RECOVERY OF THE NORTHERN PLAINS GRASSLAND COMMUNITY – AN OVERVIEW

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The grasslands of the northern plains of Victoria have long been recognised to be among the most threatened and poorly-reserved ecosystems in Victoria and Australia with only an estimated 3.8% remaining. As the protected area network (PAN) has greatly expanded in the last decade, there has been a commensurate loss of unprotected grasslands due to legal and illegal clearing. Whether or not the PAN continues to grow, there is now a significant on-going conservation management liability that must be underpinned by an improved understanding of ecosystem function and the role of disturbance. Some encouraging progress has been made by recent research. For instance, only partial recovery from cultivation is possible with long (cultivation) resting and that further improvement requires intervention to overcome the limits in seed dispersal of key functional groups. And although more has been learnt about how patterns in productivity/species-richness interactions can be managed/influenced by biomass manipulation, the use of stock grazing as a sustainable conservation management tool has still not been demonstrated. The interim regime of 'status quo' (stock) management persists despite the fact that it has failed to: (a) differentiate itself from standard pastoral practices, and (b) define the pathway to discovering better alternatives. A new technical advisory group has been established to oversee recovery strategy and has chosen the development of a 'conceptual model of how the system works', as a key priority. A further priority will be to pursue the renomination of the community under the *Environment Protection and Biodiversity Conservation Act 1999* following the recent publication of research suggesting these grasslands are naturally treeless, floristically unique and geographically confined to the southern Riverina.

Key words: grasslands, northern plains, Riverina Bioregion, Technical Advisory Group, state-and-transition model, adaptive management, landscape-scale conservation

THE grasslands of the Riverine Plains of south-east Australia – known as the northern plains grassland community within the Victorian section of the bioregion – have long been recognised as among the most threatened and poorly-reserved ecosystems in Victoria and Australia (McDougall & Kirkpatrick 1994; Kirkpatrick et al. 1995; Foreman 1996; Lunt et al. 1998; Craigie & Moorrees 2003). An increasing awareness of threatened species in particular since the 1970s (Scarlett & Parsons 1982), sparked a succession of conservation actions aimed at improving the plight of these grasslands and their threatened species (LCC 1985; DSE 1992; State of Victoria 1997; Craigie & Morrees 2003).

Based on a reconstruction of the original (pre-European) extent of treeless plains in the northern plains using a combination of historical records, soil maps, Aerial Photographic Interpretation and ground observations (Foreman 1996; Fig. 1), only ~1.7% is currently protected in reserves (Table 1). Originally extending over ~3992 km^2, today only ~3.8% of these grasslands remain in a highly variable condition. Most of these remnants and reserves are clustered in two key pockets of the northern plains – the Patho plain west of Echuca and the lower Avoca River plains west of the Kerang Lakes. At the time of this reconstruction, the level of reservation was estimated at a lowly 0.22% (Table 1) – a situation that only began to improve in 1997 with the seminal acquisition of the Davies grassland, now part of the Terrick Terrick NP. Since then, a total of $3.8m (funded by DSE's conservation land purchase program and the Commonwealth's NRS program) has been spent, adding 5111 ha of the best, remaining, privately owned remnants to the Protected Area Network (PAN) (Table 1) with a number of others 'in the pipeline'.

Over the same period of this ~6.7 fold expansion in grassland reservation, in excess of 5000 ha has been lost through legal and illegal clearing (i.e. cultivation for cereal cropping and pasture 'improvement').

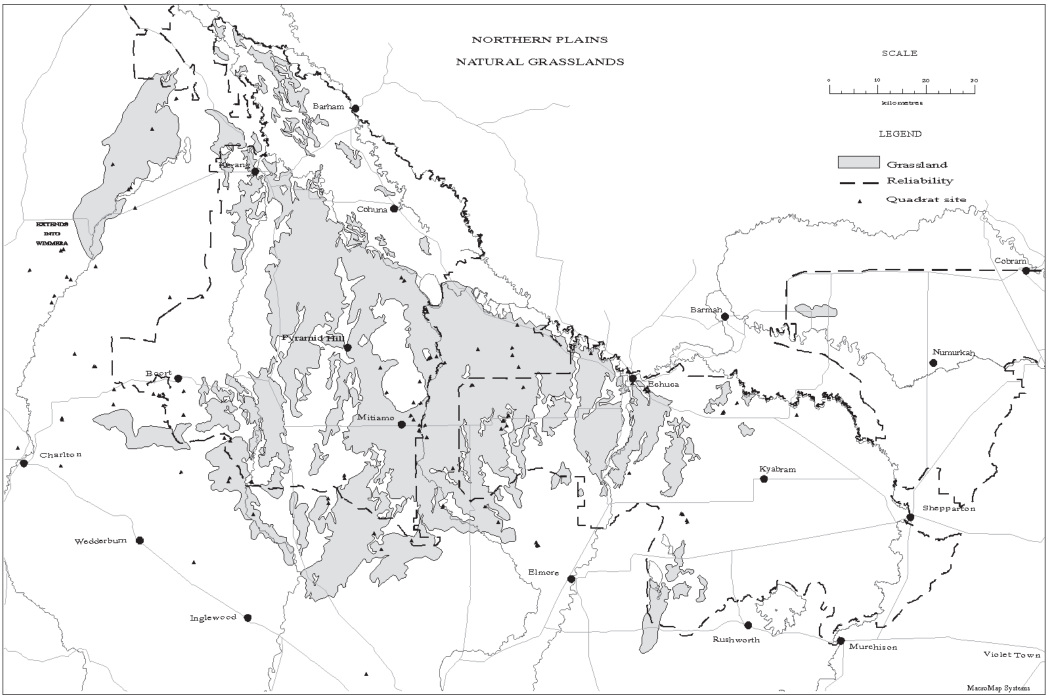


Fig. 1. A reconstruction of the original (pre-European) extent of treeless plains on the northern plains using a combination of historical records, soil maps, Aerial Photographic Interpretation and ground observations (Foreman 1996).

Whether or not the PAN continues to grow, the owners of this new estate are left with the significant on-going responsibility of conservation management and ecosystem recovery. Although our understanding of ecosystem function (and especially the role of disturbance) is still in its infancy, some progress has been made in the last two decades. Summaries of recent (largely unpublished) research in the key areas of recovery after cultivation and biomass/grazing interactions are presented below. (Note this isn't a comprehensive review of recent research and is limited to flora and vegetation ecology).

RECOVERY AFTER CULTIVATION

Understanding the impact of cultivation on grasslands is not only important for managing the key threat to unprotected remnants, but also for recovering the PAN – much of which has some history of cultivation. The anecdotal evidence is that cropped grasslands never fully recover, but, until recently, this has been poorly researched. Work by La Trobe University (Wong 2004; Andrew Scott pers. comm. 2009) has shown that although there is recovery with time since cropping, big gaps remain even after decades of resting (Fig. 2). Earlier research (experimental trials at Terrick Terrick NP, see Foreman 1996), showed that repeated cultivation eliminated entire functional groups of indigenous plants, but that recovery proceeds immediately once this disturbance ceases (Fig. 3). The poorer recovery trajectories observed in remnants at the paddock scale are probably due to constraints in seed availability driven by limits in seed dispersal of key functional groups (Andrew Scott pers. comm. 2009).

BIOMASS/GRAZING INTERACTIONS

Schultz (no date) looked at species richness inside and outside of stock grazing exclosures across Victoria and by comparing sites established by Hadden (1998) on the Victorian Volcanic Plains (VVP) and the northern plains, showed that after 12 years, only the high biomass sites in the VVP supported significantly lower species richness under exclosure (Fig. 4). This was in part driven by differences in floristic

Table 1. Grassland reserves today and prior to 1997 (incl. those owned by Trust for Nature - TfN).

	Key Grasslands	Area	Pre-1997	Post 1997	Old Name
1	Cane Grass NCR	Patho	79.2	79.2	Torrumbarry North U19
2	Patho West NCR	Patho	0.0	150.0	Area approx
3	Roslynmead NCR (1)	Patho	0.0	458.2	
4	Terrick Terrick East NCR	Patho	0.0	227.5	
5	Roslynmead NCR (2)	Patho	45.0	109.7	Torrumbarry North G4 Flora reserve
6	Tomara Gilgai Grassland NCR	Patho	0.0	333.5	
7	Terrick Terrick NP (grassland section)	Patho	0.0	1277.0	
8	Meadows Wildlife Reserve	Patho	53.2	53.2	Torrumbarry North C13 Wildlife reserve
9	Roslynmead East NCR	Patho	0.0	100.0	Area approx
10	Roslynmead Natural Features Reserve	Patho	44.7	44.7	Torrumbarry North U24 Rec Reserve
11	Kotta NCR	Patho	0.0	226.0	
12	Kotta East	Patho	0.0	225.0	Area approx
13	Pine Grove NCR	Patho	0.0	37.5	
14	Warnup NCR	Patho	0.0	119.9	
15	Millewa NCR	Patho	36.2	36.2	
16	Tang Tang Swamp Wildlife Reserve	Patho	131.7	131.7	
17	Thunder Swamp Wildlife Reserve	Patho	91.6	91.6	
18	Yassom Swamp FFR	Avoca	306.5	306.5	
19	Korrack Korrack NCR	Avoca	0.0	131.4	
20	Bael Bael NCR	Avoca	104.9	1810.0	Area approx
21	Other reserves	N/A	0.0	55.2	
	Sub-Total		**893.0**	**6004.0**	**672.34%**
21	Kinypanial Grassland (Woolshed) (P198)	Loddon	0.0	80.8	
22	Kinypanial Grassland (Weir) (P241)	Loddon	0.0	251.3	
23	Korrak Korrak Native Grassland (P256)	Avoca	0.0	240.1	
24	Glassons Grassland Reserve (P253)	Patho	0.0	174.0	
25	Naringaningalook Grassland (P66)	Other	0.0	18.3	
	Sub-Total		0.0	764.5	
	Grand-Total		**893.0**	**6768.4**	**757.94%**

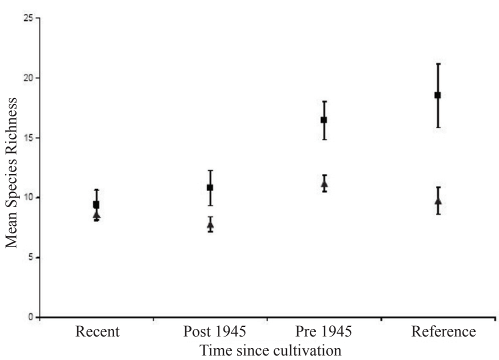


Fig. 2. Impact of cultivation on plant species richness. Indigenous species (squares); Exotic species (triangles). (Wong 2004).

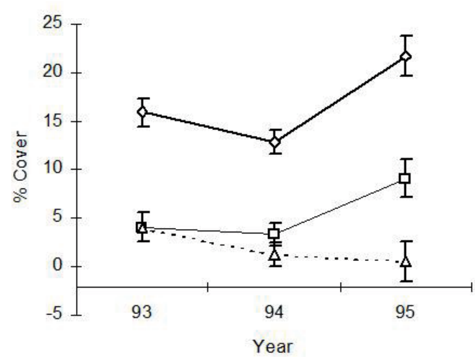


Fig. 3. Percentage cover of native perennial forbs under three treatments at Terrick Terrick NP - Control (diamonds); Cultivation once (squares); Cultivation continuously (triangles) (Foreman 1996).

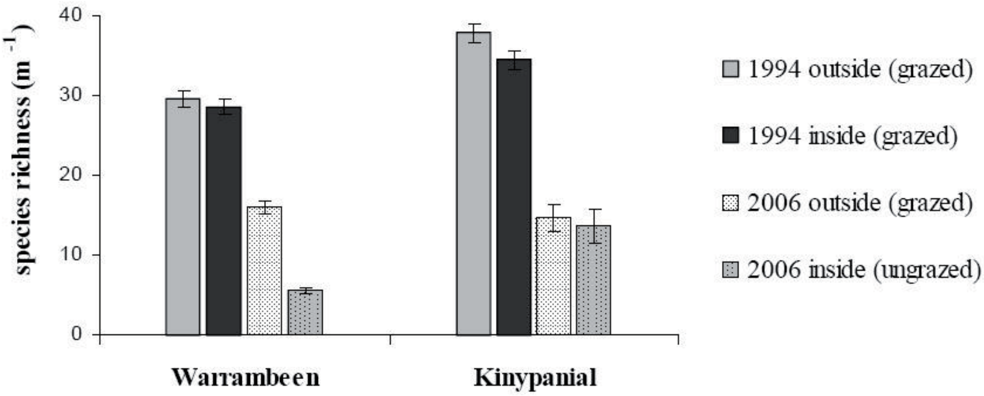


Fig. 4. Comparison of species richness at sites on the VVP (Warrambeen) and northern plains (Kinypanial) under stock grazing and exclosure since 1994 (Schultz no date).

composition and function, with the VVP and northern plains sites dominated by C_4 (*Themeda triandra*) and C_3 (*Austrodanthonia* spp. and *Austrostipa* spp.) tussock-grasses respectively. Productivity patterns are also broadly driven by rainfall, site condition, tree cover and soil attributes.

This productivity/species-richness interaction applies more broadly as an inverse linear relationship – with a negative species richness exclosure effect with higher biomass (Fig. 5). This relationship implies that biomass manipulation using tools such as stock and fire can maximise plant species richness, but this strategy is necessarily most effective/important in high productivity systems. This points to management complexity as all landscapes are heterogeneous mosaics of productivity. While the northern plains are generally in the lower end of this spectrum, soil type and rainfall fluctuations drive spatio-temporal 'spikes' in productivity that, at the patch-scale and from a biodiversity conservation perspective, would benefit from episodic intervention. The mechanism of competitive exclusion as tussock interstitial space diminishes with biomass accumulation – limiting the germination and recruitment of many plants, but particularly forbs – is well established (Stuwe & Parsons 1977; Morgan 1998; Lunt & Morgan 1999; Lunt et al. 2007). Although different functional groups appear to exhibit differential responses (e.g. the cover of indigenous annuals and perennials is respectively decreased and increased with greater biomass), with sufficient time, competitive exclusion asserts the richness-productivity relationship at both the functional group and community level.

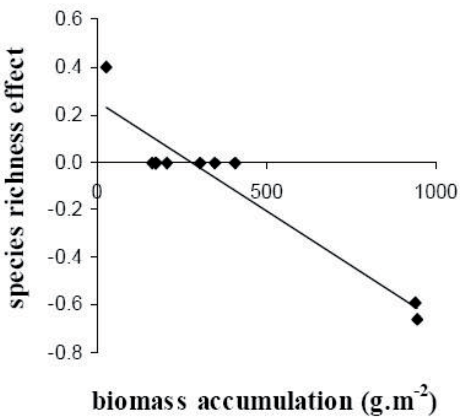
THE NORTHERN PLAINS GRASSLAND TECHNICAL ADVISORY GROUP

As the PAN here has expanded since 1997, DSE has recognised that its aspirations for ecosystem recovery must be based on strong technical advice and collaboration between key stakeholders. To this end, a Technical Advisory Group (TAG) with a broad representation of grassland ecology expertise and experience has been recently established with the charter to advise on: landscape-scale conservation strategy; long-term goals/vision; conservation grazing systems (especially on reserves); and priorities for ecological research.

In practice, TAG will fulfil its charter through a range of processes including: input to a Strategic Plan that integrates the operational needs of all three key stakeholders (DSE, TfN and Parks Victoria); sponsoring/facilitating priority monitoring, assessment and research; and input to other relevant projects as invited or desired.

A number of themes have been identified for initial attention: cropping recovery; landscape connectivity; conceptual model of how the system works; stock grazing management (especially in the PAN); invertebrate ecology; significant species – especially Plains-wanderers; goals and measuring success; management planning; and utilising remote sensing technology.

TAG sees the development of a conceptual model as a particular priority and will begin the process assuming: (1) the northern plains is a semi-arid system



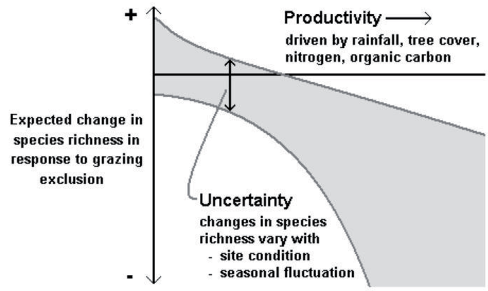


Fig. 5. Relationship between productivity and expected change in species richness under grazing exclosure (Schultz no date).

where management needs will vary greatly between seasons and years; (2) grassland dynamics greatly vary between sites depending on soils, nutrients, water availability and past degradation, and therefore different goals and approaches must be used in different circumstances; (3) because there is very limited data and experience to dictate single 'best practice' approaches for any circumstance, an 'adaptive management' system is essential; and (4) a 'state-and-transition' (ST) model (after Westoby et al. 1989) is likely to be the most useful of the available approaches to conceptual modelling – potentially adapting established generic models (such as the ST model for grassy woodlands by McIntyre and Lavorel 2007) for regional application.

Although there are numerous approaches to modelling, a ST approach is preferred here because of its practical utility (as articulated in Westoby et al. 1989: 269):

> The [ST] model guides what data are collected, and how that information is assembled so as to arrive at management decisions. We are proposing the ST formulation because it is a practicable way to organize information for management, not because it follows from theoretical models about dynamics.

Because ST models define systems which are dynamic between discrete states, it provides a practical framework to guide decision making because managers can know where they are, where they want to be and how to get there by avoiding key hazards and opportunistically exploiting key opportunities.

In developing a conceptual model for grassland systems in Victoria, White (2008: 59) considered ecological models, casual maps, fuzzy cognitive maps, bayesian networks and ST models and concluded that casual maps and 'ST models that include management alternatives, as part of the model hierarchy' represented a good compromise between the time and resources required for model construction and effective capture of ecological interactions.

STOCK GRAZING MANAGEMENT AND THE 'STATUS QUO'

The controversial practice of stock grazing in northern plains was introduced as an interim management tool to maintain the open structure known or thought to be required by various species of both flora and fauna (Diez and Foreman 1996; Foreman 1997; Lunt et al. 1999). It was based on the assumption that historical grazing had modified the ecosystem (into a different state) and that grazing (in some form) would be needed to maintain it; however, even at this time, continuing historical practice was known to be less than ideal as this quote from the well studied Plains-wanderer implies: 'published guidelines for the management of Plains-wanderer habitat are targeted at standard grazing farms, not conservation reserves' (Baker-Gabb 2005: 2).

Although conservation by status quo management was always seen as an interim measure (in place until a demonstrably better alternative was identified), it has been found wanting because it failed to: (a) adequately differentiate itself from standard (albeit conservative) pastoral practices, and (b) define the broader management system through which a demonstrably better approach would adaptively emerge. It is likely the ST model being developed by

TAG will supersede status quo management towards a more adaptive, rigorous and biodiversity-focused framework.

ADAPTIVE MANAGEMENT

Although the adaptive management concept is widely advocated, it is poorly understood and rarely successfully practised. Adaptive management is more of an abstraction than an acceptable enterprise (to institutions) and the literature reports few examples of formal structures and processes for implementing adaptive management. While attributable to a range of complex factors, natural resource management problems are social in origin and potential solutions fail to be framed in a sociopolitical context. For instance, there is often a reluctance of parties to work collaboratively, and entrenched organisational and professional biases work to prevent the necessary culture of trust and credibility and generally resist constructive change (Stankey et al. 2005).

TAG has recognised that working with the key PAN land managers, to put adaptive management into operation, is a high priority; however, the challenge of this task should not be underestimated. Salafsky et al. (2001) outlined the key steps in the process of adaptive management (Fig. 6) which serve to underline the parallel importance of establishing a sound basis for stakeholder collaboration and the conceptual model in the initial stages.

A further point of relevance here to TAG is the important role of credible applied science. An assessment of adaptive management success in North America and Australia (Ladson and Argent (2002) cited in Stankey et al. 2005: 42) concluded that system modelling should be *'complex enough to obtain credibility, but simple enough that it could be completed and used in a reasonable time frame'*. Also of relevance throughout the process, they further highlighted the importance of 'credible science, with all reports subject to peer review and an independent scientific panel overseeing research efforts.*'* By way of innovation, there is scope for TAG to be legitimised as the means by which these important principles are established and maintained in northern plain conservation management systems.

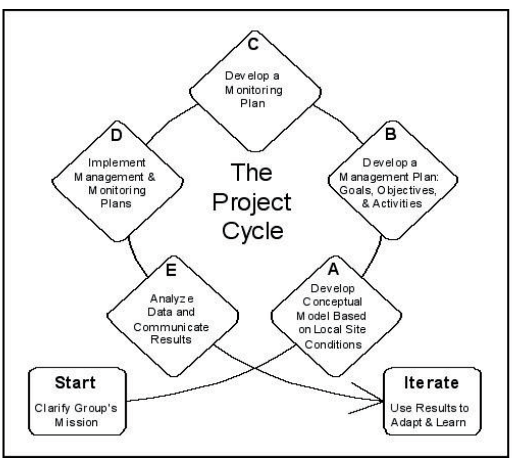


Fig. 6. The Adaptive Management Cycle (Salafsky et al. 2001).

NATIONALLY THREATENED COMMUNITY?

Although TAG isn't a lobbyist, there is a strong feeling in the group to persist with an agenda to have the community listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth). Current advice, especially now with a clearer understanding of the unique floristics and limited geographic extent of 'natural' riverine grasslands emerging from a new bioregional analysis (McDougall 2008; Fig. 7) combined with the graphic accounts of on-going destruction, is that the case (for listing) has strengthened. Riverina grasslands remain one of the only lowland grassland ecosystems not protected under Federal legislation (DEWHA website). The anecdotal evidence (from the recent listing of the 'Natural Temperate Grassland of the Victorian Volcanic Plain'; DEWHA website) points to potential benefits that could flow from a successful nomination.

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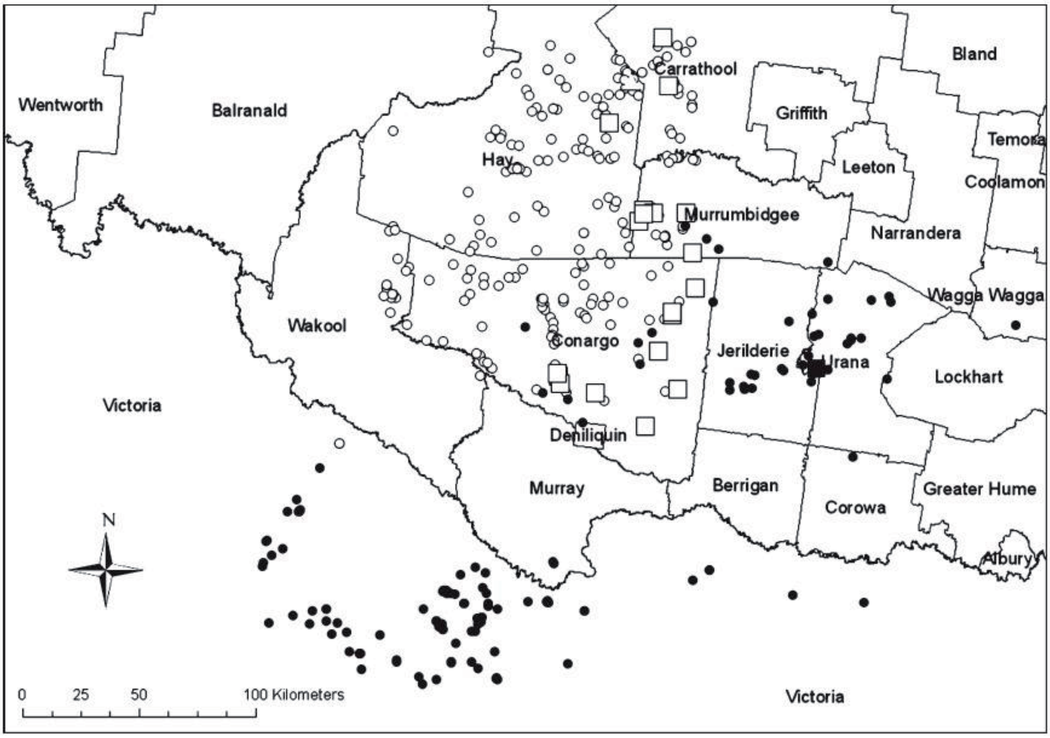

Fig. 7. The distribution of quadrats classified into broad groups after McDougall (2008). The circles indicate a northern cohort of lower rainfall grasslands that are likely to have been derived from Boree *Acacia pendula* and Old Man Saltbush *Atriplex nummularia* dominated systems and the black dots represent a southern cohort of higher rainfall grasslands that appear to be naturally treeless. It is this southern group (mostly in Victoria) that is likely to be nominated as a threatened community under the *Environment Protection and Biodiversity Conservation Act 1999*.

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