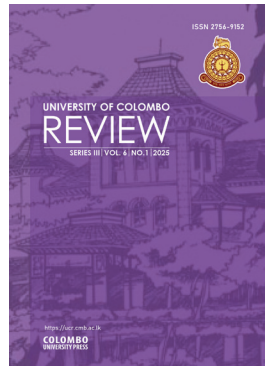

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Conservation status, crop damage and distribution of the Hog Deer (*Axis porcinus* Zimmermann, 1780) in Galle District, Sri Lanka

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ABSTRACT

Hog Deer (*Axis porcinus*), the rarest of Sri Lanka's four deer species, is listed as Critically Endangered (CR) in the 2012 National Red List of Sri Lanka. Despite its status, the species has been studied very little within the country. This study, therefore, seeks to evaluate the current conservation status of the Hog Deer in the Galle District. The research was conducted over the course of one year, from December 1st, 2021 to December 1st, 2022. A total of 246 randomly selected participants from seven divisional secretariats in the Galle District were surveyed using a questionnaire. Recent observations recorded 306 adult Hog Deer and 22 fawns. Over a span of one and a half years, 27 injured and disabled Hog Deer were brought to the Hiyare Biodiversity Education and Research Center. They are restricted to human-modified landscapes, which they utilize on a seasonal basis. The survey documented 175 confirmed Hog Deer locations. Their habitat is limited to a small region in the Galle District, between the Bentota and Gin rivers. Hog Deer is known to cause damage to three crop types: *Cinnamomum verum, Oryza sativa*, and various vegetables, with *Cinnamomum verum* being the most frequently damaged plant. However, both the questionnaire survey and crop damage assessments indicated that the damage to cinnamon was minimal. The Hog Deer face significant threats within their range in the Galle District. Therefore, community-based conservation programs, along with institutional involvement, are essential for ensuring the survival of this charismatic species in its last remaining stronghold.

KEYWORDS:

Axis porcinus, Conservation status, Depredation, Distribution, Galle District, Habitat

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Introduction

Sri Lanka is a tropical island with a total land area of 65,610 km^2, located between 79° 39' E - 81° 53' E and 5° 54' N - 9° 52' N (Senanayake, 1980; Cruz, 1986). Along with the Western Ghats of India, Sri Lanka is recognized as one of the world's 36 biodiversity hotspots (Myers et al., 2000; Gunatilleke et al., 2008). Despite its small size, Sri Lanka supports a diverse range of animal and plant assemblages, a result of its unique location, biogeography, heterogeneity of its topology, climate, soil, and vegetation (Gunatilleke et al., 2008). A large significant proportion of the island's flora and fauna are also endemic (Ministry of Environment, 2012). However, habitat loss and fragmentation, driven by rapid human population growth and associated activities, are causing a steep decline in biodiversity. This decline is further exacerbated by anthropogenic pressures and many faunal groups are now classified as nationally threatened (Kay, 1995; Ministry of Environment, 2012).

Sri Lanka has been divided into seven mammalian zones (Eisenberg & Mckay, 1970). A total of 141 mammal species have been recorded on the island, with 21 species being endemic (Kotagama & Goonatilake, 2013). The Cervidae family, which includes an even number of toes (Carrington, 1963), is represented in Sri Lanka by four deer species; the Sambar Deer (*Rusa unicolor*), Spotted Deer (*Axis axis*), Muntjac (*Muntiacus muntjac*), and Hog Deer (*Axis porcinus*) (Padmalal et al., 2003; Yapa & Ratnavira, 2013). The Sambar Deer is the largest and most widely distributed cervid in Sri Lanka, while the Spotted Deer is primarily found in the island's dry lowlands (Padmalal et al., 2003). The Muntjac also known as the Barking Deer, has a distribution throughout the island (Padmalal et al., 2003). The last is the Hog Deer (*Axis porcinus*), which is the rarest and the most endangered of the four species. Its distribution is confined to the southwestern wet zone of Sri Lanka (Vishvanath et al., 2014).

Axis porcinus is native to several countries, including Pakistan, Northern India, Nepal, Bhutan, Bangladesh, Myanmar, China, Thailand, Cambodia, and it has been introduced to Australia, South Africa, and Sri Lanka (Wilson & Mittermeier, 2011). The species has been placed in various genera, including *Axis*, *Cervus*, and *Hylaphus* (Wemmer, 1987; Wilson & Mittermeier, 2011). Two sub-species are recognized: Indian Hog Deer [*Axis procinus procinus* (Zimmermann, 1780)] from western range, including Pakistan, North India, Nepal, Bhutan, Bangladesh, and Myanmar (Wilson & Mittermeier, 2011; Wang et al., 2017), and Indochina Hog Deer [*Axis procinus annamiticus* (Heude, 1888)] from southern China (Yunnan), Thailand (reintroduced), Cambodia, Laos, and Vietnam (Wilson & Mittermeier, 2011; Wang et al., 2017). *Axis porcinus* is considered one of the most primitive members of Cervini tribe, with fossil records indicating its presence since the Pliocene and Pleistocene (Gupta et al., 2018).

The species is similar in size to the Muntjac, and its antlers are considered primitive in form (Wemmer, 1987). Adult males typically have body length ranging from 140 cm to 150 cm, while females are slightly smaller at around 130 cm. The shoulder height of males is approximately 65-75 cm, while females range from 55-65 cm (Wilson & Mittermeier, 2011). Their weight ranges from 40-55 kg for males, with females typically weighing 30-40 kg (Wilson & Mittermeier, 2011). The face is moderately short, and the tail is relatively long (Wilson & Mittermeier, 2011). Their coat is reddish or yellowish brown, with spots on the back and neck during the summer months (Long, 2003). Newborns are spotted, although individuals from Cambodia and Vietnam lack spots (Wilson & Mittermeier, 2011). Adult antlers typically range from 30-45 cm in length with some reaching 61 cm. Antler casting occurs mainly between November and April (Wemmer, 1987; Wilson & Mittermeier, 2011). This species inhabits lowland wet or moist tall grasslands and is commonly found near rivers, though it avoids dense-canopy forests (Wilson & Mittermeier, 2011). Their diet primarily consists of young grasses, along with herbs, flowers, fruits, and young leaves (Long, 2003; Wilson & Mittermeier, 2011).

In Sri Lanka, *Axis porcinus* is confined to southwestern regions, particularly in the Galle District. However, the origin of the species on the island remains uncertain, and this question has persisted for several decades (Yapa & Ratnavira, 2013). It is notably absent from other parts of Sri Lanka (Yapa & Ratnavira, 2013). Some believe that the species was introduced during the colonial period, while others suggest this may be a relict population from the time when the island was connected to the Indian subcontinent (Kelum Manamendra-Arachchi, pers. comm.). However, no definitive historical records or evidence support these theories, either in ancient chronicles or colonial documents (Yapa & Ratnavira, 2013; Vishvanath et al., 2014). Interestingly, Kelaart (1852) noted in his book that the Dutch naturalist Nobis had described this species as endemic to Sri Lanka, referring to it as *Axis oryzus*. The species is found in riparian habitats, swamps, grasslands, and paddy cultivation in the southwestern parts of the island (Yapa & Ratnavira, 2013). Despite this, the current status of the species in Sri Lanka remains unclear with minimum conservation measures having been implemented to date. Therefore, the present study aims to: (1) assess the current distribution range of *Axis porcinus*, (2) evaluate the threats faced by the species (3) examine the damage caused to crops, (4) assess local farmers' perception, and (5) propose protective measures and conservation strategies.

Materials and Methods

Study Area

The study area is located between the Bentota and Gin River basins in the Galle District of Sri Lanka. Several isolated patches of rainforest can be found within this region, including Hiyare, Kanneliya, Kottawa, Hiniduma, and Beraliya Mukalana (Vishvanath et al., 2014). The area also contains riverine mangroves and marshes along four perennial rivers: Bentota, Madu, Madampe, and Gin (Vishvanath et al., 2014). The mean annual rainfall in the region ranges from 3,000 to 5,500 mm, with rainfall lasting up to nine months in some areas (Fernando, 2002). Additionally, the Galle District has one of the highest population densities in Sri Lanka (Department of Census & Statistics, 2021). The study area supports several commercial plantations, including coconut (*Cocos nucifera*), paddy (*Oryza sativa*), tea (*Camellia sinensis*), oil palm (*Elaeis guineensis*), rubber (*Hevea brasiliensis*), and cinnamon. Of these, cinnamon cultivation is the district's primary commercial crop.

Sampling and Data Collection

Survey of Hog Deer

1. Questionnaire Survey

A general understanding of the Hog Deer distribution within the Galle District was obtained from data compiled at the Hiyare Biodiversity Education and Research Center (HBERC). Following this, selected Grama Niladari Divisions (GNDs) within the Galle District's Divisional Secretariats were visited in person. Preliminary, unstructured interview surveys were conducted in several villages to identify which deer species were likely to be present (Brook et al., 2016). These interviews took place from December 1st, 2021, to December 1st 2022. A random number generator was used to select participants from seven divisional secretariats (Bentota, Elpitiya, Karandeniya, Ambalangoda, Balapitiya, Hikkaduwa, and Baddegama) in Galle District, with one interviewer conducting the sessions. The questionnaire began with open-ended questions, and responses were recorded verbatim, as it was difficult to predict or assume what answers might be given (Brace, 2004). Interviewers included Buddhist monks, farmers, landowners, plantation workers, fishermen, poachers, caretakers, boatmen, and sand miners. A structured questionnaire with fifteen open-ended questions, designed using a standard interview format, along with photographic identification cards of the four Sri Lankan deer species, was used to gather information (McCarthy & Dissanayake, 1994; Arshad et al., 2012). The feedback from local communities was then used to determine the presence or absence of the species in each area (Arshad et al., 2012).

2. Indirect Signs

Given their shy and nocturnal habits, Hog Deer are difficult to observe during the daytime. As a result, indirect signs were crucial for gathering information. Identifying Hog Deer based on indirect signs can be challenging, as many deer species share similar characteristics, for example, Muntjac and Hog Deer are almost identical in size, and their fecal pellets and footprints are also comparable, and female and sub-adult Sambar Deer often misidentify with Hog Deer. However, Muntjac tracks are characterized by consistent prints, with one cleave longer than the other (Brown et al., 1992), while *Axis axis* tracks typically show slightly elongated slots, parallel to each other, with no dew claws and the larger tracks on damp ground that show forward slide without any spay (Brown et al., 1992). Muntjac pellets are black, shiny, and have rounded facets with striation and a small peak, around one centimeter in diameter, sometimes found as an intact mass (crottie), though more often scattered (Brown et al., 1992). Wild Boar (*Sus scrofa*) tracks are generally larger and easily distinguishable from deer tracks (Brown et al., 1992). Additionally, Domestic Goat (*Capra hircus*) tracks are small, curved, and round at the end, making them distinct from deer tracks (Brown et al., 1992); goats are not present in the study area. Wild Boar droppings can be identified by their dark color and shape, resembling half-inflated rugby galls (Brown et al., 1992). Sambar Deer footprints are larger, heart-shaped with pointed tips (West, 2018), while Hog Deer tracks are smaller, rounded, and oval with blunt tips (Vishvanath et al., 2014). Sambar tracks may show faint dewclaws (West, 2018), whereas Hog Deer tracks often feature more prominent, widely spaced dewclaws on soft ground (Vishvanath et al., 2014). Sambar fecal pellets are larger and often in small clusters (West, 2018), while Hog Deer pellets are cylindrical and typically found in larger groups (Dhungel & O'Gara, 1991). Hog Deer pellets are significantly larger than those of Muntjac but much smaller than those of Sambar and Spotted Deer (Vishvanath et al., 2014). Mouse Deer (*Moschiola meminna*) signs are easily distinguishable from those of Hog Deer due to their smaller size and shape.

3. Data from Hiyare Biodiversity, Education and Research Center (HBERC)

Unpublished data on Hog Deer were collected from the Hiyare Biodiversity Education and Research Center (HBERC), including information on the number of disabled individuals, their location of origin, sex, maturity, and the date they were received.

4. Crop Damage Assessment

Two locations were randomly chosen from each of the seven divisional secretariats to assess crop damage. A 50 m × 10 m belt transect was marked in each randomly selected site. The following details were collected for each plot: the number

of cinnamon bushes, the number of damaged plants, and the number of undamaged plants (Tzilkowski et al., 2002). The types of damage were categorized into feeding on young shoots, leaves, and bark, as well as antler rubbing.

5. Present Hog Deer Distribution in Sri Lanka

Potential sites for *Axis porcinus* were marked on a map based on a review of interviews and indirect evidence, such as recent tracks, fecal droppings, and body remains, to confirm their presence (Khan, 2012). Species reports from interviews were validated by checking verbal descriptions of the deer's morphology and ecology, and when necessary by cross-referencing the identification using photo cards (Brook et al., 2016). Once the presence of *Axis porcinus* was confirmed, either through direct or indirect observations, the date, number of individuals observed, habitat type, and any other relevant details were recorded. Geo-coordinates were recorded using a hand-held GPS meter (Garmin eTrex Venture HC GPS receiver).

6. Threat Assessment

The qualitative threat assessment method was applied following the guidelines outlined in Standards Australia (2009). The threat level was determined based on the likelihood and potential consequence of the threat to the species (Table 1). Vulnerability to threats was assessed using biological factors known to influence extinction risks, such as population size, population decline, geographic ranges, and the number of extant populations (O'Grady et al., 2004; Mace et al., 2008).

Table 1: Likelihood criteria of a threat

Description	Likelihood	Rating
The outcome is not expected to occur: no record of occurring but not impossible; may occur in exceptional circumstances	Rare	-
The outcome will only occur in a few circumstances: uncommon but known to occur elsewhere	Unlikely	+
The outcome may occur: some evidence to support it will happen	Possible	++
The outcome will occur in most circumstances	Likely	+++
The outcome is expected to occur	Almost certain	++++

Table 2: Consequence criteria of threats (rating: -insignificant; +minor; ++moderate; +++major; ++++critical)

Criteria	Consequence	-	+	++	+++	++++
1	Impact on population					
2	Fragmentation of habitat/loss of habitat connectivity/reduce the areas of occupancy					
3	Impact on the habitat critical to the survival of the species					
4	Disruption to life cycle					
5	Impact of parasite species and/or disease/predator					
6	Human pressure (hunting/poaching/electrocution, etc.)					

Likelihood Criteria (Table 1)

Likelihood refers to the chance that an event will occur, based on factors such as the geographic extent, duration, and magnitude of the threat, as well as the confidence in predicting its occurrence. It is typically expressed qualitatively in terms of probability or frequency.

Consequence Criteria (Table 2)

The consequence is the magnitude of the effect if the threat occurs, and the impact that will occur if the threat is realized. These criteria were used for assessing the particular impacts identified for the species being considered based on the Department of Environment (2013). The consequence criteria are rated from "-" to "++++" and the likelihood of occurrence is also rated from "-" to "++++" (Table 1). The final rating was determined by multiplying the values for both the consequence criteria and the likelihood criteria.

7. The First Hog Deer Conservation Program

The Hiyare Biodiversity, Education and Research Center (HBERC) launched a captive breeding program for *Axis porcinus* in late 2008, aiming to breed the species in captivity. However, the program did not achieve the expected success, according to informants at the HBERC. Despite this, they identified a location for releasing rescued individuals. The site is located at the Bentota Estuary, within the Geoffrey Bawa Estate in Lunu Ganga. Since 2009, several individuals have been released there. One visit to the island was conducted to report the status. During the visit, information was gathered on the number of deer, their sex, the number of fawns, available plant species, potential threats, and more. Caretakers were also interviewed to collect additional information.

Data Analysis

The approximate abundance of Hog Deer was derived using questionnaire surveys and unpublished data collected by HBERC. Potential sites of the species were marked by reviewing the interview data, HBERC records, and indirect evidence, such as recent tracks, fecal droppings, crop damage, and body remains, to confirm their presence at each site (Khan, 2012). A distribution map was created using ArcMap 10.3 and the Sri Lanka district layer map. The questionnaire data were analyzed using IBM SPSS 26.0 and Microsoft Excel 2016, with descriptive statistical analysis applied. Crop damage estimation was conducted using the Net Area Damage (NAD) method, as outlined by Jnawali (1989).

$A = L \times D$

Where: A = Area of damaged plot; L = Length of transect; D = Distance between transects

Results and Discussion

Results

Hog Deer Abundance

A few direct sightings of *Axis porcinus* were recorded during the survey, highlighting that the species is particularly elusive and shy. These sightings occurred in various locations, including Kosgoda, Uragaha, Karandeniya, Elpitiya, Batapola, Hikkaduwa, Gonapinuwala, and Rajgama. In Kosgoda, three individuals were observed at the Diwiyagala Hermitage while two deer were seen in Kirimatiyawa and Batukanaththa in Uragaha. Additionally, a male fawn was recorded at the Sumanaramaya Temple in Uragaha where it had been caught in a snare. The monk at the temple rescued the injured animal. In Karandeniya, five to six individuals were spotted at the Thalgaswella Temple, all which had been rescued by people. Another fawn was also found at Deeparamaya temple in Gonapinuwala, where it was rescued from dogs during the paddy harvest. Lastly, a stag, about 3.5 years old, was found at the Galathota Temple in Rajgama, where it is being kept as a pet. Several other individuals were reported by locals in the study area, though they were reluctant to disclose exact locations out of fear.

A total of 246 questionnaire forms were completed from the study area. Of these, 175 (71.13%) respondents reported seen *Axis porcinus* in their vicinity, and these locations were also confirmed through indirect records. Seventeen respondents (6.91%) reported occasional sightings, while 54 (21.9%) stated that the species was absent from their area. The recent sightings recorded 306 adults and 22 fawns in the study area and these reports were cross-checked with indirect evidence and photo cards of the four Sri Lankan deer species. Respondents also reported other deer

species in the study area, such as Sambar Deer (23.17%), Muntjac (6.91%), Spotted Deer (0.16%), and Mouse Deer (28.45%).

Data from Hiyare Biodiversity Education and Research Center (HBERC)

The Hiyare Biodiversity Education and Research Center (HBERC) regularly receives disabled and injured deer each month. From July 2020 to February 2022, a total of 27 Hog Deer, including three fawns, were brought due to injuries or disabilities.

Indirect Records

As an elusive and shy species, direct observations of *Axis porcinus* were rare. However, indirect evidence of their presence was relatively common in the study area, including footprints, droppings, nesting sites, dead animal remains, fallen antlers, and crop damage. These indirect signs were particularly prevalent in areas such as Kosgoda, Uragaha, Karandeniya, Elpitiya, Batapola, Hikkaduwa, Gonapinuwala, and Rajgama. While footprints were less frequently encountered, crop damage and nesting sites in the paddy fields were common, especially before the rice was ready for harvest. *Axis porcinus* creates distinct nesting sites in the paddy fields by trampling a small, circular area. Additionally, they cause damage to cinnamon and vegetable crops, primarily by feeding on young saplings and rubbing their antlers on tree bark.

Crop Damage

Axis porcinus caused damage to cinnamon, paddy, and vegetables in the study area. Given the extensive cinnamon plantations in the region, they frequently damage cinnamon plants. Additionally, nesting sites in paddy fields during the harvest season were commonly observed. Of the 246 questionnaires, 50% reported damage to cinnamon, 25% reported damage to paddy, and 6% reported damage to vegetables. The damage to cinnamon occurred when the deer fed on new shoots after the harvest, and the bark damaged due to antler rubbing during the rutting season (Figure 1). The paddy fields were damaged by trampling and, sometimes, by eating young rice plants. They also consumed vegetables, particularly green leaves. According to the respondents, the majority of crop damage occurred from the deer feeding on young samplings (43.49%), followed by trampling specially in paddy fields (25.2%), and a small amount from antler rubbing (13.41%). However, the overall intensity of damage was reported as medium (28.04%), with a very low percentage (0.81%) reported it as severe and others rated it as low (13.01%). Therefore, the damage to crops was not considered significant according to the interviewees. Most respondents mentioned that the damage was manageable, although they noted that damage caused by Peacocks (*Pavo cristatus*), Palm Squirrels (*Funambulus palmarum*), and Mouse Deer was much more severe.

During the transect survey, a total of 1,376 (229.5 ± 34.9 SD) cinnamon bushes were counted. Only 49 (8.17 ± 7.73 SD) saplings showed damage, which equates to approximately 163.3 trees per hectare, and just 9 (1.5 ± 2.74 SD) instances of antler rubbing were recorded, about 30 trees per hectare. This suggests that the damage to the cinnamon plants is not significant. Most of the damage was confined to specific parts of the tree rather than affecting the entire plant (new samplings and lower parts of the bark). As a result, measuring the precise extent of the damage is neither feasible nor practical.

Figure 1: Damaged crops by *Axis porcinus*
(A: Damage to Manioc- *Manihot esculenta*, B: Damage to cinnamon saplings, C: Already damaged cinnamon saplings re-growing, D: Antler rubbing on cinnamon bark)

Present Hog Deer Distribution

Based on the direct observations, indirect records, questionnaire data, and information from the Hiyare Biodiversity Education and Research Center (HBERC), the distribution of Hog Deer is limited to the Galle District, specifically along the borders of the Bentota and Gin rivers. The HBERC has received reports of Hog Deer from seven Divisional Secretariats: Bentota, Elpitiya, Karandeniya, Ambalangoda, Balapitiya, Hikkaduwa, and Baddegama. A total of 175 confirmed Hog Deer locations were identified through this survey (Figure 2). Their distribution area is confined to the Galle District with boundaries including the Bentota River to the north, the Gin River to the south, 1-2 kilometer inland stretch of coastline to the west, and the Southern Highway to the east (Figure 2). They are absent near towns and busy areas, and water barriers such as Bentota and Gin

rivers limit their range to a relatively small area of approximately 255 Km^2. Hog Deer activity was frequently recorded in locations such as Bamwelduwa and Wathurawela in Kosgoda, Uragaha, Karandeniya, Batapola, areas near Elpitiya, Gonapinuwala, Hikkaduwa, and areas near Rajgama. These areas appear to be common habitats for Hog Deer and can be considered frequent zones for the species, covering roughly 119 km^2.

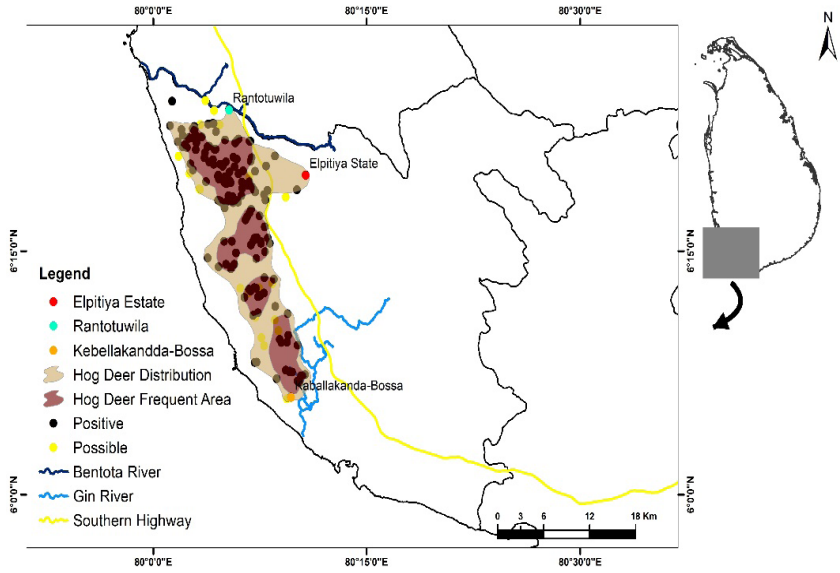

Figure 2: Hog Deer confirmed locations in the Galle District

Threat Assessment

During field excursions, several potential threats to Hog Deer were identified, encompassing both anthropogenic and natural factors. These threats include habitat destruction, electrocution, hunting for meat, snares, predator attacks (such as those by water monitors, *Varanus salvator*, and dogs, *Canis familiaris*), trap guns, hakka patas (a home-made explosive device), falling into wells, road accidents, being kept as pets, and diseases. Notably, the majority of these threats are anthropogenic in origin. Of the threats recorded, electrocution stands out as the most significant danger to Hog Deer within their range (Figure 3). Road accidents, dog attacks, and use of snares are also present substantial risks to the species (Figure 4). Additionally, reports from local communities indicated other threats, including attacks by water monitor, falling into wells, habitat destruction, keeping Hog Deer as pets, and the use of hakka patas. The hakka patas, a newly reported method of animal killing in the area, is particularly concerning. Other threats documented include the use of crackers, pesticides, pitfall traps, trap guns, and attacks by other animals such as python (*Python molorus*).

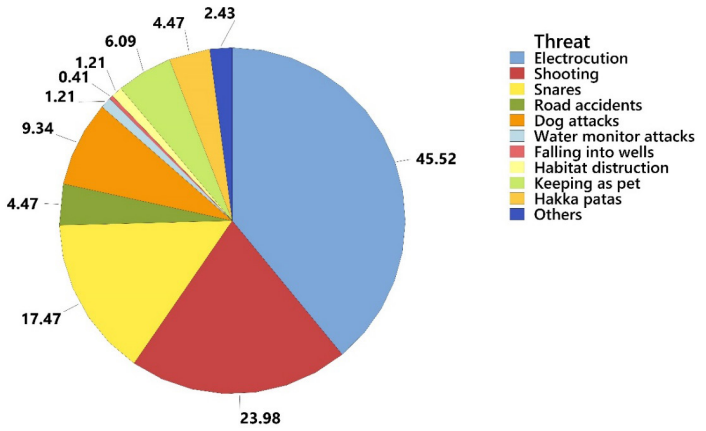

Figure 3: Threats (%) faced by *Axis porcinus* within Galle District

Figure 4: Several major threats to *Axis porcinus* in the Galle District

(A: a fawn rescued by locals from domestic dogs in Uragaha, B: another fawn rescued from dogs in Batapola, C: an electrocuted stag found close to an illegal electric wire from Kosgoda, D: a deer rescued from a snare in Uragaha, E: habitat fragmentation caused by southern highway, F: an illegal electric wire set up around a paddy field in Karandeniya, G: a paddy harvester)

The qualitative threat assessment conducted on *Axis porcinus* identified four out of six criteria's as major or critical threats to the species. Criteria's 1, 2, and 3 were categorized as major threats, while criteria 6 deemed critical, posing significant risks to their survival in the wild (Table 3). The impacts on the population are severe, given that the species' population is already fragmented into small groups. Habitat fragmentation and loss of connectivity were also classified as major threats, as most of the natural forests in the area have been cleared and converted into human-modified landscapes. Notably, the southern highway has contributed significantly to this fragmentation. The species is now only found in human-altered lands, with a little record in natural forest. Consequently, the impacts on their habitat are classified as major. While parasite infestations and specific diseases have not been recorded, predator attacks, particularly from water monitor (*Varanus salvator*) and domestic dogs (*Canis familiaris*), were observed. Water monitors primarily target fawns, while domestic dogs are known to attack individuals across all age classes, including stags. Among the six categories of threats, human pressures, and electrocution were ranked as critical, with electrocution posing one of the most significant risks to Hog Deer.

Table 3: Qualitative threat assessment for *Axis porcinus* (Adopted from Standards Australia (2009)

	Criteria	Consequence	Risk level				
			Low				High
1	Impact on population					+12	
2	Fragmentation of habitat/loss of habitat connectivity/ reduce the areas of occupancy					+12	
3	Impact on the habitat critical to the survival of the species					+12	
4	Disruption to life cycle				+8		
5	Impact of parasite species and/or disease/predator			+2			
6	Human pressure (hunting/poaching/electrocution, etc.)						+16

The First Hog Deer Conservation Program

This program was initiated with two female deer from temples in Karandeniya area. The island, which is part of the Geoffrey Bawa Trust, was designated as a wildlife sanctuary in 1973 (Rodrigo, 2013). However, there is limited documented information

available on this program. The island spans 7.3 hectares in extent and features a mix of mangroves, grasslands, marsh, and some terrestrial vegetation. According to the caretakers, the island is currently home to 27 individuals, including 12 adult males, 13 adult females and two fawns. The deer are enclosed by a non-permanent fence, allowing them to roam freely within the island. They are fed once daily, around 8.30 a.m., with supplementary foods, including artificial animal food (Prima goat food supplement) and green leaves such as Kankun (*Ipomoea aquatic*), Jack fruit leaves (*Artocarpus heterophyllus*), Mukunuwenna (*Alternanthera sessilis*), and Sweet potato leaves (*Ipomoea batatas*). Additionally, the island supports a varieties of plants species, including *Cinnamomum verum*, *Dillenia suffruticosa*, *Hedyotis fructicosa*, and *Syzygium caryophyllatum*. The grassland areas contain plants such as *Lindernia antipoda*, *Utricularia scandens*, and *Leucas zeylanica*. Due to the limited plant species available on the small island, caretakers ensure that the deer receive supplementary plant materials. However, the restricted size of the island, surrounded by water, limits their movement, and prevents them from breeding with the external population. This isolation could lead to inbreeding and associated genetic issues in the future. Therefore, it is recommended that a comprehensive monitoring system be established to track the deer's movements, diseases, breeding, feeding, behavior, and mortality on the island. Additionally, introducing wild individuals into future breeding programs could help address the risks of inbreeding.

Discussion

Axis porcinus is difficult to observe in the field due to its shy, elusive, and nocturnal behavior. This may also be attributed to the species' low abundance in the study area. However, *Axis procinus* is relatively common in certain regions of the Galle District, including Kosgoda, Uragaha, Karandeniya, Elpitiya, Batapola, Hikkaduwa, Gonapinuwala, and Rajgama. Disabled animals are frequently handed over to temples by locals, where they eventually are kept as pets. While paddy fields serve as the preferred habitat for *Axis porcinus*, these areas are not permanent, as the deer must relocate when the paddy is harvested. During this time, they move to secondary forests, home gardens, and cinnamon plantations. As a result, *Axis porcinus* faces significant threats to its survival within the study area.

According to the questionnaire survey, the abundance of *Axis porcinus* appears to be stable, with an increase in population compared to previous reports by McCarthy & Dissanayake (1994), and Vishvanath et al. (2014). Most interviewees claimed the presence of the species in their vicinity. Paddy fields in the southwestern region are active during the "Yala" season, the Southwest monsoon, which occurs from May to August. The paddy harvesting season typically begins in August and ends in September. Data recorded by the Hiyare Biodiversity Education and Research Center (HBERC), indicates that most of the deer are displaced during the

harvesting season, with seven individuals received in September alone. Three fawns were recorded in July, August, and September, suggesting a fawning season during these months.

Indirect records of *Axis porcinus* were also commonly observed, particularly nesting sites in the paddy fields, which became visible when the paddy was ready for harvest. Damage to cinnamon plants was also noted in these areas, although the extent of this damage was not significant according to the questionnaire and crop damage assessment. The deer feed on cinnamon in some areas where it is the only available plant. Consequently, local perceptions of *Axis porcinus* are not entirely negative. The distribution of *Axis porcinus* is confined to a small area (~255 Km^2) within the Galle District, bordered by Bentota and Gin Rivers. As noted by Yapa & Ratnavira (2013) and Vishvanath et al. (2014), the species may have once extended beyond these boundaries into the Kalutara District, which warrants further investigation. Despite these suggestions, the HBERC has not received deer from any part of the Kalutara District in recent times.

The species' activities are relatively common in specific areas of the Galle District, which can be considered *Axis porcinus* hotspots. As a critically endangered species living outside the protected areas, *Axis porcinus* is highly vulnerable to extinction. The fact that it now exists primarily in human-altered lands in south western part of Sri Lanka raises about whether the species was introduced or if it was forced to leave its natural habitat (i.e., natural forests). Despite significant human pressures, *Axis porcinus* has adapted well to human-altered landscapes. The results of the survey suggest a healthy breeding population is thriving, which may support the hypothesis that the species was introduced to the area. Introduced species often undergo a "lag-phase" before gradually increasing in number. It was once believed that *Axis porcinus* had become extinct in Sri Lanka since the 1930s, until McCarthy & Dissanayake (1994) re-recorded the species in 1992. This suggests that *Axis porcinus* may have been following a low-profile existence as an introduced species in its new habitat. Furthermore, while most deer in Sri Lanka exhibit non-seasonal antler cycles, *Axis porcinus* follows a seasonal antler cycle reflects temperate deer species, which could further indicate that it was introduced (Madhushanka et al., 2025). The antler casting of *Axis porcinus* occurs once annually in January and February, unlike the Spotted Deer and Sambar Deer, which shed their antlers two to three times per year in irregular cycle (Madhushanka et al., 2025). This distinction in antler shedding patterns further differentiates *Axis porcinus* from other deer species in Sri Lanka.

Despite the significant threats it faces, including electrocution and illegal electric wires, the *Axis porcinus* population is maintained at a manageable level. However, a clear understanding of population density is necessary to implement effective conservation measures. Community engagement, alongside government

involvement, is essential to safeguard this species in its last remaining stronghold, without such efforts, the future survival of this primitive deer species will be increasingly uncertain.

Recommendations

This study was conducted over a one-year period with limited resources. One of the most challenging aspect was fieldwork, particularly in cinnamon and paddy lands, due to the presence of illegally set up electric wires. The transect surveys were limited because of the time constraints and the associated risks posed by electric wires. Therefore, future studies should account for these challenges. Additionally, more comprehensive ecological data on *Axis porcinus*, including density, population trends, activity patterns, fawning period, and antler cycle should be included in future research. To accurately estimate their density and abundance, camera trapping should be integrated into these studies. Collaboration with government agencies, particularly the Department of Wildlife Conservation and the Forest Department, will be crucial for future research. Moreover, the origin of *Axis porcinus* in this region remains unclear and warrants investigation. A genetic study would be essential to resolve this issue.

While local communities are generally aware of the presence of *Axis porcinus* within the study area, their understanding of the species' rarity, critically endangered status, and restricted distribution is limited. Hence, awareness programs should be developed to address these knowledge gaps, involving relevant stakeholders. Raising awareness about the danger of illegal electric wires is also crucial, as some informants reported fatalities caused by these hazards. Furthermore, promoting non-lethal crop protection methods, such as fencing, trenches, non-lethal electric fences, and nets should be a priority. Finally, stricter law enforcement is necessary to address the issues of illegal electric wires, hunting, and the pet trade within the study area.

Conclusion

Axis porcinus is currently confined to the Galle District in the southwestern region of Sri Lanka. The species has a low abundance in the area, as direct sightings are rare. However, indirect evidence of their presence is relatively common throughout the study area. The primary crop damaged by *Axis porcinus* include cinnamon, followed by paddy and vegetables. The extent of the damage is minimal and occurs primarily in areas where the species is most abundant. *Axis porcinus* has shown a high degree of adaptability to these habitats, as evidenced by the presence of a healthy breeding population. This study has recorded a significant population of *Axis porcinus*, a species previously believed to be extinct on the island. It is possible that the species went through a lag phase with low population density, suggesting that it may have been introduced to the region. As a critically endangered deer species, *Axis*

porcinus faces significant risks due to its restricted distribution in human-modified landscapes within the Galle District. Therefore, it is essential to implement targeted conservation measures to safeguard the species in its last holding ground.

Conflict of Interest

The authors have no conflict of interest to declare

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