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***Research Article***

# Naturalistic habitat enrichment and reproductive success of captive Bengal Tigers (*Panthera tigris tigris*) at North Bengal Wild Animals Park (Bengal Safari), Siliguri, India

**Sudeb Sarkar[1]*, Nick Doley[1], Vijayakumar E[1], Abhishek Chowdhury[1], Ishita Chongder[2] and Indrani Das[3]**

[1]*North Bengal Wild Animals Park (Bengal Safari), Siliguri-734008, West Bengal, India.*
[2]*West Bengal Zoo Authority, Kolkata-700106, India.*
[3]*Seth Anandram Jaipuria College, Kolkata-700005, India.*

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## ABSTRACT

Survival and continued existence of any species depend on some crucial factors especially effective survival strategy, rich genetic diversity, healthy gene pool and reproductive success. The reproductive performance of polygamous apex predators like Bengal tigers in wild demands specific requirements which include ecological demands of vast area for territorial activities and corridors as this solitary carnivore migrates long distances to establish undisturbed territory and to find suitable mate for courtship. Captive tigers due to confinement do not exhibit natural behavior including reproductive behaviours which are well connected with stress factors, physiological and psychological factors. In North Bengal Wild Animals Park healthy breeding stocks with preferred and compatible partners were provided with nature identical environment minimizing psychological distress and other kind of stresses. Genetic management was properly executed following studbook analysis to prevent genetic erosion. Environmental enrichment by providing natural habitat like semi-wild condition resulted successful courtship and natural reproductive behaviours were observed. Our results revealed a link between semi-wild habitat and a series ofreproductive achievements including successful courtship, mating with high fertility rate, healthy offspring production and encouraging rate of cub survival. Obtained results also provide important reproductive information and novel insights on scientific management and conservation strategy for self-sustaining population in captivity and in wild as well.

**Keywords**: Conservation, Bengal tiger, naturalistic environment, semi-wild, genetic diversity, stress management

## INTRODUCTION

The tiger *Panthera tigris tigris*, a top predator species in their natural habitat, requires extensive areas to support viable populations (Jhala et al. 2021). They migrate long distances to establish territories, and immigration across the landscape of adjacent suitable habitat most likely played a vital role in population recovery (Sunquist et al. 1999). Tiger landscapes cover a wide variety of biomes and habitat types which indicates great adaptability of the species. Just over the 100 years global tiger populations have plummeted drastically making them increasingly vulnerable to extinction. This majestic carnivore is listed as 'Endangered' on IUCN Red list of Threatened Species. Habitat loss and fragmentation, human-tiger conflicts, poaching and depletion of prey base are the most obvious threats to the tigers in wild (Ramakrishnan et al. 1999, Nowell & Jackson, 1996) and the focus of most conservation interventions. Ex-situ breeding programs using managed captive reserve populations and effective Species Survival Plans (SSPs) which aim to form healthy, self-sustaining, genetically diverse populations of species in human care may be helpful to conserve threatened species (Hampson & Schwitzer, 2016). Several biological and management-related factors are associated with reproductive success in captive felids including tigers (Mellen, 1991; Traylor-Holzer, 1999, 2010; Saunders et al. 2014). IUCN has given thrust on genetic diversity and habitat in ex-situ conservation programme of a threatened species (IUCN 2002, 2014). A scientific management schedule and long-term commitment are required in any ex-situ conservation project and few challenging situations and hurdles usually appear during execution of captive and conservation breeding programme. Firstly, captive animals due to artificial surroundings or set ups and confinement do not express typical sexual behaviours including regular courtship and mating behaviours, thus reducing breeding opportunity. Secondly in absence of proper genetic management, breeding in a small population encourages inbreeding depression and loss of genetic variability. Thirdly captivity and or human influences, naturalistic behaviours of mothers are not expressed and as a result sometimes cubs show minimal or no sign of maternal care. Mothers in wild educate cubs the basics of survival strategy including hunting and defending techniques. She also teaches her cubs how to stalk and outwit prey. Her training on handling of potential danger helps them to acquire natural skill to adapt well in wild and natural habitat in an effective way. For conservation breeding programme all these issues are kept in mind while planning and execution schedules are to be framed. The information on reproductive behaviour and factors which influence reproductive success appear to be one of the most crucial components for conservation management of endangered and threatened species. Animals in captivity may not exhibit natural behaviour and breeding

*Corresponding Author's E-mail: sarkarsudeb0@gmail.com

patterns as those in the wild. Several factors like age, general and reproductive health, habitat condition, seasonality, availability of adequate quality food and veterinary care, nature of breeding enclosures, social dynamics, psychological and stress issues have great impact on reproductive behavior of animals under captivity.

When captive breeding of tiger is concerned varying degree of success has been reported across different parts of the world. At Rotterdam Zoo in Netherlands, a Bengal Tigress named Suleikha was observed to have raised 26 cubs born between 1941 to 1958 (Van Bemmel, 1968). A study conducted at Bahawalpur Zoo of Punjab, Pakistan from 2003 to 2014, also reported a high mortality rate of tiger cubs in captive environments (Ali et al., 2017). Similarly, at Nandankanan Zoological Park, Bhubaneswar, Odisha, an analysis of records from 1964 to 2015 found that a high percentage of tiger cub mortality was linked to inbreeding (Mishra et al., 2017).On the other hand, because of secretive nature of big cats and lack of visual observations in wild, little is known about their reproductive behaviour (Owen et al 2010). Present study provides some significant inputs and information on reproductive characteristics which are important for both *in-situ* and *ex-situ* tiger conservation efforts.

## MATERIALS AND METHOD

***Study area:***

The study site, North Bengal Wild Animals Park (N 26° 43' 56.28", E 88° 24' 27.792"), Siliguri which is situated in Sub-Himalayan West Bengal state of eastern India occupies an area of 299.495 hectares and is cradled between the Baikunthapur Forest Division and Mahananda Wildlife Sanctuary. According to the classification of biogeographic regions of India (Rodgers & Panwar, 1988) this area belongs to province 7B (Lower Gangetic Plain). Shyamjhora and Singhijhoram, two rivuletsenter the park from Mahananda Wildlife Sanctuary through the northern boundary of the park. The park has mixed deciduous forest and is dominated by Sal (*Shorea robusta*), Sidha (*Sida cordifolia)*, Jarul (*Lagerstroemia speciosa*), Chiloune (*Chima wallichii*), Sirish (*Albizia lebbeck*), Katush (*Castanopsis hystrix*), and Odal (*Sterculia colorata*). Environmental enrichment is crucial factor which may increase reproductive success of captive animals (Carlstead and Shepherdson, 1986). Natural habitat and semi-wild condition serve as environmental enrichment factor which aimed to tackle stereotypic behaviour through minimizing stress and uplifting positive emotional states of captive tigers. In most zoos around the world, captive tigers are kept in relatively small confined cages. However, at the North Bengal wild Animals Park, animals that are usually kept in cages are regularly released into a spacious 20 hectare safari area that consists of natural forest. Enclosures and night shelters were well-planned and scientifically designed with proper microenvironment and macro environment ensuring wellbeing of the animals .

**Breeding stock:**

The founder stock of the park includes tigress Sheela and two male tigers namely Viban which was brought from Nandankanan Zoological Park, Odisha and Tata Steel Zoological Park, Jamshedpur respectively and Snehasis who was brought from Alipore Zoo, Kolkata. The tigers planned for breeding were adults as classified by Sadhu et al., 2017. Sheela and Snehasis's first litter includes Rika and Kika. The details of the tigers are illustrated in the table below (Table 1). Breeding couples were not genetically linked in any way and were selected based on compatibility, overall good health, and fitness. Under a comprehensive scientific management plan, adequate nutrition and veterinary care was ensured to all animals. Tigresses with prior experience with greater breeding success were given priority for the next breeding programs.

**Table 1**. Details of tigers studied at North Bengal Wild Animals Park.

| Sl. No | Name | Sex | Transponder | Stud Book | Date of Birth | Brought From |
|---|---|---|---|---|---|---|
| 01 | Viban | Male | 00075FB71D | 1744:JAM 8 | 27.01.2014 | Tata Steel Zoological Park, Jamshedpur |
| 02 | Sheela | Female | 00771696B | 1819ZZW16 00158 | 27.08.2014 | Nandankanan Zoological Park, Odisha |
| 03 | Snehasis | Male | 0007716E04 | 1842 | 28.07.2014 | Alipore Zoological Park, Kolkata |
| 04 | Kika | Female | 0007717003 | - | 11.05.2018 | Zoo Born |
| 05 | Rika | Female | 000770A9B1 | - | 11.05.2018 | Zoo Born |

***Breeding session:***

No specific breeding season was selected. Behaviour, health and oestruses or heat periods of tigresses were monitored. During oestrous tigress squirts scents from anal gland, sniffs, moans, roars in low voice, does not show interest in feeding and looks restless (Schaller, 1967; Das, 1980) and she allows mounting and copulation by the compatible male tiger. Selected male and female were kept in separate but adjoining primary enclosures and outdoor enclosures to boost social and emotional compatibility. Proximity encourages olfactory stimulation too. Under favourable and suitable condition both male and female were released in a naturalistic environment, a 20 hectare of forest area of NBWAP for courtship and mating. All the behavioral features were observed and recorded by using a standardized ethogram focused on reproductive behaviours during peak heat periods employing the scan sampling method (Altman, 1974). Behaviours such as restlessness, roaring, persistent and loud moaning (typically aimed to attract males in adjacent enclosures or night shelters), urine spraying, lifting or swing tail to one side, rubbing body against enclosure structures were observed frequently during the breeding season.

## RESULTS AND DISCCUSSION

***Courtship and mating:***

Tiger pairs were noticed to take some hours to establish mutual confidence after they were released to mate in safari area of the park. Male often made purring sound whenever female attempted to get closer to him showing signs of receptivity. Pair showed constant vocalization, lashing tail, and circling each other for the initial phase. Sheela sometime displayed little aggression towards her partner during courtship. Once mutual confidence was developed, tigress showed her interest in mating by vocalizing, pacing, rolling on her back on ground in a playful manner. Under this study courtship, mating and post mating sessions could be observed only when animals were at sighting range or trap-camera range. Most of the time pair did not get back to the night shelters on the day mating started. Female usually found to return on second or third day while male used to take one or two more days. Several copulation or mating sessions were noticed and the gap between consecutive two sessions varied (Fig 1 and Table 2).

**Table.2** Breeding record of Bengal Tiger in NBWAP during study period (May 2018- June 2024).

| Breeding Pair | Duration of heat period | Period of mating | Range of Mating Session per day | Average mating session per day | Average no. of copulation in one mating session | Average interval between two consecutive mating period (minutes) | Date of Birth | Gestation period |
|---|---|---|---|---|---|---|---|---|
| Snehasis & Sheela | 4 to 5 days | 30.01.2018 to 01.02.2018 | 11 to 12 | 11.5 | 45 | 35 | 11.05.2018 | 101 days |
| Viban & Sheela | 4 to 5 days | 02.05.2020 to 08.05.2020 | 9 to 12 | 10.5 | 52 | 40 | 12.08.2020 | 102 days |
| Viban & Sheela | 4 to 5 days | 27.11.2021 to 03.12.2022 | 11 to 14 | 12.5 | 55 | 44 | 10.03.2022 | 103 days |
| Viban & Kika | 3 to 4 days | 27.03.2023 to 28.03.2023 | 10 to 14 | 12 | 57 | 35 | 12.07.2023 | 107 days |
| Viban & Rika | 3 to 5 days | 06.05.2023 to 07.05.2023 | 11 to 13 | 11.5 | 53 | 48 | 19.08.2023 | 105 days |
| Viban & Sheela | 4 to 5 days | 25.11.2023 to 01.12.2023 | 10 to 11 | 10.5 | 49 | 38 | 06.03.2024 | 102 days |

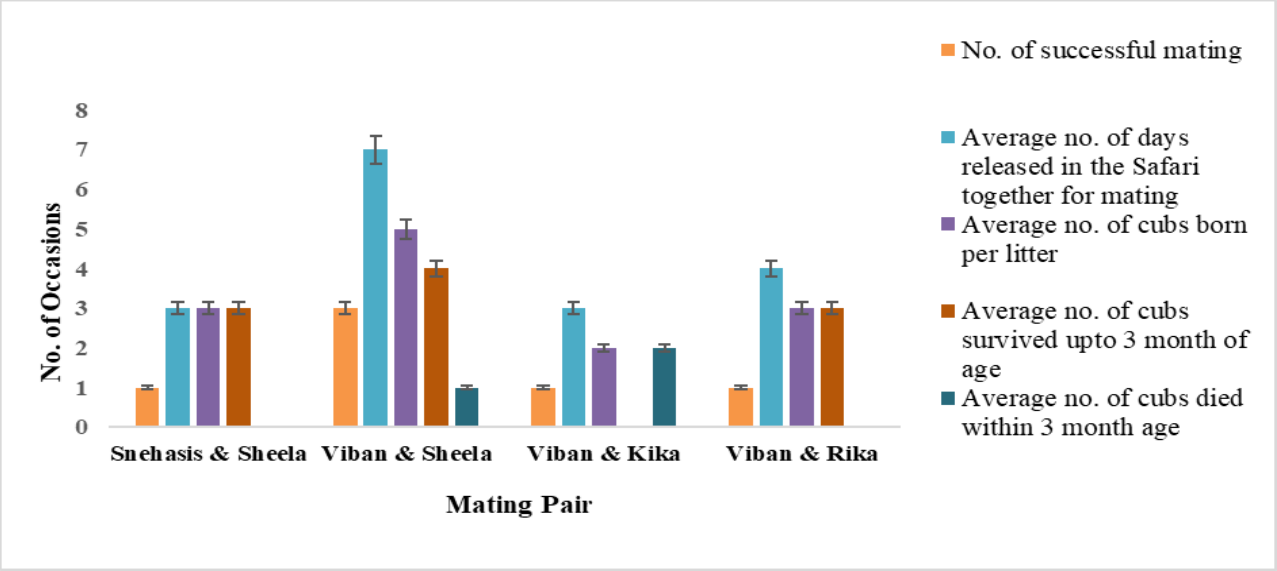


**Figure 1.** Reproductive success of breeding females in North Bengal Wild Animals Park (Bengal Safari) from May 2018 to June 2024.

**Litter size and cub survival:**

Gestation period usually restricted in between 101 days and 107 days and the litter size varied between 2-5. The survival rate for tiger cubs during the first three months was recorded as 85.71%. The chance of survival increases significantly, with three-month-old tiger cubs having a survival rate as high as 91.67% until they reach six months of age . By the time they reach six months of age, their survival is very high and reaches 100% by one year, suggesting they have passed the most vulnerable stages of their early development. A survival rate of up to 85% before 1 year of age and 79 % between 12-24 months has been recorded in tigers from Ranthambore Tiger Reserve (Singh et al., 2014). Similarly, in Chitwan National Park Nepal, survival rates of 66% during the first year and 83% during the second year were reported by Smith and Mcdougal (1991). Tidiere et al., 2021 compiled data from International Tiger Studbooks and found that tigers displayed mean mortality rate of 36.7% in the first year after birth, which decreased to 4.7% in adulthood. While factors like food availability, predators, and competition do not significantly affect breeding success in captive environments, factors like senescence in females, litter size, parental care and inbreeding have been shown to impact the survival rate of tiger cubs (Saunders et al., 2014). The effect of inbreeding on mortality in captive tigers was also studied in five zoos of Sweden, from 2002 to 2012. Studbook data indicated high mortality of tiger cubs within the first six moth of life (Morein, 2014).

## CONCLUSION

The stress-free environment and well-designed breeding strategy yielded positive outcomes which are evident from our present study. An open area mimicking natural habitat seemed to ensure privacy, security and comfort reducing stress level. From their behavioral cues it was evident that naturalistic environments contributed positive effects too on emotional and psychological states which in turn influenced courtship and mating behaviour. Successful mating is a crucial step in breeding program as it influences copulation, fertilization, and successive pregnancy. This study shows that naturalistic habitats enhance and improved social interactions and courtship behaviours followed by successful mating events. These findings are consistent with the previous research outcomes. For instance, appropriate environmental enrichment allows tigers to display naturalistic behvaiours like foraging, territorial marking, and mating (Narayan et al 2017). Similarly, a case study from Moscow Zoo involving a Bengal white tiger demonstrated that environmental enrichment reduced stress level and improved overall health, thereby increasing the chances of successful reproduction (Podturkin & Papaeva 2020). Encouraging rate of pregnancy and tiger birth supports the importance of natural environment in reproductive success which ultimately contributes to conservation of this elusive species. Regarding cub survival issue, our data indicates that tiger cubs experience a period of increased vulnerability in their first three months, with a notable survival rate of 85.71%. As they grow older, especially between three to six months, their chances of survival improve markedly. By six months of age, their survival becomes assured, and they continue to thrive with a 100% survival rate until they reach one year old. This progression highlights the critical early stages of tiger cub development and their increasing resilience as they mature into adulthood. The preference for natural breeding of compatible pairs and the rearing of cubs under maternal care and supervision is a significant aspect of the reproductive strategies and an important factor for reproductive success under captivity. Sincere efforts need to be directed toward appropriate husbandry and behavioral enrichment must be ensure to achieve such goal (Nowell & Jackson, 1996). Our study underscores the importance of holistic needs of tigers in captivity and demonstrates that creating a semi-wild naturalistic environment for tigers in captivity triggers the key factors involving understanding their natural instincts, behaviours and needs including physical, physiological, psychological, and ecological needs.

This effort increases the chances of successful breeding and with a well-designed and scientific Species Survival Plans (SSPs) which aim to maintain genetically diverse and demographically stable populations of threatened species in captivity, this model may be helpful to conserve threatened species too through cooperatively managed ex situ breeding programs using managed captive reserve populations. In addition to that, healthy gene pool with a genetic diversity can be used in future for reintroduction into the wild and assures long term survival of the species.

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## Statements and Declarations:

## Competing Interests/Conflict of interest:

The authors have no conflicts of interest to declare that are relevant to the content of this article.

## Financial Support/Fundings:

The authors declare that no external funding or grants were received for this study.

## Ethical Declaration:

Ethical approval was not required for this study because the zoo institution considered that the activities carried out were within usual management practices. Also no animals were harmed during the study. North Bengal Wild Animal Park (Bengal Safari) is a state government operated Zoo under the governance of the West Bengal Zoo Authority, India. The Zoo hospital makes sure that no wild animals are harmed or mistreated by rigorously adhering to the highest standards of animal care.

## Author Contributions:

**SS**: Data collection and Manuscript writing; **ND**: Assisting in data collection; **EVK**: Administrative support and supervision; **AC**: Administrative support and Manuscript editing; **IC**: Assisting in Manuscript editing; **ID:** Conceptualization of the whole work, Final writing and Editing of the Manuscript.

## REFERENCES


Ali, A., Azam, S. M., Iqbal, K. J., Mustafa, G., & Kaleem, M. (2017). Breeding and Mortality of Royal Bengal Tiger (*Panthera tigris tigris* Linnaeus 1758) at Bahawalpur Zoo, Punjab, Pakistan. Pakistan J. Zool, 49(4), 1-4

Altmann, J. (1974). Observational study of behavior: sampling methods. Behaviour, 49(3-4), 227-266.

Carlstead, K., & Shepherdson, D. (1994). Effects of environmental enrichment on reproduction. Zoo biology, 13(5), 447-458

Das, A.K., 1980. Observation on reproductive behaviour of the tiger *Panthera tigris tigris* Linn. in captivity. J. Bombay Nat Hist Soc., 77(2), 253-260.

Hampson, M.C. and Schwitzer, C., 2016. Effects of hand-rearing on reproductive success in captive large cats *Panthera tigris altaica*, *Uncia uncia*, *Acinonyx jubatus* and *Neofelis nebulosa*. PLoS One, 11(5), p.e0155992.

IUCN, S., 2002. IUCN technical guidelines on the management of ex-situ populations for conservation. Gland, Switzerland: IUCN.

IUCN, S., 2014. Guidelines on the use of ex situ management for species conservation.

Jhala, Y., Gopal, R., Mathur, V., Ghosh, P., Negi, H.S., Narain, S., Yadav, S.P., Malik, A., Garawad, R. and Qureshi, Q., 2021. Recovery of tigers in India: Critical introspection and potential lessons. People and Nature, 3(2), pp.281-293.

Mellen, J.D., 1991. Factors influencing reproductive success in small captive exotic felids (*Felis* spp.): a multiple regression analysis. Zoo biology, 10(2), pp.95-110.

Mishra, S. P., Chinmoy Mishra, C. M., Gangadhar Nayak, G. N., Priyanka Mishra, P. M., Niranjana Sahoo, N. S., & Sahu, S. K. (2017)

Nowell, K. and Jackson, P., 1996. Wild cats: status survey and conservation action plan.

Owen, C., Niemann, S. and Slotow, R., 2010. Copulatory parameters and reproductive success of wild leopards in South Africa. Journal of Mammalogy, 91(5), pp.1178-1187.

Podturkin, A. A., & Papaeva, N. (2020). Development of an environmental enrichment programme: case study of white Bengal tiger (*Panthera tigris bengalensis*) and jaguar (Panthera onca) at Moscow Zoo. Journal of Zoo and Aquarium Research, 8(2), 139-145.

Ramakrishnan, U., Coss, R.G. and Pelkey, N.W., 1999. Tiger decline caused by the reduction of large ungulate prey: evidence from a study of leopard diets in southern India. Biological conservation, 89(2), pp.113-120.

Rodgers, W.A. and Panwar, S.H. (1988) Bio geographical classification of India. New Forest, Dehra Dun, India.

Saunders, S.P., Harris, T., Traylor-Holzer, K. and Beck, K.G., 2014. Factors influencing breeding success, ovarian cyclicity, and cub survival in zoo-managed tigers (*Panthera tigris*). Animal Reproduction Science, 144(1-2), pp.38-47.

Schaller, G.B., 1967. Indian Wildlife. (Book Reviews: The Deer and the Tiger. A Study of Wildlife in India). Science, 155, p.1093.

Singh, R., Qureshi, Q., Sankar, K., Krausman, P. R., & Goyal, S. P. (2014). Reproductive characteristics of female Bengal tigers, in Ranthambhore Tiger Reserve, India. European Journal of Wildlife Research, 60, 579-587.

Smith, J. L. D., & McDougal, C. (1991). The contribution of variance in lifetime reproduction to effective population size in tigers. Conservation Biology, 5(4), 484-490.

Sunquist, M., 1999. Ecology, behaviour and resilience of the tiger and its conservation needs. Riding the tiger: tiger conservation in human dominated landscapes, pp.5-18.

Traylor-Holzer, K., 1999. Demographic and Genetic Analyses of the CAZG South China Tiger Population: Implications for Population Management. Report to the CAZG South China Tiger Conservation Coordination Committee. Minnesota Zoo, Apple Valley, MN.

Traylor-Holzer, K., 2010. The science and art of managing tigers in captivity. In Tigers of the World (pp. 283-292). William Andrew Publishing.

Van Bemmel, A. C. V. (1968). Breeding tigers *Panthera tigris* at Rotterdam Zoo. International Zoo Yearbook, 8(1), 60-63

Vaz, J., Narayan, E. J., Dileep Kumar, R., Thenmozhi, K., Thiyagesan, K., & Baskaran, N. (2017). Prevalence and determinants of stereotypic behaviours and physiological stress among tigers and leopards in Indian zoos. PloS one, 12(4), e0174711.