The impact of the provision of water for game on the basal cover of the herbaceous vegetation around a dam in the Kruger National Park

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A line intercept survey was done on the herbaceous vegetation in permanently marked plots at distance intervals from the Wik-en-Weeg Dam, Kruger National Park, in 1973. The survey was repeated in 1990 so that changes in basal cover could be determined in relation to distance from the dam. Positive relationships with distance from the dam were found for the relative total percentage basal cover of the herbaceous vegetation, as well as for the relative basal cover of, respectively, grasses, forbs, decreasers and increasers. It was concluded that the provision of a permanent supply of drinking water for game in the Wik-en-Weeg Dam has had an impact on the nearby herbaceous community basal cover composition, as well as a negative impact on the basal cover of the herbaceous vegetation in the vicinity. The basal cover of the herbaceous stratum was more sensitive to the effect of the dam than parameters of the woody stratum.

Key words: herbaceous vegetation, water provision, impact, Kruger National Park, basal cover.

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Introduction

It is widely believed that overgrazing of the herbaceous vegetation occurs around watering points in southern African wildlife areas during the dry season (Van der Schijff 1959; Van Wyk & Fairall 1969; Young 1970; Child *et al.* 1971; Weir 1971). Overgrazing, in turn, is believed to cause a decline in the basal cover of the herbaceous vegetation (O'Connor 1985). Water provision for game is a common practice in veld management in wildlife areas. There is little quantitative information, however, on the impact of the provision of drinking water for game on the herbaceous vegetation. Some work has been done on the herbaceous vegetation along livestock foraging gradients away from artificial watering points in the northern Transvaal (Friedel 1988; Friedel & Blackmore 1988) and in Australia (Andrew & Lange 1986). An assessment of the status of the herbaceous vegetation was done in the Kalahari Gemsbok National Park in relation to distance from watering points by Child *et al.* (1971). The percentage presence and basal cover of herbaceous species has also been monitored at windmills in the same park (Van Rooyen *et al.* 1990). Van der Schijff (1959) examined the veld surrounding watering points in the Kruger National Park and subjectively divided it into five zones according to the degree of utilisation by game. No quantitative work on whether the provision of water for game has an impact on the basal cover of the herbaceous vegetation has been done in the lowveld savanna however.

The aim of this study was therefore to determine whether the provision of a permanent supply of drinking water for game in the Wik-en-Weeg Dam, where there had previously been only an ephemeral supply in the Phugwane stream, would have any impact on the basal cover of the herbaceous vegetation in the area through overutilisation by game.

The Wik-en-Weeg Dam, constructed in 1973, is in the Phugwane watercourse 30 km west-northwest of Shingwedzi, in the far northern district of the Kruger National Park. It is situated in the Tsende Sandveld landscape (Gertenbach 1983). The altitude of the area is between 300 and 450 m above sea level. The mean annual rainfall is between 450 and 550 mm. The terrain is undulating with distinct hillsides and valleys. The parent rock is predominantly granite, with some amphibolite and dolerite intrusions and gives rise to sandy soils (less than 15 % clay in the A-horizon) on the hillsides and clayey soils in the valleys. *Colophospermum mopane* (Kirk ex Benth.) Kirk ex J. Leon. and *Combretum apiculatum* Sond. are the dominant woody plants (Gertenbach 1983), with the latter more abundant on the hillsides and former more abundant in the valleys.

Methods

In December 1973 seventeen permanently marked sampling plots (25 m by 50 m) were set out at intervals of about 1 km north and south of the Wik-en-Weeg dam along a firebreak. The herbaceous vegetation within these sampling plots was then surveyed using a line-intercept technique (Mueller-Dombois & Ellenberg 1974). Four cables were strung between the corner markers of the plots. Cables were strung at 5 m intervals across the breadth of the plots. Two 1 m lines were set out along each of the latter cables, so that a total of 20 m was sampled per plot. The basal length beneath the line and the identity of all herbaceous plants intersected by the line were recorded. Fourteen of the plots were relocated and the herbaceous vegetation resampled in January and February 1990.

The basal cover of the herbaceous stratum was calculated for each plot as the percentage of the line that fell across the basal portions of herbaceous plants. The relative basal cover of the grasses (members of the Family Gramineae) and the forbs (the remaining herbs) was calculated. The herbaceous plants recorded in the survey were assigned to two ecological groups based on the categories of Trollope *et al.* (1989). These were decreasers (Decreaser and Increaser I) and increasers (Increaser II). Decreasers are species that decrease with under or overutilisation, Increaser I species are species that increase with underutilisation and Increaser II species are species that increase with overutilisation (adapted from Trollope *et al.* 1989).

The 1990 basal cover estimates were corrected for the initial condition by dividing by the values obtained before the dam's influence (in 1973) and multiplying by 100 to obtain relative values (Andrew & Lange 1986). This was done to eliminate the effect of any trends that may have existed with distance from the Phugwane stream before the construction of the dam. Relative values greater than 100 indicated that the percentage basal cover measured in 1990 was greater than that measured in 1973. Relative values of 100 indicated no change. Relative values less than 100 indicated that the percentage basal cover measured in 1990 was less than that measured in 1973. These relative values were then tested for functional relationships with distance from the dam with regression analyses (SAS Institute Inc. 1987). Three types of regression curves were calculated to find the best fit. These were straight lines (y = b + mx), logarithmic curves (y = b + m lnx) and exponential curves (y = b.mx). The null hypotheses, that there were no functional relationships with distance from the dam, were rejected if $P \leq 0,05$. Significant relationships were taken to be sufficient evidence to conclude that the provision of water for game in the Wik-en-Weeg Dam had caused an impact on the basal cover of the herbaceous stratum in the vicinity (Sokal & Rohlf 1969; Green 1979).

Results

From Table 1 certain trends along the gradient of distance from the dam could be observed in the basal cover of the species of the herbaceous stratum over the study period. Certain species decreased in basal cover in plots in the vicinity of the dam relative to plots further from the dam, whereas other species increased. Species that decreased in the vicinity of the dam relative to further from the dam included *Schmidtia pappophoroides* Steud. and *Digitaria eriantha* Steud., and species that increased in the vicinity of the dam relative to further from the dam included *Urochloa mosambicensis* (Hack.) Dandy and *Pogonarthria squarrosa* (Roem. & Schult.) Pilg. For most species however, it was impossible to detect such trends.

There was a significant positive exponential relationship (R^2 = 0,5555; P = 0,0022; $y = 25{,}67.1{,}64^x$) between relative total percentage basal cover of the herbaceous stratum and distance from the dam (Fig. 1).

There was a significant positive exponential relationship (R^2= 0,4942; P = 0,0050; $y = 25{,}31.1{,}66^x$) between relative basal cover of grasses and distance from the dam (Fig. 2). The regression line resembled that of the relative total basal cover. There was a significant positive relationship (R^2 =0,4565; P = 0,0458; $y = 38{,}1277 + 42{,}1021^x$) between relative basal cover of forbs and distance from the dam. The relationship was linear (Fig. 3) and the slope of the regression line was greater than that for the relationship

Table 1

Changes in percentage basal cover of the species of the herbaceous stratum in permanently marked plots near the Wik-en-Weeg Dam, in the Kruger National Park, between 1973 and 1990

Species	Plot number (distance from the dam in km)													
	1 (0,2)		2 (0,5)		3 (1)		4 (1,1)		5 (1,68)		6 (2,68)		7 (3)	
	1973	1990	1973	1990	1973	1990	1973	1990	1973	1990	1973	1990	1973	1990
Schmidtia pappophoroides	0,290		0,070		0,210		0,215	0,165	1,115	0,085			0,475	0,025
Bothriochloa radicans			0,335										0,250	0,075
Digitaria eriantha	0,535		0,720	0,020						0,030	0,560	0,590	0,53	0,270
Panicum maximum	0,005	0,025	0,135	0,035		0,070	0,010		0,160	0,135	0,395			
Themeda triandra											0,270	0,015		
Sedges	0,010		0,105	0,015	0,040		0,115	0,145						
Urochloa mosambicensis		0,030	0,045	0,100			0,125		0,070	0,380	0,315		0,005	
Enneapogon cenchroides		0,130				0,070	0,005					0,130		
Eragrostis superba							0,020	0,035			0,305	0,205		
Pogonarthria squarrosa		0,085		0,075		0,025	0,050							
Aristida congesta			0,005	0,040	0,230	0,080	0,005	0,140				0,095	0,050	0,010
Tragus berteronianus	0,030	0,050	0,015		0,055		0,005	0,110	0,005		0,035		0,005	0,025
Brachiaria deflexa	0,175		0,005						0,020		0,010			
Cenchrus ciliaris									0,155					
Chloris roxburghiana							0,820							
Eragrostis heteromera			0,035											
Eragrostis rigidior					0,005						0,170			
Heteropogon contortus	0,075													
Oropetium capense			0,015											
Panicum coloratum			0,140											
Sporobolus discosporus			0,010											
Tricholaena monachne	0,260													
Sporobolus fimbriatus				0,015										0,030
Sporobolus ioclados						0,025								
Cymbopogon plurinodis														
Eragrostis cylindriflora														
Melinis repens														
Urochloa brachyura														
Gisekia africana					0,015	0,015			0,005					
Corchorus asplenifolius				0,015	0,005			0,030						
Limeum fenestratum			0,005											0,025
Evolvulus alsinoides					0,005	0,015								0,005

Table 1
(continued)

Species	Plot number (distance from the dam in km)													
	1 (0,2)		2 (0,5)		3 (1)		4 (1,1)		5 (1,68)		6 (2,68)		7 (3)	
	1973	1990	1973	1990	1973	1990	1973	1990	1973	1990	1973	1990	1973	1990
Tephrosia polystachya						0,020					0,005			
Cassia absus					0,070									
Cleome monophylla													0,005	
Brachiaria nigropedata	0,130				0,030									
Crotalaria	0,025													
Elytraria acaulis			0,015											
Melhania spp.					0,025									
Indigofera spp.					0,010								0,005	
Talinum caffrum					0,005									
Merremia tridentata					0,015									
Ceratotheca triloba							0,020							
Phyllanthus maderaspatensis									0,020					
Heliotropium steudneri													0,005	
Hemizygia bracteosa								0,020						
Tephrosia multijuga										0,015				0,015
Commelina spp.														
Abutilon spp.														
Paspalum dilatatum														
Solanum panduriforme				0,020										
Dicoma tomentosa											0,010			
Grasses	1,500	0,320	1,530	0,285	0,530	0,270	1,255	0,450	1,585	0,630	2,060	1,035	1,315	0,435
Forbs	0,035		0,125	0,050	0,190	0,050	0,135	0,195	0,025	0,015	0,015		0,015	0,045
Decreasers	0,845	0,025	1,000	0,055		0,070	0,010		0,335	0,165	1,235	0,605	0,530	0,270
Increasers	0,690	0,295	0,655	0,280	0,720	0,250	1,380	0,645	1,275	0,480	0,840	0,430	0,800	0,210
Total	1,535	0,320	1,655	0,335	0,720	0,320	1,390	0,645	1,610	0,645	2,075	1,035	1,330	0,480

Table 1
(continued)

Species	Plot number (distance from the dam in km)													
	8 (3,68)		9 (4)		10 (4,68)		11 (5)		12 (5,68)		13 (6,68)		14 (7)	
	1973	1990	1973	1990	1973	1990	1973	1990	1973	1990	1973	1990	1973	1990
Schmidtia pappophoroides	0,250	0,080		0,120	0,260	0,415	0,205	0,110		0,135				
Bothriochloa radicans		0,520				0,020								
Digitaria eriantha	0,195	0,220	0,120	0,550	0,815	0,090		0,170		0,280	0,130		0,185	0,110
Panicum maximum	0,135													
Themeda triandra		0,125			0,410	0,130								
Sedges			0,005					0,050	0,015	0,060				0,090
Urochloa mosambicensis	0,295	0,065	0,250	0,035	0,155	0,370	0,635	0,025						
Enneapogon cenchroides				0,015					0,005					
Eragrostis superba				0,010	0,540	0,120								
Pogonarthria squarrosa									0,015	0,200				
Aristida congesta		0,015	0,025			0,025				0,040			0,015	0,015
Tragus berteronianus	0,015	0,055	0,015	0,020	0,020			0,015	0,020		0,030	0,075	0,040	0,050
Brachiaria deflexa	0,015		0,035										0,020	
Cenchrus ciliaris						0,405								
Chloris roxburghiana													0,010	
Eragrostis heteromera					0,495									
Eragrostis rigidior	0,155	0,105	0,350			0,100	0,165	0,270	0,270	0,270				
Heteropogon contortus	0,005				0,005									
Oropetium capense			0,010	0,010	0,030						0,010			0,040
Panicum coloratum														
Sporobolus discosporus														
Tricholaena monachne									0,305					
Sporobolus fimbriatus				0,250										
Sporobolus ioclados											0,440	0,630		
Cymbopogon plurinodis	0,495				2,015	0,540								
Eragrostis cylindriflora							0,210							
Melinis repens													0,015	
Urochloa brachyura					0,485									
Gisekia africana														
Corchorus asplenifolius														
Limeum fenestratum							0,010							
Evolvulus alsinoides														

Table 1
(continued)

Species	Plot number (distance from the dam in km)													
	8 (3,68)		9 (4)		10 (4,68)		11 (5)		12 (5,68)		13 (6,68)		14 (7)	
	1973	1990	1973	1990	1973	1990	1973	1990	1973	1990	1973	1990	1973	1990
Tephrosia polystachya														
Cassia absus														
Cleome monophylla														
Brachiaria nigropedata													0,115	
Crotalaria														
Elytraria acaulis														
Melhania spp.													0,035	
Indigofera spp.														
Talinum caffrum														
Merremia tridentata														
Ceratotheca triloba							0,005						0,005	
Phyllanthus maderaspatensis														
Heliotropium steudneri			0,005											
Hemizygia bracteosa														
Tephrosia multijuga														
Commelina spp.			0,005											
Abutilon spp.											0,005			
Paspalum dilatatum										0,580				
Solanum panduriforme														
Dicoma tomentosa				0,005										
Grasses	1,560	1,185	0,805	0,515	5,230	2,185	1,215	0,590	0,615	1,505	0,610	0,705	0,400	0,215
Forbs			0,015	0,005			0,015	0,050	0,015	0,060	0,005		0,040	0,090
Decreasers	0,840	0,345	0,155	0,055	3,240	1,135		0,170		0,860	0,130		0,320	0,110
Increasers	0,720	0,840	0,665	0,465	1,990	1,050	1,230	0,470	0,630	0,705	0,485	0,705	0,120	0,195
Total	1,560	1,185	0,820	0,520	5,230	2,185	1,230	0,640	0,630	1,565	0,615	0,705	0,440	0,305

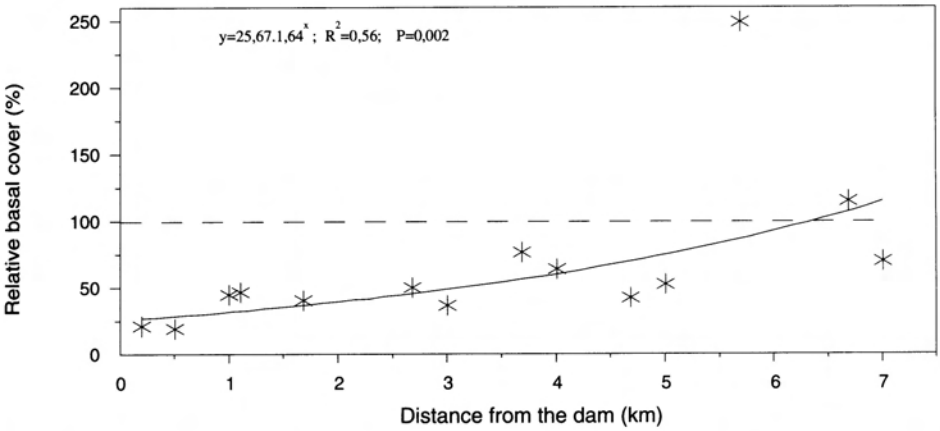

Fig.1. The positive exponential relationship between the relative total basal cover (calculated as 100 times the basal cover measured in 1973 divided by the basal cover measured in 1990) in permanently marked plots and distance (km) from the Wik-en-Weeg Dam, in the Kruger National Park.

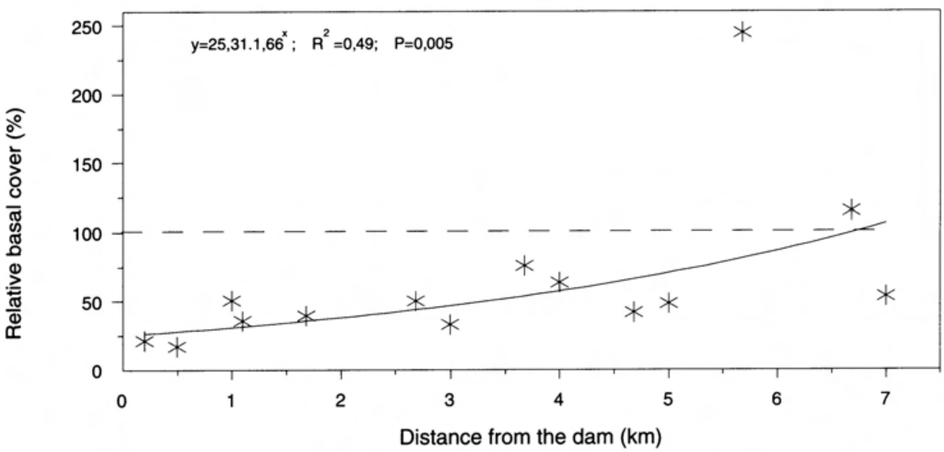

Fig. 2. The positive exponential relationship between the relative basal cover of grasses (calculated as 100 times the basal cover measured in 1973 divided by the basal cover measured in 1990) in permanently marked plots and distance (km) from the Wik-en-Weeg Dam, in the Kruger National Park.

of relative basal cover of grasses with distance from the dam.

There were significant positive relationships with distance from the dam for the relative percentage basal cover of both decreaser (R^2=0,5830; P=0,0167; y=25,0397+ 11,9662 (ln x)) and increaser (R^2=0,5765; P=0,0016; y = 20,1722 + $14,9355^x$) ecological groups. The regression line for the decreasers was a logarithmic curve levelling off about 2 km from the dam (Fig. 4). The regression line for the increasers was linear (Fig. 5).

Discussion

This study includes temporal and spatial controls and complies with the optimal impact study design of Green (1979). Therefore those relationships between herbaceous parameters and distance from the dam that were significant were considered sufficient evi-

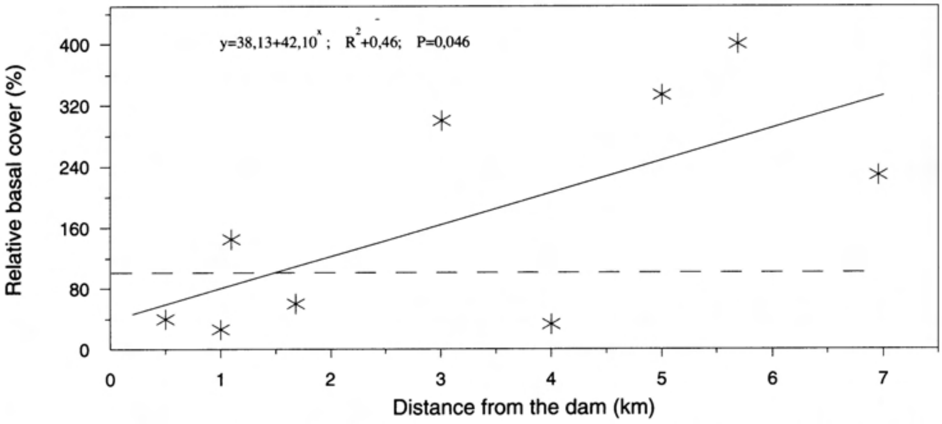

Fig. 3. The positive linear relationship between the relative basal cover of forbs (calculated as 100 times the basal cover measured in 1973 divided by the basal cover measured in 1990) in permanently marked plots and distance from the Wik-en-Weeg Dam, in the Kruger National Park.

dence to conclude that the influence of the dam had caused an impact on the herbaceous vegetation (Sokal & Rohlf 1969; Green 1979).

It was impossible to detect patterns in the changes in basal cover along the gradient of distance from the dam for most species. The cases where either a negative or a positive trend was evident are evidence for the dam having had an impact on the herbaceous community basal cover composition. This impact was probably a result of the influence of the dam on gradients in grazing pressure and trampling. Van Rooyen *et al.* (1990) also found evidence for artificial watering points causing changes in basal cover of certain species relative to further from the watering points.

The relationships with distance from the dam of the relative total basal cover and the components of the relative total basal cover that were tested, were significant and positive. This indicates that the provision of a permanent water supply for game in the Wik-en-Weeg Dam had a negative impact on the basal cover of the herbaceous vegetation in the vicinity. Several studies reviewed by O'Connor (1985), on the effects of grazing by livestock in comparable areas showed that herb stratum basal cover decreased when subjected to severe grazing. Grazing pressure, intensified by the presence of the dam, is probably the driving variable directly causing the relationship between the relative basal cover of the herbaceous stratum and distance from the dam.

The resemblance of the relationship with distance from the dam of the relative basal cover of grasses (Fig. 2) to that of the relative total basal cover (Fig. 1) was because of the dominance of the herbaceous stratum basal cover by the grasses (Table 1).

The slope of the regression line of the relationship with distance from the dam was greater for the relative basal cover of forbs (Fig. 3) than for the relative basal cover of grasses (Fig.2). The relative basal cover of forbs therefore was more sensitive to the impact of the provision of a permanent supply of drinking water for game in the Wik-en-Weeg Dam than that of grasses.

The relative basal cover of the decreaser ecological group reached an asymptote after only 2 km. The decreaser ecological group is expected to be more vulnerable to overgrazing and yet this group was less affected by the dam than was the increaser ecological group.

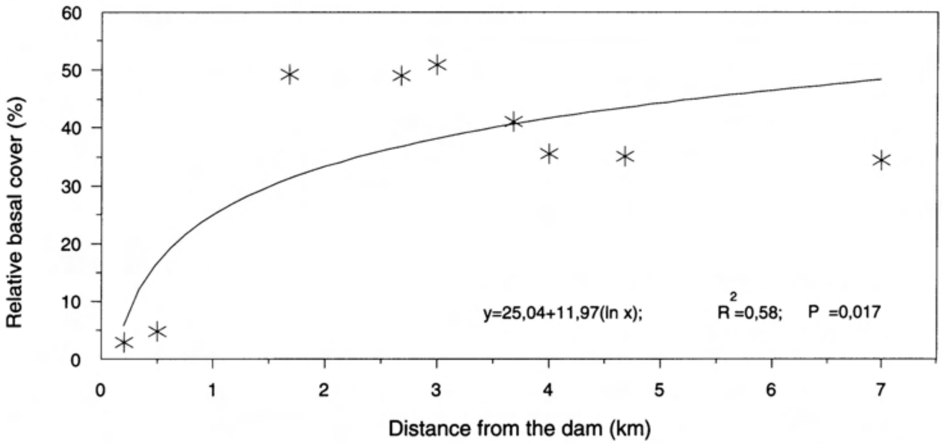

Fig. 4. The positive logarithmic relationship between the relative basal cover of the decreaser and increaser I categories of herbs (calculated as 100 times the basal cover measured in 1973 divided by the basal cover measured in 1990) in permanently marked plots and distance (km) from the Wik-en-Weeg Dam, in the Kruger National Park.

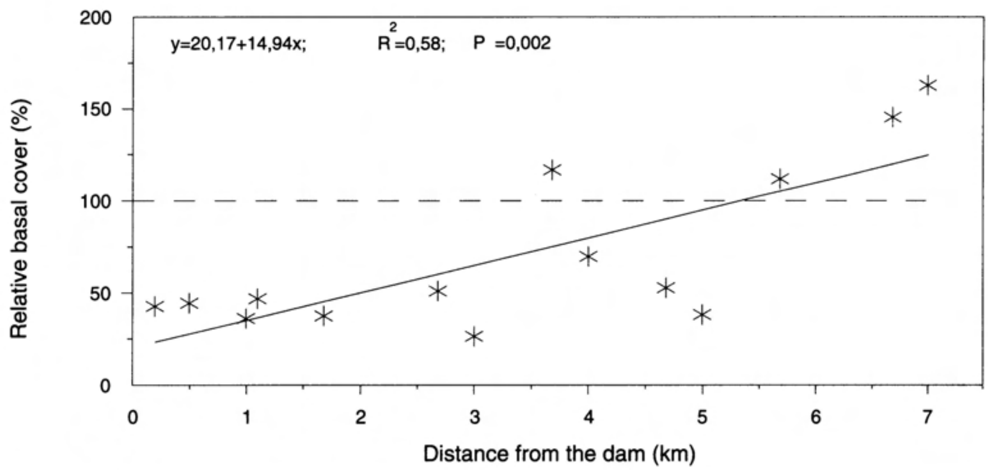

Fig. 5. The positive linear relationship between the relative basal cover of the increaser II category of herbs (calculated as 100 times the basal cover measured in 1973 divided by the basal cover measured in 1990) in permanently marked plots and distance (km) from the Wik-en-Weeg Dam, in the Kruger National Park.

Only the relationship of the relative basal cover of the decreaser ecological group with distance from the dam had an asymptote within the range of distance from the dam surveyed. The impact of the dam must taper off and become negligible at some point however. Therefore the asymptotes of the relationships with distance from the dam other than that of the relative basal cover of the decreaser ecological group must be further than 7 km from the dam. The regression lines of all the significant relationships of relative values of the woody parameters with distance from the dam reached asymptotes within 5 km (Thrash *et al.* 1991). Therefore it seems that the relative basal cover of the herbaceous stratum is more sensitive to the impact of the dam than the woody parameters tested. This may be because the herbaceous stratum is vulnerable to trampling by game, whereas the woody stratum is less so.

Conclusion

The following conclusions concerning the basal cover of the herbaceous vegetation at the Wik-en-Weeg Dam seem valid from this study:

- The provision of a permanent water supply for game in the Wik-en-Weeg Dam was followed by a decrease in the basal cover of certain species and an increase in the basal cover of other species near the dam relative to further from the dam.
- There has been a negative impact on the percentage basal cover of the herbaceous stratum in total.
- There has been a negative impact on the percentage basal cover of both the grasses and the fôrbs.
- There has been a negative impact on the percentage basal cover of both the decreaser and the increaser ecological groups.
- The basal cover of the herbaceous stratum seemed to be more sensitive to the effect of the dam than parameters of the woody stratum.

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