# EVALUATION OF MITIGATION MEASURES ON TARGETED HUMAN WILDLIFE CONFLICTS (ELEPHANT, WILD PIG, GAUR, LEOPARD, TIGER)

ADVANCED INSTITUTE FOR WILDLIFE CONSERVATION
(RESEARCH, TRAINING & EDUCATION)
CENTRE FOR CONSERVATION EDUCATION
VANDALUR,CHENNAI - 600 048

TEAM MEMBERS

MS. PRIYAMBADA ROUTRAY (PROJECT ASSISTANT)

DR.T.T.SHAMEER (PROJECT SCIENTIST)

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**Project Team**

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***For correspondence:*** aiwcrte@gmail.com, aiwcrte@tn.gov.in.

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# Summary

Human-wildlife conflict (HWC) represents a significant and complex challenge for conservation efforts on a global scale. This issue creates detrimental consequences for both human communities and wildlife populations, ranging from economic losses to threats to biodiversity. While numerous mitigation measures have been developed and implemented to address HWC, their effectiveness is not uniform and varies depending on specific locations and the species involved. Thus, the assessment of these mitigation measures, tailored to site-specific needs and the species in question, is crucial for the successful management of HWC.

To tackle this multifaceted problem, we undertook a comprehensive survey across various regions of Tamil Nadu experiencing HWC. Our primary objective was to evaluate the efficiency of different mitigation strategies based on their performance in diverse locations. We conducted an extensive questionnaire-based survey involving forest officials and residents living in proximity to conflict-prone areas, as they are directly impacted by HWC incidents. This approach allowed us to gather valuable insights from both conservation experts and the affected local communities.

Using the data collected, we assigned scores to various mitigation methods based on their efficacy in mitigating HWC. These scores were derived from real-world experiences and feedback from those who are most affected by these conflicts. By employing this rigorous evaluation process, we were able to draw conclusions regarding which mitigation methods are more effective and under what specific conditions, regions, and for which wildlife species.

Additionally, we recognized the importance of considering alternative mitigation approaches. To this end, we conducted an extensive review of the existing global literature on HWC mitigation strategies. This research allowed us to identify alternative methods that have shown promise in different parts of the world. We propose that these alternative methods be tested in various HWC conflict sites to assess their applicability and effectiveness in different contexts.

In summary, our study highlights the significance of evaluating the effectiveness of HWC mitigation measures on a case-by-case basis, considering specific site conditions and the

species involved. By involving local communities and experts, we can make informed decisions about which strategies are most suitable for mitigating HWC in different regions. Furthermore, the exploration of alternative methods based on a global literature review provides opportunities to enhance our toolkit for addressing this critical conservation challenge. Ultimately, our findings and recommendations aim to contribute to more effective and sustainable solutions for mitigating HWC in Tamil Nadu.

# Introduction

The peaceful coexistence of humans and wildlife is one of the significant concern in recent scenario where there is escalating cases of HWC. Several factors contribute to this situation such as human population growth, habitat loss, and expanding agricultural activities etc. These factors have intensified the competition for resources and space between humans and wildlife, leading to increased negative interactions (Smith *et al*., 2019; Treves *et al*., 2006; Nhyus, 2016). The state of Tamil Nadu, situated in southern India, is no exception to this global concern. As the region's population continues to grow and urbanise, the potential for HWC has also grown, necessitating the implementation of effective mitigation measures (Arshath 2020; Sekar 2013; Jones & Sharma, 2020). Although there are various mitigation models implemented on trial and error basis in Tamil Nadu, yet an effective mitigation model is lacking. Accordingly, this study aims to evaluate the efficacy of human-wildlife conflict mitigation measures implemented in Tamil Nadu, drawing insights from global experiences and identifying best practices for adoption.

**Current Scenario in Tamil Nadu**

Tamil Nadu is renowned for its rich biodiversity, including iconic species such as the Indian elephant, Bengal tiger, and various primates (Tamil Nadu Biodiversity Board, 2021). However, this diversity has also led to increased interactions between humans and wildlife, often resulting in conflicts that endanger both parties. Crop raiding, property damage, and even human injuries or fatalities caused by wild animals have prompted the state authorities to develop and implement mitigation measures (Allwin *et al*., 2016; Senthilkumar *et al*., 2016; Senthilkumar *et al*., 2020). These measures include habitat conservation, relocation of problematic animals, the installation of physical barriers, public awareness campaigns, etc. However, assessing the effectiveness of these measures is crucial to ensuring the long-term coexistence of humans and wildlife.

**Global Insights**

HWC are not limited to Tamil Nadu but are pervasive across the globe. Different regions have employed a variety of mitigation strategies, ranging from traditional practices to cutting-edge technological solutions. For instance, in parts of Africa, beehive fences are used to deter

elephants from crop fields, taking advantage of elephants' natural aversion to bees (Osborn & Parker, 2018). In North America, wildlife corridors and underpasses have been constructed to facilitate the safe movement of animals across highways, reducing the risk of road accidents and promoting genetic diversity within populations (Bissonette & Adair, 2016).

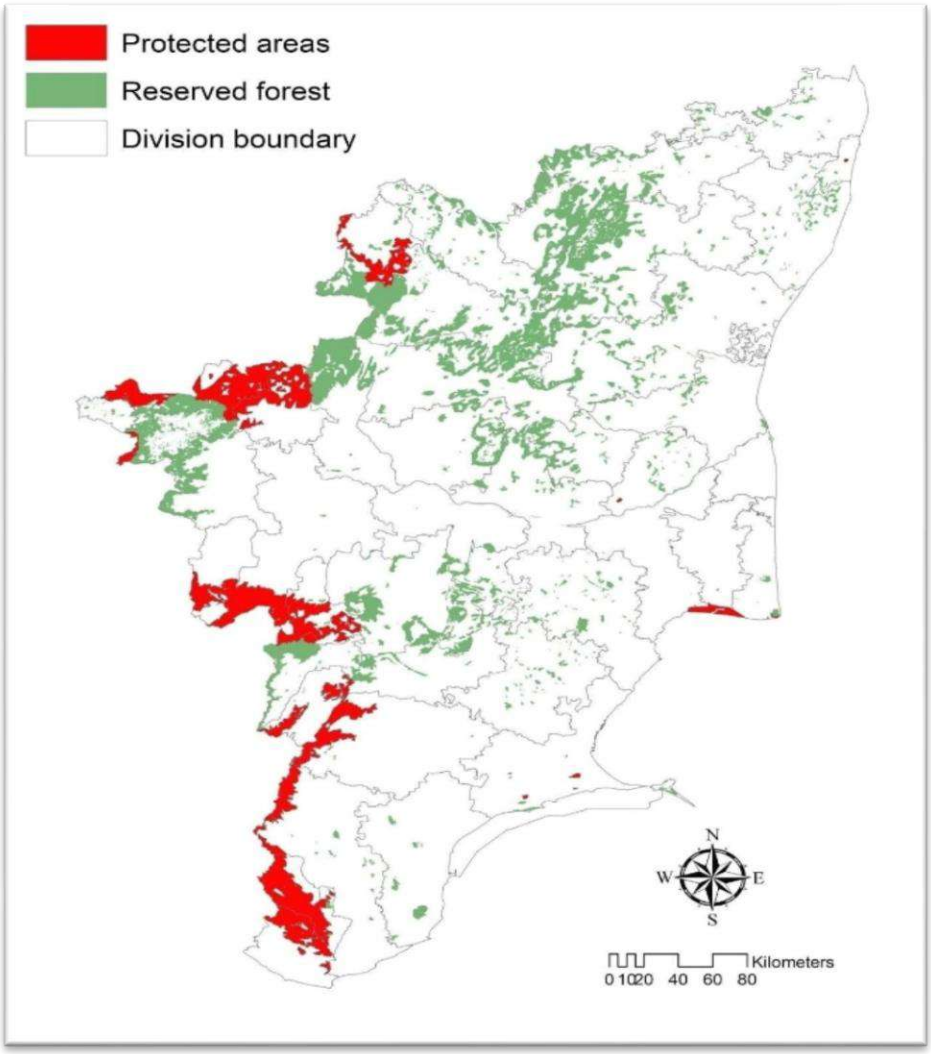
In India, several innovative mitigation models have been explored to address the challenges of human-wildlife conflicts. Community-based ecotourism initiatives have been implemented, providing local communities with economic incentives to protect wildlife and their habitats (Kalra *et al.,* 2023). Non-lethal approaches like bio-fencing, employing plants that deter wildlife, and the use of chili pepper repellents have been examined to mitigate conflicts with herbivores. Conservation incentive agreements have also emerged, compensating communities for tolerating wildlife presence and encouraging coexistence. These models offer valuable insights that could be adapted and tailored to the unique context of Tamil Nadu's human-wildlife conflicts.

Lessons learned from these global experiences can offer valuable insights into devising effective strategies for Tamil Nadu.

# Objective

- To assess the mitigation measures in specific Human-Wildlife Conflict globally and identify the best practices for trial and adoption in Tamil Nadu.

## Study area




The state of Tamil Nadu has 26,419 sq. km. of forest coverage, which constitutes around 20% of the whole geographical area. The state is home to many different types of forests, such as Tropical wet evergreen, Tropical semi-evergreen, Tropical moist deciduous, Littoral and swamp, Tropical dry deciduous, Tropical thorn, Tropical dry evergreen, Sub-Tropical Broad-leaved hill, and Montane wet temperate forests. Since the forest coverage is high, so is the number of protected areas (7,072.95 sq. km.), including 5 National parks, 15 Wildlife sanctuaries, 15 bird sanctuaries, and 2 conservation reserves, besides 5 Tiger reserves, viz. Anamalai, Kalakkad - Mundanthurai, Mudumalai, Sathyamangalam, and SrivilliputturMegamalai. Studies have been conducted in and around these protected areas, and found that Human conflicts are mostly common in the fringe areas or intersecting areas of protected areas and human settlements. There has been a steep increase in the number of studies being conducted in Tamil Nadu by both State and central government institutes

# Methodology

Our study encompassed extensive field surveys across several forest divisions in Tamil Nadu, focusing on areas characterized by heightened HWC. To comprehensively evaluate the situation, we designed a structured questionnaire that encompassed elements such as the species involved, the employed mitigation measures, and their corresponding effectiveness. Employing a scoring system categorized as non-efficient (0), moderately efficient (01), and highly efficient (02), we assessed the efficacy of the applied mitigation strategies. Interviews were conducted with forest officials and local villagers to gather on-ground perspectives and insights.

In parallel, we conducted on-site assessments of various implemented mitigation measures, visiting locations where these strategies were put in place. This enabled a first-hand evaluation of their practical application and outcomes. Furthermore, we conducted a systematic review encompassing various search engines available on the Google platform. This review aimed to collect a comprehensive array of literature encompassing both national and international mitigation measures relevant to the species under scrutiny.

By assimilating and comparing the compiled measures with the existing models implemented within Tamil Nadu, we aimed to identify gaps and potential areas of improvement. Drawing from the collective data, we sought to propose alternative models that could be explored through a trial-and-error approach to effectively address human-wildlife conflicts. Our comprehensive approach, combining field data, expert interviews, site assessments, and global research, forms the basis for suggesting refined mitigation strategies conducive to the unique context of Tamil Nadu.

**Table 1.** Data collection table format for evaluating mitigation measures.

| Division | Range | Species | Mitigation measures | Efficiency score | Remarks |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

# Results and Discussion

**Table 2.** The cumulative frequency of efficiency scores of mitigation measures evaluated

| Mitigation measures | Non-efficient | Moderately efficient | Highly efficient |
|---|---|---|---|
| APWs/ RRTs/ ADS | | 11 | |
| Awareness | | 19 | |
| Bio repellent | 2 | | |
| Capturing | | 3 | |
| Chasing | | 7 | 6 |
| Cloth fencing | | | 7 |
| Double layered fencing (EPT, Hanging Solar fence) | | | 1 |
| Early warning system | | 2 | |
| EPT | 11 | | |
| Fencing | 3 | | |
| Habitat restoration | | | 1 |
| Hanging solar fencing | | | 7 |
| Monitoring elephants' movement in railway track | | | 1 |
| Monitoring/ Patrolling | | 5 | 12 |
| Solar fencing | | 11 | |
| Sound system (deterrent) | | 1 | |
| Strengthened livestock enclosure | | | 1 |
| Watch camps | | | 1 |
| Watchdog | | 2 | |
| WhatsApp group | | | 12 |

(eg.: Number 11 under moderately efficient column means APWs/ RRTs/ ADS was found to be moderately efficient 11 times)

**Table 3.** The efficiency score of APWs/ RRTs/ ADS measure species and site specific manner

| Range | Species | Mitigation measures | Efficiency score (0,1,2) |
|---|---|---|---|
| Ovalley | Elephant | APWs/ RRTs/ ADS | 1 |
| Manamboly | Leopard | APWs/ RRTs/ ADS | 1 |
| Pandalur | Leopards | APWs/ RRTs/ ADS | 1 |
| Cherambadi | Tiger | APWs/ RRTs/ ADS | 1 |
| Naduvattam | Tiger | APWs/ RRTs/ ADS | 1 |
| Kodaikanal | Elephant | APWs/ RRTs/ ADS | 1 |
| Poombarai | Elephant | APWs/ RRTs/ ADS | 1 |
| Andipatty | Sloth bear | APWs/ RRTs/ ADS | 1 |
| Chinnamanur | Elephant | APWs/ RRTs/ ADS | 1 |
| Gudalur | Elephant | APWs/ RRTs/ ADS | 1 |
| Papanasam | Leopard | APWs/ RRTs/ ADS | 1 |

(APW – Anti Poaching Watcher; RRT – Rapid Response Team; ADS – Anti Depredation Squad)

The table above illustrates a mitigation measure that exhibits moderate efficiency across various species and visited ranges. Interestingly, this measure's moderate efficiency holds true regardless of diverse locations and species, which can be attributed to a few underlying limitations that warrant improvement. Notably, the personnel operating at the ground level are employed under minimal wages and lack adequate benefits from their employers. Moreover, instances of fatalities caused by wildlife underscore the pressing need for the provision of life insurance. The effectiveness of these personnel is hampered by a lack of logistical support, hindering their ability to carry out their duties with optimal efficiency. Additionally, the promotion of Anti-Poaching Watchers (APWs) after several years of service coupled with delayed vacancy filling perpetuates a staffing gap at the grassroots level. To enhance the overall effectiveness of this measure, we propose the implementation of improved remuneration packages and comprehensive benefits for ground level staff. Equipping them with targeted training to adeptly address conflict situations is essential. Addressing logistical shortcomings, such as providing vehicles and fuel allowances, is imperative for achieving positive outcomes.

**Awareness**

**Table 4.** The efficiency score of Awareness measure species and site specific manner.

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Boluvampatti | Leopard | Awareness | 1 |
| Madukkarai | Leopard | Awareness | 1 |
| Kotagiri | Tiger | Awareness | 1 |
| Kattabatu | Leopard | Awareness | 1 |
| Singara | Tiger | Awareness | 1 |
| Manamboly | Sloth bear | Awareness | 1 |
| Pandalur | Leopards | Awareness | 1 |
| Cherambadi | Leopard | Awareness | 1 |
| Cherambadi | Tiger | Awareness | 1 |
| Naduvattam | Leopard | Awareness | 1 |
| Naduvattam | Tiger | Awareness | 1 |
| Sirumalai | Gaur | Awareness | 1 |
| Perumpallam | Gaur | Awareness | 1 |
| Perumpallam | Wild pig | Awareness | 1 |
| Andipatty | Sloth bear | Awareness | 1 |
| Chinnamanur | Elephant | Awareness | 1 |
| Ambasamudram | Leopard | Awareness | 1 |
| Ambasamudram | Wild pig | Awareness | 1 |
| Papanasam | Leopard | Awareness | 1 |

The provided table indicates a predominant implementation of the awareness approach to address carnivore conflicts. This strategy has consistently garnered moderately efficient scores across various visited ranges and species. It's worth noting that awareness is a multifaceted endeavour constituting a wide spectrum of actions, all of which collectively contribute to impactful outcomes. To enhance the effectiveness of awareness initiatives, it's recommended to base them on well-researched facts about animal behaviors and movements. This ensures that the public is informed with accurate information. Furthermore, expanding the scope of awareness beyond local communities to involve multiple stakeholders like panchayats, agricultural departments, hospitals, and police departments is essential. These stakeholders should be educated about the factors related to HWC and how their contributions can contribute to its mitigation. Developing well-structured awareness models is also crucial, as people often lack clarity on the specific type of awareness required. In conclusion, bolstering awareness efforts by incorporating research-based insights and

engaging diverse stakeholders through effective models can substantially enhance the overall impact of these measures'

**Bio repellent**

**Table 5. The efficiency score of Bio repellent measure species and site specific manner**.

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Kannivadi | Wild pig | Bio repellent | 0 |
| Kadayam | Wild pig | Bio repellent | 0 |

The presented table highlights that the utilisation of bio repellents has demonstrated non-efficiency due to several factors. This measure lacks longevity and cost-effectiveness, primarily attributed to its reliance on oil and certain less-preferred plants as repellents. The use of oil as a repellent is economically prohibitive, and its efficacy diminishes during the rainy season as it gets washed away. Conversely, the cultivation and maintenance of repellent plants pose challenges across diverse terrains, rendering this approach inefficient for conflict management. This holds particularly true for situations involving wild pig conflicts.

**Capturing**

**Table 6. The efficiency score of capturing as a mitigation measure, species and site specific manner**

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Kotagiri | Sloth bear | Capturing | 1 |
| Thalawadi | Elephant | Capturing | 1 |
| Kadayam | Sloth bear | Capturing | 1 |

Capturing as a mitigation measure has received moderate efficient scores throughout the ranges and species (Table 6). Managing problem animals through capture is a complex procedure requiring a multifaceted approach. Initially, accurate identification of the troublesome individual is essential, followed by the coordination of a skilled team including professionals and veterinarians to execute the capture process. Nonetheless, this approach exhibits moderate effectiveness across diverse ranges and species due to certain inherent limitations. Research underscores that while capturing and relocating problematic animals can alleviate conflicts to a certain extent at specific sites, it often escalates conflicts in new locations. To enhance the efficacy of capture and relocation, it is advocated to undertake

these actions after comprehensively evaluating the animal's behavior and health condition, while also selecting relocation sites with minimized conflict potential.

In the context of Sloth bears, forest officials have encountered situations where capture cages unintentionally attract bear cubs, leading to challenging encounters with protective mother bears. Moreover, instances of unintended captures of different species have been noted. To address these issues, it is recommended to conduct supervised captures, particularly in such cases, and ensure comprehensive readiness to manage adverse scenarios. To optimize this process, it is crucial to approach the capture of problem animals with thorough understanding and preparedness. This entails not only addressing the immediate concerns but also anticipating potential complications and developing strategies to mitigate them effectively.

**Chasing**

**Table 7.** The efficiency score of chasing as a mitigation measure, species- and site-specific manner.

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Kotagiri | Sloth bear | Chasing | 1 |
| Kattabatu | Leopard | Chasing | 2 |
| Kattabatu | Tiger | Chasing | 2 |
| Ovalley | Elephant | Chasing | 1 |
| Conoor | Gaur | Chasing | 1 |
| Manamboly | Elephant | Chasing | 1 |
| Jeeraghally | Elephant | Chasing | 2 |
| Pandalur | Elephant | Chasing | 1 |
| Cherambadi | Wild dog | Chasing | 2 |
| Kodaikanal | Elephant | Chasing | 1 |
| Thalawadi | Elephant | Chasing | 1 |
| Kodaikanal | Gaur | Chasing | 2 |
| Kadayam | Sloth bear | Chasing | 2 |

The data presented in the table showcases the efficiency of chasing as a mitigation measure in specific ranges and for different species. Notably, chasing has been found to be effective in Kattabetu, Jeeraghally, Cherambadi, Kodaikanal, and Kadayam ranges for dealing with conflicts involving leopard, tiger, elephant, wild dog, gaur, and sloth bear, respectively. However, an exception is observed in the Kotagiri range; where chasing has shown only moderate efficiency for sloth bears, which do not respond well to this approach. Forest

officials attribute this to the bears' behavior, which renders chasing ineffective. In Kotagiri range, the ineffectiveness of chasing is tied to a distinct issue. A significant waste dump in the area attracts bears, transforming them into residents. To address this, a strategic recommendation is to focus on efficient waste management, which could alleviate bear conflicts by eliminating the attractant.

The Manamboly, Pandalur, Kodaikanal, Thalawadi and Ovalley ranges face challenges due to their rugged high-altitude terrains. Chasing elephants here has proven moderately effective; however, the challenging terrain has led to incidents of elephants falling or causing damage. In case of Thalawadi range we found a problem elephant tusker named Kurappan whose behaviour towards the chasing techniques were found to be counterproductive as he was charging towards the light and sound direction. To improve effectiveness, these ranges require additional manpower and specialized vehicles for monitoring and patrolling. Careful consideration should be given to the use of chasing as a mitigation measure in these terrains to prevent unintended harm or property loss. Conversely, the Conoor range employs chasing for gaur mitigation, yielding moderate effectiveness. Forest officials note that direct engagement with gaurs during chasing can lead to conflicts and risks. To enhance this approach, suggestions include employing scare tactics involving sound or controlled fire, minimizing direct interaction between humans and gaurs.

In conclusion, while chasing shows promise as a mitigation measure, its efficiency varies based on species, behavior, and terrain. Tailoring the approach to specific contexts, incorporating alternative tactics, and addressing underlying attractants can collectively bolster the effectiveness of chasing in mitigating human-wildlife conflicts.

**Cloth Fencing**

**Table 8.** The efficiency score of cloth fencing as a mitigation measure, species and site specific manner

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Kattabatu | Wild pig | Cloth fencing | 2 |
| Kattabatu | Gaur | Cloth fencing | 2 |
| Udumalpet | Wild pig | Cloth fencing | 2 |
| Jeeraghally | Wild pig | Cloth fencing | 2 |
| Vathalakundu | Gaur | Cloth fencing | 2 |
| Kodaikanal | Gaur | Cloth fencing | 2 |
| Poombarai | Gaur | Cloth fencing | 2 |

The provided table illustrates the effectiveness score of cloth fencing as a mitigation strategy. It is evident that this approach has consistently proven to be efficient across the visited ranges for mitigating conflicts involving both wild pigs and gaurs. The deployment of shiny cloths with bright fluorescent colours around crops serves to create a perception of threat for these animals. Consequently, these animals are deterred from encroaching, as their horns and snouts become entangled in the cloths, preventing their intrusion. We propose implementing the model across the species specific conflict areas.

**Double layered fencing**

**Table 9.** The efficiency score of double layered fencing as a mitigation measure, species- and site-specific manner.

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Thalawadi | Elephant | Double layered fencing (EPT, Hanging Solar fence) | 2 |

In the Thalawadi range, a noteworthy approach has been employed to mitigate human-elephant conflicts (HEC) through the implementation of double-layered fencing. This strategy has demonstrated its efficacy in safeguarding croplands from elephant intrusions, providing a potential template for addressing similar challenges in other ranges. Forest officials have reported the success of this measure in preventing elephants from encroaching into agricultural areas.

The double-layered fencing system consists of two key components. The first layer incorporates Electric Power Tape (EPT), while the second layer involves the use of Hanging Solar Fencing. This dual-layered approach not only acts as a deterrent but also enhances protection against elephant interactions with cultivated lands.

Drawing from the success observed in the Thalawadi range, there is a valuable recommendation for the adoption of a similar model in regions facing comparable terrain and human-elephant conflict patterns. By tailoring the double-layered fencing approach to suit specific contexts, it becomes possible to reduce incidents of HEC in these identified areas, fostering coexistence between human communities and elephants while protecting valuable crops.

**Early warning system**

**Table 10.** The efficiency score of early warning system as a mitigation measure, species- and site-specific manner.

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Manamboly | Elephant | Early warning system | 1 |
| Cherambadi | Elephant | Early warning system | 1 |

The provided table highlights the effectiveness rating of an early warning system utilized as a mitigation measure across various visited ranges. The system has shown a moderate level of effectiveness in its current implementation. This encompasses diverse warning methods, such as message alerts and alarm systems. However, instances have arisen where individuals overlook or miss these notifications, resulting in conflicts. In light of this, there is a proposal to enhance the early warning system to ensure more effective communication of elephant movement information.

**Elephant Proof Trench (EPT)**

**Table 11.** The efficiency score of Elephant proof trenches as a mitigation measure, species- and site-specific manner.

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Boluvampatti | Elephant | EPT | 0 |
| Perianaickenpalayam | Elephant | EPT | 0 |
| Sirumugai | Elephant | EPT | 0 |
| Bitherkadu | Elephant | EPT | 0 |
| Jeeraghally | Elephant | EPT | 0 |
| Oddanchatram | Elephant | EPT | 0 |
| Vathalakundu | Elephant | EPT | 0 |
| Kodaikanal | Elephant | EPT | 0 |
| Poombarai | Elephant | EPT | 0 |
| Uthamapalayam | Elephant | EPT | 0 |
| Kadayam | Elephant | EPT | 0 |

The provided table outlines the efficiency scores of EPT as a mitigation strategy. It becomes evident that EPTs have exhibited inefficiency across the surveyed areas. This inefficiency primarily stems from inadequate maintenance, compounded by associated costs. The existing maintenance funding, allocated on a per kilometre basis, proves insufficient for the comprehensive up keeping of the entire EPT network. Additionally, the efficacy of EPTs is compromised as elephants tend to disrupt them by

moving soil into the trenches in their attempts to cross through, rendering this measure ineffective. Addressing this issue, we recommend a revision of the funding approach to enable regular EPT maintenance or the implementation of community involvement initiatives to facilitate timely upkeep.

**Fencing**

**Table 12.** The efficiency score of fencing as a mitigation measure, species- and site-specific manner.

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Kandamanur | Wild pig | Fencing | 0 |
| Papanasam | Elephant | Fencing | 0 |
| Kadayam | Elephant | Fencing | 0 |

The efficiency scores presented in the table pertain to the use of fencing as a mitigation strategy. During the assessment of various surveyed ranges, conventional fencing methods were observed. According to insights from forest officials, standard fences have demonstrated limited efficacy in deterring wildlife. The underlying reason lies in their non-electrified nature, rendering them ineffective in restraining animals with sufficient power to breach them. Notably, instances were documented where certain wild animals, including wild pigs, managed to surmount the relatively low-height fences set at approximately 1 meter above ground level.

**Habitat restoration**

**Table 13.** The efficiency score of habitat restoration as a mitigation measure, species- and site-specific manner.

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Thalawadi | Tiger | Habitat restoration | 2 |

As indicated by the provided table, habitat restoration emerges as a mitigation strategy that addresses the fundamental causes of HWC, resulting in a notably high level of efficiency in conflict reduction. This approach has the potential to be implemented extensively across various protected areas to reduce tiger-related conflicts. Moreover, it can be explored on a trial basis within HEC zones. A recommended course of action involves enhancing habitat management and restoration, tailored to specific species, to effectively contain wildlife within

forested areas. This comprehensive strategy offers promise in mitigating conflicts while fostering coexistence between humans and wildlife.

**Hanging solar fencing**

**Table 14.** The efficiency score of hanging solar fencing as a mitigation measure, for Elephant in a site-specific manner.

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Boluvampatti | Elephant | Hanging solar fencing | 2 |
| Perianaickenpalayam | Elephant | Hanging solar fencing | 2 |
| Bitherkadu | Elephant | Hanging solar fencing | 2 |
| Jeeraghally | Elephant | Hanging solar fencing | 2 |
| Kannivadi | Elephant | Hanging solar fencing | 2 |
| Oddanchatram | Elephant | Hanging solar fencing | 2 |
| Vathalakundu | Elephant | Hanging solar fencing | 2 |

The efficiency scores depicted in the provided table pertain to the utilization of hanging solar fencing as a mitigation strategy. The data underscores the notable effectiveness of this measure in addressing HEC within the surveyed ranges. This fencing approach stands out due to its high efficiency, particularly in areas where elephants are involved. The unique attribute of providing an additional layer of electrified barrier, suspended above, poses significant challenges for elephants attempting to breach the barrier. Consequently, we recommend the widespread implementation of these hanging solar fences across ranges characterized by similar terrains. This strategic step holds the potential to substantially alleviate HEC incidents, demonstrating a promising path towards conflict reduction.

**Monitoring elephants' movement near railway tracks**

**Table 15.** The efficiency score of monitoring elephants' movement as a mitigation measure near railway tracks

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Madukkarai | Elephant | Monitoring elephants' movement in railway track | 2 |

In the Madukkarai range, a unique measure is being implemented on a trial-and-error basis to address the issue of animal fatalities resulting from railway accidents. Ensuring the safe passage of animals in this area has become a matter of utmost importance. The strategy has proven effective in understanding animal movement patterns. To enhance safety, a CCTV camera has been strategically installed along the railway track to monitor the movements of these animals. In a collaborative effort between the railway department and the forest

department, train speeds have been adjusted to approximately 45 km/h near Reserved Forests (RFs). To facilitate communication and coordination, a WhatsApp group has been established, comprising members from both departments. This group is used to relay milestone numbers located alongside the tracks, enabling the railway department to slow down trains when approaching critical areas. These combined measures have proven effective in safeguarding elephant species and other wildlife near the railway tracks in the mentioned range.

**Monitoring and Patrolling**

**Table 16.** The efficiency score of monitoring and patrolling as a mitigation measure, species- and site-specific manner.

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Sirumugai | Elephant | Monitoring/ Patrolling | 1 |
| Kattabatu | Tiger | Monitoring/ Patrolling | 2 |
| Bitherkadu | Elephant | Monitoring/ Patrolling | 1 |
| Ovalley | Elephant | Monitoring/ Patrolling | 2 |
| Thalawadi | Elephant | Monitoring/ Patrolling | 2 |
| Kannivadi | Elephant | Monitoring/ Patrolling | 1 |
| Oddanchatram | Elephant | Monitoring/ Patrolling | 2 |
| Kodaikanal | Elephant | Monitoring/ Patrolling | 2 |
| Poombarai | Elephant | Monitoring/ Patrolling | 1 |
| Uthamapalayam | Elephant | Monitoring/ Patrolling | 2 |
| Andipatty | Sloth bear | Monitoring/ Patrolling | 2 |
| Chinnamanur | Elephant | Monitoring/ Patrolling | 2 |
| Gudalur | Elephant | Monitoring/ Patrolling | 2 |
| Ambasamudram | Sloth bear | Monitoring/ Patrolling | 2 |
| Ambasamudram | Elephant | Monitoring/ Patrolling | 1 |
| Papanasam | Leopard | Monitoring/ Patrolling | 2 |
| Kadayam | Elephant | Monitoring/ Patrolling | 2 |

The provided table displays efficacy scores for the use of monitoring and patrolling as a mitigation strategy in various ranges and for different species. It is evident that this specific measure demonstrates effectiveness in certain ranges and for specific species, but it may not yield the same level of efficiency in other ranges or for particular species.

**Monitoring and Patrolling being highly effective**

**Table 17.** The efficiency score of monitoring and patrolling as a mitigation measure, species- and site-specific manner.

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Kattabatu | Tiger | Monitoring/ Patrolling | 2 |
| Ovalley | Elephant | Monitoring/ Patrolling | 2 |
| Thalawadi | Elephant | Monitoring/ Patrolling | 2 |
| Oddanchatram | Elephant | Monitoring/ Patrolling | 2 |
| Kodaikanal | Elephant | Monitoring/ Patrolling | 2 |
| Uthamapalayam | Elephant | Monitoring/ Patrolling | 2 |
| Andipatty | Sloth bear | Monitoring/ Patrolling | 2 |
| Chinnamanur | Elephant | Monitoring/ Patrolling | 2 |
| Gudalur | Elephant | Monitoring/ Patrolling | 2 |
| Ambasamudram | Sloth bear | Monitoring/ Patrolling | 2 |
| Papanasam | Leopard | Monitoring/ Patrolling | 2 |
| Kadayam | Elephant | Monitoring/ Patrolling | 2 |

The table above showcases the efficacy scores of monitoring and patrolling efforts in specific ranges, where these measures have proven to be highly effective for certain species, including Elephants, Tigers, Leopards, and Sloth bears within those ranges.

**Monitoring and Patrolling being moderately effective**

**Table 18. T**he efficiency score of monitoring and patrolling as a mitigation measure, species- and site-specific manner.

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Sirumugai | Elephant | Monitoring/ Patrolling | 1 |
| Bitherkadu | Elephant | Monitoring/ Patrolling | 1 |
| Kannivadi | Elephant | Monitoring/ Patrolling | 1 |
| Poombarai | Elephant | Monitoring/ Patrolling | 1 |
| Ambasamudram | Elephant | Monitoring/ Patrolling | 1 |

The table above highlights the efficacy scores of monitoring and patrolling activities in specific ranges, indicating moderate levels of effectiveness. Several reasons for this moderate performance have been identified, including insufficient manpower and logistical support for patrolling and enforcement, as well as issues related to awareness and communication. To address these challenges and improve the efficacy of these measures, we recommend

directing increased funding to the identified ranges. Additionally, given the relatively lower efficiency observed in the case of elephants, it is essential to conduct more in-depth, species-specific behavioural studies.

**Solar Fencing**

**Table 19.** The efficiency score of solar fencing as a mitigation measure against elephant conflict.

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Perianaickenpalayam | Elephant | Solar fencing | 1 |
| Sirumugai | Elephant | Solar fencing | 1 |
| Bitherkadu | Elephant | Solar fencing | 1 |
| Masinagudi | Elephant | Solar fencing | 1 |
| Singara | Elephant | Solar fencing | 1 |
| Udumalpet | Elephant | Solar fencing | 1 |
| Jeeraghally | Elephant | Solar fencing | 1 |
| Kannivadi | Elephant | Solar fencing | 1 |
| Oddanchatram | Elephant | Solar fencing | 1 |
| Vathalakundu | Elephant | Solar fencing | 1 |
| Uthamapalayam | Elephant | Solar fencing | 1 |

The table provided illustrates the efficacy scores of solar fencings as a mitigation measure across various visited ranges. It was observed that traditional solar fencing in these ranges demonstrated only moderate effectiveness. This was largely attributed to the tendency of elephants to attempt to breach these fences. However, it's worth noting that a more efficient alternative was found in the form of hanging solar fencing. This innovative approach has proven to be highly effective in preventing elephant incursions and is currently the preferred method in use.

**Table 20.** The efficiency score of solar fencing as a mitigation measure against elephant conflict.

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Boluvampatti | Elephant | Sound system (deterrent) | 1 |

The presented table details the effectiveness of a sound-based deterrent system employed in the mentioned range, utilizing a trial-and-error approach. This specific measure has shown moderate efficiency; however, there is a growing concern that elephants are becoming

accustomed to it and are no longer deterred by the sound. In light of this observation, we recommend exploring improved and modified deterrent methods. Additionally, a dynamic approach involving the constant modification of deterrents is advisable to prevent elephants from becoming habituated to a particular type of deterrent and to maintain their effectiveness in deterring elephant activity.

**Strengthened livestock enclosure**

**Table 21.**The efficiency score of strengthened livestock enclosure as a mitigation measure against leopard conflict in the Ambasamudram range.

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Ambasamudram | Leopard | Strengthened livestock enclosure | 2 |

The table provided highlights the effectiveness of an enhanced and fortified livestock enclosure as a successful strategy for mitigating conflicts with carnivores such as leopards. This approach has demonstrated its efficiency in safeguarding livestock and reducing conflicts. We recommend implementing this proven method in various locations where leopard-human conflicts are prevalent, as it has shown great promise in protecting livestock and minimizing potential conflicts with these carnivores.

**Watch Camps**

**Table 22.** The efficiency score of watch camps as a mitigation measure against wild pig conflict in the Kandamanur range.

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Kandamanur | Wild pig | Watch camps | 2 |

As depicted in the table above, the utilization of watch camps for monitoring and deterring wild pig activity has proven to be an effective measure within the surveyed range. Farmers stay at these watch camps to closely track wild pig movements and prevent their encroachment into crop lands.

**Watch Dog**

**Table 23. T**he efficiency score of Watch dog as a mitigation measure against leopard conflict in the visited ranges.

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Boluvampatti | Leopard | Watch dog | 1 |
| Kotagiri | Sloth bear | Watch dog | 1 |

The table above provides an overview of the efficacy scores for watch dogs as a mitigation measure employed in the visited ranges. It reveals that watch dogs, while initially considered for their potential to deter wildlife, have yielded only moderate effectiveness. This is primarily due to the dogs being vulnerable to attacks themselves. Moreover, a noteworthy concern is that some dogs reared for watch purposes have formed amicable relationships with the wild animals, rendering them ineffective in alerting humans or serving as a deterrent. In light of these observations, it is not advisable to rely on watch dogs as a mitigation strategy, and alternative approaches should be explored to enhance human awareness and safety in these areas.

**WhatsApp Group**

**Table 24.** The efficiency score of WhatsApp group as a mitigation measure against elephant conflict in the visited ranges.

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Madukkarai | Elephant | WhatsApp group | 2 |
| Kotagiri | Elephant | WhatsApp group | 2 |
| Bitherkadu | Elephant | WhatsApp group | 2 |
| Ovalley | Elephant | WhatsApp group | 2 |
| Manamboly | Elephant | WhatsApp group | 2 |
| Thalawadi | Elephant | WhatsApp group | 2 |
| Pandalur | Elephant | WhatsApp group | 2 |
| Cherambadi | Elephant | WhatsApp group | 2 |
| Kannivadi | Elephant | WhatsApp group | 2 |
| Kodaikanal | Elephant | WhatsApp group | 2 |
| Poombarai | Elephant | WhatsApp group | 2 |
| Uthamapalayam | Elephant | WhatsApp group | 2 |

The table above illustrates the effectiveness of WhatsApp groups as a valuable tool for monitoring and raising awareness about the movement of elephants. This approach has

demonstrated high efficiency in effectively communicating information regarding elephant whereabouts. One significant factor contributing to its success is the widespread availability and usage of the WhatsApp application, even among local communities. This platform allows individuals, including those who may not be literate, to send voice notes instantly, aiding forest officials in responding to elephant invasions promptly. Notably, these WhatsApp groups often encompass a range of stakeholders, such as the railways department, panchayats, and local community members. This collaboration enhances the management of conflict situations related to elephant movement, fostering better coordination and response efforts.

**SPECIES-WISE**

**Elephant: Non-efficient measures**

**Table 25.** The mitigation measures that were found to be non-efficient.

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Boluvampatti | Elephant | EPT | 0 |
| Perianaickenpalayam | Elephant | EPT | 0 |
| Sirumugai | Elephant | EPT | 0 |
| Bitherkadu | Elephant | EPT | 0 |
| Jeeraghally | Elephant | EPT | 0 |
| Oddanchatram | Elephant | EPT | 0 |
| Vathalakundu | Elephant | EPT | 0 |
| Kodaikanal | Elephant | EPT | 0 |
| Poombarai | Elephant | EPT | 0 |
| Uthamapalayam | Elephant | EPT | 0 |
| Papanasam | Elephant | Fencing | 0 |
| Kadayam | Elephant | EPT | 0 |
| Kadayam | Elephant | Fencing | 0 |

The data presented in the table indicates that attempts to manage elephant conflicts through Elephant Proof Trench (EPT) and traditional fencing have yielded unsatisfactory results within the surveyed regions. The primary cause of this inefficacy can be attributed to the inadequate maintenance of EPT systems and the insufficiency of funds allocated for their

upkeep. Furthermore, conventional fencing methods seem ill-equipped to effectively deter elephants from entering these areas.

**Elephant: Moderately efficient measures**

**Table 26.** The mitigation measures implemented against HEC, which got moderately efficient scores.

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Boluvampatti | Elephant | Sound system (deterrent) | 1 |
| Perianaickenpalayam | Elephant | Solar fencing | 1 |
| Sirumugai | Elephant | Monitoring/ Patrolling | 1 |
| Sirumugai | Elephant | Solar fencing | 1 |
| Bitherkadu | Elephant | Solar fencing | 1 |
| Bitherkadu | Elephant | Monitoring/ Patrolling | 1 |
| Ovalley | Elephant | Chasing | 1 |
| Ovalley | Elephant | APWs/ RRTs/ ADS | 1 |
| Masinagudi | Elephant | Solar fencing | 1 |
| Singara | Elephant | Solar fencing | 1 |
| Udumalpet | Elephant | Solar fencing | 1 |
| Manamboly | Elephant | Chasing | 1 |
| Manamboly | Elephant | Early warning system | 1 |
| Thalawadi | Elephant | Capturing | 1 |
| Thalawadi | Elephant | Chasing | 1 |
| Jeeraghally | Elephant | Solar fencing | 1 |
| Pandalur | Elephant | Chasing | 1 |
| Cherambadi | Elephant | Early warning system | 1 |
| Kannivadi | Elephant | Solar fencing | 1 |
| Kannivadi | Elephant | Monitoring/ Patrolling | 1 |
| Oddanchatram | Elephant | Solar fencing | 1 |
| Vathalakundu | Elephant | Solar fencing | 1 |
| Kodaikanal | Elephant | Chasing | 1 |
| Kodaikanal | Elephant | APWs/ RRTs/ ADS | 1 |
| Poombarai | Elephant | Monitoring/ Patrolling | 1 |
| Poombarai | Elephant | APWs/ RRTs/ ADS | 1 |
| Uthamapalayam | Elephant | Solar fencing | 1 |
| Chinnamanur | Elephant | APWs/ RRTs/ ADS | 1 |
| Chinnamanur | Elephant | Awareness | 1 |
| Gudalur | Elephant | APWs/ RRTs/ ADS | 1 |
| Ambasamudram | Elephant | Monitoring/ Patrolling | 1 |

The table above displays a set of mitigation measures that have achieved moderate levels of effectiveness in addressing Human-Elephant Conflict (HEC) across the surveyed regions.

Detailed discussions have been provided for each of these mitigation measures, highlighting their individual limitations, which largely stem from factors such as logistical challenges, resource constraints, and the availability of manpower. These limitations collectively contribute to the moderate efficiency observed in their implementation.

**Elephant: Highly efficient measures**

**Table 27.** The mitigation measures applied for HEC, that were found to be highly efficient .

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Boluvampatti | Elephant | Hanging solar fencing | 2 |
| Madukkarai | Elephant | Monitoring elephants' movement in railway track | 2 |
| Madukkarai | Elephant | WhatsApp group | 2 |
| Perianaickenpalayam | Elephant | Hanging solar fencing | 2 |
| Kotagiri | Elephant | WhatsApp group | 2 |
| Bitherkadu | Elephant | Hanging solar fencing | 2 |
| Bitherkadu | Elephant | WhatsApp group | 2 |
| Ovalley | Elephant | WhatsApp group | 2 |
| Ovalley | Elephant | Monitoring/ Patrolling | 2 |
| Manamboly | Elephant | WhatsApp group | 2 |
| Thalawadi | Elephant | Double layered fencing (EPT, Hanging Solar fence) | 2 |
| Thalawadi | Elephant | Monitoring/ Patrolling | 2 |
| Thalawadi | Elephant | WhatsApp group | 2 |
| Jeeraghally | Elephant | Hanging solar fencing | 2 |
| Jeeraghally | Elephant | Chasing | 2 |
| Pandalur | Elephant | WhatsApp group | 2 |
| Cherambadi | Elephant | WhatsApp group | 2 |
| Kannivadi | Elephant | WhatsApp group | 2 |
| Kannivadi | Elephant | Hanging solar fencing | 2 |
| Oddanchatram | Elephant | Monitoring/ Patrolling | 2 |
| Oddanchatram | Elephant | Hanging solar fencing | 2 |
| Vathalakundu | Elephant | Hanging solar fencing | 2 |
| Kodaikanal | Elephant | Monitoring/ Patrolling | 2 |
| Kodaikanal | Elephant | WhatsApp group | 2 |
| Poombarai | Elephant | WhatsApp group | 2 |
| Uthamapalayam | Elephant | Monitoring/ Patrolling | 2 |
| Uthamapalayam | Elephant | WhatsApp group | 2 |
| Chinnamanur | Elephant | Monitoring/ Patrolling | 2 |
| Gudalur | Elephant | Monitoring/ Patrolling | 2 |
| Kadayam | Elephant | Monitoring/ Patrolling | 2 |

The table above highlights the successful mitigation measures for Human-Elephant Conflict (HEC) encountered in various regions. These measures have proven highly effective, particularly when considering the available manpower. Notably, hanging solar fencing, WhatsApp groups, and double-layered fencing have demonstrated exceptional efficiency. We recommend the implementation of these models in comparable terrains throughout the state, with due consideration for specific nuances and requirements in each area.

**Wild Pig**

**Table 28.** The mitigation measures applied for HWPC and their efficacy.

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Kattabatu | wild pig | Cloth fencing | 2 |
| Udumalpet | wild pig | Cloth fencing | 2 |
| Jeeraghally | wild pig | Cloth fencing | 2 |
| Kannivadi | wild pig | Bio repellent | 0 |
| Perumpallam | wild pig | Awareness | 1 |
| Kandamanur | wild pig | Fencing | 0 |
| Kandamanur | wild pig | Watch camps | 2 |
| Ambasamudram | wild pig | Awareness | 1 |
| Kadayam | wild pig | Bio repellent | 0 |

The information from the table suggests that certain measures like bio repellent and regular fencing were deemed inefficient due to feasibility constraints. Conversely, awareness campaigns were found to have moderate effectiveness but still possess potential for enhancement. Cloth fencing and watch camps, according to the survey, were rated as highly effective strategies.

**Guar**

The table above provides an overview of the mitigation measures implemented in the visited regions and their effectiveness. According to the survey results, chasing in certain range and awareness campaigns have shown moderate effectiveness, while cloth fencing and chasing in particular range have proven highly effective

**Table: 27.** The mitigation measures applied for HGC and their efficacy.

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Kattabatu | Gaur | Cloth fencing | 2 |
| Conoor | Gaur | Chasing | 1 |
| Vathalakundu | Gaur | Cloth fencing | 2 |
| Sirumalai | Gaur | Awareness | 1 |
| Kodaikanal | Gaur | Chasing | 2 |
| Kodaikanal | Gaur | Cloth fencing | 2 |
| Poombarai | Gaur | Cloth fencing | 2 |
| Perumpallam | Gaur | Awareness | 1 |

Notably, the effectiveness of chasing varies between Coonoor and Kodaikanal, with Coonoor facing challenges due to animals charging back, potentially due to a shortage of manpower. To make more informed and efficient improvements, it is essential to gather additional on-the-ground knowledge and insights.

**Leopard**

**Table 29.** The mitigation measures applied for HLC and their efficacy across the visited ranges

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Boluvampatti | Leopard | Watch dog | 1 |
| Boluvampatti | Leopard | Awareness | 1 |
| Madukkarai | Leopard | Awareness | 1 |
| Kattabatu | Leopard | Chasing | 2 |
| Kattabatu | Leopard | Awareness | 1 |
| Manamboly | Leopard | APWs/ RRTs/ ADS | 1 |
| Pandalur | Leopard | APWs/ RRTs/ ADS | 1 |
| Pandalur | Leopard | Awareness | 1 |
| Cherambadi | Leopard | Awareness | 1 |
| Naduvattam | Leopard | Awareness | 1 |
| Ambasamudram | Leopard | Awareness | 1 |
| Ambasamudram | Leopard | Strengthened livestock enclosure | 2 |
| Papanasam | Leopard | Awareness | 1 |
| Papanasam | Leopard | APWs/ RRTs/ ADS | 1 |
| Papanasam | Leopard | Monitoring/ Patrolling | 2 |

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The provided table presents the effectiveness of various mitigation measures employed against Human-Leopard Conflict (HLC) in the state. According to the survey findings, chasing, strengthening livestock enclosures, and monitoring leopard movement have proven to be effective strategies. Additionally, measures such as APWs, RRTs, ADS, and awareness campaigns have shown moderate effectiveness, with potential for enhancements that could further improve their effectiveness.

**Tiger**

**Table 30.** The mitigation measures applied for HTC and their efficacy across the visited ranges.

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Kotagiri | Tiger | Awareness | 1 |
| Kattabatu | Tiger | Chasing | 2 |
| Kattabatu | Tiger | Monitoring/ Patrolling | 2 |
| Singara | Tiger | Awareness | 1 |
| Thalawadi | Tiger | Habitat restoration | 2 |
| Cherambadi | Tiger | Awareness | 1 |
| Cherambadi | Tiger | APWs/ RRTs/ ADS | 1 |
| Naduvattam | Tiger | Awareness | 1 |
| Naduvattam | Tiger | APWs/ RRTs/ ADS | 1 |

The provided table outlines the range of mitigation measures applied to address Tiger conflicts in the surveyed areas. The data suggests that Awareness campaigns and the use of APWs, RRTs, and ADS have achieved a moderate level of effectiveness. Conversely, Chasing, Habitat Restoration, and Monitoring Patrolling have proven highly effective according to the feedback from officials.

**Sloth bear**

**Table 31.** Mitigation measures applied for HSBC and their efficacy across the visited ranges

| Range | Species | Mitigation measures | Efficiency score |
|---|---|---|---|
| Kotagiri | Sloth bear | Capturing | 1 |
| Kotagiri | Sloth bear | Chasing | 1 |
| Kotagiri | Sloth bear | Watch dog | 1 |
| Manamboly | Sloth bear | Awareness | 1 |

| | | | |
|---|---|---|---|
| Andipatty | Sloth bear | APWs/ RRTs/ ADS | 1 |
| Andipatty | Sloth bear | Monitoring/ Patrolling | 2 |
| Andipatty | Sloth bear | Awareness | 1 |
| Ambasamudram | Sloth bear | Monitoring/ Patrolling | 2 |
| Kadayam | Sloth bear | Capturing | 1 |
| Kadayam | Sloth bear | Chasing | 2 |

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The table presented above illustrates the various mitigation measures implemented to address Human Sloth Bear Conflict (HSBC) across the state. It's apparent from the table that Monitoring and Patrolling, as well as Chasing, have been highly effective measures. In contrast, Capturing and Relocating, as well as Awareness campaigns and the use of Watch Dogs, have demonstrated only moderate effectiveness, and we have discussed the specific challenges associated with these measures separately.

**Overall**

**Highly efficient mitigation measures**

**Table 32.** Mitigation measures that got highly efficient scores for the species-specific manner across the ranges.

| Mitigation Measures | Elephant | Gaur | Leopard | Sloth bear | Tiger | Wild pig |
|---|---|---|---|---|---|---|
| Chasing | 1 | 1 | 1 | 1 | 1 | |
| Cloth fencing | | 4 | | | | 3 |
| Double layered fencing (EPT, Hanging Solar fence) | 1 | | | | | |
| Habitat restoration | | | | | 1 | |
| Hanging solar fencing | 7 | | | | | |
| Monitoring elephants' movement in railway track | 1 | | | | | |
| Monitoring/ Patrolling | 8 | | 1 | 2 | 1 | |
| Strengthened livestock enclosure | | | 1 | | | |
| Watch camps | | | | | | 1 |
| WhatsApp group | 12 | | | | | |

The table provides a comprehensive overview of mitigation measures that have proven to be highly effective in addressing conflicts with specific species. It is evident from the table that for mitigating elephant conflicts, measures such as utilizing WhatsApp groups to communicate elephant movement, implementing double-layered fencing, conducting monitoring and patrolling, and deploying hanging solar fencing have demonstrated effectiveness. However, there is still some room for improvement in optimizing these strategies. Likewise, cloth fencing has shown effectiveness in managing conflicts with gaurs and wild pigs, while chasing and monitoring patrolling have proven effective for carnivores and sloth bears.

**Moderately efficient mitigation measures**

**Table 33. M**itigation measures that got moderately efficient scores for the species-specific manner across the ranges.

| Mitigation Measures | Elephant | Gaur | Leopard | Sloth bear | Tiger | Wild Pig |
|---|---|---|---|---|---|---|
| APWs/ RRTs/ ADS | 5 | | 3 | 1 | 2 | |
| Awareness | 1 | 2 | 8 | 2 | 4 | 2 |
| Capturing | 1 | | | 2 | | |
| Chasing | 5 | 1 | | 1 | | |
| Early warning system | 2 | | | | | |
| Monitoring/ Patrolling | 5 | | | | | |
| Solar fencing | 11 | | | | | |
| Sound system (deterrent) | 1 | | | | | |
| Watchdog | | | 1 | 1 | | |

As indicated by the table, several measures have shown moderate effectiveness, and there is room for enhancing their efficiency. Specifically, measures like monitoring patrolling, chasing, and the use of APWs and RRTs for addressing HEC could be significantly improved with adequate manpower and logistics support. Similarly, when dealing with conflicts involving other animals, raising awareness could be enhanced through a deeper understanding of their behaviour, movement patterns, and attack strategies. Moreover, the process of capturing and relocating sloth bears could benefit from a more nuanced and well-executed approach to ensure its effectiveness.

**Non-efficient mitigation measures**

**Table 34. M**itigation measures that were found to be non-efficient for the species-specific manner across the ranges.

| Mitigation Measures | Elephant | Wild pig |
|---|---|---|
| Bio repellent | | 2 |
| EPT | 10 | |
| Fencing | 1 | 1 |

The table highlights the inefficiencies observed in certain mitigation measures, particularly concerning elephants and wild pigs. In the case of Electric Perimeter Fencing (EPTs), their ineffectiveness was primarily attributed to inadequate maintenance. Normal fencing, conversely, was found to be ineffective for both elephants and wild pigs. Furthermore, bio repellents, specifically oils, were not effective when used for mitigating conflicts involving HWPC.

# Conclusion

**Elephant Proof Trench (EPT):**

- Issue: Ineffectiveness primarily due to inadequate maintenance.
- Recommendation: Allocate sufficient funding for regular EPT maintenance.

**Normal Fencing:**

- Issue: Ineffective for both elephants and wild pigs.
- Recommendation: Explore more robust fencing solutions tailored to each species' behaviour.

**Bio Repellents (Oils):**

- Issue: Ineffective for Human-Wild Pig Conflict (HWPC) mitigation.
- Recommendation: Investigate alternative bio repellent solutions or deterrence methods.

**Chasing:**

- Effectiveness: Varied based on species, behavior, and terrain.
- Recommendation: Tailor chasing approaches to specific contexts, incorporate alternative tactics, and address underlying attractants to improve effectiveness.

**Monitoring and Patrolling:**

- Effectiveness: Effective for certain species in specific ranges.
- Recommendation: Increase funding, provide logistical support, and conduct species-specific behavioral studies to enhance effectiveness.

**Cloth Fencing:**

- Effectiveness: Highly efficient for wild pigs and gaurs.
- Recommendation: Implement cloth fencing models in species-specific conflict areas.

**Double Layered Fencing:**

- Effectiveness: Proven effective in certain ranges for elephant conflict mitigation.
- Recommendation: Implement this model in areas with similar terrain and human-elephant conflict patterns.

**Early Warning Systems:**

- Issue: Moderate effectiveness, sometimes notifications are missed.
- Recommendation: Enhance the early warning system to improve communication and response.

**Sound-Based Deterrents:**

- Issue: Elephants becoming habituated to the sound.
- Recommendation: Explore and modify deterrent methods to maintain effectiveness.

**Enhanced Livestock Enclosures:**

- Effectiveness: Highly effective for mitigating leopard conflicts.

- Recommendation: Implement this method in regions with prevalent leopard-human conflicts.

**Watch Camps and Watch Dogs:**

- Effectiveness: Moderately effective for monitoring wild pig activity.
- Recommendation: Explore alternative approaches for enhancing awareness and safety in areas with watch dogs.

**WhatsApp Groups:**

- Effectiveness: Highly efficient for monitoring elephant movements.
- Recommendation: Encourage wider use of WhatsApp groups, including diverse stakeholders.

**Habitat Restoration:**

- Effectiveness: Highly efficient in reducing tiger-related conflicts.
- Recommendation: Implement habitat restoration tailored to specific species in protected areas.

**Hanging Solar Fencing:**

- Effectiveness: Highly efficient, especially for elephant conflict mitigation.
- Recommendation: Widespread implementation in similar terrains to alleviate human-elephant conflicts.

**Trial-and-Error Approaches:**

- Example: CCTV cameras near railways to monitor elephant movements.
- Recommendation: Continuously evaluate and adapt trial approaches to improve conflict management.

**Capture and Relocation:**

- Issue: Potential conflicts in new locations after relocation.

- Recommendation: Evaluate animal behaviour and health before capture and select relocation sites carefully.

This compiled analysis summarises the key mitigation measures, their effectiveness, associated challenges, and recommendations for improvement discussed in the provided information.

**Best Practices for Adoption**

Several key principles can guide the selection and implementation of effective HWC mitigation measures in Tamil Nadu. Firstly, community involvement and local knowledge must be integrated into the decision-making process. Local communities often possess valuable insights about wildlife behavior and the most pressing conflicts. Secondly, a multidisciplinary approach is essential, involving collaboration between government agencies, conservation organizations, researchers, and local communities. This approach ensures that mitigation measures are well-informed and comprehensive.

Additionally, technology can play a pivotal role in mitigating conflicts. Advances in drone technology, remote sensing, and data analytics can help monitor wildlife movements and behaviour patterns, enabling timely interventions. The development of advanced early warning systems can alert communities about the presence of potentially dangerous wildlife, allowing them to take precautionary measures. Furthermore, fostering public awareness and education through campaigns, workshops, and school programs can cultivate a culture of coexistence, reducing negative perceptions of wildlife and enhancing tolerance.

**Figure 1. A**erial view of an Elephant-Proof Trench (EPT) shot using a drone.

**Figure 2.** A double-layered fencing system in Thalawady designed for elephant protection

Figure 3. Double shot crackers in Human-Elephant Conflict (HEC) mitigation efforts within the Periyanaickan palayam (PNP) rangewithin the The

Figure 4. The installatio of Hanging Solar Fencing in the Boluvampaty range

Figure 5. Early warning and deterrent systems developed by farmers

**igure 6** showcases cloth fencing employed for deterring wild pigs in the Boluvampatty range.

**Figure 7** displays an unmaintained elephant-proof trench

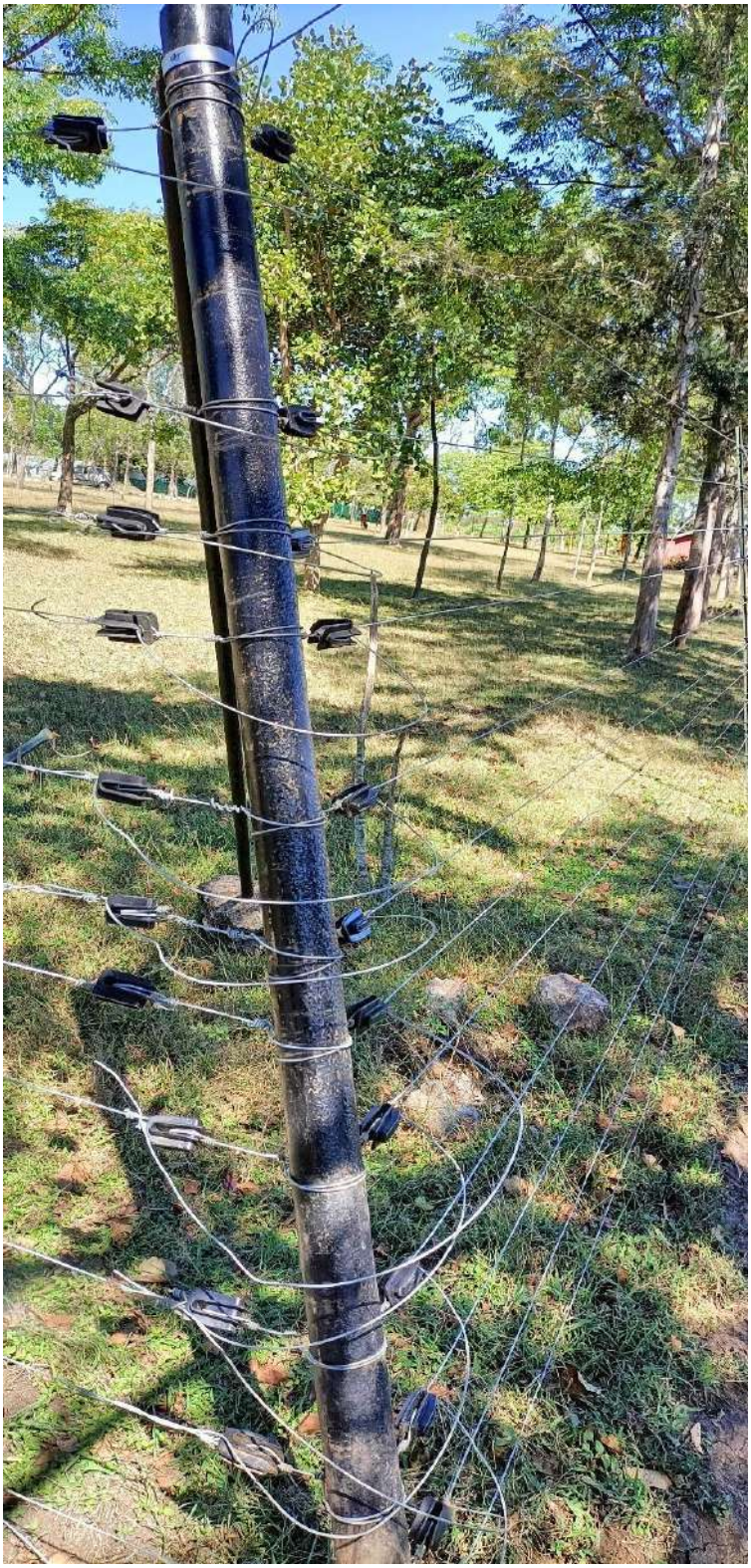

**Figure 8** presents a photograph of solar fencing implementation in the Masinagudi range

**Figure 9** displays a photograph of a tree hut being used for night-time camping and tracking of wild animals.

**Figure 10** Habitat restoration site as a mitigation measure against Human-Tiger Conflict (HTC) in the Thalawady range within the STR.

**Figure 11** Photograph of cloth fencing employed as a mitigation measure against Human-Wildlife Pig (HWPC) in crop lands

**Figure 12** Photograph of a weaker livestock enclosure

**Figure 13.** Strengthened livestock enclosure implemented to protect their livestock

**Figure 14** Photograph of bio-fencing for Human-Elephant Conflict (HEC), featuring non-preferred plants.

**Figure 15** showing the cage used for leopard capture.


**Figure 16** Project team members engaged in discussions with forest officials during a field visit


**Figure 17** Team members engaged in discussions with forest officials during a field visit

**Table summarizing implemented mitigation methods and their corresponding alternatives.**

| Current mitigation models | Animal | Alternative models | References |
|---|---|---|---|
| Cloth fencing, | Wild pig | Human scalp hair, Spraying of local pigs dung solution, Burning of dried dung cakes | Rao, V. V., Naresh, B., Reddy, V. R., Sudhakar, C., Venkateswarlu, P., & Rao, D. R. (2015). Traditional management methods used to minimize wild boar (Sus scrofa) damage in different agricultural crops at Telangana state, India. International Journal of Multidisciplinary Research and Development, 2, 32-36. |
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| Awareness, | Wild pig | Planting not preferred crops as oilseeds and sunflowers | Barwal, K. S. (2013). Ecology of wild pig (Sus scrofa) and human-wild pig conflict in and around Ranthambore Tiger Reserve, Rajasthan. Ph.D. thesis, Saurashtra University, p. 396. |
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| Trapping and Relocation | Wild pig | Electric Fencing with Alarm System | Glen, A. S., Atkinson, R., Campbell, K., Hagen, E., Holmes, N., Keitt, B., ... & Wilkinson, I. S. (2013). Eradicating multiple invasive species on inhabited islands: the next big step in island restoration?. Biological Invasions, 15(12), 2589-2603. |
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| Chasing | Elephant | Bee hives | Enukwa, E. H. (2017). Human-Elephant conflict mitigation methods: A review of effectiveness and sustainability. Journal of Wildlife and Biodiversity, 1(2), 69–78. https://doi.org/10.22120/jwb.2017.28260 |
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| WhatsApp group (TADAM) | Elephant | Agricultural based deterrents (coriander, mint etc.) | Gross, E. M., McRobb, R., & Gross, J. (2016). Cultivating alternative crops reduces crop losses due to African elephants. Journal of Pest Science, 89, 497-506. doi: 10.1007/s10340-015-0699-2 |
| Monitoring | Elephant | Translocation | Pinter-Wollman, N., Isbell, L. A., & Hart, L. A. (2009). The Relationship between Social Behaviour and Habitat Familiarity |

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| Compensation | Elephant | Rumble playbacks | King, L. E., & Douglas-Hamilton, I. (2008). African elephants: simple solutions to save them. PLoS Biology, 6(8), e203. |
| Rapid Response Team (RRT) | Elephant | Infrasound-based Deterrents | Raman, T. R. S., & Sukumar, R. (2002). Responses of elephants towards chili-and smoke-bomb repellents. Current Science, 82(5), 574-576. |
| fencing, chasing | Gaur | Corridors for gaur | Geleta, M., Jebessa, H., & Bekele, A. (2019). Human-Buffalo Conflict around Jorgo-Wato Protected Forest, Western Ethiopia. |
| Awareness | Gaur | Avoiding cultivation near the forest boundary | Geleta, M., Jebessa, H., & Bekele, A. (2019). Human-Buffalo Conflict around Jorgo-Wato Protected Forest, Western Ethiopia. |
| Awareness | Leopard | Chemical deterrents, gas exploders | Bangs, E.E., Jimenez, M.D., Niemeyer, C.C., Fontaine, J.A., Collinge, M., Krsichke, R., Handegard, L., Shivik, J.A., Sime, C.A., Nadeau, S., Mack, C.M., Smith, D.W., Asher, V.J., Stone, S.A. (2006). Non-lethal and lethal tools to manage wolf-livestock conflict in the northwestern United States. 22nd Vertebrate Pest Conference - Proceedings, January, 7–16. Retrieved from http://ddr.nal.usda.gov/handle/10113/38982. |
| monitoring | Leopard | Prey species management | Baral, K., Aryal, A., Morley, C., Kunwar, R. M., Bhandari, S., Sharma, H. P., Thapa Magar, K., Adhikari, B., &Weihong, J. (2022). Spatio–temporal pattern of human leopard conflict and mitigation strategy in Baitadi district, mid–hills of Nepal. Banko Janakari, |

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| capture | Leopard | Habitat management, Assessing the prey and predator population density | Baral, K., Aryal, A., Morley, C., Kunwar, R. M., Bhandari, S., Sharma, H. P., Thapa Magar, K., Adhikari, B., &Weihong, J. (2022). Spatio–temporal pattern of human leopard conflict and mitigation strategy in Baitadi district, mid–hills of Nepal. Banko Janakari, 32(1), 3–14. https://doi.org/10.3126/banko.v32i1.45434 |
| translocation | Leopard | Translocation has been found to be negatively impacting | Athreya, V., Odden, M., Linnell, J. D., & Karanth, K. U. (2011). Translocation as a tool for mitigating conflict with leopards in human-dominated landscapes of India. Conservation Biology, 25(1), 133-141. doi: 10.1111/j.1523-1739.2010.01599.x. |
| Compensation | Leopard | Predator proof livestock coral | Lamichhane, B. R., Persoon, G. A., Leirs, H., Poudel, S., Subedi, N., Pokheral, C. P., Bhattarai, S., Thapaliya, B. P., & de Iongh, H. H. (2018). Spatio-temporal patterns of attacks on human and economic losses from wildlife in Chitwan National Park, Nepal. PLOS ONE, 13(4), e0195373. https://doi.org/10.1371/journal.pone.0195373 |
| Hazing and Scaring | Leopard | Motion-activated Lights | Thapar, V. (2018). Saving the Last Tigers: A. Lifeline for Wildlife Photography in India. Harper Collins. |
| Human Presence Awareness | Leopard | Habitat management | Loveridge, A. J., & Macdonald, D. W. (2003). Activity patterns of servals in relation to lunar illumination and prey density. African Journal of Ecology, 41(1), 12-18. |
| Awareness | Tiger | Isolating time of activities, identifying problem individual and sharing financial benefits of tourism among locals | Bhattarai, B. R., Wright, W., Morgan, D., Cook, S., & Baral, H. S. (2019). Managing Human-Tiger Conflict: Lessons from Bardia and Chitwan National Parks, Nepal. Journal Name, Volume(Issue), Page numbers. https://doi.org/10.1007/s10344-019-1270-x |
| monitoring | Tiger | Banning livestock grazing inside parks | Gurung B, Nelson KC, Smith JLD (2009) Impact of grazing restrictions on livestock composition and husbandry |

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| Compensation | Tiger | Chemical deterrents, gas exploders | Lorand, C., Robert, A., Gastineau, A., Mihoub, J.-B., & Bessa-Gomes, C. (2022). Effectiveness of Interventions for Managing Human-Large Carnivore Conflicts Worldwide: Scare Them Off, Don't Remove Them. Science of The Total Environment, Volume 838, Part 2, 156195. |
| voice deterrents | Tiger | Habitat corridors | Lynam, A. J., Rabinowitz, A., Myint, T., Maung, M., Latt, K. T., & Po, S. (2009). Estimating abundance with sparse data: tigers in northern Myanmar. Population Ecology, 51(1), 115-121. |
| chasing | Tiger | Wildlife-friendly Livestock Practices | Athreya, V., Odden, M., Linnell, J. D., Karki, S., & Jumabay, K. (2016). Big cats in our backyards: persistence of large carnivores in a human dominated landscape in India. PLoS ONE, 11(12), e0167945. |
| translocation | Tiger | Negative | Dhungana R, Savini T, Karki JB, Dhakal M, Lamichhane BR, Bumrungsri S (2017) Living with tigers Panthera tigris: patterns, correlates, and contexts of human–tiger conflict in Chitwan National Park, Nepal. Oryx 52:1–11. https://doi.org/10.1017/S0030605316001587 |
| translocation | Tiger | Negative | Treves A, Karanth KU (2003) Human-carnivore conflict and perspectives on carnivore management worldwide. ConservBiol 17:1491–1499. https://doi.org/10.1111/j.1523-1739.2003.00059.x |
| translocation | Tiger | Negative | Harihar A, Pandav B, Goyal SP (2011) Responses of leopard Panthera pardus to the recovery of a tiger Panthera tigris population. J Appl Ecol 48:806–814. https://doi.org/10.1111/j.1365-2664.2011.01981. x |
| translocation | Tiger | Negative | Odden, M., Wegge, P., & Fredriksen, T. (2010). Do tigers displace leopards? If so, why? Ecological Research, 25, 875–881. https://doi.org/10.1007/s11284-010- |

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| monitoring | Sloth bear | Better waste management. | Rajapati, U. P., Oli, V. K. K., & Sundar, K. S. G. (2021). Vulnerable Sloth Bears Are Attracted to Human Food Waste: A Novel Situation in Mount Abu Town, India. Journal Title, Volume(Issue), Page numbers. DOI: https://doi.org/10.1017/S0030605320000216 |
| awareness | Sloth bear | Relocation | Lasgorceix, A., and Kothari, A. (2009). Displacement and Relocation of Protected Areas: A Synthesis and Analysis of Case Studies. Econ. Polit. Wkly. 44, 37–47. doi: 10.2307/25663860 |
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| sound deterrents | Sloth bear | Invasive alien species management | Debata S, Swain KK, Sahu HK, Palei HS (2017) Human–Sloth bear conflict in a human-dominated landscape of northern Odisha, India. Ursus, 27(2): 90-98 |
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## For Contact

The Principal Chief Conservator of Forests & Director,
Advanced Institute for Wildlife Conservation
(Research, Training & Education),
Tamil Nadu Forest Department, Vandalur,
Chennai – 600 048.

E-mail: aiwcrte@tn.gov.in
Website: www.aiwc.res.in