Extent of dense native woodland and exotic weed infestation in the extensive grazing lands of the Upper Herbert and Upper Burdekin River Catchments of far north Queensland: results of a producer survey

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Abstract

The Mt Garnet Landcare Group commissioned a survey of landholders within the Upper Herbert and Upper Burdekin River Catchments to assess the density of native woodlands and to gauge the extent of exotic weed infestation. Twenty-four of 49 landholders responded, representing an area of nearly 500 000 ha or 47% of the total area.

Dense native woodland covers 24% (>117 000 ha) of the area surveyed, while a further 30% (140 000 ha) supports moderately dense stands. The dense stands are largely confined to the highly fertile alluvial soils (26% dense woodland) and the lower fertility sandy-surfaced soils (33% or >96 000 ha). Moderate and dense infestations of exotic weeds, principally *Lantana camara*, occur on 54% (20 000 ha) of alluvial soils and on 13% of sandy-surfaced soils (39 000 ha), where praxelis (*Praxelis clematidia*) is the major weed. Basaltic soils have low levels of both dense woodland and exotic weed infestation. Some implications of the results are discussed.

Introduction

The Upper Herbert and Upper Burdekin River Catchments are located west of the coastal ranges but east of the Great Dividing Range between Innisfail and Ingham in north Queensland, Australia. Extensive grazing is the major land use of these seasonally dry tropical lands within the catchments. Paddocks are large, often contain a mixture of land types, and are usually continuously grazed. Property sizes vary from <400 ha to >70 000 ha, but median property size is approximately 25 000 ha. Resource identification and beef property management for these lands have been described by land managers and collated by Kernot in a confidential Best Practice Report developed in 1995, although a broader assessment of these is reported in Kernot (1998). Land resources and soil fertility of the district have been described by Isbell *et al.* (1976; 1977), Gilbert *et al.* (1987), Grundy and Bryde (1989) and Heiner and Grundy (1994).

The producer group, whose collective experience was described in the Best Practice Report, stated that tree density at that time (1995) was thicker than was the case 20 years previously and that the problem was possibly related to a lack of fires. Anecdotal evidence from Best Practice Reports and other producer groups across north and central Queensland suggests increasing tree and shrub density is an emerging problem across many land types. Indeed, increasing tree and shrub densities, usually associated with grazing, are widely recognised phenomena (*e.g.* Lewis 2002; Sharp and Whittaker 2003), although Fensham (1998) suggests the process of woodland thickening and thinning may be cyclical. In addition, exotic weeds, mainly lantana (*Lantana camara*) but also rubbervine (*Cryptostegia grandiflora*), are increasing along riparian areas which are largely unfenced and grazing uncontrolled.

Several members of the Mt Garnet Best Practice Group later formed the basis of the Mt Garnet Landcare Group. This landcare group has attracted substantial Natural Heritage Trust funding to undertake projects to rehabilitate degraded country along the Upper Herbert and Upper Burdekin River Catchments. One project was designed to rehabilitate woodlands degraded by forest thickening using fire at 3 sites.

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A second project demonstrated the use of sown pastures and grazing management to reclaim land degraded by invasion of lantana and other exotic weeds (Robert Henry, Sugarbag Station, Mt Garnet, personal communication).

The Mt Garnet Landcare Group commissioned this survey project at a meeting at Goshen Station (60 km south-east of Mt Garnet) on August 26, 2000 to inject some objectivity into the anecdotal evidence that woodland density and exotic weed invasion were increasing. The results of this survey could be used to add value to the current landcare projects and also to help identify priorities for future natural resource management projects in the region.

Methods

Survey forms were sent to the 49 landholders within the Upper Herbert and Upper Burdekin River Catchments on February 26, 2001. There were 24 replies representing an area of 496 546 ha. A copy of the survey form is shown in Appendix 1.

In the survey, respondents were asked to indicate the total areas of their properties and the percentages of the area made up of the representative soil types as identified in the Best Practice Report (sent out with the survey form). For each soil type identified, respondents were then asked to consider, separately, the extent of exotic weed infestation and the density of native woodlands. Exotic weed infestation was assessed as: nil (absent), sparse, moderate or dense. Native tree density was assessed as: nil (no trees), open, moderate or dense woodland.

No attempt was made to define or standardise what constituted a level (nil to dense) of exotic weed infestation or tree density although the assessment categories and survey process were reviewed by the landcare executive. They agreed that, based on their experience as land managers, the judgement of respondents would be sufficiently uniform to make the results useful.

Results

Soil types

Nine soil types were identified in the Best Practice Report (including an "Other" category, which incorporates a range of soil types usually associated with hills and ranges). The proportion and area of the various soil types identified by respondents are shown in Table 1. The area is dominated by sandy-surfaced soils, which occupy 60% of the total area. Soils derived from basalt occupy 28%, alluvial soils 7% and black soil hollows and other soil types together occupy 5% of the total area.

Table 1. The proportion and area of identified soil types surveyed in the Upper Herbert and Upper Burdekin River Catchments, north Queensland and grazing value as assessed by the Mt Garnet Best Practice Group in 1995.

Soil type	% of Total area	Area (ha)	Grazing value (10 = best)
Red sandy	23	115 475	1–7
Grey sandy	29	141 549	5–7
White sandy	8	36 830	1
Red basaltic	17	84 577	5
Brown basaltic	4	18 454	
Black basaltic	7	36 739	9
Alluvial	7	36 830	10
Black soil hollows	1	4 659	
Other	4	20 863	
Total	100	496 546	

Density of native woodland

Woodland density assessments for the various soil types are shown in Table 2. Almost all had some tree cover with 44% (219 145 ha) considered open woodland, 30% (148 128 ha) moderately dense and 24% (118 174 ha) densely timbered.

Table 2. Density distribution (%) of native woodland on different soil types in the Upper Herbert and Upper Burdekin River Catchments, north Queensland as assessed by survey respondents.

Soil type	Nil trees	Open woodland	Moderate tree density	Dense woodland
Red sandy	0	27	39	34
Grey sandy	0	47	26	27
White sandy	0	7	33	60
Red basaltic	0	68	26	6
Brown basaltic	0	95	5	0
Black basaltic	20	69	10	1
Alluvial	0	35	39	26
Black soil hollows	0	97	1	2
Other	14	9	65	12
Total for category	2	44	30	24

Woodland density categories were evenly distributed on the sandy soils: open woodland (99 934 ha), moderately dense (93 780 ha) and dense woodland (99 918 ha). None of these soils was free of trees. However, within this sandy soil grouping, 60% of white sandy soils were in the dense category compared with 34% and 27%, respectively, for red and grey sandy soils.

Sixty-five percent of alluvial soils (including 26% in the dense category) have moderate or dense tree cover.

Almost 80% of basaltic soils either support no trees or are classed as open woodland and only 4% of the area is dense woodland. The majority of red basaltic soils (67%) are in the open woodland category with only 6% in the dense category. Twenty percent of black basaltic soils (7405 ha) are treeless.

Exotic weed infestation

The extent of exotic weed infestation for each soil type is shown in Table 3. Moderate and dense weed infestations occur on 54% of alluvial soils (almost 20 000 ha) compared with only 4% of basaltic soils (5805 ha) and 14% of sandy soils (41 320 ha). Overall, moderate-dense infestations of exotic weeds occur on 68 000 ha or approximately 14% of the total area. Sixty-nine percent of the total area was free of weeds.

Table 3. Infestation distribution (%) of exotic weeds on different soil types in the Upper Herbert and Upper Burdekin River Catchments, north Queensland as assessed by survey respondents.

Soil type	Nil	Sparse	Moderate	Dense
Red sandy	69	15	10	6
Grey sandy	76	11	9	4
White sandy	59	32	5	4
Red basaltic	92	5	1	2
Brown basaltic	33	66	1	0
Black basaltic	78	13	5	4
Alluvial	28	18	37	17
Black soil hollows	9	91	0	0
Other	42	52	6	0
Total for category	68	18	9	5

The major exotic weeds in order of area infested are praxelis (*Praxelis clematidia*), lantana, rubbervine, grader grass (*Themeda quadrivalvis*) and rats tail grasses (*Sporobolus* spp.). The most significant weeds on alluvial soils are lantana and to a much lesser extent rubbervine, while on the sandy-surfaced soils, the main weed is praxelis.

Discussion

This survey has shown that dense native woodlands and invasion by exotic weeds are important issues across a significant area of the grazing lands in the Upper Herbert and Upper Burdekin River Catchments, confirming grazier perceptions in Best Practice Reports. Both limit stock management options and pasture growth across all soil types but particularly the fertile alluvial soils and the lower-fertility sandy soils.

Burrows (1999) described the savannah woodland communities of north-eastern Australia as a fire-mediated sub-climax wherein fire was the chief modifying influence preventing tree dominance prior to European settlement. In the absence of fire, trees and shrubs would be more competitive than grasses for available moisture and/or nutrients, particularly on light-textured soils (Burrows *et al.* 1988). Our survey results, from an area where fire has been largely absent as a management tool for longer than 2 decades, are consistent with these observations.

Alluvial soils, which represent only 7% of the total area, experience continuous heavy grazing pressure because of their inherently high fertility and grazing value (Table 1). Moderate or dense native woodlands now occur on >60% of these soils, which we consider is a result of the significantly reduced grass competition and virtual absence of fire.

Native pastures on the lower-fertility sandy soils and especially the infertile white sands have a lower grazing value than those on alluvial soils and experience lower grazing pressure. Tree-grass competition for nutrients (Burrows *et al.* 1988) nominally favours trees but, historically, they would have been contained by fire. However, regular fires, and especially hot fires, are no longer a feature of this region. Whether or not this is the cause, the current reality is that dense woodlands exist on 30–60% of sandy soils in these catchments.

Survey results of tree densities on sandy and alluvial soils can be contrasted with those on basaltic soils, of which only 4% are in the dense woodland category. Basaltic soils occupy 28% of the survey area and are recognised in Best Practice Reports as heavy grass country. They are more evenly grazed than alluvial soils and, even in the absence of regular fire, competition from the native pasture is probably enough to prevent woodland thickening.

Moderate or dense stands of exotic weeds (principally lantana) occupy >50% of the fertile alluvial soils and this invasion can be explained by the reduction of native pasture species under grazing and limited fire. The Landcare Group recognises that grazing management, including fencing to regulate stock access, will be a key tool in maintaining productive pastures and to rehabilitate degraded ones along the rivers. Grader grass occurs principally on the sparsely timbered, black basaltic soils, which, like alluvial soils, can experience heavy grazing pressure and the reduction or loss of native pasture species. However, exotic weeds are either absent or sparse on >90% of the basaltic soils.

The sandy-surfaced soils (58% of the total area) are moderately to severely phosphorus-deficient and pasture yields are usually ≤ 2000 kg/ha (Gilbert *et al.* 1987; 1990). While the open nature of the pasture would not offer much competition to invasive weeds, the generally low fertility has meant that exotic weeds have not been a problem on these soils. However, since 1998, praxelis and, to a lesser extent, rats tail grasses have invaded these soil types. Praxelis is most abundant on the sandy soils but can be found across all soil types. It was first observed in the district in 1995–96 and has spread rapidly through the catchment. It is now prevalent on both grazed and ungrazed areas and appears to have the potential to become a serious weed across the entire catchment. Little information exists for controlling and/or managing praxelis or rats tail grasses and some formal research is justified to understand the invasive capacity of these plants and also to determine methods to prevent invasion and for effective control in woodland environments.

The results of this survey provide a snapshot in time, albeit somewhat subjective, of the current situation with exotic weed invasion and woodland thickening in this catchment. They do not indicate a rate of change in woodland density or indeed that it has changed at all. However, when combined with other anecdotal evidence from landholders that thickening has occurred in the last 20 years, and the measurement of woodland thickening within other eucalypt woodlands of Queensland (Burrows *et al.* 2002), the survey results provide a strong case that woodland thickening is a widespread and serious problem affecting property viability and management. They also suggest that additional work needs to be undertaken to define the appropriate management to maintain productive and sustainable grazing systems under these eucalypt woodlands.

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References

BURROWS, W.H. (1999) Tree clearing — rehabilitation or development on grazing land? In: Orr, D.M.(convenor) *Practical Rangeland Ecology. Proceedings of Professional Workshop — VI International Rangelands Conference, Townsville, Australia.* pp. 24–41.

BURROWS, W.H., SCANLAN, J.C. and ANDERSON, E.R. (1988) Plant ecological relations in open forests, woodlands and shrublands. In: *Native Pastures in Queensland: The Resources and Their Management. Information Series QI87023. Queensland Department of Primary Industries, Brisbane.*

BURROWS, W.H., HENRY, B.K., BACK, P.V., HOFFMANN, M.B., TAIT, L.J., ANDERSON, E.R., MENKE, N., DANAHER, T., CARTER, J.O. and MCKEON, G.M. (2002) Growth and carbon stock change in eucalypt woodlands in northeast Australia: ecological and greenhouse sink implications. *Global Change Biology*, **8**, 769–784.

FENSHAM, R.J. (1998) The influence of cattle grazing on tree mortality after drought in savanna woodland in north Queensland. *Australian Journal of Ecology*, **23**, 405–407.

GILBERT, M.A., MOODY, P.W. and SHAW, K.A. (1987) Fertility assessment of soils of the Mt Garnet area, north Queensland. *Australian Journal of Experimental Agriculture*, **27**, 93–100.

GILBERT, M.A., SHAW, K.A., ARMOUR, J.D., TEITZEL, J.K. and STANDLEY, J. (1990) Low effectiveness of Duchess rock phosphate on pastures in northern Queensland. *Australian Journal of Experimental Agriculture*, **30**, 61–71.

GRUNDY, M.J. and BRYDE, N.J. (1989) Land resources of the Einasleigh — Atherton dry tropics. *Project Report QO89004. Queensland Department of Primary Industries, Brisbane.*

HEINER, I.J. and GRUNDY, M.J. (1994) Land resources of the Ravenshoe-Mt Garnet area, north Queensland, Vol 1. Land resource inventory. *Land Resources Bulletin QV94006. Queensland Department of Primary Industries, Brisbane*.

ISBELL, R.F., STEPHENSON, P.J., MURTHA, G.G. and GILLMAN, G.P. (1976) Red basaltic soils in north Queensland. *Division of Soils Technical Paper No. 28. CSIRO, Australia.*

ISBELL, R.F., GILLMAN, G.P., MURTHA, G.G. and JONES, P.N. (1977) Brown basaltic soils in north Queensland. *Division of Soils Technical Paper No. 34. CSIRO, Australia.*

KERNOT, J.C. (1998) Sustainable beef production on tropical tallgrass using the local best practice (LBP) approach. *Final Report to MLA, Project DAQ.092/NAP3.306*. September 1998.

LEWIS, D. (2002) Slower than the eye can see: environmental change in northern Australia's cattle lands — a case study from the Victoria River District, Northern Territory. *Tropical Savannas CRC, Darwin*.

SHARP, B.R. and WHITTAKER, R.J. (2003) The irreversible cattle-driven transformation of a seasonally flooded Australian savanna. *Journal of Biogeography*, **30**, 783–802.

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APPENDIX 1. Exotic and native woody weed incidence on grazing properties.

Property name: …………………………………………………

Land type	**Area on property (sum of column should add to 100%)**	**Exotic weed infestation (lantana, rubbervine, etc) (sum of each row should add to 100%)**					**Native tree density (sum of each row should add to 100%)**				
		Nil	**Sparse**	**Moderate**	**Dense**	**Total**	**Nil**	**Open**	**Moderate**	**Dense**	**Total**
Example land type	**20**	**80**	**20**			**100%**		**70**	**20**	**10**	**100%**
Red sandy						100%					100%
Grey sandy						100%					100%
White sandy						100%					100%
Alluvial						100%					100%
Black soil hollows						100%					100%
Red basalt						100%					100%
Brown basalt						100%					100%
Black basalt						100%					100%
Other						100%					100%
Total area of property — hectares											