Designing a Wildlife Crossing Structure to Mitigate the Impacts of the Central Expresway Stage 4 - Kurunegala to Dambulla

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***Abstract* — This research project addresses the challenges posed by the continuous expansion of transportation networks on indigenous wildlife and their habitats, with a specific focus on mitigating the impact of the Central Expressway Stage 4 (CEP S-4) on local fauna. The approach begins with a comprehensive literature review, delving into animal habitats, wildlife behavior, and best practices for integrating wildlife crossings into transportation projects. Building on the insights gained from previous research, the project conducts wildlife assessments using field observations and surveys to identify and document various species within the study area, considering factors such as distribution, population densities, and habitat requirements. An impact assessment follows, examining the potential consequences of the proposed CEP Stage 4 on indigenous wildlife populations and their habitats. Key factors under scrutiny include habitat fragmentation, disturbances from transportation infrastructure, and barriers to wildlife movement. Armed with these findings, the project then develops a design proposal for wildlife crossing structures. Collaborating with ecologists, wildlife experts, and stakeholders ensures that these structures align with wildlife movement patterns, habitat preferences, and conservation needs. The aim is not only to reconnect fragmented habitats but also to provide safe passage for wildlife across the expressway, ultimately contributing to the conservation of indigenous wildlife populations. In essence, this research project seeks to bridge the gap between urban development and biodiversity conservation, presenting a model for sustainable transportation planning that promotes a harmonious coexistence between human-made infrastructure and the natural world.**

I. Introduction

In the realm of environmental conservation and infrastructure development, this research project embarks on a vital endeavor - the design of a wildlife crossing structure to mitigate the profound impacts on local fauna induced by the construction and expansion of the Central Expressway Stage 4 - Kurunegala to Dambulla (CEP S-4). The importance of this undertaking is underscored by the increasing challenges faced by wildlife as their habitats are encroached upon by urban expansion and transportation infrastructure [7].

Major road networks, like the Central Expressway, have the unintended consequence of causing habitat fragmentation and disrupting existing animal habitats and migration corridors [3]. This fragmentation poses a grave threat to wildlife by impeding their natural movements, altering breeding patterns, and restricting access to essential resources [15]. Consequently, these disruptions can lead to population declines and a loss of biodiversity within the affected areas [10].

Furthermore, the surge in vehicular traffic along such expressways intensifies the risk of wildlife-vehicle collisions, endangering both the local fauna and human motorists [13]. These collisions not only result in loss of life but also impose substantial economic costs through damage to vehicles and infrastructure [6].

This research project is driven by a dual mission. Firstly, it seeks to comprehensively evaluate the existing ecological landscape affected by the Central Expressway. This encompasses a detailed understanding of the local fauna at risk and the extent of their vulnerability, drawing upon ecological assessments and habitat analyses [7]. Secondly, the core focus of this research revolves around the design and implementation of innovative wildlife crossing structures [2]. These structures aim not only to alleviate the disruptive effects of the expressway but also to ensure the safe passage of local fauna, thus fostering coexistence between humans and wildlife in the region.

By engaging in a multidisciplinary approach, and collaborating closely with ecologists, engineers, and local stakeholders, this research project aspires to develop a wildlife crossing structure that serves as a model for future infrastructure projects, striking a balance between progress and biodiversity preservation. The significance of this research extends beyond its immediate implications, holding the potential to shape a sustainable and harmonious future for our communities and the natural world.

In a significant decision, the Sri Lankan Government has opted to embark on the construction of Central Expressway Stage 4 (CEP S-4) from Kurunegala to Dambulla, a length of approximately 60.3 km, with this expressway route traversing through key towns including Kurunegala, Ridigama, Melsiripura, Galewela, and ultimately, Dambulla.

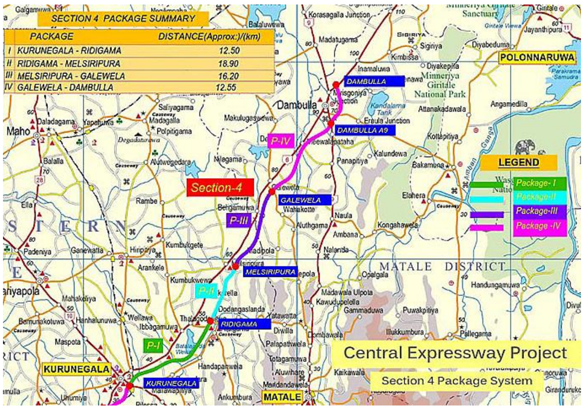

Figure 1. CEP Stage 4 Map

Stage 4 of CEP traverses through the following forests, impacting both natural habitats and causing fragmentation.

Kiridigolla Forest - In the Kiridigolla Forest, the Central Expressway (CEP) will run along the edge of the Deduru Oya river. The forest will be separated from the river by a road stretch spanning approximately 310 meters (from Ch ≈ 90+020 to Ch ≈ 90+350). Connectivity between the river and the forest will be preserved, enabling terrestrial and arboreal animals to freely access the river [5].

Henegedaralanda Forest - In the Henagederalanda Forest, the proposed Central Expressway (CEP) will pass through the forest at two points near its boundary, causing intermittent fragmentation from Ch≈103+750 to Ch≈105+000. To mitigate this impact, it is recommended to replant an equivalent area of land, as approved by the Forest Department, with indigenous vegetation to the region [5].

Hevanethenna Forest - The Hevanethenna Forest Reserve, a vital natural forest in Kurunegala, hosts significant wildlife, including barking deer, spotted deer, and civets. The proposed expressway will fragment it at three points: from Ch≈106+100 to Ch≈106+500 (approximately 400 meters), Ch≈106+800 to Ch≈107+220 (around 420 meters), and Ch≈107+400 to Ch≈108+000 (roughly 600 meters). Notably, the deer species tend to have relatively large home ranges [5].

Omaragolla Forest - In the Omaragolla Forest, there's lower biodiversity, but it's a haven for smaller mammals and boasts a diverse bird population. The effects of fragmentation on fauna might not be as severe because most understory inhabitants like birds and small mammals (murids and squirrels) can thrive in smaller forest fragments. There are plans for replanting with native species in specific areas adjacent to the Acacia plantation [5].

Bamarakanda Forest - To compensate for the loss of habitats, replanting with native species will be carried out in chosen areas adjacent to the Bamarakanda forest reserve [5].

Kathiganakanda Forest - In Kathiganakanda, the route will pass over a hillock from Ch≈120+450 to Ch≈120+810 (approximately 360 meters), which houses one of the few natural forest patches in the region. This further isolates the forest from Kathigana Wewa, creating a nearly 500-meter barrier that prevents animals from reaching the water body. Therefore, it's essential to maintain connectivity between Kathigana Wewa and the forest, enabling both terrestrial and arboreal animals to access water [5].

The construction of the CEP Stage 4 introduces a compelling predicament - habitat fragmentation, a phenomenon with far-reaching ecological ramifications. This perilous fragmentation disrupts and dissects established animal habitats, causing a cascade of deleterious effects. It obstructs the natural movements of wildlife, intricately connected to their survival strategies, impeding breeding patterns, and critically curtailing access to essential resources. These disruptions, if unchecked, have the potential to instigate the decline of local wildlife populations and precipitate a disconcerting loss of biodiversity, fundamentally destabilizing the ecosystem.

Adding to the complexity of this issue is the surge in vehicular traffic along the expressway, significantly elevating the likelihood of perilous wildlife-vehicle collisions. This heightened risk is a dual threat, imperiling both the inhabitants of these fragmented habitats and the commuters navigating the thoroughfare.

Compounding the challenges further, the expressway's construction looms as a looming specter of ecological disconnect. It acts as an imposing impediment to the seamless movement of wildlife across their native habitats. This disruption not only jeopardizes genetic diversity but also disrupts the intricate ecological processes upon which the ecosystem thrives.

The absence of dedicated animal crossing structures compounds these pressing concerns. The dearth of safe avenues for wildlife exacerbates the risk of collisions, amplifying the danger faced by both animals and road users. Simultaneously, it constricts access to critical habitats, with repercussions rippling through the entire ecological tapestry.

To navigate this intricate web of challenges, it is our solemn duty to act with urgency. Preserving the long-term sustainability of local wildlife and safeguarding the broader ecological health of the region hinges on our unwavering commitment to mitigate the impacts of expressway construction. This endeavour is emblematic of our responsibility as stewards of the environment and underscores the imperative of striking a harmonious balance between infrastructure development and ecological preservation.

II. Methodology

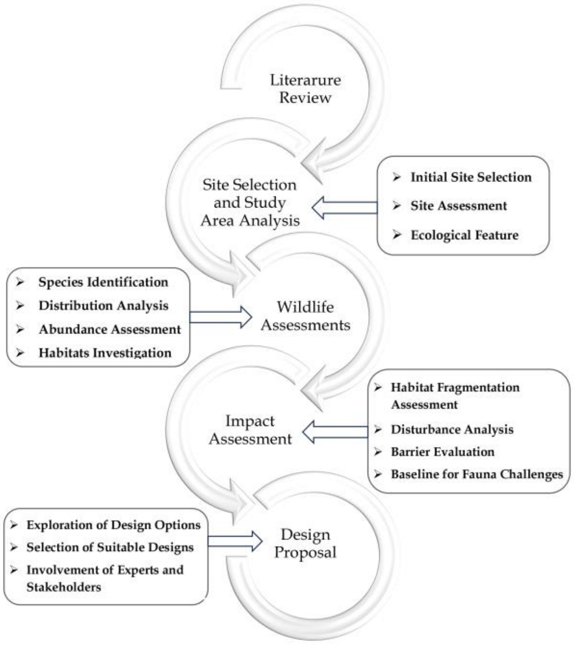

Figure 2. Flow Diagram of the Methodology

A comprehensive range of topics related to wildlife crossings was covered in the literature review, including their origins, various types, animal movement patterns, benefits, ecological disruptions caused by roads, global examples, design guidelines, past challenges, and future possibilities. Through this thorough examination, a solid foundation was established for the upcoming project aimed at designing a wildlife crossing structure for the Central Expressway Stage 4. By analyzing the history, types, and challenges of wildlife crossings, the goal of developing a practical solution that prioritized the well-being of animals impacted by road construction was pursued, with the aim of promoting a balanced coexistence between infrastructure development and the natural environment being achieved.

The methodology for site selection and study area analysis was initiated with Initial Site Selection, where potential sites were identified based on ecological relevance and highway impact. This was followed by Site Assessment, which involved a detailed evaluation of each site's topography, vegetation, and existing wildlife patterns. Ecological Feature Analysis was then conducted, integrating data on fauna distribution to identify critical ecological features that would inform the design process. A comprehensive understanding of the study area was ensured through the combination of field surveys and literature reviews. Through this methodological approach, a robust foundation was established for subsequent phases, facilitating the development of effective wildlife crossing structures tailored to the specific needs and challenges of the Central Expressway Stage 4.

The locations of forest patches in relation to the proposed project's trace and study corridor in the Central Expressway Stage 4 are illustrated in Figure 3. Direct or indirect impacts from the project may be faced by these identified sensitive habitats. The potential influence on the forest patches and their significance within the study area are highlighted.

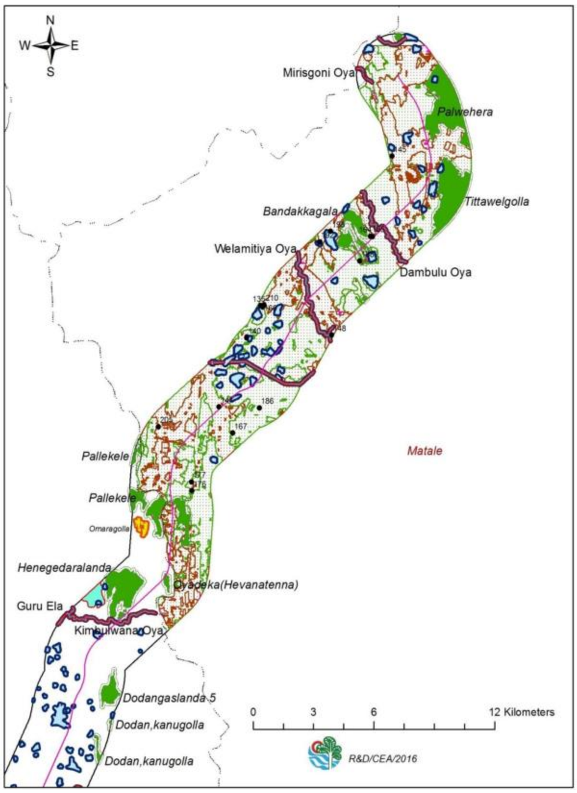

Figure 3. Map of forests closer or intersected by CEP Stage 4

After permission was obtained from the forest department for forest entry, a preliminary assessment of the selected sites was conducted. The assessed forests included Kirindigolla Forest, Henegedaralanda Forest, Hevanethanna Forest, Omaragolla Forest, Bamarakanda Forest, Kathiganakanda Forest and Bandakkagala Forest. This assessment was carried out to evaluate the impact of Central Expressway Stage 4 on natural habitats and to determine the extent of habitat fragmentation caused by the expressway's traversal through these forested areas.

For the proposed alignment points where the Central Expressway Stage 4 intersects with the identified forests, GPS coordinates were identified. These coordinates were used to pinpoint the specific locations where the expressway traversed through the forests, resulting in natural habitats being impacted and habitat fragmentation being caused. The use of GPS coordinates enabled precise identification of the areas of concern to be achieved, facilitating a targeted and accurate approach to be adopted in the design of a wildlife crossing structure to address the environmental impacts caused by the expressway on these forested regions

In the Wildlife Assessment phase, systematic species identification was conducted through field surveys, with assistance provided by ecologists. Distribution analysis was carried out using GIS technology for the mapping of wildlife habitats and corridors. Abundance was assessed through transect sampling and camera traps, with population density data being captured. Habitat requirements were investigated through the study of environmental factors affecting species suitability. This comprehensive approach, which combined traditional methods with modern technology, resulted in valuable insights being obtained regarding the diverse fauna of the Central Expressway Stage 4 area. The findings were utilized to inform subsequent stages, contributing to the design of an effective wildlife crossing structure for mitigation of potential ecological impacts.

The Wildlife Assessments phase of this research project involved Species Identification as a primary component. This process was commenced with the implementation of various passive survey techniques, including field observations, camera trapping, and other methods. Field observations were conducted to passively witness and record the natural behaviours of wildlife species without direct interference.

Figure 4. Installing Camera-trappings

Pictures of wildlife in their natural habitats were taken using camera trapping and other essential techniques, allowing the animals present in the study area to be identified. Through these methods, including surveys and camera trapping, a detailed list and documentation of the diverse animal species inhabiting the area were produced.

Due to the manner in which observations and surveys were carried out, the animals were not greatly disturbed. As a result, a clearer understanding of the animals' behavior and the diversity of species present was obtained. This initial phase established the foundation for subsequent analyses, enabling the necessary ecological balance to be properly understood. This understanding was essential for the design of effective wildlife crossings and the reduction of the impact caused by Central Expressway Stage 4.

Based on a thorough site assessment, which included camera trap data, habitat connectivity analysis, and other survey techniques, the Hevanethanna Forest was selected as the chosen location. This decision was justified by its rich biodiversity and the specific needs of the target species. Various factors were considered in the design to determine the most suitable structure type, whether an overpass, underpass, or hybrid solution. Key design elements such as fencing, natural landscaping, drainage features, lighting, noise mitigation, and escape routes were incorporated to enhance functionality and wildlife appeal.

For the topographic survey of Hevanthenna Forest, a total station along with other necessary survey equipment was employed. The aim was to gather detailed information about the terrain and landscape features of the area. The total station was set up at strategic locations within the forest, ensuring optimal coverage of the survey area. Then, using the total station, various points of interest such as elevation, slope, and contour lines were measured. These measurements were crucial for understanding the existing topography of the forest. Additionally, other relevant survey equipment was utilized to complement the data collected by the total station. This included handheld GPS devices for accurate positioning and laser rangefinders for measuring distances to specific landmarks.

Figure 5. Conducting a Topographic Survey at Hevanathenna Forest

Throughout the survey process, meticulous attention was paid to accuracy and precision to ensure reliable results. The collected data served as the foundation for subsequent analyses and design considerations for the wildlife crossing structure.

III. RESULTS & DISCUSSION

Declared as a reserve by the Forest Department, the Hevanethanna orest comprises natural and plantation segments. It is one of the few healthy natural and naturalized forests found in the Kurunegala area. Large mammals such as barking deer, spotted deer, and civets were recorded here. The natural forest areas in Hevanathenna will be traversed by the proposed CEP. Furthermore, the expressway will fragment the natural forest areas in sections Ch≈106+100 to Ch≈106+500 (≈400m), Ch≈106+800 to Ch≈107+220 (≈420m), and Ch≈107+400 to Ch≈108+000 (≈600m).

The Omaragolla forest, with comparatively lower diversity, is primarily composed of Acacia plantations and designated as a reserve by the Forest Department. This forest, encompassing both planted and natural segments, is organized into three blocks. The proposed expressway, anticipated to pass around Ch ≈ 110 + 350, poses a significant threat as it will lead to the loss of a substantial area within the central block and bisect the entire forest complex. The forest is home to a variety of birds and other smaller vertebrates. Their movement between forest patches will be hindered by the road.

Declared a reserve by the Forest Department, the Bamarakanda forest showcases a distinctive blend of rocky outcrops, sloping areas, and flat terrains. Many species of native and endemic birds and mammals, including bats, were observed to be supported by the forest. The proposed roadway is set to traverse through this forest, dominated by rock outcrops, resulting in the loss of a narrow strip of forest. Notably, this forest is characterized by its non-continuous nature, consisting of isolated hillocks. Among these, a particular rock, recognized as Natangala or Deyangala, stands out due to its unique form and position, adding to the distinctiveness of the forest landscape.

Due to its limited size, the Kathiganakanda forest has not been designated as a reserve. Nevertheless, it plays a crucial role as a significant habitat for various wildlife, including small mammals such as porcupines and rats, as well as reptiles like skinks, snakes, and lizards. Additionally, the forest serves as a vital environment for butterflies. Despite lacking formal reserve status, the ecological importance of this forest is evident, highlighting the necessity of recognizing and conserving smaller ecosystems that contribute substantially to biodiversity. The proposed CEP will cut through the forest, blocking the way to Kethigana Wewa, which is near this natural forest section (Ch≈120+450 to Ch≈120+810 ≈360m). The tank and water canal nearby might be crucial water sources for the forest animals. However, the road creates a gap of about 500m between the forest and Kathigana Wewa, stopping animals from reaching the water. Therefore, it's important to keep a connection between Kathigana Wewa and the forest so both ground and tree-dwelling animals can get to the water.

The Bandakkagala or Punchi Dambulugala, is gazetted and features a series of forests and rocky outcrops, creating a unique natural landscape. Rocky areas have sparse forests, while slopes and hills boast taller natural vegetation. Villagers refer to a section as Maligathenna. It's part of the declared forest reserve complex called Bandakkagala, comprising scrubland between natural forest segments, serving as a vital animal corridor. With a rocky terrain, this forest supports a variety of species adapted to rocky habitats. Tanks and other water sources contribute to a rich biotic component in this diverse habitat. Supporting a large colony of bats (Rhinolophus rouxii), a rocky cave was observed here. Other recorded species of interest were skinks and lizards.

The list indicates faunal species that may be affected by the proposed project. Those recorded during field surveys in different habitats are specified, while other species are those documented in similar habitats within the broader project area.

Table 1. Amphibians [5]

English Name	Sinhala Name	T S	CS	N F	F P	R I	S F	R O	G P
Common toad	Gey gemba	N	LC	√	√	√	√		
Jurdon's bullfrog	Jurdonge diya madiya	N	LC			√			
Indian bullfrog	Indiya diya madiya	N	LC			√			
Corrugated water frog	Vaka reli diya madiya	E	V U						
Common hourglass tree frog	Sulabha pahimbu gas madiya	E	LC	√	√	√			
Spotted tree frog	Pulli gas madiya	N	LC	√	√				

Abbreviations: TS – Taxonomic Status (N – Native, BR – Breeding Residence, E – Endemic, PE- Proposed Endemic) EX – Exotic, IN –Invasive, BR – Breeding resident, MG – Migrant, DD- Data Deficient , CS – Conservation Status (LC - Least Concerned VU – Vulnerable, NT- Near Threatened, EN - Endangered), NF – Natural Forest, FP – Forest Plantation, Riparian strips, SF – Sparse Forest, RO – Rock Outcrops, GP – Grassy plains

Table 2. Reptiles [5]

English Name	Sinhala Name	T S	CS	N F	F P	R I	S F	R O	G P
Common garden lizard	Gara katussa	N	LC	√	√	√	√		√
Green garden lizard	Pala katussa	N	LC	√	√	√	√	√	
Sri Lankan Kangaroo Lizard	Gomu talikatussa	E	LC	√	√				
Barnes’s cat snake	Panduru mapila	E	V U	√	√				
Brown vine snake	Henakandaya	N	LC		√				
Common bronze back	Tura haldanda	N	LC		√				
Common Cat Snake	Garandi mapila	N	LC		√				
Common kukri snake	Arani dath ketiya	N	LC	√	√				
Trinket snake	Katakaluwa	N	LC		√				
Wolf snake, house snake	Alu radanakaya	N	LC		√				
Indian cobra	Naya	N	LC	√	√	√	√		
Sri Lanka krait	Mudu karawala	E	V U	√	√	√			
The common krait	Thel karawala/ Maga maruwa	N	LC	√	√	√			
Common house-gecko	Sulaba gehuna	N	LC						
Dwarf day gecko	Kuda divasarihuna	E	V U	√	√				
Termite hill gecko	Humbas huna	N	LC		√				
Boie’s roughside	Le madilla	E	V U	√	√				
Buff Striped Keelback	Aharukuka	N	LC			V			
Checkered Keelback	Diya bariya	N	LC			√			
Sri Lanka Keelback	Diya polonga / Diya bariya	E	LC			√			
The Olive keelback watersnake	Diyawarna	N	LC			√			
Bronze green little skink	Pingu hikanala	N	LC					√	
Common lankaskink	Sulaba lakhikanala	E	LC	√	√			√	
Common skink	Sulaba hikanala	N	LC	√	√			√	
Dotted Skink	Tit hiraluhikanala	N	LC	√	√				√
Flapshell turtle	Kiri ibba	E	LC			√			
Water monitor	Kabaragoya	N	LC					√	
Green pit viper	Pala polonga	E	LC	√	√	√			
Russels viper	Tith polonga	N	LC	√	√				

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Table 3. Mammals [5]

English Name	Sinhala Name	T S	CS	N F	F P	R I	S F	R O	G P
indicine cattle	Haraka	N	N E	√	√	√	√		√
Indian water buffalo	Mee hakaka	E X	N E	√	√	√	√		√
Jackal	Nariya	N	LC	√	√				
Grey langur	Eli-vadura	N	LC	√	√				
Sri Lanka toque monkey	Sri Lanka Rilawa	E	LC	√	√				
Sri Lanka Purple-Faced Langur	Sri Lanka Kalu wandura	E	E N	√	√				
Purple-faced leaf monkey	Sri Lanka kola vandura	E	LC	√	√				
Spotted dear	Thith muwa	N	LC	√	√				
Barking deer	Olu Muwa / Weli Muwa	N	N T	√	√				
Fishing cat	Handun Diviya	N	E N	√	√				
Brown Mongoose	Bora Mugatiya	N	LC						√
Grey mongoose	Alu mugatiya	N	LC			√			
Black tipped / Ruddy mongoose	Rath Mugatiya / Hothambuwa	N	LC	√	√				
Porcupine	Iththawa	N	LC	√	√				
Black-Naped Hare	Wal Hawa	N	LC	√	√				
Grey slender loris		E	N T	√	√				
Otter	Diyaballa	N	V U			√			
Flying Fox		N	LC	√		√			
Palm squirrel	Leena	N	LC	√	√				
Giant squirrel	Dandu-leena	N	LC	√	√				
Wild boar	Wal ura	N	LC	√	√				
Sri Lanka mousedeer	Meeminna	E	LC	√	√				
Golden Palm Civet		N	LC		√				
Sri Lankan Brown Palm Civet		N	E N	√	√				
Palm Cat	Uguduwa	N	LC	√	√	√			

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The Hewanethenna forest was chosen as the most important spot for creating a wildlife crossing structure to help animals affected by the Central Expressway. This decision was based on a careful assessment using camera trap data and habitat connectivity analysis. The diversity of life in the forest was examined, and it was found to have the most variety of animals.

Figure 6. Camera-trapped images

Special cameras were used to record what animals lived there. The connections between different parts of the forest were studied to identify important movement areas (hotspots), places where habitats were fragmented, and suitable locations for safe road crossings.

The specific kinds of animals in the area, their preferred habitats, and the potential problems caused by the expressway were considered in the decision-making process. This thorough analysis helped determine the best location for the wildlife crossing, ensuring that animals were assisted and their habitats remained connected despite the expressway.

Aerial observation techniques were employed using a drone-mounted camera to comprehensively survey the entire area of the Hewanathanna forest. The drone camera was utilized, which not only ensured an efficient and thorough examination of the forest but also provided valuable visual data for precise analysis and informed decision-making in the context of the research project.

Building effective wildlife crossings requires careful consideration of various factors and design options. Overpasses are ideal for large mammals and birds, offering panoramic views and open space. Considering width, fencing, and landscaping requirements are crucial [22], [18].

Underpasses are suitable for diverse species, including smaller mammals and reptiles. Minimum dimensions, drainage, and lighting are crucial [17]. Hybrid structures, incorporating underpasses along with vegetated slopes or ledges, serve to provide not only safe wildlife passages but also additional habitat and access within the ecosystem [22].

Based on the assessment of animal habitats and identified impacts, the Overpass bridge structure was chosen as the most appropriate design for the Hewanethenna forest wildlife crossing. The decision was influenced by various factors, ensuring an effective and environmentally friendly solution for facilitating wildlife passage across the Central Expressway Stage 4.

International research and design standards provide clear guidance for wildlife crossing dimensions, with Banff National Park studies demonstrating that widths of 30-50 meters are most effective for ungulates and carnivores [8], while smaller mammals and biodiversity corridors require at least 20-30 meters to maintain both movement capacity and vegetation cover [9]. These findings align with FHWA (U.S.) and European standards that recommend minimum 30-meter widths for multi-species crossings, extending up to 100 meters in high-traffic or ecologically sensitive areas [11,17]. Applying these evidence-based standards, the Hewanethenna Forest wildlife crossing was meticulously designed with a 30-meter minimum width, carefully optimized to ensure safe passage for target species including spotted deer while meeting all international best practices for ecological connectivity.

A minimum length of 50 meters was selected to accommodate the full span of the expressway, shoulders, and additional clearances, while a height of 5.5 meters was chosen to align with both national and international standards for overpass bridges.

Additional load considerations, including live loads, dynamic loads, vegetation and maintenance loads were carefully calculated to ensure the structural integrity and functionality of the crossing. Furthermore, specific design elements were incorporated to cater to the diverse needs of spotted deer, barking deer, civets, monkeys and other species, promoting safe and effective wildlife movement. Native vegetation was included to enhance habitat connectivity and provide essential cover and foraging opportunities.

For the design calculations of the 25-meter beam used in the wildlife crossing structure, a detailed structural analysis was conducted to ensure optimal performance under various loading conditions. The process began with the determination of the dead loads, which include the self-weight of the beam and the additional weight of the vegetation layer. Live loads were then calculated, taking into account the expected presence of wildlife, such as groups of spotted deer and barking deer, as well as potential maintenance vehicles. Dynamic loads, including wind forces and seismic activities, were also considered to ensure the beam's stability in all environmental conditions. The beam was designed using high-strength reinforced concrete to provide the necessary durability and load-bearing capacity. Structural analysis involved calculating bending moments, shear forces, and deflections, ensuring that all values remained within acceptable limits as per relevant design codes. The reinforcement was meticulously detailed to handle tensile and compressive forces effectively, with appropriate spacing and anchorage lengths. Safety factors were incorporated throughout the design to account for uncertainties and provide additional security. The resulting design ensures that the 25-meter beam can safely support the wildlife crossing structure, providing a reliable and durable solution for facilitating wildlife movement.

Figure 7. Banff National Park Ecoduct, Canada - Recommended Design Option For An Overpass Wildlife Crossing

IV. CONCLUSION

The research project has successfully highlighted the critical need for wildlife crossings to mitigate the adverse effects of the Central Expressway on indigenous wildlife. The continuous expansion of transportation networks has encroached upon natural habitats, leading to habitat fragmentation and an increase in wildlife-vehicle collisions. Through a comprehensive literature review and detailed field observations, it has been established that the construction of wildlife crossings is a vital step towards ensuring the safety and well-being of local fauna. These crossings provide safe passage for animals, reducing mortality rates and promoting genetic diversity by reconnecting fragmented habitats.

The proposed design for wildlife crossing structures, with a specific focus on the Hevanethenna forest, has been carefully developed based on thorough site assessments and habitat connectivity analysis. This forest area, known for its rich biodiversity, is home to numerous endangered and vulnerable species. The chosen location for the crossings has been justified by its ecological significance and the specific needs of target species, such as spotted deer, barking deer, and various smaller mammals and reptiles. By prioritizing the reduction of wildlife-vehicle collisions and the prevention of habitat fragmentation, the design proposal aims to create a sustainable solution that aligns with the ecological balance needed to protect local fauna. Features such as vegetation cover, natural landscaping, and suitable passage dimensions have been incorporated to ensure the crossings are effective and inviting for wildlife.

Furthermore, the research project has emphasized the potential of wildlife crossings to serve as ecotourism landmarks. These structures can attract visitors, offering unique opportunities to observe wildlife in their natural habitat, thereby generating revenue for conservation efforts. This aspect underscores the broader positive impact of wildlife crossings, extending beyond the realm of wildlife conservation to encompass economic and social benefits for local communities. Enhanced ecotourism can lead to increased awareness and support for conservation initiatives, fostering a sense of stewardship among residents and tourists alike.

In conclusion, the research project has underscored the importance of integrating wildlife crossings into transportation projects as a means of fostering a balanced coexistence between infrastructure development and the natural environment. The proposed design and the insights gained from this endeavor hold the potential to shape a sustainable and harmonious future for our communities and the natural world. By addressing the ecological, economic, and social dimensions of wildlife crossings, this project advocates for a holistic approach to conservation that benefits both wildlife and human populations.

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