2019

Status of the Western Australian pastoral rangelands 2018: Condition, trend and risk

Department of Primary Industries and Regional Development, Western Australia

Department of
Primary Industries and
Regional Development

GOVERNMENT OF
WESTERN AUSTRALIA

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Contents

Acknowledgements

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Shortened forms

Short form	Long form
CU	cattle unit
DPIRD	Department of Primary Industries and Regional Development
ha	hectare
LCD	land conservation district
km^2	square kilometre
mm	millimetre
MODIS	Moderate Resolution Imaging Spectroradiometer
NDVI	Normalised Difference Vegetation Index
PCC	potential carrying capacity
UCL	unallocated Crown land
WA	Western Australia
WARMS	Western Australian rangeland monitoring system

Summary

The Department of Primary Industries and Regional Development (DPIRD) reports annually on the condition, trend and risk of pastoral rangelands in Western Australia. This report is based on the information available to the end of 2018.

Vegetation condition reflects the effects of three main drivers: seasonal quality (the timeliness and amount of rainfall), grazing pressure and fire. Trend in vegetation condition was based on remotely sensed vegetation cover (Moderate Resolution Imaging Spectroradiometer, MODIS) and greenness (how much vegetation grew) data, the Western Australian Rangeland Monitoring System (WARMS) on-ground site data, and on-ground traverse data. Based on these trend data, in combination with Bureau of Meteorology rainfall data and relative stocking rates, the risk profiles for vegetation condition at the regional and land conservation district (LCD) scales were assessed using ISO 31000:2018–compliant risk tables. This approach was designed to provide more-robust risk profiles compared to those presented in previous assessments of condition reported by DPIRD.

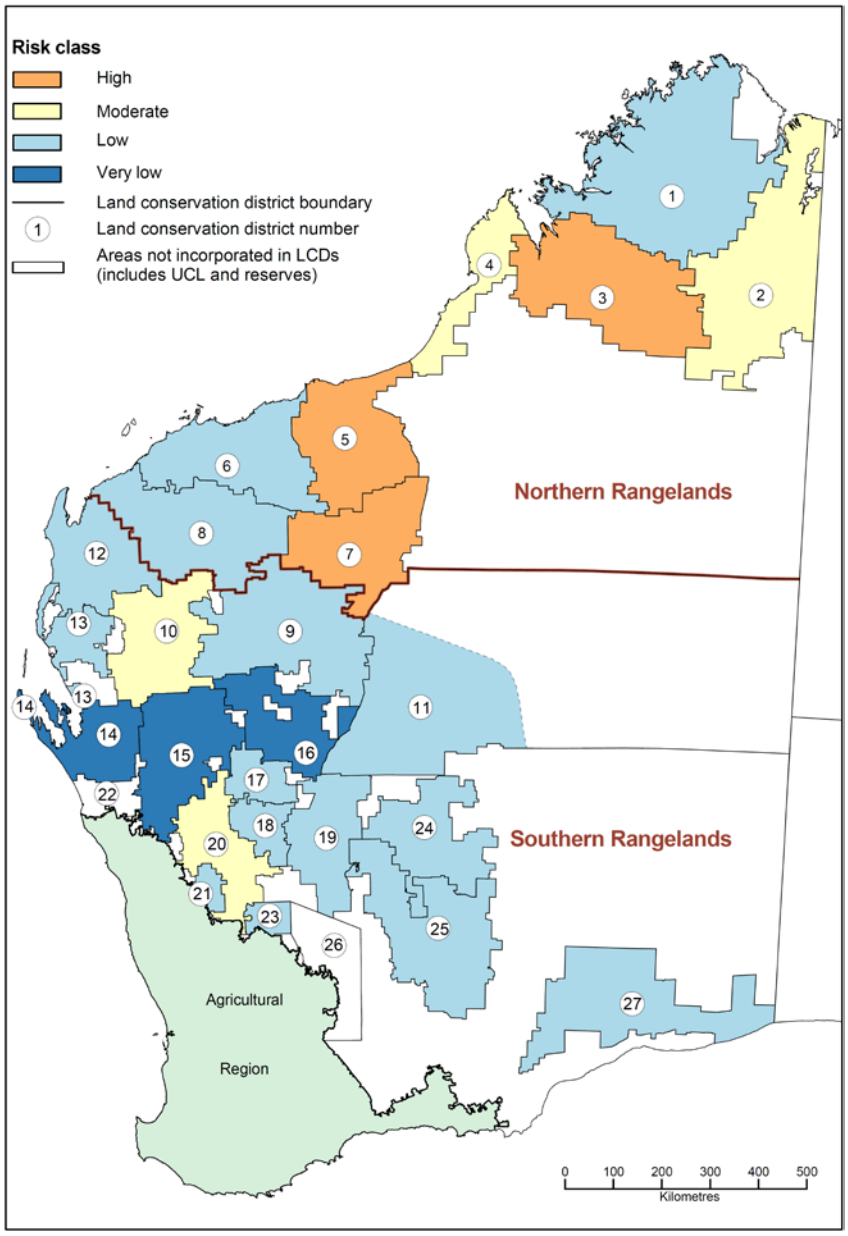
The WA pastoral rangeland estate covers about 860 000 square kilometres across 20 Australian bioregions, with a wide diversity of vegetation types, seasonal conditions and topography. The Kimberley and Pilbara regions comprise the Northern Rangelands, and the Gascoyne, Murchison and Goldfields–Nullarbor regions comprise the Southern Rangelands. A summary of the condition, trend and risk of vegetation condition decline across the entire rangelands and within LCDs in these regions follows.

Kimberley (LCDs #1–4)

- Three of the four Kimberley LCDs were assessed as being at moderate or high risk of declining vegetation condition, in areas where livestock numbers are relatively high (Figure 1).
- Based on WARMS data, vegetation condition was generally stable over the last six years. However, despite good seasonal conditions, remotely sensed data shows the vegetation cover of about 14% (1 252 000 hectares [ha]) of the most productive pasture types has decreased. This suggests these areas are responding to the drivers of fire or management (e.g. stocking rate). These specific areas were identified as being at risk of declining vegetation condition.

Pilbara (LCDs #5–8)

- Two of the four Pilbara LCDs were assessed as being at high risk of declining vegetation condition, especially in areas where livestock numbers are high. Livestock numbers in all Pilbara LCDs are relatively high and will require rapid management action to reduce livestock numbers in poor seasons.
- Based on WARMS data, vegetation condition was generally stable over the last six years in most Pilbara LCDs, but declined slightly in the Ashburton LCD. However, remotely sensed data shows the vegetation cover of about 12% (302 200ha) of the most productive pasture types decreased. This suggests these areas are responding to the driver of management (e.g. stocking rate). These specific areas were identified as being at risk of declining vegetation condition.
- The upper Ashburton LCD had low seasonal greenness over the past five years.



Note: Specific areas within each LCD may be at higher or lower risk than the LCD average.

Figure 1 Risk of vegetation condition decline for LCDs, estimated using trend in vegetation cover, average stocking rate and seasonal quality

Upper Southern Rangelands (LCDs #9–13 & 16)

- Pastures with high livestock numbers in the Upper Gascoyne LCD were assessed as having moderate risk of declining vegetation condition, with the remaining LCDs having low or very low risk of declining vegetation condition.
- Changes in vegetation condition (based on WARMS data) have been variable since 2010: condition has improved in two LCDs, was stable in one, and declined in three. Remotely sensed data showed the vegetation cover of 0.3% (8300ha) of the most productive pasture types decreased, despite years with average or above-average seasonal conditions. This suggests these areas are responding to the driver of

management (e.g. stocking rate). These specific areas were identified as at high risk of declining vegetation condition. The vegetation cover of 30% (977 500ha) of these pastures were identified as at moderate risk of declining vegetation condition.

- Most of the upper Southern Rangelands experienced below-average seasonal greenness in 2017. Areas of the Gascoyne–Wooramel, Upper Gascoyne, Gascoyne – Ashburton Headwaters and Meekatharra LCDs have had three to five seasons out of the last five years with below-average seasonal greenness.
- The current trend for declining winter rainfall is an emerging climate driver, which will affect risk levels for vegetation condition decline.

Lower Southern Rangelands (LCDs #14, 15, 17–27)

- The Yalgoo LCD was assessed as being at moderate risk of declining vegetation condition, despite the stocking rate being below potential carrying capacity. The remaining LCDs were assessed as being at low or very low risk.
- Changes in vegetation condition (based on WARMS data) have been variable since 2005: condition has improved in two LCDs, declined in five, and was stable in two. Remotely sensed data showed the vegetation cover of 12% (1 175 000ha) of the most productive pasture types decreased, predominantly in the Nullarbor – Eyre Highway and Yalgoo LCDs, despite years with average or above-average seasonal conditions. This suggests these areas are responding to the driver of management (e.g. stocking rate). These areas are identified as at high risk of declining vegetation condition.
- Most of the Cue, Mount Magnet, Murchison, Shark Bay, Yalgoo and the western part of Sandstone LCDs had below-average seasonal greenness in 2017. Over the past five years, persistently below-average seasonal greenness was evident in areas of the Shark Bay, Murchison, Yalgoo and Cue LCDs.
- If the trend for drier winters persist, the risk levels for vegetation condition decline may increase.

1 Introduction

This report outlines the current condition, trend and risk of declining vegetation condition of pastoral rangelands in WA, based on the information available to the end of 2018. It has been prepared as part of DPIRD's annual reporting on pastoral rangeland condition and forms part of a broader package of pastoral reforms announced by the WA Government in response to recommendations within the Office of the Auditor General's (OAG) 2017 report, *Management of pastoral lands in WA*.

Specifically, the OAG report included the recommendation:

> Develop and implement a reliable statewide system to monitor changes in land condition within the rangelands: (i) to inform land management activities across land tenure boundaries; (ii) at the individual lease level; and (iii) includes both remote sensing technology and ground monitoring.

It is expected that the monitoring and assessment protocols used to generate future annual condition reports will continue to be refined with the implementation of the broader pastoral lands reform package, which includes using a risk-based monitoring and compliance framework.

Using this framework, the analysis in this report includes the risk profiles for vegetation condition at the regional and LCD scales. This approach was included to provide more-robust risk profiles compared to those presented in previous condition reports generated using historical methods by DPIRD:

- reports to the Pastoral Lands Board (PLB) on the condition trend of the Western Australian pastoral resource base 2016, 2017 and 2018
- *Report card on sustainable natural resource use in the rangelands* (2017)[1].

1.1 Background

The pastoral estate (leasehold tenure) covers about 40% (nearly 860 000 square kilometres) of WA's rangeland area. Pastoralism — where livestock graze predominately native pastures — is the largest land use by area in WA, which makes pastoral land managers the single most important group in caring for and preserving the state's rangeland asset.

In 2016, WA's 436 pastoral stations generated $499 million, $6.2 million and $1.4 million in sales from cattle, sheep and goats, respectively.

The pastoral rangelands encompass a range of vegetation types (savanna, woodlands, grasslands, and mulga and chenopod shrublands) and various climatic zones (1200 millimetres [mm] to 180mm annual rainfall; summer-dominant rainfall in the north, and winter-dominant rainfall in the south).

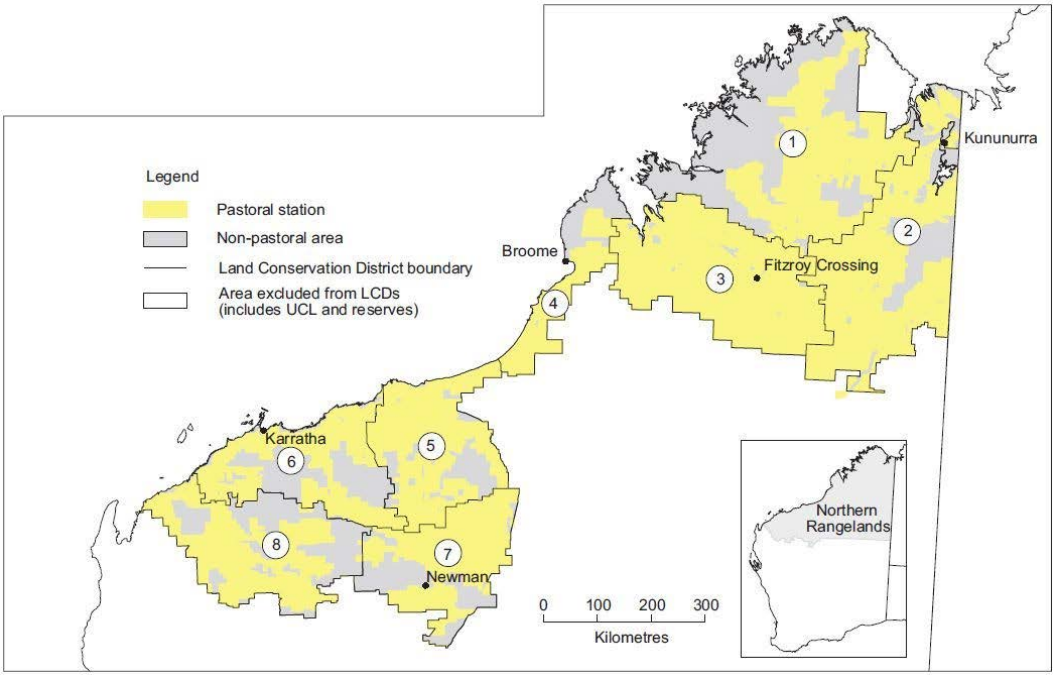
The rangelands are divided into regions — Northern Rangelands (the Kimberley and Pilbara) and the Southern Rangelands ('upper' and 'lower' zones) — based on annual

[1] Department of Agriculture and Food, Western Australia 2017, *Report card on sustainable natural resource use in the rangelands: status and trend in the pastoral rangelands of Western Australia,* Department of Agriculture and Food, Western Australia, Perth.

rainfall, seasonality of rainfall, land type, vegetation class and land management issues. Consistent with the *Soil and Land Conservation Act 1945*, these rangelands regions have been subdivided into 27 LCDs (Figure 1.1, Table 1.1).[2]

This report summarises the condition, trend and risk to vegetation condition at both the LCD and regional scales (Sections 2 and 3, respectively).

a



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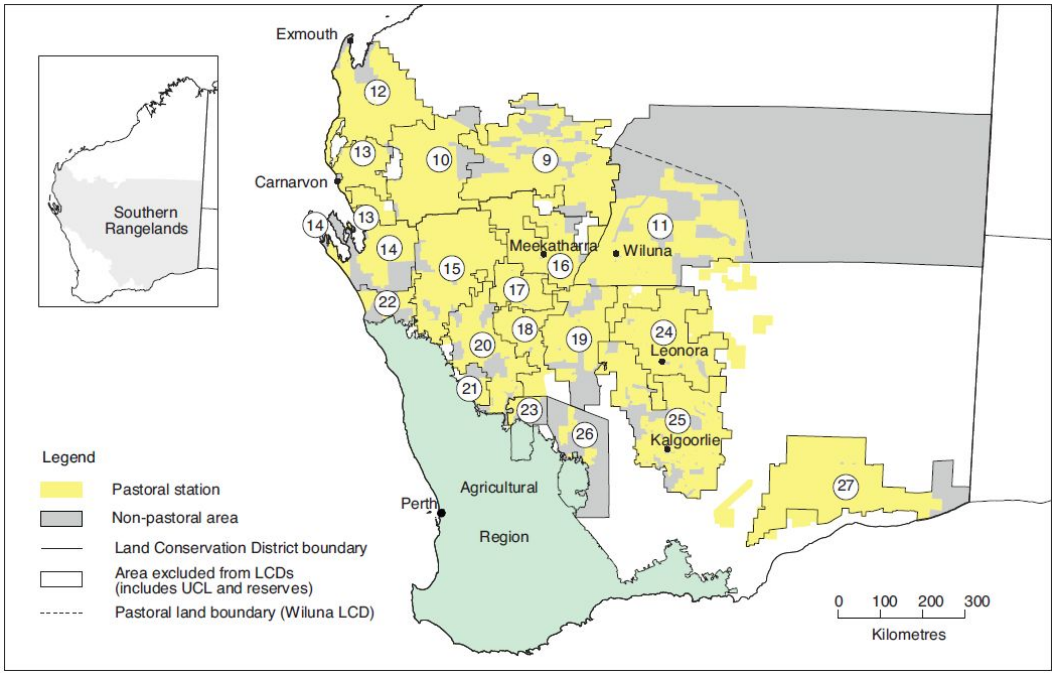


Figure 1.1 a) Northern Rangelands; and b) Southern Rangelands LCDs

[2] LCDs are legislated areas (under the *Soil and Land Conservation Act 1945*) comprising pastoral rangeland, conservation areas and unallocated Crown land (UCL).

Table 1.1 LCDs in the WA rangelands

LCDs in Northern Rangelands	LCDs in Southern Rangelands	
1 North Kimberley	9 Gascoyne – Ashburton Headwaters	18 Mount Magnet
2 Halls Creek – East Kimberley	10 Upper Gascoyne	19 Sandstone
3 Derby – West Kimberley	11 Wiluna	20 Yalgoo
4 Broome	12 Lyndon	21 Perenjori
5 De Grey	13 Gascoyne–Wooramel	22 Binnu
6 Roebourne – Port Hedland	14 Shark Bay	23 Mount Marshall
7 East Pilbara	15 Murchison	24 North-eastern Goldfields
8 Ashburton	16 Meekatharra	25 Kalgoorlie
	17 Cue	26 Yilgarn
		27 Nullarbor – Eyre Highway

1.2 Data inputs

The primary indicator of vegetation condition is the presence of desirable plant species: perennial pasture species that are productive and highly palatable to livestock. The primary indicator of vegetation condition in the grasslands is the frequency (a proxy for density) of desirable perennial grasses, and in the shrublands it is the density of desirable shrubs.

Until 2009, vegetation condition of each lease was assessed using on-ground traversing, which has so far provided the most reliable spatial dataset for condition. These traversing data now provide a baseline of quantitative pastoral vegetation condition. The percentage area in good, fair and poor condition are presented for each rangeland region in Section 3 and for each LCD in Appendix A.

Since 2009, qualitative changes in the condition of pastoral leasehold land have been inferred from analysis of the frequency or density of desirable pasture species at WARMS sites (Appendix B), rainfall data and remotely sensed (satellite) data.

Remotely sensed fractional vegetation cover data (MODIS) obtained from CSIRO were analysed to determine changes and trends in vegetation cover during the period 2008–18 (Appendix C). MODIS vegetation greenness index (Normalised Difference Vegetation Index, NDVI) data were also used to assess seasonal greenness during each growing season to provide an indication of seasonal quality and the ability of pastures to intercept and use the rainfall (Appendix D).

Areas where the vegetation cover of the most productive pasture types has decreased despite good seasonal conditions, were mapped for the period 2009–18 for the Northern Rangelands and the period 2008–17 for the Southern Rangelands. These ‘high threat areas’ are considered to be particularly vulnerable to continuing grazing pressure.

1.3 Risk-based assessment of condition

Vegetation condition reflects the effects of three main drivers: seasonal quality (the timeliness and amount of rainfall), grazing pressure and fire. The risk analysis for condition decline was completed using risk assessment protocols consistent with ISO 31000:2018 risk management guidelines and HB89-2013 risk assessment techniques.[3,4] The analysis involved assessing the risk profiles for each LCD and rangeland region based on:

- spatial estimates of trends in vegetation cover determined from remotely sensed data
- antecedent and current seasonal conditions
- antecedent and current stocking rates.

This risk analysis was done in two steps. Importantly, the current method does not identify areas which are already in poor vegetation condition; only the degree to which areas are vulnerable to further vegetation condition decline.

1.3.1 Risk level calculation

Step 1 Seasonal condition and cover trend

The trend in the vegetation cover of the three most productive pasture types in each LCD and seasonal quality (Appendix E) were analysed to determine how vegetation cover had changed during the period. These pasture types are generally the ones most likely to be grazed by livestock and other herbivores and therefore should show the first indications of overgrazing.

The underlying logic for the cover threat classes outlined in Table 1.2 reflect that if the vegetation cover has decreased or was even stable during a period with good seasonal quality, then these areas are under grazing pressure and are therefore vulnerable to overgrazing if there is a decline in seasonal conditions.

The level of cover threat was determined for each pixel, based on the trend in vegetation cover and the seasonal quality for the periods 2009–18 in the Northern Rangelands and 2008–17 in the Southern Rangelands. To reduce the effect of fire in the Northern Rangelands analysis, areas that burned for six or more of the 10 years analysed were omitted. Fires are less frequent in the Southern Rangelands so the effect of fire was not excluded from the vegetation cover trend analysis.

[3] Australian Standards 2018, *Risk management— guidelines*, AS ISO 31000:2018, Standards Australia, Sydney.

[4] Standards Australia 2013, *Risk management — guidelines on risk assessment techniques*, HB89-2013, Standards Australia, Sydney.

Table 1.2 Vegetation cover threat classes based on vegetation cover trend and seasonal quality

		Seasonal quality		
		Above average	Average	Below average
Vegetation cover trend	Increased	Low	Low	Very low
	Stable	Moderate	Low	Low
	Decreased	High	Moderate	Moderate

To report on the risk of declining vegetation condition at the LCD scale, the weighted values of the percentage area of pixels in each vegetation cover threat class in each LCD were aggregated using the following equation:

LCD vegetation cover threat weighted sum = (% High x 4) + (% Moderate x 3) + (% Low x 2) + (% Very low x 1)

The LCD vegetation cover threat weighted sum was used to assign a threat class for each LCD.

Step 2 Incorporating LCD stocking rates

To complete the risk analysis process, the final risk rating for each LCD was determined based on the LCD vegetation cover threat plus the current LCD average stocking rate relative to the LCD potential carrying capacity (PCC) for the corresponding period (Table 1.3).

Table 1.3 LCD risk rating based on vegetation cover threat and stocking rate threat

		LCD risk	
Vegetation cover threat class	Weighted sum	Above PCC	Below PCC
Very low	<150	Low	Very low
Low	150–225	Moderate	Low
Moderate	226–300	High	Low
High	>300	Very high	Moderate

PCC = potential carrying capacity

This step recognises that the risk of a decline in vegetation condition is affected by current stocking rates. The risks will be increased where the average stocking rate for an LCD is above its PCC and it will be reduced where the stocking rate is below the PCC. This is important because the calculation of current risk levels should reflect whether appropriate management actions (e.g. destocking) have already occurred. A very high risk level would be generated where there is a high vegetation cover threat combined with the average stocking rate above the PCC for the LCD.

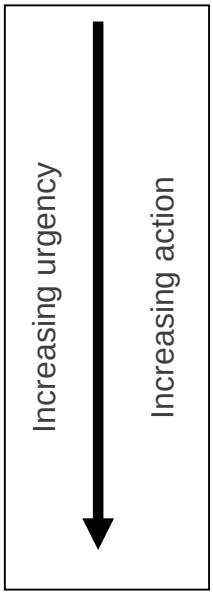
1.3.2 Risk levels and appropriate management responses

The different risk levels and their corresponding management responses are shown in Table 1.4. Using five levels is similar with approaches adopted in many other resource management systems: essentially, the higher the risk level, the more risk mitigation actions need to be taken and the quicker these need to be done.

It is important to note that a moderate level of risk is acceptable so long as there is active and responsive management in place to adjust stocking and other drivers to maintain acceptable resource condition.

Specific areas within an LCD may have areas with higher or lower risks than the overall LCD risk level and require different management responses. It is therefore planned for the outputs from the finer-scale risk analyses (Section 2.2) to be provided to the relevant leaseholders as part of the implementation of the broader pastoral reform package.

Table 1.4 Management responses based on LCD risk



Risk levels	Management response
Very low	No additional response required
Low	No specific response required under current conditions
Moderate	Management need to be aware, and: • assess pasture condition in the event of average or below-average seasons • plan to adjust stock numbers based on available feed
High	Management need to actively: • monitor pasture condition • adjust stock numbers based on available feed and increase management actions if required
Very high	Urgent management response is required in the current season: reduce grazing pressure and undertake further responses in light of assessment of pasture monitoring

2 Current overall risk levels

2.1 LCD scale

The overall risk of vegetation condition declining under average stocking rates prior to 2018 was determined for each LCD, estimated using trend in vegetation cover, average stocking rate and seasonal quality (Figure 2.1).

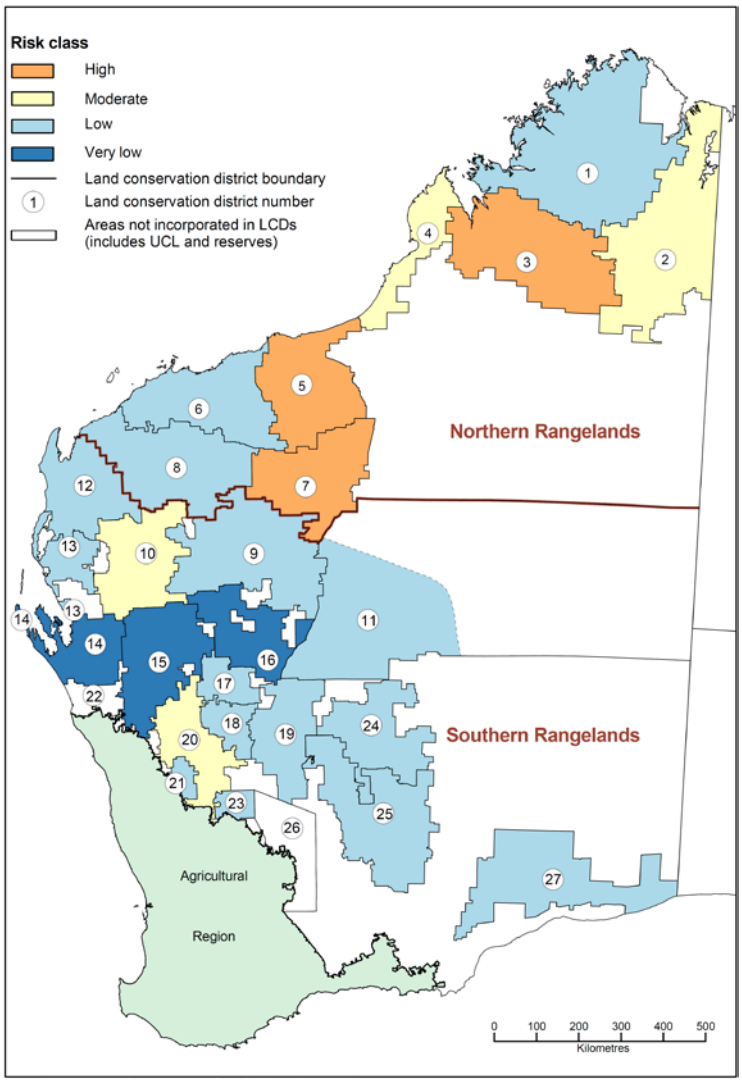


Figure 2.1 Risk of vegetation condition decline for rangelands LCDs

LCDs at high risk

- Northern Rangelands: Derby – West Kimberley, De Grey, and East Pilbara LCDs

LCDs at moderate risk

- Northern Rangelands: Broome and Halls Creek – East Kimberley LCDs
- Southern Rangelands: Upper Gascoyne and Yalgoo LCDs

The remaining LCDs were at low or very low risk.[5]

[5] Binnu (#22) and Yilgarn (#26) LCDs have very small areas of the three most productive pastures analysed and were not rated for risk of vegetation condition decline.

2.2 Finer-scale analysis

In addition to the overall LCD scale risk, there were also specific areas within individual LCDs where the vegetation cover of the most productive pasture types has decreased and the pastures are considered vulnerable to vegetation condition decline.

While the driver for these decreases may be high grazing pressure, the finer-scale analysis reports the vegetation cover threat class, based on vegetation cover and seasonal quality, and does not consider stocking rate (Table 1.2).

Kimberley

About 14% (1 252 000ha) of the three most productive pasture types have been identified as having high threat of declining vegetation condition, and may be threatened by ongoing grazing pressure (Figure 2.2). The following significant areas were identified:

- Halls Creek – East Kimberley LCD (#2): 21% (256 600ha) of the undulating tussock grass woodland pasture type, and 17% (110 200ha) of the cracking clay tussock grass pasture type
- Derby – West Kimberley LCD (#3): 11% (43 200ha) of the alluvial plains with tussock grass pasture type, and less than 10% (107 800ha) of the cracking clay tussock grass pasture type
- North Kimberley LCD (#1): 10% (144 500ha) of the undulating tussock grass woodland pasture type
- Broome LCD (#4): 12% (15 900ha) of the alluvial plains with tussock grass pasture type.

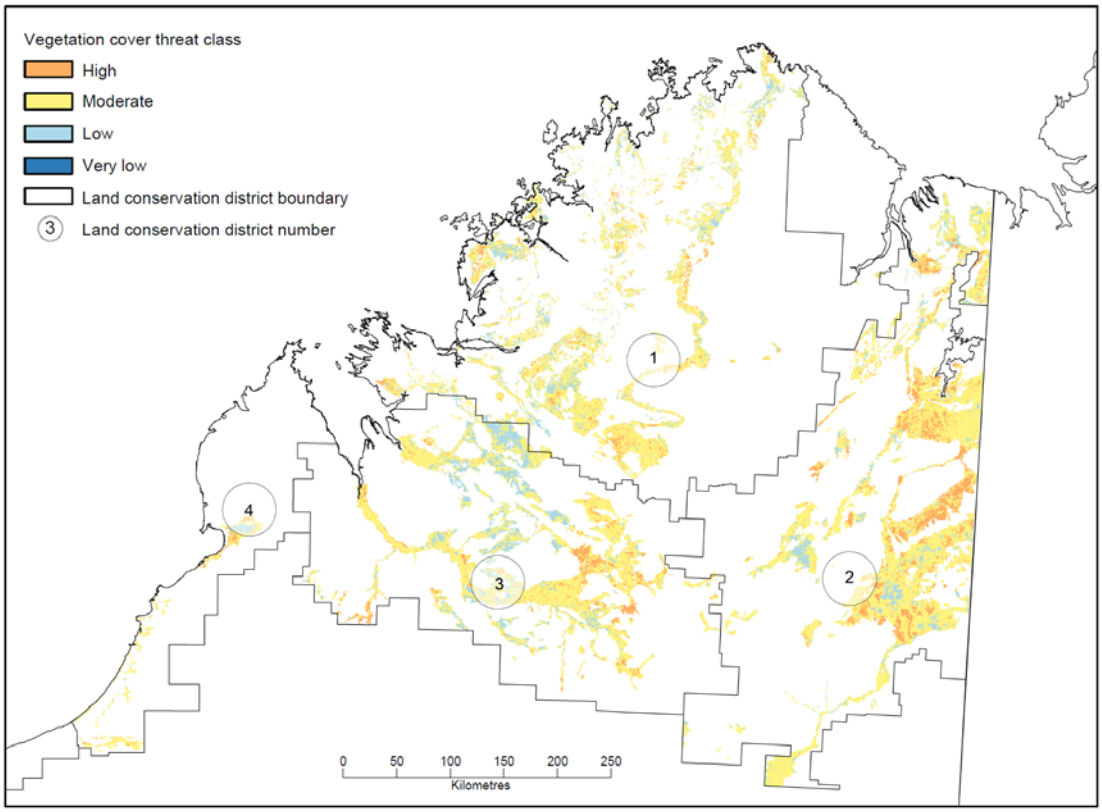


Figure 2.2 Threat of vegetation condition decline of the three most productive pasture types in the Kimberley

Pilbara

About 12% (302 200ha) of the three most productive pasture types have been identified as having high threat of declining vegetation condition, and may be threatened by ongoing grazing pressure. The following significant areas were identified (Figure 2.3):

- Roebourne – Port Hedland LCD (#6): 16% (85 300ha) of the alluvial plains with tussock grass pasture type, and 15% (55 900ha) of the river plains with tussock grass pasture type
- East Pilbara LCD (#7): 25% (55 600ha) of the river plains with tussock grass pasture type
- De Grey LCD (#5): 10% (13 500ha) of the alluvial plains with tussock grass pasture type
- Ashburton LCD (#8): 6% (21 000ha) of the river plains with tussock grass pasture type.

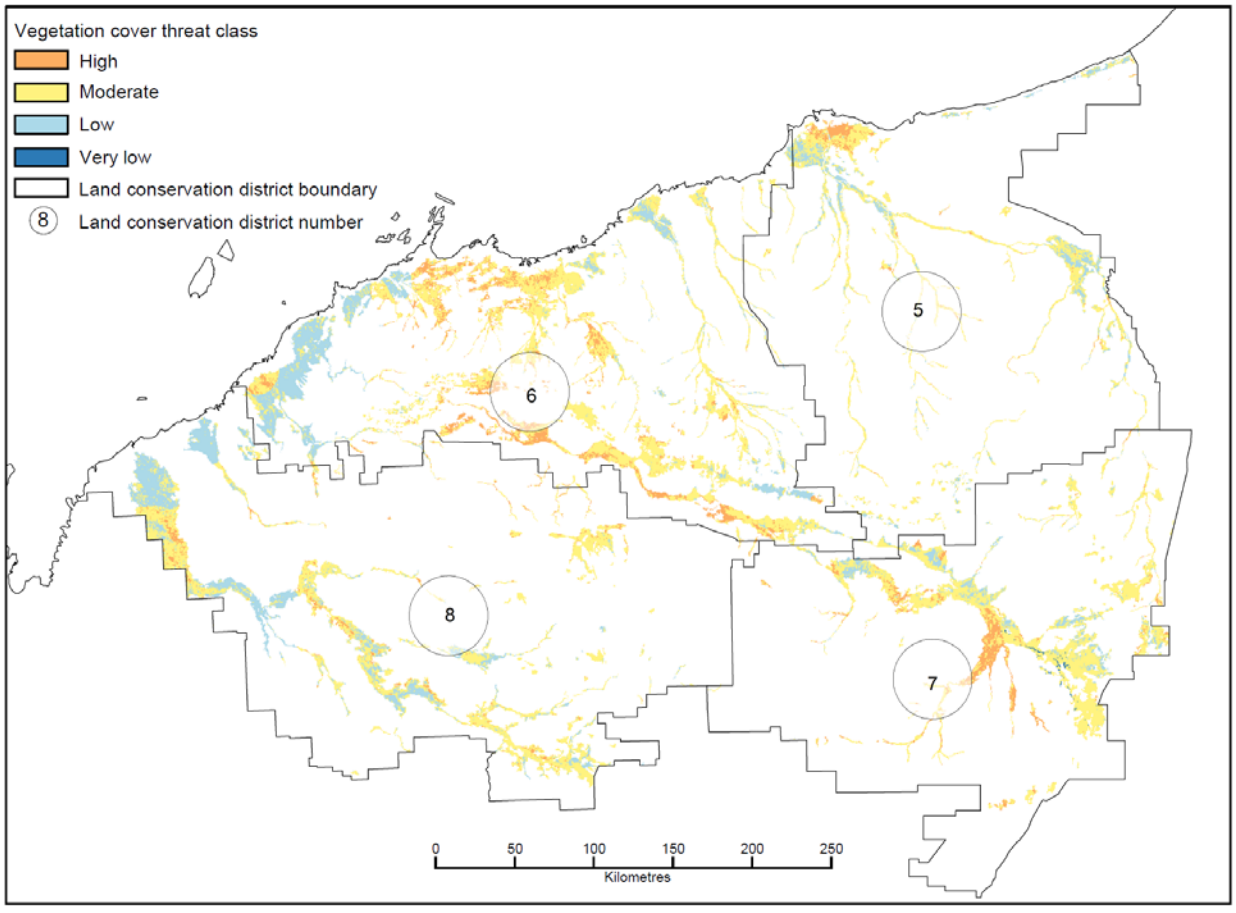


Figure 2.3 Threat of vegetation condition decline in the three most productive pasture types in the Pilbara

Upper Southern Rangelands

Poor seasonal conditions meant less than 1% of the four most productive pasture types were rated as having high threat of declining vegetation condition, and 30% (977 500ha) at moderate threat. There is 28% (378 800ha) of the alluvial plains with halophytic shrubs pasture type at moderate threat, with 202 100ha of this pasture type in the Gascoyne–Wooramel LCD (#13), and 138 000ha of this pasture type in the Lyndon LCD (#12) (Figure 2.4).

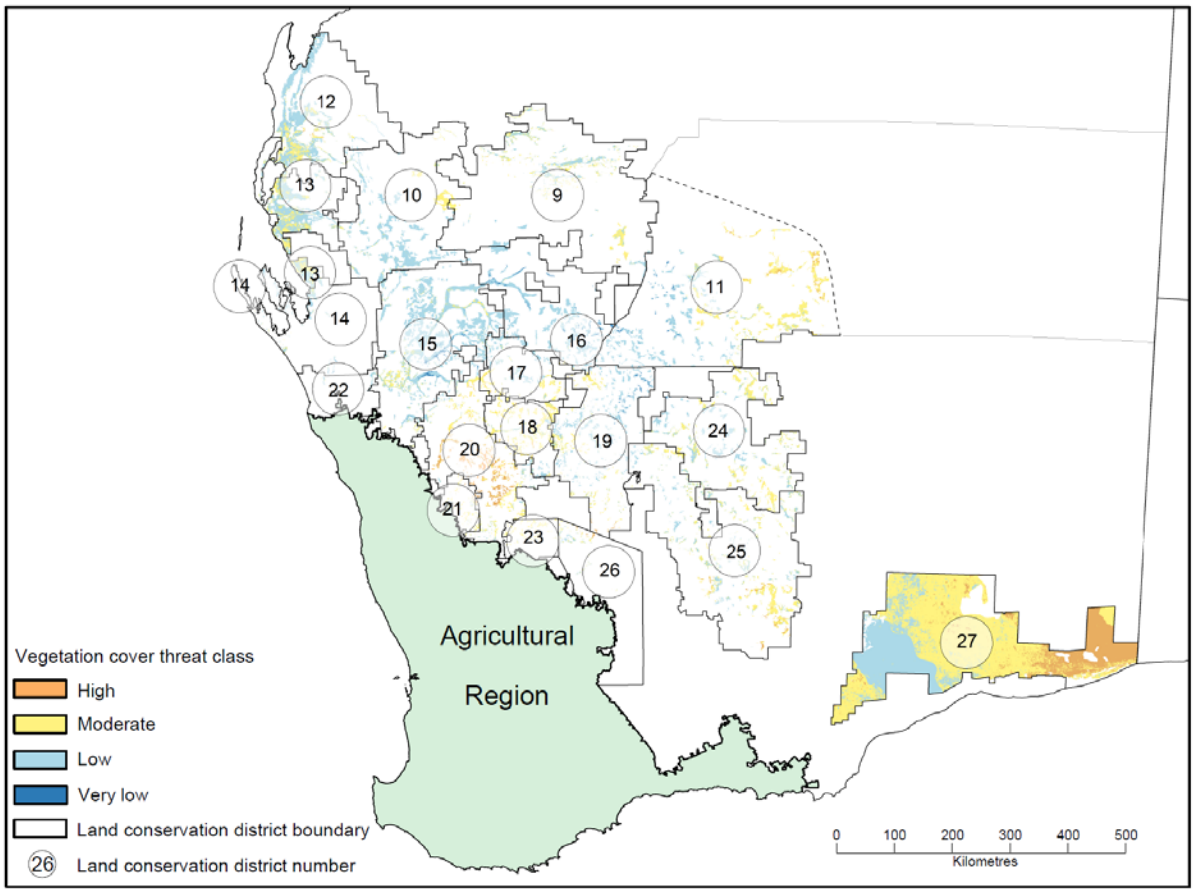


Figure 2.4 Threat of vegetation condition decline in the four most productive pasture types in the Southern Rangelands

Lower Southern Rangelands

About 12% (1 175 000ha) of the four most productive pasture types have been identified as being at high threat of declining vegetation condition and may be threatened by ongoing grazing pressure. The following significant areas were identified (Figure 2.4):

- 17% (1 007 100ha) of the pearl bluebush plains pasture (likely due to fires in the eastern section), predominantly in the Nullarbor – Eyre Highway (#27) and Kalgoorlie (#25) LCDs
- 6% (112 000ha) of the breakaways and stony plains with halophytic shrubs, predominantly in the Yalgoo (37%), Mount Magnet (3%) and Sandstone (3%) LCDs
- 4% (43 800ha) of the alluvial plains with halophytic shrubs, predominantly in the Yalgoo (34%) and Cue (2%) LCDs

- 1% (12 200ha) of the pasture associated with saline alluvial plains and lake frontages, predominantly in the Yalgoo LCD (8%).

Excluding the Nullarbor – Eyre Highway LCD, about 80% of the land with high threat occurs in the Yalgoo LCD, where a ground inspection in 2017 found high levels of tree mortality and reduced tree canopy; DPIRD are investigating the cause of this decline.

3 Regional condition assessments

3.1 Kimberley

Summary

Seasonal quality: 2017–18 summer rainfall was above average across the Kimberley and has been above average or average for 17 of the past 20 years.

Vegetation condition in the four Kimberley LCDs was generally stable over the last six years. Since 1994, there has been an increase in the frequency of desirable perennial pastures across three of the LCDs.

Based on trend in vegetation cover, seasonal quality and average stocking rate, two of the four Kimberley LCDs were assessed as being at moderate risk and one at high risk of declining vegetation condition.

In addition, about 14% (1 252 000ha) of the three most productive pasture types are vulnerable to declining vegetation condition.

Areas of the Fitzroy Valley and Sturt Creek have shown persistently low seasonal greenness since 2012, indicating possible areas of preferred grazing or a change in the soil surface affecting plant-available water.

3.1.1 Background

The Kimberley has a tropical monsoon climate with a hot, wet summer season and dry winter. Vegetation types range from open woodlands, through savanna to open grasslands, with perennial grasses forming the productive resource base for the pastoral industry.

There are 90 pastoral stations covering 20 681 608ha in the Kimberley. The region is represented by four LCDs: North Kimberley (#1), Halls Creek – East Kimberley (#2), Derby – West Kimberley (#3) and Broome (#4) (Figure 3.1).

Vegetation condition was 52% good, 32% fair and 16% poor, when assessed by on-ground traversing between 2002 and 2009 (Table A1).

3.1.2 Trends

Seasonal condition

The 2017–18 summer rainfall was above average across the Kimberley and exceeded the long-term average by 183% in Broome, 47% in Derby – West Kimberley and 37% in North Kimberley LCDs (Figures E1 and E3).

In general, there has been a sequence of average or above-average seasons in 17 of the last 20 years, except for 2015–16, 2009–10 and 2004–05.

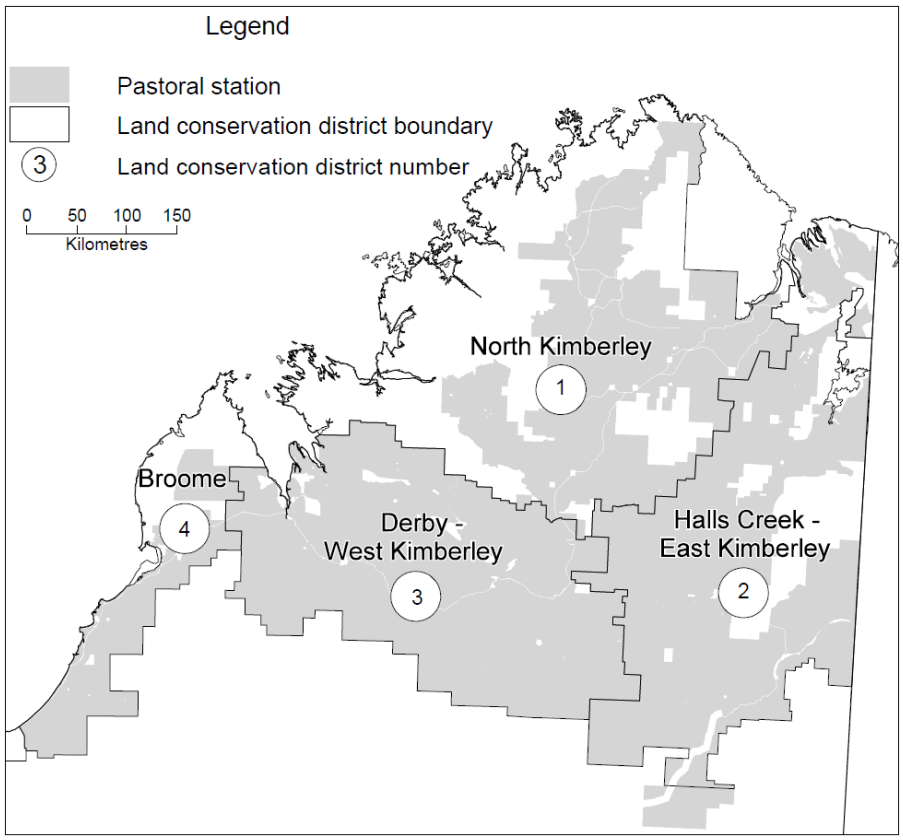


Figure 3.1 LCDs in the Kimberley

Livestock numbers

The PCC (defined in Appendix F and expressed as cattle units per square kilometre, CU/km^2) is estimated at:

- 5.0CU/km^2 for Broome LCD
- 4.8CU/km^2 for Derby – West Kimberley LCD
- 3.5CU/km^2 for Halls Creek – East Kimberley LCD
- 2.8CU/km^2 for North Kimberley LCD (Figure 3.2).

The PCC for the Kimberley is 825 190CU.

In 2017, pastoralists reported cattle numbers in the Kimberley to be 656 362, which is equivalent to 731 853CU. The number of livestock in the Kimberley has generally increased over the last 20 years, with livestock numbers in the Derby – West Kimberley LCD close to the estimated PCC in 2017; other LCDs had numbers below the PCC (Figure 3.2).

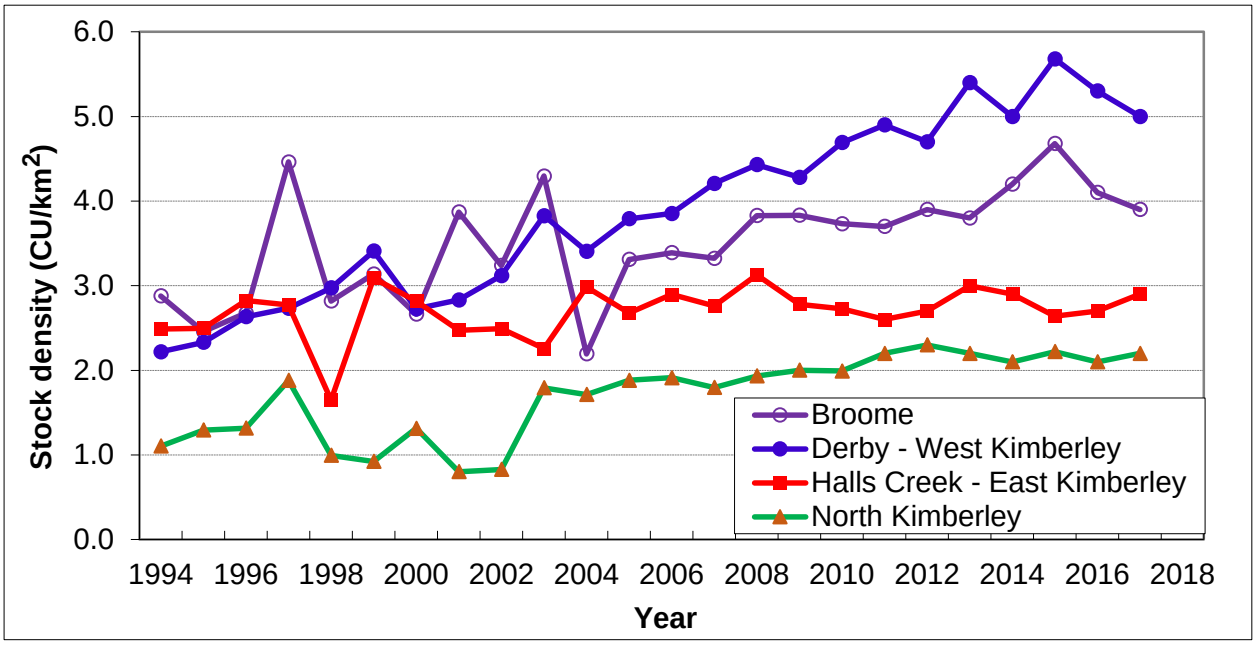


Figure 3.2 Mean reported livestock densities in the Kimberley LCDs, 1994–2017

Plant populations (on-ground data)

The frequency of desirable perennial grasses on WARMS sites averaged 77% between 2015 and 2017, with average frequencies indicating good to fair vegetation condition for all four LCDs (Figure B1, Table B1). Desirable grass frequency was stable (±5% change) between 2012 and 2017 (Table 3.1). While there have been significant fluctuations in desirable grass frequency since measurements began in 1994, frequency in 2015–17 has increased compared to 1994–96, except in the Broome LCD where it was unchanged (Table 3.1).

Table 3.1 Percentage change in the frequency of desirable perennial grasses in the Kimberley LCDs, 1994–2017

LCD	1994–96 to 1997–99 (%)	1997–99 to 2000–02 (%)	2000–02 to 2003–05 (%)	2003–05 to 2006–08 (%)	2006–08 to 2009–11 (%)	2009–11 to 2012–14 (%)	2012–14 to 2015–17 (%)	Overall change (%)
1 North Kimberley	–3	14	–8	4	2	–2	5	8
2 Halls Creek – East Kimberley	1	12	–2	5	–3	2	–1	14
3 Derby – West Kimberley	7	6	0	0	1	1	0	18
4 Broome	4	–9	–1	4	1	2	0	1

Vegetation cover (remotely sensed data)

The three most productive pasture types in the Kimberley are alluvial plains with tussock grass, cracking clays, and undulating hills with tussock grass.

Analysis of these pasture types using remotely sensed data showed the vegetation cover trend:

- increased on alluvial plains with tussock grass in Derby – West Kimberley and Broome LCDs
- decreased on cracking clays, and undulating hills with tussock grass in Halls Creek – East Kimberley LCD (Table C1 and Figures C1–C4).

Cover trend was stable elsewhere. Fire reduced vegetation cover in large areas of the Broome and North Kimberley LCDs.

Risk and threat of condition decline

Analysis of vegetation cover trend, seasonal quality and stocking rate showed pastures in the Derby – West Kimberley LCD were at high risk of vegetation condition decline (Figure 2.1). The Halls Creek – East Kimberley and Broome LCDs have a moderate risk, and the North Kimberly LCD is at low risk because the reported stocking rate is under the PCC.

There are also specific areas in individual LCDs where the most productive pasture types are considered at threat of vegetation condition decline (Section 2). About 14% (1 252 000ha) of the three most productive pasture types have been identified as threatened by ongoing grazing pressure.

Seasonal greenness response

Sections of the Halls Creek – East Kimberley and Derby – West Kimberley LCDs had below-average seasonal greenness in 2018 (Figure D1). Previously reported areas of the Fitzroy Valley and Sturt Creek with persistently low seasonal greenness over the period 2012–16 also showed below-average seasonal greenness in 2018 (Figure D3). Localised areas that now have persistently low greenness suggest either preferred grazing or a change to the soil surface which has changed the plant-available water.

3.2 Pilbara

Summary

Seasonal quality: 2017–18 summer rainfall was average or above average across the Pilbara and has been above average or average for 13 of the previous 20 years.

Vegetation condition in the four Pilbara LCDs was generally stable over the last six years. However, since 1994, there has been a significant decrease in desirable perennial grasses in the Ashburton LCD.

De Grey and East Pilbara LCDs were assessed as being at high risk of vegetation condition decline based on trend in vegetation cover, seasonal quality and average stocking rate.

Across the Pilbara, 12% (302 200ha) of the most productive pasture types are vulnerable to declining vegetation condition.

The upper Ashburton River Catchment in the Ashburton LCD has shown persistently low seasonal greenness over the past five years, indicating possible areas of preferred grazing or a change in the soil surface affecting plant-available water.

3.2.1 Background

The Pilbara is characterised by very hot summers, mild winters, and low and variable rainfall. Annual rainfall declines from 300–350mm in the north-east to less than 250mm in the south and west. Elevated areas in the Hamersley Ranges average more than 500mm. Rainfall is greatest during summer and autumn, and least during winter and spring.

Vegetation types are predominately grasslands in the north, and transition to shrublands in the south, with perennial grasses forming the productive resource base for the pastoral industry.

There are 62 pastoral stations covering 13 721 071ha in the Pilbara. The region is represented by four LCDs: De Grey (#5), Roebourne – Port Hedland (#6), East Pilbara (#7) and Ashburton (#8) (Figure 3.3).

Vegetation condition was 64% good, 24% fair and 12% poor when assessed by on-ground traversing between 2002 and 2009 (Table A1).

3.2.2 Trends

Seasonal condition

The 2017–18 summer rainfall was generally above average, though Ashburton and Roebourne LCDs were about 12% below average (Figures E1 and E3).

Seasons in the Pilbara are more variable than in the Kimberley, with 13 of the last 20 years above average or average; 2015–16 was the last below-average season.

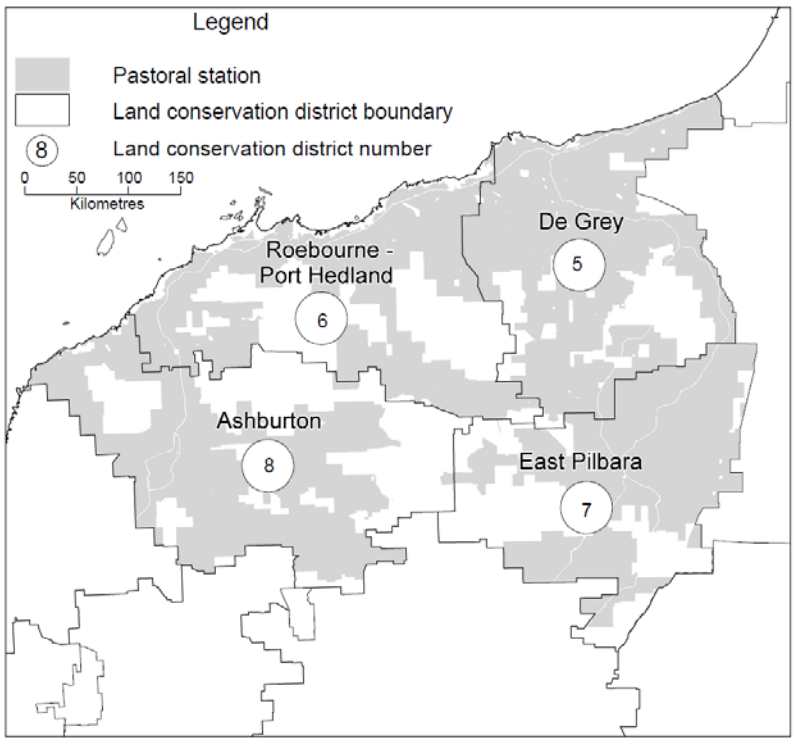


Figure 3.3 LCDs in the Pilbara

Livestock numbers

The PCC (defined in Appendix F) is estimated at:

- 2.2CU/km^2 for Roebourne – Port Hedland LCD
- 1.9CU/km^2 for Ashburton LCD
- 1.6CU/km^2 for De Grey LCD
- 1.4CU/km^2 for East Pilbara LCD (Figure 3.4).

The PCC for the Pilbara pastoral region is 252 180CU.

In 2017, pastoralists reported cattle numbers in the Pilbara to be 243 549, which is equivalent to 279 963CU. Livestock numbers were at or above the estimated PCC in all LCDs (Figure 3.4). These high stock numbers increase vulnerability to vegetation condition decline.

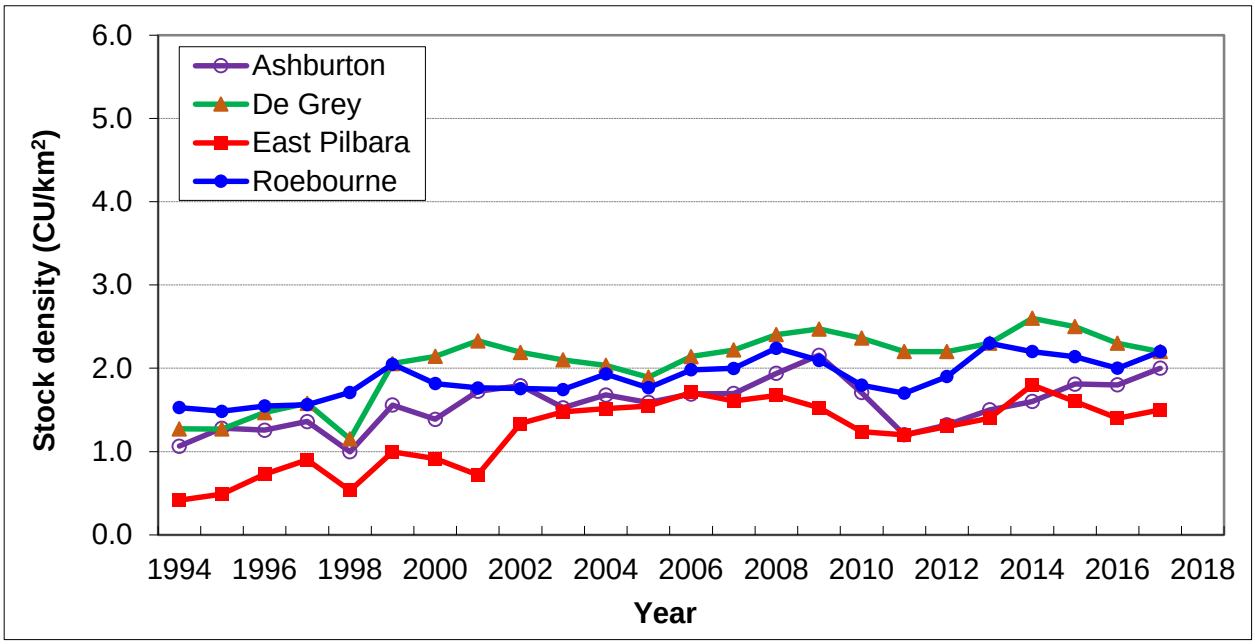


Figure 3.4 Mean reported livestock densities in the Pilbara LCDs, 1994–2017

Plant populations (on-ground data)

The frequency of desirable perennial grasses on WARMS sites in the Pilbara averaged 63% in 2015–17, with average frequencies indicating good vegetation condition in the De Grey LCD and fair vegetation condition in the Ashburton, East Pilbara and Roebourne – Port Hedland LCDs (Figure B2, Table B2). Frequency was stable (±5% change) between 2012 and 2017 (Table 3.2).

While there have been significant fluctuations in desirable grass frequency since measurements began, frequency in 2015–17 (Table 3.2) was:

- unchanged (±5%) in three LCDs compared to 1997–99 (2000–02 for the East Pilbara LCD)
- 22% less in the Ashburton LCD
- 20% less in the Lyndon LCD.

Table 3.2 Percentage change in the frequency of desirable perennial grasses in the Pilbara LCDs, 1994–2017

LCD	1994–96 to 1997–99 (%)	1997–99 to 2000–02 (%)	2000–02 to 2003–05 (%)	2003–05 to 2006–08 (%)	2006–08 to 2009–11 (%)	2009–11 to 2012–14 (%)	2012–14 to 2015–17 (%)	Overall change (%)
5 De Grey	n/a	8	–2	–3	–9	7	–2	–2[a]
6 Roebourne – Port Hedland	n/a	16	–20	9	–4	6	–3	–2[a]
7 East Pilbara	n/a	n/a	–3	–3	–6	18	2	5[b]
8 Ashburton	8	–5	n/a	n/a	–4	–7	2	–22[a]

n/a = not assessed

a Assessment from 1997–99 to 2015–17

b Assessment from 2000–02 to 2015–17

Vegetation cover (remotely sensed data)

The three most productive pasture types in the Pilbara are river plains with tussock grass, alluvial plains with tussock grass, and alluvial plains with shrubs.

Analysis of these pasture types using remotely sensed data showed the vegetation cover trend increased in all pasture types in the De Grey and East Pilbara LCDs (Table C2 and Figures C5–C8).

Cover trend decreased in Roebourne – Port Hedland LCD and was stable elsewhere.

Risk and threat of condition decline

Analysis of vegetation cover trend, seasonal quality and stocking rate showed pastures in the De Grey and East Pilbara LCDs have moderate risk of vegetation condition decline, and the other LCDs have low risk (Figure 2.1).

There are specific areas in individual LCDs where the most productive pasture types are considered at threat of vegetation condition decline (Section 2). About 12% (302 200ha) of the three most productive pasture types have been identified as threatened by ongoing grazing pressure.

Seasonal greenness response

Large areas of the Ashburton, East Pilbara and Roebourne – Port Hedland LCDs had below-average seasonal greenness in 2018 (Figure D1). Persistently low seasonal greenness in the upper Ashburton River Catchment of the Ashburton LCD (about 9% of the LCD) over the past five years indicates areas where vegetation condition is at risk of decline (Figure D3). Localised areas that now have persistently low greenness suggest either preferred grazing areas or a change to the soil surface which has changed the plant-available water.

3.3 Upper Southern Rangelands

Summary

Seasonal quality: 2017 winter rainfall was below average.

Change in vegetation condition in the four upper Southern Rangeland LCDs that were monitored between 2016 and 2018 was variable: two LCDs had improved vegetation condition, one was stable and one had declined, compared to 2010–15. Vegetation condition has generally declined since measurements began in 1994, except in the Wiluna LCD where condition has been stable.

Upper Gascoyne LCD was assessed as being at moderate risk of declining vegetation condition, with the remaining LCDs at low or very low risk based on trend in vegetation cover, seasonal quality and average stocking rate.

Across the upper Southern Rangeland LCDs, 0.3% (8300ha) of the most productive pasture types are identified as being at high threat, and 30% (977 500ha) at moderate threat of declining vegetation condition.

Most of the upper Southern Rangelands had below-average seasonal greenness in 2017. Areas of the Gascoyne–Wooramel, Upper Gascoyne, Gascoyne – Ashburton Headwaters and Meekatharra LCDs have had three to five seasons out of the last five years with below-average seasonal greenness.

3.3.1 Background

The Southern Rangelands are characterised by predominately winter rainfall, with average annual rainfall generally below 300mm. Rainfall is highly variable between and within years. Summer rainfall is greater in the upper Southern Rangelands compared to the lower Southern Rangelands, and constitutes a significant percentage of annual rainfall.

Typical vegetation types include mulga and chenopod shrublands. For pastures in good condition, shrubs, perennial grasses and forbs constitute the productive resource base for the pastoral industry. Where vegetation condition is degraded, ephemeral grasses and forbs replace perennial pasture species.

There are 109 pastoral stations covering 21 511 618ha in the upper Southern Rangelands. The region is represented by six LCDs: Gascoyne – Ashburton Headwaters (#9), Upper Gascoyne (#10), Wiluna (#11), Lyndon (#12), Gascoyne–Wooramel (#13) and Meekatharra (#16) (Figure 3.5).

Vegetation condition was 32% good, 39% fair and 29% poor when assessed by on-ground traversing between 2002 and 2009 (Table A2).

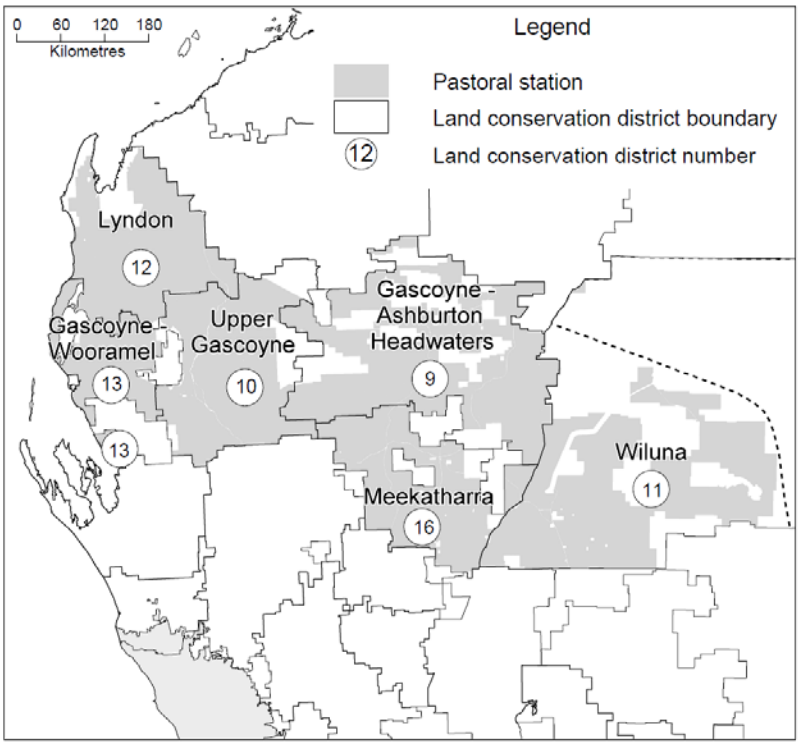


Figure 3.5 LCDs in the upper Southern Rangelands

3.3.2 Trends

Seasonal condition

Recent seasons have been variable, with a general trend to declining winter rainfall (Figure E3).

The 2017 winter rainfall in the upper Southern Rangelands was below average in all LCDs (Figure E2), ranging from 6% below average in the Wiluna LCD to 78% below average in the Upper Gascoyne LCD. Across the whole region, the 2017 winter rainfall averaged 39mm, compared to the long-term average of 102mm. While winter rainfall is important for shrub survival and recruitment, summer rainfall can benefit perennial grasses. Across the region the 2017–18 summer rainfall, although above average (150mm, compared to a long-term average of 118mm) was variable, with Wiluna, Gascoyne – Ashburton Headwaters, Upper Gascoyne and Meekatharra LCDs receiving above-average rainfall, while the Lyndon and Gascoyne–Wooramel LCDs only received about 50% of the summer average (115mm and 76mm, respectively) (Figure E1).

Livestock numbers

The PCC (defined in Appendix F) is estimated at:

- 1.9CU/km^2 for Gascoyne–Wooramel and Lyndon LCDs
- 1.0CU/km^2 for Upper Gascoyne LCD
- 0.9CU/km^2 for Gascoyne – Ashburton Headwaters and Meekatharra LCDs
- 0.8CU/km^2 for Wiluna LCD (Figure 3.6).

The PCC for the upper Southern Rangelands is 246 880CU.

In 2017, pastoralists in the upper Southern Rangelands reported cattle numbers to be 176 916 and sheep numbers to be 35 414, which together is equivalent to 209 489CU.

Reported livestock numbers were above the estimated PCC in the Upper Gascoyne LCD and below the PCC in the other LCDs (Figure 3.6).

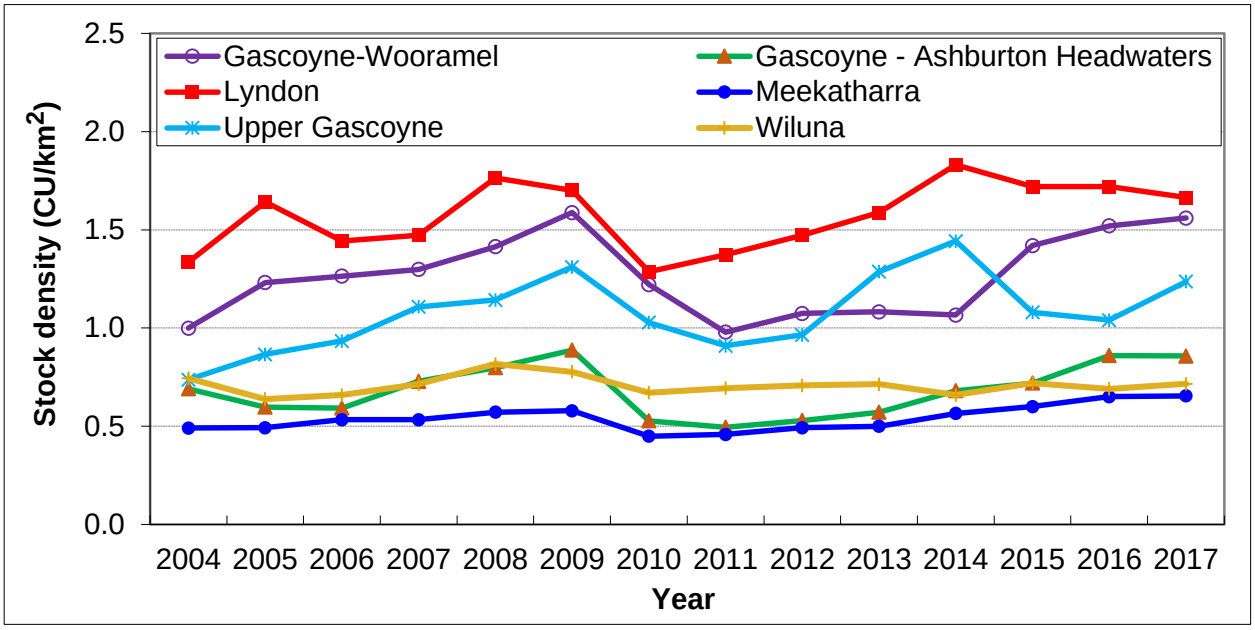


Figure 3.6 Mean reported livestock densities in the upper Southern Rangelands LCDs, 2004–2017

Plant populations (on-ground data)

WARMS assessment for the 2016–18 period is complete for four LCDs. These assessments show that since 2010–15, the density of desirable shrubs increased by 10% in the Gascoyne – Ashburton Headwaters and by 6% in the Wiluna LCD, decreased by 16% in the Lyndon LCD, and was stable (±5% change) in the Upper Gascoyne LCD (Table 3.3).

Desirable shrub density has decreased in all LCDs since measurements began in 1994, except in the Wiluna LCD where it was stable (Table 3.3, Figure B3).

Table 3.3 Percentage change in the density of desirable shrubs in the upper Southern Rangelands

LCD	Change in density (%)		
	1994–99 to 2010–15 or 2016–18	2005–10 to 2010–15	2010–15 to 2016–18
9 Gascoyne – Ashburton Headwaters	–31[a]	–32	10
10 Upper Gascoyne	–14[a]	–16	–5
11 Wiluna	–3[a]	–24	6
12 Lyndon	–38[a]	–29	–16
13 Gascoyne–Wooramel	–28	–25	n/a
16 Meekatharra	–49	–36	n/a
Upper Southern Rangelands	**–24**	**–27**	**n/a**

n/a = sites not yet reassessed

a The change in density of these sites is from 1994 to 2018.

Vegetation cover (remotely sensed data)

The three most productive pasture types in the upper Southern Rangelands are breakaways, alluvial plains, and pasture associated with saline alluvial plains and lake frontages.

Analysis of these pasture types using remotely sensed data showed the vegetation cover trend:

- increased on breakaways and alluvial plains in the Gascoyne – Ashburton Headwaters LCD
- increased on breakaways, alluvial plains, and saline alluvial plains and lake frontages in the Wiluna LCD
- decreased on alluvial plains in the Upper Gascoyne, Lyndon and Gascoyne–Wooramel LCDs (Table C3 and Figures C9–C11).

Cover trend was stable elsewhere.

Risk and threat of condition decline

Analysis of vegetation cover trend, seasonal quality and stocking rate showed pastures in the Upper Gascoyne LCD were assessed as being at moderate risk of vegetation condition decline, with the other LCDs at low or very low risk (Figure 2.1).

There are specific areas in individual LCDs where the most productive pasture types are considered at threat of vegetation condition decline (Section 2). About 0.3% (8300ha) of the most productive pasture types are identified as being at high threat and 30% (977 500ha) at moderate threat as threatened by ongoing grazing pressure.

Seasonal greenness response

Most of the upper Southern Rangelands had below-average seasonal greenness in 2017 (Figure D2). Poor seasonal greening in parts of the western Southern Rangelands in 2017 was a result of low winter rainfall, causing low biomass growth (Figure D2, Figure E2). The Gascoyne–Wooramel, Upper Gascoyne, western portion of Gascoyne – Ashburton Headwaters and Meekatharra LCDs have had three to five seasons out of the last five years with below-average seasonal greenness, suggesting vegetation condition is at risk of decline in these areas (Figure D4).

3.4 Lower Southern Rangelands

Summary

Seasonal quality: 2017 winter rainfall was below average and 2017–18 summer rainfall was above average.

Change in vegetation condition between 2005 and 2015 has been variable across the nine lower Southern Rangeland LCDs. The density of desirable shrubs increased in two LCDs, decreased in five LCDs, and was stable in two LCDs.

Based on trend in vegetation cover, seasonal quality and average stocking rate, the Yalgoo LCD was assessed as being at moderate risk of declining vegetation condition, with the remaining LCDs at low or very low risk.

Across the lower Southern Rangeland LCDs, 12% (1 175 000ha) of the most productive pasture types are identified as being at high risk of declining vegetation condition, predominantly in the Nullarbor – Eyre Highway and Yalgoo LCDs.

Most of the Cue, Mount Magnet, Murchison, Shark Bay, Yalgoo and western part of Sandstone LCDs had below-average seasonal greenness in 2017. Over the past five years, persistently below-average seasonal greenness was evident in areas of the Shark Bay, Murchison, Yalgoo and Cue LCDs.

3.4.1 Background

The Southern Rangelands are characterised by predominately winter rainfall, with average annual rainfall generally below 300mm. Rainfall is highly variable between and within years. Summer rainfall is highly variable and less significant compared to the upper Southern Rangelands.

Typical vegetation types include mulga and chenopod shrublands, open eucalypt woodlands, with areas of grasslands on the Nullarbor Plain. For pastures in good condition, shrubs, perennial grasses and forbs constitute the productive resource base for the pastoral industry. Where vegetation condition is degraded, ephemeral grasses and forbs replace perennial pasture species.

There are 175 pastoral stations covering 30 024 714ha in the lower Southern Rangelands. The region is represented by 13 LCDs (LCD numbers 14, 15, 17–27), 9 of which are reported here: Shark Bay (#14), Murchison (#15), Cue (#17), Mount Magnet (#18), Sandstone (#19), Yalgoo (#20), North-eastern Goldfields (#24), Kalgoorlie (#25) and Nullarbor – Eyre Highway (#27) (Figure 3.7). The Perenjori (#21), Binnu (#22), Mount Marshall (#23) and Yilgarn (#26) LCDs have only a small number of pastoral stations and are not included in the WARMS analyses for this report.

Vegetation condition was 39% good, 39% fair and 22% poor when assessed by on-ground traversing between 2001 and 2009 (Table A2).

3.4.2 Trends

Seasonal condition

The 2017 winter rainfall was below average in all LCDs, ranging from 31% below average in the Mount Magnet LCD to 63% below average in Shark Bay LCD (Figure E2). Across the whole region, the 2017 winter rainfall averaged 65mm, compared to the long-term average of 122mm. However, across the region the 2017–18 summer rainfall was above average (142mm, compared to a long-term average of 102mm), with the Murchison and Nullarbor – Eyre Highway LCDs receiving more than 75% above average (157mm and 188mm, respectively) (Figure E1).

Recent seasons have been variable, with a general trend to declining winter rainfall (Figure E3).

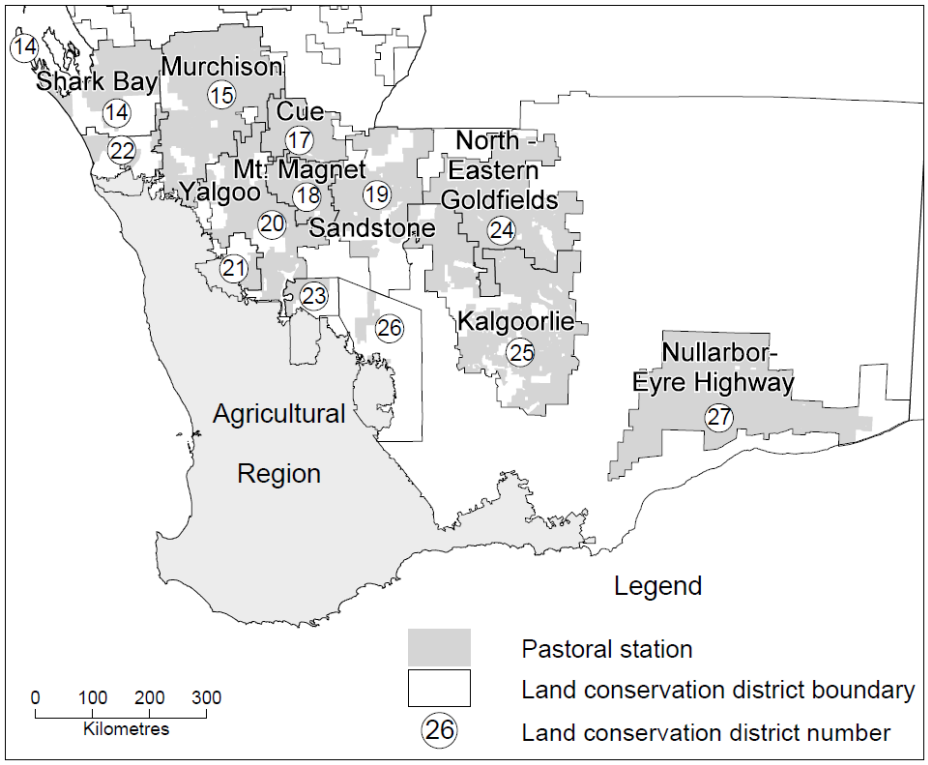


Figure 3.7 LCDs in the lower Southern Rangelands

Livestock numbers

The PCC (defined in Appendix F) is estimated at:

- 1.5CU/km^2 for Shark Bay LCD
- 1.1CU/km^2 for Mount Magnet and Murchison LCDs
- 1.0CU/km^2 for Cue and Nullarbor – Eyre Highway LCDs
- 0.9CU/km^2 for Kalgoorlie, Sandstone and Yalgoo LCDs
- 0.8CU/km^2 for North-eastern Goldfields LCD (Figure 3.8).

The PCC for the lower Southern Rangelands is 290 890CU.

In 2017, pastoralists reported cattle numbers to be 89 415 and sheep numbers to be 169 898, which together are equivalent to 132 393CU.

Reported livestock numbers were below the PCC in all LCDs (Figure 3.8).

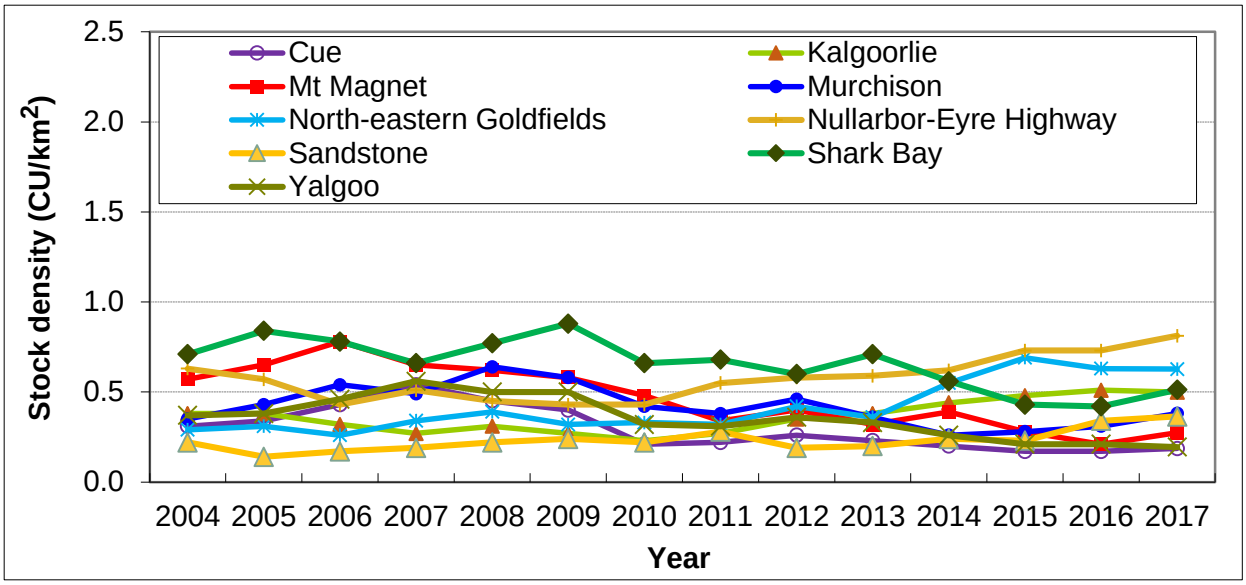


Figure 3.8 Mean reported livestock densities in the lower Southern Rangelands LCDs, 2004–2017

Plant populations (on-ground data)

WARMS assessment for the 2016–21 period is only complete for the North-eastern Goldfields LCD, where density of desirable shrubs increased by 7% since 2010–15 (Table 3.4). The last complete WARMS assessment period (2010–15) found the density of desirable shrubs increased in two LCDs, decreased in five LCDs and was stable (±5% change) in two LCDs. Since measurements began in 1994, the density of desirable shrubs has increased in three LCDs, was stable in one, and has decreased in five LCDs.

Table 3.4 Percentage change in the density of desirable shrubs in the lower Southern Rangelands

LCD	Change in density (%)		
	1994–99 to 2010–15 or 2016–18	2005–10 to 2010–15	2010–15 to 2016–18
14 Shark Bay	–37	–6	n/a
15 Murchison	–45	–14	n/a
17 Cue	–5	6	n/a
18 Mount Magnet	30	20	n/a
19 Sandstone	15	1	n/a
20 Yalgoo	–14	2	n/a
24 North-eastern Goldfields	23 [a]	–14	7
25 Kalgoorlie	–7	–9	n/a
27 Nullarbor – Eyre Highway	–21	–9	n/a
Lower Southern Rangelands	**–13**	**–7**	**n/a**

n/a = sites not yet reassessed

a The change in density of these sites is from 1994 to 2018.

Vegetation cover (remotely sensed data)

The four most productive pasture types in the lower Southern Rangelands are breakaways, alluvial plains, pasture associated with saline alluvial plains and lake frontages, and pearl bluebush plains.

Analysis of these pasture types using remotely sensed data showed the vegetation cover trend:

- decreased on breakaways in the Murchison and Yalgoo LCDs
- increased on breakaways in the Sandstone, North-eastern Goldfields and Kalgoorlie LCDs
- decreased on alluvial plains in the Shark Bay LCD
- increased on alluvial plains in the Sandstone, North-eastern Goldfields and Kalgoorlie LCDs
- decreased on saline alluvial plains and lake frontages in the Murchison and Yalgoo LCDs
- increased on saline alluvial plains and lake frontages in the North-eastern Goldfields, Kalgoorlie and Nullarbor – Eyre Highway LCDs
- increased on pearl bluebush plains in the Kalgoorlie and Nullarbor – Eyre Highway LCDs (Table C4 and Figures C12–C16).

Cover trend was stable elsewhere.

Risk and threat of condition decline

Analysis of vegetation cover trend, seasonal quality and stocking rate showed pastures in the Yalgoo LCD were at moderate risk of vegetation condition decline, with the other LCDs at low or very low risk (Figure 2.1).

There are specific areas in individual LCDs where the most productive pasture types are considered at threat (Section 2). About 12% (1 175 000ha) — predominantly in the Nullarbor – Eyre Highway and Yalgoo LCDs — of the three most productive pasture types have been identified as threatened by ongoing grazing pressure. In the Yalgoo LCD a ground inspection in 2017 found high levels of tree mortality and reduced tree canopy; DPIRD are investigating the cause of this decline.

Seasonal greenness response

Most of the Cue, Mount Magnet, Murchison, Shark Bay, Yalgoo and western part of Sandstone LCDs had below-average seasonal greenness in 2017 (Figure D2). Poor seasonal greening in parts of the western Southern Rangelands in 2017 was a result of low winter rainfall (Figure E2). Persistently below-average seasonal greenness during the past five years was evident in the north-eastern half of the Shark Bay LCD, much of the Murchison LCD, northern part of the Yalgoo LCD and into the Cue LCD (Figure D4). The persistently below-average seasonal greenness in the Nullarbor – Eyre Highway LCD is likely a result of fire.

4 Appendix A On-ground traverse assessment of vegetation condition

Estimates of vegetation condition used to be determined for each LCD from on-ground resource condition and inventory surveys carried out over the past 45 years. These statements of vegetation condition were regularly updated via a program of routine lease inspections, which involved assessing vegetation condition at one-kilometre intervals along traverses. This program ceased in 2009. Tables A1 and A2 show the vegetation condition in each LCD as determined during the last round of routine lease inspections.

Table A1 Vegetation condition of LCDs in the Northern Rangelands determined by lease inspection

LCD	Condition of traverse points			Period condition was determined
	Good (%)	Fair (%)	Poor (%)	
1 North Kimberley	52	43	5	2002–07
2 Halls Creek – East Kimberley	52	27	21	2003–09
3 Derby – West Kimberley	50	36	14	2003–09
4 Broome	64	29	7	2005–09
Kimberley (mean)	52	32	16	2002–09
5 De Grey	85	13	2	2002–08
6 Roebourne – Port Hedland	68	23	9	2002–09
7 East Pilbara	49	31	20	2002–08
8 Ashburton	55	30	15	2001–08
Pilbara (mean)	64	24	12	2001–09
Northern Rangelands (mean)	**57**	**29**	**14**	2001–09

Table A2 Vegetation condition of LCDs in the Southern Rangelands determined by lease inspection

LCD	Condition of traverse points			Period condition was determined
	Good (%)	Fair (%)	Poor (%)	
9 Gascoyne – Ashburton Headwaters	27	40	33	2002–09
10 Upper Gascoyne	11	34	55	2002–09
11 Wiluna	56	32	12	2001–08
12 Lyndon	47	33	20	2001–08
13 Gascoyne–Wooramel	29	50	21	2003–09
14 Shark Bay	30	54	16	2003–08
15 Murchison	18	42	40	2003–09
16 Meekatharra	21	45	34	2002–09
17 Cue	21	46	33	2003–08
18 Mount Magnet	29	47	24	2002–08
19 Sandstone	46	36	18	2001–08
20 Yalgoo	28	48	24	2002–08
21 Perenjori	81	18	1	2002–04
22 Binnu	72	8	20	2003
23 Mount Marshall	34	44	22	2005–06
24 North-eastern Goldfields	35	42	23	2001–09
25 Kalgoorlie	39	43	18	2002–09
26 Yilgarn	72	23	5	2003–07
27 Nullarbor – Eyre Highway	63	28	9	2005–07
Southern Rangelands (mean)	**36**	**39**	**25**	2001–09

5 Appendix B Plant population change analysis

WARMS provides information on vegetation condition in the pastoral rangelands at a regional or district scale. WARMS uses fixed sites on representative areas of pastoral land, with 633 grassland sites assessed in a three-year interval, and 989 shrubland sites assessed on a six-year interval.

Figure B1 shows the mean frequency of desirable perennial grasses for each assessment period in each LCD in the Kimberley. The frequency of desirable grasses ranges from 80% to 100% for vegetation in good condition, and 15% to 50% for vegetation in poor condition (Table B1).

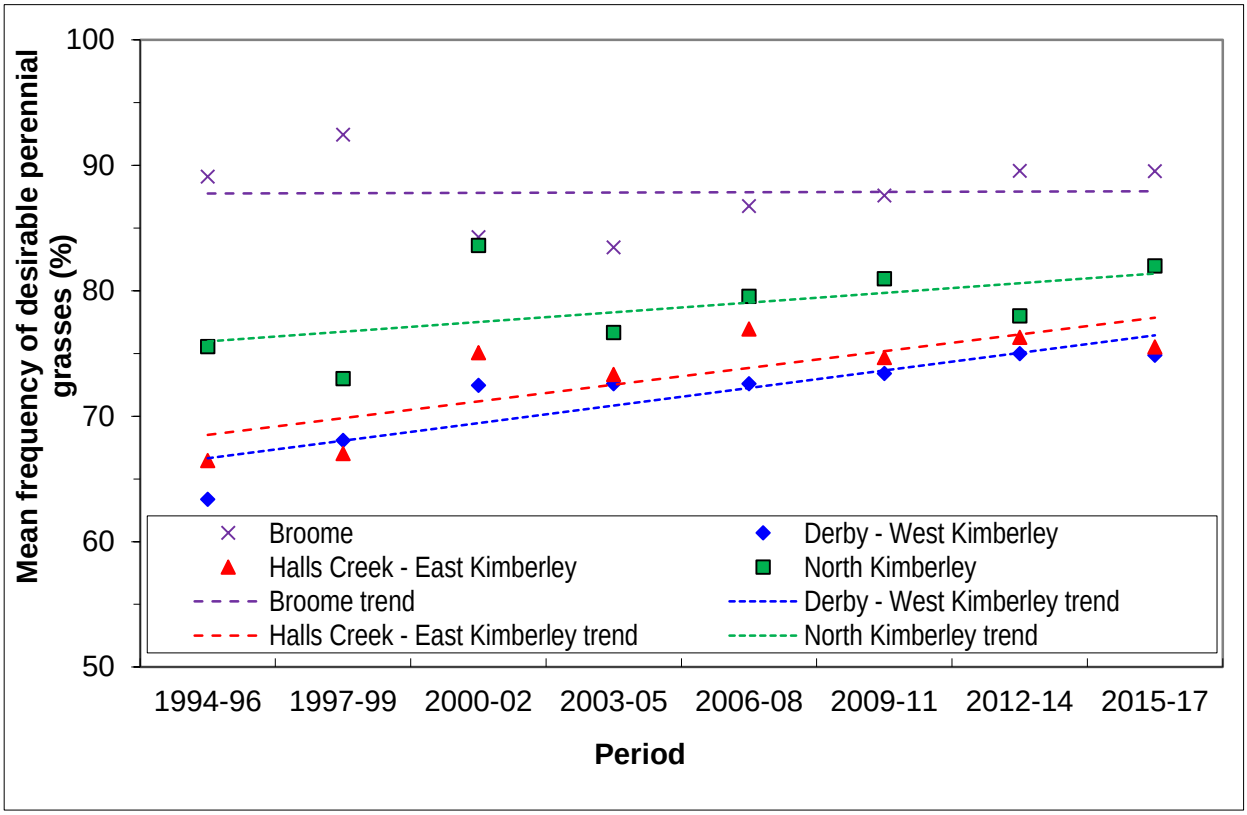


Figure B1 Mean frequency and trend line for desirable perennial grasses in the Kimberley LCDs, 1994–2017

Table B1 Typical range in frequency of desirable perennial grasses for vegetation condition classes in the Kimberley, based on WARMS data

LCD	Good condition (%)	Fair condition (%)	Poor condition (%)
1 North Kimberley	80–100	70–80	15–35[a]
2 Halls Creek – East Kimberley	90–100	65–80	35–50
3 Derby – West Kimberley	90–100	65–80	20–40
4 Broome	90–100	75–90	30–45[a]

a There are only a small number of WARMS sites in this LCD in the poor condition class to determine this range.

Figure B2 shows the mean frequency of desirable perennial grasses for each assessment period and LCD in the Pilbara. The frequency of desirable perennial grasses ranges between 65% and 100% for vegetation in good condition, and 10% to 30% for vegetation in poor condition (Table B2).

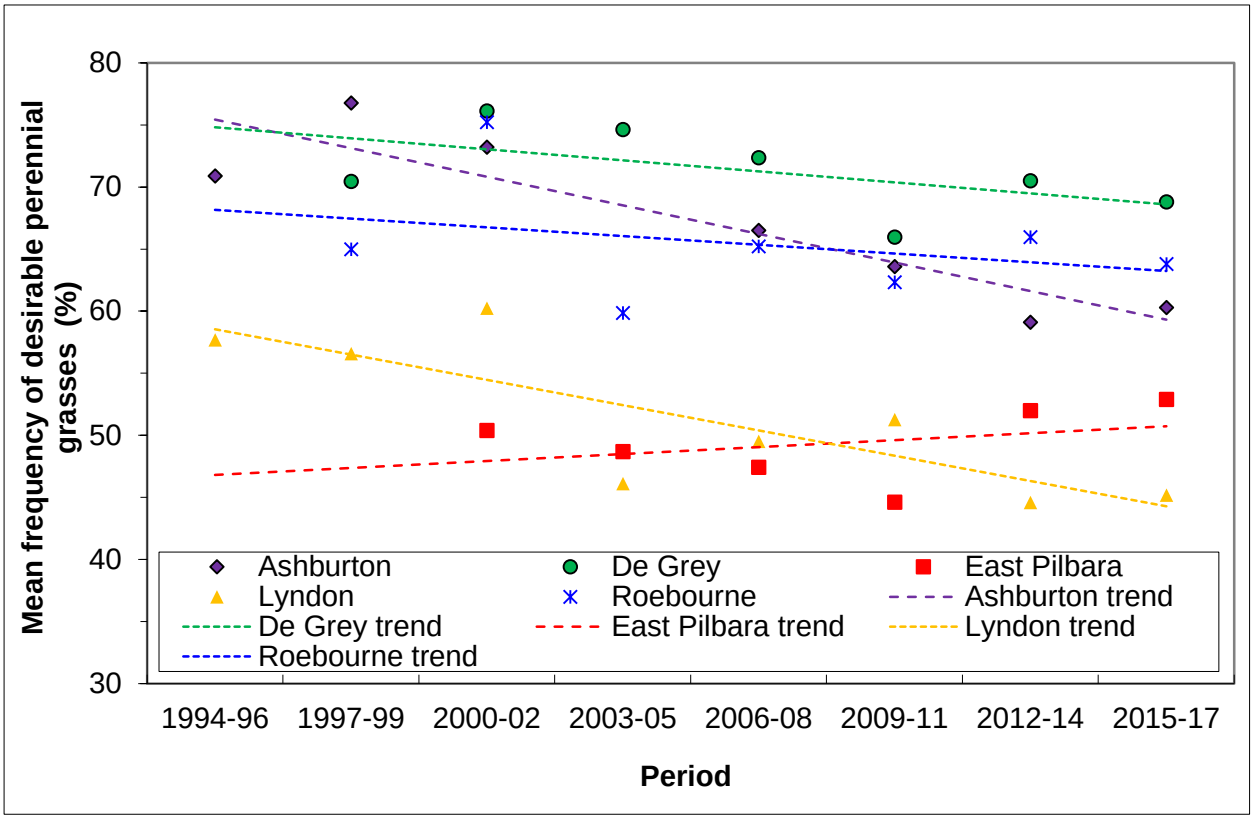


Figure B2 Mean frequency and trend line for desirable perennial grasses in the Pilbara LCDs, 1994–2017

Table B2 Typical range in frequency of desirable perennial grasses for vegetation condition classes in the Pilbara, based on WARMS data

LCD	Good condition (%)	Fair condition (%)	Poor condition (%)
5 De Grey	75–100	45–70	15–30[a]
6 Roebourne – Port Hedland	70–100	40–60	15–30[a]
7 East Pilbara	65–100	30–50	10–20[a]
8 Ashburton	65–100	45–65	15–30[a]

a There are only a small number of WARMS sites in this LCD in the poor condition class to determine this range.

Note: While Lyndon LCD has grassland and shrubland sites in a transition zone between the Pilbara and Southern Rangelands, there were not enough sites to reliably determine frequency for each condition class.

Figures B3 and B4 show the mean density of desirable shrubs for each assessment period and LCD in the upper and lower Southern Rangelands, respectively.

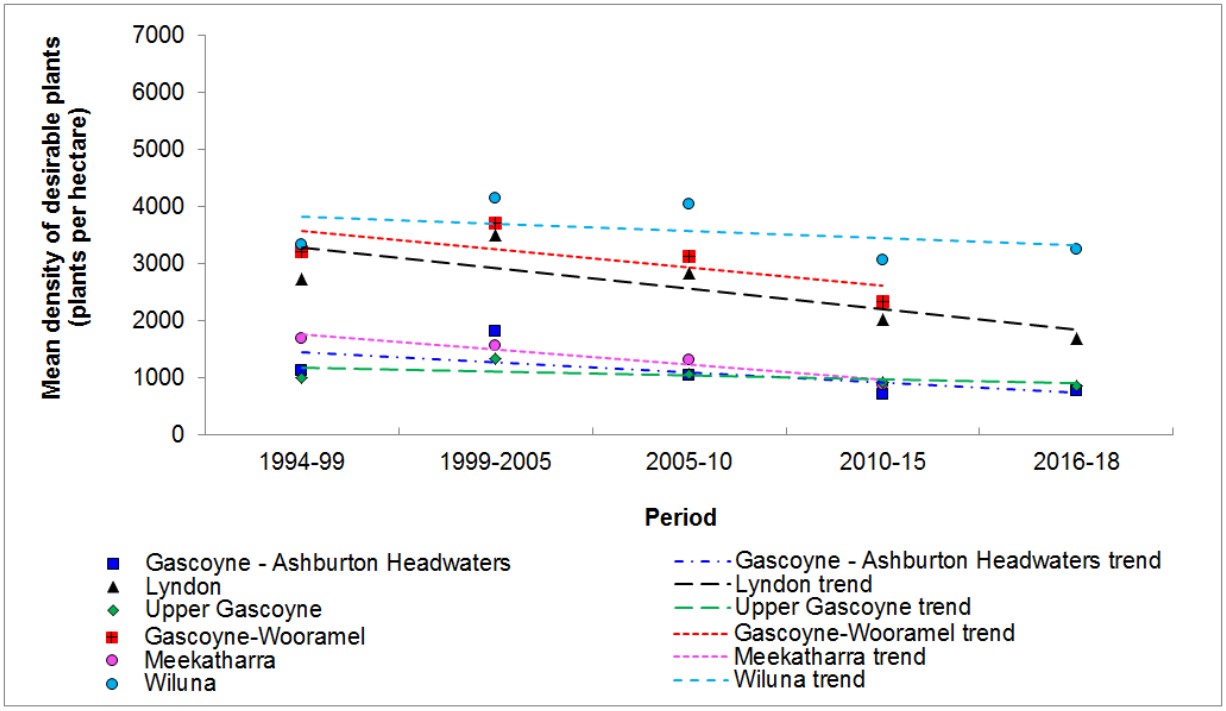


Figure B3 Mean density and trend line for desirable shrubs in the upper Southern Rangelands between 1994 and 2015 or 2018

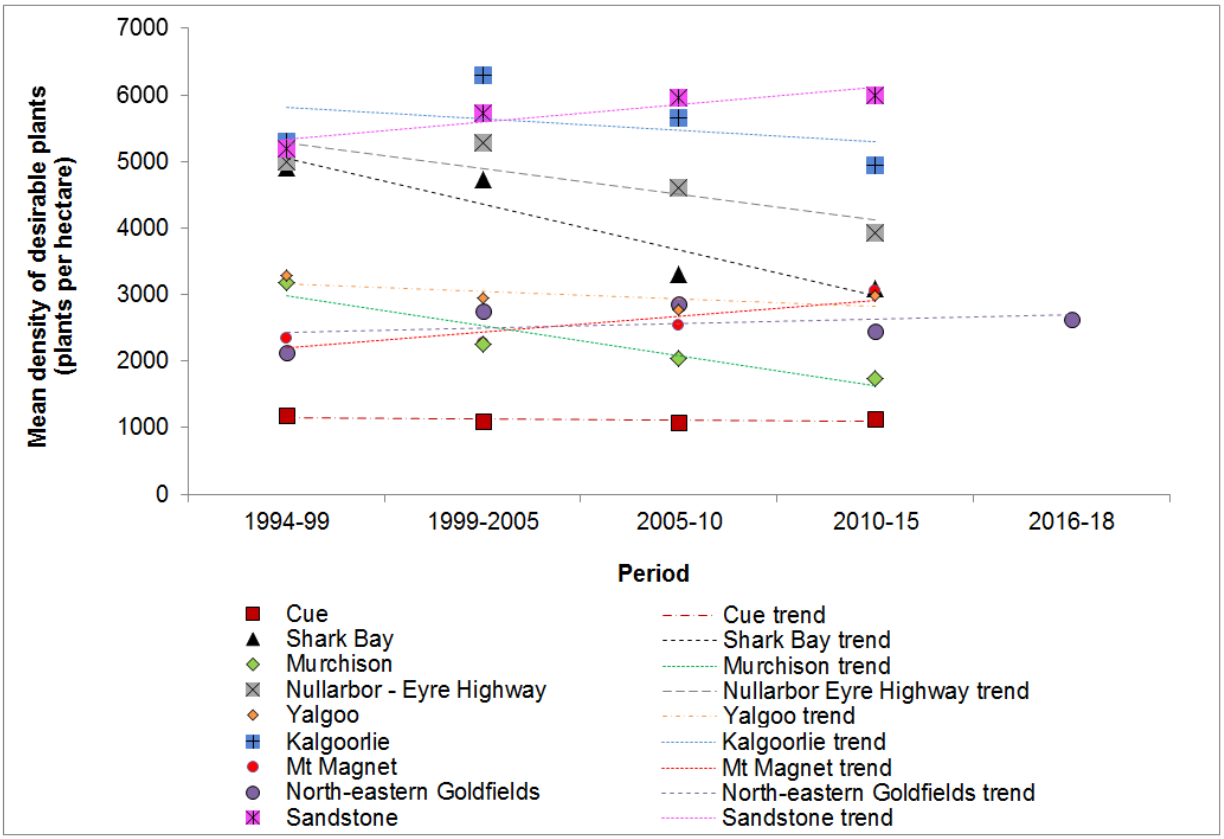


Figure B4 Mean density and trend line for desirable shrubs in the lower Southern Rangelands between 1994 and 2015 or 2018

6 Appendix C Vegetation cover, 2008–18

Remotely sensed data were used to estimate vegetation cover since 2008 for the most productive pasture types in each region. Three pasture types were analysed in the Kimberley, Pilbara and upper Southern Rangelands, and four were analysed in the lower Southern Rangelands to account for the wide extent of pearl bluebush plains in the Nullarbor – Eyre Highway LCD.

Trend lines were fitted to the vegetation cover data for each pasture type (Tables C1–C4 and Figures C1–C3, C5–C7, C9–C11 and C13–C16).

Where the slope of the trend line is more than one standard deviation greater or less than the mean slope, vegetation cover is considered to have significantly increased or decreased, respectively. This trend class is mapped for the three most productive pasture types (Figures C4, C8 and C12).

Kimberley

Table C1 Change and trend in vegetation cover in Kimberley LCDs, 2008–18

LCD	Alluvial plains with tussock grass		Undulating hills with tussock grass		Cracking clays	
	Cover change (%)	Trend	Cover change (%)	Trend	Cover change (%)	Trend
1 North Kimberley	na	na	–1	no	–1	no
2 Halls Creek – East Kimberley	–1	no	–3	dec.	–2	dec.
3 Derby – West Kimberley	4	inc.	1	no	1	no
4 Broome	10	inc.	na	na	na	na

na = not applicable because the vegetation type does not occur in the LCD; inc. = positive cover trend; dec. = negative cover trend; no = no trend

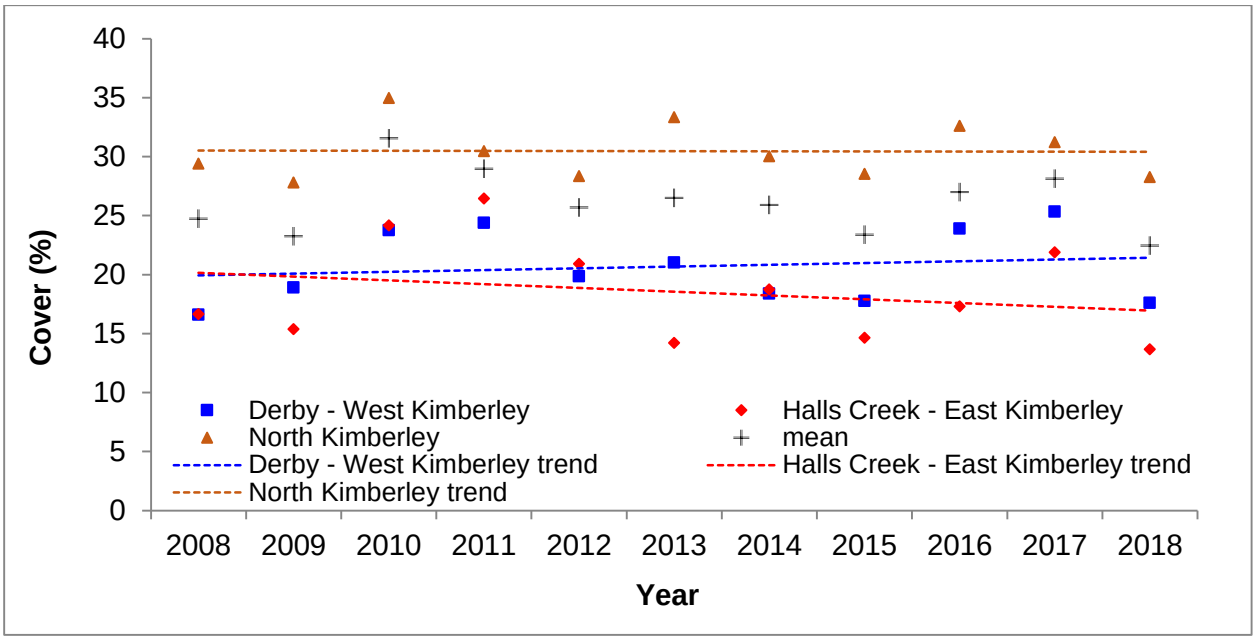


Figure C1 Vegetation cover and trend of undulating tussock grass woodland pasture type in Kimberley LCDs, 2008–18

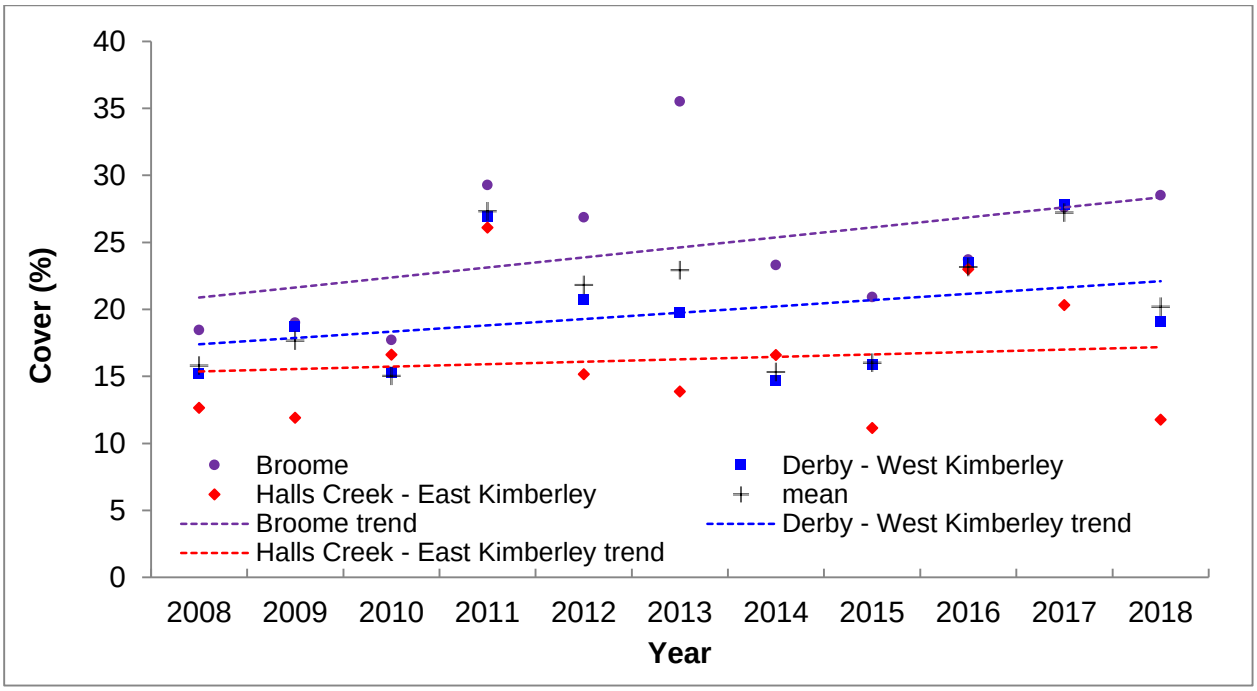


Figure C2 Vegetation cover and trend of alluvial plains with tussock grass pasture type in Kimberley LCDs, 2008–18

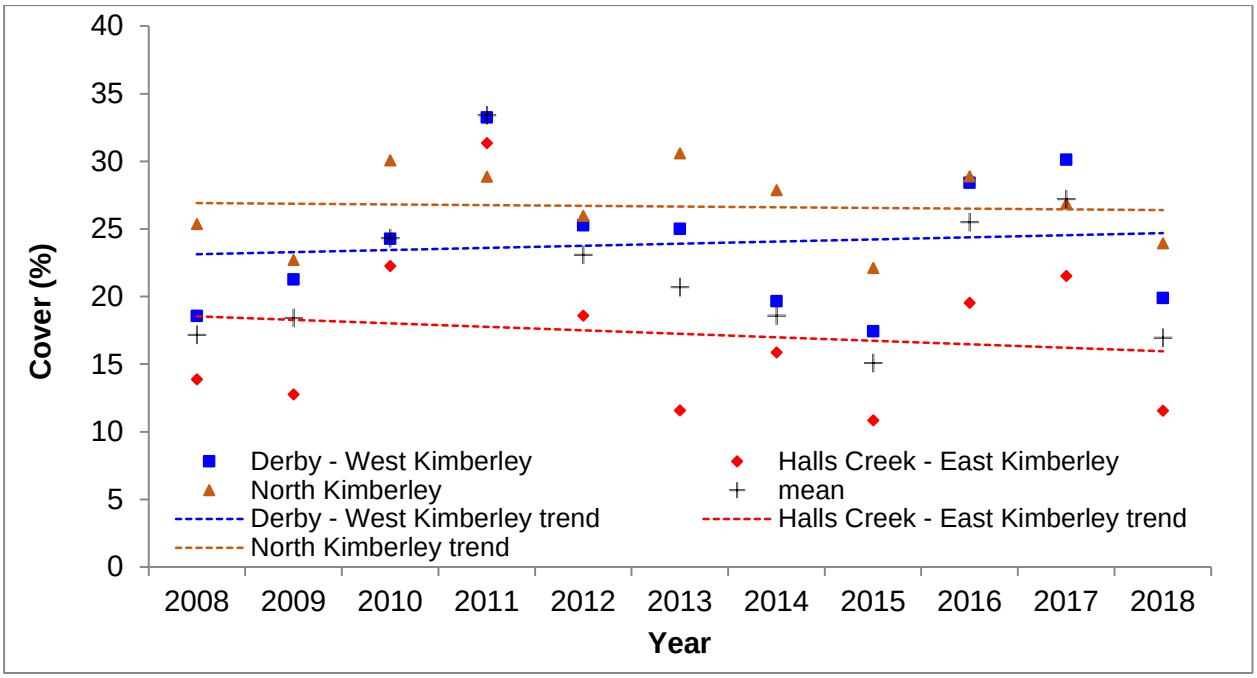
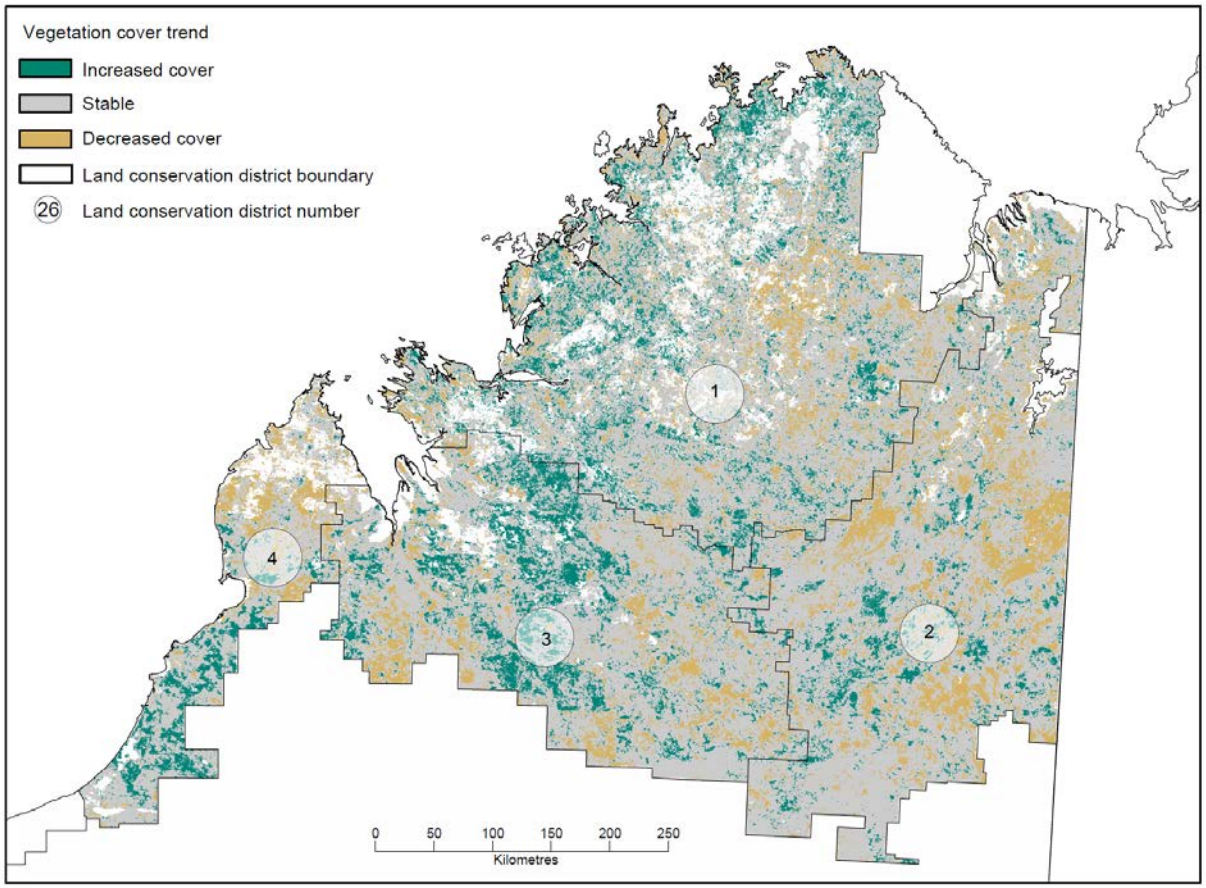


Figure C3 Vegetation cover and trend of cracking clay tussock grass pasture type in Kimberley LCDs, 2008–18



Note: Green indicates vegetation cover was above the regional mean trend, grey is the regional mean trend, and orange is below the regional mean trend between 2009 and 2018. Areas that experienced six or more years of fire were excluded.

Figure C4 Trend in vegetation cover relative to the mean cover in the Kimberley, 2009–18

Pilbara

Table C2 Change and trend in vegetation cover in Pilbara LCDs, 2008–18

LCD	River plains with tussock grass		Alluvial plains with tussock grass		Alluvial plains with shrubs	
	Cover change (%)	Trend	Cover change (%)	Trend	Cover change (%)	Trend
5 De Grey	5	inc.	6	inc.	4	inc.
6 Roebourne – Port Hedland	–2	no	–4	no	–4	dec.
7 East Pilbara	0	inc.	1	inc.	3	inc.
8 Ashburton	–11	no	–9	no	–7	no

inc. = positive cover trend; dec. = negative cover trend; no = no trend

Note: Rainfall on 25 May 2015 may have influenced vegetation cover across parts of the Pilbara.

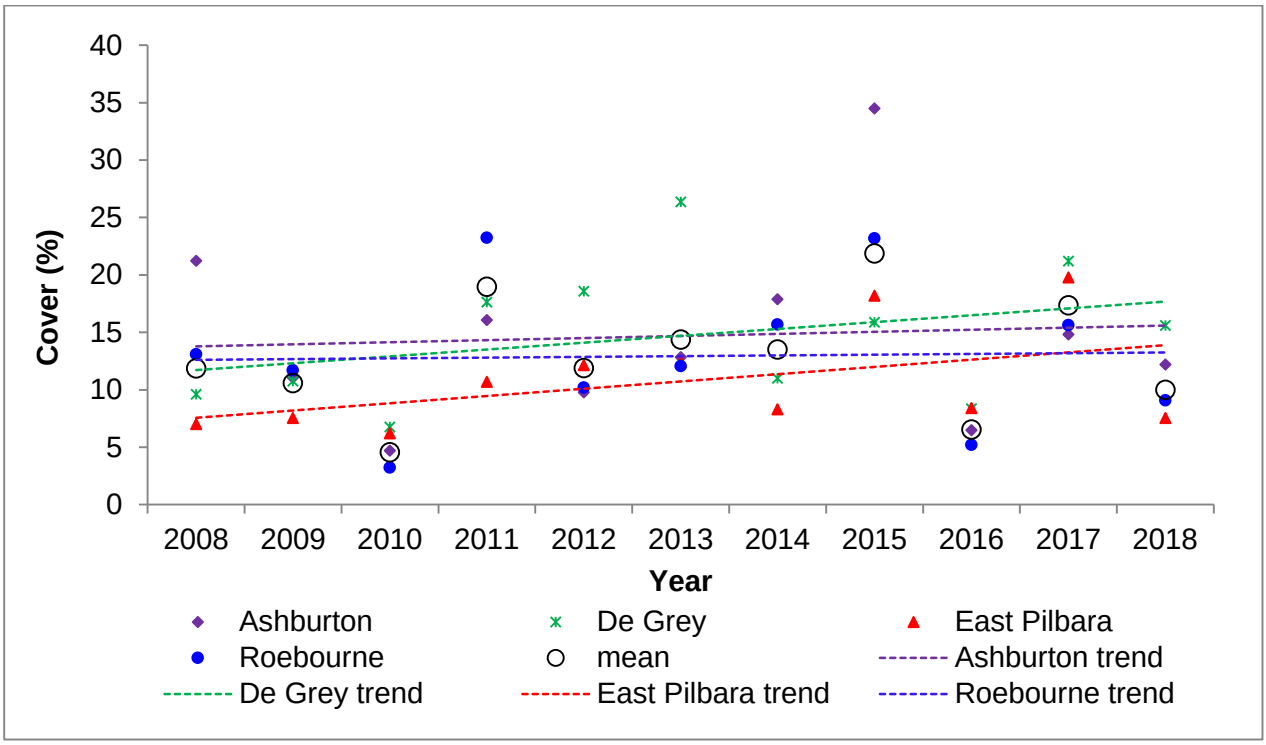


Figure C5 Vegetation cover and trend for alluvial plains with tussock grass pasture type in Pilbara LCDs, 2008–18

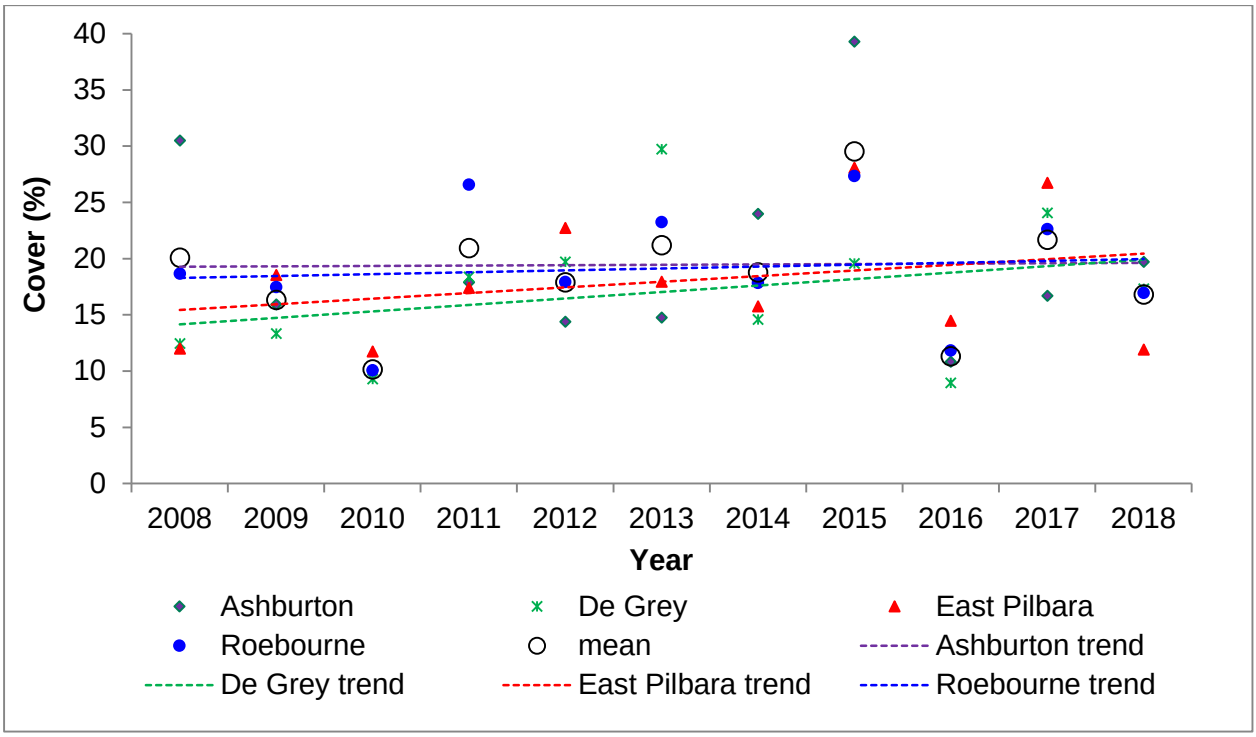


Figure C6 Vegetation cover and trend for river plains with tussock grass pasture type in Pilbara LCDs, 2008–18

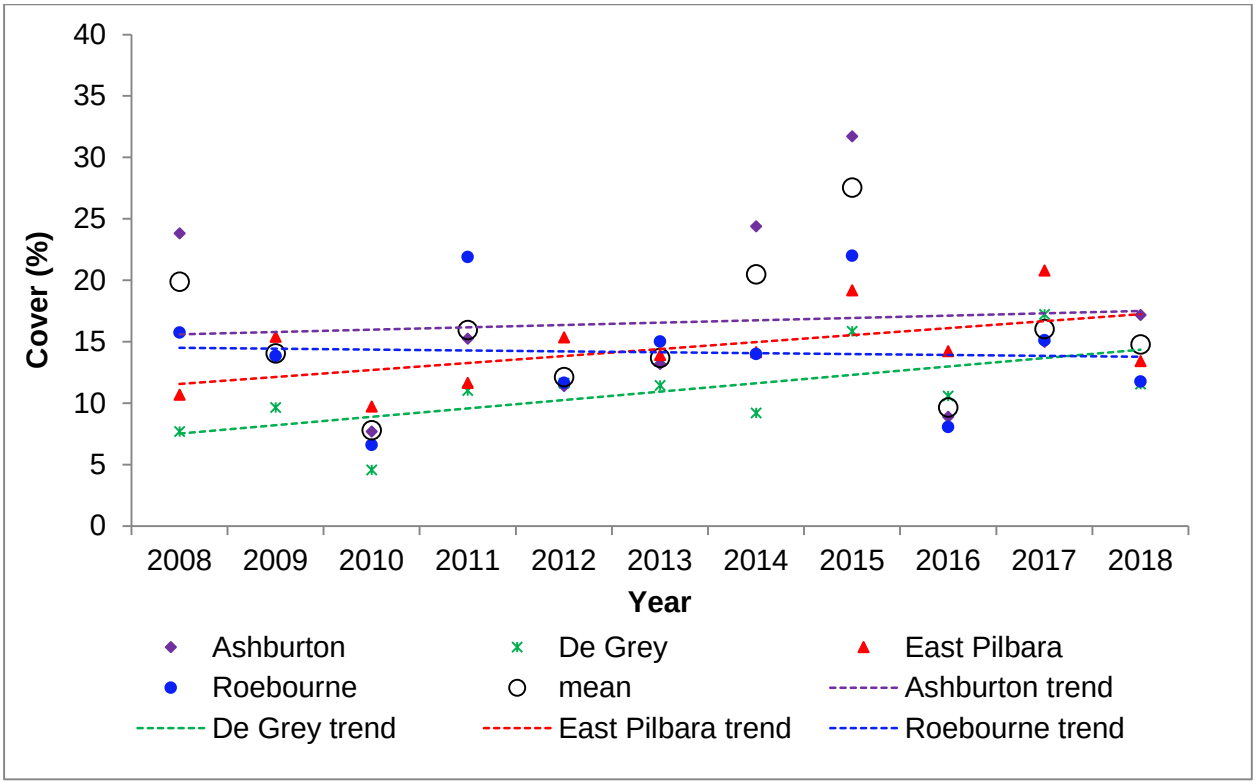
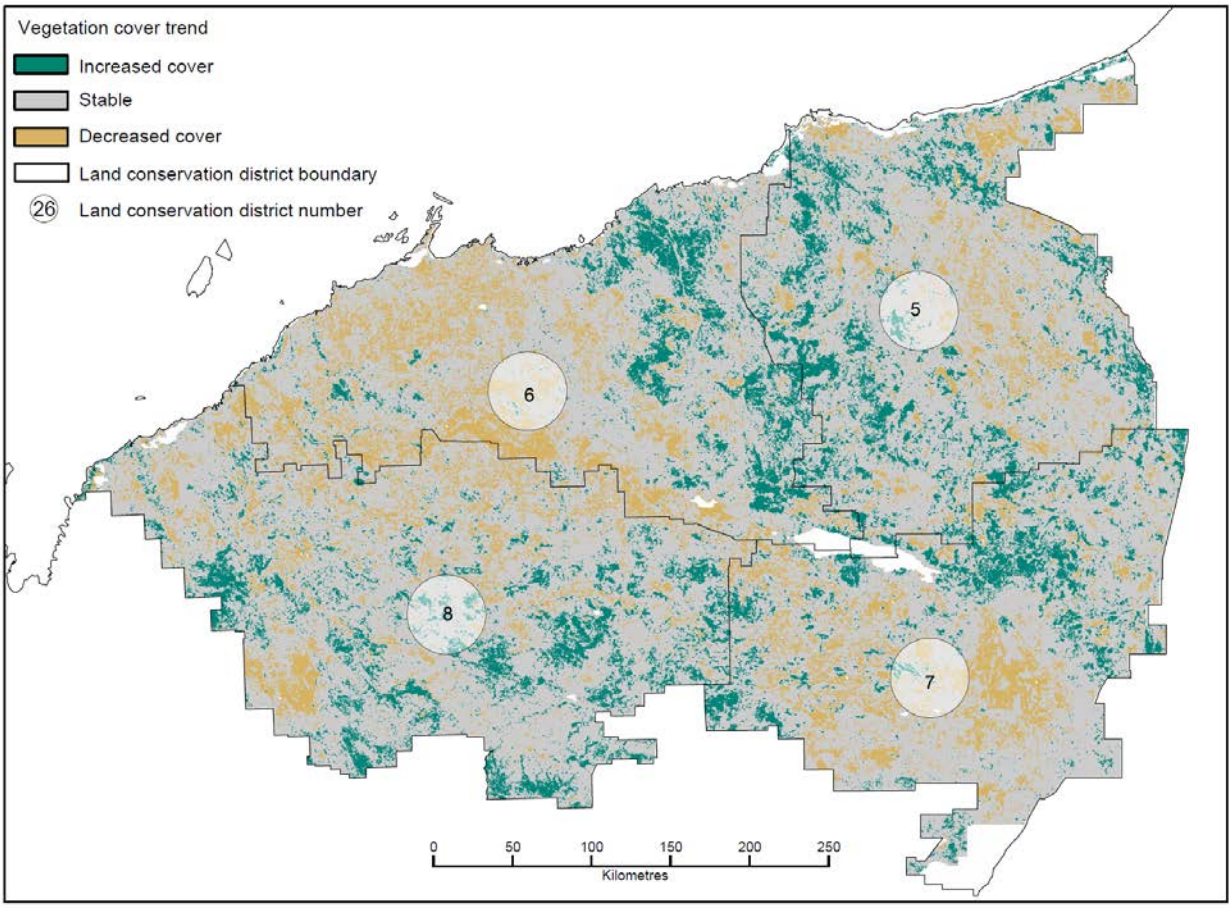


Figure C7 Vegetation cover and trend for alluvial plains with tussock grass and shrubs pasture type in Pilbara LCDs, 2008–18



Note: Green indicates vegetation cover was above the regional mean trend, grey is the regional mean trend, and orange is below the regional mean trend between 2009 and 2018. Areas that experienced six or more years of fire were excluded.

Figure C8 Trend in vegetation cover relative to the mean cover in the Pilbara, 2009–18

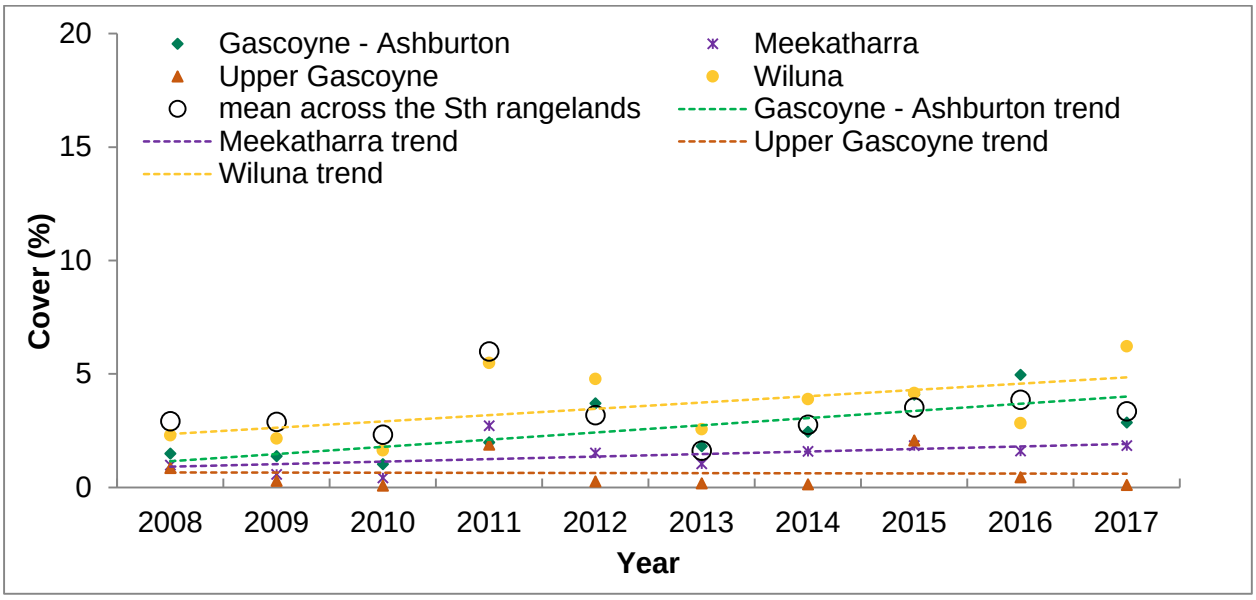
Upper Southern Rangelands

Vegetation cover trend analysis in the Southern Rangelands was based on imagery captured around day 289 (October) each year. At the time of analysis, available data dictated the trend analysis for the Southern Rangelands was for the period 2008 to 2017.

Table C3 Change and trend in vegetation cover in upper Southern Rangelands LCDs, 2008–2017

LCD	Breakaways		Alluvial plains		Salt lakes	
	Cover change (%)	Trend	Cover change (%)	Trend	Cover change (%)	Trend
9 Gascoyne – Ashburton Headwaters	1	inc.	1	inc.	na	na
10 Upper Gascoyne	–1	no	–5	dec.	na	na
11 Wiluna	4	inc.	4	inc.	3	inc.
12 Lyndon	na	na	–6	dec.	na	na
13 Gascoyne–Wooramel	na	na	–9	dec.	na	na
16 Meekatharra	1	no	–2	no	0	no

na = not applicable because the vegetation type does not occur in the LCD; inc. = positive cover trend; dec. = negative cover trend; no = no trend



Note: Rainfall on 5–6 October 2017 may have influenced vegetation cover in eastern parts of the Wiluna LCD

Figure C9 Vegetation cover for the breakaway and stony plains with halophytic shrubs pasture type in upper Southern Rangelands LCDs, 2008–17

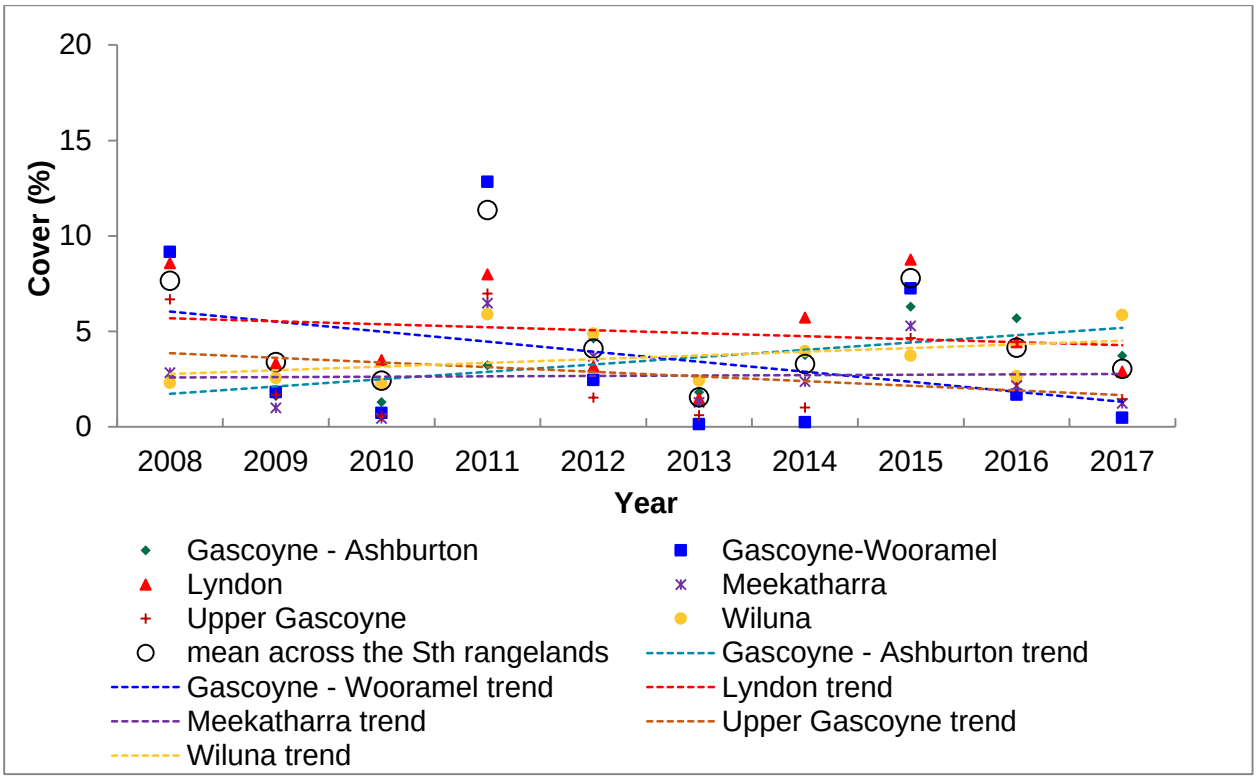


Figure C10 Vegetation cover and trend for alluvial plains with halophytic shrubs pasture type in upper Southern Rangelands LCDs, 2008–17

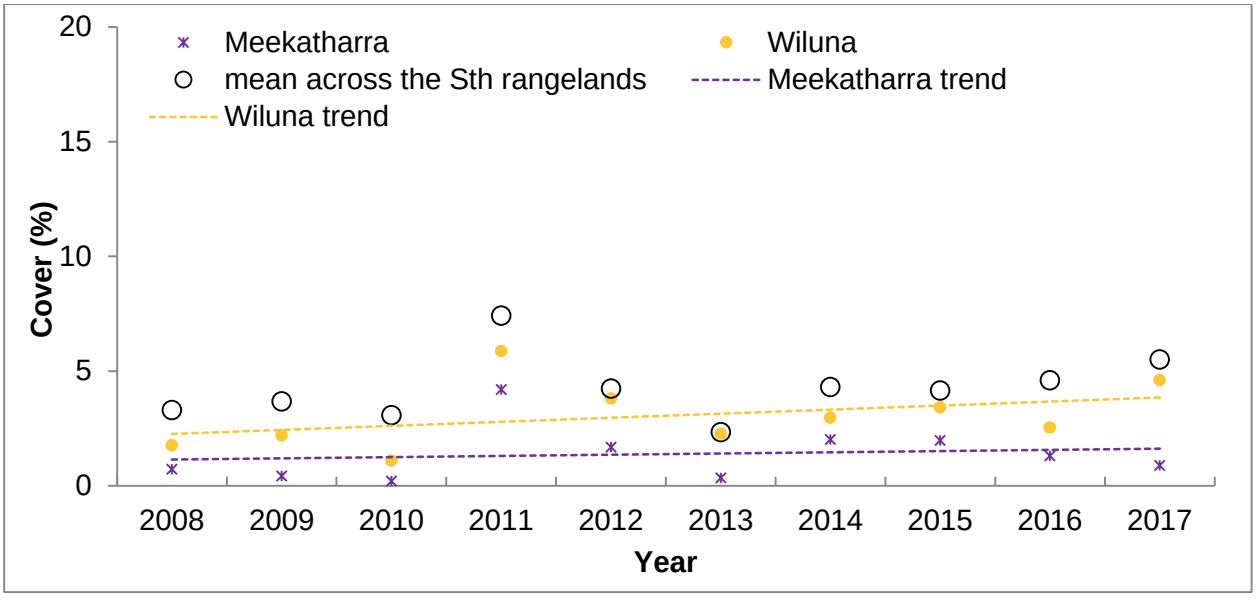
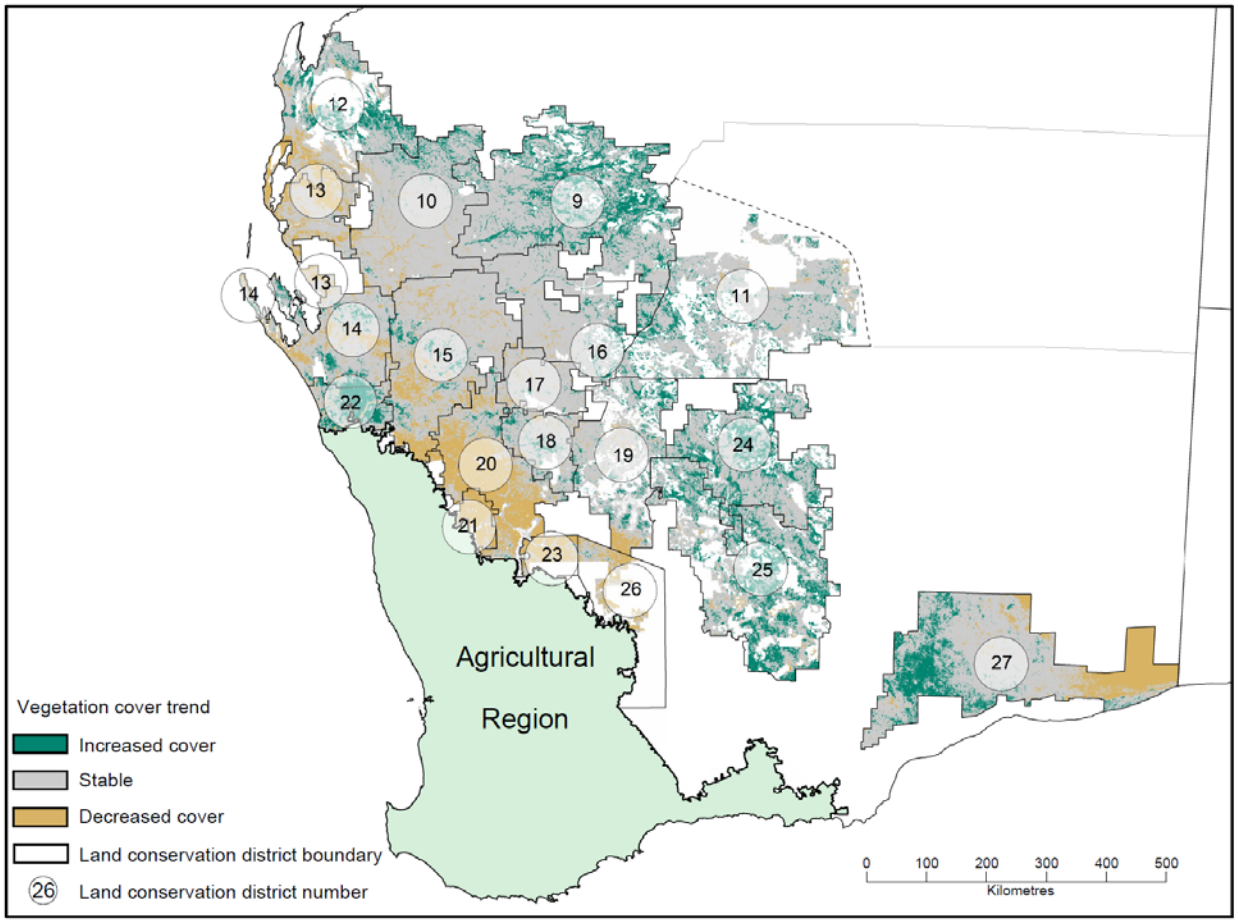


Figure C11 Vegetation cover and trend for lake frontage and saline vegetation pasture type in upper Southern Rangelands LCDs, 2008–17



Note: Green indicates vegetation cover was above the regional mean trend, grey is the regional mean trend, and orange is below the regional mean trend between 2008 and 2017.

Figure C12 Trend in vegetation cover relative to the mean cover in the Southern Rangelands, 2008–17

Lower Southern Rangelands

Table C4 Change and trend in vegetation cover in lower Southern Rangelands LCDs, 2008–2017

LCD	Breakaways		Alluvial plains		Salt lakes		Pearl bluebush plains	
	Cover change (%)	Trend	Cover change (%)	Trend	Cover change (%)	Trend	Cover change (%)	Trend
14 Shark Bay	na	na	–8	dec.	na	na	na	na
15 Murchison	–1	dec.	–2	no	–4	dec.	na	na
17 Cue	0	no	na	na	0	no	na	na
18 Mt Magnet	2	no	1	no	1	no	na	na
19 Sandstone	3	inc.	2	inc.	3	no	na	na
20 Yalgoo	–6	dec.	–6	dec.	–6	dec.	na	na
24 North-eastern Goldfields	5	inc.	6	inc.	6	inc.	na	na
25 Kalgoorlie	7	inc.	4	inc.	5	inc.	4	inc.
27 Nullarbor – Eyre Highway	na	na	na	na	7	inc.	6	inc.

na = not applicable because the vegetation type does not occur in the LCD; inc. = positive cover trend; dec. = negative cover trend; no = no trend

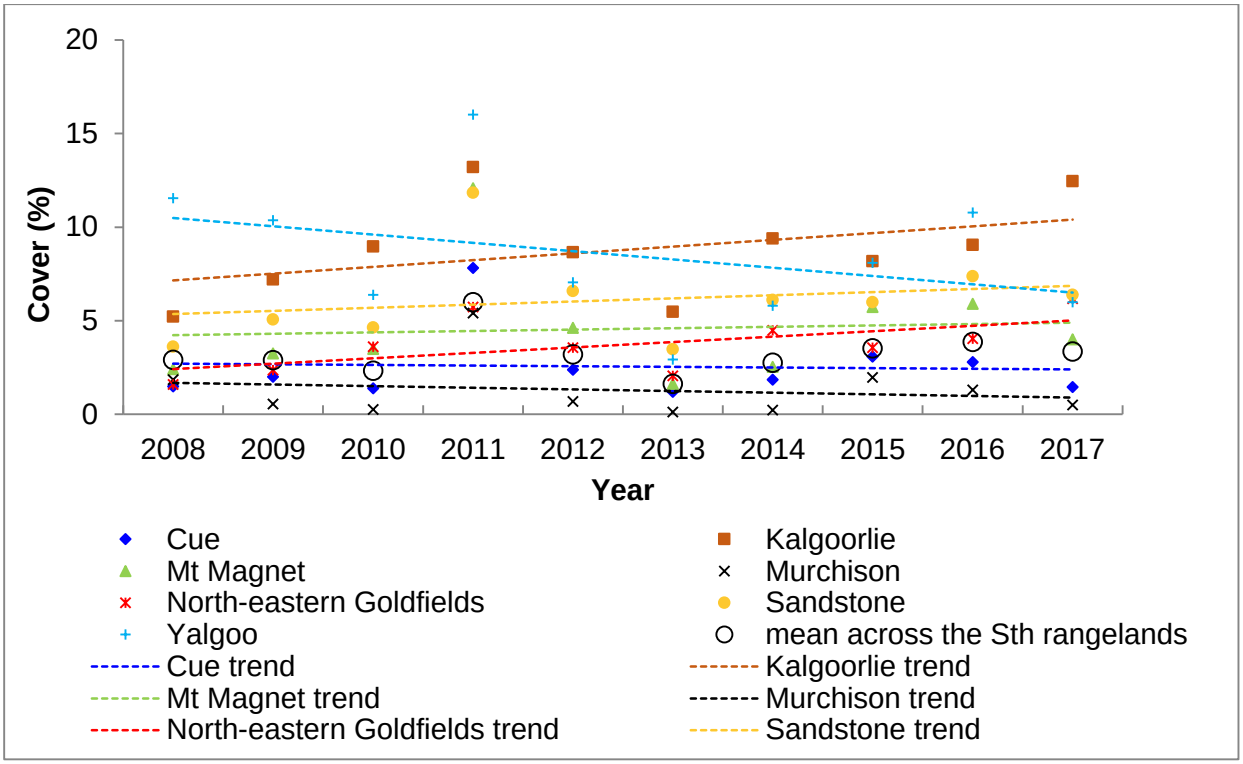


Figure C13 Vegetation cover and trend for breakaways and stony plains with halophytic shrubs pasture type in lower Southern Rangelands LCDs, 2008–17

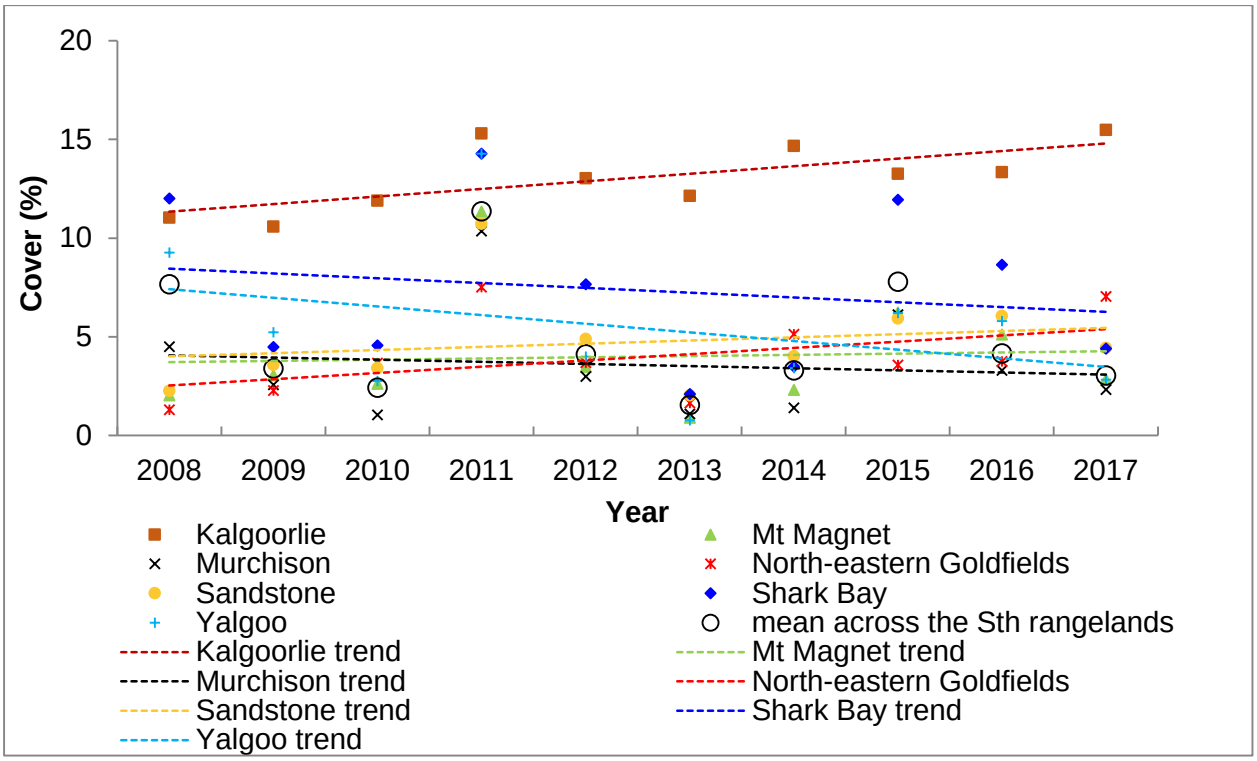


Figure C14 Vegetation cover and trend for alluvial plains with halophytic shrubs pasture type in lower Southern Rangelands LCDs, 2008–17

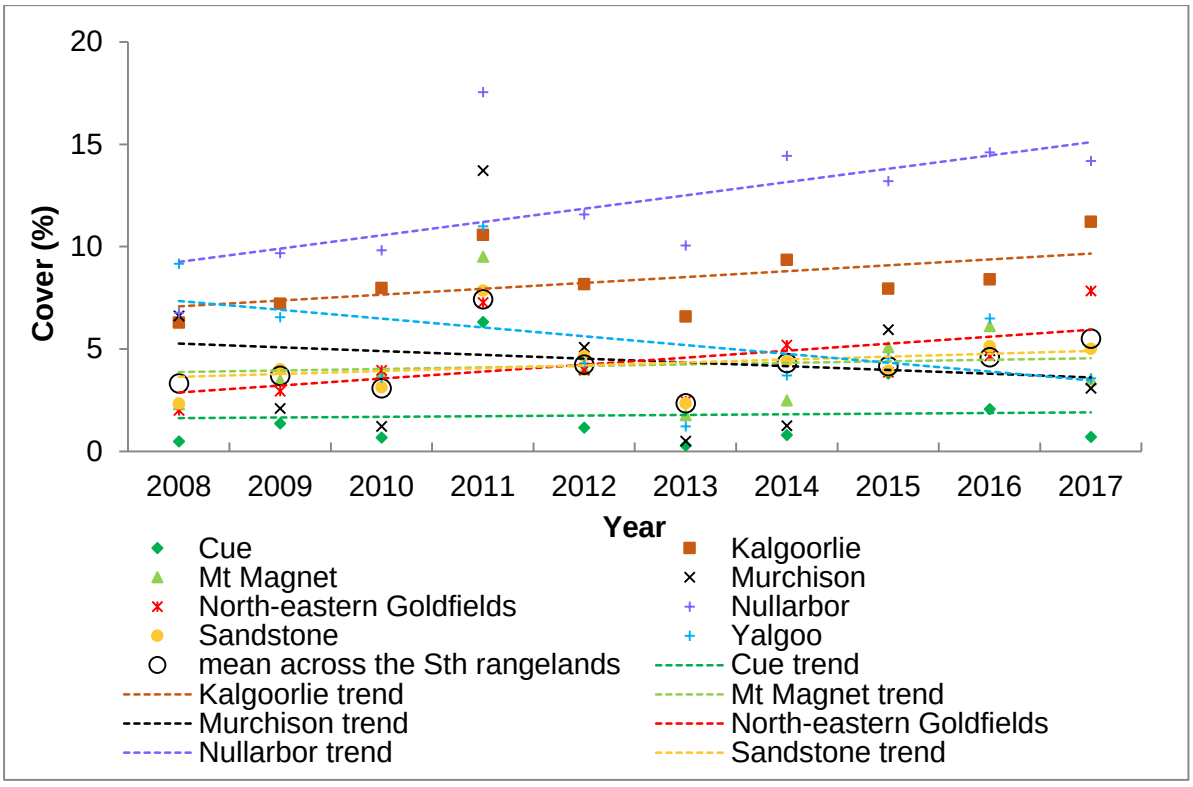


Figure C15 Vegetation cover and trend for lake frontage and saline vegetation pasture type in lower Southern Rangelands LCDs, 2008–17

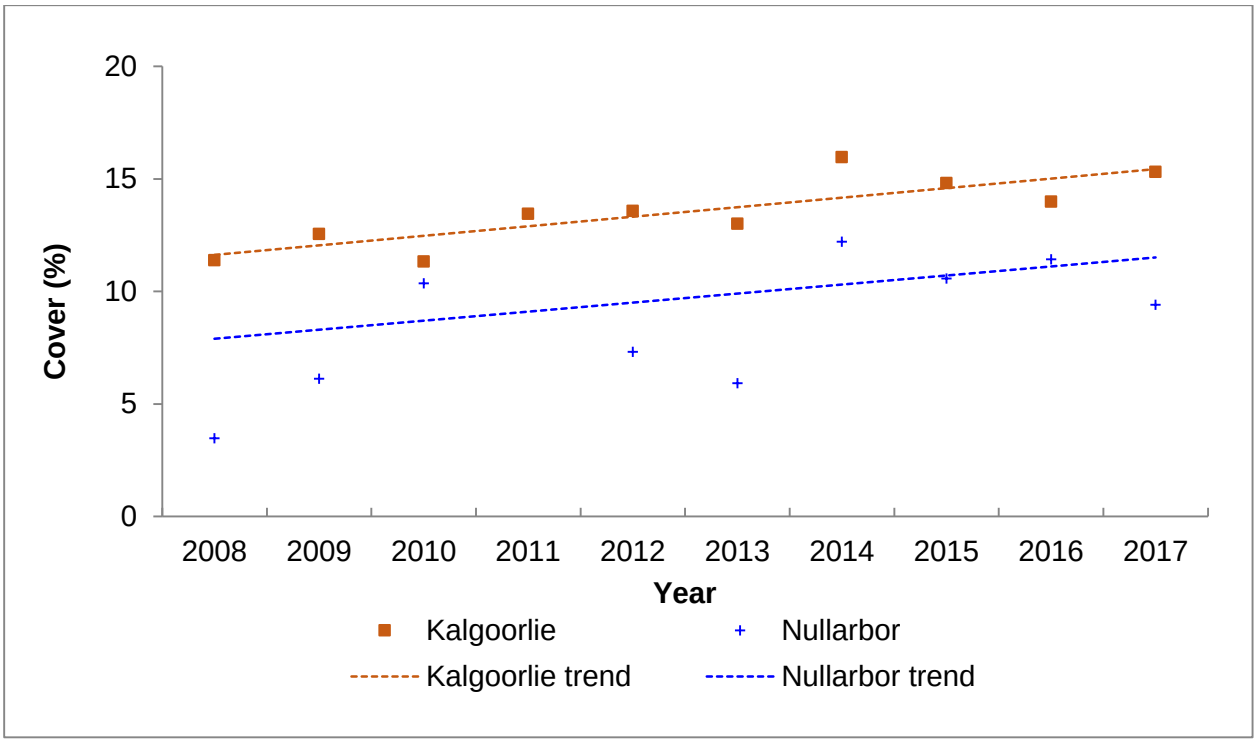


Figure C16 Vegetation cover and trend for pearl bluebush plains vegetation pasture type in lower Southern Rangelands LCDs, 2008–17

7 Appendix D Seasonal vegetation greenness

Vegetation greenness data from the MODIS NDVI were used to assess how much vegetation grew or 'greened up' (seasonal greenness) during each growing season for the period 2004 to 2017–18. This provides an indication of seasonal effectiveness — in terms of the timeliness and amount of rainfall — and the ability of the pasture to use the rainfall.

The seasonal greenness is determined by:

- calculating the green flush for each pixel (image resolution 250m by 250m) for each year (i.e. the maximum NDVI value minus the minimum NDVI value for that year)
- calculating the maximum green flush that pixel has had since 2004 (note: the very wet year 2011 was excluded because NDVI values were outside the normal range)
- expressing the green flush each year as a percentage of the maximum green flush value (2004 to 2017–18). For example, the green flush of a pixel was 10 units in 2017 and the maximum green flush for that pixel is 20 units; therefore, the seasonal greenness in 2017 is 50%.

Seasonal greenness is classed as above average for values greater than 65%, average for values of 45–64%, below average for values of 20–44%, and well below average for values of 1–19%.

NDVI analysis is based on calendar year in the Southern Rangelands, and from July to June in the Northern Rangelands.

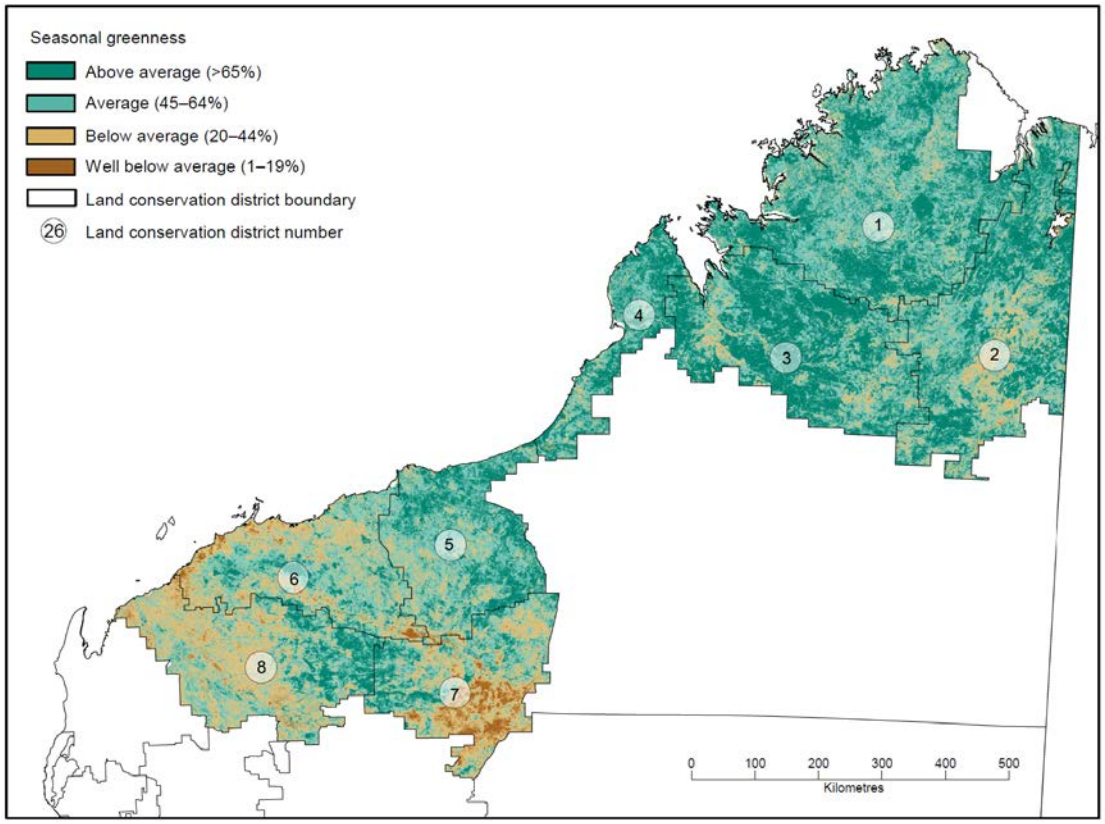


Figure D1 Seasonal greenness in 2017–18 in the Northern Rangelands, based on MODIS NDVI

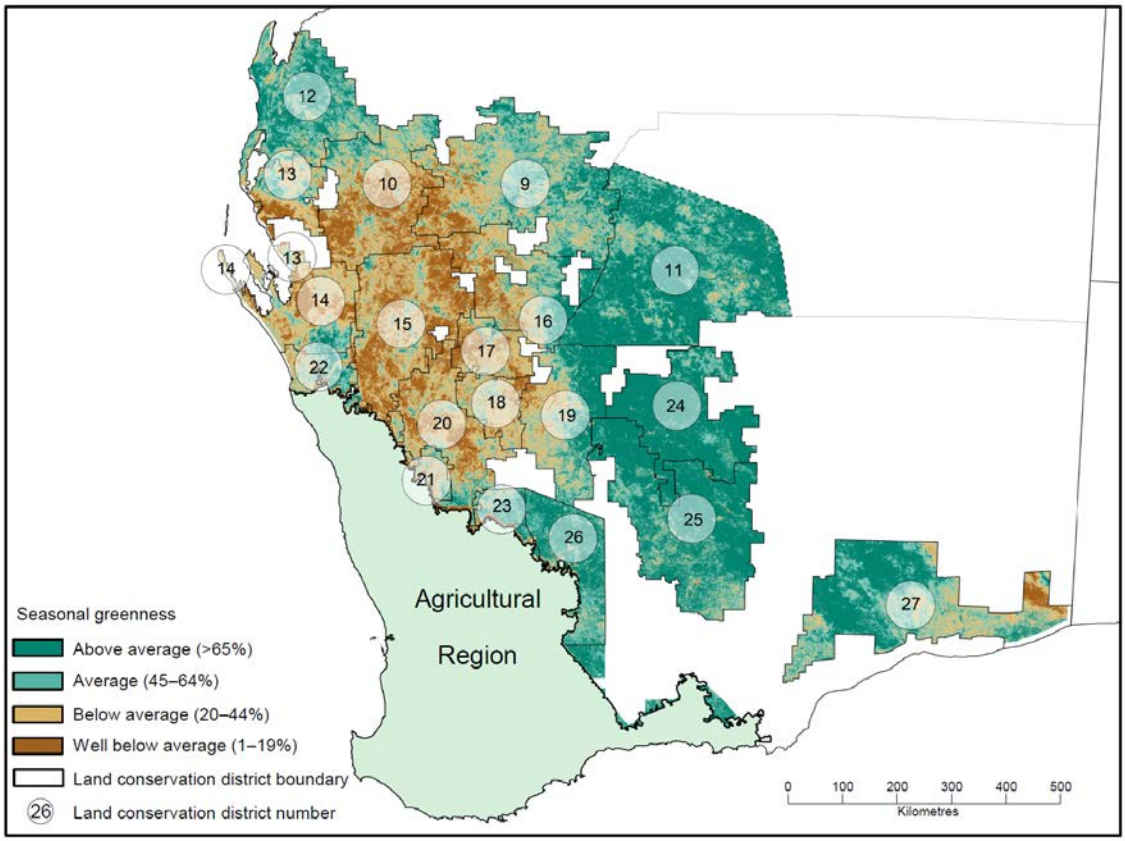


Figure D2 Seasonal greenness in 2017 in the Southern Rangelands, based on MODIS NDVI

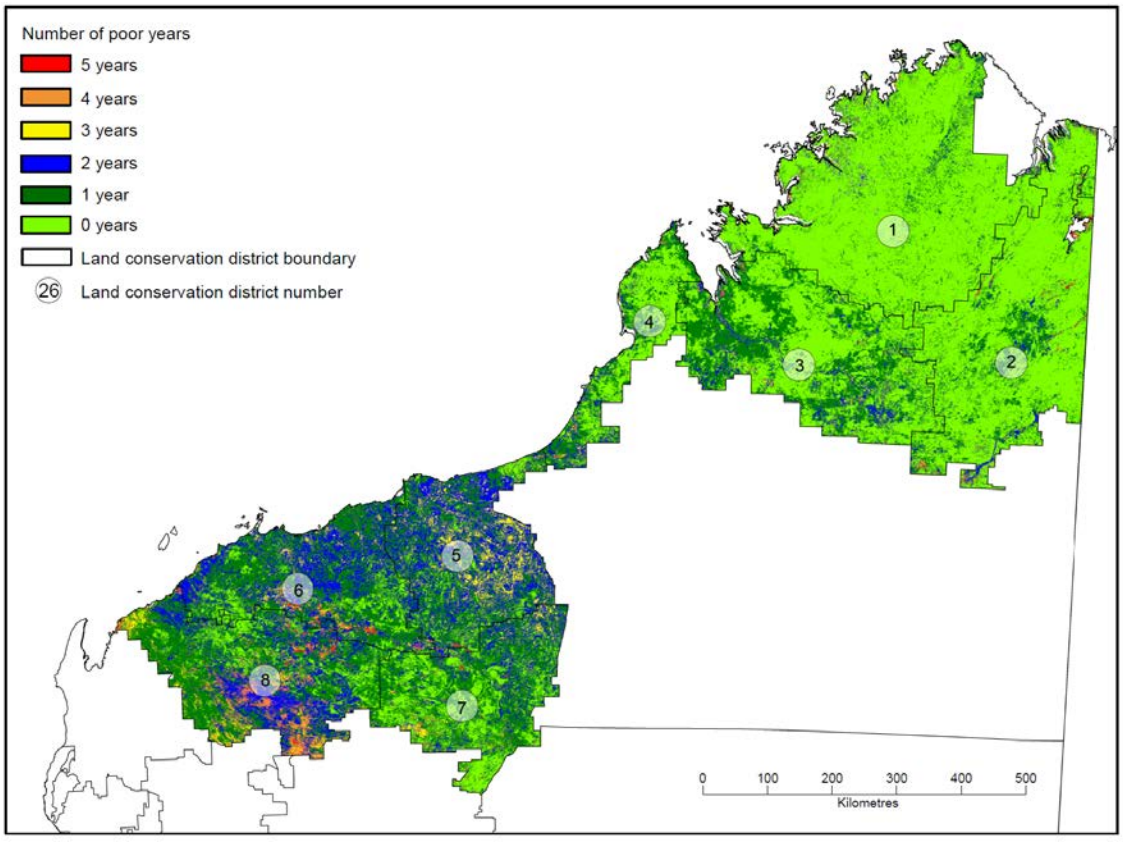


Figure D3 Number of years with poor greenness response in the last five years (2013–14 to 2017–18) in the Northern Rangelands

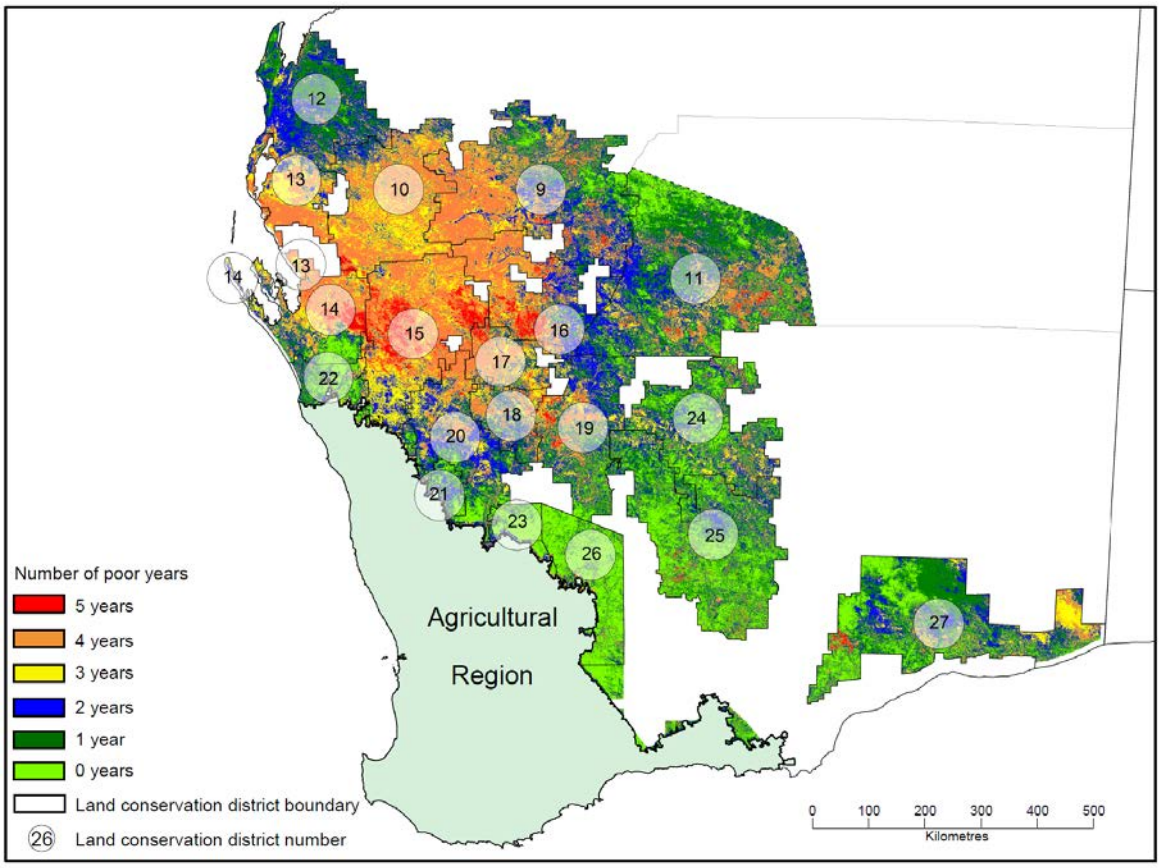


Figure D4 Number of years with poor greenness response in the last five years (2013–17) in the Southern Rangelands

8 Appendix E Rainfall and seasonal quality

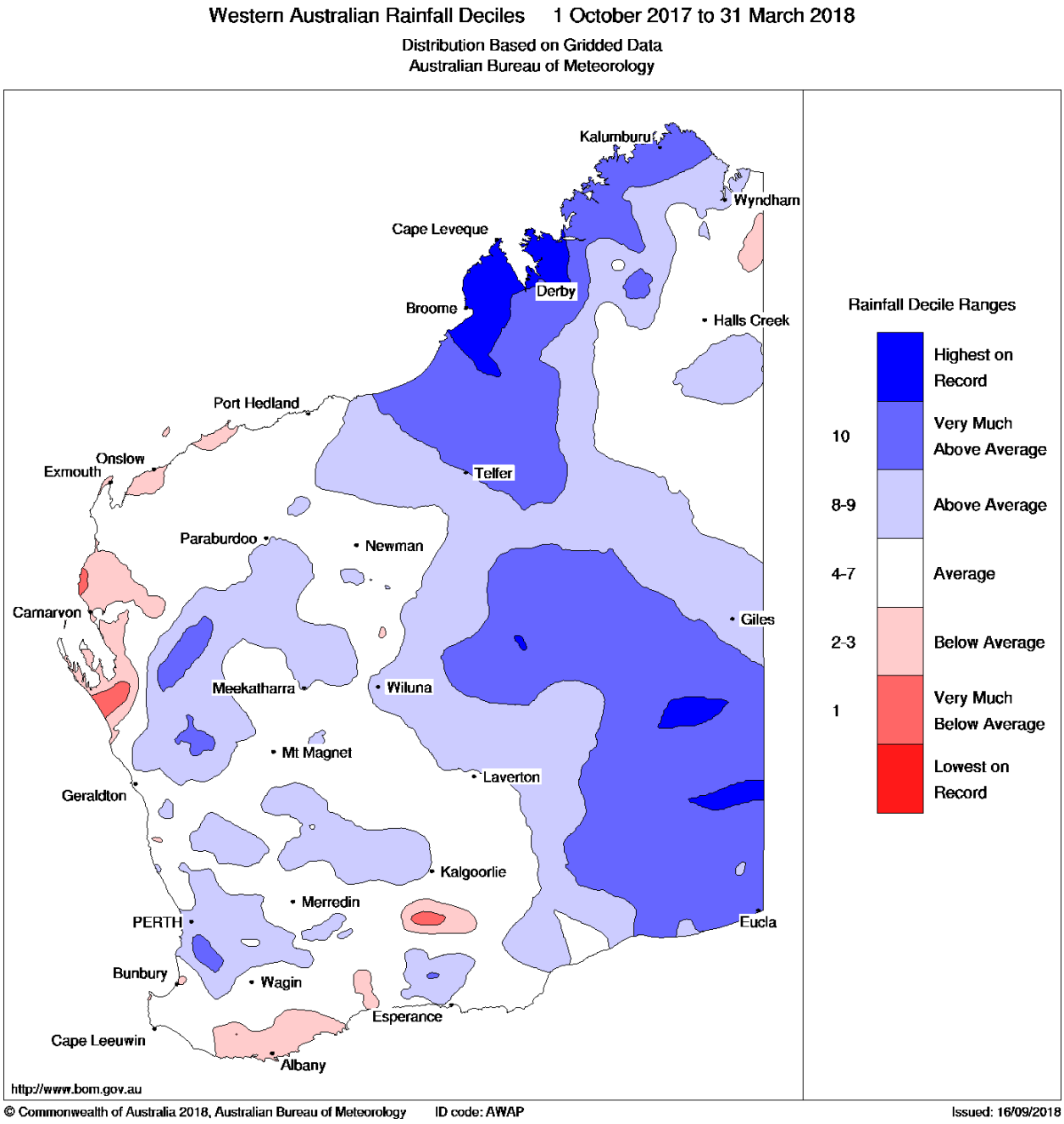


Figure E1 Summer rainfall deciles, October 2017 to March 2018

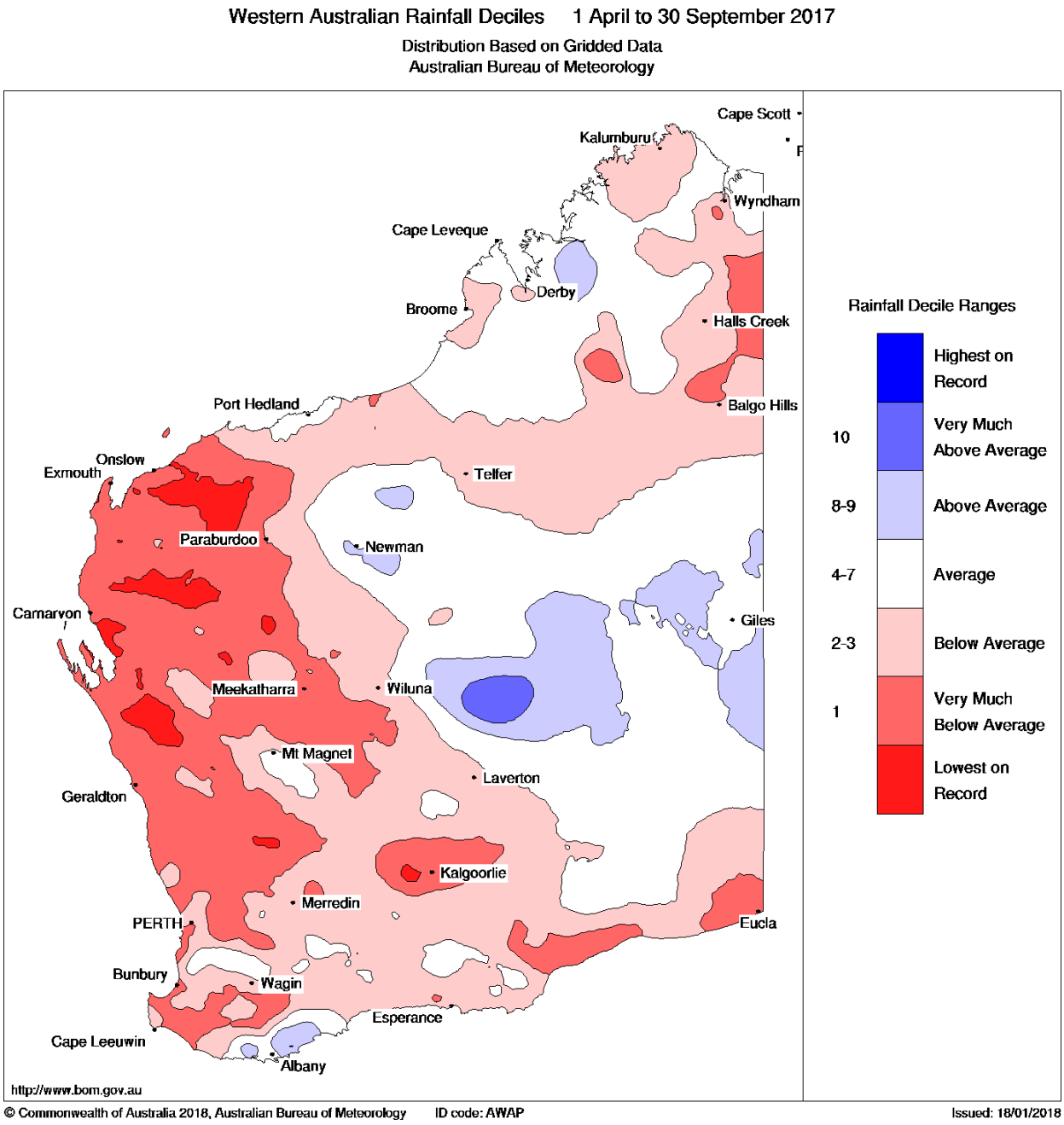


Figure E2 Winter rainfall deciles, April–September 2017

Seasonal quality

Seasonal quality is an index of seasonal rainfall each year, or number of years, expressed relative to the long-term average seasonal rainfall. It relies upon interpolated data from the Bureau of Meteorology's patched point dataset (Figure E3).

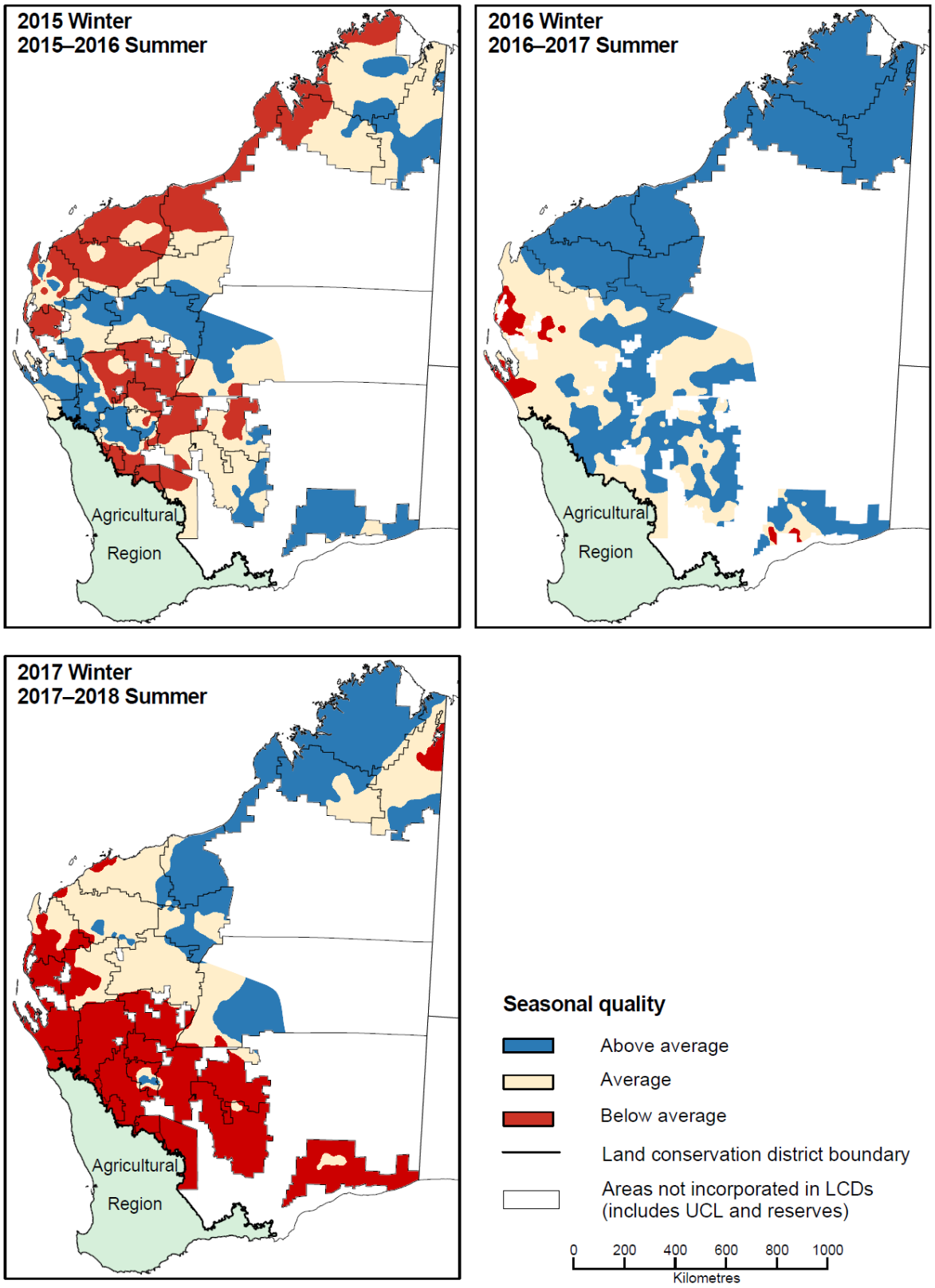


Figure E3 Estimated seasonal quality for the pastoral rangelands, 2015–18

9 Appendix F Livestock numbers

Livestock information is collected by the Pastoral Lands Board through the *Annual return of livestock and improvements* submitted by pastoral lessees, and catalogued in DPIRD's Pastoral Livestock Database.

In 2017, 1 166 242 mature cattle, 205 312 mature sheep and 7087 mature goats were reported. The number of reported mature cattle was 6% higher, mature sheep was 9% lower and mature goats was 51% lower than the 2012–16 average. For reporting, the number of cattle, sheep and goats is expressed as 'standard cattle units' (CU) based on the animals' feed requirements and reported as cattle units per square kilometre (CU/km^2).

The PCC of a rangeland area or vegetation system is an estimate of the number of livestock that can be sustainably carried over the long term. It is based on all the vegetation being in good condition and able to be accessed by livestock, and average seasonal conditions. Declining vegetation condition, the extent of infrastructure development (e.g. water points and fencing) and seasonal conditions will affect actual carrying capacity.