



**Seasonal Variation in Rock Hyrax
Behavior and Energy Budget:
A Comparative Study in Randilen
Wildlife Management Area, Tanzania**

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<https://doi.org/10.48091/35wg1c75>

Abstract

The rock hyrax (*Procavia capensis*) exhibits varying thermoregulation and foraging habits between seasons, which reflect the rock hyrax's overall behavior and energy budget. However, this relationship has not been sufficiently studied in Tanzania, as rock hyraxes are among the least studied mammals in East Africa. This observational study was conducted during a 10-day period in November 2025 on the kopje at Buti Main Gate in Randilen Wildlife Management Area (WMA) in Tanzania. The objectives were to analyze the social behavior and energy budget of rock hyraxes during the dry season at the gate of Randilen WMA and determine whether it differs from that of the wet season. Scan sampling was conducted twice daily (morning and evening) every 5 minutes to observe the behavior and activity state of all visible rock hyraxes. This rock hyrax population ranged from 43 to 116. Data were categorized by age class (adults, juveniles, and both) to determine how often rock hyraxes were inactive versus active and socializing versus isolating. We found that while rock hyraxes were primarily inactive and social year-round, they were more frequently observed active and isolating in the dry season compared to the wet season. Juveniles were primarily observed foraging, whereas adults were frequently seen resting alone in shady areas during hotter times of the day. These results suggest that the conditions in the dry season can significantly reduce rock hyrax social behavior and increase the amount of time spent in an active state, especially for juveniles. The increased energy budget of juveniles in this dry season study challenges previous studies which show that rock hyraxes are primarily inactive, thus warranting future research.

Keywords: rock hyrax, Tanzania, behavior, energy budget

1. Introduction

The rock hyrax (*Procavia capensis*) is a species of the family Procaviidae, the only extant family of the order Hyracoidea.¹ The rock hyrax lives in rocky areas of the savannah and can be found in sub-Saharan and northeast Africa, as well as the Middle

East.¹ The rock hyrax is a gregarious, diurnal species, exhibiting social behavior and is primarily active during the day. As a result of these low energy expenditures while at rest, rock hyraxes spend most of their time in an inactive state.² Due to the rock hyrax's poor thermoregulation capabilities, they often bask or take refuge in rocky crevices to

stabilize their body temperature.¹ However, a study conducted in South Africa found that thermoregulation capabilities vary greatly between summer and winter, roughly corresponding to the wet and dry seasons, respectively.³ Specifically, the study found that rock hyrax body temperature is lower during the winter but also more variable, likely because rock hyraxes spend more time basking to raise their body temperature. These results suggest that hyraxes have a lower energy budget during the dry season.

Rock hyraxes have a seasonal breeding period, usually during the dry season from August to November.⁴ Males engage in significantly more territorial and aggressive behaviors such as calling and chasing during the breeding season, corresponding with significant increases in testicle size.¹ The presence of predators in an area influences the rock hyrax group size and the tendency to leave their refuges, meaning rock hyrax behavior is likely influenced by predators as well.¹ Rock hyrax predators include leopards, hyenas, jackals, and birds of prey.⁵ These predators may exhibit different behavioral patterns at different times of year. A study of leopard population density in Serengeti National Park in Tanzania found that the population density was lower during the dry season than the wet season.⁶ This pattern was concluded to be the result of leopards tending to avoid areas with other predators such as lions due to lower food availability during the dry season. As a result, rock hyrax behavior might differ between seasons based on seasonal variation in predator behavior.

These traits amongst others all relate to the rock hyrax's behavior and energy budget in some way, but this relationship has not been sufficiently studied in Tanzania. Rock hyraxes are among the least studied mammals in East Africa.⁷ In 2024, Alice Thompson et al. conducted the first study on rock hyraxes in Randilen Wildlife Management Area (WMA) in Tanzania. However, it was conducted during a 10-day period in the wet season and

therefore behavioral differences between wet and dry season have yet to be examined. Here, we aim to determine the seasonality of rock hyrax behavior and energy budget, as a comparative study between seasons in Randilen WMA is important for documenting variations depending on external environmental conditions. This information is pertinent to conservation, which has the potential to alter the rock hyrax's environment, energy budget, behavior, and midden composition.

Given that the rock hyrax spends most of its time in an inactive state and in the presence of other individuals,¹ we hypothesize a similar pattern will be observed in this study. In comparison to the wet season, rock hyraxes are expected to spend more time in an inactive state during the dry season because they will spend more time basking to regulate body temperature. The frequency of aggressive behaviors such as chasing, especially from males, are also expected to increase during the dry season, as the dry season coincides with the rock hyrax mating season, when intraspecies competition among male rock hyrax looking to reproduce increases.

2. Methods

2.1 Study Area Description

Randilen WMA is found in the Monduli District, one of seven districts in the Arusha Region of Tanzania. Randilen WMA occupies 312 km², or 31,200.68 ha, of land.⁸ Randilen WMA borders Tarangire National Park to the south and the WMA member villages to the northwest, southwest, north, and east (Figure 1). The area contains multiple kopjes such as Buti, Kirowa, and Sunset Hills.⁸ The climate is semi-arid and the area receives around 500-800 mm of precipitation annually. The short rains begin in November or December while the heavy rains begin from March to May.

The coordinates of the Buti Hill site are 3°42'34" S and 36°5'25" E (Figure 2). The study site

We used scan sampling to make observations of the rock hyraxes. We conducted the scan from left to right every 5 minutes across all visible individuals from the observation point. Rock hyrax activity states and behaviors were recorded during each scan. Any observed behaviors not included in the predefined ethogram were noted.

The rock hyrax colony residing at the gate to Randilen was the sole subject of the study. The total area was 3,248 m² and the observable area was 1,578 m².² We found an estimated rock hyrax population on the kopje using the maximum number of hyraxes seen as well as the total area of the kopje and the area of observation (Equation 1). Using the highest maximum of 43, we estimated the population to be 116. Using the lowest maximum of 17, we estimated the population to be 46. Based on these calculations, the rock hyrax population size is estimated to range from 43 to 116. We utilized a t-test at the $\alpha=0.05$ level to compare Thompson’s wet season data to the new dry season data.

Equation 1. Species density estimate for the rock hyrax population on the kopje.² The equation multiplies the observed number of individuals from a certain species by the ratio of the total area to the observed area.

$$N_{est} = N_c(A_{tot}/A_c)$$

3. Results

3.1 Population

The results show 17 to 43 hyraxes observed each day in the dry season (Figure 3). We observed the highest maximum of 43 on Day 4 and the lowest maximum of 17 on Day 7. The wet season had a higher lowest maximum of 22 and lower highest maximum of 38. We observed a maximum of 9 to 25 juveniles each day in the dry season, and a similar range of 8 to 25 adults at this time. Despite the similar range, the mean maximum number of juveniles was 19 while the mean maximum number

of adults was 15. In the wet season, the mean maximum number of juveniles was 23 while the mean maximum number of adults was 11.

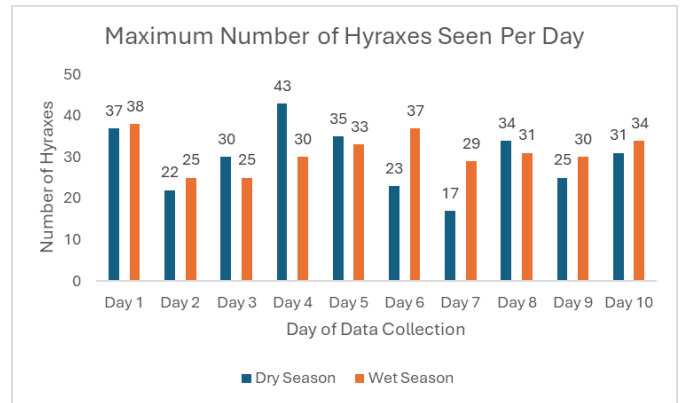


Figure 3. Maximum number of hyraxes seen during one scan on each day of observation in the dry and wet season, respectively (wet season data from Thompson et al., 2024).

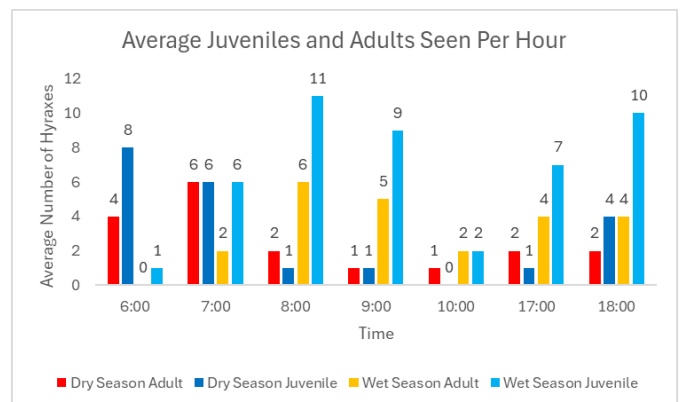


Figure 4. Combined graphs of the average number of juvenile and adult hyraxes seen on one scan during each hour of observation in the dry and wet season (wet season data from Thompson et al., 2024).

During the dry season morning scan of 6:00 to 11:00, we saw the most rock hyraxes during the hours of 6:00 and 7:00 with an average of 12 hyraxes per scan (Supplementary Material 2). During the dry season evening scan of 17:00 to 18:40, we saw the most rock hyraxes during the hour of 18:00. During the dry season morning scan, we saw the most juveniles during the hour of 6:00 and the most adults

during the hour of 7:00 (Figure 4). During the dry season evening scan we saw the most juveniles during the hour of 18:00 and we saw a similar number of adults during both hours. This adult data aligns with the wet season evening scan, but the most juveniles were seen during the hour of 18:00 in the wet season.

3.2 Behavior

We observed no instances of fighting at any time by any type of individual during the dry season. The combined data shows that rock hyraxes spent 78.12% of the observations socializing compared to 21.88% isolating in the dry season (Table 1). In the wet season, rock hyraxes spent 97.64% of the observations socializing, which is significantly greater than in the dry season study ($p < 0.0001$). Of the time spent socializing in the dry season, rock hyraxes spent 42.89% eating, 26.14% resting, 19.69% basking, 8.35% huddling, 2.88% playing, and 0.06% mating. Of the time spent isolating in the dry season, rock hyraxes spent 68.00% resting, 18.84% eating, and 13.16% basking.

Table 1. Summary of behavior for all hyraxes in the dry and wet season throughout the day, during the morning, and during the evening.

Combined Dry Season Data					Combined Wet Season Data				
Energy Budget	100%	Inactive	Sitting	72.54%	Energy Budget	100%	Inactive	Sitting	21.61%
			Standing	5.67%				Standing	18.56%
			Laying Down	21.79%				Laying Down	59.83%
			Running	8.62%				Running	15.38%
		Active	Walking	8.20%			Active	Walking	18.24%
			Climbing	83.18%				Climbing	66.38%
Morning Dry Season Data					Morning Wet Season Data				
Energy Budget	100%	Inactive	Sitting	78.70%	Energy Budget	100%	Inactive	Sitting	25.94%
			Standing	5.10%				Standing	15.00%
			Laying Down	16.20%				Laying Down	59.06%
			Running	8.90%				Running	14.86%
		Active	Walking	8.30%			Active	Walking	18.25%
			Climbing	82.80%				Climbing	66.89%
Evening Dry Season Data					Evening Wet Season Data				
Energy Budget	100%	Inactive	Sitting	43.75%	Energy Budget	100%	Inactive	Sitting	14.89%
			Standing	8.33%				Standing	24.08%
			Laying Down	47.92%				Laying Down	61.02%
			Running	7.71%				Running	13.92%
		Active	Walking	7.90%			Active	Walking	18.77%
			Climbing	84.39%				Climbing	67.31%

Adult rock hyraxes spent 69.60% of the observations socializing compared to 30.40% spent isolating in the dry season (Table 2). In the wet season, adult rock hyraxes spent 93.17% of the observations socializing. Based on a t-test, this observation is significantly greater than in the dry season study ($p < 0.0001$). Of the time spent

socializing in the dry season, adult rock hyraxes spent 41.49% resting, 33.73% basking, 19.77% huddling, 4.57% eating, 0.31% playing, and 0.13% mating). Of the time spent isolating, adult rock hyraxes spent 79.51% resting, 15.33% basking, and 5.16% eating.

Table 2. Summary of behavior for adult hyraxes in the dry and wet season throughout the day, during the morning, and during the evening.

Combined Adult Data					Combined Adult Data				
Energy Budget	100%	Inactive	Sitting	70.14%	Energy Budget	100%	Inactive	Sitting	26.19%
			Standing	4.51%				Standing	16.91%
			Laying Down	25.25%				Laying Down	56.91%
			Running	29.72%				Running	11.94%
		Active	Walking	27.62%			Active	Walking	25.67%
			Climbing	42.66%				Climbing	62.39%
Morning Adult Data					Morning Adult Data				
Energy Budget	100%	Inactive	Sitting	76.32%	Energy Budget	100%	Inactive	Sitting	29.13%
			Standing	4.55%				Standing	15.12%
			Laying Down	19.13%				Laying Down	55.76%
			Running	31.31%				Running	11.74%
		Active	Walking	28.04%			Active	Walking	24.38%
			Climbing	40.65%				Climbing	63.88%
Evening Adult Data					Evening Adult Data				
Energy Budget	100%	Inactive	Sitting	42.55%	Energy Budget	100%	Inactive	Sitting	21.22%
			Standing	4.88%				Standing	19.93%
			Laying Down	52.57%				Laying Down	58.85%
			Running	25.00%				Running	12.33%
		Active	Walking	26.39%			Active	Walking	28.19%
			Climbing	48.61%				Climbing	59.47%

Juvenile rock hyraxes spent 86.93% of the observations socializing compared to 13.07% spent isolating in the dry season (Table 3). In the wet season, juvenile rock hyraxes spent 100% of the observations socializing. Based on a t-test, this observation is significantly greater than in the dry season study ($p < 0.0001$). Of the time spent socializing in the dry season, juvenile rock hyraxes spent 72.4% eating, 13.46% resting, 8.19% basking, 4.83% playing, and 1.38% huddling. Of the time spent isolating, juvenile rock hyraxes spent 50.16% eating, 41.64% resting, and 8.20% basking.

Table 3. Summary of behavior for juvenile hyraxes in the dry and wet season throughout the day, during the morning, and during the evening.

Combined Juvenile Data					Combined Juvenile Data				
Energy Budget	100%	Inactive	Sitting	85.43%	Energy Budget	100%	Inactive	Sitting	19.13%
			Standing	9.87%				Standing	19.46%
			Laying Down	4.71%				Laying Down	61.42%
			Running	5.46%				Running	17.21%
		Active	Walking	5.35%			Active	Walking	14.42%
			Climbing	89.19%				Climbing	68.60%
Morning Juvenile Data					Morning Juvenile Data				
Energy Budget	100%	Inactive	Sitting	89.49%	Energy Budget	100%	Inactive	Sitting	24.12%
			Standing	7.55%				Standing	14.93%
			Laying Down	2.96%				Laying Down	60.95%
			Running	5.59%				Running	16.38%
		Active	Walking	5.46%			Active	Walking	15.14%
			Climbing	88.95%				Climbing	68.25%
Evening Juvenile Data					Evening Juvenile Data				
Energy Budget	100%	Inactive	Sitting	65.33%	Energy Budget	100%	Inactive	Sitting	11.73%
			Standing	21.33%				Standing	26.16%
			Laying Down	13.33%				Laying Down	62.11%
			Running	5.00%				Running	14.32%
		Active	Walking	5.00%			Active	Walking	12.84%
			Climbing	90.00%				Climbing	69.38%

The frequency of socializing behavior in juveniles was higher than in adults. The most frequently observed behavior in adult rock hyraxes was socializing while resting, sometimes in trees but more often on the rocks, whereas the most frequently observed behavior in juvenile rock hyraxes was socializing while eating, typically in trees.

3.3 Energy Budget

Overall, rock hyraxes spent 52.90% of the observations in an inactive state compared to 47.10% in an active state in the dry season (Table 4). In the wet season, rock hyraxes spent 76.87% of the observations in an inactive state. Based on a t-test, this is significantly less than in the dry season study ($p < 0.0001$). Of the time spent in an inactive state in the dry season, rock hyraxes spent 72.54% sitting, 21.79% laying, and 5.67% standing. Of the time spent in an active state, rock hyraxes spent 83.18% climbing, 8.62% running, and 8.20% walking.

Table 4. Summary of energy budget for all hyraxes in the dry and wet season throughout the day, during the morning, and during the evening.

Combined Dry Season Data				Combined Wet Season Data							
Behavior	100%	Socializing	78.33%	Playing	2.84%	Behavior	100%	Socializing	97.64%	Playing	N/A
				Huddling	9.49%					Huddling	N/A
				Mating	0.06%					Mating	N/A
				Fighting	0.00%					Fighting	N/A
				Eating	42.36%					Eating	18.50%
		Basking	19.44%	Basking	76.75%						
		Resting	25.81%	Resting	4.75%						
		Isolating	21.67%	Eating	18.84%			Isolating	2.36%	Eating	13.51%
				Basking	13.16%					Basking	22.70%
				Resting	68.00%					Resting	63.78%
Morning Dry Season Data				Morning Wet Season Data							
Behavior	100%			Socializing	80.32%	Playing	3.35%			Behavior	100%
		Huddling	11.65%			Huddling	N/A				
		Mating	0.07%			Mating	N/A				
		Fighting	0.00%			Fighting	N/A				
		Eating	39.78%			Eating	18.99%				
		Basking	23.80%	Basking	77.72%						
		Resting	21.36%	Resting	3.29%						
		Isolating	19.68%	Eating	19.48%	Isolating	3.65%	Eating	14.12%		
				Basking	15.47%			Basking	19.77%		
				Resting	65.06%			Resting	66.10%		
Evening Dry Season Data				Evening Wet Season Data							
Behavior	100%			Socializing	70.66%			Playing	0.60%	Behavior	100%
		Huddling	0.00%			Huddling	N/A				
		Mating	0.00%			Mating	N/A				
		Fighting	0.00%			Fighting	N/A				
		Eating	53.72%			Eating	17.73%				
		Basking	0.30%	Basking	75.22%						
		Resting	45.39%	Resting	7.05%						
		Isolating	29.34%	Eating	17.20%	Isolating	0.27%	Eating	0.00%		
				Basking	7.17%			Basking	87.50%		
				Resting	75.63%			Resting	12.50%		

Adult rock hyraxes spent 87.58% of the observations in an inactive state compared to 12.42% in an active state in the dry season (Table 5). In the

wet season, adult rock hyraxes spent 77.40% of the observations in an inactive state. Based on a t-test, this is significantly less than in the dry season study ($p < 0.0001$). Of the time spent in an inactive state in the dry season, adult rock hyraxes spent 70.14% sitting, 25.25% laying, and 4.61% standing. Of the time spent in an active state, adult rock hyraxes spent 42.66% climbing, 29.72% running, and 27.62% walking.

Table 5. Summary of energy budget for adult hyraxes in the dry and wet season throughout the day, during the morning, and during the evening.

Combined Adult Data				Combined Adult Data							
Behavior	100%	Socializing	69.60%	Playing	0.31%	Behavior	100%	Socializing	93.17%	Playing	N/A
				Huddling	19.77%					Huddling	N/A
				Mating	0.13%					Mating	N/A
				Fighting	0.00%					Fighting	N/A
				Eating	4.57%					Eating	18.73%
		Basking	33.73%	Basking	75.72%						
		Resting	41.49%	Resting	5.54%						
		Isolating	30.40%	Eating	5.16%			Isolating	6.83%	Eating	13.51%
				Basking	15.33%					Basking	22.70%
				Resting	79.51%					Resting	63.78%
Morning Adult Data				Morning Adult Data							
Behavior	100%			Socializing	73.15%	Playing	0.29%			Behavior	100%
		Huddling	23.20%			Huddling	N/A				
		Mating	0.15%			Mating	N/A				
		Fighting	0.00%			Fighting	N/A				
		Eating	4.04%			Eating	17.75%				
		Basking	39.43%	Basking	77.59%						
		Resting	32.89%	Resting	4.66%						
		Isolating	26.85%	Eating	6.00%	Isolating	10.28%	Eating	14.12%		
				Basking	18.20%			Basking	19.77%		
				Resting	75.80%			Resting	66.10%		
Evening Adult Data				Evening Adult Data							
Behavior	100%			Socializing	54.38%			Playing	0.42%	Behavior	100%
		Huddling	0.00%			Huddling	N/A				
		Mating	0.00%			Mating	N/A				
		Fighting	0.00%			Fighting	N/A				
		Eating	7.63%			Eating	20.29%				
		Basking	0.84%	Basking	72.78%						
		Resting	91.10%	Resting	6.93%						
		Isolating	45.62%	Eating	3.03%	Isolating	0.81%	Eating	0.00%		
				Basking	8.08%			Basking	87.50%		
				Resting	88.89%			Resting	12.50%		

Juvenile rock hyraxes spent 80.89% of the observations in an active state compared to 19.11% in an inactive state in the dry season (Table 6). In the wet season, juvenile rock hyraxes spent 76.63% of the observations in an inactive state. Based on a t-test, this is significantly less than in the dry season study ($p < 0.0001$). Of the time spent in an inactive state in the dry season, juvenile rock hyraxes spent 85.43% sitting, 9.87% standing, and 4.71% laying. Of the time spent in an active state, juvenile rock hyraxes spent 89.19% climbing, 5.46% running, and 5.35% walking.

The frequency of an active state in juveniles was higher than in adults. Adults spent most of the

observations sitting, both in trees and on the rocks, whereas juveniles spent most of the observations climbing.

Table 6. Summary of energy budget for juvenile hyraxes in the dry and wet season throughout the day, during the morning, and during the evening.

Combined Juvenile Data				Combined Juvenile Data							
Behavior	100%	Socializing	86.93%	Playing	4.83%	Behavior	100%	Socializing	100.00%	Playing	N/A
				Huddling	1.38%					Huddling	N/A
				Mating	0.00%					Mating	N/A
				Fighting	0.00%					Fighting	N/A
				Eating	72.14%					Eating	18.39%
		Basking	8.19%	Basking	77.26%						
		Resting	13.46%	Resting	4.36%						
		Isolating	13.07%	Eating	50.16%			Isolating	0.00%	Eating	0.00%
				Basking	8.20%					Basking	0.00%
				Resting	41.64%					Resting	0.00%
Morning Juvenile Data				Morning Juvenile Data							
Behavior	100%			Socializing	87.67%	Playing	5.97%			Behavior	100%
		Huddling	1.76%			Huddling	N/A				
		Mating	0.00%			Mating	N/A				
		Fighting	0.00%			Fighting	N/A				
		Eating	70.35%			Eating	19.60%				
		Basking	10.43%	Basking	77.78%						
		Resting	11.49%	Resting	2.62%						
		Isolating	12.33%	Eating	49.55%	Isolating	0.00%	Eating	0.00%		
				Basking	9.38%			Basking	0.00%		
				Resting	41.07%			Resting	0.00%		
Evening Juvenile Data				Evening Juvenile Data							
Behavior	100%			Socializing	84.33%			Playing	0.69%	Behavior	100%
		Huddling	0.00%			Huddling	N/A				
		Mating	0.00%			Mating	N/A				
		Fighting	0.00%			Fighting	N/A				
		Eating	78.67%			Eating	16.47%				
		Basking	0.00%	Basking	76.42%						
		Resting	20.64%	Resting	7.10%						
		Isolating	15.67%	Eating	51.85%	Isolating	0.00%	Eating	0.00%		
				Basking	4.94%			Basking	0.00%		
				Resting	43.21%			Resting	0.00%		

4. Discussion

In the dry season, we saw the most rock hyraxes during the earliest two hours of the morning session and the last hour of the evening session. The wet season data showed more activity later in the morning and earlier in the evening, times when the temperature was higher relative to the rest of the day. Therefore, one possible reason for the lack of activity in the later hours of the morning during the dry season is the high temperatures. During this dry season study, the maximum temperature was between 31°C and 32°C. It is common for rock hyraxes to hide in crevices during hotter times of day.¹ These occurrences affected our visibility of rock hyrax behavior and might explain why so few rock hyraxes were seen during the later morning hours and the earliest evening hours in the dry season compared to the wet season.

According to the dry season observations, rock hyraxes spent 78.12% of the observations

socializing compared to 21.88% of the observations isolating. Rock hyraxes are known to be social animals,¹⁰ so this result is generally unsurprising. However, rock hyraxes, especially juveniles, spent significantly less of the observations socializing in this dry season study compared to the wet season study, in which juveniles were never observed to be isolated. Rock hyraxes tend to travel further from their homes to forage during the dry season,¹⁰ which we observed during two instances where rock hyraxes were seen at the woodland near the bottom of the kopje. However, we observed most isolating behaviors at the top of the kopje and therefore cannot justify it with existing research. Despite the observations being conducted during the mating season, we observed mating only once during the 70 hours of observation in the dry season. These results are consistent with the wet season results, which was expected because the mating season occurs in the dry season in Randilen. In the dry season, the fact that the data was collected in November, at the end of mating season, suggests that most mating had already occurred for the year at the time of the study.⁴ Similarly, we never observed fighting in the dry season. There were two instances in which adult rock hyraxes made loud vocalizations similar to those described in previous literature on male aggression during the mating season.⁴ They were the only potential occurrences of aggressive behavior from males.

According to the dry season observations, rock hyraxes spent 52.90% of the observations in an inactive state compared to 47.10% of the observations in an active state. Contrary to the hypothesis that rock hyraxes would spend most of their energy budget thermoregulating by basking in the dry season, we observed resting in shady areas far more frequently. The rock hyraxes were still presumably thermoregulating, but they spent less time in direct sunlight than expected, especially in the later hours of the morning. Like the low numbers of rock hyraxes observed in the later hours

of the morning compared to the wet season, resting in the shade was likely the result of the much higher temperatures in the dry season discouraging the rock hyraxes from spending too much time in direct sunlight. During the later hours of the morning, we often observed a small number of rock hyraxes resting under a shaded part of a tree or on the kopje itself. The most common position in basking adults in the dry season was sitting, which differs from the wet season, where laying was most common. This difference might be explained by the temperature of the surface of the kopje being too warm for rock hyraxes to tolerate because of the high air temperature and direct sunlight in the dry season.

Rock hyraxes may have spent nearly the same amount of time in each activity state in the dry season primarily due to the relative inactivity of adults compared to juveniles. In the wet season, both adults and juveniles spent around three-fourths of the observations in an inactive state. The energy budget was relatively similar for adults between seasons, but juveniles spent significantly more of their energy budget in an active state in the dry season. By far the most common use of the juveniles' energy budget in the dry season was climbing, which was almost always paired with eating or playing. Rock hyraxes feed during a brief period in the morning three hours after sunrise and another brief period in the evening two hours before sunset.⁴ The morning feeding period was earlier than what previous literature described, and the evening feeding period was later. However, there were two observable feeding periods less than an hour in duration each day. The juveniles observed in this dry season study almost exclusively ate while climbing trees, and eating while socializing was their most common behavior. There were up to 18 juveniles observed climbing and eating from a single tree on the kopje at a time. Other rock hyrax studies have shown that they primarily browse and eat from trees in the dry season,¹¹ which could explain the greater proportion of climbing observed during the dry

season than the wet season. It is possible that the juvenile energy budget results were skewed by the large groups of juveniles being seen over several consecutive scans while other activities such as sitting and standing may have been conducted out of the viewing range. The larger proportion of climbing observed in juveniles in the dry season helps explain why they were more active than adults, but juveniles being primarily active is a drastically different finding from the wet season that has not yet been recorded in rock hyraxes.

Due to the rock hyraxes often being within or behind the foliage on the kopje and their coat color matching their surroundings, they were often hidden from our field of vision even when being looked at directly. As a result, it is possible that rock hyraxes were seen in one scan but not the next. This limitation in observations influenced the data for population size, behavior, and energy budget. Similarly, some rock hyraxes were of medium size and therefore difficult to categorize in terms of being juvenile or adult. Rock hyraxes of this size were usually considered juveniles, but it is possible that some of these hyraxes were adults and that the data for adults and juveniles was altered by this challenging distinction.

Additionally, only 70 hours of data were collected. This short timeframe limits the ability to draw wider conclusions about rock hyrax behavior and energy budget for the entire dry season. Furthermore, scan sampling has limitations as it does not continuously monitor behavior or track specific individuals. A continuous observation method would have provided further information on behavioral patterns which could help explain some of the findings of this study. The comparisons between the wet and dry season data may also be limited due to the definitions of certain behaviors and activity states, especially the difference between sitting and standing, not being standardized prior to data collection.

5. Conclusion

We found rock hyraxes to primarily spend their time socializing and in an inactive state in both the wet and dry seasons, but rock hyraxes were more frequently active and isolated in the dry season. Tanzania's dry season can be less bearable for the rock hyrax due to its higher temperatures and limited precipitation. The wet season data collection period saw lower maximum temperatures and more frequent precipitation.² The differences in weather conditions seemed to affect when the rock hyraxes were most observed as well as how often they basked as opposed to resting. We observed juvenile rock hyraxes climbing and eating more frequently in the dry season due to differing foraging habits between seasons. It is unknown why such a great proportion of juveniles were climbing and foraging in the dry season as opposed to exhibiting inactive behavior, but one possible hypothesis is that the juveniles foraged in areas that were visible to us and were inactive in areas outside of the viewing range.

This study found significant differences in rock hyrax energy behavior and energy budget between the wet and dry season that can be explained by the differing weather conditions and mating habits associated with each season. However, the findings obtained from this comparative study are limited by the lack of standardization between procedures. The wet and dry season studies had different interpretations of certain types of behavior and activity state because different researchers performed each study. It would be ideal for this study design to be conducted by a single team of researchers during both seasons to minimize variables between the two seasons or for reliability tests to be conducted between researchers.

Further research may be necessary to determine the underlying reasons for findings in this study. For example, it is unknown why rock hyraxes isolated more frequently in the dry season or why juveniles spent most of their energy budget climbing

in the dry season. Neither of these findings have been observed in previous studies and they are not explainable by weather conditions. In the future, a study that captures a greater proportion of kopjes using cameras might be helpful in determining whether the results of this dry season study occurred because a great proportion of rock hyraxes were outside of the viewing range. If future findings are consistent with dry season study, it will be pertinent that behavioral studies are conducted to determine why isolating behavior and juvenile activity is more prevalent in the dry season in Randilen WMA and possibly beyond.

Acknowledgements

First, thank you to the staff of Randilen WMA, especially Baba Erick, for allowing me to conduct this study and teaching me a lot about the other wildlife in the area. I also must thank the SIT staff for their constant support in every aspect of academics and life in Tanzania. Thank you, Mama O, for providing detailed feedback and teaching me so much about conducting scientific research. Thank you, Kaiza, for providing so much helpful feedback on my proposal before data collection began. Thank you, Jackson, for helping plan logistics for all of my travel throughout Tanzania while also being so energetic and positive through even the most stressful times. Thank you, Oscar, for being my main contact during this independent study project and helping me make preliminary conclusions with my observations. Thank you, Mwima and Mama Juni, for always being there for every SIT student when we needed help with anything while navigating through Tanzania. Thank you to the rest of the SIT staff for making the center feel like a home for the last four months. Additionally, I would like to thank the several scientists who reviewed my proposal and are likely currently reading this acknowledgement. Your feedback is most useful, and I aspire to work in your field in the future.

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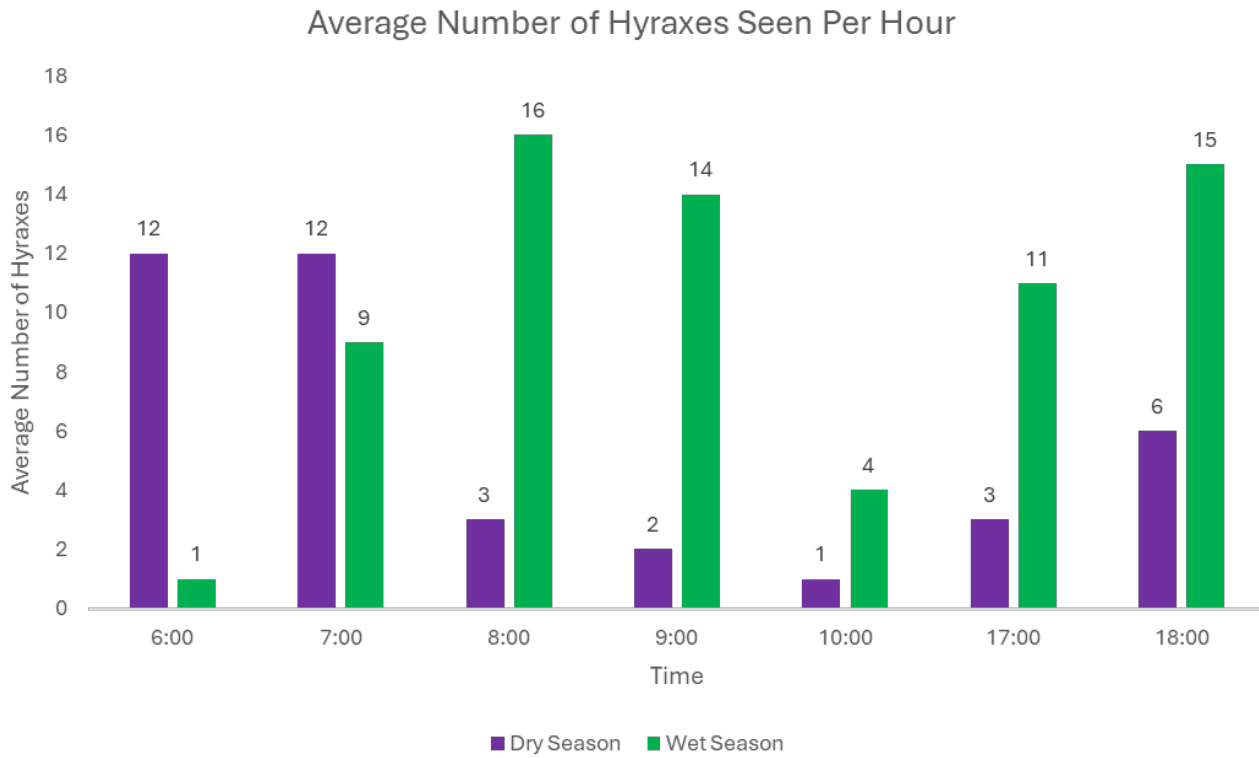
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Appendix

Supplementary Material 1. List and description of energy states and behavioral states rock hyraxes can exhibit. All descriptions are based on personal observation.

Energy State		Description
Inactive	Sitting	Idle position in which the pelvis is in contact with the ground.
	Standing	Idle position in which the stomach is not in contact with the ground.
	Laying	Idle position in which the entire trunk, and sometimes the head and neck, is in contact with the ground.
Active	Running	An active state characterized by fast movement and synchronized locomotion between both of the front legs and both of the hind legs.
	Walking	An active state characterized by slower movement and no legs exhibiting synchronized locomotion.
	Climbing (vegetation)	Movement up or down a tree or other plant.
Behavior		Description
Socializing	Playing	The occurrence of multiple hyraxes running, jumping, chasing, or other active behaviors in a non-aggressive manner.
	Huddling	The occurrence of multiple inactive hyraxes (sitting, standing, or laying) being in contact with each other.
	Mating	The occurrence of one adult hyrax being mounted on another's back.
	Eating	The occurrence of a hyrax visibly chewing.
	Basking	The occurrence of a hyrax sitting or lying in an area with direct sunlight or in an area which would have direct sunlight in the case of cloudy weather.
	Resting	The occurrence of a hyrax sitting or lying in an area with shade or indirect sunlight.
	Fighting	The occurrence of multiple hyraxes running, jumping, chasing, calling, or making direct contact in an aggressive manner.
Isolating	Eating	The occurrence of a hyrax visibly chewing.
	Basking	The occurrence of a hyrax sitting or lying in an area with direct sunlight or in an area which would have direct sunlight in the case of cloudy weather.
	Resting	The occurrence of a hyrax sitting or lying in an area with shade or indirect sunlight.

Supplementary Material 2. Combined graphs of the average number of hyraxes seen on one scan during each hour of observation in the dry season (wet season data from Thompson, 2024).





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