Collector app mapping to assess effectiveness of invasive grass control

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Summary The Collector app has been used for several years in the Australian Capital Territory (ACT) for mapping infestations of naturalised plants and invasive plants and their control. The app is used on both Smartphones and tablets. There is now sufficient data to reveal trends in distribution and density of targeted species after control work. African lovegrass, serrated tussock and Chilean needle grass are the most commonly controlled invasive grasses in the ACT. All three of these invasive species have massive impacts on native plant diversity, so understanding the resources required for control work is important. The data shows that with stable resourcing over a number of years, land managers can gain control of invasive grass infestations. Direct control involves using herbicides such as glyphosate and/or flupropanate, but other management tools also play an important part in successful control. The analysis also revealed how to improve both the accuracy of polygons and visual estimates of density.

Keywords Invasive grasses, African lovegrass, serrated tussock, Chilean needle grass.

INTRODUCTION

Invasive alien grasses are regarded as an increasing landscape threat (Godfree *et al.* 2017). They impact upon landscape connectivity, biodiversity and productivity.

The invasiveness and impact of *Nassella trichotoma* (Nees) Hack. ex Arechav. (serrated tussock) and *Nassella neesiana* (Trin. & Rupr.) Barkworth (Chilean needle grass) in south eastern Australia is well documented (Osmond *et al.* 2008, Snell *et al.* 2007, respectively). These two invasive grasses are well established in urban Canberra and are increasing in distribution in rural areas, including Tidbinbilla Nature Reserve and Namadgi National Park (Taylor and Conolly 2017).

Eragrostis curvula (Schrad.) Nees (African lovegrass) has also proven to be highly invasive and threaten grassy ecosystems (Downey *et al.* 2010, Firn *et al.* 2010, Firn *et al.* 2012, Firn *et al.* 2018). It is also well established in urban and peri-urban areas of the Australian Capital Territory (ACT) and is spreading along river and road corridors into Namadgi National Park and Tidbinbilla Nature Reserve.

Hyparrhenia hirta (L.) Stapf (Coolatai grass) established in northern parts of NSW, has also been shown to threaten biodiversity (McArdle *et al.* 2004). This species has recently started to spread into Southern NSW (e.g. Southern Highlands and Monaro) and a small infestation was recently detected in the ACT.

Anthoxanthum odoratum L. (sweet vernal grass) has spread considerable distances in Kosciuszko National Park and is starting to spread rapidly in nearby Namadgi National Park. It has a relatively lower impact in natural or undisturbed ecosystems but will dominate disturbed areas lacking perennial grass cover.

Nassella leucotricha (Trin. & Rupr.) Pohl (Texas needle grass) may also be present in the ACT but it could be concealed by the more abundant Chilean needle grass, so its status is uncertain.

This paper focuses on results of control efforts for serrated tussock, Chilean needle grass and African lovegrass because there is sufficient mapping data for analysis. All three of these species meet the spatial and impact based definitions of invasive plants: spatial (naturalised plants that produce reproductive offspring, often in very large numbers, at considerable distances from parent plants, and have the potential to spread over long distances) and impact (naturalised plants that threaten biological diversity) (Hui and Richardson 2017).

Managing the spread and impact of invasive grasses requires accurate mapping of infestations and control effort. This helps with location of follow-up control sites and with planning and reporting. Measuring successful invasive grass management involves three variables: (i) reduction in area of infestations; (ii) reduction in density of infestations; and (iii) replacement of invasive grasses with local native plant species. This paper examines recent mapping data with respect to (i) and (ii).

MATERIAL AND METHODS

Naturalised plants and invasive plant control have been recorded on ArcGIS On-line and its associated field app, Collector, since 2014 (Esri 2018). Staff, contractors and volunteers all edit the one unique feature layer (spatial data file), so there is no confusion about where control work has been undertaken.

This data has revealed trends in the area and density of invasive grass infestations.

Approximately 182 ha of Chilean needle grass, 266 ha of African lovegrass and 699 ha of serrated tussock were controlled multiple times in the lowlands grasslands of Canberra Nature Park reserves, between the years 2014–2017. The total area of each species treated was stratified by grassland type: Natural Temperate Grassland (NTG) (396 ha); native grassland other than NTG (514 ha); and exotics dominated grassland (237 ha). Data from weed control sites was categorised by treatment number. To determine the success or otherwise of control work, only sites with follow-up control were included in the analysis.

Each treatment involved spot spraying using glyphosate and/or flupropanate. The herbicide rates were those listed in permit PER9792 (APVMA 2018). The lower rates in this permit were used (e.g. 150 mL flupropanate 100 L^{-1} water for African lovegrass) to minimise off-target damage. There was usually only one treatment a year in the serrated tussock and Chilean needle grass infestation sites, whereas African lovegrass infestation sites often required more than one treatment per year. Weed control operators searched for and destroyed target species, with thoroughness of control achieved by a grid search and/or zig-zag search methods.

Once control work was complete the Collector app was used on smartphones or tablets to create a polygon around the distinct infestations (streaming mode gave greater accuracy) so the area of the control work could be calculated. The area controlled for each target species was calculated by grassland type and treatment number to compare changes in area treated over time. The proportion of area in each grassland type was also calculated by treatment number to demonstrate prioritising of high value conservation areas (NTG) for invasive weed control.

A density rating for the target species was assigned to each polygon: <1% cover (density 1), 1–10% cover (density 2), 11–25% cover (density 3), 26–50% cover (density 4), >50% cover (density 5). For each targeted species the number of sites (polygons) in each density category was shown by treatment number.

Visual estimates of density or cover are prone to error depending on the size of the area it applies to – smaller polygons tend to have less error. There is also the issue of observer bias and therefore data consistency when different weed control operators are undertaking the work.

Field workers estimate density in one of three ways:

- estimate the area covered by a target plant and multiply by the number treated plants and then divide by the polygon area (can be very accurate if plants are a similar size);
- visual sample of quadrats within the polygon and produce an average density estimate for the polygon (good for larger polygons); or
- visual clumping of plants within the polygon to determine density (works well with small polygons).

RESULTS

The type of mapping data that was available from the Collector app for the analysis is shown (Figures 1 and 2). The reserves are located within urban Canberra. The tan coloured polygons in Figure 1 are serrated tussock control. The green coloured polygons in Figure 2 are Chilean needle grass control. The search areas in both cases were the entire reserves (green shaded areas).

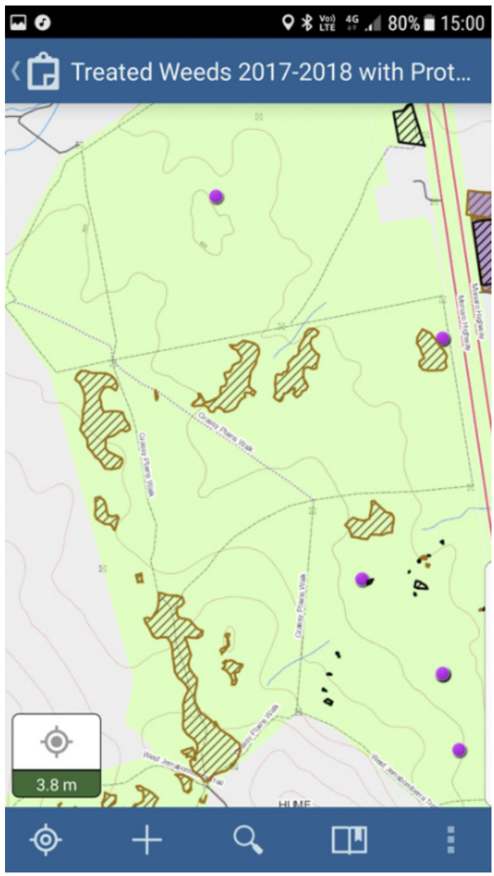

Figure 1. Serrated tussock control (tan/brown polygons) at Jerrabomberra Grasslands West. Pink/purple dots are rare native plant locations. Reserve size is 290 ha.

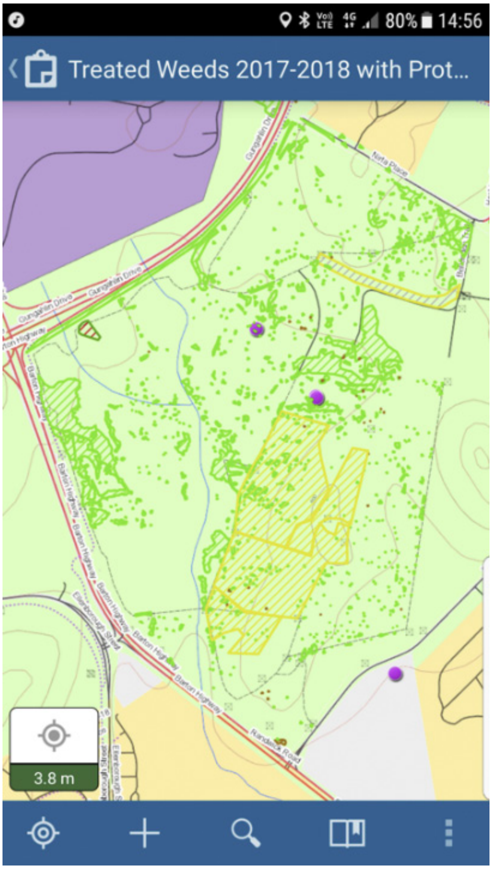

Figure 2. Chilean needle grass control (green polygons) at Crace Grasslands. Pink/purple dots are rare native plant locations. Reserve size is 145 ha.

Data collected during mapping of invasive plants including area and density sprayed (Figures 3–8) showed successful reduction in area and density of infestations for all three invasive grasses studied. They also show that high value grasslands such as native dominated and natural temperate grasslands, have been prioritised for treatment.

The first treatment for all species led to a significant drop in infestation area. Reasons for this are: (i) when larger – older plants are killed the polygons are considerably reduced in size; (ii) outliers are often younger plants that produce less seed; (iii) the seed bank at the edge of the infestation range front is smaller; and (iv) in polygons where flupropanate was used there is a suppressing effect on further germination for up to two years. Once the infestations start being broken down then polygons reduce in size. There are often more polygons mapped after the first treatment but the cumulative area is less than the large initial polygons.

Figures 6–8 show persistence at the various sites. Denser initial infestations require more treatments before no follow-up control was required during the study period. This is no surprise because seed banks of the target species would be larger and there is less interspecific competition from neighboring plants so a higher level of re-infestation is expected. Infestations are broken up once treatment begins, but smaller polygons remain that have a relatively high density requiring further follow-up control. This is an artifact of mapping with polygons.

African lovegrass, unlike serrated tussock and Chilean needle grass, continuously flowers and seeds through its growing season in the ACT (September to

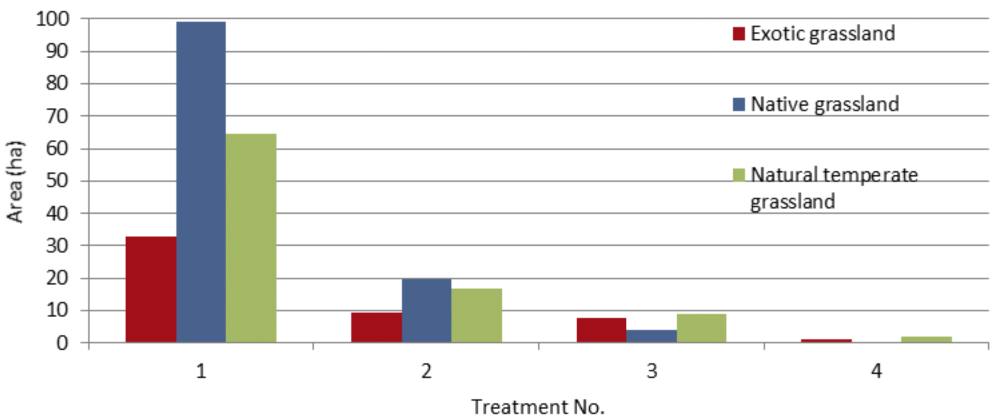

Figure 3. Area of African lovegrass controlled and treatment number. Each treatment involved spot spraying with glyphosate and/or flupropanate.

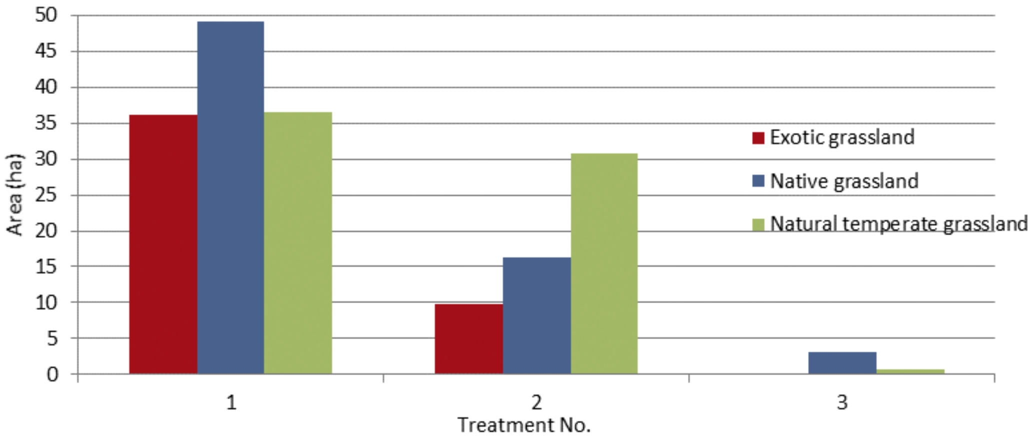

Figure 4. Area of Chilean needle grass controlled and treatment number. Each treatment involved spot spraying with glyphosate and/or flupropanate.

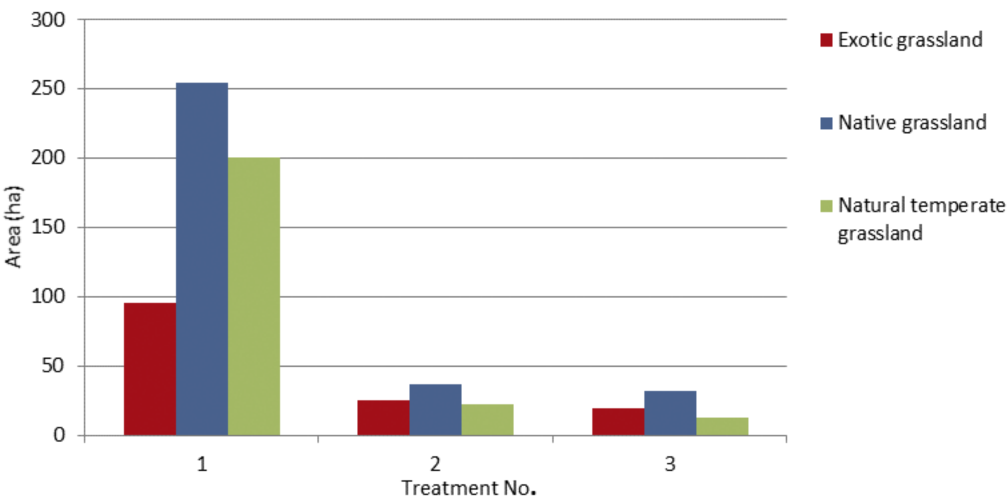

Figure 5. Area of serrated tussock controlled and treatment number. Each treatment involved spot spraying with glyphosate and/or flupropanate.

April). The flowering corresponds with rainfall, particularly for infestations that have been slashed, burnt or grazed before the rain. The resulting propagule pressure can therefore be relative high compared to other invasive grasses. This may explain why relatively more treatments are required for African lovegrass compared to the other invasive grasses over the study period (Figure 6 c.f. Figures 7 and 8).

Accuracy and consistency of data is important in interpretation of these results. This was a recognised problem in visual estimates of density (Morrison 2016). Factors that help with accuracy of visual estimates of treated invasive grasses are: small polygons; easily accessible terrain; treatment season that makes the target species more visible; and spray dyes. Consistency is very important for interpretation of trends in data. This can be an issue for density estimates if different spray operators map the different treatments. Fortunately this source of consistency error is lower than it otherwise would be because spraying contractors are often allocated to the same reserves over a number of years.

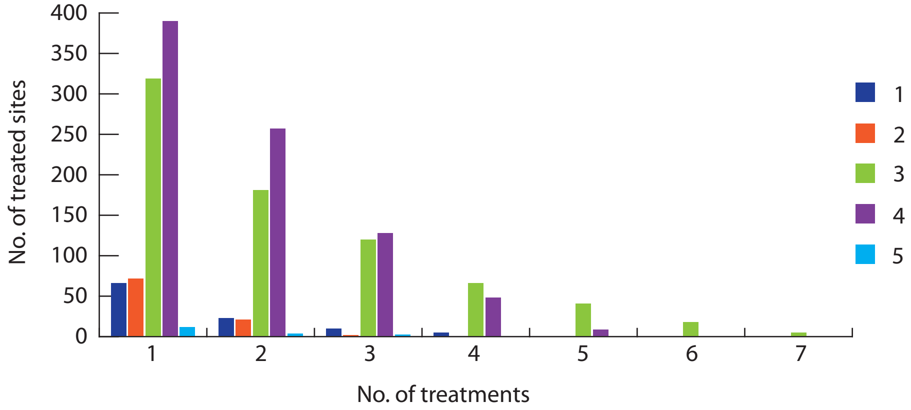

Figure 6. No. of sites in each density category (1 lowest, 5 highest) by treatment – African lovegrass. Each treatment involved spot spraying with glyphosate and/or flupropanate.

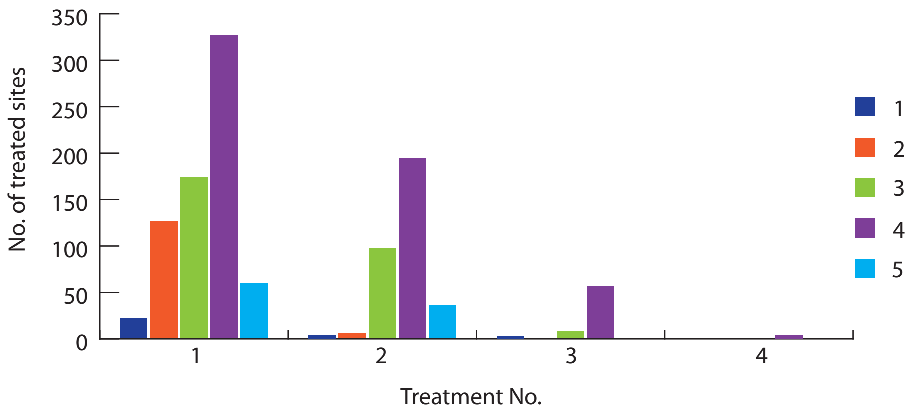

Figure 7. No. of sites in each density category (1 lowest, 5 highest) by treatment – Chilean needle grass. Each treatment involved spot spraying with glyphosate and/or flupropanate.

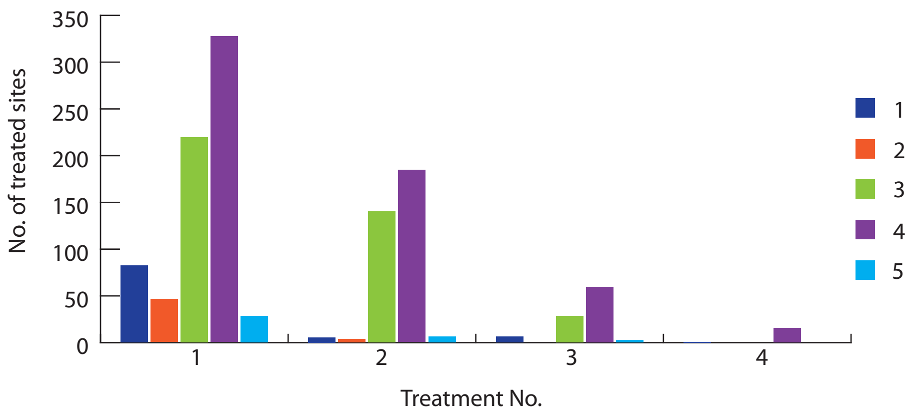

Figure 8. Number of sites in each density category (1 lowest, 5 highest) by treatment – serrated tussock. Each treatment involved spot spraying with glyphosate and/or flupropanate).

Feedback from staff was that an additional field of spray mix volume should be recorded on the Collector app maps for larger polygons. This will be added to the feature layer in 2018/2019. It will be a good method of verifying the accuracy of visual estimates.

DISCUSSION

The Collector app-ArcGIS On-line mapping system records all the treated invasive plant infestations and ensures follow up control sites are not overlooked. The Collector app data, which is synced to ArcGIS On-line, produced the summary data for the bar charts in this study. The data from the bar charts shows:

- on-going follow-up control is essential to deal with re-infestation from seed banks and adjacent un-treated infestations;
- denser infestations require more follow-up control, so on-going resourcing is essential to bring such infestations under control (the use of the residual herbicide flupropanate can partially offset this); and
- relatively more control effort is required for African lovegrass (a species that seeds a number of times in its growing season, making re-infestation more likely) as opposed to invasive grasses that seed once a year (Chilean needle grass and serrated tussock in this study).

The introduction of spray mix volume as a new field on the Collector app maps will increase the accuracy and consistency of visual density estimates for larger polygons.

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