SRAS Final Report

Assessment of the status of Gharials (Gavialis gangeticus) in West-Rapti River within Banke National Park

Abhishu Neupane
Kathmandu Forestry College, Kathmandu, Nepal (abhishun@gmail.com)

Abstract

This study assessed the status of captive released gharials (*Gavialis gangeticus*) in the West Rapti River within Banke National Park, Nepal, where 20 individuals were released between 2023 and 2024. Absence of systematic post release monitoring provided the need for baseline data on survival, distribution and habitat suitability. A boat-based transect survey was conducted across 55km river stretch in February 2026, recording direct sightings, indirect evidence and habitat variables. A Habitat Suitability Index was calculated for each of the 18 segments following the USFWS (1981) methodology, incorporating river depth, river width, flow velocity, water temperature, bank type and human disturbance. A direct encounter rate of 0.036 individuals per kilometer was recorded where 2 juveniles were observed. Indirect evidence was confirmed at two different places other than the segment of direct sighting. The survival rate based on direct sighting was 10%, with local interviews reporting four known mortalities. Of the 18 river segments, seven (38.9%) were classified as high suitability, six (33.33%) were recorded as moderate suitability and five (27.7%) was recorded as low suitability. All the evidence of Gharial presence records fell within high suitability segments providing preliminary support for the habitat classification. Human disturbance, particularly sand mining and gold extraction was identified as a critical limiting factor for Gharial conservation in this river system.

Introduction

The Gharial (*Gavialis gangeticus*) is the last surviving member of the family Gavialidae within the genus Gavialis that falls under the order Crocodilia (Hussain, 1991). The keystone species is considered a reliable indicator species for understanding the health of riverine ecosystems, and studying its population can create basis for sustained research programs to monitor changes in river health (Behera et al., 2014). It is listed under Appendix I of CITES and Schedule I of Nepal's National Park and Wildlife Conservation act 1973, reflecting its higher conservation priority status (DNPWC, 2018)

Before the 1940s, gharials thrived in significant numbers, estimated between 5,000 to 10,000 individuals across the major river systems of Indian subcontinents. After a 95% decline in population size, the species is found only in isolated stretches of India and Nepal mostly within the boundaries of Protected Areas (Panda et al., 2023). Artificial constructions like dams, barrages, sand mining and water abstraction have adversely affected the Gharial Population by turning suitable river habitat into marginal or unsuitable conditions affecting both quantity and quality of water available (Sharma et al., 2025). Sustained mining may destroy vital basking and nesting sites that impacts Gharial behavior (WWF, n.d.).

In Nepal, gharial populations were once distributed across multiple river systems but are now restricted to the Narayani-Rapti river systems in Chitwan National Park and Karnali-Babai rivers in Bardiya National Park (DNPWC, 2018). The Gharial Conservation project was created for captive breeding the Gharials and releasing them in the wild (Ballouard et al., 2003.; Dhami et al., 2023). Since then, a total of 1692 captive Gharials have been released into various river systems of Nepal, with the highest number of releases being in Rapti and Narayani. Ten gharials (9 female, 1 male) were released into the West Rapti River within Banke National Park during 2023, and ten (9 female, 1 male) more during 2024 (Pandey et al., 2023; WWF Nepal.,

2024). No post release systematic survey had been conducted to monitor the post release. Therefore, the primary objective of this project was to record the status of the released Gharial in West-Rapti River.

Methodology

Study Area

This study was conducted in the West Rapti River, which flows through Banke National Park, Nepal (Figure 1). The total river extends 80 km from Amiliya to Narainapur However, for this study, the boat-based transect survey and Habitat Suitability Index assessment were conducted along a 55 km stretch from Amiliya to Kachnapur, as the remaining downstream stretch beyond Kachnapur was inaccessible by boat due to extremely shallow water depth (<0.4 m), confirmed by visual reconnaissance as unsuitable Gharial habitat. The stretch from Kusum to Agaiya (30 km) acts as the boundary of buffer-zone of Banke National Park.

Secondary Data Collection

Data regarding previous Gharial releases were obtained from the archives of Banke National Park and Department of National Park and Wildlife Conservation (DNPWC) and published articles. As the record for mortality could not be obtained from the same source, an informal interview was conducted with local people residing in the vicinity of West-Rapti River.

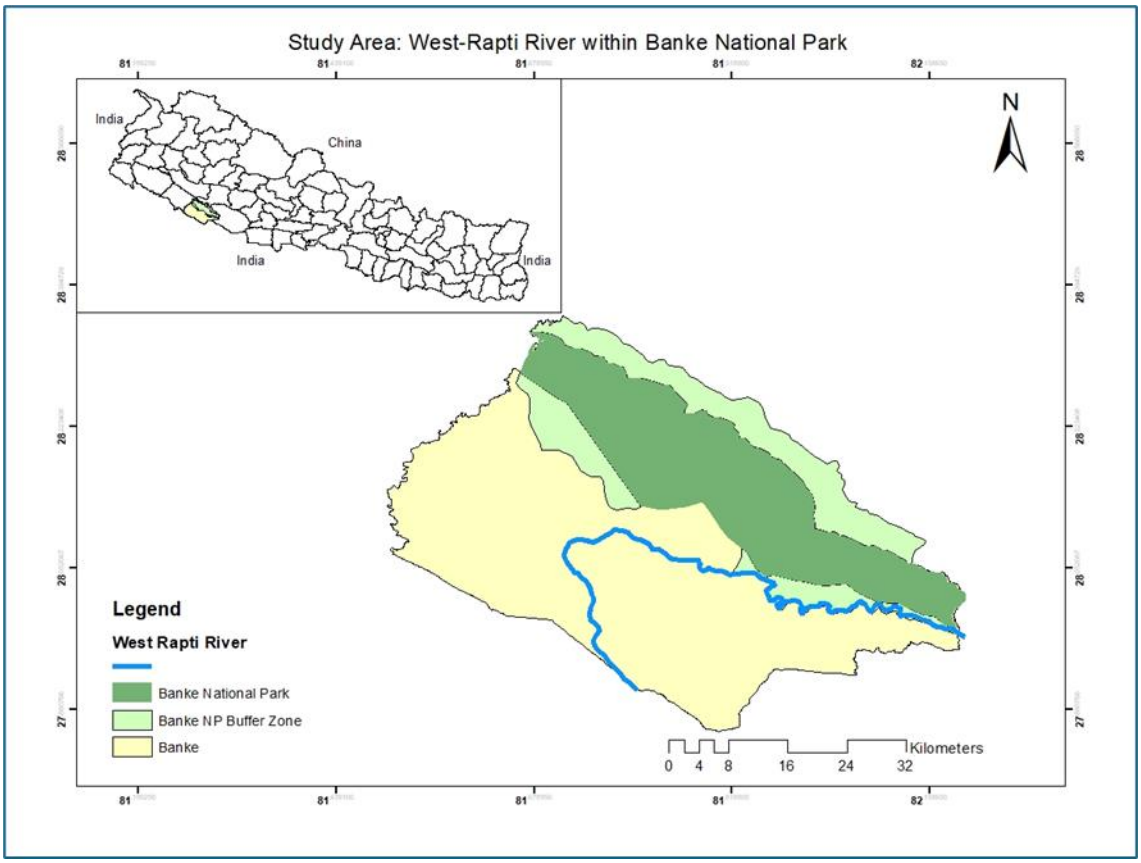


Figure 1. Map of study area showing the West Rapti River flowing through the Banke National Park in Nepal.

Population Assessment

A boat-based transect survey was conducted in February 2026 between 10 AM and 4PM moving downstream at a slow pace allowing systematic observation at both banks. GPS co-ordinates were recorded at every direct sighting as well as when any indirect sigs were noted (eg tracks). Binoculars were used to detect and record individuals. Due to the nature of Gharials and their immediate flight response upon disturbance, sightings were recorded even when photographic evidence could not be secured (Adhikari et al., 2022). Encounter rate of individuals and survival rate of released gharials were calculated using Excel.

Habitat Assessment

The 55km long stretch of West Rapti River was separated into 18 equal segments. Environmental variables recorded included the depth and width of the river, water flow velocity, water temperature and bank type. Along with the environmental variables, various human disturbance factors were also collected.

The Habitat Suitability Index (HSI) was calculated for each of the 18 river segments following the USFWS (1981) methodology. For each variable, a Suitability Index was scored ranging from 0 (unsuitable) to 1 (optimal) based on established literature. Water depth was scored using trapezoidal function, with optimal range defined as 2-3m (Hussain, 2009), for Gharials up to 180 cm, ascending slope from 0.5m and descending slope to 0 at 8m. Flow velocity was scored using an ascending linear function with minimum suitability of 5cm/s and optimal range of 20-70cm/s (Bhat et al., 2023). River width was scored linearly with values below 50m assigned SI=0 (Neupane et al., 2020), and value over 300m assigned as optimum river width (Dhami et al., 2023). Water temperature was scored using trapezoidal function with optimal range 20˚-25˚ with unsuitable environment starting from 10˚ and 35˚. Bank type and disturbance level were scored categorically based on known Gharial habitat preference (Dhami et al., 2023).

The total habitat suitability score was calculated for each segment using geometric mean of all the six SI score:

$$HSI = (S1 \times S2 \times S3 \times S4 \times S5 \times S6)^{(1/6)}$$

River segments were classified as High ($S \geq 0.6$), Moderate($0.4 \leq HSI < 0.6$) or Low ($HIS < 0.4$) suitability following the USFWS classification thresholds.

In addition to direct sightings, indirect evidence was documented to identify areas of habitat use. Observed individuals were categorized into size class, based on total length, following the criteria by Lang and Kumar, (2016).

Results

Encounter rate

With a total of two direct sightings over the 55 km transect, the encounter rate was determined to be 0.036 individual per kilometer. Both individuals were classified as juveniles based on their estimated total length of <1.5m (Lang and Kumar, 2016). In addition to direct sighting, indirect evidence including tracks were recorded at two locations: Bhamka and Keraghari confirming habitat use.

Survival rate

Only 2 individuals were observed from direct sighting. Survival rate = $(2/20) \times 100 = 10\%$
While direct sighting accounts for only 10% of the released group, indirect signs were visible in two other places with two signs in each habitat.

According to the informal interviews conducted with the residents, four mortalities of Gharial were reported, among which three were attributed to natural causes and one accidental death. This was confirmed by the President of Community Forest User Group of the area.

Habitat Suitability Index

HSI was calculated for all 18 river segments (Table 1). Of these, seven segments (38.9%) were classified as High Suitability (HSI≥0.6), six segments (33.33%) were classified as Moderate suitability (0.4<HSI<0.6) and five segments (27.7%) were classified as Low Suitability (HSI<0.4; Figure 2). Four of the five Low HIS segments (12, 13, 17 and 18) were scored 0. Segments 17 and 18 scored zero primarily due to extremely shallow water depth (0.5m), failing the minimum threshold for the juvenile Gharials. Segments 12 and 13 scored zero due to artificially reduced flow velocity (4cm/s) due to the Agaiya Dam, which resulted due to downstream dam influence and therefore does not represent natural habitat conditions.

Among the High Suitability segments, segment 7 recorded the highest HSI score (0.75) followed by segment 6 (0.690) and segment 5 (0.625). All the places where Gharial were observed and indirect signs were recorded fell under the High Suitability category.

Community interviews, additionally reported Gharial sighting at Gabar other from the release site further supporting the predictive value of Habitat Suitability Index (HSI).

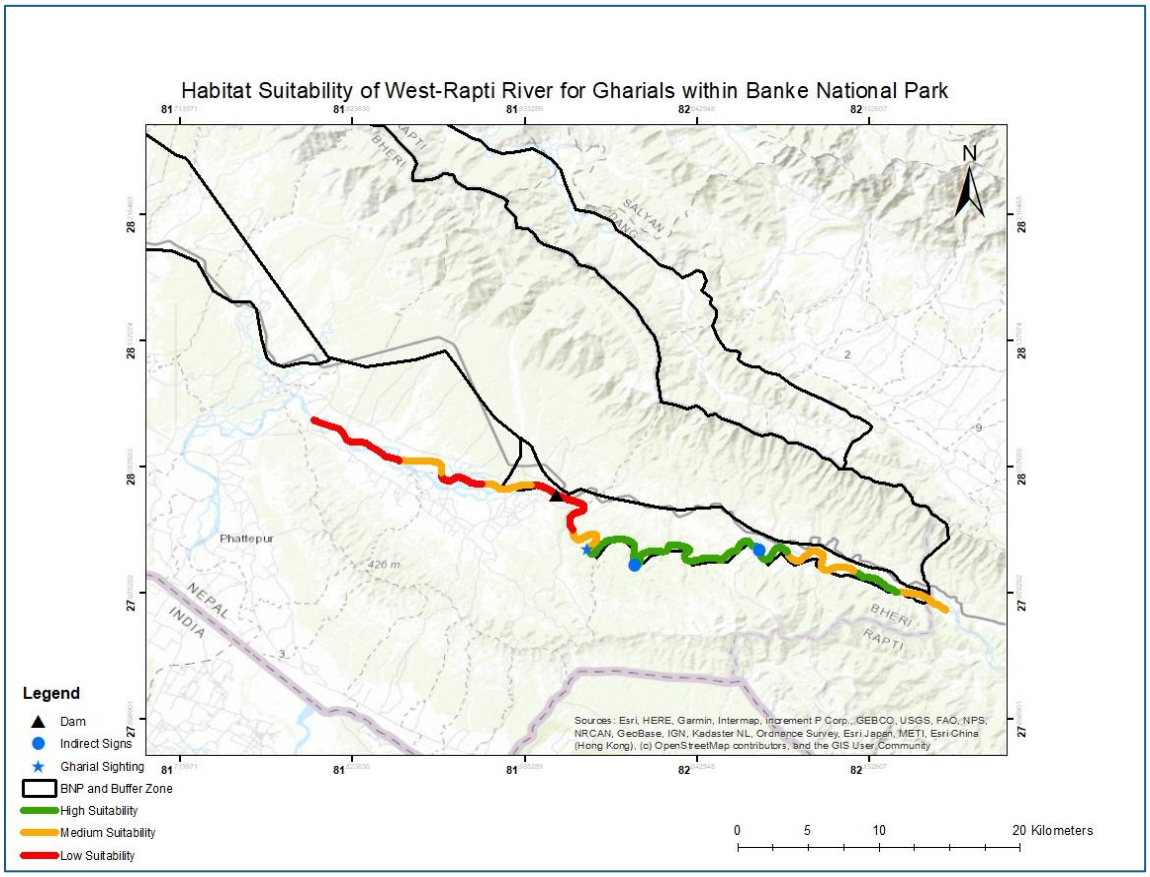


Figure 2. Map showing the calculated Habitat Suitability Index along the segment of the West Rapti River used in the study.

Table 1. Calculated Habitat Suitability Index for each of the 18 segments of the West Rapti River used in the study.

River Segment	Velocity (cm/s)	Depth (m)	Width (m)	Temp (°C)	Bank Type	Disturbance	HSI Score	Classification
1	14	1	150	16	Sandy muddy	Mid	0.426276975	Moderate
2	11	3	200	16	Rocky Sandy	Mid	0.614797784	High
3	9	1	100	18	Rocky Sandy	Low	0.447213595	Moderate
4	14	3	100	16	Grass Sandy	Low	0.586015591	Moderate
5	15	1	200	18	Grass Sandy	Low	0.625689031	High
6	11	3	150	17	Sandy	No	0.694282689	High
7	14	1.5	180	17	Sandy	No	0.725315395	High
8	14	1.5	180	17	Grass Sandy	No	0.691359242	High
9	16	1	150	17.5	Grass Sandy	No	0.61668083	High
10	16	1	150	17.5	Rocky Sandy	No	0.61668083	High
11	16	1	150	17.5	Rocky	No	0.576383985	Moderate
12	4	8	300	17.5	Sandy Rocky	No	0	Low
13	4	8	300	17.5	Sandy	No	0	Low
14	10	1	250	18	Rocky Sandy	Mid	0.546589715	Moderate
15	13	0.8	200	18	Muddy Sandy	High	0.383876621	Low
16	13	0.8	200	18	Rocky	High	0.430886938	Moderate
17	11	0.5	210	18	Rocky Sandy	High	0	Low
18	11	0.5	210	18	Sandy	High	0	Low

Discussion

The low encounter rate of 0.036 individual per kilometer recorded in this study reflects the critically low population status was the Gharials in the West-Rapti River. The minimum survival rate of 10% based on direct sighting is concerning, though indirect signs show possibility of individuals' presence at other locations suggesting that the actual number of surviving individuals may be higher.

The observed individuals were classified as juveniles based on the estimated total length of 1.5m. Captive released Gharials in Nepal are usually released at 4-7 years of age approximately at 1.5m length (Khadka & Bashyal, 2019). As the first release of Gharial in this river system was during 2023, the individuals should have grown considerably beyond 1.5m. As captive gharials have been recorded growing approximately 1.58cm per month (Khadka and Bashyal, 2019), the absence of measurable growth in the observed individuals may indicate the suboptimal habitat conditions.

The Habitat Suitability Index analysis revealed that 7 out of 18 segments were classified High Suitability, suggesting that West-Rapti River possesses the adequate habitat for the conservation of this endangered species despite of current low numbers. Flow velocity across all 18 segments ranged from 4-16 cm/s, which is below the optimal threshold of 20-70 cm/s established for Gharials (Bhatt et al., 2023). It should be noted that this study was conducted during the winter season when water level is naturally reduced. Similarly, water temperature during the time of survey were recorded to be 16-18ºC, which was below the optimal range, (20-25 ºC). Despite these suboptimal conditions, Gharial presence was confirmed in the river, suggesting behavioral adaptation to seasonal and environmental variations.

Four river segments recorded zero in HSI analysis. Segment 17 and 18 recorded zero due to shallow water depth. Segment 12 and 13 scored 0 primarily due to reduced flow velocity of the water resulting from the downstream dam influence. The dam at Agaiya represents a structural barrier that may restrict Gharial movement and those that pass through the opening of dam cannot move upstream (Vashistha et al., 2021).

Human disturbance was seen as the critical limiting factor for Gharial Conservation in the West Rapti River. Sand and stone mining involving heavy trucks were recorded in several segments outside of the buffer zone. The noise pollution generated and direct physical disturbance to the river might affect the Gharial presence. Manual gold mining was widespread, and often was accompanied by the presence of livestock, compounding disturbance levels. The manual gold mining could be seen inside the buffer zone sector as well, leaving only a few undisturbed river sections.

On World Wetlands Day (February 2, 2026), five additional Gharials (4 male, 1 female) were released into the West Rapti River by Banke National Park and NTNC (National Trust for Conservation of Nature). I had the opportunity to be present during the release event. The total number of Gharials released into the river system increased to 25, but the newly released Gharials were not included in the survey as they were kept in enclosure for 2 days.

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Field Photographs:



Figure 1: New Released Gharial



Figure 2: Sign of Habitat Use (GPS: 28.002181 82.0045817)- Segment 5



Figure 3: Sign of Habitat Use (GPS: 27.004644 82.001318) – Segment 9



Figure 4: Site of observation of Gharial (GPS: 28.002329 81.5823940)- Segment 10



Figure 5: Gharial Track (Segment 10)



Figure 6: Disturbance in the River Segments



Figure 7: Manual Gold Mining