SHORT TERM EFFECTS OF HARVESTING ON MESIC MOUNTAN FYNBOS NEAR CALEDON, SOUTH AFRICA

Botany Honours
Synecology Project, 1985
M Parisi

ABSTRACT

The short term effects of four harvesting methods (brushcutting, suction harvesting, handharvesting and brushcut and suction harvesting) and two harvesting seasons (winter and summer) were investigated by comparing harvested strips of vegetation to adjacent unharvested buffer strips. The impacts of harvesting on the vegetation were assessed relative to changes in vegetation height, canopy cover and plant mortality of physiognomic groups according to regenerative strategies. Although summer brushcutting resulted in greater regeneration than winter brushcutting, the effects of harvesting in different seasons were variable. The harvesting methods were rated according to their short term impacts and the following sequence was determined:

brushcut and suction > bushcut > handharvesting > suction harvesting

The ecological implications of harvesting and further disturbance are discussed.

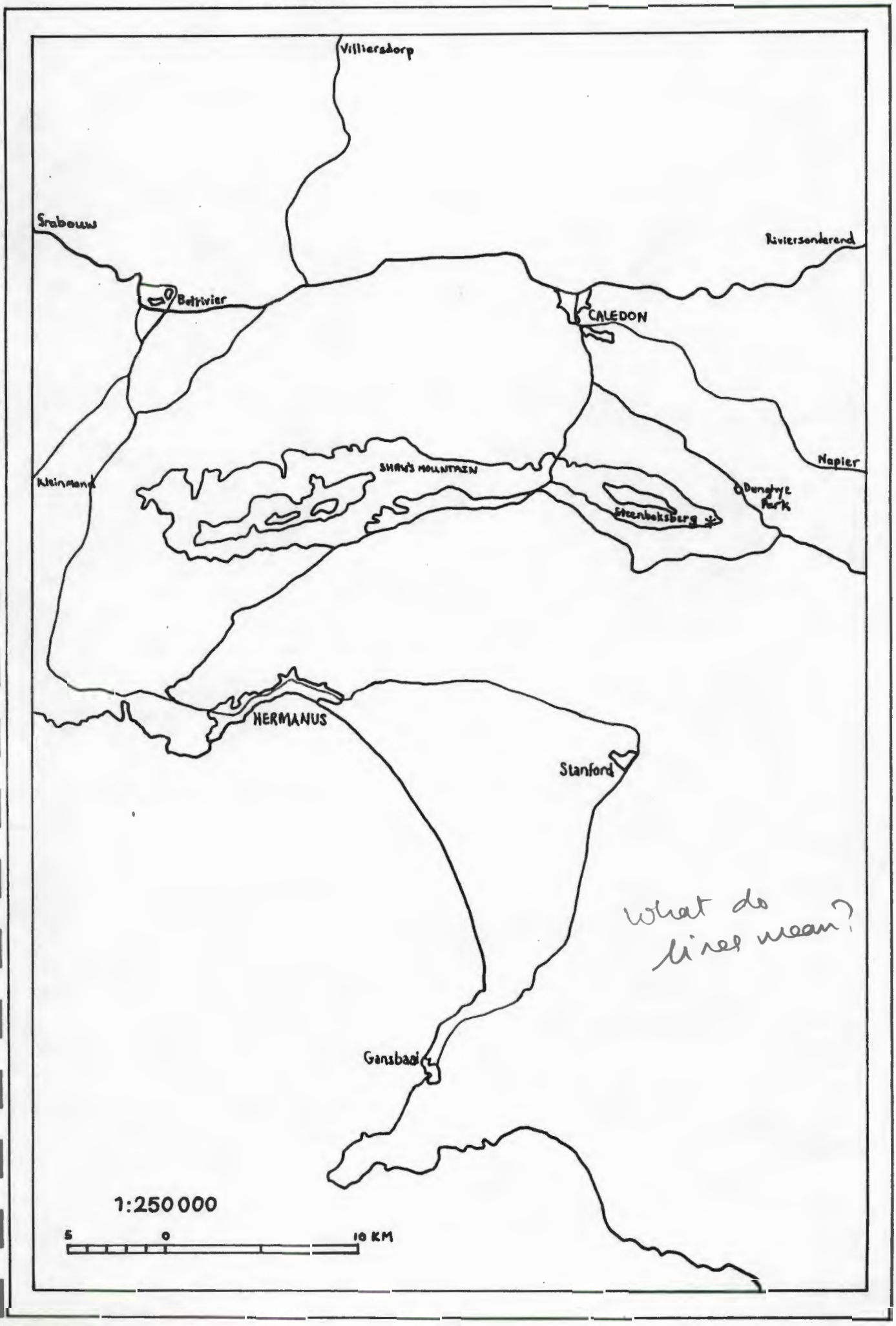

Figure 1 Location of the study site* south-east of Caledon, on the Steenboksberg.

Figure 2 Aerial view of harvest areas A (foreground) and B (background) showing alternating harvest and buffer strips.

Figure 3 Suction harvesting with an industrial vacuum cleaner.

INTRODUCTION

In this paper I report on results of a harvesting experiment which is part of a programme initiated by the Fynbos Reclamation Project, to investigate ways of re-establishing indigenous fynbos vegetation on disturbed sites (Dawson & Romoff, 1984). The aim of the experiment was to investigate the short-term effects of four harvesting methods, and two harvesting seasons, on various structural and floristic attributes of fynbos vegetation. Because many species occur, a structural approach was emphasized.

The study site was situated on a south-east facing slope of the Steenboksberg, 20 km south-east of Caledon in the south-western Cape (Figure 1). The vegetation was young (approximate post-fire age eight years) Mesic Mountain Fynbos (Moll et al, 1984) on a gentle slope (±6°), at an altitude of 240-270 m.

METHODS

The site preparation and the harvesting of the vegetation was organized by Dawson and Romoff (1984/1985). They selected three harvest areas which were as homogenous as possible, in an area of Mesic Mountain Fynbos adjacent to a borrow-pit at Dunghye Park (where other experiments investigating establishment of fynbos on disturbed areas are on-going). Each site was divided into alternating harvest and buffer strips (each 3 x 50 m) to facilitate the regeneration of harvested vegetation. Prior to harvesting, dead wood was removed from the harvest plots and placed on the adjacent buffer strips.

The vegetation was harvested over a two week period during June 1984 (wet winter rainfall season) and February 1985 (dry summer season).

The following harvesting methods were used:

1. Brushcutting: a sickle-bar mower was used to cut off vegetative material (containing differential amounts of seed) at a height of ten to fifteen centimetres, however, this varied according to the eveness of the ground surface. This material was then removed.

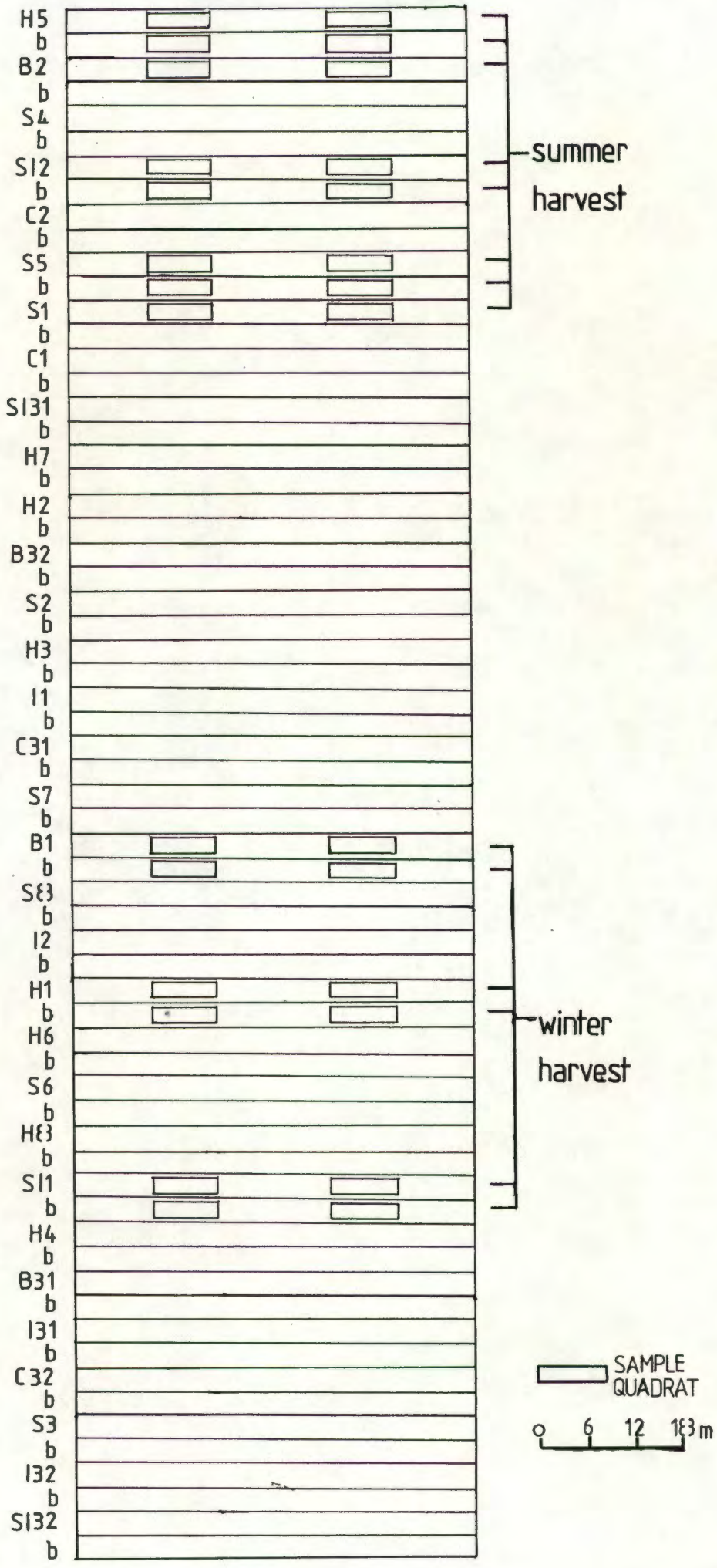

Figure 4 Stratified random sampling showing two replicate samples in each harvest and buffer strip investigated where H=handharvesting, B=brushcutting; S=suction harvesting; B-S=brushcut and suction harvesting.

2. Suction harvesting: a 'Billy-Goat' (a motor-driven industrial vacuum cleaner) was used to suck seed and fruiting bodies from standing plants and from the litter layer.

3. Hand harvesting: sickles, or secateurs, were used to selectively remove flowers and fruiting bodies from the vegetation.

4. Brushcutting followed by suction harvesting: the vegetation was brushcut, followed immediately by suction harvesting of the surface to retrieve any additional seeds or fruits that may occur.

The harvesting methods were randomly allocated to harvest strips, however, the allocation of brushcutting was modified to avoid rocky sites. This was to ensure that the sickle-bar mower could negotiate the harvest strips.

One of these harvest sites (B) was chosen for investigation in this project. Data for the present study were collected in June and August, 1985. Strips, representing treatments, were chosen using a stratified random technique (Figure 4). Two quadrats, or replicate samples, were marked out with metal pegs in each harvest and buffer strips investigated. Each quadrat was located ten metres from the ends of the strips and subdivided into four sub-quadrats (2 x 2 m). A total of twenty-eight quadrats were sampled, which is 18,6% of the area investigated.

The following parameters were measured:

1. Structural characters

1.1 Vegetation height (cm)

Two heights were measured namely average height of the ground stratum and height of the tallest vegetative organ.

1.2 Cover (%)

All percentage cover values were estimated visually. Data were estimated separately for canopy cover, bare ground, litter and rock.

1.3 Monocharacter growth forms (Orshan, 1982)

1.3.1 Plant mortality

Percentage dead standing material was estimated and the number of cut stems were counted.

1.3.2 Regenerative strategies

Plant species were placed into the following physiognomic groups (Campbell et al, 1981):

Ericoid = species having narrow, sclerophyllous leaves with the lower surface deeply grooved;

Graminoid = this consists of three floristic types, namely: Restoids (Restionaceae), Grasses (Poaceae) and Sedges (Cyperaceae);

Proteoid = members of the Proteaceae;

Geophytes and

Other.

Two types of regenerative strategies were distinguished within these physiognomic groups, namely below ground vegetative regeneration and regeneration by seed. Percentage canopy cover values were estimated in each category.

2. Floristics

Percentage cover values were estimated for genera or species (where known) in the buffer strips.

RESULTS

Due to the heterogeneity of structural characters (Table 1), each harvesting strip (representing a treatment) was compared to an adjacent buffer strip (control). Difference scores (treatment minus buffer values) were analyzed using Lord's Range Test (Zar, 1980). The means were examined to indicate the nature of the difference (magnitude and direction) and used as a measure of the impact of the various treatments.

Table 2. Seasonal differences in the mean and range of difference scores (treatment minus buffer values) for significant structural characters (Lord's Range Test, L = 1,71, p = 0,05, k = 2, n = 2 and 2, indicated by *) in each harvesting treatment. A trend (T) is distinguished for L = 0,88. Only the categories having significant values or trends are shown and the impact of the treatments is indicated.

Category		Brushcut		Handharvest		Brushcut & Suction		Suction harvest	
		Summer	Winter	Summer	Winter	Summer	inter	Summer	Winter
Bareground	Mean	0,59	24,86	9,24	4,85	10,47	11,57	6,19	7,77
	Ratio (L)	3,27* increase		0,26		0,07		0,14	
Litter	Mean	33,07	14,71	4,50	4,55	14,22	2,83	-1,53	-0,74
	Ratio (L)	2,38* increase		0,01		0,48		0,05	
Total vegetation cover	Mean	-19,04	-31,83	-17,30	-8,01	-24,29	-19,12	-5,08	-5,90
	Ratio (L)	2,07* decrease		1,18t decrease		0,31			
Height of tallest vegetative organ	Mean	-30,00	-32,50	-17,50	-7,50	-52,50	-22	0	-10,00
	Ratio (L)	0,04		1,00t decrease		1,53t decrease		0,33	
Cut dead stems	Mean	34,00	61,00	16,50	42,50	100,00	81,00	-	-
	Ratio (L)	0,52		1,30t increase		0,32			

CATEGORY		Minimum and Maximum Values	Braun-Blanquet cover-abundance values	
% Cover	Bare ground	15-45	2-3	
	Rock cover	0-60	r-4	V
	Litter	2-10	1-2	
Height (cm)	Average height of ground stratum	20-30	-	V
	Tallest Vegetative organ	60-80	-	V
Number	Seedlings	0-7	-	V
	Individual geophytes	0-90	-	V
	Geophyte clumps	0-9	-	V
	Total geophytes	5-99	-	V
% Canopy cover	Total vegetative cover	60-80	4-5	
	Dead standing	2-26	1-3	V
	Proteoid reseeders	6-33	2-3	
	Ericoid reseeders	18-69	2-4	V
	Proteoid resprouters	0- 6	r-2	V
	Ericoid resprouters	0-25	r-2	V
	Graminoid resprouters	12-30	2-3	V
	Other resprouters	0- 3	r-1	V

Table 1. Percentage cover, height, number and percentage canopy cover of structural characters in the buffer strips. Minimum and maximum values for percentage data have been converted to Braun-Blanquet cover-abundance values. Percentage cover and numerical data were considered variable (V) if the range of the Braun-Blanquet score was more than one unit and the range of the minimum and maximum values exceeded ten units respectively.

SEASON OF HARVESTING

Differences between summer and winter harvests for each treatment are given in Table 2.

Bare ground, litter and total vegetation cover showed significant seasonal differences for brushcutting. Winter brushcutting resulted in more bare ground and less vegetation cover, whereas summer brushcutting increased the amount of litter.

The remaining three treatments (handharvesting, suction harvesting and brushcut and suction harvesting) showed no significant seasonal differences. However trends were distinguished for an arbitrary cut-off point of 50% (Table 2). No significant seasonal differences or trends were shown for suction harvesting.

Table 3. A comparison of the effects of harvesting treatments on the percentage canopy cover and number of cut dead stems. The means of difference scores were analyzed using Lord's Range Test (ratio L)

Category	Brushcut vs Suction		Brushcut vs Handharvest		Brushcut vs Brushcut & Suction			Brushcut & Suction vs Suction		Brushcut & Suction vs Handharvest		Handharvest vs Suction	
	B	S	B	H	B	B&S		B&S	S	B&S	H	H	S
Canopy cover Mean	-19,04	-5,49	-19,04	-12,65	-19,04	-21,70		-21,70	-5,49	-21,70	-12,65	-12,65	-5,49
L=0,73, p=0,05	0,92*		0,39^{t}		0,16		L=0,41, p=0,05	0,64*		0,34^{t}		0,29^{t}	
k=2, n=2 and 4 Ratio(L)	decrease		decrease				k=2, n=4 and 4	decrease		decrease		decrease	
Cut dead stems Mean	47,50	0	47,50	90,50	47,50	29,50		90,50	0	90,50	29,50	29,50	0
L=0,41, p=0,05	0,90*		0,20^{t}		0,42*		L=0,41, p=0,05	1,85*		0,72*		0,82*	
K=2, n=4 and 4 Ratio(L)	increase		increase		increase		k=2, n=4 and 4	increase		increase		increase	

Table 4. A comparison of the effects of brushcutting (B), suction harvesting (S), brushcut and suction harvesting (B&S) and handharvesting (H) on various structural parameters. The means of difference scores were analyzed using Lord's Range Test (ratio, L). Only the categories having significant values or trends are shown and the impact of the treatments is indicated.

Category		Brushcut vs Suction			Brushcut & Suction			Handharvest vs Suction	
		B	S		B&S	S		H	S
Litter	Mean	33,07	-1,13		8,52	-1,13		4,53	-1,13
L=0,73, p=0,05, k=2, n=2 and 4	Ratio(L)	2,80* increase		L=0,41, p=0,05 k=2, n=4 and 4	0,31^{t} increase			0,50* increase	
Canopy cover	Mean	-19,04	-5,49		-21,70	-5,49		-12,65	-5,49
L=0,73, p=0,05, k=2, n=2 and 4	Ratio(L)	0,92* decrease		L=0,41, p=0,05 k=2, n=4 and 4	0,64* decrease			0,29^{t} decrease	
Average height of ground stratum	Mean	-12,50	-2,50		-8,25	-2,50		-8,75	-2,50
L=0,41, p=0,05, k=2, n=4 and 4	Ratio(L)	0,50* decrease			0,23^{t} decrease			0,21^{t} decrease	
Height of tallest vegetative organ	Mean	-31,25	-10,00		-37,50	-10,00		-12,50	-10,00
L=0,41, p=0,05, k=2, n=4 and 4	Ratio(L)	0,39^{t} decrease			0,46* decrease			0,07	
Seedlings	Mean	1,00	-7,00	L=0,73, p=0,05 k=2, n=2 and 4	-	-		1,50	-7,00
L=0,41, p=0,05, k=2, n=4 and 4	Ratio(L)	0,47* decrease						0,77* decrease	
Cut dead stems	Mean	47,50	0		90,50	0		29,50	0
L=0,41, p=0,05, k=2, n=4 and 4	Ratio(L)	0,90* increase			1,85* increase			0,82* increase	
Reseed-Proteoid	Mean	-20,21	5,51		-16,25	5,51		-6,23	5,51
L=0,41, p=0,05, k=2, n=4 and 4	Ratio(L)	0,82* decrease			1,01* decrease			0,38^{t} decrease	
Reseed Ericoid	Mean	-18,18	-4,06		-14,13	-4,06		-7,37	-4,06
L=0,41, p=0,05, k=2, n=4 and 4	Ratio(L)	0,30^{t} decrease			0,36^{t} decrease			0,09	
Resprout-Ericoid	Mean	-9,88	4,12		-2,51	4,12		-3,70	4,12
L=0,64, p=0,05, k=2, n=3 and 3	Ratio(L)	0,52^{t} decrease			0,21			70,47^{t} decrease	

METHODS OF HARVESTING

To determine the relative short-term impacts of the harvesting methods on the vegetation, the effects on percentage canopy cover and number of cut dead stems were considered (Table 3). These are representative of the relative impacts on all the structural parameters. The results show that brushcutting and brushcut and suction harvesting have a greater short term impact on the standing biomass than suction harvesting and hand-harvesting. The relative impact of brushcutting and brushcut and suction harvesting is difficult to separate. However, brushcut and suction harvesting resulted in greater plant mortality than brushcutting. This indicated that brushcut and suction harvesting has a more severe impact on the vegetation. Handharvesting has a greater impact than suction harvesting.

The relative short term impact of the harvesting methods on the vegetation is summarized below:

brushcut and suction > brushcut > handharvest > suction harvest.

To quantify the effects of harvesting, each method was compared to suction harvesting which has the least short term impact on the vegetation (Table 4). These comparisons are representative of the effects of harvesting in all categories except for bare ground and graminoid resprouters. All four treatments increased the amount of bare ground. The canopy cover of graminoids was only reduced by brushcut and suction harvesting.

Table 4 shows that brushcutting, brushcut and suction harvesting and hand harvesting increased the amount of litter and plant mortality (cut dead stems) and decreased the vegetation height (ground stratum), total vegetation canopy cover and the cover of proteoid reseeders. Brushcutting and brushcut and suction harvesting decreased the vegetation height and the cover of ericoid reseeders. Suction harvesting decreased the number of seedlings. Brushcutting and handharvesting decreased the cover of ericoid resprouters.

The following three categories showed no significant values for any of the comparisons between the harvesting methods namely geophytes, proteoid and other resprouters. This may be due to the large variability encountered within these groups. The total number of geophytes vary from

Figure 5 A brushcut and suction harvested strip showing four month's recovery.

Figure 6 Plant mortality of woody reseeders resulting from brushcut and suction harvesting. The chance survival of occasional reseeders is due to variability in the height of brushcutting, caused by the uneven terrain(x).

Figure 7 A brushcut and suction harvested strip showing four months recovery (mostly restioids) compared to an eight year old buffer strip

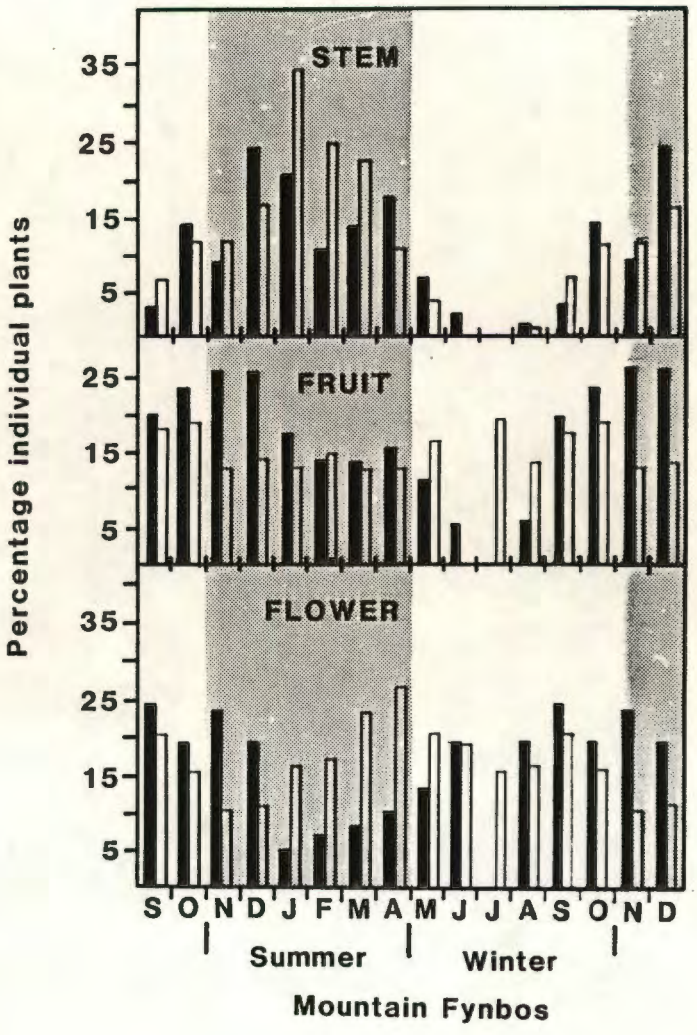

Figure 8 Vegetative growth, fruiting and flowering phenology from Mountain Fynbos (shaded columns from Swartboschkloof and unshaded columns from Sir Lowry's Pass).

0-99 with 0-90 individual geophytes and 0-17 clumps (eg Corymbium). The proteoid resprouters varied from 0-6% cover, but only one species (Leucadendron salignum) was represented. This species had a variable distribution in the harvest site (found in 16 of the 28 samples). The category, other resprouters, was a small group consisting of a few individuals of Lobostemon, Rhus and Podylaria spp. varying from 0-3% cover and which were variable in distribution (eg found in 17 of the 28 samples).

DISCUSSION

Season of harvesting

The results show that the effects of harvesting over different seasons (summer and winter) were variable, both between treatments (eg the vegetation showed a greater recovery in terms of total vegetation cover after both summer brushcutting and winter handharvesting) and within a treatment (eg both plant mortality and vegetation recovery was higher after winter handharvesting). Although the data was inconclusive as to a favourable season of harvest (one which promotes the greatest recovery of the vegetation to pre-harvest conditions), it appears that summer is a favourable season for brushcutting.

The season of harvest is affected by at least two factors namely the ability of the vegetation to survive disturbance and the availability of seed. Research on fire behaviour indicates that the ecologically favourable fire season (ie the season in which the vegetation can survive fires through regeneration) in the South Western Coastal Zone (Van Wilgen, 1985) occurs during summer and winter. This implies that recovery after summer or winter harvesting may be similar as the fynbos vegetation may be adapted to disturbance during these periods.

Plants are least susceptible to disturbance during periods of dormancy. Phenological data for Mountain Fynbos (Figure 8) shows that growth occurs mainly during summer, with peaks in early summer in older fynbos (eg Swartboschkloof, about 20 years old) and in mid-summer in younger fynbos (Sir Lowry's Pass, less than five years old). The main season of fruiting is spring-summer with most seed ripening during late spring and

early summer. Therefore phenological data indicates that late summer may be a favourable harvesting season.

At the time of sampling, the vegetation harvested during winter was one year old, whereas the vegetation harvested during summer was four months old. Adamson (1935) investigated post-fire regeneration of fynbos on Table Mountain and recorded a difference in plant cover after eight months (10% of soil surface covered by vegetation) and eighteen months (40%) regeneration. If the age factor was significant in the recovery of vegetation after harvesting one would expect the winter harvests (one year old) to show the greatest recovery. However, vegetation which was brushcut during winter showed less recovery than during summer. This implies that either the age factor is insignificant or that seasonal effects override this factor. The variability in the effects of handharvesting may be due to an interaction between age (less recovery after the summer harvest) and season (greater mortality after the winter harvest).

METHODS OF HARVESTING

The results show that woody reseeders (eg Erica, Aspalathus, Stoebe and Protea spp.) were most affected by harvesting which resulted in a reduction in cover and mortality. Although suction harvesting does not have these impacts, it removes seeds from the litterlayer and canopy which results in fewer seedlings than in uncut buffer strips. Therefore, suction harvesting depletes the soil-stored seed reserves and removes the current production of seeds. Although seed stores were not investigated this reduction may be significant if a fire occurs at the site before seed stores can be replenished, as fynbos reseeders apparently rely mainly on onsite-stored seed for germination and recovery (Kruger & Bigalke, 1984).

Serotinous species (Protea repens, P. longifolia, Leucadendron salignum and L. tinctum) store seeds in woody structures (cones) for several years. Handharvesting removes these cones. This eliminates the seed store as serotinous species do not appear to have a seed store in the soil (Bond, 1980) and seeds appear to be short-lived after release from cones (Van Staden, 1978). Therefore serotinous species will be particularly sensitive to further disturbance (eg fire) until their seed stores are replenished.

Figure 9 A restioid tussock killed by brushcutting at a height of twelve centimetres.

Bond (1985) showed that the current season's seed crop contributed substantially to total seed reserves in serotinous Protea and Leucadendron spp. in the southern Cape. This suggests that serotinous species can recover fairly rapidly after handharvesting. However, recruitment after fire depends on seeds produced over several seasons to ensure good regeneration (Bond, 1985). If serotinous species fail to regenerate, there may be marked changes in community structure. For example, broad-leaved shrubland vegetation, 2-4 m high can change to herblands dominated by Restionaceae after a single fire according to Bond et al, 1984.

Seedling establishment in fynbos vegetation appears to be concentrated into the immediate post-fire period (one to two years after fire), as very few seedlings can be found in mature fynbos (Kruger & Bigalke 1984). Both fire and brushcutting are a disturbance which removes the vegetation canopy. Keeley (1977) postulates that the success of seeders depends on the availability of 'post-fire openings in the regenerating vegetation where seedlings could establish and grow. However, there was no significant increase in the number of seedlings with brushcutting. The recovery of reseeders (particularly serotinous species) after brushcutting will require a number of years. For example Protea repens reaches reproductive maturity in approximately four to eight years and retains its seeds for two to four years (Kruger & Bigalke, 1984).

Resprouting occurs from dormant buds in rootstocks (eg Leucadendron salignum) and rhizomes (eg Restionaceae). The resprouters were less affected by harvesting, particularly the graminoids which are resilient and recover rapidly (four months) after harvesting. The height of brushcutting may influence the survival of resprouters as two Restionaceae tussocks did not resprout after brushcutting at a height of eight and twelve centimetres respectively. Griffin and Hopkins (1981) found that the impact of brushcutting on Kwongan vegetation (Western Australia) was increased by low cutting (height of 14 cm).

CONCLUSIONS

The impact of harvesting varied according to the season and method of harvesting. It is suggested that late summer may be a favourable harvesting season which is determined by the ability of the vegetation to survive disturbance and the availability of seeds. The woody reseeders (particularly serotinous species) were most affected by harvesting, while the resprouters recovered rapidly. Brushcut and suction harvesting had the greatest short-term impact on the vegetation, while suction harvesting had the least, with brushcutting and handharvesting having intermediate effects. The long-term impacts of harvesting will depend on the interaction between various ecological factors (eg fire) and the regenerating vegetation. The impacts of harvesting will be reduced if the site is protected from fire for a number of years.

ACKNOWLEDGEMENTS

I thank Prof E J Moll and N Romoff for valuable discussion and comment, as well as for funding. My thanks to J Burbidge, T Jennings, J Bloomer and L Brown for assistance in the field and to E Mantle for typing the manuscript.

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HONOURS PROJECT

SHORT TERM EFFECTS OF HARVESTING ON MESIC MOUNTAIN FYNBOS NEAR CALEDON, SOUTH AFRICA.

by

M. Parisi

A challenging project since identifications were difficult and there is lots of variability in the site. Nevertheless the planning and fieldwork have been well done, and some very interesting results have been obtained. The not unexpected conclusion that season of harvesting has least effect in summer fits in neatly with what is known about post fire regeneration following fire in the same season. The fact that some species are killed by bushcutting is noteworthy - again the species most affected were predictably the re-seeders after fire.

The data have been reasonably well analysed with some good statistical tests to justify conclusions and trends. The main problem I have with the project is the write-up. Page 5 for example is extremely difficult to follow. The candidate has little idea of punctuation or of self-critical review.

In conclusion then the data are good and well analysed, but the presentation is weak.

Eugene Moll

68% ✓

Agreed. The project is adequate with regard to data & conception. The write-up could have been better. 68%.

EGG.

Orshan, G. 1982. Monocharacer growth form types as a tool in an analytic-synthetic study of growth forms in mediterranean type ecosystems: A proposal for an inter-regional program. Ecologia Mediterranea. Definition et localistion des Ecosystèmes Méditerranéens terrestres. Saint-Maximin 16-20/11/81 pg. 159-171.

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Appendix 1. Taxa recorded in each physiognomic group

CATEGORY	RESEED	RESPROUT
Proteoid	*Protea repens* *P. longifolia* *Serruria* spp. *Leucadendron tinctum* *Leucospermum cordifolium*	*Leucadendron salignum*
Ericoid	*Stoebe brunoides* *Elytropappus* sp. *Phenocoma* sp. *Anthospermum* sp. *Struthiola ciliata* *Aspalathus* spp. *Erica* spp. *Erica pluckinetti* *Helichrysum* sp.	*Erica* sp. Asteraceae *Asparagus* sp. *Aspalathus* sp. Rutaceae *Phylica* sp.
Other	-	*Lobostemon* sp. *Rhus* sp. *Podylaria* sp.
Graminoid	-	*Thamnocortus* sp. *Restio* sp.

Appendix 2. Vegetation height, seedlings, geophytes and cut dead stems recorded for two replicates ('a' and 'b') in each harvest and buffer strip. Difference scores were calculated for each replicate.

TREATMENT	CATEGORY	SUMMER HARVEST						WINTER HARVEST					
		B2(a)	BUFFER	DIFFERENCE SCORE	B2(b)	BUFFER	DIFFERENCE SCORE	B1(a)	BUFFER	DIFFERENCE SCORE	B1(b)	BUFFER	DIFFERENCE SCORE
Brushcutting	Average height of ground stratum (cm)	15	30	-15	10	20	-10	15	30	-15	10	20	-10
	Height of tallest vegetative organ (cm)	30	75	-45	50	65	-15	45	60	-15	35	85	-50
	Seedlings (no)	5	-	+5	-	2	-2	7	4	+3	-	2	-2
	Individual geophytes (no)	9	-	9	10-15	15-20	-5	25-35	10-15	-18	63	20	+43
	Geophyte clumps (no)	17	5	+12	3	5	-2	8	6	+2	1	2	-1
	Total geophytes (no)	26	5	+18	15	22	-7	38	18	+20	64	22	+42
	Cut dead stems (no)	25	-	+25	43	-	+43	44	-	+44	78	-	+78
		H5(a)			H5(b)			H1(a)			H1(b)		
Handharvest	Average height of ground stratum (cm)	20	30	-10	20	20	0	15	30	-15	20	30	-10
	Height of tallest vegetative organ (cm)	55	75	-20	50	65	-15	50	60	-10	75	80	-5
	Seedlings (no)	-	-	-	3	2	+1	2	-	+2	-	-	-
	Individual geophytes (no)	10	-	+10	40-45	15-20	+25	30-40	20-30	+10	68	61	+7
	Geophyte clumps (no)	6	5	+1	6	5	+1	2	2	0	8	2	+6
	Total geophytes (no)	16	5	+11	48	22	+26	37	27	+10	76	63	+13
	Cut dead stems (no)	11	-	+11	22	-	+22	47	-	+47	38	-	+38
		SI-2(a			SI-2(b			SI-1(a			SI-1(b		
Brushcut & Suction	Average height of ground stratum (cm)	10	25	-15	15	20	-5	12	20	-8	15	20	-5
	Height of tallest vegetative organ (cm)	25	80	-55	30	80	-50	35	65	-30	45	60	-15
	Seedlings (no)	-	-	-	-	2	-2	2	4	-2	-	-	-
	Individual geophytes (no)	15-20	20-40	-11	18	17	+1	25-35	80-100	-60	44	41	+3
	Geophyte clumps (no)	13	7	+6	2	-	+2	-	9	-9	4	7	-3
	Total geophytes (no)	30	37	-7	20	17	+3	30	99	-69	48	48	0
	Cut dead stems (no)	93	-	+93	107	-	+107	58	-	+58	104	-	+104
		S5(a)			S5(b)			S1(a)			S1(b)		
Suction	Average height of ground stratum (cm)	30	30	0	25	20	+5	20	30	-10	20	20	0
	Height of tallest vegetative organ (cm)	85	85	0	75	75	0	60	85	-25	80	75	+5
	Seedlings (no)	1	7	-6	1	2	-1	3	7	-4	6	2	+4
	Individual geophytes (no)	4-8	6-10	-2	30	12	+18	15-20	6-10	+9	14	12	+2
	Geophyte clumps (no)	8	5	+3	-	1	-1	12	5	+7	1	1	0
	Total geophytes (no)	14	13	+1	30	13	+17	29	13	+16	15	13	+2
	Cut dead stems (no)	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 3. Percentage cover and percentage canopy cover of structural characters for replicates a and b in each harvest and and buffer strips

TREATMENT	CATEGORY	SUMMER HARVEST				WINTER HARVEST			
		B2(a)	BUFFER	B2(b)	BUFFER	B1(a)	BUFFER	B1(b)	BUFFER
Brushcutting									
% Cover	Bare ground	40	38	40	40	70	33	60	15
	Litter	40	2	50	3	20	3	15	3
% Canopy cover	Total vegetation cover	40	70	35	70	25	80	30	80
	Proteoid-reseed	1	6	1	26	0	9	0	25
	Ericoid-reseed	22	48	11	21	9	69	10	23
	Proteoid-resprout	0	3	0	6	2	1	0	0
	Graminoid-resprout	15	15	25	25	10	12	16	15
	Ericoid-resprout	0	0	1	7	1	1	3	25
	Other-resprout	0	0	1	1	1	0	0	2
		H5(a)		H5(b)		H1(a)		H1(b)	
Handharvest									
% Cover	Bare ground	60	38	50	40	35	35	35	20
	Litter	6	2	5	3	6	3	8	4
% Canopy cover	Total vegetation cover	35	70	46	70	50	65	60	72
	Proteoid-reseed	3	6	12	26	10	5	6	25
	Ericoid-reseed	16	48	18	21	37	38	35	46
	Proteoid-resprout	1	3	0	6	1	4	1	0
	Graminoid-resprout	20	15	15	25	10	15	25	25
	Ericoid-resprout	0	0	3	7	0	1	5	5
	Other-resprout	0	0	0	1	1	1	0	0
		SI-2(a)		SI-2(b)		SI-1(a)		SI-1(b)	
Brushcut & Suction									
% Cover	Bare ground	35	30	55	25	60	40	65	45
	Litter	30	5	20	10	3	5	15	6
% Canopy cover	Total vegetation cover	35	70	28	75	25	65	35	60
	Proteoid-reseed	1	9	5	33	1	20	2	10
	Ericoid-reseed	16	39	8	18	11	41	12	29
	Proteoid-resprout	1	3	2	2	0	0	0	0
	Graminoid-resprout	15	20	15	30	8	12	15	12
	Ericoid-resprout	0	0	1	3	4	1	9	20
	Other-resprout	0	0	1	0	0	1	1	1
		S5(a)		S5(b)		S1(a)		S1(b)	
Suction									
% Cover	Bare ground	55	45	30	20	50	45	40	2
	Litter	3	2	4	8	4	2	4	8
% Canopy cover	Total vegetation cover	55	70	68	70	50	70	70	70
	Proteoid-reseed	23	17	24	15	18	17	30	15
	Ericoid-reseed	31	45	17	22	28	45	31	22
	Proteoid-resprout	2	0	1	0	0	0	0	0
	Graminoid-resprout	12	15	25	20	5	15	20	20
	Ericoid-resprout	0	0	11	8	5	0	5	8
	Other-resprout	0	3	0	2	0	3	1	2