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# Population Status and Distribution of Gharial in Rivers of Chitwan National Park

**September 2018**

# Population Status and Distribution of Gharial in the major rivers of Chitwan National Park


***Contributors***

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## Executive Summary

Gharials (*Gavialis gangeticus*), the only survivor of the Gavialidae family, are highly threatened keystone species of freshwater ecosystems. They are confined in few tributaries of Ganga river in India and Nepal in fragmented populations. Their population also declined drastically due to anthropogenic as well as natural causes. Governments and conservation organizations have initiated various programs on gharial conservation including the breeding centers. A large number of gharials have been released in different river systems of Nepal from 1981-2018. Although it contributed to sustaining the wild gharial populations in the rivers, the wild populations haven't yet recovered to the viable breeding population.

Periodic monitoring of the wild gharials is necessary because the wild populations are small and vulnerable to local extinction. This report presents the findings of a survey was conducted in February/March 2018 in Rapti, Narayani and their tributaries to assess the gharial population. Population survey of gharials was assessed through a direct count of basking gharials. The entire river stretches with potential gharial distribution was divided into a segment of ~ 16 km (10 – 25). All segments (except two) were surveyed simultaneously and repeated three times. Three replicates on a total of 221.39 km segments of the Rapti and Narayani counted minimum 219 gharials in Chitwan National Park and adjoining river stretches including 118 in Rapti and 101 in Narayani. Although gharial population size has increased compared to 2016 survey, the number of adult gharials has not increased. Gharials were not uniformly distributed but concentrated in few locations with undisturbed natural sand banks, low anthropogenic pressures and a healthy lotic ecosystem. It is recommended to prepare and implement a river management plan to protect such sites. Monitoring of the gharials should also be continued.

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# 1. Introduction

Gharial (*Gavialis gangeticus*), a keystone species of freshwater ecosystems, is the only survivor of the Gavialidae family (Maskey and Percival, 1994). It is highly threatened globally with increasing exploitation of rivers by humans, thus, listed as 'Critically Endangered' in the IUCN Red List since 1975 (Choudhary et al. 2007). It is also included in Appendix I of the Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES). Nationally, gharial is a listed as protected species in the National Park and Wildlife Conservation Act, 1973.

Historically, gharials were distributed across major rivers of the northern part of the Indian sub-continent. However, it is virtually extinct from most of its historical range i.e. Myanmar, Pakistan, Bhutan and Bangladesh. At present they are confined in few tributaries of Ganga River in India and Nepal in fragmented populations. Their population also declined drastically, a 96% decline since the 1940s due to anthropogenic as well as natural causes (Maskey 1997). Various studies indicate less than 200 breeding adult gharials surviving in the wild. The current population also includes the numbers established through reintroduction (GSRP, 2011).

The fragmented population of the endangered gharial crocodile is continuously under high risk of extinction due to human disturbances in rivers including overfishing, grazing, dam construction and over-exploitation of natural resources (Rajbhandari & Acharya 2013; Choudhury et al. 2007; Stevenson 2015). Realizing the precarious status, governments and conservation organizations have initiated various programs on gharial conservation to minimize the extinction threats. As part of this, the Government of Nepal established a Gharial Breeding Center (GBC) at Kasara in 1978 with the support of national and international conservation organizations. The breeding center has been very successful in breeding and raising the gharials in captivity. So far, 1,246 gharials have been released in different river systems of Nepal from 1981-2018 which contributed to sustaining the wild gharial populations in the rivers (DNPWC 2018). However, the wild populations haven't yet increased to the viable breeding population without supplements of captive-bred gharials.

There is limited information available about the dispersal and survival of the captive-bred gharials released in the wild.

The wild populations of gharials are small and vulnerable to local extinction. It is necessary to monitor their population periodically. It also helps to understand the status of the released gharials and their survival in the wild. Thus, a survey was conducted in February/March 2018 in Rapti, Narayani and their tributaries to assess the gharial population in Chitwan National Park and adjoining river stretches where gharials occur.

## 2. Objective

The Department of National Parks and Wildlife Conservation (DNPWC) has been conducting the monitoring of gharial population periodically through the Chitwan National Park Office in Rapti and Narayani river systems in central Nepal. The objective of this study is to update the existing status and distribution pattern of gharial in Chitwan National Park through a simultaneous and systematic survey.

## 3. Study Area

The survey was conducted in Rapti and Narayani Rivers in Chitwan Valley. Major portion of surveyed river stretches falls inside or at the boundary of Chitwan National Park. The Park is situated in south-central Nepal in the sub-tropical lowlands of the inner Terai of Chitwan, Makawanpur, Parsa and Nawalparasi districts. It is located between 27° 20’ 32” - 27° 41’ 23” North latitudes and 83° 52’ 40” - 84° 44’ 34” East longitudes and its buffer zone is located between 27° 16’ 56” - 27° 42’ 13” North latitudes and 83° 50’ 23” - 84° 46’ 25” East longitudes in the south-central lowland Nepal (CNP, 2016).

The Rapti River flows westward, along the northern border of Chitwan National Park, and confluences with the Narayani River near the northwestern corner of the park. It is a perennial river, originates in Mahabharat range, and flows for about 120 km before reaching Narayani River (Smythies, 1941 and Shankar, 1984). Two of the tributaries i.e. Budhi Rapti and Dhugre Khola which confluences in the Rapti were also surveyed.

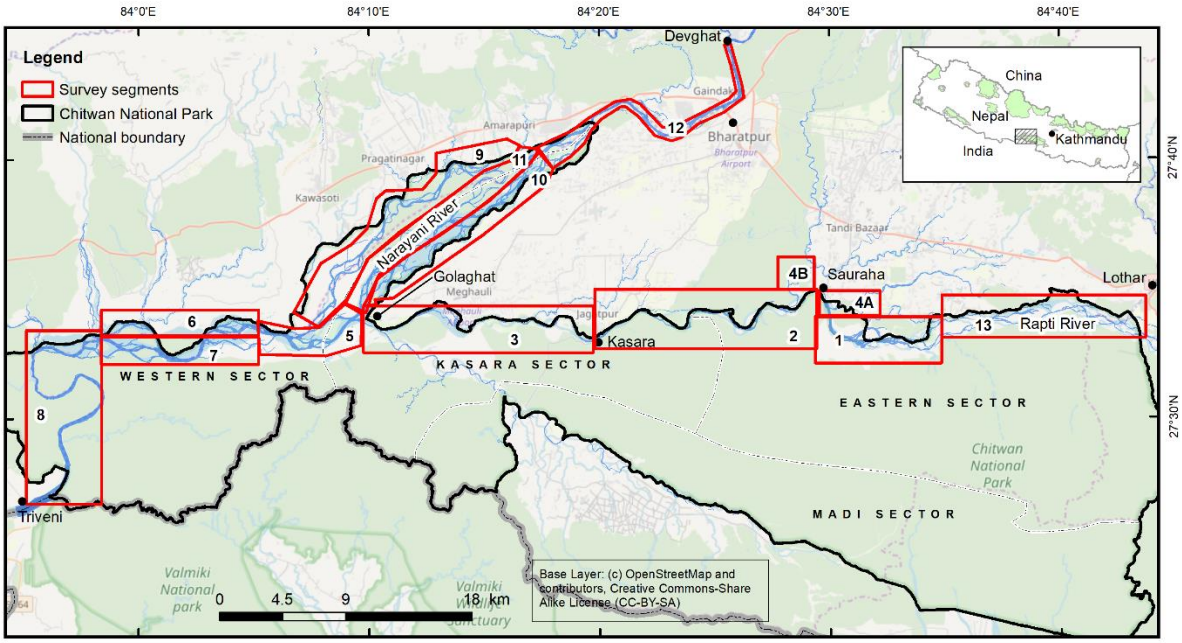


*Figure 1: Study area showing Narayani and Rapti rivers along with survey sections Chitwan National Park, Nepal*

The Narayani River is one of the major river systems in Nepal. It is a snow-fed river which originates in the Himalaya. It forms the north-western boundary of Chitwan National Park. After entering into Chitwan valley from Devghat, it flows southwest for 30 km before conjoining with Rapti. It then flows for about 20 km toward the west and 10 km south, reaching Tribeni and in due course joins the Ganga River in India.

The Rapti River from Lothar to Narayani-Rapti confluence was divided into 4 segments while Narayani River from Devghat to Triveni was divided into 8 segments for the study purpose. Similarly, tributaries of Rapti called Budhi Rapti and Dhungre Khola were considered as segment (4A and 4B) for this study (Fig 1).

## 4. Methodology

Population survey of gharials was carried out along the rivers through direct observation with active searches along the rivers following the methods of Acharya et al. (2017). This method assumes that all gharial come out of the water to bask during daytime in the surveyed season (winter months – late January to early March) and all of the basking gharials are counted (Maskey, 1989). However, to observe variation in the count as well as

to ensure greater detectability and reliability, we increased our sampling effort to three replicates for each of the river segments.

### 4.1 Sampling design

All the potential river segments where gharials reported to occur were surveyed in this study. The river segments were divided based on the approximate distribution of river length and ease in field logistics. The average length of the segment was ~16 km (range 10 – 25 km). Details of the survey segments and their location is given in Table 1 and figure 1.

*Table 1: Surveyed river segments and their length.*

| Segment | Segment name | Length (km) |
|---|---|---|
| **Rapti River** | | |
| **1** | Jindagani ghat to Sauraha, | 12.13 |
| **2** | Sauraha to Kasara Bridge | 20.17 |
| **3** | Kasara Bridge to Golaghat (Rapti – Narayani confluence) | 19.03 |
| **4** | Bhudi Rapti (A – Baghmara 4.52km) & Dhunge (B – Harnari to Sauraha 5.52 km) | 9.75 |
| **13** | Lothar to Jindagani Ghat | 13.17 |
| | *Sub-total* | *74.25* |
| **Narayani River** | | |
| **5** | Golaghat to Amaltari & back to Golaghat | 15.3 |
| **6** | Amaltari to ArunKhola (outer branch) | 18.73 |
| **7** | Amaltari to Arunkhola (Inner branch) | 13.97 |
| **8** | Arunkhola to Triveni | 17.24 |
| **9** | Giddeni to Gharial Monitoring Center (Confluence) | 25.25 |
| **10** | Ganjipur to Golaghat (outer branch) | 16.8 |
| **11** | Tinbhangalo to Golaghat (Inner branch) | 19.53 |
| **12** | Dev Ghat to Gideni/ Tin Bhangalo | 20.32 |
| | *Sub-total* | *147.14* |
| | **Total** | **221.39** |

### 4.2 Field survey

The field survey was conducted between Feb 23 and 25, 2018 in most of the river sections. Two segments (12 and 13) was surveyed a week later (Mar 02 & 04, 2018). Before the field survey, a daylong orientation training was conducted on Feb 22, 2018. The survey was conducted during the daytime after sunshine (~ 09:00 to 16:00 hrs). At the starting of the survey in each segment, GPS location, start time, weather condition were recorded. A team

of two trained data recorders and two boatmen used a dugout canoe or raft (in two segments – 8 & 12, of Narayani river) to float along the river segments. The survey teams scanned river banks on both sides for basking gharials using binoculars. They also recorded any gharial seen while floating on the river surface. A Garmin eTrex GPS unit was used to record the coordinates of the spot perpendicular to gharial locations at every sighting. Gharials were classified into Adults (>280), sub-adults (220 – 280), juveniles (100 – 220 cm) and yearling (<100 cm) (Acharya et al. 2017). The adult males were identified based on the presence of the ghara on the snout (Stevenson and Whitaker 2010). Sex cannot be determined for sub-adult, juvenile and yearlings from external characteristics.

# 5. Results

## 5.1 Population status and Distribution in Chitwan National Park

A total of 221.39 km segments of the Rapti and Narayani rivers were surveyed with three replicates. Minimum count of the gharials ranged between 173 and 219 during the survey (Fig 2). We estimated the minimum gharial population of 219 in Chitwan National Park and adjoining river stretches including 118 in Rapti and 101 in Narayani (Table 2).

*Table 2: Count of gharials in each of the three replicates on the surveyed river segments.*

| River | Segment | Segment name | Replicate 1 | Replicate 2 | Replicate 3 |
|---|---|---|---|---|---|
| Rapti | 1 | Jindagani ghat to Sauraha | 38 | 32 | 33 |
| | 2 | Sauraha to Kasara | 12 | 25 | 23 |
| | 3 | Kasara to Golaghat | 34 | 37 | 51 |
| | 4 | Dhungre-Budi Rapti | 6 | 4 | 7 |
| | 13 | Lothar to Jindagani ghat* | 3 | 4 | 4 |
| | | ***Subtotal*** | ***93*** | ***102*** | ***118*** |
| Narayani | 5 | Golaghat to Amaltari | 31 | 37 | 42 |
| | 6 | Amaltari to Arunkhola (outer channel) | 3 | 6 | 5 |
| | 7 | Amaltari to Arunkhola (inner channel) | 8 | 7 | 10 |
| | 8 | Arunkhola to Triveni | 7 | 11 | 6 |
| | 9 | Gideni Post to Amaltari | 9 | 10 | 10 |
| | 10 | Ganjipur to Golaghat | 11 | 12 | 15 |
| | 11 | Tinbhangala to Golaghat | 10 | 22 | 13 |
| | 12 | Devghat to Gideni* | 1 | 0 | 0 |
| | | ***Subtotal*** | ***80*** | ***105*** | ***101*** |
| | | **Total** | **173** | **207** | **219** |

*Survey was done during Mar 02 – 04

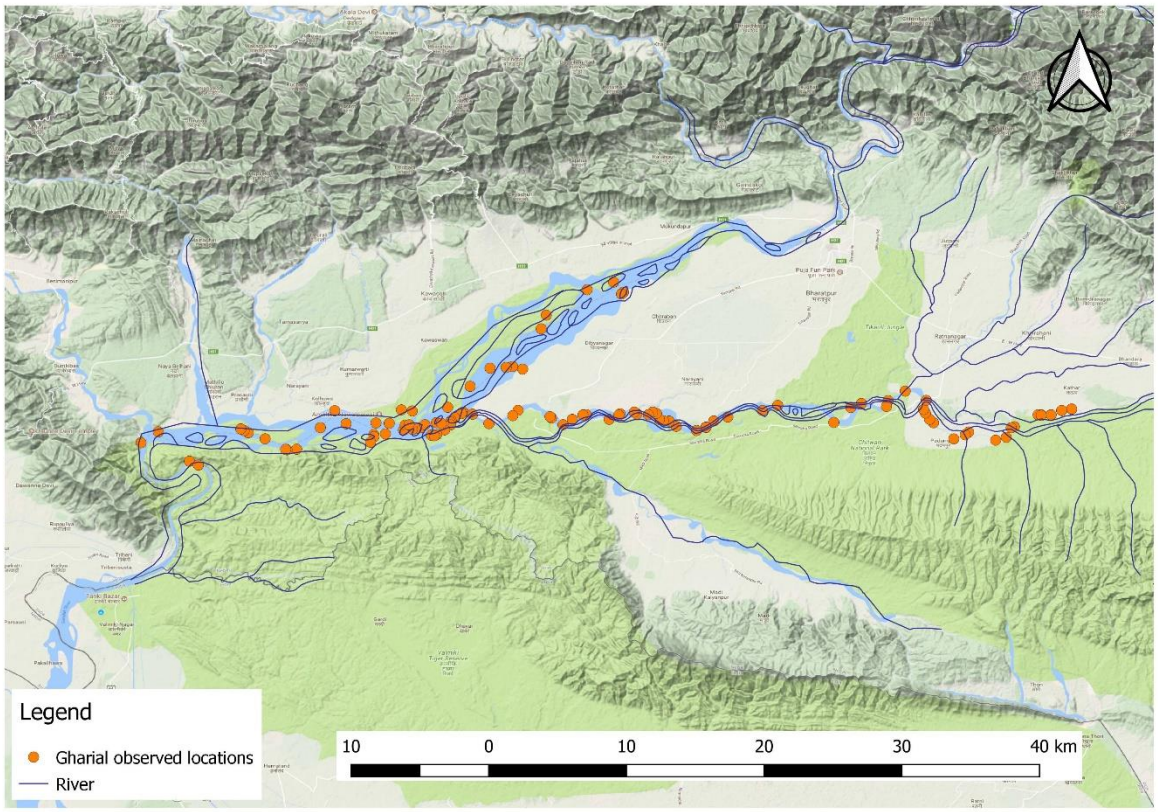


*Figure 2: Distribution of the gharials in Chitwan National Park and adjoining rivers segments.*

A total of 67 adult gharials (Male 3, Female 54, Sex undetected 10) were recorded during the survey. Juvenile gharials were seen more frequently (79) followed by sub-adults (66) and adults. Yearlings were rarely spotted (7). The following table (Table 2) shows the age-sex composition and encounter rate of gharials recorded in Rapti and Narayani rivers during the 3rd replicate.

*Table 3: Age-sex composition and encounter rate (number of individuals detected per km of search) of the gharials in Rapti and Narayani Rivers (AM – Adult Male, AF- Adult Female, AU – Adult Unknown sex, SU – Sub-adult, J – Juvenile, Y – Yearling).*

| River | Segment | Segment name | AM | AF | AU | SU | J | Y | Total | Encounter rate (per km) |
|---|---|---|---|---|---|---|---|---|---|---|
| Rapti | 1 | Jindagani ghat to Sauraha | 1 | 7 | | | 25 | | 33 | 2.72 |
| | 2 | Sauraha to Kasara | | 11 | | 1 | 11 | | 23 | 1.14 |
| | 3 | Kasara to Golaghat | 1 | 11 | | 10 | 27 | 2 | 51 | 2.68 |
| | 4 | Dhungre-Budi Rapti | | 2 | | | 3 | 2 | 7 | 0.72 |
| | 13 | Lothar to Jindagani ghat | | 2 | 1 | 1 | | | 4 | 0.30 |
| | | **Subtotal** | **2** | **33** | **1** | **12** | **66** | **4** | **118** | **1.59** |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Narayani | 5 | Golaghat to Amaltari | | 10 | | 30 | 2 | | 42 | 2.75 |
| | 6 | Amaltari to Arunkhola (outer) | 0 | | | 4 | 1 | | 5 | 0.27 |
| | 7 | Amaltari to Arunkhola (inner) | | 1 | 2 | 2 | 4 | 1 | 10 | 0.72 |
| | 8 | Arunkhola to Triveni | | | 1 | 4 | | 2 | 6 | 0.35 |
| | 9 | Gideni Post to Amaltari | | 9 | | | | | 10 | 0.40 |
| | 10 | Ganjipur to Golaghat | | | | 9 | 6 | | 15 | 0.89 |
| | 11 | Tinbhangala to Golaghat | 1 | 1 | 6 | 5 | | | 13 | 0.67 |
| | 12 | Devghat to Gideni | | | | | | | - | - |
| | | **Subtotal** | **1** | **21** | **9** | **54** | **13** | **3** | **101** | **0.69** |
| | | **Total** | **3** | **54** | **10** | **66** | **79** | **7** | **219** | **0.99** |

### 5.2 Population status in Rapti River

A total of 118 gharials were detected from Rapti River including 36 adults, 12 sub-adults, 66 juveniles and 4 yearlings (Table 2). The highest number of gharials were sighted in the downstream segment of the Rapti River (Segment 3, Kasara to Golaghat) followed by Segment 1 (Jindagani ghat to Sauraha) and Segment 3 (Sauraha to Kasara). However, the encounter rate (number of gharials sighted per km of search) was highest in segment 1.

### 5.3 Population Status in Narayani River

A total of 101 gharials were detected from Narayani River including 31 Adults 54 sub-adults, 13 juveniles and 3 yearlings. The highest number of gharials were sighted in Golaghat to Amaltari (Segment 5) followed by Ganjapur to Golaghat (Segment 10), Tinbhangale to Golaghat (Segment 11). Highest encounter rate was also found in segment 5.

## 6. Discussion

Gharial population in Rapti and Narayani Rivers within Chitwan National Park and adjoining river sections was found increasing since 2011. Compared to the previous survey in 2016 (Acharya et al. 2017), the population has increased by 32%. However, the increase in the population was primarily due to a higher number of sub-adult and juvenile gharials. During this survey, we covered longer river stretches (Upstream of Rapti and Narayani River) compared to previous surveys. Three adult males (one in Narayani and two in Rapti) were recorded during this survey. Only seven yearlings (immature hatchling) were detected which indicates low natural hatching in the wild.

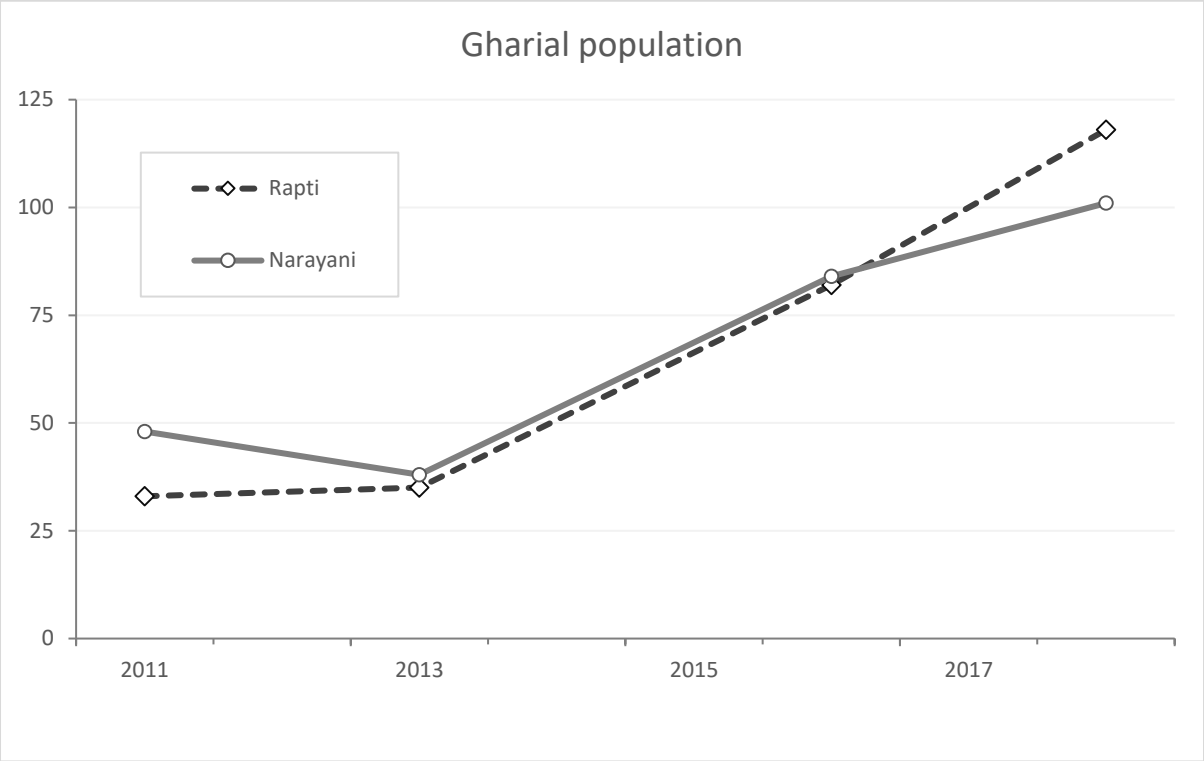


*Figure 3: Gharial population trend in the Rapti and Narayani rivers between 2011 and 2018.*

The adult gharial population remained stable, while there was a high increase in juvenile and sub-adult populations. Compared with 2016 survey, both the Rapti and Narayani rivers observed an increase of gharial population i.e. rise of 34 and 19 gharials respectively. A large number of juvenile gharials (n=48) were released at the junction of Segment 2 (Sauraha – Kasara) and 3 (Kasara – Golaghat) a week before the survey. This may have caused in an inflated population of juveniles, especially on these survey segments. However, some experts believe that the released gharials are shy to come out for basking and remain mostly under water for few weeks after release (Personal Commnication, Bed B. Khadka, 2018).

There was a high variation of gharial numbers recorded among three replicates in most of the rivers segments. During the first and second replicate (23$^{rd}$ and 24$^{th}$ February 2018) the weather was cloudy with faint sunlight. Such weather might have caused gharials to stay inside the water violating the assumption of population survey that all gharials come out for basking during the sunny winter days. Thus, we reported the gharial population recorded on the third replicate on which the maximum number of individuals were counted. It also

indicates that a single replicate is not sufficient for obtaining reliable estimates of population status.

The study also indicates that the gharials in CNP were not uniformly distributed across the segments. Their distribution was uneven between the segments. Only a few locations showed a high concentration of the species while many segments were sparsely populated. Segment 3 of the Rapti River (Kasara Bridge-Golaghat) had the highest concentration of the species i.e. 51 in a total of which 21 individuals were sighted at Dharampur Ghat itself, confirming it as a Gharial hotspot (Figure 2). Simultaneously, segment 5 in the Narayani River (Golaghat-Amaltari) had the highest concentration of the species i.e. a total of 42 of which 21 individual sightings occurred at the Rapti confluence itself. This congregation of Gharials in the two locations indicate these areas as their suitable habitat with the availability of substantial fish stocks, undisturbed natural sand banks, low anthropogenic pressures and an overall healthy lotic ecosystem.

The sex ratio of adult gharials was highly skewed towards female (male to female ratio 1:21) in spite of an increase in adult male gharial count from one in 2016 to three this year. Previous surveys of gharials have also documented a highly skewed sex ratio with very small number of adult males (male to female ratio of 1:9 in 1984 and 1:6 in 1987). However, it was record low during 2016 survey with only a single adult male in Chitwan (sighted in downstream segments of Narayani River) while 68 adult females (distributed across all segments) were sighted during the same survey. The adult male gharial of Narayani River died in 2016 and another male was translocated from Bardia in 2017 to fill the gap. Sighting of three adult males during this survey is a good indication for increasing genetic diversity of the gharial population.

The potentially suitable habitats for the gharial along the edges of the Rivers (border of CNP) are continuously declining with increasing human disturbances. The survival of the gharials depends on the protection of such sites. Thus, we strongly recommend to prepare and immediately implement a river management plan separately or incorporated within the management plan of CNP and buffer zone. Similarly, regular monitoring of the wild and the reintroduced Gharials needs to be carried out to evaluate its population status, habitat

requirements, effects of existing conservation practices, the survival rate of the reintroduced individuals, and assess the impacts of overfishing on its survival in the rivers of the Chitwan National Park.

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# 8. Annex

Annex 1. Start and end point GPS coordinates of survey segments.

| River | Segment | Segment name | Start | | End | |
|---|---|---|---|---|---|---|
| | | | Latitude | Longitude | Latitude | Longitude |
| Rapti | 1 | Jindagani ghat to Sauraha, | 27.56172 | 84.58078 | 27.57388 | 84.49316 |
| | 2 | Sauraha to Kasara Bridge | 27.57388 | 84.49316 | 27.55142 | 84.32554 |
| | 3 | Kasara Bridge to Golaghat (Rapti – Narayani confluence) | 27.55142 | 84.32554 | 27.56356 | 84.15929 |
| | 4 | Bhudi Rapti (Baghmara) | 27.59593 | 84.48567 | 27.57563 | 84.51615 |
| | | Dhunge (Harnari to Sauraha) | 27.57680 | 84.47353 | 27.57323 | 84.49458 |
| | 13 | Lothar to Jindagani Ghat | 27.56147 | 84.70923 | 27.56172 | 84.58078 |
| Narayani | 5 | Golaghat to Amaltari & back to Golaghat | 27.56356 | 84.15929 | 27.55567 | 84.08851 |
| | 6 | Amaltari to ArunKhola (outer branch) | 27.55567 | 84.08851 | 27.55249 | 83.96418 |
| | 7 | Amaltari to Arunkhola (Inner branch) | 27.55567 | 84.08851 | 27.55249 | 83.96418 |
| | 8 | Arunkhola to Triveni | 27.55249 | 83.96418 | 27.47130 | 83.94278 |
| | 9 | Giddeni to Gharial Monitoring Center (Confluence) | 27.66952 | 84.26642 | 27.55614 | 84.11926 |
| | 10 | Ganjipur to Golaghat (outer branch) | 27.65561 | 84.28331 | 27.56356 | 84.15929 |
| | 11 | Tinbhangalo to Golaghat (Inner branch) | 27.66822 | 84.27341 | 27.56356 | 84.15929 |
| | 12 | Dev Ghat to Gideni/ Tin Bhangalo | 27.73965 | 84.42313 | 27.67362 | 84.28093 |

**Annex 2: DATASHEET - CROCODILE MONITORING IN CHITWAN NATIONAL PARK – RIVERS SIGHTING RECORDS 2018**

Form No:

Date: _____ Replicate Number: _____ Observers Name: _____

River Name_____ Segment Name_____

Start GPS: wpt:____N _____ E_____ Start time: _____ Weather: _____

End GPS: Wpt: _____ N _____E _____ End Time: _____ Weather: _____

| S.N | Time | Weather | Species seen | | Indirect sign type | Location | GPS | उमेर समुह (Age group) | | | | | | | नदीको वहाव River flow | Activity | Substratum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | वयश्क (>300cm) | | | अर्ध वयश्क (180-300cm) | Juvenile (90-180cm) | बच्चा Yearling (<90cm) | उमेर थाहा नभएको | | | |
| | | | Gharial | Mugger | | | | भाले | पोथी | भा./पो. नछुट्टि | | | | | | | |
| | | | | | | | N: E: | | | | | | | | | | |
| | | | | | | | N: E: | | | | | | | | | | |
| | | | | | | | N: E: | | | | | | | | | | |
| | | | | | | | N: E: | | | | | | | | | | |
| | | | | | | | N: E: | | | | | | | | | | |

**Habitat Substratum**: Sandy bank (SB), Grassy Bank (GB), Muddy Bank (MB), Boulders/Gravel Bank (BB), Water (W), Others –specity (O)
**Activity**: Basking (B), Fishing (F) , Swimming (S), **Indirect sign type:** पाईला/घस्रेको (T), दिसा (SC) वा गुँड (फुलपारेको वा प्वाल) (N)
**River Flow**: Fast flowing, (FF) Slow flowing (SF), Stagnant (ST)

**Annex 3: DATASHEET: CROCODILE MONITORING IN CHITWAN NATIONAL PARK – RIVERS HABITAT & DISTURBANCE PARAMETERS 2018**

Form No:

Date: _____ Observers Name: _____

River Name_____ Segment Name_____

Start GPS: wpt:____N _____ E_____ Start time: _____

End GPS: Wpt: _____ N _____E _____ End Time: _____

| Replicate-Every 200m | Sign of Gharial/ Mugger (Y/N) | GPS location | Anthropogenic Parameters | | | | | | | Habitat parameters | | | | Others (Comment) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Washing/Bathing / Swimming (No.) | Cattle grazing (No.) | Sand mining/Stone quarrying (No.) | temporary camps Fishermen huts (No.) | River pollution (waste /effluents/domestic sewage) (Y/N) | Fishing | | River width (m) | River depth (ft) | Sand bank (None /one side / both side) | River / stream confluence (Y/N) | |
| | | | | | | | | Type * | Number | | | | | |
| | | N: | | | | | | | | | | | | |
| | | E: | | | | | | | | | | | | |
| | | N: | | | | | | | | | | | | |
| | | E: | | | | | | | | | | | | |
| | | N: | | | | | | | | | | | | |
| | | E: | | | | | | | | | | | | |
| | | N: | | | | | | | | | | | | |
| | | E: | | | | | | | | | | | | |

* Fishing Type: Gill net, Hand net, Hook, Poisoning, Electrocution