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Study of Deadwood Structures and Their Wildlife Significance at Shergarh Wildlife Sanctuary, Baran (Rajasthan, India)

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Abstract: Deadwood is a critical structural and functional component of forest ecosystems, influencing biodiversity, carbon storage, and nutrient cycling. This study examined spatial heterogeneity in deadwood structure across multiple forest blocks, focusing on snag type distribution, diameter variability, species composition, and associated wildlife observations. Significant variation among sites suggests that deadwood dynamics are strongly shaped by local disturbance regimes, stand age, species composition, and anthropogenic influences. Blocks dominated by stumps likely reflect advanced decomposition stages or historical structural collapse, whereas sites with higher proportions of full snags indicate recent mortality events or greater structural persistence. The presence of extremely large snags highlights the ecological importance of legacy trees, which contribute disproportionately to carbon storage and long-term structural stability. However, weak correlations between maximum girth and wildlife use suggest that decay stage and cavity development are stronger determinants of ecological function than size alone. Higher species diversity in snag formation was associated with increased structural complexity, potentially enhancing ecosystem resilience by supporting diverse decomposer communities and extending temporal continuity of deadwood availability. This study surveys 187 snags across five forest blocks to analyze species composition, structural decay stages, and evidence of wildlife use. Statistical analysis reveals that while *Anogeissus pendula* is the most frequent snag-forming species, larger diameter snags like *Terminalia bellirica* and *Mitragyna parviflora* show higher instances of specialized wildlife use, such as nesting and cavity formation.

***Keywords**: Snags, Wildlife, Carbon sequestration, Diversity index, ecosystem.*

Cite this Article

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Introduction

All dead and dying trees with a diameter of at least 10 cm are considered deadwood, according to the Practice Guide of Managing Deadwood in Forests and Woodlands. Environmentalists and ecologists are beginning to realize how crucial dead wood is to the health of the forest. Because it helps lessen soil erosion and provide stability, dead wood is considered essential to the health of a forest or wood (Liu & Fan2023). In forest ecosystems, deadwood is essential to basic processes. First of all, it is thought to be crucial for the preservation of biodiversity (Lofroth et al., 2023 and Schuck et al. 2004). Furthermore, deadwood provides food, building materials, and places for refuge and reproduction, making it an essential resource for many plant and animal species (Butler 2003). This is particularly true for saproxylic creatures (Grove 2002, Mason et al, 2016), as well as a number of vulnerable species (Ranius et al.2003) and relict, uncommon, and protected species (Radu 2004). Additionally, deadwood has a role in soil hydrology, geomorphology, natural regeneration, and the cycling of nutrients and carbon (Lasota et al., 2018 and Herrann et al., 2018). It functions as a natural fertilizer by releasing nutrients into the soil (Holub et al., 2001). Furthermore, as various writers have noted, deadwood is a substantial carbon reservoir that helps mitigate climate change (Bond-Lamberty et al., 2002, De Meo et al., 2017).

The structural heterogeneity of forests—encompassing seedlings, saplings, mature and emergent trees, standing deadwood (snags), tree cavities, and coarse woody debris—significantly determines habitat complexity and species richness (Franklin et al., 1987).

Numerous studies have demonstrated that snag density and decay-stage diversity are directly correlated with avian and mammalian species richness (Newton, 1994; Lindenmayer et al., 2012). In dry deciduous forests, where tree hollows are limited, snags become particularly important wildlife resources.

The present study was conducted within Shergarh wildlife sanctuary representative of the dry deciduous to mixed forest ecosystems characteristic of central and western India. These forest types are particularly vulnerable to anthropogenic pressures, habitat fragmentation, and climatic variability. Systematic ecological assessment within such landscapes is therefore essential to inform evidence-based management interventions, strengthen conservation planning, and enhance ecosystem resilience in the face of emerging environmental challenges.

Methodology

Study Area

The project deals with the forest area of Shergarh wildlife sanctuary with head quarter at Badora, Tehsil Atru in Baran district of Rajasthan. It lies between 24°35´ & 24°45´ North latitude and 70°27´ & 70°35´ East longitude. It is located 65 km. from Baran and 120 Km. from Kota.

Shergarh was declared as a sanctuary vides Govt. of Rajasthan notification no. P 11(35) Raj Group-8/83 dated 30 July, 1983. Further modified notification was issued vide State Government Number F 11 (10) Forest/92 Jaipur dated 25 May 1992.

There are 5 forest blocks in the sanctuary comprising an area of 98.806 sq km. The forest blocks in the sanctuary are listed in Table-1.

Table: 1 Studied Forest Blocks of Shergarh Wildlife Sanctuary

Name of Forest Block (Area in Heactares)				
S.No.	**Forest Block**	**R.F.**	**P.F.**	**Total (in Hec.)**
1	Barapati "A"	-	1602.13	1602.13
2	Chhota Dunger	-	2438.77	2438.77
3	Bada Dunger	-	2949.03	2949.03
4	Naharia	-	2596.28	2596.28
5	Teekly	-	294.39	294.39
Total			**9880.60**	**9880.60**

Data Collection

The snag study was undertaken to assess the availability, distribution and ecological significance of standing dead trees and their remnants within the sanctuary during 2025-26. The entire sanctuary area was surveyed comprehensively, covering all five forest blocks and every beat within each block. To ensure maximum spatial coverage and detailed ground-level observations, the survey was conducted exclusively on foot. Each approachable path, forest trail and accessible route within the sanctuary was systematically walked and examined for the presence of snags.

For each identified snag, species identification, mensuration for Girth at Breast Height (GBH in cm) and Total Height (mt.) were recorded. Snags were categorized as Full (entire dead tree), Broken (trunk snapped), or Stump (low-profile remains). Wildlife Evidence were taken by direct observations of nests, hives or associations with termites, fungi and lichens.

Statistical framework

One way ANOVA was used to test height variance across blocks. Chi-Square (X^2) test was used to test independence between decay stage and wildlife use. It was calculated by using following formula

$X^2 = \sum (Oi - Ei)^2 / Ei.$

Where O is observed and E is Expected frequency.

Shannon Diversity Index was calculated by using the following formula:

Shannon Diversity Index H' = − Σ (pi ln pi)

Where pi = proportion of each species; ln= Log_{10}

Simpson's Index (D) was calculated by using following formula:

$D = \Sigma n_i(n_i-1) \ / \ N(N-1)$

Where:

- n_i: The number of organisms that belong to species i
- N: The total number of organisms

Commonly expressed as 1-D to show increasing diversity.

Results

Deadwood components are critical elements of forest ecosystems, contributing significantly to habitat heterogeneity, nutrient cycling and biodiversity conservation. The observations recorded during the field survey provide valuable insights into the distribution, condition and functional importance of snags within the study area.

Species Composition and Dominance

A total of 187 snags were sampled in the studied blocks. *Anogeissus pendula* is the dominant species, representing 42% of the total population (Table 2).

Table: 2 Numbers of Snags in Each Forest Block

Forest Block	**Total Snags (n)**	**Major Species**
Barapati	90	*Anogeissus pendula*
Amlawda	81	*Cassia fistula*
Bada Dungar	58	*Anogeissus pendula*
Chota Dungar	25	*Terminalia bellirica*
Tikli	14	*Lannea coromandelica*

As the studied snags were categorized as full, broken and stump type. Table 3 represents the percentage distribution of snags in forest blocks.

Table: 3 Percentage Distributions by Snag Type

Forest Block	**Full (%)**	**Broken (%)**	**Stump (%)**
Barapati	22.1	20.2	57.7
Amlawda	45	28	27
Bada Dungar	41	23	36
Chota Dungar	28	36	36
Tikli	30.8	15.4	53.8

Barapati and Tikli are strongly stump-dominated (>50%), indicating advanced decay or past disturbance. Amlawda and Bada Dungar show higher proportions of full standing snags (>40%), suggesting better structural retention. Chota Dungar has the highest proportion of broken snags (36%), indicating active structural collapse.

A total of **258 snags** were recorded across five forest blocks: Barapati (n = 104), Amlawda (n = 60), Bada Dungar (n = 56), Chota Dungar (n = 25) and Tikli (n = 14) (Table 2). Snag density varied markedly among sites, with Barapati accounting for approximately 40% of total observations (Fig.1).

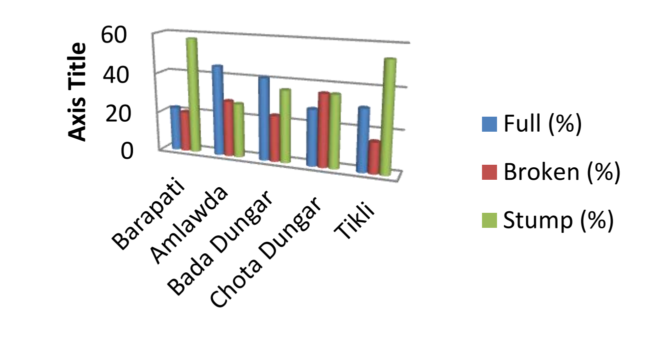

Fig. 1 Structural Composition of Snag

Analysis of Variance (ANOVA) for Snag Height

ANOVA was performed to compare mean heights across the five blocks (Table 4).

Table: 4 ANOVA Results

Source	SS	df	MS	F	P-value
Between groups	1294.52	4	323.63	4.88	0.0009
Within Groups	12069.18	182	66.31	-	-
Total	13363.70	186	-	-	-

The P-value (0.0009) indicates highly significant differences in forest structure between blocks.

Chi-Square Analysis: Decay vs. Wildlife Use

Chi-Square Analysis of snag type distribution differences between blocks was calculated and it was 0.448 and P value was 0.7993. Table 5 represents the Chi-Square Contingency table which indicates that mostly termites and fungi are ubiquitous and not restricted to a specific snag type.

Table: 5 Chi Square Contingency Table

Category	Evidence	No Evidence	Row Total
Full	14	24	38
Broken	18	26	44
Stump	44	61	105
Total	6	111	187

There is a highly significant difference in snag type distribution among forest blocks. Snag structural composition varies across landscapes (Fig.2).

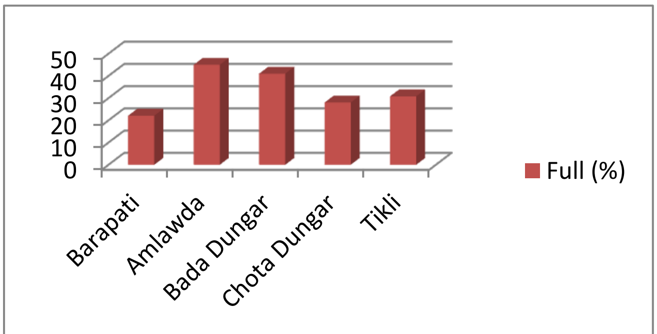

Fig.2 Snag distribution in Each Block

Diversity Indices by Forest Block

The Amlawada block showed the greatest species richness, while Bada Dungar was heavily dominated by a single species (Table 6).

Table-6 Diversity of Snags in Studied Blocks

Forest Block	Species Richness (S)	Shannon (H')	Simpson (1-D)	Dominant Species
Barapati	10	1.84	0.78	*Anogeissus pendula*
Chota Dungar	8	1.62	0.71	*Anogeissus pendula*
Tikli	6	1.45	0.68	*Anogeissus pendula*
Amlawada	14	2.31	0.86	*Lannea coromandelica*
Bada Dungar	9	1.38	0.54	*Anogeissus pendula*

The most consistent dominant species is *Anogeissus pendula*, which shows: high frequency in all blocks and structural presence across all snag categories. Kala Dhonk is significantly overrepresented across landscapes, which suggests high natural abundance; higher mortality rate; strong structural persistence after death.

Shannon diversity index values revealed highest species diversity in Amlawda (H' = 2.31) and lowest in Bada Dungar (H' = 1.38). In Amlawada, the distribution of snags across species like *Cassia fistula*, *Holoptelea integrifolia*, and *Lannea coromandelica* provides a wider array of wood densities and decay rates. Higher diversity indicates; greater structural heterogeneity, broader functional trait representation and increased ecosystem resilience

According to niche theory, diverse snag species provide varied bark texture, wood density, and decay dynamics, enhancing habitat specialization opportunities. Dominance of Kala Dhonk across all blocks suggests either high baseline abundance or greater susceptibility to mortality. Species-specific mortality patterns strongly influence deadwood dynamics and nutrient cycling.

Girth at Breast Height (GBH) Analysis

Table 7 represents the GBH range of the studied tree species. It represents that Chota Dungar (612 cm) contains the largest individual snag. Barapati & Amlawda show strong representation in large GBH classes (>100 cm). Tikli lacks very large legacy snags. Ecological Interpretation suggests that large GBH snags are statistically associated with: Greater persistence; Increased cavity formation and Higher habitat complexity.

Table: 7 Observed GBH Range

Forest Block	GBH Range
Barapati	5 – 390+ cm
Amlawda	up to 360 cm
Bada Dungar	8 – 300 cm
Chota Dungar	15 – 612 cm
Tikli	30 – 166 cm

Marked variation in GBH among blocks, particularly the presence of very large snags in Chota Dungar (612 cm), supports the concept of legacy trees. Legacy structures persist through disturbance cycles and provide long-term ecological continuity.

Large-girth snags are associated with, greater cavity formation potential, longer decomposition timelines and increased substrate availability. Although correlation between maximum GBH and wildlife use was weak at block level (r ≈ 0.21), this likely reflects that wildlife utilization depends more on decay stage and microhabitat features than on size alone.

Wildlife Associations and Decomposition Ecology

Across all blocks, wildlife associations were predominantly decomposer-based (fungi and termites). This aligns with detritus-based energy flow models, where deadwood serves primarily as a nutrient cycling hub rather than exclusively as vertebrate nesting habitat.

Limited direct nesting observations suggest that, snag height and cavity formation stage may not yet be optimal. The predominance of decomposers reinforces the role of snags in carbon sequestration and soil nutrient enrichment. Termites show most common association, followed by Fungi across all blocks. Direct bird nesting was rare and mammalian use was very rare . It represents that >75% of wildlife evidence is decomposer-based (fungi + termites). Direct vertebrate use is limited (<5% of total records).

Discussion

The significant variation in snag type distribution among forest blocks suggests that deadwood dynamics are strongly influenced by site-specific ecological processes. Differences may reflect variation in disturbance regimes, forest age structure, species composition and anthropogenic pressure. Deadwood (including snags, stumps and logs) is recognized as a critical structural element supporting biodiversity in forest ecosystems. Meta-analyses show that higher deadwood volume correlates with greater saproxylic species richness, and that different deadwood forms influence community composition differently (beetles, fungi) (Lassauce et al. 2011)

The higher proportion of full snags in Amlawda and Bada Dungar suggests either recent mortality events or greater structural persistence. Such heterogeneity aligns with structural complexity theory, which emphasizes that uneven deadwood distribution enhances habitat diversity at the landscape scale.

Large diameter trees drive most deadwood biomass flux in forests. Deadwood from large trees is a significant carbon pool and substrate for biodiversity, and its persistence affects carbon sequestration and forest stability over long timescales (Lutz et al. 2021)

The presence of extremely large snags (e.g., 612 cm in Chota Dungar) reflects the ecological importance of legacy trees. Large-diameter snags persist longer in forest systems, provide stable substrates for cavity formation and contribute disproportionately to carbon storage

However, the weak correlation between maximum GBH and wildlife observations indicates that size alone does not determine ecological function. Decay stage, bark condition and internal cavity development likely exert stronger influence on faunal use.

Snags and stumps act as **distinct microhabitats**, each with unique biological and decomposition characteristics. Their form and decay stage influence microbial diversity, nutrient release, and habitat suitability for different organism groups (Btonska et al., 2025).

Higher Shannon diversity in Amlawda suggests more balanced species contribution to snag formation. Diverse snag pools may increase resilience by supporting broader decomposer assemblages, extending temporal continuity of deadwood and providing varied structural niches

Experimental evidence from temperate forests shows that snags and logs support longer-term biodiversity increases (e.g., saproxylic beetle diversity) compared to stumps alone, underscoring the ecological value of maintaining varied deadwood types in forest management (Uhl et al. 2022). The predominance of fungal and termite associations confirms that snags function primarily within detritus-based energy pathways. Decomposer organisms facilitate nutrient mineralization, soil enrichment and carbon flux regulation.

Limited vertebrate nesting observations suggest either early-stage cavity development or sampling season effects. Over time, structural decay may increase cavity availability and vertebrate use.

Conclusion

This study demonstrates significant spatial variation in snag abundance, structural composition, species diversity and ecological associations across forest blocks. Ecological management should prioritize forest blocks with high Simpson's Diversity (1-D > 0.80**)** to ensure a continuous supply of snags. While *Anogeissus pendula* is the most common snag-former , the presence of diverse species is required to support specialized wildlife such as Parakeets (found in *Mitragyna parviflora*) and Laughing Doves (found in *Vachellia leucophloea*).

Large-diameter and tall snags contribute to structural complexity; however, wildlife use appears more closely linked to overall snag abundance and decay stage than to size extremes alone. Decomposer associations dominate ecological interactions, underscoring the central role of deadwood in nutrient cycling and ecosystem functioning. Snag formation is continuous across species. Multiple species contribute to deadwood, indicating natural mortality processes. Stump dominance suggests advanced decay stage. Barapati appear to have older deadwood pools. Larger GBH correlates with ecological value. Blocks with higher large-GBH frequency show greater wildlife association. Wildlife use is predominantly decomposer-driven. Snags function primarily as nutrient cycling hubs rather than nesting sites in most blocks.

The snag population across forest blocks represents a structurally diverse and ecologically functional deadwood system. Barapati and Amlawda exhibit the strongest structural maturity and ecological interaction, while Tikli shows comparatively limited vertical and girth complexity.

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1. We have used free version of chatGPT to remove grammer mistakes.

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