A contemporary assessment of land condition in the Northern Gulf region of Queensland

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Abstract

A framework using assessments of soil condition, pasture composition and woodland density was applied to describe 14 grazing land types as being in A (100% of original carrying capacity), B (75%), C (45%) or D (20%) condition. We assessed the condition of 260 sites, principally along public and some station roads, to provide a benchmark for current land condition. Land types were also assigned relative grazing values between 10 (best) and 0, reflecting soil fertility and potential biomass production. The method identifies particular, 'at-risk' land types for priority investment of resources, while the rationale behind assessments might point to management interventions to improve the condition of those land types.

Across all land types, 47% of sites were in A condition, 34% in B condition, 17% in C condition and only 2% in D condition. Seventy-five percent of land types with grazing values >5 were in A or B condition, compared with 88% for those with grazing values ≤5. For Georgetown granites, only 27% of sites were in A or B condition, with values for other land types being: alluvials 59%, black soils 64% and red duplex soils 57%, suggesting that improving management of these land types is a priority issue. On land types with high grazing value, the major discounting factor was pasture composition (72% of sites discounted), while increasing woodland density was the main discount (73% of sites discounted) on low grazing value land types.

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Introduction

The Northern Gulf region of Queensland comprises the catchments of the Norman, Gilbert, Staaten and Mitchell River systems, all of which flow into the Gulf of Carpentaria. The region is situated between 15° and 19°S and 141° and 145°E. About 60% of the region is contained in the Northern Gulf Plains bioregion (Sattler and Williams 1999), while the remaining 40% is in the Northern Einasleigh Uplands bioregion. The Northern Gulf region experiences a 4-month wet season (December–March) followed by an extended, 8-month dry season (April–November). Wet season rainfall varies from 1200 mm in the north-west of the region to 500 mm in the south-west.

Extensive grazing of cattle is the principal land use across the region with a total herd size of approximately 800 000 head. There are approximately 160 grazing businesses, covering an area of about 17 M ha, which rely principally on native pastures to turn off about 200 000 cattle per year. The range of markets targeted includes live export, the store market and the US grinding beef trade, while some owners transfer weaners to growing and fattening properties in central and southern Queensland.

Sustainable management of the natural resources within the Northern Gulf region is of concern to many groups, who collectively make up the community natural resource management association Northern Gulf Resource Management Group (NGRMG). The most contemporary assessment of land condition in the region is that of Tothill and Gillies (1992), who used a matrix based on soil condition, vegetation condition and management capability to describe land condition in 3 categories, namely: A (sustainable), B (deteriorating) or C (degraded). Based almost entirely on expert opinion, they reported that 70% of black speargrass (*Heteropogon contortus*) and 50% of alluvial lands in the gulf region were 'deteriorating', whereas 75% of the *Aristida-Bothriochloa*

and 90% of the littoral pasture lands were in a sustainable condition. The major issues of concern were exotic weeds, decline in pasture species and timber regrowth.

More recently, a new framework has been developed to describe grazing land condition (Chilcott *et al.* 2003), by considering soil condition, pasture composition and woodland density to assign a particular rating to a land type. In the framework, land condition has a specific meaning: the capacity of a particular land type to respond to rain and produce useful forage. The method relies on the observer having some experience in a region to understand what a particular land type looks like in 'best' condition. As applied in north Queensland, A, B, C and D condition categories represent, respectively, 100, 75, 45 and 20% of potential carrying capacity. Taking into account rainfall variability, we consider that a sustainable management system would see grazing lands oscillating between A and B condition.

The NGRMG has accepted the 'Chilcott' method as appropriate for describing grazing land condition, and one of the aspirational targets in their draft regional plan, under the National Heritage Trust 2 program, is that 70% of the Northern Gulf landscapes be in A or B condition by 2017.

The project described here used a rapid appraisal method to describe current land condition in the Northern Gulf region. It could be used to refine draft Management Action Targets under the regional plan and to identify particular, at-risk land types, where some priority investment might be directed at reversing deterioration. In addition, understanding the reasoning behind condition assessments will help identify management options or interventions necessary to improve the condition of particular land types.

Methods

Land type definition

For this project, we defined the regional land types according to producer descriptions in Best Practice Reports for specific northern districts (Kernot 1998), but amalgamated across districts, where vegetation, soil and production characteristics were similar, to provide a regional perspective. We recognised 14 separate land types within the Northern Gulf region, which were assigned a subjective grazing value, again an amalgamation of producer ratings, and reported in several Best Practice Reports (Kernot 1998). This grazing value was related to biomass production and soil fertility when in A condition, reflecting that land type's productive capacity (kg of beef per hectare). The highest value (10) was allocated to the most productive land type, and relative values were assigned to other land types. Land types and grazing values are shown in Table 1.

Observer training

We undertook training in land condition assessment to ensure consistency in assessments across the whole team. Subsequent training with both landholders and other government agency staff has shown the method to be simple, accurate and repeatable (D.R. Smith, personal communication). Most assessments in 2003 and all assessments in 2004 involved teams of 2 members (various combinations of the authors) and assessments were made by consensus. We found it necessary to further subdivide the 4 standards to reflect the condition of particular sites more accurately. Thus, we used 7 condition categories, namely: A, A^-, B, B^-, C, C^- and D, although individual site data are not reported here.

Site information

Over the periods May–June 2003 and March–June 2004, we made 260 individual land condition assessments throughout the Northern Gulf region. The locations of these are shown in Figure 1. Sites were selected using a combination of distance from the previous site and change in land type or apparent condition. Distance between sites varied from <1 km to c. 10 km. Sites were essentially near existing public roads, although assessments were made of some sites by following internal station roads. We acknowledge that major roads often follow ridge-lines or 'hard' country and some important land types (*e.g.* alluvial soils) might not be represented adequately in road-based surveys. However, we consider the outcomes from this project adequately reflect actual land condition across the region. Each site assessment took approximately 10 minutes.

At each site, a record was made of the easting and northing using a GPS. The land type and the top 5 pasture species (in order of dominance) were recorded, and pasture dry matter yield (kg/ha)

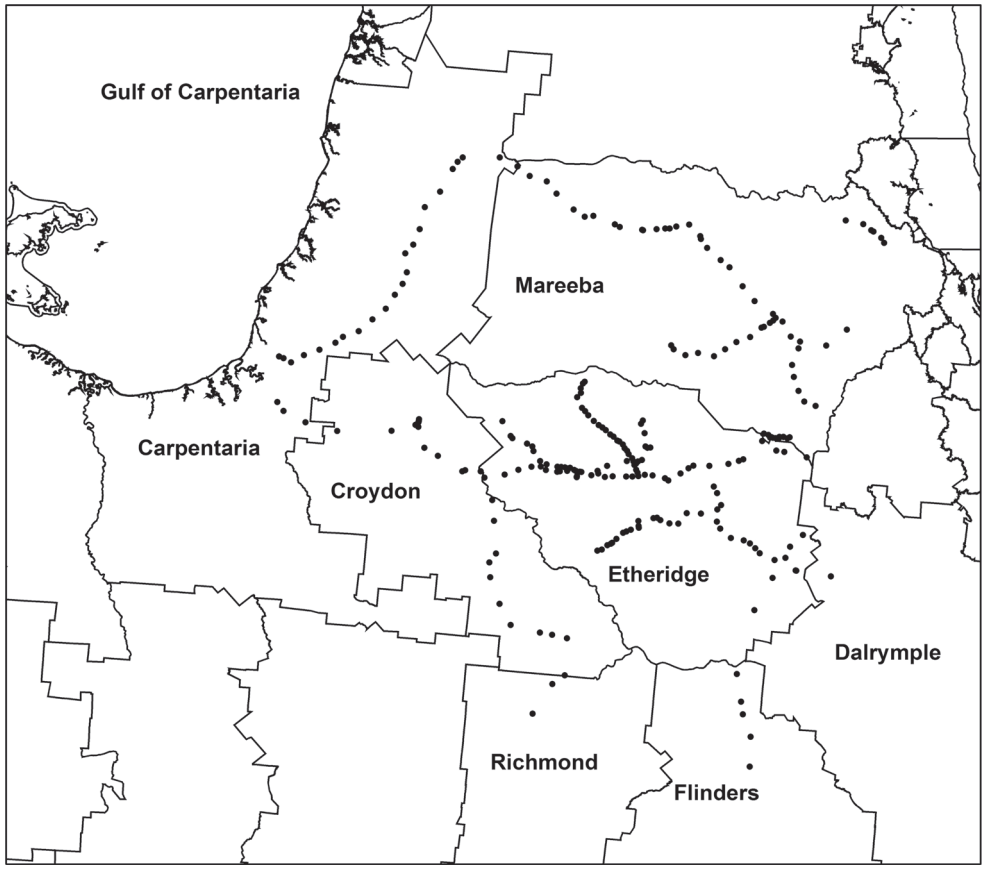

Figure 1. Sampling sites for the Northern Gulf region land condition assessment. Shires where sites were sampled are indicated.

was estimated using yield photostandards that we developed as grazing management tools for the Northern Gulf region. Ground cover was estimated visually using a 0.25 m^2 quadrat and a graphic template representing various proportions of cover (Forge 1994). The top 5 woodland species were recorded and tree basal cover (m^2/ha) estimated using a modified Bitterlich (1976) method.

Land condition was decided after considering pasture composition, soil condition, weed invasion and woodland density parameters and the rationale for that assessment recorded. We introduced a fourth criterion to record the extent of exotic weed infestation to differentiate between degradation caused by encroachment of inferior native pasture species and that from exotic weeds. Hyptis (*Hyptis sauveolens*), rubber vine (*Cryptostegia grandiflora*), lantana (*Lantana camara*), calotrope (*Calotropis procera*) and flannel weed (*Sida cordifolia*) are examples of species included in the weed category. Pasture composition was assessed on the dominance of the original or preferred pasture species for that land type. For example, on red earth soils, we expected that the original dominant pasture species was black speargrass, and if that species was still dominant, pasture composition was considered good. On shallow, range soils, we anticipated that wire grasses (*Aristida* spp.) were the original vegetation, and if these were still dominant, again pasture composition was rated as good. Although we estimated pasture dry matter yields at each site, pasture yield *per se* was not considered in assessing land condition.

Score for soil surface condition was decided on the basis of evidence of either gully or sheet erosion. While gullying was self-evident, sheet erosion was assessed on evidence of scalding, pedestalling or loss of fine particles.

In the woodland density category, we examined the level of change in density of native or naturalised woody species. We looked for signs such as a normal spread in age groups of woody species or whether a particular generation of a certain species had escaped from within the grass canopy and grown to the extent that it was now unlikely to be controlled by fire or management. For example, we observed numbers of breadfruit trees (*Gardenia vilhelmii*) of similar age, far above the norm, on some granites and earths. In other cases, we observed similar increases in *Eucalyptus* and *Corymbia* spp.

Photographic records were made of each site. These have multiple purposes: to provide evidence of why a certain land condition assessment was made at that site; to serve as photostandards to represent a certain land condition for that land type; and to become part of an on-property tool kit for graziers to self-assess paddock land condition and pasture yields on their properties.

Results

Land condition

A summary of land condition assessments for the 260 sites is shown in Table 1, including the sum of percentages in A or B condition and in C or D condition. Two land types, marine plains and 'other granites', are minimally represented in this assessment. 'Other granites' is a minor land form, whereas marine plains are of major importance, but were inaccessible during the assessment period. This latter land type is referred to later in the discussion.

Our results show that condition of all land types has declined from their original levels, although the degree of deterioration varies with land type. Across all land types, 47% of sites were in A condition, 34% in B condition, 17% in C condition and only 2% in D condition. Overall, 110 assessments were made on land types with a grazing value >5 (higher grazing value) and 150 on land types with a grazing value ≤5 (lower grazing value). On higher grazing value land types, 75% were in A or B condition, whereas 88% of assessments on lower grazing value land types were in A or B condition.

Land condition varied markedly between individual land types. Within higher grazing value land types, Georgetown granites had 27% of assessments in A or B condition, with 11% in A condition. Fifty-seven percent of assessments on red duplex soils were in A or B condition (8% in A condition), while alluvials had 59% in A or B condition (24% in A condition). Sixty-four percent of assessments on black soils were in A or B condition (29% in A condition), while the highest condition scores were for red basalts and old alluvials with 100% and 91%, respectively, in A or B condition.

Discounts

Overall, 75% of the sites (194 of the 260 assessments) were discounted from condition A (Table 2). Of those discounted, 40% were in higher

Table 1. Land types identified across the Northern Gulf region together with relative grazing values (highest = 10), number of sites assessed for each, and the percentages of sites in A or B condition and in C or D condition.

Land type	Grazing value	No. of sites	% in A or B condition	% in C or D condition
Alluvial soil	10	17	59	41
Black soil/Black basalt	9	14	64	36
Marine plain	8	1	100	0
Red basalt	7	8	100	0
Red duplex	7	35	57	43
Georgetown granite	6	11	27	73
Other granites	6	2	100	0
Old alluvial	6	22	91	9
Red earth	5	31	94	6
Yellow earth	3	58	71	29
Sandy forest	1	17	82	18
Sand ridge	1	9	89	11
Range soil	0.7	29	93	7
Lancewood	0.5	6	100	0
Total		260		

Table 2. The percentage of sites within each land type discounted on each category. An individual site may be discounted on more than one category.

Land type	Soil condition	Pasture composition	Increased woodland density	Weed invasion
Alluvial soil	0	71	36	79
Black soil/ Black basalt	0	100	9	64
Marine plain	0	0	0	0
Red basalt	50	0	50	50
Red duplex	55	72	45	17
Georgetown granite	55	73	9	18
Other granites	0	0	0	0
Old alluvial	30	60	50	10
Red earth	7	32	75	14
Yellow earth	14	52	62	21
Sandy forest	0	0	100	0
Range soil	38	33	71	5
Sand ridge	0	11	78	22
Lancewood	0	0	0	0
Region Wide	22	49	58	22
% total discounts GV[1] > 5	33	72	35	35
% total discounts GV ≤ 5	14	34	73	14

[1] GV = Grazing value.

grazing value land types, while the remaining 60% were on lower grazing value land types.

Assessments may be discounted on more than one category, so the sum of percentages for discounts may exceed 100%. On discounted sites, 22% were discounted for soil condition, 49% for pasture composition, 22% for weed invasion and 58% for increased woodland density. The major discounting factor on higher grazing value land types was pasture composition, with 72% of assessments being discounted. The frequency of discounts was similar at c. 35% each for soil condition, weed invasion and increased woodland density. On lower grazing value land types, the major discounting factor was increased woodland density (73%). Other discounts for this group were pasture composition (34%) and soil condition and weed invasion (14% each).

On alluvial soils, 14 of 17 sites were discounted, with pasture composition (71% of sites) and weed invasion (79% of sites) being the main reasons. Eighty-three percent of red duplex soils and 100% of Georgetown granite soils were discounted. Discounts for soil condition (55%) and pasture composition (70%) were similar on both land types, but red duplex soils were also discounted heavily for increased woodland density (45%) compared with the Georgetown granites (9%). Less than 50% of old alluvial soils were discounted and, of these, 60% were discounted on pasture condition and 50% on increased woodland density.

Generally, on lower grazing value land types, soil condition, pasture composition and weed invasion were of low importance, with increased woodland density accounting for 60–100% of discounts. However, 52% of yellow earths were discounted on pasture composition and 38% of range soils on soil condition. Lancewood has a very low grazing value and we consider that it has retained 100% of its original carrying capacity across the region.

Ground cover

Assessments of ground cover ranged from 5 to 100% with 213 of the 260 records at ≥50% cover. The results of a regression analysis of ground cover against pasture dry matter yield for all land types combined are shown in Figure 2. For all sites, the fitted equation explained only 46% of the variation in dry matter yield. The relationship was extremely poor for black soils, granite soils, range soils, sand ridge soils and sandy forest soils, with fitted equations explaining less than 30% of the variation, but was much stronger for alluvial soils, old alluvial soils, red basalts, red duplex soils and yellow earth soils with fitted equations explaining more than 60% of the variation (data not presented). Over all sites and on those where strong relationships existed, a ground cover of 50% was achieved when dry matter yields were between 800 and 1000 kg/ha.

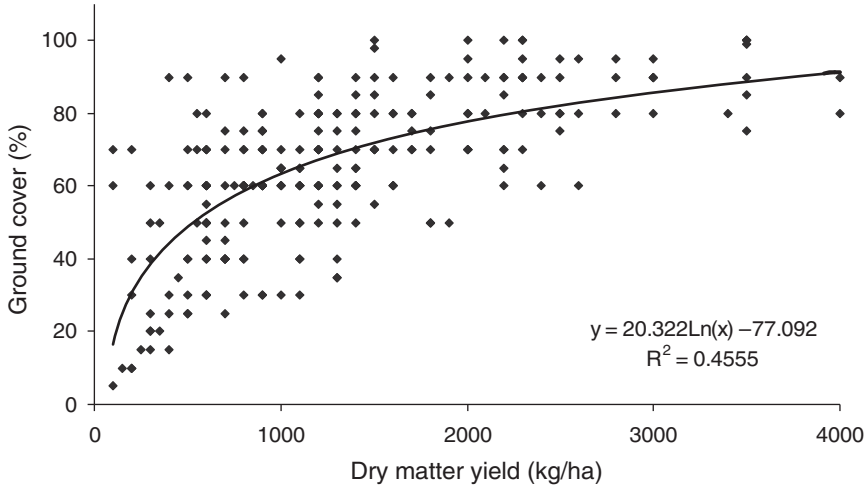

Figure 2. The relationship between ground cover and pasture dry matter yields for land types in the Northern Gulf region.

Discussion

This land condition assessment provides a good benchmark for the region, and points towards priorities to achieve Management Action Targets identified in the regional plan. We consider the significant proportion of higher grazing value land types (alluvial soils, black soils, red duplexes and Georgetown granites) in poor (C or D) condition makes them a high priority for the NGRMG. These land types make a major contribution to regional productivity, which could be increased if the badly degraded areas were returned to A or B condition. The dominance of increasing woodland density as a discount on lands of lower grazing value highlights the need to carefully monitor and manage this issue into the future to prevent any further deterioration in land condition.

Most paddocks on properties in the Northern Gulf region are large and contain a mix of land types, so stock can preferentially graze those with a higher grazing value. Where paddocks consist only of land types with lower grazing value, stock numbers need to be low, so that animals have the greatest opportunity to select a diet of reasonable quality. In this situation, pasture composition is unlikely to be threatened by over-grazing.

Our results largely reflect this situation. In paddocks in the Northern Gulf region, alluvial soils are generally made up of a relatively thin strip of highly fertile soil adjacent to the rivers and creeks, which may back on to an area of older alluvial soil, which in turn is adjacent to large areas of soil of low grazing value. These narrow alluvial strips are subjected to heavy grazing pressure, with resultant deterioration in pasture composition and subsequent weed invasion, so that land condition is heavily discounted. Our results showed that only 59% of alluvial soils were in A or B condition.

Black soils and black basalts also have high grazing value, but usually occupy low-lying areas. Seasonal inundation offers some protection to these soils, with stock not grazing these areas until they have dried out. Nevertheless, only 64% of these soil types were in A or B condition and, like the alluvial soils, were discounted on pasture composition and weed invasion.

While marine plains were poorly represented in this survey, our experience is that these pasture lands are in good condition and we expect them to remain so. This situation arises from the long periods of inundation experienced by this land type each wet season, which results in a natural annual wet season spelling program.

Red basaltic soils were generally in very good condition with 88% of assessments in A condition and the remaining 12% in B condition. They are recognised as heavy grass country and have a relatively high grazing value. Historically, cattle productivity has been poor on this land type owing to deficiencies of salt and sulphur (Hunter *et al.* 1979) and sparse water supplies. As a result, stocking rates have not matched typical potential pasture yields. In more recent times, water supplies have been improved and mineral supplements are fed, so productivity has improved and

the potential for overuse has increased. However, this has not yet been reflected in a drop in land condition.

Red duplex and Georgetown granite land types are often part of the same land complex. They are soils of reasonable grazing value, and may be dominant land types on smaller properties and experience continuous, heavy grazing pressure. These land types were once dominated by Townsville stylo (*Stylosanthes humilis*) pastures before the legume was lost to the fungal pathogen anthracnose *(Colletotrichum gloeosporioides)* in 1974. Pastures on red duplex soils are generally more robust than those on Georgetown granites, which is reflected in the 57% in A or B condition on the red duplexes compared with only 27% for the granites. Pasture composition, particularly on the granites, is very poor. Large proportions of both land types are denuded of forage at the onset of storm rains (break of season; November–December) and, as a result of water runoff, are often severely scalded. This very poor surface condition is a hostile environment on which to re-establish 3P (perennial, palatable, productive) grass pastures, even if soil seed reserves are adequate.

All land types below the median grazing value have combined A and B condition values greater than NGRMG's draft target of 70%. Soil condition, pasture composition and weed incidence were all in near-original condition. Overgrazing is not an issue on these land types since animal condition is visibly affected when diet selection on these naturally low quality, low yielding pastures is limited (Kernot 1998). Increased woodland density is an emerging issue on these land types, probably due to unplanned fire incidence across these landscapes. Burning too often, too seldom, in the wrong season and with insufficient fuel loads and inadequate post-fire stock control have all been implicated (Grice and Slatter 1996; Dyer *et al*. 2001).

Our results are not directly comparable with those expressed in Tothill and Gillies (1992) since we recognised 14 different land types compared with 7 and used 4 condition categories rather than 3. However, if one accepts that A condition, B + C condition and D condition in the Chilcott framework equate with A, B and C condition, respectively, under Tothill and Gillies (1992), then our results are broadly similar for alluvials, marine plains and the *Aristida/Bothriochloa* pasture lands (sandy forest in our study). Differences are apparent in the black speargrass lands but we recognised several more land types in this category than the single pasture community in the earlier study. Across all land types we recognised <5% of sites to be in D condition compared with 15% in C condition in the earlier assessment.

Ground cover *per se* is not considered in assessing land condition. However, regular low levels of cover at the break of season would indicate that grazing strategies are inappropriate and predispose that area to a decline in land condition. The relationship between ground cover and pasture yield is not particularly strong (Figure 2), but it does provide a useful guide to the yield required (800–1000 kg/ha) to achieve 50% ground cover. This appears to be a critical level below which runoff on tussock grass pastures accelerates sharply (Gardiner *et al*. 1990). The relationship is particularly weak on two of the better land types for different reasons. Overgrazed and degraded alluvial soils may be dominated by weeds, which have virtually no grazing value, yet provide good ground cover. On the other hand, overgrazed black soils can be colonised by species such as Indian couch (*Bothriochloa pertusa*) and angleton grass (*Dichanthium aristatum*), which provide high ground cover at very low pasture yields (<200 kg/ha).

Our estimates for ground cover include both attached pasture plants and litter. Technically, litter must be included in this measurement. While it protects the soil against raindrop impact, for ongoing protection it needs to be anchored against attached pasture plants or other debris (*e.g*. fallen branches etc.). In degraded situations, where there are few attached plants, the usefulness of the litter component is limited as it can be transported away with runoff, leaving bare ground exposed to continuing rainfall impact and subsequent soil loss.

Our results suggest that the higher grazing value land types should be a priority for investment in management change in the Northern Gulf region. They have contributed greatly to nutrient and sediment flows, and returning them to good (A or B) land condition would have positive production and environmental benefits. Options available to graziers to rehabilitate degraded land will revolve around combinations of rotational, wet season pasture spelling to restore 3P pasture composition and strategic burning for managing woody vegetation. On lower grazing value lands,

the emphasis should be on controlling increases in woodland density. Careful monitoring will be required into the future.

We suggest sites assessed here be resurveyed in 2009 to measure trends in land condition as an indication of progress towards the regional group's goals.

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