



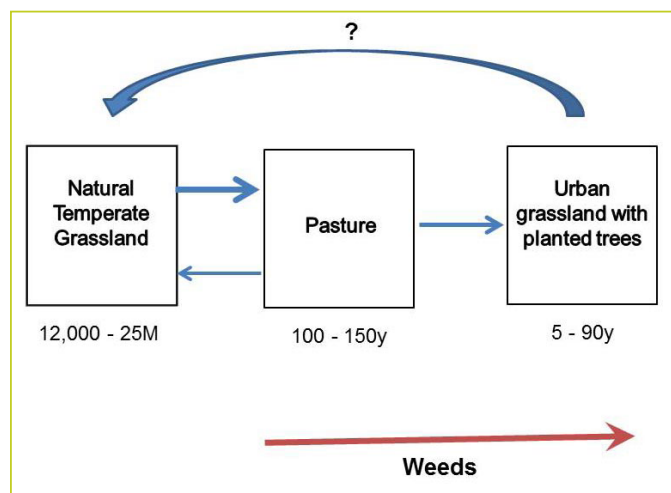
Management of grassland floristic diversity ⁺

Ken Hodgkinson

North Belconnen Landcare Group/Ginninderra Catchment Group

Abstract: Natural Temperate Grasslands are losing plant species from many landscapes in the absence of fire. Plant species richness on slopes was significantly higher after frequent autumn burning, and less so after spring burning, than after annual mowing or no management (control). The species added to the plant community from the soil seed bank after fire were both native and exotic species. Several iconic species were established after autumn burning. Literature on responses to management of these grasslands is reviewed and implications for governments and Landcare groups are discussed.

During my research career in CSIRO I worked on how grazing and fire influence the structure and functioning of semi-arid wooded grasslands, and how these management approaches interact with drought. Now retired in Canberra I am continuing these interests as a member of North Belconnen Landcare Group (NBLG) where the focus is the restoration of urban grasslands. The group is looking for easy and cheap ways of restoring the Natural Temperate Grassland (NTG) along Ginninderra Creek and in urban Canberra generally. The two grassland types (semi-arid and temperate) are remarkably similar in function but differ in weed content. The NTG of Canberra are typically weedy. Most native plant species struggle to survive in the competitive weedy environments outside the patches of remnant native grasslands. Regular mowing (six times a year) for wildfire hazard reduction in urban grasslands further reduces the chance of reproduction by, and survival of, most native plant species.



Canberra was built on century-old pasture land. Patches of remnant NTG remain. They are typically small areas of modest plant diversity and disconnected from each other. Many exotic trees have been planted into Canberra's urban grassland, introducing conflict between tree planting for amenity value and restoration management of the grasslands. Exotic weed species have been deliberately introduced or have invaded from accidental introduction (see conceptual model diagram above) and appear to be on the increase. The challenge for landcarers is to restore these iconic grasslands to something like their condition under Aboriginal management. The NBLG received competitive funding nine years ago to look at prescribed fire and sowing seed of native plant species as restoration tools. In the funding application we foresaw the prospect of utilising successful management approaches for widespread restoration of the NTG along Ginninderra Creek and in other urban grasslands.

The six treatments established by the NBLG were:

- Low mow (<5 cm) each November
- High mow (~15 cm) each November
- Spring burn (achieved in 2009, 2011, 2012 and 2014)



'Grass half full or grass half empty? Valuing native grassy landscapes'

Friends of Grasslands' forum 30 October – 1 November 2014

Friends of Grasslands Inc. (www.fog.org.au) supporting native grassy landscapes

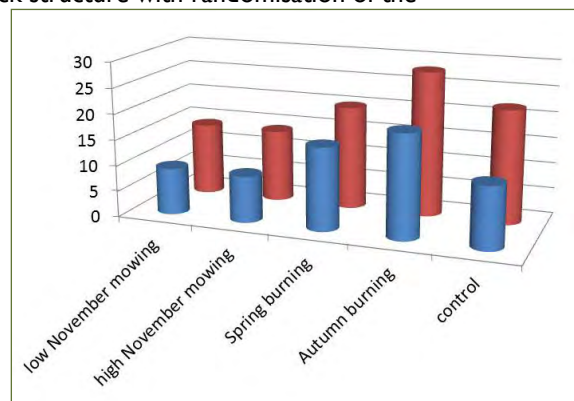
- Autumn burn (achieved in 2008, 2011, 2013 and 2015)
- Control (no burning or mowing), and
- Reseed with native grasses.

The treatments were applied in an area adjacent to Croke Place (photo at right) just below the dam wall that forms Lake Ginninderra. The reseeding treatment failed because of drought conditions and we did not try this treatment again because of high expense and uncertainty of success. We applied five of the treatments (1 to 5) on two similar parts of a band of remnant NTG on sloping ground that is in the centre of the site. The five treatments were randomly allocated at each of the two sites along the band of NTG. The upper half of each treatment plot was the NTG dominated by *Themeda triandra* and the lower half was NTG dominated by exotic grasses without any *T. triandra*. The timing (early November) of the two mowing treatments was intended to weaken tillering and reproduction of the dominant weedy grasses *Phalaris aquatica* and *Dactylis glomerata*.

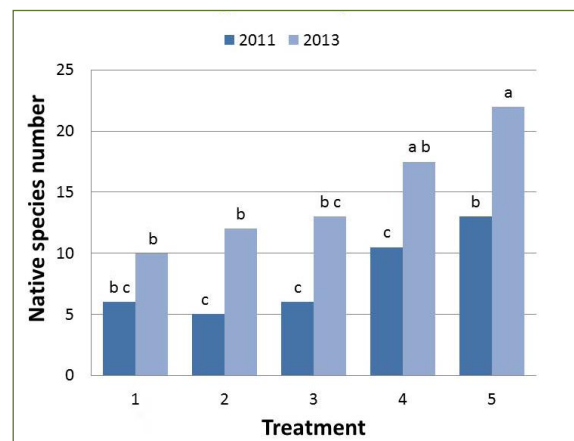


The study was initially set up to demonstrate the effects of different management approaches on the floristics of NTG. It was soon realised that the emerging differences between treatments in floristic composition were substantial and that rigorous measurements were justified. Fortunately the study was laid out in a block structure with randomisation of the treatments.

The top chart (at right) shows the number of plant species – both exotics (red bars) and natives (blue bars) – in the set area of each plot (180 m²). Species richness is scale-dependent, as John Morgan (2015, this proceedings) points out in his comment on quadrat size. However, the areas were constant in space and time, and randomisation of the treatments reduced some of the error from spatial heterogeneity in species distribution. The data suggest that Spring and Autumn burning were associated with increased numbers of species relative to the mown and control plots. Autumn burned plots had the most native and exotic plant species.



The next chart (right) focuses on the native species in these treatments, measured in 2011 (darker blue) and 2013 (lighter blue). Bars with different letters are significantly different in value ($P < 0.05$). Treatment 1 is the control; treatment 2 is low mowing in November (as low as the mower will cut); treatment 3 is high-level mowing in November (about 15 cm above ground). Treatments 4 and 5 are the Spring and Autumn burning, respectively. There are more native species after the Autumn burn and possibly after the Spring burn, than after mowing or after no treatment (control).

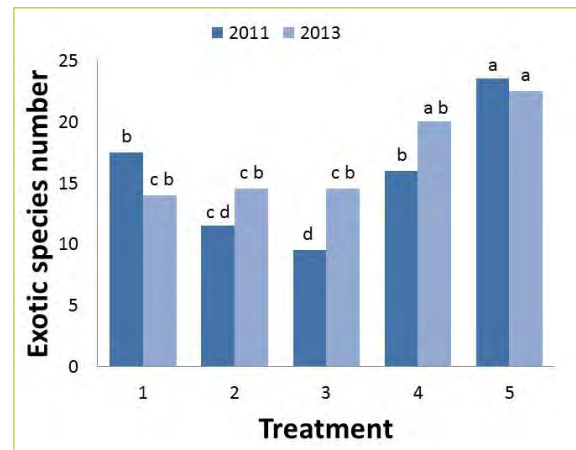


The number of exotic plants (top chart next page) also increased after burning.



We invited an expert to measure the fuel hazard index and the results showed that both the burning and the mowing treatments reduced the plant biomass significantly through the summer, and therefore were equally effective in reducing bushfire hazard.

The site at Croke Place is very weedy NTG in general, outside the remnant patch of NTG; 57% of the 72 plant species are exotic (21 forbs, 20 grasses). By late 2013, after the three Autumn and Spring fires, 11 of the 31 native species were only found in the burnt plots (5 forbs, 3 grasses, 1 lily, 1 fern and 1 orchid). That is the critical finding; without fire these species would eventually be lost from the NTG at Croke Place.



Mechanisms

What mechanisms are driving these results? The pioneering work of John Morgan and his colleagues found the creation of bare spaces between grass tussocks by burning or other means of biomass removal provided suitable habitat for the recruitment and growth of plants (Morgan, this proceedings). The heat of fire and the strigolactones in smoke also stimulate seeds to germinate (e.g. Clarke & French 2005). I also think that the main difference between Spring and Autumn burning may lie in the higher soil temperatures one could expect after Autumn fire, going into Winter. In the Canberra region, many plant species germinate and establish at this time. Spring fire, on the other hand, may similarly promote germination but the likelihood of dry surface soil going into Summer is much higher than when going into Winter, and establishment would be problematic. I think the stimulus of germination and establishment by fire is quite complex, involving potentially a number of mechanisms.

Management options

The conclusions I have drawn from this study are that:

- burning is required to maintain plant diversity in Canberra's Natural Temperate Grasslands;
- autumn burning maintains the highest number of native plant species; and
- autumn burning effectively reduces the fire hazard risk in the coming summer.

Of the three management options used in Canberra for managing fire hazard risk in urban grasslands – mowing, grazing, burning – Autumn fire is as effective as other biomass-reduction management approaches, and in addition it stimulates germination and establishment of native plant species and appears to promote the spread of *T. triandra* into weedy NTG, probably outcompeting many weed species in time.

Under the set mowing regime practised by the ACT Government (close mowing six times per year), many native and exotic plant species cannot reproduce and survive, especially during drought. The plants need time for flowering and seed reproduction. Furthermore, mowing is costly and not only brings in weeds – as widely observed – but also appears to disadvantage native plant species. Grazing does not really have a place in urban grasslands. A grazed disclimax grassland may be the best habitat for some threatened fauna species, but herbivores, especially large herbivores, are selective in what they eat. They 'eat out' palatable native plant species in preference to other species. The research in progress on grazing is an important area to pursue in relation to management for rare and endangered animal species.

Burning, on the other hand, is non-selective, and many native species (plants and animals) require a fire regime to survive. Burning in Autumn would appear to be the optimum management for Canberra's NTG. This is confirmed by knowledge handed down over thousands of years, as we are hearing at this forum (e.g. Brown, these proceedings). However, in urban Canberra many remnant and weedy NTG that remain, such as along Ginninderra Creek, are managed only by frequent mowing. In extreme hot and dry weather conditions,

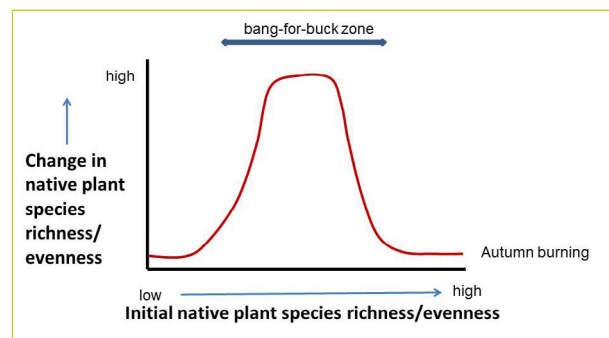


with strong westerly wind, fire could enter Canberra along these urban corridors of grassland and easily travel across both mown and un-mown sections.

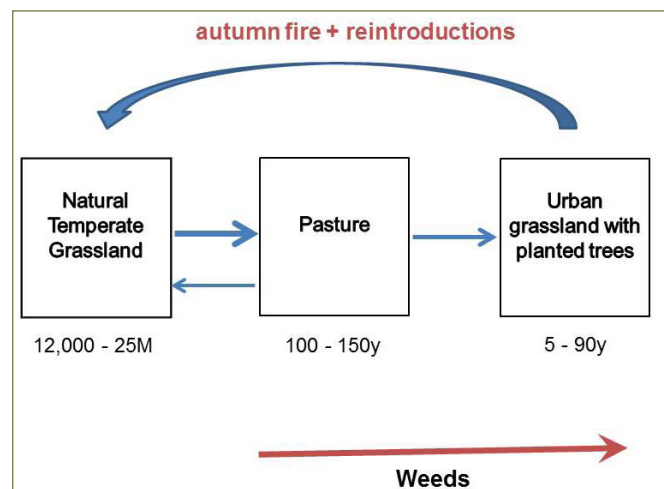
People living in the urban areas have low tolerance for smoke and fear snakes, and they want their local grassy areas kept mown like European lawns. It would therefore be difficult to use fire as a grassland management tool, but with appropriate education programs it is not a difficult task to make prescribed burns. If the ACT Government can successfully promote kangaroo harvesting for reducing grazing damage to NTG, against the wishes of a strong and vocal minority, then prescribed burning for restoration of NTG is achievable in urban Canberra.

Our next steps

The NBLG with the full cooperation of the Ginninderra Catchment Group (GCG) are planning to begin looking at the relationship between initial plant species richness and evenness, exotics and natives, and the floristic responses to Autumn prescribed fire. The conceptual relationship is shown in the diagram (at right). Where no native species are present we expect there is no seed left in the soil seed-bank for a response to an Autumn burn, and where there is a high plant species richness there may be no more species left in the soil seedbank that are not already present as plants in the community.



We are setting up a follow-on study to define the relationship between initial plant species richness and Autumn fire treatments, with burning every 2–3 years compared with burning every 4–6 years. For the grasslands of Canberra, Autumn fire, plus reintroductions where there are no remaining seed of endemic native species, could be a useful management method for restoring the urban NTG and potentially controlling weedy species, including *Eragrostis curvula* and *Nassella neesiana*. Ideally we would be reversing history, as in the revised concept diagram shown here (at right).



Change in the density of exotic plant species under the management treatments in our inaugural study is of interest. We also need to clarify whether any of the treatments give better 'control' of weeds than others and whether the treatment effects are dependent on La Niña and El Niño weather conditions.

Acknowledgements

Many people are involved as volunteers in our studies, and I thank them for their inputs. They are listed in the box at right (GCG = Ginninderra Catchment Group). We would welcome more volunteers to work on this new study, particularly in identifying plants in the field in the new study.

Thanks

- Past and present staff in the GCG office, especially Karissa Preuss.
- Adam Leavesley for grass fuel hazard measurement.
- Warren Muller for statistical analyses.
- Michael Bell of City Services for mowing plots.
- Tony Corrigan and Julian Seddon (Conservation Planning & Research), Brian Levin and Adam Leavesley (Urban Parks & Places: Fire Unit) and others for involvement in planning and support.
- Volunteers (more are required – contact Ken or Karissa) for the follow-on study.



References

- Brown A. (2015) Indigenous values and grassy ecosystems in the ACT region. In: *Grass half full or grass half empty? Valuing native grassy landscapes*. Proceedings of the Friends of Grasslands 20th anniversary forum, 30 October – 1 November 2014, Canberra, Australia. Eds: A. Milligan & H. Horton. Friends of Grasslands Inc.
- Clarke S. & French K. (2005) Germination response to heat and smoke of 22 Poaceae species from grassy woodlands. *Australian Journal of Botany* 53: 445–454.
- Morgan J. (2015) Biomass accumulation in grasslands and why it matters. In: *Grass half full or grass half empty? Valuing native grassy landscapes*. Proceedings of the Friends of Grasslands 20th anniversary forum, 30 October – 1 November 2014, Canberra, Australia. Eds: A. Milligan & H. Horton. Friends of Grasslands Inc.

Dr Ken Hodgkinson was appointed to CSIRO's Rangeland Program in 1967. His grassland research led to the adoption by land managers in semi-arid wooded grasslands of prescribed burning to reduce native shrubs and increase grass production. He developed a new grazing management involving tactical resting during onset of droughts for the maintenance of perennial grasses in semi-arid pastoral land. Currently he is an Honorary Fellow in CSIRO's Land & Water Flagship and a Visiting Fellow in ANU's Fenner School of Environment and Society. He continues research on the functioning of grassland plants, community structure and the combined influence of drought, fire and/or grazing on plant community dynamics and plant species-richness and the supervision of post-graduate students. He is invited to speak to community groups, university seminars and national and international conferences.

+ This record of the talk given at the forum has been checked by the presenter, but not peer-reviewed. To find out more, contact the presenter, via their institution or by email to: info@fog.org.au.