Gorse monitoring in native grassland. Aerial photograph interpretation and volunteer involvement, Kalkallo Common, Kalkallo 2011-2013

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Reinforcing Grassland Ecological Values in the Merri Valley North of Melbourne

CARING FOR OUR COUNTRY

MERRI CREEK MANAGEMENT COMMITTEE

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1 Introduction

Gorse (**Ulex europaeus*) infestations threaten native grassland vegetation in a variety of ways (See Appendix 10.1). Eradication in high quality native grassland requires strategic deployment of resources Accurate, up to date mapping of Gorse at an appropriate scale assists the land manager to plan works, select annual targets and allocate equipment and staff.

In high quality grassland, off-target damage has severe ramifications for biodiversity conservation so generally higher-input techniques are necessary compared to agricultural or wasteland situations. Different approaches to Gorse treatment are appropriate in different densities and in different vegetation qualities (See Appendix 10.2).

Efficient mapping of environmental weeds can be aided by frequently updated, high definition aerial photography. This has recently been made available via the internet. In Melbourne, Nearmap™ has been providing access to such aerial imagery since late 2009.

The degree to which aerial photography can discriminate different cover classes of Gorse is unknown for local Native grassland areas along the Merri Creek.

Confidence in aerial interpretation relies on comparing analysis with ground-truthed data. Ground-truthing surveys can be time-consuming, especially in grasslands where vegetation management occurs at a fine scale. Students from land management courses working as volunteers are a possible source of labour for such surveys, however, it is a challenge to organise student volunteers to produce consistent, accurate weed density assessment while also providing worthwhile learning experiences.

The project described in this report investigates the potential of aerial photo interpretation of Gorse using Nearmap™ in native grassland and trials a technique for marshalling student volunteers in ground-truthing surveys.

The techniques will be used as part of the monitoring of Gorse eradication works at Kalkallo Common in 2011-2013 under Caring for Our Country grant. It is anticipated that the final report will describe the techniques appropriate to monitor follow up of the Gorse eradication works in a native grassland.

2 Aims

1. Identify the capacity of aerial photography available from Nearmap™ to map Gorse infestations in native grasslands at the scale needed to plan an eradication program
2. Develop a method of fine-scale weed density mapping in grassland that is capable of efficiently making use of volunteer student labour while providing educational value.

3 Objectives

- Generate a density map of Gorse infestation in native grassland from aerial interpretation of Nearmap photo tiles
- Develop and conduct a ground-truthing survey exercise compatible with the capacity and needs of students of Victoria's Conservation and Land Management TAFE course.
- estimate of the accuracy of an aerial photo interpretation of Gorse infestation by comparing it with ground-truthed data.

4 Method

4.1 Site description

Kalkallo Common is an area of Crown land in the township of Kalkallo to the north of Melbourne. It consists of 9 hectares on the eastern edge of the Victorian Volcanic Plains Bioregion. The vegetation

of the reserve is Heavier-soils Volcanic Plains Grassland Ecological Vegetation Class, EVC 132-61. This is a particularly wet variant of this vegetation community, dominated by hundreds of shallow depressions. The dominant plant in the wet areas is Brown-back Wallaby-grass, *Austrodanthonia duttoniana*. In drier parts of the grassland, the vegetation is dominated by Kangaroo Grass, *Themeda triandra*. Several species of conservation significance persist in the reserve.
The vegetation remains in relatively good condition and has been subject of intensive but intermittent weed control efforts for over ten years. High threat weeds at the reserve include **Ulex europaeus*, **Phalaris aquatica*, **Anthoxanthum odoratum*, **Nassella neesiana* and **Nassella hyalina*.
In the 2010 Operational management plan (MCMC 2010), the reserve was divided into 7 different zones based on management logistics and vegetation quality. The 'Eastern perimeter' of the reserve was identified as a distinct zone due to the high proportion of Toowoomba Canary Grass and Gorse which threatens indigenous vegetation. The high fuel loads caused by the weeds and adjacent windbreak trees complicates the introduction of an ecological burning program. Gorse and *Phalaris* eradication are the high priority management actions identified for this zone.

4.2 Nearmap™

Nearmap™ (www.nearmap.com) is a proprietary product of high resolution aerial photography provided online covering an expanding range of areas in Australia. The company launched its Melbourne coverage in October 2009. The site provides readily available aerial imagery which is updated at frequencies ranging from monthly to several months.
In the experience of MCMC staff, the quality of the photos is more variable than traditional aerial photographs taken by piloted aircraft.
The accessibility, currency and frequent updating combine to make the product potentially valuable for environmental monitoring by smaller environmental groups for whom contracted aerial photography is generally unaffordable.
Various contract types governing use of data from the site are available for use by organisations depending on their scale and usage patterns. MCMC currently (September 2011) uses these photos under a non-commercial licence.

4.3 Ground truthing survey

4.3.1 Setup of temporary monitoring grid

Establishing permanent monitoring infrastructure in grasslands is problematic due to;

- The susceptibility to vandalism/theft of permanent monitoring infrastructure in a peri-urban reserve.
- Visual intrusion of permanent monitoring infrastructure.
- The impact of artificially increasing perches for hunting birds and insects in an ecosystem where such perches are naturally limited. Increased perches in native grasslands have also been observed to generate intense nitrogen enrichment from bird droppings, enhancing weed invasion.

A method of arranging a temporary monitoring grid aligned to coordinates over the grassland was developed as follows;

- A 5mx5m grid was generated on the MCMC GIS across a 30x300 metre area aligned with the eastern boundary of the reserve overlying the main areas of the Gorse infestation.
- Coordinates of GPS locations along the area at 50m intervals were extracted and printed on a map of the grid.
- In the field, the map was used to place star pickets at the recorded coordinates with the aid of a GPS unit.
- 50m tapes were laid between the first two pairs of star pickets at the northern end of the survey area.
- Two 30m ropes with 5 metre graduations marked on them were unrolled and held taut between two wooden stakes hammered in at 5 metre intervals.
- The above arrangement created the first line of six 5m x 5m quadrats for assessment.

4.3.2 Weed assessment with student volunteers

Thirteen students from the first year Conservation and Land Management course at Holmesglen TAFE were inducted into the site on 31st March 2011.

- Students were split into 6 groups of two or three and allocated a line in the assessment grid.
- Training in the identification of Gorse and also of the weedy pasture grass, Toowoomba Canary Grass **Phalaris aquatica*, ('Phalaris'), was provided to the group and individual groups checked to ensure identification was made consistently.
- Students were trained on methods of assessing the cover percentage of a plant species within a 5x5m quadrat (e.g. each square metre represents 4% cover). Forms (appendix 2) were used. Students were asked to nominate a percentage of cover for each quadrat.
- Groups began assessment of individual quadrats for both Gorse and **Phalaris* As each line of quadrats was assessed, the hindmost rope with graduated marks was moved to the next five metre interval, creating the next line of quadrats (see photo on cover of report).
- Experienced MCMC crew members and teachers closely supervised and assisted students in the first ten assessments, with a lower level of assistance for the subsequent 30 assessments.
- Induction, training and assessments were completed between 10am and 1pm, with over 20 assessments taking place in the last hour.
- Total effort on site on the day included 13 volunteer students and 2 Holmesglen TAFE teachers for three hours and 3 MCMC staff for approximately 4 hours creating a total effort of 57 people hours not counting travel time and preparation.

4.4 Interpretation of aerial photography for Gorse cover

Aerial photograph interpretation was carried out by a single MCMC staff member, Parkland Tema Coordinator Ben North (the 'assessor'), who had taken part in the survey a few months earlier, but who had not seen the resulting data. No attempt was made to assess Phalaris.

The following steps were used to generate a map of Gorse cover using aerial photo interpretation.

- Nearmap™ aerial photos from the eastern margin of Kalkallo Grassland were downloaded into MCMC's Geographic Information system which uses a Mapinfo™ platform. The image from the 7th January 2011 was chosen due to the clarity of the image and the contrast between the dark foliage of the Gorse and pale summer-sere grasses. The Nearmap™ website has a facility (Hypertile™) to download geo-referenced images.
- A grid corresponding to the ground-truthing survey was overlaid on the aerial photos.
- The assessor did the analysis on images at a zoom level of 0.051 km.
- The assessor was asked to allocate a score in one of five cover classes- these were presented to the assessor in as both percentage and the nearest whole number fraction to assist with visualisation (See Table 4.4-1 Cover classes used for aerial interpretation of Gorse cover). The classes correspond to classes applied to the data from the field-based assessment.

Table 4.4-1 Cover classes used for aerial interpretation of Gorse cover

Percentage	Fraction
<16% cover	< 1/6
16-32%	1/6 - 1/3
32-48%	1/5 - 1/2
48-64%	1/2 - 2/3
68-80%+	2/3 - 4/5+.

- The assessor noted that he examined the different parts of the survey area, in particular highest density patches to help calibrate his scoring of cover before beginning to allocate scores. The assessor noted that their scoring was influenced by the score they allocated to adjacent areas.
- These scores were put into a GIS layer and a thematic map generated using the same classes and themes as the map of ground-truthed data.

The time spent by the assessor to fill in the data was less than half an hour.

5 Results

5.1 On ground survey

The map of the ground truthed survey is included as Section 7.4, Appendix 4.
The map shows several features of the infestation of interest in planning a Gorse eradication strategy and management of other Grassland vegetation values;

- The first fifty metres in the north of the 30 metre band is free of Gorse entirely, meaning it should not require further inspection in the short term, a quick inspection in the post-burn year will be an efficient means to ensure this remains Gorse-free.
- Several loci of dense Gorse infestations are visible, in the 100 meter band in the middle of the survey area under or within 30metres of the pine tree windbreak. These must be treated and removed for ecological burns to take place in this area. Given flame height from living and dead Gorse can easily exceed twenty metres flame-height, it is likely that all mature Gorse within 30 metres of the boundary must be removed to allow staff working on the firebreak to work safely and to prevent damage to the windbreak trees.
- By timing treatment so that seed is not present on the dead Gorse bushes, it may be possible to cut and take the dead bushes into the interior of the grassland prior to the ecological burn for disposal by the fire. This would avoid substantial transport and disposal costs. This will require careful assessment to ensure seed is not present and to avoid placing dead bushes where they will present a risk to staff conducting the ecological burn.
- The southernmost 50m band of the survey area is mostly in the lowest class of Gorse cover, suggesting cut and disposal of the Gorse may not be essential and not need to be prioritised. This requires further investigation.
- The distribution pattern suggests where low density of Gorse is likely to be present beyond the surveyed area, in particular to the south and west.

5.2 Comparison of Aerial interpretation with ground-truthed data

A visual comparison of ground-truthed survey with the results of the aerial interpretation survey (Section 7.5, Appendix 5), the following features were common to both maps;

- Virtually no Gorse was detected in the northern-most fifty metre band of the survey area.
- The distribution of loci of high density Gorse was very similar across the survey area.
- The estimation of higher density Gorse appeared to correspond closely with the ground-truthed data

Differences in the maps that have implications for planning include;

- A few false negative low density Gorse patches in the northern hundred metres
- A false negative high density patch in the southern fifty-metre band, possibly a mis-interpretation of a shadow from an adjacent pine tree.
- Generally the lowest infestation class was under-detected across the survey areas.

6 Discussion

6.1 Develop and conduct a ground-truthing survey exercise compatible with the capacity and needs of students of Victoria's Conservation and Land Management TAFE course.

Students from this course appeared to readily develop the identification skills for the two target weed species and skills in estimating cover percentage.
Student participation in moving the quadrat line went smoothly.

Satisfaction with the exercise by students was generally high. The following comments were recorded on the day by Catchment Program Officer Angela Foley, MCMC in response to the question "In what way was this a satisfying or unsatisfying activity for you?"

"It's satisfying in that its not just toned down because I'm a student – it feels like actual helping"

"It's unsatisfying – I feel I should be doing more of this in my course"

"Getting to actually work for someone and generally good to be outside – exciting to be out instead of theory in the classroom."

"Its satisfying in that I've never done this before and we were taken through the steps really well."

"I had no idea -I thought one person would walk around and make an estimate, not this much detail."

The project involved substantial prototyping, suffering from some delays as MCMC staff adapted to unexpected challenges and opportunities. Important lessons from this day included;

- *Phalaris is a viable target for student volunteer mapping, with students readily identifying this species even when fertile parts were not present.
- Ready-made survey tape measures would have been possibly more reliable than the use of marked ropes. Making a marked rope with securely flagged intervals could be time consuming compared with purchasing a tape measure but has the benefit that the markings can be made very easily seen from several metres away.

6.2 Using comparison with ground-truthed data, make an estimate of the accuracy of an aerial interpretation of Gorse infestation.

The visual comparison of the aerial photo interpretation with ground-truthed data shows that these were very similar, suggesting aerial interpretation would provide a sufficient basis for directing teams and resources to conduct weed eradication works.
Three differences having impact on allocation of Gorse treatment resources were apparent, namely;

1. A few false negative low density Gorse patches in the northern hundred metres
2. A false negative high density patch in the southern fifty-metre band, possibly a mis-interpretation of a shadow from an adjacent pine tree.
3. Generally the lowest infestation class was under-detected across the survey areas.

Difference 1 might be addressed by a cursory inspection by treatment operators of the few false positive spots to eliminate the area from further patrol effort.
Difference 2 appears to represent a misinterpretation that might be addressed by;

- Greater experience in aerial interpretation, with opportunities to conduct comparisons of assessments with on ground conditions and instruction in the most likely misinterpretation scenarios.
- Comparison with multiple aerial photographs

Difference 3 may be overcome by ensuring resources to allow field eradication staff to patrol in sweeps or spirals out from the dense infestations- a standard approach.

6.3 Generating a monitoring sequence

Gorse will be treated in 2011-2012 across the area that has been surveyed. By 2013 any remaining living plants will be at an early stage of regrowth. The results demonstrate that aerial photography for Gorse mapping does not reliably detect low level infestations. The projected ecological burn in 2012 across the survey area will also greatly alter the appearance (visual signatures) of vegetation from aerial photographs.
For the reasons above it is anticipated that only gross differences in Gorse treatment success would be detectable from aerial photographic interpretation (e.g. if an area of mature Gorse was not treated).

7 Conclusion

From our results, aerial photograph interpretation of Nearmap™ photos appears to provide a reliable way to map different cover classes of unburnt Gorse infestations in native grasslands when coverage exceeds 16% and where the assessor has been 'trained' through a site visit.
Aerial interpretation is unable to reliably detect Gorse at lower densities, such as the fringes of infestations where seedling Gorse is establishing.
Aerial photo interpretation should be teamed with a ground based inspection method such as a transect to if the intentions is to establish a monitoring sequence capable of detecting regrowth and low density Gorse.
Supervised classes of first year students of Conservation and Land Management are capable of generating valuable accurate ground-truthing data using a grid assessment of weed cover percentage of Gorse and Phalaris. The exercise can be designed so that it is a valued learning experience by these students and their tutors.

8 Further investigation

Avenues to investigate in order to expand the value of aerial photo interpretation include;

- Repetition of this exercise may increase the confidence in the conclusions of this report.
- The capacity of aerial photography to map Gorse in other grassland contexts such as regrowth Gorse in burnt, regenerating grassland
- Methods to extrapolate transect data and aerial photo interpretation to monitor low level and regrowth gorse
- How much value does the density data generated from aerial photo mapping have in planning eradication strategies, allocating resources and directing field works compared with standard site visits and rough visual estimates from aerial photos.

9 References

Merri Creek Management Committee (2010), Operational Management Plan for Kalkallo Common Grassland. Unpublished report for Hume City Council.

National Gorse Taskforce, Australia (2006), Gorse national best practice manual : managing gorse (*Ulex europaeus* L.) in Australia / National Gorse Taskforce. Dept. of Primary Industries and Water, New Town, Tasmania.

10 Appendices

10.1 Appendix 1. Weed threat of Gorse to native grassland

Gorse is a weed of National significance and is a controlled weed under Victorian legislation

Gorse impacts environmental values and management of Victorian Volcanic Plain vegetation through;

- Competing/smothering indigenous vegetation
- Providing harbour for rabbits in volcanic plains grasslands where rabbits are otherwise uncommon due to the unsuitable conditions for warrens.
- generate a heavy fuel load that requires additional resources to manage prior to implementing ecological burning
- enhancing nitrogen levels of surrounding soil (being a legume with nitrogen fixing bacteria contained within root nodules). These can benefit nitrophilous plants including many environmental weeds.

Features of Gorse that are relevant to strategic eradication in an conservation reserve;

- is a long-lived perennial shrub- lifespan exceeding twenty years
- shrubs regrow following cutting or burning- regrowth is rapid and flowering will occur within second year of disturbance
- has a long-lived seed bank-likely to exceed 20 years in field conditions
- seed germination is stimulated by burning or by clearing of competing vegetation
- high mortality of new germinants is usual, particularly in first summer however a wet summer will permit a high survival rate.
- Germinants take approximately three years to reach flowering size.

Features of an eradication program in native grassland;

- Burning or clearing will stimulate massive germination of soil-stored seed-bank. This may be undesirable where resources for follow up eradication measures are limited but may be useful for achieving eradication in situations where follow up resources can be mobilised.
- Agricultural approaches such as ripping are inappropriate in environmental reserves. Grooming machinery is unsuitable for trafficking over sensitive vegetation, rocks and soft soils such as occur at Kalkallo Grassland reserve for much of the year.
- physical removal requires application of herbicide to stumps. This is time-consuming and only suitable for detailed work where spraying is impossible
- cut-stump application of herbicide is not 100% effective – follow-up inspection and treatment is essential
- Physical removal may be incorporated as a pre-treatment, allowing herbicide treatment of re-growth in a manner that minimises off-target damage.
- Allowing regrowth to reach a height of 40cm is recommended in the Gorse best practice guide However, in the experience of MCMC, this height is makes damage to interspersed forbs inevitable so spraying at earlier stages (up to approx 20cm) is more usual in sensitive areas. This presumably reduces spray effectiveness (less area for herbicide take-up relative to root mass) and so increases the need for follow up treatments.

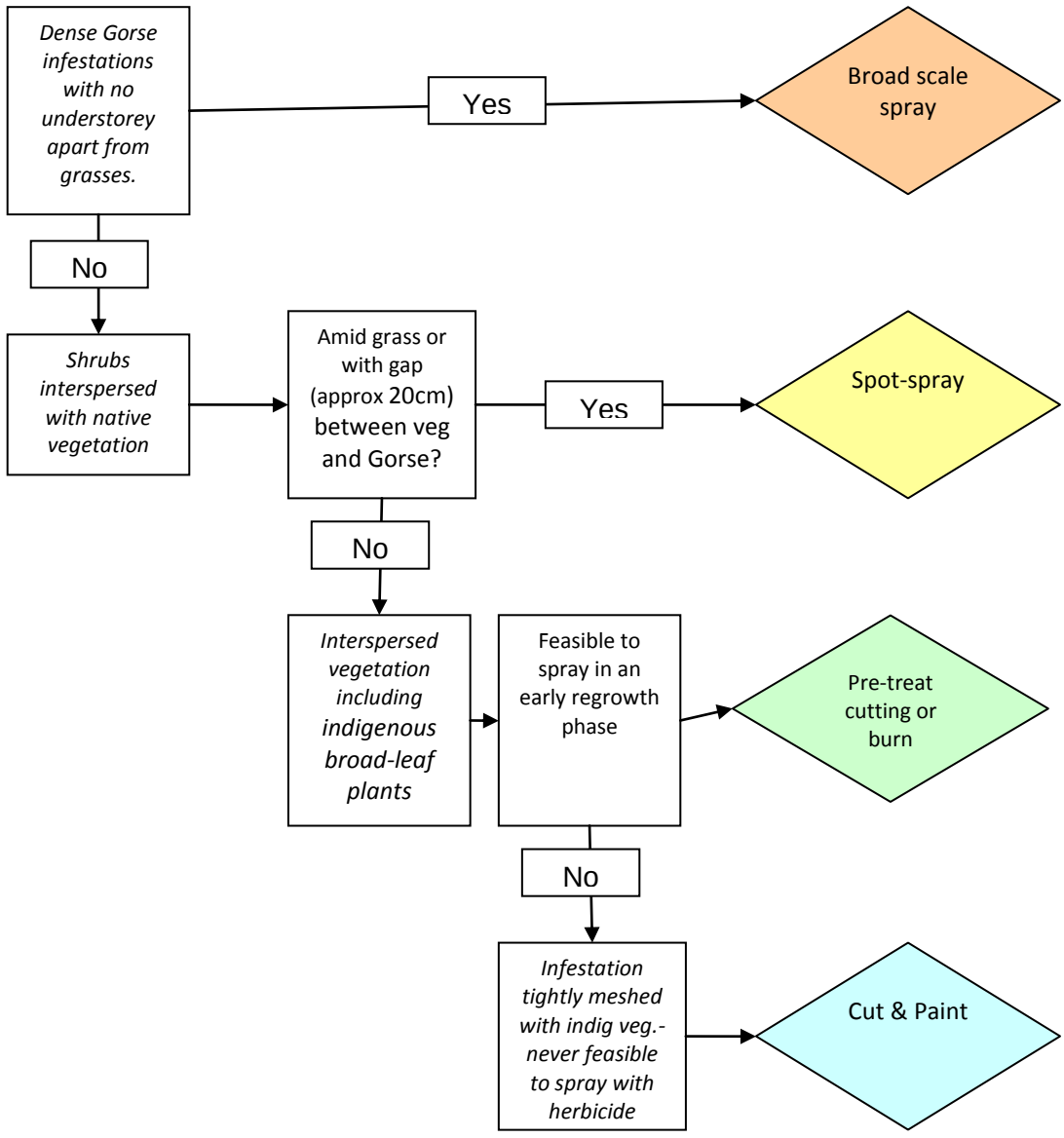
- The period that elapses to make regrowth for follow-up spray varies with season and maturity of plants so regular inspection is essential for making judgement about treatment.

10.2 Appendix 2 Gorse Treatment classes

MCMC Gorse spraying may be stratified into four 'treatment classes' depending on the infestation type, detailed in the following table.

Table 10.2-1 Gorse Treatment classes

Class	Features	Approach
Broad scale	Dense infestations-generally of long-standing with no discernable broad-leaf native understorey species	Broad-scale spray using backpack
Spot-spray	Isolated Gorse amid grasses or adequately separated from surrounding indigenous vegetation (20cm gap) to avoid off-target damage in good spray conditions	Spot spray
Pre-spray	Shrubs interspersed with native vegetation that includes significant indigenous broad-leaf that would be feasible to spray in an early regrowth phase.	treat regrowth following small scale or broad-scale biomass removal
Cut & Paint	Infestation meshed with indigenous vegetation such that spraying will not be possible regrowth phase	Cut and Paint



10.3 Appendix 3. Data survey sheet

Gorse mapping Kalkallo	**Date;**	**Surveyors;**	**Distribution N**
Line (Circle) A B C D E F	***Gorse treatment class***		
#			
#			
#			
#			
#			
#			
#			
#			
#			
#			

1. Record date, Surveyor name
2. Write in the Line (a to p)
3. Estimate treatment class of *Gorse* in Plots

10.4 Appendix 4 Gorse percentage cover as determined by ground survey

10.5 Appendix 5 Gorse cover percentage as determined by Aerial photo interpretation