Scavenger assemblage and carcass utilization at a community-managed supplementary feeding station for vultures in Nepal

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Abstract
Supplementary Feeding Stations for Vultures (SFSVs) are an important conservation intervention in Nepal, supporting threatened scavenger populations while providing opportunities for ecosystem services. This study assessed scavenger assemblages and carcass consumption at a community-managed SFSV in Dang, Nepal. During the study period, a moderately diverse scavenger assemblage was recorded with eight scavenger species. Obligate vultures accounted for most observations, with White-rumped Vultures *Gyps bengalensis* and Himalayan Vultures *G. himalayensis* being the most frequently recorded species. Six cattle carcasses with an estimated combined biomass of *c.*425 kg were monitored during the study period. Scavengers consumed *c.*360 kg of biomass, leaving *c.*65 kg of residual material. Carcass utilization was more rapid for skinned carcasses than for unskinned carcasses, suggesting that pre-skinning may facilitate access to carrion for scavengers.

Introduction
The catastrophic population decline of Asian vultures, primarily *Gyps* sp., represents one of the most rapid biodiversity collapses in modern history. Between 1992 and 2007, populations of the White-rumped- *G. bengalensis*, the Indian- *G. indicus*, and the Slender-billed Vulture *G. tenuirostris* plummeted by over 97% across South Asia due to the veterinary drug diclofenac, which induces fatal renal failure in scavenging birds (Oaks et al. 2004; Prakash et al. 2012). This crisis destabilized ecosystems, as vultures historically provided critical services by efficiently removing carrion, preventing zoonotic disease transmission, and recycling nutrients (Carter et al. 2007).

In response, Nepal emerged as a leader in Asian vulture conservation through the innovative establishment of community-managed Supplementary Feeding Stations for Vultures (SFSV), or "vulture restaurants" since 2006 (Praveen 2009). These sites provide diclofenac-free carcasses and have been pivotal in stabilizing critically endangered populations, with some areas in Nepal documenting significant annual recovery rates (Galligan et al. 2020). Nationwide counts demonstrate continued progress, with 1,905 individuals across seven vulture species recorded across 32 districts during the 2019 national survey (Rana et al. 2020). Populations of the White-rumped Vulture increased in Terai lowlands and Pahad hills of Nepal at a mean rate of 22% per year between 2013 and 2018 (Galligan et al. 2020) coinciding with the implementation of multiple vulture conservation measures in Nepal reflecting the success of conservation interventions outlined in Nepal's Vulture Conservation Action Plan 2023–2027 (DNPWC & DoFSC 2023). GPS tracking of wild White-rumped Vultures in Nepal confirmed adult annual survival rates of 97%, with no recorded NSAID-caused mortalities, providing direct evidence that the food chain is now effectively free of toxic drugs among tracked individuals during the study (Mallord et al. 2024). This progress culminated in the declaration of the world's first Vulture Safe Zone, the Gandaki-Lumbini Vulture Safe Zone in December 2021, covering nesting, roosting, and foraging areas across Nepal's Gandaki and Lumbini provinces (SAVE 2021).

However, critical knowledge gaps persist. Existing research on SFSVs has predominantly focused on vulture population dynamics and diclofenac mitigation, neglecting broader ecological impacts. Specifically, it remains unknown how SFSV management practices such as carcass pre-processing and site rotation influence scavenger guild diversity and carcass removal efficiency.

This study aims to address the gaps by evaluating the carcass utilization by scavengers in SFSVs. Specifically, it aims to document the diversity of scavenger assemblages that utilize these feeding sites and quantify the efficiency of carcass removal.

Methodology
The study was carried out in November 2023 at the SFSV inside Divya Kamdhenu Gaushala in Shantinagar-2, Dang District, Nepal. We employed a multi-faceted approach to collect data on scavenger diversity and carcass removal dynamics at the SFSV. All fieldwork was conducted for ten days from 17 March to 27 March 2025.

Study site
The SFSV (28.1796°N, 82.1937°E; 250 m asl) is a 2,774.6 m² feeding area that lies within the Bagmare Bishnupur Community Forest (subtropical Sal Forest), interspersed with farmland. The SFSV operates under a community co-management system: the Gaushala (cow sanctuary) maintains *c.*100 aged or sick cattle, and the Community Forest User Group handles the station's operations, funded partly by selling cow dung. The station receives an estimated 15–20 carcasses per month i.e. *c.*180–240 carcasses per year. Carcass placement follows protocol guidelines; depending on labour availability; some carcasses are skinned before feeding, while others are left intact.

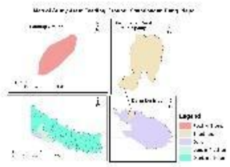

Fig 1. Map of the study area, and its geographic placement within the larger landscape.

Scavenger diversity monitoring

Scavenger assemblages were monitored using camera trapping and direct daytime observations to document both diurnal and nocturnal species **[1, 2]**. A motion-activated camera trap was positioned approximately three meters from the carcass deposition area and operated continuously, day and night, to record still photographs and video clips. Camera data were retrieved daily for species identification and behavioural observations. During daylight hours (0700–1700 h), direct observations were conducted from a concealed vantage point using a Panasonic Lumix FZ80 camera with 100x optical zoom, allowing recording of species identity, counts, and feeding activity.

Camera photographs and video sequences from both type of cameras were examined individually and chronologically. To standardize replication and avoid inflating counts from repeated triggers during a single feeding bout, a distinct observation was defined as the duration from when an animal first entered the frame until it was no longer in the frame. As scavengers were not marked, it was not always possible to be certain whether the return visits by the scavengers involved fresh individuals or not.

All photographic and video footage captured by the automated trail camera and the daytime direct surveillance camera were synchronized and cross-checked using precise embedded timestamps. This temporal alignment allowed us to reconcile overlap observations, verify species activity periods, and maintain a temporally consistent dataset across both monitoring systems.

All species were identified based on morphological characteristics observed in photographs, video footage, and direct sightings, using standard field guides for the region (Grimmett et al. 2011).

[1] Mixed scavenger guild feeding on a cattle carcass at the Divya Kamdhenu Gaushala Supplementary Feeding Station for Vultures, Dang, Nepal. Photo: Sagar Nath Rimal

[2] Mixed scavenger guild feeding on a cattle carcass at the Divya Kamdhenu Gaushala Supplementary Feeding Station for Vultures (SFSV), Dang, Nepal captured through a trap camera. Photo: Sagar Nath Rimal

Carcass removal efficiency

Carcass removal processes were monitored qualitatively. Fresh domestic cattle *Bos taurus* carcasses were placed in open areas to maximize scavenger accessibility.

- Mass estimation: Initial and residual carcass mass were estimated visually by SFSV station workers, rather than measured directly, as no weighing equipment was available at the feeding station. Estimators were experienced in cattle handling, transport, and carcass skinning through their routine work at the station. There were four SFSV workers, each with about five years of experience in cattle handling. However, they had received no formal training specifically in visual weight estimation. No calibrated reference weights or reference animals were used to check or correct estimates during the study. Estimates were based on the estimators' general familiarity with local cattle body size and condition, informed by routine handling of livestock of known approximate market weight in the course of their work, rather than on any standardized visual assessment protocol. These values are therefore treated as approximate field estimates, accurate only to the nearest 5 kg; this precision is carried through all subsequent calculations.
- Precision and reporting of estimated masses: Because initial and final carcass masses were estimated visually rather than measured instrumentally, the resulting values were treated as approximate field estimates. Derived quantities calculated from these estimates were reported only to a level of precision justified by the underlying mass estimates. Accordingly, carcass mass, removal, removal rate, and removal efficiency were rounded to an appropriate level of precision following established guidance for the reporting of measurement results (Taylor & Kuyatt 1994; JCGM 2023).

- Parameter recording: For each observation, parameters like the date, carcass type, number of carcasses, estimated initial mass (kg), estimated final mass (kg), total feeding time (hours), and skinning status (yes/no) were recorded. Skinning significantly influences scavenger accessibility and hence that is an important parameter to record (Ogada et al. 2012a).
- Informal interviews: To supplement observational data with contextual information on station management practices, informal interviews were conducted with SFSV station managers and skinners at Divya Kamdhenu Gaushala during fieldwork. Interviews focused on carcass sourcing, handling, and skinning practices, and were recorded as field notes.

Analysis

Scavenger diversity analysis

Data from all ten days were pooled for a site-level assessment. Relative abundances were calculated from the cumulative number of individual scavengers recorded during all carcass monitoring sessions. Because individuals were not uniquely marked, counts represent observed abundance records rather than confirmed unique individuals. Consequently, diversity metrics describe the composition of scavenger observations at carcasses during the study period and should not be interpreted as estimates of the true population-level diversity of the scavenger community. Species diversity was assessed using the Shannon–Wiener diversity index (H′) (Shannon 1948).

Removal efficiency: Carcass removal rate (kg/hour) and percentage removal were calculated using visual mass estimates and recorded feeding time. Visual mass estimates (initial and final) and feeding duration were used for these computations. Carcass removal efficiency was represented by two measures; a 'Removal rate' (in kg/hour) and 'Percentage removal' (as %). Removal rate is the ratio of total mass of the carcass removed and total feeding time. Percentage removal is the ratio of total mass of the carcass removed and the initial mass, expressed as a percentage.

Results

Scavenger community & diversity

Over 463 camera-trap events, we recorded three *Gyps* vultures and five facultative scavenger species (Table 1). White-rumped Vultures were most abundant, followed by Himalayan Vultures **[3]**. Egyptian Vultures were rare accounting to just three observations (Table 1). Among facultative scavengers, visits by Large-billed Crows *Corvus macrorhynchos*, followed by Common Mynas *Acridotheres tristis*, with occasional feral dogs, Bengal Foxes *Vulpes bengalensis*, and Wild Boars *Sus scrofa* were recorded. The Shannon diversity index for the assemblage was H = 1.54 (Pielou's J = 0.52), indicating moderate diversity but strong dominance by the Gyps vultures.

[3] White-rumped Vulture (top) and Himalayan Vulture (bottom) resting in a tree adjacent to the SFSV at Divya Kamdhenu Gaushala, Dang, Nepal. Photo: Sagar Nath Rimal

Table 1. Scavengers recorded at SFSV, in Divya Kamdhenu Gaushala, SRM - 2, Dang, Nepal

Species	Total Observation	Feeding time	Scavenger type
White-rumped Vulture *Gyps bengalensis*	158	Diurnal	Obligatory
Himalayan Vulture *Gyps himalayensis*	148	Diurnal	Obligatory
Egyptian Vulture *Neophron percnopterus*	3	Diurnal	Obligatory
Large-billed Crow *Corvus macrorhynchos*	86	Diurnal	Facultative
Common Myna *Acridotheres tristis*	30	Diurnal	Facultative
Feral Dog *Canis lupus familiaris*	18	Both	Facultative
Bengal Fox *Vulpes bengalensis*	7	Nocturnal	Facultative
Wild Boar *Sus scrofa*	13	Nocturnal	Facultative

Carcass removal

During the 10-day monitoring period at the SFSV, six cattle carcasses with a combined initial estimated mass of *c.*425 kg were observed for scavenging activity. Scavengers effectively processed an estimate of *c.*362 kg of biomass, leaving approximately 63 kg of residual material, demonstrating an overall removal efficiency of 85%. Carcass and residual masses were estimated visually based on standard livestock weight ranges and field assessment of remaining biomass. Estimates were also informed by the routine manual cleaning of residual carcass material by site workers familiar with carcass handling at the feeding station. Feeding station exhibited rapid carcass processing capabilities throughout the study period (Table 2).

Skinning had a dramatic effect: skinned carcasses were consumed at 30 kg/hour, compared to only 5 kg/hour for unskinned carcasses (Table 4). Correspondingly, mean removal efficiency was much higher for skinned carcasses than for unskinned.

Table 2: Details of feeding parameters

Parameters	Results
Total no. of carcasses	6

Mean no. of carcasses/day	0.6
Total initial mass (kg)	425
Mean initial mass (kg)	70
Total final mass (kg)	65
Mean final mass (kg)	11
Total removal (kg)	360
Mean removal (kg)	60
Total feeding time (hrs)	33.5
Mean feeding time (hrs)	5.6

Table 3: Skinned vs Unskinned Mean

Group	Mean removal rate (kg/hr)	Mean removal efficiency (%)
Skinned	~ 30	~ 89
Unskinned	~ 5	~ 62

Discussion

Scavenger community trade-offs

The feeding station effectively concentrates resources for target *Gyps* vultures, but this comes with a homogenization of the scavenger guild. Our moderate Shannon diversity (H=1.54) with low evenness reflects a classic pattern: obligate vultures overwhelmingly dominated the predictable food supply, while opportunistic feeders were comparatively scarce. This mirrors findings from other vulture-rich feeding sites, where facultative scavengers like mammals and generalist birds arrive mainly after vultures have finished feeding (Ogada et al. 2012b). The low presence of nocturnal mammals (e.g., foxes, wild boars) suggests temporal niche partitioning: these species may exploit carcasses only at night. Such competitive exclusion of facultative scavengers could reduce ecosystem resilience, since facultative scavengers normally provide "back-up" carrion removal when vultures are absent (Ogada et al. 2012b; Hill et al. 2018).

Impact of skinning on carcass processing

Our results confirm that pre-skinning carcasses dramatically accelerate consumption. Vultures must tear through tough hides to access internal tissues; removing the hide beforehand allows birds immediate access to high-value tissues (organs, muscle) and greatly speeds feeding (Ogada et al. 2012b). Rapid carcass consumption by vultures reduces carcass persistence time, thereby shortening the period during which carcasses may act as pathogen reservoirs and indirectly limiting opportunities for disease transmission through increased scavenger dispersal (Ogada et al. 2012b). Despite this, routine skinning is not universally practiced. Informal interviews revealed that skinning was primarily performed only by historically marginalized Dalit community members, consistent with traditional caste-based occupational roles for carcass handling, inherently constraining labour availability for this task.

Conclusion

This study provides a short-term assessment of scavenger assemblages and carcass utilization, at a community-managed supplementary feeding station for vultures in Dang, Nepal. The feeding station was used extensively by *Gyps* vultures and other scavengers, and carcass utilization appeared to be more rapid for skinned than for unskinned carcasses under the conditions observed. These findings suggest that pre-skinning may improve carcass accessibility and utilization at feeding stations.

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