Department of
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GOVERNMENT OF
WESTERN AUSTRALIA

Report to the Commissioner of Soil and Land Conservation on the condition of the Western Australian pastoral resource base, 2013

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Contents

Summary

This report updates changes in the Western Australian pastoral rangelands at the Land Conservation District (LCD) scale, providing information on seasonal quality, stock numbers and changes in the density/frequency of perennial shrubs and grasses. It is based on data from the Bureau of Meteorology, the *Annual return of livestock and improvements* (submitted annually by pastoral lessees) and the Western Australian Rangeland Monitoring System (WARMS). The sixth assessment of the Kimberley grassland sites (Epoch 6) was completed in 2011. The second full cycle (i.e. 3 assessments) was completed for shrubland sites in 2010. This report includes the most recently collected data where sufficient sites in an LCD have been reassessed. However, in many LCDs, particularly in the southern Rangelands Region where the reassessment period is 5 years, insufficient new data are available to expand on the information provided in the previous report.

Important points

- Rainfall was generally favourable in the Kimberley and for grassland sites south of Kimberley during 2012 (although there were some regional differences). However, 77% of WARMS sites were assessed as receiving below average seasonal conditions in the southern Rangelands Region. Recent years have illustrated the extreme climate variability of the rangelands, with some locations experiencing their wettest period on record. Such inter-annual variability places severe restrictions on management to avoid overgrazing.
- Although variable, stock densities have generally risen in the Kimberley over the past 16 years, with the exception of the Halls Creek East Kimberley LCD. However, stock densities vary significantly between leases, with some Kimberley leases virtually destocked. While the run of favourable seasons supports this, the risk of overgrazing if seasons deteriorate has increased.
- Perennial grass frequency (both desirable and undesirable grasses taken together) remains high in all Kimberley LCDs, although the increase was more variable in both the Broome and the North Kimberley LCDs.
- Depending on the LCD, between 29% and 80% of leases with grassland sites south of the Kimberley reported cattle numbers above the estimated Present Carrying Capacity (Present CC). The frequency of desirable grasses has generally declined in recent sampling, and the most recent data (for the Ashburton LCD) confirms this trend. Serious issues are developing on some leases, with a risk of rangeland degradation if management does not better equate stock numbers to forage availability.
- Reported stock numbers have varied across the shrublands over the past 10 years. Compared with 2002, numbers in 2012 were higher in only 4 of the 17 LCDs. However, there was considerable variation, with declines and increases recorded in all LCDs. Reported stock numbers are generally below the Present CC in all LCDs, except for Wiluna and Upper Gascoyne LCDs.
- Shrub numbers have declined at a high proportion of WARMS sites in the southern Rangelands Region between Epoch 3 (2005–10) and Epoch 4 (2010–12), with declines even at sites assessed as receiving above average seasonal conditions. This suggests that season alone did not cause the decline, but that excessive grazing pressure also contributed.

1 Introduction

This report is prepared for the Commissioner of Soil and Land Conservation to satisfy the obligation under Section 137(2) of the *Land Administration Act 1997* to furnish the Pastoral Lands Board of WA with an annual report on the current condition of land under pastoral lease.

Western Australia's rangelands cover 87% of the state (all but the south-west). Pastoral leases, used for grazing livestock on native vegetation, cover 35% (874 000 km^2) of the rangelands; the balance consists of Unallocated Crown Land and land vested for conservation and indigenous purposes. There are currently 453 registered pastoral stations (comprised of 508 pastoral leases); 152 stations in the northern Rangelands Region (Kimberley and Pilbara — 93 in the Kimberley and the remainder in the Pilbara), 292 stations in the southern Rangelands Region, and nine stations in the South West Land Division, which are usually grouped with the southern Rangelands Region. Ownership is variable, including large corporate conglomerates, private companies, family operations, and indigenous organisations and, particularly in the Pilbara and Goldfields, mining companies.

In the Pilbara, vegetation gradually changes from grasslands common to the Kimberley (hummock, mainly spinifex, or tussock grasses) to a shrub-dominated understorey (a mix of semi-arid mulga, spinifex and saltbush/bluebush vegetation communities) common in the south. Consequently, range condition assessment in the Kimberley and much of the Pilbara is based on the frequency of perennial grasses, and in the southern Rangelands Region (also referred to as shrublands) it is determined by the density of perennial shrub species.

1.1 Data sources and information provided

This report provides information on seasonal conditions and information provided by the Western Australian Rangeland Monitoring System (WARMS), the Pastoral Lands Board's *Annual returns* database and the Bureau of Meteorology (BoM).

WARMS provides information on rangeland condition trend in the pastoral rangelands at a regional or district scale, not the lease scale. It does this through a representative network of point-based sites on which attributes of the soil surface and the vegetation are recorded. Site installation began in 1993, with the final sites installed in 1999. There are 1622 sites, with 633 grassland sites and the remainder shrubland sites. Grassland sites are reassessed on a 3-year cycle and shrubland sites are reassessed on a 5-year cycle. The sixth assessment (Epoch 6) of the grassland sites was completed in 2011. The second full cycle (i.e. 3 assessments) was completed for shrubland sites in 2010 (Table 1). As WARMS site reassessment data for each LCD is only provided on completion of the WARMS sites for each cycle, this report should be read in conjunction with the reports provided in July 2011 and July 2012 to provide context for much of the information presented.

Table 1 Assessment periods for WARMS

	Epoch						
Area	1	2	3	4	5	6	7
Grasslands	1994–96	1997–99	2000–02	2003–05	2006–08	2009–11	2012–*
Shrublands	1995–1999	1999–05	2005–10	2010–12*			

* Assessment in this epoch is ongoing.

In this report, data are provided at the Land Conservation District (LCD) scale. Seasonal quality was estimated for each WARMS site reassessment period (Epoch) or each year at

each site. Seasonal quality describes the relative value of recent climate (principally interpolated rainfall from patch point dataset) with respect to biological functioning. Biological functioning broadly means vegetation growth as a basic resource for both livestock (forage) and fauna (food and shelter) and for soil protection.

All pastoral lessees in WA submit an *Annual return of livestock and improvements* to the Pastoral Lands Board, providing, among other information, an estimate of the number of stock held on the lease, defined by specific categories. This information is made available to the Department of Agriculture and Food Western Australia (DAFWA) for analysis and interpretation.

2 Seasonal conditions

2.1 Annual rainfall

Averaged across WA as a whole, 2012 rainfall was near average, while large parts of the Pilbara and parts of the Kimberley and Interior recorded above to very much above average rainfall (Figures 1 and 2). Wet months were observed for WA as a whole in January (sixth-wettest) and November (eleventh-wettest), while May (fifth-driest), July (third-driest), and August (tenth-driest) were in the lowest 10% of records since 1900, mainly due to low rainfall over southern WA. As a result of the relatively dry months in the middle of the year, WA recorded its third-driest April to September period. However, much of the Kimberley and the eastern pastoral zone received less rainfall during this period than in the previous 12 months (Figure 2).

2.2 Autumn/spring 2012

Rainfall during April to September 2012 was below average throughout much of southern WA (Figure 3). On a state-wide basis, May (fifth-driest), July (third-driest), and August (tenth-driest) were in the lowest 10% of rainfall records since 1900, mainly due to low rainfall over southern WA during these months. As a result of the relatively dry months in the middle of the year, WA recorded its third-driest April to September period. This was particularly so in the southern regions of the pastoral zone, extending through the Goldfields and the Nullarbor. Parts of the Gascoyne catchment also received very much below average winter rainfall. Northern WA received above to very much above average rainfall during October 2012, although it should be noted that rainfall totals are generally low in northern WA in October and a number of sites along the coastal Pilbara, west Gascoyne and in the Interior observed no rainfall for the month.

2.3 Summer/autumn 2013

Rainfall in November and December was above to very much above average in western and southern Gascoyne, Goldfields, western Eucla, western parts of the northern and southern Interior, east Pilbara, and parts of the Kimberley. The central Pilbara and parts of the inland Gascoyne experienced below average rainfall. When averaged across the state as a whole, November 2012 rainfall ranked in the highest 10% of observations and was eleventh highest on record. Several sites in the north-east Gascoyne and inland Pilbara recorded their wettest December as a result of frequent thunderstorm activity. Below average rainfall was generally confined to parts of the Goldfields.

Rainfall during January 2013 was above to very much above average through much of western and central WA, particularly in central and western Pilbara (Figure 4). Western parts of the Gascoyne also had above average rainfall. Below average rainfall was mainly confined to parts of the Kimberley as monsoonal activity was confined to a brief period in the middle of the month. February rainfall was above to very much above average in the east Pilbara and adjacent west Kimberley, mainly due to heavy rainfall associated with severe tropical cyclone Rusty towards the end of the month. Yarrie, in the east Pilbara, reported its wettest February for 33 years. Very much below average rainfall was reported in parts of the southern Gascoyne, Goldfields, and Eucla.

In the north, particularly in the Kimberley, thunderstorms were active during the first half of March and, after a quiet period, became active again in last few days of the month. Some moderate to heavy falls were registered during the storm activities. Little monsoonal activity occurred over northern areas. April 2013 rainfall was below to very much below average across parts of the Gascoyne. Above average rainfall was observed in the east Pilbara and

parts of the Kimberley, mainly due to heavy rainfall during the first few days of the month, while much of the remainder of the state saw near average rainfall for April 2013.

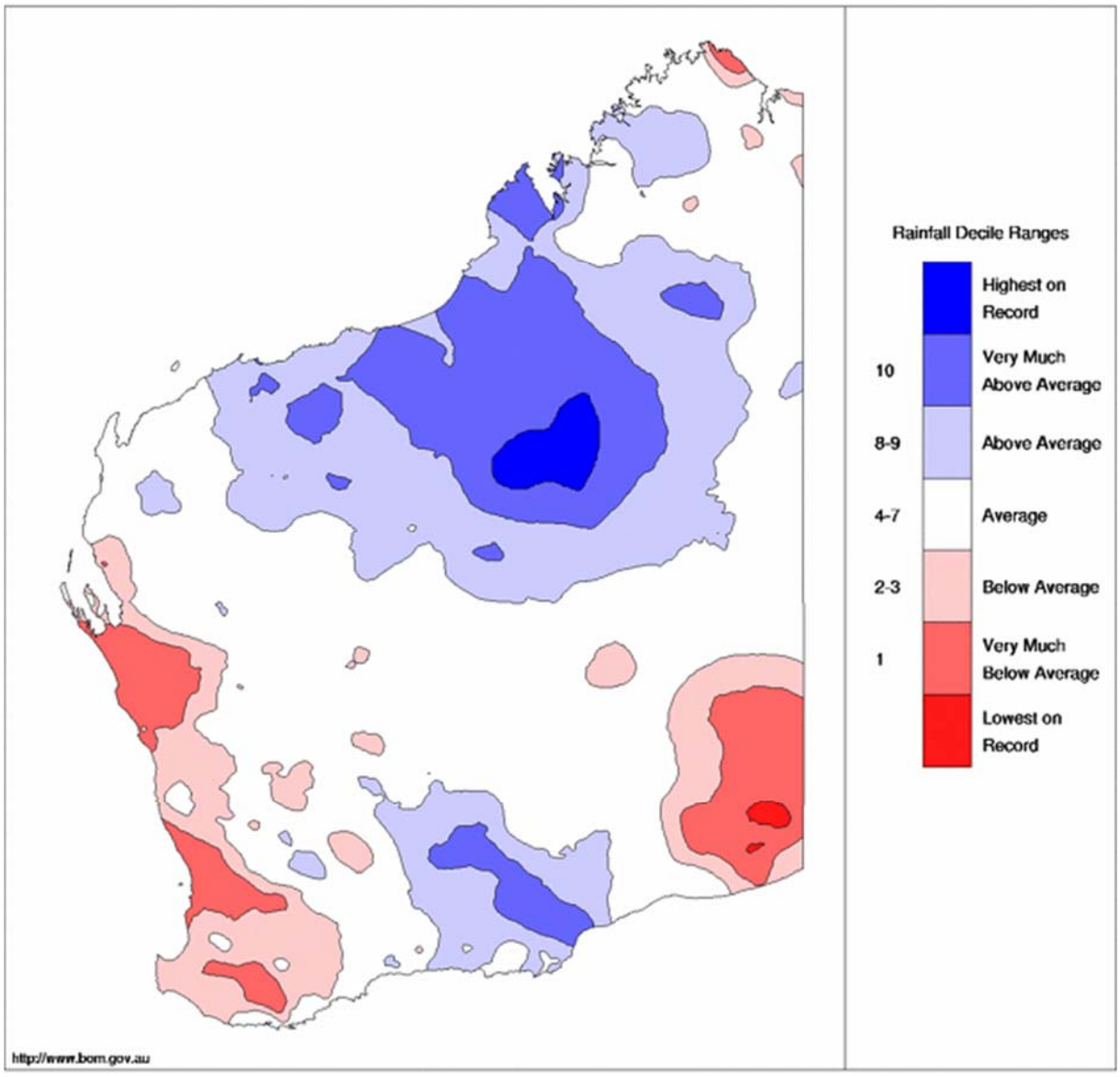

Figure 1 Rainfall deciles for July 2012 to June 2013. Source: BoM.

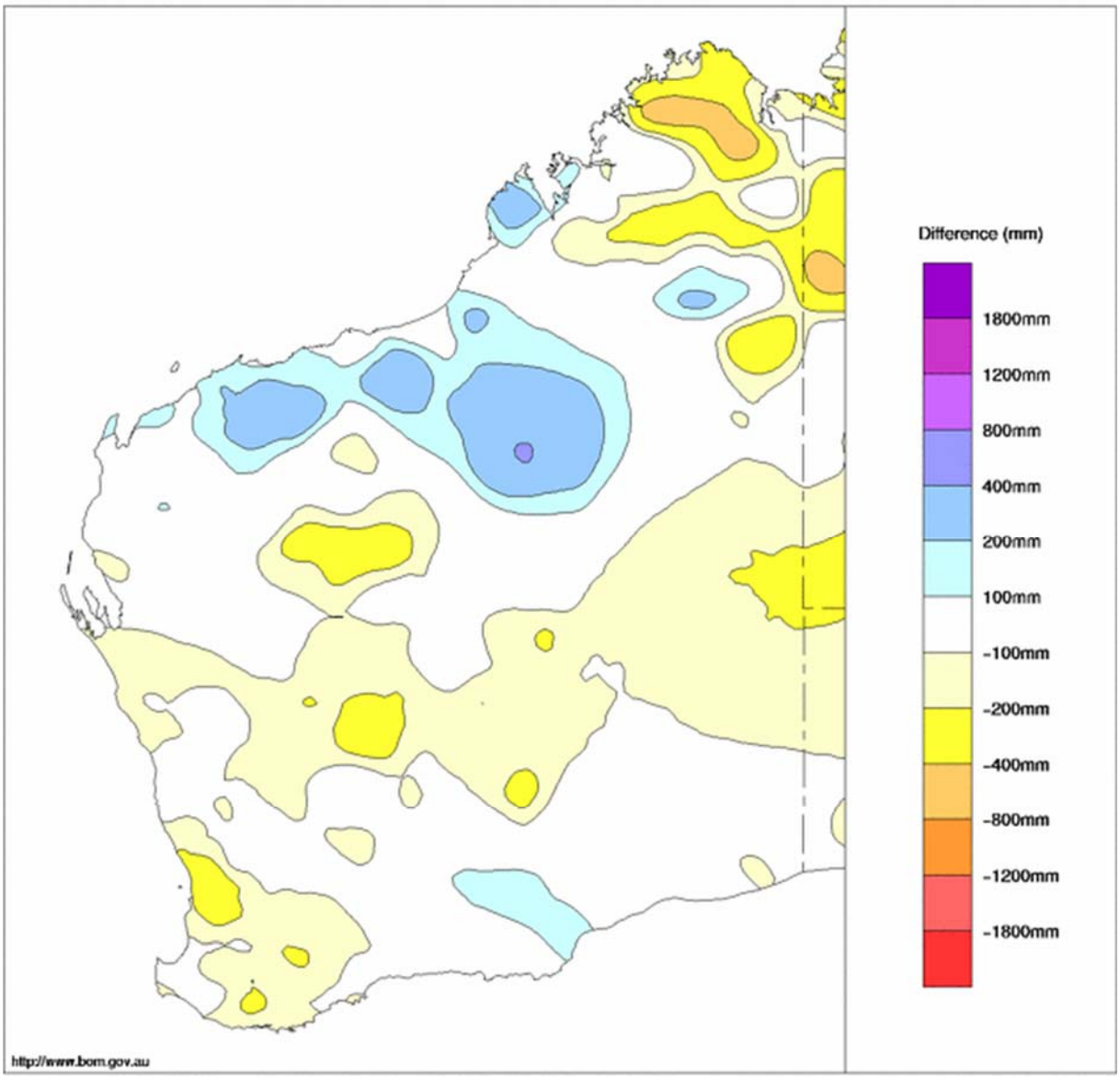

Figure 2 Inter-annual rainfall variations, 2012/13 versus 2011/12. Source: BoM.

Blue and purple shades indicate areas which have been wetter this year. Yellow and red shades indicate areas which have been drier this year.

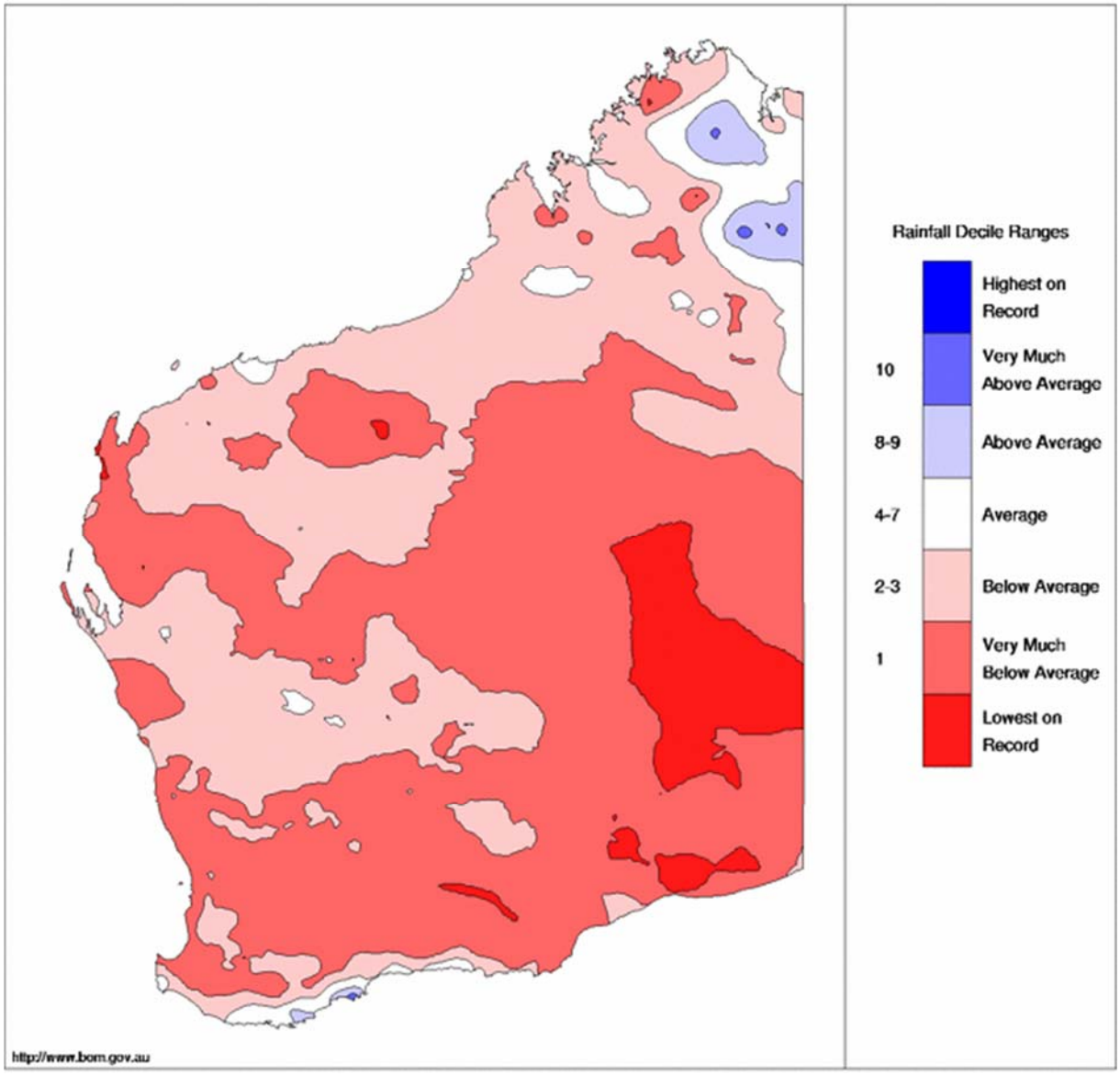

Figure 3 Rainfall deciles for April to September 2012 (winter rain). Source: BoM.

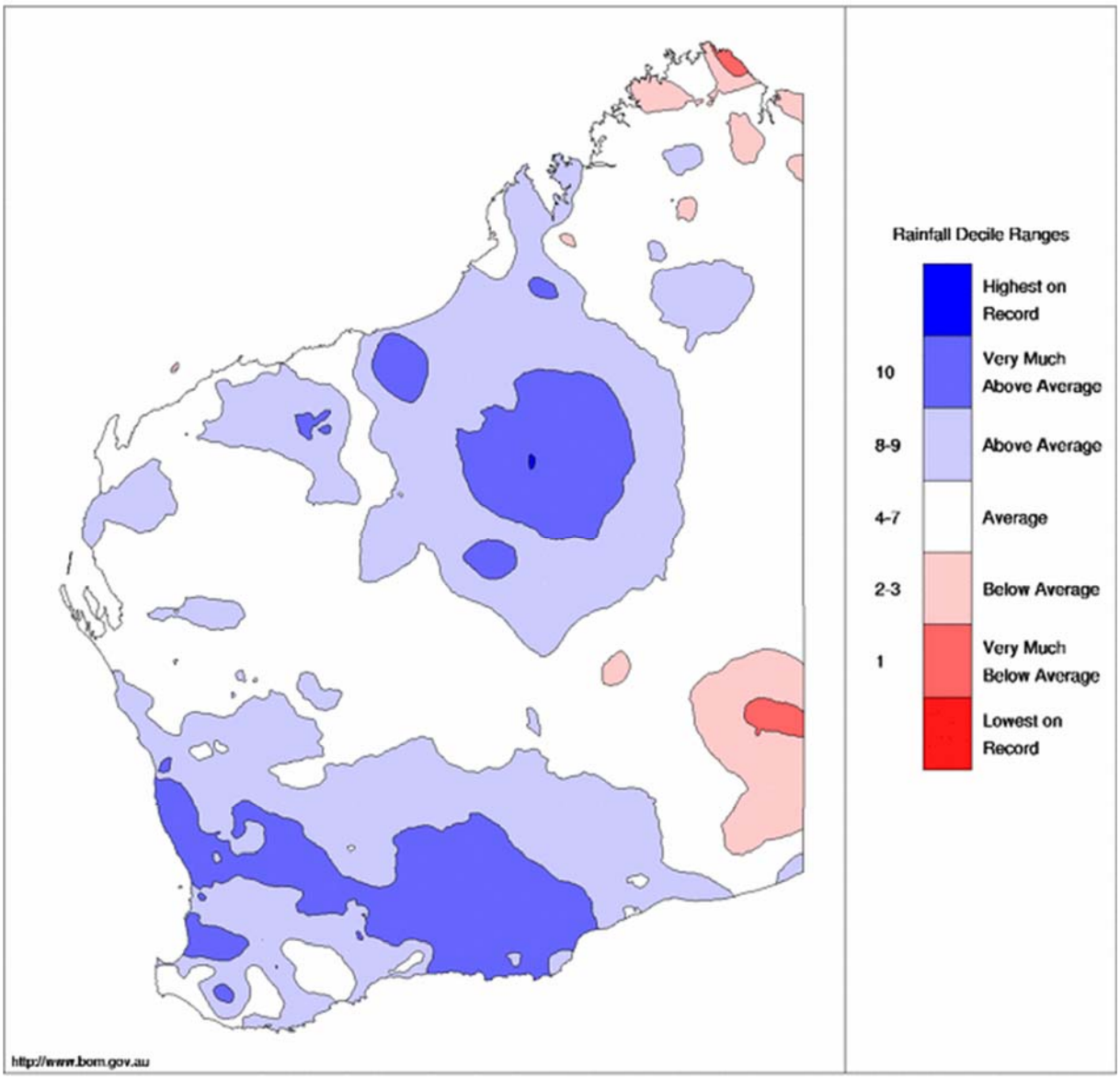

Figure 4 Rainfall deciles for November 2012 to April 2013 (summer rain). Source: BoM.

2.4 General comments on rainfall

While rainfall deciles indicate an average to above average annual rainfall throughout the rangelands (except in the coastal zone south of Carnarvon and in the south-east of the state — Figure 1), Figures 3 and 4 (seasonal rather than annual conditions) paint a bleaker picture and illustrate the potential misinterpretations associated with annual rainfall data. Winter (April to September) rainfall is vital for the germination, establishment and growth of shrub species in the southern Rangelands Region. The winter rainfall in 2012 was poor throughout this southern Rangelands Region, with significant areas very much below average, which would have increased stress and fragility to grazing for existing plants, and potentially severely restricted the growth and development of juvenile shrubs. Conversely, the northern summer was generally average (to above average in parts of the Pilbara), except for isolated areas in the north and east Kimberley. This variation highlights the importance of seasonality of rainfall and the basis for the seasonal quality assessments discussed in Sections 3.1.1, 3.2.1 and 3.3.1.

3 Regional rangeland assessments

3.1 Grasslands in the Kimberley LCDs

3.1.1 Seasonal quality

Seasonal quality is the term used to rank the degree of climate variability from one period to the next. Seasonal quality broadly describes the relative value of recent rainfall on biological functioning. Relative value (quality) is judged with reference to the longer term record. Biological functioning broadly means vegetation growth as a basic resource for both livestock (forage) and fauna (food and shelter).

Assessed seasonal quality has been generally above average in the Kimberley LCDs over the past 19 years, with the majority of WARMS sites classified as above average or average. For the first time since WARMS assessments began in the Kimberley (1994), some sites (19%) in the Halls Creek East Kimberley LCD were assessed as below average seasonal quality over the 2012/13 season (Table 2).

Summer rainfall is the primary driver in the northern grasslands. At the LCD scale, and based on interpolated rainfall data of WARMS sites, all Kimberley LCDs received above, or close to, the regional average of their long-term summer rainfall for 2012/13, except for isolated areas in the north and east Kimberley (Table 2 and Figure 4).

Table 2 Seasonal quality for 2012/13 in the Kimberley LCDs

	Seasonal quality				
LCD	Above average %	Average %	Below average %	Proportion of long-term summer rainfall %	Average long-term (113 years) summer rainfall mm
Broome	69	31	0	131	458
Derby West Kimberley	29	71	0	106	502
Halls Creek East Kimberley	13	68	19	96	530
North Kimberley	26	74	0	102	780
Kimberley LCDs overall	**28**	**66**	**6**		

3.1.2 Perennial grass frequency

The average frequency — the percentage of sample units (quadrats) containing the grasses — of both desirable and undesirable perennial grasses at WARMS sites generally increased in all Kimberley LCDs from Epochs 1 to 5 and into Epoch 6, although the increase was more variable in the Broome and the North Kimberley LCDs (Table 3 and Figure 5). Although data in the current Epoch 7 are incomplete, available data suggest some decline in desirable grass frequency in the latest data collections. Because the levels of desirable grasses vary among pasture types, this decline in average desirable species frequency does not necessarily indicate a decline from one condition class to another. However, this decline does represent a negative trajectory, in that the frequency of desirable species has declined since the previous assessment, and therefore represents an unfavourable response. This

decline is not yet significant, and the frequency of desirable grass species remains high in all LCDs. Frequency of all perennial grasses is above the frequency recorded in the initial sampling in Epoch 1, except for the Broome LCD, where frequency recorded during initial sampling was particularly high (Figure 5).

Table 3 Change in frequency of desirable perennial grasses in the Kimberley LCDs

LCD	Change in frequency %					
	Cycle 1 E1 to E2*	Cycle 2 E2 to E3	Cycle 3 E3 to E4	Cycle 4 E4 to E5	Cycle 5 E5 to E6	Cycle 6 E6 to E7
Broome	3.2	-11.9	-3.6	4.3	-0.3	2.6
Derby West Kimberley	8.8	7.1	-0.6	2.6	-0.4	n.a.
Halls Creek East Kimberley	0.8	11.0	-2.4	2.9	-3.5	0.1†
North Kimberley	1.5	2.9	-2.7	2.8	6.0	-2.7

* E1 – Epoch 1; E2 – Epoch 2 etc. See Table 1 for definition of epochs.

† Based on 40% of WARMS sites assessed.

n.a. not available.

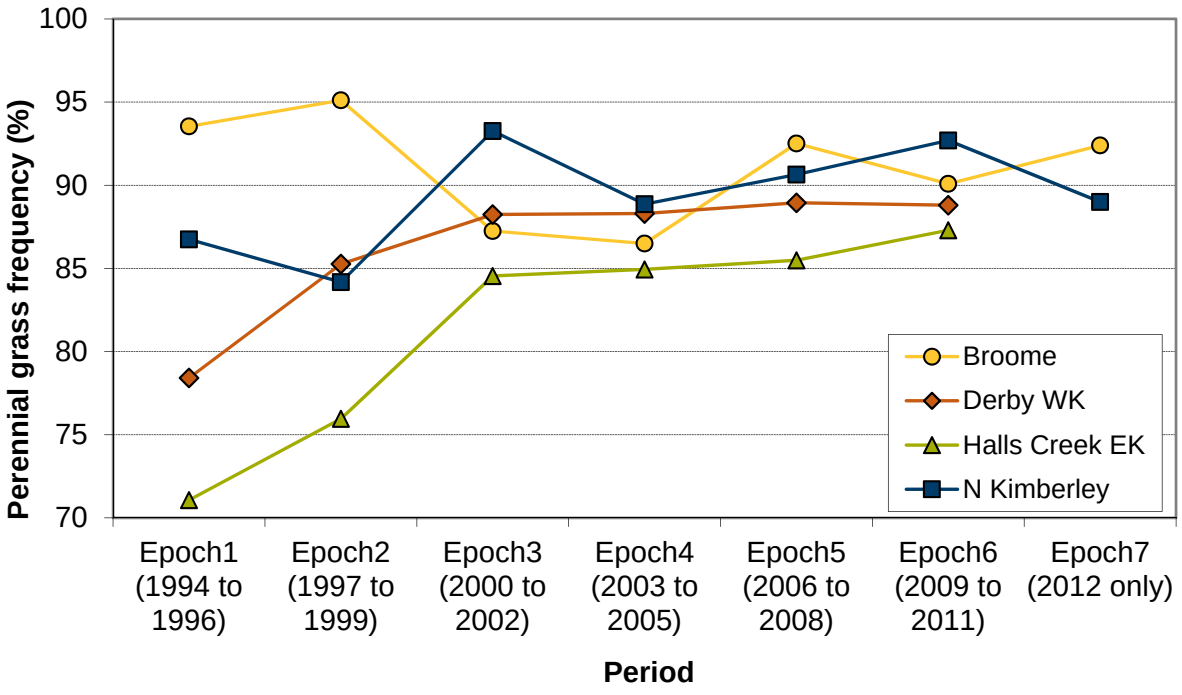

Figure 5 Mean perennial grass (all grasses) frequency in the Kimberley LCDs (without Halls Creek LCD data) (refer to data in Table 3)

3.1.3 Stock density

Relative stock densities between LCDs reflect both the different potentials (in terms of carrying capacity) of the LCDs and the degree of individual lease development. Grazing capacity is defined as a Present Carrying Capacity (Present CC), that is, the Potential Carrying Capacity, which is the inherent capacity of the rangeland to run stock when the rangeland is in good condition, and all areas of the lease are accessible to domestic stock and seasonal conditions are average, discounted (if appropriate) for the current range condition. Neither the Potential nor Present CC values are defined maximum stock numbers; lessees are able to carry stock numbers in excess of these figures if seasonal conditions permit, and would be expected to do so during favourable seasons. Conversely, during unfavourable seasons stock numbers would be expected to be substantially below these values.

Reported stock numbers (from the *Annual return of livestock and improvements* provided by each pastoral lease) show that, although variable, stock densities (cattle units per square kilometre, cu/km^2) have generally risen in the Kimberley since WARMS sampling began, except for the Halls Creek East Kimberley LCD (Figure 6). Reported 2012 figures indicate a slight rise for all LCDs except Broome, where there was a slight decline. As a point of contrast to current stocking levels (Figure 6), estimated Present CC for the region are 4.1 cu/km^2 in Broome LCD, 3.1 cu/km^2 in Derby West Kimberley LCD, 2.5 cu/km^2 in Halls Creek East Kimberley LCD and 2.2 cu/km^2 in North Kimberley LCD. These reported figures indicate that Derby West Kimberley LCD is running stock numbers in excess of the Present CC, and that this is currently being sustained by the long run of favourable seasons.

Stock densities vary significantly between leases, with some Kimberley leases virtually destocked. Lease carrying capacities per unit area also vary widely. Of the leases reporting stock numbers in 2012, stock numbers were above the Present CC in 33% of Broome LCD leases, 61% of Derby West Kimberley LCD leases (including one lease stocked to over 440% of the Present CC), 42% of Halls Creek East Kimberley LCD leases and 31% of North Kimberley LCD leases. Finally, with the cessation of rangeland traversing by DAFWA, data on current range condition are no more recent than 2008 at best. Therefore, comparisons between an estimated carrying capacity and reported stock numbers should be treated with caution.

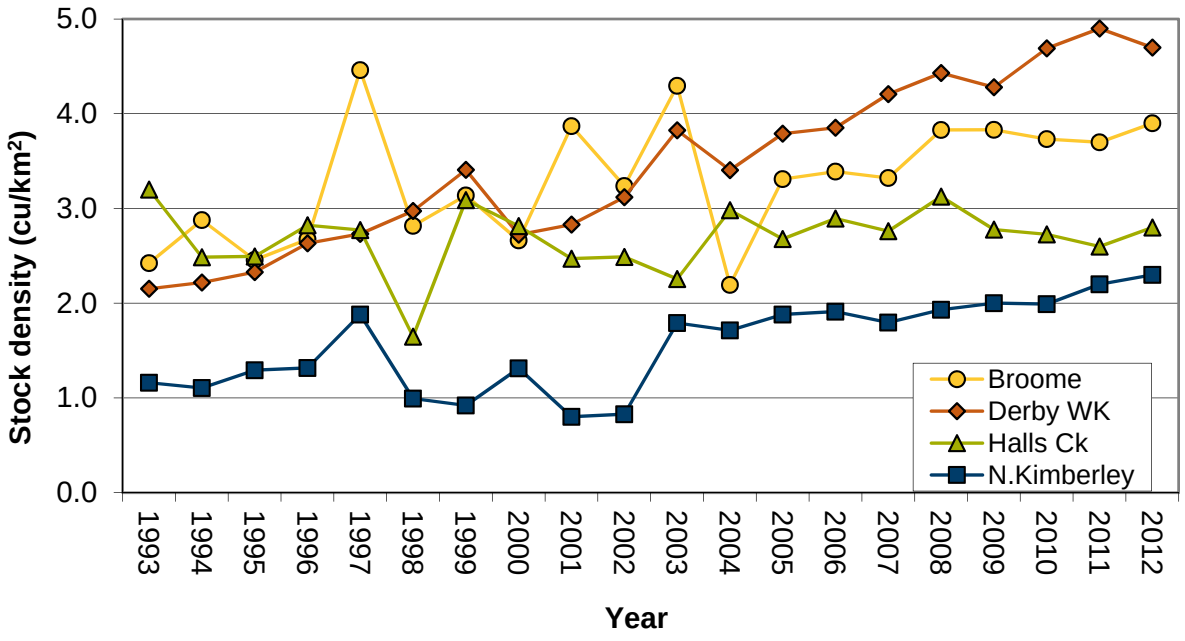

Figure 6 Mean reported stock densities in the Kimberley LCDs, 1993–2012

3.1.4 Interaction of stock numbers and desirable plant counts

Figure 7 illustrates the relationship between stock numbers (the ratio of the actual numbers i.e. those reported each year by the lessee to the Present CC for each of the reporting years) and the rangelands resource (as described by changes in the desirable species) from 2010 to 2012 in the northern Rangeland Region. Changes in frequency of desirable grasses from WARMS sites are represented horizontally, either increasing (to the right of the vertical line) or decreasing (to the left) compared with the previous WARMS sampling cycle (Epoch 5 versus Epoch 6, or Epoch 6 versus Epoch 7 for those LCDs where a complete set of data for the most recent assessment cycle are available). Ideally, the place to be is on the right hand side of the vertical line in Figure 7.

Reported stock numbers relative to the assessed Present CC (the Potential CC discounted for current range condition) of leases within each LCD are represented vertically on a relative scale, with the reported stock numbers and the Present CC equal at the zero point. Present CC has been averaged for stations within each LCD. Note that not all stations have a calculated Present CC. LCDs with average reported stock numbers above the average Present CC are in the upper half of the figure, and those with average stock numbers below the average Present CC are in the lower half of the figure.

A complete set of change data for the most recent cycle are only available for the North Kimberley and Broome LCDs. These data indicate an increase in desirable grass frequency in the Broome LCD, but a substantial decline in the North Kimberley LCD (Table 3). Figure 7 illustrates data from Cycle 5 (Epoch 5 to 6) for Derby West Kimberley and Halls Creek East Kimberley LCDs, and Cycle 6 (Epoch 6 to 7) for the North Kimberley and Broome LCDs.

Although stock density in the Halls Creek East Kimberley LCD is currently below 1993 levels, it remains above the Present CC, as does the stock density in the Derby West Kimberley LCD. The remaining LCDs in the Kimberley are close to or below the Present CC.

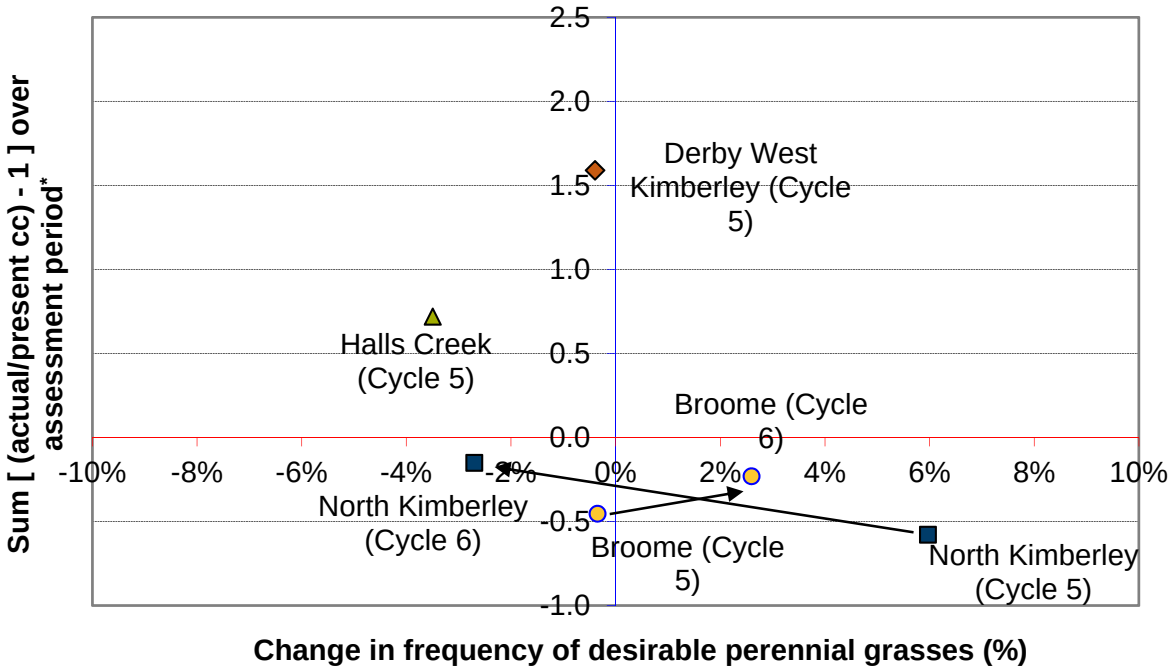

Figure 7 Change in frequency of desirable perennial grasses in relation to grazing pressure (Cycle 5 or 6) in the Kimberley LCDs (refer to data in Table 3)

3.2 Grasslands south of the Kimberley LCDs

3.2.1 Seasonal quality

Since WARMS assessments began, seasonal conditions in the grasslands south of the Kimberley LCDs have been variable, with the most favourable conditions being recorded in the 1990s, and a greater prevalence of average or below average years recorded since 2000. However, in 2012 seasonal quality (refer to Section 3.1.1. for definition of seasonal quality) was assessed as above average or average in all grasslands south of the Kimberley LCDs, with the East Pilbara LCD recording 100% above average for the second consecutive year (Table 4 and Figure 4).

Table 4 Seasonal quality for 2012 for grasslands south of the Kimberley LCDs

	Seasonal quality			Proportion of long-term summer rainfall	Average long-term (113 years) summer rainfall
LCD	Above average %	Average %	Below average %	%	mm
Ashburton	66	34	0	124	177
De Grey	86	14	0	157	247
East Pilbara	100	0	0	158	192
Lyndon	74	26	0	129	125
Roebourne	76	24	0	148	219
Grasslands south of Kimberley overall	**79**	**21**	**0**		

3.2.2 Perennial grass frequency

The Lyndon LCD is the “changeover” LCD between the grasslands and the shrublands in pastoral WA. There are 3 stations (Maroonah, Wandagee and Williambury) that have no WARMS grassland sites and 5 stations (Koordarrie, Ningaloo, Yanrey, Exmouth Gulf and Emu Creek) that have grassland sites only. Other stations in the LCD have both grassland and shrubland sites.

Change in the frequency of desirable grasses (refer to Section 3.1.2 for definition of frequency) in grasslands south of Kimberley LCDs have been variable over the sampling epochs (Table 5 and Figure 8). However, apart from the Lyndon LCD, desirable grass frequency has declined in recent samplings. The Cycle 6 data (Epoch 6 to 7), which is only available to date for the Ashburton LCD, suggests that this trend is continuing. As noted in Section 3.1.2, species frequency varies between pasture types. Consequently, rather than define the rangeland condition of the WARMS sites, WARMS assesses trend, that is, the change in frequency, with an on-going decline in the frequency of desirable grasses considered non-sustainable.

In interpreting this response, the antecedent status of grass frequency should be considered. For example, while desirable grass frequency in Roebourne LCD improved substantially (12.9%) in Cycle 4 (despite a slightly above capacity stock level across the district and 34% of WARMS sites having a seasonal quality rated as below average and only 18% above average), data indicate that this increase was on the back of the previous 3-year period in which the frequency of desirable perennial grasses in the Roebourne LCD declined by more

than 27% (Table 5). Therefore, the increase in desirable grass frequency in Cycle 4 in the Roebourne LCD was from a low base, with the recovery significantly less than the decline in Cycle 3. The further decline of 4.4% in Cycle 5 (the last 3 years) is therefore worrying as it suggests that any further recovery may have stalled. De Grey LCD is particularly worrying, as the most recent data (Cycle 5, collected in 2010) suggest a continued decline in desirable grass frequency, particularly given the favourable 2010/11 rainfall, when 75% of sites were assessed as receiving above average seasonal quality, and no sites were assessed as being below average seasonal quality (Novelly and Thomas 2012).

Table 5 Change in the frequency of desirable grasses in the grasslands south of the Kimberley LCDs

	Change in frequency %					
LCD	Cycle 1 E1 to E2*	Cycle 2 E2 to E3	Cycle 3 E3 to E4	Cycle 4 E4 to E5	Cycle 5 E5 to E6	Cycle 6 E6 to E7
Ashburton	6.4	-6.2	n.a.	0.9	-3.5	-9.0
De Grey		7.3	-2.7	-2.8	-9.1	n.a.
East Pilbara			0.3	-3.2	-8.2	n.a.
Lyndon		16.9	-4.4	-6.2	8.2	n.a.
Roebourne		4.3	-27.1	12.9	-4.4	n.a.

* E1 – Epoch 1; E2 – Epoch 2 etc. See Table 1 for definition of epochs.

n.a. not available.

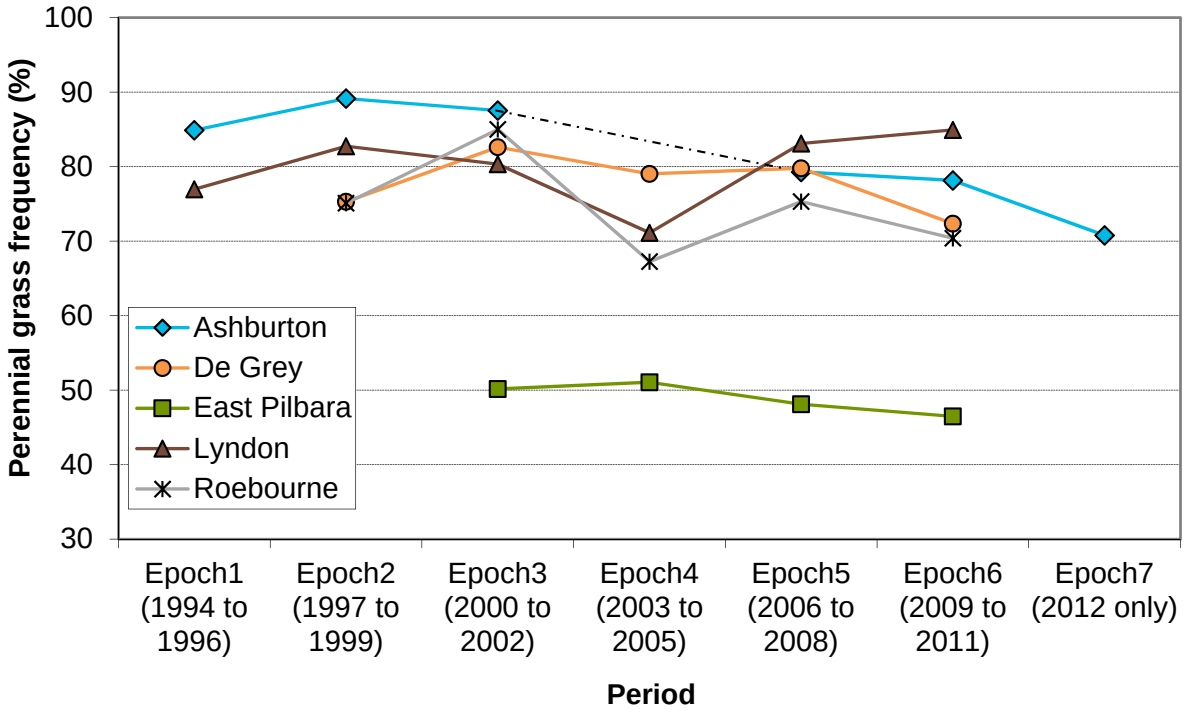

Figure 8 Mean perennial grass (all grasses) frequency in the grasslands south of Kimberley LCDs

3.2.3 Stock density

Reported stock numbers in the grasslands south of the Kimberley LCDs increased from 1993 to 2009, more than doubling in the East Pilbara and De Grey LCDs, although stock numbers fell in all LCDs in 2010, and in all except Lyndon LCD in 2011 (Figure 9). Reported stock numbers increased somewhat in all LCDs in 2012, except De Grey LCD (where figures were stable), and generally remain well above estimated Present CC, both for all LCDs as a group and on the majority of leases. The estimated Present CC is 1.5 cu/km^2 for Ashburton LCD, 1.6 cu/km^2 for De Grey LCD, 1.0 cu/km^2 for East Pilbara LCD, cu/km^2 for Roebourne LCD and 1.5 cu/km^2 for Lyndon LCD. The stock numbers from those leases reporting in 2012 in the De Grey LCD indicate that reported numbers are above Present CC in 80% of leases (12 of 15 leases), with densities in the Ashburton, East Pilbara and Roebourne LCDs also above Present CC at 29% (4 of 14 leases), 43% (6 of 14 leases) and 41% (7 of 17 leases) respectively. Stock numbers in the Lyndon LCD are above Present CC on 9 of 19 leases (47%), but again the absence of current range condition data should be noted. Stock numbers on some of these leases are at levels of twice the estimated Present CC. The long-term non-sustainable nature of this situation is undeniable.

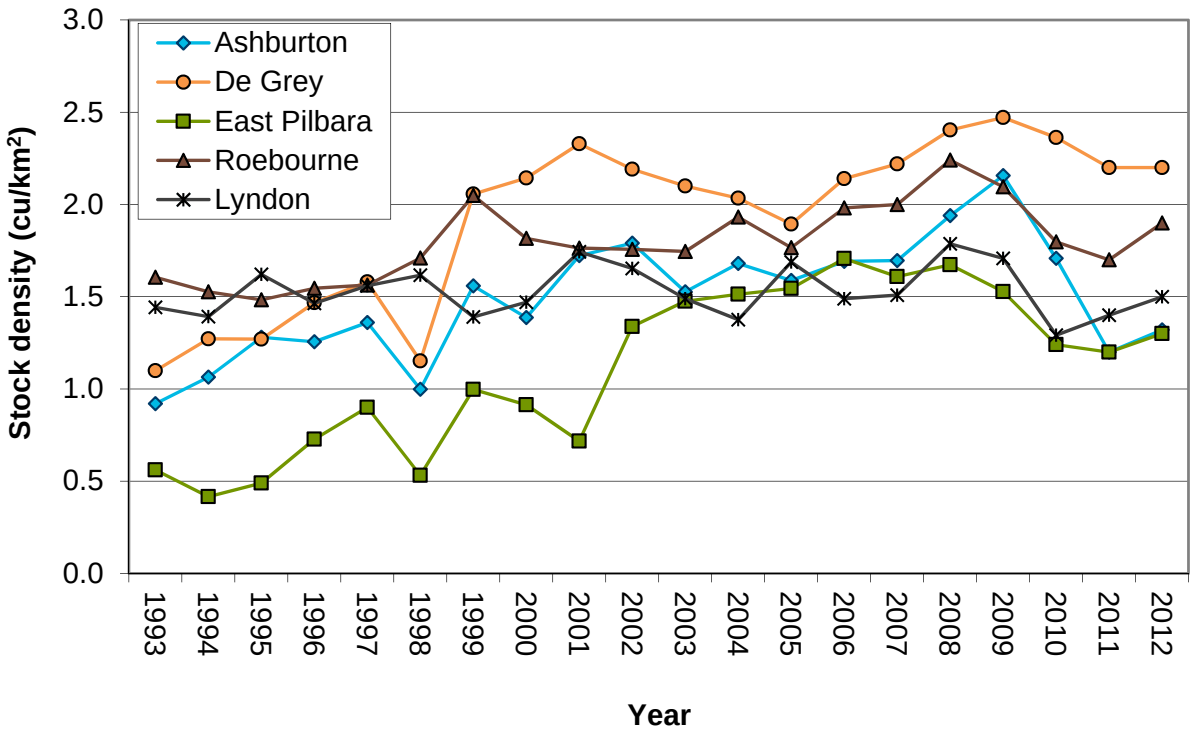

Figure 9 Mean reported stock densities in the grasslands south of the Kimberley LCDs, 1993–2012

3.2.4 Interaction of stock numbers and desirable plant counts

Desirable perennial grass frequency has declined in all grasslands south of the Kimberley LCDs where reported stock numbers exceed the Present CC (Figure 10). The most recent data (Cycle 6) for the Ashburton LCD indicate that this trend is continuing, with a further decline of 9% in desirable grass frequency following a 3.5% decline in Cycle 5 (Figure 10 and Table 5).

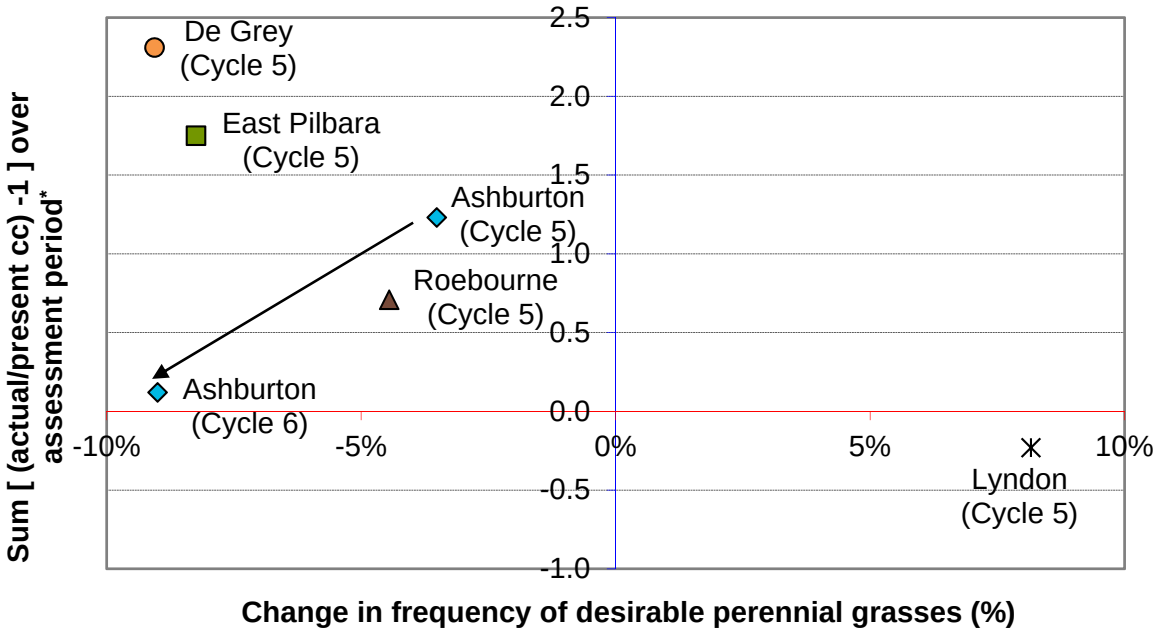

Figure 10 Change in frequency of desirable perennial grasses in relation to grazing pressure (Cycles 5 or 6) in the grasslands south of the Kimberley LCDs (refer to data in Table 5)

The declines in the frequency of desirable species are despite an average to above average seasonal quality in 2011, almost 100% above average seasonal quality in 2010, and a significant proportion of WARMS sites assessed as being above average seasonal quality in 2009. The declines reflect the effect of high grazing pressure which suggests that the estimation of the resilience of the rangelands and their production of usable forage by lessees (and consequently the stocking rates that can be supported) is, in the main, optimistic and unsustainable. The rise in stock numbers in all LCDs since the mid-1990s has not been buffered by the constant above average seasons as noted in the Kimberley LCDs. Consequently, the rangelands are being degraded on many leases, steadily and inexorably, and this is being recorded epoch after epoch in the WARMS sites.

3.3 Shrublands in the southern Rangelands Region

3.3.1 Seasonal quality

Winter rainfall is important in the shrublands of the southern Rangelands Region. Seasonal conditions varied between 1999 and 2012. The Binnu LCD has only two WARMS sites and therefore the seasonal quality at these sites does not necessarily reflect the entire LCD. Seasonal quality in 2012 was commonly below average (77%) or average (20%), with seven LCDs reporting 100% of sites as below average (Table 6 and Figure 3).

3.3.2 Shrubland sites

Preliminary analysis of data to the end of 2012 shows desirable perennial shrub density in the southern Rangelands Region declining (Tables 7 and 8 and Figure 11). In the Gascoyne Ashburton Headwaters LCD, about half of all desirable shrubs have disappeared on WARMS sites between Epoch 3 (2005–07) and Epoch 4 (2010–12) where seasonal conditions in 2012 were rated as above average. Seasonal quality assessments from previous years are available in previous reports, but in general terms, seasonal conditions, while variable, have not been extreme, and grazing pressure is a major driver of desirable shrub density. This

decline is occurring where seasonal quality is assessed as above average (Kalgoorlie, Upper Gascoyne, Wiluna, Gascoyne Ashburton Headwaters and Meekatharra LCDs), suggesting grazing pressure is excessive. The decline at sites assessed as having below average seasonal quality suggests that management response to unfavourable seasonal conditions has been inappropriate.

Figure 11 is based on sites reassessed to December 2012, during the first 3 years of Epoch 3 (2005–07), compared to the corresponding sites assessed during the first 3 years of Epoch 4 (2010–12). The majority of WARMS sites fall below the diagonal line (along which a site would be considered stable, i.e. numbers in Epoch 4 equal to numbers in Epoch 3). This fall occurs despite 68% of WARMS sites being assessed as above average seasonal quality in 2011 and a further 25% of sites being assessed as average seasonal quality (Novelly and Thomas 2012). Despite figures representing only a limited number of WARMS sites from the latest reassessment cycle, overall shrub numbers represent a reasonable sample of the situation in the southern Rangelands Region.

Overall, there has been a 16% decline in desirable shrubs for sites assessed between Epoch 3 and Epoch 4 in the southern Rangelands Region, with over a 20% decline in those sites listed as having a below average seasonal quality (Table 8). This negative trend indicates a steady decline in the carrying capacity of the rangelands with the potential for significant change (transition) in the plant community. Such transitions may not be reversible within a management timeframe, leading to a permanently reduced capacity to run stock (and hence business financial return), as well as a permanent change in the native vegetation, with associated impacts on biodiversity.

Table 6 Seasonal quality in the southern Rangelands Region, 2012

	Seasonal quality		
LCD	Above average %	Average %	Below average %
Binnu	0	0	100
Cue	6	12	82
Gascoyne Ashburton Headwaters	11	89	0
Gascoyne Wooramel	0	0	100
Kalgoorlie	0	0	100
Lyndon	0	0	100
Meekatharra	0	0	100
Mt Magnet	29	23	48
Murchison	0	5	95
North-eastern Goldfields	0	0	100
Nullarbor Eyre Highway	0	0	100
Sandstone	0	11	89
Shark Bay	9	6	85
Upper Gascoyne	0	53	47
Wiluna	0	100	0
Yalgoo	0	4	96
Yilgarn	0	0	100
Shrublands overall	**3**	**20**	**77**

Table 7 Change in number of desirable shrubs (Epoch 3 to 4) in the southern Rangelands Region*†

LCD	Seasonal quality		
	Above average %	Average %	Below average %
Cue	4.6	0.8	n.a.
Kalgoorlie	-12.7	-9.0	-26.1
Lyndon	n.a.	-20.4	-28.5
North-eastern Goldfields	n.a.	-9.7	-21.7
Upper Gascoyne	-20.3	-11.2	-41.5
Wiluna	-20.9	-36.5	-42.1
Gascoyne Ashburton Headwaters (49% assessed)	-49.5	-30.6	n.a.
Meekatharra (57% assessed)	-20.2	-42.2	-65.7
Nullarbor Eyre Highway (34% assessed)	-8.4	-11.4	17.1

* Epoch 3 – July 2005 to June 2010; Epoch 4 – July 2010 to December 2012.

† Data only available from LCDs reassessed to December 2012.

n.a. not available.

Table 8 Change in all perennial shrub numbers in the southern Rangelands Region

Seasonal quality	Change	Plant population in Epoch 4
Overall	-16.2%	49 458
Above average	-14.5%	13 473
Average	-13.4%	19 677
Below average	-20.6%	16 308

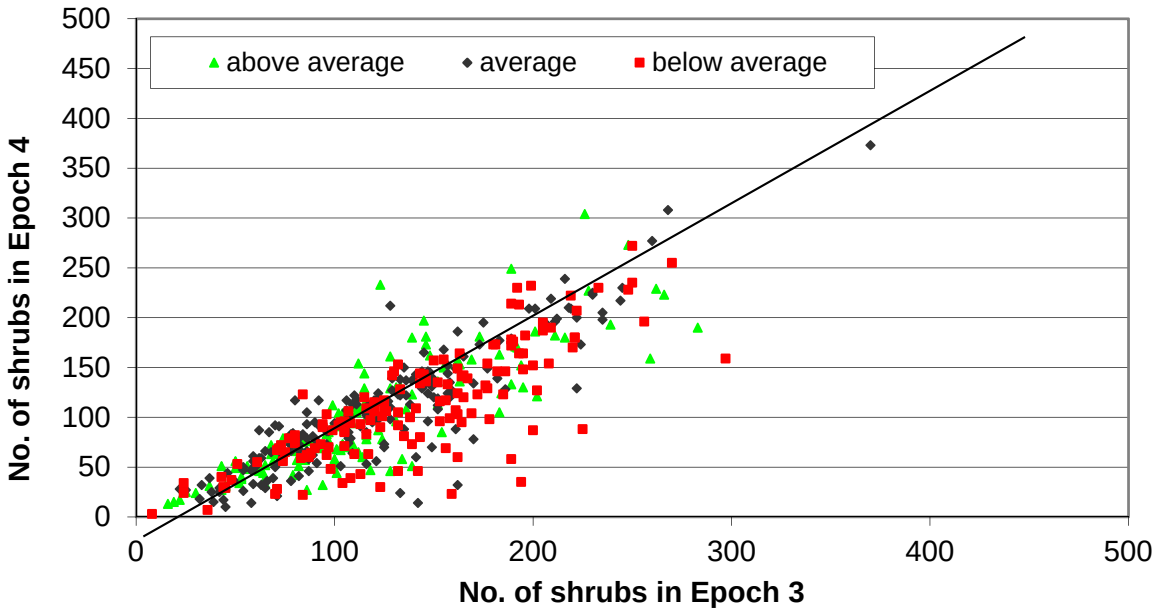

Figure 11 Shrub number at WARMS shrubland sites of varying seasonal quality, in Epoch 3 (2005–07) and Epoch 4 (2010–12). Data as at December 2012

3.3.3 Stock density

On an LCD-wide basis, only the Upper Gascoyne and Wiluna LCDs reported stock numbers in 2012 above the Present CC, highlighting the variability within LCDs and the need to be cautious when assessing aggregated figures. However, when the figures are considered for the region as a whole, of the 246 leases reporting stock numbers in 2012, 55 (22%) reported numbers above the most recently calculated Present CC. The percentage of leases above the Present CC was highest in the Wiluna LCD (60%), and lowest in Binnu, Sandstone and Cue LCDs (0%) (Table 9).

Table 9 Reported stock densities in the southern Rangelands Region, 2002–12

	Stock density ha/DSE											
LCD	Ave. Present CC	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Binnu	25.2	53.9	40.6	44.7	54.2	45.1	15.1	60.7	52.7	55.8	51.4	83.8
Cue	18.7	28.0	29.9	46.0	41.6	33.6	26.5	31.9	35.8	67.7	64.9	54.3
Gascoyne Wooramel	11.4	13.6	16.8	14.3	11.6	11.3	11.0	10.1	9.0	11.7	14.6	13.3
Gascoyne Ashburton Headwaters	20.8*	20.1	19.1	20.7	23.9	24.1	19.6	17.9	16.1	27.1	28.9	27.0
Kalgoorlie	20.3	27.0	34.0	37.5	37.2	45.2	53.4	46.5	52.6	61.4	53.1	40.3
Lyndon	9.5	8.9	10.8	10.7	8.7	9.9	9.7	8.1	8.4	11.1	10.4	9.7
Meekatharra	22.2	32.6	30.8	29.1	29.0	26.8	26.8	25.0	24.7	31.8	31.2	29.0
Mount Magnet	17.1	18.8	24.1	25.0	22.1	18.3	22.0	22.9	24.6	29.6	41.8	35.4
Murchison	18.1	23.5	32.2	40.6	33.4	26.4	29.0	22.2	24.7	34.3	37.8	30.9
North-eastern Goldfields	23.1	47.7	46.2	48.6	46.2	55.0	42.2	36.8	44.4	43.8	44.3	34.1
Nullarbor Eyre Highway	24.2	24.5	23.5	22.7	25.0	32.9	27.8	32.0	32.9	33.4	26.1	24.5
Sandstone	19.2	84.7	77.5	64.0	99.2	85.0	74.1	64.2	59.5	64.6	51.3	74.0
Shark Bay	12.8	17.3	18.2	20.2	17.0	18.4	21.7	18.5	16.3	21.7	21.0	23.7
Upper Gascoyne	19.2	17.5	23.0	19.4	16.5	15.3	12.9	12.5	10.9	13.9	15.7	14.8
Wiluna	23.6*	31.0	17.5	19.2	22.4	21.7	20.0	17.5	18.4	21.3	20.6	20.2
Yalgoo	18.1	23.4	33.0	39.1	37.4	30.9	25.6	28.8	28.4	44.9	46.4	40.1
Yilgarn	16.8	44.1	46.9	51.6	111.9	118.7	104.0	52.5	109.7	101.6	54.8	78.8

* Not all stations in the LCD have a Present CC determined.

3.3.4 Interaction of stock numbers and desirable plant counts

Current WARMS sampling in the southern Rangelands Region is only partially complete in the Meekatharra (57%), Nullarbor Eyre Highway (34%) and Gascoyne Ashburton Headwaters (49%) LCDs. Consequently, there are only minor changes to those data presented in the July 2012 report.

Changes in desirable shrub populations between Epoch 3 and 4 for those LCDs with available data — Cue, Kalgoorlie, Lyndon, North-eastern Goldfields, Upper Gascoyne and Wiluna LCDs — are variable (Figure 12). Significant declines in desirable shrub numbers were recorded in the North-eastern Goldfields and Wiluna LCDs, with the former having an average reported stock number below the Present CC (on an LCD aggregated basis) and the latter reporting stock numbers above the Present CC. There were minor changes, both positive and negative, recorded in the other LCDs.

In the Wiluna LCD, reported stock numbers have increased steadily over the past decade, in part associated with an extended period of above average seasonal conditions from 1999 to 2008. All WARMS sites in this LCD were assessed as average seasonal quality in 2012 (Table 6). In 2011 more than half of the sites were assessed as below average seasonal quality (Novelly and Thomas 2012) but stock density actually increased slightly (Table 9). The result is a quite significant decline in perennial shrub densities. If the apparent trend of not relating stock numbers to seasonal conditions continues, it is likely that the density of desirable shrubs on WARMS sites in this LCD will continue to decline.

In the North-eastern Goldfields LCD, all of the WARMS sites recorded below average seasonal quality in 2012 (Table 6), while none of the WARMS sites recorded a below average seasonal quality in 2011. This inherent inter-year variability (low median rainfall with high inter-annual coefficients of variation) makes management difficult. Moreover, of the 30 leases in this LCD, 13 are owned by mining companies (generally running stock numbers well below the Present CC) and two are managed by indigenous communities (again with low stock numbers). This distorts the LCD average stock number on many leases. Stock numbers are evidently too high to maintain rangeland condition in the face of unfavourable seasonal conditions, as grazing pressure is not being sufficiently reduced to respond to unfavourable seasons.

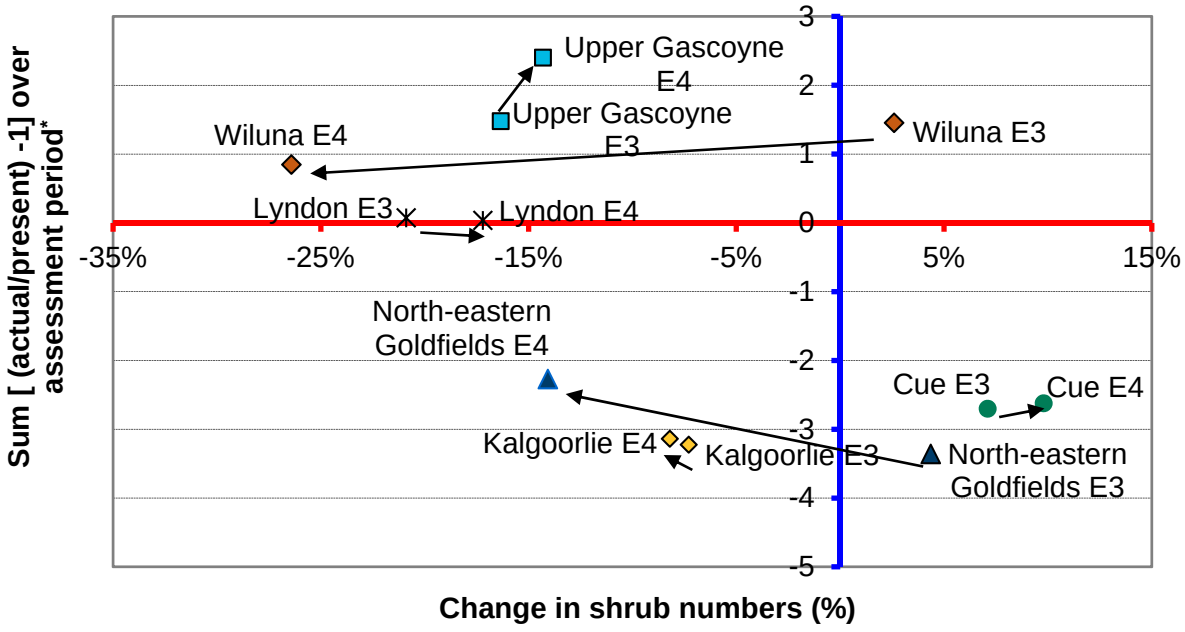

Figure 12 Change in shrub numbers in relation to grazing pressure (Epoch 3 to 4) for Cue, Kalgoorlie, Lyndon, North-eastern Goldfields, Upper Gascoyne and Wiluna LCDs

4 Discussion

4.1 Grasslands in the Kimberley LCDs

The long sequence of favourable seasonal conditions and the generally stable stock numbers in the Kimberley LCDs have driven the trend in the frequency of all perennial grasses (desirable and undesirable) and the relatively stable range condition trend.

However, this is not so in the case when the frequency of only the desirable grasses is considered. The decline in the frequency of desirable perennial grasses for Kimberley LCDs in Cycle 5 was noteworthy, and a recent decline has also been recorded in the North Kimberley LCD in Cycle 6 — a comparison between sites assessed in 2012 and those assessed in the previous period (2009 to 2011). The situation with the other Kimberley LCDs will be confirmed with further data collection over the coming 12 to 24 months. However, if seasonal conditions were to turn less favourable, current stock numbers would require an immediate and substantial reduction response from lessees, as the variability in desirable grass frequency indicates a fine margin between sustainable and unsustainable grazing pressure.

The data presented in this report are aggregated at the LCD scale, and numerous Kimberley leases, in particular most of the 30% of leases currently managed by indigenous communities, are carrying relatively low stock numbers. Of the 86 leases that reported stock numbers for 2012, 41 (38%) reported numbers above the Present CC.

The decline in the frequency of desirable perennial grasses over the previous cycle reflects this increase in stock numbers, although the potential impact of stock numbers has been mitigated by the remarkable run of favourable conditions since monitoring began in the 1990s. It is concerning that the frequency of desirable grasses is declining when desirable grasses should be increasing and consolidating in response to favourable seasons, in preparation for the inevitable return to more average season conditions or worse.

4.2 Grasslands south of the Kimberley LCDs

For the WARMS grassland sites south of the Kimberley LCDs, the frequency of desirable perennial grasses declined during Cycle 5 (2006–08 to 2009–11) in all LCDs except Lyndon LCD, and also declined at sites in Ashburton LCD where data are available for Cycle 6 (2009–11 to 2012 only), despite favourable seasonal condition over the past few years (Table 5).

However, stock densities remained relatively high in all LCDs. WARMS and seasonal quality data suggest that excessive grazing pressure may have a negative influence on the capacity of these grasslands to respond to the more favourable seasons recorded over the last few years.

Both these factors suggest current stock numbers in the grasslands south of the Kimberley LCDs are unlikely to be sustainable, while in the East Pilbara LCD, a return to average seasons or perhaps below average seasons could cause significant problems if stock numbers are not rapidly reduced. Data suggest that many leases in the region, are stocked above assessed Present CC.

As in the Kimberley LCDs, most areas south of the Kimberley recorded average or above average rainfall and associated pasture growth for many of the 12 years to 2005 and again in recent years. This may have inflated expectations of property carrying capacities. Indeed, the current stock numbers reflect the sharp increase in regional stock numbers that occurred

from 1997 and continued to rise until about 2007 or 2008 (depending on the LCD). The condition of the pastoral resource in the grasslands south of the Kimberley LCDs is at considerable risk, and close attention should be paid to this region over the coming 12 months.

4.3 Shrublands in the southern Rangelands Region

As expected, as seasonal conditions declined in southern Rangeland Region there was a pronounced decline in shrub densities, suggesting an inadequate response from lessees to the current seasonal conditions.

More than half of the sites have lost desirable plants between Epoch 3 and 4 (Figure 11). Such changes are leading to long-term, virtually permanent changes (transitions) in the rangeland resource, leading to reduced carrying capacity, significant changes to rangeland biodiversity, or both, in most instances.

4.4 General discussion

The most obvious changes in Australian pastoral rangelands are those associated with the gross changes that occurred when livestock were first introduced to the rangelands or when drought subsequently interacted with high stock numbers to produce severe degradation episodes. These changes (transitions) often included soil degradation and a decline in the condition of the vegetation, such as the loss of productive perennial species or the onset of severe woody-weed thickening in both shrubland and grassland systems.

However, concern continues that some of the contemporary negative changes on WARMS sites are transitions to other less productive rangeland states, and that reversal of these changes will be neither straightforward nor short term.

Analysis of the WARMS dataset using 306 grassland sites and 919 shrubland sites identified transitions that have occurred between 1993 and 2010, during which the grassland sites were assessed on 5 occasions and the shrubland sites on 3 occasions (Watson and Novelly 2012).

Eleven per cent of the grassland sites and 1% of the shrubland sites were determined to have undergone a transition, although in a few cases the transition was deemed to have been positive from a pastoral production perspective (sites where specific management changes, in particular complete destocking for some years in association with excellent seasonal conditions). In these situations, the transition was from a less desirable to a more desirable species composition. Transitions were more common in the northern grasslands than in the southern shrublands, perhaps because grassland species are more dynamic than shrubs and species composition is able to change more rapidly.

The response to a declining trend and changes in seasonal conditions must be immediate to prevent a degradation sequence which, once started, is difficult to stop, leads to a transition and often becomes virtually irreversible within a realistic management timeframe. That such transitions are being recorded is particularly worrying and indicative of totally inappropriate livestock management throughout much of pastoral WA.

The consequences of these changes, for both government and pastoral lessees are substantial. First, where a persistent change, at least within what could be termed a management timeframe, has occurred in the state of the vegetation, the assessment and interpretation of the rangeland condition, its production potential and future management scenarios within this new management context must be considered. Where change is negative from a pastoral perspective, managers need to accept the new state and its altered

productive potential as reality for the foreseeable future, and they will need to adjust their management (and their aspirations for financial return) to reflect the new vegetation community.

Second, land administrators must accept that the capacity to enact a realistic and feasible management regime that will return the vegetation community to its previous state may not necessarily exist, and that requiring a change in vegetation that is ecologically unlikely under any management regime is pointless.

Both condition assessment and prescribed management must be predicated on the fact that, while not a desired outcome, a threshold has been crossed, the ecology of the site has been altered and that reversal of the change may be difficult, independent of the management imposed.

5 Conclusion

The WARMS data continues to identify serious issues, and these issues appear more pronounced in LCDs in which the average stock numbers are above the Present CC. The frequency (of grasses) or density (of shrubs) of desirable perennial species is declining, and while this may be, in the case of the shrubs, in part a response to changes in seasonal conditions in the southern Rangelands Region, it appears that stocking rates are commonly excessive, and rangeland condition is deteriorating as a result.

That this decline is occurring during generally favourable seasons in some locations is particularly disturbing, suggesting the rangelands are unable to develop resilience during favourable seasons to assist in survival during less favourable seasons. The implication of this low resilience will be that when a higher proportion of severely unfavourable seasons occur, quite dramatic declines in desirable species will be more likely.

This report indicates that on-going rangeland degradation continues under present management on many leases, and that such management is therefore not in accordance with Section 95 of the *Land Administration Act 1997.* Action to address this situation will not be simple, but is necessary and should be immediate.

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