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Occurrence and Conservation Threats of the Endangered Indian Softshell Turtle (*Nilssonia hurum*) in the Kankai River and Adjacent Wetlands of Eastern Nepal

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ABSTRACT

Nilssonia hurum (Gray, 1831), an endangered Indian softshell turtle, faces increasing threats due to habitat degradation and direct human exploitation. This study, conducted from October 2023 to September 2024 in the Kankai River and its adjacent wetlands in eastern Nepal, to document species occurrence and assessed conservation threats using community-based surveys. The species showed a high probability of occurrence ($\Psi = 0.71 \pm 0.05$ SE) which was significantly and negatively correlated with the Human Disturbance Index ($HDI = 0.29$; $\beta = -1.2, p < 0.05$), indicating that even moderate human activity adversely affects its distribution. Major threats identified included sand mining, macroplastic accumulation, and wetland encroachment. The physicochemical parameters, including dissolved oxygen($10.4 \pm 2.95\ mg/L$), pH (8.37 ± 0.31) and temperature (21.95 ± 1.49 ℃) were within the optimal ranges for freshwater turtles. Field data and perceptions from local stakeholders also confirmed a declining turtle population, with habitat loss cited as the predominant threat. Conservation measures such as regulated sand extraction, pond restoration, and public awareness campaigns are urgently recommended to safeguard remaining populations.

1. INTRODUCTION

Nepal is home to 17 species of freshwater turtles, belonging to 11 genera and three families, including the recently reported occurrence of *Nilssonia nigricans* (Rai et al., 2022; Praschag et al., 2022). Among them, the Indian peacock softshell turtle *Nilssonia hurum*, a member of the Trionychidae family, is classified as Endangered on the IUCN Red List and listed in Appendix I of CITES (Das et al., 2021). This species is distributed across Bangladesh, India, Pakistan, and Nepal, particularly in the Ganga, Brahmaputra, and Indus River basins, typically below 300 m elevation (Das et al., 2010; Schleich & Kästle, 2002; Uetz, 2021). In Nepal, *N. hurum* has been reported from lowland Tarai regions, including Jhapa, Morang, Sunsari, and the Koshi Tappu Wildlife Reserve of eastern Nepal (Rai, 2003; Kharel & Chhetry, 2013).

Nilssonia hurum inhabits rivers, ponds, and wetlands surrounded by dense vegetation and swamps (Schleich & Kästle, 2002). However, it faces severe threats from direct exploitation for meat and traditional medicine, habitat degradation due to sand mining, macroplastic pollution, water contamination, and accidental entanglement in fishing gear (Das et al., 2010; Horne et al., 2012; Rhodin et al., 2010). Illegal collection and wildlife trade remain prevalent, particularly in urban centers such as Narayanghat, Biratnagar, and Mahendranagar (Shrestha, 1997). Despite its endangered status, baseline ecological data on the distribution, occupancy, and conservation threats of *N. hurum* remain limited in Nepal. Wetlands of eastern lowlands are rich in biodiversity (Praschag et al., 2022). The Kankai River in eastern Nepal, along with its adjacent wetlands, represents a potentially significant habitat for *N. hurum*, yet has received little scientific attention. This river system lies within a biodiversity-rich corridor connecting the Chure foothills to the Tarai plains and supports diverse

aquatic ecosystems. However, increasing anthropogenic pressures including sand extraction, agricultural expansion, and pollution have raised concerns about the degradation of turtle habitats in the region. While occasional sightings of turtles have been reported by locals, these observations have not been scientifically verified. This study was therefore

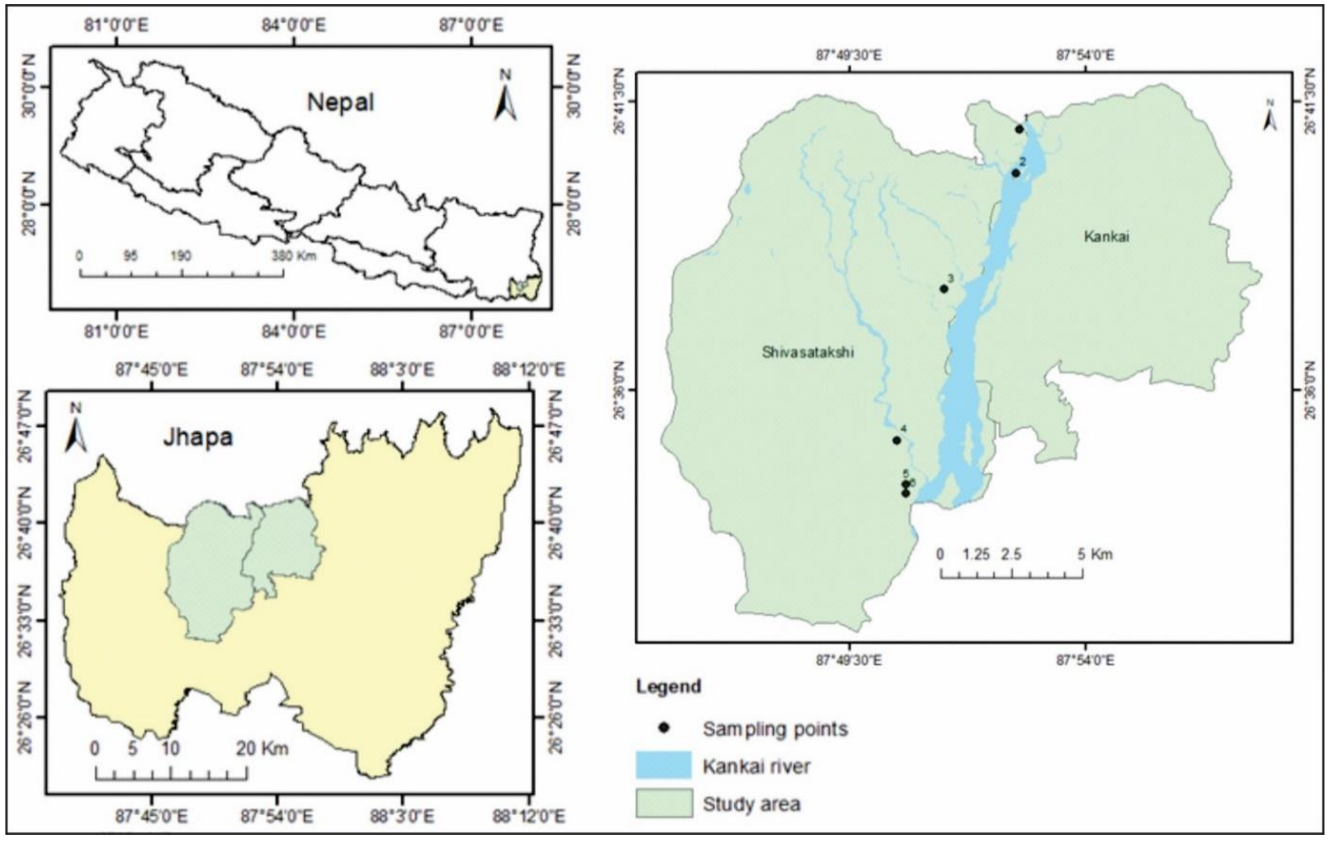


Figure 1
Map of the study area showing sampling stations.

conducted from October 2023 to September 2024 to estimate the occurrence probability of *Nilssonia hurum* in the Kankai River and its adjoining wetlands, assess habitat quality based on key physicochemical parameters, and document community knowledge and perceived threats to turtle conservation. Findings from this research aim to fill critical knowledge gaps and support evidence-based conservation strategies for this endangered species in eastern Nepal.

2. MATERIALS AND METHODS

2.1 Study Area

This study was conducted in the lowlands of Jhapa district in the vicinities of the Kankai river. The study area was divided into six sampling stations based on the purposive sampling method starting from Domukha in the north to Kachhudaha in the south and covering a length of 12 km. (Figure 1) Each sampling station was subdivided into 10 grids each measuring 50m x 50m (Table 1).

2.2 Sampling Design

Potential habitats of *Nilssonia hurum* were surveyed using fixed-area quadrats measuring 50 × 50 m², laid at 50 m intervals. A total of 60 quadrats (10 per sampling station) were established across six selected stations based on prior reconnaissance surveys. Within each quadrat, direct observations were made to record live individuals, carapace and plastron remnants, eggshell fragments, and bones as indicators of turtle presence or past activity

2.3 Data Collection

2.3.1 Field Survey

The occurrence of *Nilssonia hurum* was assessed using a total of 10 spatial grids (50 m × 50 m each) per sampling station. Transects were established within these grids to ensure representative habitat coverage. The Human Disturbance Index (HDI) was incorporated as a site-level covariate to evaluate its influence on the occurrence probability of *Nilssonia hurum* (Wang et al., 2023). Each of the 60 quadrats was surveyed three times using temporal replicates to enhance the detection probability of the target species (Mackenzie et al., 2005). Both diurnal (06:00-09:00 hrs and 15:00-18:00 hrs) and nocturnal (19:00-21:00 hrs) direct observations were conducted at each station two times every week (Saturday and Wednesday) for the three months to record presence data of the target species (Table 2). Preliminary mapping and georeferencing of water bodies were conducted using Google Earth imagery, and grids with more than 75% area coverage of aquatic or riparian habitat

were prioritized. Presence data and habitat covariates were recorded during diurnal and nocturnal surveys. The Human Disturbance Index (HDI) was calculated to quantify anthropogenic pressures at each site (Wang et al., 2023). Both primary (field observations, interviews) and secondary (published literature) data sources were used to assess habitat conditions and occupancy

2.3.2 Questionnaire Survey

Structured questionnaires containing a set of closed-ended questions were used to assess species occurrence and local perceptions of turtle population trends while Likert scales were used to assess anthropogenic impacts and conservation threats were used. Individual interviews were conducted with 120 respondents including key informants, conservation staff, district forest officers, community forest user groups, village leaders and locals using a standardized checklist to gather insights on threats, historical presence, and suggested conservation strategies for *N. hurum.*

2.4 Threat Assessment

Threats were evaluated through a combination of direct field observation, structured interviews, and analysis of physicochemical habitat parameters. Threat intensity at each site was scored and integrated into the Human Disturbance Index (HDI), based on the premise that increased anthropogenic pressure negatively correlates with species occupancy. The HDI served as a key covariate in assessing the impact of human-induced disturbances on the spatial distribution of *N. hurum.*The Human Disturbance Index (HDI) was calculated by using the HDI formula adapted from Wang et al., 2023.

$$HDI = (E \times 0.20) + (A \times 0.20) + (WP \times 0.20) + (W \times 0.20) + (DK \times 0.20)$$

Where,

E = Electric fishing
A = Angling
WP= Water pollution level
W= Wetland encroachment
*DK= Direct killing (*Adapted from Wang et al., 2023)

Table 1
Sampling site characteristics with grid allocation, geographic coordinates, and elevation.

Station	Station Name	Grid No.	Coordinates	Elev. (m)
1	Domukha Dam Site	D1-D10	N26°41′01″ E87°52′44″	102
2	Gainde Canal	G1-G10	N26°38′11″ E87°51′18″	100
3	Chillagadh pond	C1- C10	N26°37′56″ E87°50′21″	94
4	Satakshi river	S1- S10	N26°35′05″ E87°50′25″	96
5	Hattisar Floodplain	H1- H10	N26°34′13″ E87°50′38″	85
6	Kachhudaha Floodplain	K1-K10	N26°34′03″ E87°50′37″	84

Table 2
Detection of *Nilssonia hurum* in each sampling station, indicating time of observation (day/night).

Sampling stations	Grid 1	Grid 2	Grid 3	Grid 4	Grid 5	Grid 6	Grid 7	Grid 8	Grid 9	Grid 10
Domukha Dam Site	+(1)N	0	0	0	0	0	0	0	0	0
Gainde Irrigation Canal	-	-	-	-	-	+(1)N	-	-	-	-
Chillagadh pond	-	+(1)D	-	-	-	-	-	+(1)N	-	-
Satakshi river	-	-	-	-	-	-	-	-	-	-
Hattisar Floodplain	-	-	-	-	-	-	-	-	-	-
Kachhudaha Floodplain	+(1)N	-	-	-	-	-	-	-	-	-

(+) Detected, (0) Not detected, (D) Daytime observation, (N) Nighttime observation. Values in parentheses indicate number of individuals observed.

2.4.1 Covariate selection and Data Analysis

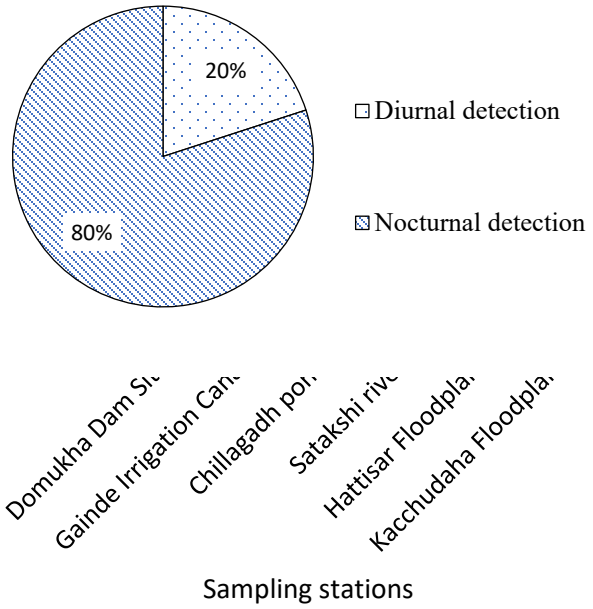
As an aquatic species, *Nilssonia hurum* known to inhabit a variety of freshwater environments, including rivers, brooks, swamps, ponds, and fishery farms (Schleich & Kästle, 2002). Based on existing literature and field reconnaissance, habitat types considered in this study included brooks (small streams), flat ponds (< 3 ft depth), deep ponds (> 3 ft depth), swamps with dense vegetation, fishery farms, and rivers. To evaluate anthropogenic threats, we selected covariates related to human disturbances, such as electrified fishing, angling, water pollution (e.g., pH level, presence of macroplastics), wetland encroachment, and direct killing. Macroplastic (>5 mm) pollution was assessed through riverbank transects of 100 m at each sampling station (e.g., Domukha, Gainde), following the UNEP/IUCN National Guidance for Plastic Pollution Monitoring protocol (UNEP, 2009). The Human Disturbance Index (HDI) was calculated for each survey site to integrate various human impact variables into a unified disturbance metric, following the approach of Wang et al. (2023). All collected data were compiled and analyzed using Microsoft Excel.

3. RESULT AND DISCUSSION

3.1 Habitat Characteristics

3.1.1 Occurrence

Out of the six sampling stations, *Nilssonia hurum* was detected in four locations: Domukha ($n = 1$), Gainde ($n = 1$), Chillagadh ($n = 2$)and Kachhudaha ($n = 1$). Of the total five individual sightings, 80% ($n = 4$) occurred during nighttime surveys, while only 20% ($n = 1$) were recorded during the daytime (Figure 2). Among the 60 surveyed transects (grids), the species was detected in five,



resulting in a Naïve detection probability estimate $(Pn) = 1\ (12.5\%)$ (Figure 3)

Figure 2
Detection time of *Nilssonia hurum* across all sampling stations, showing proportion of sightings recorded during daytime and nighttime surveys.

Figure 3
Number of *Nilssonia hurum* sightings recorded across different sampling stations in the study area.

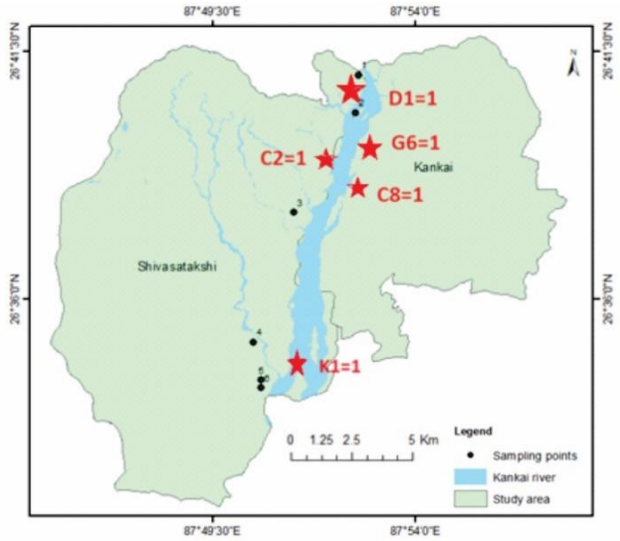


Figure 4
Grid-wise distribution of *N. hurum* occurrences across the study area.

3.2 Habitat Type

Six types of suitable habitats for *N. hurum* were taken into consideration in each sampling station (Table 3). The data suggests that habitat distribution varies significantly by location, reflecting ecological diversity (e.g., rivers vs. floodplains) (Figure 2). Chillagadh pond and its vicinities had the most diverse, with five Flat ponds, four Deep ponds, and two Swamps.

3.3 Habitat Disturbance

Disturbance activities were recorded by direct sightings daily during field surveys. A categorical scale was employed to classify the intensity of disturbances based on frequency of occurrence. A practical field-based scoring method was applied where activities observed every day in a week were categorized as very high frequency (++++), five days in a week as high frequency (+++), three days in a week as moderate frequency (++), and one day in a week as occasional presence (+) (Table 4).

Table 3
Habitat types associated with the occurrence of *Nilssonia hurum* in the study area.

SN	Sampling stations	Habitat type					
		Brooks	Flat pond <3ft	Deep pond >3 ft	Swamp thick vegetation	Fishing Fishery farm	River
1	Domukha Dam	1	0	2	0	0	1
2	Gainde Canal	1	3	2	1	2	0
3	Chillagadh Pond	2	5	4	2	1	0
4	Satakshi River	0	0	2	1	2	1
5	Hattisar Flood plain	0	3	2	3	0	1
6	Kachhudaha FP	1	1	3	2	0	1

Values represent the number of recorded habitat types.

Table 4
Frequency and intensity of anthropogenic disturbances observed across sampling stations affecting *Nilssonia hurum* habitats.

SN	Sampling stations	No. of grids	Habitat disturbance				
			Electric	Poisoning	Sand mining	Habitat modification	Fishing (Traps & Hooks)
1	Domukha Dam	10	-	-	+++	+++	+
2	Gainde Canal	10	-	-	-	+++	-
3	Chillagadh pond	10	-	-	-	++++	-
4	Satakshi river	10	-	-	++	+	+
5	Hattisar FP	10	-	-	+++	-	-
6	Kachhudaha	10	-	-	+++	+	++

Absence (–), Occasional Presence (+), Moderate Frequency (++), High Frequency (+++), Very High Frequency (++++).

Major anthropogenic threats documented included sand and gravel mining, riverbank agriculture, wetland encroachment, diversion of river flow, and overfishing. These disturbances were widespread and persistent across several stations and were identified as key contributors to habitat degradation, directly affecting the ecological integrity of the Kankai River system and associated wetlands. Such activities pose serious challenges to the survival of aquatic biodiversity, particularly the endangered *Nilssonia hurum*, whose habitat preference and occupancy are sensitive to human-induced pressures.

No direct evidence of electric fishing or poisoning was recorded at any of the sampling stations during the survey period, indicating that while such practices may occur in other regions, they were not prevalent in the study area at the time of investigation. Instead, sand mining and habitat modification due to watermelon cultivation in the sandy bank of the Kankai river and construction of temple and buildings around Chillagadh pond emerged as the most widespread and significant threats. The cumulative anthropogenic pressures, particularly in locations such as Chillagadh and Domukha areas, represent major conservation challenges for *Nilssonia hurum* and its aquatic ecosystem.

3.4 Human Disturbance Index (HDI) Calculation

Each of five disturbance variables is standardized from 0 (no contribution) to 10 (high contribution). Equal weight (20%) was given considering all were equally influential in HDI formulation. HDI designed to quantify cumulative anthropogenic pressure at each site based on disturbance level. This help to relate species occupancy to human induced stress. The HDI values was grouped into 10 equal interval classes as (Table 5):

Table 5

Human disturbance range category (McGarigal et al 2002).

HDI Score Range	Levels	Disturbance Category
0.00-0.33	I-III	Minimum disturbance
0.34-0.66	IV-VI	Moderate disturbance
0.67-1.00	VII-X	High disturbance

The results of electric fishing, angling, water pollution (macroplastic) level, wetland encroachment and direct killing were obtained by summing the human disturbance scores for each of the five datasets with the same weight. Afterward, the given formula was used to compute the HDI. In this study, the five datasets were selected as major disturbance factors then standardized scores from 0 (low contribution) to 10 (high contribution) were attributed to reflect the estimated contribution to human disturbances following visual abundance scoring Dudgeon (2000) for electric fishing, Valerio and Ceballos (2016) for Angling, UNEP (2009) for water pollution (macroplastic), Bhandari (1996) for wetland encroachment, Moll& Moll (2004) for direct killing. High and low HDI values indicate high and low levels of human disturbances, respectively (Figure5). To further reflect the differences in human disturbances, the HDI values were classified into 10 levels using equal interval classification (Table 6).

Table 6

Identified conservation threats affecting *Nilssonia hurum* across sampling sites.

Station	Station Name	E	A	WP	W	DK	HDI
1	Domukha Dam Site (D1 to D10)	0/10	5/10	8/10	8/10	3/10	0.48
2	Gainde Irrigation Canal (G1 to G10)	0/10	0/10	6/10	9/10	0/10	0.30
3	Chillagadh pond (C1 to C10)	0/10	4/10	3/10	8/10	1/10	0.32
4	Satakshi river (S1 to S10)	0/10	3/10	4/10	3/10	0/10	0.20
5	Hattisar Floodplain (H1 to H10)	0/10	6/10	1/10	3/10	3/10	0.26
6	Kachhudaha Floodplain (K1 to K10)	0/10	4/10	1/10	0/10	4/10	0.18
						Average HDI	**0.29**

(E= electric fishing, A=angling, WP= water pollution (macroplastic) level, W= wetland encroachment and DK= direct killing)

3.5 Physicochemical parameters

Dissolved oxygen (DO) was measured by using Lutran Dissolved Oxygen meter (Model: A20 DO-5509). pH and temperature of water was measured at each sampling grid using a Hanna waterproof pocket pH tester (Model: pHep HI98107). The mean values for each parameter were calculated across all sampling grids and are presented collectively to represent the overall physicochemical conditions of the study area.

The mean dissolved oxygen (DO) concentration across the study sites was found $10.4 \pm 2.95\ mg/L$, mean pH value 8.37 ± 0.31 and a mean temperature of water was $21.95 \pm 1.49\ ℃$. These physicochemical conditions are within favorable ranges for aquatic biodiversity and indicate

suitable habitat for freshwater turtles, including the target species *Nilssonia hurum* (Figure 6).

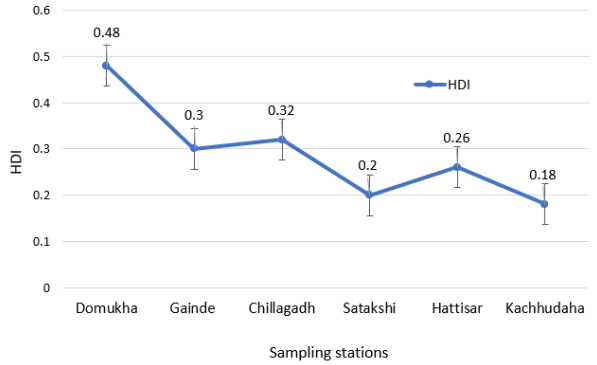


Figure 5
Average human disturbance index (HDI) across sampling stations in the study area.

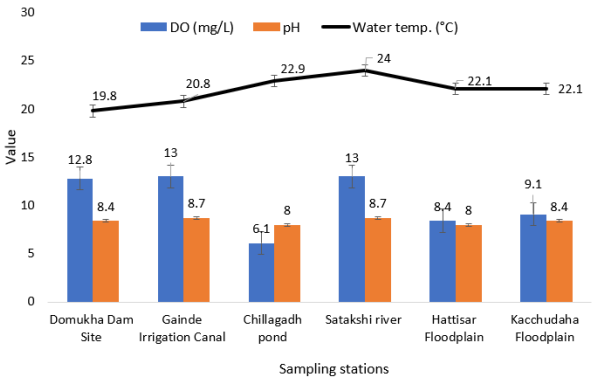


Figure 6
Mean dissolved oxygen (DO), pH, and water temperature recorded across sampling sites in the study area.

3.6 Threats Assessment

Information about target species was acquired based on a structured questionnaire. The questionnaires were based on demographics, socio-economic backgrounds, personal experience, knowledge, and general background of the local hunters and fishermen.

The majority of the respondents 57% ($n = 68$) were adults aged 15–59 years, followed by 30% ($n = 36$) children (6–14 years) and 13% ($n = 16$) elderly (60+ years), indicating a predominant input from the working-age population. Gender distribution showed that 85% ($n = 120$) of the respondents were male and only 15% ($n = 18$) female, reflecting either cultural roles or a male-dominated participation in outdoor or conservation-related activities. A significant portion of the community has not seen turtles recently, with only a very small proportion reporting any direct sightings. Most sightings occurred in rivers 45% ($n = 54$), followed by ponds 40% ($n = 48$) and canals 15% ($n = 18$, suggesting rivers are still the most common and critical habitats (Figure 7). Alarmingly, nearly all respondents believed that the turtle population is not increasing, highlighting a shared perception of decline. When asked about causes of decline, 52% ($n = 62$) cited habitat loss as the primary threat, 36% ($n = 43$) pointed to other causes such as overgrazing or pollution, and only 12% ($n = 14$) believed direct killing was the main issue (Figure 7). This indicates a shift in local awareness from direct exploitation toward broader ecological degradation as the principal conservation concern.

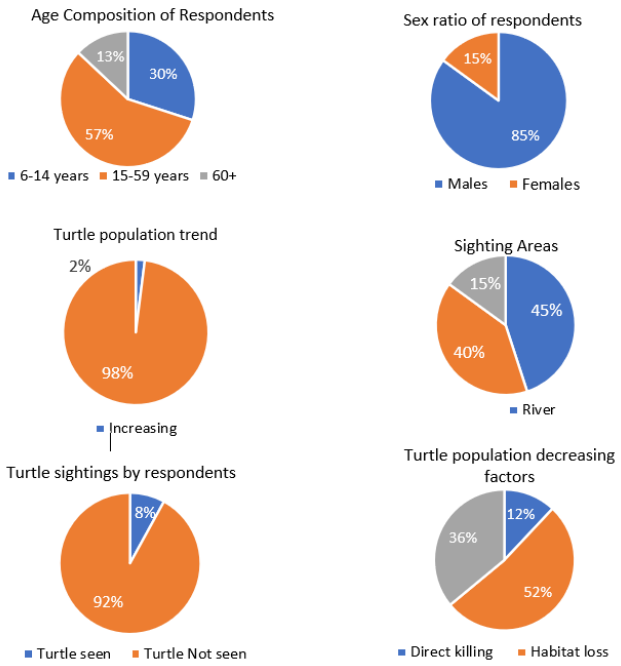


Figure 7
Socio-demographic composition of respondents.

3.6.2 Conservational Threats

Nilssonia hurum faces multiple anthropogenic threats throughout its range in the eastern lowlands of Nepal. Field observations, questionnaire surveys, and interviews with local stakeholders ($n = 120$) revealed a range of conservation challenges, which are categorized and described as:

a) Harvest for Food

Although now relatively rare, the practice of harvesting turtles for consumption still persists among certain ethnic groups, particularly the Satar community residing along the Kankai River. Five percent ($n = 6$) of respondents admitted to hunting *N. hurum* and *Lissemys punctata* for food and traditional uses. Traditional hunting techniques involve probing muddy substrates with sticks or iron rods and detecting hidden turtles by auditory cues (Schleich & Kästle, 2002). Reports suggest that turtle meat was occasionally sold in local markets at rates ranging from 100–300 Nepalese rupees per kilogram about a decade ago; however, such practices have become sporadic in recent years.

b) Traditional Medicines

Turtles are often targeted due to cultural beliefs that their body parts possess curative properties. Interviews and field surveys documented a range of misconceptions linking turtle parts to traditional remedies for both human and livestock

ailments (Table 7). These practices contribute significantly to illegal harvesting, particularly during the breeding season when turtles are more vulnerable.

c) Harmful Fishing Practices
Unsustainable fishing methods were observed in parts of the Kankai River, particularly near Hattisar and the Kachhudaha floodplain. Some local fishermen were found using sharp spears to kill softshell turtles and excavate nesting sites, leading to the destruction of eggs, juveniles, and adult individuals. Such practices pose a severe threat to recruitment and population stability.

d) Recreational Disturbance
The Domukha foothill area, which constitutes a suitable habitat for *N. hurum*, is increasingly subjected to human disturbance from recreational activities. Picnics, educational tours, and tourism events draw large crowds, particularly during weekends and holidays. The resulting littering, noise, and trampling of nesting grounds further degrade habitat quality.

Table 7
Traditional beliefs regarding medicinal uses of turtle body parts.

Turtle part	Believed cure	Preparation and application
Blood	Anaemia	Ingested fresh, mixed with alcohol
Bone	Intestinal infection	Used as a talisman, worn around the neck
Eggs	Stomach cramps	Boiled and consumed
Meat	Asthma	Cooked and consumed
Shell (carapace/plastron)	Skin disease	Burned, powdered, and mixed with coconut oil for topical use.
Shell	Tonsilitis	A paste is made by rubbing the shell on a stone with water and given orally to the children.
Shell	Pneumonia	Inhaled as smoke from burning shell
Shell	Piles	Ground into a paste and applied externally

Source: Field survey, 2024.

e) Habitat Loss
Habitat degradation due to deforestation, agricultural expansion, and sand mining emerged as a primary threat. In particular, the conversion of sandy riverbanks for seasonal watermelon farming was observed along the Kankai River, significantly reducing available basking and nesting sites for turtles. The major factors of habitat destruction are deforestation, sand mining, and expansion of agricultural land on the sandy bank of the Kankai river especially for watermelon cultivation.

f) Overgrazing
Overgrazing by livestock was reported as a significant disturbance in riparian zones such as Gainde forest (Shivasatakshi Municipality), Hattisar floodplain (Shivaganj), and Kachhudaha wetland (Sarnamati). Excessive grazing reduces vegetative cover and destroys nesting habitats, making these areas unsuitable for turtle habitation and reproduction.

g) River Damming and Water Diversion
The construction of a dam at Domukha, near the Chure foothills, has significantly altered the natural flow regime of the Kankai River. Water is impounded upstream and released only twice weekly for irrigation purposes downstream. This creates artificial hydrological extremes flooding upstream and desiccation downstream. Given the large body size of *N. hurum*, the species is unable to thrive in shallow, stagnant waters, leading to population declines in these altered sections.

h) Pollution
Macroplastic pollution was documented in high levels near Domukha (8/10) and Gainde irrigation canal (9/10), a popular recreational site (Table 6). In addition, waste generated from nearby markets such as Surunga Bazaar (particularly during periodic ‘Haat’ or local markets) contributes significantly to riverine pollution. The accumulation of plastics and other waste not only degrades habitat quality but can also pose direct ingestion or entanglement threats to turtles.

4. DISCUSSION

This study confirmed the presence of *Nilssonia hurum* in four locations within the Kankai River and its adjacent wetlands, with five individual sightings recorded during the survey period. This supports and updates earlier findings by Aryal et al. (2010), who reported four individuals of *N. hurum* in Jhapa district. Unlike Aryal et al., who also confirmed the trade of this species from Koshi, Kapilvastu, and Kanchanpur districts, our study did not observe any active trade of *N. hurum*. Furthermore, while Shah and Tiwari (2004) and Aryal et al. (2010) highlighted the species' exploitation for meat, traditional medicine, and local trade, we did not document the use of turtle parts for decorative purposes or commercial trade. Our results suggest a reduction in direct exploitation but continued habitat degradation, which was also reported by Rai (2003), who emphasized deforestation, construction, and pollution as major threats. Additionally, while Rawat et al. (2020) documented two *Nilssonia* species from Shuklaphanta National Park (*N. gangetica* and *N. hurum*), only *N. hurum* was observed in our study area, indicating potential regional differences in species composition.

The probability of occurrence for *N. hurum* (Ψ= 0.71 ± 0.05 SE) was higher than the 58% reported from Koshi Tappu by Aryal et al. (2010), despite our study area having a higher average Human Disturbance Index (HDI = 0.29 vs. 0.18). This suggests that some habitats in Kankai River still support viable populations, especially in enclosed or less-disturbed aquatic habitats. Our findings align with Kharel and Chhetry (2013), who previously documented *N. hurum* from Domukha and Chauni, and Praschag et al. (2022), who emphasized the species' presence in eastern Nepal. However, *N. nigricans*, reported by Praschag et al. (2022) from Betana, was not recorded in our study area, indicating that it may have a more restricted distribution. *Nilssonia hurum* detections were mostly concentrated in river and floodplains, particularly during nocturnal surveys. This pattern underscores the species' sensitivity to human activity and habitat structure. The absence of detections in heavily modified river systems may reflect true absence or reduced detectability due to anthropogenic disturbance, as suggested by earlier occupancy studies (MacKenzie et al., 2002).

The mean dissolved oxygen (DO) across all stations was 10.4 mg/L, with pH averaging 8.36 and water temperature at 21.95°C all falling within optimal ranges for freshwater turtles. These values align with the findings of Ernst and Lovich (2009), who indicated that DO levels above 5 mg/L, pH between 6.5–8.5, and temperatures from 20–30°C are suitable for freshwater turtles. The highest DO (13 mg/L) was observed at Gainde and Satakshi, while the lowest (6.1 mg/L) was recorded at Chillagadh Pond, indicating possible stagnation or organic pollution. Despite slightly alkaline conditions (pH 8.4–8.7), most values remain tolerable for aquatic species. Only Chillagadh showed borderline low DO, which could pose a risk to more sensitive organisms if levels decrease further.

We documented multiple anthropogenic threats, including sand mining, agricultural encroachment, macroplastic pollution, and recreational disturbances particularly around Domukha and Chillagadh. These findings corroborate earlier reports by Rai (2003) and Rawal et al. (2020), who identified habitat alteration, sand extraction, and turtle exploitation as major threats to herpetofauna. In our study, the highest HDI was recorded at Domukha (0.48) and the lowest at Kachhudaha (0.18), showing spatial variation in disturbance intensity. Although direct killing has declined compared to historical levels, it remains a concern in Domukha and Kachhudaha, where intentional harvesting was observed. Our field observations confirmed that traditional uses of *N. hurum* especially among the Satar community persist, less frequently. This agrees with earlier results by Shah and Tiwari (2004), who noted the cultural exploitation of turtles in Nepal. In addition, we observed harmful fishing practices (e.g., spearing) and egg destruction in Hattisar and Kachhudaha, which compromise reproductive success and long-term population viability. While electric fishing and angling were less frequently recorded, they still pose threats due to bycatch risk, as also highlighted by Valerio and Ceballos (2016).

The most critical conservation challenge identified in our study was habitat loss due to agricultural expansion, sand mining, and wetland modification. Notably, seasonal watermelon farming along sandy banks and building construction around Chillagadh pond severely impacted turtle nesting sites. Overgrazing in floodplains such as Hattisar and Kachhudaha further degraded nesting grounds and riparian vegetation. These pressures mirror observations by Dudgeon (2000) and Moll & Moll (2004), who highlighted the ecological consequences of unregulated land use and riverbank degradation. The artificial regulation of water flow at Domukha Dam, which alters the Kankai River's natural hydrology, also emerged as a significant threat. Water release only twice per week has led to unnatural flooding upstream and desiccation downstream, affecting turtle movement and habitat quality. Such hydrological fragmentation aligns with broader regional patterns described by Dudgeon (2000), who emphasized that altered flow regimes reduce habitat suitability for aquatic fauna.

Macroplastic accumulation was notably high around picnic zones like Domukha and Gainde irrigation canal, degrading nesting and basking areas (Table 6). This finding is consistent with UNEP (2009), which links plastic pollution with habitat deterioration and risks of ingestion or entanglement for aquatic species. The presence of plastic waste reflects broader regional challenges in waste management and recreational use of natural sites.

5. CONCLUSION

The lower HDI value suggested higher chances of occurrence of the *N. hurum* in the study area. The estimated probability of occurrence of *Nilssonia hurum* in the Kankai River and its adjacent wetlands was relatively high ($\Psi = 0.71 \pm 0.05$ SE , but negatively influenced by human disturbance, as indicated by a statistically significant correlation with the Human Disturbance Index ($HDI = 0.29;\ \beta = -1.2, p < 0.05$). This suggests that for every unit increase in HDI, the log-odds of occupancy decrease by 1.2 units, aligning with ecological understanding that disturbance-sensitive species are excluded from highly modified habitats (Wang et al., 2023). The mean HDI value of 0.29 reflects moderate anthropogenic pressure primarily from angling, plastic pollution, wetland encroachment, and sand mining making HDI a reliable predictor of species presence in this landscape. The most widespread threats included sand mining and intensive cultivation (e.g., watermelon farming) along sandy banks, which compromise turtle nesting sites. Despite these threats, the water quality measured in terms of dissolved oxygen ($10.4 \pm 2.95\ mg/L$), pH (8.37 ± 0.31) and temperature (21.95 ± 1.49 ℃) remained within a favorable range for aquatic life, including *N. hurum*. However, Chillagadh Pond showed lower DO levels, indicating potential organic loading and stagnation, warranting targeted monitoring. Questionnaire data revealed that only 8% of respondents had recently seen turtles, while 52% identified habitat loss as the primary cause of population decline, surpassing concerns of direct exploitation. Most respondents were adult males, commonly engaged in fishing or farming, highlighting the need to incorporate their perspectives into local conservation efforts. This study provides important baseline data on the occupancy, habitat conditions, and conservation threats

faced by the *N. hurum* in the Kankai River and its adjacent wetlands in eastern Nepal. The species demonstrated a relatively high occupancy rate ($\Psi = 0.71 \pm 0.05$ SE , indicating that the landscape still retains ecological value for its persistence. However, the species occurrence was significantly and negatively correlated with the Human Disturbance Index ($HDI = 0.29$; $\beta = -1.2, p < 0.05$), affirming that human-induced pressures particularly sand mining, wetland encroachment, angling, and macroplastic pollution reduce habitat suitability for *N. hurum.* Despite these threats, the study found that key physicochemical parameters such as dissolved oxygen ($10.4 \pm 2.95\ mg/L$), pH (8.37 ± 0.31) and water temperature (21.95 ± 1.49 ℃) were generally within the optimal range for freshwater turtles, suggesting that water quality is not yet a limiting factor in most sites. Nonetheless, local anomalies such as the lower DO levels at Chillagadh Pond highlight the need for continuous habitat monitoring and management interventions. Perceptions from the local community underscored a concerning decline in turtle sightings, with only 8% of respondents having seen *N. hurum* recently. Habitat loss was identified by 52% of interviewees as the primary driver of population decline, underscoring the urgent need to address land-use pressures and incorporate local knowledge into conservation planning.

In light of these findings, the study strongly recommends the following conservation actions for the long-term survival of *N. hurum* in Nepal's eastern lowlands.:

- Regulate sand mining, particularly during nesting seasons (March–June).
- Restore historical wetlands and ponds, such as those near Chillagadh.
- Manage plastic waste, especially in recreational zones like Domukha.
- Enforce no-fishing zones and ban harmful practices like spearing and egg harvesting.
- Engage local communities, especially fishermen and farmers, through targeted awareness programs and participatory monitoring.

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CONFLICTS OF INTEREST

The author declares that there do not have any conflict of interest.

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