Scientific Research Publishing

Open Journal of Ecology, 2026, 16(5), 237-253
https://www.scirp.org/journal/oje
ISSN Online: 2162-1993
ISSN Print: 2162-1985

Influence of Ecological Disturbances on Herbaceous Productivity and *Euryops floribundus* Density in Communal Rangelands of the Eastern Cape Province, South Africa

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How to cite this paper: Tokozwayo, S., Mthi, S., Royimani, L., Mbambalala, L. and Rapiya, M. (2026) Influence of Ecological Disturbances on Herbaceous Productivity and *Euryops floribundus* Density in Communal Rangelands of the Eastern Cape Province, South Africa. *Open Journal of Ecology*, **16**, 237-253.
https://doi.org/10.4236/oje.2026.165015

Received: February 18, 2026
Accepted: May 11, 2026
Published: May 14, 2026

Abstract

Shrub encroachment continued to alter grasslands into savanna ecosystem, diminishing grazing capacity, and weakening the resilience rural farming systems. Expansion of indigenous shrubs is associated anthropogenic activities such as unprescribed burning and overutilisation of natural resources. The study aimed to evaluate the influence of burning and continuous grazing on herbaceous layer and *Euryops floribundus* density. A 5-hectare plot was divided into subplots (*i.e.* burned and continuously grazed), each further partitioned into 6 plots. Three parallel transects (80 m^2) were established per plot and step-point method (40 points) was employed to determine species composition. Along the same transects woody plants were counted to determine bush density. Three quadrats (0.25 m^2) per plot randomly placed and vegetation within the quadrat were clipped above ground level. In total, 36 samples harvested and over oven-dried to determine forage production. The results showed that burned site enhanced the abundance of desirable perennial grasses species such as *Hyperrhenia hirta* (17.00%) and *Themeda triandra* (16.70%), while continuously grazed site was dominated by less acceptable species such as *Aristida congesta* (17.21%) and *Eragrostis plana* (15.04%). Climax species comprised 28% of burned against 14% of grazed sites. *E. floribun-*

dus density declined from 2300 to 0 plants/ha in burned site but persisted at 2351 plants/ha at continuous grazing site. Forage production displayed a positive relationship at burned site compared to continuous grazed site. The results confirmed that repeated burning, where fuel load is not the limiting factor, can suppress or reduce bush density. However, long-term studies need to be conducted to quantify fire intensity, fuel load, and monitor the potential recovery *E. floribundus* over time.

Keywords

Encroachment, *Euryops floribundus*, Continuous Grazing, Burning

1. Introduction

Shrub encroachment by *Euryops floribundus* is progressively altering communal rangelands in the Eastern Cape [1] [2], resulting in decreased herbaceous productivity, reduced grazing capacity and resilience of rural farming systems [3]. This phenomenon emphasizes the essential role of fire as an ecological regulator, given its fundamental influence on plant community dynamics, nutrient cycling, and overall ecosystem functioning across multiple biomes [4].

In the South African context, fire is integral to the maintenance of species composition, structural characteristics, and functional resilience of grassland, fynbos, and savanna ecosystems [5], with its frequency and intensity exerting a significant control over the balance between woody and herbaceous vegetation [6]. The grassland biome, recognized as one of the most biodiverse terrestrial ecosystems, continues to face substantial threats from land degradation associated with suboptimal veld management practices, including uncontrolled grazing and inadequate resting periods [6].

Consequently, approximately 60% of the grassland biome has undergone permanent transformation, leaving only a limited proportion in a natural or minimally conserved state [7]. Increasingly, woody plant encroachment into open grasslands has emerged as one of the most noticeable indicators of vegetation shift or deterioration [8]. Grasslands, which cover nearly 40% of the Earth's terrestrial surface, provide a wide range of essential ecosystem services, including forage production, soil stabilization, medicinal plants, carbon sequestration, and water regulation [2] [9]. These rangelands also support millions of households and livestock populations across the African continent [10]-[12]. However, grasslands remain highly susceptible to anthropogenic pressures such as overgrazing, soil degradation, and loss of soil cover [13]. Specifically, uncontrolled grazing reduces the productivity of perennial grasses, impairs vegetation recovery, and creates microsites conducive to shrub establishment [14] [15]. Furthermore, trampling around water points accelerates bare patch formation, thereby facilitating the recruitment and spread of encroaching shrubs such as *E. floribundus* [16].

These pressures are particularly pronounced in the communal rangelands of the Eastern Cape, where *E. floribundus* has become widespread, suppressing herbaceous productivity, changing vegetation structure, and ultimately reducing grazing capacity. This trend is further intensified by the absence of structured grazing management practices, as weakened herbaceous vegetation provides limited competition against aggressive shrubs such as *E. floribundus*, thereby facilitating their proliferation and making encroachment progressively more difficult to reverse.

In this context, prescribed burning has emerged as a practical and ecologically appropriate management tool for mitigating shrub encroachment, particularly in resource-limited rural communities. Fire removes accumulated litter, increases light penetration, and enhances nutrient cycling, thereby promoting the growth of palatable perennial grasses and improving forage quality [17] [18]. However, the effectiveness of prescribed burning is influenced by several interacting factors, including fuel load, fire intensity, moisture content of the litter, wind speed and direction, type of fire applied, and the subsequent grazing regime [19]-[21]. Together, these factors determine the success of vegetation recovery, the suppression of undesirable plant species, and the long-term sustainability of rangeland management strategies.

However, despite its ecological and socio-economic importance, limited empirical research has quantified how repeated burning interacts with continuous grazing to influence herbaceous composition and woody plant density in grasslands encroached by *E. floribundus*. This knowledge gap is particularly significant because *E. floribundus* possesses traits such as a short multi-stemmed structure, fine leaves, and exposed seeds that may increase its susceptibility to fire [22]. Moreover, uncontrolled grazing and unplanned burning can reduce the fuel loads necessary for an effective prescribed burn, thereby creating uncertainty regarding the interactive effects of these disturbances in communal rangelands. Consequently, understanding these dynamics is critical for developing rangeland management strategies capable of restoring productivity while suppressing infestations of undesirable woody plants. Therefore, this study aimed to evaluate the influence of repeated burning and continuous grazing on herbaceous species composition, ecological condition, and *E. floribundus* density in the communal rangelands of Sakhisizwe Local Municipality. It was hypothesized that repeated burning would enhance the abundance of palatable perennial grasses and substantially reduce *E. floribundus* density, whereas continuous grazing without burning would facilitate its persistence and further expansion.

2. Method and Materials

2.1. Site Description

The study was carried out at Mxe communal grazing lands in Cala within Sakhisizwe Local Municipality under the Chris Hani District of the Eastern Cape Province. The area lies at 31˚32'39.17"S, 27˚37'22.73"E, with an elevation of 4017

meters above sea level (Figure 1). Cala is a small town between Elliott and Lady Free, located near the Tsomo River, approximately 28 km southwest of Elliot [23] [24]. The area receives an average annual rainfall of 430 mm to 790 mm, and experiences mean annual temperatures ranging between 14.7˚C to 37˚C [25]. The predominant vegetation type is Tsomo Grassland, which is characterized by gently sloping lowland plains interspersed with mountainous areas [25]. The herbaceous layer is dominated by white grasses, which are often grazed short or replaced by encroaching *Euryops floribundus* species. Soils are derived from two parent materials namely mudstone and shale [25]. Grazing capacity for the areas ranged from 4 - 8 hectare per large stock unit (ha/LSU) [25].

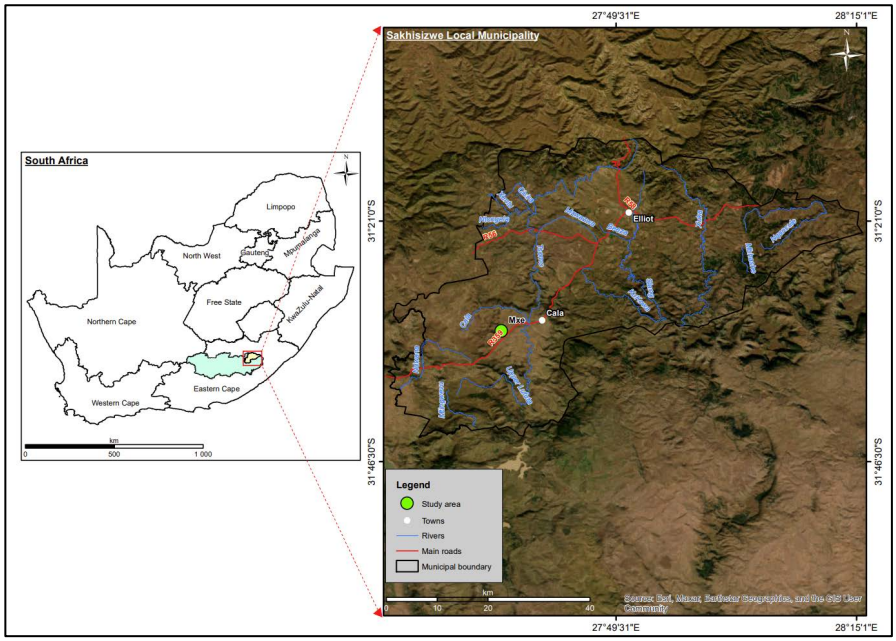


Figure 1. The map shows the study site at Mnxe communal rangeland in Cala.

2.2. Experimental Design

The study site was selected based on its relatively homogenous vegetation cover (encroached by *Euryops floribundus*), similar land use (livestock farming with the grazing capacity of 4 - 8 ha/LSU), and mountainous topography. In August 2018, Mnxe communal rangelands was identified by communal farmers as study site. This study site was selected primarily to establish research trial for testing fire as potential measure for reducing the *E. floribundus* density. The study site has not been subject to burning due to insufficient fuel load resulting from continuous grazing as shown in Figure 2. 5 hectares (ha) were selected, demarcated, and subdivided into two subplots (each measuring 2.5 ha) using a tape measure and metal rods. One subplot (2.5 ha) was fenced (burned) and protected from grazing while the other remained unfenced and left open for continuous grazing. Both burned and continuously grazed plots were divided into 6 small plots (each measuring 40 m × 20 m with 2 m distance apart) and were marked by steel rods. All plots under

burned site were burned simultaneously at the beginning of September month in 2019 until 2025. Under continuously grazed site 6 blocks were marked with permanent iron roads. Under continuously grazed site, there are restrictions no grazing capacity, as the area falls within a communal rangeland system. Communal rangelands are generally characterized by the absence of clearly defined regulations governing the use of natural resources.

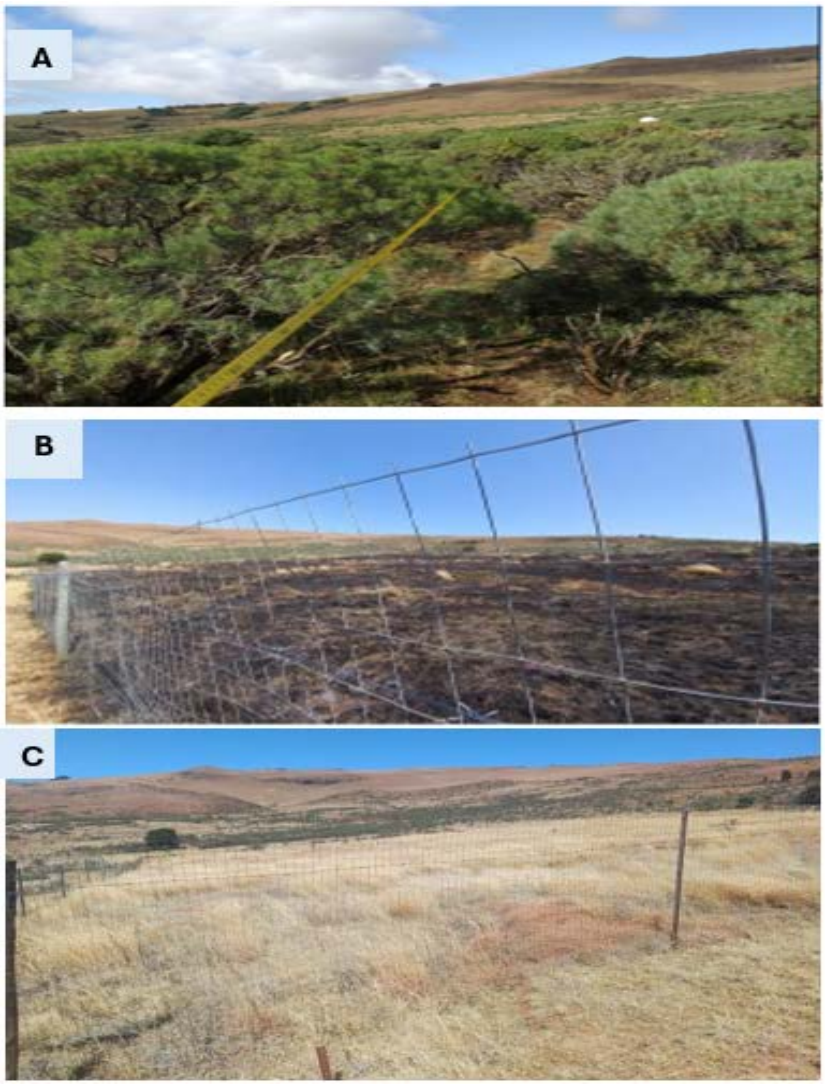


Figure 2. Picture A, B and C show encroached continuously grazed area in 2018, burned plot in 2022, and recovered plot in 2024, respectively.

3. Burning Procedure

The first burn was carried out done in September 2019, employing both backfire and headfire as defined by [26]. Prior burning date, burning application was submitted to Chris Hani District Municipality (Fire and Rescue department). This process was done primarily to minimize the risk of uncontrolled veldfires, safeguard surrounding communities and infrastructure and ensuring prescribed

burning is conducted under suitable conditions in accordance with National Veld and Forest Fire Act 101 of 1998 of South Africa. Farmers as land users were also informed about the burning date. The burning was informed by the Fire Danger Indexes weekly released by South African Weather Services (SAWS). Tools used during the burning include firebeaters, a lighter, a drip torch, and a bakkie equipped with a water tank. A lighter was utilized to start fire. Fire beaters were used to control and extinguish flames along the fire line and to prevent the spread of fire beyond boundaries. Drip torch was used for spreading the fire ensuring an even and manageable burning pattern (see the drip torch and head fire in **Figure 3**). Bakkie with a mounted water tank served as a mobile firefighting unit, providing immediate access to water for suppressing fire flames.

Figure 3. The picture shows application of head fire at Mnxe communal rangeland.

3.1. Data Collection

Data collection commenced after first year of burning in September 2020 and continued annually until 2025. In each plot, three parallel transects (40 m × 2 m) with 2 m apart were laid out in each plot, were established in both burned and continuously grazed site. Woody plants occurred within the transects were counted to determine bush density [26]. Along the same transect, grass species present were identified and recorded using the step-point technique to determine species composition at burned and continuously. A total of 100 points were sampled using

step point technique [26]. Identified species were classified according to their ecological groups, perenniality and palatability [26]. Along the same transect, 0.5 m × 0.5 m quadrant was randomly placed with three quadrants per transect. Herbaceous vegetation within a quadrat was clipped at ground level using scissors. Three samples were collected per transect, resulting in 9 samples per plot, and a total of 36 samples across both burned and continuously grazed sites. As from 2019 until, a total of 36 samples were harvested and oven-dried at 65˚C for 48 hours at Dohne Agricultural Development Institute to determine dry matter yield (kg/ha). A quadrat (0.5 m × 0.5 m) was converted into kg/ha, assuming that, 10,000 m^2 is equivalent to 1 hectare.

3.2. Data Analysis

The collected data were entered into an Excel spreadsheet, where they were organised and processed to generate descriptive statistics. This allowed for a clear summary of patterns, trends, and general characteristics within the dataset. The relative abundance percentage and bush density of *E. floribundus* were calculated using the following for formulas:

$$\mathrm{RA} = n_i \Big/ \left(N_j\right) \times 100\% \tag{1}$$

where:

RA: is a proportion percentage of individuals species compared to the total number of individuals of all species present in a community.

n_i: is the number of individual species.

N_j: is the number of species population.

$$\mathrm{PD} = \left(\text{Number of trees counted}\right) \Big/ \left(\text{Area sampled}\left(\mathrm{m}^2\right)\right) \times 10000\text{ha} \tag{2}$$

where:

PD: is a plant density of per hectare. Number of plants counted: total of woody plants recorded in sampled transect. Area sampled (m^2): total area of all plots combined. Dried weight per each quadrat was converted to dry weight per kilogram, assuming that 1 ha is equivalent to 10,000 m^2.

3.3. Results and Discussion

Species Composition

Table 1 presents the species composition of the herbaceous layer under the burned and continuously grazed sites within the encroached environment. The continuously grazed site was dominated by C4 grasses that are generally less palatable to livestock. The most prevalent species were *Aristida congesta* (17.21%) and *Eragrostis plana* (15.04%), followed by *Eragrostis capensis* (11.75%). Similar dominance of Aristida and Eragrostis species in heavily grazed areas has been reported by [26], reflecting their tolerance to grazing pressure and the reduced competitiveness of palatable species under continuous defoliation.

In contrast, the burned site showed a clear shift in species composition, with higher proportions of desirable perennial grasses such as *Hyperrhenia hirta*

(17.00%), *Themeda triandra* (16.70%) and *Eragrostis capensis* (12.35%). This pattern suggests that repeated burning supports the persistence of palatable, fire-tolerant perennials, thereby improving overall ecological condition. This finding aligns with [17], who reported that fire promotes the growth of perennial grasses such as *Themeda triandra* and *Digitaria eriantha*.

Table 1. Effect of burning and continuously grazed on species relative abundance and composition.

Botanical name	Perenniality	Ecological status	Burned	Continuously grazed
Aristida congesta	Perennial	Increaser II	4.15	17.21
Aristida diffusa	Perennial	Increaser III	0.57	8.95
Bachiaria serrata	Perennial	Decreaser	1.50	-
Cynodon dactylon	Creeper	Increaser II	4.55	6.00
Elionurus muticus	Perennial	Increaser III	5.74	-
Eragrostis capensis	Perennial	Increaser II	12.35	11.75
Eragrostis chloromelas	Perennial	Increaser II	8.17	5.60
Eragrostis curvula	Perennial	Increaser II	6.19	3.00
Eragrostis obtusa	Perennial	Increaser II	2.64	4.80
Eragrostis plana	Perennial	Increaser II	5.77	15.04
Eustachys paspaloides	Perennial	Decreaser	6.39	1.89
Heteropogon contortus	Perennial	Increaser II	4.00	3.00
Hyperrhenia hirta	Perennial	Increaser I	17.00	8.77
Marximurela disticha	Perennial	Increaser I	2.00	0.00
Microchloa caffra	Perennial	Increaser II	0.34	3.09
Non-grass plants	-	-	0.17	3.59
Sporobulus Africanus	Perennial	Increaser III	0.65	3.00
Themeda triandra	Perennial	Decreaser	16.70	4.34
Trichoneura grandiglumis	Perennial	Increaser III	1.17	-
Grand total			**100**	**100**

In the absence of burning, highly palatable species are suppressed and shade-tolerant taxa such as *Eragrostis plana* and *Elionurus muticus* tend to dominate. The presence of highly palatable species such as *Bachiaria serrata*, *Eustachys paspaloides* and *Eragrostis curvula* at the burned site further reflects improved veld condition, consistent with their use as indicators of well-managed rangelands [27]. These contrasting patterns between sites are consistent with the hypothesis, which anticipated that burning would favour palatable perennial grasses while

continuous grazing would encourage the dominance of less desirable species.

Species richness also differed between treatments, with 18 species recorded at the burned site compared to 14 at the continuously grazed site. The burned site contained 83% increaser species and 17% decreaser species, while the continuously grazed site had 86% increasers and only 14% decreasers. This shift is ecologically meaningful, as decreaser species generally thrive under good veld condition. The higher proportion of decreasers at the burned site suggests that fire suppressed fewer desirable taxa and facilitated the return of palatable perennials, a response also noted by [28], who observed that burning reduces increasers and enhances decreaser abundance in grassland systems.

One of the ecological mechanisms likely influencing these patterns is the reduction of accumulated litter following fire. The removal of moribund material increases light penetration and improves soil–plant moisture interactions, which enhances the growth of emerging shoots [18]. Although the long-term effects of burning on forage quality remain debated, removing old biomass generally leads to a temporary improvement in palatability [29]. Lastly, the continuously grazed site had a slightly higher proportion of forbs (3.59%) compared to the burned site (0.17%). This difference corresponds with observations by [30], who noted that dense C4 grass cover following burning can suppress forb growth by limiting sunlight availability.

3.4. Influence of Burning and Continuous Grazing on Plant Succussion

Sub-climax species were dominant in both treatments, comprising 50% (9) at burned site and 57% (8) at continuously grazed site (**Table 2**). This indicates that the prevailing plant community in both sites was largely composed of moderately stable species that are cable of persisting under conditions of burning and grazing pressure. Although disturbance was present in both treatments demonstrated resilience to maintain their dominance. The combined effects of fire and grazing typically influence vegetation structure by creating a patchy distribution of successional stages across the landscape. Such interactions frequently improve spatial heterogeneity and create a mosaic of vegetation patches at different recovery stages, which in turn supports a greater variety of plant species broader spatial scales [31].

Climax species were prevalent at burned site 28% (5) compared to 14% (2) at continuously grazed site (**Table 2**). This suggests that that burning may have encouraged recovery of more mature, stable grasses species, and reduces competition from less desirable pioneer species and rejuvenate dominate perennials. Prescribed burning reduces the abundance of shrubs or trees, improves biodiversity and increasing yield and abundance of climax perennial herbaceous species [32]. Pioneer grass species accounted for 29%, suggesting a notable presence of early successional species that quickly establish in disturbed environments. Their abundance at this level suggests that parts of the vegetation are still in a relatively early recovery stage following disturbance events. In rangeland ecosystems, burning

plays an important role in shaping species composition and successional pathways by removing accumulated forage yield. Consequently, burning has an important influence on vegetation dynamics and the direction of succession [33].

Table 2. Influence of burning and continuous grazing on plant succession.

Burned site			Continuously grazed site		
Succession	**Frequency**	**Proportion**	**Succession**	**Frequency**	**Proportion**
Pioneer	4	22	Pioneer	4	29
Subclimax	9	50	Subclimax	8	57
Climax	5	28	Climax	2	14
Grand total	18	100	Grand total	14	100

4. Influence of Burning and Continuously Grazing on Grazing Value

Table 2 shows a slight variation in grazing values between treatments, with the burned site recording 39% and the continuously grazed site 36%. Although the difference is small, it reflects a meaningful improvement in the quality of the herbaceous layer under burning. A higher grazing-value score generally signifies a greater presence of palatable species, which supports ecological balance, improves ground cover, and strengthens root systems that help reduce soil erosion. Improved species diversity also contributes to better forage yield and long-term grazing sustainability [34] [35]. The continuously grazed site was dominated by grasses with moderate grazing value (36%), compared to 28% at the burned site. This pattern indicates that moderately palatable grasses were more resilient under ongoing grazing pressure. [35] noted that these species tolerate frequent defoliation and trampling, allowing them to maintain ground cover and contribute to rangeland stability even under heavy grazing. Their dominance at the continuously grazed site reflects this adaptive resilience and the reduced opportunity for more palatable grasses to re-establish.

Grass species with high grazing value were more prevalent at the burned site (33%) than at the continuously grazed site (28%). This suggests that burning creates conditions favourable for highly palatable perennial grasses, improving overall grazing value. The positive response of desirable species to burning is consistent with observations by [34] [36], who reported that species such as *Themeda triandra* increase under well-managed fire regimes. In contrast, the absence of fire encourages the persistence of low-value grasses like *Merxmuellera disticha*, which tend to dominate under continuous grazing.

This shift in grazing value aligns with the hypothesis, indicating that repeated burning enhances palatable perennial grasses whereas continuous grazing promotes fewer desirable species. This pattern is further supported by the role of fire in rejuvenating vegetation, as the removal of dead herbaceous material enhances

light penetration and stimulates new nutrient-rich growth [34] [37]. Mucina and Rutherford (2006) also noted that South African rangelands are naturally maintained by seasonal fire events. Nonetheless, unplanned, or overly frequent burning can negatively affect vegetation composition [30], emphasizing the importance of controlled fire regimes (Table 3).

Table 3. Influence of burning on plant grazing value.

Burned site			Continuously grazed site		
Grazing value	**Frequency**	**Proportion (%)**	**Succession**	**Frequency**	**Proportion (%)**
Low	**7**	39	Low	5	36
Medium	**5**	**28**	Medium	5	36
High	**6**	33	High	4	28
Grand total	**18**	**100**		**14**	**100**

4.1. Influence of Burning of Bush Density

The results reveal a clear variation in woody plant density between the continuously grazed and burned sites throughout the study period (2018-2025). At continuously grazed site, *Euryops floribundus* density showed a sightly increase of *E. floribundus* from 2521 plants/hectare in 2018 to 2601plants/hectare in 2021. This trend clearly demonstrates that encroaching species like *E. floribundus* will continue to spread if grazing it's not controlled. Comparable with [3] and [38], these authors reported that continuous grazing creates favourable conditions for the encroaching species to recruit and expansion of encroaching woody plants.

Consequently, facilitating the replacement of strong perennial by weak perennial and less desirable species. This finding aligns with [39], who noted that high grazing reduces of grasses, ultimately weakening their ability to compete with encroaching woody plants for water and nutrients. The most encroaching species in heavily grazed communal rangelands tend to utilise all the available moisture and nutrients from the soil to their advantage, enabling the species to establish and spread successfully.

A significant decline in *E. floribundus* density was observed at the burned site between 2021 and 2023, decreasing from 2300 to 1771 plants per hectare. This decline indicates that repeated burning, when fuel load is not the limiting factor and prescribed burning can be highly effective to suppress the density of woody plants [40]. Based on our observations, another factor that contributed to the effectiveness of burning was that *E. floribundus* is a short, multi-stemmed plant with fine leaves and exposed seeds (*i.e.*, seeds not covered by a seed coat). In addition, another feature that makes fire to be effective was the fact that *E. floribundus* is sightly flammable. Flammability refers to the ability of vegetation to ignite and burn [22] [41] and serves as a measure of fire behaviour, which is important in studies of fire risk and fire ecology [42]. We assumed that flammability of *E.*

floribundus trait enabled fire to destroy both seeds and fine leaves. However, flammability trait does not diminish the significance of fuel load quality, moisture content of fuel load, carbon compounds (*i.e.* cellulose, hemicellulose, and lignin), fuel load quantity, volatile organic compounds (terpenes) in determining the intensity of fire [43].

Thereafter, a modest decline to 2571 plants/hectare in 2023 and 2351 plants/hectare in 2025 was recorded. This overall pattern indicates that continues grazing facilities the persistence and gradual proliferation of woody plants. The exclusion of burning likely allowed woody plants such as *E. floribundus* to maintain dominance, as grazing pressure on grasses reduces competition for soil resources, enabling woody to establish and mature. On the hand, results show a 970 plants/ha in 2023, and reaching 0 plants /ha in 2025. This continuous downward trend indicates that repeated burning effectively suppressed *E. floribundus* growth and regeneration. Ecologically, this pattern demonstrates the important role of burning as natural disturbance that maintains the balance between woody and herbaceous vegetation. These findings suggest that burning helps control woody encroachment and restores rangeland productivity by enhancing light penetration and nutrient cycling, which benefits herbaceous growth. Furthermore, these findings confirm that prescribed burning is an effective management practice for suppressing encroaching *E. floribundus*, thereby improving the ecological condition and increasing grazing capacity (**Table 4**).

Table 4. Impact of burning and continuous grazing on *Euryops floribundus* density at Mnxe communal rangelands.

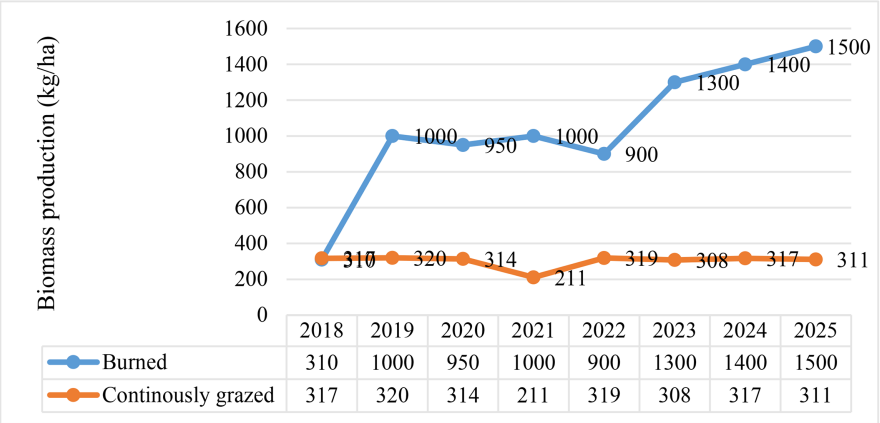
Variables	Continuous grazed site	Burned site
Density (tree/ha): 2018	2521	2300
Density (tree/ha): 2021	2601	1771
Density (trees/ha): 2023	2571	970
Density (trees/ha): 2025	2351	0

4.2. Forage production

Figure 3 compares biomass production (kg/ha) between continuously grazed and burned sites from year 2018 (pre-burn), 2020, 2022 and 2024. Pre-burning (2018), biomass production was nearly the same in both burned (310 kg/ha) and continuously grazed (317 kg/ha) sites. Low forage production in 2018 was expected because grazing without resting can suppress forage growth through the repeated defoliation. This finding in agreement with [44] who reported that continuous grazing restricts herbage to reach maturity phase and complete their life cycle. Abundance of *E. floribundus* in communal rangelands might be promoted by grazing without sufficient resting periods. Continuous grazing can also reduce the competitive potential of desirable grasses through repeated trampling, thereby creating open niches that favours the expansion of *E. floribundus*. Reaped defoli-

ation under continuously grazed conditions may potentially lead to low forage yield, poor grass vigour and facilitated establishment encroaching woody plants [41].

Forage production at burned site increase significantly to 950 kg/ha (2020), reflecting a strong positive response to burning. Although there was a slight decline in biomass production (900 kg/ha) in 2022, forage production remained higher than in the continuously grazed site. In 2024, forage production reached 1400 kg/ha, showing strong recovery and continued productivity improvement. In agreement with [44], who reported that burning stimulates forage growth through removal of moribund, improves light accessibility and enhances nutrient cycling (**Figure 4**).



	2018	2019	2020	2021	2022	2023	2024	2025
Burned	310	1000	950	1000	900	1300	1400	1500
Continously grazed	317	320	314	211	319	308	317	311

Figure 4. Forage production between continuously grazed and burned sites from 2018 to 2025.

4.3. Implications for Farmers

Farmers managing communal rangelands affected by *E. floribundus* encroachment can draw several practical lessons from the findings of this study. Continuous grazing without resting periods weakens the herbaceous layer and creates conducive conditions for establishment of encroaching woody plants. This decline in rangeland productivity directly affects livestock performance and long-term grazing capacity. Farmers should therefore recognize that grazing without resting accelerates bush encroachment and reduces forage yield.

Repeated prescribed burning where fuel load is not a limiting factor can reduce the density to of *E. floribundus* density and grass species diversity. This indicates that well-planned burning, supported by adequate fuel loads, is a practical and cost-effective method for suppressing undesirable plants. Burning can improve grass vigour, offering improved grazing material for livestock. However, burning should be implemented with caution, as inappropriate use or poorly timed fires can have unintended consequences ecological consequences. Unplanned burning may reduce plant diversity and weaken the herbaceous layer if grasses are not given sufficient time to recover from grazing. Farmers are therefore encouraged to use fire as part of an integrated rangeland management approach that includes

rotational grazing where fencing is not a problem, vesting and regular monitoring of forage production.

5. Conclusion and Future Recommendations

This study demonstrated that burning and continuous grazing exert contrasting effects on herbaceous species composition. Repeated burning reduced the density of *E. floribundus* while simultaneously promoting the recovery of perennial grasses, improving overall ecological condition, and ultimately driving *E. floribundus* density to zero by 2025. In contrast, continuous grazing weakened the herbaceous layer and promoted the abundance of less desirable C4 grasses and created conditions that facilitate the expansion of encroaching shrubs. These findings confirm the hypothesis that planned or prescribed burning promotes desirable perennial species and suppresses the expansion of woody plants, whereas uncontrolled grazing creates conditions that support shrub persistence. Future work should investigate the optimum burning frequency and seasonal timing required to sustain both shrub control and biodiversity, while long-term monitoring of soil nutrients, seedbank dynamics, and post-burn regrowth would help clarify ecosystem resilience under repeated fire. Integrating rotational grazing and veld resting into future studies would also identify effective management strategies for communal systems, and examining farmer-led burning practices alongside socio-economic barriers could improve the adoption of prescribed burns. Further research on fuel load thresholds in heavily grazed areas would strengthen practical guidelines for restoring degraded rangelands and improving sustainable grazing capacity.

Acknowledgements

The authors are indebted to the Cala (Mnxe village) farmers and Dohne staff (Pasture Section) for their assistance during the data collection and burning. We are grateful to Dohne Agriculture Development Institute (ADI) and Eastern Cape Department of Agriculture (ECDOA) for permitting us to conduct this research.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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