Comparison of effect of different methods of removing broom on plant community composition / structure and on ground-active invertebrate communities

Main editor: Ewan Hitchcoe. Introduction and method: Abigail Croker, Hayley Dancer, Mellissa Stephens, Katherine Lower. Results and discussion: Ewan Hitchcoe.

Participants - Stuart Farrington, Ewan Hitchcoe, Madison Errington, Miriam Treadway, Abby Pidgen, James Sokolnicki, Lewis Swadling, Katherine Lower, Hayley Dancer, Eleanor Carlton, Joshua Blaber. Keane Aroun-Maxwell, Melissa Stephens, Abigail Croker.

Introduction:

Humans have been present in the Pico's de Europa since the last interglacial period, consequently these mountains have a long history of livestock farming activity that has transformed and shaped the landscape ever since.

The evolution of social and economic factors here has resulted in many young people moving away from the park and the difficult lifestyle that it offers, preferring to live and work in less rural areas (Rescia et al. 2008). This exodus has led to a decrease in livestock farming and in turn grazing activity has fallen dramatically. The result of this is that the landscape is beginning to return to its natural state. At this stage this 'rewilding' effect would have disastrous consequences for the ecology of the area.

To combat this, it has been decided that it is necessary to clear areas of vegetation, specifically Broom, to open up the grasslands so that grazing can be reintroduced in these areas.

In this study we are aiming to find most effective method of clearing the land for cattle grazing. The local preference for vegetation clearance is to simply burn it, however, this is not a viable option due to obvious ecological concerns and the fact that it is illegal within the Pico's de Europa National Park.

As well as judging the effectiveness of the treatment methods, we must also consider the labour intensity and therefore associated costs in terms of both time and money for each removal method, and not least we must assess the ecological impact of each method on both the vegetation, invertebrates and other inhabitants, such as the Capercaillie *Tetrao urogallus*. a species of large grouse that is currently experiencing rapid decline within the national park as well as across Europe.

Method:

Three different zones were surveyed. Each zone contained four 10mx10m homogenous plots with Bilberry being present, for a total of 12 plots. At each plot a different treatment method had been used, the treatments being manual removal by hand cutting, retro spider (a type of mechanical thrasher), removal by tractor and a control where no treatment had been carried out. The treatments had been carried out in October 2015, approximately 9 months previously.

At each plot four 2m squared quadrats were surveyed. The quadrats were located at each of the 4 corners but not within 1m of the plot boundary.

For each quadrat the percentage cover of different vegetation types, as well as average mean height of each type, maximum and minimum height of Bilberry, heathers, Broom, forbs, graminoids and bare ground were recorded. 5 random heights within the quadrat were measured and the mean height, minimum and

maximum height for the quadrat as a whole and overall volume were estimated. This was repeated at each zone.

An invertebrate pitfall trap was placed in the centre of each plot. The pitfall trap consisted of a plastic cup filled ¾ with water and peptidoglycan. The pitfall traps were collected up and reset every 6 days, three times consecutively i.e. the first group was set on 16 July and collected on the 22nd July, the second group was set on 22nd July and collected on the 28th July and the final group was set on the 28th July and collected on the 3rd of August. The contents of the pitfall traps were recorded at each collection.

When analysing the results, these questions were considered;

What is the effect of different methods of removing broom on plant and surface-active invertebrate communities?

Do the treatments affect the % cover of abundance of different plant species / groups?

Do the treatments affect the structure of vegetation?

Do the treatments affect the abundance of surface active invertebrates?

Do the treatments affect the community composition of surface active invertebrates?

Fig 1. Survey team assess a quadrat.

Results: Vegetation structure / composition

Figures 2-5 represent the raw data collected through surveys of the 3 zones. Further analysis of the raw data is represented in Figures 6-10, which are graphs made using the mean values from each of the 3 different treatment methods plus the control, over all 3 zones.

In the case of ground cover diversity (Fig. 10.) bare ground cover has also been factored in as a 'cover type' as there is a strong likelihood that bare ground is significant habitat type that may affect invertebrate activity (Fahrig and Jonsen 1998).

BLOCK	ZONE 1	ZONE 1	ZONE 1	ZONE 1	ZONE 2	ZONE 2	ZONE 2	ZONE 2	ZONE 3	ZONE 3	ZONE 3	ZONE 3
Treatment	Control	Control	Control	Control	Control	Control	Control	Control	Control	Control	Control	Control
quadrat	A	B	C	D	A	B	C	D	A	B	C	D
Surveyor name 1	Liz				Liz				Liz			
Surveyor name 2	Ant				Ant				Ant			
Bilberry % cover	2	0	20	2	3	0	0	0	3	0	0	15
Heathers % cover	10	30	25	70	70	85	15	65	20	0	0	35
Broom % cover	30	30	40	25	20	20	45	15	75	25	50	35
Herbs % cover	4	5	2	4	2	1	2	1	2	1	0.5	8
Grass % cover	81	30	30	7	20	9	50	20	20	65	30	15
Bare Ground % cover	17	15	5	2	7	0	10	7	0	30	20	3
5 Random Vegetation Height (cm)												
	11	30	27	27	24	86	8	60	70	7	5	28
	79	102	81	7	98	80	86	10	47	69	12	40
	9	23	17	92	6	20	22	0	98	68	32	98
	26	9	10	87	32	78	14	10	29	0	60	67
	40	75	88	12	27	8	16	28	74	8	0	4
Max Overall veg height (cm)	105	118	125	129	77	145	97	134	188	103	103	106
Min Overall veg height (cm)	0	0	0	0	0	0	0	0	3	0	0	0
Mean Overall veg height (cm)	38	55	60	63	26	80	50	55	60	28	40	80
Overall Vegetation Volume												
0-10	90	85	95	98	93	99	90	93	100	70	80	97
10 20	60	50	85	90	85	95	85	85	25	20	50	95
20-30	50	15	30	70	25	80	60	50	35	10	30	85
30-40	35	10	30	40	20	80	50	50	30	15	30	90
40-50	25	10	40	45	25	60	30	45	40	15	25	90
50-60	15	20	40	45	5	60	25	45	50	15	15	50
60-70	12	5	5	40	2	60	15	40	60	5	15	50
70-80	7	5	3	15	0	60	5	30	55	0.5	10	45
80-90	5	5	1	15	0	50	1	25	20	0.5	5	35
90-100	2	2.5	0	10	0	30	0.5	15	10	0.5	1	25
100-110	1	3	0	10	0	20	0	5	3	0	0	20
110-120	0	1	0	5	0	5	0	1	2	0	0	10
120-130	0	0.5	0	1	0	2	0	0	1	0	0	5
130-140	0	0	0	0	0	0.5	0	0	0	0	0	2
140-150	0	0	0		0	0	0	0		0	0	0.5
Bilberry max ht	10	0	26	10	15	0	0	0	22	0	0	44
Bilberry min ht	5		8	7	8	0	0	0	10	0	0	4
Bilberry mean ht	7.5		15	8	11	0	0	0	15	0	0	25
Heathers max ht	22	65	83	80	106	98	90	134	98	0	0	78
Heathers min ht	10	7	6	14	8	19	10	50	18	0	0	25
Heathers mean ht	15	33	42	36	79	72	40	90	70	0	0	62
Broom max ht	105	120	94	108	146	143	97	78	118	86	103	160
Broom min ht	12	9	17	19	50	45	40	35	70	27	22	22
Broom mean ht	55	60	50	70	118	125	15	60	120	45	53	68
Herbs max ht	31	35	43	37	8	30	10	31	27	16	32	48
Herbs min ht	5	3	8	8	4	7	4	5	12	4	3	8
Herbs mean ht	20	12	22	17	5	15	6	15	20	10	10	25
Grass max ht	65	80	125	83	61	47	42	71	10	107	68	78
Grass min ht	7	5	6	5	4	7	4	6	14	5	3	5
Grass mean ht	25	20	20	17	20	20	15	13	17	20	15	20

Fig 2. Vegetation structure / composition results table for Zones 1,2 and 3 - Control plots (P1).

BLOCK	ZONE 1	ZONE 1	ZONE 1	ZONE 1	ZONE 2	ZONE 2	ZONE 2	ZONE 2	ZONE 3	ZONE 3	ZONE 3	ZONE 3
Treatment	Manual	Manual)	Manual	Manual	Manual	Manual	Manual	Manual	Manual	Manual	Manual	Manual
quadrat	A	B	C	D	A	B	C	D	A	B	C	D
Surveyor name 1	Hayley Dancer				Maddie				Maddie			
Surveyor name 2	Kat Lower				Miriam				Miriam			
Bilberry % cover	1	0	15	0	15	0	0	0	30	0	0	0
Heathers % cover	0	0	2	0	15	15	10	30	2	0	10	0
Broom % cover	0	0	0	0	0	0	0	0	0	0	20	0
Herbs % cover	5	17	5	8	5	5	20	20	8	10	50	30
Grass % cover	50	50	60	60	10	40	30	20	50	30	20	60
Bare Ground % cover	50	40	30	40	55	40	40	30	10	60	0	10
5 Random Veg Height (cm)												
	6	6	17	20	7	3	34	11	12	5	6	6
	10	21	13	16	4	19	11	10	4	8	4	8
	16	42	6	27	4	9	3	8	10	12	6	7
	35	20	5	0	9	32	3	12	25	4	10	5
	18	3	7	4	11	43	5	12	5	22	4	15
Max Overall veg height (cm)	64	68	126	17	19	63	82	32	69	48	65	49
Min Overall veg height (cm)	2	1	1	2	3	4	2	4	4	2	2	2
Mean Overall veg height (cm)	6	9	9	9	9	15	4	10	11	10	6	6
Overall Vegetation Volume												
0-10	65	0	70	65	50	25	70	25	40	20	20	25
10 20	20	9	12	6	15	20	30	1	0	0	1	1
20-30	5	2	1	0	1	4	5	1	0	0	1	1
30-40	2	2	1	0	1	1	1	1	0	0	1	1
40-50	1	1	0	0	4	1	1	0	0	0	0	0
50-60	1	1	0	0	0	0	1	0	0	0	0	0
60-70	1	0	0	0	0	0	1	0	0	0	0	0
70-80	0	0	0	0	0	0	1	0	0	0	0	0
80-90	0	0	0	0	0	0	1	0	0	0	0	0
90-100	0	0	0	0	0	0	0	0	0	0	0	0
100-110												
110-120												
120-130												
130-140												
140-150												
Bilberry max ht	4	0	16	0	19	0	0	0	14	0	0	0
Bilberry min ht	2	0	4	0	8	0	0	0	3	0	0	0
Bilberry mean ht	4	0	8	0	12	0	0	0	6	0	0	0
Heathers max ht	0	0	7	0	14	6	11	7	12	0	11	0
Heathers min ht	0	0	2	0	7	2	3	3	4	0	2	0
Heathers mean ht	0	0	4	0	9	5	9	5	7	0	9	0
Broom max ht	0	0	0	0	0	0	0	0	0	0	8	0
Broom min ht	0	0	0	0	0	0	0	0	0	0	2	0
Broom mean ht	0	0	0	0	0	0	0	0	0	0	5	0
Herbs max ht	22	38	11	28	7	11	9	7	6	12	8	8
Herbs min ht	10	18	9	2	3	7	3	4	2	6	2	4
Herbs mean ht	15	23	8	17	5	2	7	6	5	9	6	6
Grass max ht	64	68	126	71	17	63	82	32	69	48	65	49
Grass min ht	2	1	1	1	2	5	6	4	3	4	2	4
Grass mean ht	11	23	11	12	10	13	10	10	9	8	8	7

Fig 3. Vegetation structure / composition results table for Zones 1,2 and 3 - Manual method plots (P2).

BLOCK	ZONE 1	ZONE 1	ZONE 1	ZONE 1	ZONE 2	ZONE 2	ZONE 2	ZONE 2	ZONE 3	ZONE 3	ZONE 3	ZONE 3
Treatment	Retro Spider	Retro Spider	Retro Spider	Retro Spider	Retro Spider	Retro Spider	Retro Spider	Retro Spider	Retro Spider	Retro Spider	Retro Spider	Retro Spider
quadrat	A	B	C	D	A	B	C	D	A	B	C	D
Surveyor name 1	tuart Farrington				Joshua Blaber				Abi			
Surveyor name 2	Abby Pidgen				Ellie carlton				Mel			
Bilberry % cover	1	0	0	15	0	8	5	0	0	5	30	0
Heathers % cover	2	1	0	10	6	6	0	8	0	5	5	3
Broom % cover	5	10	10	10	0	0	0	0	0	0	0	0
Herbs % cover	4	10	5	5	4	14	18	22	5	3	3	20
Grass % cover	55	60	55	35	10	51	41	60	70	40	10	50
Bare Ground % cover	40	40	30	50	80	21	36	10	40	80	90	50
5 Random Veg Height (cm)												
	12	26	13	17	5	6	7	11	8	4	14	10
	15	20	16	20	3	12	4	9	11	34	6	21
	23	7	7	11	16	36	12	6	17	12	6	8
	10	5	16	27	40	12	36	46	11	18	9	12
	23	22	13	10	2	6	4	6	7	7	72	26
Max Overall veg height (cm)	81	80	80	86	40	45	42	39	77	38	45	84
Min Overall veg height (cm)	1	1	1	3	1	2	1	1	2	1	1	2
Mean Overall veg height (cm)	20	10	14	22	9	14	8	7	14	13	10	10
Overall Vegetation Volume												
0-10	60	25	50	40	20	74	51	70	45	55	30	70
10 20	30	10	20	10	14	80	45	8	10	40	2	10
20-30	5	4	5	5	5	62	21	3	5	3	1	1
30-40	5	3	1	1	1	5	6	4	0	0	0	0
40-50	4	1	1	1	0	0	7	0	0	0	0	0
50-60	1	1	1	1	0	0	0	0	0	0	0	0
60-70	1	1	1	1	0	0	0	0	0	0	0	0
70-80	1	1	1	1	0	0	0	0	0	0	0	0
80-90	1	0	0	1	0	0	0	0	0	0	0	0
90-100	0	0	0	1	0	0	0	0	0	0	0	0
100-110	0	0	0	0	0	0	0	0	0	0	0	0
110-120												
120-130												
130-140												
140-150												
Bilberry max ht	16	0	0	15	0	0	0	0	0	21	16	0
Bilberry min ht	1.5	0	0	1	0	0	0	0	0	2	2	0
Bilberry mean ht	4	0	0	9	0	0	0	0	0	8	9	0
Heathers max ht	9	0	0	15	15	14	10	8	0	14	10	8
Heathers min ht	2	0	0	4	5	2	1	2	0	2	1	2
Heathers mean ht	3	0	0	11	9	8	7	4	0	8	7	4
Broom max ht	24	27	34	30	0	0	0	0	0	0	0	0
Broom min ht	8	7	9	8	0	0	0	0	0	0	0	0
Broom mean ht	11	12	12	14	0	0	0	0	0	0	0	0
Herbs max ht	36	10	32	39	15	41	28	13	15	41	28	13
Herbs min ht	1.5	1	2	13	5	5	7	2	5	5	7	2
Herbs mean ht	13	4	13	28	11	20	16	4	11	20	16	4
Grass max ht	81	80	80	86	40	45	42	39	77	58	44	84
Grass min ht	1	2	1	3	3	2	1	2	3	2	2	2
Grass mean ht	16	10	14	22	20	12	12	11	20	12	12	55

Fig 4. Vegetation structure / composition results table for Zones 1,2 and 3 - Retro spider method plots (P3).

BLOCK	ZONE 1	ZONE 1	ZONE 1	ZONE 1	ZONE 2	ZONE 2	ZONE 2	ZONE 2	ZONE 3	ZONE 3	ZONE 3	ZONE 3
Treatment	Tractor	Tractor	Tractor	Tractor	Tractor	Tractor	Tractor	Tractor	Tractor	Tractor	Tractor	Tractor
quadrat	A	B	C	D	A	B	C	D	A	B	C	D
Surveyor name 1				Keana	Hayley Dancer				ewan			
Surveyor name 2				Lewis	Kat Lower				james			
Bilberry % cover	30	19	40	3	10	15	0	0	6	7	4	2
Heathers % cover	5	3	8	3	0	10	5	5	2	2	10	2
Broom % cover	0	3	1	4	0	0	0	0	5	3	0	1
Herbs % cover	5	15	6	5	8	5	20	3	5	3	3	3
Grass % cover	30	50	25	75	70	40	65	45	30	15	30	15
Bare Ground % cover	30	10	25	10	30	45	40	56	65	80	70	85
5 Random Veg Height (cm)												
	14	10	16	16	8	12	14	4	10	10	37	7.5
	10	12	9	10	45	7	12	7	12	15.5	11.5	22
	9	10	3	9	12	10	4	16	8	9	21.5	23.5
	20	3	7	3	21	17	34	12	8	6.5	8	48.5
	5	47	49	8	4	5	42	6	12	11	10	11
Max Overall veg height (cm)	53	45	71	91	50	53	62	64	84	1	70	1
Min Overall veg height (cm)	1	1	2	1	2	1	1	14	0.5	48	1.5	65
Mean Overall veg height (cm)	20	6	15	20	12	12	12	14	12	5	14	12
Overall Vegetation Volume												
0-10	45	15	60	45	60	55	60	65	25	15	20	12
10 20	3	4	7	10	30	30	42	15	10	10	15	8
20-30	5	3	4	3	2	2	5	5	6	5	6	5
30-40	2	3	2	3	1	1	2	1	3	1	4	4
40-50	0	1	2	2	1	1	1	1	1	1	2	2
50-60	0	0	2	2	0	1	1	1	1	0	1	1
60-70	0	0	3	2	0	0	1	1	1	0	1	1
70-80	0	0	0	2	0	0	0	0	1	0	0	0
80-90	0	0	0	3	0	0	0	0	1	0	0	0
90-100	0	0	0	0	0	0	0	0	0	0	0	0
100-110												
110-120												
120-130												
130-140												
140-150												
Bilberry max ht	17	31	14	14	8	15	0	0	15	15	11.5	14
Bilberry min ht	1	2	1	1	2	1	0	0	7	10	4	2.5
Bilberry mean ht	10	7	6	9	7	8	0	0	13.5	7	8	5.5
Heathers max ht	14	12	16	12	0	9	8	15	7	9	14	13
Heathers min ht	4	5	3	3	0	1	1	1	3.5	4	1.5	1.5
Heathers mean ht	7	7	5	5	0	6	4	5	5	7	4.5	5.5
Broom max ht	0	8	1	9	0	0	0	0	17	7	0	17.5
Broom min ht	0	3	1	4	0	0	0	0	6	5	0	2.5
Broom mean ht	0	4	1	6	0	0	0	0	7.5	6	0	8
Herbs max ht	45	35	29	15	41	48	34	13	31	19	39	30
Herbs min ht	12	17	13	2	3	1	4	1	11	17	7	6
Herbs mean ht	20	21	21	8	16	16	22	5	21	18	24	16
Grass max ht	53	47	71	91	50	53	67	64	34	48	70	65
Grass min ht	2	2	2	1	1	2	6	1	50	7	3	3.5
Grass mean ht	15	6	4	20	36	14	32	11	14	15	10	15

Fig 5. Vegetation structure / composition results table for Zones 1,2 and 3 - Tractor method plots (P4).

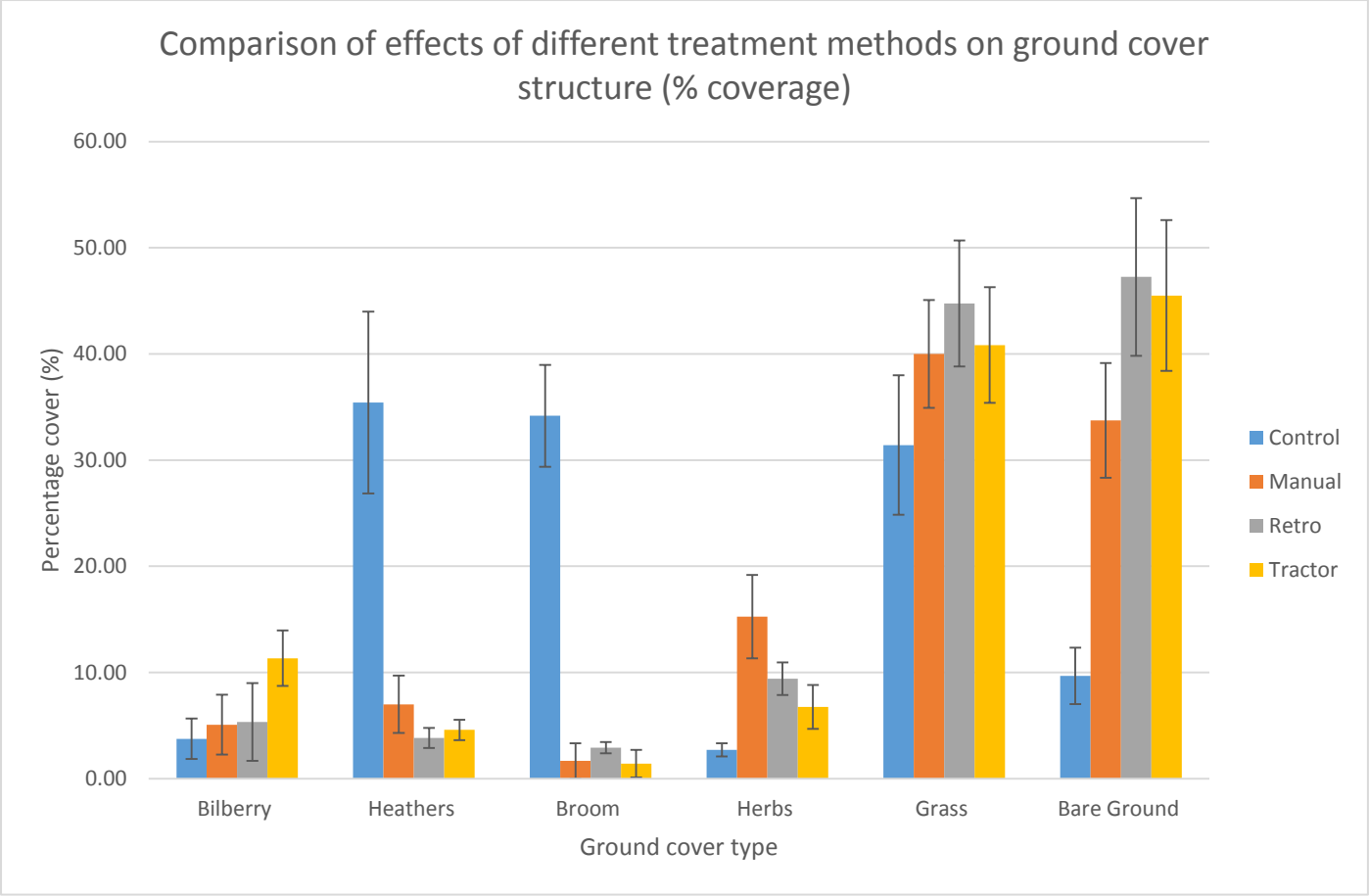

Fig 6. Comparison of effects of different treatment methods on mean vegetation type coverage.

Fig. 6. Shows that manual hand clearing of Broom resulted in less areas of bare ground. This is reasonably unsurprising, as we might expect manual removal techniques to be less intrusive than mechanical methods. Bare ground cover for both retro spider and tractor removal methods are fairly comparable with the tractor coming out with just slightly less bare ground than the retro spider.

Grass cover is significantly higher with all removal techniques compared to the control plots, with the retro spider having the highest percentage cover, followed by tractor and then very closely by manual removal.

In the case of herbaceous plants, cover was significantly higher with all treatment methods when compared to the control plots, with the highest coverage being with manual removal followed by retro spider and lastly tractor removal.

The tractor method appears to be the most effective at clearing Broom with the lowest Broom cover of the 3 treatment methods, followed closely by manual removal, the retro spider appears to be the least effective Broom removal method.

Heather cover was lowest in the retro spider plots, followed by the tractor, with the highest levels after the control being in the manual plots.

The most surprising results were with Bilberry cover. Bilberry cover was significantly higher with the tractor treatment plots, the method that we might have expected to be the most intrusive or destructive method. Bilberry

cover levels were very similar in the manual and retro spider plots, with a slightly higher coverage with the retro spider method.

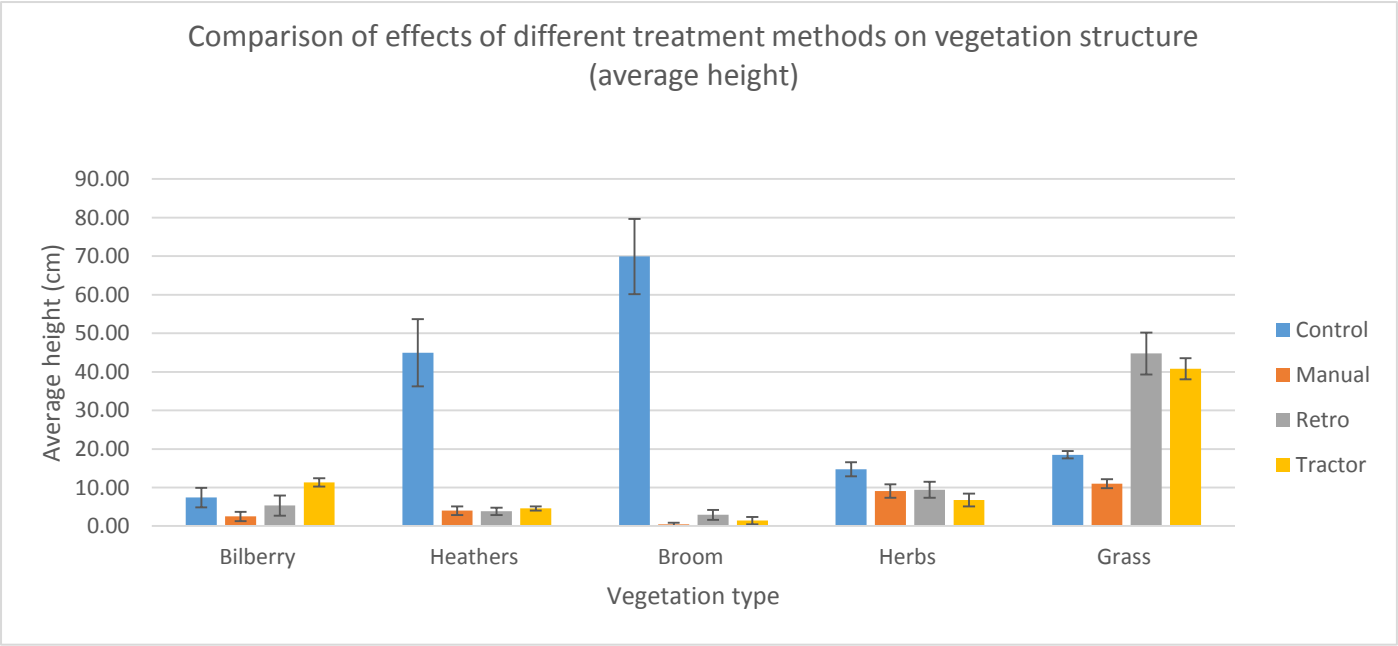

Fig 7. Comparison of effects of different treatment methods on mean heights of different vegetation types.

For the most part, mean heights of the different vegetation types mirrored the results of the percent cover results, with Bilberry being highest in the tractor removal plots, followed by the retro spider and manual removal. Broom heights were low with all 3 treatment types especially manual removal with a mean height of just 0.42cm, followed by tractor removal at 1.42cm and then retro spider removal at 2.92cm.

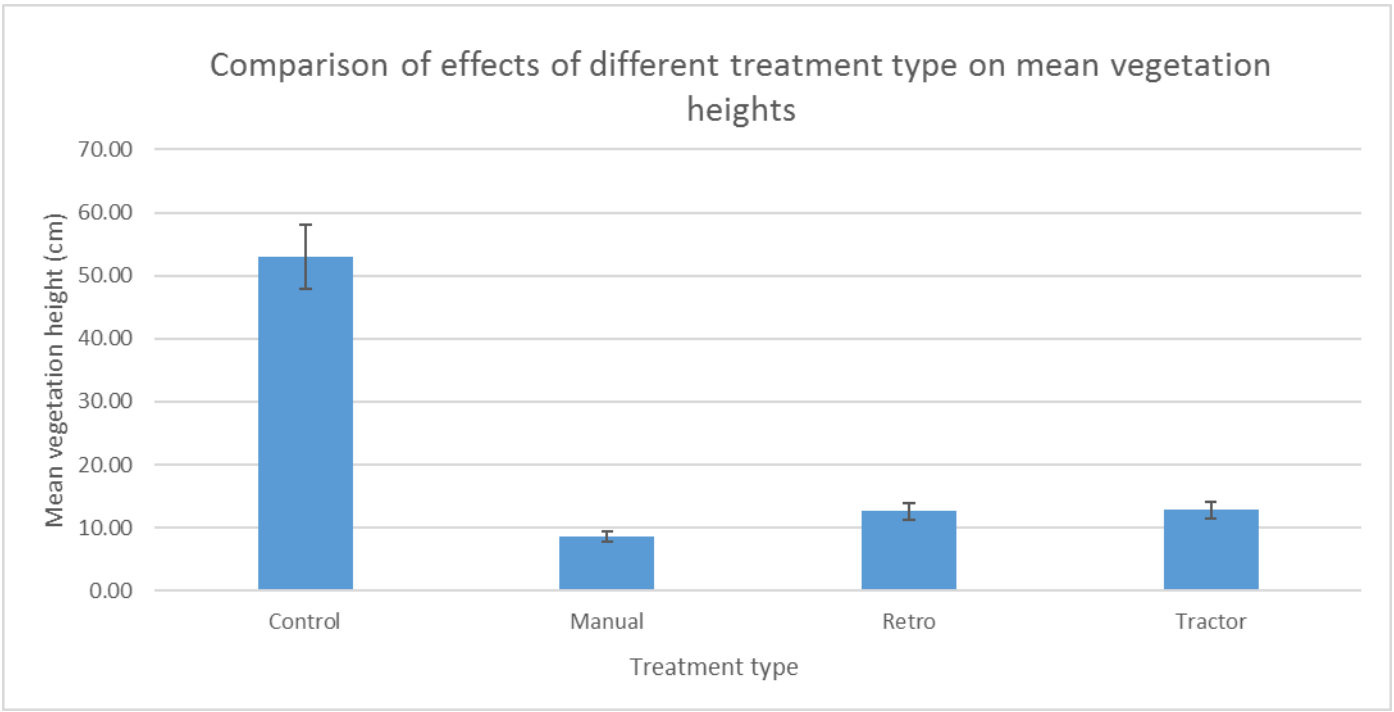

Fig 8. Comparison of effects of different treatment methods on mean vegetation heights.

The mean vegetation heights when taking all vegetation types as a whole were similar across the 3 methods. The heights for retro spider and tractor being particularly close at 12.58cm and 12.83cm respectively. Vegetation height at manual removal plots was the lowest at 8.67cm.

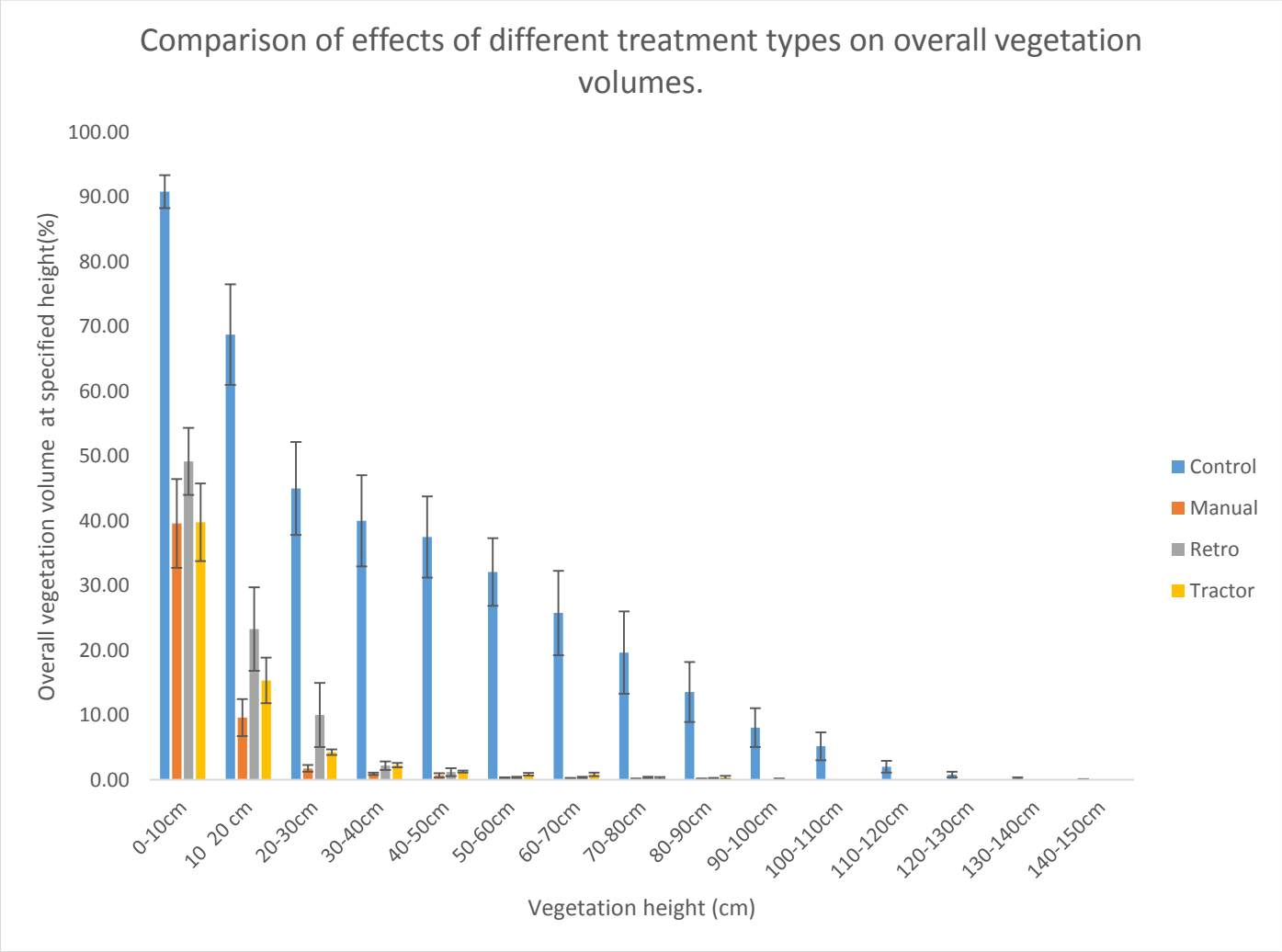

Fig 9. Comparison of effects of different treatment methods on overall vegetation volumes.

Overall vegetation volume (%)	Control	Manual	Retro	Tractor
0-10cm	90.83	39.58	49.17	39.75
10-20cm	68.75	9.58	23.25	15.33
20-30cm	45.00	1.75	10.00	4.25
30-40cm	40.00	0.92	2.17	2.25
40-50cm	37.50	0.67	1.17	1.25
50-60cm	32.08	0.25	0.33	0.83
60-70cm	25.75	0.17	0.33	0.83
70-80cm	19.63	0.08	0.33	0.25
80-90cm	13.54	0.08	0.17	0.33

Fig 9.1. Comparison of effects of different treatment methods on overall vegetation volumes.

Overall vegetation volume results stayed fairly uniform throughout the range. Between 0cm-30cm the lowest volumes were found in the manual plots, the tractor method had the next lowest volume, with the highest volume of vegetation in the retro spider plots. Beyond 30cm volume percentages dropped off considerably, with manual hand removal having the lowest volume and retro spider and tractor methods having comparable overall volumes.

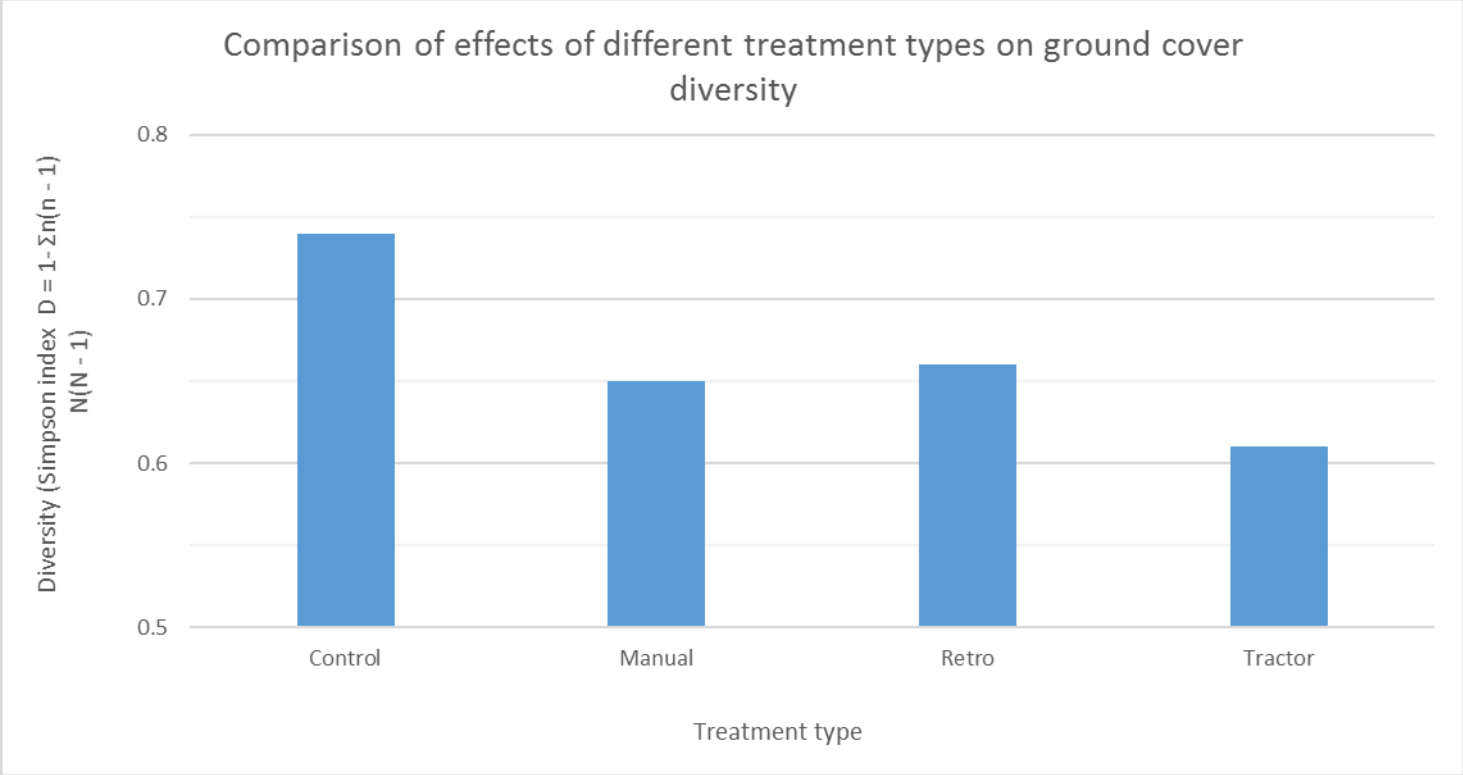

Fig 10. Comparison of effects of different treatment methods on overall vegetation volumes.

Figure 10 shows the diversity across all the plots calculated using Simpson diversity index where 0 represents no diversity and 1 represents infinite diversity. As mentioned previously bare ground was also factored as a ground cover type.

All 3 methods had lower levels of diversity than the control plots, and showed similar levels of diversity with each other, with the highest diversity present at retro spider plots and the lowest at the tractor method plots.

The data collected in this survey shows that different treatment methods do have various effects on both abundance cover and structure of vegetation within the plots.

As far as vegetation is concerned the data suggests that using tractors for Broom removal may not only be the least labour intensive but also the most effective method.

Not only is the tractor seemingly the most effective at Broom removal it also appears to have least effect on the presence of Bilberry, a highly important dietary resource for the Capercaillie (Blanco-Fontao, Fernández-Gil, Obeso and Quevedo 2009), a species whose continued viability is of much concern in the Pico's de Europa national park.

Results: Surface active invertebrates

Awaiting data…

Conclusions

References

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