Final report on the results and analysis of the Wild Oats control experiment in the Nieuwoudtville Wildflower Reserve.

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By

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Introduction

Alien species and in particular alien annual grasses have been identified as a particular threat to Renosterveld (Milton 2004, Musil et al. 2005). Various methods such as herbicides, burning and clearing treatments have been used to control the abundance of alien grasses in renosterveld in the southern Cape (Musil et al. 2005). However, similar case studies for different areas are severely lacking and information on the most appropriate control methods for alien grasses on the Bokkeveld Plateau remain unknown. Alien grasses are one of the greatest threats to the biodiversity of the Bokkeveld Plateau, an area that has been identified as an area of exceptional diversity and endemism (van Wyk and Smith 2001). In heavily infested areas, the cover of alien grasses commonly exceeds 80% relative cover, demonstrating the ability of these grasses to invade and dominate local plant communities. This report details the SKEP-funded trial that has been carried out since 2007 in the Nieuwoudtville Wildflower Reserve. The different treatments that have been applied are described and their impact on the target species assessed.

Trial Layout

An area of approximately 20 ha was identified on the dolerite plains within the Nieuwoudtville Wildflower Reserve for this experiment. The area is heavily invaded by alien grasses, in particular Wild Oats, *Avena fatua*, but ryegrass *Lolium rigidum*, Wild Barley *Hordeum murinum*, and Brome *Bromus diandrus* are also common. Within the area identified for the experiment, five 30x100m treatment areas were laid out in 2007. Within each of these treatment areas three 10x10m plots were marked out and randomly assigned to one of three treatments as follows: Mow and Clear; Mow and Mulch, Control. In the Mow and Clear treatment, the 10x10m plots are mowed using a handheld 'weedeater' and the plant residue raked up and removed from the plot. In the Mow and Mulch treatment, the plots are similarly mowed, but the residue left where it falls. In the control treatment, the vegetation is left undisturbed. In order to prevent edge effects, the area treated was larger than the 10x10m plots, and usually consisted of a 30x30m block centred on the sample plot. In the area adjacent to each of the 30x100m blocks, an additional 10x10m plot was also laid out. These plots as well as the rest of the area surrounding the five treatment areas constituted the final treatment and were treated with selective herbicide (Co-Pilot). The mowing treatments were conducted in late September 2007 while the herbicide application was conducted in July 2008.

Sampling Design

In terms of the actual data collected within each sample plot, five 1x1m plots were laid out within each plot and the density and composition of the vegetation recorded within each of these subplots. As the density of alien grasses is very high, the density of grasses was assessed using a 20x20cm quadrat placed at the centre of each 1m^2 quadrat. The centre of each of these quadrats was also individually marked with a peg, such that the same site could be sampled from year to year, thereby reducing sampling variability and increasing the ability of the sampling design to detect changes in grass density and plant species composition and diversity. The final data matrix collected from each treatment thus consists of a species list of all species that occurred within the 10x10m treatment plots, as well as the cover of each species as recorded from the five 1m^2 samples and the density of alien grasses as recorded from the five 20x20cm quadrats placed at the centre of each 1m^2 quadrat. The vegetation was sampled in 2007 before the application of any treatments as well as in September 2008 once all the treatments had been applied.

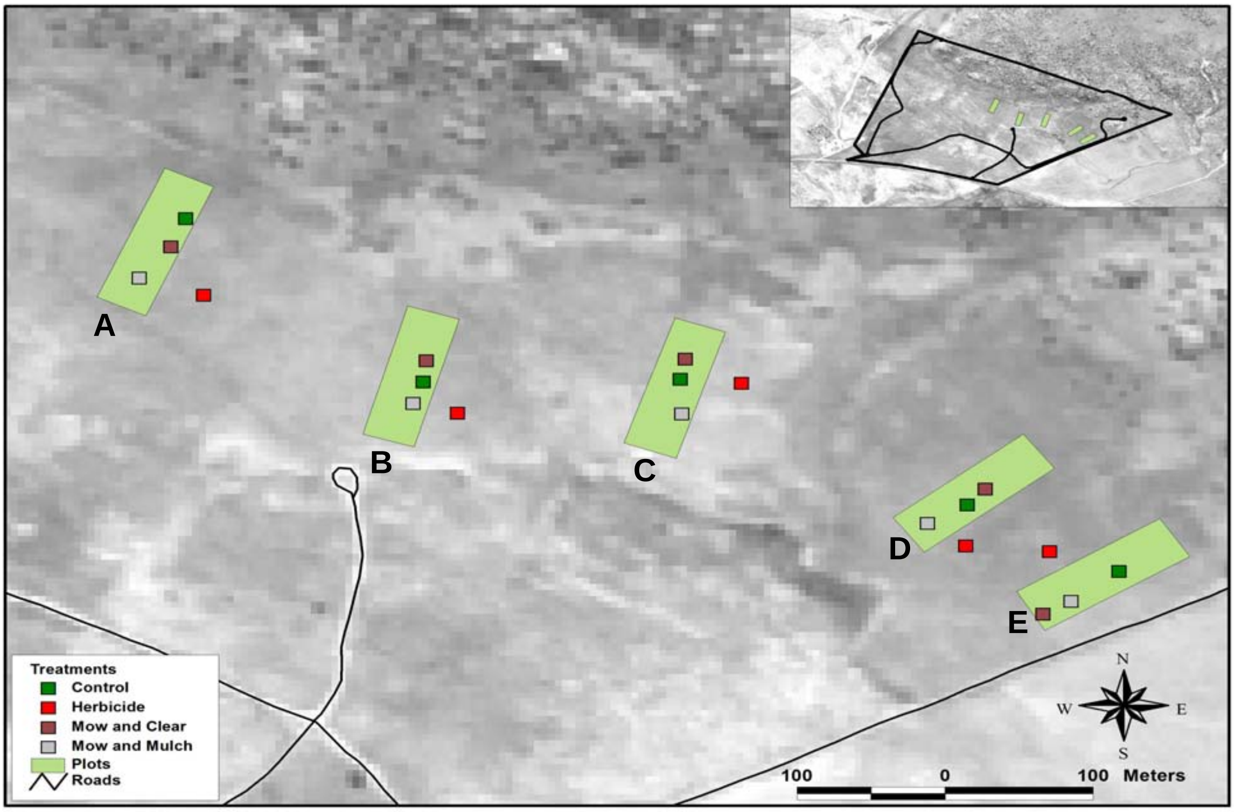

Figure 1. The layout of the alien grass eradication trial within the 115ha Nieuwoudtville Wildflower Reserve (Inset). Five 30x100m plots have been marked out and three treatments randomly located within each. An additional selective herbicide treatment has been located outside of each 30x100m plot, within the larger area that was treated with selective herbicide.

Results

Treatment effect on Wild Oats density

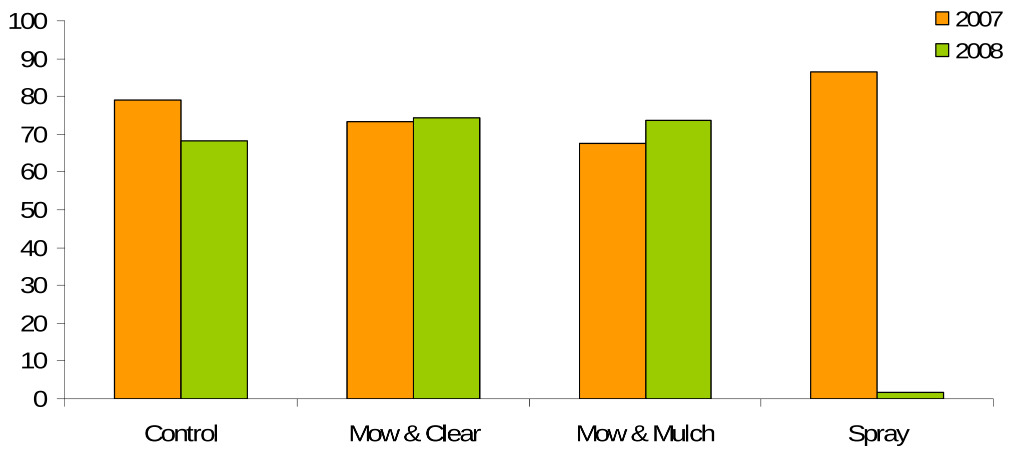

Figure 2. The mean density (No. per 400 cm^2) of Wild oats, *Avena fatua*, in each of the four treatments that were laid out within the Reserve, before treatment in 2007 and after all treatments in 2008.

The mean density of wild oats in the plots (Figure 2) was between 70 and 80 plants per 20x20cm plot, which translates to a mean density of 1750 to 2000 plants per square meter. This high density demonstrates the extent of the problem and the potential Wild Oats has to dominate communities and overshadow shorter species. Only the herbicide application appeared to have an effect on the density of Wild Oats (Figure 2), reducing the density to a negligible level. The mowing treatments had no apparent effect in reducing the abundance of Wild Oats compared to the control.

Treatment effect on other plant species

The species richness of all the different treatments was much higher in 2008 compared to 2007 (Figure 3). The higher species richness recorded in 2008, stems from the fact that in 2007 the data was collected in late September, when the vegetation had already started to dry out and many species of annual and geophyte were no longer present. There were no significant differences in species richness between the treatments in 2007 or 2008, except for the spray treatment which had a lower species richness in 2008 compared to the other treatments. The lower species richness of the spray plots in 2008, results from the fact that the herbicide had killed the annual grass species in these areas, thereby excluding them from these plots and lowering the overall species richness.

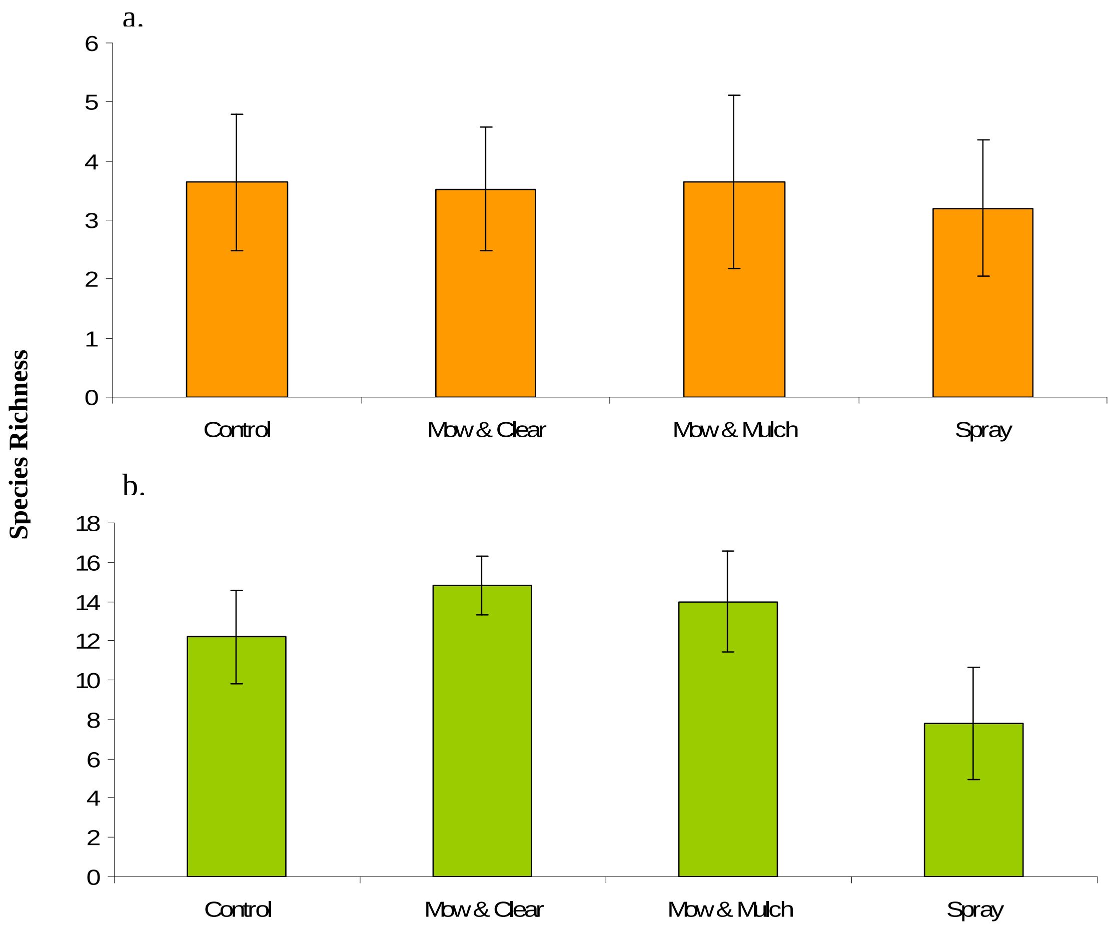

Figure 3. The mean species richness of the 1m^2 sample plots in each of the different treatments, in *a.* 2007 and *b.* 2008 (n= 25 in each case). Vertical bars are standard deviations.

Impact on different plant growth forms

In terms of the abundance of different plant growth forms in 2007 and 2008, there was very little difference among the treatments between years (Figure 4), except for the spray treatment which was highly effective at reducing annual grass abundance. Consequently, the spray treatment was the only one not dominated by annual grasses but rather by a more even mix of geophytes, forbs and annuals. The difference in total cover between the spray treatment and other treatments was 20%, and considering that the difference in cover of wild oats between the treatments was 68%, this indicates that the other species present in the spray treatment had increased in cover abundance by almost 50%. The dominant species within the spray treatment and the other treatments are listed in Table 1. This table indicates that *Lotononis hirsuta* had increased from an average of 4% cover in the other treatments to 24% in the spray treatment. Other species that increased substantially in the spray treatment include the alien annuals Medicago, Erodium and Amsinckia as well as the indigenous perennial forb *Arctotis acaulis*. The perennial grass *Ehrharta melicoides* changed little between the treatments.

Table 1. The mean cover of the six most abundant species listed independently for the spray treatment and the other treatments, as well as their rank within either treatment.

Species	**Other Treatment**		**Spray Treatments**	
	Mean cover (%)	**Species Rank**	**Mean cover (%)**	**Species Rank**
Total Cover	80.8		60	
Avena fatua	68.61	1	0.44	12
Lotononis hirsuta	4.25	2	24.03	1
Erodium cicutarium	0.69	5	8.8	2
Actotis acaulis	0.54	6	7.47	3
Medicago polymorpha	3.96	3	6.55	4
Amsinckia retrorsa	0.44	7	4.4	5
Morea fragrans	0.186	10	2.15	6
Ehrharta melicoides	1.37	4	1.14	8

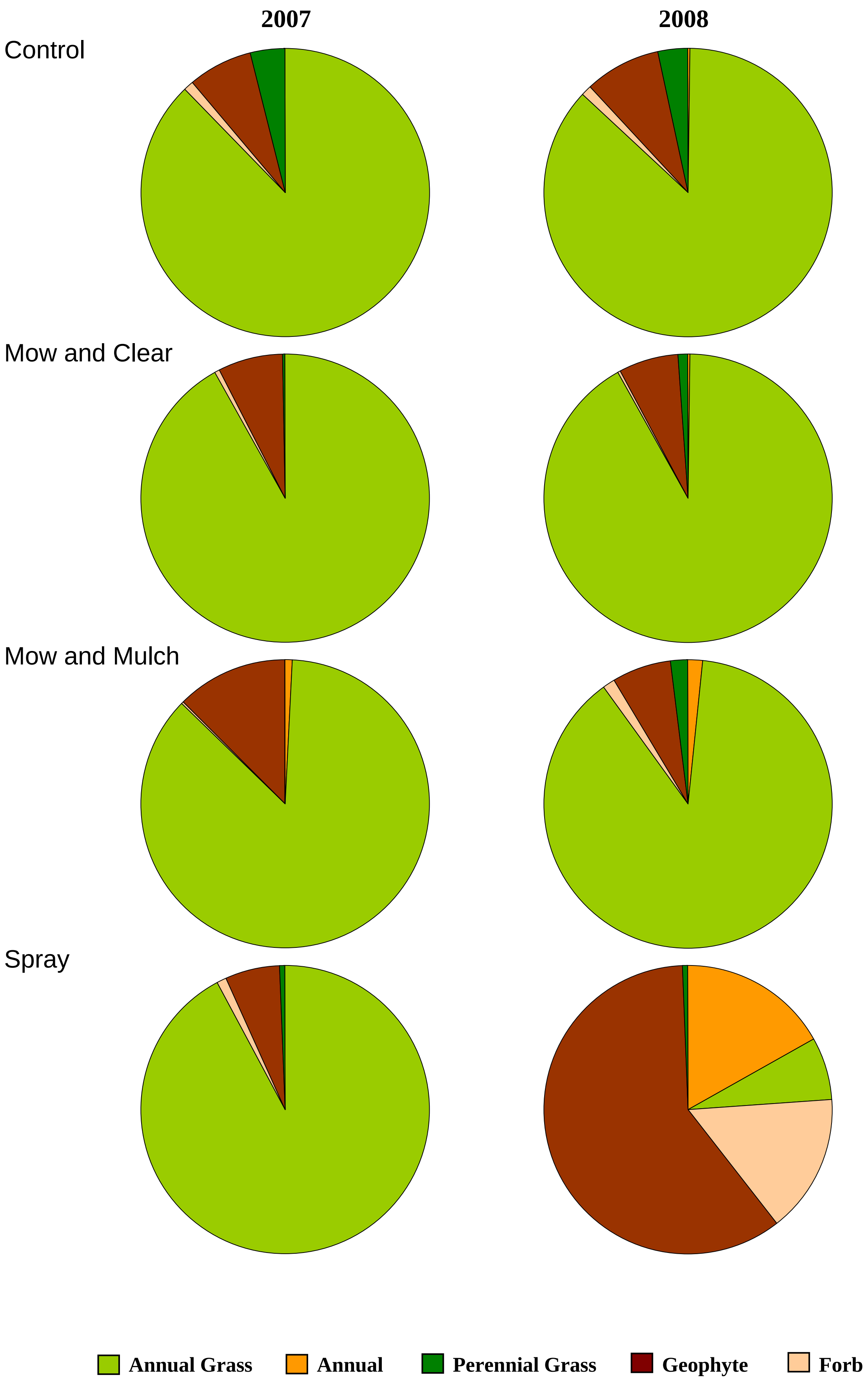

Figure 4. The relative cover of different plant growth forms in the different treatments in 2007 and 2008.

Discussion

The results indicate that spraying with selective herbicide is the only treatment that is effective in the short-term for reducing the abundance of Wild Oats. The results of this study as well as various other studies have demonstrated that mowing treatments need to be repeated several times before an effect becomes apparent (Wilson and Clark 2001). This is because not all Wild Oats seed germinates each year and so there is a large carry-over of seed from year to year. If timed correctly, mowing treatments can however reduce Wild Oats to low levels within 3-5 years (McGillion & Storrie 2006). Although there were some beneficial results in terms of an increase in indigenous bulb and forb species in the spray treatment, some alien species also increased. An increase in alien forb species has also been observed in other studies and appears to be a common side-effect of selective herbicides (Cox and Allen 2008). Whether or not this effect will persist or if the indigenous species will ultimately reduce the abundance of the alien species through competition in the future will require additional monitoring.

These results also indicate that spraying is not the ideal quick-fix it may at first appear, and that management in the post-spraying treatment will probably play a large role in determining the final outcome of the spray treatment. The post-spray period with its reduced cover of alien grasses represents a recruitment opportunity for the remaining species and seed set during this time will be an important factor that determines which species will benefit from the treatment. Given the current results, it should be expected that the major changes in vegetation composition in the spray areas will occur only in the second and third years after the application. This is because the high density of alien grasses may impact both the abundance and seed set of indigenous species before application, thereby limiting the potential response immediately after application. In the second and third years after application, the indigenous species will have benefited from the reduced competition, and the greater seed production expected in the first and second yeas will boost recruitment of these species. Poor grazing management in this period would also have a greater than expected negative effect because unpalatable species would be able to increase much faster than normal due to the reduced competition.

Apart from the increase in alien forbs associated with the herbicide application, the results also indicate that not all Wild Oats was eliminated from the treated areas. Regular visits to the experimental area indicate that the treatment itself was highly effective and that all plants which came into contact with the herbicide were killed. However the herbicide used (Co-Pilot) does not have a residual effect and does not prevent Wild Oats from germinating after the spray treatment. In years with an extended wet period, this reduces the final effectiveness of the herbicide because some Wild Oats germinates after the application. The late germinating Oats and the seed persisting in the seed bank mean that the Wild Oats population could build up quickly again after the treatment. Grazing could however be used effectively against the late-germinating oats because it would be in the vegetative stage while the majority of other species had already set seed. As a result it would be selected by livestock and seed set could be prevented or highly reduced with little impact on other species.

Considering that it may be necessary to spray an area more than once and the potential unknown ecological knock-on effects of herbicide application, mowing should still be considered as a potentially useful treatment to reduce alien grasses, especially on old lands where soil compaction is not such an issue. Where there is sufficient residue it could be made into hay which would provide useful fodder and offset the cost of the treatment. Although it would have to be repeated more often, the fodder provided could ultimately reduce the cost to below that of the spray treatment. Since the mowing would also remove biomass, it would also serve to bring down the soil nitrogen levels which would also favour the return of the indigenous species. The height at which the mower was set would however be a critical aspect of such treatment as very low settings would impact all species negatively.

References

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