e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

A SOLAR-POWERED APPROACH TO RADIO TELEMETRY FOR PANTHERA TIGRIS HABITAT PRESERVATION

Rishit Chatterjee[*1]

[*1]Student, Department Of Science, Kalyani Public School, Kolkata, West Bengal, India.

ABSTRACT

India is losing its tiger population due to a combination of habitat loss and fragmentation caused by human encroachment, rampant poaching for illegal trade, and increasing human-tiger conflicts driven by habitat destruction. Comprehensive conservation efforts, including habitat protection, anti-poaching measures, and community involvement, are essential to curbing the decline of India's tigers. To address these challenges, we propose a solar-powered approach integrated with telemetry technologies for tiger conservation. Remote tracking and monitoring of tigers through satellite-based telemetry devices equipped with solar-powered radio collars enable researchers to gain invaluable insights into their movements, behaviour, and ecological requirements. This case study delves into various strategies employed in tiger habitat preservation, with a central focus on the innovative solar-powered collar technology. It elucidates the pivotal role telemetry plays in our understanding of tiger ecology and behaviour and how the solar-powered approach addresses persistent challenges in tiger conservation. Additionally, it explores the collaborative efforts involving researchers, governments, and local communities, underscoring the importance of a holistic approach to tiger habitat preservation. The challenges of tiger conservation persist, and this study reinforces the need for continuous advancements in technology and streamlined protocols.

Keywords: Tiger, Telemetry, Habitat, Ecosystem, Poaching, Solar.

I. INTRODUCTION

In an era marked by unprecedented environmental challenges, the preservation of critical habitats for endangered species remains a central concern for biodiversity conservationists worldwide. Among these, the tiger (Panthera tigris), an apex predator and keystone species, stands as an emblematic flagship species, reflecting the health and vitality of ecosystems it inhabits. Tigers not only captivate our imagination but also serve as sentinel species, their conservation emblematic of broader habitat protection efforts.

India is losing its tiger population due to a combination of habitat loss and fragmentation caused by human encroachment, rampant poaching for illegal trade, and increasing human-tiger conflicts driven by habitat destruction. These factors are compounded by the lack of connectivity between isolated tiger habitats, contributing to inbreeding. Climate change further exacerbates the situation by altering prey availability and ecosystems. Comprehensive conservation efforts, including habitat protection, anti-poaching measures, and community involvement, are essential to curbing the decline of India's tigers.

The urgency of tiger habitat preservation arises from the alarming decline in their numbers over the past century [1]. It is imperative to recognize the critical link between habitat loss and tiger population decline [2]. This interdependence underscores the fundamental importance of securing their habitats as a key strategy for their conservation. Scientific evidence unequivocally establishes the correlation between habitat preservation and the persistence of tiger populations. The loss of vast swaths of natural habitats, primarily due to human encroachment and habitat degradation, has led to habitat fragmentation and a sharp reduction in available prey, causing tigers to venture closer to human settlements, increasing human-tiger conflicts. These conflicts have adverse consequences for both tigers and human communities, further underscoring the urgency of habitat preservation.

In this context, telemetry technologies have emerged as indispensable tools for tiger conservation. Remote tracking and monitoring of tigers through satellite-based telemetry devices enable researchers to gain invaluable insights into their movements, behavior, and ecological requirements. This data, often collected in real-time, aids in crafting targeted conservation strategies, ensuring that the protection of tigers is informed by scientific precision. This case study will delve into various strategies employed in tiger habitat preservation, with a central focus on telemetry. It will elucidate the pivotal role telemetry plays in our understanding of tiger ecology and behavior, and how this knowledge informs effective strategies to safeguard their habitats.

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

Additionally, it will explore the collaborative efforts involving researchers, governments, and local communities, underscoring the importance of a holistic approach to tiger habitat preservation.

II. LITERATURE REVIEW

Through this literature review, we have attempted to create a collection of research results obtained by using various common tiger habitat preservation techniques.

1. Camera Traps - Singh et al.

Dispersal, a crucial aspect of population dynamics, was studied by using camera traps in the semi-arid habitats of western India from 2003 to 2010 [3]. The study focused on estimating the distances male and female tigers moved away from Ranthambhore Tiger Reserve (RTR). Camera traps were set up whenever tiger tracks were spotted in areas adjacent to protected regions where tigers had not been recently observed. Tigers were identified by matching their strip patterns in photographs with the RTR database. The research found that one female and three male tigers dispersed from RTR, covering distances ranging from 78.4 km for the female to 148.4 km for the longest dispersal by a male tiger. Male tigers began dispersing at around 24 months of age. These findings have significant implications for making conservation decisions, especially regarding landscape connectivity restoration.

2. Telemetry – Habib et al.

This article reviewed 82 studies involving 47 species across four taxonomic classes [4]. It highlighted a notable bias in the selection of study species and regions, often limited to traditional research questions. Challenging-to-access habitats like the Trans-Himalayas and northeastern India were overlooked. The research found that malfunctions in radio collars were common, with 49% failing before their expected lifespan due to various reasons, particularly early battery drainage. Different technologies and collar manufacturers were analyzed, but small sample sizes posed limitations. Argos-based collars and tags frequently had issues with recording and transmitting precise locations. The article also addresses challenges related to permissions and animal capture for tagging in India, suggesting the need for a centralized system for granting permissions and guidelines for future telemetry studies.

3. Human-Tiger Conflict Mitigation – Struebig et al.

This study combined spatial models of tiger-human encounter risk with data on human tolerance from 2386 Sumatrans to understand the factors driving human-tiger conflicts [5]. It found that the risk of encountering tigers was higher in areas near villages close to forests or rivers connecting tiger habitats. The study identified three core areas with high risk. People's tolerance for tigers was influenced by their attitudes, emotions, social norms, and spiritual beliefs. Combining these factors in socio-ecological models improved predictions of tolerance, which were 32 times better than models based solely on social factors. By using these socio-ecological predictions, it was possible to prevent up to 51% of attacks on livestock and people, saving the lives of 15 tigers. This research highlights the benefits of interdisciplinary approaches in addressing conservation conflicts.

III. METHODOLOGY

To solve the issue of battery drainage in telemetry methods, we propose a solar-powered radio collar approach for navigating tiger movements. This will help in the eventual goal of tiger habitat conservation. The solar collar design has been explained below.

1. Solar Cells:

The core of the solar panel is a series of solar cells. For the wildlife telemetry collar, high-efficiency monocrystalline or polycrystalline silicon solar cells are typically used. These cells are known for their reliability and efficiency in converting sunlight into electrical energy. The choice between monocrystalline and polycrystalline cells depends on factors like cost, available space, and desired efficiency.

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

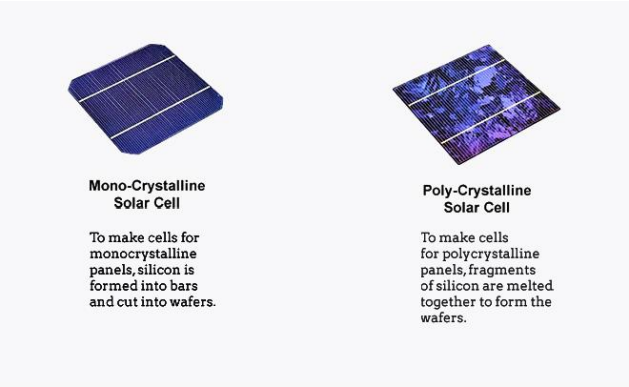

Figure 1: Mono- and poly-crystalline solar cells

2. Encapsulation Material:

The solar cells are encapsulated in a protective material to ensure durability and longevity. Ethylene vinyl acetate (EVA) is commonly used for this purpose, as it offers excellent UV resistance and protection against environmental factors. It also helps in binding the cells together.

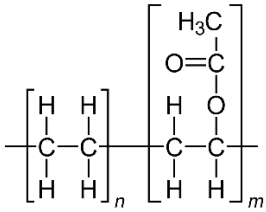

Figure 2: Ethylene vinyl acetate chemical structure

3. Front Glass:

A tempered glass sheet is placed on the front of the solar panel to protect the cells and maintain their efficiency. This glass is specially designed to be both durable and transparent to allow maximum sunlight to reach the solar cells. It also provides protection against dust, moisture, and physical damage.

4. Back Sheet:

The back sheet is typically made of a durable and weather-resistant material like Tedlar. It acts as a barrier to protect the cells from moisture and the environment while also offering electrical insulation.

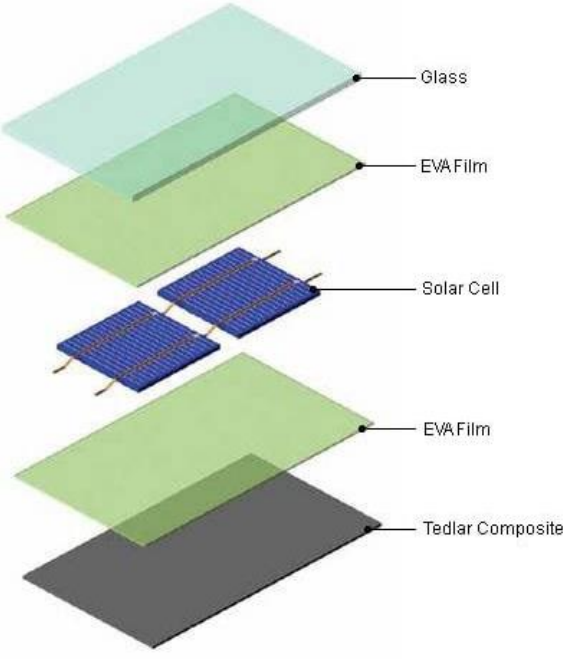

Figure 3: A representation of the proposed solar-powered collar

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

V. KUNO NATIONAL PARK – A CASE STUDY

Kuno National Park, nestled in the heart of India, has been a focal point in the nation's tireless efforts to conserve and restore the dwindling population of tigers. With a vision to reintroduce tigers into their historical range, this sanctuary embarked on a journey enriched by the successful application of telemetry technology. This case study delves into the achievements of this conservation initiative, underlining the invaluable role of telemetry in understanding tiger behavior. Nevertheless, it is essential to illuminate the persistent challenges that have threatened the realization of this ambitious project.

The application of telemetry in Kuno National Park has yielded profound insights into the life of its resident tigers. By equipping selected individuals with radio collars and GPS-based telemetry devices, researchers have unveiled intricate patterns of tiger behavior, including home range sizes, migration routes, and habitat preferences. This knowledge has proven instrumental in making informed conservation decisions, guiding the protection of core tiger habitats within the park, and promoting the overall well-being of the population. As such, telemetry stands as a cornerstone in the success story of Kuno National Park's tiger habitat preservation efforts, offering hope for a brighter future for this endangered species.

Amidst these achievements, a myriad of challenges persistently hinder the realization of the Kuno National Park project's full potential. Human-tiger conflicts, driven by coexistence with local communities, and instances of livestock predation continue to pose a threat. Moreover, habitat degradation, a consequence of factors like livestock grazing and illegal logging, demands continuous vigilance to protect and rehabilitate critical tiger habitats. The intricate process of introducing tigers from other reserves, central to the project's goals, faces logistical and ecological challenges, further complicating the journey. The constant specter of poaching remains a formidable adversary, necessitating the establishment of rigorous anti-poaching measures.

Kuno National Park's tiger habitat preservation initiative, buoyed by the triumphs of telemetry, represents an emblematic example of dedication to the conservation of this iconic species. Nevertheless, the journey is not without its formidable challenges. It underscores the enduring significance of interdisciplinary efforts, community engagement, and unwavering anti-poaching vigilance. The successful restoration of tigers in their historical range stands as an ecological imperative and a testament to human perseverance in protecting these magnificent creatures and their ecosystems. As the Kuno National Park project continues its mission, it reminds us of the formidable battles yet to be won in the name of tiger conservation.

Amidst these achievements, the deployment of telemetry in Kuno National Park has offered remarkable insights into the lives of its resident tigers. By equipping select individuals with radio collars and GPS-based telemetry devices, researchers unveiled intricate patterns of tiger behavior, including home range sizes, migration routes, and habitat preferences. However, it's important to note that this invaluable technology isn't without its challenges. Some tigers were lost due to the untimely demise of their radio collar batteries. These losses serve as a poignant reminder of the ongoing obstacles facing the Kuno National Park project. While telemetry has been a cornerstone in understanding and conserving the tiger population, ensuring the uninterrupted functionality of these collars is a critical concern, one of many that underscores the complexities of tiger conservation in this remarkable sanctuary.

VI. RESULTS AND DISCUSSION

In this study, we have explored various common tiger habitat preservation techniques, each shedding light on different aspects of tiger conservation. The use of camera traps, as exemplified by Singh et al., has provided essential insights into the dispersal patterns of tigers in semi-arid habitats. The study supported that some male and female tigers from Ranthambhore Tiger Reserve dispersed over considerable distances, impacting our understanding of landscape connectivity and conservation decisions.

Human-tiger conflict mitigation strategies, represented by Struebig et al., showed that understanding the risk of encountering tigers and the factors influencing human tolerance are crucial for successful coexistence. The use of socio-ecological models was effective in preventing conflicts, emphasizing the significance of interdisciplinary approaches in conservation.

Telemetry, as evidenced by Habib et al., has been employed in a multitude of studies covering diverse species. However, the review also brought to the fore certain challenges, including high failure rates of radio collars,

technical limitations of different technologies, and issues related to permissions and animal tagging. Thus, there is a need for continuous advancements in telemetry methodologies and streamlined protocols. The solar-powered approach proposed has potential to make remarkable strides in this context.

VII. CONCLUSION

Kuno National Park has emerged as a symbol of tireless efforts in tiger conservation, aiming to reintroduce these iconic creatures into their historical range. The successful application of telemetry technology has enriched our understanding of tiger behavior, shaping conservation decisions. However, this triumph is met with persistent challenges, from human-tiger conflicts and habitat degradation to the complexities of reintroduction and poaching threats.

The case of Kuno National Park underlines the enduring significance of interdisciplinary conservation efforts, community engagement, and unwavering anti-poaching measures. While telemetry technology has contributed significantly to the success story of this initiative, it also emphasizes the necessity for continual advancements in technology and the establishment of streamlined guidelines to ensure the continued preservation of these magnificent creatures and their ecosystems. As Kuno National Park's journey continues, it reminds us of the formidable battles yet to be won in the name of tiger conservation, an ecological imperative and a testament to human perseverance in protecting these endangered species.

ACKNOWLEDGEMENTS

I would like to thank my family who helped in the completion of this project. Without their invaluable support, this would not have been possible.

VIII. REFERENCES

[1] J. Walston et al., “Bringing the tiger back from the brink-the six percent solution,” PLoS Biol., vol. 8, no. 9, p. e1000485, Sep. 2010, doi: 10.1371/journal.pbio.1000485.

[2] A. R. Joshi et al., “Tracking changes and preventing loss in critical tiger habitat,” Sci. Adv., vol. 2, no. 4, p. e1501675, Apr. 2016, doi: 10.1126/sciadv.1501675.

[3] R. Singh, Q. Qureshi, K. Sankar, P. R. Krausman, and S. P. Goyal, “Use of camera traps to determine dispersal of tigers in semi-arid landscape, western India,” J. Arid Environ., vol. 98, pp. 105–108, Nov. 2013, doi: 10.1016/j.jaridenv.2013.08.005.

[4] B. Habib, S. Shrotriya, K. Sivakumar, P. R. Sinha, and V. B. Mathur, “Three decades of wildlife radio telemetry in India: a review,” Anim. Biotelemetry, vol. 2, no. 1, p. 4, 2014, doi: 10.1186/2050-3385-2-4.

[5] M. J. Struebig et al., “Addressing human-tiger conflict using socio-ecological information on tolerance and risk,” Nat. Commun., vol. 9, no. 1, p. 3455, Aug. 2018, doi: 10.1038/s41467-018-05983-y.