International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 9s, 2025
https://www.theaspd.com/ijes.php

Summer Diet Overlap Amongst Herbivore Mammals In Kawal Tiger Reserve, Telangana State, India

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Abstract
The Kawal Tiger Reserve, situated in the northern part of Telangana state with connecting patches to Maharashtra, boasts a diverse array of large herbivore mammals. Among these are the Nilgai (Boselaphus tragocamelus), Sambar (Rusa unicolor), Chital (Axis axis), Chinkara (Gazella bennettii), Chausingha (Tetracerus quadricornis), wild boar (Sus scrofa), and the Indian gaur (Bos gaurus). These species contribute significantly to the reserve's ecological richness, displaying unique adaptations within the dry deciduous forest ecosystem. The region experiences notable shifts with the seasons, particularly after autumn when many plants shed leaves, leaving only a limited number retaining foliage in summer. This creates challenges in food availability for herbivores, compounded by the fact that not all green plants are edible for them. Our study focused on understanding the intricate dynamics of food resource sharing among these large herbivore mammals during the summer season. We identified 28 edible plant species in the reserve during summer, highlighting the resilience of certain vegetation and its importance in sustaining herbivorous populations. By studying dietary preferences and resource partitioning, we discerned patterns of resource utilization and overlap among herbivores. Utilizing niche analysis and diet overlap calculations, we quantified the degree of dietary overlap between different pairs of large herbivores. Contrary to expectations of intense competition due to limited food resources, we observed a significant degree of resource partitioning among herbivores. This phenomenon allows species to coexist by utilizing different portions of available resources, thereby reducing direct competition. For instance, species like Sambar (Rusa unicolor) prefer browse species such as Acacia and Ziziphus, while Chital (Axis axis) shows a preference for grass species like Cynodon and Iselimalaxum. Such differential utilization contributes to the stability and coexistence of herbivore populations in the reserve.
Our analysis also revealed relatively low levels of diet overlap between different pairs of large herbivores, indicating evolved mechanisms that mitigate direct competition. These mechanisms include dietary specialization, temporal and spatial resource partitioning, and behavioral adaptations. Understanding these complex ecological dynamics is crucial for effectively managing and conserving biodiversity-rich ecosystems like the Kawal Tiger Reserve. Our study provides valuable insights into the mechanisms that drive coexistence and adaptation among large herbivores, aiding in the formulation of effective conservation strategies for long-term sustainability and promoting the health of wildlife habitats.

Key words: *Herbivore mammals, Ecological richness, Dietary preferences, resource partitioning, Differential utilization, Diet overlap, Ecological dynamics, Coexistence, conservation strategy.*

Introduction

The concept of the ecological niche is central to ecology, though its definition has varied significantly over time. Early ecologists such as Grinnell (1917, 1924, 1928) saw the niche primarily as the behavioral and spatial role of an organism in its community. Elton (1927) expanded on this, defining the niche in terms of an animal's interactions with food and enemies, emphasizing size and feeding habits. Dice (1952) took a more spatial view, seeing niches as subdivisions of habitat, largely ignoring functional roles. Clarke (1954) introduced the ideas of the "functional niche" and "place niche," acknowledging that similar roles could be filled by different species in different regions—what Grinnell earlier called "ecological equivalents."
Hutchinson (1957) brought mathematical rigor to the concept using set theory, defining a niche as the full range of conditions under which a species can survive and reproduce. He introduced the influential distinction between the fundamental niche (the potential niche space in the absence of competition) and the realized

niche (what is actually occupied due to competition and predation). However, Hutchinson's focus on physical and spatial conditions tended to overlook behavioral aspects of niches.

Odum (1959) defined the niche more holistically, as an organism's role within its community, shaped by structure, physiology, and behavior. He distinguished habitat (the "address") from niche (the "profession"). Weatherley (1963), in contrast, suggested limiting the niche definition to an animal's nutritional role. Some ecologists prefer breaking the niche into components like "food niche" or "place niche" to capture its multidimensional nature.

Because of its varied interpretations, the niche concept can be ambiguous, prompting some to avoid the term altogether. Still, the ecological niche is broadly understood as the sum of an organism's adaptations and its interactions with the environment. Unlike the environment, which exists independently of the organism, the niche encompasses how the organism uses and interacts with that environment.

In modern ecology, niche theory is often tied to interspecific competition and resource use. Niche relationships are frequently modeled with resource utilization functions (RUFs) along resource gradients like prey size or vertical habitat use. This approach facilitates empirical study and has enriched theoretical frameworks on competition and coexistence.

A key area of interest is niche overlap, which occurs when species use similar resources or occupy similar niches. High overlap can intensify competition, potentially leading to exclusion, resource partitioning, or shifts in behavior and diet. Studying niche overlap helps ecologists understand community structure and the mechanisms that maintain biodiversity. It highlights how species coexist, compete, or differentiate their niches to reduce conflict and sustain ecological balance

Materials and Methods

Study area

The present study was conducted in Kawal Tiger Reserve, located in the united Adilabad district, which spans approximately 894 sq. km and borders Maharashtra, Chhattisgarh, Nizamabad, and Jagitial districts. The region features dry deciduous and tropical forests, with some semi-evergreen patches in Utnur division. The climate is tropical, with summer temperatures ranging from 48°C to 54°C and winter temperatures dropping to 2°C. Annual rainfall averages between 500–600 mm.

Sampling

To study diet niche overlap among large herbivorous mammals, fieldwork was conducted during the summers of 2018 and 2019, when food resources are limited. Palatable grasses, leaves, fruits, and barks were identified through physical observation. Food preferences of each species were recorded with the help of forest staff, animal trackers, and local grazers. Species pairs were formed, and niche overlap indices were calculated using MacArthur and Levins' method (1967) to determine the degree of dietary overlap and resource sharing among herbivore species in the reserve.

MacArthur and Levins' Measure

One of the first measures proposed for niche overlap was that of MacArthur and Levins (1967):

$$M_{jk} = \frac{\sum_{i}^{n} P_{ij} P_{ik}}{\sum P_{ij}^{2}}$$

where M_{jk} = MacArthur and Levins' niche overlap of species k on species j

p_{ij} = proportion that resource i is of the total resources used by species j

p_{ik} = proportion that resource i is of the total resources used by species k

n = total number of resource states

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If the value is 0 for the calculation then there is no overlap in between that 2 species that indicates there is a possibility of resource partitioning in between both the species, which leads to coexistence in the same landscape. If the value is 1 then there is an overlap in between both species.

Results

Edible plants available in summer for Herbivores in Kawal Tiger Reserve.

S. No	Vernacular Name	Scientific name	Common name
	Leaves		
1	Battaganam	*Mitragynaparvifolia*	Kaim ,
2	Jivilika	*Grewiatilifolia*	Daman
3	Palakodisha	*Wrightiatinctoria*	Sweet Indrajao, Dyer's Oleander.
4	Nemalinara	*Holopteleaintegrifolia*	Jungle cork tree
5	Thuniki	*Diospyrosmelanoxylon*	Beedi leaf, Tendu
6	Thumma	*Acacia nilotica*	Gum arabic tree
7	Teak	*Tectonagrandis*	Teak
8	Raale	*Cassia fistula*	Golden shower
9	Bamboo	*Dendrocalamusstrictus*	Solid bamboo
10	Bamboo	*BambusaBambos*	Spiny bamboo
11	Booruga	*Bobaxceiba*	Red silk cotton
12	Thellamaddi	*Terminalia arjuna*	Arjun tree
13	Modhuga	*Butea monosperma*	Flame of forest
14	Thirumani	*Anogeissuslatifolia*	Axlewood
	Vernacular Name	**Scientific name**	**Common English name**
	Fruits		
15	Buddadarimi	*Careyaarborea*	Wild guava , Ceylon oak
16	Thani	*Terminalia bellirica*	Bedda nut , Bahera
17	Ippa	*Madhucaindica*	Mahua
18	Thuniki	*Diospyrosmelanoxylon*	Coramandal ebony, Beedi leaf, Tendu
19	Iriki	*Cordia myxa*	Assyrian plum
	Barks		
20	Thani	*Terminalia bellirica*	Bedda nut , Bahera
21	Teak	*Tectonagrandis*	Teak
22	Palakodisha	*Wrigtiatinctoria*	Sweet Indrajao, Dyer's Oleander.
23	Bilugu	Chloroxylonswietenia	Satinwood
	Grasses		
24	Jinjwagaddi	*Dicanthiumannulatum*	Marvel grass
25	Dhubbugaddi	*Cynodondactylon*	Bermuda grass , common lawn grass
26		*Paspaladiumflavedium*	Yellow watercrown grass
27	Moshi	*Iselimalaxum*	Musal grass
28		*Chloris gayana*	Rhodes grass

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S. No.	Resources	Sambar	Gaur	Nilgai
1	Grasses	5	3	5
2	Leaves	14	2	14
3	Barks	4	4	0
4	Fruits	3	3	4
	Total	26	12	23

Table Showing number of food resources preferred by each herbivore species

After the data collection overall we have found 28 food resources which include 14 types of leaves, 5 types of grasses, 4 types of barks and 3 types of fruits which are available during summer and edible foe the herbivore animals. Based on the diet pattern we grouped the large herbivores into 3 groups and 6 combinations each consisting 2 to understand the dietary overlap between the species.

- Pure grazers - Chinkara
- Pure grazers & occasional others - Spotted deer , Chousinga
- Grazers & Browsers -Nilgai, Sambar, Indian gaur.

In the current research we have studied the summer diet overlap among the browsing and grazing type herbivores i.e., Sambar *(Rusa unicolor),* Nilgai *(Boselaphus tragocamelus)* and Gaur *(Bos gaurus).* We have the three following combinations to understand the diet pattern and its overlap among them during the summer season in Kawal Tiger Reserve.

Combinations

1. Indian gaur & Sambar
2. Indian gaur & Nilgai
3. Sambar & Nilgai

To know the degree of dietary overlap between the species we used MacAurther and Levin's measure.

Overlap between Sambar and Gaur

S. no.		Sambar	Gaur				M_{jk}	M_{kj}
	Resources	P_{ij}	P_{ik}	$P_{ij}P_{ik}$	P^2_{ij}	P^2_{iK}	$P_{ij}P_{ik}/P^2_{ij}$	$P_{ij}P_{ik}/P^2_{iK}$
1	Grasses	5(0.192)	3(0.25)	0.048	0.0369	0.0625		
2	Leaves	4(0.154)	2(0.17)	0.0261	0.0237	0.0289		
3	Barks	14(0.538)	4(0.33)	0.177	0.2894	0.1089		
4	Fruits	3(0.120)	3(0.25)	0.03	0.0144	0.0625		
				0.2817	0.3644	0.2628	0.7730	1.0719
	Total	26	12					

The number of food resources used by Sambar is 26 and the number of food resources used by Gaur is 12. When the niche overlap was calculated through MacAurther and Levin's measure the values are as follows.
Sambar is overlapped by Gaur is up to the extent of **0.773**
Gaur is overlapped by sambar is up to the extent of **1.071**

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Overlap between Gaur and Nilgai

S. no.		Gaur	Nilgai				M_{jk}	M_{kj}
	Resources	P_{ij}	P_{ik}	$P_{ij}P_{ik}$	P^2_{ij}	P^2_{iK}	$P_{ij}P_{ik}/P^2_{ij}$	$P_{ij}P_{ik}/P^2_{iK}$
1	Grasses	03 (0.25)	5 (0.215)	0.053	0.062	0.046		
2	Leaves	04 (0.33)	14 (0.608)	0.200	0.109	0.371		
3	Barks	03 (0.25)	0	0	0.062	0		
4	Fruits	02 (0.17)	04 (0.173)	0.029	0.028	0.029		
				0.283	0.262	0.445	1.079	0.636
	Total	12	23					

The number of food resources preferred by Gaur is 12 and the number of food resources preferred by Nilgai is 23. When the niche overlap was calculated through MacAurther and Levin's measure the values are as follows.
Gaur is completely overlapped by Nilgai is up the extent of **1.0799**
Nilgai is overlapped by Gaur is up to the extent of **0.636**

Overlap between Sambar and Nilgai

S. No.		Sambar	Nilgai				M_{jk}	M_{kj}
	Resources	P_{ij}	P_{ik}	$P_{ij}P_{ik}$	P^2_{ij}	P^2_{iK}	$P_{ij}P_{ik}/P^2_{ij}$	$P_{ij}P_{ik}/P^2_{iK}$
1	Grasses	05 (0.192)	05 (0.217)	0.041	0.036	0.047		
2	Leaves	14 (0.538)	14 (0.608)	0.327	0.289	0.369		
3	Barks	03 (0.120)	0	0	0.014	0		
4	Fruits	04 (0.154)	04 (0.173)	0.026	0.023	0.029		
				0.395	0.364	0.446	1.085	0.885
	Total	26	23					

The number of food resources preferred by Sambar is 23 and the number of food resources preferred by Nilgai is 23. When the niche overlap was calculated through MacAurther and Levin's measure the values are as followed.
Sambar is completely overlapped by Nilgai is up the extent of **1.085**
Nilgai is overlapped by Sambar is up to the extent of **0.885**

Discussion

According to research on dietary niche overlap done in the Kawal Tiger Reserve, various herbivore species cohabit in the same habitat and have similar feeding habits. The appropriate supply of resources in the area is chiefly responsible for this coexistence. Let's explore the effects of resource availability on herbivore species and their coexistence in more detail to better understand the dynamics at work.

Resource Abundance and Diet Variation: Herbivores have access to a broader variety of food sources in settings like the Kawal Tiger Reserve where resources are plentiful. They can adjust their diets based on seasonality, culinary preferences, and nutritional requirements thanks to this availability. When resources are plentiful, herbivores can afford to be picky about what they eat.

Resource Partitioning: The phenomenon known as resource partitioning might result from adequate resource availability. Resource partitioning, which involves distinct herbivore species specializing in consuming different plant components or foraging at various heights or places within the habitat, allows them to live in the same habitat. This specialization lessens competition for the same food sources, allowing many herbivore species to coexist peacefully in the same habitat.

Coexistence of Similar Diet Patterns: When resources are abundant, herbivores with comparable dietary preferences can coexist since there is enough food to meet everyone's nutritional needs. For instance, if two

herbivore species predominantly consume grasses, the abundance of grasses ensures that neither species would face substantial competition for food.
Seasonal Variation: It's crucial to remember that seasonal fluctuations can affect herbivore diets even in ecosystems with sufficient overall food availability. Some plant species may become less common or nutritious during dry summers or other times when resources are low. In order to adjust to the shifting landscape of available resources, herbivores may change their diets as a result.
Competition for Limited Resources and Resource Scarcity: In contrast, herbivore species that depend on comparable food sources may engage in more intense competition when resources are scarce. As herbivores look for new food sources, this competition may result in changes in behavior or migration patterns or it may cause one species to outcompete the other.

The Kawal Tiger Reserve's overall sufficiency of resources makes it possible for herbivore species to coexist in the same environment with one another and share comparable dietary patterns. Resources that are sufficient enable resource partitioning, whereby species adjust to various elements of resource utilization and lessen competition. It's important to understand, too, that seasonal fluctuations in resource availability can still have an impact on feeding patterns, and that a lack of resources might increase competition among herbivore species with similar nutritional preferences. For conservation efforts and maintaining wildlife populations in such ecosystems, an understanding of these processes is essential. Because it can throw off the habitat's natural balance and harm the associated species. Associated species are often defined as additional plant and animal species that coexist with the main species in the same habitat or ecosystem. Associated species may include different plants, birds, insects, and other herbivores and carnivores that depend on the same environment in an arid landscape like Kawal.

Conclusion

In this study, we have been investigating the dietary preferences and ecological interactions of above reported large herbivore species over a predetermined time span in a particular ecosystem. The overlap in diet of these herbivore animals is one important factor we looked at, as it can reveal information about how they coexist and use resources.
We have learned a lot about how these herbivores interact in terms of their dietary choices through our examination of niche overlap indices. The co-existence of various species within the same environment does not necessarily imply competition for resources, even though some combinations of herbivore species demonstrate a higher degree of dietary overlap. Instead, it reveals a complicated pattern of resource partitioning after cohabitation.
The idea of niche width is a key element affecting this coexistence. The variety of resources that a species can make use of in its habitat is referred to as niche breadth. According to our research, species that have a wider range of niches are more likely to live in harmony with other herbivore species that have comparable dietary preferences.
For instance, the Gaur, which has a narrow niche, prefers to stay in particular areas of the study area. Its nutritional specificity may account for why it is restricted to specific geographical areas. In comparison, the Nilgai takes up more space in the research area because to its wider niche. Compared to the Gaur, it may inhabit a larger territory thanks to its capacity for exploitation of a wider variety of resources.
These results from our niche analysis offer an indication of the habitat's overall ecological balance. They imply that the area's diversified herbivore community can be sustained with no shortage of resources. These Large herbivores have relatively low levels of competition, which emphasizes their ability to coexist by partitioning the available resources.
Our findings highlight the significance of niche width in determining how large herbivore species interact and use resources. Understanding these dynamics allows us to obtain important insights into the ecological interactions and linkages that influence the habitat's species composition and overall ecosystem dynamics.

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