Review articles

Veld management with specific reference to game ranching in the grassland and savanna areas of South Africa

W.S.W. TROLLOPE

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Veld management refers to the management of natural vegetation for specific objectives related to different forms of land use. In the wildlife context a wide spectrum of different forms of land use are practised ranging from pure nature conservation in large national parks through to smaller areas used for game farming. Consequently the products useable to society emanating from these areas vary greatly, and therefore the management of veld stocked with wildlife is extremely complex and must be adapted to the particular form of land use that is being practised.

A generally accepted principle is that the smaller the area being used for wildlife the more intensively it must be managed, particularly game ranches. A prerequisite for the development of an effective veld management program is a comprehensive assessment of the condition of the veld upon which realistic veld management practices can be formulated. These practices will include stocking the veld with the appropriate species and numbers of animals, grazing and browsing management, veld burning and the provision of watering points. Finally a programme for monitoring veld condition over time is a prerequisite for sound veld management.

Key words: veld management, veld condition, wildlife, carrying capacity, fire, game ranching.

W.S.W. Trollope, Department Livestock and Pasture Science, Faculty of Agriculture, University of Fort Hare, Alice, Ciskei.

Introduction

Veld management refers to the management of natural vegetation for specific objectives related to different forms of land use (Trollope, Trollope & Bosch 1990). In the wild life context a wide spectrum of different forms of land use are practised ranging from pure nature conservation through to game ranching with different combinations of both occurring throughout the spectrum. Consequently the products useable to society emanating from these areas vary greatly from creating and maintaining plant and animal communities attractive to tourists through to trophy hunting and producing venison and other animal products. Therefore the management of veld stocked with wildlife is extremely complex and must be adapted to the particular form of land use that is being practised.

A generally accepted principle is that the smaller the area being used for wild life the more intensively it must be managed (Bothma 1989), because such areas are not self-regulating ecological units. Even large areas like

the Kruger National Park (1,9 million ha), where the management policy is one of minimum interference, certain management actions like veld burning and controlling the numbers of elephants, buffalo and hippopotami, have to be taken to maintain biological diversity and a relatively stable and resilient ecosystem. In this paper there will be a bias towards the veld management practices that have to be applied in smaller and more intensively managed wildlife areas like game ranches. In this context, the most important factors to consider in the formulation of a veld management program are the assessment of veld condition, the setting of realistic stocking rates of adapted wildlife species, grazing and browsing management, water provision, veld burning and monitoring veld condition.

Assessment of veld condition

In this section attention will be limited to assessing the condition of grassland and savanna vegetation because these types of veld constitute the major portion of the game ranching areas of South Africa, particularly the latter. The concept of veld condition refers to the condition of the vegetation in relation to some functional characteristic (Trollope *et al.* 1990). Bearing in mind that optimal habitat conditions are the most important requirement for the successful establishment and maintenance of a game population (Bothma 1989), the first step in formulating a veld management program is the identification and assessment of the condition of the vegetation in each habitat type on the game ranch. This will involve demarcating the different veld types in the area and identifying the various homogeneous vegetation units or habitats in each veld type. Sample sites are then located in each homogeneous, vegetation unit to assess the condition of the vegetation in relation to some functional characteristic. There are obviously a wide range of functional characteristics that can influence whether a habitat is suitable or not for different game species. However, the two most important functional characteristics are the potential of the vegetation to produce forage and the physiognomic structure of the vegetation.

In the case of the herbaceous layer the botanical composition of the grass sward is a good indicator of the inherent ability of the veld to produce forage for grazing ungulates. Danckwerts (1981) found that veld dominated by *Themeda triandra* in the sweet thornveld areas of the eastern Cape had a higher grazing capacity than that dominated by pioneer species like *Aristida congesta.* A good indicator of the physiognomic structure of the grass sward is the standing crop of grass as it describes the volume and density of plant material at ground level. Results obtained by De Wet (1988) in the Kruger National Park showed that the standing crop of grass is closely related to the habitat preferences of game species like buffalo *Syncerus caffer* and blue wildebeest *Connochaetes taurinus* which prefer tall and short grassland respectively.

Research in the Kruger National Park has led to the development of a rapid technique based on key grass species for assessing the forage production potential of the grass sward in the eastern Transvaal lowveld (Trollope, Potgieter & Zambatis 1989). The forage production potential of the veld is indicated by a forage score which is derived from the botanical composition of the key grass species in the sward. The technique also assesses the potential of the veld to produce grass fuel for generating a fire in view of veld burning being such an important practice in wildlife management. This is expressed as a fuel score and is derived from the botanical composition of the key grass species. Finally the technique provides a measure of the ecological status of the veld in terms of whether it is or has been heavily or lightly grazed. This technique is available for use in the veld types occurring in the Kruger National Park but research is

currently underway to extend its use to other areas in South Africa e.g. Kangwane and Ciskei.

A rapid technique for estimating the standing crop of grass in the veld is the disc pasture meter developed by Bransby & Tainton (1977). This apparatus relates the settling height of an aluminium disc to the standing crop of grass holding it off the ground. A standard calibration for the disc pasture meter has been developed for the Kruger National Park (Trollope & Potgieter 1986) and experience has shown that this calibration yields satisfactory results elsewhere in the Transvaal bushveld. Besides being able to indicate the habitat preferences of different grazing species of game it also gives an accurate estimation of grass fuel loads that can be used to decide whether it is necessary to burn the veld or not.

The important functional characteristics of the woody component are the browsing potential of the trees and shrubs and the density and height of the vegetation. No well developed technique is currently available for assessing the condition of the bush in wildlife areas but Teague (1989) describes a technique that is used in the thornveld areas of the eastern Cape for assessing the condition of the veld for goats. The technique develops an index of the amount of browse available in the 1,5 m stratum from ground level and is based on the density and height of palatable bush species in this stratum. The data are expressed as the number of browsing units per hectare (Browsing unit = 1,5 m palatable bush) and empirical results obtained at the University of Fort Hare show that it is significantly related to the browsing capacity of veld for goats. The technique also provides an index of the phytomass of bush which is expressed as the number of tree equivalents (1 tree equivalent = 1,5 m bush) per hectare. This latter parameter has also been found to describe the physognomic structure of the trees and shrubs in a biologically meaningful manner. It is firmly believed that a similar technique could be developed for use in wildlife areas by adapting the estimate of the browsing potential of the veld to the feeding preferences, and browsing heights of the different wildlife species. In the absence of such a technique this avenue of research deserves a high priority.

Finally the assessment of veld condition is a prerequisite for the formulation of a sound veld management program. Whether appropriate veld condition assessment techniques are available or not for the area being planned, the condition of the different habitat types must be evaluated whether it be subjectively or objectively.

Stocking rate

The stocking rate of different game species on a game ranch will be determined by the types and condition of the different available habitats and the mangement objectives for the ranch (Bothma 1989; Thompson 1986). Considerable information is available in South Africa on the habitat requirements of certain game species (Bothma 1989; Young 1989) and this information together with the different habitats that are identified during an assessment of the condition of the veld can be used to determine what species are best suited to a ranch. Of course, the choice of species will also be influenced by the management objectives of the ranch as to whether it is to be used for trophy hunting, venison production, sport hunting or viewing.

The stocking rate of the different game species will be primarily a function of the grazing and browsing capacity of the veld which is in turn, dependent on the condition of the veld as discussed earlier. This is not necessarily true for low density game species where optimal habitat conditions are the most important requirement for the successful es-

tablishment and maintenance of a game population (Bothma 1989).

Nevertheless veld condition is generally of paramount importance in determining the stoking rate of ungulates on a game ranch. It is also recommended that the stocking rate of game should be varied according to the management objectives of the area (Thompson 1986; Bothma 1989) and this can be expressed as a percentage of the ecological carrying capacity (ECC) (Fig. 1). The ecological carrying capacity is the maximum population

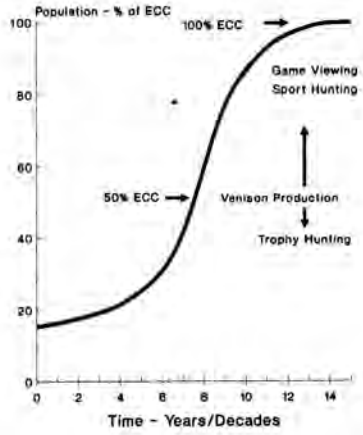

Fig. 1. Recommended stocking rates for different management objectives expressed as a percentage of the ecological carrying capacity (ECC).

of animals that an area can support without deterioration to the habitat (Thompson 1986; Bothma 1989).

For maximum venison production it is recommended that the stocking rate should be equivalent to approximately 50% of the ecological carrying capacity. At this level the rate of increase of an animal population is at a maximum. For trophy hunting the stocking rate should be below 50% of the ecological carrying capacity so that the environmental conditions, especially forage, are optimal for animal performance. Conversely for sport hunting and game viewing the stocking rate should be higher than the maximum rate of increase (50% of ECC) because here the emphasis of management is on maximising animal numbers (Thompson 1986; Bothma 1989).

The aforementioned guidelines can be further clarified by considering the general effect of stocking rate on animal performance as described by the widely accepted model pro-

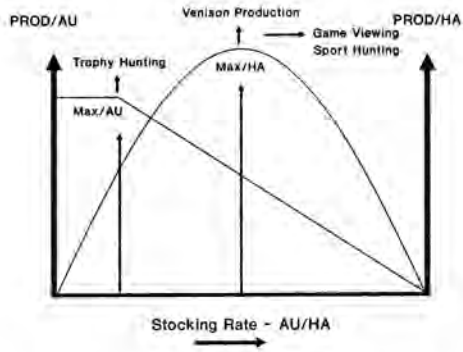

Fig. 2. Effect of stocking rate on animal performance (Jones & Sandland 1974).

posed by Jones & Sandland (1974) (Fig. 2).

Briefly, Figure 2 indicates that at very low stocking rates production per animal unit is at a maximum but after a certain point when competition for forage occurs production per animal unit decreases linearly to zero. Conversely at very low stocking rates animal production per hectare is very low but it increases with an increase in stocking rate until it reaches a maximum after which animal performance decreases to zero. Thus when the objective of management is to maximise production per animal unit as in trophy hunting a low stocking rate should be applied to achieve

this objective. Conversely if the emphasis of management is on venison production then a stocking rate should be applied that will maximise production per hectare. Finally where animal production is not a priority but game numbers are important for sport hunting and game viewing, then the stocking rate should be increased towards that of the ecological carrying capacity when production per hectare and per annual unit are tending towards zero.

The current methods used for estimating the carrying capacity of the veld on game ranches are the estimate method, the energy method and the large animal stock unit method (Bothma 1989). An assessment of these methods shows that the estimation of the carrying capacity of veld for game populations is partly an art and partly a science (Bothma 1989) and that generally the current methods are unsatisfactory. It is firmly believed that the solution to the problem is to consider and adapt the current methods being used in agriculture for estimating the carrying capacity of veld for domestic livestock which are based on veld condition. Considerable progress has been made in the agricultural field and the current techniques are fully described in the publication by Danckwerts & Teague (1989) entitled *Veld management in the eastern Cape*. The veld condition data are used for estimating the grazing and browsing capacity of the veld for domestic grazers and browsers. It is believed that with appropriate adaptations these estimates could be related to different game populations expressed on an animal unit equivalent basis using the conversions proposed by Meissner (1982) for different animal species. In this way the stocking rate of game could be varied according to the condition of the veld on a game ranch. These estimates could be tested in practice and adapted if necessary in the light of field experience. These estimates of the carrying capacity are approximately equivalent to a stocking rate that will maximise animal production per hectare in Figure 2. Therefore, adjustments to the stocking rate will have to be made according to the management objectives of the game ranch, i.e. equal to, greater than, or less than this stocking rate.

Finally, whatever the final stocking is, it should be conservative in order to cope with unfavourable rainfall conditions. For the management options requiring higher stocking rates a possible solution is to base the number of breeding stock of game on the mean annual rainfall for all the below average rainfall years. This will provide a viable strategy for coping with drought periods and permit an accumulation of grass fuel for veld burning for controlling problems like bush encroachment (Danckwerts 1989).

Animal ratios

Among grazing animals the need for managerial skills is inversely proportional to the size of the animals because smaller animals generally graze more selectively than large animals. With this in mind Mentis (1981) classified ruminant and non-ruminant ungulates according to their relative potential for defoliation and selective grazing, *viz.*

- Bulk grazers — large grazing animals which normally do not exercise a high degree of selective grazing.
- Concentrate grazers — generally small grazing animals which exercise some or other form of extreme species or area selective grazing.
- Browsers — animals which feed mostly on leaves, flowers and fruits of woody plants and forbs.

A classification of the more common ungulate species is presented in Table 1.

The selective grazing habits of ungulates is related to the grazing sequence in which different classes of animals utilise a pasture and normally involves heavy animals preceding light animals thus preparing the pasture for

Table 1
Classification of some common ungulates according to their feeding habits (Mentis 1981)

Feeding Group	Animal Type
Bulk grazer	Domestic cattle
	Buffalo
	Burchell's zebra
	Waterbuck
Concentrate grazer	White rhino
	Blue wildebeest
	Gemsbok
	Black wildebeest
	Nyala
	Common reedbuck
	Blesbok
	Bushpig
	Domestic sheep
	Impala
	Warthog
	Springbok
	Mountain reedbuck
	Grey rhebuck
	Oribi
Browser	Black rhino
	Giraffe
	Eland
	Kudu
	Domestic goat
	Bushbuck
	Grey duiker
	Steenbok

use by those animals which follow. This has been observed in East Africa (Vesey-Fitzgerald 1965; Mentis 1981) and has been recorded in the Kruger National Park where De Wet (1988) found that buffaloes preferred areas with 2 200 - 2 300 kg/ha of grass material, zebras 1 900-2 000 kg/ha and blue wildebeest 2 600 kg/ha. To cater for this phenomenon Mentis (1981) recommended that the metabolic mass of concentrate grazers should not be permitted to exceed that of bulk grazers in any grazing unit. He proposed a maximum ratio of 1 AU bulk grazers: 1 AU concentrate grazers based on the experience with domestic livestock of not having a ratio greater than 1 bovine (bulk grazer): 6 sheep (concentrate grazer). While agreeing with the necessity for formulating guidelines for grazing animal ratios, the aforementioned ratio was determined in sourveld and experience in the sweetveld areas of the eastern Cape suggests that a narrower ratio of 1 bovine: 3 sheep is preferable in low rainfall areas where veld condition is more sensitive to selective grazing. Consequently it is recommended that on game ranches a maximum ratio of 1 AU bulk grazers: 1 AU concentrate grazers be applied in sourveld areas and a maximum ratio of 1 AU bulk grazers: ½ AU concentrate grazers in sweetveld areas (see Trollope *et al.* (1990) for definitions of sour and sweetveld). Ofcourse, narrower ratios can be used as the objective of this practice is to control selective grazing.

In savanna areas Mentis (1981) recommends a ratio of 2 AU bulk grazers: 2 concentrate grazers : 1 AU browsers. This recommenda-

grazers utilise different and unrelated sources of forage and their numbers should, therefore, be a function of the browsing and grazing capacity of the veld.

Grazing and browsing management

The basic objective of grazing and browsing management is the improvement and/or maintenance of the condition of the veld for the benefit of grazing and browsing animals. This can be achieved through rotational grazing and browsing where the frequency, intensity and selectivity of defoliation of the veld is controlled by allowing animals access to restricted areas of veld for limited periods of time followed by periods of absence during which time the vegetation can recover. This can also be achieved by rotational resting where extensive areas of veld are withdrawn from grazing for extended periods of time for specific objectives like seed production, recruitment of new plants and improving and maintaining the vigor of the veld. Continuous grazing and browsing generally lead to the selective overutilization of preferred forage species and areas resulting in veld deterioration (Tainton 1981; Danckwerts & Teague 1989; Zacharias 1990). Thus some form of rotational stocking is necessary to maintain veld condition.

Under natural wildlife conditions some form of rotational stocking does occur particularly amongst high density grazing species. Large annual migrations of blue wildebeest occur in the extensive grasslands of East Africa (Brown 1970) and there is an annual movement of buffalo, zebra *Equus burchelli* and wildebeest from the central district of the Kruger National Park to the south eastern region in response to grazing conditions (De Wet 1988). However, this seldom occurs on game ranches because they are generally too small and do not constitute naturally functioning ecological units and therefore some form of pro-active management is necessary.

Of the two rotational strategies it is believed that rotational resting is the more practical option on game ranches because it does not require the frequent movement of game from one area to another. Generally, moving undomesticated wild game species is either very difficult or completely impractical, particularly in broken savanna country. Young (1989) reported that a measure of success had been obtained with a simple pauci-camp system where game was moved from one camp to another by co-ordinating the opening and closing of watering points and camp gates. Nevertheless the erection of game proof internal fences would also be a serious limiting factor because of the exorbitant costs of fencing.

The implementation of a rotational resting program will firstly involve the sub-division of the ranch into different major veld types. The data from the veld condition surveys will provide the necessary information. Where applicable, sour and sweetveld areas must be identified and separate plans developed for each type of veld. The basic management technique is to apply treatments to the veld on a rotational basis that will attract game to these areas thus providing a rest period to the vacated area. Generally the most effective way of attracting game to a particular area is to burn the veld resulting in the production of highly palatable and nutritious forage. Details regarding veld burning will be dealt with later. Suffice it to say that the burning program must be carefully planned, the most important factor being the size of area to be burnt. Care must be taken to ensure that the burnt area far exceeds the short term forage requirements of the game that will be attracted to it so that no over-utilization of the veld occurs. Another important factor is that the stocking rate of game, particularly grazers, must be such that sufficient grass fuel will accumulate for the implementation of a burning program. The aforementioned recommendation by Danckwerts (1989), that the stocking rate of breeding animals be based on

burning program. The aforementioned recommendation by Danckwerts (1989), that the stocking rate of breeding animals be based on the mean rainfall of below average rainfall years is particularly pertinent in this regard. Veld burning is especially important in situations where there is both south and sweetveld on a game ranch. Portions of the sourveld can be burnt regularly to attract the animals away from the sweetveld and the remaining portions of the sourveld, which will then have an opportunity to rest. Rotational resting can also be implemented by the strategic placing of licks to attract game to a new area and by the opening and closing of watering points (Young 1989). The effectiveness of the latter method will depend upon the presence and absence of permanent watering points like dams and rivers.

It must be stressed, though, that rotational resting can never be implemented completely on a game ranch because there will always be some preferred areas, e.g. around permanent watering points, that will be continuously stocked. Furthermore some species of game are territorial and will not move readily. Consequently, the overall stocking rate together with that of certain problem game species must remain the most important veld management practice and must be carefully regulated in order to maintain the condition of the veld.

Veld burning

When developing a burning program for a game ranch, the most important factors to consider are the reasons for burning and the appropriate fire regime to be applied. There are basically two reasons for burning veld (Trollope 1989):

- To remove moribund and/or unacceptable grass material.
- To eradicate and/or prevent the encroachment of undesirable plants.

The fire regime refers to the type and intensity of fire and the season and frequency of burning.

i) *Type of fire*

In grassland and savanna areas surface fires are the most commonly occurring type of fire and within this category there are head fires that burn with the wind and back fires that burn against the wind. It is recommended that head fires be used in all cases because they cause least damage to the grass sward but can cause maximum damage to woody vegetation if required (Trollope 1989)

ii) *Fire intensity*

Fire intensity refers to the rate at which heat energy is released per unit length of fire front and is expressed in kilojoules per second per metre ($kJ.s^{-1}m^{-1}$). When burning to remove moribund and/or unacceptable grass material a cool or low intensity fire of $< 1\ 000\ kJ.s^{-1}m^{-1}$ is recommended. This can be achieved by burning when the air temperature is < 20 °C and the relative humidity > 50 %. When burning to control undesirable plants like encroaching bush, a high intensity fire of $> 2\ 000\ kJ.s^{-1}m^{-1}$ is necessary. This can be achieved by burning when the grass fuel load is > 4 000 kg/ha, the air temperature is 25-30 °C and the relative humidity < 30 % (Trollope 1989). This will cause a significant topkill of stems and branches of bush species up to a height of 3 metre.

iii) *Season of burning*

Research in Natal and the eastern Cape has shown that the least damage is caused to the grass sward if burning is applied when the grass is dormant. Therefore, it is recommended that when burning to remove moribund and/or unacceptable grass material burning should preferably be applied after the first spring rains when the grass is still dormant. Conversely, when burning to control

iv) *Frequency of burning*

When burning to remove moribund and/or unacceptable grass material, the frequency of burning will depend upon the accumulation rate of excess grass litter (Trollope 1989). Field experience indicates that this should not exceed 4 000 kg/ha and therefore the frequency of burning should be based on the rate at which this phytomass of grass material accumulates. This approach has the advantage that the frequency of burning is related to the stocking rate of grazers and to the amount of rainfall the game ranch receives. Generally, in sourveld areas this will result in the frequency of burning being every 2 - 4 years. In sweetveld areas it will be much lower and, in fact, this rule of thumb will exclude fire where the condition of the veld is so poor that excessive grass fuel loads never accumulate. Thus in terms of rotational resting the frequency of burning will be one of the determining factors in the application of this veld management practice.

When burning to control undesirable plants (like encroaching bush), this will be determined by the rate of re-encroachment of the bush. In the sour bushveld areas burning once very 2 - 4 years will be adequate for controlling bush encroachment. In the sweet bushveld areas the role of fire is to maintain bush at an available height and in an acceptable state for browsing animals. Normally burning for this reason will be relatively infrequent and will depend on the stocking rate of browsers. Fire should be applied after above average rainfall years when adequate grass fuel loads have accumulated (Trollope 1989).

Water provision

Adequate and well distributed watering points are essential for the optimum utilization of veld on a game ranch. The factors to consider when developing watering points are the topography, type of soil, type of veld, distance from other watering points and the movements and habits of game species (Bothma 1989; Young 1989). Watering points should be located in flat terrain with non-erodible soils to avoid excessive runoff and soil erosion. Sensitive sweetveld that is prone to overgrazing should be avoided. The maximum distance between watering points will vary according to the size of the game. Research in the Kruger National Park has shown that impala will graze up to 2,2 km from water, zebras 7,2 km, blue wildebeest 7,4 km and buffaloes 7,8 km during the winter months (Young 1989).

The daily water requirements of game can be estimated on the basis of 4 litres per 100 kg livemass. These estimates are for the dry winter period and can serve as a guideline for the development of watering points on a game ranch (Young 1989). Finally as mentioned previously, the opening and closing of watering points can play an important role in the application of a rotational resting program. Therefore, in the management of wild ungulate species, particularly grazers, drinking troughs are preferred to permanent dams as they can be more easily manipulated for this purpose.

Monitoring veld condition

The recent development of techniques for assessing veld condition is one of the most important advances in the field of veld management. This is because veld condition data are not only important in the planning of a veld management program but trends in veld condition monitored over time can be used to evaluate and adapt veld management practices when necessary. It is, therefore, essential that the condition of the veld be monitored on a regular basis on a game ranch. One or more permanently marked sample sites should be located in the different habitat types at a sampling intensity of approximately one sample site per 100 ha. Grass and bush surveys must be conducted at each sample site preferably once every three years but not less

frequently than once very five years. The grass surveys must include an estimate of the standing crop of grass using a disc pasture meter. The data from these surveys will provide the basis for adjusting the stocking rate of grazers and browsers, the rotational resting program and the veld burning program if necessary. An additional, but valuable, veld monitoring technique is the taking of fixed point photographs at key sample sites on the game ranch. Photographs are particularly valuable for monitoring trends in the condition of bush. An extensive veld condition monitoring program is currently being implemented in the Kruger National Park and it is yielding very interesting and valuable trends in the condition of the veld that are proving useful for management purposes.

In conclusion it must be stressed that the veld on a game ranch forms part of a dynamic ecosystem that is constantly changing and monitoring veld condition provides the means of applying adaptive veld management which is essential for the successful running of a game ranching enterprise.

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