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Narrative Review Paper

Timor Deer Conservation on Sumbawa Island in Wallacea A Critical Review of Available Evidence

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Abstract: Conservation decisions for Timor deer on Sumbawa Island require evidence that matches the population and geographic scale concerned. This critical narrative review evaluates studies and identifies research priorities. Targeted searches reported through November 4, 2026 were supplemented on November 18, 2026. The review cites 25 references: 17 substantive publications and eight methodological sources. Six substantive publications concern mainland Sumbawa; eleven provide external context. Local evidence mainly addresses captive feeding, behavior, husbandry, and vegetation at a Tambora site. It does not establish island-wide wild abundance or population trends. External studies contribute comparisons concerning habitat, genetic sampling, and captive site assessment, without supplying estimates for Sumbawa. Methodological literature clarifies the importance of independent sampling units, consistent behavioral observations, imperfect detection, and monitoring objectives. Conservation research should prioritize repeated seasonal surveys, habitat measurements matched to deer occurrence, effort-standardized pressure indicators, individual husbandry records, and documented population provenance. Camera traps and noninvasive genetic sampling offer options whose suitability requires local assessment. The synthesis distinguishes reported findings from interpretation and proposed action. Its conclusions apply to the selected evidence rather than an exhaustive literature inventory. Management recommendations should therefore remain specific to the populations, settings, and outcomes that their supporting studies examined and measured.

Keywords: Conservation; Critical narrative review; *Rusa timorensis*; Sumbawa Island; Wallacea.

Introduction

The usefulness of a species review depends on whether its evidence answers the management question at the appropriate scale. For Timor deer (*Rusa timorensis*) on Sumbawa Island, West Nusa Tenggara, this requires separating observations of captive animals from descriptions of wild habitat and regional explanations of dispersal. A feeding experiment can guide the evaluation of a captive diet. Its results do not, by themselves, establish the abundance, distribution, or habitat requirements of free-ranging deer across the island. This distinction defines the scope of the present review.

The Wallacean context introduces a second question concerning population origin. Martins et al. (2018) investigated the historical biogeography of *Rusa timorensis* and *Rusa unicolor* and identified human-mediated movement as relevant to deer dispersal across Wallace's line. Their regional findings warrant caution when interpreting local occurrence as evidence of natural origin. Accordingly, this review treats Sumbawa as the focal geographic unit and Wallacea as a biogeographic context. It does not designate Timor deer as endemic to Sumbawa or reconstruct the ancestry of individual Sumbawa populations.

Previous reviews provide broader conservation perspectives. Ali et al. (2021)

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examined the genus Rusa in the Indo-Malayan archipelago, including habitat monitoring and genetic conservation. Firhamsah et al. (2025) reviewed Timor deer management in West Nusa Tenggara, emphasizing husbandry, institutional capacity, and community participation. The present review complements those discussions by examining the relationship between the measurements available from Sumbawa and the decisions those measurements can support. Its contribution is an explicit assessment of the limits of transferring evidence between captive and wild conditions.

The practical concern is a mismatch between the scale of observations and the scale of recommendations. Site records may identify variables for monitoring, but island-wide conclusions require observations from a defined sampling frame. Likewise, regional accounts of threats can guide questions for local investigation without establishing which pressure has the greatest effect at a particular Sumbawa site. Review methods should therefore preserve the distinction between reported findings, interpretation, and proposed action. Snyder (2019) provides a methodological basis for aligning a review's purpose with its selection and synthesis procedures.

This article asks what local evidence describes Timor deer ecology, how far captive findings can inform discussion of wild populations, and which information would improve conservation decisions. It evaluates selected studies by location, population condition, observation design, and measured outcome. The aim is to formulate a research agenda supported by the reviewed evidence, while avoiding unsupported estimates of abundance or change. The proposed contribution concerns the use of existing evidence; it does not establish that the review exhausts the literature or represents the first treatment of these questions.

The review also connects those evidence limits to established approaches for observation and monitoring. Behavioral sampling requires a defined observation rule (Altmann, 1974), repeated measurements require an appropriate independent unit (Hurlbert, 1984), and occurrence surveys must consider imperfect detection (MacKenzie et al., 2002). These principles help explain why more observations do not necessarily justify broader geographic conclusions.

Materials and Methods

Review design and scope

This critical narrative review used targeted web searches reported through November 4, 2026, with supplementary searches on November 18, 2026. No lower publication-year limit was applied. Mainland Sumbawa remained the focal area; nearby islands, including Moyo, were not pooled as mainland population records. Studies from other regions provided explicit comparisons. Snyder (2019) informed alignment of the review purpose and synthesis. This is a narrative review, without a claim of exhaustive coverage or meta-analysis.

Search and selection

Searches combined "*Rusa timorensis*", "rusa timor", "Sumbawa", "Tambora", "habitat", "vegetasi", "perilaku", "pakan", and "Wallacea". Supplementary searches addressed genetic variation, captive site assessment, behavioral sampling, pseudoreplication, occupancy, camera traps, and conservation monitoring. Publisher pages, university repositories, open archives, and DOI records supported retrieval and bibliographic checks. Subscription databases were not searched directly. Indexing and access limitations constrained coverage.

Eligible substantive publications supplied Sumbawa observations, regional biogeographic evidence, or comparisons relevant to local inference. News reports, tourism pages, duplicates, and unsupported population figures did not underpin the findings. One thesis remained eligible as identified gray literature. The review cites 25 references: 17 substantive publications, comprising six local and eleven contextual publications, and eight methodological sources. The substantive group contains fifteen primary studies and two reviews. Five contextual publications address genetic variation, habitat, population surveys, or captive site assessment outside Sumbawa. These comparisons do not increase the number of local study sites.

Extraction and interpretation

Extraction recorded location, publication type, captive or wild conditions, observation schedule, methods, and limits of application. Accessible methods and results supported detailed comparisons; where only an abstract or publisher summary was accessible, interpretation remained limited to the information explicitly reported there. Qualitative appraisal considered sampling units, temporal coverage, outcome definition, and compatibility with the inference. No numerical quality score or independent two-reviewer assessment was performed. Findings were grouped into biogeography, habitat, feeding, behavior, and management. Methodological sources informed interpretation rather than contributing deer population observations. Differences in sampling and outcomes precluded statistical pooling.

Results and Discussion

Local evidence and geographic coverage

The six local publications address captive feeding, behavior, husbandry, or vegetation at a Tambora site. Table 1 distinguishes their evidence from the inferences they cannot support. Multiple publications concerning Wisma Daerah and Pendopo should not be treated automatically as independent spatial replicates. Site names, observation dates, and possible overlap require examination before combining records. The corpus consequently provides examples of local evidence rather than a representative sample of all Sumbawa populations.

Table 1. Local publications and limits of inference. Descriptions synthesize the cited sources

Publication and setting	Evidence examined	Principal limitation
Mutmainnah et al. (2021) Wisma Daerah	Feed-choice tests using two deer	Captive conditions and small individual sample
Aminullah et al. (2022) Wisma Daerah	Feed composition and feeding behavior	Provisioned feed and site-specific observations
Suparta et al. (2022) Goa, Jereweh	Six-feed cafeteria test using two deer	Preference among offered feeds
Fajar et al. (2023) Goa	Behavioral observation over 14 days	Daytime coverage and limited duration
Amalyadi and Munandar (2023) Pendopo	Husbandry survey in May 2023	Descriptive management record
Akbar (2023) Tambora, Bima sector	Vegetation plots and importance values	Gray literature without deer demography

Biogeography and population provenance

Martins et al. (2018) provide a regional account of historical dispersal that informs the interpretation of origin. Their results do not establish the provenance of every present-day Sumbawa herd. A record of occurrence, an inference about arrival history, and a current management objective require different evidence. Geographic labels should therefore remain separate from claims about endemism. Local provenance investigations would require documented sampling locations and suitable comparison populations.

For management, the useful question is how population history affects the decision under consideration. A proposed transfer would require information about the source animals and recipient population, alongside site suitability and health assessment. The reviewed corpus does not establish the ecological consequences of Timor deer at each Sumbawa site. This review therefore recommends investigation of provenance where it informs a defined decision, rather than assuming a benefit or harm from the species' regional history alone.

Iman et al. (2024) used fecal samples to investigate mitochondrial variation in deer from national parks in Java and Bali. Their work illustrates an option for obtaining genetic information without capturing animals. Nooratiny and Kumara (2022) examined mitochondrial cytochrome b variation in six deer from two Malaysian breeding locations. These studies concern different samples and

markers. Neither establishes the ancestry, relatedness, or genetic diversity of a Sumbawa herd. For Sumbawa, a provenance study should specify its sampling coverage and reference populations before interpreting genetic differences.

Habitat description and demographic inference

Akbar (2023) characterized vegetation in a Timor deer habitat within the Bima sector of Tambora National Park using plots and importance values. Those observations describe vegetation composition and structural dominance at the sampled site. They do not measure deer consumption, recruitment, survival, or population change. Dominant plants cannot be interpreted automatically as the most important dietary resources. Linking vegetation to deer occurrence requires observations of the animals and measurements matched in space and time.

An external comparison illustrates this distinction. Iswandono et al. (2024) combined population observations and habitat description at Menipo Nature Tourism Park, East Nusa Tenggara. Their January–February 2020 fieldwork yielded a reported estimate of 399 animals, with a 95% confidence interval of 366–432. These are Menipo results. They cannot estimate abundance on Sumbawa. Before adopting the calculations, researchers should also check consistency among reported area, density, and abundance.

A suitable Sumbawa design would define the area of inference before choosing survey locations. Repeated observations should record effort and detection conditions, together with vegetation, water access, and disturbance. Habitat measurements can then test associations with deer occurrence. The appropriate demographic method depends on visibility and available resources. Neither raw sightings nor vegetation importance values alone justify an island-wide abundance estimate. This is a proposed design principle, not a demographic result from the review.

Buling et al. (2023) used concentration counts and vegetation observations at Pulau Rusa in Alor. This comparison shows how encounters and habitat descriptions can be collected together at a defined site. It does not supply a detection-adjusted estimate for Sumbawa. Repeated surveys can support occupancy models that distinguish occurrence from imperfect detection (MacKenzie et al., 2002). For wide-ranging deer, researchers must also explain whether camera-based occupancy represents use of the sampled area rather than permanent residence (Burton et al., 2015).

Camera-based density estimation requires additional assumptions beyond obtaining photographs. Rowcliffe et al. (2008) developed an approach for animals without individually recognizable markings using encounter rates and movement and detection information. Sollmann (2018) explains the distinction among activity, occupancy, and abundance analyses. A Sumbawa survey should choose the intended quantity first, then assess whether its design supplies the required information. Camera encounter frequency alone should not be labeled population density.

Captive feeding and nutritional interpretation

Mutmainnah et al. (2021) tested feed preferences with one male and one female at Wisma Daerah during January–March 2019. Repeated observations characterize responses under those test conditions but do not increase the number of independent animals. The results can inform further captive trials. Application to other herds requires attention to body size, age, physiological condition, and the diets offered.

Suparta et al. (2022) used a cafeteria-feeding design with six feeds and two animals at Goa. *Paspalum dilatatum* and *Hibiscus tiliaceus* ranked highly among the offered plants. Preference under simultaneous provision differs from selection when wild animals encounter unevenly distributed resources. These results therefore do not establish a universal ration or the carrying capacity of Sumbawa habitat.

Aminullah et al. (2022) examined feed composition and feeding activity at Wisma Daerah, using scan sampling at five-minute intervals over 14 observation days. Their combination of nutritional assessment and behavior adds a local dimension beyond preference alone. However, provisioned feeds and a daytime observation window limit transfer to free-ranging diets. Nutrient composition should be interpreted with its analytical basis

and feed preparation, rather than treated as the nutritional state of the deer.

Together, these studies support trials that connect intake with an animal-level outcome. Future work could distinguish fresh mass from dry matter, record body condition, and separate repeated days from independent animal replicates. Diet evaluation should also document refusals and changes in management. Such information would help determine whether a preferred feed contributes to an appropriate ration. The present synthesis does not prescribe quantities for a herd whose body weights and health status are unknown.

Small captive samples also require careful interpretation of replication. Hurlbert (1984) explains why repeated observations cannot replace independent experimental units. A feeding trial with two deer and many observation days therefore differs from a trial involving many independently allocated animals. Researchers should report individual identity, repeated measurements, and the unit of analysis. This improves interpretation without assuming that a descriptive study was designed to estimate a treatment effect.

Behavioral observation and management conditions

Fajar et al. (2023) observed deer behavior at Goa over 14 days using focal animal sampling across three daytime periods. The reported age-class differences describe that setting and observation schedule. They do not establish nocturnal activity, seasonal patterns, or behavior in wild populations. A comparison with other studies must align behavioral categories and sampling intervals before interpreting percentages.

Romansah et al. (2024) provide a comparator from captive females in Dawe, Kudus, using scan sampling over seven observation days. They reported differences in feeding activities among observation periods. The comparison highlights the importance of schedules, sex composition, and recording methods. Pooling these outcomes with Goa would obscure those differences.

Husna et al. (2024) examined behavior under contrasting visitor conditions at a Semarang conservation facility. Their findings identify visitor context as a variable worth recording in captive studies. The article's abstract and methods differ in their descriptions of animal numbers and observation duration. Those details require clarification before quantitative pooling. The study is used here to identify a management covariate, not to estimate a visitor effect on Sumbawa deer.

Amalyadi and Munandar (2023) described a herd of 78 deer at Pendopo in May 2023 through surveys, observations, and interviews. Their account addresses feeding and natural mating in a shared enclosure. That herd record is not an estimate for Sumbawa in 2026. A reported risk of mating among relatives should also remain distinct from a measured inbreeding coefficient. Pedigree or genetic evidence would be needed to quantify relatedness.

The management implication is a register that connects individual identity with observation history. Births, deaths, origin, transfers, and health records would provide a basis for evaluating change within a herd. Behavioral observations could then be compared before and after a management adjustment, while accounting for visitor activity and other concurrent changes. Improvement should be evaluated with predefined outcomes rather than inferred from reproduction or food consumption alone.

Altmann (1974) distinguishes behavioral sampling procedures according to the variables and questions under study. Future comparisons should use a common ethogram and distinguish behavior frequency, duration, and scan proportions. Subeno et al. (2023) assessed the biophysical setting and forage availability of a proposed small captive facility in East Java. Their study provides a planning comparison, while Sumbawa facilities still require their own assessment of space, forage, water, and management needs.

Threats and conservation priorities

Firhamsah et al. (2025) discuss hunting, habitat change, and husbandry constraints in West Nusa Tenggara. Those concerns motivate local monitoring, but the reviewed evidence does not rank their effects across Sumbawa. Records from different locations, years, and survey methods do not constitute a comparable

population time series. This review therefore does not calculate an island-wide rate of decline.

Threat indicators need an explicit denominator. For example, snare encounters could be recorded against patrol effort, while land-cover change should use a consistent geographic boundary and classification. Conflict records should distinguish incidents from animals involved and area affected. These are proposed measurements. Their usefulness requires evaluation at the intended monitoring sites.

Ali et al. (2021) discuss genetic conservation alongside habitat protection and monitoring. For Sumbawa, an integrated research agenda should connect those themes to a specific management objective. Table 2 identifies the information required for different questions. The sequence prioritizes baseline information needed to interpret subsequent observations; it is not a costed implementation plan.

Nichols and Williams (2006) place monitoring within a defined scientific or management process. Applied to Sumbawa, this means specifying the decision before collecting additional records. A dietary change, for example, should have a predefined animal-condition outcome and observation period. A protection intervention should document patrol effort and comparable indicators through time. These are proposed applications of monitoring principles, rather than demonstrated intervention effects in the selected local studies.

Table 2. Research priorities proposed from the limits of the reviewed evidence.

Management question	Proposed measurements	Decision supported
Where do deer occur?	Repeated seasonal observations, survey effort, and detection histories	Site selection and occupancy or habitat-use analysis
Which habitat variables matter?	Matched observations of deer, forage, water, and cover	Testing local habitat associations
Where is human pressure concentrated?	Patrol effort, disturbance records, and consistent land-cover measures	Site-specific protection priorities
Is captive management improving?	Individual condition, births, deaths, diet, and management changes	Evaluation within a defined herd
What is population provenance?	Documented origin and suitable genetic or historical comparisons	Assessment before proposed transfers

Island and coastal context

The island context concerns dispersal, provenance, and the geographic limits of inference. It does not make deer a marine fauna group. Iswandono et al. (2024) reported use of mangrove plant parts at Menipo, offering a question for coastal comparisons. That finding does not establish the same feeding pattern on Sumbawa. Local tests would first need to document deer occurrence, plant use, and seasonal conditions at a defined coastal site. Rumakar et al. (2019) described Timor deer habitat use across mangrove, coastal forest, and grassland settings at Banggoi in Maluku. Together with the Menipo account, this supports examining coastal habitat as a research question. These external records do not show that Sumbawa deer depend on mangroves. Local observations should distinguish direct plant consumption, shelter use, and movement through coastal vegetation before assigning a conservation function to that habitat.

Limitations of the review

Targeted searches may omit inaccessible or poorly indexed studies. The six local publications do not represent all Sumbawa districts or protected areas. Adding external references broadens comparison but does not resolve local spatial gaps. Several captive records concern similar settings, so publication counts do not measure spatial replication. The vegetation thesis provides gray literature with a different publication status from journal articles. Variable access to full texts limits the depth of appraisal for some contextual studies. These constraints limit the strength and geographic extent of the conclusions.

The review provides no new field observations, abundance estimate, population trend, or estimate of local genetic diversity.

Comparisons evaluate transferability rather than the relative effectiveness of captive and wild conservation. A subsequent synthesis should broaden database coverage, document a reproducible search log, and check overlap among local records. Within the selected evidence, management recommendations should remain matched to the populations, settings, and outcomes studied.

Conclusion

The selected literature provides site-specific information on captive feeding, behavior, husbandry, and vegetation on mainland Sumbawa. It does not establish island-wide trends in wild Timor deer populations. External deer studies strengthen comparisons concerning habitat, genetic sampling, and captive site assessment; methodological sources clarify sampling independence, detection, and monitoring design. Conservation research should prioritize repeated seasonal observations, habitat measurements matched to deer occurrence, effort-standardized indicators of human pressure, individual husbandry records, and provenance assessment when relevant to a proposed action. These priorities require local validation. Management decisions require further Sumbawa field evidence where the selected studies leave local conditions unresolved.

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