Observations on the Distribution, Abundance and Activity of *Megaponera analis* ant in a dry Savanna Protected Area

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Abstract

Background: Invertebrates such as ants are important bioindicators of ecological systems.
Objective: The distribution, abundance and activity of a predatory ant *Megaponera analis* was explored in Sengwa wildlife research area, Chirisa Safari Area in Zimbabwe.
Methods: The study used *M. analis* sightings (presence location) data derived from road transect surveys in six major vegetation habitats from April 2025 to March 2026. The surveys were conducted from 0530am to 1830pm. Access roads passing through major vegetation types were traverse by a vehicle at 15km per hour.
Results: The ant species was mostly observed in Mopane and Miombo woodlands. However, no statistically significant differences in ant abundance were noted across different vegetation (habitat) types. Habitat suitability of *M.analis* is influenced by land cover (40%-weighted score), Soil Adjusted Vegetation Index (SAVI) (20%), Soil Moisture Index (SMI) (15%), Slope (10%) while Terrain Ruggedness Index (TRI) (7%) and distance from roads (7%) had least contribution. The ant colonies were associated with habitat mostly within the altitudinal range of 840m to 950m. Ants were active in the morning and evening hours indicating the sensitivity nature of the species to high daytime temperatures. The most observed activity of the species was hunting termites.
Conclusion: Aside from determining baseline on the species, the results of this study have ecological research and monitoring utility as the species they provide baseline information on the status of termites its major prey and act as bioindicator environmental change.

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Keywords: Predatory ant, habitat association, population, daytime activity

1. Introduction

Ants (Hymenoptera: Formicidae) have received significant attention as terrestrial ecological bioindicators yet few studies have utilised them in Africa's protected areas [32]. The *Megaponera analis* (Matebele ant) is a stenophage termitophagous ponerine ant species found in sub-Saharan Africa [41] that specialises on foraging the subfamily Macrotermitinae termites [52]. The presence of *M. analis* therefore mirrors the distribution of termites its prey [53]. Research studies on *M. analis*, have examined and revealed its natural history, biology, foraging behavior and functional ecology in African savanna [15].

Ants are an example of a group of invertebrates that is significantly impacted by local disturbances like roads and this is more pronounced at species level [38]. The staggering omnipresence of ants has prompted many naturalists to look at their exact number on earth, but systematic and empirically derived estimates are lacking [43]. Knowledge of species distributions is limited for invertebrates, which represent the absolute majority of species that play dominant roles in energy and nutrient flow in most terrestrial ecosystems [34, 14, 43]. The extent and magnitude of insect declines in tropical regions, with few long-term insect monitoring schemes are few and inconclusive [18].

The use of predator species to explore presence and abundance of prey species is not a widely used approach. This is because most predators may shift prey use in accordance to prey availability. There is need to quantify the effects of ants on termite populations in different habitats and evaluate the consequences for ecosystem processes [47]. Habitat suitability of *M. analis* has not been explored at local scale. Understanding this aspect will illuminate its endemic and why it is confined to sub-Saharan Africa [31]. Habitat suitability studies modeling that incorporates present prey distributions are essential for predator prey studies [36, 20] and future scenarios interactions in respect of climate change, which has been forecasted to affect subterranean termites [46]. Comparative studies of nesting, scouting behavior, reasons for frequent migration, reproduction, and termites' dietary preferences will also be useful in developing region-specific strategies against termites [53].

Ants communities can be shaped by either biotic or abiotic factors at different scales. At a large spatial scale, climatic variables and habitat productivity greatly determine the distribution of ant species [22]. Climatic variables influence foraging activity, control the development of eggs, larvae, and pupae [22]. Habitat components such as vegetation and edaphic characteristics shape habitat productivity [52]. At smaller spatial scales, inter-specific competition is often considered as the main structuring force of ant communities [3, 16]. Anthropogenic infrastructure such as roads also influence ants occurrence because of their open-habitat specialization in that the canopy cover near roads is much lower [6]. The *M. analis* affinity to open areas is due to it being a fairly big ant species, thick grass areas can be obstacles, which the ants need to circumvent while foraging [23, 15]. Quantitative synthesis studies on the effects of fire disturbance on ant assemblages indicate that habitat type is an important predictor of ant community responses to fire [48,49]. The most important effects of habitat disturbance on ants are typically indirect, through its effects on habitat structure, microclimate, resource availability and competitive interactions [1]. Disturbance such flooding and dispersal processes jointly shape ant assemblage structures across multiple spatial scales [6]. The interactive effects of topography, disturbance history and vegetation structure determine the taxonomy and functional diversity of ant assemblages [27]. Space, food type, and time are three niche factors that can affect ant distribution and activity [46].

Ponerines are noteworthy for their social organization, morphological, ecological and behavioral traits [41]. Biologically, termites and ant bodies require moisture for survival, influencing their habitat selection and behavior [24]. The *M. analis* is a termite specialist ponerine species that hunts by conducting militaristic like group raids on its prey [53]. Obligate collective foraging is highly developed with polymorphic worker castes in *M. analis* [41]. The size of a raiding party is determined by factors such as colony size, colony requirements, richness of the food source, and termite defenses [2, 52]. Typically, raiding parties consist of between 20 and 500 ants, or approximately 30–75% of the total nest population. The ponerine species uses the trail pheromones produced by several Macrotermitinae termites to track them [51]. After that, the scout returns to its nest by laying a scent trail aided by learning and memory to recruit both major and minor workers to raid their prey [11].

The study explores the distribution, estimates the abundance and establishes the activity patterns of a mega ant predator in Sengwa Wildlife Research Area (SWRA). The knowledge on the distribution and abundance of organisms is central to knowing their roles within ecosystems and their ecological importance for other taxa [45]. Despite the ubiquitous and the central role ants play in terrestrial ecosystems, there are geographic gaps in our current knowledge on ants species [47] and how ants can be used as bioindicators proxies of long term climate change monitoring [37]. Initial field observations indicate frequent sightings of *M. analis* in the study area yet little is known about the species, its role in the ecosystem and potential monitoring utility.

2. Materials and Methods

2.1. Study Area

The SWRA is located at the southern end of the Chirisa Safari Area (CSA). Sengwa Wildlife Research Area where the SWRI is located covers an area of 373 km2 of CSA. The area lies between 28° 03′ and 28° 20'E and 18°0′ and 18°13′ in Gokwe South District, north-western Zimbabwe (Fig 1). The research programme for Sengwa Wildlife Research Area has been the long term monitoring of wildlife population and vegetation including the interaction between the two [10]. Annual precipitation ranges from 400-700 mm. The mean annual temperature is 22.2C. The area has a diverse mammalian community of 7 species of large carnivores and 18 species of large herbivores [44], 230 species of birds [29], 15 reptile species, over 50 amphibian species and 5 fish species [28].

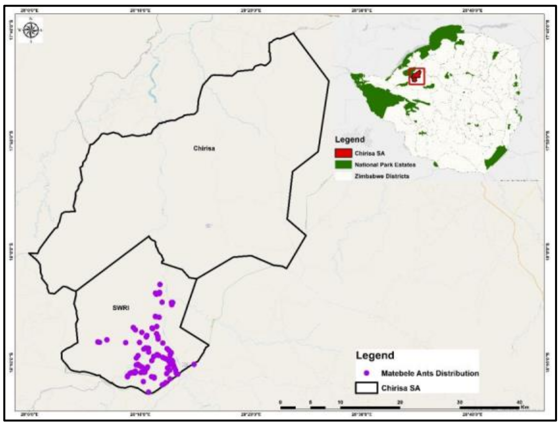

Fig 1: Location of Sengwa Wildlife Research Area in Chirisa Safari Area Zimbabwe

2.2. Field survey

Ant distribution and population estimation studies have used methodology including leaf-litter extractions and pitfall traps [43]. The study used *M. analis* sightings (presence location) data derived from road transect surveys in six major vegetation habitats from April 2025 to March 2026. The surveys were conducted from 0530am to 1830pm. Access roads passing through major vegetation types were traverse by a vehicle at 15km per hour a speed used for road transect survey to allow observers to identify potential ants colonies along the roads. In addition to vehicle road survey, opportunistic sightings on foot during field work were considered. When a colony of ants was sighted along the road, two field technician would mark the front and rear ends of the colony to determine colony length after the ants have gone past. Another technician would place a white A4 white sheet along the colony and take a photograph of ants along the length of the paper for estimating ant numbers which allowed data collection without disturbing the ant activity. Data was collected using forms in Kobo Toolbox application which allowed precise data collection on location, altitude, time and observed ant activity.

3. Data analysis

The Shapiro-Will Test was used to determine the normality of the distribution of ants across the vegetation types and subsequent statistical tests. The data did not conform to normal distribution therefore the Kruskal-Wallis non-parametric test was to explore *M. analis* habitat association and the Spearman Rank Correlation for altitudinal distribution. Statistical analysis was performed in R (version 4.3.1) and in Excel.

Population estimate of ants per colony was derive using the following formula: Abundance (A) =CL/0.3*n, where *CL* is colony length and *n* is number of ants counted per 30cm (0.3m) length.

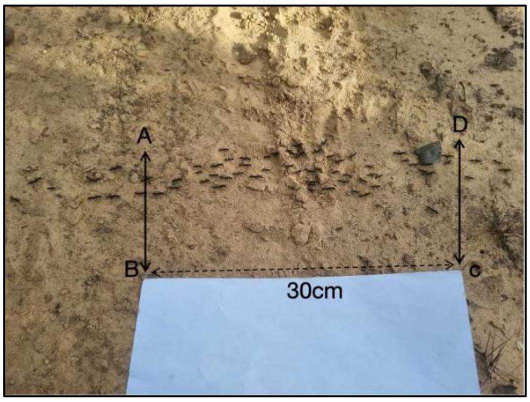

Fig 2: Methodology used to determine ant estimate by counting ants that found withing the the 30cm region (A-B-C-D) of a photographed printing paper laid on the ground along the ants colony. All ant bodies that lie 75% inside the 30cm were counted

3.1. Habitat suitability of *M. analis* ants

Environmental variables are often used to explore the distribution of species is determined by different environmental gradients, which change along with latitude and altitude [8, 21]. The environmental variables used in this study were: vegetation cover, soil moisture index,

Vegetation cover (land cover)

Nesting density is highly correlated with woody cover and termite presence [52].

Soil moisture index

Moisture availability increases ant species activity, composition and density [8, 15].

Soil-Adjusted Vegetation Index (SAVI)

SAVI is used as a basic worldwide model to monitor the dynamics of the soil and vegetation systems because both abiotic and climatic variables affect SAVI indices [33].

Slope

Slope is a terrain-based matric that determine an areas macro-climatic conditions such as temperature, soil moisture and vegetation diversity [27]. The effects of altitude on ant species is linked to local conditions such as conservation status, soil type, or vegetation cover [9]. The Digital Elevation Model (DEM) was clipped to the extent of the study area. Elevation was taken into consideration since it can influence the availability of resources, such as forage and habitat type.

Terrain ruggedness

Terrain ruggedness of an area can also play a significant role in the habitat suitability for ants. Foraging speed is mainly dependent on morphological traits, but also on the surface structure [17].

Distance to roads

Distance from roads was considered an important factor in habitat suitability modelling. Data on roads were obtained from GPS road tracks from the SWRI GIA database. Distance from roads was calculated using the Euclidean distance function under the spatial analyst tool in ArcMap 10.8 [39]. Since roads can be influence wildlife distribution and movement geographically, they were considered an important factor in the analysis.

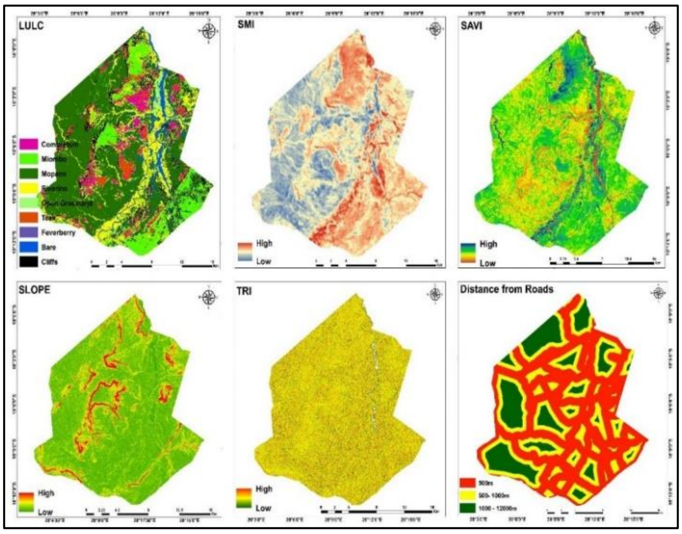

Fig 3: Spatial variation of environmental predictor variables (Vegetation type, soil moisture, SAVI, elevation, terrain ruggedness, and distance from roads) used for modelling *M. analis* habitat suitability in SWRA

4. Results

A total of 122 observation were made of *M. analis* colonies. Colony length ranged from 1 to 17 metres and the maximum recorded number of ant estimate was 2 000 individuals. No statistically significant differences in ant abundance were noted across different vegetation (habitat) types, Kruskal-Wallis chi-squared = 6.2786, df = 5, p = 0.28. However, open grassland areas had the least observed number of ants

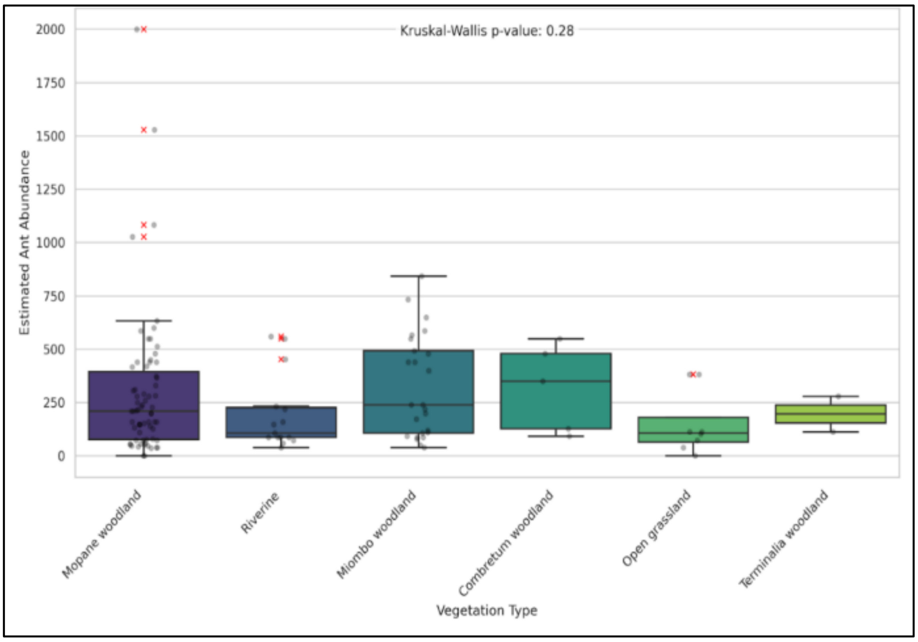

Fig 4: Abundance of *M. analis* distribution in different vegetation types. population estimate range from 1 to as many as 2000 individuals in large colonies. The plot features coloured red "x" markers for outliers. The semi-transparent black dots show the distribution and density of the sampling points within each habitat

Habitat suitability analysis

Habitat suitability of *M. analis* in this study is influenced by land cover (40%-weighted score), Soil Adjusted Vegetation Index (SAVI) (20%), Soil Moisture Index (SMI) (15%), Slope (10%), Terrain Ruggedness Index (TRI) (7%) and distance from roads (7%).

The results indicate a weak positive correlation between altitude and A. analis abundance implying that elevation is not a primary driver of ant population size in the study area. There was no significant relationship between elevation and *M. analis* ant occurrence, p=0.113.

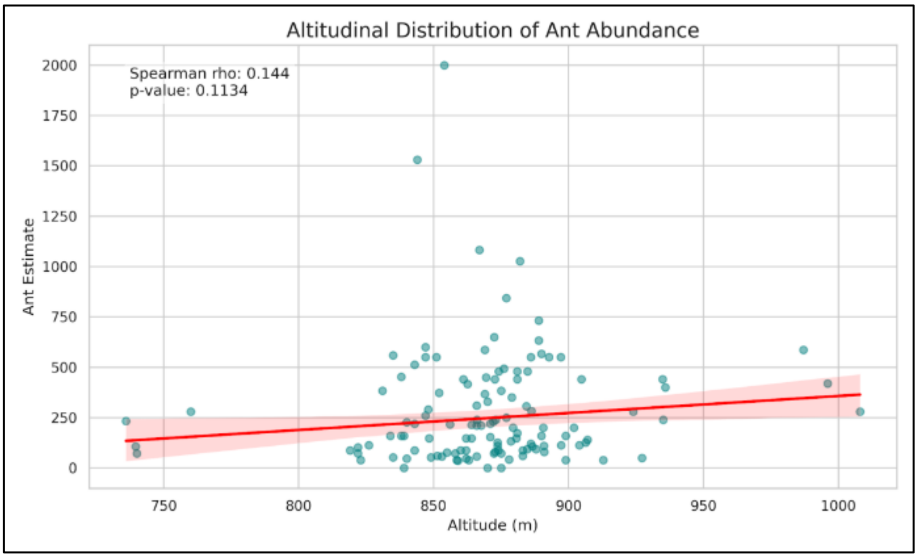

Fig 5: The ant colonies were associated with habitat mostly within the altitudinal range of 840m to 950m, with similar observed outliers below 800m and above 950m

M. analis activity

The results highlights a significant difference in the activity of M. analis ants with hunting being the main observed activity, p-value of 0.000075 (Fig 5). Very few occasions were noted when the ants were carrying eggs indicating that they are unlikely to shift nest during breeding. The ants activity is mostly pronounced in the morning and late afternoon (Fig 6). however, observations were noted of ants activity throughout on cooler days.

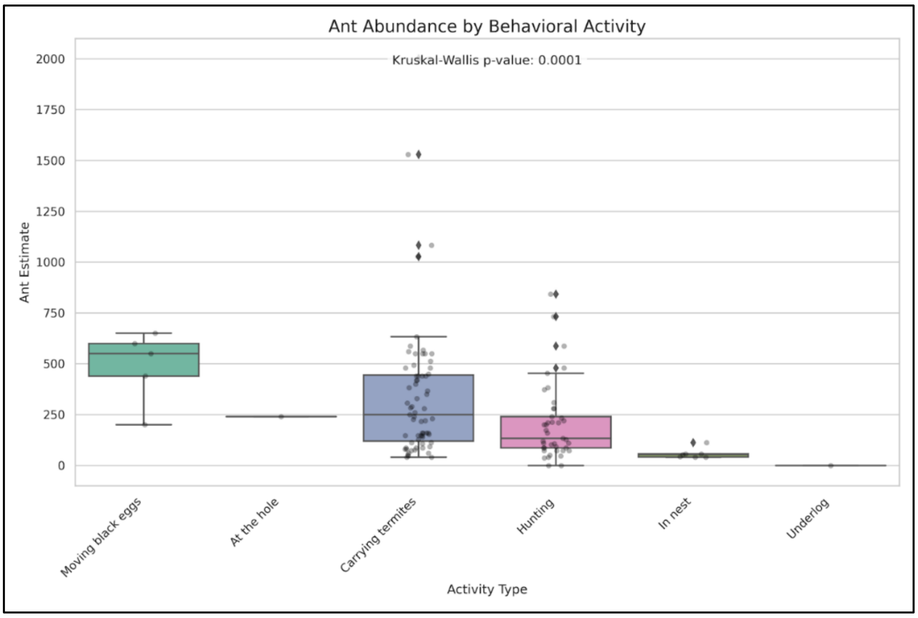

Fig 6: the main observed activity of M.analis. Ants were observed on fewer occasions at nest sites and moving eggs from one nest site to the other

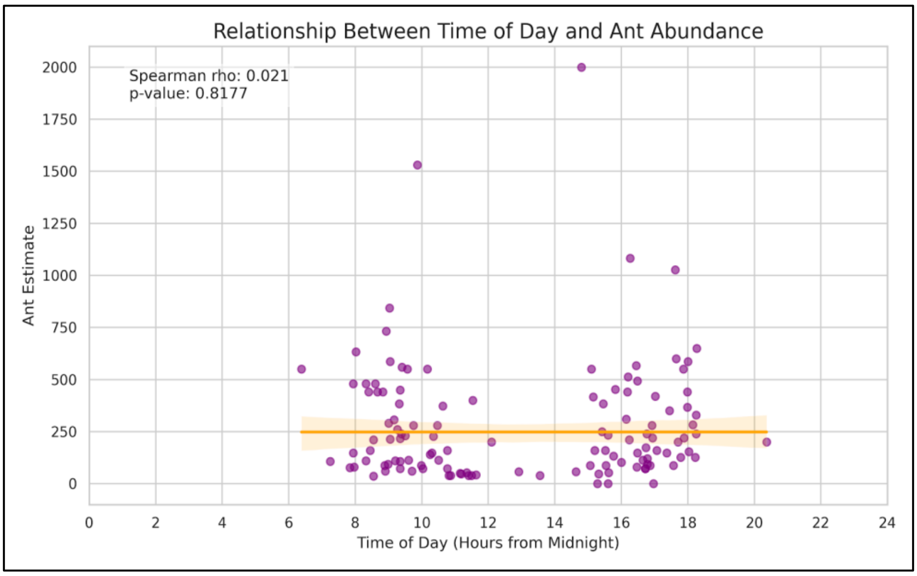

Fig 7: The ants activity is mostly pronounced in the morning and late afternoon

5. Discussion

This is one of the few studies that aims at exploring ant species distribution at small spatial scale in arid savanna protected areas. Knowledge on the spatial distribution of organisms is important for understanding of organisms population dynamics, community interactions and ecosystem functions [4, 25]. Our main observation highlight that mopane and Miombo woodlands are key habitat for *M. analis*. This is important basis for research and monitoring activities directed towards other species that interact with this species in many ways. The three most important determinats of habitat suitability of the species are land cover, SAVI and SIM. Closed woodlands are preferred over open habitat due to thermal regulation. Yusuf *et al*. [52] noted that nesting density of the species is highly correlated with woody cover and termite presence. SAVI is being used as a basic worldwide model to monitor the dynamics of the soil and vegetation systems because both abiotic and climatic variables affect SAVI indices [33]. Soil moisture influence *M. analis* occurrence due to its sensitivity to desiccation and high moisture supports termite activity (prey) and nest structural integrity [23]. Early researchers such as Leuthold (1977) emphases that foraging activity and colony survival of ants are tied to soil humidity and thermal thresholds. The factors which least determined *M. analis* presence were slope, terrain ruggedness and distance to road. Steeper slopes increase runoff and erosion, which can destroy nests and reduce the stability of termite mounds [17], ruggedness complicates the raiding activity and increase forage cost [19] while compacted road surfaces negatively impact the nesting sites of large ponerine ants [41].

The ant species is a successful predator which has evolved over time [43]. Our findings conform to observation across Africa that colony sizes for *M. analis* vary significantly among regions and subspecies [53]. The species spends most of its time foraging in the cooler hours of the day and does not prefer very high and low altitudes. The species has a narrower thermal range and is very sensitive to high temperature conditions which is consistent with the phylogeny and physiology of ants of being ectothermic as well as thermophilic [9]. The observations from our study highlight and further suggest that *M. analis* an other ants species could be a reliable indicator of changing climate in arid environments [32]. More so, the species can also be a used as an indicator of termite abundance and termite hotspots. Several characteristic makes the species an important ecological monitoring indicator in arid conservation areas. The species is a large apex ant predator specialising on termites feeding, it has few predators, it is found along road edges and in greater numbers. With systematic monitoring of this species, any changes to its occurrence and abundance is quickly noticeable and may be a reliable baseline for investigating environmental perturbations.

Our findings reveal high activity and abundance of a flagship insect species along park access road verges. Despite, *M. analis* having few predators, their main threat is from run-over by vehicles given that they prefer to nest along road edges, hunt and carry their prey across roads. Their active times which are associated with cool day time of the morning and late afternoon coincide with heavy traffic of vehicles in conservation areas increasing their vulnerability. More often attention on road kills has been directed to ungulates, birds and reptiles along major highways and service roads [44, 30, 5, 32]. Another, threat to the species is fireguards which are more often constructed along roads using fire. In view of this, the impact of roads on invertebrate populations becomes a fundamental area of ecological research [26].

6. Conclusion

This study advances research in specialised predatory ant species which are important for determining ecological status of other high biomass invertebrates. This work provides evidence to support calls for awareness raising on need to conduct research and monitoring of invertebrates which serve as bioindicators of environmental change in conserved and none conserved areas at local scales.

Author Contributions

Ndlovu Mukululi (Conceptualisation, Methodology, Writing-original draft and review) [Lead], Badza Brian (Data collection and data analysis), Marunya Sly (Data collection), Shumba Marvelous (Data Collection), Hungwe Christopher (Data collection) and Chakuya Jeremiah (Editing)[supporting].

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Conflict of Interest

None declared.

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