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Cover: Oil painting of Humpback Whale *Megaptera novaeangliae*. © R. Mahesh.



Population dynamics and habitat assessment of Indian Flapshell Turtle *Lissemys punctata vittata* (Reptilia: Testudines: Trionychidae) in Chawandiya, Rajasthan, India

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Abstract: Freshwater turtles are increasingly threatened by habitat degradation, pollution, and other human disturbances, particularly in small urban and semi-urban wetlands. In the present study, the Indian Flapshell Turtle *Lissemys punctata vittata* was monitored in Chawandiya Pond, Rajasthan, northwestern India, to understand changes in population dynamics in relation to habitat conditions and water quality. Weekly field observations using fixed transects were conducted from January 2023 to March 2025, and seasonal water-quality parameters were analysed following APHA (2017) standard methods. Observations showed a noticeable increase (~33–38 %) in turtle density during the breeding season, while a further 13–15 % rise during non-breeding periods may be linked to immigration into the pond under suitable ecological conditions. Stable hydrology, comparatively low pollution, adequate dissolved oxygen, and food availability appear to favour the persistence of the population. However, increasing anthropogenic activities and mild detergent-related pollution could become potential threats if left unmanaged. The study highlights the conservation value of semi-protected wetlands such as Chawandiya Pond and stresses the importance of continued habitat and population monitoring for freshwater turtle conservation and also proposes Chawandiya Pond as a candidate conservation site for this species.

Keywords: Anthropogenic disturbance, habitat suitability, hydrological stability, population monitoring, semi-protected wetland, softshell turtle, turtle conservation, water quality.

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Ethics statement: All research was conducted through non-invasive in situ observation, in compliance with the Wildlife Protection Act, 1972. No animals were harmed or captured during this study.

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Author contribution: MPV—conceptualization, field work, ecological analysis, data interpretation, manuscript preparation. AA—field work, data collection and analysis.

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INTRODUCTION

Freshwater wetlands are increasingly being threatened from urbanization, pollution, overexploitation, and unsustainable agricultural practices (Rao 1986; Reid et al. 2019). These pressures alter hydrology, reduce water quality, and destroy nesting and basking sites, which are critical for the survival of freshwater turtles. The disappearance of turtles from degraded wetlands and unmanaged water bodies has been documented across India and other parts of Asia (Rao et al. 2018; Singh & Rao 2019).

Turtles decline serves as a sensitive indicator of wetland health, since even moderate habitat disturbances can lead to rapid local extinctions (Moll 1983; Moll & Moll 2004). Monitoring turtle populations, therefore, provides important insights into both species-level conservation needs and broader ecosystem stability. Without regular monitoring, declines often go unnoticed across India (Krishnakumar et al. 2009; Vasava et al. 2021; Abinesh et al. 2022; Dubey et al. 2025; Mandal & Mallick 2025; Mandal et al. 2025; Sunny et al. 2025) and also bordering countries (Kashmi et al. 2025; Safi et al. 2025).

In a pond in Rajasthan, such impacts were observed in Nehru Talai, where flapshell turtles were initially recorded in 2022 but disappeared entirely by early

2023. Possible causes included pollution, poor habitat conditions, and the absence of protective measures. In contrast, Chawandiya Pond, a semi-protected wetland with partial cultural safeguarding, has continued to support turtles. The present study monitored the population dynamics of *L. p. vittata* and analyzed how ecological factors contribute to observed trends.

MATERIALS AND METHODS

Field Surveys

Population monitoring of *Lissemys punctata vittata* (Image 1) was conducted from January 2023 to March 2025. The observational method included 1–2 field visits weekly, increasing to 2–3 times per week during the breeding season (May–August). Observations were conducted during early morning and late afternoon when basking behaviour made turtles more visible. Data were collected visually using fixed transects of 100 m² (20 × 5 m) along the shore per sampling area. All observations were conducted in situ, with no direct interaction or disturbance to the turtles. Research adhered strictly to the provisions of the Indian Wildlife Protection Act, 1972.



Image 1. Indian Flapshell Turtle *Lissemys punctata vittata* basking along the shore of Chawandiya Pond, Rajasthan, India.

Water Quality Test

Monthly water samples were collected and analyzed in the laboratory (of Vidya Professional and Technical College, Paldi, Bhilwara) according to the APHA (2017) standard procedures. Parameters included: total dissolved solids (TDS), pH, dissolved oxygen (DO), biological oxygen demand (BOD), nitrate and phosphate concentrations, and general pollution indicators. Equipment used for water analysis included: Thermometer — Thermocare-ST9283B; pH meter — Metzer-METZ-202M; TDS meter — Aquasol Digital AM-P-EC; Nephelometer (Deluxe turbidity meter) — PSAW-LT-34; DO meter — Metzer-METZ-902M, BOD Incubator — D.D.R.INT and Colorimeter OPTeC Instrumentation-910 /211231019.

Study Species

The Indian Flapshell Turtle, a trionychid species distributed across the Indian subcontinent, is one of the 22 species of turtles found in India and comprises three recognized subspecies: *Lissemys punctata punctata*, *L. p. vittata*, and *L. p. andersonii* (Das 1985; Bhupathy et al. 2000; Gramentz 2011). Among these, *L. p. vittata* is known for its adaptability to a variety of freshwater environments. Owing to its 'Vulnerable' status under IUCN Red List (Rahman et al. 2021; IUCN 2025, Appendix II of CITES(CITES 2025)) and Schedule I of the Wildlife Protection Act, 1972, India (Government of India 1972), which affords it the highest level of national legal protection, *Lissemys punctata* faces significant threats due to poaching, habitat degradation, and pollution (CITES CoP17 Doc 73 2016).

Study Area

The study was carried out in Chawandiya Pond (25.331° N, 74.775° E; 375–402 m) in Bhilwara District of Rajasthan that spans nearly 48 ha. It is situated in the periphery of the Bhilwara City outskirts, just 15 km east of the city. The climatic conditions include hot and dry summers (32–37 °C), cooler winters (10–15 °C), with an overall average of 23–28 °C temperature annually and an average annual rainfall of 600–700 mm (Ground Water Department Rajasthan 2013, Sharma et al. 2021; Climate-Data.org 2023). The pond has recently been recognized as a protected area under the Rajasthan State Wetland Conservation framework (Chawandiya Wetland Gazette Notification 2021), highlighting its ecological and cultural importance. Chawandiya Pond serves as an important freshwater wetland system, supporting both permanent and migratory fauna. Its ecological profile includes varied shoreline vegetation, submerged aquatic plants, and stable hydrological conditions for most of the year (Sharma et al. 2023).

RESULTS

Initial sightings (January–April 2023) averaged 10–12 turtles per 100 m² (Figure 1). During the breeding season (mid-June to early July) numbers increased to 14–15, which continued to increase, peaking at 16–17 by August with the onset of heavy monsoon. Density stabilized after rains and plateaued until March 2024, rising again during the 2024 breeding season. After the seasonal stabilization, by June 2024, 20–22 turtles were observed per transect, reaching 23–24 from August

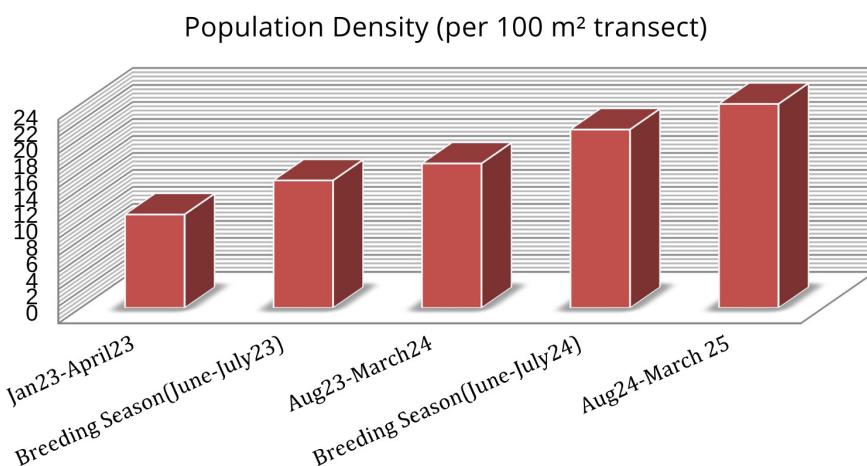


Figure 1. Breeding vs. non-breeding seasons variations in sighting frequencies of *Lissemys punctata vittata* in Chawandiya Pond, across the transects sampled during 2023–25.

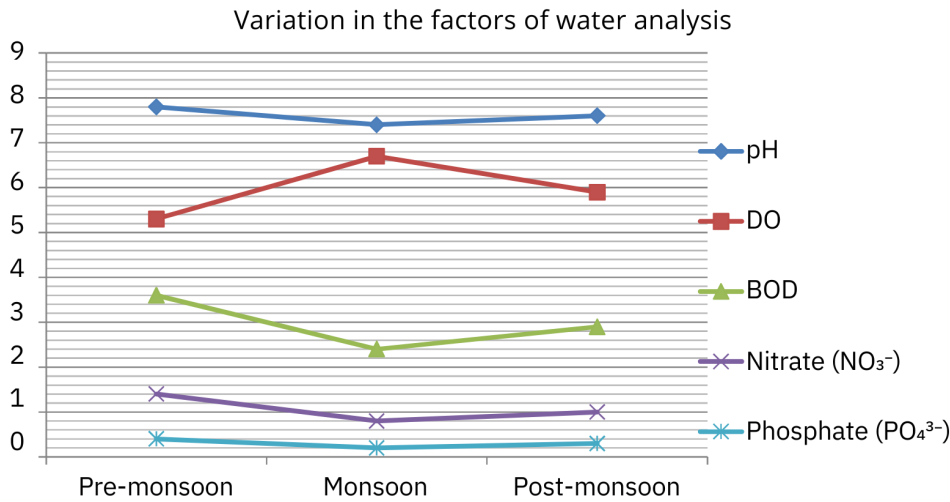


Figure 2. Seasonal break-up of chemical water quality parameters of Chawandiya Pond.

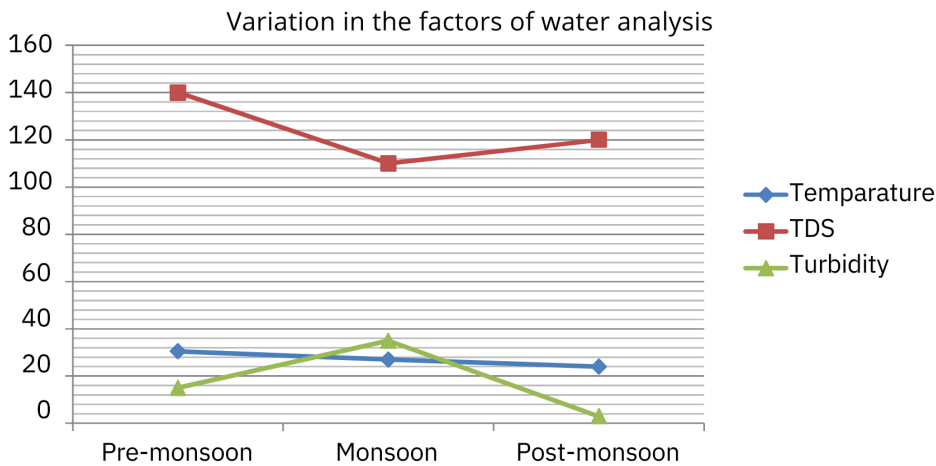


Figure 3. Seasonal break-up of physical water quality parameters of Chawandiya Pond.

2024–March 2025, i.e., there was a rise of ca. 33–38 % in the population of turtles in the breeding period. Further, there was a rise of 13–15 % after the breeding season.

From the above observations it may be inferred that, in the recent years, there has been a significant rise in the population dynamics of the Indian Flapshell Turtle in the Chawandiya Pond. Approximately a 33–38 % rise can be reported during the breeding season. In this study it was found that the mating occurs in mid to late May, nesting occurs in July–August and the hatchlings emerged in May after an incubation period of approximately 235–250 days, which is in accordance with the common behaviour. (Affunberg 1981; Gramentz 2011). Thus, the mating and hatchlings emerging season is almost the same during May. An additional slight rise of approximately 13–15 % after the breeding season is

also observed by the study.

The recent sightings (March 2025) have recorded the presence of approximately 23–24 turtles in the shore region of around 100 m². By this it can be estimated that a total of nearly 580–600 *Lissemys punctata vittata* are present in the Chawandiya Pond. By seasonal and year-round study of the wetland habitat (Figures 2, 3), it can be inferred that, Chawandiya Pond is a stagnant freshwater body providing a perennial source of water for the turtles that has favourable conditions accounting for the persistence of turtle populations and their prey base. Moreover, the less turbid water, with very mild pollution, adequate amounts of dissolved oxygen, slightly alkaline pH, and low TDS, indicates favourable habitat conditions for the freshwater fauna, especially the turtles. The good ecological conditions of the habitat

Table 1. Seasonal break-up of water quality parameters of Chawandiya Pond.

Parameter	Unit	Pre-monsoon (avg ± SD)	Monsoon (avg ± SD)	Post-monsoon (avg ± SD)
Temperature	°C	30.5 ± 0.5	27.0 ± 0.5	24.0 ± 0.5
pH	—	7.8 ± 0.2	7.4 ± 0.2	7.6 ± 0.2
TDS	mg/L	140 ± 10	110 ± 10	120 ± 10
Turbidity	NTU	15 ± 5	35 ± 5	20 ± 5
Dissolved Oxygen (DO)	ppm	5.3 ± 0.5	6.7 ± 0.5	5.9 ± 0.5
BOD	ppm	3.6 ± 0.5	2.4 ± 0.5	2.9 ± 0.5
Nitrate (NO ₃ ⁻)	mg/L	1.4 ± 0.2	0.8 ± 0.2	1.0 ± 0.2
Phosphate (PO ₄ ³⁻)	mg/L	0.4 ± 0.1	0.2 ± 0.1	0.3 ± 0.1

are the reason for the increase in the migrant population of the turtles.

Another ecological benefit of the Chawandiya Pond habitat is that since it is an eco-religious tourist spot, the tourists and devotees visiting here feed the organisms with grains and other food items, creating an abundance of food for the organisms. As the result of it, both intraspecific and interspecific competition between the organisms is reduced, and more or less there's a positive or neutral interaction between the organisms, especially for the food, making it a good freshwater ecosystem. All these ecological conditions support and push forward the rise in the population density of the *Lissemys punctata vittata* in the Chawandiya Pond. Mildly elevated phosphate concentrations during the pre-monsoon season, along with moderate BOD, indicate a mild degree of organic and detergent-based pollution, likely linked to in-pond washing and other human activities which might serve as a possible future ecological threat.

DISCUSSION

The increase in *Lissemys punctata vittata* population at Chawandiya Pond clearly shows that the wetland offers highly suitable ecological conditions. Breeding-season rises were strongly tied to the onset of monsoon rains, which is consistent with earlier reports linking rainfall with reproduction in softshell turtles (Gramentz 2011). The rise in density during the breeding months (33–38 %) is similar to observations from post-monsoon increase recorded in the Banni grasslands of Gujarat (Bhupathy et al. 2000). This parallel suggest that rainfall and associated hydrological changes are key drivers of breeding success in this species.

An additional rise of 13–15 % after the breeding

season can be accounted for the tendency of the turtle to immigrate into the pond because of improved habitat conditions. Water-quality analysis also supports this trend, with generally low pollution, sufficient dissolved oxygen, and balanced nutrient levels. At the same time, certain human activities influence habitat conditions. Feeding of aquatic fauna by visitors' increases food availability and may reduce competition, while washing activities add mild detergent loads, reflected in slightly elevated phosphate concentrations. Similar pollution-related impacts on turtle nesting and hatching have been reported from wetlands in West Bengal and Bangladesh (Hossain et al. 2020). Although concentrations at Chawandiya remain below critical thresholds, continued monitoring is essential to prevent long-term impacts.

The delayed hatching pattern (235–250 days) recorded in this study aligns with regional climatic cycles and earlier findings from other southern Asian populations (Singh & Rao 2019). Such delayed emergence likely enhances hatchling survival under uncertain pre-monsoon conditions. When compared with other regional studies, turtle density at Chawandiya Pond stands out. The observed average of 23–24 individuals per 100 m² (ecological density) was substantially higher than the 0.86 (direct count) to 1.05 (capture–mark–recapture) per 100 m² reported by Yousaf (2017) from Pakistan's Pothwar Plateau. Although methodological differences between studies should be considered, but this contrast highlights the exceptional concentration of *L. p. vittata* at Chawandiya Pond, possibly associated with hydrological stability, food availability, and partial cultural protection.

Studies from other regions demonstrate that freshwater turtle populations are highly vulnerable to a range of anthropogenic threats. Illegal exploitation and trade continue despite legal protection (Vijaya 1982; Choudhury & Bhupathy 1993; Uttara 2017), as

documented for *Lissemys punctata* in Kerala wetlands (Krishnakumar et al. 2009) and through long-term confiscation records in West Bengal (Mandal et al. 2025). Infrastructure-related mortality, such as turtle deaths along railway tracks, has also been reported in southern India (Abinesh et al. 2022). In Bangladesh's largest wetland, extensive habitat degradation, pollution, and loss of nesting sites have resulted in significant conservation challenges for *L. punctata* (Kashmi et al. 2025). At the same time, positive roles of indigenous beliefs in reducing exploitation have been reported from parts of eastern India (Mandal & Mallick 2025), supporting the importance of cultural protection, especially in sacred temple ponds. Broad regional reviews further emphasize that habitat loss, exploitation, pollution, and hydrological alterations remain the dominant threats to southern Asian trionychid turtles (Safi et al. 2025). Field-based studies also show that wetlands with stable water levels and lower disturbance support healthier populations (Sunny et al. 2025), consistent with observations from Chawandiya Pond.

Although Chawandiya Pond currently supports a growing population, increasing human pressure could pose future risks. Regular habitat and population monitoring is essential to ensure the steady growth of *L. p. vittata*, as the absence of such oversight may result in sudden and unexplained mortalities, as reported from Gujarat wetlands (Vasava et al. 2021). Controlled access during the breeding season, regulation of detergent use, and community-based awareness programs represent low-cost but effective conservation measures. Similar community-involved conservation approaches have proven successful in other Indian wetlands (Rao et al. 2018) and could be applied here. By focusing on breeding patterns, seasonal changes, water quality, and human interactions, the research aims to establish a foundation for conservation-oriented policy recommendations. Given its population status and official wetland recognition, Chawandiya Pond merits consideration as a site of local conservation importance for *Lissemys punctata vittata*.

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