

RESIDUAL PRESENCE AND IMPACT ASSESSMENT OF HERBICIDE FOR GORSE CONTROL AT LONG POINT RESERVE, TASMANIA, AUSTRALIA

by L. Williams and D. Kingdom

(with one text-figure)

Williams, L. & Kingdom, D. 2018 (14:xii): Residual presence and impact of herbicide for gorse control on native species diversity at Long Point Reserve, Tasmania, Australia. *Papers and Proceedings of the Royal Society of Tasmania* 152: 17–19.

<https://doi.org/10.26749/rstpp.152.17> ISSN: 0080–4703. Tasmanian Land Conservancy, Taroona, Tasmania 7005, Australia (LW*, DK)

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Gorse (*Ulex europaeus*) is an invasive weed managed extensively throughout temperate areas of the world. At Long Point Reserve on the east coast of Tasmania, management has been highly effective, reducing the cover of the gorse population by 90% using cut-and-paint applications of glyphosate and spot-spraying of Grazon™ Extra. Considerable quantities of Grazon™ Extra have been applied repeatedly over a 10-year period and there is concern over whether the herbicide is persisting in the soil and impacting native plant recruitment. We collected soil samples and quantified plant species richness across sites with a range of spray frequencies. No herbicide residues were detected in the soil and plant species richness did not differ between treated and untreated areas. Given the moderate persistence of the active ingredients of Grazon™ Extra (picloram and triclopyr), detection in the soil was expected; however, it appears these herbicides have either quickly dissipated, leached to other areas or the skill of the spray contractor resulted in little spray drift or excess herbicide application. This research suggests good practice chemical control of gorse does not negatively affect native species, although this may be situation-specific. **Key Words:** picloram, triclopyr, *Ulex europaeus*, herbicide, weed control.

INTRODUCTION

Gorse (*Ulex europaeus* L.) is a Weed of National Significance in Australia, infesting up to one million hectares across Australia (Gouldthorpe 2006). It causes reduced stocking rates, presents a fire hazard, provides habitat for feral animals and can form dense monocultures in natural areas, reducing floral diversity (DPIPWE 2014). In Tasmania, gorse is distributed across much of the state, infesting between 30 000 and 100 000 hectares (Gouldthorpe 2006). Methods for the control of gorse include mechanical clearing, cultivation, herbicide application, hand-weeding, fire, grazing, pasture management, revegetation and biological control. A combination of several methods is often most effective (Gouldthorpe 2006).

The management of invasive species can result in many benefits to the ecosystem, but can sometimes result in unexpected negative outcomes (Caut *et al.* 2009, Rinella *et al.* 2009). For example, removal of invasive plants can trigger reinvasion by the target species, or other invaders or hinder the establishment of native species (see Kettenring & Adams 2011). The off-target impacts of invasive plant control or eradication are rarely considered in scientific studies (Kettenring & Adams 2011), though potential impacts are considered in management manuals like the Weeds of National Significance manuals.

The Tasmanian Land Conservancy (TLC) has been controlling gorse at Long Point Reserve on the east coast of Tasmania for the past decade. An integrated weed control program utilising cut-and-paint techniques with glyphosate, spot-spraying with Grazon™ Extra (picloram and triclopyr) and burning has resulted in a 90% reduction in the cover of gorse. Although control is highly successful,

large quantities of herbicide have been repeatedly applied to the reserve and so concerns have arisen as to whether this is negatively impacting on native plant diversity. We aimed to determine the residual presence of herbicides following gorse control by quantifying the concentration of picloram and triclopyr in the soil at Long Point in areas with differing spray frequencies and to assess the impact of any herbicide residue on native plants by measuring the native species diversity in areas of differing spray frequencies.

METHODS

Long Point Reserve is owned and managed by the not-for-profit conservation organisation, TLC. It is located at Moulting Lagoon on Tasmania's east coast (42.0506°S, 148.1512°E). The reserve comprises 386.5 ha of mixed saltmarsh/woodland/grassland overlying sandy soils (TLC 2008). Moulting Lagoon is an internationally important wetland site (Ramsar) (TLC 2008). Long Point has a long history of human activity leading to some environmental degradation including the introduction of weeds.

When Long Point was purchased by TLC in 2005, there were significant gorse infestations covering 49.9 ha, with much of this area being a gorse monoculture. The previous owners burnt gorse which reduced the biomass in the short term but did not prevent spread and establishment. The gorse spider mite (*Tetranychus lintearius* Dufour, 1832) biological control agent is established at Long Point, but its effectiveness is unknown. The TLC has reduced the gorse cover by 90% using combinations of cutting and painting individual plants with glyphosate, spot-spraying denser areas with Grazon™ Extra and burning.

Sample collection and analysis

On 25 October 2016 we collected soil samples at Long Point to test for herbicide residue and measured plant species richness at four sites: high spray frequency (sprayed five times between 2005 and 2016); low/moderate spray frequency (sprayed three times between 2008 and 2016); unsprayed/low spray frequency (sprayed once or twice between 2005 and 2016) and an unsprayed low-lying area downslope of sprayed areas potentially subject to herbicide leaching. Due to concern arising over herbicide impacts well after herbicide application, we had to design our sampling methodology around treatments that had already been established and so could not avoid the pseudoreplication that resulted from our sampling methods. It is unlikely that each of the sites is different, but we recognise that applying one treatment at each of the sites, rather than all treatments at all sites is not optimal design.

Within each site, fifteen 1 m x 0.5 m quadrats (arrayed along three randomly assigned transect lines) were established. Within each quadrat the presence of dead gorse, gorse seedlings and each vascular plant species was recorded. Within each site, three soil samples were collected, one at the start of each transect, using a square tree planting device (5 x 5 cm x 15 cm deep). The surface litter layer was removed from each soil sample to enable analytical analysis and the remainder of each sample stored in a glass jar and refrigerated prior to analysis. The top 15 cm of the soil was collected as this is where we considered the herbicides most likely to accumulate and affect subsequent seedling emergence. The soils were sent to a NATA accredited laboratory (Eurofins, Melbourne) where the soil samples were tested for residues of triclopyr using the method MGT 530A and picloram using the method LTM-ORG-2180 Phenoxy Acid Herbicides. These tests are based on SW-846 Test Method 8000D: Determining Chromatographic Separations from the United States Environmental Protection Agency. The reporting limit was 0.5 mg/kg.

In 2006, prior to widespread spraying, 5 x 50 m-long transects (line intercepts) were established to study vegetation composition. Any plant intersecting the transect was recorded in the categories of bracken, gorse, grass, forb, native shrub or sedge. Two of the transects in a high spray frequency area close to our sample collection sites were resurveyed in 2016, with flooding preventing access to the remaining three transects.

Statistical analysis

Statistical analysis was carried out using R version 3.2.1. Species richness within the quadrats was analysed using analysis of variance (ANOVA) where *P* values were considered significant when < 0.05.

RESULTS

With the exception of a single sample, no picloram or triclopyr was detected in any of the 12 soil samples above the limit of reporting value of 0.5 mg/kg. One sample had the limit of reporting raised to < 2 mg/kg of triclopyr due to matrix interference (i.e., where another parameter in the soil interfered with the reliability of the testing method).

The average plant species richness in quadrats at Long Point in 2016 was 5 (± 1 sd) in the high spray frequency, 6 in both the low/moderate (± 2 sd) and no/low (± 3 sd) spray frequency areas and 7 (± 1 sd) in the unsprayed area. There was no statistically significant difference in species richness between the sites of different spray frequency ($P = 0.09$).

The transect data could not be statistically analysed due to the small number of replicates, but the data do show some trends (fig. 1). In both transects, the cover of gorse declined considerably between 2006 and 2016. The abundance of grasses also declined, while bracken and sedges increased. Forbs and native shrubs showed partially contrasting trends.

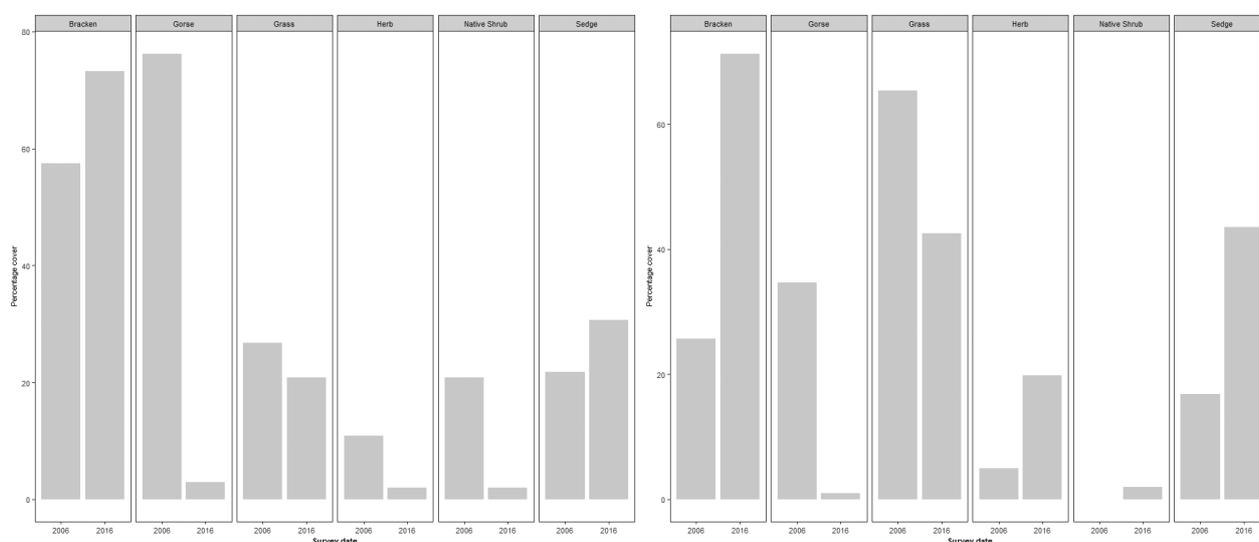


FIG 1. — Percentage cover of vegetation classes in Transect 1 (left) and Transect 2 (right) at Long Point Reserve in 2006 prior to widespread application of Grazon™ Extra and in 2016 following 10 years of herbicide application

DISCUSSION

None of the twelve soil samples collected from Long Point contained residues of picloram or triclopyr, despite multiple applications over a decade. Given we sampled across sites with a range of spray frequencies and application times (the most recent March 2016) and collected samples from directly under gorse plants sprayed six months earlier, it is surprising no herbicide residues were present.

Picloram is reported to have a half-life of between one month and three years, with a typical half-life in field studies of 20–49 days. Triclopyr is less persistent with half-lives of 4–314 days and 7–54 days in field studies (Tu *et al.* 2001, Lewis *et al.* 2016). The dissipation of both compounds is highly dependent on soil and environmental conditions (Tu *et al.* 2001, Lewis *et al.* 2016). Given the range of half-lives, it is possible picloram and triclopyr had mostly dissipated from the soil prior to sample collection. Triclopyr, and particularly picloram, are both subject to leaching, particularly in sandy soils such as at Long Point (Tu *et al.* 2001). We did not detect any herbicide residues in the area directly down slope of the heavily sprayed area, indicating leaching may not be occurring, however more research is required to determine whether the herbicide residues are leaching to deeper soil depths or off-site.

Another possibility for the lack of herbicide residues in the soil is that very little herbicide is reaching the soil surface. The spray contractor used is a highly skilled operator, taking care to avoid spray drift or excess herbicide application. Given we collected some samples directly under recently sprayed gorse plants and still did not detect any herbicide residues, this appears to be a likely scenario.

Our results indicate that the application of Grazon™ Extra has not resulted in reduced species diversity in areas of different spray frequency at Long Point Reserve. Trends in the line transect data suggest that while there has been a decline in gorse since widespread spraying at the site, there has been no consistent decline in any plant form. This is surprising given that picloram and triclopyr are both used to control a variety of woody plants and herbs (Tu *et al.* 2001) and so would be expected to kill native shrubs and herbs as well as gorse. Likewise this may be attributed to the skill of the spray contractor in avoiding non-target plants.

This research suggested that Grazon™ Extra carefully and selectively applied at Long Point Reserve, even in dense infestations, with repeat applications over extended time periods, does not persist in the surface soil at, or

directly down slope of, the spray site. However, we were constrained by resources which limited the number of soil samples collected and the way in which treatments were applied which created pseudoreplication. Further research is required to determine whether herbicide residues have remained in the litter layer (which was removed for analysis), leached to deeper soils or if long-distance dispersal and movement into the water table has occurred. Species diversity did not differ between unsprayed sites and sites of varying spray frequencies. It is important to note that herbicide persistence is highly dependent on soil and environmental properties and so this result may not be extrapolated to all areas. However, this is a very important finding which requires further research to determine whether concerns over off-target impacts of gorse control are founded.

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(accepted 2 October 2018)

