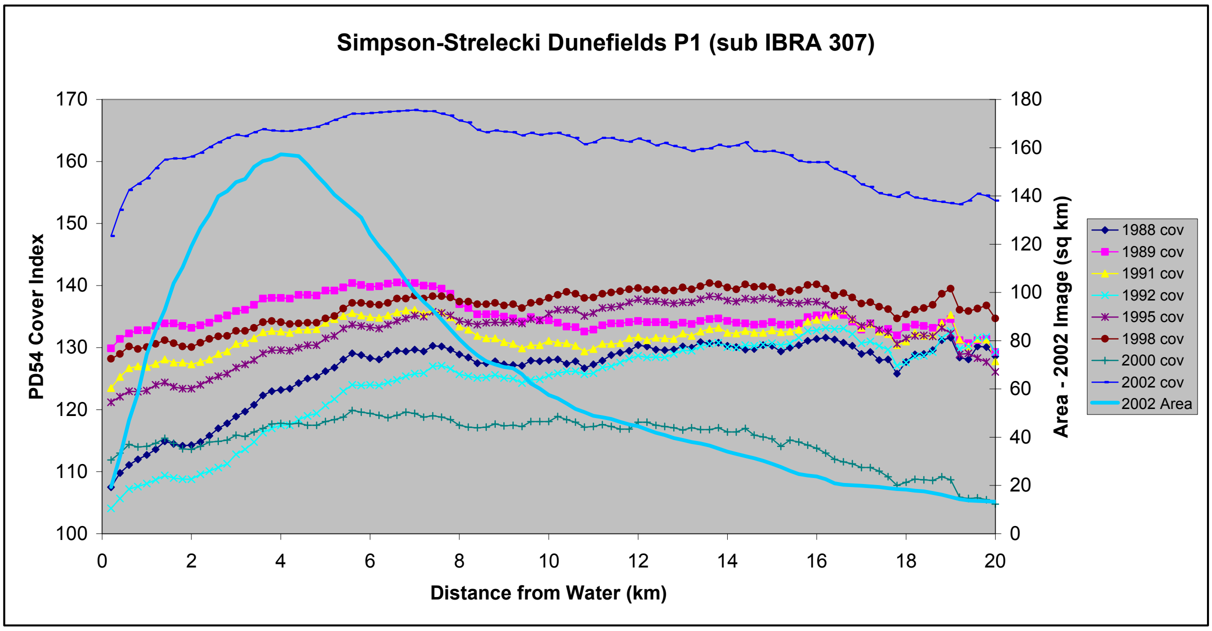


Figure 64: Grazing gradient results for Simpson-Strezelecki Dunefields P1 sub IBRA.

Due to variations satellite coverage, differences can be seen in the grazing gradient trends of 2000 and 2002 (100% coverage) and the pervious years (western 50%)

Grazing gradient persisted in both 1989 and 2002 after significant rainfall events, with 1989 most likely not receiving enough rainfall to result in full recover.

There was a significant increase in cover between 2000 and 2002.

The 2002 grazing gradient is initially very sharp close to water and extents to approximately 5.4 km from water, indicating a potential loss of cover and therefore landscape function.

In summary, Simpson-Strelecki dunefields P1 has experienced a decreased landscape function extending to 5km from water.

Simpson Desert (sub IBRA 308)

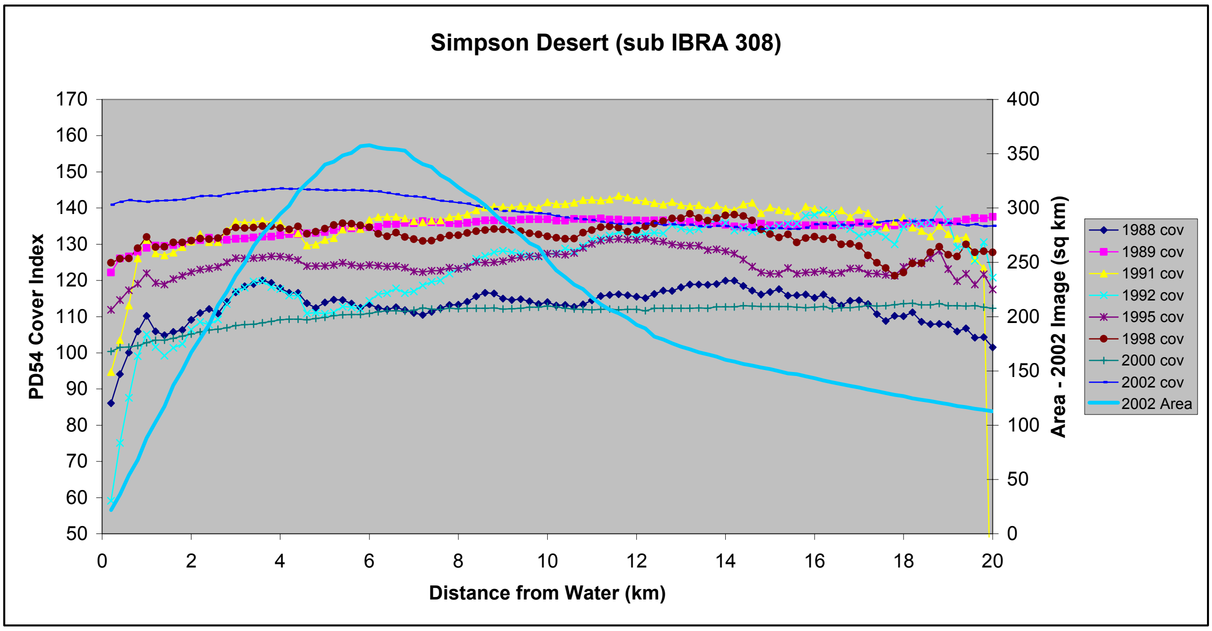


Figure 65: Grazing gradient results for Simpson Desert sub IBRA.

Due to variations satellite coverage, differences can be seen in the grazing gradient trends of 1989 (includes portion in the north), 2000 and 2002 (100% coverage) and other years (very small % of sub IBRA).

Looking at only 1989, 2000 and 2002 grazing gradients, this sub IBRA has very minor to insignificant cover loss near water, with both significant rainfall events in 1989 and 2002 producing very small gradients.

Only 23% of sub IBRA was assessed as majority of area is not grazed and water points are limited to the raining areas, with a large portion of the sub IBRA well away from water as shown in Figure above.

In summary, landscape function is fairly even through this sub IBRA and this has remain unchanged through the reporting period.

Breakaways, Stoney Desert (sub IBRA 314)

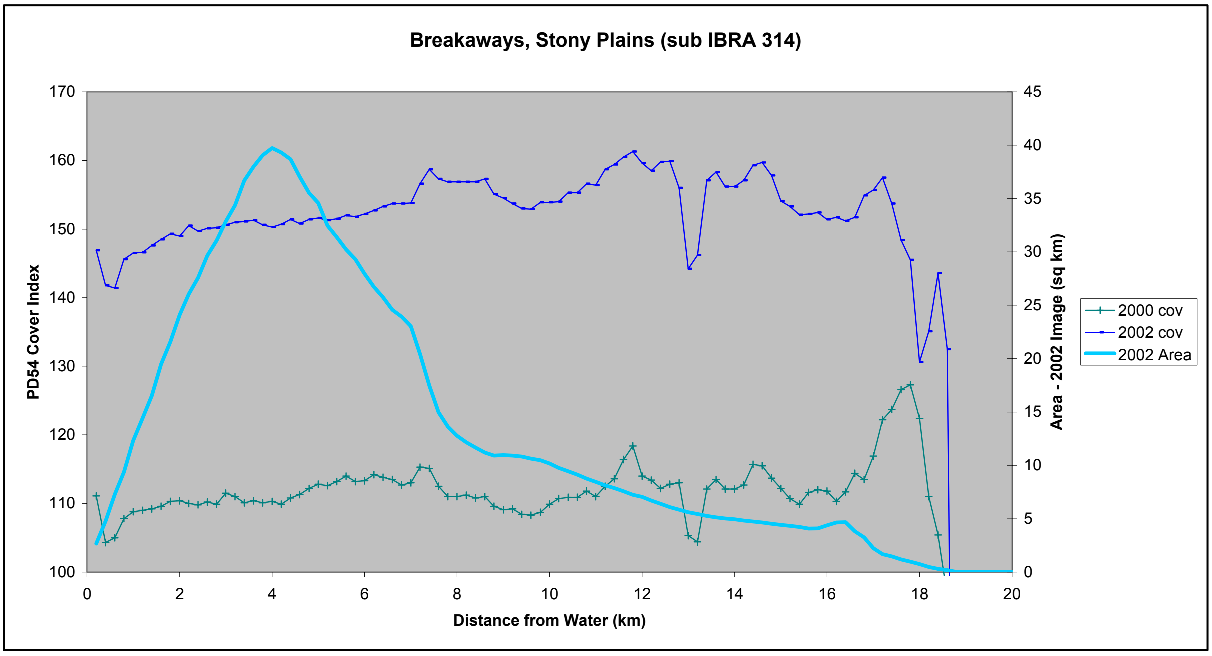


Figure 66: Grazing gradient results for Breakaways, Stoney Desert sub IBRA.

This sub IBRA is small with only 2000 and 2002 images covering the bioregion.

The majority of sub IBRA comprises undulating stony plains, spinifex covered sand dunes and river plains and swamps, minor land systems are stony tablelands, stony plains with steep hills and associated floodplains and channels, river plains and spinifex sand plains.

Around some watering points there are some small areas of shrubs and mallee, which may count for the initial small inverse gradient. The peaks and troughs of the gradient can also be a result of patches of shrubs and mallee dispersed throughout the area, as well as patches of stony surfaces.

Grass species of the area includes Aristida holathera (short lived perennial), A. contorta (slp), Enneapogon avenaceus (slp) and Eragrostis setifolia (perennial), and a grass-like sedge Fimbristylis dicotoma.

From photos taken within the area, the grasses are continually disappearing most likely grazed out and then flush back with rain. Rainfall between 2000 and 2002 significantly increased cover, however a grazing gradient remained to 7.2 km from water.

High feral camels numbers is a issue within the area, and increase erosion has also contribute to the poor landscape function of the bioregion.

In summary, Breakaways, Stoney Plains sub IBRA has low landscape function, with erosion and feral camels increasing the ongoing loss of landscape function.

Tanami P2 (sub IBRA 325)

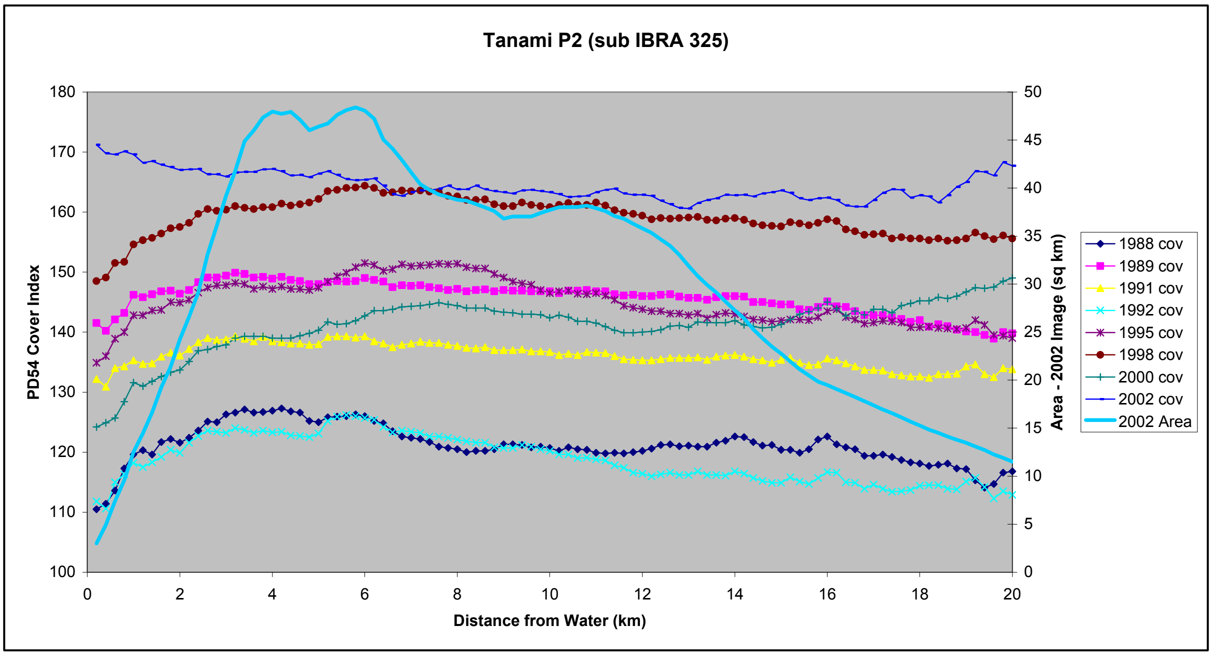


Figure 67: Grazing gradient results for Tanami P2 sub IBRA.

2000 had a grazing gradient to 7.4 km from water, with 2002 showing full recovery.

Although rainfall in 1989 probably wasn't enough to expect full recovery, there appears to some recovery of the grazing gradient between 1988 and 1989.

Rainfall in 1998 was considered enough to expect full recovery, however even though the 1998 and 2002 cover and gradient are similar from approximately 7 km from water, 1998 shows a significant grazing gradient < 7km from water.

Looking at photos taken within the sub IBRA over the reporting period, cover and landscape function has been generally good, comparing the grazing gradient results for 1989, 1998 and 2002, landscape function also appears to be improving.

In summary Tanami P2 has good landscape function which has continued to improve through the reporting period.

Tanami P3 (sub IBRA 326)

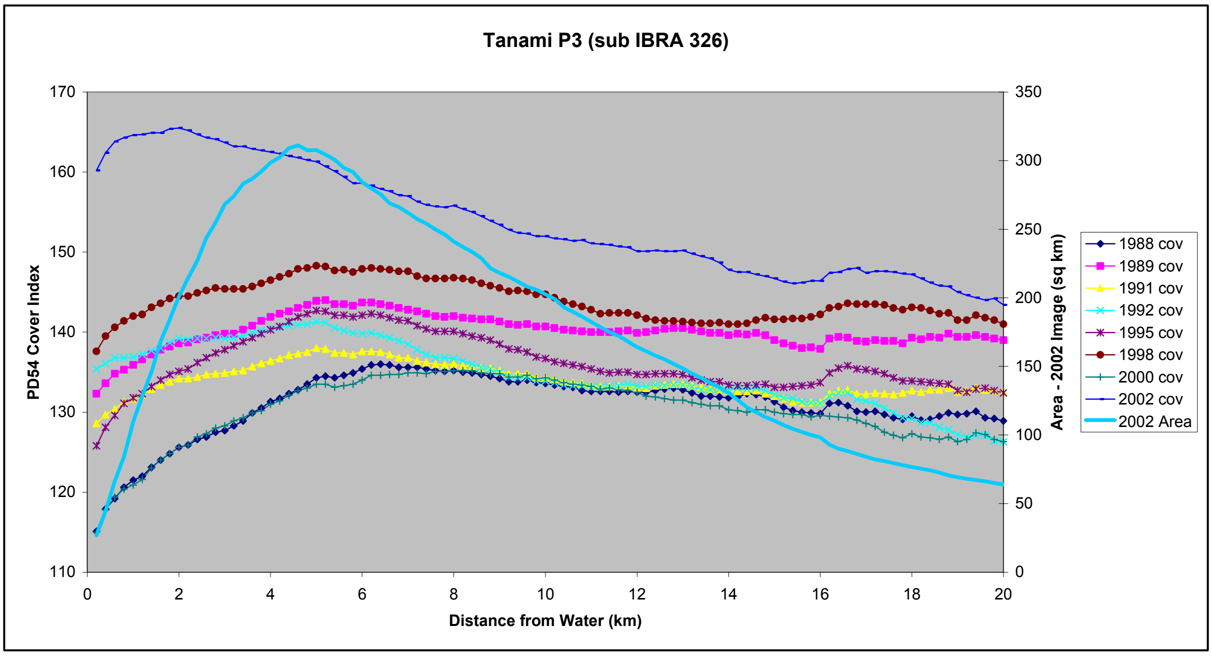


Figure 68: Grazing gradient results for Tanami P3 sub IBRA.

Majority of area is spinifex sand plains and to a lesser degree, undulating plains with mulga or spinifex. Minor country includes river plains and swamps, sandy river plains and minor accessible areas of narrow valley floor and channels surrounded or adjacent to sandstone or limestone plateaux.

The sub IBRA has large unwatered areas, accounts for the large areas 20 km from water.

Both 1989 and 1998 gradients are the same as there pervious dry gradients, only slightly increasing in cover, most likely due to insufficient rainfall. Where as the 2000 gradient (to 7.4 km) had the lowest cover, where as the 2002 gradient the highest cover with a significant improvement in the gradient indicating full recovery was possible, with the grazing gradient to 1.8 km from water, indicating a small potential loss in landscape function close to water.

Tier 1 site data and photos (low frequency and distribution for separate assessment) show majority are improving cover and frequency of perennial and short lived perennial grasses.

In summary, Tanami P3 has good landscape function and based on pervious years grazing gradients and Tier 1 site data it has been improving through the reporting period.

%CPL (Cover Production Loss)

% CPL (Cover Production Loss) values were calculated by comparing good wet-period images to pervious dry-period images grazing gradients. The inflexion point and distance of the inflexion point to water of the wet-period to the dry-period. Table 3 shows the 2002 %CPL in descending values, with <3 %CPL seen as full recovery as low %CPL is considered part of the 'sacrifice' area experienced close to water. Values highlighted green have been calculated with rainfall expected to result in full recovery, where as yellow has less confidence in comparing to the green %CPL values as they had experienced less rainfall that would mostly likely not result in full recovery. Higher %CPL values of good wet-period grazing gradient are an indication of loss of landscape function and therefore less than ideal grazing management practices.

Table 40: Pastoral Productive with Inflection Distance and resulting CPL% values.

Sub IBRA	Pastoral Productivity	2002 Infl Dist	2002 CPL%	1989 Infl Dist	1989 CPL%	1992 Infl Dist	1992 CPL%	1995 Infl Dist	1995 CPL%	1998 Infl Dist	1998 CPL%
MacDonnell Range P3 (198)	Low	6.4	11	10.4	16.9						
Breakaways, Stony Plains (314)	Moderate	7.2	9								
MacDonnell Range P1 (196)	Low	6.8	7.4								
MacDonnell Range P2 (197)***	Low	6.4	5.3	9	26.5						
Burt Plain P3 (60)	Moderate	3.6	3.7	4.8	5.9			2.4	2.9		
Burt Plain P2 (59)	Moderate	5	3.6	10.2	10.7					10.6	46.8
Simpson-Strzelecki Dunefields P1 (307)	Low	5.4	3.6	5.4	10						
Finke P1 (138)	Low	3.8	1.8	10.8	19.1						
Toko Plains (66)	Moderate	4.4	1.1	11.8	30.2	10.2	13.3				
Tieyon, Finke P3 (140)	Low-Moderate	4	1.1	5.2	3.4						
Finke P2 (139)	Moderate	2.6	1	15.6	40.3						
Burt Plain P1 (58)***	Moderate	5	1	9.2	8.8					9	16.7
Simpson Desert (308)	Very Low	3.8	0.8	6.2	0.6						
Tanami P3 (326)	Very Low	1.8	0.2	4.8	8.8					4.8	9.7
Burt Plain P4 (61)	Moderate	1.4	0.1	7	2.3	0.8	0.2			1.2	0
Davenport Murchison Range P2 (113)	Very Low	0.4	0	2.4	2.1					2.4	2.6
Tanami P2 (325)***	Very Low	0.4	0	3	6.6					5.2	5

Green – Confidence in assessment, Yellow – Less confident in assessment (comparing to 2002 probably unsuitable)

All show improvement, however I would be less confident with earlier years as 2002 was after two successive years of good rainfall in most areas within southern NT.

The %CPL shows that the MacDonnell Range IBRA and Breakaways, Stony Plains sub IBRA have the lowest landscape function in southern NT. These areas would require further assessment at a finer scale to help determine areas requiring a more intensive review of grazing management practices to ensure landscape health does not continue to decline and improvement possible.
Burt Plain P2, P3 and Simpson-Strelecki Dunefields P1 sub IBRAs have also reduced landscape function, however they are fairly close to the 3 %CPL, indicating that with improved management practices full recovery could be possible.
The remaining 10 sub IBRAs all appear to have very good landscape function, with majority showing improvement through the reporting period.

ACRIS Reporting – Northern Territory

Theme 2 – Change in Sustainable Grazing Management

Reporting of change in Sustainable Grazing Management from Tier 1 monitoring sites follows as Attachment 2.

Results were compiled by Debbie Mullin and Kate Richardson, NT Department of Natural Resources, Environment and the Arts (NRETA).

Attachment Two

ACRIS Reporting – Northern Territory

Theme 2 – Change in Sustainable Grazing Management

Contents

Tables

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Sustainable Grazing Management Rationale

Within the constraints of land capability (particularly soil type and fertility) for each bioregion, the minimum requirement for sustainable grazing is the maintenance of palatable and productive forage across the range of seasonal variability likely to be experienced. Where land has been adversely affected (degraded) by past grazing practices, a reasonable expectation for sustainable grazing is gradual improvement in the condition of these altered areas, at least in average and above-average seasons.

In northern and central Australia, palatable perennial grasses are the mainstay of sustainable grazing. Their expected contribution to the pasture varies widely with rainfall amount and reliability, and soil quality. The composition of perennial grasses in the pasture generally increases with increasing annual rainfall, and increasing reliability of wet-season (summer) rainfall, as latitude decreases. However, there is large variation in composition of perennial grasses, and their associated quality for grazing, at local scale. This variation is driven by soil quality, position in the landscape (e.g. run-on in the more arid central Australia) and the cumulative effects of past grazing.

NT Reporting: Data Sources Available

Tier 1 monitoring

Tier 1 monitoring utilises visual estimates to assess land condition. Data collected includes pasture species, composition and utilisation. Composition data is recorded as pasture biomass measured as dry weight. Sustainable grazing reporting is based upon change in % composition (by biomass) of 2P grasses.

Change in the estimated percentage contribution of combined high and moderate palatability perennial (2P) grasses us based on pasture biomass (on a dry-weight basis), again with regard to prior seasonal conditions.

This approach has similarities with the concept of 3P grasses in Queensland (i.e. GrassCheck monitoring of the frequency of palatable, perennial and productive grasses). It is also akin to the monitoring of 2P grasses in NSW (as part of the Range Assessment Program) and the Kimberley and Pilbara regions of WA (through WARMS, WA Rangeland Monitoring System). Estimated species composition at Tier 1 sites is adjusted for the effects of utilization (i.e. short term grazing). Thus there is no penalty against sites assessed late in the dry season (that will likely have a lower contribution of 2P grasses to actual biomass present) compared with sites assessed shortly after good wet-season rains (that have undergone little grazing).

Percentage composition of 2P grasses

Using the combined biomass of high and moderately palatable perennial (2P) grasses each bioregion had their ‘contribution 2P grasses’ categories (low medium and high) calculated. Threshold limits vary across the NT because northern bioregions and those with better quality (more fertile) soils have a greater propensity to support a higher proportion of 2P grasses. The thresholds were calculated from each bioregions terciles (33% and 67%), producing the ‘contribution of 2P grasses’ component of the ACRIS change matrix. A tolerance of + or – 20% change was calculated for all bioregions using both mean and standard deviation of the change between initial and most recent reassessment of the combined high and moderate % biomass of 2P grasses.

Table 1: Example of ACRIS matrix showing the combine high and moderate 2P grasses into the three 'contribution 2P grasses' categories.

Contribution 2P Grass Category	Seasonal Condition	Number of Reassessments	Percentage of Assessments		
			Decline	No Change	Improvement
High	Above Ave				
	Average				
	Below Ave				
Medium	Above Ave				
	Average				
	Below Ave				
Low	Above Ave				
	Average				
	Below Ave				

Table 2: Threshold categories for each bioregion of their 'Contribution 2P grass category'; low, medium and high.

Bioregion	Contribution (%) of 2P Grasses		
	Low	Medium	High
Burt Plain	0-5	6-20	21-100
Channel Country	0-5	6-20	21-100
Daly Basin	0-30	31-80	81-100
Darwin Coastal	0-40	41-90	91-100
Davenport Murchison Ranges	0-5	6-45	46-100
Finke	0-5	6-10	11-100
Gulf Coastal	0-20	21-55	56-100
Gulf Fall and Uplands	0-35	36-75	76-100
MacDonnell Ranges	0-5	6-15	16-100
Mitchell Grass Downs	0-45	46-80	81-100
Ord Victoria Plain	0-40	41-75	76-100
Pine Creek	0-50	51-80	81-100
Simpson Strzelecki Dunefields	0-5	6-15	16-100
Sturt Plateau	0-40	41-70	71-100
Victoria Bonaparte	0-25	26-70	71-100

Photographic Sequences

Photographic sequences can show vital histories of landscapes that in conjunction with site data can give an understanding of changes of landscapes through time that data alone would otherwise be conceptually difficult. Photographic sequences allows those that have never been to a place to see what it's like and what it was like before and therefore allow a greater understanding that otherwise wouldn't have been possible. Visually seeing changes in the landscape such as distribution, frequency, bulk, grazed grasses, bare ground, litter, soil, etc. gives more flexibility in understanding changes through time. These changes can be as dramatic as the complete invasion of weeds, the restoration or demise of palatable perennial grasses, the effects of rain on seed banks in central Australia, or the effects of fires in the north. These changes to landscapes can be natural or the result of management practices.

This section will show examples of different rangelands throughout the Northern Territory of Australia, different issues affecting these rangelands, examples of management practices and natural processes changing rangelands within the Northern Territory.

Data Analysis and Results

Percentage composition of 2P grasses

Method Summary

Every grass species recorded within the Tier 1 database was assigned its longevity (annual or perennial) and its palatability category (High, Moderate, Low, Very Low or Unpalatable). The combined contributing High and Moderate 2P grasses biomass was extracted for each site assessment from the Tier 1 database.

Two analyses of high-moderate contributing 2P grasses are conducted in this section, the first is an analysis of all sites in all years within the reporting period, to given an understanding of changes through years, included will be examples following trends of consistence sites through the reporting period. The second analysis uses the ACRIS change matrix to compare the initial with the most recent reassessment of sites, see if they have declined, improved or are unchanged after experiencing Above Average, Average or Below Average seasonal conditions.

By separating high-moderate 2P grasses from other perennial grasses allows an opportunity to assess if grazing practices are sustainable. Seasonal condition can also have an effect on biomass dynamics, therefore the ACRIS change matrix allows changes to be compared to seasonal conditions.

Each bioregion's High, Medium and Low contributing category thresholds of combined High and Moderate palatable perennial grass biomass were calculated using all sites assessments H-M 2P biomasses to calculated their terciles. Each site's contribution H-M 2P grass category was calculated for their initial assessment. A tolerance of + or – 20% for 'no change' was calculated of all bioregions using both mean and standard deviation of the H-M 2P contributing biomass. However these thresholds are bias towards the bioregions state during the reporting period and they maybe either harsh or generous, for example majority of Sturt Plateau is in good condition, therefore those categorized as in low contributing category is generally harsh.

Burt Plain

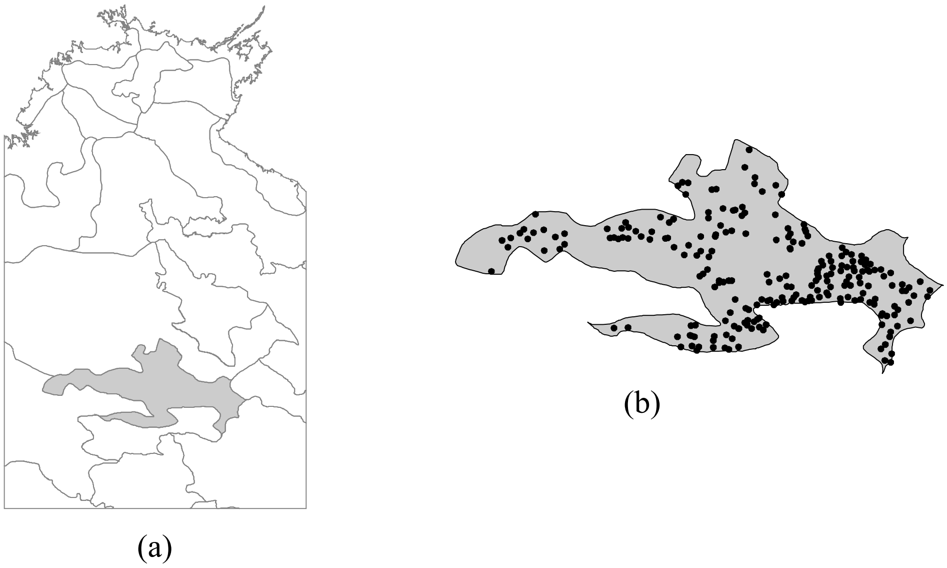


Figure 1: (a) Location of Burt Plain bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed by H-M 2P grasses within Burt Plain bioregion.

Table 3: Areas, number of Tier 1 sites and density of sites per 1000 km2 within Burt Plain bioregion.

Bioregion		Pastoral Estate within bioregion	Analysed with H-M 2P grasses
Area (km^2)	73797	60280	60280
Tier 1 sites	305	282	235
Site density per 1000 km^2	4.13	4.68	3.90

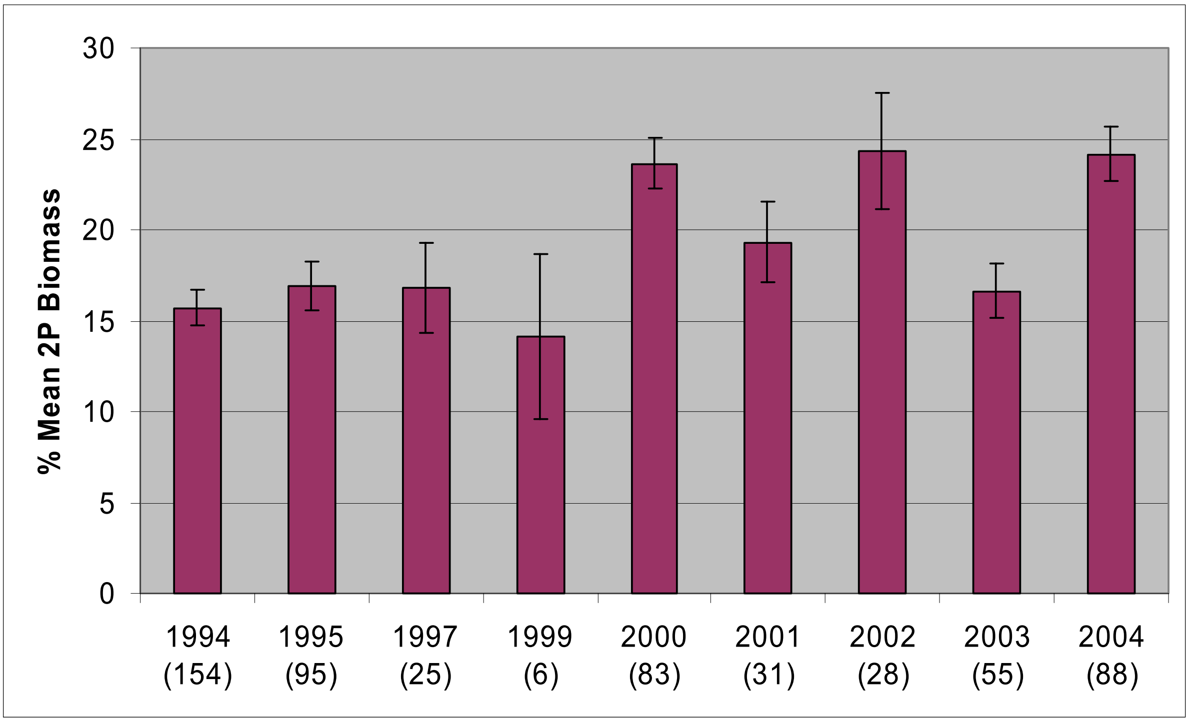


Figure 2: Burt Plain - Mean % 2P grass biomass between 1994 and 2004.

- Generally it appears that H-M 2P grass biomass was higher from 2000 to 2004 compared to 1994 to 1999, with a small drop in 2003 to earlier H-M 2P grass levels.
- There were significant rainfall events in 2000 and 2001, which would have created a seasonal flush or short lived perennials and annual grasses (not included in assessment).

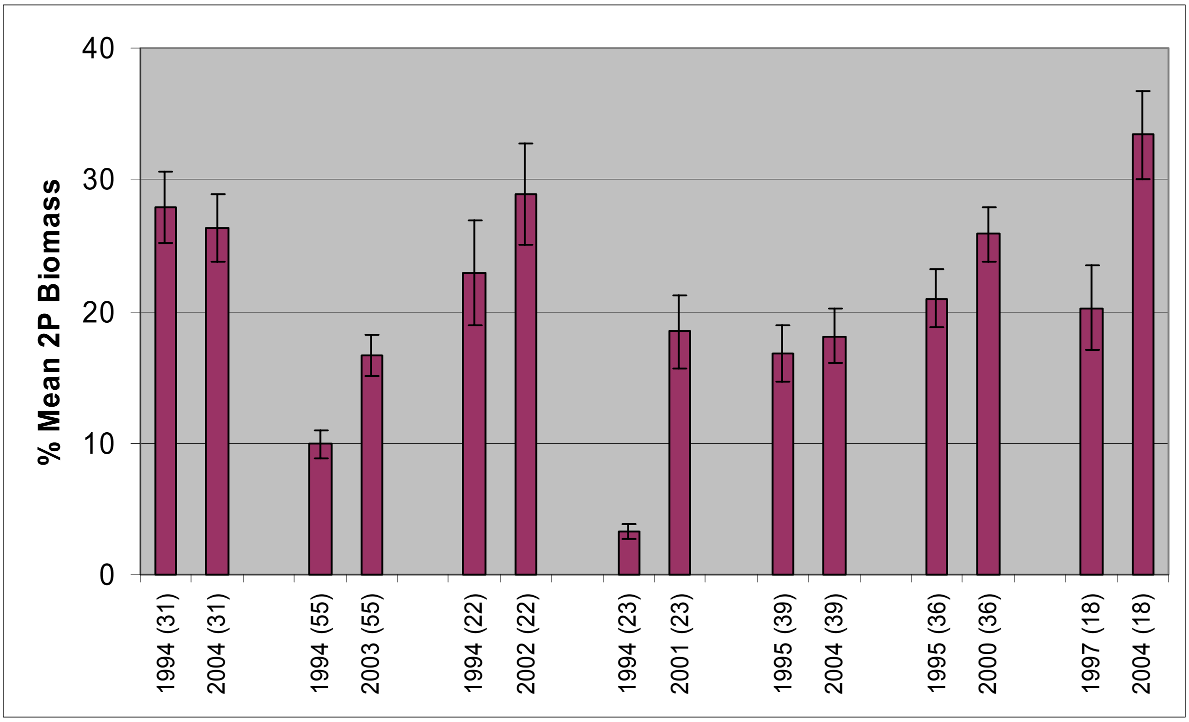


Figure 3: Burt Plain - Mean % 2P grass biomass of consistent sites between 1994 and 2004.

- Following consistent sites, generally Burt Plain is improving with some more significantly than others.

- The slight drop in mean % H-M 2P biomass in 2001 and 2003, was not the result of a seasonal flush in short lived perennials and annual grasses (therefore dropping over H-M 2P grass percentage) caused by the higher rainfall, following consistent sites indicates that sites assessed in 2000 and 2003 showed significant improvements from their original assessments in 1994.
- H-M 2P grass biomass are generally low within this bioregion, % mean between 15% to 25%, however this is typical of the area, with short lived perennials also contributing to the bioregions general health.

In summary, the Burt Plain bioregion has medium to lower levels of H-M 2P grass biomass, however it appears improvement in H-M 2P grass biomass through the reporting period has occurred, with the significant rainfall events in 2000 and 2001 assisting this already improving bioregion, however all indications are that the bioregion was experiencing sustainable to improving grazing practices before, during and after the high rainfall in 2000 and 2001.

Table 4: Burt Plain – Change in H-M 2P grasses.

Contribution 2P Grass Category	Seasonal Condition	Number of Reassessments	Percentage of Assessments		
			Decline	No Change	Improvement
High	Above Average	15	33	67	0
	Average	32	13	66	22
	Below Average	6	17	83	0
Medium	Above Average	24	0	79	21
	Average	17	0	94	6
	Below Average	3	0	33	67
Low	Above Average	69	0	81	19
	Average	49	0	82	18
	Below Average	20	0	80	20

A tolerance of + or - 20% was used to categories 'no change'

- Initial assessments of the 235 sites were conducted between 1994 and 1997, with the most recent reassessments between 2000 and 2004, giving a reporting period of 10 years from 1994 to 2004 (Appendix 1).
- 37 sites had no H-M 2P grasses in either assessments, 16 from Above Average, 12 from Average and 9 from Below Average.
- There were overall 10 sites declining with 5 after Above Average seasonal conditions, 4 after Average seasonal conditions and 1 after Below Average seasonal conditions, all experienced their perennials disappearing completely or to only 'present' values (1%).
- The 5 sites in Above Average seasonal conditions all had significantly increasing cover of short lived perennials and/or annual grasses.

Table 5: Burt Plain – Percentage change in H-M 2P grasses within their seasonal condition terciles.

Seasonal Condition	Number of Reassessments	Percentage of Assessments		
		Decline	No Change	Improvement
Above Average	108	5	79	17
Average	98	4	79	17
Below Average	29	3	76	21

A tolerance of + or - 20% was used to categories 'no change'

- Overall Burt Plain experienced only 4% declining sites, even though these sites were significantly declining, 17% improving and 78% within the unchanged tolerance, however majority were improving but not significantly enough to be categorized as improving.

In summary, Burt Plain bioregion has a majority of improving areas of H-M 2P grasses from 1994 to 2004. 17% of sites experiencing significant improvement and only 4% of the bioregion is of concern as the H-M 2P grasses have decreased significantly. Overall the bioregion has experienced sustainable grazing practices with rainfall currently the most influential factor in the bioregions health.

Channel Country

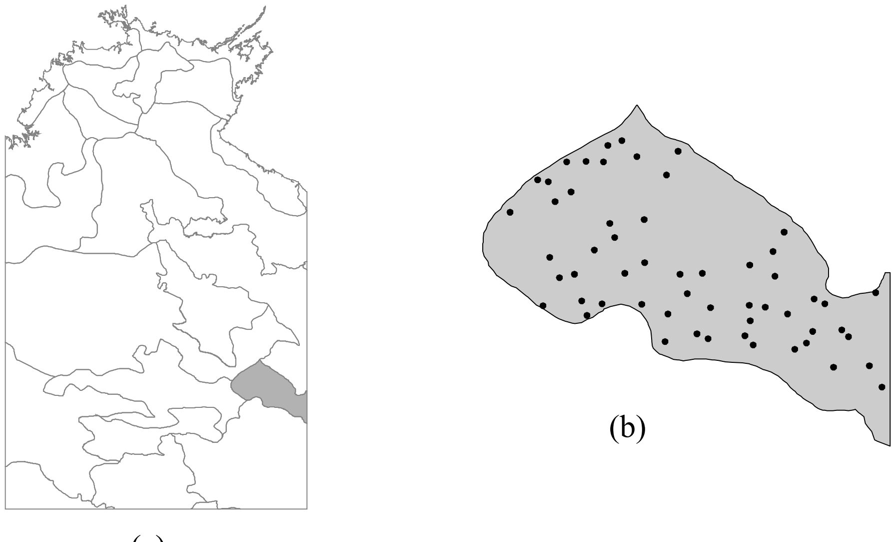


Figure 4: (a) Location of Channel Country bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed by H-M 2P grasses within Channel Country bioregion.

Table 6: Areas, number of Tier 1 sites and density of sites per 1000 km2 within Channel Country bioregion.

Bioregion		Pastoral Estate within bioregion	Analysed with H-M 2P grasses
Area (km^2)	23277	22893	22893
Tier 1 sites	77	77	56
Site density per 1000 km^2	3.31	3.36	2.45

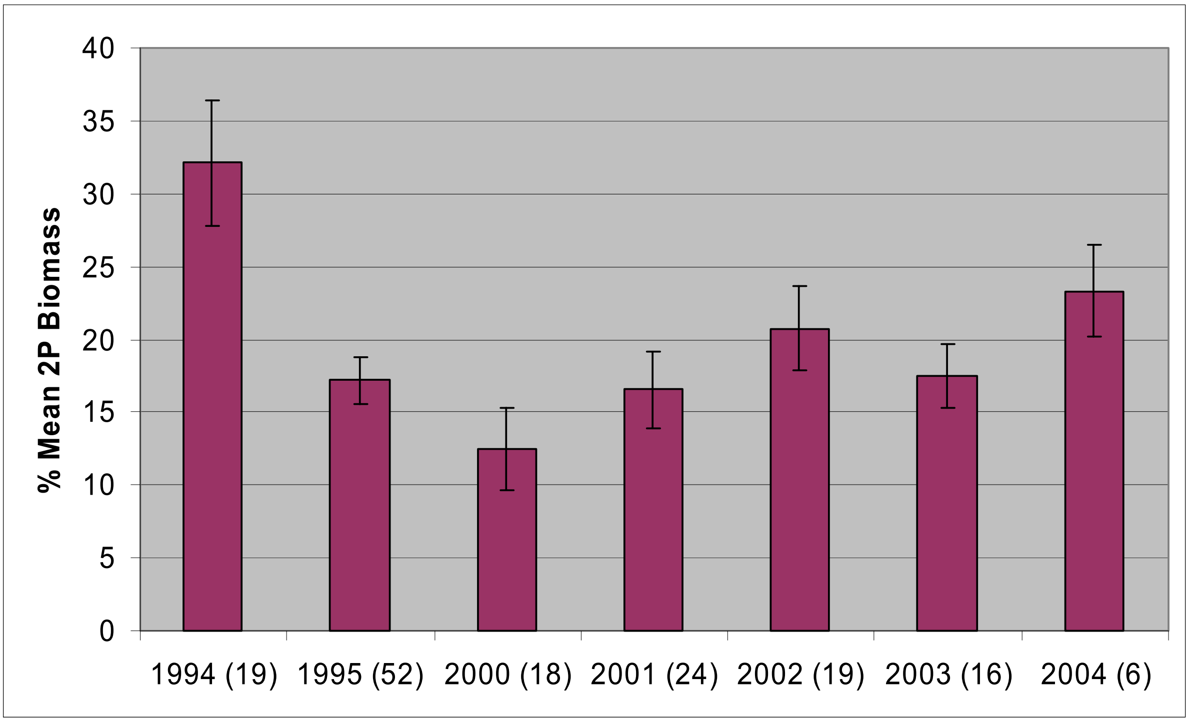


Figure 5: Channel Country - Mean % 2P grass biomass between 1994 and 2004.

- The Channel Country bioregion generally has low to very low H-M 2P grass biomass, with the highest recordings in 1994 due to a majority of sites with 95% bare ground and only one or two plant species present.

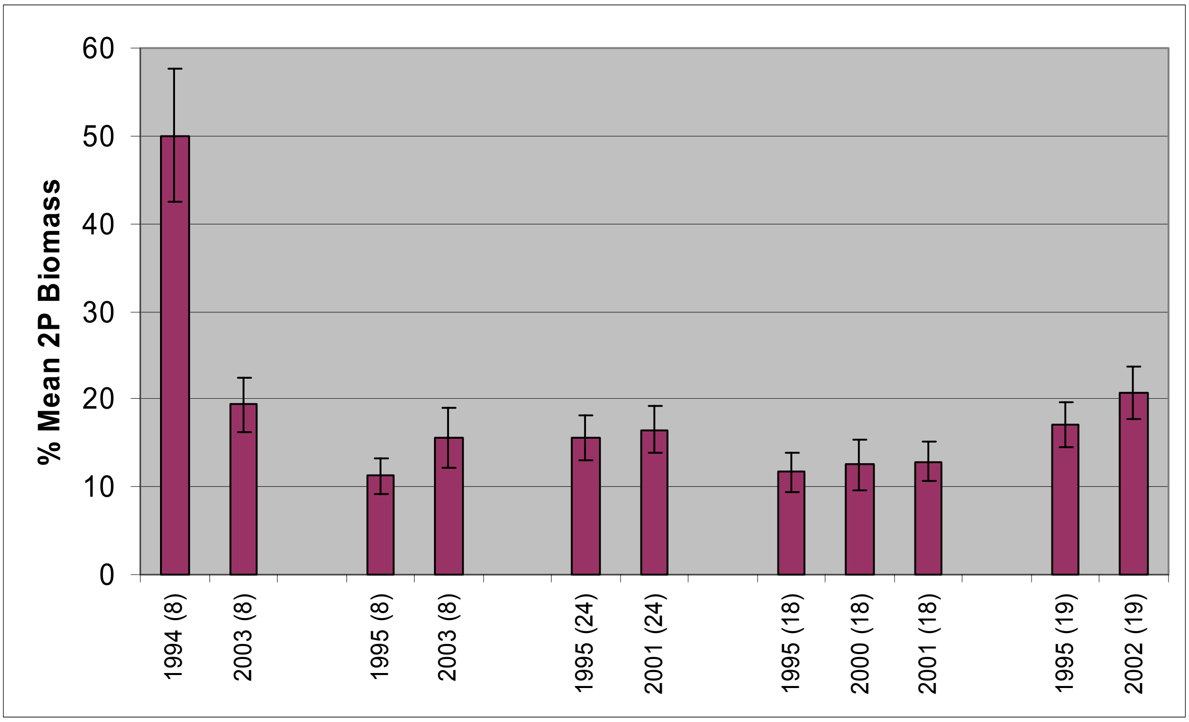


Figure 6: Channel Country - Mean % 2P grass biomass of consistent sites between 1994 and 2003.

- Following consistent sites, there is generally very little change over the reporting period and the mean % H-M 2P grass levels are consistently low within the bioregion.
- However there are some sites with higher % H-M 2P grasses within the region and some that have none through the reporting period.

- Some sites have a very high bareground assessment initially, these sites then recover with good cover levels and biomass between 2000-2002 with good rainfall. These sites then returned to low cover and biomass, indicating that a majority of the bioregion's biomass is short lived perennials and annuals, with some perennial grasses. Perennials and H-M 2P grasses play an important role during periods of no and low rainfall events that occur naturally within the bioregion.
- Within the bioregion there are areas that are over grazed during these low rainfall years, which has resulted in the perennial and especially H-M 2P grasses being placed under heavy grazing pressure , leaving the area susceptible to erosion. Seed banks of perennial grasses appear to be relatively healthy as new rains allow germination of perennial grasses, but they require more sustainable management to allow to mature so seed banks can be resupplied ready for the next long dry period.

In summary, Channel Country naturally experiences long dry periods and short wet periods, making perennial species of great important for long term landscape health. Seed banks are very important to allow the country to recover when rains do fall, especially when the majority of grass species have died from the long period of no rain. During the reporting period the bioregion had experienced a long dry period at the beginning of the reporting period. It then received some good rain in early 2000 and 2001,but by the end of the reporting period majority of the area was declining again, with the amount of bare earth increasing, and by recent assessment conduced in 2006 (outside reporting period) majority of the bioregion sites have very high bareground similar to 1994.

Table 7: Channel Country – Change in H-M 2P grasses.

Contribution 2P Grass Category	Seasonal Condition	Number of Reassessments	Percentage of Assessments		
			Decline	No Change	Improvement
High	Above Average	8	0	100	0
	Average	8	75	25	0
	Below Average	na	na	na	na
Medium	Above Average	6	0	100	0
	Average	4	0	100	0
	Below Average	4	0	100	0
Low	Above Average	10	0	80	20
	Average	15	0	87	13
	Below Average	1	0	0	100

A tolerance of + or - 20% was used to categories 'no change'

- Initial assessments of the 56 sites were conducted in 1994 and 1995, and most recent reassessments between 2001 and 2004, giving a reporting period of 10 years from 1994 to 2004.
- 6 sites initially in High contribution category declined, and 5 sites initially in Low contribution category improved, remaining sites were unchanged.
- In the initial assessment 32% were calculated as being in the High contributing category, 21% in the Medium and 46% in the Low. At the most recent reassessment High increased to 32%, Medium decreased to 21%, while Low remained at 46%.
- There were 35% (9 sites) of the Low categorised sites that didn't have any H-M 2P grasses in either assessment.

- Approximately half of the Channel Country bioregion has Low contribution H-M 2P grass categories through the reporting period, with a small percentage (19%) of Low sites increasing and 38% of High sites declining.

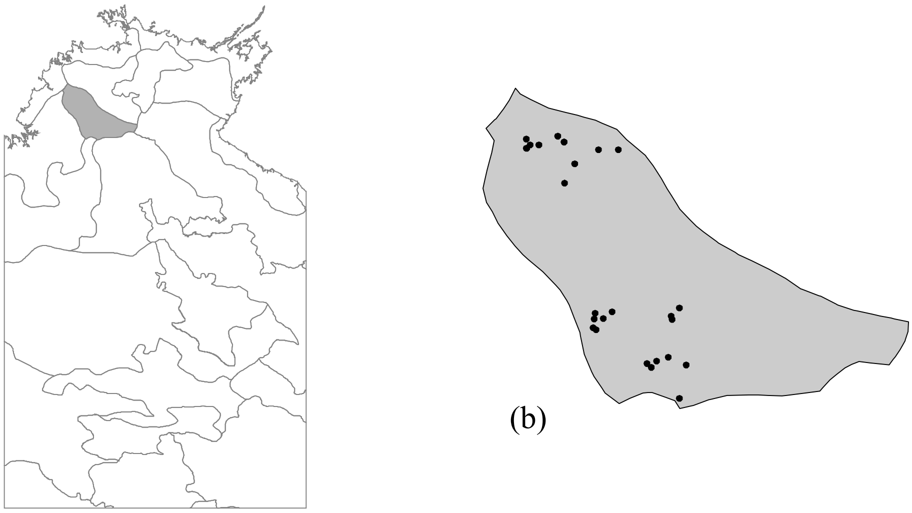
Table 8: Channel Country – Percentage change in H-M 2P grasses within their seasonal condition terciles.

Seasonal Condition	Number of Reassessments	Percentage of Assessments		
		Decline	No Change	Improvement
Above Average	24	0	92	8
Average	27	22	70	7
Below Average	5	0	80	20

A tolerance of + or - 20% was used to categories 'no change'

In summary, the Channel Country bioregion has remained relatively unchanged when comparisons are made between initial to most recent assessments within the reporting period. However following sites history through the reporting period, there was an increase in H-M 2P grasses and overall site biomass in the years 2000 to 2002, with some of these sites declining back to 1994 low biomass by 2004 as part of the current dry period.
It is difficult to make suggestions about the bioregions grazing practices as long periods of none to low (drought) rainfall was experiences before and during earlier and later stages of the reporting period, with only a few years of good rain in 2000 and 2001.

Daly Basin



(a) (b)

Figure 7: (a) Location of Daly Basin bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed by H-M 2P grasses within Daly Basin bioregion.

Table 9: Areas, number of Tier 1 sites and density of sites per 1000 km2 within Daly Basin bioregion.

Bioregion		Pastoral Estate within bioregion	Analysed with H-M 2P grasses
Area (km^2)	20922	10822	10822
Tier 1 sites	42	40	27
Site density per 1000 km^2	2.01	3.7	2.49

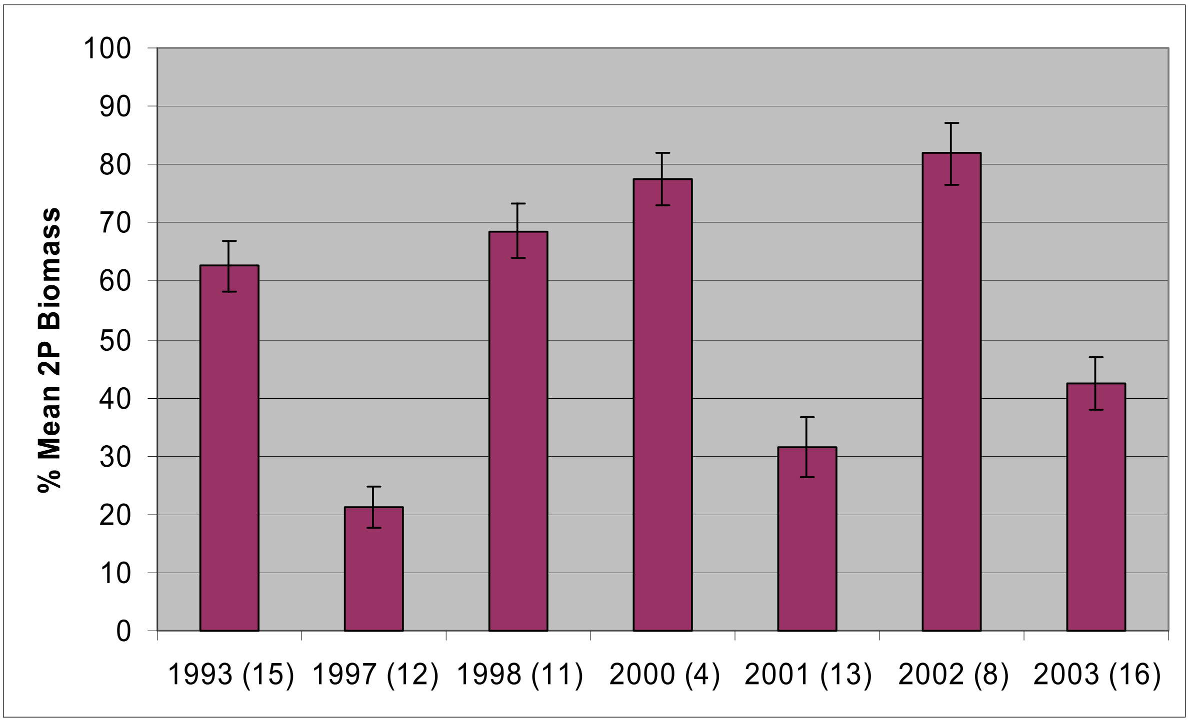


Figure 8: Daly Basin - Mean % 2P grass biomass between 1993 and 2003.

- There appears to be large changes to % H-M 2P biomass between 1993 and 2003, however following consistent sites, these changes are due to site selection.

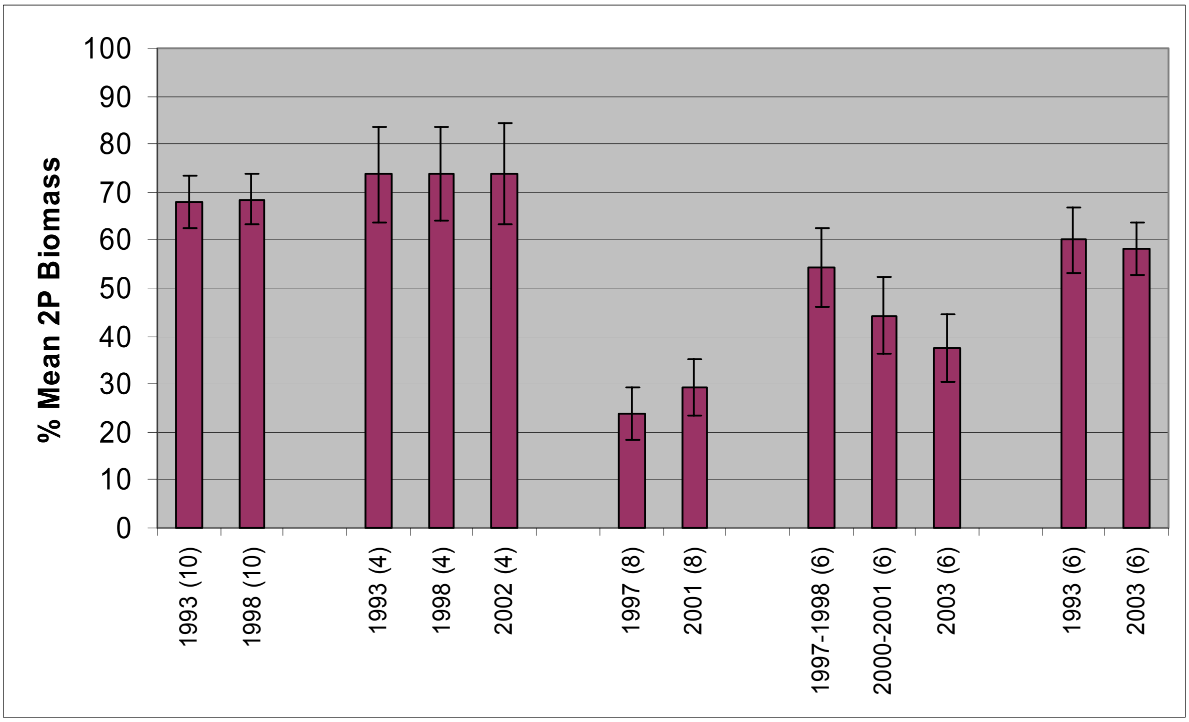


Figure 9: Daly Basin - Mean % 2P grass biomass of consistent sites between 1993 and 2003.

- Of the 10 sites assessed both in 1993 and 1998, 4 were also assessed in 2002, with all showing no changes to their % H-M 2P biomass.
- The 8 low % H-M 2P biomass sites in 1997 were from 4 sites of either no or only 5% H-M 2P grasses with a dominant low to unpalatable perennial grass species, and the remaining sites are within paddocks that were cleared in the mid 1980's.

- The decrease in the mean % H-M 2P grass biomass of consistent sites from 1993 to 2003 is the result of one site losing one of its two H-M 2P grass species and a low 2P grass species increasing.
- The consistent sites that are shown as decreasing through the reporting from 1997-1998 to 2003 are the result of improved pastures species been out competed by less palatable and weed species.

In summary, the Daly bioregion has generally been unchanged through the reporting period, with fire, areas naturally dominated by undesirable perennials and weed invasion of both natural and cleared land the major issues within this bioregion.

Table 10: Daly Basin – Change in H-M 2P grasses.

Contribution 2P Grass Category	Seasonal Condition	Number of Reassessments	Percentage of Assessments		
			Decline	No Change	Improvement
High	Above Average	2	0	100	0
	Average	3	33	67	0
	Below Average	3	0	100	0
Medium	Above Average	5	20	80	0
	Average	3	0	100	0
	Below Average	na	na	na	na
Low	Above Average	5	0	100	0
	Average	4	0	100	0
	Below Average	2	0	50	50

A tolerance of + or - 20% was used to categories 'no change'

- Initial assessments were conducted between 1993 and 2001, and most recent reassessments between 1998 and 2003, giving a reporting period of 10 years from 1993 to 2003.
- One site initially in High and one in Medium contribution category declined, one site initially in Medium and one in Low contribution category improved, remaining sites were unchanged.
- In the initial assessment 30% were calculated as being in the High contributing category, 30% in the Medium and 41% in the Low. At the most recent reassessment High decreased to 22%, Medium increased to 37%, while Low remained at 40%.
- There was only 17% (2 sites) of the Low categorised sites that didn't have any H-M 2P grasses in either assessment.

Table 11: Daly Basin – Percentage change in H-M 2P grasses within their seasonal condition terciles.

Seasonal Condition	Number of Reassessments	Percentage of Assessments		
		Decline	No Change	Improvement
Above Average	12	8	92	0
Average	10	10	90	0
Below Average	5	0	80	20

A tolerance of + or - 20% was used to categories 'no change'

In summary, the Daly Basin bioregion H-M 2P grasses have been unchanged over a 10 year period between 1993 and 2003. Areas that have changed are a result of weed invasion, the natural dominance of unpalatable perennial species and the management of cleared land for improved pasture.

Overall the bioregion is in good condition with wild fires a frequent event, however there appears to be little to no longer term effects.

Davenport Murchison Ranges

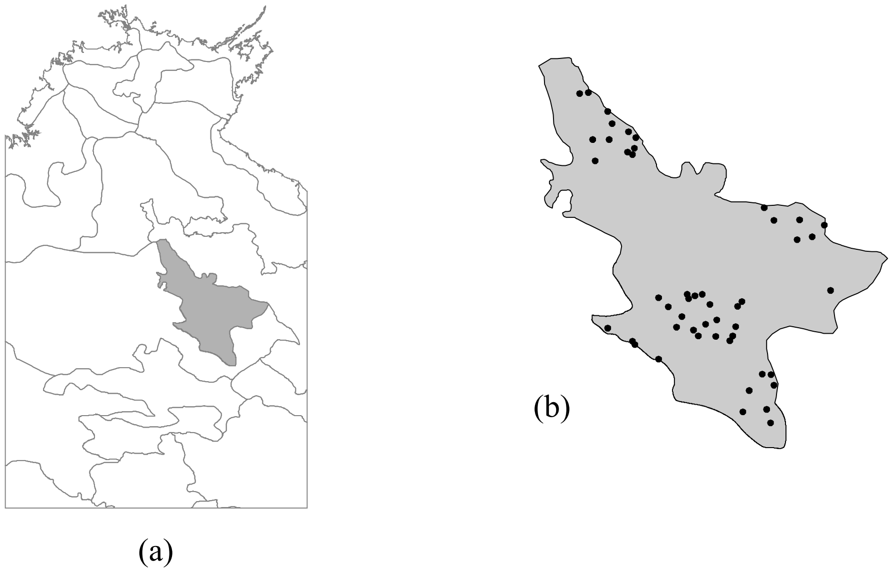


Figure 10: (a) Location of Davenport Murchison Ranges bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed by H-M 2P grasses within Davenport Murchison Ranges bioregion.

Table 12: Areas, number of Tier 1 sites and density of sites per 1000 km2 within Davenport Murchison Ranges bioregion.

Bioregion		Pastoral Estate within bioregion	Analysed with H-M 2P grasses
Area (km^2)	58051	31009	31009
Tier 1 sites	69	66	49
Site density per 1000 km^2	1.19	2.13	1.58

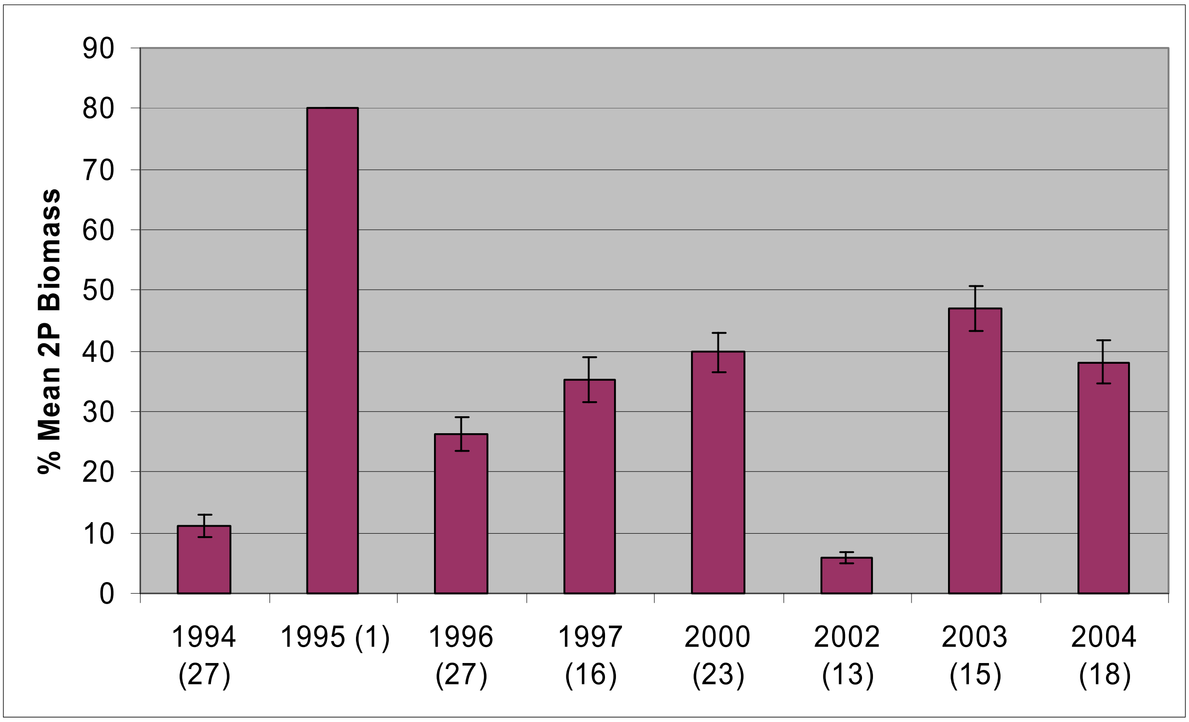


Figure 11: Davenport Murchison Ranges - Mean % 2P grass biomass between 1993 and 2004.

- The Davenport Murchison Ranges bioregion has low to medium levels of H-M 2P grass biomass, which appear to increase through the reporting period. The low biomass in 2002 is due to site selection.

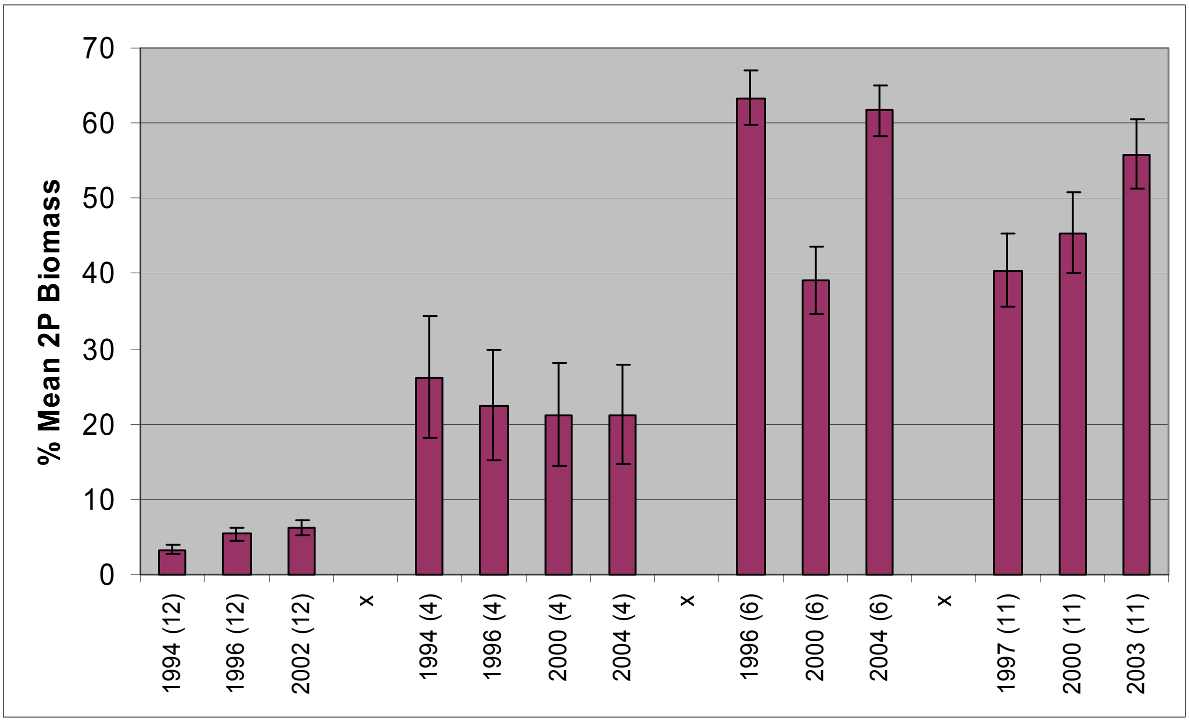


Figure 12: Davenport Murchison Ranges - Mean % 2P grass biomass of consistent sites between 1993 and 2004.

- The very low H-M 2P biomass sites are all from one station; however they are dominated by short lived perennials with about half of the sites having High-Moderate palatability, with only a few H-M 2P grass species across these sites.

- Sites that the biomass levels of 2000 had decreased when compared to the 1996 levels and then increased in 2004, are the result of increased overall biomass. The increase of H-M 2P grasses in 2004 indicates an increasing trend of H-M 2P grasses across the region.

In summary, Davenport Murchison Ranges bioregion is generally improving, with some areas more reliant on H-M short lived perennial grasses (SLP) than H-M 2P grasses. Overall these areas are improving across the reporting period.

Table 13: Davenport Murchison Ranges – Change in H-M 2P grasses.

Contribution 2P Grass Category	Seasonal Condition	Number of Reassessments	Percentage of Assessments		
			Decline	No Change	Improvement
High	Above Average	11	18	73	9
	Average	2	0	100	0
	Below Average	2	50	50	0
Medium	Above Average	5	0	60	40
	Average	7	14	43	43
	Below Average	1	0	100	0
Low	Above Average	16	0	94	6
	Average	1	0	100	0
	Below Average	4	0	50	50

A tolerance of + or - 20% was used to categories 'no change'

- Nine sites improved, with the introduced Buffel grass becoming dominant in a naturally short lived perennial landscape.

Table 14: Davenport Murchison Ranges – Percentage change in H-M 2P grasses within their seasonal condition terciles.

Seasonal Condition	Number of Reassessments	Percentage of Assessments		
		Decline	No Change	Improvement
Above Average	32	6	81	13
Average	10	10	60	30
Below Average	7	14	57	29

A tolerance of + or - 20% was used to categories 'no change'

- Overall the bioregion has 73% unchanged, 8% declining and 18% improving.

In summary, Davenport Murchison Ranges bioregion has moderate to low levels of H-M 2P grass biomass that has a stable increasing trend. This can be seen to indicate that grazing practices are most likely sustainable.

Finke

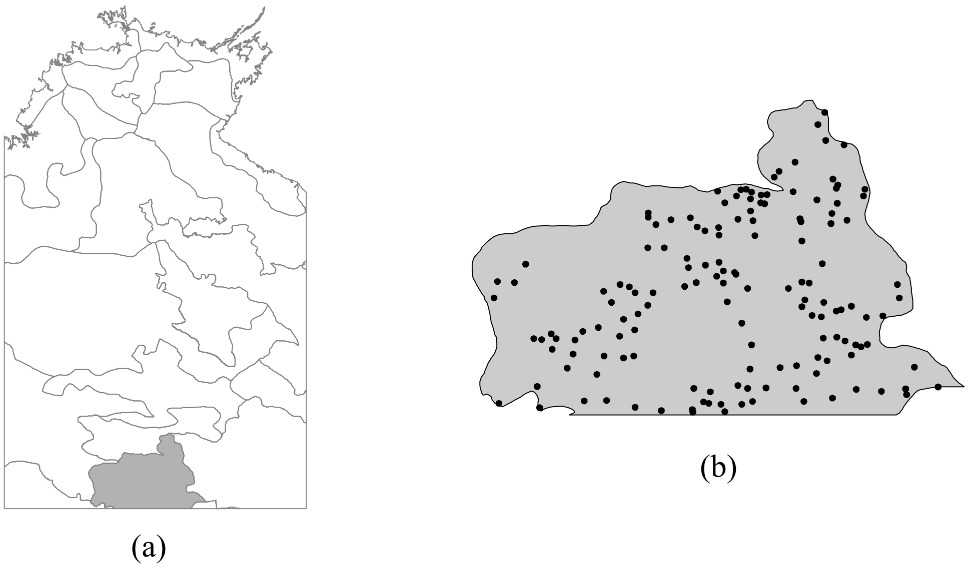


Figure 13: (a) Location of Finke bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed by H-M 2P grasses within Finke bioregion.

Table 15: Areas, number of Tier 1 sites and density of sites per 1000 km2 within Finke bioregion

Bioregion		Pastoral Estate within bioregion	Analysed with H-M 2P grasses
Area (km^2)	54258	51966	51966
Tier 1 sites	158	154	150
Site density per 1000 km^2	2.91	2.96	2.89

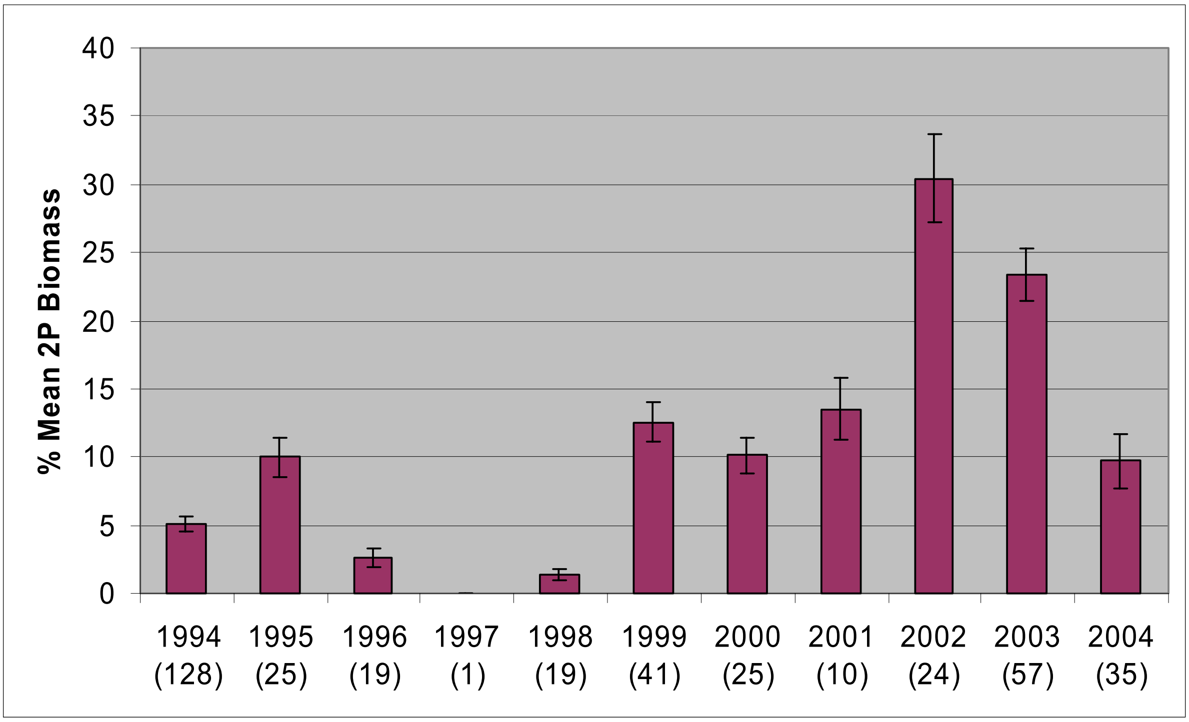


Figure 14: Finke - Mean % 2P grass biomass between 1993 and 2004.

- The distribution of the % mean 2P biomass indicates that H-M 2P grasses were at higher levels from 1999 to 2004 compared to previous years, with 2002 and 2003 experiencing the highest H-M 2P grass biomass.

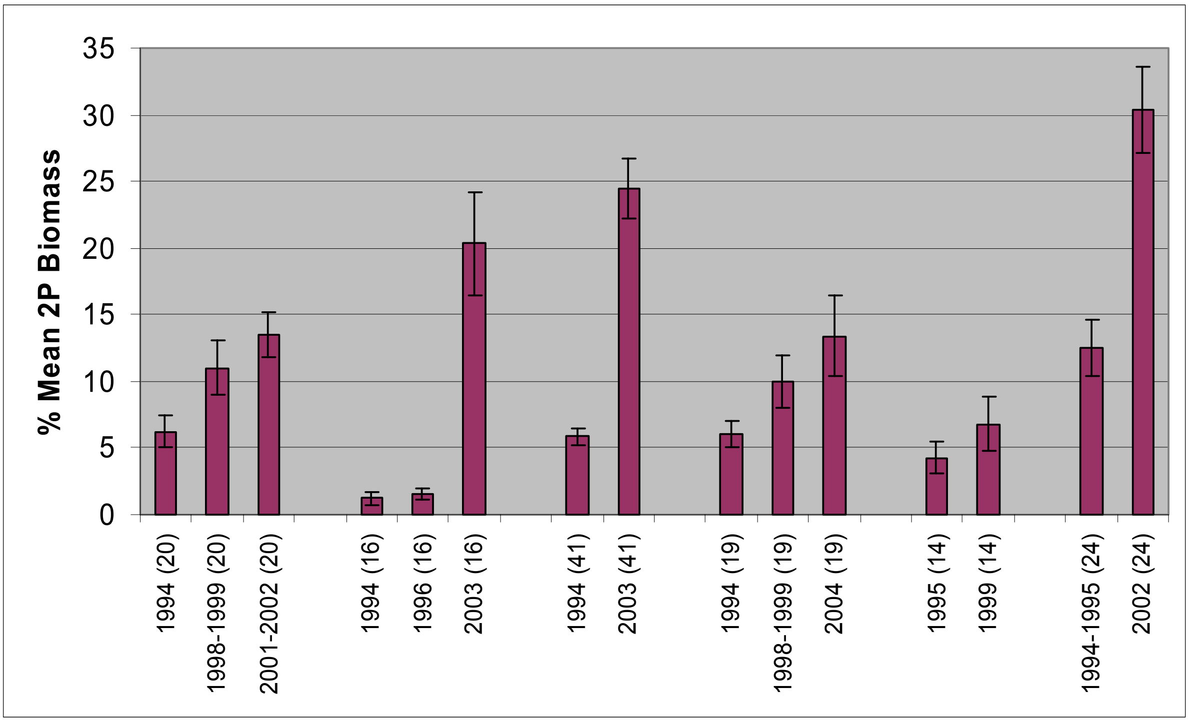


Figure 15: Finke - Mean % 2P grass biomass of consistent sites between 1993 and 2004.

- Following consistent sites throughout the reporting period, the years 2002 and 2003 have the highest % H-M 2P grass biomass assessed, due to the previous seasons higher than average rainfall.

- Significant rainfall events are the main drivers for increased 2P grass biomass within the Finke Bioregion. The region experienced higher than average rainfalls for the 2001 and 2002 season resulting in increase in biomass levels in the proceeding assessment period.

Table 16: Finke – Change in H-M 2P grasses.

Contribution 2P Grass Category	Seasonal Condition	Number of Reassessments	Percentage of Assessments		
			Decline	No Change	Improvement
High	Above Average	15	7	53	40
	Average	13	0	69	31
	Below Average	na	na	na	na
Medium	Above Average	2	0	100	0
	Average	3	0	100	0
	Below Average	na	na	na	na
Low	Above Average	78	0	79	21
	Average	39	0	85	15
	Below Average	na	na	na	na

A tolerance of + or - 20% was used to categories 'no change'

- Within the reporting period, one site had declining levels of 2Pgrass biomass, with the remaining sites experiencing significant increases in biomass levels; due to significant rainfall events.
- Naturally the bioregion is dominated by short lived perennials, which have not been analysed, therefore the assessment that Finke as low to very H-M 2P grasses and therefore sustainable grazing practices is very harsh.

Table 17: Finke – Percentage change in H-M 2P grasses within their seasonal condition terciles.

Seasonal Condition	Number of Reassessments	Percentage of Assessments		
		Decline	No Change	Improvement
Above Average	95	1	76	23
Average	55	0	82	18
Below Average	na	na	na	na

A tolerance of + or - 20% was used to categories 'no change'

The Finke bioregion has been assessed with contributions of H-M 2P grasses, however the bioregion is dominated by short lived perennials and the assessment is considered harsh. Assessment of H-M 2P grasses was able to highlight some improvements within the reporting period, due to largely, the higher rainfall in the later parts of the reporting period.
At the end of the reporting period, 21% of the bioregion’s H-M 2Pgrasses were at healthy levels, indicating that sustainable grazing practices are being undertaken throughout the region.

Gulf Fall and Uplands

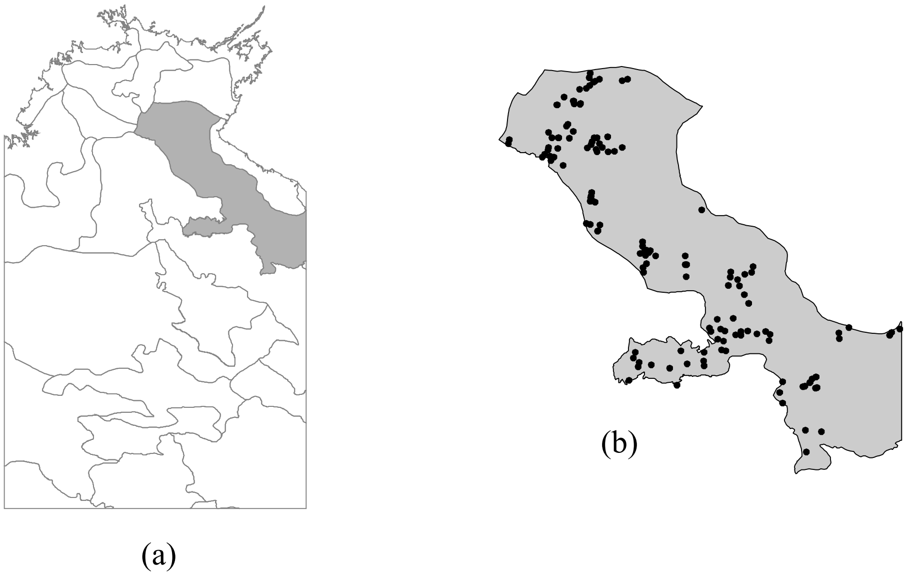


Figure 16: (a) Location of Gulf Fall and Uplands bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed by H-M 2P grasses within Gulf Fall and Uplands bioregion.

Table 18: Areas, number of Tier 1 sites and density of sites per 1000 km2 within Gulf Fall and Uplands bioregion.

Bioregion		Pastoral Estate within bioregion	Analysed with H-M 2P grasses
Area (km^2)	112587	64090	64090
Tier 1 sites	173	148	141
Site density per 1000 km^2	1.54	2.31	2.20

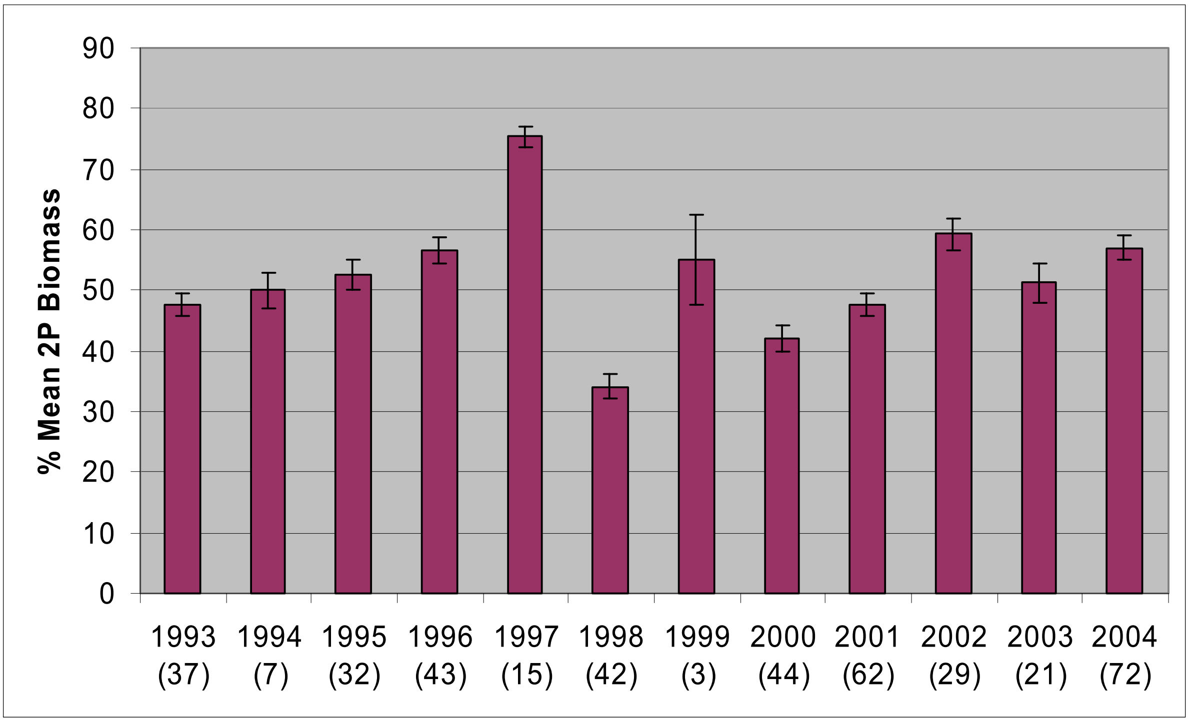


Figure 17: Gulf Fall and Uplands - Mean % 2P grass biomass between 1993 and 2004.

- % H-M 2P grass biomass levels slightly increased between 1993 and 1997, this ws then followed by a decrease in the years 1998 to 2001, with a recovery period from 2002 to 2004.

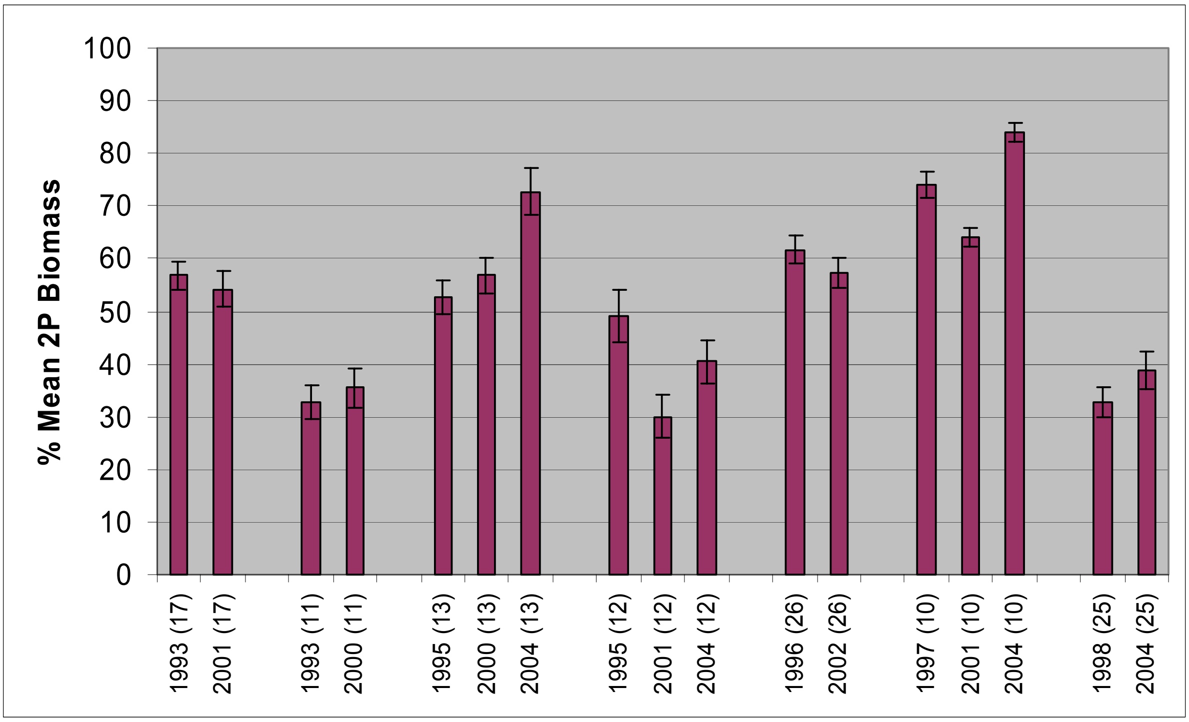


Figure 18: Gulf Fall and Uplands - Mean % 2P grass biomass of consistent sites between 1993 and 2004.

- The mean % H-M 2P grass biomass decreased slightly in 2002, with 6 categorized as declining, 6 improving and 17 as no change, and when summing all the change in % H-M 2P grass biomass there was only -5, all indicating there was a slight decrease, with only 3 sites continuing to decline to 2005.

- The lowest % H-M 2P grass biomass values in 1998 are the result of site selection, with these sites showing some improvement by 2004.
- Sites assessed in 2000 showed a mean improvement through out the reporting period with the lower % H-M 2P grass biomass in 2000 due to site selection, not an actual decrease in % H-M 2P grass biomass as was seen in 2001.

In summary, the Gulf Fall and Uplands bioregion has experienced an improving H-M 2P grass biomass through the reporting period, with a few areas declining in 2001 and 2002, however majority recovered by 2004 and 2005.

Table 19: Gulf Fall and Uplands – Change in H-M 2P grasses.

Contribution 2P Grass Category	Seasonal Condition	Number of Reassessments	Percentage of Assessments		
			Decline	No Change	Improvement
High	Above Average	23	26	74	0
	Average	8	13	88	0
	Below Average	na	na	na	na
Medium	Above Average	47	9	64	28
	Average	12	25	50	25
	Below Average	na	na	na	na
Low	Above Average	25	16	60	24
	Average	26	4	69	27
	Below Average	na	na	na	na

A tolerance of + or - 20% was used to categories 'no change'

- Initial assessments were conducted between 1993 and 1998, and most recent reassessments were between 2000 and 2004, giving an eleven year reporting period from 1993 to 2004.
- Majority of sites with improving 2P grass levels are a result of increasing Chrysopogon fallax and decreasing annuals or Aristida (Low 2P) species.
- Using the Contribution 2P grass category classification thresholds, there was an increase of 22% of High and a decrease of 10% for Medium and decrease of 2% for Low, indicating that there is an increasing trend of H-M 2P grasses within the Gulf Fall and Uplands.
- Using the 20% change in combined H-M 2P biomass, there was 13% decline, 66% no change and 21% improvement.

Table 20: Gulf Fall and Uplands – Percentage change in H-M 2P grasses within their seasonal condition terciles.

Seasonal Condition	Number of Reassessments	Percentage of Assessments		
		Decline	No Change	Improvement
Above Average	95	15	65	20
Average	46	11	67	22
Below Average	na	na	na	na

A tolerance of + or - 20% was used to categories 'no change'

In summary, Gulf Fall and Uplands bioregion, has remained relatively unchanged between 1993 and 2004 with 21% improving and an increase of 22% into the High 2P contributing category. This suggests that the initial de-stocking and reduction in stock in some areas as well as feral animal control has improved some previously degraded areas.

Mitchell Grass Downs

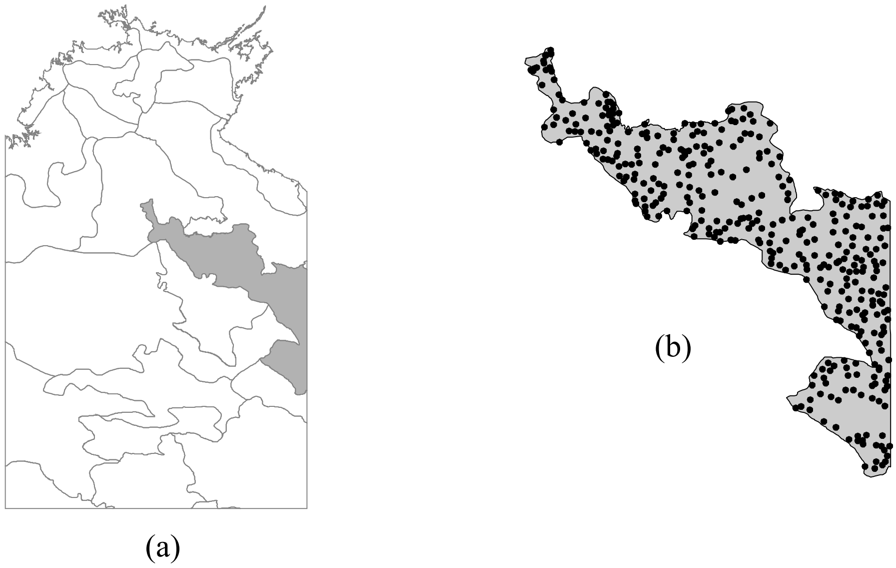


Figure 19: (a) Location of Mitchell Grass Downs bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed by H-M 2P grasses within Mitchell Grass Downs bioregion.

Table 21: Areas, number of Tier 1 sites and density of sites per 1000 km2 within Mitchell Grass Downs bioregion.

Bioregion		Pastoral Estate within bioregion	Analysed with H-M 2P grasses
Area (km^2)	93073	90474	90474
Tier 1 sites	410	396	379
Site density per 1000 km^2	4.41	4.38	4.19

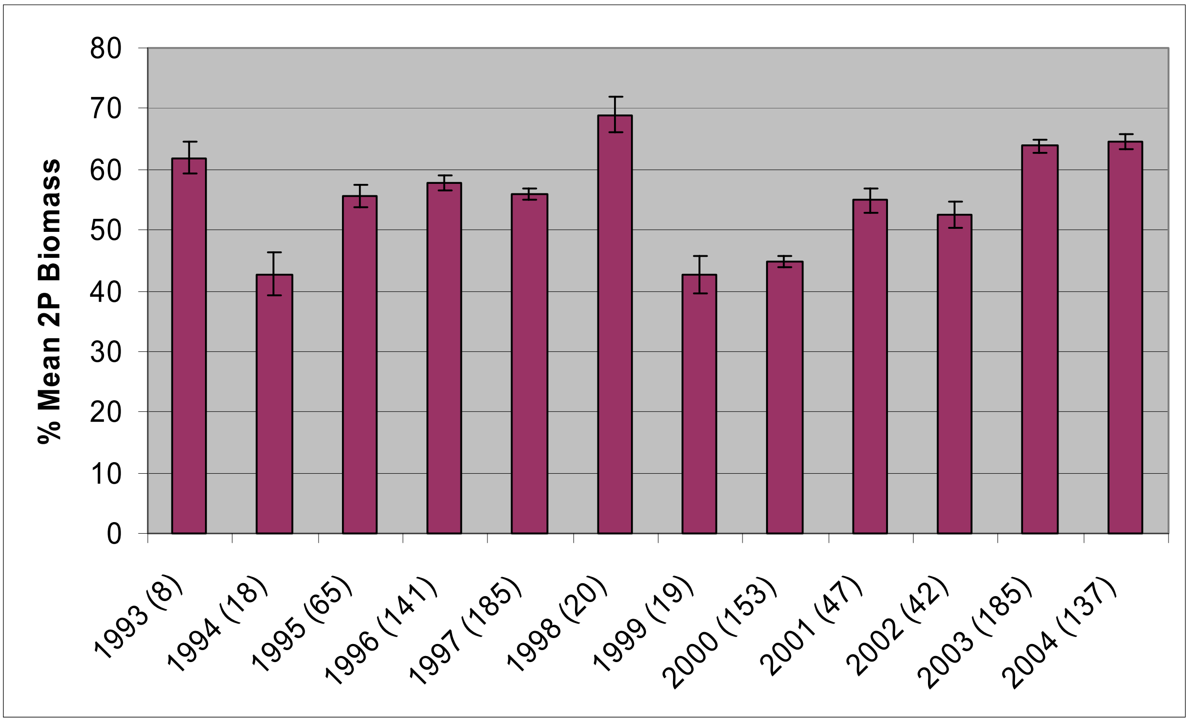


Figure 20: Mitchell Grass Downs - Mean % 2P grass biomass between 1993 and 2004.

- Between 1995 and 1997 there was an average of approximately 55% 2P biomass which dropped to approximately 45% in 1999 and 2000, followed by an increase back to approximately 55% in 2001 and 2002, with the highest mean values in 2003 and 2004, values of over60% 2P biomass.

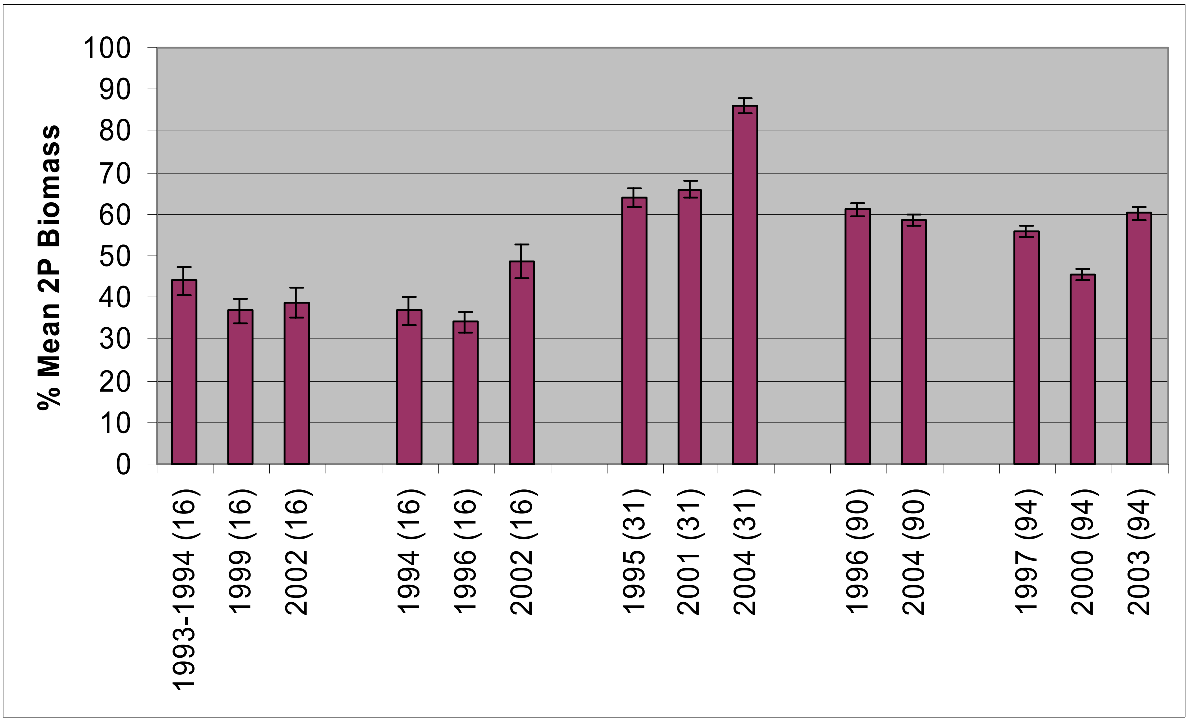


Figure 21: Mitchell Grass Downs - Mean % 2P grass biomass of consistent sites between 1993 and 2004.

- Sites established early in the reporting period (1993 – 1994) decreased further in 1996 and 1999, but improved by 2002.

- Sites established in 1995 slightly increased in 2001, but had significantly increased by 2004.
- Sites established in 1995 had slightly decreased by 2004, however majority of sites having increased by 2004.

In summary, majority of Mitchell Grass Downs appears to be stable with slight improvement, with the majority of declining values from sites decreasing from High to Medium 2P contribution category, however there was a small group of sites that showed a significant increase into the High category.

Table 22: Mitchell Grass Downs – Change in H-M 2P grasses.

Contribution 2P Grass Category	Seasonal Condition	Number of Reassessments	Percentage of Assessments		
			Decline	No Change	Improvement
High	Above Average	41	29	71	0
	Average	44	16	84	0
	Below Average	10	30	70	0
Medium	Above Average	95	11	74	16
	Average	45	9	67	24
	Below Average	17	0	59	41
Low	Above Average	74	8	58	34
	Average	35	3	49	49
	Below Average	18	6	50	44

A tolerance of + or - 20% was used to categories 'no change'

- Initial assessments of the 379 sites suitable for 2P grasses analysis were from 1993 to 1999, with the most recent reassessments ranging from 1997 to 2004, giving an eleven year reporting period from 1993 to 2004 (Appendix 1).
- 27 sites initially assessed as having High contributing 2P grasses declined, however 10 of these sites had experienced a significant seasonal flush of Flinders annual grass in the spaces between perennial grasses, where at the initial assessment, the ground was generally bare.
- The 12 High sites were assessed as declining in Above seasonal conditions, 4 were not really declining as the change in % biomass was due to Flinders and Kimberley couch flushes, the remaining 8 sites did experience decline with majority experiencing Mitchell grasses decline or completely disappearing, with a few experiencing other 2P grasses disappearing or declining.
- The 7 High sites declined after experiencing Average seasonal conditions, 5 were manually assessed having nodecline but experiencing seasonal flushes of Flinders annual grass, the remaining 2 sites both lost all the Mitchell grasses, with other 2P grasses also declining.
- The 14 sites initially assessed as having Medium contributing 2P grasses declined, however on manual review 6 are not declining but experiencing a seasonal flush of annual grasses.
- 10 Medium sites declined after experiencing Above Average seasonal conditions, however 4 of these were seasonal flushes of Flinders or annual sorghum, the 6 sites really declining experienced a decline of Mitchell grasses and/or decline or complete disappearance of other 2P grasses.

- 4 Medium sites were assessed as declining after experiencing Average seasonal conditions, however 2 were really experiencing a seasonal flush of annuals, with the remaining two sites experiencing a decline in Mitchell grass or disappearance of Queensland Bluegrass and an increase in annuals.
- From the Low category 8 sites declined further, with 5 2P's disappearing completely, with the remaining 3 reduced their 2P contribution significantly and were replaced by annuals, with one going from 4 2P species to just 1 2P species.
- 50 sites initially assessed as having Low contributing 2P grasses improved, with eight after experiencing Below Average seasonal conditions, however all started improving from 2000 to 2002 after experiencing Above Average rainfall for a few years, and this improvement continued in the following Average and Below Average years in 2003 and 2004.

Table 23: Mitchell Grass Downs – Change in H-M 2P grasses with manual reassessment of 2P % biomass declining sites to account for seasonal flushes of annuals.

Contribution 2P Grass Category	Seasonal Condition	Number of Reassessments	Percentage of Assessments		
			Decline	No Change	Improvement
High	Above Average	41	20	80	0
	Average	44	5	95	0
	Below Average	10	20	80	0
Medium	Above Average	95	6	78	16
	Average	45	4	71	24
	Below Average	17	0	59	41
Low	Above Average	74	8	58	34
	Average	35	3	49	49
	Below Average	18	6	50	44

A tolerance of + or - 20% was used to categories 'no change'

- Mitchell Grass Downs has a majority (71%) of sites unchanged between 1993 and 2004, with 22% improving and 7% declining.
- Initially assessed Low 2P contribution category sites improved the most with 39% improving, 54% unchanged and 6% declining, Medium sites had 21% improving, 74% unchanged and 5% declining, and with majority of High sites unchanged with 87% and 13% declining.

Table 24: Mitchell Grass Downs – Change in H-M 2P grasses with manual reassessment of 2P % biomass declining sites to account for seasonal flushes of annuals.

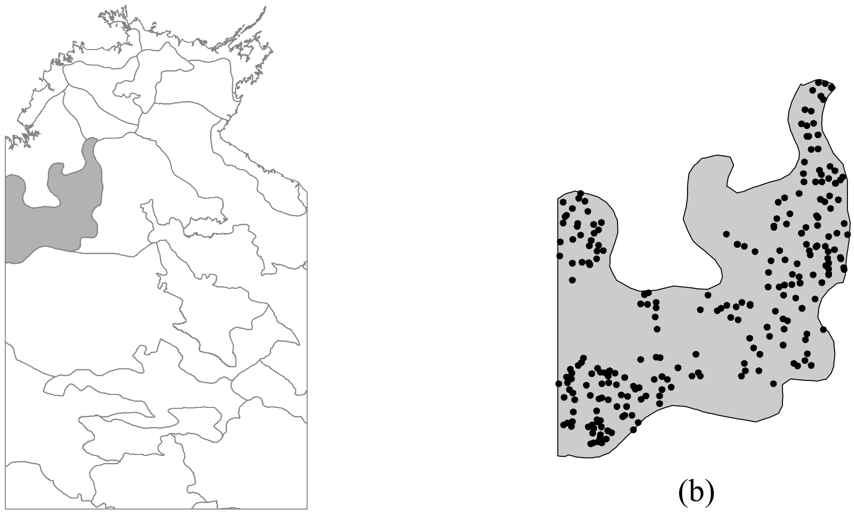
Seasonal Condition	Number of Reassessments	Percentage of Assessments		
		Decline	No Change	Improvement
Above Average	210	10	71	19
Average	124	4	73	23
Below Average	45	7	60	33

A tolerance of + or - 20% was used to categories 'no change'

- In all seasonal conditions the majority of sites were unchanged, with substantially more sites improving than declining, suggesting grazing management is sustainable to slightly improving within the bioregion.

In summary, majority of Mitchell Grass Downs experienced stable 2P grasses, therefore management appears to be unchanged for 71% of the bioregion, however 22% of the bioregion are experiencing improvement in 2P grasses suggesting improving grazing management practices in these areas. , Overall Mitchell Grass Downs is experiencing sustainable management over a majority (93%) of it landscape.

Ord Victoria Plain



(a) (b)

Figure 22: (a) Location of Ord Victoria Plain bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed H-M 2P grasses within Ord Victoria Plain bioregion.

Table 25: Areas, number of Tier 1 sites and density of sites per 1000 km2 within Ord Victoria Plains bioregion.

Bioregion		Pastoral Estate within bioregion	Analysed with H-M 2P grasses
Area (km^2)	70428	52560	52560
Tier 1 sites	274	263	251
Site density per 1000 km^2	3.89	5.00	4.78

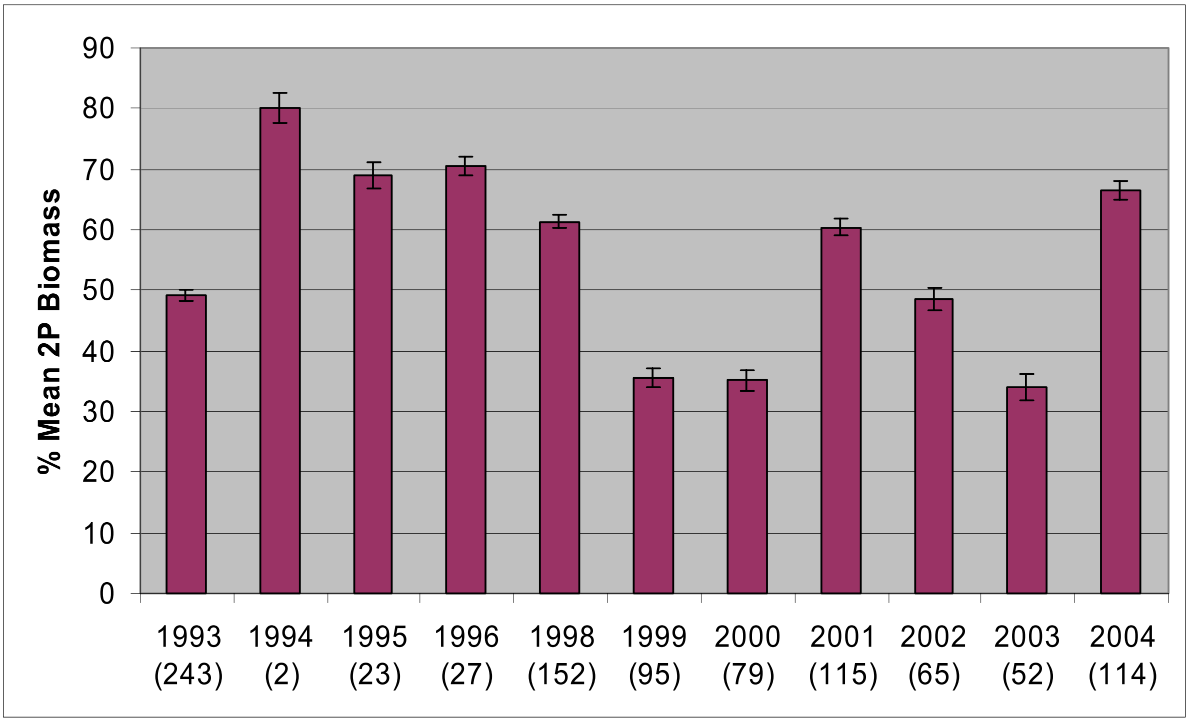


Figure 23: Ord Victoria Plain - Mean % 2P grass biomass between 1993 and 2004.

- The earlier stages of the reporting period have consistently higher values than the later parts fo the erporting period.

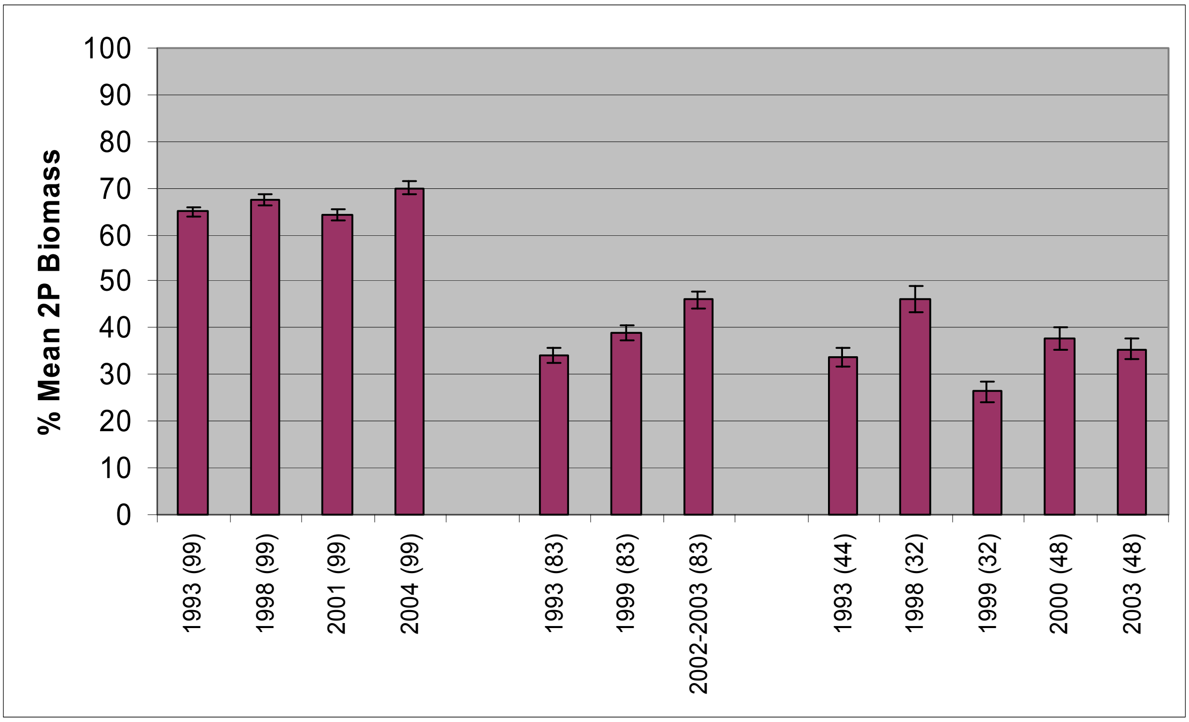


Figure 24: Ord Victoria Plain - Mean % 2P grass biomass of consistent sites between 1993 and 2004.

- As with the landscape function analysis, following consistent sites generally shows 2P grasses are generally stable to slightly increasing, however it did show that 1998 and 2004 had higher 2P grasses and 1993 and 1999 lower.

- Overall the large increase from 2003 to 2004 and the generally higher 2P grass levels later in the reporting period suggests that 2P grasses have improved over the reporting period, indicating possible sustainable to improving grazing management within the bioregion.

In summary, the Ord Victoria Plain bioregion has experienced fluctuation in the 2P grasses % biomass over its reporting period, however the recovery trends in later years, indicates that 2P grasses have improved, suggesting sustainable grazing practices.

Table 26: Ord Victoria Plain – Percentage change in H-M 2P grasses within their contribution 2P grass category and seasonal condition tercile.

Contribution 2P Grass Category	Seasonal Condition	Number of Reassessments	Percentage of Assessments		
			Decline	No Change	Improvement
High	Above Average	25	24	76	0
	Average	30	10	90	0
	Below Average	2	0	100	0
Medium	Above Average	64	25	50	25
	Average	28	4	46	50
	Below Average	3	0	100	0
Low	Above Average	82	6	55	39
	Average	17	24	71	6
	Below Average	na	na	na	na

A tolerance of + or - 20% was used to categories 'no change'

- Initial assessments of the 251 sites suitable for 2P grasses analysis were from 1993 to 1999, with the most recent reassessments ranging from 1998 to 2004, giving an eleven year reporting period from 1993 to 2004 (Appendix 1).
- At their initial assessment 23% had High contributing 2P grasses, 37% Medium and 40% Low, 2P grasses generally improved by most recent reassessment with 36% High, 26% Medium and 38% Low.
- Of the Low 2P contributing sites, 9 declined further with all except one either lost all or some of their 2P grass species, with the remaining species declining. These sites experienced an increase in low palatable perennial grasses and/or annuals and/or forbs.
- Of the Medium 2P contributing sites, 16 (17%) declined, 48 (51%) unchanged and 30 (32%) improved.
- Of the High 2P contributing sites, 9 (16%) declined and 48 (84%) experienced no change.

Table 27: Ord Victoria Plain – Percentage change in H-M 2P grasses within their seasonal condition terciles.

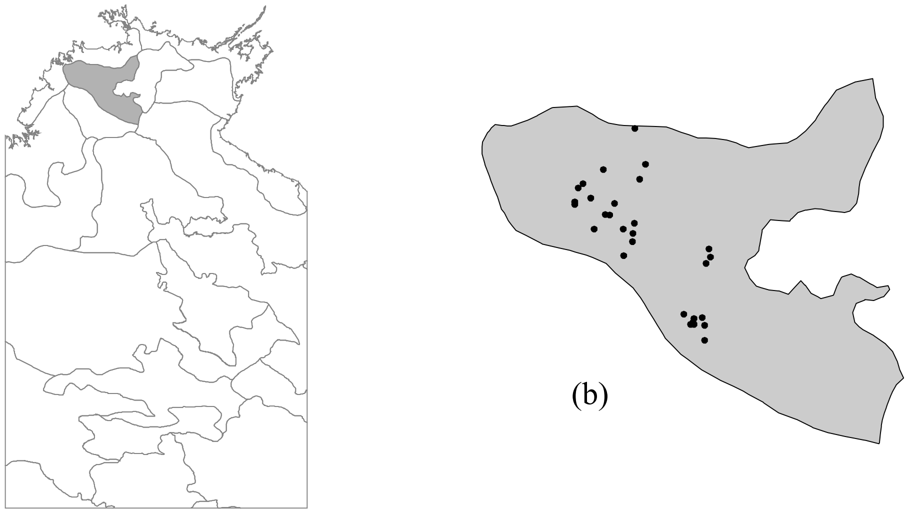
Seasonal Condition	Number of Reassessments	Percentage of Assessments		
		Decline	No Change	Improvement
Above Average	171	15	57	28
Average	75	11	69	20
Below Average	5	0	100	0

A tolerance of + or - 20% was used to categories 'no change'

- Majority (68%) of reassessments were of sites that had experienced Above Average seasonal conditions, which had 15% declining, 28% improving and 57% unchanged.

In summary, the Ord Victoria Plain bioregion experienced 14% declining, 25% improving and 61% unchanged of 2P biomass between 1993 and 2004, with large areas of Medium and Low contributing 2P grasses areas experiencing improvements, suggesting that a majority of the bioregion is under sustainable grazing management.

Pine Creek



(a)

Figure 25: (a) Location of Pine Creek bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed by H-M 2P grasses within Pine Creek bioregion.

Table 28: Areas, number of Tier 1 sites and density of sites per 1000 km2 within Pine Creek bioregion.

Bioregion		Pastoral Estate within bioregion	Analysed with H-M 2P grasses
Area (km^2)	28518	7358	7358
Tier 1 sites	51	49	29
Site density per 1000 km^2	1.79	6.66	3.94

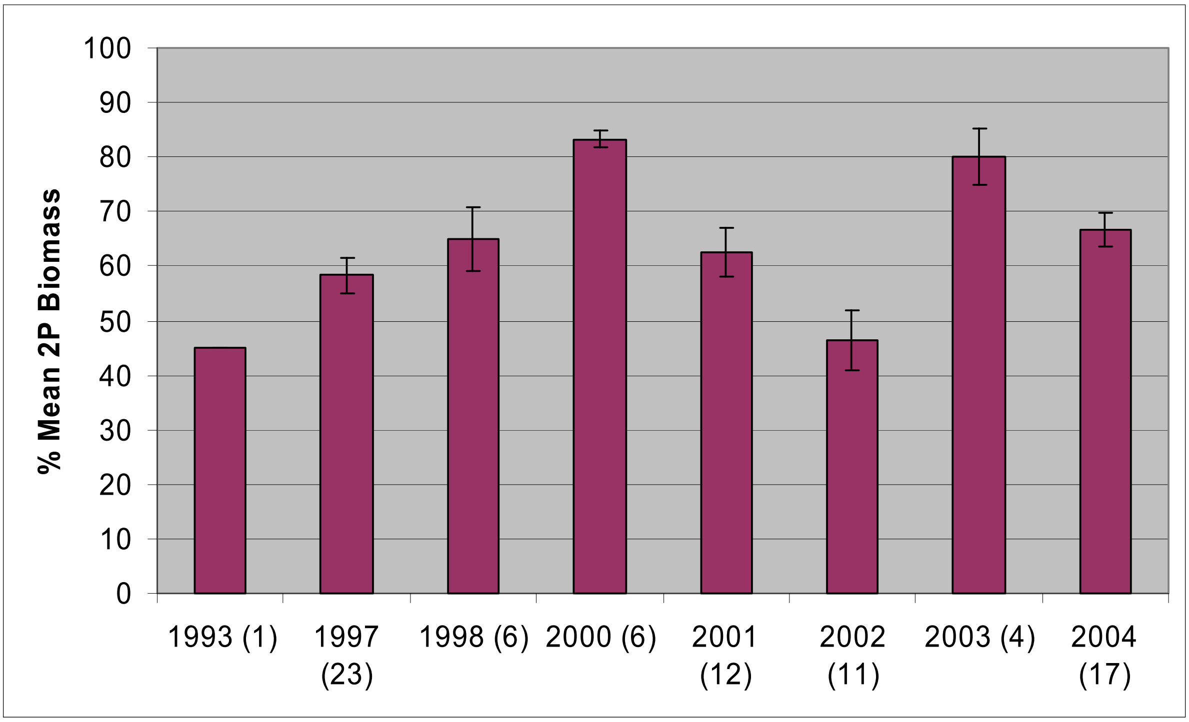


Figure 26: Pine Creek - Mean % 2P grass biomass between 1993 and 2004.

- Pine Creek bioregion only has 29 sites that are assessed at least twice and 15 assessed once, therefore analysis of changes of only a few sites per year does not indicate bioregion trends.
- 1997, 2001, 2002 and 2004 have the most sites assessed, and these suggests a slight increasing trend of 2P grasses from 1997 to 2004.

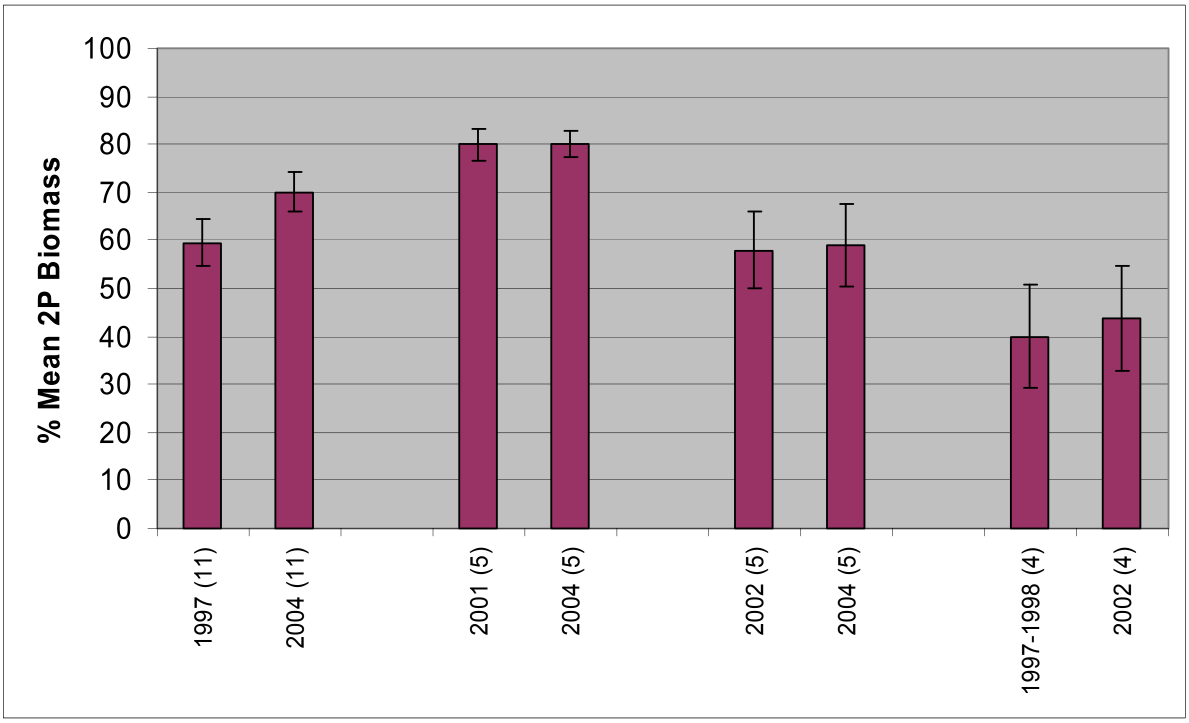


Figure 27: Pine Creek - Mean % 2P grass biomass of consistent sites between 1993 and 2004.

In summary, Pine Creek appears to have a slight increasing 2P grasses trend between 1997 and 2004.

Table 29: Pine Creek – Change in H-M 2P grasses.

Contribution 2P Grass Category	Seasonal Condition	Number of Reassessments	Percentage of Assessments		
			Decline	No Change	Improvement
High	Above Average	4	25	75	0
	Average	3	0	100	0
	Below Average	4	0	100	0
Medium	Above Average	1	0	100	0
	Average	8	0	88	13
	Below Average	2	0	100	0
Low	Above Average	3	0	100	0
	Average	2	0	100	0
	Below Average	2	0	100	0

A tolerance of + or - 20% was used to categories 'no change'

- Initial assessments of the 29 sites suitable for 2P grasses analysis, were from 1993 to 2002 with 59% in 1997, and most recent reassessments ranging from 2001 to 2004 with 52% in 2004, giving a reporting period of 11 years from 1993 to 2004 with a majority ranging over 7 years from 1997 to 2004 (Appendix 1).
- Only one declined (annual sorghum increased) and one improved (annual sorghum decreased), with remaining sites unchanged.
- 38% (11 sites) of sites were categorized in the High contributing category, 38% in Medium, and 24% (7 sites) in the Low H-M 2P grasses contributing category at initial assessment, with only Low increasing by one at last reassessment.

Table 30: Pine Creek – Percentage change in H-M 2P grasses within their seasonal condition terciles.

Seasonal Condition	Number of Reassessments	Percentage of Assessments		
		Decline	No Change	Improvement
Above Average	8	13	88	0
Average	13	0	92	8
Below Average	8	0	100	0

A tolerance of + or - 20% was used to categories 'no change'

- Overall Pine Creek bioregion had only 3% declining (1 sites – annual sorghum increased) and 3% improving (1 site – annual sorghum decreased) both due to fires influence on annual sorghum levels.

In summary, Pine Creek bioregion 2P grasses was unchanged from 1993 and 2004, with fire being the major management issue within the bioregion, which appears to have no to low impact on long term 2P grass levels, suggesting the bioregion is experiencing sustainable grazing practices.

Sturt Plateau

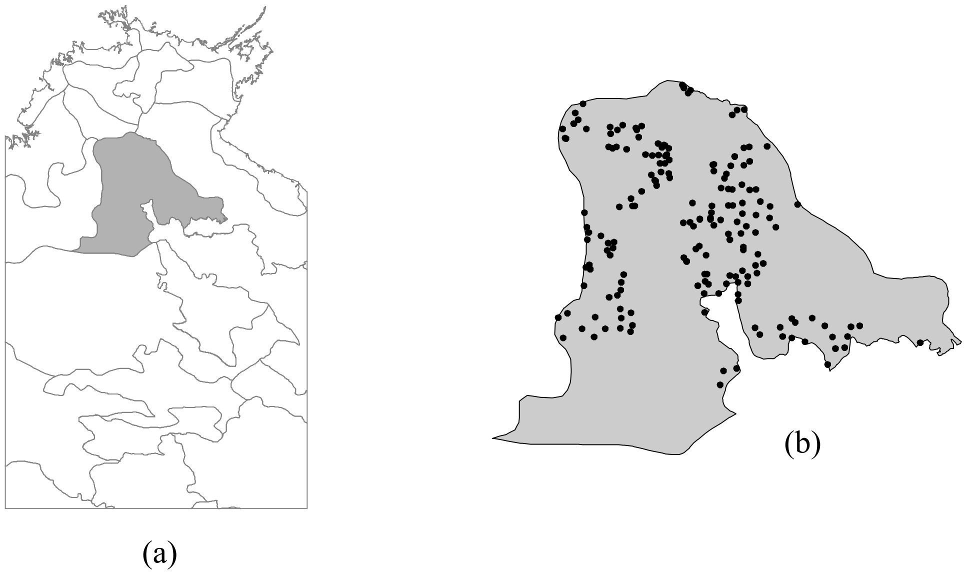


Figure 28: (a) Location of Sturt Plateau bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed by H-M 2P grasses within Sturt Plateau bioregion.

Table 31: Areas, number of Tier 1 sites and density of sites per 1000 km2 within Burt Plain bioregion.

Bioregion		Pastoral Estate within bioregion	Analysed with H-M 2P grasses
Area (km^2)	98575	69534	69534
Tier 1 sites	218	200	183
Site density per 1000 km^2	2.21	2.88	2.63

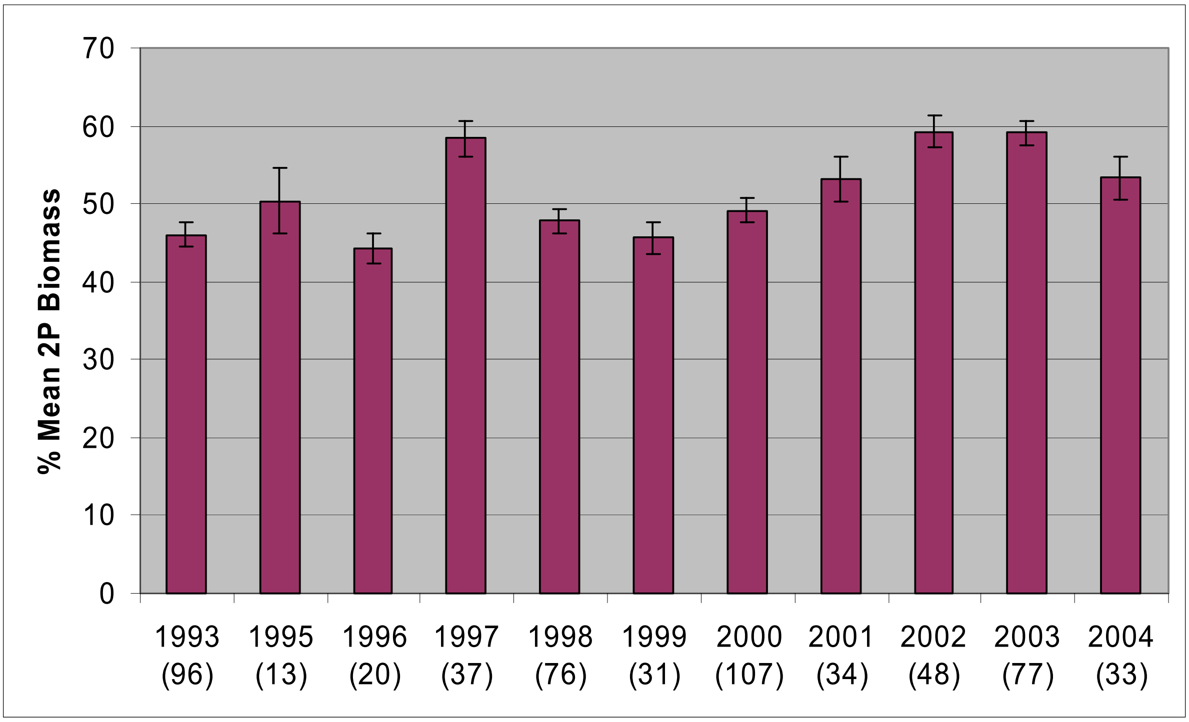


Figure 29: Sturt Plateau - Mean % 2P grass biomass between 1993 and 2004.

- Sturt Plateau bioregion appears to, over the reporting period, have a steady increase in %2P biomass, suggesting improvement.

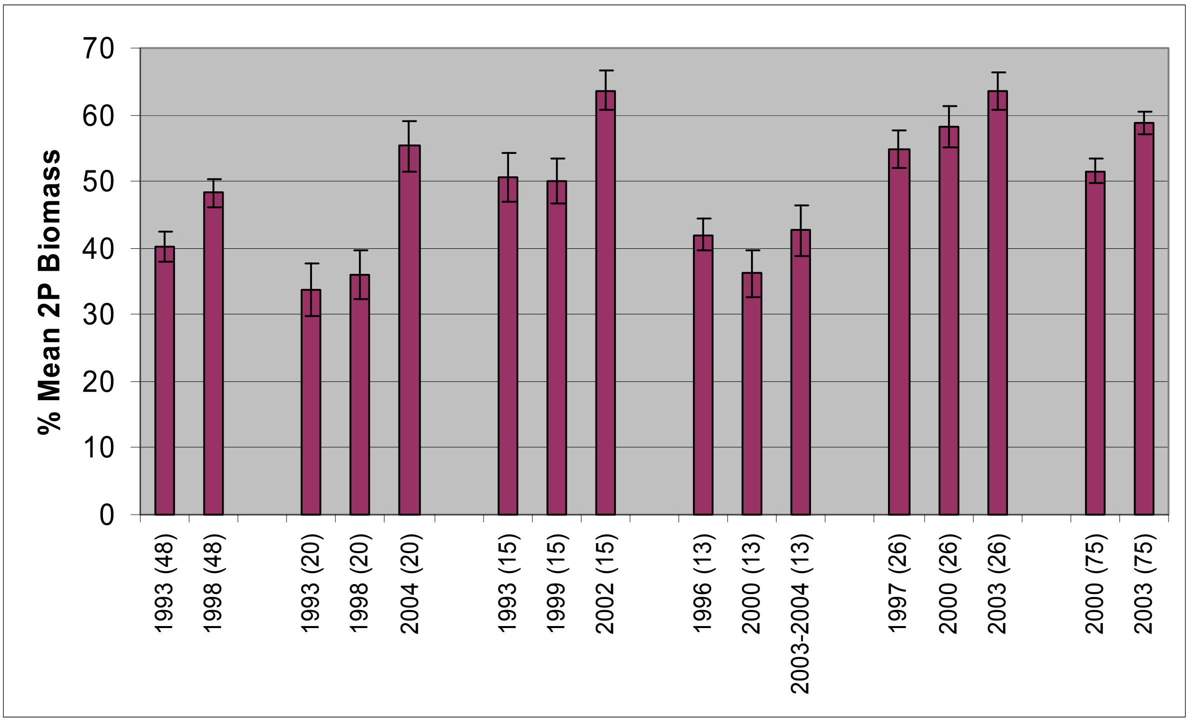


Figure 30: Sturt Plateau - Mean % 2P grass biomass of consistent sites between 1993 and 2004.

- Following consistent sites, majority of the sites appear to be showing signs of improvement, with a small group decreased in 2000, but recovered to pervious 2P grass levels by 2003-2004.

- Some areas of the bioregion were previously undeveloped (not grazed), and had improving levels of 2P grass biomass from 1993 to 2000. When stock were introduced the 2P grasses continued to improve, indicating that the Above Average seasonal conditions were generally improving the productivity potential of some of the bioregion despite the introduction of cattle.

In summary, Sturt Plateau bioregion has improved from 1993 to 2004 despite the introduction of stock into some previously undeveloped areas during the reporting period, indicating that the region is in very good condition and stocking numbers are sustainable in current seasonal conditions.

Table 32: Sturt Plateau – Change in H-M 2P grasses.

Contribution 2P Grass Category	Seasonal Condition	Number of Reassessments	Percentage of Assessments		
			Decline	No Change	Improvement
High	Above Average	48	8	92	0
	Average	3	0	100	0
	Below Average	na	na	na	na
Medium	Above Average	49	14	67	18
	Average	8	0	88	13
	Below Average	na	na	na	na
Low	Above Average	74	3	51	46
	Average	1	0	100	0
	Below Average	na	na	na	na

A tolerance of + or - 20% was used to categories 'no change'

- 183 sites were assessed at least twice, with initial assessments between 1993 and 2000, and their most recent reassessments between 1998 and 2004.
- As majority of this bioregion is in good condition with generally high 2P grass levels, the categorization of sites into the Low 2P grass category does not indicate that their 2P grass contribution is actually low for this bioregion.
- Of the 51 sites initial assessed with High contributing H-M 2P grasses only 4 were reassessed as declining, 1 was burnt in both assessments, one had a major (75% to 15%) decline in Chrysopogon fallax (moderate 2P) and an increase in annuals, the remaining 2 sites had a significant increase in Sehima nervosum (Low 2P).
- Of the 57 sites initially assessed as having Medium contributing H-M 2P grasses, 7 were reassessed as declining with 1 burnt at both assessments, 4 had significantly increasing Sehima nervosum and decreasing Chrysopogon fallax, one with an increasing Aristida species (Low 2P) and decreasing Dichanthium (High 2P) and Eulalia (Moderate 2P) species, the last site had a significant increase in annual sorghum and decrease other species including some that disappeared.
- Of the 75 sites initial assessed as having Low contributing H-M 2P grasses, 8 of the ‘no change’ sites either had 0% to 0% (4 sites) or Low % contribution to 0% (4 sites), and 5 of the 34 sites that improved had an initial assessment of 0% 2P grasses. The two sites assessed as declining, one had Chrysopogon and Dichanthium disappear and newly germination Eulalia (5%) appear, the other had all 2P grasses disappear and annual sorghum take over as it has experienced frequent fires.

Table 33: Sturt Plateau – Percentage change in H-M 2P grasses within their seasonal condition terciles.

Seasonal Condition	Number of Reassessments	Percentage of Assessments		
		Decline	No Change	Improvement
Above Average	171	8	67	25
Average	12	0	92	8
Below Average	na	na	na	na

A tolerance of + or - 20% was used to categories 'no change'

- Over all 7% declined, 69% were unchanged and 24% improved, even though 93% of sites experienced Above Average seasonal condition preceding their recent reassessment and 78% of sites experienced Average seasonal conditions preceding their initial assessment.

In summary, the Sturt Plateau bioregion has generally been unchanged to a slight improvement during the reporting period, with majority of the bioregion in good condition and approximately half (45%) of the areas with a lower proportion of 2P grass improving, suggesting that the recently developed Sturt Plateau is experiencing sustainable grazing practices.

Victoria Bonaparte

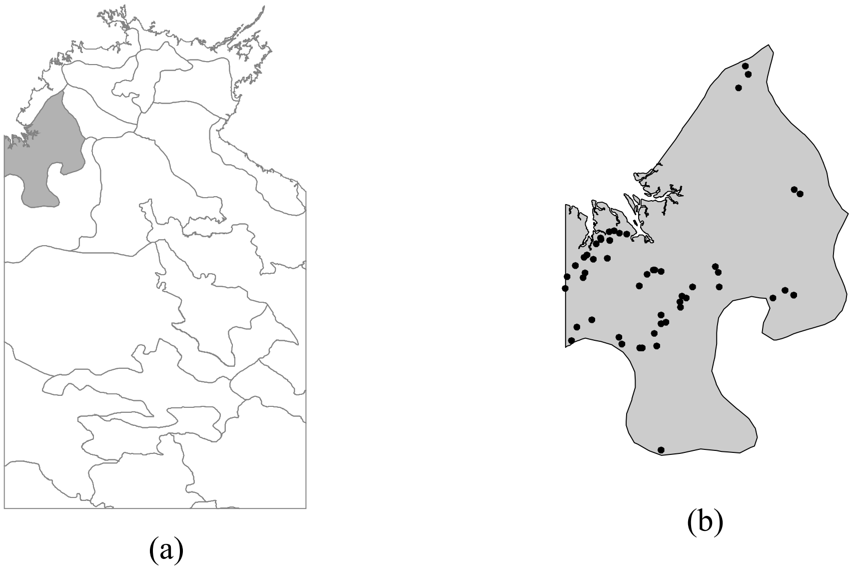


Figure 31: (a) Location of Victoria Bonaparte bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed by H-M 2P grasses within Victoria Bonaparte bioregion.

Table 34: Areas, number of Tier 1 sites and density of sites per 1000 km2 within Victoria Bonaparte bioregion.

Bioregion		Pastoral Estate within bioregion	Analysed with H-M 2P grasses
Area (km^2)	54098	18148	18148
Tier 1 sites	73	54	52
Site density per 1000 km^2	1.35	2.98	2.87

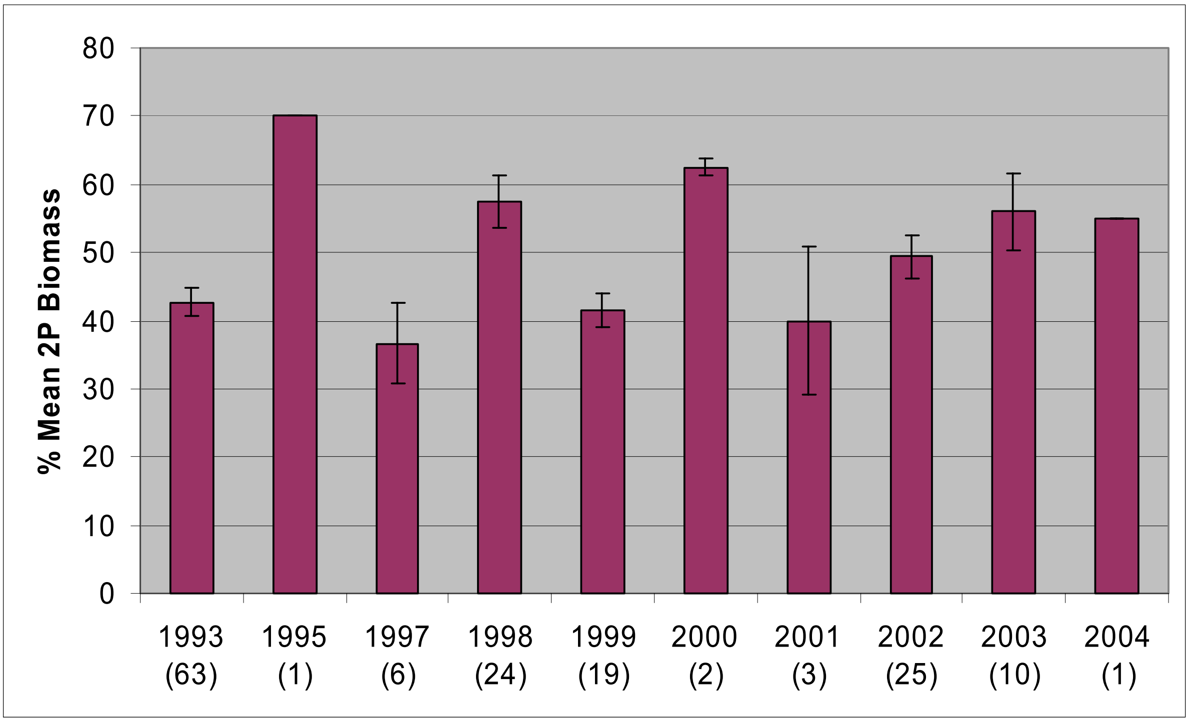


Figure 32: Victoria Bonaparte - Mean % 2P grass biomass between 1993 and 2004.

- Majority of site assessments for Victoria Bonaparte bioregion were conducted in 1993, 1998-1999 and 2002-2003, following these sites, the mean 2P % biomass values appears to be stable to improving, with 1998 having the highest 2P grass levels of % biomass.

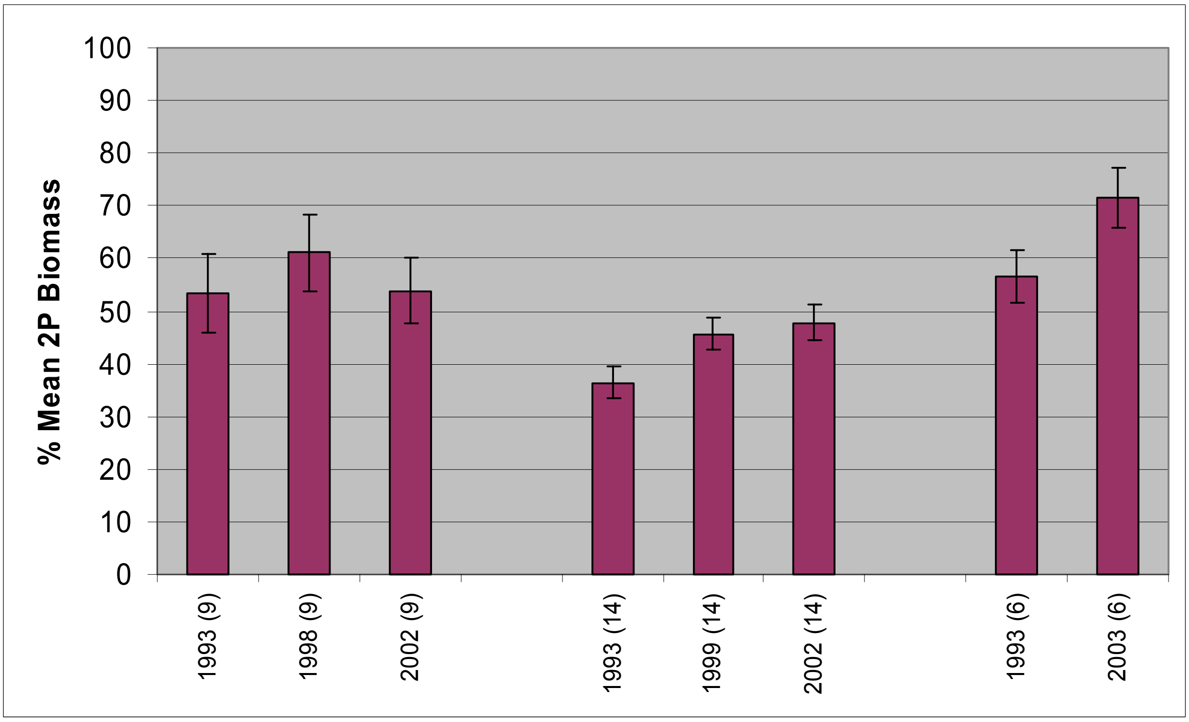


Figure 33: Victoria Bonaparte - Mean % 2P grass biomass of consistent sites between 1993 and 2004.

In summary, Victoria Bonaparte bioregion overall is generally has stable to improving 2P grass biomass between 1993 and 2003.

Table 35: Victoria Bonaparte – Change in H-M 2P grasses.

Contribution 2P Grass Category	Seasonal Condition	Number of Reassessments	Percentage of Assessments		
			Decline	No Change	Improvement
High	Above Average	5	20	80	0
	Average	8	25	75	0
	Below Average	na	na	na	na
Medium	Above Average	8	0	75	25
	Average	8	0	38	63
	Below Average	3	0	100	0
Low	Above Average	7	0	100	0
	Average	11	0	55	45
	Below Average	2	0	100	0

A tolerance of + or - 20% was used to categories 'no change'

- Initial assessments of the 52 sites were conducted between 1993 and 1998, with 92% in 1993, with the most recent reassessments conducted between 1998 and 2004, with 48% in 2002 and 23% in 1998.
- 48% of sites were assessed over a 9 year period (1993 to 2002), and 25% over a 5 years (1993 to 1998).
- 25% of sites were assessed initial as in the High contribution H-M 2P category for Victoria Bonaparte bioregion, with 37% as Medium and 38% as Low. This changed through the reporting period with High increasing to 38% and Medium and Low both decreasing to 33% and 29% respectively.
- This slight improving trend was also shown in the ACRIS change matrix with 23% improving, 69% not changing and 8% declining.
- Three sites were assessed as declining over a 9 year period, however 2 were burnt therefore unable to assess change appropriately, and the remaining site had it's H-M 2P grass slowly being replaced by an unpalatable perennial grass (Cane grass).

Table 36: Victoria Bonaparte – Percentage change in H-M 2P grasses within their seasonal condition terciles.

Seasonal Condition	Number of Reassessments	Percentage of Assessments		
		Decline	No Change	Improvement
Above Average	20	5	85	10
Average	27	7	56	37
Below Average	5	0	100	0

A tolerance of + or - 20% was used to categories 'no change'

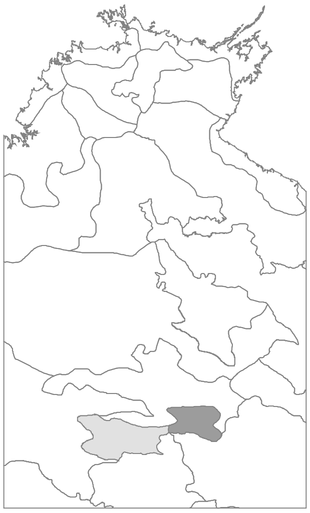
Table 37: Victoria Bonaparte – Percentage change in H-M 2P grasses within their seasonal condition terciles, with declining sites manually reassessed.

Seasonal Condition	Number of Reassessments	Percentage of Assessments		
		Decline	No Change	Improvement
Above Average	20	0	90	10
Average	27	4	59	37
Below Average	5	0	100	0

- Manually reassessing the two burnt declining sites to no changed, results in only 2% (1 site) declining, 23% improving and 75% unchanged.

In summary, Victoria Bonaparte bioregion is mostly unchanged between 1993 and 2004 (majority 1993 to 2002) with some areas improving.

MacDonnell Ranges P3



(a)

(b)

Figure 34: (a) Location of MacDonnell Ranges P3 bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed by H-M 2P grasses MacDonnell Ranges P3 bioregion.

Table 38: Areas, number of Tier 1 sites and density of sites per 1000 km2 within MacDonnell Ranges P3 bioregion.

Bioregion		Pastoral Estate within bioregion	Analysed with H-M 2P grasses
Area (km^2)	13527	12934	12934
Tier 1 sites	35	34	19
Site density per 1000 km^2	2.59	2.63	1.47

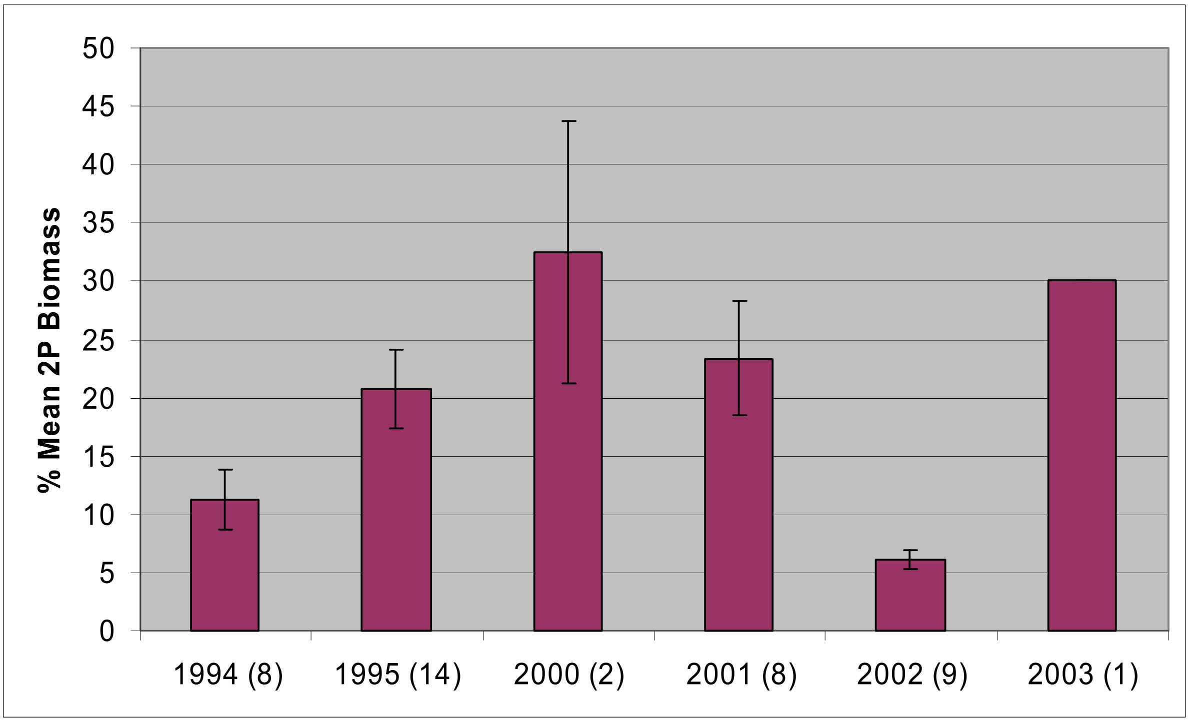


Figure 35: MacDonnell Ranges P3 - Mean % 2P grass biomass between 1994 and 2003.

- There are only 19 sites assessed twice between 1994 and 2003, comparing 1994-1995 to 2001-2002. The MacDonnell Ranges has low contribution of H-M 2P grasses, with the sites assessed 2002 having decreasing values, to a low of only 5% H-M 2P % biomass.

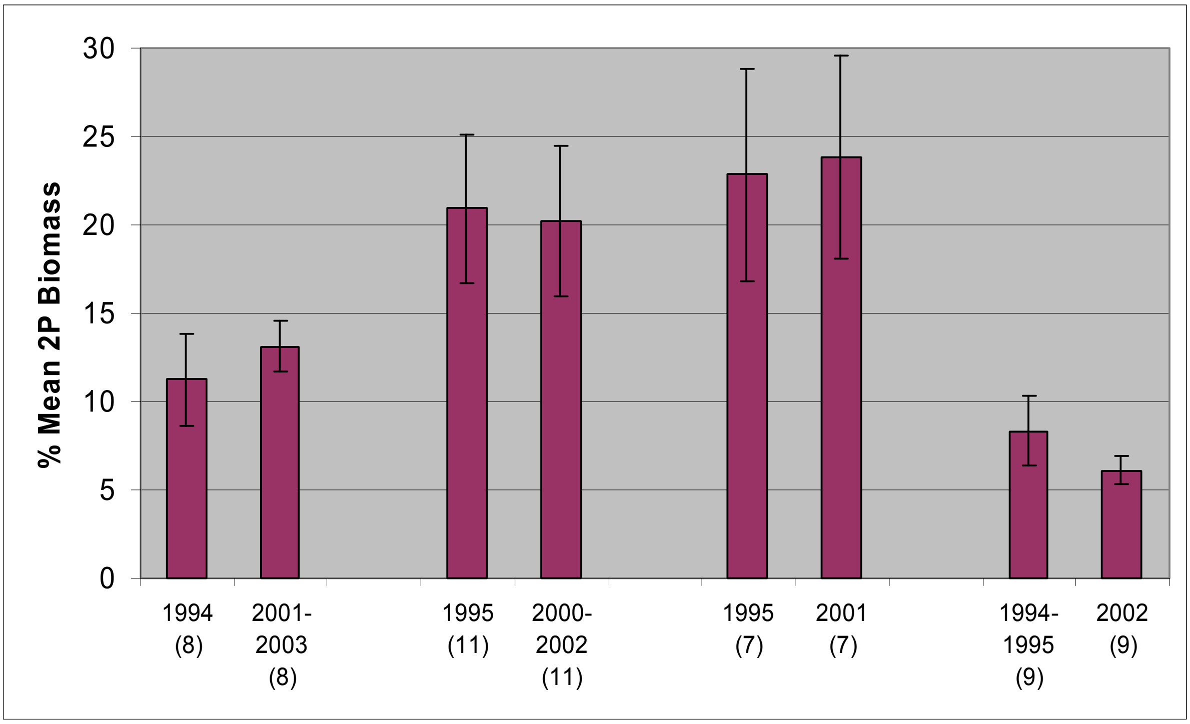


Figure 36: MacDonnell Ranges P3 - Mean % 2P grass biomass of consistent sites between 1994 and 2003.

- Over the reporting period, some sites slightly increased and some slightly decreased their H-M 2P grass contribution, and as the changes are very small they are considered to be unchanged.

- Sites established in 1994 (75% one station) have approximately 10% less H-M 2P biomass then those established in 1995 (71% one station).

In summary, the majority of MacDonnell Ranges P3 is essentially two stations only, with one having 10% more H-M 2P grasses then the other, however changes in H-M 2P grass biomass are insignificant, suggesting that these two stations have been stable over the reporting period.

Table 39: MacDonnell Ranges P3 – Change in H-M 2P grasses.

Contribution 2P Grass Category	Seasonal Condition	Number of Reassessments	Percentage of Assessments		
			Decline	No Change	Improvement
High	Above Average	7	14	86	0
	Average	1	0	100	0
	Below Average	na	na	na	na
Medium	Above Average	1	0	100	0
	Average	na	na	na	na
	Below Average	na	na	na	na
Low	Above Average	8	0	88	13
	Average	2	0	100	0
	Below Average	na	na	na	na

A tolerance of + or - 20% was used to categories 'no change'

- 19 sites were initial assessed in 1994 and 1995, with reassessments between 2000 and 2003, 89% in 2001 and 2002.
- The declining site was still assessed as declining with short lived perennials included even though there was a very large increase in the sites overall biomass, however majority of this was an unpalatable short lived perennial. The H-M 2P grass that declined in both biomass and frequency over a six year period (1995 to 2001) was the introduced Buffel grass.
- Using the H-M 2P contribution categories for MacDonnell Ranges, this sub-bioregion had a trend towards the Medium (6 to 15% biomass) category with both High (16 to 100% biomass) and Low (0 to 5% biomass) declining, therefore Medium 2P contribution category increasing from 5% to 37%.

Table 40: MacDonnell Ranges P3 – Percentage change in H-M 2P grasses within their seasonal condition terciles.

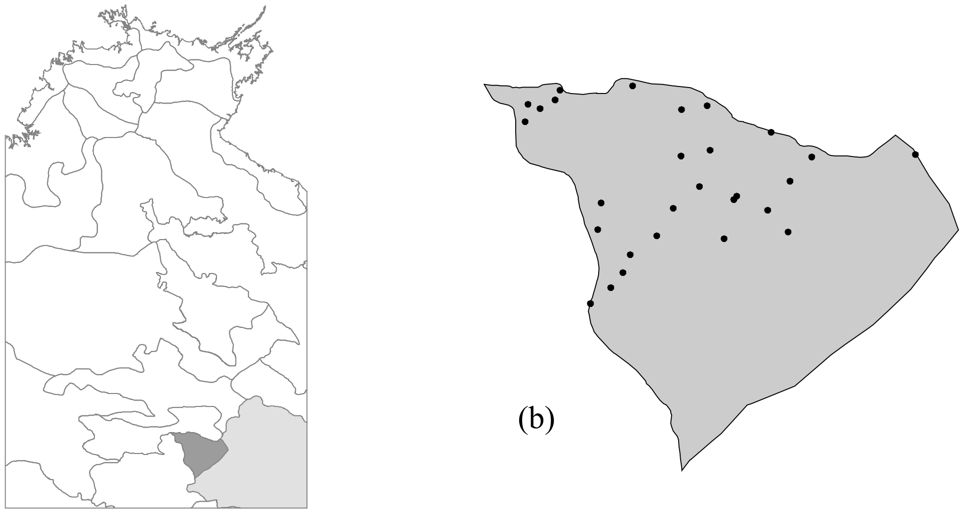
Seasonal Condition	Number of Reassessments	Percentage of Assessments		
		Decline	No Change	Improvement
Above Average	16	6	88	6
Average	3	0	100	0
Below Average	na	na	na	na

A tolerance of + or - 20% was used to categories 'no change'

- Only one site declined, one improved, with approximately 90% unchanged.

In summary, MacDonnell Ranges P3 appears to have fairly low contribution of H-M 2P grasses that are mostly unchanged between 1994 and 2003.

Simpson Strezelecki Dunefields P1



(a)

Figure 37: (a) Location of Simpson-Strzelecki Dunefields P1 bioregion within the Northern Territory, (b) distribution of Tier 1 monitoring sites analysed by H-M 2P grasses within Simpson-Strzelecki Dunefields P1 bioregion.

Table 41: Areas, number of Tier 1 sites and density of sites per 1000 km2 within Simpson-Strelecki Dunefields P1 bioregion.

Bioregion		Pastoral Estate within bioregion	Analysed with H-M 2P grasses
Area (km^2)	13552	10331	10331
Tier 1 sites	35	34	28
Site density per 1000 km^2	2.58	3.29	2.71

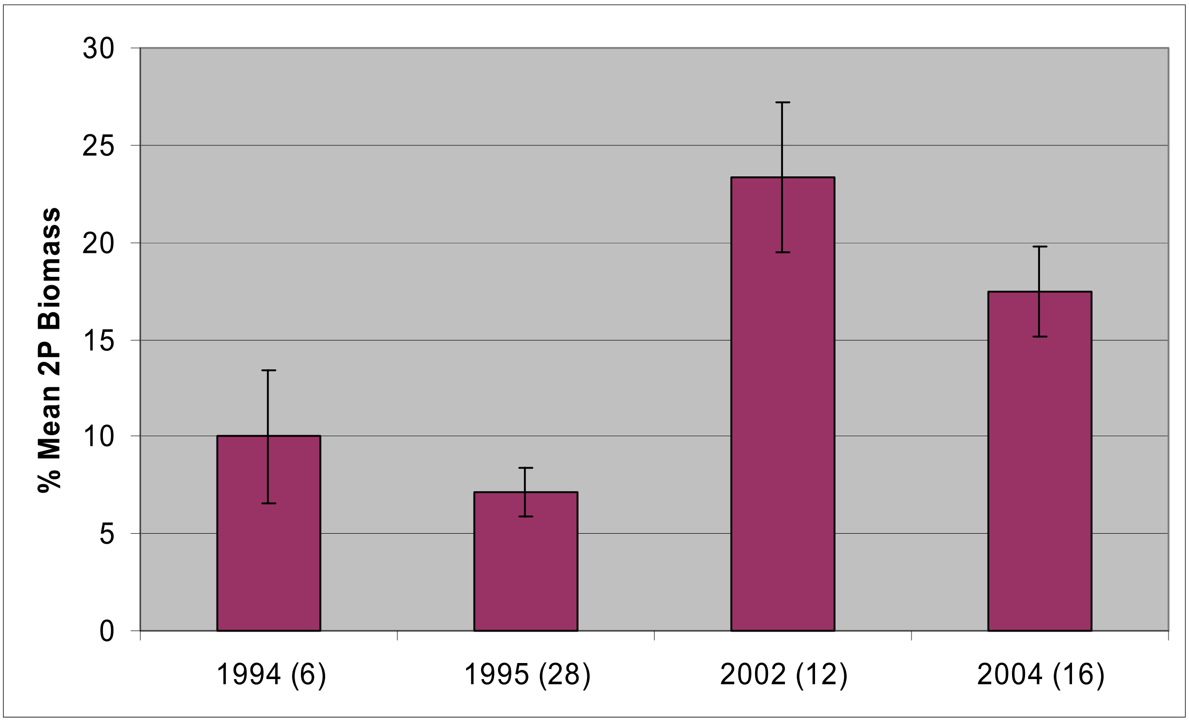


Figure 38: Simpson Strezelecki Dunefields P1 - Mean % 2P grass biomass between 1994 and 2003.

- There appears to be a significant increase in H-M 2P grass biomass between 1994-1995 and 2002-2004.
- Six sites (5 from 1995) have no H-M 2P grasses in either assessment, and when removed from the mean calculations, they all increase with 1994 to 12%, 1995 to 10%, 2002 to 28% and 2004 to 23%.

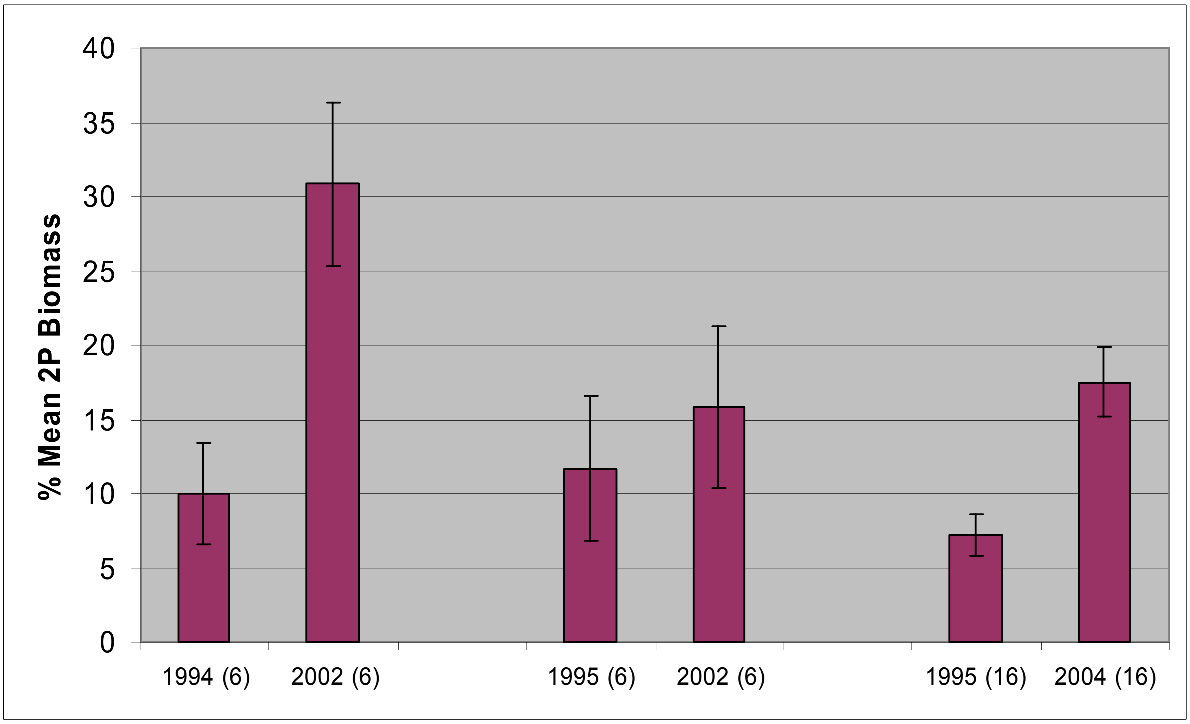


Figure 39: Simpson Strezelecki Dunefields P1 - Mean % 2P grass biomass of consistent sites between 1994 and 2003.

- All sites appear to be increasing in their H-M 2P grass biomass, with the largest improvements from the 6 sites initially assessed in 1994.

In summary, Simpson Strezelecki Dunefields P1 has seen an improvement in a majority of the sites, however most of this improvement is within the 20% "unchanged" tolerance.

Table 42: Simpson Strezelecki Dunefields P1 – Change in H-M 2P grasses.

Contribution 2P Grass Category	Seasonal Condition	Number of Reassessments	Percentage of Assessments		
			Decline	No Change	Improvement
High	Above Average	2	0	100	0
	Average	4	25	50	25
	Below Average	na	na	na	na
Medium	Above Average	na	na	na	na
	Average	1	0	0	100
	Below Average	na	na	na	na
Low	Above Average	6	0	67	33
	Average	13	0	77	23
	Below Average	2	0	50	50

A tolerance of + or - 20% was used to categories 'no change'

- Initial assessments of the 28 sites were conducted in 1994 and 1995, with 80% in 1995, and the most recent reassessments conducted in 2002 and 2004.
- Only one site declined, however at establishment all grasses were newly germinated, where as at the next assessment grasses were more mature, overall site biomass had increased and the site had good coverage of short lived perennials (SLP). Including H-M SLP there was only a small decrease in combined H-M 2P and H-M SLP grasses biomass levels.
- Naturally this bioregion is dominated by short lived perennials, which have not been assessed here, therefore making any assessment possibly harsh.

Table 43: Simpson Strezelecki Dunefields P1 – Percentage change in H-M 2P grasses within their seasonal condition terciles.

Seasonal Condition	Number of Reassessments	Percentage of Assessments		
		Decline	No Change	Improvement
Above Average	8	0	75	25
Average	18	6	67	28
Below Average	2	0	50	50

A tolerance of + or - 20% was used to categories 'no change'

- This bioregion has low to very low pasture biomass, with % biomass of 2P grasses influenced more by bareground and site biomass levels then actual changes in % 2P biomass.
- This bioregion has experienced long periods of low to no rainfall, making assessment of grazing practices, sustainable or otherwise difficult, if not misleading.
- Overall only 1 (4%) site declined, 19 (68%) unchanged and 8 (29%) improved.

In summary, The Simpson Strezelecki Dunefields P1 has a majority of sites assessed as unchanged , with 29% of sites improving, indicating sustainable management, however without an analysis of short lived perennials and long periods of low rainfall makes this assessment possibly unreliable.

Appendix 1: Tier 1 Site Assessment Years

The initial and recent reassessments of Tier 1 sites varies across the NT and through time, although every effort is made for reassessment to be only three years apart this is not always possible. The analysis of change between 1993 and 2004 and change in estimated percentage contribution of high and moderate palatable perennial (2P) grasses biomass requires two date comparison. The following tables show the number of sites assessed in each year during the reporting period for Tier 1 monitoring data (1993 to 2004).

Table 44: Tier 1 site assessment years used for change in High and Moderate combined palatable perennial (2P) grasses biomass.

Bioregion or sub bioregion	Assessment	# Sites	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Burt Plain	Initial	235		143	72		20							
	Recent	235								35	31	26	55	88
	Total	470		143	72		20			35	31	26	55	88
Channel Country	Initial	56		9	47									
	Recent	56									16	19	16	5
	Total	112		9	47						16	19	16	5
Daly Basin	Initial	27	14				10	1			2			
	Recent	27						4			4	5	14	
	Total	54	14				10	5			6	5	14	
Davenport Murchison Ranges	Initial	49		26	1	7	15							
	Recent	49				2				2		12	15	18
	Total	98		26	1	9	15			2		12	15	18
Finke	Initial	150		123	25		1		1					
	Recent	150				3		3	5	14	10	24	57	34
	Total	300		123	25	3	1	3	6	14	10	24	57	34
Gulf Fall and Uplands	Initial	141	32	6	31	25	12	35						
	Recent	141								5	17	28	19	72
	Total	282	32	6	31	25	12	35		5	17	28	19	72
Mitchell Grass Downs	Initial	379	8	18	60	117	158	17	1					
	Recent	379					2		2	15	4	42	184	130
	Total	758	8	18	60	117	160	17	3	15	4	42	184	130
Ord Victoria Plain	Initial	251	239	2				8	2					
	Recent	251						4	6	3	7	65	52	114
	Total	502	239	2				12	8	3	7	65	52	114

Pine Creek	Initial	29	1				17	4		3	2	2		
	Recent	29									6	4	4	15
	Total	58	1				17	4		3	8	6	4	15
Sturt Plateau	Initial	183	93		13	3	35	28	1	10				
	Recent	183						1	3	12	14	47	73	33
	Total	366	93		13	3	35	29	4	22	14	47	73	33
Victoria Bonaparte	Initial	52	48				3	1						
	Recent	52						12	4			25	10	1
	Total	104	48				3	13	4			25	10	1
MacDonnell Ranges P3	Initial	19		8	11									
	Recent	19								1	8	9	1	
	Total	38		8	11					1	8	9	1	
Simpson-Strzelecki Dunefields P1	Initial	28		6	22									
	Recent	28										12		16
	Total	56		6	22							12		16