PASTORAL LAND BOARD

NORTHERN TERRITORY

ANNUAL REPORT 2018-19

LETTER OF TRANSMITTAL

PASTORAL
LAND BOARD
NORTHERN TERRITORY

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Hon Eva Lawler MLA
Minister for Environment, Parks and Water Security
Parliament House
GPO Box 3146
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Dear Minister,

In accordance with section 29(a) of the *Pastoral Land Act 1992*, I hereby submit for your information and presentation to Parliament, the Annual Report of the Pastoral Land Board for the reporting period ended 30 September 2019.

Yours sincerely

Julie Ross
Chairman

EXECUTIVE SUMMARY

Good land condition is not only essential for a profitable and sustainable pastoral industry but is also essential to underpin future growth and development of agribusiness.

The Pastoral Land Board is chartered with monitoring the condition and use of pastoral land to facilitate its sustainable use and economic viability. The Board is committed to the maintenance, and where possible, the improvement of the condition of the Northern Territory's pastoral land.

The Board is a statutory authority made up of at least five members, including a Chairman, appointed by the Minister for Environment and Natural Resources and is tasked with reporting to the Minister on the general condition of pastoral land under the Pastoral Land Act 1992. This report provides the Minister with a comprehensive analysis of current land condition across the NT Pastoral Estate. Encompassing an area of approximately 596 542 km^2 the NT Pastoral Estate comprises 45% of the Northern Territory's land mass held under 224 pastoral leases.

The Board's annual reporting period spans from 1 October to 30 September to align with the growing season. Using a comprehensive integrated monitoring system, Rangeland Monitoring Officers from the Department of Environment and Natural Resources (DENR) combine measured field data collected on-ground with remote sensing satellite monitoring products and the knowledge and experience of the land managers to enable reporting of land condition at property, landscape and regional scales.

During this 2018-19 reporting season, mapping and monitoring was undertaken at 301 sites on 45 properties across 10 of the 11 pastoral districts. Of the 301 sites assessed, 97 were assessed in 'Excellent' / 'Good' condition, 115 were assessed in 'Fair' condition and 89 were assessed in 'Poor' condition. Seasonal conditions based on rainfall amount compared with the long-term record were below-average to lowest on record for large areas of the Northern Territory. Most of the northern Barkly, Sturt Plateau, Northern Alice Springs, and the southern Victoria River Pastoral Districts had lowest on record conditions. Most of the Roper, Southern Alice Springs, and Tennant Creek Pastoral Districts had below average rainfall. The Plenty Pastoral District had average to above-average rainfall and the central and western part of the Gulf Pastoral District had average conditions.

The report includes specific land condition issues faced by pastoralists including erosion, feral animals, weeds and bushfires and the impact of seasonal conditions. Low rainfall across much of the NT contributed to below average vegetation cover at many of the monitored sites. The extent and significance of fire on vegetation cover and grazing effects, where present, are also reflected in the changes to vegetation cover and overall land condition. What is apparent through the observations and previous year comparisons, is that the conditions in 2019 are not unique, with similar poor conditions identifiable in other years.

The report also provides supplementary information relating to the operations of the Board and the state of the NT cattle industry as supplied by the Department of Primary Industry and Resources.

In the execution of its duties, the Board held four meetings during this reporting period, including one in Darwin and one in Alice Springs. The Board assessed five and determined to approve four land clearing permits for improved pasture, pastoral purposes and a commercial power project. Additionally four non-pastoral use applications were considered, with the Board determining to issue two permits. A non-pastoral use permit was issued for horticulture and another for tourism purposes.

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CHAIRPERSON'S FOREWORD

As Chairman of the NT Pastoral Land Board, I have the pleasure in presenting the Annual Report of the Board for 2018-19.

The important task associated with this Annual Report is reporting on the condition of pastoral land across the NT. The monitoring undertaken by the Rangelands Monitoring team during this season provided informative data on the land condition on 45 pastoral leases across 10 pastoral districts. I thank the Rangelands staff for their efforts in undertaking these on-ground observations.

The 2018-19 reporting period saw the Board hold meetings in both Darwin and Alice Springs, as well as via teleconferences. The Board considered many applications for pastoral land clearing and non-pastoral uses, resulting in four land clearing permits for improved pasture and a commercial power project and two non-pastoral use permits for horticulture and tourism.

The Board continues to strive to allow diversification of the pastoral estate, while maintaining a balance with sustainable cattle production and overall land condition. We appreciate the professional advice received from service authorities across the NT Government in supporting our decision making.

I would like to acknowledge the contribution of outgoing Chairman Mr Paul Zlotkowski and Member Mrs Anne Kilgariff Stanes whose appointments ended during this reporting period. I acknowledge both for their contribution to the Board and work undertaken during their terms. The Board welcomed Mr Roy Chisholm and Mr Alastair Shields as members and I thank Dr Leigh Hunt for stepping in as interim Chairman.

In conclusion, I would like to thank the Pastoral Lease Administration staff, in assisting the Board to carry out its extensive work and all the Board members for their dedication and contributions to the considerations and decisions undertaken during 2018-19.

Julie Ross

IN MEMORIAM
PAUL ZLOTKOWSKI

Paul Zlotkowski served on the Pastoral Land Board from 2016 to 2019. Paul was an influential and progressive chair who was committed to sustainable development. Sadly Paul died in late 2019.

Paul was born in Yeppoon in the 1930s. He grew up on his parents' sheep and cattle property near Longreach working stock and riding horses from a young age. Paul moved to Sydney to attend school, after which he gained employment at Goolgumbla Station then Buttabone Stud Park in New South Wales (NSW).

Paul was appointed as manager of the family's three properties in the mid-fifties. During the 15 years spent managing these properties, Paul was continually on the move buying cattle in the northern NSW region and walking them south to sell.

In 1967 he bought Yelvertoft Station in Queensland and a year later Wollogorang Station in the Territory. Paul moved to Wollogorang permanently in 1979, later buying adjoining Wentworth Station then Amungee Mungee Station in 2003 to develop a live export depot for Wollogorang cattle. Here he spent five years building infrastructure such as lanes and waters to handle about 10,000 head. As an avid sailor, Paul retired in 2015 to live permanently on his boat in Cullen Bay.

Paul committed his life to the pastoral industry, experiencing an array of issues including droughts, floods, cyclones and the 1980s BTEC program. In doing so he contributed to the development of the Northern Territory's pastoral estate for some 55 years. Ultimately, he brought his experience to the Pastoral Land Board where he served as chairman from 26 June 2016 to 25 June 2019. Paul was well respected across the pastoral industry and will be greatly missed.

MEMBERSHIP OF THE BOARD

Ms Julie Ross - Chair

Commenced with the Board on 22 November 2019

Dr Leigh Hunt - Member

Commenced with the Board on 28 September 2015

Interim Chairman 25 June 2019 to 21 November 2019

Mr Steven Craig - Member

Commenced with the Board on 25 June 2002

Mr David James - Member

Commenced with the Board on 28 September 2015

Mr Alastair Shields

Commenced with the Board on 19 June 2019

MEMBERSHIP OF THE BOARD

Mr Roy Chisholm

Commenced with the Board on 19 June 2016

Former Chairman Mr Paul Zlotkowski

Term expired with the Board on 25 June 2019

Former Member Mrs Anne Kilgariff Stanes

Term expired with the Board on 20 June 2019

Executive Officers

Ms Cassandra Arnott and Ms Jailee Kelly

FUNCTIONS OF THE BOARD

Section 29 of the Pastoral Land Act outlines the function of the Board:

a. to report regularly to, and as directed by, the Minister, but in any case not less than once a year, on the general condition of pastoral land and the operations of the Board;

b. to consider applications for the subdivision or consolidation of pastoral land and make recommendations to the Minister in relation to them;

c. to plan, establish, operate and maintain systems for monitoring the condition and use of pastoral land on a district or other basis;

d. to assess the suitability of proposed new pastoral leases over vacant Crown land;

e. to direct the preparation, and monitor the implementation of, remedial plans;

f. to monitor, supervise or cause to be carried out work in relation to the rectification of degradation or other damage to pastoral land;

g. to monitor the numbers and effect of stock and feral and other animals on pastoral land;

h. to monitor and administer the conditions to which pastoral leases are subject;

i. to consider and determine applications for permission to use pastoral land for a non-pastoral purpose in accordance with Part 7;

j. to make recommendations to the Minister on any matter relating to the administration of the Act;

k. to hear and determine all questions, and consider and make recommendations on all matters, referred to it by the Minister; and

m. such other functions as are imposed on it by or under the Pastoral Land Act or any other Act or as directed by the Minister.

Other functions outlined in the Act include:

1. to determine applications for clearing pastoral land [section 38(1)(h)]
2. to consider breaches of conditions referred by the Minister [section 41]
3. to consider and make recommendations to the Minister on application for conversion of term pastoral leases to perpetual tenure [section 62]
4. to administer the access provisions of the Act, including nomination of access routes under Part 6
5. to determine applications for non-pastoral use of pastoral land under Part 7.
6. to consider and make recommendations to the Minister on application for consent to transfer a pastoral lease or sub-lease should the advice of the Board be sought [section 68(2)].

LAND CONDITION

Land condition is an assessment of vegetation and soil health as indicated by ground cover species composition, tree and shrub density, abundance of invading plants (native and exotic), soil surface condition and soil erosion. These attributes are assessed relative to land in near-pristine condition.

The main influences on land condition are grazing by domestic, native and feral grazers, fire and combinations of the two. Grazing is managed by manipulating stocking rate, stock water distribution, feral grazing control and fire. Fire on its own can change land condition by being too frequent or too infrequent over a long period of time, but its main effect on land condition is through changing the distribution of grazing as grazers prefer younger grass.

Implementation of management plans to address land condition issues

In cases where land condition issues are identified on a pastoral property, the Board may request the lessee to prepare a management plan detailing the action to be taken to address the land management issues which have been identified. It is a basic tenet of the Pastoral Land Act 1992 that pastoral lessees acknowledge their duty to adopt sound management practised and their responsibility to address any land condition issues that may arise. In line with this philosophy, the Board seeks voluntary collaboration with pastoral lessees to address land condition issues and implementation of rehabilitation programs.

While voluntary management plans are preferred in the first instance, if the Board is of the opinion that where pastoral land has been degraded or otherwise damaged it may require a remedial management plan detailing the proposed management of the pastoral land over a specified period of time. Remedial plans need to be endorsed by the Board and are registered on the title. There are currently no remedial plans in place.

PASTORAL LAND MONITORING PROGRAM

The Northern Territory Government's Department of Environment and Natural Resources (DENR) is chartered with the assessment, monitoring and reporting of land condition on behalf of the Pastoral Land Board.

Integrated monitoring program

The integrated monitoring program was introduced in 2013 to provide objective, whole of landscape reporting of changes in land cover across the pastoral estate. It comprises a network of ground based sites, incorporating the existing Tier 1 sites where suitable, with newly established ground sites appropriate to validate and inform satellite data and products.

New sites are established at or near existing Tier 1 sites to maintain consistency in the photographic and data records. In some cases, it is not appropriate to locate a site nearby due to factors such as proximity to infrastructure, land system boundaries and changes in vegetation structure and type. Where Tier 1 sites are not appropriate for inclusion in the integrated monitoring program, sites continue to be photographed to expand the Tier 1 photo archive.

The integrated monitoring program, like the previous Tier 1 system, is heavily reliant upon the knowledge and experience of land managers and lessees. Both the ground data collected and information products produced from satellite data require on-ground local knowledge and understanding to explain changes and gain a further understanding of landscape dynamics. Measured field data are used to better calibrate Landsat-derived products to Northern Territory conditions and then validate their accuracy for specific locations. The two sources of information (ground based and remote sensing) are then interpreted with regard to the knowledge and experience of practical land managers to enable reporting of land condition at property, landscape and regional scales.

As the number of revisits increase at a site, the expanding monitoring record will allow changes in the vegetation and soils, and their probable causes, to be documented – in a similar way to that which is now possible for vegetation cover using remote sensing.

Remote sensing of the dynamics of vegetation cover

The remote sensing or satellite based data component of the integrated monitoring program was developed through a collaborative research program between DENR and the Queensland Department of Environment and Science (DES). Through this collaboration, DENR officers are contributing to an internationally recognised method for systematically monitoring change in vegetation cover and its converse, bare ground, at a range of spatial and temporal scales. The 30-m pixel size of Landsat imagery allows change in vegetation cover to be analysed at site level (1ha) through to pastoral districts (~10 000km^2 to >130 000km^2) and the entire Northern Territory (~1 346 500km^2). Reporting interval can be as short as three months over a 29 year period (1988 to current).

Fractional cover

Analysis of the dynamics of vegetation cover (conversely, bare ground) within this report is based on fractional cover. This is an estimate of the components of land cover that can be distinguished from the spectral data collected by the Thematic Mapper instrument carried on the Landsat satellite (i.e. Landsat TM). The three components are bare ground (comprising soil, rocks and gravels), actively growing (photosynthetic) vegetation and senescent (non-photosynthetic) vegetation (including litter). This can be represented using the diagram below.

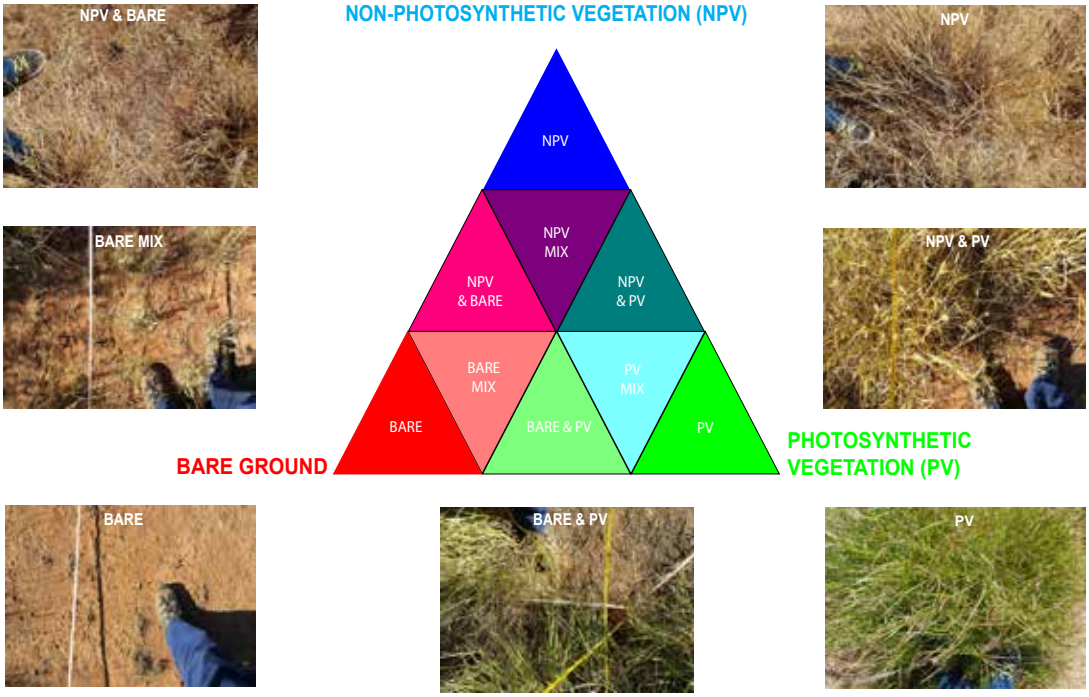

Diagram 1: The three components of fractional cover and the various combinations illustrated in the associated ground cover photos.

The level of vegetation cover or bare ground present and its change over time is reported in three ways:

1. As the actual amount present during a specified period of time. For this report, this is September to November 2019, termed 'spring composite', coinciding with the latter part of the Dry season for central and northern pastoral districts and the time when early summer storms may promote pasture growth in the southern NT. It is important to maintain adequate ground cover in the latter months of each year to minimise soil loss from wind erosion and intense, early Wet season/summer storms. It is also important to carry dry feed, and associated ground cover, into the latter months of each calendar year in case there is a late start to the usual Wet season/summer and/or rains fail more generally.

2. As a decile rank of vegetation cover present in late 2019 (spring composite) compared with that present at similar times back to 1988, a 31 year period.

3. The percentage area of each pastoral district having various categories of bare ground between September and November 2019 (spring composite). Categories of bare ground are:
   - minor, ≤20% of Landsat pixel is bare ground;
   - moderate, 21% - 40% bare ground in pixel;
   - high, 41% - 60% bare ground in pixel; and
   - very high, >60% [illegible]

The number of pixels in each category are counted, multiplied by pixel area (900 m^2 or 0.09 ha) and converted to the percentage of pastoral district area.

The bare ground threshold for each district is based on the frequency distribution of all 30m Landsat bare ground fractional ground cover pixels at the end of 2018 (spring composite). A threshold was determined which represents 75% of a district's bare ground. The remaining 25% is considered to have above-threshold bare ground.

A 75% threshold bare ground value of 48% equates to 48% actual bare soil of a Landsat fractional ground cover pixel.

Rainfall

The amount, timing and effectiveness of rainfall is a major driver of the quantity, composition and quality of pastures across the NT pastoral estate. Monitoring data collected using ground and remote sensing-based methods must account for the effects of variable rainfall (seasonal quality) in understanding the impacts of stocking rates and grazing management on the vegetation resource.

Due to the large variation in annual rainfall across the Northern Territory, a comparison of location-specific rainfall against its longer term history is a useful way of illustrating recent seasonal conditions. A Northern Territory map of decile-ranked rainfall for the current reporting cycle (October 2018 to September 2019) is shown on Figure 1. Rainfall is ranked on a baseline of approximately 100 years.

Fire

Fire and its effect on vegetation cover across the NT cannot be understated. This can be seasonal in the savannah landscapes of the central and northern parts of the NT or relatively infrequent and episodic in the southern arid region. Mapped fire scars and associated statistics accessible from the North Australia and Rangelands Fire Information website (www.firenorth.org.au/nafi3) are used to report spatial and temporal information on burnt area.

Woody cover

The density of trees and shrubs changes over time in many rangeland environments, but generally at a slower rate than changes in the pasture layer. A particular issue facing long term sustainability of the pastoral industry in some landscapes is woody thickening which can suppress pasture growth and reduce opportunities to use fire for broadscale control of problem tree or shrub species. Two remote sensing products are being adapted to NT conditions to improve monitoring of vegetation cover dynamics. The first is a foliage projective cover product that discriminates woody cover from ground cover. The second is a probability based model that allows ground cover under trees to be estimated. Both will allow improved monitoring of cover dynamics in woodland/savannah environments when suitably refined and validated.

CRITERIA USED TO ASSESS LAND CONDITION

Assessing land condition

The following table summarises how the pasture and woody layers, soil surface features and presence of any weeds are considered to assess land condition.

Land Condition	Soil	Pasture	Weed	Woodland & Shrubland
A (= Excellent) All of these features	No erosion and good surface condition	Good coverage of palatable perennial grasses in the north and annual forage species in the south, minimal bare ground in most years	No weeds	No signs of woody thickening
B (= Good) At least one or more of these features	Minimal evidence of previous erosion or of current erosion risk	Some decline in the presence of palatable grasses and other forage species, a small increase in bare ground	Small infestations of weeds	Some thickening in the density of woody plants
C (= Fair) One or more of these features	Evidence of past erosion and/or current susceptibility to erosion	General decline in palatable perennial and annual grasses, obvious increase in the amount of bare ground	Obvious presence of weeds	General thickening in the density of woody plants
D (= Poor) One or more of these features	Severe erosion, scalding or compaction resulting in a hostile environment for plant growth	General lack of palatable forage species	Large weed infestations covering significant areas	Thickets of woody plants that cover significant areas

2018-19 MONITORING SEASON AND PASTORAL DISTRICTS

The Rangeland Monitoring Branch within the Department of Environment and Natural Resources visited 45 pastoral leases in ten Pastoral Districts during the 2018-19 reporting cycle, from 1 October 2018 to 30 September 2019.

Assessed land condition for each district is summarised in this section. This overview is drawn from the analysis of vegetation-cover dynamics based on Landsat imagery, data collected at 301 integrated monitoring sites and more general assessment of land condition during lease visits.

The criteria and methods used to monitor land condition are explained on pages 8-10.

Seasonal conditions

Seasonal conditions for 2018-19, based on rainfall amount compared with the long-term record (Figure 1), were:

- Below-average to lowest on record for large areas of the Northern Territory.
- Most of the northern Barkly, Sturt Plateau, Northern Alice Springs, and the southern Victoria River Pastoral Districts had lowest on record conditions.
- Most of the Roper, Southern Alice Springs, and Tennant Creek Pastoral Districts had below average rainfall.
- The Plenty Pastoral District had average to above-average rainfall and the central and western part of the Gulf Pastoral District had average conditions.

Assessing land condition

Land condition was assessed using a combination of remotely sensed (satellite) and field (site) data, and lease inspection. Landsat data are processed to indicate the proportions of vegetation cover (photosynthetic and non-photosynthetic) and bare ground in each pixel, an area of 0.09ha. Change in each component can be examined since 1988 providing important information on cover dynamics over the last 30 years. It is important that pastoral land managers maintain adequate ground cover in the latter months of each year to minimise soil loss from wind erosion and intense summer storms. It is also important to carry dry feed, and associated ground cover, into this period in case there is a late start to the usual wet season / summer rains and/or monsoonal rains fail more generally.

Decile ranked total cover for the winter seasonal composite image is shown in Figure 2. The decile ranked total cover provides an indication of how the current season compares against a constant baseline 1988-2019 and indicates that total vegetation cover was below to lowest on average over large parts of the NT.

In summary, Figure 2 shows the contrast and relative change in levels of vegetation cover (conversely, bare ground) across the NT over one year, the extent and significance of fire on the dynamics of vegetation cover and, within individual pastoral districts, the influence of rainfall on the amount of cover present. Grazing effects, where present, are more subtly embedded within these gross changes.

The low rainfall across much of the NT (Figure 3) is also reflected in the below average total vegetation cover in the 2019 June-August seasonal composite. Figure 8 presents a time-series of total cover decile images covering a 31 year period from 1988 to 2019 and enables the conditions in 2019 to be put into context with the last 31 years. There are large areas of lowest of record total cover in 2019, compared to the previous three years. What is apparent in the time-series is that the conditions in 2019 are not unique, with similar poor conditions in other years (e.g. 1992, 2005 and 2008).

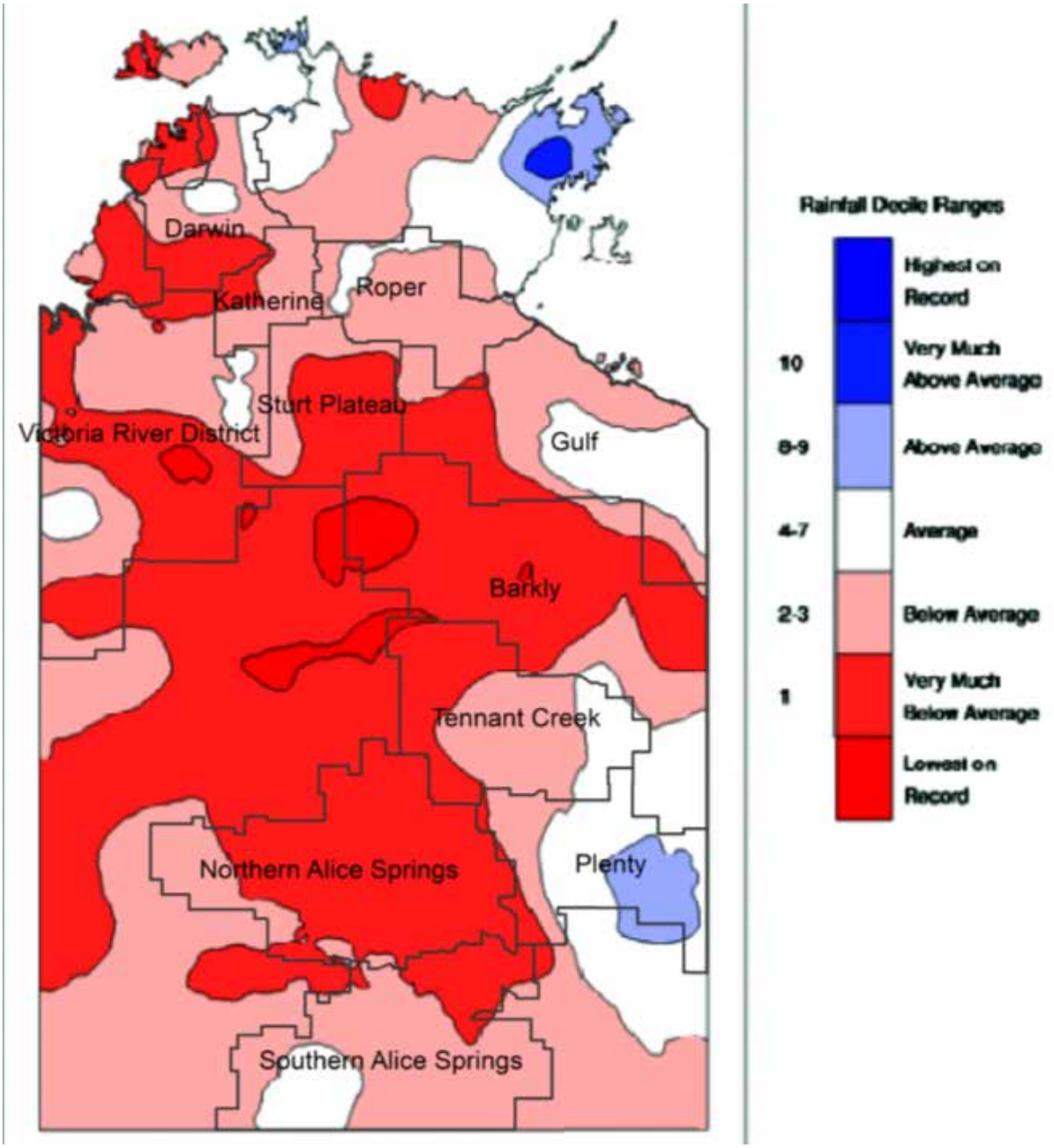

Figure 1. Decile-ranked rainfall for the October 2018 to September 2019 period (Source BOM).

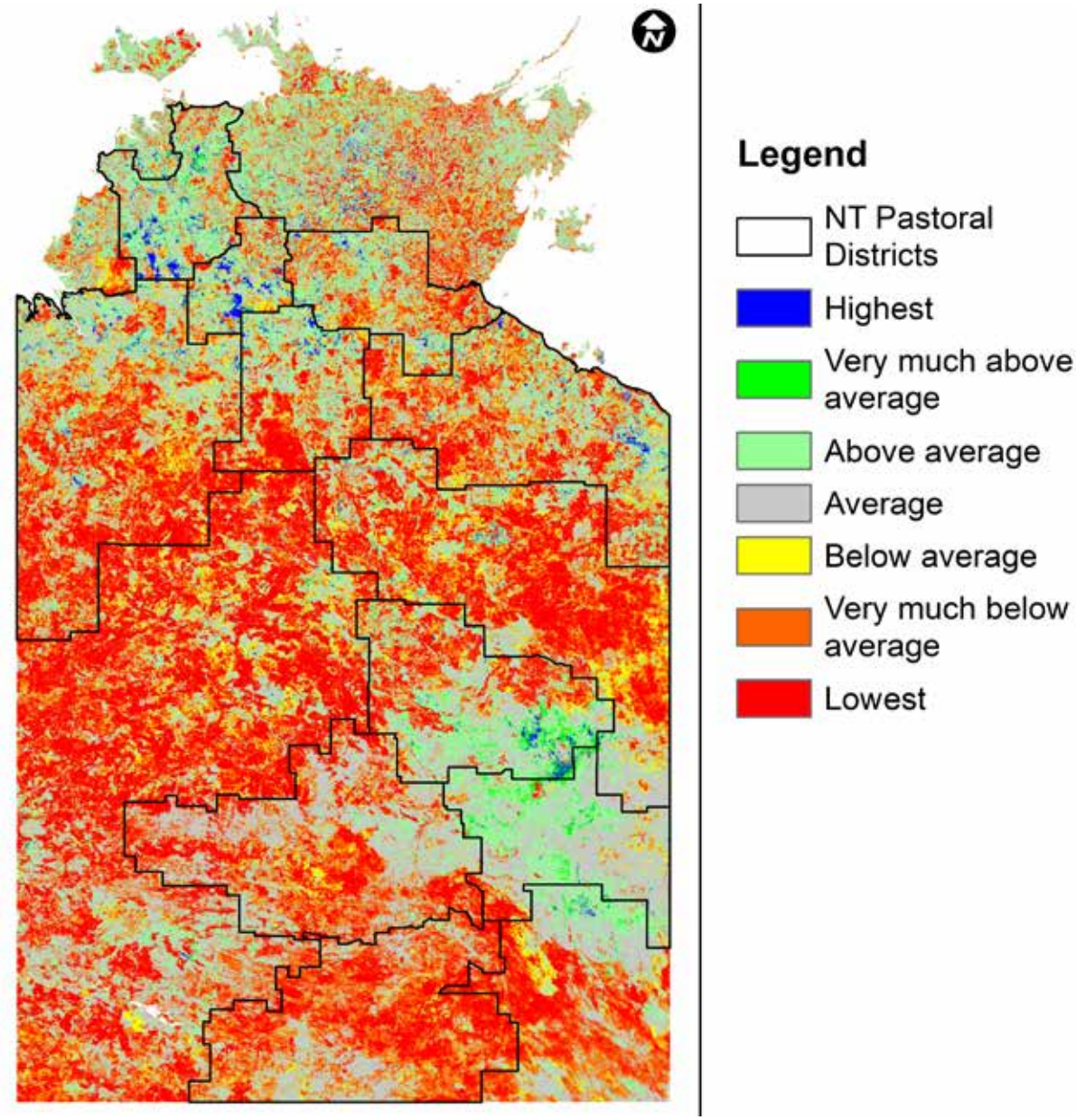

Figure 2. Decile-ranked total cover for winter seasonal composite images (June-August) for current (2019) reporting season. The decile ranking is derived from 0.09ha (30 x 30m) Landsat pixels, based on the total cover (green plus brown fractions) for a given season, which is compared against a constant baseline between 1988-2019. In this case the winter (June-August) season is illustrated as it is least affected by cloud.

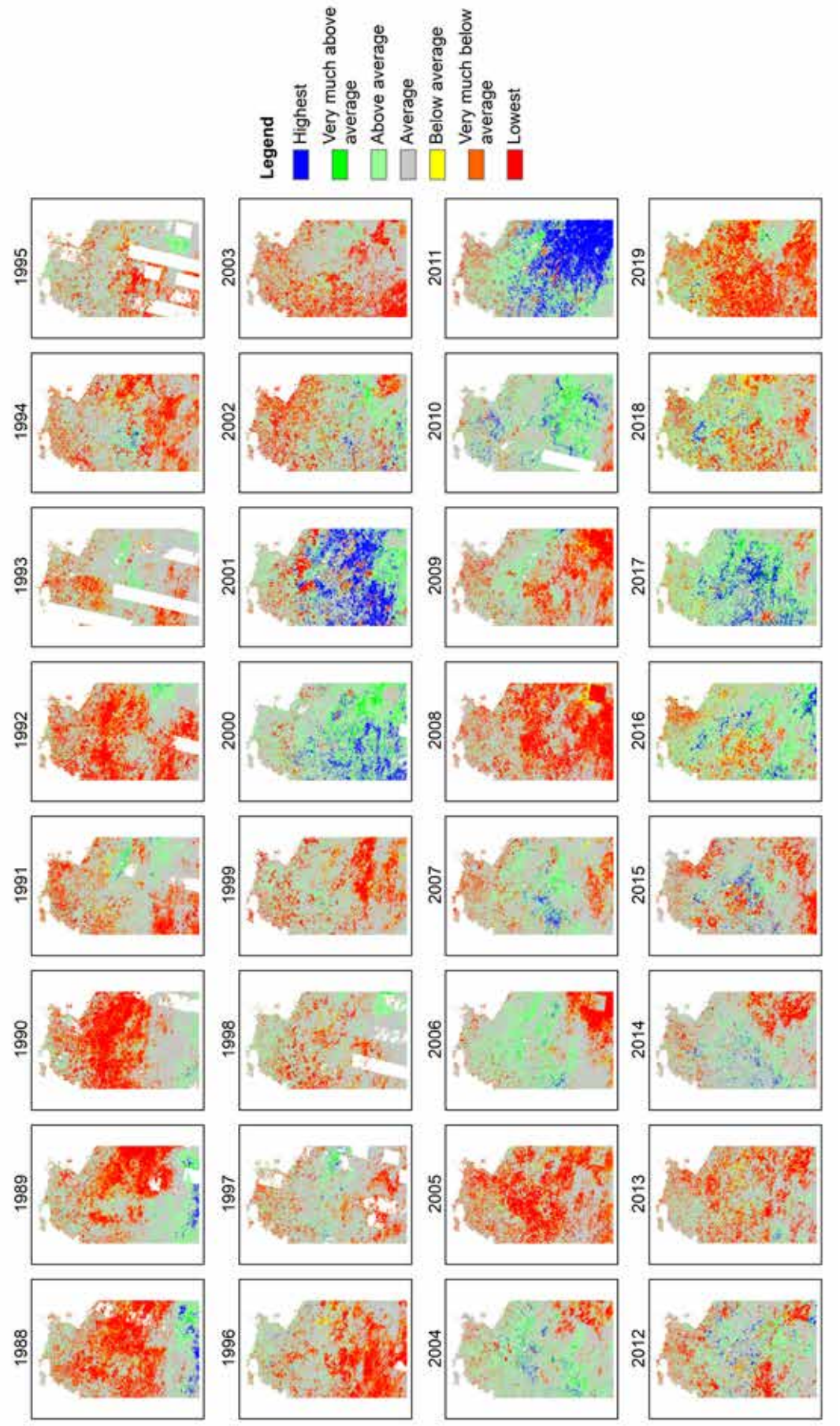

Figure 3. Time-series of decile rank of total cover for the winter seasonal composite (June - August) for the Northern Territory 1988 to 2019.

Understanding seasonal effects on land condition

The amount of forage available for grazing or level of ground cover present to protect the soil surface against erosion is influenced by the quantity and effectiveness of rainfall throughout the year (or wet season in the north), and subsequent grazing and fire. The effects of rainfall variability and fire, whether episodic or recurrent, must be accounted for when assessing grazing impacts in the rangelands.

A simple framework for better understanding seasonal (mainly rainfall) effects on vegetation change is the 'seasonal quality' matrix (Figure 4). Here, some measure of recent seasonal quality is intersected with the direction of change for those attributes of the vegetation being monitored. In the case of remotely sensed bare ground, we would expect bare ground to decrease following more rainfall (better seasons) and increase in droughts (i.e. poorer seasonal quality). Seasonally expected change is shown with the '~' symbol in Figure 9. When it is known what is expected, it is then possible for monitoring and management to focus on unexpected change (the ✓✓and ××cells in Figure 4). For example, at landscape and regional scales, the amount of bare ground will increase after extensive wildfire that can follow improved seasonal conditions. This is one obvious plausible explanation for unexpected change. At more local scales (water points and paddocks), an unexpected increase in bare ground may be associated with heavy stocking. A decrease in the amount of bare ground following poorer seasonal quality probably requires further investigation. It could be that areas are being temporarily spelled (protected from grazing) or the composition and/or structure of the vegetation are changing. These changes could mean recruitment of perennial species, a desirable change for the pastoral industry where such species are palatable, or longer-term thickening of woody vegetation – less desirable for grazing where competition results in reduced pasture availability.

Seasonal Quality	Change in remotely-sensed bare soil		
	Increase	No change	Decline
Above average	XX	X	~
Average	X	~	✓
Below average	~	✓	✓✓

Figure 4. Seasonal quality matrix used to interpret change in bare ground with respect to preceding seasonal conditions. 'Seasonal quality' describes the relative value of recent rainfall in producing forage for livestock. The white cells with the ~ symbol represent expected change and coloured cells show unexpected change, akin to traffic lights; that is, less desirable change in the case of orange and red cells and more desirable for green cells.

Regional interpretation of change in bare ground: 2018 to 2019

This change, for bare ground, is summarised for the extent of pastoral leases in pastoral districts in Table 1. In producing this statistical summary:

- Seasonal quality is described in terms of expected pasture growth based on rainfall received, simulated using AussieGRASS (www.longpaddock.qld.gov.au). Modelled growth between October 2018 and September 2019 was ranked as a percentile of the growth for all previous 12-month periods (back to 1957).

- Areas (5km by 5km grid cells) having less than 30% of their long-term modelled pasture growth were assigned 'below-average' seasonal quality. Growth percentiles above 70 were allocated to 'above-average' seasonal quality. Remaining grid cells were considered to have experienced average seasonal quality.

- Change in bare ground was arbitrarily split between 'increase', 'no change' and 'decline' according to pastoral district.

- In the southern NT (Southern and Northern Alice Springs, Plenty, Tennant Creek and Barkly Pastoral Districts), 'no change' was interpreted as bare ground (for each Landsat pixel) in 2019 being within ±15 percentage points of that present in 2018. An increase in bare ground of >15 percentage points was considered an 'increase' and a decrease of more than 15 points a 'decline'.

- For remaining (central and northern) pastoral districts, change in bare ground of more than ±5 percentage points was considered an 'increase' or 'decline' (depending on its direction).

- The percentage area of the pastoral estate in each of the nine cells (Figure 4) was then calculated for each pastoral district. The percentage areas showing unexpected change (decline in bare ground with below-average seasonal quality or increase in bare ground with above-average seasonal quality) is summarised in Table 1. Percentage areas for increased bare ground following average seasonal quality are also included. This could serve as a possible warning to where areas of future concern may lie.

If a reasonable upper limit for unexpected change is less than 5% of the pastoral area within the pastoral district, then the magnitude and direction of change in bare soil from 2018 to 2019 accorded with seasonal expectations in most pastoral districts (Table 1).

The Darwin and Katherine Pastoral Districts however had a 12% and 17% bare ground increase with above average seasonal quality (respectively). The North Australia and Rangelands Fire Information website (NAFI) reports that 47% and 34% of the Darwin and Katherine Pastoral Districts burnt between October 2018 and September 2019 (respectively). This would contribute to the unexpected increase in bare ground, given above-average seasonal quality. Fire dynamics play an important role in vegetation dynamics in these environments.

The threshold used for assigning 'no change' in bare ground obviously influences the percentage area calculated as exhibiting unexpected change. This is also applicable to threshold 'bare ground' based on the frequency distribution of all 30-m pixels within each district; arbitrarily determined as the value which represents 75% of a district's bare ground.

Table 1. The percentage area of pastoral leases within pastoral districts showing unexpected change in bare ground with respect to seasonal quality between the latter parts of 2018 and 2019. Larger percentage values in the first column (e.g. > 10%) serve as a possible warning of future concern. Higher values (e.g. > 5%) in the second column are of greater concern; except for recent effects of fire, bare ground should not increase following above average seasonal quality. The third (final) column is a more favourable outcome and it is useful to try and understand where and why the amount of bare ground has decreased following unfavourable seasonal conditions.

Pastoral District	Percentage area showing unexpected change		
	Increase in bare ground following average seasonal quality	Increase in bare ground following above average seasonal quality	Decline in bare ground following below average seasonal quality
Darwin	12	12	8
Katherine	20	17	4
VRD	2	1	4
Sturt Plateau	5	0	0
Roper	13	1	9
Gulf	3	1	8
Barkly	0	0	0
Tennant Creek	1	0	0
Plenty	0	0	0
Northern Alice Springs	0	0	0
Southern Alice Springs	0	0	0

Other indicators of land condition

The following sections provide a detailed account of other components of land condition for each pastoral district. Information is compiled on:

- Seasonal quality – the spatially averaged growth percentile (from AussieGRASS) for each district as a summarising statistic of the amount and effectiveness of rainfall in growing forage for livestock
- Extent and timing of wildfire
- Further information on bare ground dynamics including mapped areas exceeding specified thresholds of bare ground
- Data collected at monitoring sites and observations made during lease inspections relevant to pasture condition, presence of weed species, tree-grass balance (e.g. woody thickening) and soil erosion.

Information from the pastoral district reports is summarised in Table 2. This table effectively provides a brief snapshot of each pastoral district.

Table 2. Summary of land condition by Pastoral District.

Pastoral District	AG[1] Growth Percentile	% PD[2] Burnt	% PD with category of Bare Ground[3]				Site Data		Summary of Pastoral District
			minor	moderate	high	very high	#[4] stations	Rating	#[5] sites	
Darwin	58	47	57	37	6	0	1	Good	2	Seasonal quality based on AussieGRASS pasture growth, varied from much below to much above average across the Darwin Pastoral District Rainfall was below the long-term median but displayed considerable spatial variation across the District. The District experiences extensive and frequent fire. The total area burnt between October 2018 and September 2019 was 17 218km2. One-quarter of the District had bare ground above 28% (per 30-m pixel) late in the 2019 dry season, which was largely attributed to fire. On-ground monitoring for land condition was conducted on one pastoral lease. Perennial and annual grasses dominated at the majority of integrated sites. The lease inspected had some isolated patches of rubber bush (Calotropis procera).
								Fair	1	
Katherine	59	34	52	39	9	0	4	Excellent	1	Rainfall for the District was significantly below the long-term median. Seasonal quality, as indicated by AussieGRASS-modelled pasture growth, ranged from very much below average to very much above average. Approximately 34% of the District was affected by fire between October 2018 and September 2019. Based on analysis of satellite data one-quarter of the District had bare ground above 30% (per 30-m pixel) late in the 2019 dry season. On-ground monitoring was conducted on four pastoral leases. Sites, on average, had a moderate cover of perennial grasses, low bare ground, and moderate amounts of litter, as would be expected from more timbered country in this District. Grazing at a majority of the sites was assessed as minimal to moderate.
								Good	11	
								Fair	3	

Pastoral District	AG[1] Growth Percentile	% PD[2] Burnt	% PD with category of Bare Ground[3]				Site Data			Summary of Pastoral District
			minor	moderate	high	very high	#[4] stations	Rating	#[5] sites	
VRD	14	19	8	37	41	14	2	Good	9	The District experienced mostly below average rainfall. Modelled pasture growth (AussieGRASS) over the 2018-19 wet season was mostly very much below-average across most of the District. Approximately 19% of the District burnt between October 2018 and September 2019. Based on analysis of satellite imagery, twenty-five percent of the District recorded bare ground >54% (per 30-m pixel), which in the north was strongly associated with fires in either 2018 or 2019. On-ground monitoring was conducted on two pastoral leases. Sites, on average, had only a moderate cover of perennial grasses and approximately a third of the site was comprised of bare ground and litter. The majority of field sites were assessed as minimally grazed.
								Fair	2	
Sturt Plateau	10	12	40	43	16	0	8	Good	15	Modelled pasture growth generally reflected rainfall distribution across the District, with most of the District experiencing well-below-average rainfall. Approximately 12% of the region burnt between October 2018 and September 2019. Analysis of satellite imagery indicated that twenty five percent of the District had >35% bare ground per 30-m pixel. On-ground monitoring was conducted on eight leases and on average the integrated sites, had a good cover of perennial grasses, a moderate amount of litter as would be expected with the more timbered land systems in this District. Pasture utilisation at the integrated sites was generally well-aligned with pasture availability, with 58% of sites assessed as minimally grazed, 18% moderate, 18% moderate/heavy and 6% heavily grazed.
								Fair	15	
								Poor	6	

Pastoral District	AG[1] Growth Percentile	% PD[2] Burnt	% PD with category of Bare Ground[3] minor	moderate	high	very high	Site Data #[4] stations	Rating	#[5] sites	Summary of Pastoral District
Roper	31	35	44	45	10	1	On-ground monitoring not conducted in 2018-19 reporting period.			Overall rainfall for the District was below average however, rainfall was variable across the District. A large portion of the south east of the District experienced very much below average seasonal quality based on AussieGRASS-modelled pasture growth and below-average rainfall but had variable pasture growth and rainfall across the north west of the District. Much of the north western and south eastern parts of the District had below average to the lowest ranking of vegetation cover in late 2019; areas with low ranking cover were often strongly related to incidence of fire. In total, 35% of the District burnt between October 2018 and September 2019. No pastoral leases were visited in 2019.
Gulf	10	21	32	49	18	2	7	Good	18	Rainfall for the District was below the long-term median. Modelled pasture growth (AussieGRASS) was consistent with the rainfall, with the majority of the District predicted to experience very much below average growth. Approximately 21% of the District burnt between October 2018 and September 2019. Analysis of satellite imagery estimated that one quarter of the region had more than 37% bare ground (per 30-m pixel) later in the 2019 dry season, mostly in the central and south-eastern parts of the District. On-ground monitoring was conducted on seven leases. On average the integrated sites consisted of 44% perennial grasses, 5% annual grasses, 26% litter and 21% bare ground. The majority of the sites (63%) had minimal grazing and 21% of the sites had heavy to very heavy grazing.
								Fair	18	
								Poor	11	

Pastoral District	AG[1] Growth Percentile	% PD[2] Burnt	% PD with category of Bare Ground[3]				#[4] stations	Site Data		Summary of Pastoral District
			minor	moderate	high	very high		Rating	#[5] sites	
Barkly	10	3	7	23	42	28	4	Good	3	Rainfall for the District was well below the long term median. Seasonal quality, based on expected pasture growth (AussieGRASS) was very much below average across most of the Barkly Pastoral District. Three percent of the District burnt over the reporting period, with the majority of this occurring in November and December 2018. Analysis of satellite imagery indicated that, one quarter of the District had >61% bare ground (per 30-m pixel) in the late dry season, mainly in the east and central parts of the District. On-ground monitoring was conducted on four leases across the District. On average, the integrated sites recorded moderate cover of perennial grasses (20%) while bare ground contributed to 56% of the cover. Pasture utilisation was recorded as minimal at 33% of the integrated sites while 17% were moderately grazed, 30% moderate to heavily grazed and 13% were heavily grazed.
								Fair	23	
								Poor	3	
Tennant Creek	20	3	0	16	66	18	2	Good	5	Seasonal quality based on rainfall and AussieGRASS-modelled pasture growth ranged from below average to very much below average across the District. Three percent of the District burnt between October 2018 and September 2019 with most fire activity in January 2019. Analysis of satellite imagery estimates that one quarter of the District recorded bare ground cover >57% per 30-m pixel. Many of the areas across the District with high bare ground were related to historic fire events. On-ground monitoring was undertaken on two leases. The integrated sites had moderate to high levels of bare ground (60%) and moderate levels of perennial (14%) and annual (13%) grasses. Pasture utilisation at 46% of the sites were assessed as not grazed or minimally grazed while 15% were moderate, 8% heavy and 31% were very heavily grazed.
								Fair	4	
								Poor	4	

Pastoral District	AG[1] Growth Percentile	% PD[2] Burnt	% PD with category of Bare Ground[3]				Site Data		Summary of Pastoral District
			minor	moderate	high	very high	#[4] stations	Rating	#[5] sites	
Plenty	42	1	0	15	72	13	2	Good	6	Rainfall for the District was just below the long-term median however, rainfall was well below the median in the west and south-east of the District. Modelled pasture growth (AussieGRASS) largely reflected the rainfall. There was minimal incidence of fire (1%) across the District between October 2018 and September 2019. Analysis of satellite imagery indicated that just under 15% of the District had <40% bare ground and one quarter had >55% bare ground per 30-m pixel. On-ground monitoring was undertaken on two pastoral leases. The integrated sites, on average, had a moderate to high amount of bare ground, and a moderate contribution of litter and annual and perennial grasses. Pasture utilisation at 50% of the integrated sites was assessed as minimal while 25% were recorded as moderate and the 25% moderately to heavily grazed.
								Fair	7	
								Poor	4	
Northern Alice Springs	8	3	0	18	66	16	11	Good	18	Rainfall was well below the long-term median. Predicted pasture growth (AussieGRASS) was also well below average across the District. Fire across the District was minimal with 3% burnt between October 2018 and September 2019. Analysis of satellite imagery indicates that one-quarter of the District had more than 56% bare ground per 30-m pixel. On-ground monitoring for land condition was conducted on eleven pastoral leases. Bare ground cover values at the integrated monitoring sites were moderate to high with reasonable levels of litter cover and low levels of perennial and annual grasses and forbs. Pasture utilisation at 80% of the sites was assessed as moderate to very heavily grazed, while 16% were minimal and 4% recorded no grazing.
								Fair	30	
								Poor	41	

Pastoral District	AG[1] Growth Percentile	% PD[2] Burnt	% PD with category of Bare Ground[3]				#[4] stations	Site Data		Summary of Pastoral District
			minor	moderate	high	very high		Rating	#[5] sites	
Southern Alice Springs	20	1	0	3	45	52	4	Good	9	Rainfall was below the long-term median across the District. Modelled pasture growth (AussieGRASS) for the District ranged from below average to very much below average. Analysis of satellite imagery indicated that one quarter of the District had more than 70% bare ground per 30-m Landsat pixel. Fire over the previous 12 months was minimal (impacting 1% of the District) and did not appear to be a contributing factor however; the legacy effects of fires in 2011 and 2012 may help to account for higher levels of bare ground in some areas. On-ground monitoring was undertaken on four pastoral leases. On average the integrated monitoring sites, were comprised of more than three quarters bare ground, moderate litter cover and small contributions of grasses and forbs. Pasture utilisation at 16% of the sites were assessed as having minimal levels of grazing, and 73% of the sites were heavy to very heavily utilised.
								Fair	12	
								Poor	20	

1 AussieGRASS modelled pasture growth for the period November 2018 to April 2019 or October 2018 to September 2019 as a percentile of the modelled growth for all previous similar periods. The 12-month growth percentile used for the Northern and Southern Alice Springs Pastoral Districts and the Plenty District. The summer growth percentile reported elsewhere. Percentile values are available for Australia on a 5-km square grid. Reported value is the spatial average of all grid-cell values in the pastoral district.

2 Percentage area of pastoral district burnt between October 2018 and September 2019. Fire scars sourced from the North Australia and Rangelands Fire Information website (www.firenorth.org.au/nafi3). Repeat fires in the Darwin Pastoral District means that cumulative burnt area is greater than the area of the pastoral district.

3 The area of bare ground present between September and November 2019 (spring composite), as a percentage of the area of the pastoral district. Bare ground is derived from Landsat satellite imagery where the fractions of photosynthetic (green) vegetation, non-photosynthetic vegetation (dry vegetation and litter) and bare ground are estimated in each 30-m square pixel (900m2 or 0.09ha). Categories of bare ground are: minor, ≤20% of pixel is bare ground; moderate, 21% - 40% bare ground in pixel; high, 41% - 60% bare ground in pixel; and very high, >60% of pixel is bare ground. The number of pixels in each category are counted, multiplied by pixel area (0.09ha) and converted to the percentage of pastoral district area.

4 Number of stations visited in the pastoral district between October 2018 and October 2019.

5 Number of integrated monitoring sites in each land condition rating score measured in the pastoral district.

DARWIN PASTORAL DISTRICT

Map 2: Location of Darwin Pastoral District

The Darwin Pastoral District encompasses approximately 37 000km^2 and includes 23 pastoral leases.

Seasonal quality based on AussieGRASS-modelled pasture growth, varied from much below to much above average across the Darwin Pastoral District. The District experiences extensive and frequent fire. The total area burnt between October 2018 and September 2019 (17 218km^2) was similar to the preceding reporting period (2017-18, 18 791km^2). Based on the Landsat record for the last 30 years, most areas of reduced vegetation cover were related to recent fire. One-quarter of the District had bare ground above 28% per 30-m pixel (bare ground threshold) late in the 2019 dry season. On-ground monitoring for land condition was conducted at three sites on one pastoral lease. Perennial and annual grasses dominated at the majority of sites, with bare ground, on average, comprising approximately 5% of total ground cover. The lease had some isolated patches of rubber bush (Calotropis procera). Land condition was rated as Good at two sites and Fair at one site.

Seasonal quality

'Seasonal quality' describes the relative value of recent rainfall in producing forage for livestock. It is judged with reference to the historical record. Two indicators are used: rainfall amount compared with the long-term median and expected pasture growth based on rainfall received, simulated using AussieGRASS (www.longpaddock.qld.gov.au).

Descriptors of seasonal quality provide useful context for interpreting various measures of land condition. However, to the extent possible, land condition is assessed independently of seasonal conditions.

Rainfall statistics (Table 3) are based on gridded rainfall produced by the Bureau of Meteorology (www.bom.gov.au/jsp/awap/rain/index.jsp). Pixel (grid cell) values are calculated from rainfall amounts at recognised recording stations. Rainfall is from October of one year to September the following year thus incorporating an entire growing season. Modelled pasture growth is for the summer/wet season period November 2018 to April 2019. This growth is ranked as a percentile of the growth for all previous summers.

Table 3. Indicators of seasonal quality. Data spatially averaged for the Darwin Pastoral District.

Rainfall (mm)		AussieGRASS	
2018 – 2019	1 049	Growth (kg/ha)	1 975
Long-term median	1 272	Percentile	58

DARWIN PASTORAL DISTRICT

Spatially averaged rainfall for the Darwin Pastoral District was less than the long-term median (Table 3) but displayed considerable spatial variation (Figure 5, left-hand panel). Rainfall increased from the south-east to north-east and north-west (drier inland to wetter coastal areas) across the District with areas near the coast in the north-east having rainfall greater than the long term median District rainfall.

Modelled pasture growth over the last summer was slightly above the long term average based on the spatial mean (Table 3), although there were areas with 'very much below average' pasture growth scattered across the District (Figure 5, right-hand panel).

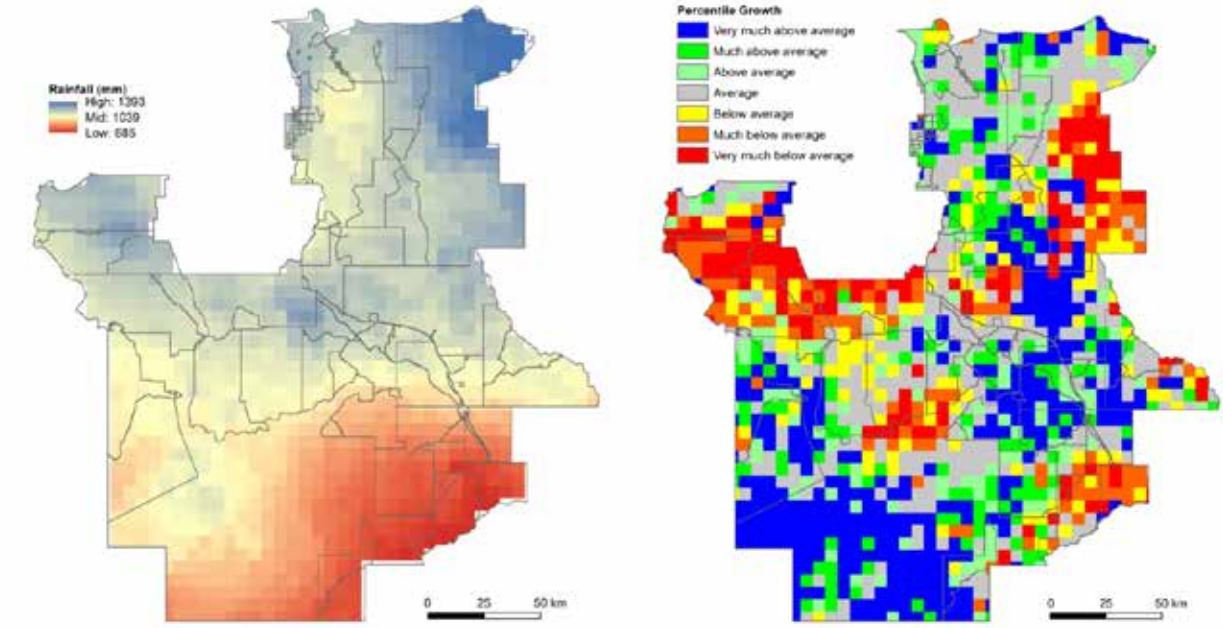

Figure 5. Maps of seasonal quality. Left, spatially interpolated rainfall, October 2018 to September 2019; right, AussieGRASS-modelled pasture growth for the 2018-19 summer (wet season) period as a percentage of previous summers. The grid cells on this map are at 5km x 5km resolution (i.e. each square represents 25km^2) area burnt (km^2).

DARWIN PASTORAL DISTRICT

Rainfall data for the District over the past six years indicates that for three out of the six years rainfall has been below the median with 2018-19 receiving the lowest rainfall (Figure 6).

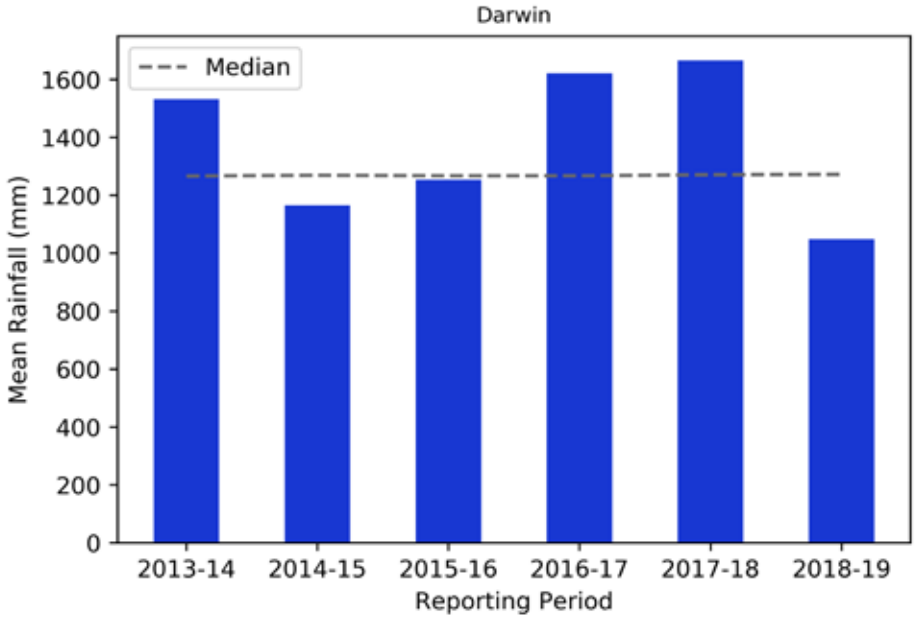

Figure 6. Spatially averaged historic rainfall for the Darwin Pastoral District. Long-term median indicated by dashed line.

Modelled pasture growth over the past six years indicates that four out of the six years pasture growth was above the median percentile, including 2018-19 (Figure 7).

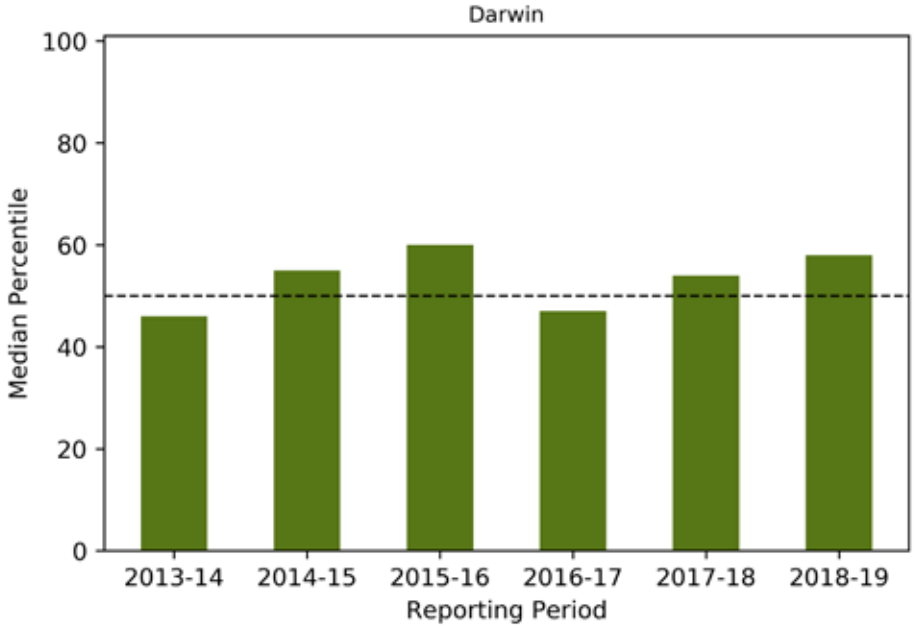

Figure 7. Historic pasture growth (kg/ha) from AussieGRASS for the Darwin Pastoral District. Long-term median indicated by dashed line.

DARWIN PASTORAL DISTRICT

Fire

The North Australia and Rangelands Fire Information website (www.firenorth.org.au/nafi3/) reports that 17 330km² burnt (47% of Darwin Pastoral District) between October 2018 and September 2019 (Figure 8). This was similar to the previous two reporting periods (October 2017 to September 2018 and October 2016 to September 2017), which recorded areas of 18 791km² and 15 808km² burnt.

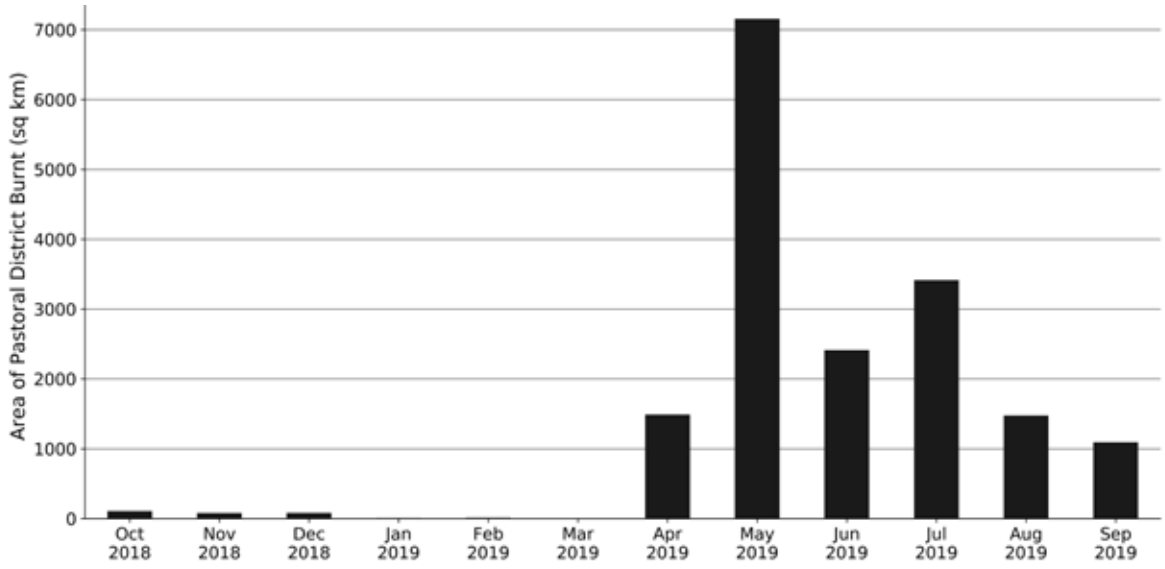

Figure 8. Monthly area burnt (km²) in the Darwin Pastoral District between October 2018 and September 2019.

Ground cover dynamics

It is important to maintain adequate ground cover in the latter months of each year to minimise ground loss from wind erosion and intense summer storms. It is also important to carry dry feed, and associated ground cover, into the latter months of each calendar year in case there is a late start to the usual wet season and/or monsoonal rains fail more generally.

Vegetation cover in the Darwin Pastoral District is strongly correlated with incidence of fire which is a recurrent (almost annual) event across the Top End region. Most areas of reduced vegetation cover, compared with the last 30 years, across much of the District were associated with recent fire (Figure 9, burnt areas shown with diagonal hatching). Ignoring fire effects on the dynamics of vegetation cover, almost half of the District had their lowest levels of cover in late 2019 compared with the same period back to 1988. Contrasting with this were small patches scattered across the District with their highest late dry-season cover since 1988.

DARWIN PASTORAL DISTRICT

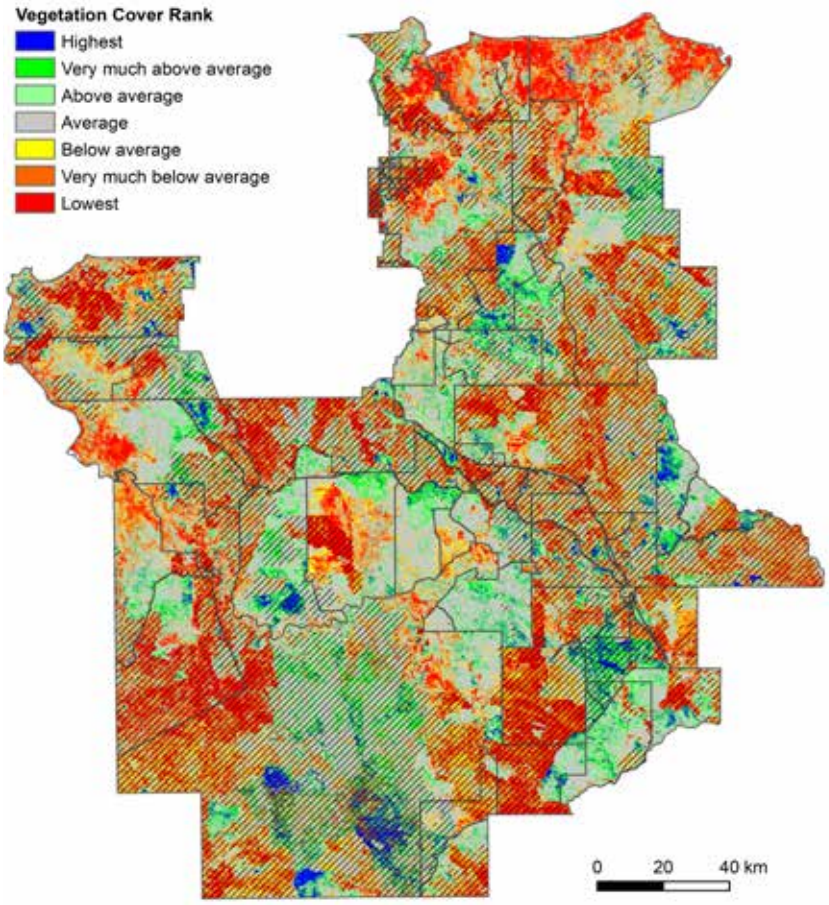

Figure 9. Rank of the amount of remotely-sensed vegetation cover present from September to November 2019 against that for previous years back to 1988. Diagonal lines show those areas burnt between January and November 2019.

The amount of bare ground present at any location changes from year to year depending on rainfall and its effectiveness, fire history and amount of grazing. The percentage of bare ground in each 30-m square Landsat pixel (900m2 or 0.09ha) was used to report the amount of bare ground across all pixels in the Darwin Pastoral District for the end of dry season (September to November Spring composite).

Approximately 57% of the District had minor amounts of bare ground (<20% of the 30-m Landsat pixel) towards the end of 2019 (Figure 10). The threshold level of bare ground used for mapping purposes is selected to show at what level approximately 25% of the district is affected; for the Darwin Pastoral District, this was calculated as 28% bare ground in each Landsat pixel (mapped in Figure 11). It includes areas burnt earlier in 2019.

DARWIN PASTORAL DISTRICT

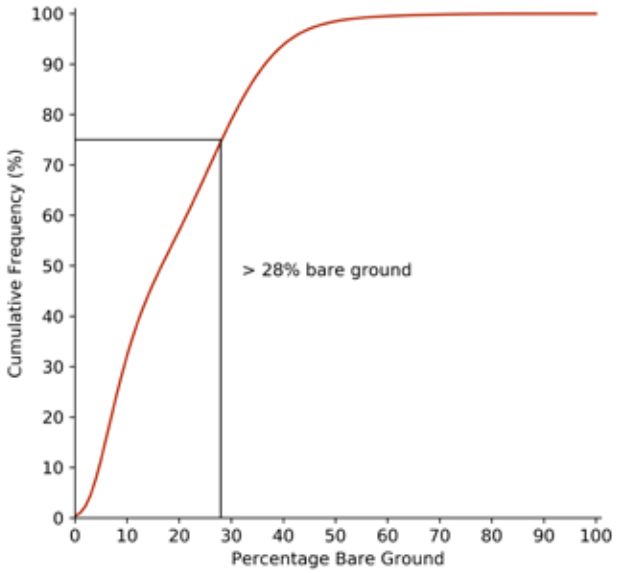

Figure 10. Percentage cumulative frequency of varying levels of bare ground in 30-m square Landsat pixels in the Darwin Pastoral District between September and November 2019. Areas with >28% bare ground are mapped in Figure 11.

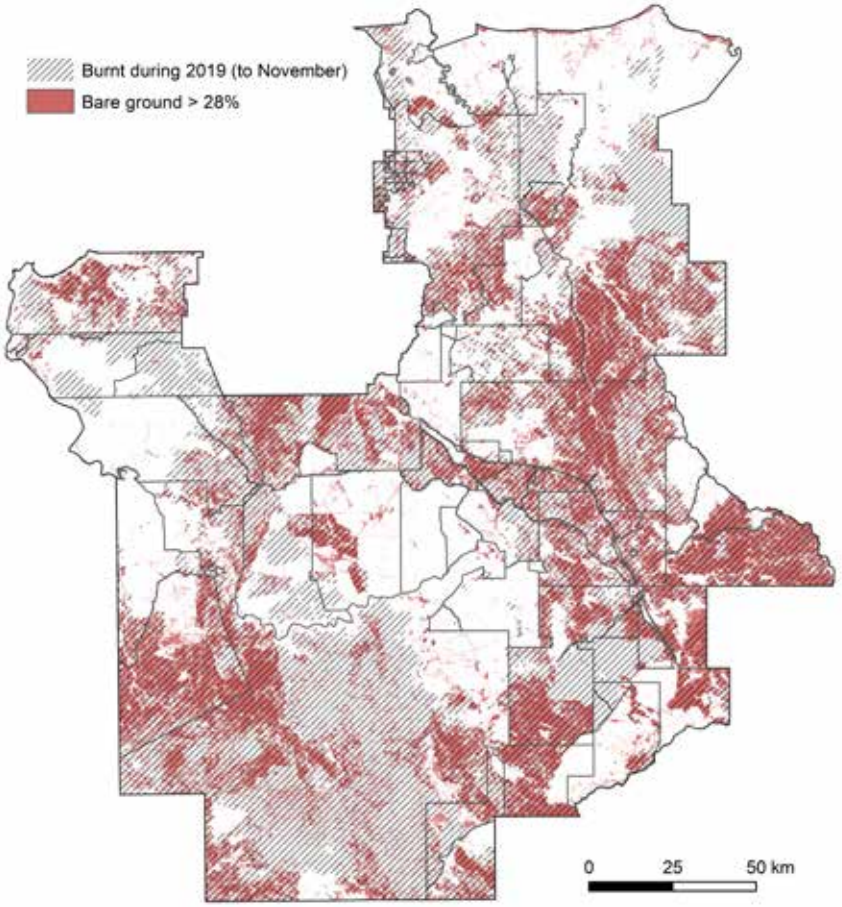

Figure 11. Parts of the Darwin Pastoral District having >28% bare ground per Landsat pixel in late 2019. Areas burnt between January and November 2019 shown with diagonal lines. Note that the threshold level of bare ground used for mapping purposes varies between pastoral districts. It is selected to show at what l approximately 25% of the district is affected.

DARWIN PASTORAL DISTRICT

Site-based monitoring

One pastoral lease in the Darwin Pastoral District was visited in 2019.

Vegetation cover of the ground layer was measured at three sites on the lease. Annual and perennial grasses were the dominant component, by cover, at most sites (Figure 12). Moderate amounts of litter were generally present, consistent with the more timbered land systems, with basal area recorded at all three sites. Bare ground, on average, comprised approximately 5% of total ground cover.

Perennial grasses are important because they protect the ground surface against wind and water erosion and, where palatable, provide persistent forage to carry livestock through dry times. Litter cover also protects the ground surface, assists infiltration of rain water and helps retain plant seeds in-situ.

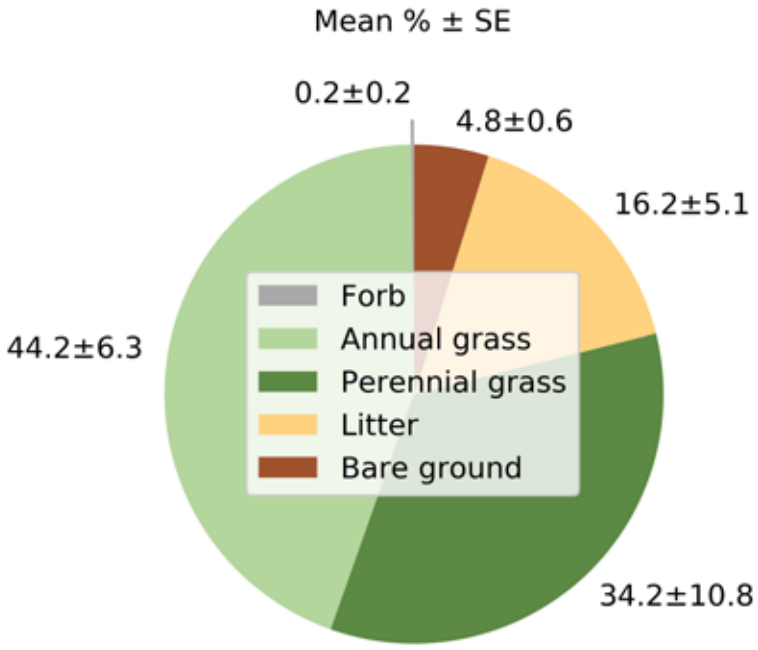

Figure 12. Mean: percentage and standard error of measured components of vegetation cover in the ground layer from three sites on one pastoral lease in the Darwin Pastoral District.

DARWIN PASTORAL DISTRICT

Two of the three sites (67%) had minimal grazing (Table 4). There was no evidence of erosion recorded at any of the monitoring sites, consistent with the high cover provided by perennial grasses and litter.

Table 4. Levels of pasture utilisation recorded at 18 sites on four pastoral leases in the Darwin Pastoral District.

Pasture Utilisation	
Rank	**% of sites**
No grazing	33
Minimal (<25%)	67
Moderate (26-50%)	0
Moderate to heavy (51-75%)	0
Heavy (76-90%)	0
Very heavy (>90%)	0

Land condition ratings assigned at monitoring sites and the more generalised assessment of land condition across those parts of pastoral leases traversed are summarised in Table 5. To the extent possible, these assessments are independent of the variable seasonal quality across the Darwin Pastoral District during 2018-19 (described above).

Table 5. Assessed land condition at monitoring sites and traversed parts of four pastoral leases in the Darwin Pastoral District.

Station	Condition Rating (number of sites)	Comments with regard to pastoral lease
1	Good: 2 Fair: 1	Land condition across the property was generally assessed as Good condition, which is consistent with the previous monitoring conducted in 2015. The 2018-19 below average wet season slightly affected pasture growth. Isolated areas of erosion were observed on the property, especially along roads, tracks, and fence lines. There were isolated weed infestations, including hyptis and sida. Weed management programs were in place on the property. Frequent early dry season fires appear to be resulting in a loss of more pastorally productive species and an increase in annual spear grass.

KATHERINE PASTORAL DISTRICT

Map 3: Location of Katherine Pastoral District

The Katherine Pastoral District encompasses just over 19 000 km^2. Seasonal quality, as indicated by AussieGRASS-modelled pasture growth, was very much below average to very much above average.

Approximately 34% of the District was affected by fire between October 2018 and September 2019, with the most extensive areas being burnt in November and December 2018 and May 2019. One-quarter of the District had bare ground above 30% per 30-m pixel (bare ground threshold) late in the 2019 dry season. Approximately half of the District had minor occurrence (<20%) of bare ground at this time. On-ground monitoring was conducted at fifteen sites on four pastoral leases, with one site rated as excellent, eleven sites rated as Good and three as Fair. Sites, on average, had a moderate cover of perennial grasses, low bare ground, and moderate amounts of litter, as would be expected from more timbered country in this District. Forbs and annual grasses were minor components of total ground cover.

Seasonal quality

'Seasonal quality' describes the relative value of recent rainfall in producing forage for livestock. It is judged with reference to the historical record. Two indicators are used: rainfall amount compared with the long-term median and expected pasture growth based on rainfall received, simulated using AussieGRASS (www.longpaddock.qld.gov.au).

Descriptors of seasonal quality provide useful context for interpreting various measures of land condition at particular times. However, to the extent possible, land condition is assessed independently of seasonal conditions.

Rainfall statistics (Table 6) are based on gridded rainfall produced by the Bureau of Meteorology (www.bom.gov.au/jsp/awap/rain/index.jsp). Pixel (grid cell) values are calculated from rainfall amounts at recognised recording stations. Rainfall is from October of one year to September the following year thus incorporating an entire growing season. Modelled pasture growth is for the period November 2018 to April 2019. This growth is ranked as a percentile of the growth for all previous summers (back to 1957).

Table 6. Indicators of seasonal quality. Data spatially averaged for the Katherine Pastoral District.

Rainfall (mm)		AussieGRASS modelled pasture growth	
2018 – 2019	706	2018 - 19 Growth (kg/ha)	2 096
Long-term median	906	Long-term median	59

KATHERINE PASTORAL DISTRICT

Spatially averaged rainfall for the Katherine Pastoral District was significantly below the long-term median (Table 6) with most of the north receiving up to 999mm between October 2018 and September 2019. The south and south west parts of the region had notably lower rainfall at less than 800mm. The 2018-19 rainfall was the lowest when compared with the previous 5 years (Figure 13). Rainfall for the 2013-14, 2014-15, and 2017-18 growing seasons was close to the long term median, while the 2015-16 and 2016-17 seasons had significantly above median rainfall.

Modelled pasture growth over the last summer was above average based on the spatial mean (Table 6), although there was some variation across the region; very much above average for much of the southern and western portion of the District; very much below average to average for the north-east (Figure 38, right-hand panel). A comparison of the 2018-19 pasture growth with the previous 5 years is shown in Figure 20. Modelled pasture growth for 2018-19, 2017-18, and 2015-16 was above the long term median, while 2013-14, 2014-15, and 2016-17 had below median pasture growth. It is obvious from Figure 14 and Figure 15 that seasonal rainfall averages across the district over the last six years is not directly reflected in pasture growth levels.

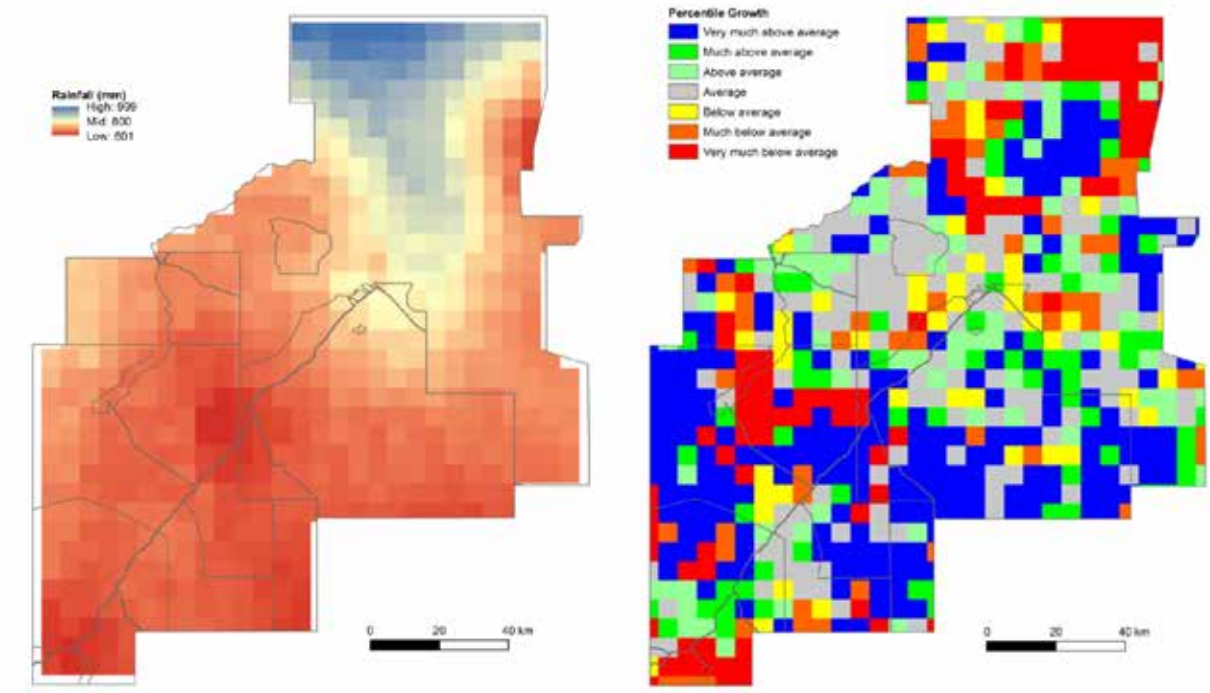

Figure 13. Maps of seasonal quality. Left, Spatially interpolated rainfall, October 2018 to September 2019; right, AussieGRASS-modelled pasture growth for the 2018-19 summer period as a percentage of previous summers. The grid cells on these maps are at 5km x 5km resolution (i.e. each square represents 25kms)

KATHERINE PASTORAL DISTRICT

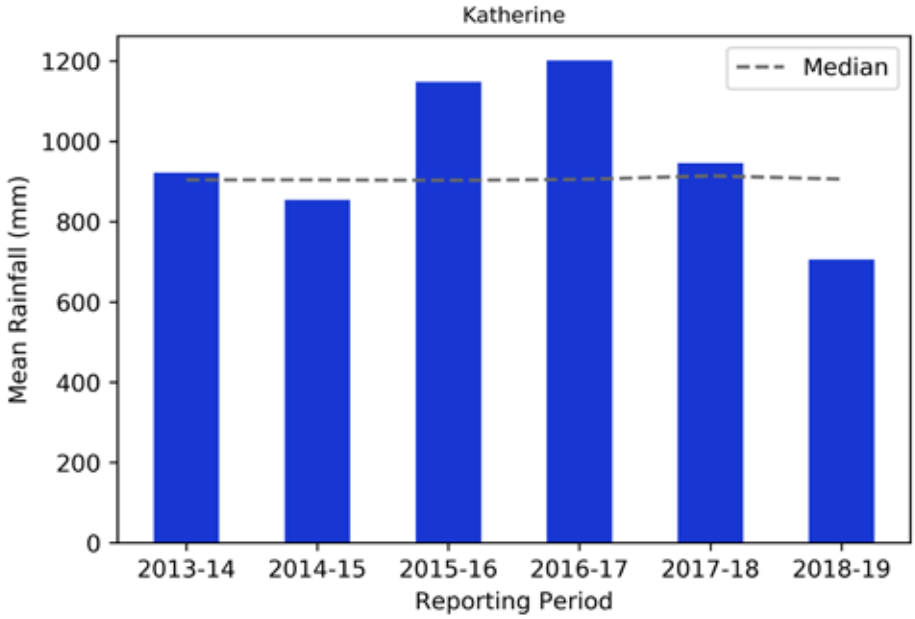

Figure 14. Spatially averaged historic rainfall for the Katherine Pastoral District.

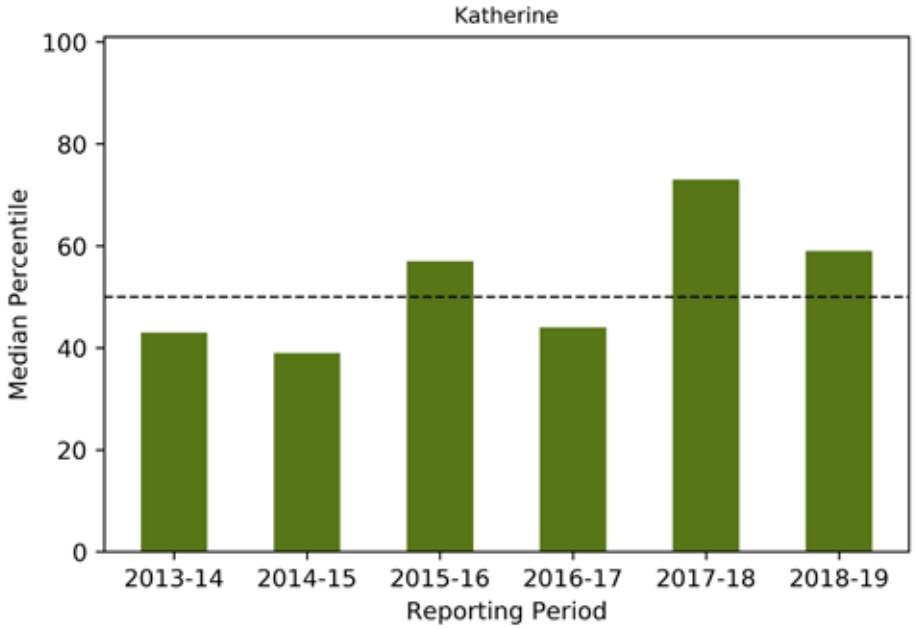

Figure 15. Historic pasture growth (as a percentile of long term growth) from AussieGRASS for the Katherine Pastoral District.

KATHERINE PASTORAL DISTRICT

Fire

The North Australia and Rangelands Fire Information website (www.firenorth.org.au/nafi3/) reports that 6 669km^2 (34% of the District) burnt between October 2018 and September 2019. There was some fire activity in November and December 2018 (Figure 16) suggesting wildfire was the main reason (as this is typically when wildfires started by lightning occur). In 2019, the main peak in fire activity over the reporting period was in April, May and August 2019, probably due to managed early dry-season burning (April, May) and wildfires (August).

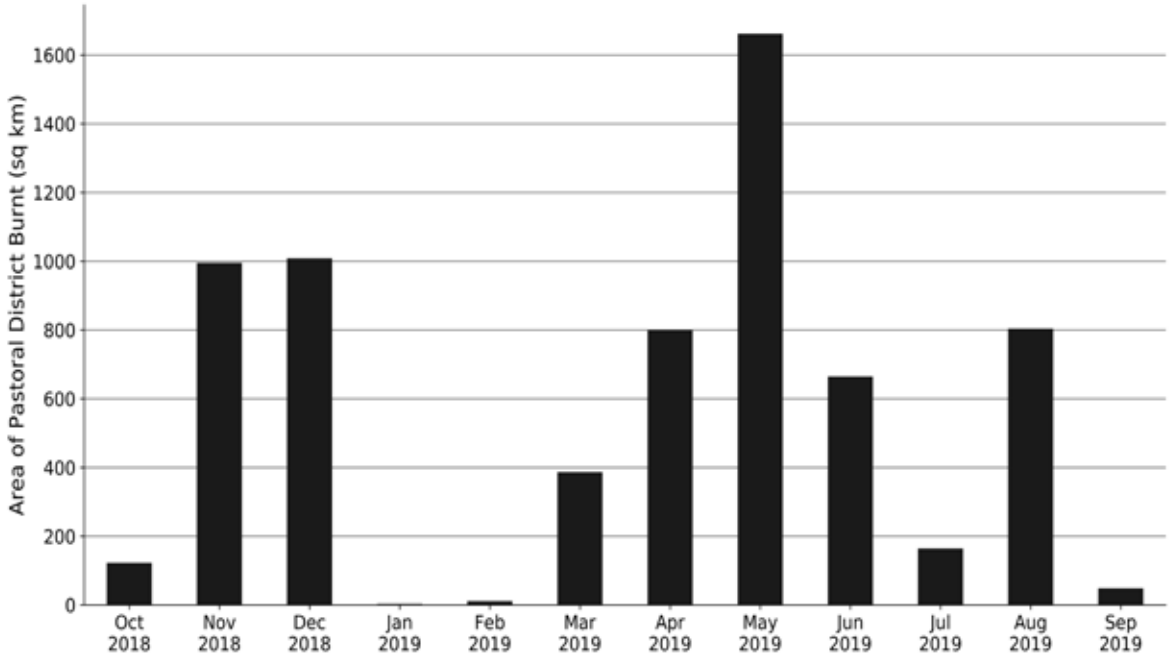

Figure 16. Monthly area burnt (km2) in the Katherine Pastoral District between October 2018 and September 2019.

Ground cover dynamics

It is important to maintain adequate ground cover in the latter months of each year to minimise soil loss from wind erosion and intense wet-season storms. It is also important to carry dry feed, and associated ground cover, into the latter months of each calendar year in case there is a late start to the usual wet season and/or monsoonal rains fail more generally.

Recent fire contributed to the majority of the reduced vegetation cover compared with the last 30 years, occurring across much of the Katherine Pastoral District (Figure 17, burnt areas shown with diagonal hatching). There were a number of large contiguous patches of very much above average and highest levels of vegetation cover; and scattered smaller patches of above average to highest levels of vegetation cover against a background of average levels of vegetation cover. The areas of lowest vegetation cover mostly corresponded to fire in 2019. There were some patchy areas of below-average vegetation cover that did not correspond to fire, particularly in the southern part of the district.

KATHERINE PASTORAL DISTRICT

The amount of bare ground present at any location changes from year to year depending on rainfall and its effectiveness, fire history and amount of grazing. The percentage of bare ground in each 30-m Landsat pixel (900m^2 or 0.09ha) was used to report the amount of bare ground across all pixels in the Katherine Pastoral District.

The bare ground threshold is based on the cumulative frequency distribution of bare ground for all 30-m Landsat pixels at the end of 2019 (spring composite). The bare ground percentage corresponding to 75% cumulative frequency was selected as the bare ground threshold (Figure 18). Bare ground percentage for 75% of the district is equal to or below this threshold. The remaining 25% of the district is considered to have above-threshold bare ground.

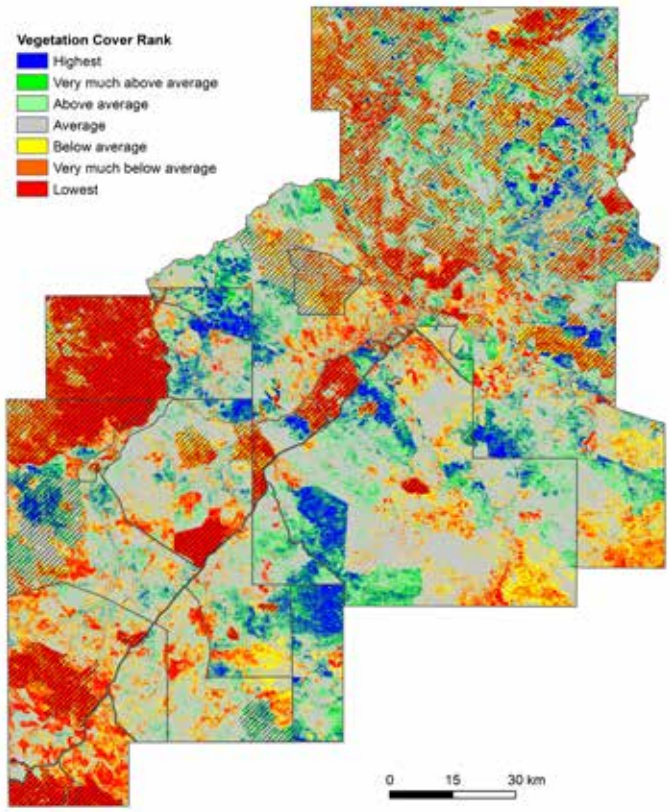

Figure 17. Rank of the amount of remotely-sensed vegetation cover present in late 2019 against that for previous years back to 1988. Diagonal lines show those areas burnt between January and November 2019.

Fifty two percent of the District had minor amounts of bare ground (< 20% of the 30-m Landsat pixel) towards the end of 2019 (Figure 24). The bare ground threshold value for the Katherine Pastoral District was 30%; one quarter of the District had bare ground per pixel greater than this value (Figure 20) and includes areas burnt earlier in 2019.

KATHERINE PASTORAL DISTRICT

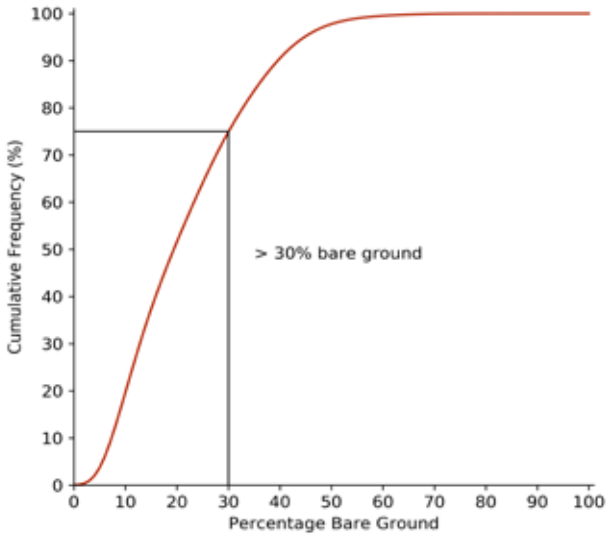

Figure 18. Percentage cumulative frequency of varying levels of bare ground in 30-m Landsat pixels in the Katherine Pastoral District between September and November 2019. Areas with greater than 30% bare ground are mapped in Figure 19.

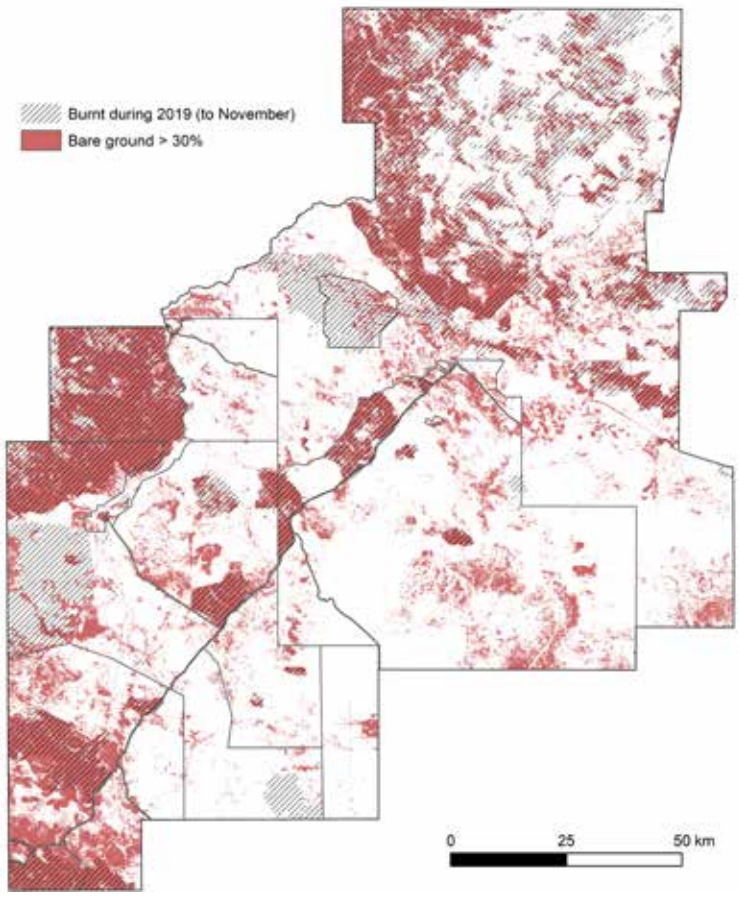

Figure 19. Parts of the Katherine Pastoral District having more than 30% bare ground per Landsat pixel in late 2019. Areas burnt between January and November 2019 shown with diagonal lines. Note that the threshold level of bare ground used for mapping purposes varies between pastoral districts. It is selected to show at what level approximately 25% of the district is affected.

KATHERINE PASTORAL DISTRICT

Site-based monitoring

Four pastoral leases within the Katherine Pastoral District were visited during 2019.

Vegetation cover of the ground layer was measured at fifteen sites across the four leases. Perennial grasses, on average, comprised greater than half of the sites (Figure 20). Annual grasses and forbs (both perennial and annual) were a minor component, partly due to the late dry season timing of the monitoring. Moderate amounts of litter were generally present, which is not unexpected given the timbered landscapes in this District, and contributed to the low levels of bare ground as a percentage of total ground cover.

Perennial grasses are important because they protect the soil surface against wind and water erosion and, where palatable, provide persistent forage to carry livestock through dry times. Litter cover also protects the soil surface, assists infiltration of rain water and helps retain plant seeds in situ.

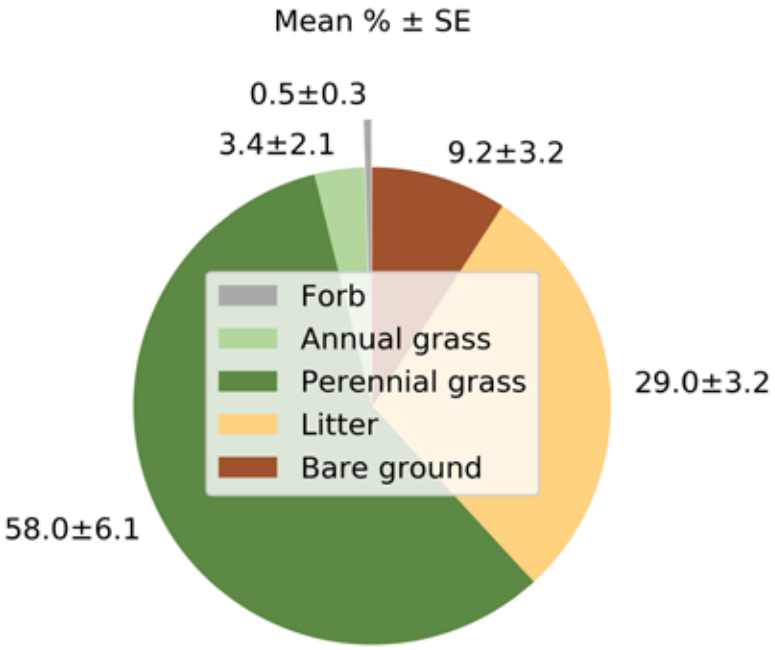

Figure 20. Mean percentage and standard error of measured components of vegetation cover in the ground layer from fifteen sites on four pastoral leases in the Katherine Pastoral District.

KATHERINE PASTORAL DISTRICT

The majority of integrated monitoring sites had minimal or moderate grazing (Table 7). There was no evidence of erosion recorded at any of the integrated monitoring sites, however there were major erosion issues affecting roadsides on one of the leases

Table 7. Levels of pasture utilisation recorded at eight sites on two pastoral leases in the Katherine Pastoral District.

Pasture Utilisation

Rank	% of sites
No grazing	7
Minimal	66
Moderate	20
Moderate to heavy	7

Land condition ratings assigned at monitoring sites and the more generalised assessment of land condition across those parts of the pastoral lease traversed are summarised in Table 8. To the extent possible, these assessments are independent of the variable seasonal quality across the Katherine Pastoral District during 2018-19 (described above).

KATHERINE PASTORAL DISTRICT

Table 8. Assessed land condition at monitoring sites and traversed parts of two pastoral leases in the Katherine Pastoral District.

Station	Condition Rating (number of sites)	Comments with regard to pastoral lease
1	Good: 3 Fair: 1	Land condition was generally assessed as Good condition which is consistent with the previous visit in 2014. Pasture responded reasonably well to the 2018-19 below average wet season with the majority of the property having low bare ground, mixed percentage of vegetation cover and low levels of undesirable species. The only area of concern was an area within one paddock which was heavily grazed resulting in low pasture growth. There were no significant areas of weed infestations or erosion. There was some woody thickening in one paddock but this was of little concern in terms of land condition.
2	Good: 2 Fair: 1	Land condition on this station was generally assessed as Good to Fair condition. Changes in land condition scores at monitoring sites, and supported by fractional cover and bare ground threshold products, indicated that land condition was consistent with the previous monitoring conducted in 2014. The 2018-2019 below-average wet season was reflected in the lower than usual pasture production, however there was a good-fair diversity of palatable desirable perennial grass species.
3	Excellent: 1 Good: 2 Fair: 1	Land condition was generally assessed as Poor condition due to significant areas of erosion and weed infestations. The property can be viewed as two separate areas with a main road running east to west dividing the previously cleared and extensively utilised north paddocks and the relatively unimproved southern paddocks. Condition in the south is in Fair condition and in general the integrated monitoring sites are in Good to Fair condition. However this is due to sites being further into the paddock with major erosion issues affecting roadsides and no sites in heavily weeded areas. Changes in land condition scores at monitoring sites, and supported by fractional cover and bare ground threshold products, indicate that land condition was consistent with the previous monitoring conducted in 2015 with some erosion control established and a start to weed control.
4	Good: 4	Land condition on this station was generally assessed as Good condition, which is consistent with the previous monitoring conducted in 2014. The 2018-19 well below average wet season was reflected in fair pasture growth. No significant areas of erosion were observed.

VRD PASTORAL DISTRICT

The Victoria River District (VRD) Pastoral District is the second largest of the eleven districts, encompassing just over 134 000 km^2.

Map 4: Location of VRD Pastoral District

The District experienced mostly below average seasonal quality in the north, and well below average in the south, based on below median rainfall and well below median (14th percentile) modelled pasture growth through the 2018-19 wet season. Almost 19% of the District burnt between October 2018 and September 2019. Twenty five per cent of the District had >54% bare ground per Landsat pixel (bare ground threshold), which (particularly in the north) was strongly associated with fires in either 2018 or 2019. This area includes 'desert-like' country of low pastoral value that is periodically burnt. On-ground monitoring was conducted at 11 sites on two pastoral leases, during June and July 2019. Sites, on average, had only moderate cover of perennial grasses and approximately a third of the site was comprised of bare ground and litter. Forbs and annual grasses were minor components of total ground cover. Nine sites were in Good condition and two in Fair condition.

Seasonal quality

'Seasonal quality' describes the relative value of recent rainfall in producing forage for livestock. It is judged with reference to the historical record. Two indicators are used: rainfall amount compared with the long-term median and expected pasture growth based on the rainfall received, simulated using AussieGRASS (www.longpaddock.qld.gov.au).

Descriptors of seasonal quality provide useful context for interpreting various measures of land condition at particular times. However, to the extent possible, land condition is assessed independently of seasonal conditions.

Rainfall statistics (Table 9) are based on gridded rainfall data produced by the Bureau of Meteorology (www.bom.gov.au/jsp/awap/rain/index.jsp). Pixel (grid cell) values are calculated from rainfall amounts at recognised recording stations. Rainfall is from October of one year to September the following year thus incorporating one entire growing season. Due to the considerable north-south transition in long-term median rainfall for this large District, rainfall statistics are reported based on an arbitrary split of the region into two sub-districts (Figure 21). Spatially averaged rainfall for the north and south sub-districts of the VRD Pastoral District was below the long-term median across each sub-district (Table 9).

Table 9. Recent seasonal quality for the VRD Pastoral District as indicated by spatially averaged rainfall relative to the long-term median.

Rainfall (mm)	VRD North	VRD South
2018 – 2019	534	236
Long-term median	758	464

VRD PASTORAL DISTRICT

In the north of the District, there was a considerable north-to-south decrease in the spatial distribution of rainfall (Figure 21), whereas this was more uniformly distributed in the south, as indicated by the colour shading in Figure 21. Land fringing the Tanami Desert in the south east of the District had lower rainfall (<200mm) for the 12 months between October 2018 and September 2019. Spatially averaged historic rainfall for the five reporting seasons prior to 2018-19 for the north and south VRD Districts is shown in Figure 22 and Figure 23. For both the north and south, the mean rainfall was at or above the median for the first four years and below the median in 2017-18.

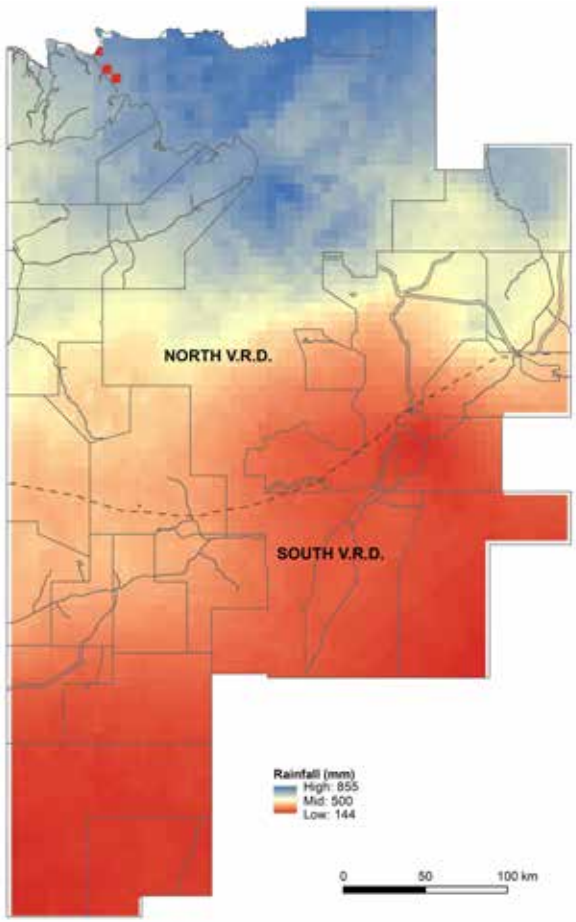

Figure 21. Spatially interpolated, gridded rainfall for the Victoria River Pastoral District. Reporting period is October 2018 to September 2019. The grid cells on this map are at 5km x 5km resolution (i.e. each square represents 25km^2).

VRD PASTORAL DISTRICT

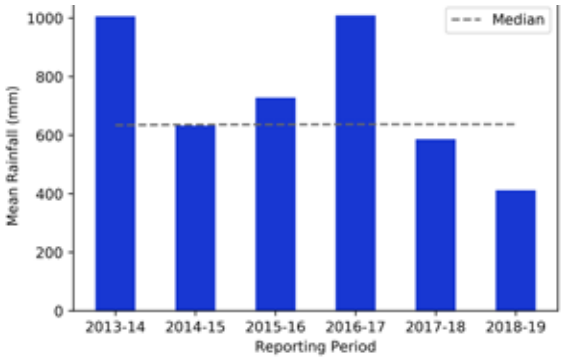

Figure 22. Spatially averaged historic rainfall for north VRD Pastoral District. Long-term median indicated by dashed line.

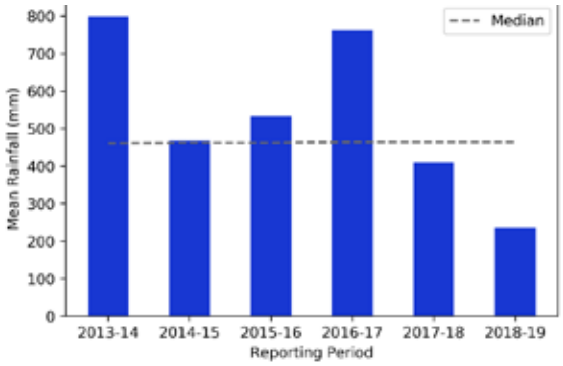

Figure 23. Spatially averaged historic rainfall for south VRD Pastoral District. Long-term median indicated by dashed line.

AussieGRASS-modelled pasture growth, as a second indicator of seasonal quality for the entire VRD Pastoral District, is for the period November 2018 to April 2019. This growth is ranked as a percentile of the growth for all previous summers back to 1957. In this case, spatially-averaged growth through the 2018-19 wet season was well below the long-term median (Table 10).

The median percentile pasture growth for the entire VRD Pastoral District for the five reporting periods prior to 2018-19 is shown in Figure 24. These five reporting periods, prior to 2018-19, indicate pasture growth was above the 40th percentile.

Table 10. Recent seasonal quality averaged across the entire VRD Pastoral District, as indicated by modelled pasture growth.

	AussieGRASS
Growth (kg/ha)	973
Percentile	14

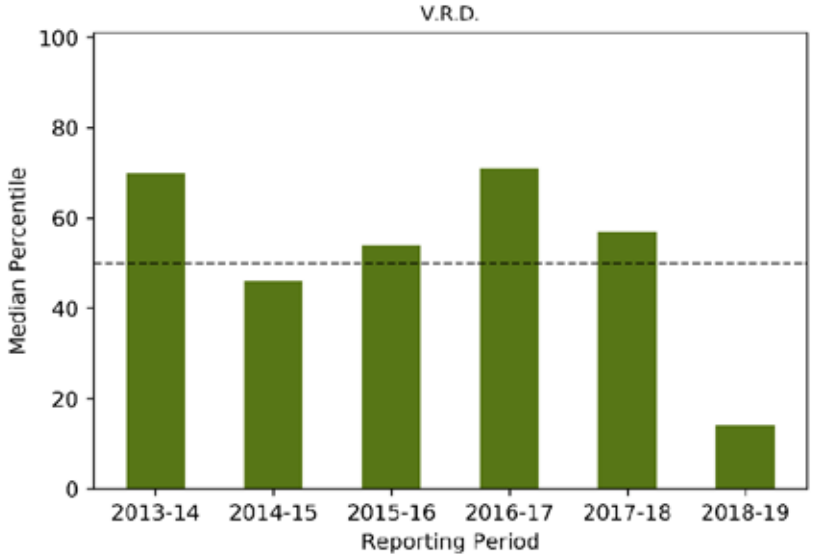

Figure 24. Median percentile pasture growth for the entire VRD Pastoral District for the five reporting periods prior to 2018-19. The 50th percentile is indicated by a dashed line..

VRD PASTORAL DISTRICT

Modelled pasture growth over the 2018-19 wet season, as a percentage of the long-term record, was mostly very much below-average across most of the District (Figure 25).

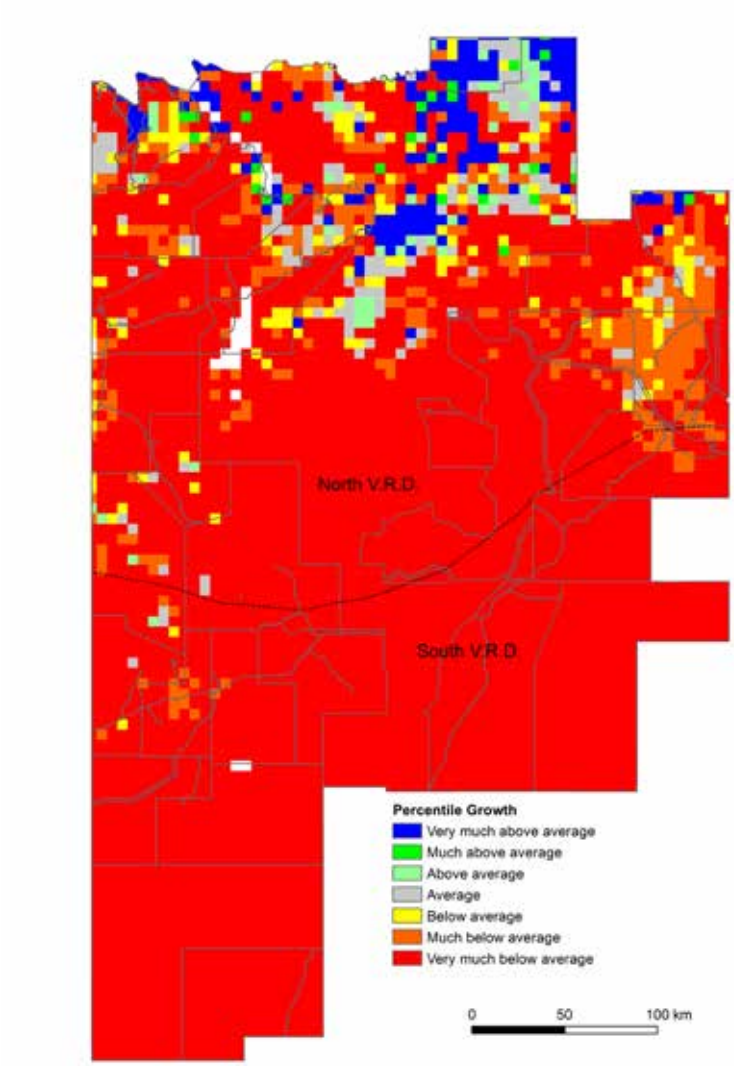

Figure 25. Simulated pasture growth for the 2018-19 wet season as a percentage of the long-term record. The grid cells on this map are at 5km x 5km resolution (i.e. each square represents 25km^2).

VRD PASTORAL DISTRICT

Fire

The North Australia Rangelands and Fire Information website (www.firenorth.org.au/nafi3) reports that 25 065km² (19%) of the District was burnt between October 2018 and September 2019 (Figure 26). This was less than that burnt in the previous (2017-18) reporting period (38 687km²). Fire was most extensive in October to December 2018 and in July and August 2019, which may have been due to controlled burning.

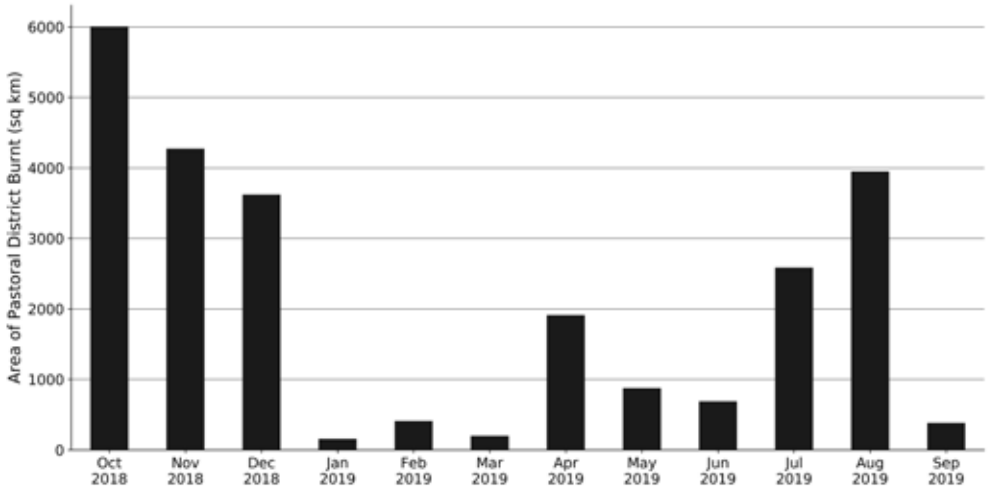

Figure 26. Monthly area burnt (sq. km) in the VRD Pastoral District between October 2018 and September 2019.

Ground cover dynamics

It is important to maintain adequate ground cover in the latter months of each year to minimise soil loss from wind erosion and intense summer storms. It is also important to carry dry feed, and associated ground cover, into the latter months of each calendar year in case there is a late start to the usual wet season and/or monsoonal rains fail more generally.

Fire during 2019 (and below-average rainfall for the 2018-19 wet season) contributed to reduced vegetation cover, compared with the last 30 years, across most of the northern parts of the District (Figure 27). Fire was also a contributing factor to the lowest average vegetation cover elsewhere, with extensive fires in the south during 2017 (fire scars not shown), followed by the lower rainfall in 2019 (Figure 22 and Figure 23).

VRD PASTORAL DISTRICT

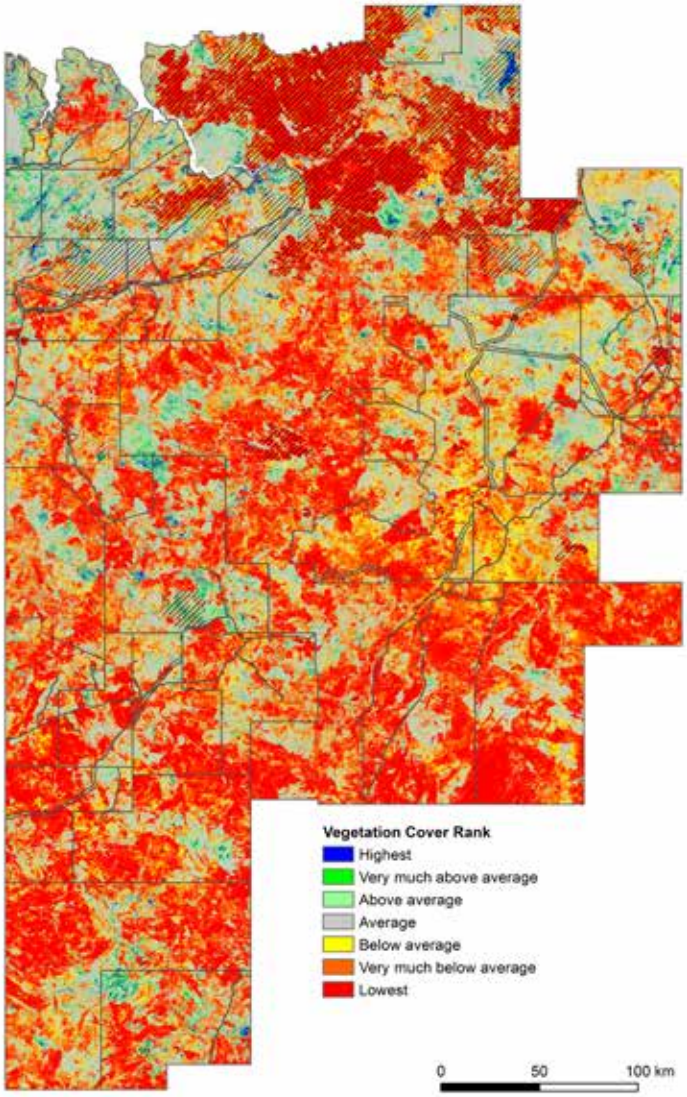

Figure 27. Rank of the amount of remotely-sensed vegetation cover present from September to November 2019 against that for previous years back to 1988. Diagonal lines show those areas burnt between January and November 2019.

VRD PASTORAL DISTRICT

The amount of bare ground present at any location changes from year to year depending on rainfall and its effectiveness, fire history and amount of grazing. Remote sensing was used to assess the amount of bare ground. The percentage of bare ground in each 30-m square Landsat pixel (900m^2 or 0.09ha) was used to report the amount of bare ground across all pixels in the VRD Pastoral District.

Approximately 8% of the District had minor levels of bare ground (<20% of the 30-m Landsat pixel) towards the end of 2019 (Figure 28). The bare ground threshold value for the VRD Pastoral District was 54%; one quarter of the District had bare ground per pixel greater than this value (Figure 28 and Figure 29) and includes some of the country burnt in 2019 (until November).

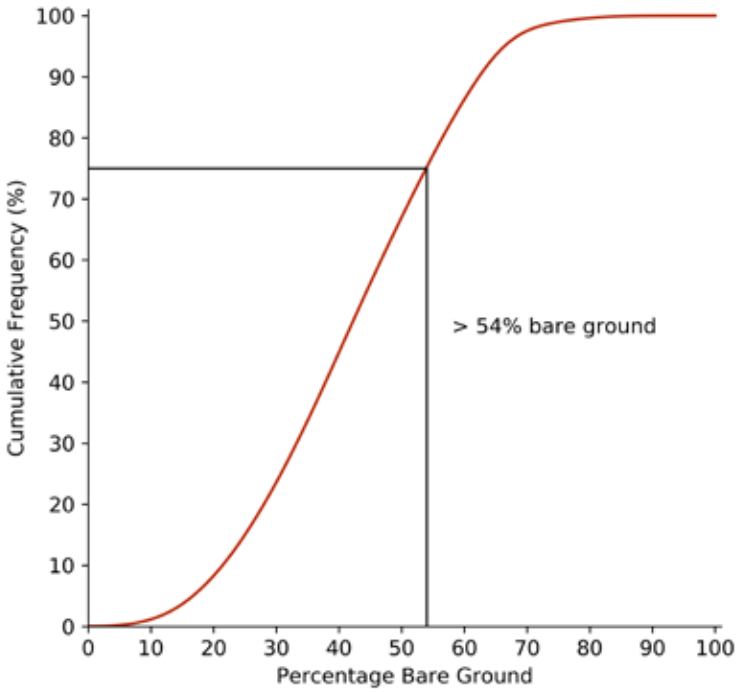

Figure 28. Percentage cumulative frequency of varying levels of bare ground in 30-m square Landsat pixels in the VRD Pastoral District between September and November 2019. Areas with greater than 54% bare ground are mapped in Figure 29.

VRD PASTORAL DISTRICT

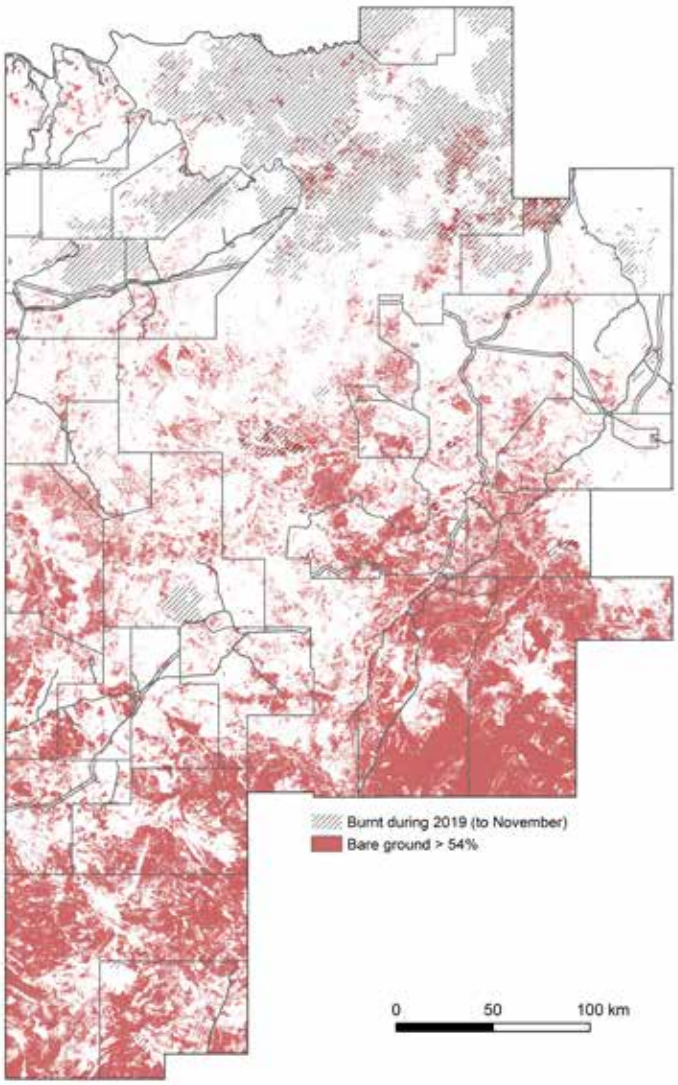

Figure 29. Parts of the VRD Pastoral District having greater than 54% bare ground per Landsat pixel in late 2019 (bare ground threshold). Country burnt between January and November 2019 is shown with diagonal lines. Note that the threshold level of bare ground used for mapping purposes varies between pastoral districts. It is selected to show at what level approximately 25% of the district is affected.

Concentrated areas exceeding the 54% bare ground threshold in the south and south-east include desert country of low pastoral value. Wildfire occurs most years here and the extensive 2017 fires probably contributed to elevated levels of bare ground, compounded by poor seasonal quality in 2018-19, as indicated by modelled pasture growth in this south eastern area (Figure 25).

VRD PASTORAL DISTRICT

Site-based monitoring

Two pastoral leases in the VRD Pastoral District were visited by monitoring officers in 2019.

Vegetation cover of the ground layer was measured at 11 sites across the two leases. Sites, on average, had only moderate cover of perennial grasses and approximately half the site comprised bare ground and litter (Figure 30). Only one of the 11 sites had bare ground measured at more than 30%, but this was likely to increase as the season progressed and litter disappeared. Annual grasses and forbs (both perennial and annual) were minor components of total ground cover.

Perennial grasses are important because they protect the soil surface against wind and water erosion and, where palatable, provide persistent forage to carry livestock through dry times. Litter cover also protects the soil surface, assists infiltration of rain water and helps retain plant seeds in situ.

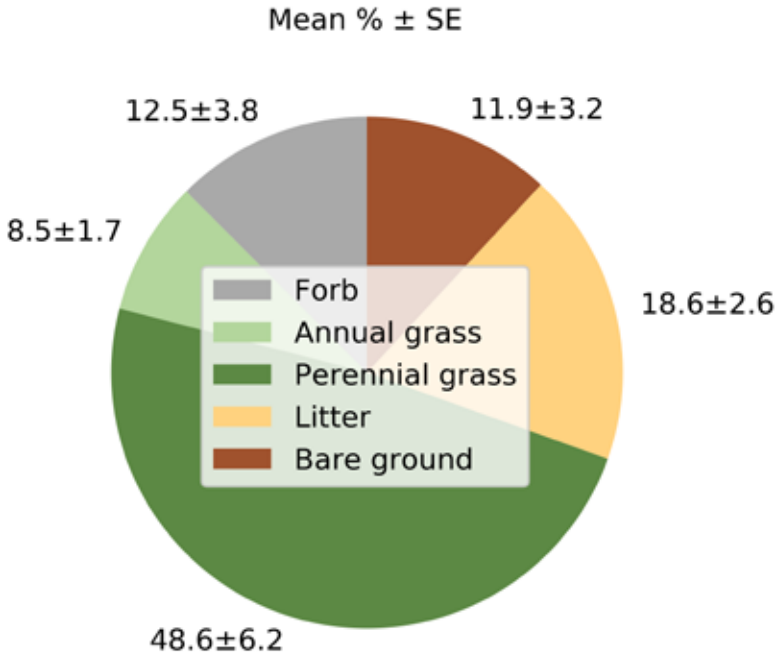

Figure 30. Mean percentage and standard error of measured components of vegetation cover in the ground layer from 11 sites on two pastoral leases in the VRD Pastoral District.

VRD PASTORAL DISTRICT

Most sites were minimally grazed at the time of assessment (Table 11). There was no erosion recorded across the 11 monitoring sites.

Table 11. Levels of pasture utilisation assessed at 11 sites on two pastoral leases in the VRD Pastoral District.

Pasture Utilisation	
Rank	**% of sites**
No grazing	0
Minimal (<25%)	91
Moderate (26-50%)	0
Moderate to heavy (51-75%)	9
Heavy (75-90%)	0
Very heavy (>90%)	0

Land condition ratings assigned at monitoring sites and the more generalised assessment of land condition across those parts of pastoral leases traversed are summarised in Table 12. To the extent possible, these assessments are independent of the variable seasonal quality experienced across the region in the current reporting cycle (described above).

Table 12. Assessed land condition at 11 monitoring sites and traversed parts of two pastoral leases in the VRD Pastoral District.

Station	Condition Rating	Comments with regard to pastoral lease
1	Good: 4 Fair: 2	Land condition was assessed as Fair condition. Changes in land condition scores at monitoring sites supported by fractional cover and bare ground threshold products, indicate that land condition has remained consistent since the previous monitoring conducted in 2012. This is despite two poor wet seasons preceding the inspection and the effect of wildfires across the property.
2	Good: 10	Land condition was generally assessed as Good condition. Changes in land condition scores at monitoring sites supported by fractional cover and bare ground threshold products, indicate that land condition has remained consistent since the previous monitoring conducted in 2014. Pasture responded extremely well to the 2018-19 below-average wet season with the majority of the pastorally viable areas of the property having low bare ground with low levels of undesirable species at most sites. There were some areas of weed infestations with the majority being actively treated. Gully erosion and water sheeting were observed on different areas of the property but they appeared stable at the time of inspection. Donkeys and wild dogs were spotted in the south of the property.

STURT PLATEAU PASTORAL DISTRICT

Map 5: Location of Sturt Plateau Pastoral District

This District encompasses just over 43 000 km^2. Eight pastoral leases were assessed for land condition in 2019.

Modelled pasture growth generally reflected rainfall distribution across the Sturt Plateau Pastoral District, with most of the District experiencing well-below-average season quality. Approximately 12% of the District burnt between October 2018 and September 2019. Twenty five percent of the District had >35% bare ground (in each Landsat pixel for the spring composite fractional cover). Monitoring was conducted at 36 sites on eight leases. Sites, on average, had a good cover of perennial grasses, a moderate amount of litter as would be expected with the more timbered land systems in this District, and a small amount of bare soil. Pasture utilisation was generally well-aligned with pasture availability. Fifteen sites were assessed to be in Good condition and 15 in Fair condition. Six sites were assessed in Poor condition.

Seasonal quality

'Seasonal quality' describes the relative value of recent rainfall in producing forage for livestock. It is judged with reference to the historical record. Two indicators are used: rainfall amount compared with the long-term median and expected pasture growth based on the rainfall received, simulated using AussieGRASS (www.longpaddock.qld.gov.au).

Descriptors of seasonal quality provide useful context for interpreting various measures of land condition at particular times. However, to the extent possible, land condition is assessed independently of seasonal conditions.

Rainfall statistics (Table 13) are based on gridded rainfall produced by the Bureau of Meteorology (www.bom.gov.au/jsp/awap/rain/index.jsp). Pixel (grid cell) values are calculated from rainfall amounts at recognised recording stations. Rainfall is from October of one year to September the following year thus incorporating one entire growing season. Modelled pasture growth is for the period November 2018 to April 2019. This growth is ranked as a percentile of the growth for all previous wet seasons back to 1957.

Spatially averaged rainfall for the Sturt Plateau Pastoral District in 2018-19 was well below the long-term median (Table 13). Rainfall decreased from north to south across the region (Figure 31, left-hand panel). The spatially averaged rainfall in the five seasons prior to 2018-19 in shown in Figure 32, where rainfall was either above or at the median.

Table 13. Indicators of seasonal quality. Data spatially averaged for the Sturt Plateau Pastoral District.

Rainfall (mm)		AussieGRASS	
2018 – 2019	389	Growth (kg/ha)	958
Long-term median	640	Percentile	10

STURT PLATEAU PASTORAL DISTRICT

Modelled pasture growth over the 2018-19 summer for the District was 958kg/ha, which was at the 10th percentile (Table 13). Growth generally reflected rainfall distribution (Figure 31, right hand panel). Figure 33 shows that the modelled pasture growth percentiles over the previous five seasons to 2018-19 were at or above the 50th percentile, which highlights the low modelled pasture growth for the 2018-19 summer.

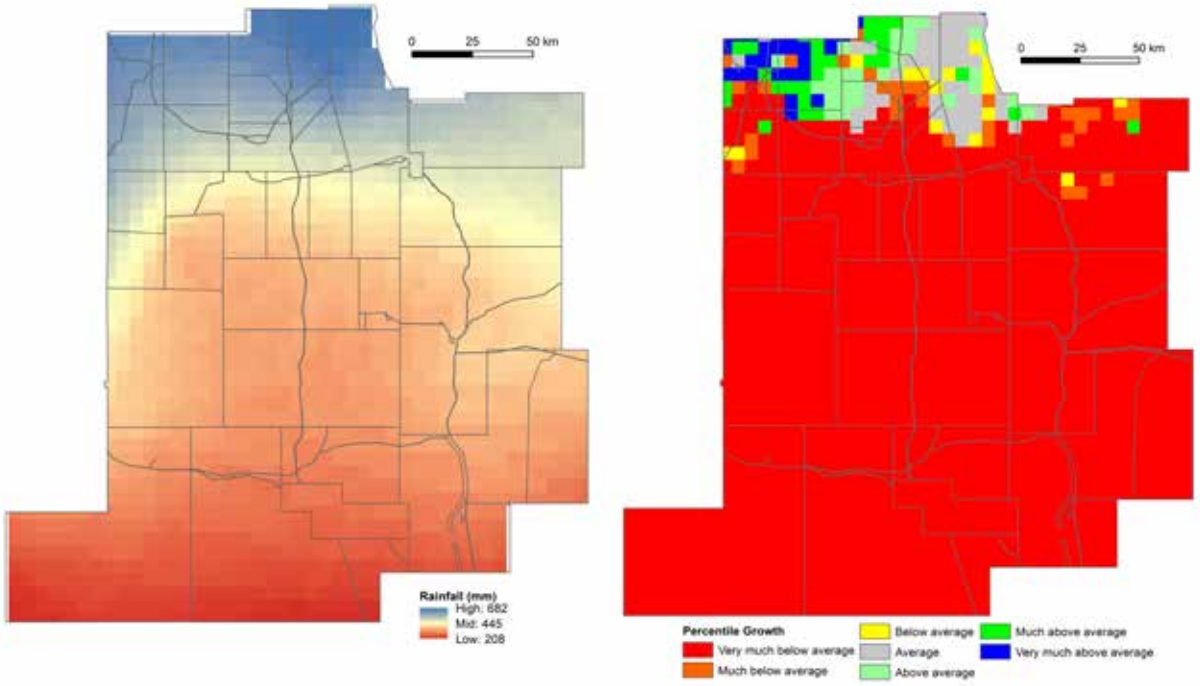

Figure 31. Maps of seasonal quality. Left, gridded rainfall, October 2018 to September 2019; right, AussieGRASS-modelled pasture growth for the 2018-19 summer as a percentage of previous summers. The grid cells on this map are at 5km x 5km resolution (i.e. each square represents 25km^2).

STURT PLATEAU PASTORAL DISTRICT

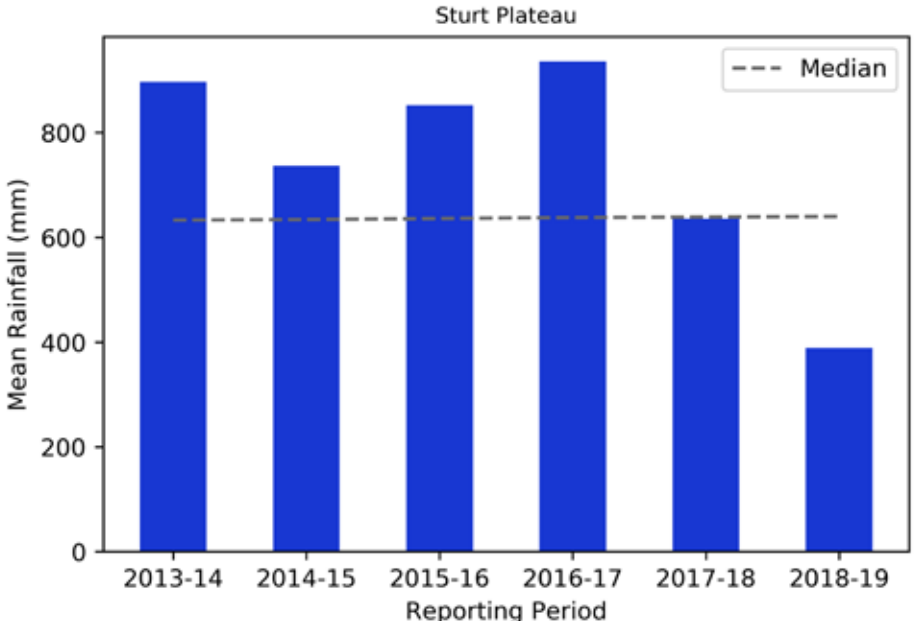

Figure 32. Spatially averaged historic rainfall for the Sturt Plateau Pastoral District. Long-term median indicated by dashed line.

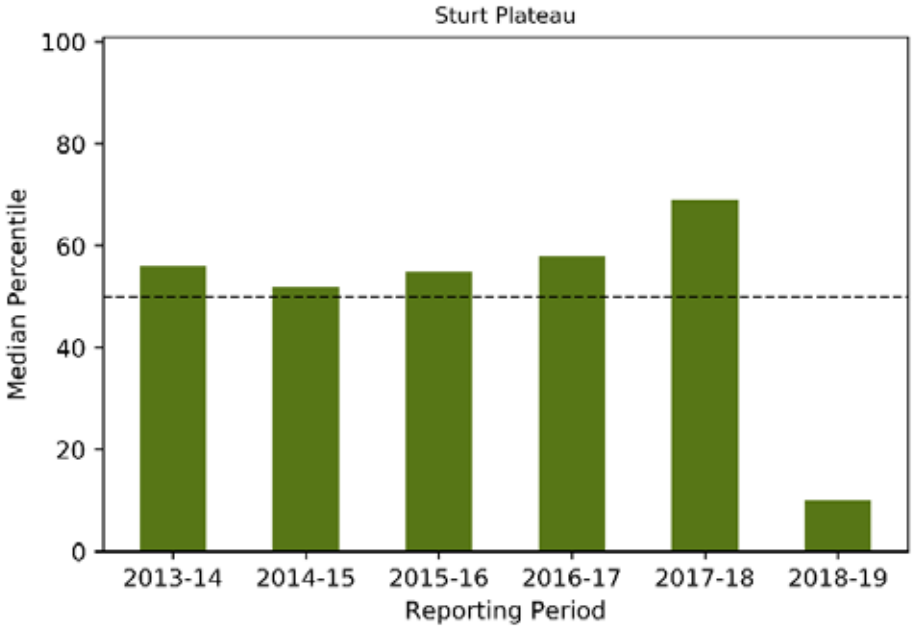

Figure 33. Historic pasture growth (percentile) from AussieGRASS for the Sturt Plateau Pastoral District. The 50th percentile is indicated with a dashed line.

STURT PLATEAU PASTORAL DISTRICT

Fire

The North Australia Fire Information website (www.firenorth.org.au/nafi3) reports that 5 099km^2 (12%) of the Sturt Plateau Pastoral District was burnt over the reporting period, with a significant area burnt in November and December 2018 (Figure 34). This was less than the area burnt in the 2017-18 reporting period (7 724km^2).

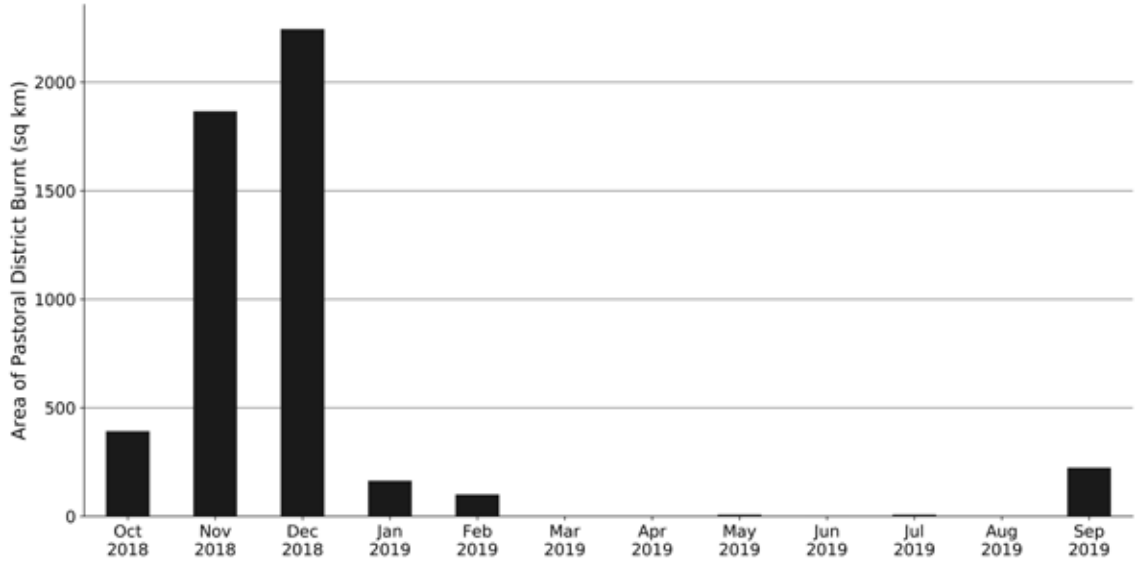

Figure 34. Monthly area burnt between October 2018 and September 2019 in the Sturt Plateau Pastoral District.

Ground cover dynamics

It is important to maintain adequate ground cover in the latter months of each year to minimise soil loss from wind erosion and intense wet-season storms. It is also important to carry dry feed, and associated ground cover, into the latter months of each calendar year in case there is a late start to the usual wet season and/or monsoonal rains fail more generally.

The decile ranked vegetation cover in Figure 35 depicts the amount of vegetation present in the late 2019 dry season relative to that present at the same time each year since 1988. A number of areas of lower vegetation cover correspond with fire prior to image acquisition (i.e. areas shown with diagonal lines). The District as a whole had higher amounts of average to lowest vegetation cover in the 2019 dry season, when compared with the last 30 years.

STURT PLATEAU PASTORAL DISTRICT

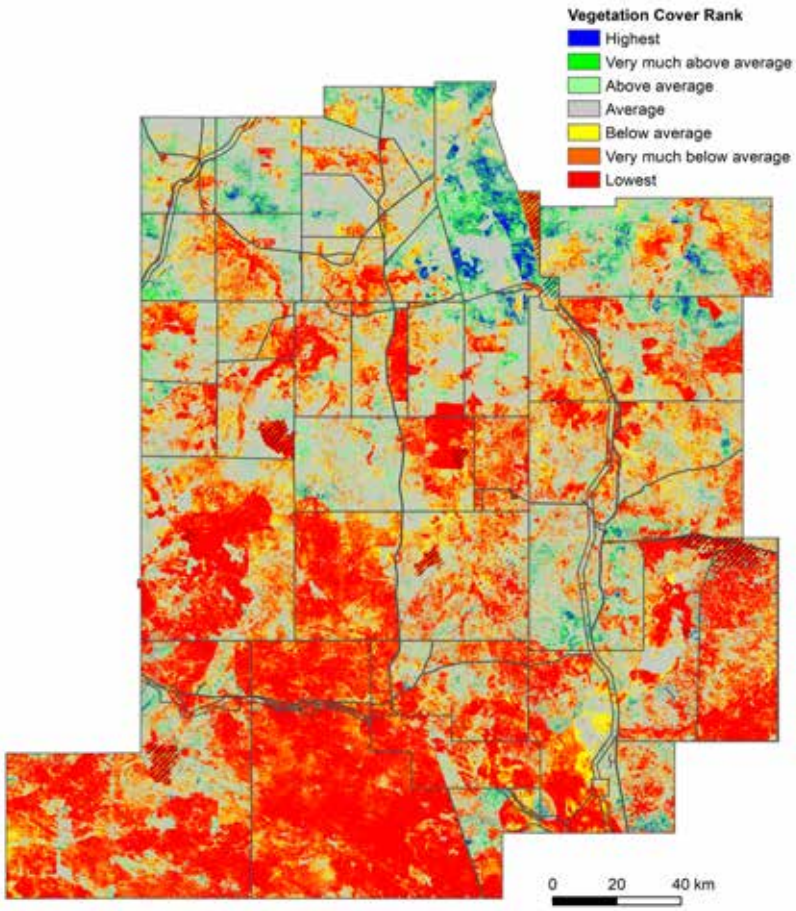

Figure 35. Rank of the amount of remotely-sensed vegetation cover present from September to November 2019 against that for previous years back to 1988. Diagonal lines show those areas burnt between January and November 2019.

The amount of bare ground present at any location changes from year to year depending on rainfall and its effectiveness, fire history and amount of grazing. The percentage of bare ground in each 30-m square Landsat pixel (900m^2 or 0.09ha) was used to report the amount of bare ground across all pixels in the Sturt Plateau Pastoral District.

The bare ground threshold is based on the frequency distribution of all 30-m Landsat bare ground cover pixels at the end of 2019 (spring composite). A threshold was determined which represents 75% of a district's overall bare ground. The remaining 25% is considered to have above-threshold bare ground.

Approximately 40% of the District had negligible amounts of bare ground (<20% of the 30-m Landsat pixel) towards the end of 2019 (Figure 36). The bare ground threshold value for the Sturt Plateau Pastoral District was 35%; one quarter of the District had bare ground greater than this value (Figure 31), mostly in the south west of the District (Figure 37), and includes areas burnt earlier in 2019.

STURT PLATEAU PASTORAL DISTRICT

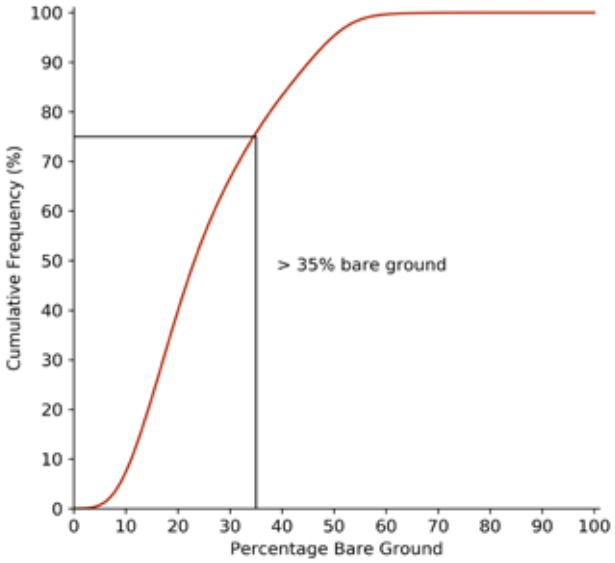

Figure 36. Percentage cumulative frequency of varying levels of bare ground in 30-m square Landsat pixels in the Sturt Plateau Pastoral District between September and November 2019. Areas with greater than 35% bare ground are mapped in Figure 37.

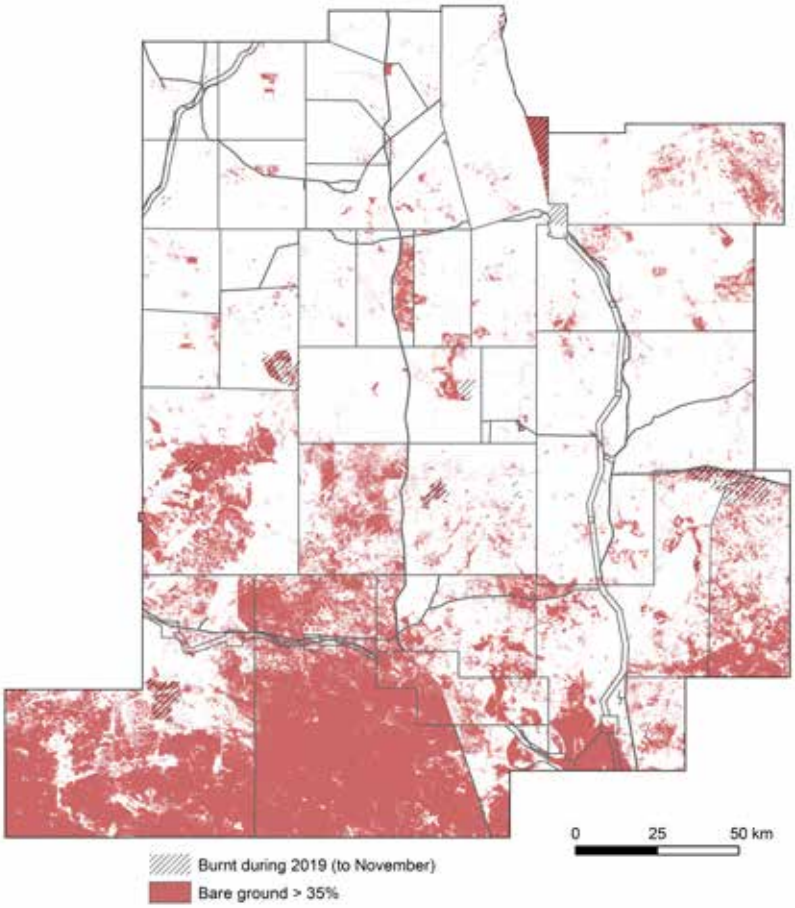

Figure 37. Parts of the Sturt Plateau Pastoral District having more than 35% bare ground per Landsat pixel in late 2019 (threshold bare ground). Diagonal lines show areas burnt between January and November 2019. Note that the threshold level of bare ground used for mapping purposes varies between pastoral districts. It is selected to show at what level approximately 25% of the district is affected.

STURT PLATEAU PASTORAL DISTRICT

Site-based monitoring

Eight pastoral leases in the Sturt Plateau Pastoral District were visited in the 2018-19 reporting period.

Vegetation cover of the ground layer was measured at 36 sites across the eight leases. Sites, on average, had a good cover of perennial grasses, a moderate amount of litter as would be expected given the predominance of wooded land systems, and a small amount of bare ground (Figure 38). Annual grasses and forbs (both annual and perennial) were minor components of the total ground cover. Perennial grasses are important because they protect the soil surface against wind and water erosion and, where palatable, provide persistent forage to carry livestock through dry times. Litter cover also protects the soil surface, assists infiltration of rain water and helps retain plant seeds in-situ.

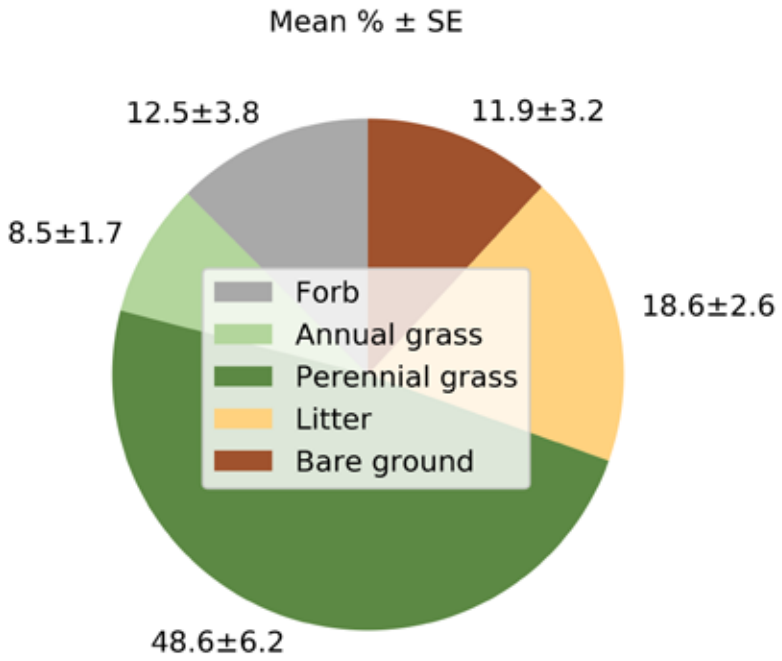

Figure 38. Mean percentage and standard error of measured components of vegetation cover in the ground layer from 36 sites on eight pastoral leases in the Sturt Plateau Pastoral District.

STURT PLATEAU PASTORAL DISTRICT

The majority of sites (58%) were minimally grazed at the time of assessment (Table 14). There was no evidence of erosion at any site.

Table 14. Levels of pasture utilisation assessed at 39 sites on nine pastoral leases in the Sturt Plateau Pastoral District.

Pasture Utilisation

Rank	% of sites
No grazing	0
Minimal (<25%)	58
Moderate (26-50%)	18
Moderate – heavy (51-75%)	18
Heavy (76-90%)	6
Very heavy (>90%)	0

Land condition ratings assigned at monitoring sites and the more generalised assessment of land condition across those parts of pastoral leases traversed are summarised in Table 15. To the extent possible, these assessments are independent of the average to below-average seasonal quality applying to the general area of each station.

STURT PLATEAU PASTORAL DISTRICT

Table 15. Assessed land condition at integrated monitoring sites and traversed parts of eight pastoral leases in the Sturt Plateau Pastoral District.

Station	Condition Rating (number of sites)	Comments with regard to pastoral lease
1	Good: 1 Fair: 4	Land condition was assessed as Fair condition. Changes in land condition scores at monitoring sites and general observations supported by fractional cover and bare ground threshold products, indicate that land condition has deteriorated since the previous monitoring conducted in 2014, where it was assessed in Good condition. Pasture within walking distance of permanent water responded poorly to the 2018-19 below-average wet season while areas with less grazing pressure responded reasonably well. The heavily grazed areas had low pasture growth and a reduced diversity of desirable grass and forbs species.
2	Good: 6 Fair: 2 Poor: 2	Land condition was generally assessed as Fair condition. Changes in land condition scores at monitoring sites supported by fractional cover and bare ground threshold products, indicate that land condition was generally declining at specific areas compared with the previous monitoring conducted in 2014. The recent below-average wet season was reflected in the pasture production with a fair diversity and density of palatable desirable perennial grass species in the north and lower levels in the south. There were some areas of weed infestation, primarily rubber bush (Calotropis procera) around yards and bores.
3	Good: 3 Fair: 2	Land condition was generally assessed as Good condition, which is consistent with the previous monitoring conducted in 2014. The 2018-19 below-average wet season was reflected in good to fair pasture growth. The property is grazed without set spelling of paddocks, for short periods as the property is used to finish off weaners from a neighbouring property before they go to market. Boundary fence lines were complete and generally in good condition. There were no erosion issues on the property due to in flat topography, and tracks are graded and were in good condition.
4	Good: 1 Fair: 4	Land condition was generally assessed as Fair condition. Changes in land condition scores at monitoring sites supported by fractional cover and bare ground threshold products, indicate that land condition has deteriorated slightly since the previous monitoring conducted in 2014 where it was assessed as Fair to Good condition. Pasture responded as expected to the 2018-19 below-average wet season with the majority of the property having moderate bare ground and a reduced diversity of palatable perennial grass species. Despite this, the pasture is mostly robust and expected to recover following a good wet season. There were no significant areas of weed infestations and those weeds that were present are being actively managed. There were no areas of erosion or woody thickening observed during the monitoring visit.

STURT PLATEAU PASTORAL DISTRICT

Station	Condition Rating (number of sites)	Comments with regard to pastoral lease
5	Good: 1 Fair: 1	Land condition was generally assessed as Fair condition. Changes in land condition scores at monitoring sites, and supported by fractional cover and bare ground threshold products, indicate that land condition was consistent with the previous monitoring conducted in 2014. The recent below-average wet season was reflected in the pasture production with a reduced diversity of palatable desirable perennial grass species. There were no significant areas of weed infestations and those weeds that are present are being actively managed. No significant areas of erosion were observed, with mainly natural sinkholes appearing in the mostly yellow soil paddocks and this was supported by satellite imagery products.
6	Good: 3 Fair: 1	Land condition was generally assessed as Good condition and was consistent with the previous monitoring conducted in 2014.The recent well below-average wet season over the previous two years was reflected in the recent poor pasture production, although due to well managed grazing regimes and conservative stocking rates, a good diversity of palatable desirable perennial grass species was still present at the time of the 2019 inspection. There were no significant weed, erosion or pest animal issues observed. Woody thickening due to tree regrowth was observed in one paddock which had been cleared for hay production.
7	Poor: 4	Station 7 is managed in conjunction with Station 8 as one property. Land condition was generally assessed as Fair to Poor condition, which has declined from the previous monitoring conducted in 2014. All four measured sites were assessed as Poor. The 2018-19 well-below-average wet season was reflected in poor pasture growth. There were no weeds, erosion, feral animals or woody thickening issues of concern. Decline in land condition was mostly related to increases in bare ground and a decrease in desirable pasture species across the sites, although there were still some desirable species present. Increases in bare ground corresponded with two below-average wet season rainfalls, although heavy grazing pressure likely exacerbated the bare ground levels and poor wet season recovery.
8	Fair: 1	Station 8 managed in conjunction with Station 7 as one property. Land condition was generally assessed as Fair to Poor condition, which has declined from the previous monitoring conducted in 2014. The only measured site on this portion was in Fair condition. The 2018-19 well-below-average wet season was reflected in poor pasture growth. There were no weeds, erosion, feral animals or woody thickening issues of concern. Decline in land condition was mostly related to increases in bare ground and decreases in desirable pasture species, although there were still some desirable species present. Increases in bare ground corresponded with two below average wet season rainfalls, although heavy grazing pressure likely exacerbated the bare ground levels and poor wet season recovery.

ROPER PASTORAL DISTRICT

The Roper Pastoral District encompasses just over 42 000 km^2 and includes 11 pastoral leases.

Map 6: Location of Roper Pastoral District

A large portion of the south east of the District experienced very much below average seasonal quality based on AussieGRASS-modelled pasture growth and below-average rainfall but had variable pasture growth and rainfall across the north west of the District. Much of the north western and south eastern parts of the District had below average to the lowest ranking of vegetation cover in late 2019; areas with low ranking cover were often strongly related to incidence of fire. In total, 35% of the District burnt between October 2018 and September 2019.

No pastoral leases were visited in 2019.

Seasonal quality

'Seasonal quality' describes the relative value of recent rainfall in producing forage for livestock. It is judged with reference to the historical record. Two indicators are used: rainfall amount compared with the long-term median and expected pasture growth based on rainfall received, simulated using AussieGRASS (www.longpaddock.qld.gov.au).

Descriptors of seasonal quality provide useful context for interpreting various measures of land condition at particular times. However, to the extent possible, land condition is assessed independently of seasonal conditions.

Rainfall statistics (Table 16) are based on gridded rainfall produced by the Bureau of Meteorology (www.bom.gov.au/jsp/awap/rain/index.jsp). Pixel (grid cell) values are calculated from rainfall amounts at recognised recording stations. Rainfall is from October of one year to September the following year. Modelled pasture growth is for the period November 2018 to April 2019. This growth is ranked as a percentile of the growth for all previous summers.

Spatially averaged 12-month rainfall (October 2018 to September 2019) for the Roper Pastoral District was below the long-term median (Table 16) and progressively decreased from the north-west towards the south-east (Figure 39).

Below-median rainfall (October 2018 to September 2019) across most of the Roper Pastoral District was reflected by very much below average modelled pasture growth over the 2018-19 wet season across the south-east. Patches across the north-west ranged from very much above average to average growth compared to long-term records (Table 16 and Figure 40).

Indicators of seasonal quality. Data spatially averaged for the Roper Pastoral District.

Rainfall (mm)		AussieGRASS	
2018 – 2019	582	Growth (kg/ha)	1 746
Long-term median	797	Percentile	31

ROPER PASTORAL DISTRICT

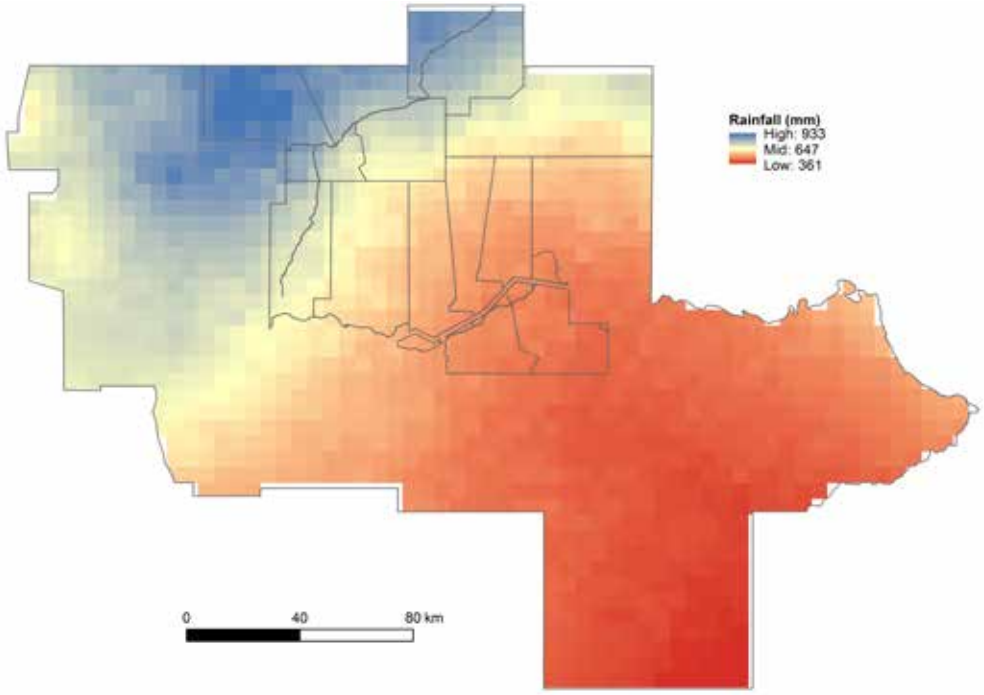

Figure 39. Spatially interpolated rainfall, October 2018 to September 2019.

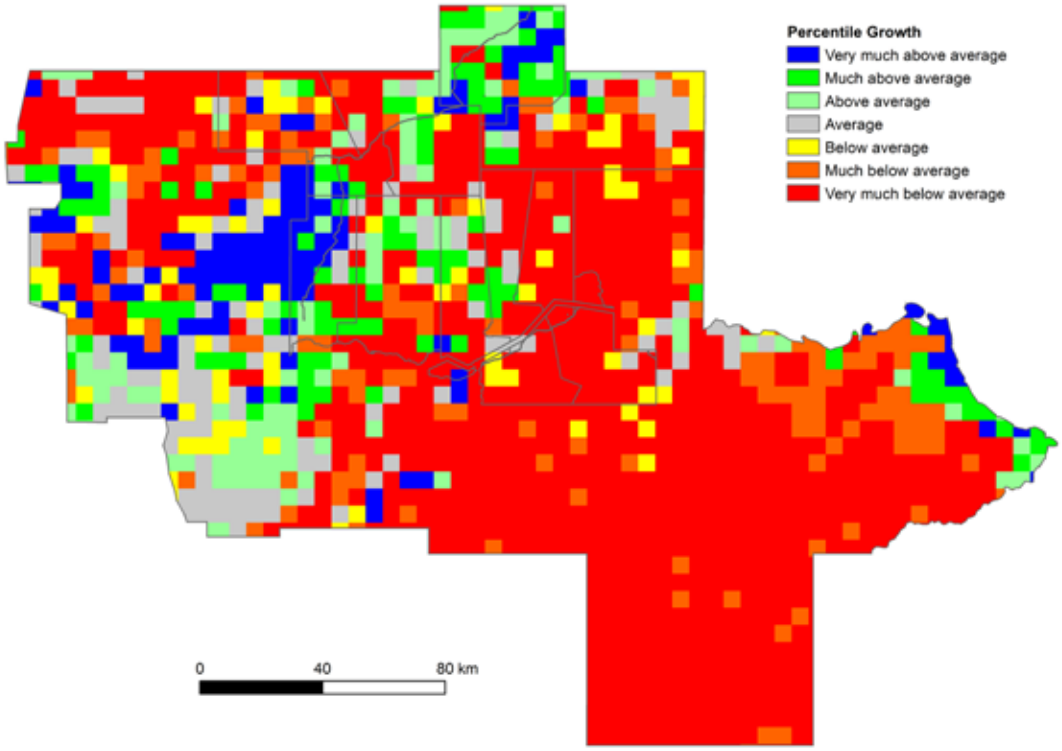

Figure 40. AussieGRASS-modelled pasture growth for the 2018-19 summer period as a percentage of previous summers.

ROPER PASTORAL DISTRICT

Spatially averaged historic rainfall data for the District indicates that 2018-19 received below median rainfall with the previous five years receiving the median or just above the median (Figure 41).

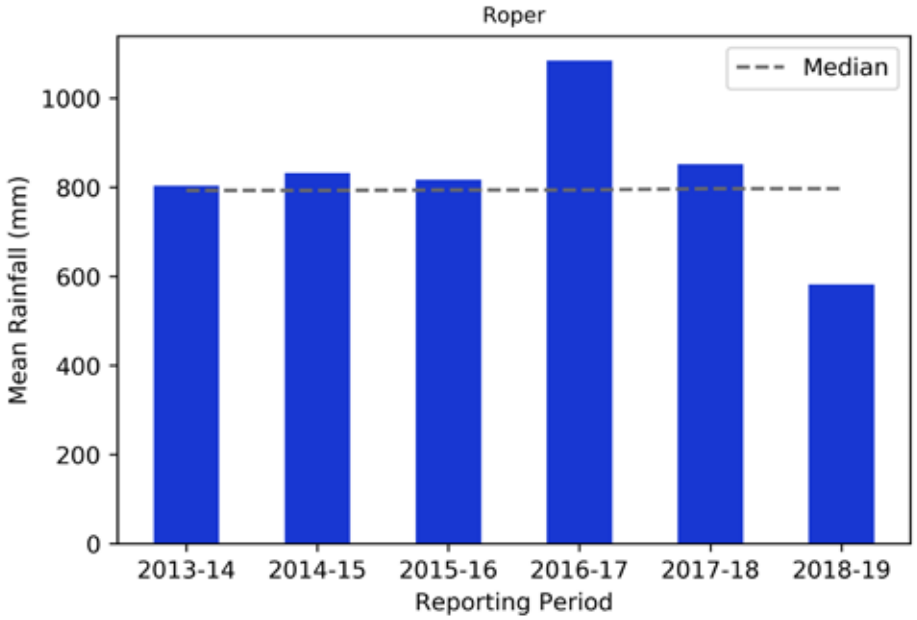

Figure 41. Spatially averaged historic rainfall for the Roper Pastoral District. Long-term median indicated by dashed line.

Historic pasture growth indicates that for four out of the previous six years, pasture growth was below the long-term median with 2015-16 and 2018-19 well below (Figure 42). Even though 2015-16 received median rainfall, most of the rain fell in late 2015 and the remainder of the 'wet' was relatively dry and not conducive to extended periods of pasture growth. Whereas the below average pasture growth in 2018-19 is a result of below median rainfall.

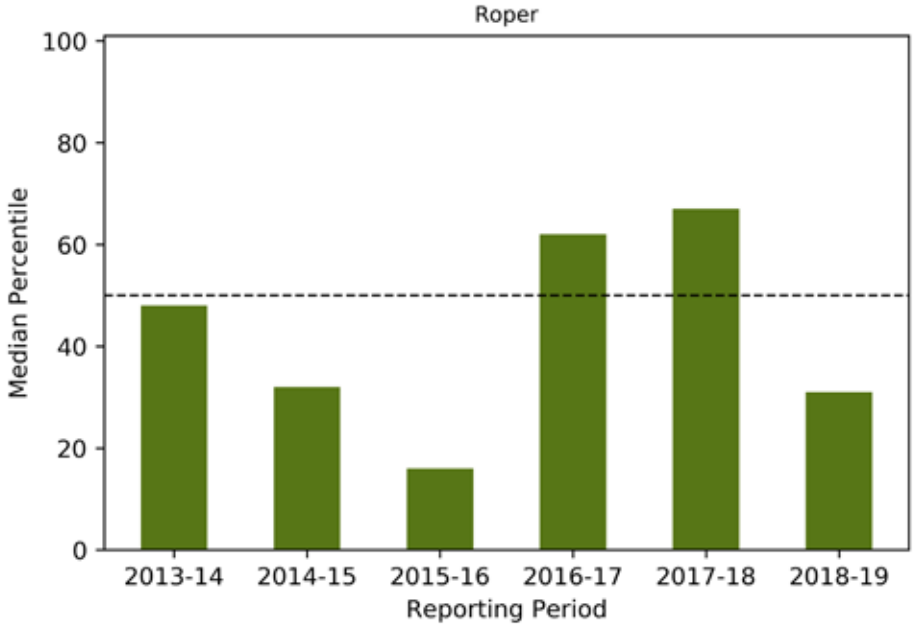

Figure 42. Historic pasture growth (kg/ha) from AussieGRASS for the Roper Pastoral District. Long-term median indicated by dashed line.

ROPER PASTORAL DISTRICT

Fire

The North Australia and Rangelands Fire Information website (www.firenorth.org.au/nafi3) reports that 14 765km2 (35% of the District) burnt between October 2018 and September 2019. This was over 3 500km^2 more than burnt in the previous reporting period (October 2017 to September 2018) which may have been the result of the below average wet season rainfall received during 2018-19. Peak fire activity was in October 2018 and May 2019, of which the former may have been due to naturally caused fire (e.g. lightning strike); and the latter by controlled burning for wildfire mitigation (Figure 43).

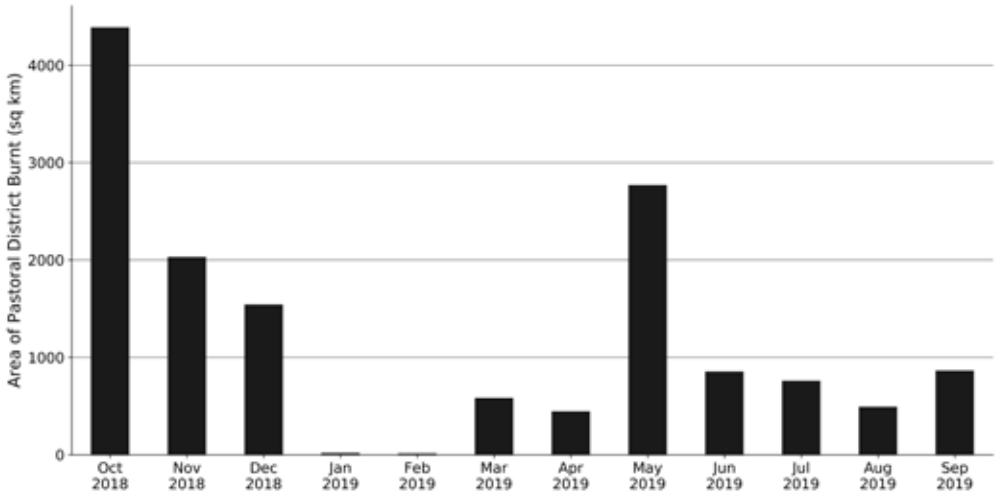

Figure 43. Monthly area burnt (km^2) in the Roper Pastoral District between October 2018 and September 2019.

Ground cover dynamics

It is important to maintain adequate ground cover in the latter months of each year to minimise soil loss from wind erosion and intense wet-season storms. It is also important to carry dry feed, and associated ground cover, into the latter months of each calendar year in case there is a late start to the usual wet season and/or monsoonal rains fail more generally.

Much of the north western and south eastern parts of the District had below average to the lowest ranking of vegetation cover in late 2019; areas with low ranking cover were often strongly related to incidence of fire. Only very small pockets scattered across the District (total area 19.2%) had above average vegetation cover (Figure 44).

ROPER PASTORAL DISTRICT

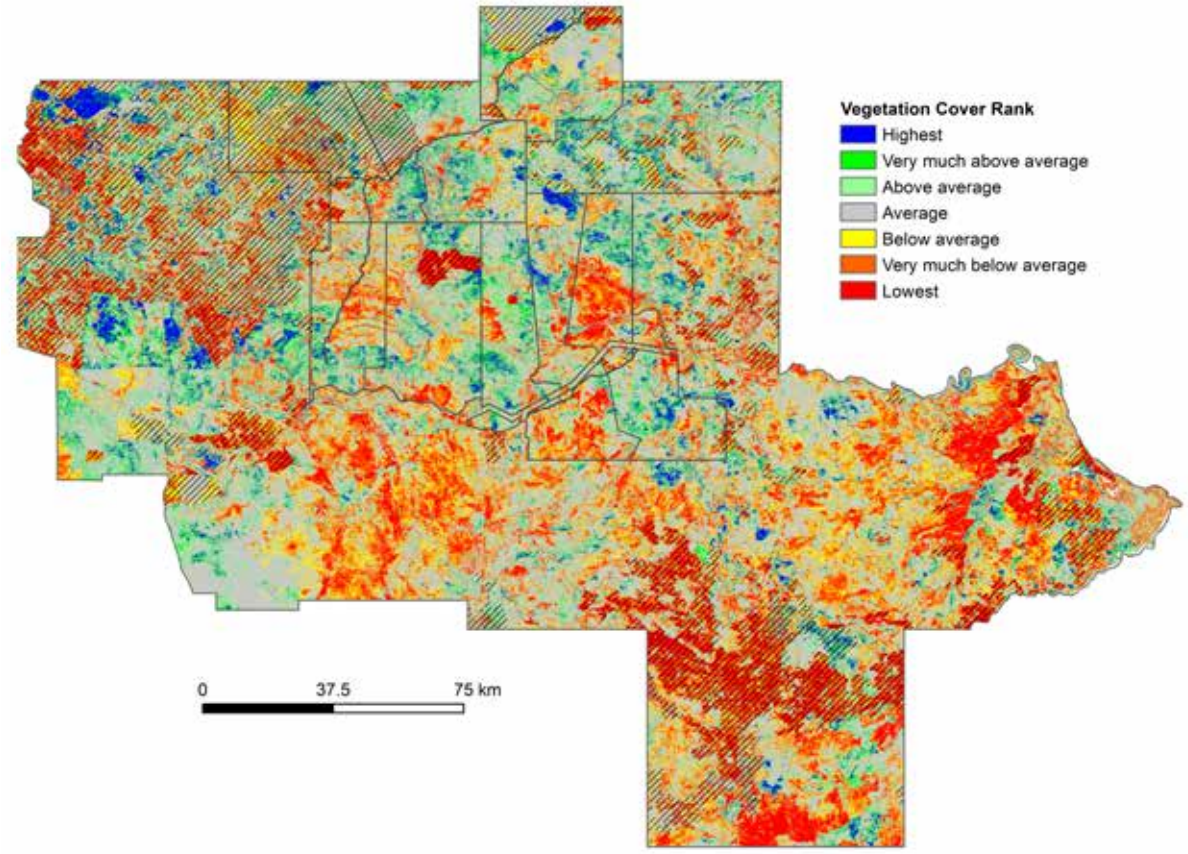

Figure 44. Rank of the amount of remotely-sensed vegetation cover present from September to November 2019 (spring composite) against the average cover since 1988. Diagonal lines show those areas burnt between January and November 2019.

The amount of bare ground present at any location changes from year to year depending on rainfall and its effectiveness, fire history and amount of grazing. The percentage of bare ground in each 30-m square Landsat pixel (900m^2 or 0.09ha) was used to report the amount of bare ground across all pixels in the Roper Pastoral District.

The bare ground threshold is based on the frequency distribution of all 30-m Landsat bare ground cover pixels at the end of 2019 (spring composite). A threshold was determined which represents 75% of a district's overall bare ground. The remaining 25% is considered to have above-threshold bare ground.

Approximately 44% of the District had negligible amounts of bare ground (<20% of a 30-m Landsat pixel) towards the end of 2019 (Figure 45). The bare ground threshold value for the Roper Pastoral District was 32%; one quarter of the District had bare ground greater than this value (Figure 45 and Figure 46).

Bare ground threshold across the District is presented in Figure 46 and includes areas burnt earlier in 2019; areas with elevated bare ground are strongly associated with incidence of fire in 2019.

ROPER PASTORAL DISTRICT

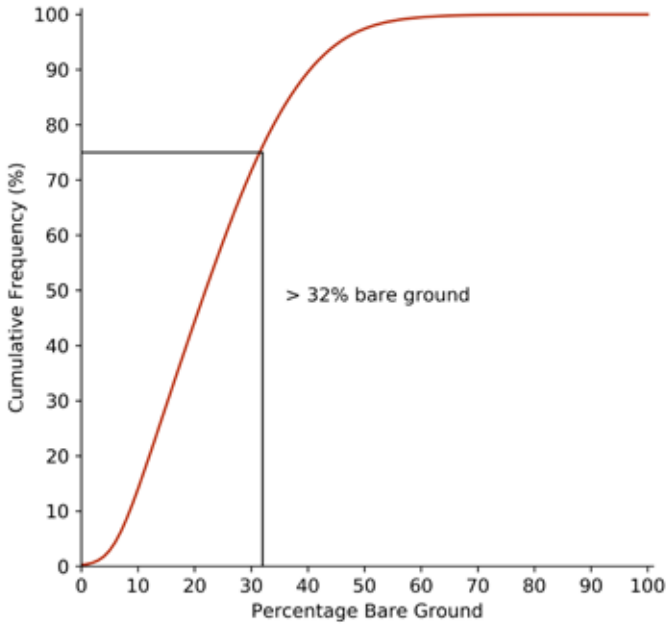

Figure 45. Percentage cumulative frequency of varying levels of bare ground in 30-m square Landsat pixels in the Roper Pastoral District between September and November 2019 (spring composite). Areas with >32% bare ground (threshold) are mapped in Figure 46.

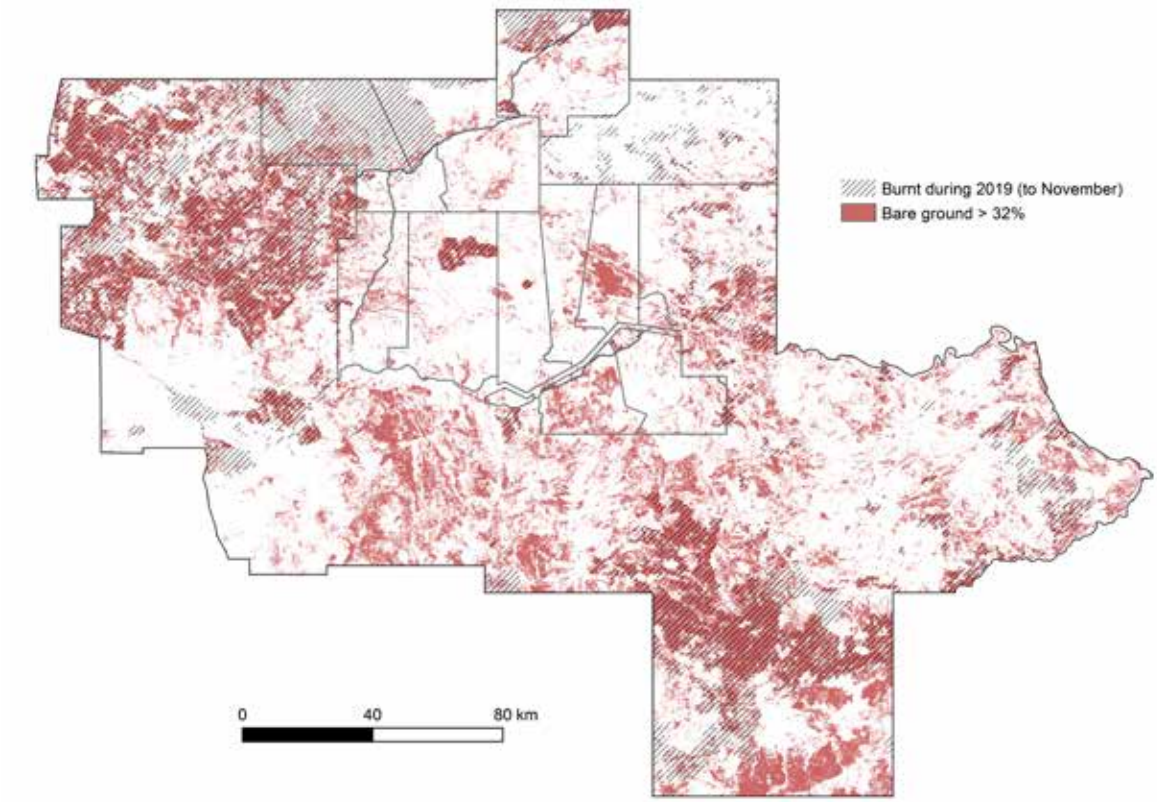

Figure 46. Parts of the Roper Pastoral District having >32% bare ground per Landsat pixel in late 2019 (Landsat Spring composite). Areas burnt between January and November 2019 shown with diagonal lines. Note that the threshold level of bare ground used for mapping purposes varies between pastoral districts. It is selected to show at what level approximately 25% of the district is affected.

GULF PASTORAL DISTRICT

This District encompasses more than 92 000 km^2 and includes 16 pastoral leases, seven of which were visited in 2019.

Map 7: Location of Gulf Pastoral District

The Gulf coast and hinterland extending up to 100km inland experienced below to much below average quality based on AussieGRASS-modelled pasture growth, consistent with below average rainfall in this area. The rest of the District experienced very much below average seasonal quality and below average rainfall. Fire is an important feature of this savanna region, with approximately 21% of the District burnt between October 2018 and September 2019. Areas of much reduced vegetation cover, as monitored with remote sensing, were scattered throughout the District – and were mostly, but not always associated with recent fire. One quarter of the region had more than 37% bare ground per Landsat pixel later in the 2019 dry season, mostly in the central and south-eastern parts of the District. Eighteen of the 47 sites across seven leases were rated in Excellent / Good condition with 18 sites in Fair condition and 11 in Poor condition.

Seasonal quality

'Seasonal quality' describes the relative value of recent rainfall in producing forage for livestock. It is judged with reference to the historical record. Two indicators are used: rainfall amount compared with the long-term median and expected pasture growth based on rainfall received, simulated using AussieGRASS (www.longpaddock.qld.gov.au).

Descriptors of seasonal quality provide useful context for interpreting various measures of land condition at particular times. However, to the extent possible, land condition is assessed independently of seasonal conditions.

Rainfall statistics (Table 16) are based on gridded rainfall produced by the Bureau of Meteorology (www.bom.gov.au/jsp/awap/rain/index.jsp). Pixel (grid cell) values are calculated from rainfall amounts at recognised recording stations. Rainfall is from October of one year to September the following year. Modelled pasture growth is for the period November 2018 to April 2019. This growth is ranked as a percentile of the growth for all previous summers.

Table 16. Indicators of seasonal quality. Data spatially averaged for the Gulf Pastoral District.

Rainfall (mm)		AussieGRASS	
2018 – 2019	465	Growth (kg/ha)	1 013
Long-term median	666	Percentile	10

GULF PASTORAL DISTRICT

Spatially averaged rainfall for the Gulf Pastoral District was below the long-term median (Table 16), and generally increased from south to north. Most pastoral leases received below average annual rainfall; non-pastoral lease in the southern-most area of the District also received below average rainfall. Rainfall for 2018-19 was the lowest when compared with the previous five years (Figure 47).

Modelled pasture growth over the last wet season, as a percentage of the long-term record, was mostly below or much below the long-term average adjacent to the Gulf coast (Figure 48). Modelled growth in the west bordering the Sturt Plateau and Barkly Pastoral Districts was very much below average, due to the region receiving below-average rainfall; similarly the central District, pasture growth was very much below average. When compared with the previous five years, the 2018-19 modelled pasture growth was the lowest (Figure 50). This trend is consistent with the rainfall pattern shown in Figure 49.

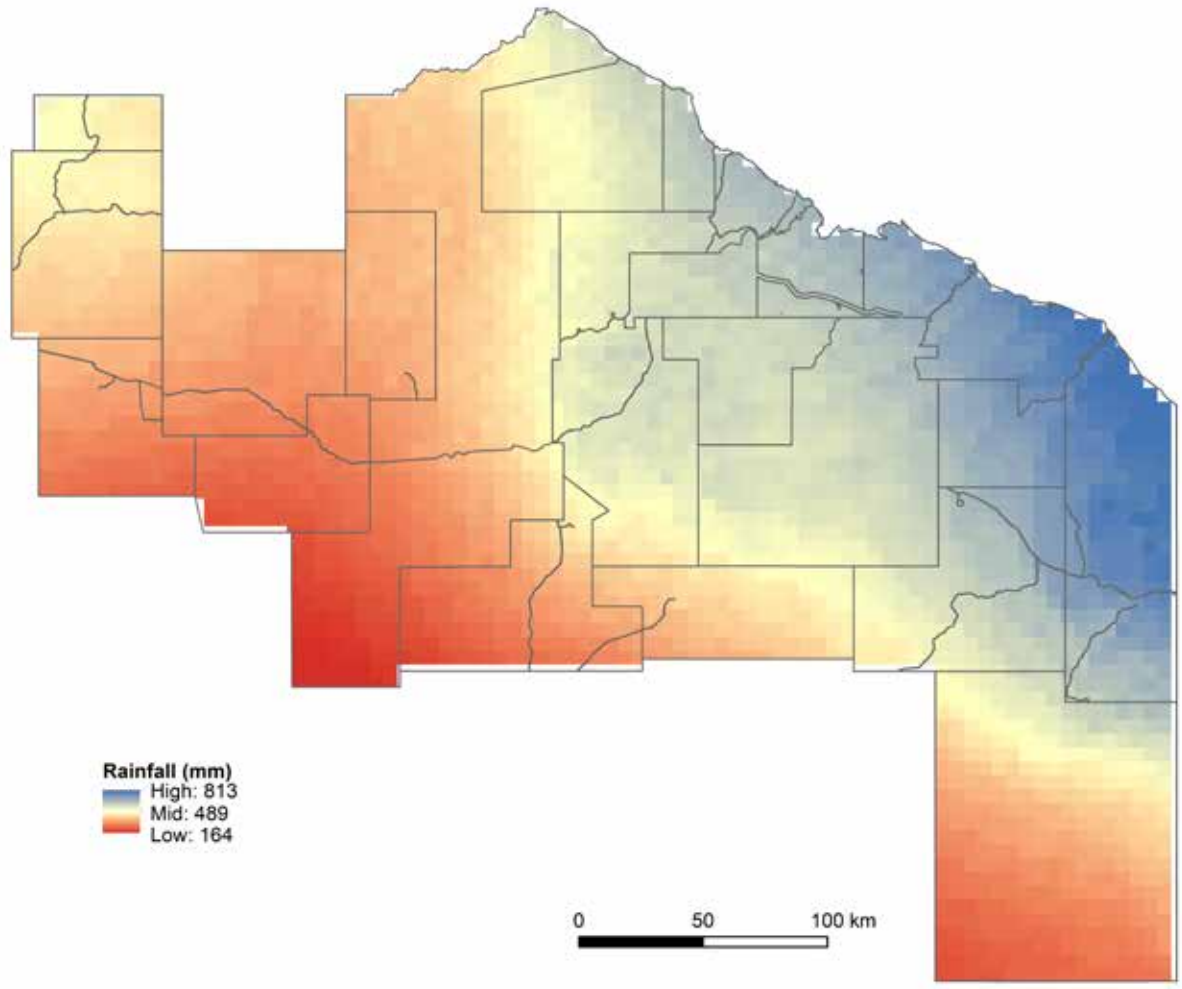

Figure 47. Spatially interpolated rainfall, October 2018 to September 2019. The grid cells on this map are at 5km x 5km resolution (i.e. each square represents 25km²).as a percentage of previous summers. The grid cells on this map are at 5km x 5km resolution (i.e. each square represents 25km²).

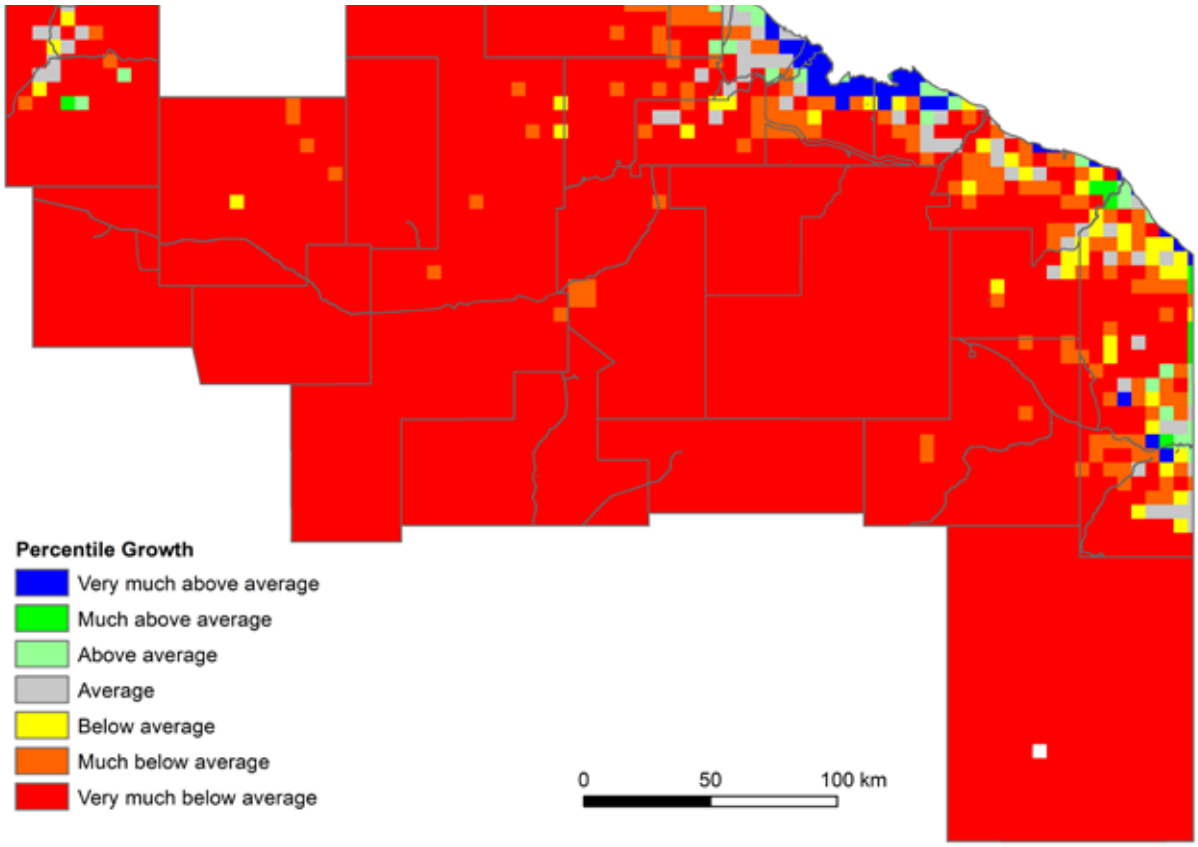

Figure 48. AussieGRASS-modelled pasture growth for the 2018-19 summer period as a percentage of previous summers. The grid cells on this map are at 5km x 5km resolutions (i.e. each square represents 25km^2).

GULF PASTORAL DISTRICT

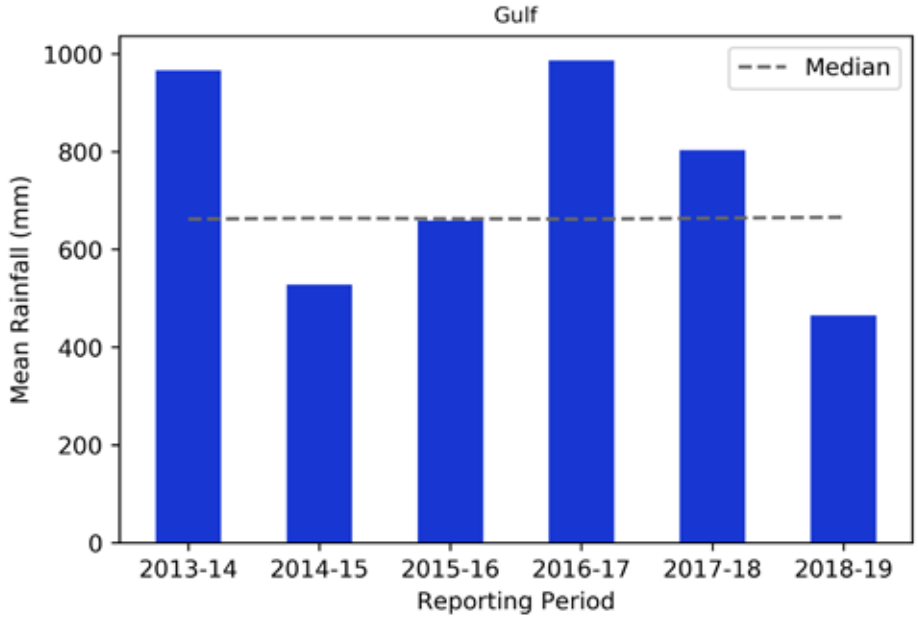

Figure 49. Spatially averaged historic rainfall for the Gulf Pastoral District. Long-term median indicated by dashed line.

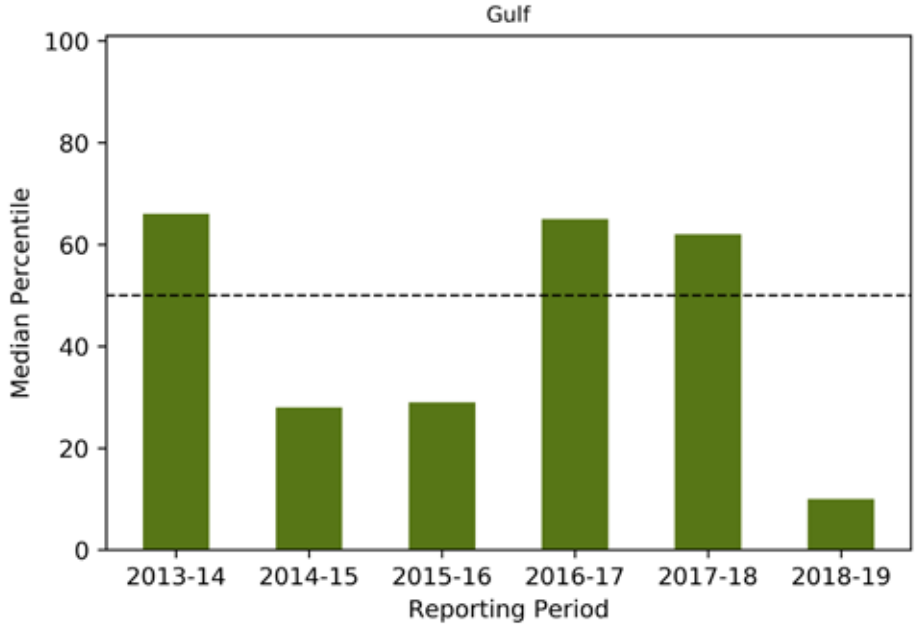

Figure 50. Historic pasture growth percentile from AussieGRASS for the Gulf Pastoral District. The 50th percentile is indicated with a dashed line.

GULF PASTORAL DISTRICT

Fire

The North Australia Fire and Rangelands Information website (www.firenorth.org.au/nafi3) reports that 19 464km^2 (21% of the District) burnt between October 2018 and September 2019 (Figure 51), which was significantly less than the 29 101km^2 in the preceding reporting period. Most of the area was burnt in November and December 2018.

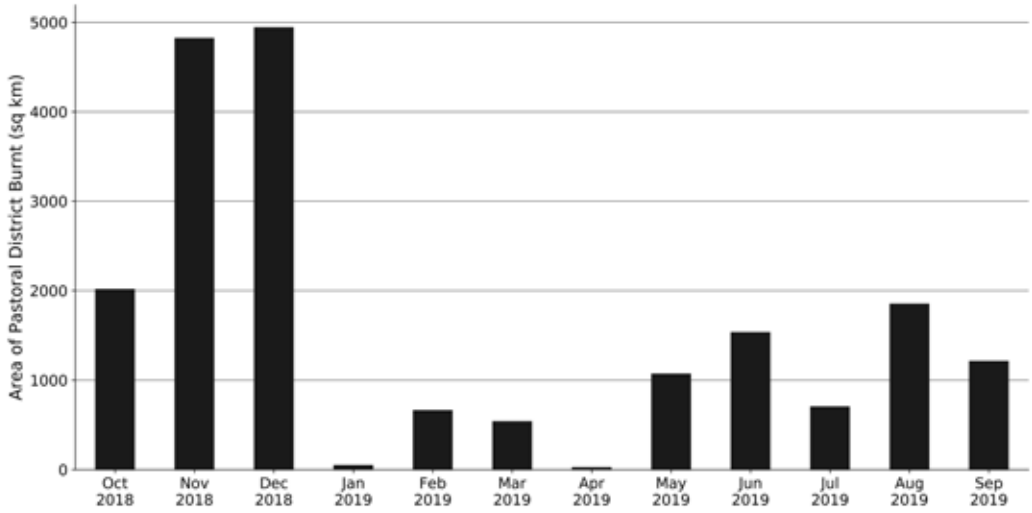

Figure 51. Monthly area burnt (km^2) between October 2018 and September 2019 in the Gulf Pastoral District.

Ground cover dynamics

It is important to maintain adequate ground cover in the latter months of each year to minimise soil loss from wind erosion and intense wet-season storms. It is also important to carry dry feed, and associated ground cover, into the latter months of each calendar year in case there is a late start to the usual wet season and/or monsoonal rains fail more generally.

The relative amount of vegetation cover present in the late dry season of 2019, compared with that present in the late dry season since 1988 (Figure 52), shows that most of the District had reduced vegetation cover ranging from average to lowest categories. There were isolated patches of above average to very much above average cover, which are mostly due to persistent tree and shrub cover.

GULF PASTORAL DISTRICT

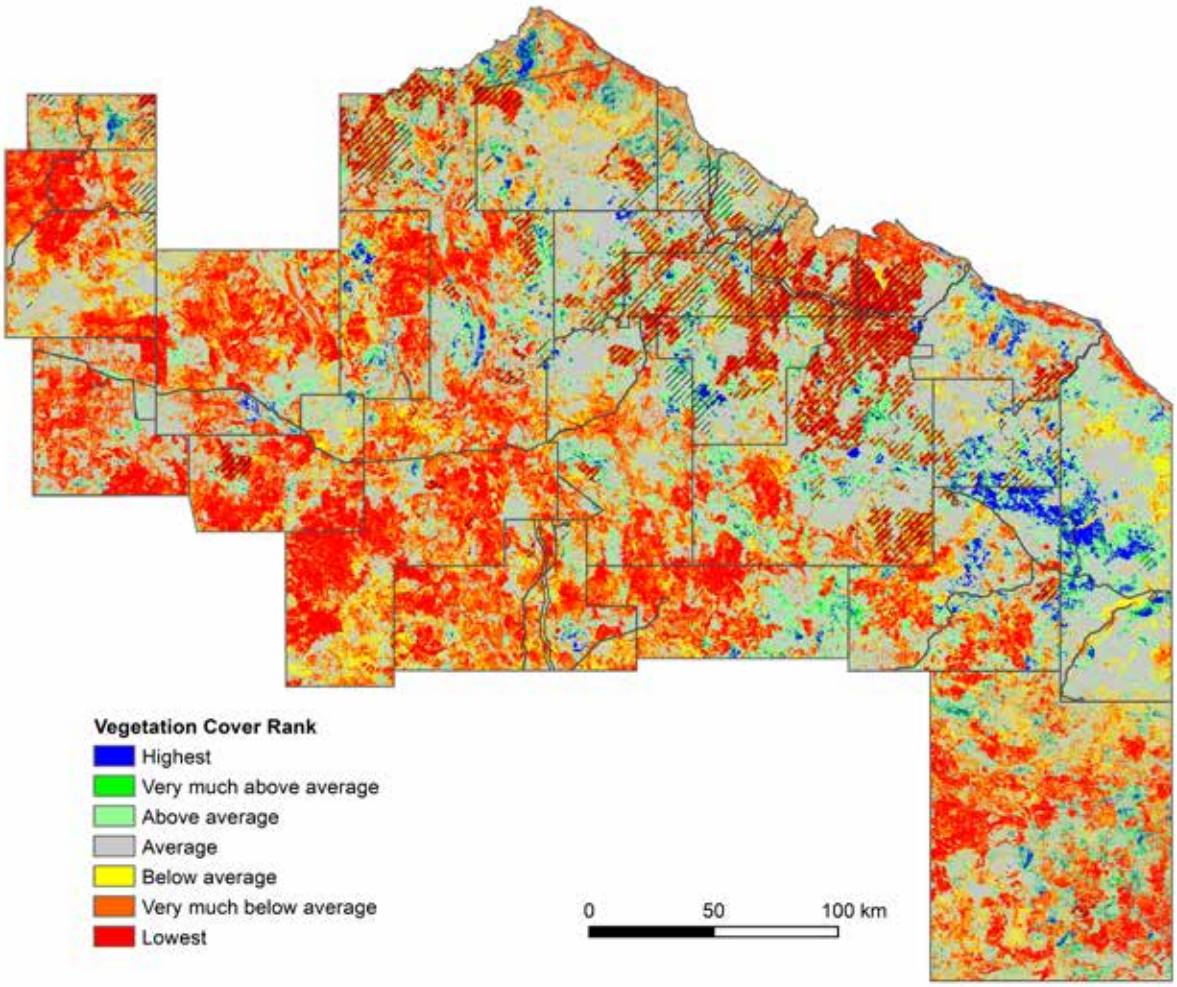

Figure 52. Rank of the amount of remotely-sensed vegetation cover present from September to November 2019 against that for previous years back to 1988. Diagonal lines show those areas burnt between January and November 2019.

The amount of bare ground present at any location changes from year to year depending on rainfall and its effectiveness, fire history and amount of grazing. The percentage of bare ground in each 30-m Landsat pixel (900m^2 or 0.09ha) was used to report the amount of bare ground across all pixels in the Gulf Pastoral District.

The bare ground threshold is based on the cumulative frequency distribution of bare ground for all 30-m Landsat pixels at the end of 2019 (spring composite). The bare ground percentage corresponding to 75% cumulative frequency was selected as the bare ground threshold (Figure 53). Bare ground percentage for 75% of the district is equal to or below this threshold. The remaining 25% of the district is considered to have above-threshold bare ground.

The bare ground threshold value for the Gulf Pastoral District was 37%; one quarter of the District had bare ground greater than this value (Figure 53). This includes some areas burnt earlier in 2019. However the most extensive areas with relatively high bare ground occurred in the central and south-eastern parts of the District and these areas were mostly not affected by fire earlier in 2019. Approximately 32% of the District had minor amounts of bare ground (<20% of the 30-m Landsat pixel) towards the end of 2019 (Figure 54).

GULF PASTORAL DISTRICT

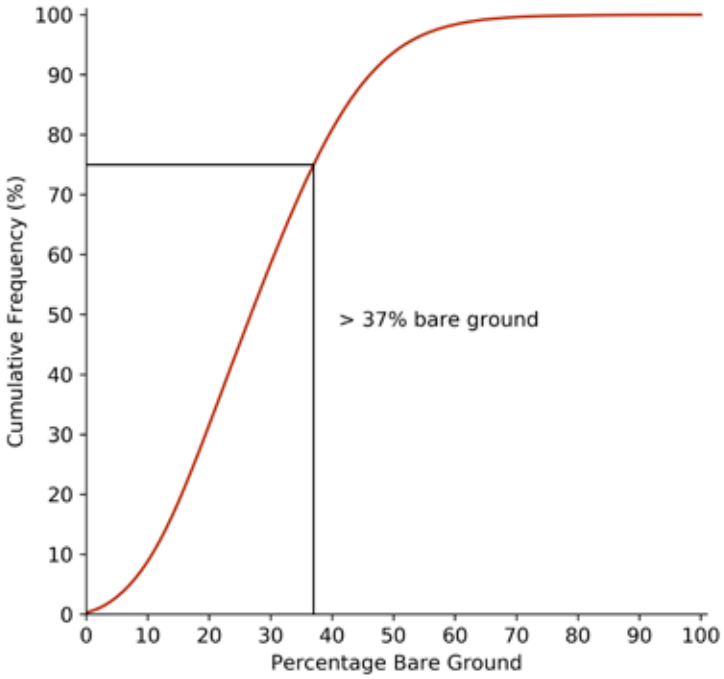

Figure 53. Percentage cumulative frequency of varying levels of bare ground in 30-m square Landsat pixels in the Gulf Pastoral District between September and November 2019. Areas with greater than 37% bare ground are mapped in Figure 54.

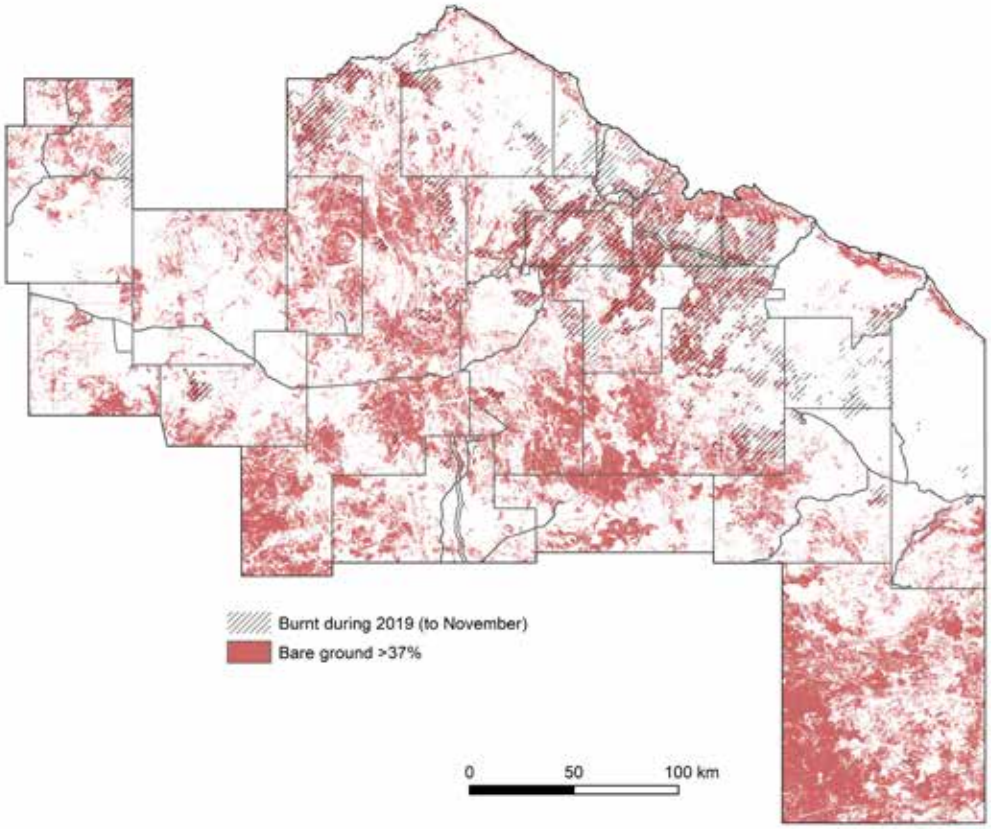

Figure 54. Parts of the Gulf Pastoral District having more than 37% bare ground per Landsat pixel in late 2019 (bare ground threshold). Note that the threshold level of bare ground used for mapping purposes varies between pastoral districts. It is selected to show at what level approximately 25% of the district is affected. Areas burnt between January and November 2019 shown with diagonal lines.

GULF PASTORAL DISTRICT

Site-based monitoring

Seven pastoral leases in the Gulf Pastoral District were visited during 2019.

Vegetation cover of the ground layer was measured at 47 sites across the seven leases. Sites, on average, had nearly one-fifth bare ground, reasonable litter cover as may be expected with more timbered land systems in the north, and fair to moderate cover of perennial grasses (Figure 55). The mean bare ground cover for the 47 sites was 21%, with a maximum of 65%; perennial grass cover was up to 90%, but was mostly around the mean values. Perennial grasses are important in the Gulf country because they protect the soil surface against wind and water erosion and, where palatable, provide persistent forage to carry livestock through dry times. Litter cover also protects the soil surface, assists infiltration of rain water and helps retain plant seeds in situ.

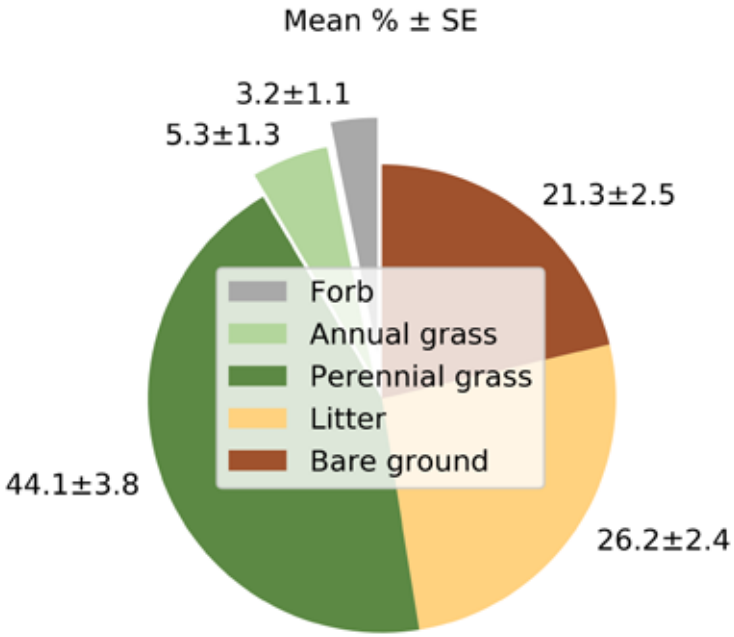

Figure 55. Mean percentage and standard error of measured components of vegetation cover in the ground layer from 47 sites on seven pastoral leases in the Gulf Pastoral District.

The majority of the sites had minimal grazing and 21% of the sites had heavy to very heavy grazing (Table 17). There was no evidence of erosion recorded at any of the sites.

Table 17. Levels of pasture utilisation recorded at 47 sites on seven pastoral leases in the Gulf Pastoral District.

Pasture Utilisation

Rank	% of sites
No grazing	2
Minimal (<25%)	63
Moderate (26-50%)	8
Moderate to heavy (51-75%)	6
Heavy (75-90%)	17
Very heavy (>90%)	4

GULF PASTORAL DISTRICT

The seven pastoral leases with monitored sites experienced below average seasonal quality based on modelled pasture growth through the 2018-19 wet season.

Land condition ratings assigned at monitoring sites and the more generalised assessment of land condition across those parts of pastoral leases traversed are summarised in Table 18.

Table 18. Assessed land condition at 47 monitoring sites and traversed parts of seven pastoral leases in the Gulf Pastoral District.

Station	Condition Rating	Comments with regard to pastoral lease
1	Fair: 3 Poor: 3	Land condition was found to be Poor. A recent history (since 2007) of heavy grazing combined with two failed wet seasons has contributed to a high bare ground component with a related poor pasture composition. Plans are in place to develop the underutilised west of the property to hopefully spread grazing pressure.
2	Good: 3 Fair: 2 Poor: 1	Land condition was generally assessed as Good to Fair condition, which is consistent with the previous monitoring conducted in 2014. The 2018-19 below average wet season was reflected in the poor pasture growth. The one site that was in Poor condition was close to the main road, which had been sprayed extensively with herbicide for grader grass (Themeda quadrivalvis) control since 2017. Bellyache bush (Jatropha gossypifolia) and devils claw (Martynia annua) have also been known to occur on the property in previous visits, although these were not observed on the station during the 2019 inspection. There were programs in place to manage these as well as some other less significant weeds, and the managers were very active with weed control. Seven donkeys were observed during the 2019 inspection.
3	Good: 1 Fair: 2	Land condition was generally assessed as Good to Fair condition. Comparisons of land condition scores at the monitoring sites and general observations across the property indicate that land condition was consistent with the previous monitoring conducted in 2014, and this is supported by fractional cover and bare ground threshold products.
4	Good: 3 Fair: 4 Poor: 2	Land condition was overall assessed as being Good to Fair, which is consistent with the previous monitoring conducted in 2014. The 2018-19 below-average wet season was reflected in moderate pasture growth. Erosion has been acknowledged as an issue on the property especially along fence lines and some internal tracks, however no significant areas of erosion were observed in pastorally productive areas. The erosion is mostly a legacy issue. There has been no significant new erosion, and water diversion banks have been implemented into tracks to help mitigate erosion. There were isolated patches of weed infestations, including bellyache bush (Jatropha gossypifolia), parkinsonia (Parkinsonia aculeate), devils claw (Martynia annua) and noogoora burr (Xanthium strumarium).

GULF PASTORAL DISTRICT

Station	Condition Rating	Comments with regard to pastoral lease
5	Good: 1 Fair: 3 Poor: 3	Land condition was generally assessed as Fair, which is a decline from the previous monitoring conducted in 2014. The 2018-19 below average wet season was reflected in poor pasture growth. Poor condition sites were not reflective of overall property condition, as two of these were located in the south west where there had been even less rainfall than the rest of the property, and were heavily grazed. There were no weeds observed during 2019 inspection, although bellayache bush has potential in the catchment to become a large infestation. The manager mentioned some woody thickening of Eucalpytus pruinosa occurring over last few decades. There were some minor erosion areas, some of which may be natural. Buffalo, donkeys, pigs and dingos/wild dogs noted by lessee however appear well controlled. Aerial weed survey by lessee may be beneficial if not done recently.
6	Good: 8 Fair: 2 Poor: 2	Land condition was generally assessed as Good to Fair in 2019, which is a slight decline from the previous monitoring conducted in 2014 when the property was assessed as Good condition. The 2018-19 well-below-average wet season was reflected in poor pasture growth, however a good diversity of desirable pasture species had been maintained through conservative stocking rates and holding onto pasture from the 2017-2018 growth event.
7	Good: 2 Fair: 2	Land condition was found to be Fair with relatively good pasture cover despite failed wet seasons. A large part of the property is unable to be grazed and the remainder along the rivers and creeks is heavily utilised.

BARKLY PASTORAL DISTRICT

Map 8: Location of Barkly Pastoral District

The Barkly Pastoral District encompasses nearly 134 000 km^2 making this the most extensive of the 11 pastoral districts.

Seasonal quality, based on expected pasture growth, was very much below average across most of the Barkly Pastoral District. The southern-most portion had average simulated pasture growth. Rainfall was well below the long term median. Analysis of Landsat imagery for the late dry season of 2019 showed that the central and northern parts of the District had mostly lowest recorded or very much below average vegetation cover recorded since 1988 (the start of the Landsat record used for monitoring land condition). The southern-most part of the District had average vegetation cover based on the 30-year record. One quarter of the District had >61% bare ground (per Landsat pixel) in the late dry season, mainly in the east and central parts of the District. Three percent of the District burnt over the reporting period, with the majority of this occurring in November and December 2018. Four pastoral leases were visited where three of 29 sites were rated in Good land condition, 23 in Fair condition and three in Poor condition..

Seasonal quality

'Seasonal quality' describes the relative value of recent rainfall in producing forage for livestock. It is judged with reference to the historical record. Two indicators are used: rainfall amount compared with the long-term median and expected pasture growth based on the rainfall received, simulated using AussieGRASS (www.longpaddock.qld.gov.au).

Descriptors of seasonal quality provide useful context for interpreting various measures of land condition at particular times. However, to the extent possible, land condition is assessed independently of seasonal conditions.

Rainfall statistics (Table 19) are based on gridded rainfall produced by the Bureau of Meteorology (www.bom.gov.au/jsp/awap/rain/index.jsp). Pixel (grid cell) values are calculated from rainfall amounts at recognised recording stations. Rainfall is from October of one year to September the following year. Due to the considerable north-south transition in long-term median rainfall for this large Pastoral District, rainfall statistics are reported based on an arbitrary split of the region into two sub-districts (Figure 56).

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BARKLY PASTORAL DISTRICT

Table 19. Recent seasonal quality for the Barkly Pastoral District as indicated by spatially averaged rainfall relative to the long-term median and AussieGrass modelled pasture growth.

Rainfall (mm)	Barkly North	Barkly South	Index of seasonal quality	Barkly Pastoral District
2018 – 2019	180	170	Growth (kg/ha)	129
Long-term median	428	303	Percentile	10

Spatially averaged rainfall for the northern and southern sections of the Barkly Pastoral District was considerably below the long-term median (Table 19). Twelve-month rainfall was lower (less than 100mm) in the far south east in line with the increasing aridity of this part of the Barkly region. When compared with the seasonal rainfall for the previous five years (Figure 56 and Figure 57), the 2018-19 rainfall was the lowest for both the northern and southern parts of the Barkly Pastoral District. Rainfall was above median in the four years from 2013-14 to 2016-17, just below median in 2017-18, and well below median in 2018-19.

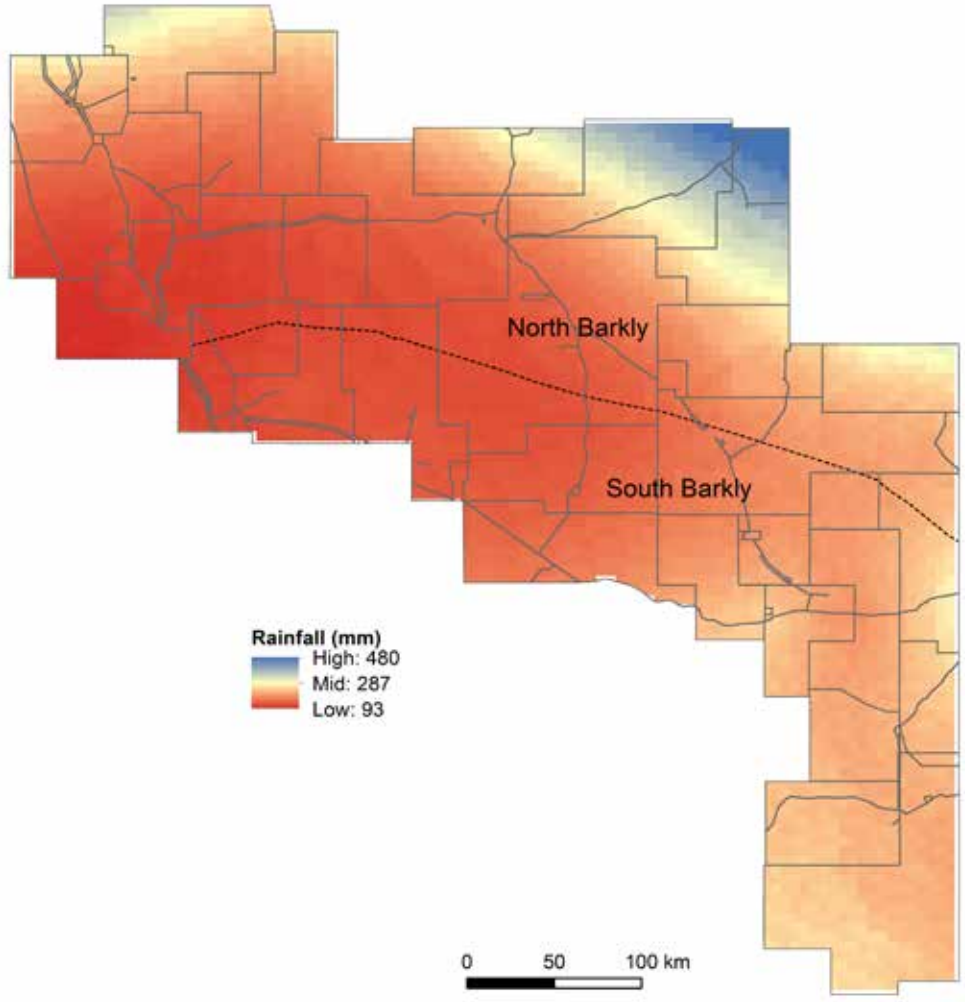


Figure 56. Spatially interpolated, gridded rainfall for the Barkly Pastoral District. Reporting period is October 2018 to September 2019. The grid cells on this map are at 5km x 5km resolution (i.e. each square represents 25km^2).

BARKLY PASTORAL DISTRICT

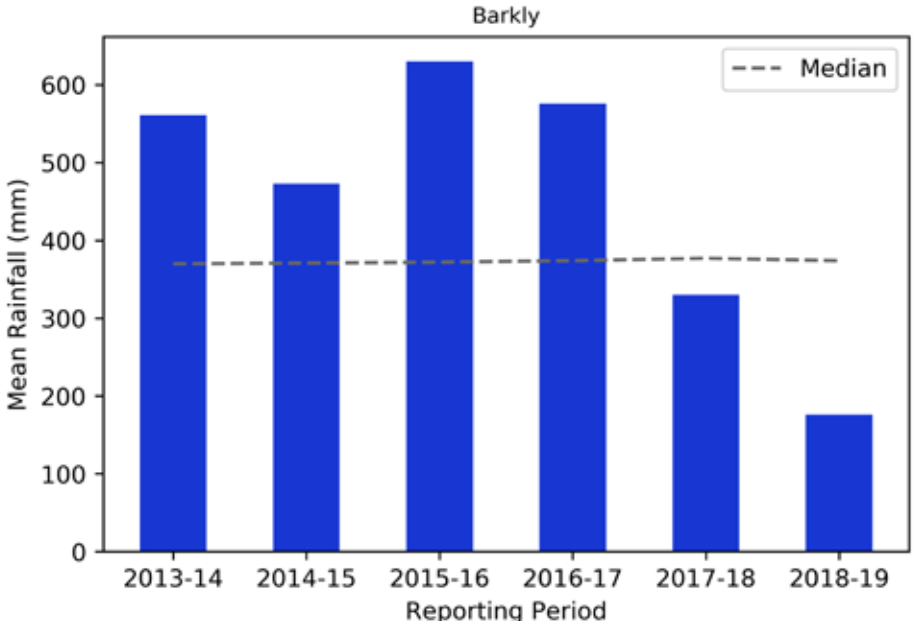


Figure 57. Spatially averaged historic rainfall for the Barkly Pastoral District. Long-term median indicated by dashed line.

AussieGRASS-modelled pasture growth, as a second indicator of seasonal quality for the entire Barkly Pastoral District, is for the period November 2018 to April 2019. This growth is ranked as a percentile of the growth for all previous summers (back to 1957). In this case, spatially-averaged growth through the 2018-19 wet season was approximately 129kg/ha which was very much below the long-term median (Table 19).

Modelled pasture growth over the 2018-19 wet season, as a percentage of the long-term record, was very much below average for much of the District (Figure 58). Some of the southern-most portions of the District had average modelled pasture growth.

BARKLY PASTORAL DISTRICT

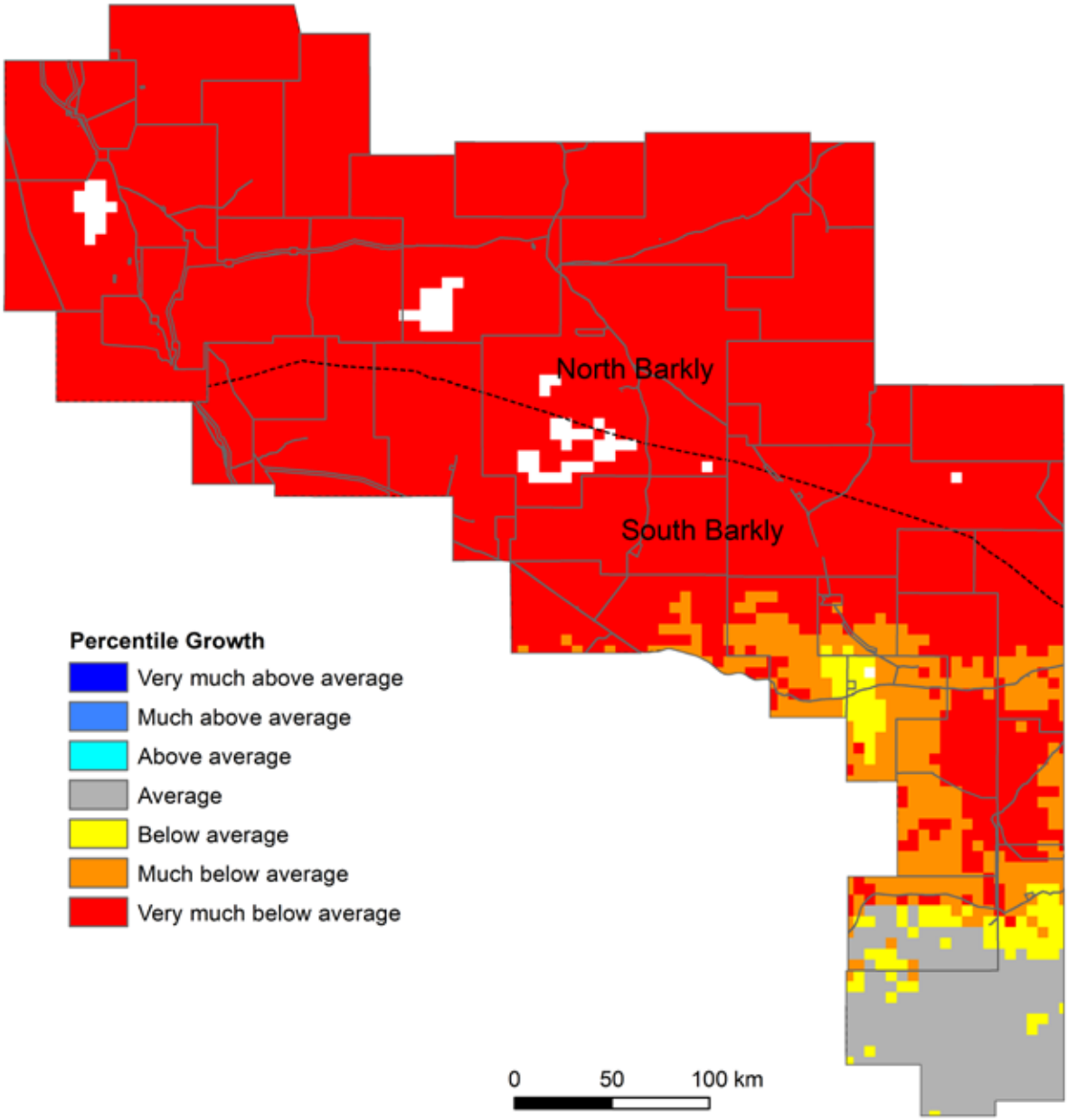


Figure 58. Simulated pasture growth for the 2018-19 wet season as a percentage of the long-term record. The grid cells on this map are at 5km x 5km resolution (i.e. each square represents 25km²).

A comparison of the modelled pasture growth for the last six years (Figure 59) shows that pasture growth was above median for the years 2013-14 to 2017-18, but fell to very much below median in 2018-19.

BARKLY PASTORAL DISTRICT

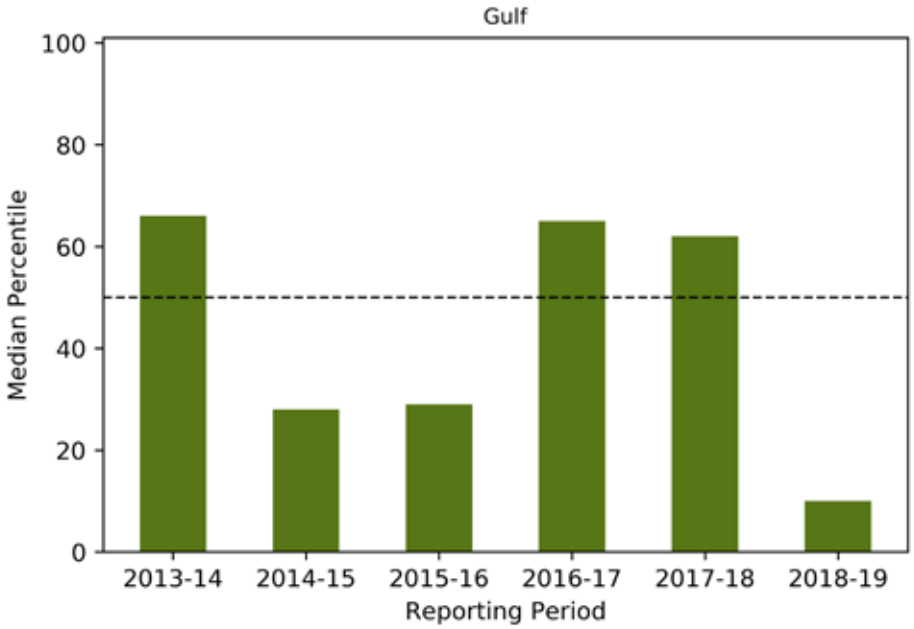


Figure 59. Median percentile of pasture growth for the Barkly Pastoral District, in the five reporting periods prior to current. The 50th percentile is indicated by a dashed line.

Fire

The North Australia and Rangelands Fire Information website (www.firenorth.org.au/nafi3/) reports that 4 439km^2 (3% of the Barkly Pastoral District) burnt between October 2018 and September 2019. Fire was most extensive in November and December 2018 (Figure 60), and may be correlated with controlled burns in the early wet season targeting non-Mitchell grass country.

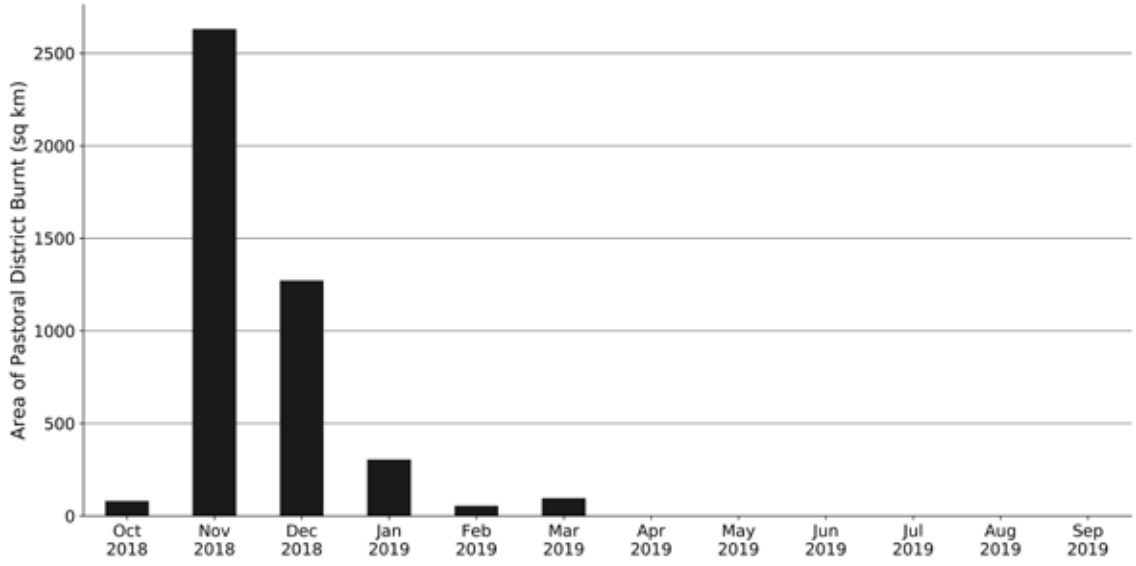


Figure 60. Monthly area burnt (km^2) in the Barkly Pastoral District between October 2018 and September 2019.

BARKLY PASTORAL DISTRICT

Ground cover dynamics

It is important to maintain adequate ground cover in the latter months of each year to minimise soil loss from wind erosion and intense summer storms. It is also important to carry dry feed, and associated ground cover, into the latter months of each calendar year in case there is a late start to the usual wet season and/or monsoonal rains fail more generally.

The southern-most part of the Barkly Pastoral District had average levels of vegetation cover recorded since 1988 (Figure 61). Much of the central and eastern parts had the lowest to very much below average vegetation cover based on the 30-year record, with scattered areas of significantly reduced vegetation cover (increased bare ground).

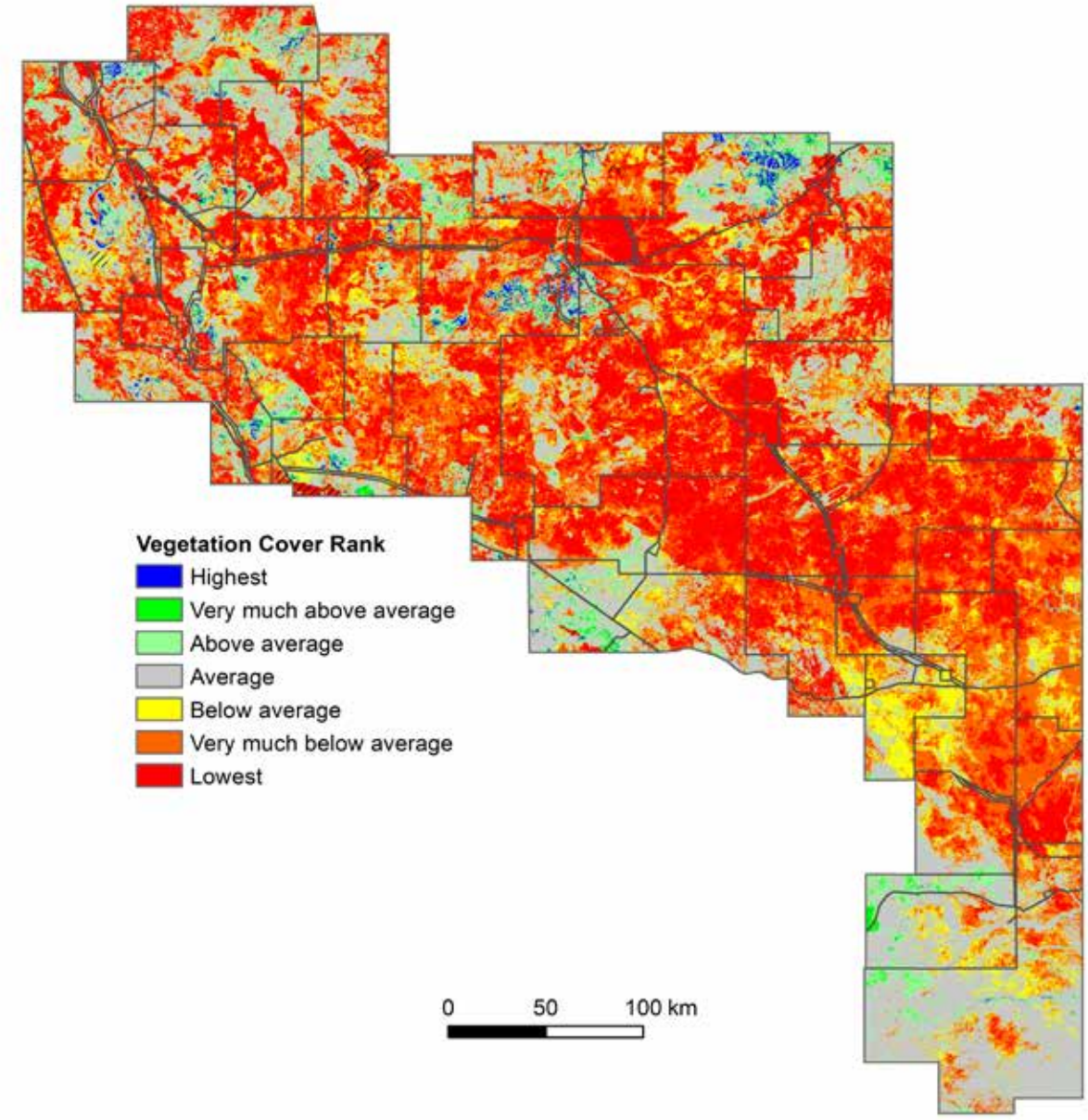


Figure 61. Rank of the amount of remotely-sensed vegetation cover present from September to November 2019 against that for previous years back to 1988. White areas show larger lakes.

BARKLY PASTORAL DISTRICT

The amount of bare ground present at any location changes from year to year depending on rainfall and its effectiveness, fire history and amount of grazing. The percentage of bare ground in each 30-m Landsat pixel (900m^2 or 0.09ha) was used to report the amount of bare ground across all pixels in the Barkly Pastoral District.

The bare ground threshold is based on the cumulative frequency distribution of bare ground for all 30-m Landsat pixels at the end of 2019 (spring composite). The bare ground percentage corresponding to 75% cumulative frequency was selected as the bare ground threshold (Figure 62). Bare ground percentage for 75% of the district is equal to or below this threshold. The remaining 25% of the district is considered to have above-threshold bare ground.

The bare ground threshold value for the Barkly Pastoral District was 61%; one quarter of the District had bare ground greater than this value (Figure 62). This latter area was mostly in the east, south east and central part of the District (Figure 63). Approximately 7% of the District had minor amounts of bare ground (<20% of the 30-m Landsat pixel) towards the end of 2019.

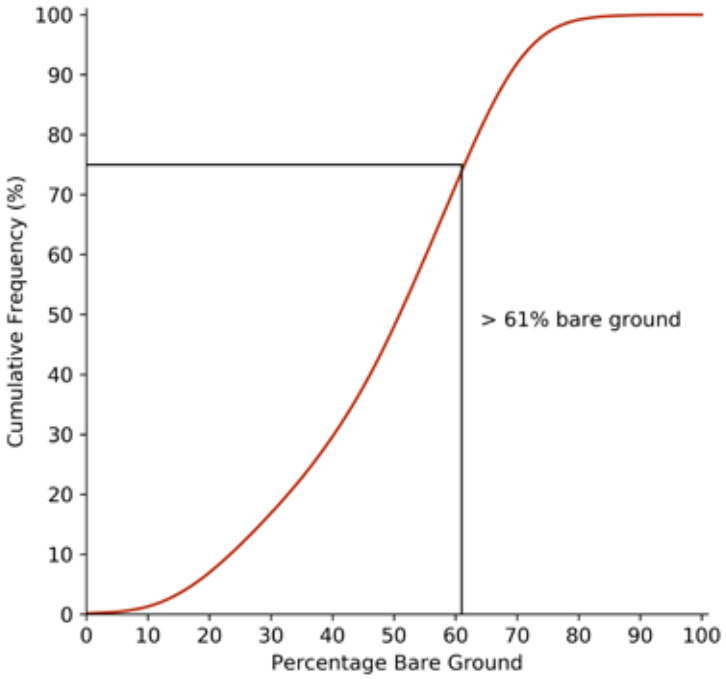


Figure 62. Percentage cumulative frequency of varying levels of bare ground in 30-m Landsat pixels in the Barkly Pastoral District between September and November 2019. Areas with greater than 61% bare ground are mapped in Figure 63.

BARKLY PASTORAL DISTRICT

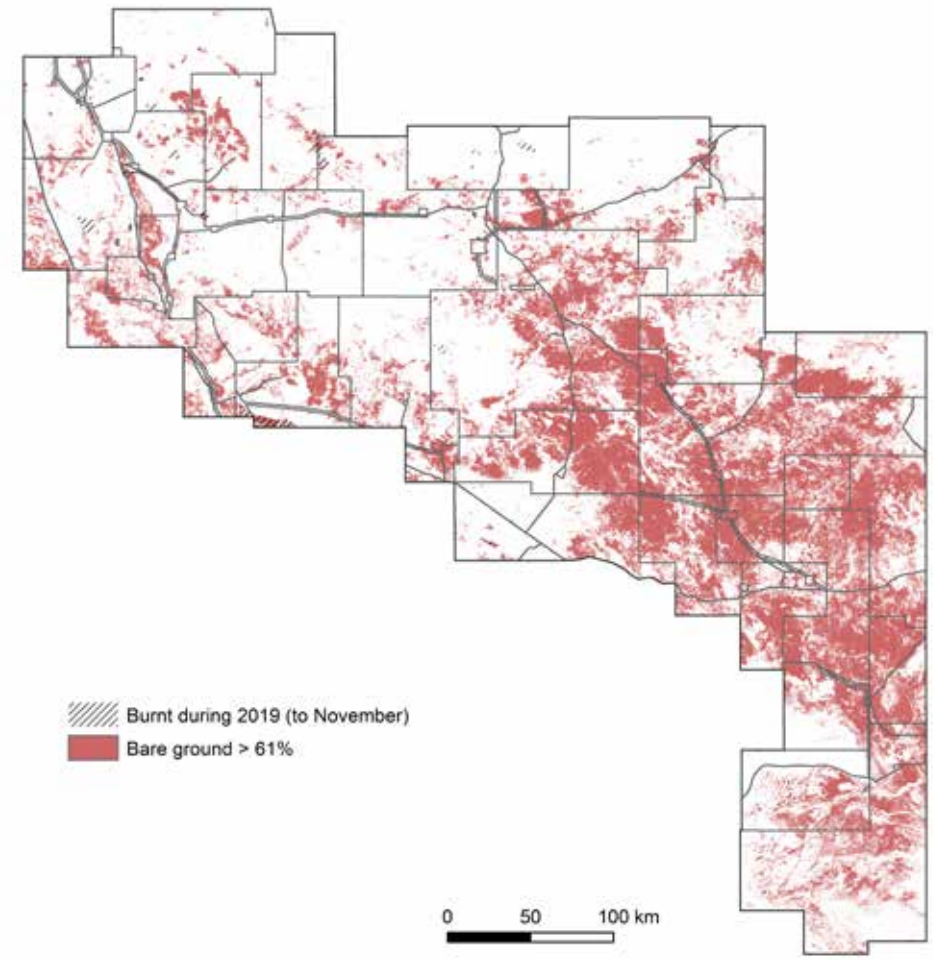


Figure 63. Parts of the Barkly Pastoral District having more than 61% bare ground per Landsat pixel in late 2019. Note that the threshold level of bare ground used for mapping purposes varies between pastoral districts. It is selected to show at what level approximately 25% of the district is affected.

Site-based monitoring

Four pastoral leases in the Barkly Pastoral District were visited during 2019.

Vegetation cover of the ground layer was measured using the star transect method at 29 sites across the four leases. Sites, on average, had a moderate cover of perennial grasses, largely due to the predominance of Mitchell grasses in this District (Figure 64). Litter contributed, on average, about one-tenth of the ground layer, which was associated with seasonal perennial versus annual grass dynamics. The percentage of litter and subsequently bare ground, will likely increase as the annual grasses, mainly red Flinders grass, disintegrate as the dry season progresses. Bare ground comprised about 56% of the 1-ha site area. Perennial grasses are particularly important on the Mitchell grass downs as the mainstay of the grazing industry. They also protect the soil surface against wind and water erosion and, where sufficiently dense, provide competition against invasive woody species such as parkinsonia and rubber bush. Litter cover also protects the soil surface, assists infiltration of rain water and helps retain plant seeds in situ.

BARKLY PASTORAL DISTRICT

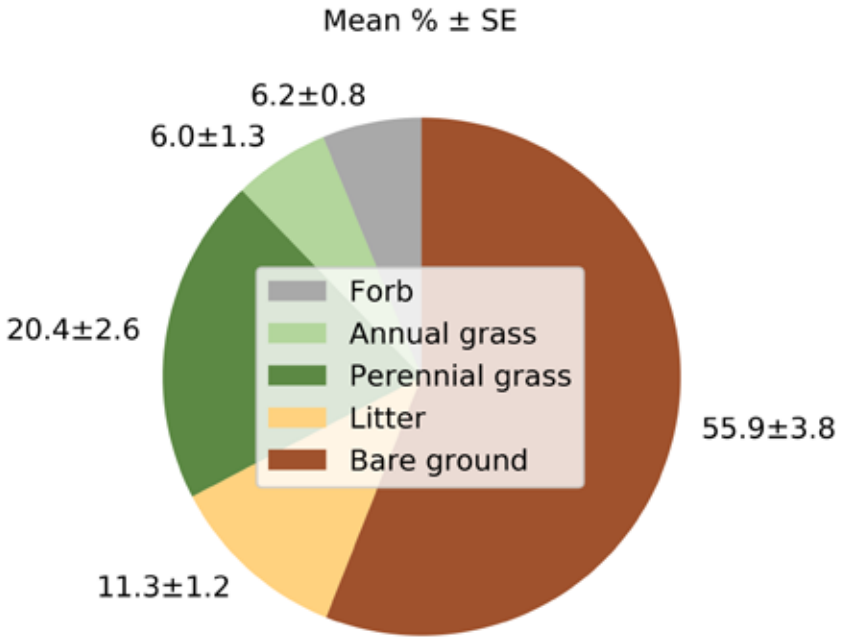


Figure 64. Mean percentage and standard error of measured components of vegetation cover in the ground layer from 29 sites on four pastoral leases in the Barkly Pastoral District.

A third of the sites were minimally grazed and 30% had moderate to heavy grazing (Table 20), although this assessment is partly dependent on the time at which a lease is visited relative to the end of the growing season; later assessments may mean increased levels of pasture utilisation.

Erosion was not recorded at any of the 29 sites.

Table 20. Levels of pasture utilisation recorded at 29 sites on four pastoral leases in the Barkly Pastoral District.

Pasture Utilisation

Rank	% of sites
No grazing	7
Minimal (<25%)	33
Moderate (26-50%)	17
Moderate to heavy (51-75%)	30
Heavy (75-90%)	13
Very heavy (>90%)	0

Land condition ratings assigned at monitoring sites and the more generalised assessment of land condition across those parts of pastoral leases traversed are summarised in Table 21. Four stations visited in 2019 were mostly contained within the southern Barkly Pastoral District, and experienced very-much below average seasonal quality, based on 12-month rainfall and modelled wet-season pasture growth.

BARKLY PASTORAL DISTRICT

Table 21. Assessed land condition at monitoring sites and traversed parts of four pastoral leases in the Barkly Pastoral District.

Station	Condition Rating (number of sites)	Comments with regard to pastoral lease
1	Good: 1 Fair: 4 Poor: 2	Managed along with Station 3 as one station. The general land condition in 2019 was considered Fair with most areas showing signs of a decrease in ground cover since the previous monitoring in 2014. There were some concerns regarding land condition, which was mostly related to increased levels of bare ground and limited amounts of pasture available to stock. Wet season spelling of some paddocks, particularly the central areas may be beneficial to assist with recovery of desirable vegetative ground cover including 3P species. There were some isolated infestations of rubber bush (Calotropis procera) around the station, mainly restricted to within 250m of bores and Turkey Nests and control programs were in place. No other land management issues with erosion, feral animals, or woody thickening were observed on the property. It is acknowledged that the 2018-2019 wet season rainfall (Nov-Apr) is one of the lowest on record and the manager was actively managing to conditions at the end of the wet season by progressively destocking the property from 24 000 to 10 500 (16 000 at time of inspection) to assist with land condition recovery.
2	Good: 1 Fair: 2	Land condition on this station was generally assessed as Fair. A change in land condition score at one monitoring site, and the current land condition at the other monitoring sites, supported by fractional cover and bare ground threshold products, indicate that land condition was consistent with the previous monitoring conducted in 2014. It was expected that there would be an improvement in condition as the station had been de-stocked since (2018) and the previous inspection had a herd of unknown numbers. While land condition was fair, the poor state of the infrastructure means that effective herd management is non-existent.
3	Good: 1 Fair: 7 Poor: 1	Managed along with Station 1 as one station. The general land condition in 2019 was considered Fair with most areas showing signs of a decrease in ground cover since the previous monitoring in 2014. There were some concerns regarding land condition, which was mostly related to increased levels of bare ground and limited amounts of pasture available to stock. Wet season spelling of some paddocks, particularly the central areas may be beneficial to assist with recovery of desirable vegetative ground cover including 3P species. There were some isolated infestations of rubber bush (Calotropis procera) around the station, mainly restricted to within 250m of bores and Turkey Nests and control programs were in place. No other land management issues with erosion, feral animals, or woody thickening were observed on the property. It is acknowledged that the 2018-2019 wet season rainfall (Nov-Apr) is one of the lowest on record and the manager was actively managing to conditions at the end of the wet season by progressively destocking the property from 24 000 to 10 500 (16 000 at time of inspection) to assist with land condition recovery.
4	Fair: 10	Land condition on this station was generally assessed as Fair condition which is a decline since the last monitoring in 2015, mainly due to drought conditions. The below average rainfall in the previous two years was reflected in the pasture production with low biomass of palatable desirable perennial grass species, and the germination but lack of subsequent production of biomass in annual grass species in infill between perennial species tussocks. There were some significant areas of weed infestations, including rubber bush, which is noted as legacy populations, and prickly acacia, both of which are part of active and ongoing weed management programs.

TENNANT CREEK PASTORAL DISTRICT

Map 9: Location of Tennant Creek Pastoral District

The Tennant Creek Pastoral District encompasses approximately 69 200 km^2 and includes eight pastoral leases.

Seasonal quality based on rainfall and AussieGRASS-modelled pasture growth ranged from below average to very much below average across the District; after experiencing a second year of below average rainfall. Three percent of the District burnt between October 2018 and September 2019 with most fire activity in January 2019. Based on Landsat imagery, just over half of the District had average to highest levels of vegetation cover recorded since 1988; although extensive areas experienced lowest vegetation cover. One quarter of the District had >57% bare ground per Landsat pixel (threshold bare ground). These areas of high bare ground were largely related to historic occurrence of fire. Two pastoral leases in the Tennant Creek Pastoral District were visited during 2019 with the 13 sites assessed as in either Good or Fair land condition.

Seasonal quality

'Seasonal quality' describes the relative value of recent rainfall in producing forage for livestock. It is judged with reference to the historical record. Two indicators are used: rainfall amount compared with the long-term median and expected pasture growth based on rainfall received, simulated using AussieGRASS (www.longpaddock.qld.gov.au).

Descriptors of seasonal quality provide useful context for interpreting various measures of land condition at particular times. However, to the extent possible, land condition is assessed independently of seasonal conditions.

Rainfall statistics (Table 22) are based on gridded rainfall produced by the Bureau of Meteorology (www.bom.gov.au/jsp/awap/rain/index.jsp). Pixel (grid cell) values are calculated from rainfall amounts at recognised recording stations. Rainfall is from October of one year to September the following year. Modelled pasture growth is for the period November 2018 to April 2019. This growth is ranked as a percentile of the growth for all previous summers.

Spatially averaged rainfall for the Tennant Creek Pastoral District was well below the long-term median (Table 22). Across the District, the median rainfall received increased from west to east; however areas receiving the highest rainfall within the District were still below the long-term median (Figure 65).

Table 22. Indicators of seasonal quality. Data spatially averaged for the Tennant Creek Pastoral District.

Rainfall (mm)		AussieGRASS	
2018 – 2019	161	Growth (kg/ha)	128
Long-term median	286	Percentile	20

TENNANT CREEK PASTORAL DISTRICT

Modelled pasture growth over the last summer, as a percentage of the long-term record, was predominately well below average to very well below average. Areas that received slightly more rainfall (central and south-east of the District) modelled below average pasture growth (Figure 66).

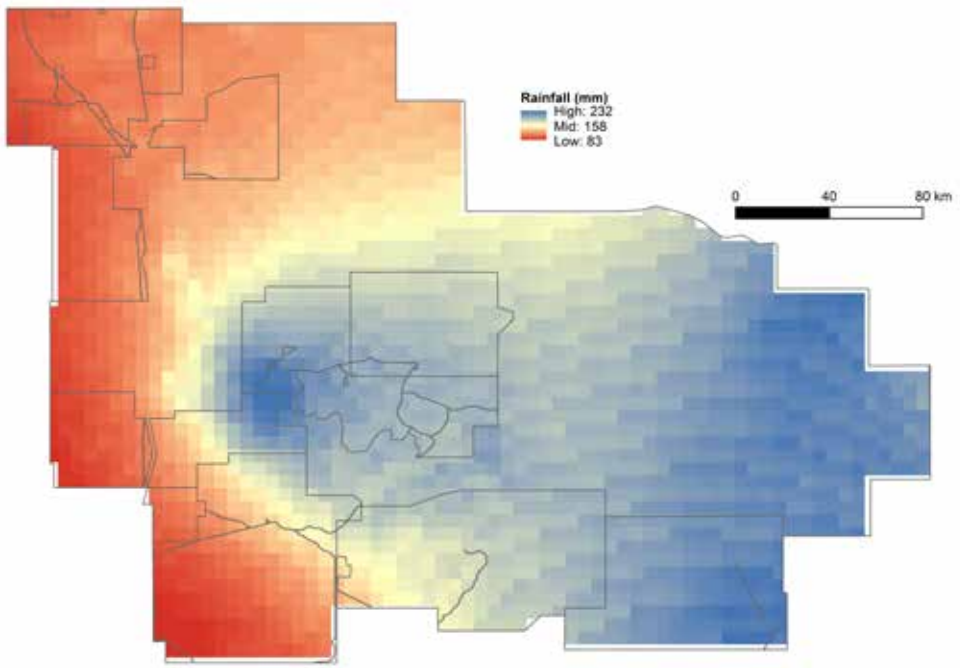


Figure 65. Spatially interpolated rainfall, October 2018 to September 2019. The grid cells on this map are at 5km x 5km resolution (i.e. each square represents 25km^2).

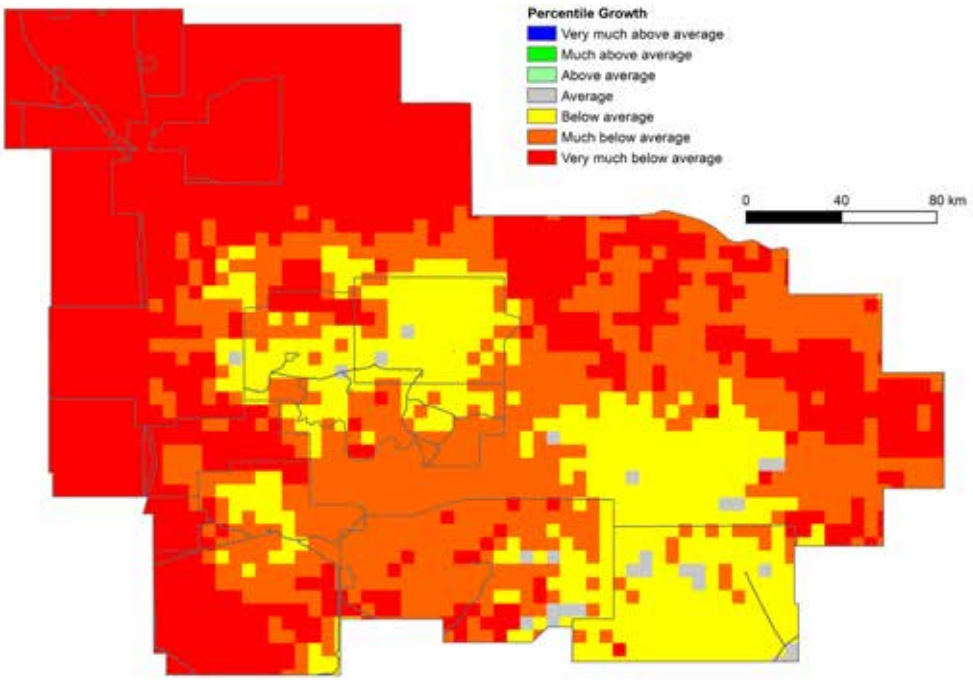


Figure 66. AussieGRASS-modelled pasture growth for the 2018-19 summer period as a percentage of previous summers. The grid cells on this map are at 5km x 5km resolution (i.e. each square represents 25km^2).

TENNANT CREEK PASTORAL DISTRICT

Spatially averaged historic rainfall for the District over the past six years indicates that only two years out of the six had below median rainfall with 2018-19 receiving well below the median. Prior to this, 2014-15 to 2016-17 received well above the median rainfall (Figure 67).

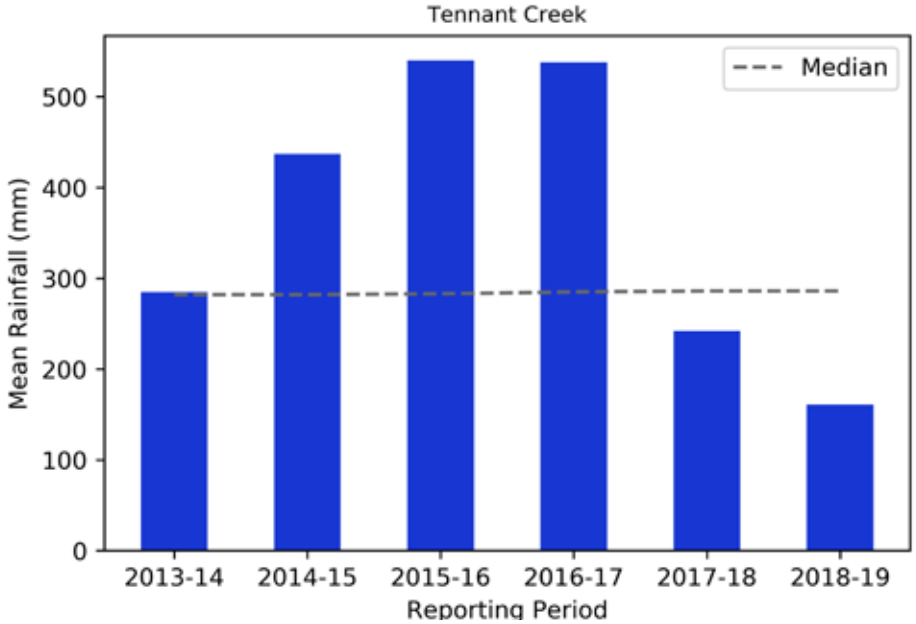


Figure 67. Spatially averaged historic rainfall for the Tennant Creek Pastoral District. Long-term median indicated by dashed line.

Modelled pasture growth over the past six years indicates that for five out of these six years pasture growth was above the median percentile. Only 2018-19 was below the median percentile and pasture growth over this time was significantly below the median (Figure 68).

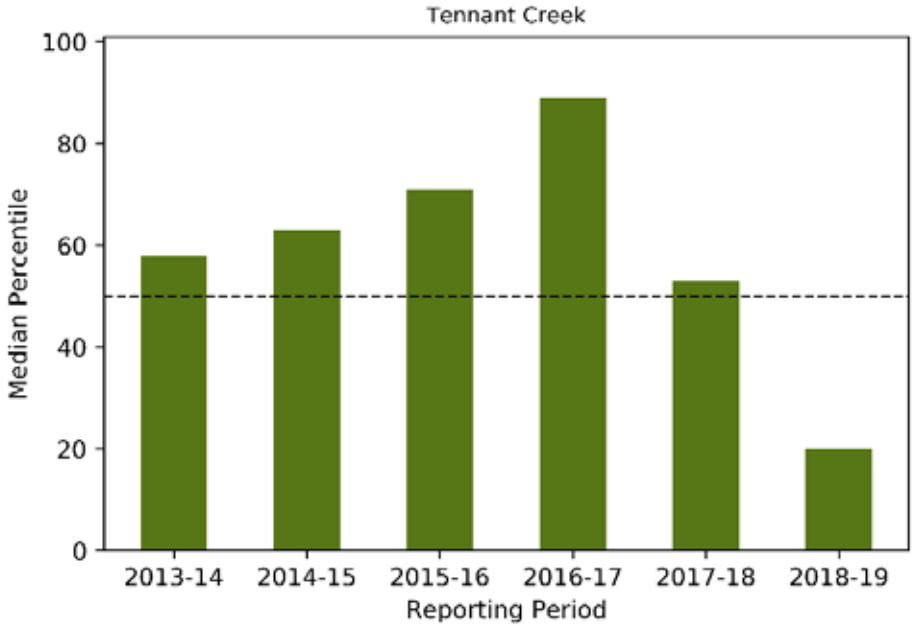


Figure 68. Historic pasture growth (kg/ha) from AussieGRASS for the Tennant Creek Pastoral District. The 50th percentile is indicated with a dashed line.

TENNANT CREEK PASTORAL DISTRICT

Fire

The North Australia and Rangelands Fire Information website (www.firenorth.org.au/nafi3/) reports that 2 001km^2 (3%) of the Tennant Creek Pastoral District burnt between October 2018 and September 2019. This was much less than the area burnt during the 2017-18 reporting period (8 043km^2). Most of the area was burnt in January 2019 (Figure 69).

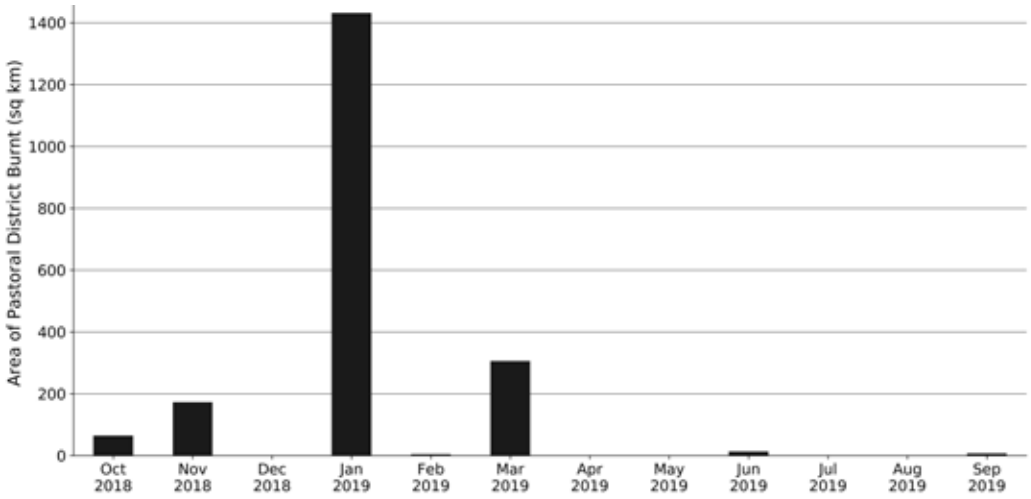


Figure 69. Monthly area burnt (km^2) in the Tennant Creek Pastoral District between October 2018 and September 2019.

Ground cover dynamics

It is important to maintain adequate ground cover in the latter months of each year to minimise soil loss from wind erosion and intense summer storms. It is also important to carry dry feed, and associated ground cover, into the latter months of each calendar year in case there is a late start to the usual Wet season and/or summer rains fail more generally.

Just over half of the District had average to highest levels of vegetation cover recorded since 1988, with large areas of below average to lowest cover rank in northern and western parts of the District (Figure 70). Fire in 2018 and 2019 accounted for only a small proportion of those areas which had much below average vegetation cover however, large areas with the very much below average or lowest ranking were associated with historic fires (fire scars shown in Figure 70).

TENNANT CREEK PASTORAL DISTRICT

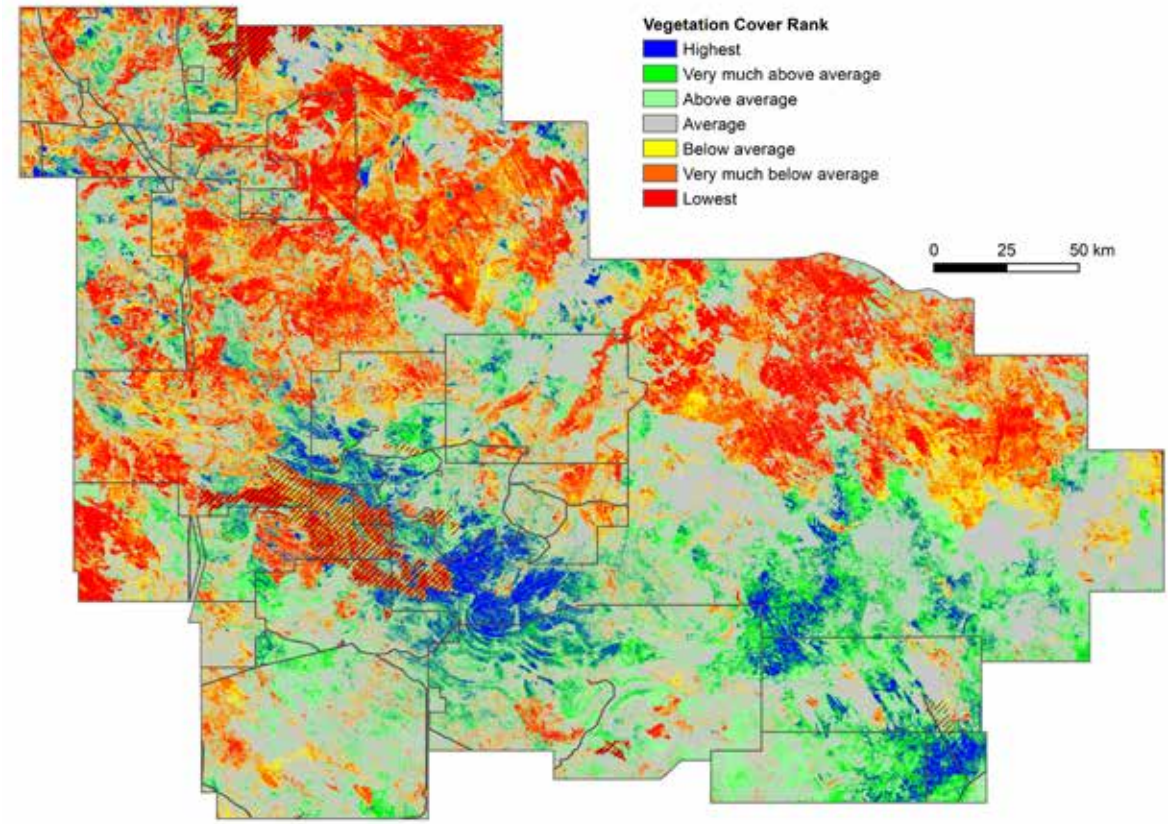


Figure 70. Rank of the amount of remotely-sensed vegetation cover present from September to November 2019 against that for previous years back to 1988. Diagonal lines show those areas burnt between January and November 2019.

The amount of bare ground present at any location changes from year to year depending on rainfall and its effectiveness, fire history and amount of grazing. The percentage of bare ground in each 30-m square Landsat pixel (900m^2 or 0.09ha) was used to report the amount of bare ground across all pixels in the Tennant Creek Pastoral District.

The bare ground threshold is based on the frequency distribution of all 30-m Landsat bare ground cover pixels at the end of 2018 (spring composite). A threshold was determined which represents 75% of a district's overall bare ground. The remaining 25% is considered to have above-threshold bare ground.

Less than one percent of the District had minor bare ground (<20% of the 30-m Landsat pixel) towards the end of 2019 (Figure 71) and one quarter of the District had >57% bare ground (bare ground threshold) (Figure 71 and Figure 72).

TENNANT CREEK PASTORAL DISTRICT

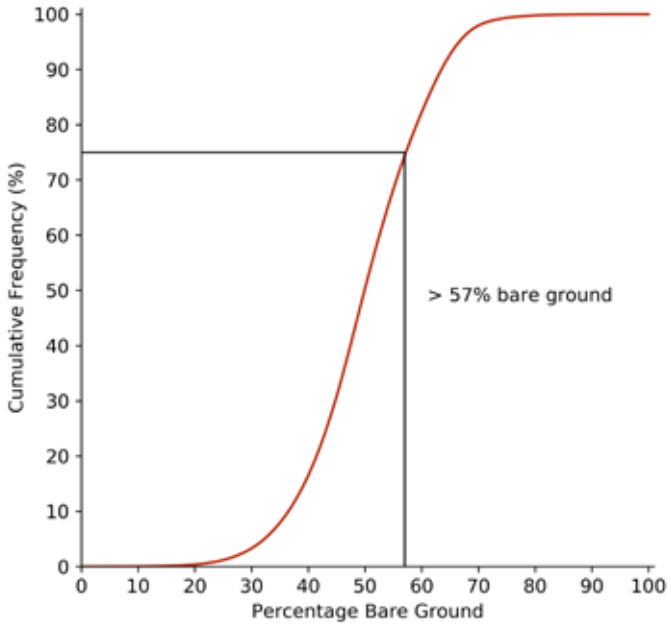


Figure 71. Percentage cumulative frequency of varying levels of bare ground in 30-m square Landsat pixels in the Tennant Creek Pastoral District between September and November 2019. Areas with >57% bare ground are mapped in Figure 72.

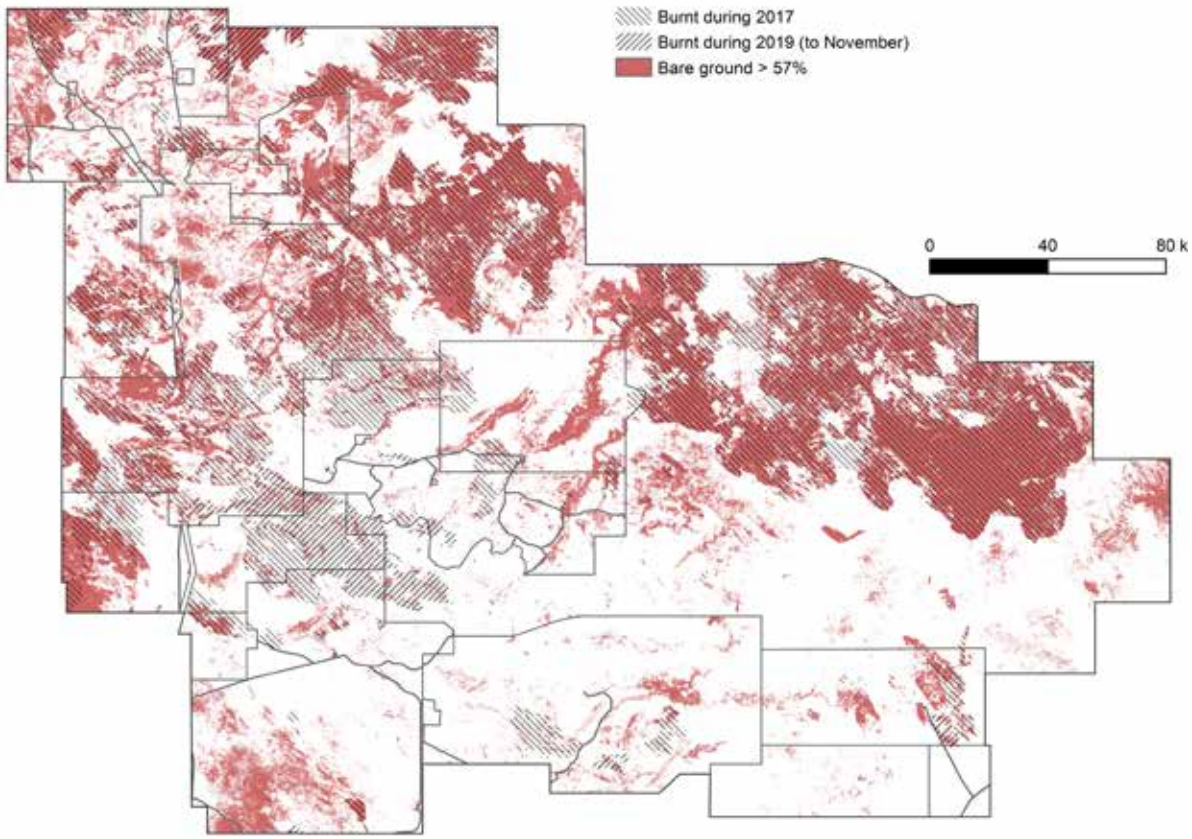


Figure 72. Parts of the Tennant Creek Pastoral District having >57% bare ground per Landsat pixel in late 2019. Areas burnt between January and November 2019 shown with diagonal lines. Note that the threshold level of bare ground used for mapping purposes varies between pastoral districts. It is selected to show at what level approximately 25% of the district is affected.

TENNANT CREEK PASTORAL DISTRICT

Site-based monitoring

Two pastoral leases in the Tennant Creek Pastoral District were visited during 2019.

Vegetation cover of the ground layer was measured using the point intercept method at 13 sites across the two leases. Sites, on average, had a moderate to high level of bare ground, and moderate cover of litter cover, perennial and annual grass, and small contributions of forbs (Figure 73).

There was, however, considerable variation in cover components amongst sites. Five sites had more than 70% bare ground, a high level for the Tennant Creek region. Perennial grasses exceeded 30% total cover at only one site and comprised <10% cover at seven sites.

Perennial grasses are important because they protect the soil surface against wind and water erosion and, where palatable, provide persistent forage to carry livestock through dry times. Litter cover also protects the soil surface, assists infiltration of rain water and helps retain plant seeds in situ.

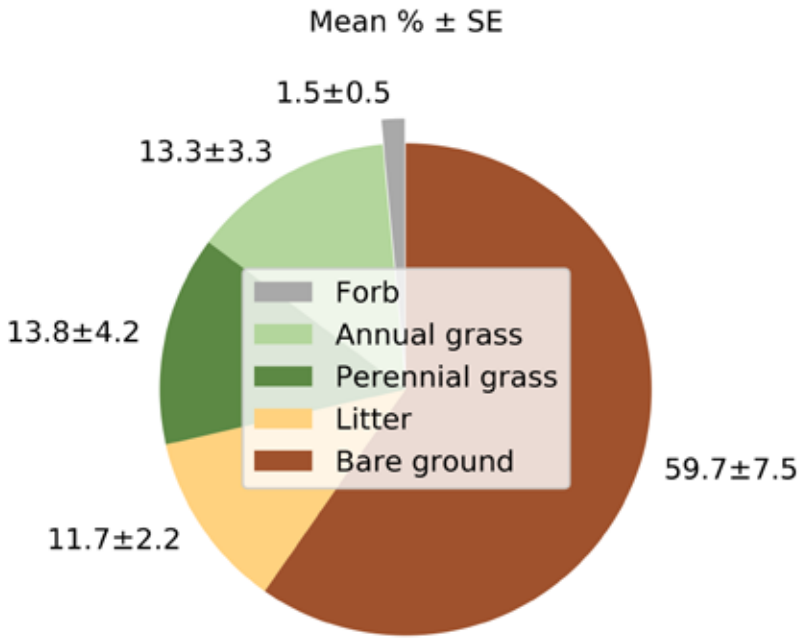


Figure 73. Mean percentage and standard error of measured components of vegetation cover in the ground layer from 13 sites on two pastoral leases in the Tennant Creek Pastoral District.

Forty-six percent of the 13 sites were not grazed or minimally grazed at the time of assessment (Table 23). More than 75% of the seasonal pasture growth had been consumed at eight sites, spread across the two leases.

Twelve sites (85%) showed evidence of erosion by wind and water sheeting. Evidence of scalding and gullying was recorded at 15% and 8% of the sites respectively.

TENNANT CREEK PASTORAL DISTRICT

Table 23. Levels of pasture utilisation and evidence of erosion assessed at 13 sites on two pastoral leases in the Tennant Creek Pastoral District.

Pasture Utilisation		Evidence of erosion	
Rank	% of sites	Type	% of sites
No grazing	8	Wind	85
Minimal (<25%)	38	Scalding	15
Moderate (26-50%)	15	Water sheeting	85
Moderate to heavy (51-75%)	0	Gullying	8
Heavy (75-90%)	8		
Very heavy (>90%)	31		

Land condition ratings assigned at monitoring sites and the more generalised assessment of land condition across those parts of pastoral leases traversed are summarised in Table 24. Both stations visited experienced below average seasonal quality, based on rainfall and modelled pasture growth. To the extent possible, condition assessments are independent of year-to-year variability in rainfall.

Table 24. Assessed land condition at monitoring sites and traversed parts of two pastoral leases in the Tennant Creek Pastoral District.

Station	Condition Rating (number of sites)	Comments with regard to pastoral lease
1	Good: 4 Fair: 4	Land condition on was generally assessed as in Fair to Good condition, which showed an improvement from the last visit in 2014. In very general terms, the northwest of the station was in Good condition, with lots of feed. The eastern side was fully utilised with very little feed, but still in Fair condition. The central part of the station was a mixture of spinifex and useful 3P (palatable, perennial, and productive) grasses. Parts of this area were in Fair condition as a result of woody thickening, other areas were in Good condition, as would be expected from a spinifex dominated area. Horses and donkeys were observed at several locations in the north-west of the station.
2	Good: 1 Poor: 4	Extensive areas of less pastorally productive spinifex dominated country were assessed in Good condition. The pastorally productive floodplains, valley floors and run-on depressions, mostly in central and south-eastern parts of the property, had high levels of bare ground and a general absence of productive pasture species. Land condition indicators suggest considerable decline in condition in these areas as a result of preferential grazing. However an inspection following rainfall sufficient for a growth event would enable a more accurate assessment of the potential for the country to respond. Declared weeds, rubber bush (Calotropis procera), parkinsonia (Parkinsonia aculeata) and bellyache bush (Jatropha gossypiifolia) had all been present in the recent past. All known parkinsonia and bellyache bush plants had been treated prior to the visit. Stabilisation and rehabilitation of tracks and fencelines was required in some areas.

PLENTY PASTORAL DISTRICT

The Plenty Pastoral District encompasses approximately 52 242 km^2 and includes 14 pastoral leases.

Map 10: Location of Plenty Pastoral District

The Plenty Pastoral District experienced below-average seasonal quality based on AussieGRASS-modelled pasture growth and marginally below average rainfall, with the exception of the central and north-east portion of the District which received average to above average rainfall. There was minimal incidence of fire (1%) across the District between October 2018 and September 2019. Just under 15% of the District had <40% bare ground and one quarter had >55% bare soil (bare ground threshold). Based on the Landsat record for the last 30 years, most of the District had average vegetation cover; although notably the south-west section experienced its lowest vegetation cover in the past 30 years. While this area was not impacted by fire, this region did experience below average rainfall. Two pastoral leases were assessed in this District in 2019, with the majority of the 17 assessed sites observed to be in Good to Fair land condition.

Seasonal quality

'Seasonal quality' describes the relative value of recent rainfall in producing forage for livestock. It is judged with reference to the historical record. Two indicators are used: rainfall amount compared with the long-term median and expected pasture growth based on rainfall received, simulated using AussieGRASS (www.longpaddock.qld.gov.au).

Descriptors of seasonal quality provide useful context for interpreting various measures of land condition at particular times. However, to the extent possible, land condition is assessed independently of seasonal conditions.

Rainfall statistics (Table 25) are based on gridded rainfall produced by the Bureau of Meteorology (www.bom.gov.au/jsp/awap/rain/index.jsp). Pixel (grid cell) values are calculated from rainfall amounts at recognised recording stations. Rainfall is from October of one year to September the following year. Modelled pasture growth is for the same period (October 2018 to September 2019) to take account of useful winter rainfall during 2019. This growth is ranked as a percentile of growth for all previous October – September periods.

Table 25. Indicatorsof seasonal quality. Data spatially averaged for the Plenty Pastoral District.

Rainfall (mm)		AussieGRASS	
2018 – 2019	191	Growth (kg/ha)	352
Long-term median	205	Percentile	42

Spatially averaged rainfall for the Plenty Pastoral District was close to (within 10mm of) the long-term median (Table 25). Rainfall was well below the medium within the west and south-east of the District between October 2018 and September 2019. However, above average rainfall was received across the central to north-eastern parts of the District (Figure 74, left-hand panel).

PLENTY PASTORAL DISTRICT

Modelled pasture growth in the 12 months between October 2018 to September 2019 was below the long term average based on the spatial mean (Table 26), although there were areas with 'above average' and 'much above average' pasture growth through the centre of the District (Figure 74, right-hand panel).

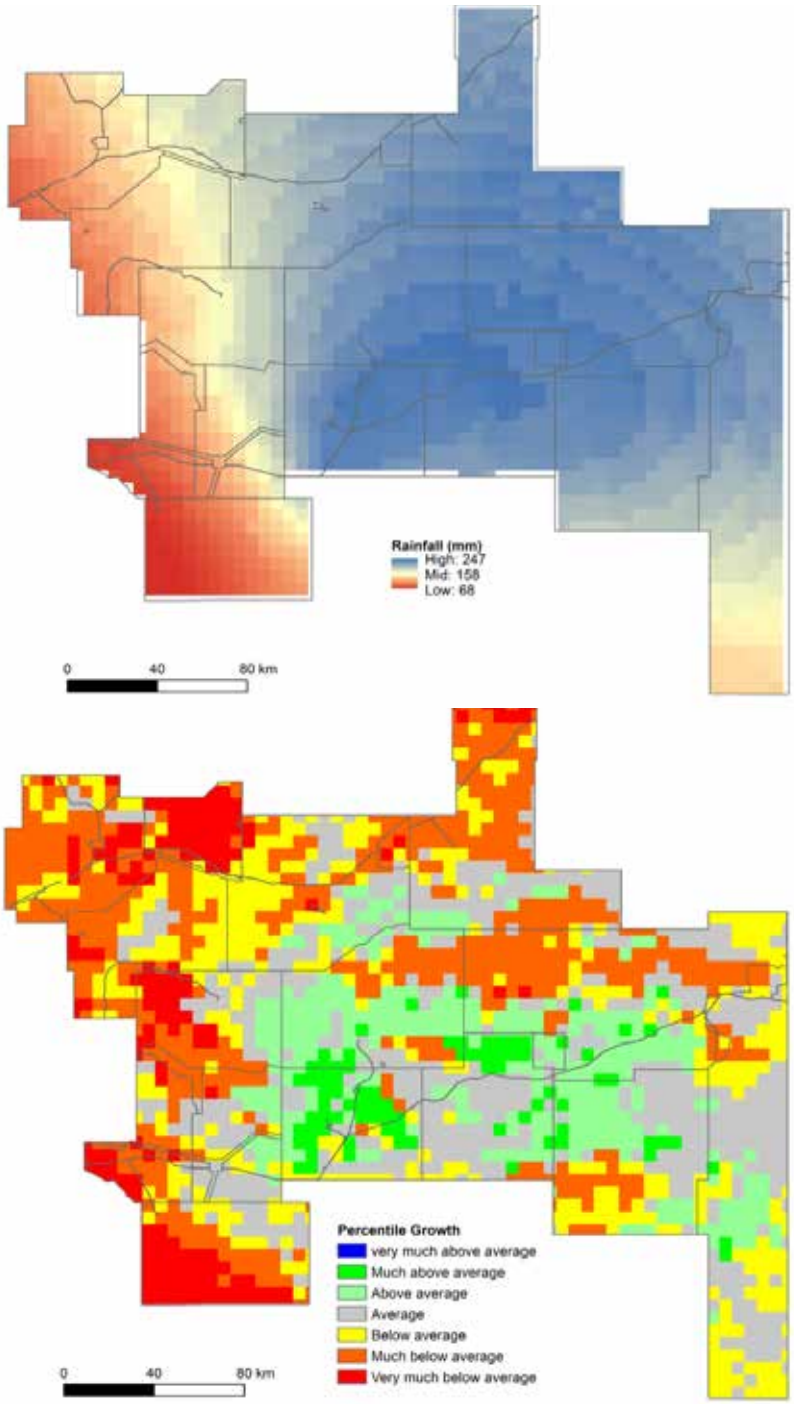


Figure 74. Maps of seasonal quality for the period, October 2018 to September 2019. Left, Spatially interpolated rainfall; right, AussieGRASS-modelled pasture growth as a percentage of previous similar periods. The grid cells on this map are at 5km x 5km resolution (i.e. each square represents 25km²).

PLENTY PASTORAL DISTRICT

Spatially averaged historic rainfall for the District indicates that rainfall over three of the past six years was below the long-term median with 2017-18 receiving the least amount (Figure 75). This is generally reflected in the historic pasture growth being the lowest in the corresponding below median rainfall years (Figure 76).

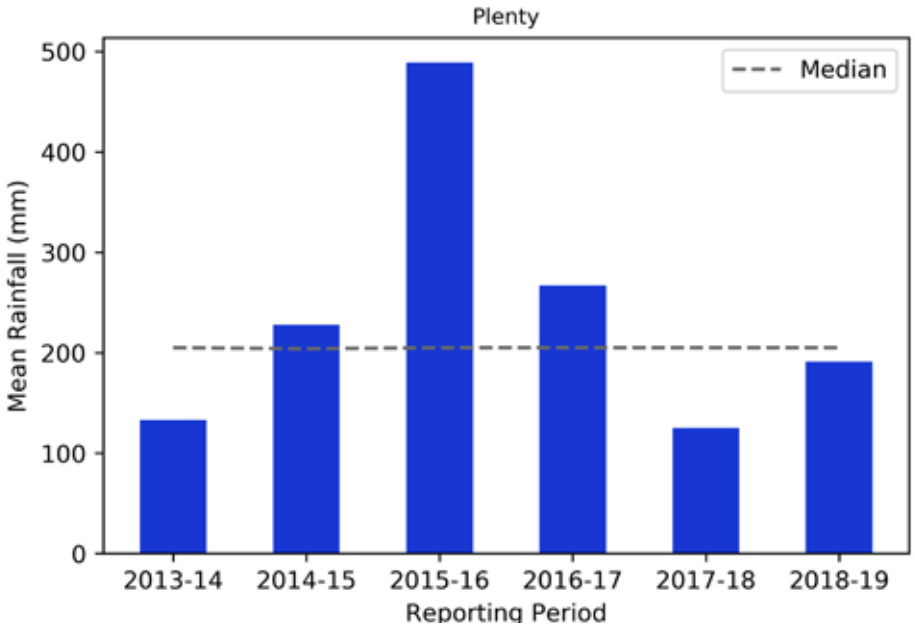


Figure 75. Spatially averaged historic rainfall for the Plenty Pastoral District. Long-term median indicated by dashed line.

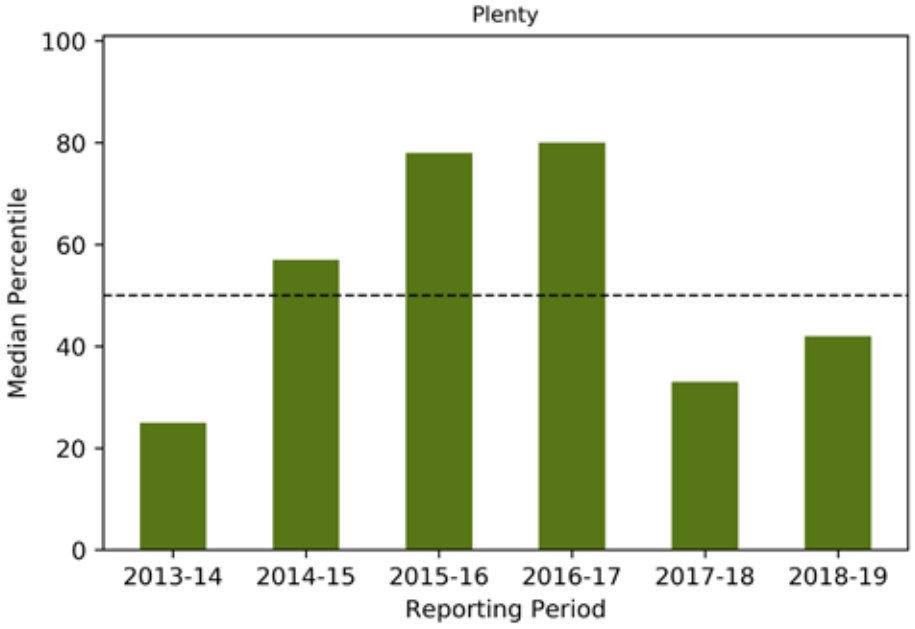


Figure 76. Historic pasture growth (kg/ha) from AussieGRASS for the Plenty Pastoral District. Long-term median indicated by dashed line.

PLENTY PASTORAL DISTRICT

Fire

There was minimal fire activity in the Plenty Pastoral District between October 2018 and September 2019 based on data from the North Australia and Rangelands Fire Information website (www.firenorth.org.au/nafi3). Approximately 427km^2 burnt during October and November 2018, and February 2019 which represents 1% of the District (Figure 77).

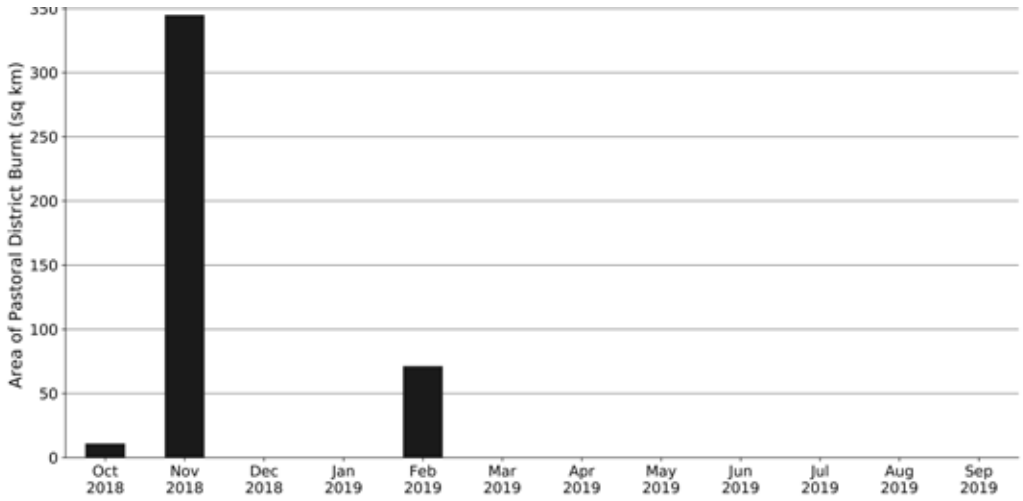


Figure 77. Monthly area burnt (km^2) in the Plenty Pastoral District between October 2018 and September 2019.

Ground cover dynamics

It is important to maintain adequate ground cover in the latter months of each year to minimise soil loss from wind erosion and intense summer storms. The highly variable nature of rainfall in the southern NT also means that it is necessary to carry dry feed, and associated ground cover, into the hotter months in case summer rains fail.

Most of the District had average vegetation cover relative to that present in the latter part of each year back to 1988 (Figure 78). There were patches across the north-west and the centre of the District where vegetation cover was above-average to very much above average over the 32 year recording period, whereas there were patches in the south, particularly the south-west with below average to lowest level of vegetation cover.

PLENTY PASTORAL DISTRICT

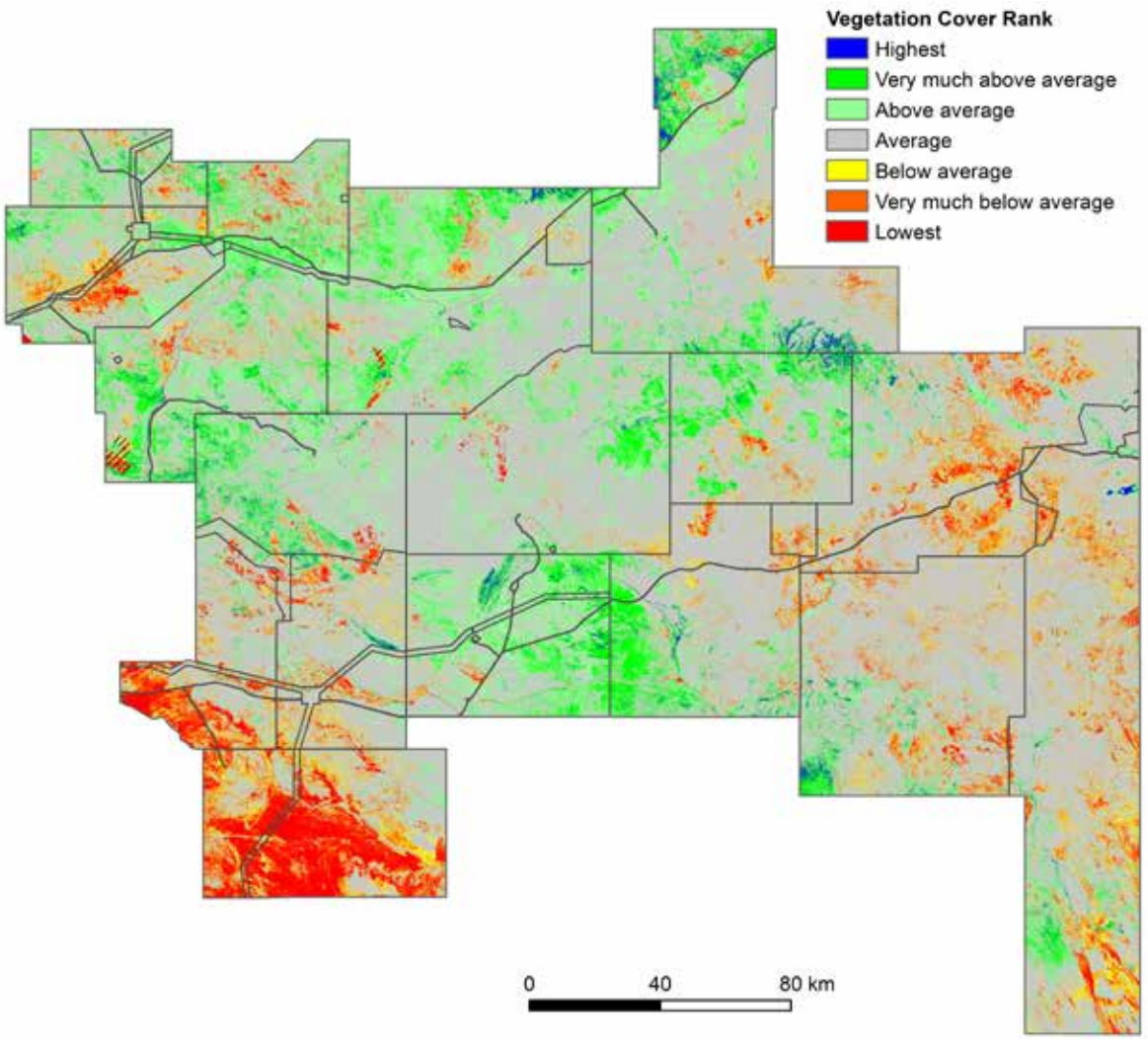


Figure 78. Rank of the amount of remotely-sensed vegetation cover present from September to November 2019 against that for previous years back to 1988.

The amount of bare soil present at any location changes from year to year depending on rainfall and its effectiveness, fire history and amount of grazing. The percentage of bare ground in each Landsat pixel (900m^2 or 0.09ha) was used to report the amount of bare ground across all pixels in the Plenty Pastoral District.

Less than 1% of the District had a small amount of bare ground towards the end of 2019 (i.e. <20% of the 30-m Landsat pixel) (Figure 79); and just under 15% of the region had <40% bare ground. The bare ground threshold value for the Plenty Pastoral District was 55%; one quarter of the District had bare ground per pixel greater than this value (Figure 80).

PLENTY PASTORAL DISTRICT

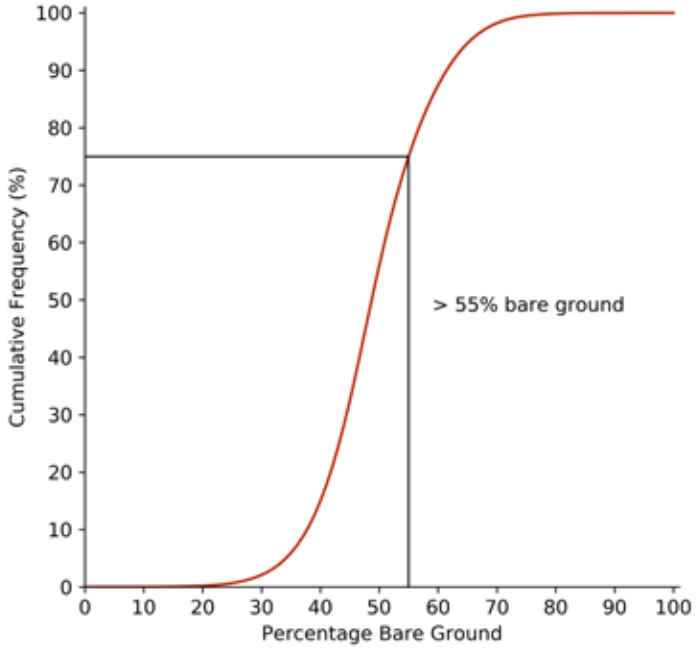


Figure 79. Percentage ccumulative frequency of varying levels of bare soil in 30-m square Landsat pixels in the Plenty Pastoral District between September and November 2019. Areas with >55% bare ground are mapped in Figure 80.

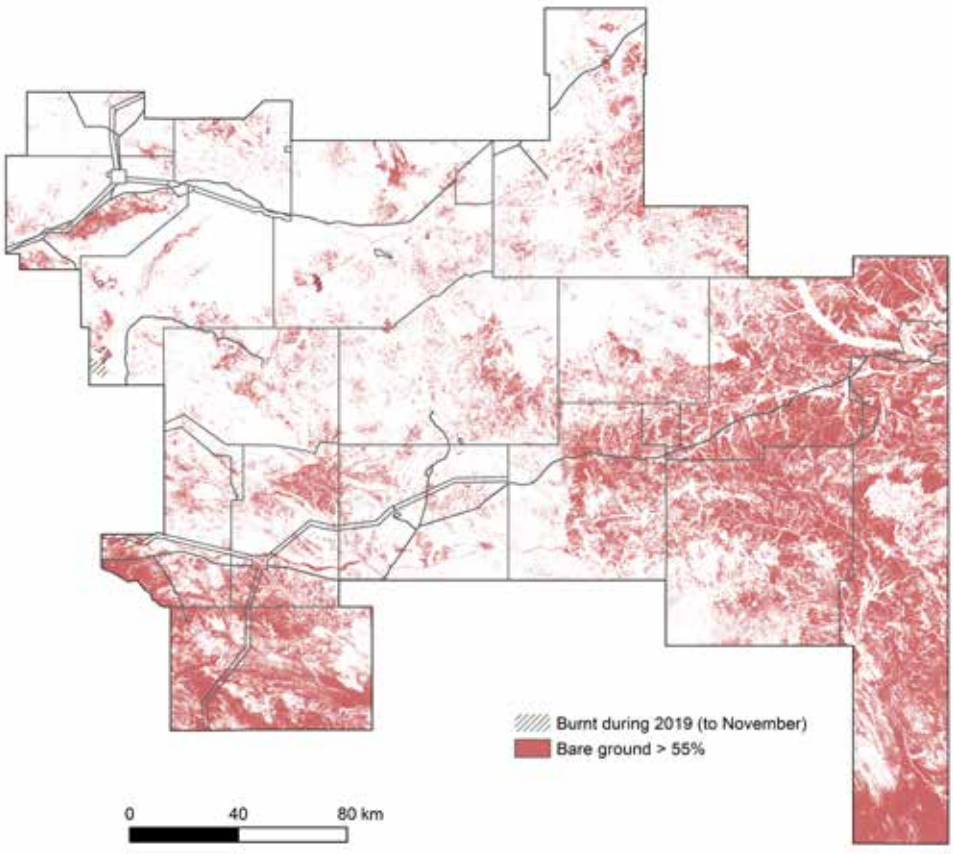


Figure 80. Parts of the Plenty Pastoral District having >55% bare ground per Landsat pixel in late 2019. Note that the threshold level of bare ground used for mapping purposes varies between pastoral districts. It is selected to show at what level approximately 25% of the district is affected.

PLENTY PASTORAL DISTRICT

Site-based monitoring

Two pastoral leases were visited in the Plenty Pastoral District during 2019.

Vegetation cover of the ground layer was measured at 17 sites across the leases. Sites, on average, had a moderate to high amount of bare ground, and a moderate contribution of litter and annual and perennial grasses (Figure 81).

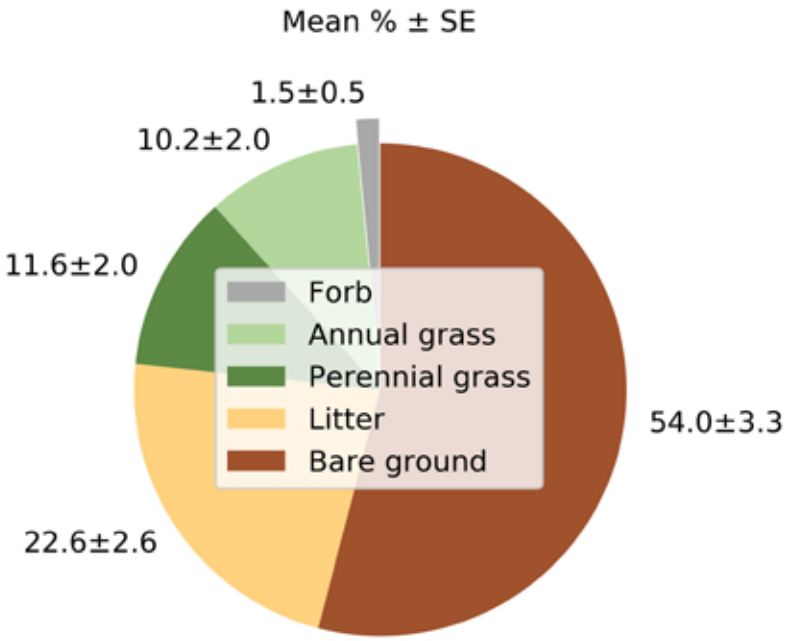


Figure 81. Mean percentage and standard error of measured components of vegetation cover in the ground layer from 16 sites on two pastoral leases in the Plenty Pastoral District.

Half of the sites were minimally grazed (Table 26), although this assessment is partly dependent on the time at which a lease is visited relative to the end of the growing season; later assessments may mean increased levels of pasture utilisation. Erosion from water and wind were recorded at 88% and 75% of the sites respectively.

Table 26. Levels of pasture utilisation and evidence of erosion recorded on two pastoral leases in the Plenty Pastoral District.

Pasture Utilisation		Evidence of erosion	
Rank	% of sites	Type	% of sites
No grazing	0	Wind	88
Minimal (<25%)	50	Scalding	6
Moderate (26-50%)	25	Water sheeting	6
Moderate to heavy (51-75%)	12.5	Gullying	75
Heavy (75-90%)	12.5		0
Very heavy (>90%)	0		

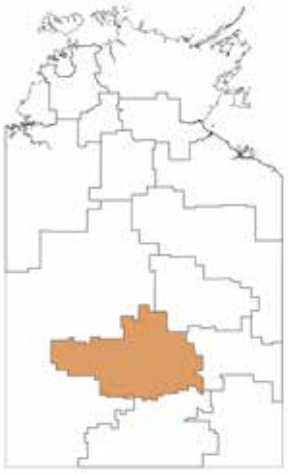
PLENTY PASTORAL DISTRICT

Land condition ratings assigned at monitoring sites and the more generalised assessment of land condition across those parts of pastoral leases traversed are summarised in Table 27. To the extent possible, condition assessments are independent of year-to-year variability in rainfall.

Table 27. Assessed land condition at monitoring sites and traversed parts of two pastoral leases in the Plenty Pastoral District.

Station	Condition Rating (number of sites)	Comments with regard to pastoral lease
1	Good: 5 Fair: 3 Poor: 2	Country in the north of the property had benefitted from low recent stocking rates and higher recent rainfall. Measurements at monitoring sites indicate a decrease in bare ground at most sites in the north and east of the property since the previous visit in 2014. Increases in bare ground were identified in pastorally productive areas in the south of the property. Areas of active gully erosion were observed mostly in the hillier northern parts of the property and were often associated with the concentration of rainwater runoff along roads. Localised infestations of parkinsonia (Parkinsonia aculeata), a Class B weed; and amenity plantings of athel pine (Tamarix aphylla), a Class A weed, are known from the homestead area and were being appropriately managed. There is concern regarding recent decline in land condition in southern parts of the property, where careful consideration of stocking rates will be required to achieve improvements in land condition.
2	Good: 1 Fair: 4 Poor: 2	Land condition was generally assessed as Fair condition, which showed an improvement from the last visit in 2014. Most of the station is made up of the less productive Singleton land system, which generally comprises spinifex sand plains. However, on this station buffel grass is increasing in this land system, especially in the south. The station's more productive country is in the northwest and west, where paddock sizes are smaller, and were in general in Fair/Poor condition with high levels of bare ground. The north and northeast of the station were in general in Fair/Good condition. This area was predominately also in more productive land systems and showed a good response by annual and resurrection grasses. The east of the station was also in general in Fair/Good condition. The central part of the station was generally in Poor condition with high levels of bare ground consistent with recovering from fire and poor rainfall. The station's southwest and southern areas were in general in Fair/Good condition with high amounts of buffel grass.

NORTHERN ALICE SPRINGS PASTORAL DISTRICT



Map 11: Location of Northern Alice Springs Pastoral District

The Northern Alice Springs Pastoral District encompasses just under 103 000 km² including 28 pastoral leases, 11 of which were visited in 2019.

Much of the District experienced below-average seasonal quality based on expected pasture growth (modelled using AussieGRASS), and low rainfall. Most of the District had very much below average seasonal conditions. Approximately 38% the Northern Alice Springs District had average vegetation cover, with 27% having below to very much below average cover. One-quarter of the District had more than 56% bare ground per 30-m pixel at this time (bare ground threshold).

On-ground monitoring for land condition was conducted at 89 sites on eleven pastoral leases, with 18 sites rated as Good, 30 as Fair, and 41 as Poor. Sites, on average, had a moderate to high level of bare soil, reasonable litter cover and small contributions of perennial and annual grasses, and forbs. Approximately two percent of the District burnt over the reporting period, primarily over the late 2018 dry season. Slight to moderate sheet erosion was recorded at approximately 68% of the sites and 80% of sites were moderately to heavily-grazed at the time of assessment.

Seasonal quality

'Seasonal quality' describes the relative value of recent rainfall in producing forage for livestock. It is judged with reference to the historical record. Two indicators are used: rainfall amount compared with the long-term median and expected pasture growth based on rainfall received, simulated using AussieGRASS (www.longpaddock.qld.gov.au).

Descriptors of seasonal quality provide useful context for interpreting various measures of land condition at particular times. However, to the extent possible, land condition is assessed independently of seasonal conditions.

Rainfall statistics (Table 28) are based on gridded rainfall produced by the Bureau of Meteorology (www.bom.gov.au/jsp/awap/rain/index.jsp). Pixel (grid cell) values are calculated from rainfall amounts at recognised recording stations. Rainfall is from October of one year to September the following year. Modelled pasture growth is for the same period (October 2018 to September 2019) to take account of any winter rainfall across parts of the region during 2019. This growth is ranked as a percentile of growth for all previous October – September periods.

Table 28. Seasonal quality indicators for the Northern Alice Springs Pastoral District.

Rainfall (mm)		AussieGRASS	
2018 – 2019	88	Growth (kg/ha)	73

NORTHERN ALICE SPRINGS PASTORAL DISTRICT

Long-term median	258	Percentile	8

Spatially averaged rainfall for the Northern Alice Springs Pastoral District during 2018-19 was well below the long-term median across most of the District (Table 28, Figure 82). The long-term spatially averaged rainfall for the five seasons prior to 2018-19 is shown in Figure 82. The spatially averaged rainfall for the district was above the median for the first four years and below the median in 2017-18.

Modelled pasture growth in the 12 months between October 2018 and September 2019 was generally well correlated with rainfall distribution, with below to very much below average pasture growth across most of the District, compared with the long-term record (Figure 83). The long-term median pasture growth for the five seasons prior to 2018-19 is shown in Figure 84 The median percentile was above average (50th percentile) for the first four seasons and below that for 2017-18 (Figure 85).

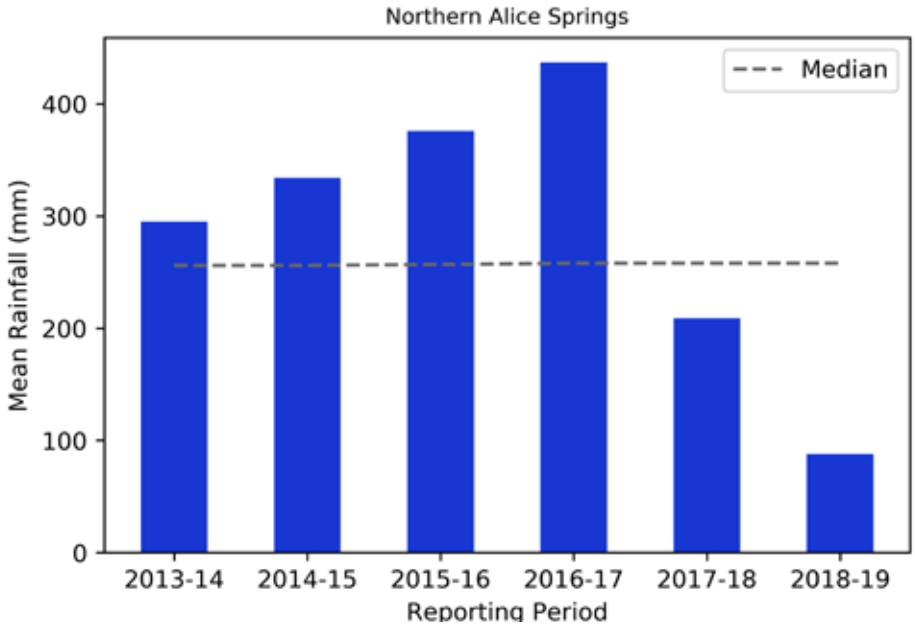


Figure 82. Spatially averaged historic rainfall for the North Alice Springs Pastoral District. Long-term median indicated with dashed line.

NORTHERN ALICE SPRINGS PASTORAL DISTRICT

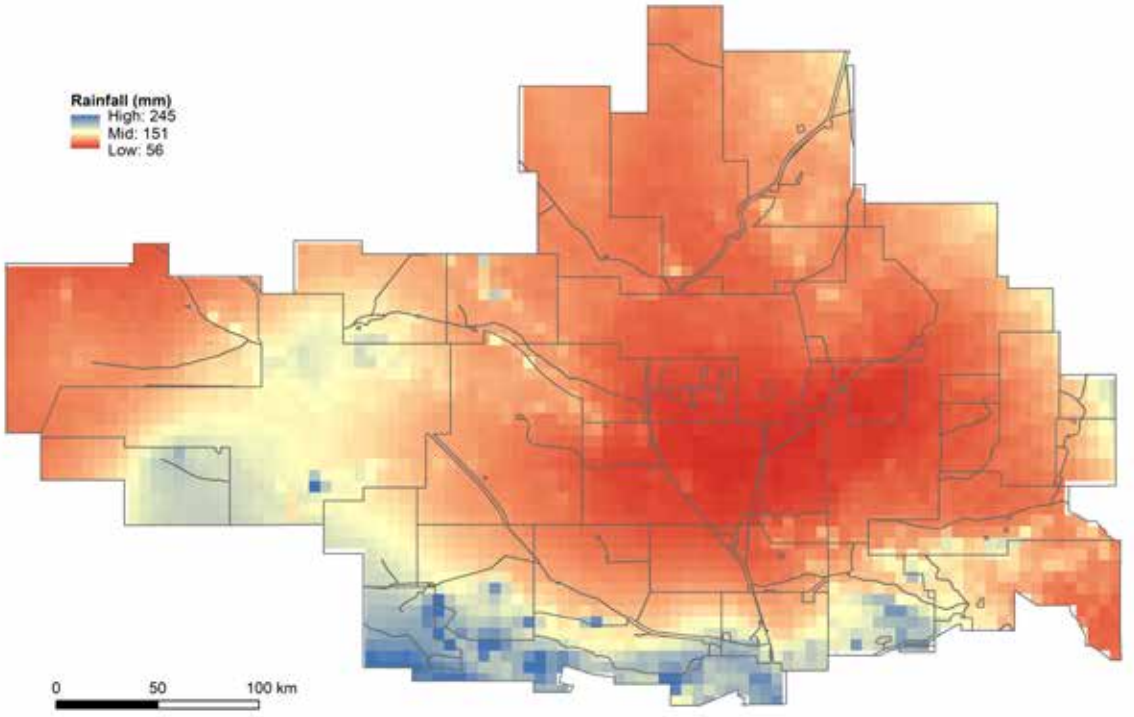


Figure 83. Spatially interpolated rainfall, October 2018 to September 2019. The grid cells on this map are at 5km x 5km resolution (i.e. each square represents 25km²).

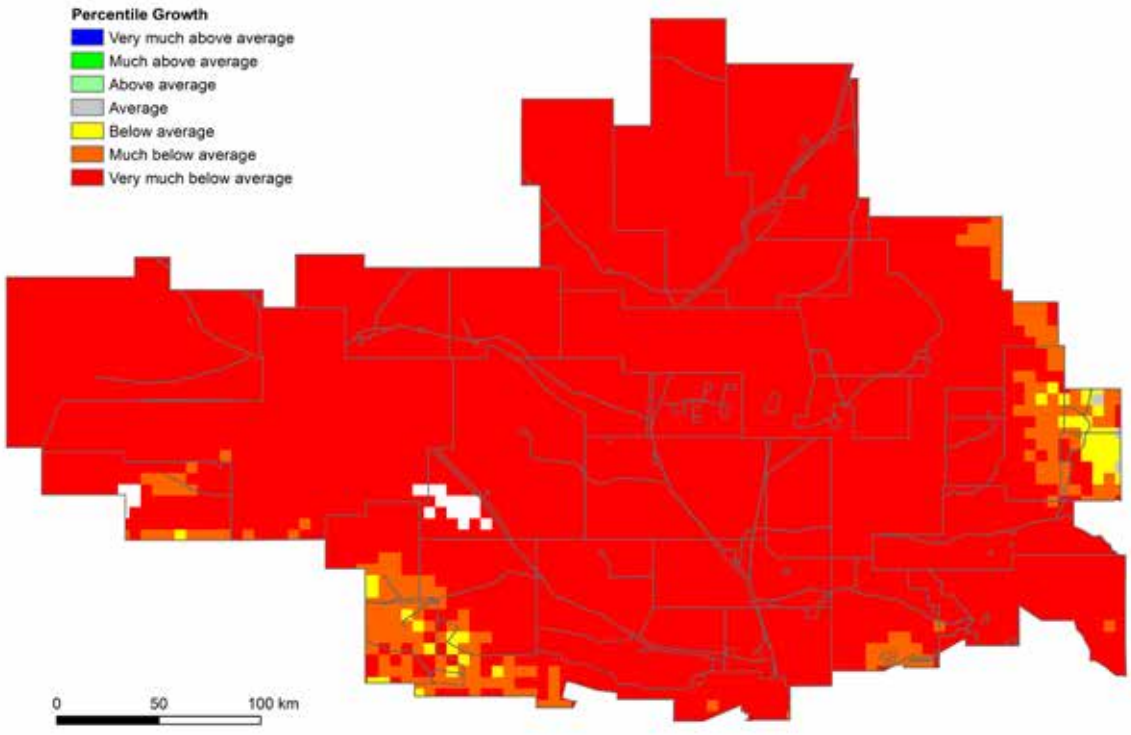


Figure 84. AussieGRASS-modelled pasture growth as a percentage of previous similar periods. The grid cells on this map are at 5km x 5km resolution (i.e. each square represents 25km²).

NORTHERN ALICE SPRINGS PASTORAL DISTRICT

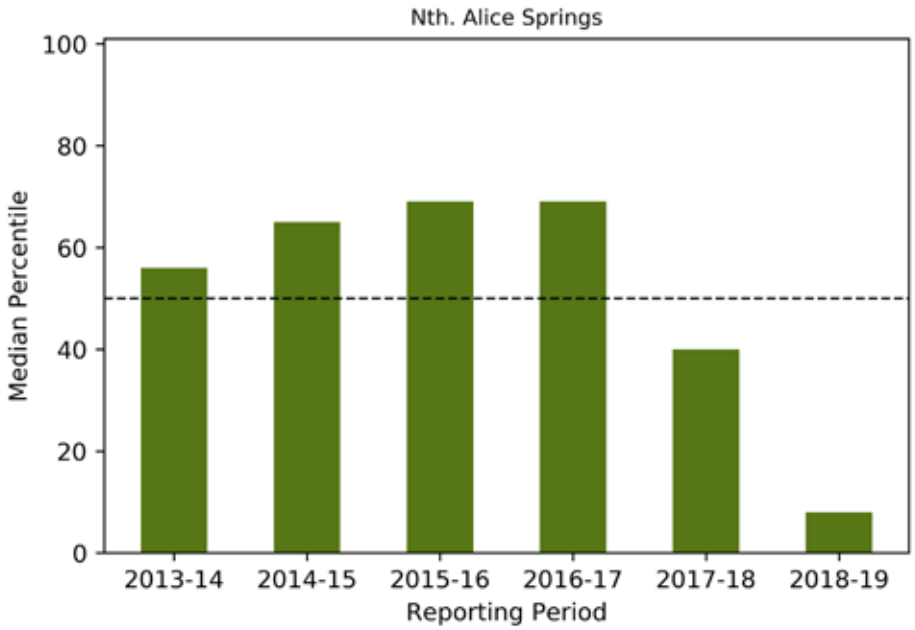


Figure 85. Historic pasture growth (kg/ha) from AussieGRASS for the North Alice Springs Pastoral District. The 50th percentile is indicated with a dashed line.

Fire

Data available from the North Australia and Rangelands Fire Information website (www.firenorth.org.au/nafi3) shows that 3 103km^2 (3% of the District) burnt between October 2018 and September 2019 (Figure 86). Fire was most active during the summer period of 2018-19.

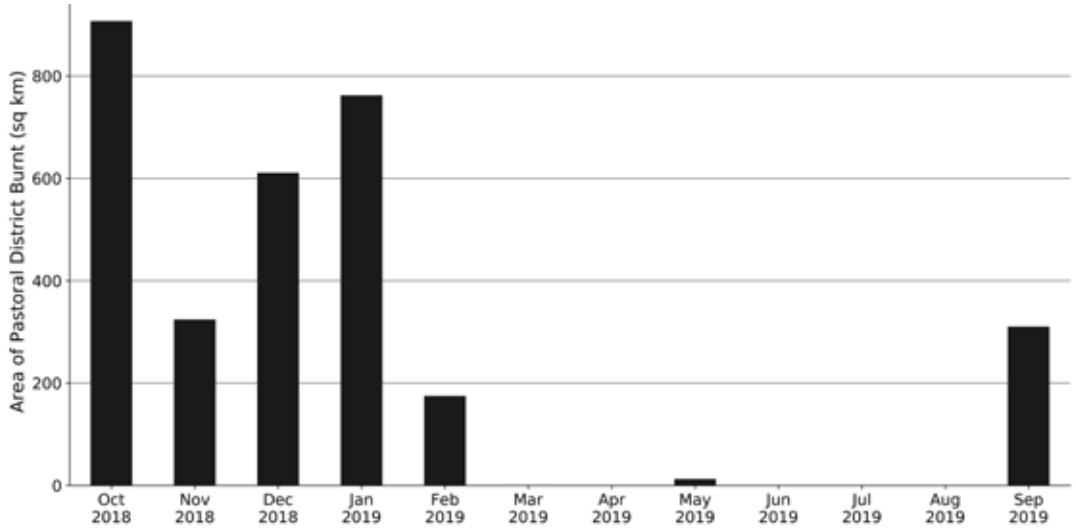


Figure 86. Monthly area burnt (km^2) in the Northern Alice Springs Pastoral District between October 2018 and September 2019.

NORTHERN ALICE SPRINGS PASTORAL DISTRICT

Ground cover dynamics

It is important to maintain adequate ground cover in the latter months of each year to minimise soil loss from wind erosion and intense summer storms. The highly variable nature of rainfall in the southern NT also means that it is necessary to carry dry feed, and associated ground cover, into the hotter months in case summer rains fail.

Approximately 38% the Northern Alice Springs Pastoral District had average vegetation cover, with 27% having below to very much below average cover. Nearly a quarter of the District area had the lowest average vegetation cover in the latter period of 2019 compared with previous years since 1988 (Figure 87). This pattern was consistent with the spatial pattern of modelled below-average pasture growth (Figure 84). Only a small proportion of areas of 'lowest' vegetation cover were associated with 2019 fire.

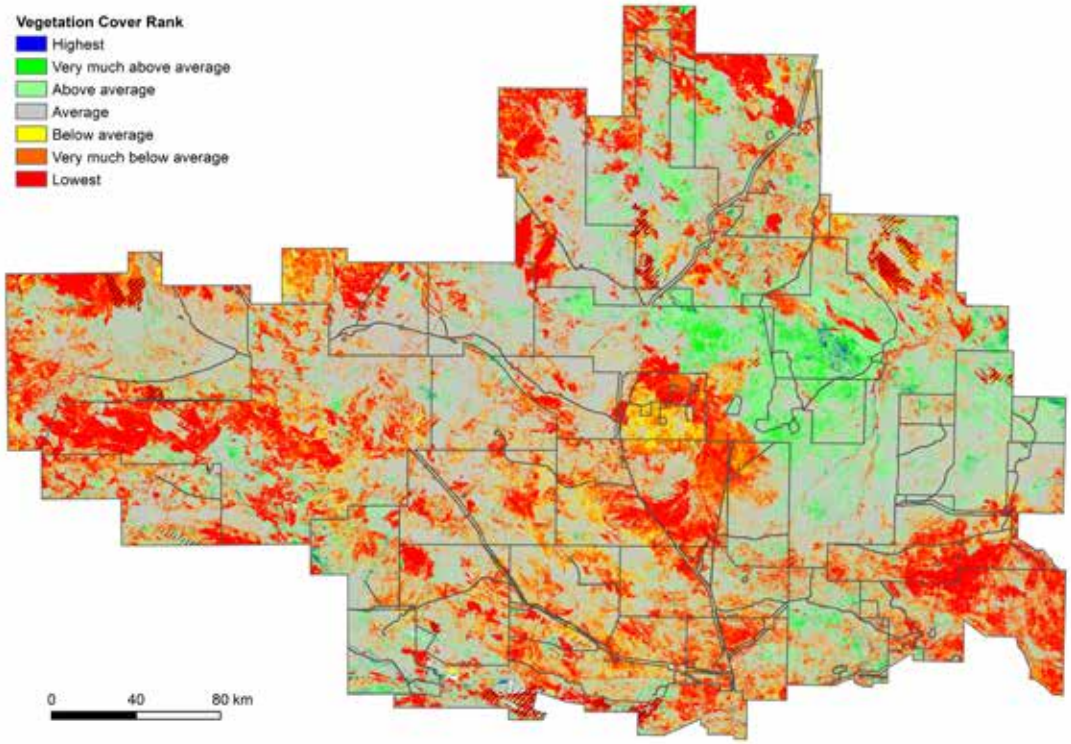


Figure 87. Rank of the amount of remotely-sensed vegetation cover present from September to November 2019 against that for previous years back to 1988. Diagonal lines show those areas burnt between January and November 2019.

The amount of bare ground present at any location changes from year to year depending on rainfall and its effectiveness, fire history and amount of grazing. The percentage of bare ground in each 30-m square Landsat pixel (900m^2 or 0.09ha) was used to report the amount of bare ground across all pixels in the Northern Alice Springs Pastoral District.

The bare ground threshold is based on the frequency distribution of all 30-m Landsat bare ground cover pixels at the end of 2019 (Spring composite). A threshold was determined which represents 75% of a district's overall bare ground. The remaining 25% is considered to have above-threshold bare ground.

NORTHERN ALICE SPRINGS PASTORAL DISTRICT

Less than one percent of the Northern Alice Springs Pastoral District had low amounts of bare ground (<20% of the 30-m Landsat pixel) towards the end of 2019 (Figure 88). The bare ground threshold value for the Northern Alice Springs Pastoral District was 56%; one quarter of the District had bare ground greater than this value (mapped in Figure 89).

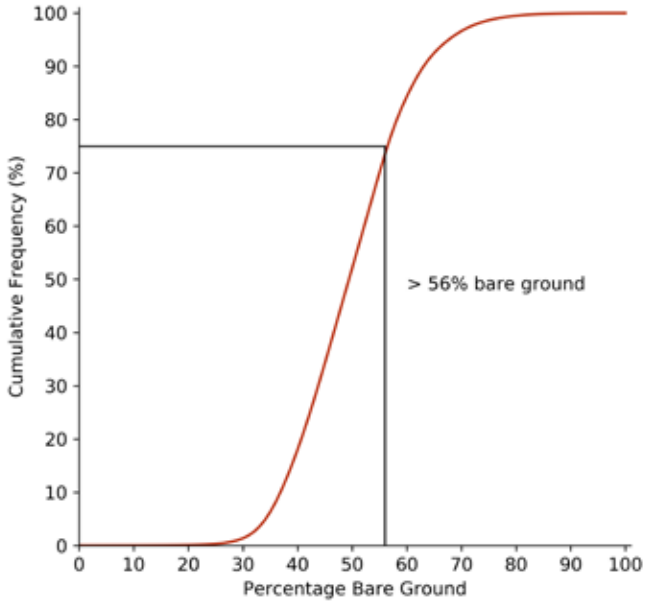


Figure 88. Percentage cumulative frequency of varying levels of bare ground in 30-m square Landsat pixels in the Northern Alice Springs Pastoral District between September and November 2019. Areas with greater than 56% bare ground (threshold) are mapped in Figure 89.

NORTHERN ALICE SPRINGS PASTORAL DISTRICT

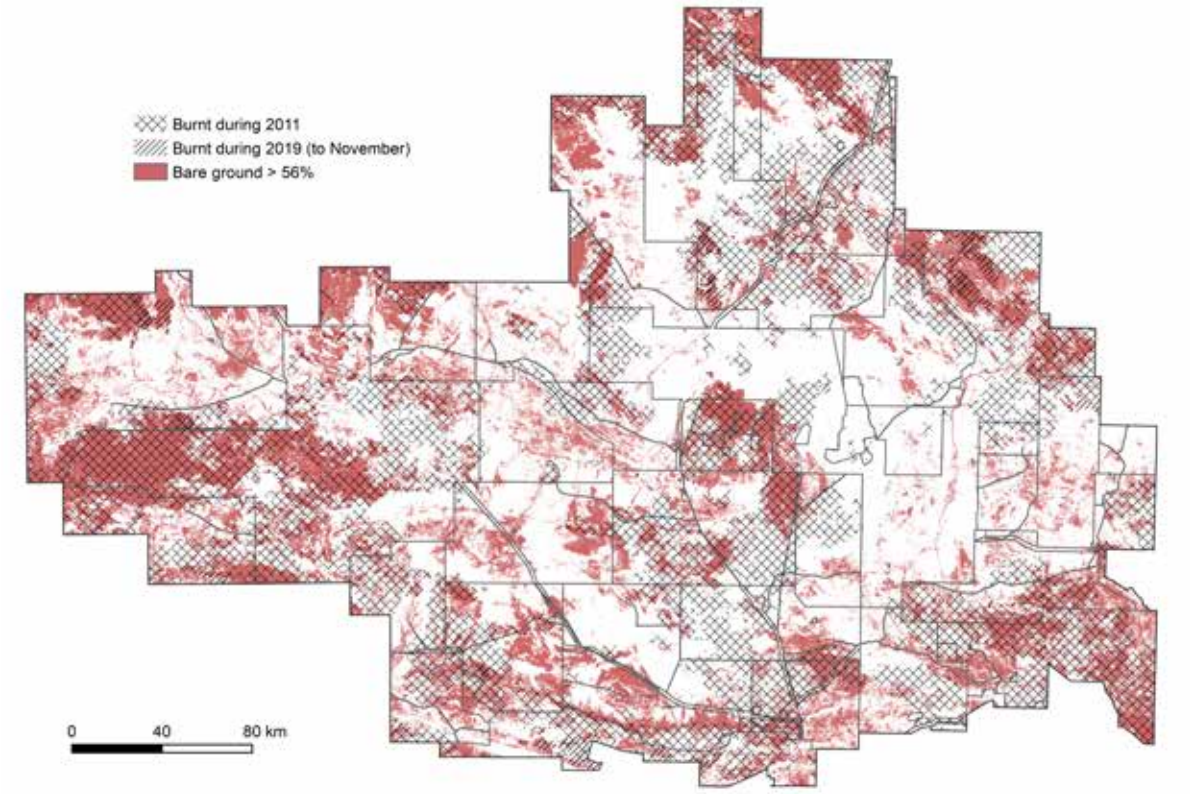


Figure 89. Parts of the Northern Alice Springs Pastoral District having more than 56% bare ground per Landsat pixel in late 2019 (bare ground threshold). Note that the threshold level of bare ground used for mapping purposes varies between pastoral districts. It is selected to show at what level approximately 25% of the district is affected.

Site-based monitoring

Eleven pastoral leases were visited in the Northern Alice Springs Pastoral District during 2019.

Vegetation cover of the ground layer was measured at 89 sites across the eleven leases. Sites, on average, had a moderate to high level of bare ground, reasonable litter cover and small contributions of perennial and annual grasses, and forbs (Figure 90). Litter cover is important because it assists infiltration of rain water, helps retain seed on site and reduces erosion risk.

There was considerable variation in ground cover components between sites, and between properties; amounts of bare ground ranging from 25% to 95%, which was generally inversely correlated to proportion of perennial species, which is not unexpected.

NORTHERN ALICE SPRINGS PASTORAL DISTRICT

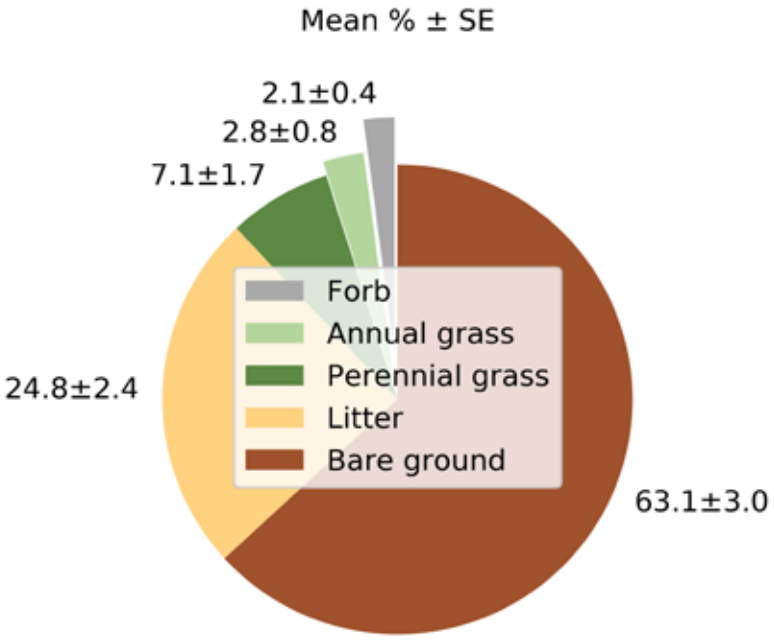


Figure 90. Mean percentage and standard error of measured components of vegetation cover in the ground layer in the Northern Alice Springs Pastoral District.

Eighty percent of the 89 sites were rated as being moderate to heavily grazed indicative of more than 25% of the seasonal growth utilised at the time of assessment (Table 29). Slight to moderate sheet erosion was recorded at 58 sites.

Table 29. Levels of pasture utilisation assessed in the Northern Alice Springs Pastoral District.

Pasture Utilisation	
Rank	**% of sites**
No grazing	4
Minimal (<25%)	16
Moderate (26-50%)	12
Moderate to heavy (51-75%)	21
Heavy (76-90%)	16
Very heavy (>90%)	31

Land condition ratings assigned at monitoring sites and the more generalised assessment of land condition across those parts of pastoral leases traversed are summarised in Table 31. Most leases did not receive useful winter rainfall and experienced below-average seasonal quality based on modelled pasture growth in the 12 months from October 2018 to September 2019. To the extent possible, condition assessments are independent of year-to-year variability in rainfall and associated seasonal condition.

NORTHERN ALICE SPRINGS PASTORAL DISTRICT

Table 30. Assessed land condition at monitoring sites and traversed parts of eleven pastoral leases in the Northern Alice Springs Pastoral District.

Station	Condition Rating (number of sites)	Comments with regard to pastoral lease
1	Good: 2 Fair: 1 Poor: 7	Land condition in the most pastorally productive parts of the property, particularly the alluvial granite plains was assessed as mostly Poor. High levels of bare ground were measured at monitoring sites and very low rainfall was an important driver of this. However other land condition indicators, including an absence of expected productive pasture species, widespread soil erosion and increased shrub density were consistent with the effects of prolonged heavy grazing. Remote sensing analysis indicated a reduced capacity in these areas to produce pasture in response to rainfall. Extensive areas of moderately productive mulga woodland appeared to be in mostly Poor condition although a more accurate assessment would be possible following a more favourable season. Extensive spinifex dominated sandplains were being increasingly utilised for grazing but were assessed in Good condition. Prickly pear (Opuntia stricta) and devil's rope cactus (Cylindropuntia imbricata), both Class A weeds, were present in various locations.
2	Good: 3 Fair: 3 Poor: 4	Land condition was varied, but could be generally seen as in Fair, which represents a deterioration from conditions at the last visit in 2015. The highly productive Mitchell grass plains varied in condition and were divided up into smaller paddocks: two paddocks were in Fair condition and two paddocks were in Good condition. The unproductive spinifex country in the north of the station (Singleton land system) was in general in Good condition. The slightly more productive areas at the centre of the station (east to west) comprising mulga woodland over perennial grasses, like woollybutt, were in general in Poor condition with very high levels of bare ground and low ground vegetation. The mulga areas in the southwest of the station were in marginally better condition and were in Fair condition. The Class A weed, the devil's rope cacti, was observed on the station.
3	Good: 2 Fair: 1	Land condition was generally assessed as in Fair/Good condition, and represents an improvement from the last visit in 2014. The station had below average annual rainfall, but received a good dump of rain from Cyclone Trevor in March 2019. The north, east, and west were in Good condition with an abundance of buffel grass and a good response from annual grasses. The central and southern parts of the station were in Fair condition, with less feed available. The station comprised predominantly productive land systems and had useful amounts of feed available.

NORTHERN ALICE SPRINGS PASTORAL DISTRICT

Station	Condition Rating (number of sites)	Comments with regard to pastoral lease
4	Fair: 3 Poor: 5	Land condition was generally assessed as in Fair/Poor condition, which is very similar to the previous visit in 2014. Almost 90% of the station is in pastorally productive land systems, much of this supporting softer annual grasses. The northeast corner of the station, with undulating plains with a granite influence, supported mulga woodland over annual grasses and had very high levels of bare ground during this visit and were in Poor condition. Similarly, the eastern side of the station with open mulga or gidgee woodlands had high levels of bare ground, but were in general in Fair/Poor condition with some areas of perennial grassland in better condition. The southern parts of the station were generally in Fair condition with areas supporting buffel, Mitchell grass, and resurrection grasses. The central and western parts of the station were variable with areas in Poor condition (e.g. open gidgee or mulga woodland with very little ground cover), and areas in Fair/Good condition (neverfail and Mitchell grass plains). The northern part of the station was in Fair/Poor condition. Areas with buffel were in general in better condition, while areas with open gidgee woodland had high levels of bare ground and were Poor.
5	Fair: 2 Poor: 3	The assessment was broadly similar to the previous assessment in 2016. Areas of alluvial country associated with the property's major drainage system, and representing the property's most pastorally productive country, were assessed in Poor condition. Low levels of pasture cover were observed during the on-ground assessment, and areas of extensive sheet erosion and scalding were common in floodplain areas. Shrub encroachment, particularly of mimosa bush (Acacia farnesiana) into these more productive areas was common, and rubber bush (Calotropis procera), a Class B weed, was well established and widespread. Areas of moderately productive mulga and open woodland were assessed in mostly Fair condition. Areas of spinifex-dominated sand dunes and sandplains, which are of low pastoral productivity but represent a large majority of the station area, were assessed in Good condition. There was some evidence to suggest that land condition in some of the productive alluvial country may have benefitted from reduced stocking rates since the previous assessment.
6	Good: 1 Fair: 3 Poor: 3	Areas within the more pastorally productive alluvial land types were assessed in Poor condition. Sheet and gully erosion were widespread and there was heavy browsing of woody plants. Analysis of satellite imagery indicated persistently high levels of bare ground in these areas. Areas of moderately productive mulga woodland were assessed in Fair condition, while the less accessible and less utilised hilly and range country within were considered to be in Good condition. Low densities of rubber bush (Calotropis procera), a Class B weed, were present. Poor land condition in the more pastorally productive parts of the property are at least partly a result of the legacy effects of prolonged heavy grazing under previous management. There were, however, some indications of recent heavy stocking in parts of the property during the current visit.

NORTHERN ALICE SPRINGS PASTORAL DISTRICT

Station	Condition Rating (number of sites)	Comments with regard to pastoral lease
7	Fair: 3 Poor: 7	Land condition was generally assessed as in Poor condition, which showed a deterioration in condition from the previous visit. The 12 months prior to the visit were the driest on record. The pastorally more productive alluvial country, making up just under a quarter of the station, which stretches down the centre of the station from west to east, was in general in Poor condition with high levels of bare ground. Areas with pastorally productive loamy red soils in the northeast of the station was in general in Fair/Poor condition. Around 40% of the station consists of harder perennial grasses, typically woollybutt grasses, under mulga trees and covers the northeast of the station. This area was generally in Fair/Poor condition with high levels of bare ground and very little feed remaining. There is range country in the north and south of the station that has been impacted by fire. Erosion is an issue at the base of the southern range country.
8	Good: 3 Fair: 6 Poor: 4	This assessment may represent some improvement over the previous assessment in 2014. Since the previous inspection, levels of bare ground had decreased on seven of the ten monitoring sites despite very much below average rainfall prior to the visit. Remote sensing identified elevated levels of bare ground in productive sparsely timbered country associated with the major drainage systems and were also associated with some of the older water points. The recent establishment of new water points should help to spread grazing and reduce the pressure on these older water points. Areas of gully erosion were not considered to be widespread. Localised infestations of parkinsonia (Parkinsonia aculeata), a Class B weed, were being appropriately managed.
9	Good: 1 Fair: 1 Poor: 6	Land condition was generally assessed as in Poor condition, which showed a deterioration from the previous visit in 2014. The 12 months prior to the visit were the driest on record. The northern half of the station, which is pastorally less productive spinifex country in Singleton land system, was in general in Good condition. Large parts of this area burnt in fires in 2017 and to a lesser extent 2018, and were in general in Fair condition. The southern granite country and alluvial country represent the station's more pastorally productive country. This area was in general in Poor condition. This area had very high levels of bare ground and low vegetation cover dominated by resurrection grasses that respond quickly to rain and are palatable, but lack bulk. Gully erosion is a serious issue in some parts of this alluvial country, which is compounded by high levels of bare ground. Parkinsonia, a Class B weed, was observed on the station.

NORTHERN ALICE SPRINGS PASTORAL DISTRICT

Station	Condition Rating (number of sites)	Comments with regard to pastoral lease
10	Good: 4 Fair: 2	Some possible legacy effects of grazing were identified in the more pastorally productive grassy calcareous plains and open saltbush flats, although land condition across the property was generally assessed as Good. Levels of pasture cover were generally good and the expected pasture species present. Soil erosion was limited and localised. A program of regular burning had resulted in a complex fire history that accounts for most of the areas with elevated levels of bare ground which were identified using satellite imagery. There were no known declared weeds on the property.
11	Good: 2 Fair: 5 Poor: 2	Extensive spinifex sandplains were assessed in Good condition. Elsewhere the property was assessed to be in mostly Fair condition. Within this, some areas of pastorally productive alluvial country associated with major drainage features on the property were considered to be Poor due to the effects of preferential grazing. Although not widespread, there were areas of gully erosion associated with major drainage systems. Declared weeds including athel pine (Tamarix aphylla), prickly pear (Opuntia stricta), devil's rope cactus (Cylindropuntia imbricata), and parkinsonia (Parkinsonia aculeata) were present on the property and being managed according to a Weed Management Plan.

SOUTHERN ALICE SPRINGS PASTORAL DISTRICT

The Southern Alice Springs Pastoral District encompasses approximately 92 500 km^2. Four pastoral leases were assessed for land condition in 2019.

Map 12: Location of Southern Alice Springs Pastoral District

The south-west of the District experienced below average seasonal conditions based on rainfall and expected pasture growth (modelled using AussieGRASS), but much below to very much below average elsewhere across the District. Analysis of Landsat imagery acquired during the latter months of 2019 showed that half of the District had average vegetation cover while the remaining half had the lowest recorded amount of vegetation cover compared to the same period in previous years since 1988. One quarter of the District had more than 70% bare ground per 30-m Landsat pixel. Fire over the previous 12 months was minimal (impacting 1% of the District) and did not appear to be a contributing factor however; the legacy effects of fires in 2011 and 2012 may help to account for higher levels of bare ground in some areas. Nine of the 41 sites measured on four pastoral leases were rated in Good condition, 12 sites in Fair condition and 20 sites in Poor condition.

Seasonal quality

'Seasonal quality' describes the relative value of recent rainfall in producing forage for livestock. It is judged with reference to the historical record. Two indicators are used: rainfall amount compared with the long-term median and expected pasture growth based on rainfall received, simulated using AussieGRASS (www.longpaddock.qld.gov.au).

Descriptors of seasonal quality provide useful context for interpreting various measures of land condition at particular times. However, to the extent possible, land condition is assessed independently of seasonal conditions.

Rainfall statistics (Table 31) are based on gridded rainfall produced by the Bureau of Meteorology (www.bom.gov.au/jsp/awap/rain/index.jsp). Pixel (grid cell) values are calculated from rainfall amounts at recognised recording stations. Rainfall is from October of one year to September the following year. Modelled pasture growth is for the same period (October 2018 to September 2019) to take account of winter rainfall during 2019. This growth is ranked as a percentile of growth for all previous October – September periods.

Spatially averaged rainfall for the Southern Alice Springs Pastoral District was below the long-term median (Table 31), but there was considerable spatial variation across the District (Figure 92) with a trend from well below average in the eastern parts to below average in the south-west and smaller areas in the north.

SOUTHERN ALICE SPRINGS PASTORAL DISTRICT

Table 31. Indicators of seasonal quality. Data spatially averaged for the Southern Alice Springs Pastoral District.

Rainfall (mm)		AussieGRASS	
2018 – 2019	100	Growth (kg/ha)	92
Long-term median	173	Percentile	20

Modelled pasture growth in the 12 months from October 2018 to September 2019, was below average in the south-west of the region (Figure 92), and much below to very much below average elsewhere, this is consistent with rainfall distribution.

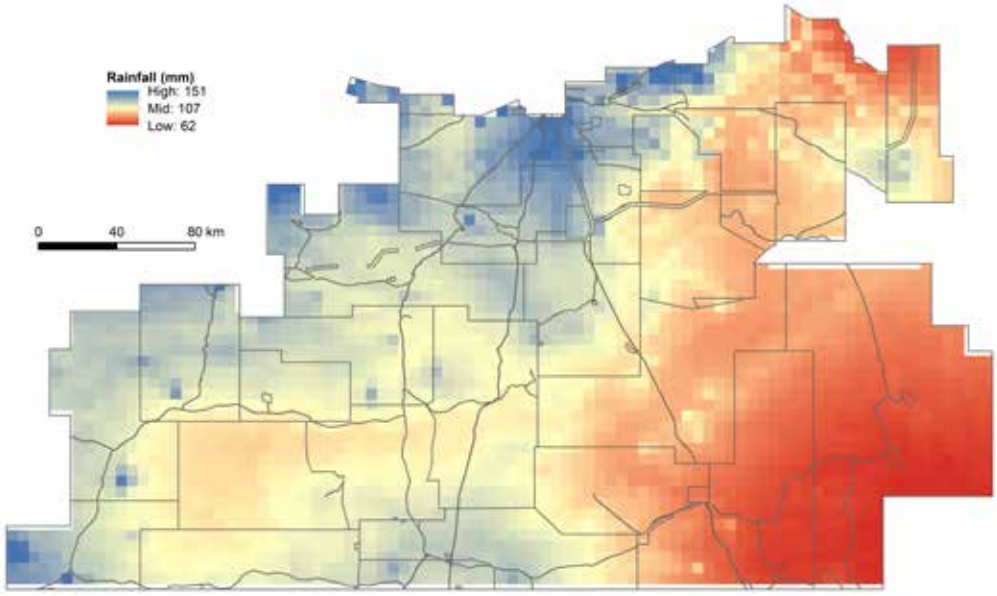


Figure 92. Spatially interpolated rainfall, October 2018 to September 2019. The grid cells on this map are at 5km x 5km resolution (i.e. each square represents 25km^2).

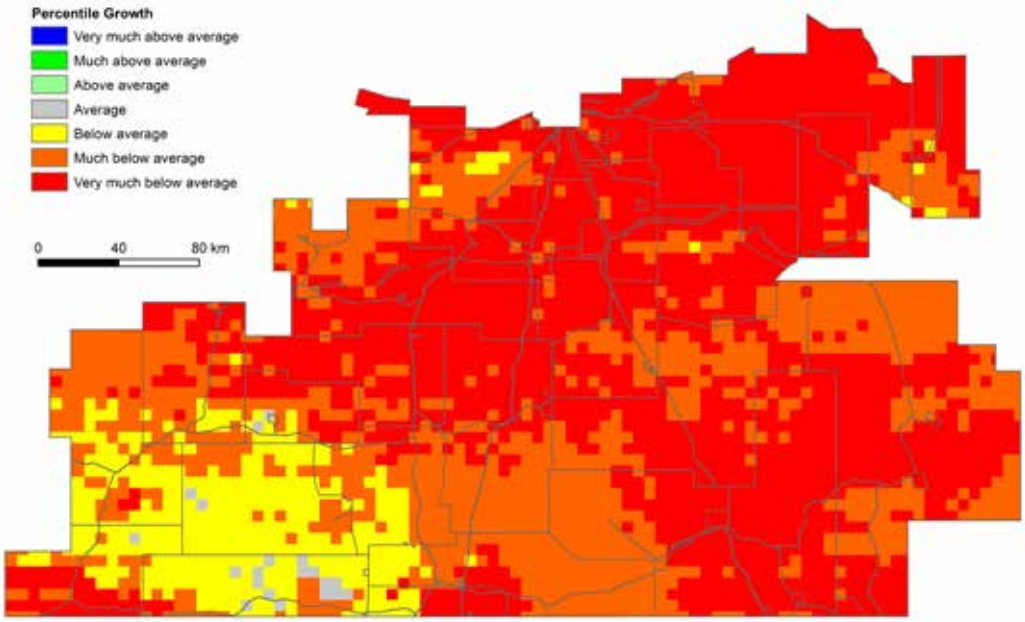


Figure 93. AussieGRASS-modelled pasture growth as a percentage of previous similar periods. The grid cells on this map are at 5km x 5km resolution (i.e. each square represents 25km^2).

SOUTHERN ALICE SPRINGS PASTORAL DISTRICT

Rainfall data for the District over the past six years indicates four of the previous six years were below the median with 2018-19 receiving less than 50% of the median (Figure 93). This is reflected in the modelled pasture growth over this time period with 2018-19 showing pasture growth of only 20 percentile (Figure 94).

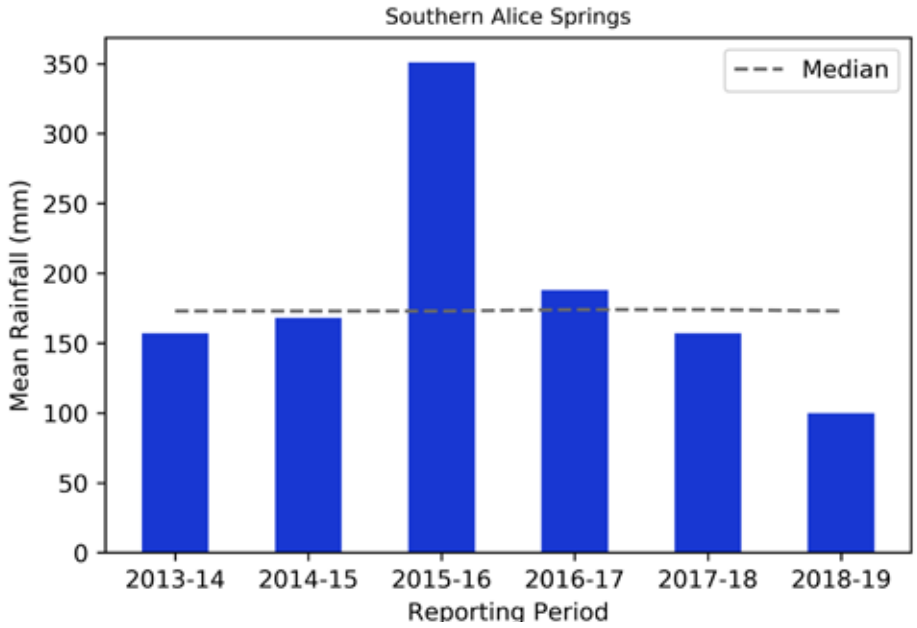


Figure 94. Spatially averaged historic rainfall for the Southern Alice Springs Pastoral District. Long-term median indicated by dashed line.

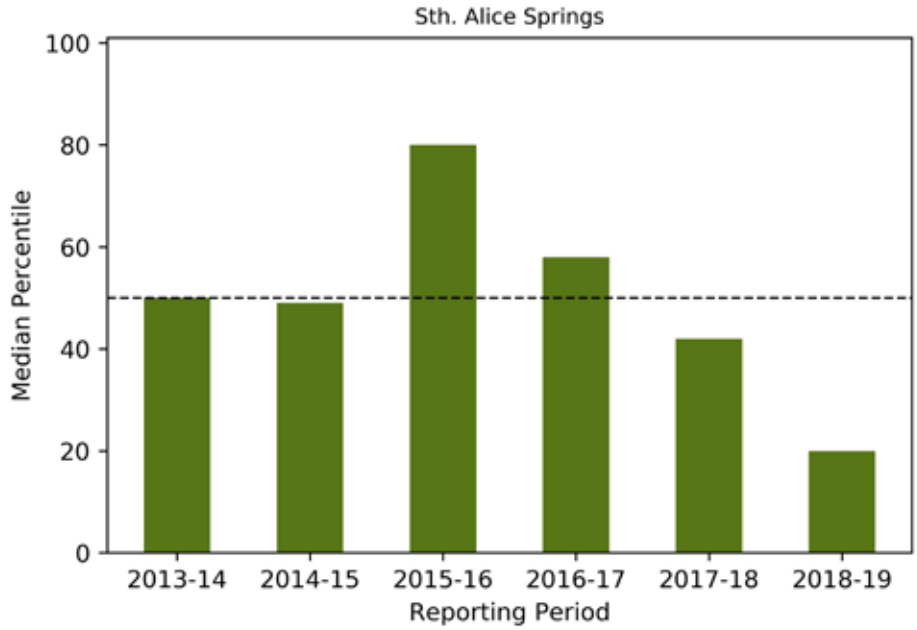


Figure 95. Historic pasture growth (kg/ha) from AussieGRASS for the Southern Alice Springs Pastoral District. Long-term median indicated by dashed line.

SOUTHERN ALICE SPRINGS PASTORAL DISTRICT

Fire

There was minimal fire activity in the Southern Alice Springs Pastoral District between October 2018 and September 2019 (1% of the District burnt) based on data available from the North Australia and Rangelands Fire Information website (www.firenorth.org.au/nafi3/).

Ground cover dynamics

It is important to maintain adequate ground cover in the latter months of each year to minimise soil loss from wind erosion and intense summer storms. The highly variable nature of rainfall in the southern NT also means that it is necessary to carry dry feed, and associated ground cover, into the hotter months in case summer rains fail.

Decile ranked vegetation cover (September to November 2019) shows that half of the District had average vegetation cover while the other half had below average to very much below or lowest vegetation cover (i.e. high levels of bare ground) in the latter part of 2019 compared with previous years since 1988 (Figure 96). There were only very small areas across the District with above average vegetation cover.

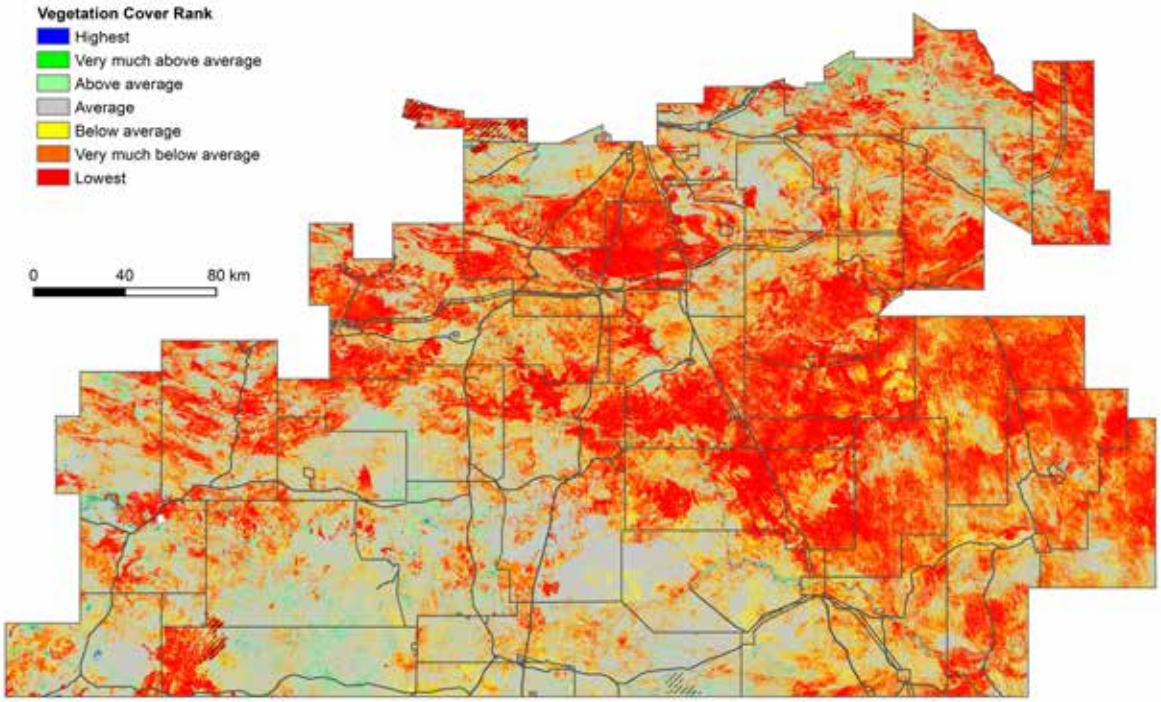


Figure 96. Rank of the amount of remotely-sensed vegetation cover present from September to November 2019 against that for previous years since 1988..

The amount of bare ground present at any location changes from year to year depending on rainfall and its effectiveness, fire history and amount of grazing. The percentage of bare ground in each 30-m Landsat pixel (900m^2 or 0.09ha) was used to report the amount of bare ground across all pixels in the Southern Alice Springs Pastoral District.

SOUTHERN ALICE SPRINGS PASTORAL DISTRICT

The bare ground threshold is based on the frequency distribution of all 30-m Landsat bare ground cover pixels at the end of 2019 (spring composite). A threshold was determined which represents 75% of a district's overall bare ground. The remaining 25% is considered to have above-threshold bare ground.

Less than 1% of the Pastoral District had minor to moderate amounts of bare ground (<40% of the 30-m Landsat pixel) towards the end of 2019 (Figure 96). The bare ground threshold value for the Southern Alice Springs Pastoral District was 70%; one quarter of the District had bare ground greater than this value (Figure 96 and Figure 97). Considerable areas of increased bare ground in the central and eastern portions of the District appear to be a continuing legacy effect of extensive wildfire in 2011.

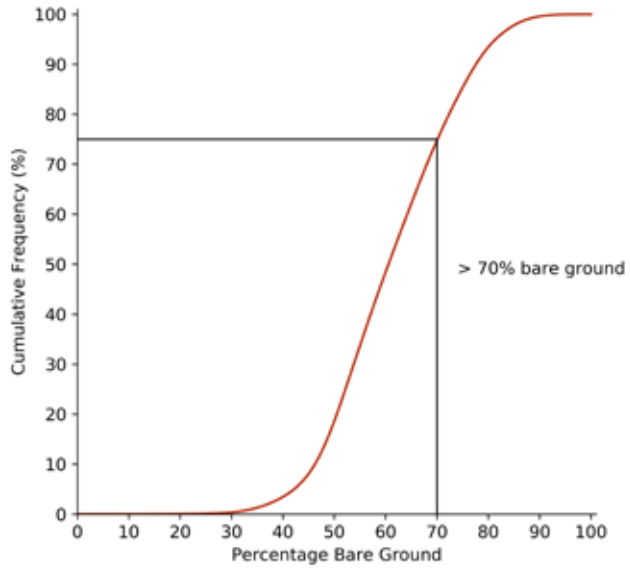


Figure 97. Percentage cumulative frequency of varying levels of bare ground in 30-m square Landsat pixels in the Southern Alice Springs Pastoral District between September and November 2019. Areas with >70% bare ground (threshold) are mapped in Figure 98.

SOUTHERN ALICE SPRINGS PASTORAL DISTRICT

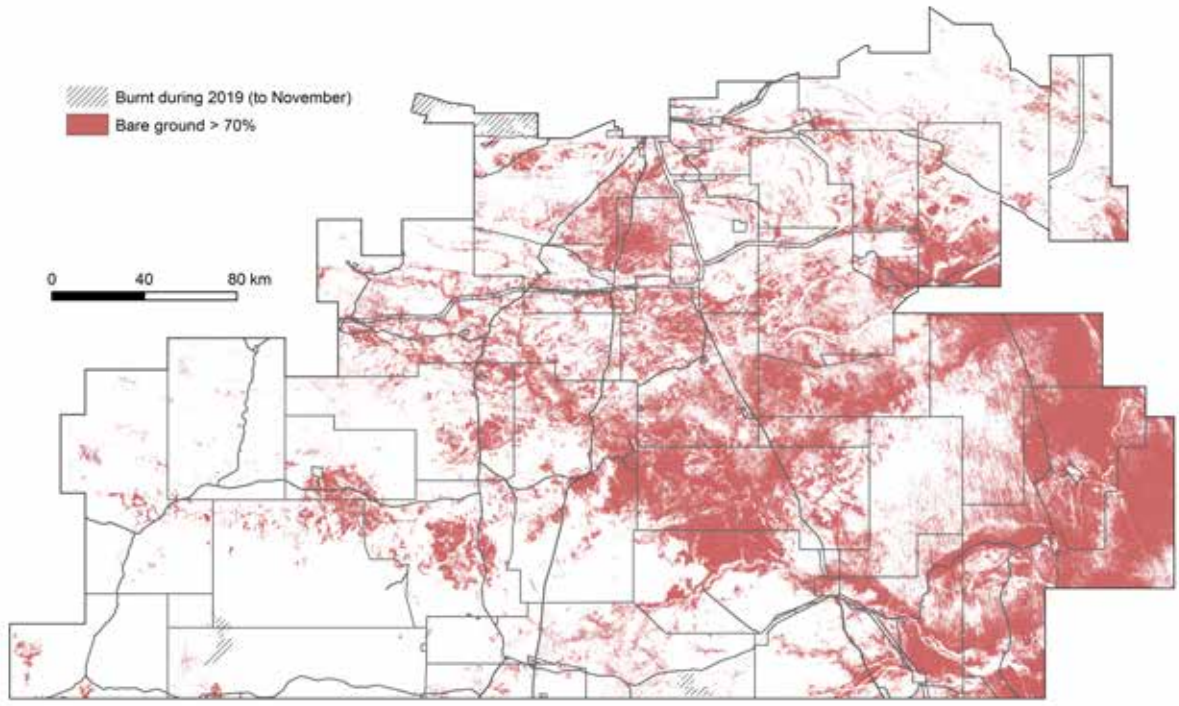


Figure 98. Parts of the Southern Alice Springs Pastoral District having >70% bare ground per Landsat pixel in late 2019. Note that the threshold level of bare ground used for mapping purposes varies between pastoral districts. It is selected to show at what level approximately 25% of the district is affected.

Site-based monitoring

Four pastoral leases were visited during 2019.

Vegetation cover of the ground layer was measured using the star transect method at 37 sites across the four leases. Sites, on average, were comprised of more than three quarters bare ground, moderate litter cover and small contributions of grasses and forbs (Figure 99). Litter cover is important because it assists infiltration of rain water, helps retain seed on site and reduces erosion risk.

SOUTHERN ALICE SPRINGS PASTORAL DISTRICT

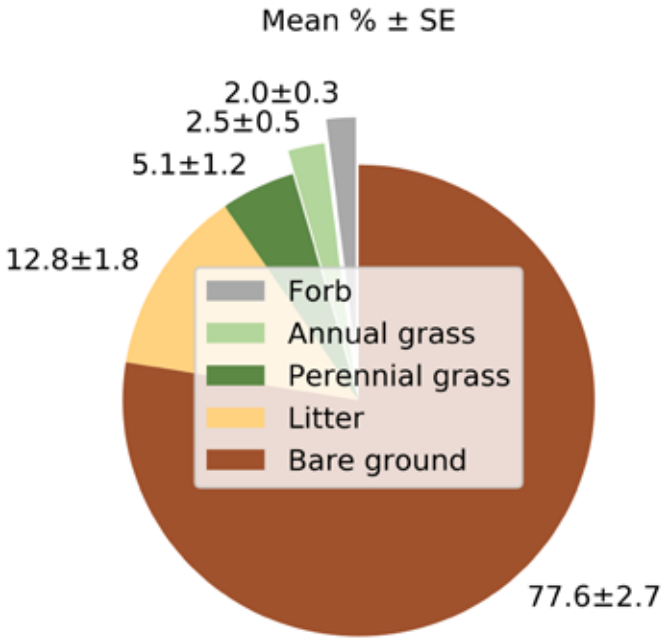


Figure 99. Mean percentage and standard error of measured components of vegetation cover in the ground layer from 37 sites on four pastoral leases in the Southern Alice Springs Pastoral District.

Sixteen percent of the sites were assessed as having minimal levels of grazing, and 73% of the sites were heavy to very heavily utilised (Table 32). A combination of wind sheeting and erosion by water (scalding and water sheeting) was observed at most sites (Table 32), generally associated with past disturbances.

Table 32. Levels of pasture utilisation and evidence of erosion assessed at 41 sites across four pastoral leases in the Southern Alice Springs Pastoral District.

Pasture Utilisation		Evidence of Erosion	
Rank	% of sites	Type	% of sites
Not grazed	0	Wind	86
Minimal (<25%)	16	Scalding	5
Moderate (26-50%)	5	Water sheeting	73
Moderate-heavy (51-75%)	5	Gullying	14
Heavy (76-90%)	22		
Very heavy (>90%)	51		

Land condition ratings assigned at monitoring sites and the more generalised assessment of land condition across those parts of pastoral leases traversed are summarised in Table 33. To the extent possible, assessment of land condition is independent of recent seasonal conditions.

SOUTHERN ALICE SPRINGS PASTORAL DISTRICT

Table 33. Assessed land condition at monitoring sites and traversed parts of four pastoral leases in the Southern Alice Springs Pastoral District.

Station	Condition Rating (number of sites)	Comments with regard to pastoral lease
1	Good: 4 Fair: 6 Poor: 4	Increases in bare ground were largely driven by seasonal conditions. Extensive areas of spinifex dominated sand dune country were in Good condition. In the more pastorally productive undulating plains and open stony tablelands, land condition was generally Fair. In run-on and floodout areas, remote sensing indicated relatively high levels of bare ground and condition was assessed as mostly Poor. Soils in these areas retain moisture for longer and are more likely to be intensively grazed. Areas of run-on and floodout country associated with drainage features in the far south of the property were likewise in Poor condition. Athel pine (Tamarix aphylla), a Class A weed was observed at several locations.
2	Good: 3 Fair: 2 Poor: 2	Land condition was highly variable. The majority of the station was pastorally less productive desert spinifex country (Simpson land system) which was in Good condition. Within this land system, the more productive areas (e.g. mulga over woollybutt and erect kerosene grass), were in poorer condition. The central part of the station and the eastern more productive country was in general in Fair/Poor condition with high levels of bare ground with ongoing gully erosion linked to old tracks, and woody thickening of cassias and eremophila. The southern parts of the station were in Good condition and comprised areas of bluebush/cotton bush, bladder saltbush, seaheath and perennial grasslands.
3	Good: 2 Fair: 2 Poor: 7	Land condition was generally assessed as in Poor condition, which showed a deterioration from the previous visit in 2014. The pastorally more productive alluvial country was in Poor condition with very high levels of bare ground and low ground vegetation cover. There are two areas supporting harder perennial grasses (e.g. woollybutt) under mulga woodland that were in Fair/Good condition. One area was in the southwest and the other was in the southeast. Sixty eight percent of the station was spinifex country, in Simpson or Singleton land systems and was in Good condition. Athel pine is abundant in the alluvial country and a weed management plan has been developed to address this. The lessee has expressed an intention to develop an extensive network of ponding banks and check dams in the alluvial country.
4	Fair: 2 Poor: 7	Land condition was generally assessed as in Poor condition, which showed a deterioration from the last visit in 2014. The pastorally more productive country on the station corresponds to alluvial and stony plains supporting annual grasses in the south. This alluvial country was in Poor condition with very high levels of bare ground. The stony areas had high levels of bare ground, but would be naturally quite bare, and were in general in Fair/Poor condition. The majority of the station is in the pastorally less productive Simpson and Singleton land systems dominated by spinifex grasses. This area covers most of the north of the station and was in general in Fair/Good condition, with the spinifex covered dunes in Good condition and the more productive dune swales in Fair condition. Athel pine is abundant in the alluvial country and a weed management plan has been developed to address this. The lessee has engaged in an impressive effort to build a network of ponding banks and check dams in the alluvial country, which is more than 50% complete.

BUSHFIRE ACTIVITY

Climate and weather conditions have significant influence on bushfire activity. Seasonal climatic conditions have a strong influence on fuel loads and fuel curing rates, while daily weather conditions are the key drivers of short-term bushfire risk.

Map 13: Fire Management Zones

Rainfall was below average across most parts of the Territory in 2018-19. Grass growth was very much lower than average across central and southern parts taking in the Savanna, Barkly and Alice Springs Fire Management Zones. Very low rainfall led to greatly reduced available fuel and, in turn, reduced fire activity in those areas. The Savanna zone had less than 50% of long-term average fire activity; the Alice Springs zone had less than 20% and the Barkly zone less than 10% of the long term average.

Lower than average rainfall in the north had a very different effect on fire activity. The Vernon Arafura zone experienced a record high proportion of land affected by fire at 62.9%. This was due to the fire season starting early and ending late, and to long periods of particularly bad fire weather during the season. The Arnhem zone experienced similar conditions, but there the conditions had a notably lesser effect on fire activity. This reflects the expansion of fire management based carbon abatement projects in Arnhem Land and on the Tiwi Islands. Income generated by these projects has funded extensive early strategic burning programs. Arnhem Land is now clearly the standard-bearer for effective fire management arrangements in the Territory.

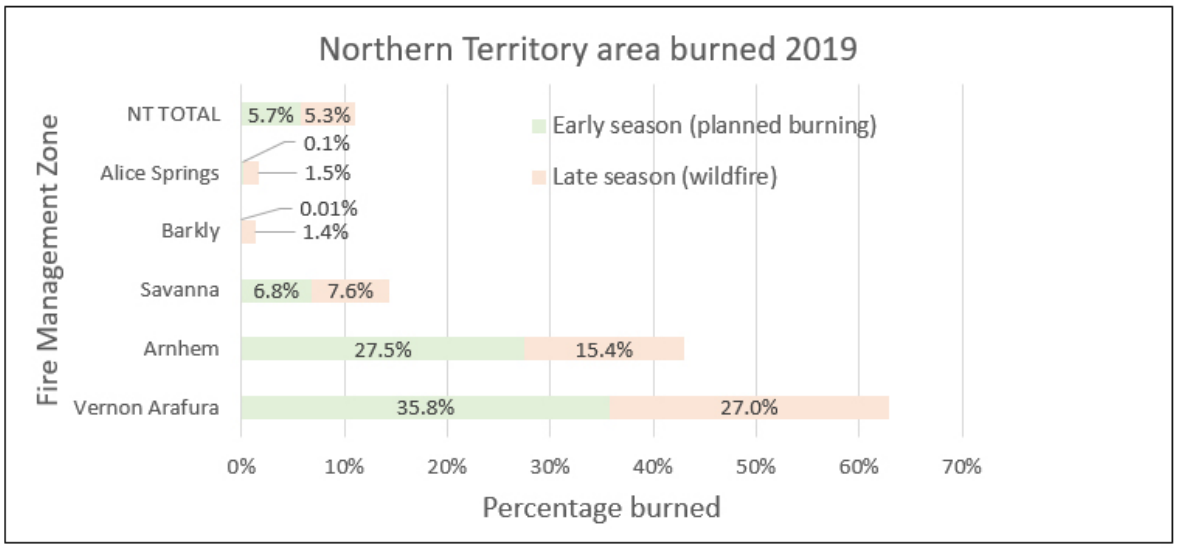


Figure 100. Fire activity by Fire Management Zone in 2019.

BUSHFIRE ACTIVITY

ALICE SPRINGS

The Alice Springs fire management zone experienced drier than average conditions in most areas during the period, with rainfall totals around 25% of the average. Very little roadside burning was required within the Alice Springs Fire Protection Zone due to very limited grass growth. A small area of fuel reduction burning was completed along the lower Todd River in August to protect the River Red Gums from wildfire. As a consequence of the very low fuel loads, there was little interest amongst land managers in aerial planned burning.

A period of extreme fire weather driven by strong gusty winds and high temperatures in January 2019 led to the only significant wildfire of the season in the West McDonnel Range. The total area affected by fire across the Alice Springs zone was just 1.6%; this is around 20% of the long term average.

Table 34. Fire extent in the Alice Springs Fire Management Zone 2019

	Area burned km^2	% of zone
Planned burning, April – September 2019	877	0.1%
Wildfire 2019	8 831	1.5%
TOTAL	**9 708**	**1.6%**
Average 2010 - 2018	*50 806*	*8.6%*

BARKLY

Rainfall was significantly down through the Barkly fire management zone in 2018 and 2019, continuing the trend of recent years. Many stations reported having conditions equating to the driest on record, and average temperatures for the period were above average. These conditions meant that fuel remained cured with little if any recovery over the winter.

The absence of any significant fuel load across most of the area led to extremely low levels of fuel reduction burning. The absence of fuel, combined with low rainfall and lack of a wet season, led to an historically low level of fire activity in 2019, with a much lower than average proportion of the land affected by fire. Just 1.4% of the Barkly zone was affected by fire in 2019, less than 10% of the long term average.

Table 35. Fire extent in the Barkly Fire Management Zone 2019

	Area burned km^2	% of zone
Planned burning, April – September 2019	25	0.01%
Wildfire 2019	3 689	1.4%
TOTAL	**3 714**	**1.4%**
Average 2010 - 2018	*39 503*	*14.7%*

BUSHFIRE ACTIVITY

SAVANNA

Just 14.4% of the Savanna fire management zone was affected by fire in 2019; this was around 50% of the long term average. Below average rainfall across the zone in 2019 led to reduced pasture growth. Fuel reduction burning was greatly reduced as a result, and while the fire season started earlier and finished later than usual, the lower fuel loads generally resulted in reduced frequency and severity of fires. Despite the reduced fuel loads, severe fire weather led to a fire ban being declared on 11 occasions. During a period of severe fire weather late in the season, a wildfire continued for over seven days and affected 135,000 Ha on the Stuart Estate and surrounding area near Katherine.

Very little aerial burning occurred in the zone, with the major focus for mitigation burning being roadside fuel reduction burning. Volunteer brigades in Katherine and Edith Farms conducted over 180km of roadside burns within the Katherine Fire Protection Zone early in the season, and this was matched by extensive roadside burning by pastoralists further afield.

Table 36. Fire extent in the Savanna Fire Management Zone 2019

	Area burned km^2	% of zone
Planned burning, April – September 2019	20 296	6.8%
Wildfire 2019	22 840	7.6%
TOTAL	**43 136**	**14.4%**
Average 2010 - 2018	*82 973*	*27.7%*

ARNHEM

The fire season in the Arnhem zone was affected by the poor 2018-19 wet season; the season started early and finished late. The expansion of carbon abatement projects in this zone has seen continuing improvement in fire management outcomes across Arnhem Land and the Tiwi Islands. Extensive early strategic burning is central to the management of carbon project areas and the positive impact of this burning can be seen in the comparison between areas affected by late fires in the Arnhem and Vernon Arafura zones.

The area north of Gunbalanya does not currently support any form of carbon abatement project. Bushfires NT assisted local landowners to conduct early season aerial burning in that area.

Table 37. Fire extent in the Arnhem Fire Management Zone 2019

	Area burned km^2	% of zone
Planned burning, April – September 2019	34 696	27.5%
Wildfire 2019	19 456	15.4%
TOTAL	**54 151**	**43.0%**
Average 2010 - 2018	*50 381*	*40.0%*

BUSHFIRE ACTIVITY

VERNON ARAFURA

The poor 2018-19 wet season led to an early start to the fire season with 60 wildfire incidents reported in May. This had the effect of reducing the time available for hazard reduction burning. Despite this difficulty, volunteer brigades and landowners completed 172 hazard reduction burns including 124 during May and June. Volunteer brigades were often required to respond to wildfires during the day, before conducting fuel reduction burning in the evening.

Unusually hot and dry conditions occurred for extended periods in 2019. The fire season continued longer than usual, with 22 wildfires in November and 13 in December. Many of these late season fires resulted from dry lightning storms. Bushfires NT attended over 400 fire incidents across the fire season; this included several dangerous fires in the urban interface area that required Bushfires NT to provide aerial firefighting support for the NT Fire and Rescue Service.

The declaration of 38 fire ban days in the Top End reflects the severity of fire weather experienced in 2019. This included a record sequence of eleven consecutive days in September and another of six consecutive days in October. It was necessary to issue an emergency warning, the highest level of public warning for fire danger, on two occasions during September.

In general, in 2019 fire incidents were more frequent, more intense, and continued for much longer than usual. The continuing presence and spread of Gamba grass in urban interface and rural residential areas presents significant challenges for fire managers. When combined with more frequent occurrence of severe fire weather, the challenges increase significantly. The capacity of existing fire management resources in Vernon Arafura was stretched to the limit.

Table 38. Fire extent in the Vernon Arafura Fire Management Zone 2019

	Area burned km^2	% of zone
Planned burning, April – September 2019	21 406	35.8%
Wildfire 2019	16 166	27.0%
TOTAL	**37 572**	**62.9%**
Average 2010 - 2018	*30 274*	*50.6%*

WEED ACTIVITY

NT WIDE

Gamba grass

Gamba grass (Andropogon gayanus) was originally introduced as an improved pasture through the mid-1900's. It was promoted and planted widely on the Darwin pastoral areas through the latter half of the century. Unfortunately, the weedy potential of the plant was not given enough attention and it has led to severe infestations in areas where gamba is not controlled and maintained through appropriate grazing regimes. Gamba continues to destroy infrastructure, native bushland and wildlife with its large biomass late curing and resulting in high intensity

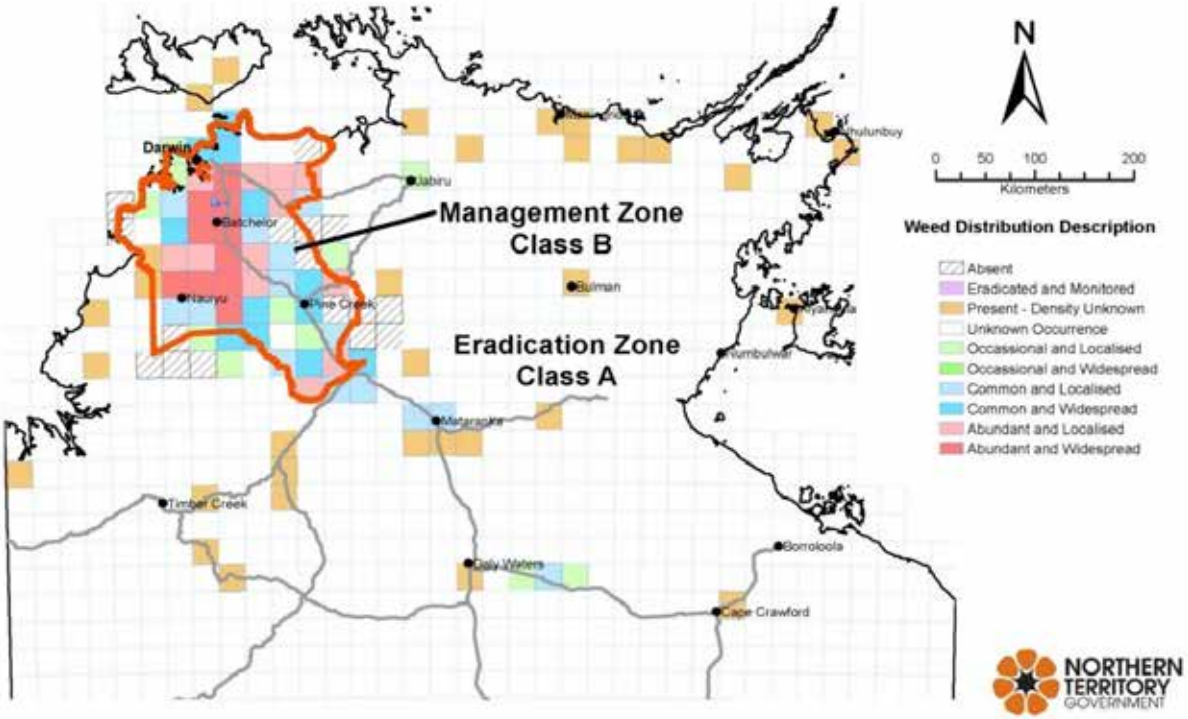


Figure 101. Gamba grass zones.

fires.

Gamba grass is declared a weed across the NT, and management objectives are split to reflect varying distribution, density, and feasibility of control. The eradication zone (Class A) has lower density and a higher feasibility of eradication, while gamba in the management zone (Class B) is at a higher density and has a lower feasibility of control (Figure 101).

The Weed Management Branch of the Department of Environment and Natural Resources works with landholders in the eradication zone to first locate gamba infestations, then work towards their eradication. In the management zone, landholders with gamba grass which is not actively maintained by grazing are obligated to treat the plant as a weed. Lessees and other landholders are required to prevent spread of gamba from their properties and not to promote

WEED ACTIVITY

the spread of the grass over their property.

For the last few years, the Weed Management Branch has been actively enforcing landholder compliance with the NT Weeds Management Act 2001 and under it, the Weed Management Plan for Gamba Grass. Gamba grass on Darwin rural area properties is the focus of the compliance program, however compliance and enforcement activities also commenced around Katherine in 2018.

It is now well known that three permits to graze gamba in the eradication zone were issued to pastoral properties in the Katherine region. One of these was cancelled in 2019, with the remaining permit areas being compliant with permit conditions. It is now departmental policy that no new permits will be issued for the purposes of grazing within the eradication zone. The Weed Management Branch is supporting the cancelled permit holder with their eradication program and another four pastoral leases within the eradication zone have active control programs, with two advising that eradication had been achieved.

Gamba may be utilised for hay by pastoral lessees in the management zone; however, it must only be used internally on the property it was cut on. Gamba hay should be cut whilst the plant is vegetative and prior to flowering. Hay containing gamba must not be sold or traded, or transported along roadways.

Onshore petroleum weed management

The Scientific Inquiry into Hydraulic Fracturing in the Northern Territory made 135 recommendations to reduce the identified risks associated with the development of any onshore shale gas industry in the NT, to acceptable limits. Three of these recommendations related directly to weeds:

8.2 – conduct baseline weed assessments with ongoing weed monitoring

8.3 – companies to employ a dedicated weed officer for each gas field. Additionally, the industry funds an NT Government weed management officer

Photo 1. Baseline aerial weed survey of the Sturt Plateau pastoral district

WEED ACTIVITY

8.4 – companies develop weed management plans for areas to be accessed for exploration

An Onshore Petroleum Weed Management Officer was subsequently appointed and has coordinated baseline weed assessments in the Sturt Plateau, Gulf, Barkly and Southern Alice Springs pastoral districts (Photo 1 & Figure 102). Weed management plans have been developed for exploration activities, with appropriate level of engagement with pastoralists.

The weed species most commonly detected during surveys include hyptis, sida, sicklepod, parkinsonia and rubber bush. These weeds are mostly in areas of disturbance and high cattle traffic, such as along roads, around water points and on approaches to paddock gates.

Good weed hygiene practices are vital for petroleum companies and pastoralists to maintain the relative scarcity of weeds. However, it should be noted that conditions in 2019 were extremely dry and annual weeds may not have been actively growing. Ongoing weed monitoring in 2020 and beyond will determine the effect of the dry conditions on weeds.

Weed identification and spread prevention training has been provided to gas companies and their contractors. Development of extension materials and programs are ongoing.

Weed management planning

The Weed Management Branch has developed a number of species-specific weed management plans under the Weeds Management Act (the Act) that set out additional requirements for landholders and landowners in addition to general requirements outlined under the Act. A total of 10 statutory weed management plans have been developed and are available at:

https://nt.gov.au/environment/weeds/how-to-comply-with-the-law/statutory-weed-management-plans.

In accordance with the Act, these plans must be reviewed at least every 3 years. Throughout 2019, the neem, prickly acacia, mesquite and chinee apple plans underwent a review, and key stakeholders will be informed once the revised versions are finalised and endorsed.

Review of the Cabomba Weed Management Plan and Grader Grass Weed Management Plan will occur in early 2020, with all feedback considered to determine whether the plans will be confirmed, revoked or amended.

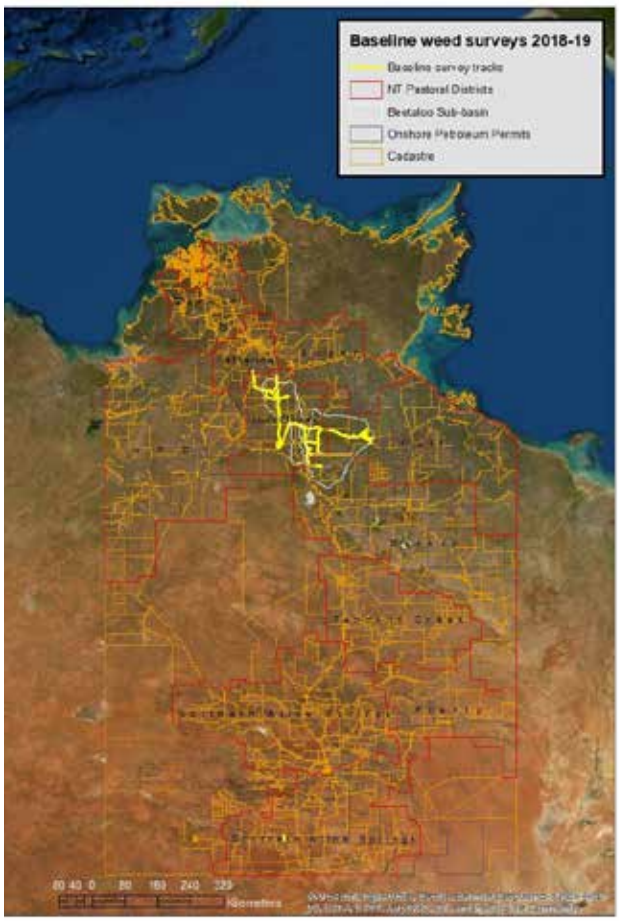


Figure 102. Baseline weed surveys conducted over pastoral properties 2018-19

WEED ACTIVITY

DARWIN REGION

The Darwin Region weed management area covers approximately 150 000 km^2, encompassing 21 pastoral leases that make up 13% of the region's land area. Aboriginal land accounts for 73% of the region and includes Arnhem Land, Kakadu and the Daly/Port Keats Aboriginal Lands Trust and most of the NT's islands. Many of the NT's high value floodplain pastoral properties are in the Darwin region. Priority weeds identified in the Darwin Regional Weed Management Plan 2015-2020 have been the critical focus for Weed Management Branch business. The Plan is being reviewed and a new strategy is expected mid-2020. During 2019, a Siam weed emergency response was initiated; and gamba grass and mimosa remained major focus of Weed Management Branch activities.

Siam weed

The first detection of Siam weed (Chromolaena odorata) in the NT occurred in July 2019 on a Top End pastoral lease. The property managers reported the finding to the Weed Management Branch shortly thereafter. An emergency response was enacted and a further 2 'infected premises' (on Aboriginal Land Trust) have been identified. The core infestation comprises an area of around 300ha.

Siam weed has an extremely fast growth rate (up to 20mm per day) and prolific seed production. In the tropics of Africa and Asia, it is a major pest of crops such as coconuts, rubber, tobacco and sugar cane. Some agricultural areas in South-East Asia have been abandoned because Siam weed has taken over pastures and crops. Siam weed is toxic to stock and there are also health issues to humans, such as skin complaints and asthma.

The current priority for the Branch is to contain and to find the extent of the infestation in the known area and to determine if it is present further afield in the NT. Survey for Siam weed is best carried out during flowering (June to August). It is hoped that after August 2020 the extent of Siam weed in the NT will be known and efforts towards eradication can begin in earnest.

The known infestation area has been fenced off by the landholder and strict spread prevention practices implemented.

Mimosa

Mimosa (Mimosa pigra) remains the major weed impacting on the pastoral industry in the Top End, having infested the Mary, Adelaide, Finniss, Reynolds and Daly River catchments. Major infestations negatively impact on pastoral production, stocking rates and land condition.

The biological control agent 'Nessie' (Nesaecrepida infuscata) continues to increase its distribution. Nessie, a flea beetle, is having a dramatic effect reducing the vigour of mimosa plants especially in the lower Daly, Mary, Adelaide, Finniss and Reynolds River areas.

WEED ACTIVITY

Although the Finniss Reynolds Mimosa Program funding has been allocated, pastoral properties in the region continue to see the benefits from their mimosa control programs - with all stations spraying similar amounts of mimosa as when the project was in full swing. This has allowed them to capitalise on the resources used in the program and these properties continue to see an ongoing reduction in mimosa's impact.

Mimosa herbicide resistance

Pastoral properties in the Mary, Daly and Finniss catchments have continued to report mimosa being resistant to metsulfuron-methyl ('Brush Off') herbicide. Any suspected resistance should be reported to the Weed Management Branch and alternative herbicides used. Those permitted for aerial application are listed below:

- Fluroxypyr ('Starane Advanced')
- Tebuthiuron ('Graslan')
- Dicamba ('Kamba')
- Aminopyralid and metsulfuron-methyl ('Stinger')[1]

Rat's tail grasses

There are 4 records of giant rat's tail grass (Sporobolus natalensis) in the NT (with two controlled by the Weed Management Branch in 2018). This introduced grass causes many millions of dollars' worth of damage to the Queensland and New South Wales pastoral industries. Other than reducing available pasture, this tough unpalatable grassy weed can reduce grazing life of cattle through increased wear of teeth.

The related American rat's tail grass (S. jacquemontii) continues to spread across Top End properties. Pastoralists need to know to recognise and control this weed in new areas. Yarding, laneways and high traffic areas such as water points and gates are very prone to infestation and it is from these areas that it is spread to wider pasture. Glyphosate control in the first instance can be effective in preventing further spread.

[1] *Not recommended for resistant mimosa as product also contains metsulfuron- methyl*

Rat's tail grass infested paddock

WEED ACTIVITY

Grader grass

Grader grass (Themeda quadrivalvis) continues to spread north into the Darwin Region pastoral areas. It is important that pastoralists:

- ensure heavy machinery and vehicles are clean of seeds, vegetative materials and soils before entering their property
- do not spread or introduce soils from known grader grass contaminated areas
- do not let anybody drive through seeding grader grass

It is also very important that hay sourced from properties is from grader grass-free paddocks. As grader grass seeds early in the Wet season, it easily contaminates hay product cut later in the year. Once cut into product it can easily be transported from property to property.

Grader grass identification and control is very difficult. Being an annual grass it is almost impossible to identify until flowering. However, the time between flowering and seed set is very short. Stations need to be ready to treat the grass as soon as it becomes noticeable, or have measures in place to treat known infestation areas prior to flowering.

KATHERINE REGION

The Katherine Region weed management area covers approximately 386 000 km^2, encompassing 95 pastoral leases. The region includes the VRD, Katherine, Roper, Sturt Plateau and Gulf Pastoral Districts. Priority weeds identified in the Katherine Regional Weed Management Plan 2015-2020 have been the critical focus for Weed Management Branch business in this region. This document is currently under review by the Katherine Regional Weed Reference Group with the new strategy to be completed by mid-2020.

The 2019 reporting year has seen a major focus on the emergency responses for parthenium weed and rubber vine, both self-reported by pastoralists within the Katherine Region. The Weed Management Branch has also kept an ongoing focus on working with managers of government-owned land, local government and corridors to ensure priority weeds are managed in accordance with statutory obligations. This engagement is starting to see improved results, including a significant decrease in the amount gamba grass found within road reserves.

Grader grass

WEED ACTIVITY

Parthenium weed

Parthenium weed (Parthenium hysterophorus) was reported by the landholder to the Weed Management Branch in October 2018. It is at least the eighth detection of the weed in the NT. Extensive and regular survey and control has seen around 2,100 plants destroyed on site. To control the risk of spread, a Weed Spread Prevention Plan was written by the landholder with guidance from the Weed Management Branch. Due to the high number of variables which could result in the spread of parthenium weed, a pastoral lessee phone survey was undertaken within the Katherine and Barkly Regions (both at greatest risk to parthenium weed) to determine areas of highest risk. Surveillance of these areas will commence in February 2020 following rainfall. To this date, no parthenium weed plants have been found outside the initial infestation area and the current infestation has been assessed as technically feasible to eradicate. The Weed Management Branch is in the process of handing the responsibility of the infestation back to the landholder with ongoing oversight from weed management officers.

Rubber vine

Rubber vine ground team

Rubber vine (Cryptostegia grandiflora) is widespread throughout northern Queensland. It was reported on Settlement Creek near the NT/Queensland border in March 2019. Initial control of over 500 plants involving the Weed Management Branch, Parks and Wildlife rangers and a large station contingent made the infestation manageable. Since then, the landholder has worked hard towards eradication, achieving excellent results. Survey for rubber vine will be ongoing as there are known infestations along waterways 3km from the NT border. The Weed Management Branch is working with Indigenous ranger groups and government authorities in Queensland to ensure that any future incursions of this weed are detected as soon as possible. The Branch is also in close communication with Western Australia as rubber vine control and eradication continues in the East Kimberley.

Parthenium weed seedling

WEED ACTIVITY

Mimosa

Mimosa (Mimosa pigra) is only found in small isolated infestations and remains a priority for the Katherine Region. All known infestations currently have active control and monitoring programs. One property reported that in 2019 no mimosa plants were found. This is a long-term surveillance program; however, it is promising to see that the size of these small infestations is decreasing with three survey and control visits each year.

BARKLY REGION

The Barkly Region weed management area encompasses the Mitchell Grass Downs and Davenport Murchison Ranges Bioregions and parts of the Tanami and Sturt Plateau. It covers an area of 283,648 km2. The Weed Management Branch, in conjunction with regional stakeholders, implements the Barkly Regional Weed Management Plan. The Plan, which is being reviewed in early 2020, identifies the declared weeds prickly acacia, mesquite, bellyache bush, parkinsonia and rubber bush as priority species that require management.

Prickly acacia

There has been a continued focus on prickly acacia (Vachellia nilotica) in the Barkly Region with core infestations surveyed and control programs implemented. Core infestations have showed a reduction in abundance and distribution; there has also been a clear change in the population, with the age cohort shifting from predominantly adult trees to seedlings and juveniles. Eradication of prickly acacia remains the highest priority within the Barkly.

Funding through the Australian Government's 'Established Pest Animals and Weeds Measure' allowed for a remote sensing project for prickly acacia on the Barkly. Using existing techniques applied in Queensland by Desert Channels Queensland and Queensland University of Technology, trials were conducted to detect infestations using both satellite and UAV imagery. Results indicated that, due to the low densities of prickly acacia on the Barkly, this technology is currently not suitable to detect individual or small isolated infestations. The final report can be found on the DEPWS webpage.

In 2019, the Weed Management Branch joined the Prickly Acacia Alliance, which comprises key stakeholders in both Queensland and the Northern Territory. This group aims to work collaboratively to share information and lobby for coordinated approaches to eradicate prickly acacia.

Prickly acacia

WEED ACTIVITY

Mesquite

Mesquite (Prosopis spp.) has remained a focus with two surveys completed on the Barkly's largest mesquite infestation. Data collected from this survey will allow the lessee to complete the required work during the 2020 dry season. All of the more isolated occurrences of mesquite on remaining Barkly Region properties are currently under active management programs. Mesquite remains an achievable eradication target on the Barkly with a reduction in both distribution and density on many properties.

Bellyache Bush

Bellyache bush (Jatropha gossypiifolia) is found on one pastoral lease in the Barkly. The drier than average wet season on the Barkly in 2019 prevented any germination of bellyache bush. The close proximity to Tennant Creek ensures regular monitoring is undertaken, with eradication an achievable goal. The promising start to the 2019/20 wet season may trigger germination, and survey and control is planned for early 2020 to control all plants prior to seeding.

Parkinsonia

Parkinsonia (Parkinsonia aculeata) can be found on most pastoral leases in the Barkly region. Ad-hoc control occurs during the survey and treatment of priority weeds. A naturally occurring dieback (soil-borne fungus) is having dramatic effects on what were once large, dense infestations across several catchment areas. This includes the Lake Sylvester catchment, which incorporates several large pastoral holdings in the region. To complement the success of the naturally occurring dieback, a commercial bioherbicide 'Di-Bak' continues to be used to inoculate infestations at various locations where the dieback phenomenon has not been shown to occur.

Rubber bush

Rubber bush (Calotropis procera) continues to be a significant concern for landholders within the region. Weed Management Branch are continuing to investigate further potential for herbicide trials to establish an effective and convenient means of controlling this weed. During the 2019 Dry season, weed management officers observed lesser wanderer butterfly larvae actively eating and defoliating rubber bush. In Australia, the foods of this butterfly are all from the milkweed family, to which rubber bush belongs.

WEED ACTIVITY

ALICE SPRINGS REGION

The Alice Springs Region weed management area covers a vast area of approximately 576,000km² bordered by Western Australia, Queensland and South Australia. The pastoral estate in central Australia is made up of 66 pastoral leases which cover approximately 40% of the land area. Aboriginal land in the region makes up 50% of the total land area. The Alice Springs Regional Weed Management Plan, which is currently being revised, lists priority weed species and landscapes across the region which are the focus for weed management activities. The priority weeds listed for management within the region include athel pine, cacti, parkinsonia and rubber bush; all of which have undergone a rigorous scientific weed risk assessment process, which has determined their weed risk and high potential for effective management.

Athel pine

The Weed Management Branch have continued to work collaboratively with affected landholders in the upper managed 420 km of the Finke River catchment in managing residual infestations of athel pine (located on Henbury, Idracowra, Maryvale, and Horseshoe Bend Stations). The success of the ongoing management of residual levels of athel pine in the upper catchment areas of the Finke River presents a real opportunity for eradication within the next 5-10 years.

Cacti

There are several species of declared Class A weedy opuntioid cacti within Central Australia, which have become naturalised at several different locations. All of the known cacti infestations located on the pastoral estate are currently under active management programs, with ongoing monitoring and controls in place, and eradication at all sites is a distinct possibility in the next 5 years. An ongoing awareness and education campaign is currently underway with local Alice Springs residents and landholders to assist with the identification and removal of amenity plantings of declared cacti from gardens. Ongoing surveillance for the presence of declared cacti has continued across the region in 2019 with continued education and awareness.

Mesquite

Mesquite (Prosopis spp.) within the region occurs as one isolated infestation to the northwest of Alice Springs. Previous issues with organic certification hampered the use of chemicals for the control of this infestation but these have now been resolved. Weed management officers have recently liaised with station management to initiate an eradication program for the identified infestation in 2020.

FERAL ANIMALS

The Northern Territory (NT) harbours extensive populations of large feral animals. The main species of concern are feral horses, donkeys, camels, water buffalo and pigs. The Department of Environment and Natural Resources (DENR) is supporting the management of feral animals on Aboriginal land through the Indigenous Ranger Grants Program. The Department of Tourism, Sports and Culture (DTSC) currently assists landholders with the management of large feral herbivores through the provision of accredited aerial shooters. Introduced predators such as foxes and feral cats can have significant impact on conservation values.

Water buffalo

Unmanaged Water Buffalo can be a significant pest especially across Arnhem Land, degrading habitat. Maps of survey data collected recently from the northern floodplains and inland areas were collated for a two-day workshop on feral herbivore management organised by Territory NRM in September 2019. Whilst population sizes aren't known exactly, buffalo numbers have increased substantially in the past decade and noticeably in the past few years. There may be over 150 000 buffalo in the region. Territory NRM, DENR, Indigenous Ranger groups and Land owners are working together to develop cross-tenure solutions.

In October 2019 the Commonwealth Government announced a $4 million grant to CSIRO under the Smart Farming Partnerships program to look at innovations in large-scale herd management techniques to safeguard Australia's Top End from the impact of feral buffalo.

Rabbits

While rabbit numbers in central Australia have increased in recent years, numbers are still well below levels recorded prior to the arrival of Rabbit Haemorrhagic Disease (RHD) in the mid-1990s. RHD and myxomatosis are periodically active throughout the region and help keep rabbit numbers in check. Very little additional rabbit management is undertaken anywhere in central Australia. The new K5 strain of RHD was released nationally in 2017 including at one site in central Australia. This strain is expected to increase the level of control across some parts of Australia.

FERAL ANIMALS

Wild dogs

During 2019, DENR and the Department of Primary Industry and Resources (DPIR) collaborated on the project "Best practice management of wild dogs in the Northern Territory". The project was funded through the Australian Government's Agricultural White Paper. Wild dog management practices were documented on 73 pastoral properties. Most participants relied on 1080 baiting to manage wild dogs, often supplemented by shooting. Approximately 30% of respondents conducted trapping. Mean calf loss to wild dogs, estimated by pastoralists, was 3.8% but ranged widely (0 – 15%). Results were highly variable, suggesting localised issues on individual properties. There was no clear relationship between estimated calf loss and intensity of baiting. Nor did extra time and money spent on wild dog management appear to ensure improved success. 1080 bait records indicated ~300,000 baits are used per annum, an increase on past practice. Dog-bite records submitted by pastoralists indicated that the average incidence of unbranded cattle presenting with sign of non-fatal attack was 4.1 per 100 cattle inspected (ranging between 0.2 and 18). Project recommendations are being finalised.

Feral pigs

Feral pig management is undertaken on pastoral properties in the Top End. The recent spread of African Swine Fever in south east Asia has raised awareness of feral pig management in NT more broadly as feral populations are likely to be a significant reservoir if the disease were to reach Australia, threatening the domestic pig herd. One of the more long standing programs has been the Territory NRM supported pastoral floodplain pig management project around the Finniss/Reynolds River regions now into its 6th year. Whilst funding has been variable, there have been high levels of collaboration and certain areas have retained low pig populations. A key outcome has been improved mimosa management.

FERAL ANIMALS

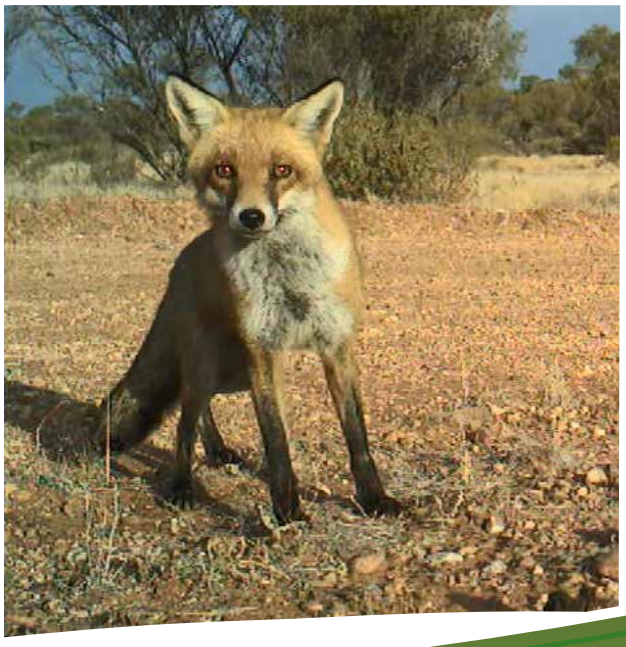
Feral cats

Feral cats are prevalent across the NT - including our most arid and remote regions. Cats are renowned for their impacts on our native wildlife and are recognised as a key threatening process. They can also have an impact on the meat industry, particularly for sheep, through spreading the parasite Toxoplasmosis gondii. Controlling cats is best undertaken in a targeted manner, through creating refuges on cat-free islands or by constructing exclusion fencing, or by undertaking ongoing targeted control to protect particular high conservation value wildlife.

Exclusion fences are used to protect small populations of the endangered mala (rufous hare wallaby) from foxes and cats on Uluru-Kata Tjuta National Park and Newhaven Reserve. Other threatened animals also benefit from these areas and more species may be re-introduced to them as insurance populations.

In 2019, DENR again carried out experimental cat control with the 1080 Eradicat bait in core central rock-rat refuge habitat in the Tjoritja/West MacDonnell National Park. Baits were deployed aerially at a density of 50 per km^2 in two 4000 ha areas during winter months. Monitoring results showed an 85% reduction in the density of cats, and the ongoing cat control is improving the colonization and persistence of the central rock-rat.

Red foxes



Red foxes are distributed throughout the arid and semi-arid regions of the NT. Red foxes pose a threat to native fauna species; however, there is no systematic management within the NT due to the potential impact that widespread baiting in the conservation context may have on native carnivores such as the dingo. In 2018-2019, DENR ran unpoisoned trials of a new collar attachment for the Canid Pest Ejector (CPE), a toxin (e.g. 1080) delivery device that takes advantage of the morphological differences between dingo and fox snouts. Results for this innovative design were promising, showing that foxes could trigger the CPEs with the collar attachment but dingoes could not. There has been interest from other jurisdictions to undertake further trials.

FERAL ANIMALS

DENR and DTSC have together undertaken some aerial culls of camels and horses over the past 10 years, including on Aboriginal land, in consultation with and at the request of landholders. In 2019 DENR has worked with Traditional Owners to protect and rehabilitate wetlands damaged by horses and camels in central Australia. DENR and DTSC have been collaborating with colleagues in WA who are looking at the genetic structures of Feral Donkey populations to get a better idea of management units and movements across both jurisdictions.

MEETINGS OF THE BOARD

Four meetings of the Pastoral Land Board were held between 1 October 2018 and 30 September 2019 as follows:

120th Meeting: teleconference held 4 December 2018

Two land clearing applications were considered by the Board, with a permit being granted for one. A variation to a land clearing permit was considered and endorsed, rectifying an administrative anomaly. The Board considered a new non-pastoral use application deferring consideration pending further information and also endorsed amendments associated with an existing non-pastoral use permit.

The Board endorsed a development plan for conversion of a term lease to perpetuity and considered changes to the Pastoral Land Clearing Guidelines.

121st Meeting: teleconference held 25 February 2019

Two non-pastoral use applications were considered by the Board, with the Board consenting to grant a permit for one. The Board determined that for the second application an Environmental Management Plan addressing future developments for the station would be required prior to further non-pastoral use applications being considered. The Board noted briefings regarding voluntary management plans and conversion applications.

122nd Meeting: held 26 and 27 March 2019 in Darwin

The Board considered two non-pastoral use applications and consented to one for tourism. The second was determined as an allowable activity and a non-pastoral use permit was unnecessary. Two Development Plans for or conversion of a term lease to perpetuity were considered with further information requested. The 2017/18 Land Condition reports were considered and the Pastoral Land Board Annual Report 2017/18 was finalised.

The Board received briefings on matters from various NT Government agencies and considered administrative updates relating to the Board's functions. The Board acknowledged a revised approach to assessment of land clearing applications utilising the expertise Native Vegetation Assessment Panel (NVAP).

123rd Meeting: held 27 September 2019 in Alice Springs

The Board provided consent to two pastoral land clearing applications and granted extensions to existing land clearing and NPU permits. The Board varied the use of a non-pastoral use permit to enable more diversification within the existing allowable use.

MEETINGS OF THE BOARD

Out of Session

The Board considered three matters out of session, including a land clearing application, voluntary management plan development progress and notification of a non-pastoral use permit condition precedent being completed.

APPLICATIONS CONSIDERED BY THE BOARD

Land clearing applications

Station	Pastoral District	Purpose	Total Area (approx.)	Decision
Hidden Valley	Sturt Plateau	Improved pasture	3 517.7 hectares	Approved
Gilnockie	Sturt Plateau	Improved pasture		Deferred
Owen Springs	Southern Alice Springs	Commercial Power Project	31.78 hectares	Approved
Newcastle Waters	Barkly	Pastoral Purposes	505.97 hectares	Approved
Ucharonidge	Barkly	Pastoral Purposes	317.81 hectares	Approved

Non-pastoral use applications

Station	Pastoral District	Purpose	Term	Decision
Tipperary East	Darwin	Agriculture	-	Deferred
Tipperary East	Darwin	Horticulture	30 years	Approved
Seven Emu	Gulf	Tourism	30 years	Approved
Banjo	Sturt Plateau	Agriculture	-	Allowable activity, permit unnecessary

MEETINGS OF THE BOARD

Subdivision Applications

Under section 61 of the Pastoral Land Act, the Minister refers applications for subdivision of pastoral leases to the Board for consideration and recommendation. During 2018-19 no applications for subdivision were lodged with the Board.

Perpetual Pastoral Lease Applications

Under section 62 of the Pastoral Land Act, the Minister refers applications for conversion of term pastoral leases to perpetual tenure to the Board for consideration and recommendation. There were no applications for conversion referred during 2018-19, however three development plans were considered by the Board.

APPENDICES

APPENDIX 1

NT Farm Performance

Financial performance of beef enterprises in the Northern Territory (NT) has been strong in recent years (Australian Bureau of Agricultural and Resource Economics (ABARES) Farm performance: broadacre and dairy farms, 2016–17 to 2018–19 - Peter Martin and Vernon Topp). In 2015–16 high prices for beef cattle and strong demand for live export cattle in northern Australia resulted in average farm cash income for NT beef enterprises being the highest recorded in over 20 years. Farm cash income remained high in 2016-17. Refer to Table 1 and Figure 1.

However, average farm cash income declined from $1,569,600 per farm in 2016-17 to an average of $1,075,000 in 2017-18 due to lower beef cattle prices, reduced cattle turn-off and higher costs because purchases of cattle increased and transfers of cattle onto properties in the NT increased by enterprises operating multiple and interstate properties. Purchases and transfers resulted in increased beef cattle numbers, particularly on the Barkly Tableland where a substantial increase in value of cattle inventory and a rise in business profit was recorded (Table 1).

In 2018–19 dry seasonal conditions and sustained demand for cattle for live export is projected to result in increased turn-off of beef cattle from all NT regions and a 33.1 per cent increase in average farm cash income. This income may be offset by higher than expected operating costs (fuel in particular). Lower farm business profit is expected in all regions in 2018–19 compared with 2017–18.

Table 39. Financial performance in the Northern Territory, by region and industry, 2016–17 to 2018–19

Average per farm

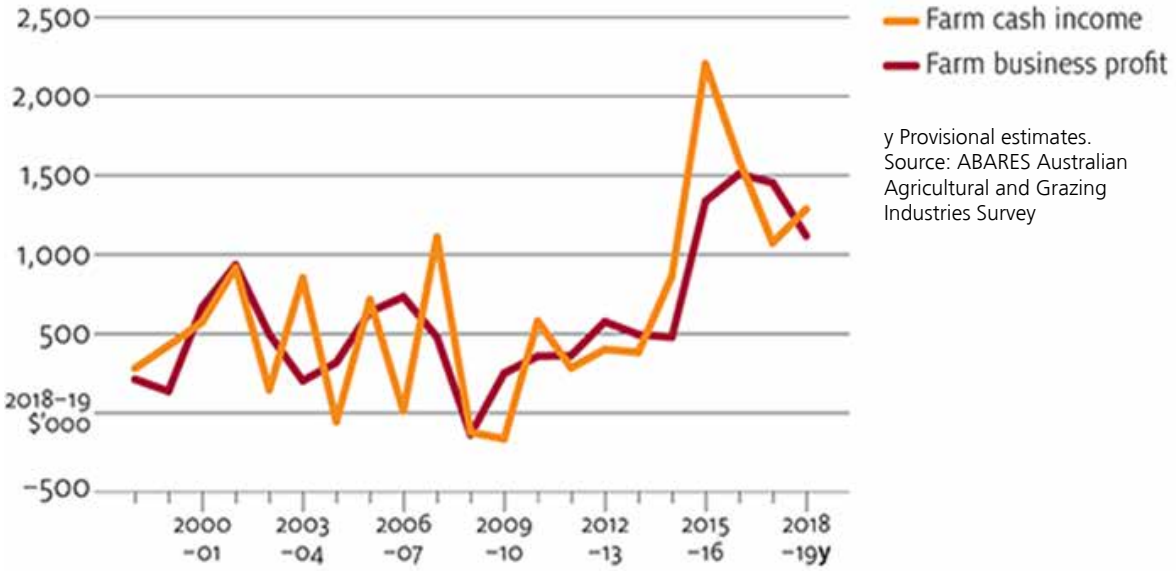
Region	Unit	Farm cash income			Farm business profit		
		2016-17	2017-18p	2018-19y	2016-17	2017-18p	2018-19y
Broadacre industries	$	1 569 600	1 075 000	1 288 000	1 481 200	1 455 000	1 119 000
Beef	$	1 569 600	1 075 000	1 288 000	1 481 200	1 455 000	1 119 000
Broadacre industries by region							
NT Alice Springs District	$	905 700	872 000	1 095 000	936 500	841 000	478 000
NT Barkly Tablelands	$	4 294 700	2 346 000	2 642 000	3 248 700	4 840 000	3 905 000
NT Victoria River District - Katherine	$	1 356 600	1 062 000	1 168 000	1 489 600	1 033 000	852 000
NT Top End Darwin and the Gulf	$	333 700	218 000	402 000	226 200	180 000	3 000

p Preliminary estimates. y Provisional estimates.
Source: ABARES Australian Agricultural and Grazing Industries Survey

APPENDIX 1

In 2018-19 dry seasonal conditions and sustained demand for cattle for live export is projected to result in increased turn-off of cattle from all NT regions and a rise in average farm cash income.

Average per farm



y Provisional estimates.
Source: ABARES Australian Agricultural and Grazing Industries Survey

Figure 103. Farm cash income and farm business profit for broadacre farms, Northern Territory, 1998–99 to 1998-99 to 2018-19

Trade

In the reporting period 1 October 2018 to 31 December 2019, 459 512 cattle were shipped from the Port of Darwin to South-east Asian markets. This included an estimated 304 691 of Northern Territory (NT) cattle. In this period 11 430 buffalo were also shipped.

Demand for Australian live cattle in markets continued to be robust in 2019 and export volume remained strong. For the 2019 calendar year, 366 108 head of cattle were shipped from the Port of Darwin, with 246 347 (67%) being cattle sourced from the NT. In 2019, 9 364 head of buffalo were exported through the Port of Darwin, down just 1 per cent (56 head) from the 2017 record high of 9 420 head.

For the period 1 October 2018 to 31 December 2019, Indonesia remained the major export destination (81 per cent) of the cattle exported from Darwin. This was followed by Vietnam (12 per cent), the Philippines and Malaysia (3 per cent each) and Brunei and Thailand (less than 1 per cent each).

Vietnam, Indonesia, Malaysia and Brunei were the main destinations for buffalo exported from the NT.

APPENDIX 1

Cattle prices remained at historically high levels during 2019 as a result of strong demand. From a high of $3.35 per kilogram during the 2018-19 Wet season, the price for live export steers in Darwin dropped as low as $2.90 per kilogram at the beginning of the Dry season before recovering to $3.20 per kilogram by the end of the reporting period. Tightening supplies pushed the prices higher after months of lower prices resulting from widespread destocking in response to successive dry seasonal conditions in some parts of the NT in 2018 and 2019.

By late 2019, African Swine Fever was reported in most of the NT's live export markets, including the largest markets of Indonesia and Vietnam. This led to a destabilisation of protein prices and increased demand for all protein. However, many live export markets across South-east Asia remain price-sensitive, which means this pressure does not directly translate to increased prices for NT cattle.

The Australian Agricultural Company suspended operations at its abattoir at Livingstone near Darwin in July 2018 after three years of operation. The closure of this facility removed the option of local processing of cull cows for the northern NT cattle industry. The remaining option for processing of these cattle is in abattoirs in southern states requiring an average travel distance of about 3 000 km.

The refurbished abattoir at Batchelor, trading as Rum Jungle Meat Exports, re-opened in December 2019. The facility plans to process cattle and buffalo and in the longer term donkeys and camels. The abattoir will complement the live export trade by taking out-of-export-specification cattle and buffalo with trade of boxed beef into domestic and international markets.

APPENDIX 2

Grazing land management research and advisory services

Source: Department of Primary Industry and Resources; Livestock Industries Development Group

The Department of Primary Industry and Resources (DPIR) Livestock Industries Development group provides research, development and extension services to facilitate the sustainable development of the Northern Territory pastoral industry. Areas of expertise include grazing land management, carrying capacity assessment, animal production, genetics, improved pastures and market development. During 2018-19, DPIR also continued to support Aboriginal economic development through its partnership in the Indigenous Pastoral Program.

The DPIR Rangeland Program's research and extension activities aim to optimise the sustainable and productive use of native pastures. Over the past 18 years, DPIR has developed a nationally-significant catalogue of pasture growth models for the important pastoral land types of the NT. These models are used to estimate sustainable livestock carrying capacity and to test management scenarios with potential to increase the resilience of pastoral businesses to seasonal variability and climate change. The following sections highlight some of the main activities undertaken in the past 18 months.

NT pastoral feed outlook

Since late 2011 DPIR has produced a quarterly bulletin that summarises the seasonal outlook, recent forage growth and current estimated standing pasture biomass in each of the 11 pastoral districts of the NT. The Outlook can alert producers and industry advisers to issues such as low pasture levels, increasing drought risk and high fire risk. The Outlook is available as a free subscription service on the DPIR website: https://dpir.nt.gov.au/primary-industry/primary-industry-publications/northern-territory-pastoral-feed-outlook

The 2018/19 summer season commenced with patchy rain across much of the NT but seasonal conditions quickly deteriorated in several districts as a result of the late onset to the northern wet season. By March 2019, some districts had received their lowest rainfall on record. As a result, many districts experienced extremely low pasture growth (in the lowest 10% of years on record). By the end of 2019, critically low pasture levels (less than 200kg/ha) were widespread in the Barkly, Sturt Plateau and Northern Alice Springs districts. Furthermore, large parts of the NT were experiencing very low levels (200-500 kg/ha) of standing pasture biomass, including in the Darwin, Katherine, Victoria River District, Gulf, Tennant Creek, Plenty and Southern Alice Springs districts. Significant destocking occurred in several districts throughout 2019 in response to the deteriorating feed conditions.

Carrying Capacity Research and Advice

The DPIR provides carrying capacity assessments to property owners on request. This typically involves a property visit to verify infrastructure and land type mapping and to assess pasture growth and land condition. The agency also fields numerous requests each year from both family-owned and corporate enterprises to provide advice on property development and land management. DPIR also provides advice to the PLB on subdivision and land clearing applications.

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The DPIR has calibrated pasture growth models for more than 20 pasture types across the NT. Median pasture growth estimates from these models are routinely used for property carrying capacity assessments, Grazing Land Management workshops and for testing the performance of management options/practices arising from research projects.

High quality land type mapping is essential for carrying capacity assessment. Ongoing investment by DENR to improve the land type mapping in the Roper, Gulf and southern Sturt Plateau Districts, in particular, has been welcomed by DPIR.

Evidence-based Property Development

In 2019 the DPIR started a new project called Paddock Power. This MLA-funded project aims to provide sound evidence for the sustainable and profitable intensification of infrastructure in northern Australia. DPIR is conducting research in the Barkly region to measure the impact of paddock area and distance to water on livestock production, with a focus on reproductive performance. The project is also developing a calculator tool so that producers can compare different paddock development options they have in mind and work out the return on investment on the basis of their specific cost base, land types and animal productivity. More information about the project can be found on FutureBeef: https://futurebeef.com.au/projects/paddockpower/ or by contacting dionne.walsh@nt.gov.au.

Grazing Management Research

The Sweet Spot project also commenced in 2019. This project is using existing grazing trial datasets from across northern Australia to identify pasture utilisation rates that optimise breeder herd productivity. Ultimately the goal of the project is to help producers to maximise the kilograms turned off per hectare whilst maintaining the resource base. More information about the project can be found on FutureBeef: https://futurebeef.com.au/projects/sweetspot/ or by contacting robyn.cowley@nt.gov.au.

In 2018 DPIR commenced a demonstration at Kidman Springs to test "Rangelands Self Herding", which is a grazing approach developed by Dean Revell (WA) and Bruce Maynard (NSW). The trial, which concluded in 2019, aimed to demonstrate how positive reinforcement (e.g. food rewards) can be used to modify grazing patterns in paddocks. The goal was to see if the techniques had potential for creating a form of rotational grazing that did not rely on permanent fencing. Whilst many producers already move lick around their paddocks, this method amplifies that approach by offering a variety of feed attractants and using intermittent and unpredictable timing and locations. GPS collars were fitted to heifers in the trial so that we could track their paddock usage patterns. The results showed that we were able to draw cattle to graze in areas that had not traditionally been used very much. The MLA final report can be found here: https://www.mla.com.au/research-and-development/search-rd-reports/final-report-details/Grazing-with-Self-Herding/4325. More information can also be obtained from FutureBeef (https://futurebeef.com.au/projects/self-herding-kidman-springs/) or by contacting dionne.walsh@nt.gov.au.

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DPIR grazing systems trials and demonstrations continue to be conducted at Old Man Plains Research Station near Alice Springs, Douglas Daly Research Farm and Victoria River Research Station (Kidman Springs). Updates on these projects can be found in the latest DPIR Annual Research Achievement Report.

The "Quality Graze" trial at Old Man Plains is testing and demonstrating recommendations that have been identified from recent research projects and promoted through the Grazing Land Management (GLM) workshops. The strategies being investigated include using the GLM methodology to set sustainable stocking rates, annual stocking rate adjustment based on seasonal variability, and pasture spelling achieved via rotational grazing. Pasture productivity, land condition and animal performance are regularly measured. Key findings to date include:

- Our current carrying capacity methodology appears to be sustainably matching stocking rate to land capability and maintaining land condition regardless of spelling or annual stocking strategy, and provides a buffering strategy for cattle production over a dry period of at least 12 months.
- Consistent production of steers for premium beef markets is possible in terms of growth rate and fat deposition across a range of seasons when stocking rates are matched to forage supply.
- Meat Standards Australia (MSA) compliance is possible under conditions similar to those experienced over the past 5 years however more research is required to determine how to achieve more consistent levels of compliance.

More information about this trial can be obtained by contacting chris.materne@nt.gov.au.

Prescribed Burning Research

The "Shruburn" experiment at Kidman Springs (established in 1993) has been investigating how to use prescribed burning to manage woodland thickening and optimise pasture production. The trial plots are replicated on red and black soil sites, with the experiment testing the influence of season of burning (early vs late dry season) and frequency of burning (every two, four and six years). The experiment also includes a series of unburnt control plots for comparison. The major findings can be found in the Rangeland Journal (Cowley et al. 2014, Rangeland Journal 36(4): 323-345). More information about this long-term experiment can be found at http://futurebeef.com.au/resources/projects/kidman-springs-fire-experiment-shruburn/ or by contacting robyn.cowley@nt.gov.au. The local industry has asked DPIR to continue this research because it is providing rigorous data to demonstrate that 4-yearly late dry season burning is an environmentally sound management practice in grazed savannas.

DPIR commenced an experiment in 2017 with the Barkly Landcare and Conservation Association and Newcastle Waters Station to investigate whether prescribed burning can be used as a tool for controlling feathertop wiregrass (Aristida latifolia) in Mitchell grass pastures. Research previously conducted in Queensland has shown that burning in about July or August can reduce feathertop whilst not adversely affecting the preferred grasses. However, burning Mitchell grass plains at that time of the dry season is very risky so the experiment aimed to determine whether the rewards outweigh the risks in the Barkly region.

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We undertook burns in July 2017 and September 2017 and completely spelled the site from grazing over the wet season. When we returned in April 2018 we compared the burnt plots to unburnt (control) plots and found that:

- Burning reduced the plant size and biomass of feathertop
- The fires had only killed 1% of the feathertop plants
- Burnt plots had lower pasture yields and ground cover overall
- Burnt plots had more "weedy" annuals like sensitive plant (Neptunia spp.)
- No desirable perennial grasses were killed
- Burning increased seed production in the valued pasture species curly bluegrass (Dichanthium fecundum)

We concluded that fire can kill feathertop wiregrass, but it's not a "sure bet" that you will get a good kill – some years it will work and some years it won't. To maximise the chances of success, you will require high fuel loads (>2,000kg/ha), very good fuel continuity, low humidity and low soil moisture levels for several weeks before and after burning.

Industry Training Opportunities

DPIR continues to provide a range of grazing management training opportunities to industry. These include the EDGE Network Grazing Land Management (GLM) course, the one-day Grazing Fundamentals workshop, Rangeland Management Courses for first-year stock-camp staff and the Barkly Herd Management Forum. Producers can contact their local DPIR office to find out more.