Report on the clearing trial of *Pteronia incana* (bluebush) and *Elytroppappus rhinocerotis* (renosterbos) in Mgwalana catchment, Ngqushwa District, Eastern Cape Province: rehabilitating degraded rangeland

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Introduction

Invasion of blue bush (*Pteronia incana*) and *renosterbos* (*Elytropappus rhinocerotis*) continues in the rangeland of the Mgwalana catchment of the Ngqushwa district (formerly Peddie) of the Eastern Cape (Kakembo et al. 2006, Kakembo et al. 2007). These species, both indigenous to the Nama karoo region of South Africa, successfully invade natural grassland and thicket. Both species have been recorded in un-disturbed rangelands across the Great Fish river and Keiskamma river valleys, but are known to increase and become dominant in the absence of fire or when excessive soil disturbance has occurred. Disturbance of the soil surface by excessive trampling, cultivation (Kakembo 2001) or subterranean mammal activity (e.g. termites or mole rats) creates gaps which can be colonized by seedlings.

Control of both species on free-hold rangeland with adequate infra-structure can be affected using fire. However, communal rangelands do not lend themselves to the use of fire, as there are no options for the control of grazing after burning, and little opportunity to build up fuel loads which would enable a burn to be applied. This is principally due to the absence of livestock control systems (adequately fenced and gated camps, water provision) in areas under communal tenure. The project aims at evaluating the cost effectiveness of a range of manual clearing techniques which may be used as an alternative control measure. In order to evaluate the effectiveness and cost of clearing these species, a project was initiated to experimentally clear a number of trial areas as part of the National Department of Agriculture's Landcare Programme. Five sites of known bluebush and renosterbos infestation were identified from high resolution near infra-red (NIR) photography in the Mgwalana catchment. In four sites, intensive manual clearing was carried out to assess the cost and efficacy of three clearing techniques. At the fifth site, a landscape-scale clearing action occurred to measure the impact of clearing on the MODIS leaf area index (LAI). The sites varied in the density of infestation.

Aim

The aim of this trial was to evaluate the cost and effectiveness of manual clearing of blue bush (lavender bush) (*Pteronia incana*) and renosterbos (*Elytropappus rhinocerotis*) on the communal rangelands of the Ngqushwa district.

Methods

Three physical clearing treatments were applied at each of the intensive clearing site in March 2003. Treatments were applied to three randomly selected sub-plots of the five quadrangular sub-plots of approximately 3ha. (100mx300m). One sub-plot was used as a control, and the fifth was used as the area to be packed with dead material and burned at a later stage. A burn was applied to these sites on 17 September 2003. The three physical clearing treatments were applied during a single operation in March 2003. The first used a specially designed instrument or “dicker” (manufactured by Fabcomp, King Williams Town), which pulls the rooted plant out of the ground. The second used commercial lopping shears to cut the plant off at the base, and the third employed a “slasher” to chop the plant off.

At all sites, the density of large plants (>0.5m in height), was determined using the point-centred quarter (PCQ) technique. The boundaries of each treatment were determined from the aerial photographs, and marked in the field using a GPS. Each team was allocated an equal amount of cash to complete the three treatments and pack the burn plot. The limiting factor to completing the 3 ha was the finances allocated to each team. Teams were encouraged to complete the full 3ha, but at the highest densities of infestation this was not possible within the financial allocation. At the completion of the 22 day working period, the area completed by each team was recorded using a GPS and the area calculated using a GIS package.

MODIS LAI product (Collection 4)

We acquired 8 years of the MODIS 8-day 1 km Collection 4 (MOD15A2) composite LAI/FPAR product (Knyazikhin et al. 1998) for the period March 2000 to December 2007 from the NASA Distributed Active Archive Centre. The data were extracted from the archive using the MODIS re-projection tool (HegTool) and imported into IDRISI (Version I32.11, Clark Labs) image processing package to create an 8-year data stack. The geo-codes for the centre of site 5 and the two control sites (village, un-cleared and grassland) were entered into the GIS and 8-day LAI values for each site were extracted.

Photo: Tony Palmer. The dicker instrument being operated by one of the ladies from the village of Nyaniso,

Results
The results of the costs associated with the various treatments are presented (Table 1).

Treatment	Site 1	Density		Team Celetyuma		Total person days	
	Area (ha)		days worked	Area/day	Team size		Cost per ha.
Dicker	1.99441	High	38	0.052484	3	114	R 2,958.86
Lopper	2.359212	Low	7	0.33703	3	21	R 460.77
Slasher	2.971566	Low	6	0.495261	3	18	R 313.56
Pack	1.944959		17	0.114409	1	17	R 452.45
Control	3						
					Total	170	R 51.76
	Site 2			Team Mgwalana			
	Area (ha)		days worked	Area/day	Team size		Cost per ha.
Dicker	0.985735	High	18	0.054763	3	54	R 2,398.39
Lopper	0.716058	High	21	0.034098	3	63	R 3,851.93
Slasher	0.78571	High	21	0.037415	3	63	R 3,510.47
Pack	0.135282		21	0.006442	1	21	R 6,796.21
Control	0.764488						
					Total	201	R 43.78
	Site 3			Team Mgwalana:Youth			
	Area (ha)		days worked	Area/day	Team size		Cost per ha.
Dicker	0.322315	High	22	0.014651	3	66	R 8,190.74
Lopper	0.547779	High	22	0.024899	3	66	R 4,819.46
Slasher	0.649184	High	22	0.029508	3	66	R 4,066.65
Pack	0.62375		22	0.028352	1	22	R 1,410.82
Control	0.759029						
					Total	220	R 40.00
	Site 4			Team:Amahlubi			
	Area (ha)		days worked	Area/day	Team size		Cost per ha.
Dicker	2.429	Moderate	11	0.220818	3	33	R 934.03
Lopper	2.409477	Moderate	14	0.172105	3	42	R 1,198.39
Slasher	2.870326	Moderate	13	0.220794	3	39	R 934.13
Pack	0.52434		14	0.037453	1	14	R 1,835.64
Control	2.575065						
					Total	128	R 68.75

Near infra-red imagery was recorded in October 2004 over 2 sites using the Kodak DCS420 infra-red digital camera. Eighteen months after clearing (October 2004) there were some visible differences in the near infra red reflectance and NDVI's (Figure 1) between treatments, but these were not all significant and their interpretation must be dealt with cautiously. The dicker treatment on Site 3 had a higher infra-red signal and NDVI than the other treatments (Figure 1).

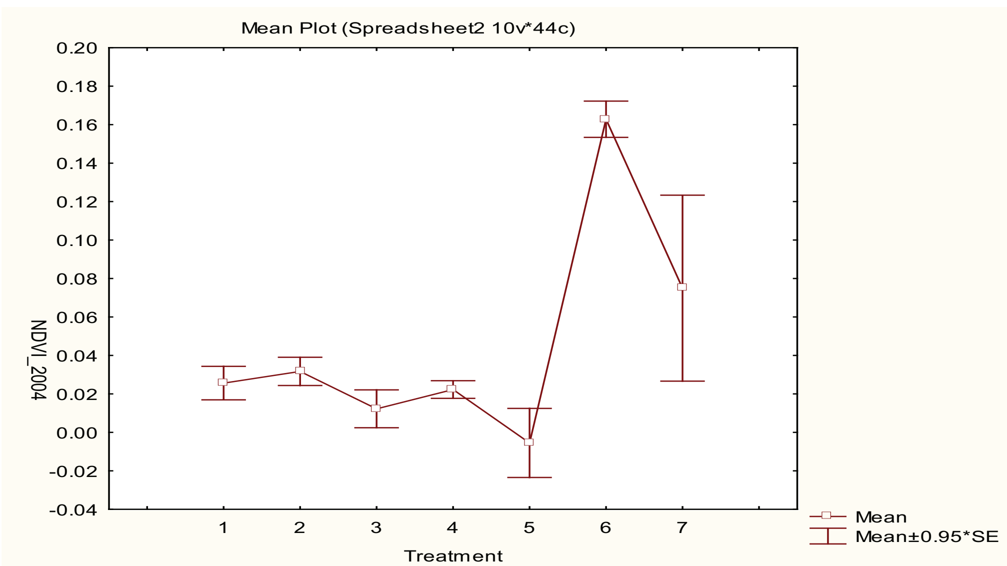

Figure 1. NDVI values for the 4 treatments, control, adjacent woody thicket and good condition grassland in October 2004. NDVI was calculated from the NIR and red bands of the Kodak DCS420 digital camera. 1=Dicker, 2=Control, 3=Lopper, 4=Slasher, 5=Burned (Falkia repens absent)/ bare soil, 6=Riparian thicket (woody species), 7=Good grassland, un-invaded by Pteronia incana.

This pattern was not repeated at site 2. This may be due to the stimulation of the soil microbial activity after complete extraction of plants by the dicker, resulting in the release of nutrients and greater active green growth. During October 2004, these burn scars were covered by a single herbaceous species, Falkia repens. This was not a desirable species, and as there was only one herbaceous species present, this was likely to die off during the dry season, leaving no ground cover. The NDVI of woody shrubs and healthy grassland were significantly higher than Pteronia incana stands and clearing treatments (Figure 2).

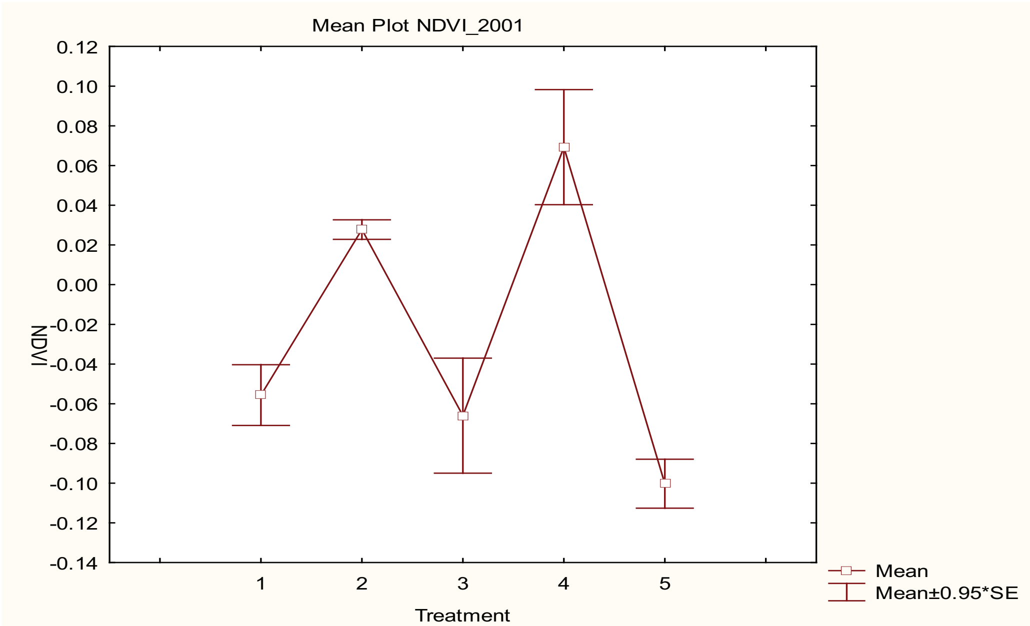

Figure 2. The mean and standard errors of the DCS 420 NDVI's for the five treatments. The riparian zone (Treatment 4), with its woody component and high perennial grass cover has the highest NDVI, followed by the control grassland in good condition (Treatment 2). 1= sparse grassland with Pteronia incana, 2=grassland with Elytropappas rhinocoerotis (control), 3=Pteronia incana shrubland, 4=riparian thicket, 5=sparse shrubland on shallow rocky soil.

During a site visit in June 2007, it was clear that there was an increase cover of bluebush from those seedlings that had not been extracted during the clearing operation. The clearing techniques only removed large plants and left many seedlings and seeds. Opening up of the gap created space for the seedlings to grow and they have been growing vigorously. I expect a higher NDVI for these sites during 2008, as the emerging bluebush seedlings are in an active growth phase. Further assessment was planned during 2008, with the possible purchase of more ASTER imagery. Using a supervised classification procedure on the ASTER data, we defined the area invaded by high densities of *Pteronia incana* to be approximately 27000ha. The image did not cover the whole of Ngqushwa, and therefore represents an under-estimate of the extent of the problem. A time series plot of the 8-day MODIS leaf area index (LAI) of the cleared area and the three control sites was provided for the period April 2000 to December 2007.

Prior to the clearing event in November 2003, the *Pteronia* infested site (Site 5) had a lower LAI than the grassland site and a higher NDVI than the village. This matched well with the expectation for the site, as the 1km MODIS pixel included some good condition grassland. After clearing in November 2003, there was a decline in the LAI for that site for the whole of 2004 compared with the control-village and control grassland where, no treatment took place. This agrees with the reduction in leaf area that would have accompanied the clearing of 30ha of *P. incana* at site 5. The decline in MODIS LAI was significant at the end of 2004, but in the growing season of 2005 the MODIS LAI had increased to a value midway between the control-village and control grassland. This was an indication of the extent of the re-growth of P. incana after the treatment. The very low LAI values of the treated-site (Site 5), control-village and control- *P. incana* relative to the control-grassland are indicative of extremely low production potential of the invaded grasslands. In order to quantify the possible impact of this difference on grassland production, I integrated the area under the two time series plots for the cleared and grassland sites.

The leaf area index of the undisturbed grassland in the growing season was significantly higher than that of the degraded rangeland at the other three sites (village, cleared and control-*P. incana*). This difference can be attributed to the lower water use efficiency of the senescent stands of P. incana and the effectiveness of grassland in using rainfall to capture carbon. A simple integration of the area under the curve in a normal year (e.g. 2004) reveals that the annual LAI of the grassland exceeds that of the degraded *P. incana* by 213%. In addition, *P. incana* was totally un-available to livestock, so this figure could be inflated by perhaps as much as another 200%, making the production of the grassland nearly 5 times greater than that of the degraded rangeland.

Conclusion

The project provided an indication of the approximate labour cost of clearing varying densities of bluebush infestation. Under very dense conditions, labour costs per hectare cleared were extremely high (Table 1). These densities did not prevail at consistent levels throughout the landscape, and an approach was recommended where groups are invited to quote on clearing large, previously measured areas. Using this approach, an area of 30ha was cleared during November 2003. This area (Figure 4), comprising a large proportion of high density infestation, was cleared at a cost of R1000 per ha. This represents an example of how the results of the clearing trials can be applied to large scale clearing and rehabilitation of rangeland. Results on the kill rate of the three clearing techniques showed that loppers and slashers did not achieve a significant kill rate (<5%). Dickers achieve a high kill rate (100%) of adult plants but there was a substantial seedling re-growth. Follow up is required. The burns were too hot, caused soil scorching and were colonized by a single species. This was not a desirable state and hot burning (scorching) should be avoided at all costs. However a more appropriate burning programme could be considered if a rest can be guaranteed after the burn. This would have to include the cost of fencing to exclude all herbivores for a lengthy period (6-12 months) before and after the burn.

References

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