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Effects of Mining Dumpsites on the Abundance of Rodents: Luanshya, Zambia

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Abstract: ***The present study compared rodent abundance in a low-density mining dumpsite area and a non-dumpsite area in Roan Township of Luanshya district, Zambia. A mark re-capture method was used and the rodents were trapped by using Sherman traps. In each of the two habitats transects were laid down which were 50m apart in a 100m by 100m plot. Three sampling plots were made in each area. The abundance was determined by counting the individual number of rodents captured in each study area and was recorded on a recording sheet. A two way (ANOVA) in Microsoft Excel was used to determine the association of various variables. The results showed that the presence of a dumpsite had significant effect on the abundance of rodents (F=6.079, P=0.020). The non-dumpsite area recorded the highest number of rodent captures compared to the dumpsite area that recorded the least. Only three species of rodents were captured and these were Mastomys natalensis, Rattus.novergicus and Rattus rattus. A total of 29 rodents were caught with 12 from the M. natalensis, 8 from the R. norvegicus and 9 from the R. rattus species. We recommend that a more prolonged trapping effort is needed for estimating abundance, as rodents are often secretive in nature and difficult to capture.***

Keywords: Mining dumpsites, conservation, abundance, rodents, ecosystem services, Zambia

1. Introduction

Rodents are the most diverse and abundant among animals in Africa (Bekele & Yihune, 2012).Owing to their prolific nature of breeding, they represent a significant amount of biomass in different ecosystems (Habtamu & Bekele, 2012). These species belong to the order rodentia (Wilson & Reeder, 2005). They include porcupines, mole rats, dormice, squirrels, cane rats, rats and they rely mainly on very common vegetable food sources such as grass, seeds and acorns (Pelikan, 2014). Rodents are known to be major pests for crops and food stocks and a harbour of various diseases worldwide. However, Only 10% of the rodent species are known to have harmful effects (Peter, et al., 2012). Irrespective of their destructive nature, rodents are important contributors to biodiversity in that they play a role in food webs, converting plant material into a form that hawks, owls and snakes can consume (Pelikan, 2014).

Rodents occupy a diverse number of habitats that include urban and rural areas, mining areas, swamps and tropical rainforests (Green, et al., 2009). For example, mining dumpsites harbour large quantities of solid wastes that are disposed-off haphazardly and these can have serious environmental impacts (Green, et al., 2009).Mining industries have been viewed as key drivers of economic growth and development (Olalekan, et al., 2016). However, studies have shown that mining poses serious threats to biodiversity (Lloyd, et al., 2012). For example, dumping of mining wastes has inevitable impacts such as generated wastes and vegetation suppression to expand the extraction area (Ardente, et al., 2016). Mining also causes displacement of species in areas of excavation and piling of mine wastes such that sedentary animals like rodents and other small mammals are severely affected (Gisore & Matina, 2015). Ardente *et al.*(2016) reported that mining activities affect detectability of species. Kendal et al. (2001) that exposure of small mammals to contaminants from mining wastes results into a reduction in species diversity reported similar results. Phelps (2006) also reported similar results that small mammal communities inhabiting sites contaminated with mining wastes have lower species diversity. Pineda *et al.*(2007) reported that rodents in polluted areas have high levels of metal accumulation in their kidneys and liver. Similar results were reported by Nakayama *et al.*(2013) that high metal accumulation in rodents organs cause biological responses such as MT-mRNA induction. Studies have documented the presence of metals in different tissues of small mammal species. However, studies to investigate how mining dumpsites affects the abundance of small mammals particularly rodents still remain poorly documented. Therefore, the objective of the present study was to assess rodent abundance in a low-density mining dumpsite area and a non-dumpsite area.

2. Methodology

Study area

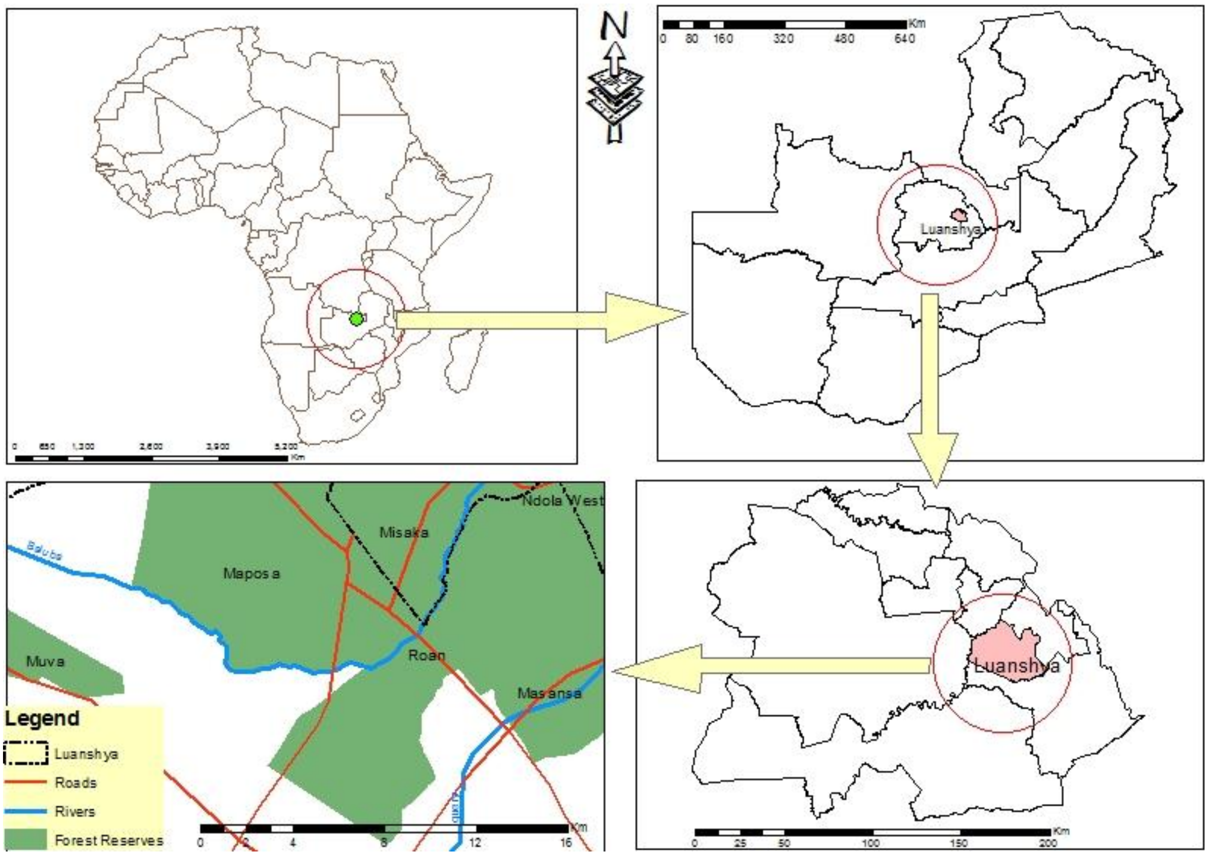

Figure 1: Map showing Roan Township in Luanshya district

The study was conducted in Luanshya. Luanshya lies between latitudes 13°08'S and longitude 28°24' E. It has a humid subtropical climate that is characterised by hot, usually humid summers and mild to cool winters and this is according to the Korean Geiger Climate Classification. It lies at altitudes ranging between 1129m and 1521m with an elevation of approximately 1257m. It is located 35km southwest of Ndola and 43km from Kitwe. It belongs to the Savanna-woodland type with significant areas being agriculturally cultivated. The population of Luanshya over the years depended on mining as its mainstay though the agriculture sector has currently grown.

Data Collection

We used a matched paired design to collect data on the abundance of rodents in a dumpsite area and a non-dumpsite area. Two transects in each study site were laid systematically 50m apart in a 100m by 100m plot. Three sampling plots were made in each study area. Mark re-capture method was used and rodents were trapped using Sherman traps. Fifteen Sherman traps, which were 10m apart, were set in each transect. All the traps were baited with peanut butter. The traps were covered with leaves and grass to prevent from the cold weather and to avoid damage by people and animals like dogs (Bekele & Yihune, 2012). The traps were set late afternoon (between 16:00-17:00 hours) and checked once a day in the morning between (06:00-07:00 hours).Each trap was reported as either open, closed with an animal trapped, closed but no animal trapped or bait removed (Panti-May, et al., 2016). Each trapped animal was marked and released in the area where it was trapped (Clausnister, 2003). Abundance was determined by counting the number of each individual rodent captured in both areas. The number of animals caught was recorded on a sheet and after each capture event, the traps were re-baited.

(a) (b)

Figure 2: Shows the setting up of traps in a non-dumpsite area and dumpsite area

Data analysis

Data collected on rodent abundance was analysed descriptively. Rodent abundance was the response variable while dumpsite and a non-dumpsite areas were explanatory variables respectively. A two way ANOVA in Microsoft Excel was used to determine the association of explanatory variables and the response variable.

3. Results

A total of 29 individuals, consisting of three different species were captured, of which 8 individuals were captured in a mining dumpsite area and 21 in a non-dumpsite area. In decreasing order of abundance, species comprising the community in the dumpsite area were *R. rattus* with (5), *R. norvegicus* with (2). *M. natalensis* with (1) and in decreasing order of abundance, species comprising the community in the non-dumpsite area were *M. natalensis* with (11),*R. norvegicus* with (6) and *R. rattus* with (4).Average species abundance of *R. rattus* was higher in the dumpsite area than in the non-dumpsite area while species abundance of *M. natalensis* was higher in the non-dumpsite area than in the dumpsite area.The table below shows the species and number of rodents caught on each day in the two habitats (dumpsite and a non-dumpsite area) in Roan Township, Luanshya.

Table 1: A summary of the number of rodents and the types of species caught in each study area

Habitat Type	Plot #	Days	Species: *Mastomys natalensis*	*R. norvegicus*	*Rattus rattus*	Total number
Non-dumpsite area	1	1	2	2	1	5
		2	1	0	1	2
	2	3	2	2	0	4
		4	0	0	1	1
	3	5	3	1	1	5
		6	3	1	0	4
Total			11	6	4	21
Dumpsite area	1	1	1	1	0	2
		2	0	0	3	3
	2	3	0	1	0	1
		4	0	0	0	0
	3	5	0	0	2	2
		6	0	0	0	0
Total			1	2	5	8

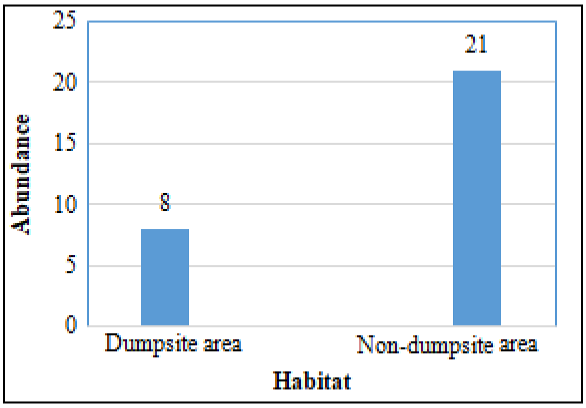

Figure 3: Shows the abundance of rodents in each study area

In reference to figure 5 below, *M. natalensis* was the most abundant species in the non-dumpsite area while *R.rattus* was the least. However, *R. rattus* was the most abundant in the dumpsite area while *M. natalensis* was the least. *M. norvegicus* was second most abundant in both areas.

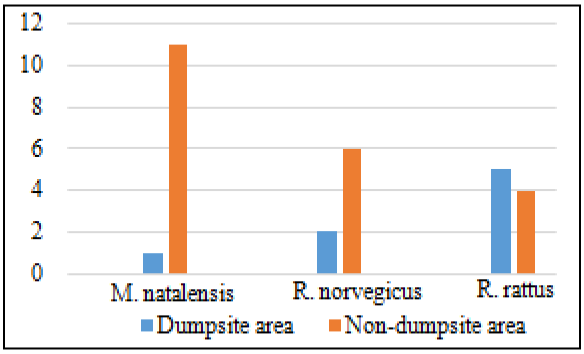

Figure 4: Shows the abundance and number of species captured in each study area

The table below shows the species composition and relative abundance of live-trapped rodents in two low-density areas (dumpsite and a non-dumpsite area).

Table 2: Shows the relative abundance of each of the captured species in each of the study areas

Species	Dumpsite area: Total number of captures	Dumpsite area: Relative Abundance %	Non-dumpsite area: Total number of captures	Non-dumpsite area: Relative Abundance %
M. natalensis	1	12.5	11	52.4
R. norvegicus	2	25	6	28.6
R. rattus	5	62.5	4	19
Total	8	100	21	100

As can be seen in table 3 below, the results showed that dumpsites had an effect on the abundance of rodents. The calculated F value was greater than the F-critical value while the calculated p-value was smaller than the chosen alpha value 0.05. The ANOVA results were $F_{(1, 2)} = 6.079$ and the p value was 0.020.

Table 3: ANOVA Two-factor

ANOVA: Two-Factor with Replication				
SUMMARY	Day 1	Day 2	Day 3	Total
Non-dumpsite area				
Count	6	6	6	18
Sum	11	6	4	21
Average	1.833	1	0.667	1.167
Variance	1.367	0.8	0.267	0.971
Dumpsite area				
Count	6	6	6	18
Sum	1	2	5	8
Average	0.167	0.333	0.833	0.444
Variance	0.167	0.267	1.767	0.732
Total				
Count	12	12	12	
Sum	12	8	9	
Average	1	0.667	0.75	
Variance	1.455	0.606	0.932	

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F critical*
Sample	4.694	1	4.694	6.079	0.02	4.171
Columns	0.722	2	0.361	0.468	0.631	3.316
Interaction	5.056	2	2.528	3.273	0.052	3.316
Within	23.167	30	0.772			
Total	33.639	35				

4. Discussion

The present study revealed that the non-dumpsite area recorded the highest number of rodents (21) while the dumpsite area recorded the least with only (8) as seen in Table 1 and Figure 4. The study yielded three similar species of rodents that were common in all the two study areas; these were*M. natalensis, R. norvegicus* and *R. rattus* as seen in Table 1. The results coincide with Pacheo *et al.*(2013) who found that abundance estimators for small mammal populations yielded three species that where common in the study area. Non-dumpsite area recorded highest number of *M. Natalensis* **(**11 individuals)with a relative abundance of 52.4% while *R.rattus* was the least with (4 individuals) and a relative abundance of 19%. However, in the dumpsite area *R. rattus* was the most abundant species with (5 individuals) and a relative abundance of 62.5%while *M. natalensis* was least abundant with (1 individual) and a relative abundance of 12.5%. *M. norvegicus* was the second abundant species in both the dumpsite and non-dumpsite area with a relative abundance of 25% and 28.6% respectively (Table 2). *M.natalensis* species were most abundant in non-dumpsite areas because of sufficient habitat and cover (Massawe, et al., 2012). The dumpsite area had insufficient habitats due to the disposing-off of mining wastes. However, the individual number of species of *R. rattus* caught was slightly higher than *M. natalensis* and *M. norvegicus* combined. This may because *R. Rattus* can live on the ground or below and does not require forest structure (Shiels, 2013).

The results revealed that mining dumpsites have an effect on the abundance of rodents as seen in figure 4 and Table 3. The non-dumpsite area recorded the highest number of rodent captures as seen in (Figure 4).This is because distribution and abundance of small mammals particularly rodents is influenced by environmental factors such as the nature and density of vegetation(Johnson & Horn, 2008). Similarly, Lentic & Dickman(2005)reported that the density of rodents enhances in habitats such as bush land, grassland, and forest due to the presence of ample food. The least number of rodents was recorded in a dumpsite area and this can be attributed to the severe impacts that mining operations exerts on the environment such as habitat loss and pollution(PEGASUS Foundation, 2017) thereby leading to poor cover of the habitat exposing the rodent to predators and other factors that decrease their population (Bekele & Yihune, 2012). Similarly, Bowman *et al.*(2017) reported that fire decreases diversity of rodents. Furthermore, Ardente *et al.*(2016) reported that mining activities lowers detectability of small mammals. Therefore, non-dumpsite areas are the most suitable habitats to set traps for capturing of rodents, as they are not disturbed and have dense vegetation cover compared to dumpsite areas that are disturbed.

5. Conclusion

The present study revealed that dumpsites have an effect on the abundance of rodents F-value (6.079) and P-value (0.020). There was a significant difference in the abundance of rodents in a dumpsite area and a non-dumpsite area. Non-dumpsite area had a higher number of rodents captured compared to the dumpsite area. This is because distribution and abundance of small mammals particularly rodents are influenced by environmental factors such as the nature and density of vegetation and habitat exploitation by humans (Johnson & Horn, 2008). Thus, rodents are important contributors to biodiversity of ecosystems. *R. Rattus* was found to be very adaptive to both environments (dumpsite and non-dumpsite areas). We recommend that future studies should focus on the effects of mining on the feeding behaviour, reproduction and growth of rodents.

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