Gharial (*Gavialis Gangeticus*): Population Status and Habitat Mapping in Babai River, Bardiya, Nepal.

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Abstract

The *Gavialis gangeticus* is the solitary member of the family Gavialidae and has been listed as Critically Endangered species in IUCN Red Data book. It is considered as an indicator species of healthy freshwater ecosystems. Physically, it bears long slender snout with clear sexual dimorphism. Gharial are only confined in Karnali, Babai, Narayani and Rapti river system of Nepal. Between 1940 and 1980, there has been about 90% of gharial population declination which pushes it to fringe of extinction. Habitat fragmentation and destruction, construction of dams, over fishing and pollution are main causes of its declination. Government of Nepal has declared this critically endangered species as protected species under National Park and Wildlife Conservation Act 1973. Since 1978, the restocking program with establishment of Gharial Conservation Project at Chitwan National Park, the population was brought back from the stage of extinction. Babai river is one of the potential habitats for Gharial in Nepal. The main aim of this study was to update the existing population status and habitat mapping of gharial in Babai river. The survey was carried out in Babai river located both inside and outside the Bardiya National Park. Intensive survey was carried out on foot in Feb to March 2021 in sunny days only. No repetition of survey has been done. For direct observation Binocular, camera and GPS were used while U shaped marking were checked for the gharial presence. Key informant interview was carried with park authorities for high potential habitat of gharial. The collected data were analyzed using Ms-excel Google Earth pro and Arc GIS. A small population of 7 and 2 were sighted in Prewaodar and Gaile respectively which are inside National Park. No gharial was directly observed outside the national park but two U shaped markings were observed near river bank. Most of the habitats are high sand bank with fast flowing river which are very suitable for basking, laying eggs and nesting. Babai river meets all the habitat components which are very suitable for gharial. Due to frequent movement of Wild Elephant and man eater tiger in the study area some section could be cover. The survey was carried out in late February due to Covid-19 pandemic.

Keywords: Gharial, Babai river, Habitat, Population.

Introduction

The Gharial corocodile, a large piscivorous reptile endemic to Indian subcontinent, is the sole surviving member of family Gavialidae, that falls within the order Crocodilia (Tirtha Man Maskey 1989; Katdare et al. 2011). Considered as a keystone species of healthy freshwater, Gharial plays a critical role in maintaining the aquatic ecosystem and its function through its activities (Behera et al. 2014; Singh and Rao 2017). The widely distributed gharial population was estimated from 5000 to 10,000 until 1940s ((Thapaliya et al. 2009; Maskey et al. 2006). Between 1940 and 1980, there has been about 90% of Gharials population decline which pushes it to verge of extinction throughout their range (Maskey 1989; Choudhury et al. 2007). These crocodilians are listed as Critically Endangered by IUCN which are currently distributed in 14 widely spaced locations in India and Nepal (Lang et al. 2019). In Nepal, these crocodiles species are only confined in the Karnali and Babai river system in Bardiya National park and the Narayani and Rapti river system in Chitwan National Park (Khadka and Bashyal 2019). Habitat destruction and alteration, land cover change, alien species, construction of dam & barrages, fishing nets and pollution are all

recognized causes of crocodilians diversity decline (Cushman 2006; Goode et al. 2004; Lang et al. 2019).

The largest of the living crocodilians, *Gavialis gangeticis,* bears long slender snout with clear sexual dimorphism (Bhatta 2009). Adult male grow a bulbous nasal appendages, known as *ghara*, from which species derives its name (Stevenson and Whitaker 2010). The maximum body length of male is 7m whereas female is of 5m and matures at the age of 14 and 10 respectively (Ballouard and Cadi 2005). The breeding season starts from February to April. Especially in winter season, basking is characteristic activity of gharial.

There are two species of crocodilians found in Nepal i.e., Gharial (*Gavialis gangeticus*) and Mrash Mugger (*Crocodylus palustris*). Gharial is one of the protected wildlife listed in Schedule I of National Parks and Wildlife Conservation Act, 1973. With the establishment of Gharial conservation project at Chitwan National park, it was brought back from the stage of extinction by restocking program from 1978 (Bhatta 2009). This program restocks Gharial population through egg collection from river bank, captive rearing and releasing young to the wild. Till 2007, a total of 691 Gharials have been released to the different river (DNPWC 2007a). But the current population of Gharial is estimated to be only 198 individuals with adult population of 85 (Acharya et al. 2017). In addition to this out of 110 Gharials released till 2017 only 31 individuals are reported from Babai river (Acharya et al. 2017).

Babai River is one of the potential habitat for Gharial in Nepal. Threats to Gharial include the overwhelming and irreversible loss of riverine habitat due to the construction of dams, irrigation canals, sand-mining, pollution and agriculture. Moreover, communities around the National Park are heavily dependent on natural resources for their day to day lives, relying on fishing for their livelihoods and food impacting both Gharial and local people. This dependency causing ecological disaster for the gharial is not far.

Rationale

Gharial, the only survivor of the Gavialidae family, is the most important keystone species of running freshwater. It helps in maintaining the aquatic ecosystem and increase the primary production and fish population (CSG 2007). They are the top predator and as such are an essential part of biodiversity of these habitats. They feed on the slow moving prey among moving predatory fish thus removing diseased individuals, thereby maintaining good stocks of commercially valuable fish in any water body (Thapaliya et al. 2009). Few studies of Africa, Australia and America shows that the presence of crocodile in any water system boosted fish stocks in it (Deppert 2004). So, any loss of the crocodile species in the river would represent a significant loss of biodiversity.

Habitat loss along with intensive fishing had led to declination of population of gharial in Nepal. Gharial was literally brought back from the verge of extinction by restocking program from 1978 with the establishment of gharial conservation at Chitwan National Park (Bhatta 2009). Limited distribution of gharial itself is a major threat for conservation. The department of National Park and Wildlife Conservation through its captive breeding program, is regularly releasing the gharial population in the wild but it has not been stabilized and rearing and releasing of its population is

not enough for gharial conservation. Moreover, very few studies have been carried out on gharial in Babai river, as this river is one of the major habitats for gharial. Most of the studies have been focused in Narayani and Rapti river in Nepal. Little is known about the current population status and habitat of gharial in Babai river.

Understanding the population status and habitat mapping is foremost step to start conserving and managing wild population. Therefore, this study has been conceptualized to determine population status and habitat mapping in Babai river both inside and outside the Bardiya National Park. This will provide significant insight for adopting appropriate management intervention for gharial conservation in perpetuity.

Objectives

The main aim of this project was to update the existing status and support the conservation of Gharial population in Babai river. The specific objectives are:

- To assess the population status of Gharial in Babai river (both inside and outside the National Park).
- Gharial habitat mapping for understanding the associated habitat characteristics.

Methodology

1. Study Area

The research was carried out in Babai river (27°44′08″N 81°17′54″E), which is located inside and outside the Bardiya National Park of Nepal. It is major perennial river which flow along a North-South gradient and form its flood plains. The Babai river is approximately 43.76 km long inside the national park and 45.07 km long outside the national park. The total catchment area of this river is ~2602 km2 encompassing the northern and southern Churia range and Foothill areas (Thapa et al. 2018). The water temperature goes 17-22°C in winter and 27-28°C in summer. The gharial, mugger and smooth coated otter are the main freshwater predators along with 125 species of fish as prey base found in this river (DNPWC 2007b). It is also home to majority of species including large mammals such as Asian elephant (Elephas maximus), Greater one-horned rhinoceros (Rhinoceros unicornis), and Bengal Tiger (Panthera tigris tigris). The vegetation is sub-tropical, consisting of a mosaic of early successional floodplain vegetation along the Babai and its tributaries, and with large areas of Sal (Shorea robusta) forest on the upper, drier land (Steinheim et al. 2005).

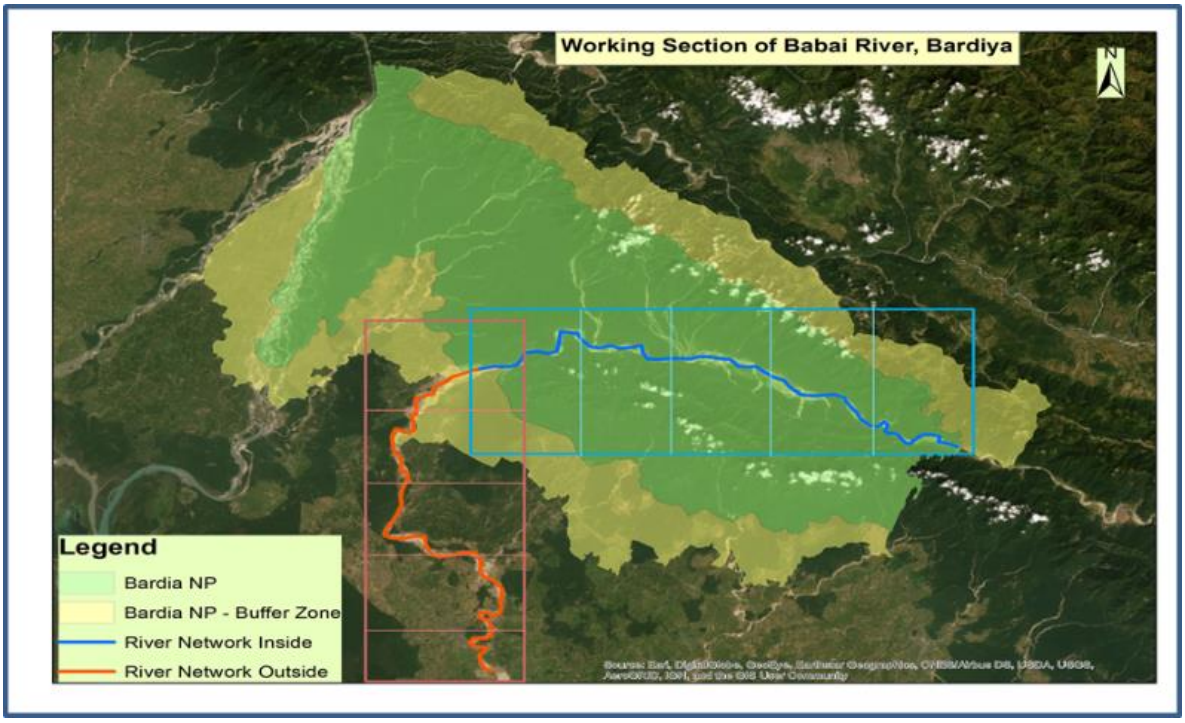


Figure 1: Map showing study location

Field data were collected on the sections of Babai river. The river was divided into 2 sections and each section was further divided into 5 segments. Thus, the survey was done in these sections and segments.

Table 1: Section statistics of study area

River	Section no.	Length approximate (Km)
Babai River	1	43.76 (Inside the Park)
	2	45.07 (Outside the Park)

2. Method

Basically, this study mainly relies on primary data collection in the field. Primary data constitutes preliminary survey, direct sightings and indirect sightings. Secondary data was also collected through literature review which includes research reports, journals articles, books and relevant websites. Secondary data were very important for analyzing primary data as well as comparing the results with the previous findings.

a) Preliminary survey

Preliminary survey was done in March 2020 to understand the field more critically and for primary data collection. Informal interview with key informants, local people and direct observation was also included for the preliminary survey.

b) Detailed Field survey

The intensive survey for estimating Gharial population and its habitat types along the Babai river system was conducted in Feb to March, 2021. The river system was divided into 2 sections and it was further divided into 5 sub sections for survey convenience and to keep track of the field work within the predetermined time frame. Based on the direct observation, opportunistic search was conducted during the mid day between 1100 to 1600 hrs. in sunny days. In the foggy weather, an adverse condition for basking, the survey was kept on hold. Because the accuracy of survey largely depends on the basking habit of gharial as gharial come out of water for basking in sunny days.

Moreover, no repetition of survey has been done i.e., it was conducted only once so statistical error could not be computed and determination of the range of maximum and minimum population was difficult. Number, stage of maturity, sex and GPS location of sighted gharials were recorded along with the habitat type. Binocular and camera with lens range 150-600mm were used for direct observation to determine the details of the individual i.e., sex, activity during sighting etc. According to procedure mentioned in Whitaker and Basu (1982), maturity and sex of gharial were identified.

For indirect observation of gharial presence, a 'U' shaped marking was checked because gharials leave this marking on the sand bank (Whitaker and Basu 1982). Additionally, survey was conducted on foot along the Babai river. Due to very shallow river depth, boat was not used for the survey.

c) Key Informant survey

High potential area for the gharials was identified through key informant interview based on the knowledge of Park officials and Buffer zone people.

3. Data analysis

The collected data were compiled and analyzed using MS-Excel. The habitat mapping of gharial was mapped using Google earth pro and Arc map software.

Results

A. Population Status

The result of the population status conducted in both outside and inside the Bardiya National Park has been interpreted as the minimum count of the gharials which is the number of gharials directly sighted by the observation team. the indirect evidences were further verified through direct inspection of the evidence and discussion with key informant. Thus, the number of gharials confirmed through indirect sightings was also summed up with the minimum population to total population.

Inside Bardiya National Park

A population of seven individuals were observed in Parewaodar section. Four out of seven were female and three were immature. The sex of these three individuals could not be differentiated. The two female and three immatures were found basking on the smooth sand bank while two

females are found in water pool near to the Babai dam for fishing. 13 mugger crocodiles were also found in this section sharing the habitat with gharial which is flat smooth sand bank and in the water pool.

Another small population of two individual of gharial were sighted along Gaile section of river. Both individuals were immature found basking on the sand bank. Sex could not be identified. Along with gharial 4 mugger individuals were also found basking on the sand.

Outside Bardiya National Park

Unfortunately, survey conducted over 45.07 km (outside the park) river sections of banks of Babai river, no Gharials were observed. However, 10 individuals of mugger crocodile were observed basking near bushes, sand bank and sandy gravel. But we observed two U shaped markings near the bank of river, which was confirmed to be of the gharial. These signs were verified based on the knowledge of park officials who worked on gharial for long period.

Table 2: Record of gharial in Babai river

S.N	Location	Northing	Easting	Sex	Age	Habitat	Activity
1	Parewaodar	28°25'29.9"	81°22'47.7"	Female	Adult	Sand Bank	Basking
2	Parewaodar	28°25'29.9"	81°22'47.7"	Female	Adult	Sand Bank	Basking
3	Parewaodar	28°25'29.9"	81°22'47.7"	Female	Adult	Water pool	Fishing
4	Parewaodar	28°25'29.9"	81°22'47.7"	Female	Adult	Water pool	Fishing
5	Parewaodar	28°25'29.9"	81°22'47.7"	Unknown	Immature	Sand Bank	Basking
6	Parewaodar	28°25'29.9"	81°22'47.7"	Unknown	Immature	Sand Bank	Basking
7	Parewaodar	28°25'29.9"	81°22'47.7"	Unknown	Immature	Sand Bank	Basking
8	Gaile	28°22'12.9"	81°39'36.7"	Unknown	Immature	Sand Bank	Basking
9	Gaile	28°22'12.9"	81°39'36.7"	Unknown	Immature	Sand Bank	Basking
10	Bawanpur*	28°24'55.5"	81°20'22.9"	Unknown	Unknown	Sand Bank	Unknown
11	Bela*	28°16'59.6"	81°19'16.4"	Unknown	Unknown	Sand Bank	Unknown

*Indirect Observation

B. Habitat Mapping

Major Habitat components were observed on the basis of mentioned habitat monitoring sheet. The gharials were observed at Parewodar and Gaile section inside the national park and Bawanpur and Bela section outside the national park. According to local sightings, they were often sighted at Rohini Dhunga, Jagati Ghat, Gandaki Ghat sections of the river. These spots are regarded as primary habitats of gharial. Most of the habitats are high sand bank with fast flowing river which are very suitable for basking, nesting and laying eggs. The long stretch of Babai river section that flows inside the national park boundary is also free from human disturbances. Several studies shows that gharial usually occupy river stretch where there is zero to very low level of disturbances, presence of fine sand banks and greater prey availability (Nair et al. 2012). Babai river meets all these habitat components which are suitable for gharials. Besides this, mugger crocodiles were also found sharing the habitat with gharial where the river has flat sand bank with medium water velocity. This habitat sharing also indicated the competition between these two crocodilian species in the favorable locations and yet served as an indicator of preferred habitat

condition for crocodiles. Habitat maps of gharial was prepared on the basis of both local sightings and study sightings.

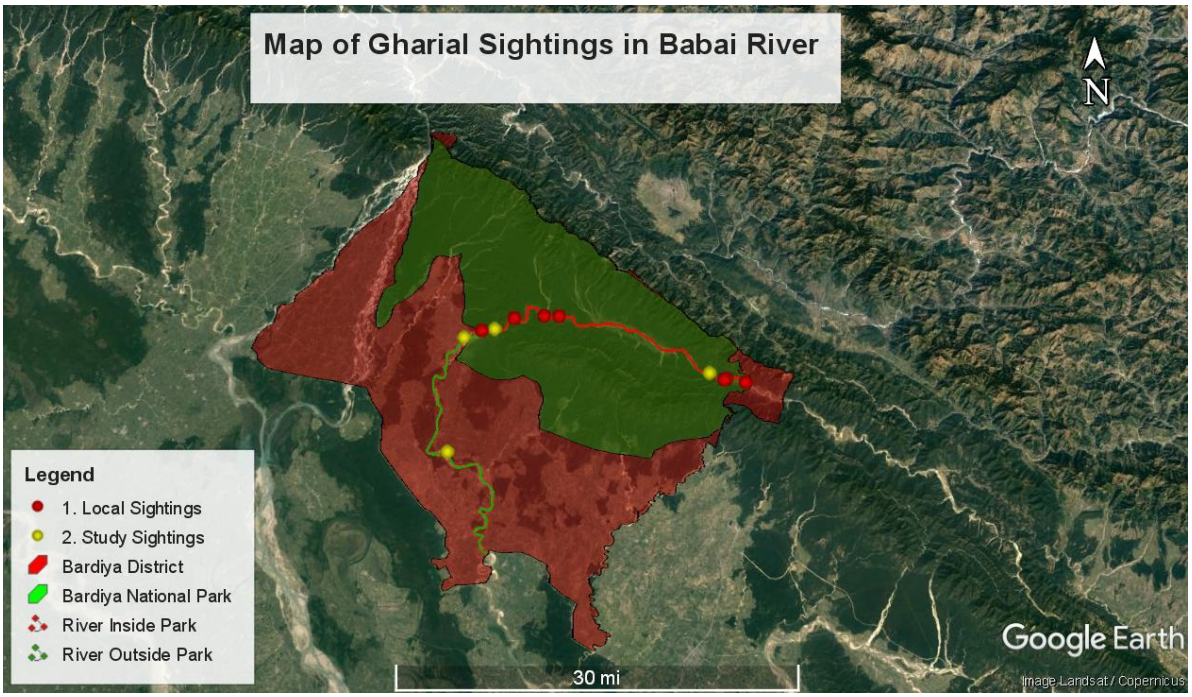


Figure 2: Showing study sighting and local sightings of gharial

Conclusion

The study identified a total of 11 gharials from the area. Out of 11, seven were recorded from Parewaodar, two from Gaile area and remaining two U shaped marking were observed. Since the survey was conducted at the selected section of the river based on the knowledge of the local experts and park officials mapping of the gharial habitat was not possible. Due to the Covid-19 situation we were not able to cover all the sections as proposed. This limited the number of experts, park officials and local experts who could help us explore more areas suitable for gharial. Moreover, the existing movement of the man eater Tiger in the study area and frequent recorded human-elephant conflict limited our field visit thus confining us to the certain area as explained above.

Recommendation

Frequent and intensive survey along the Babai river (both outside and inside the park) is crucial to explore the population of gharial. Further, detail study on gharial habitat, sand bank percentage, food availability, water quality assessment and possible threats on the species is recommended for safeguarding the population of these threatened species.

Limitation

- Survey carried out late Feb to March due to Covid-19 pandemic.

- Survey cannot be done in few sections due to frequent movement and incidents caused due to man eater Tiger and wild Elephants.

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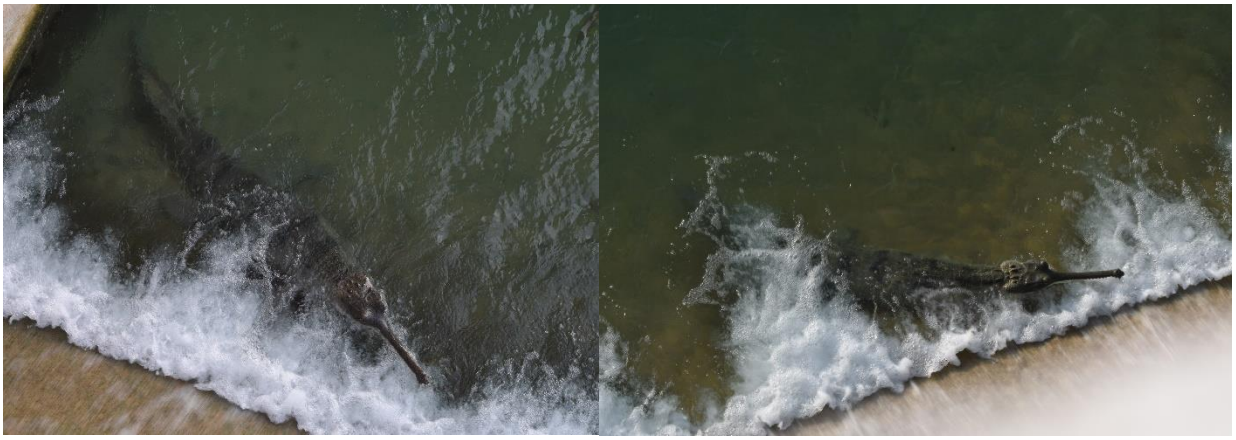
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Photo Plate



Gharial in water pool in Babai dam, Parewaodar



Gharial basking on smooth sand bank, Parewaodar

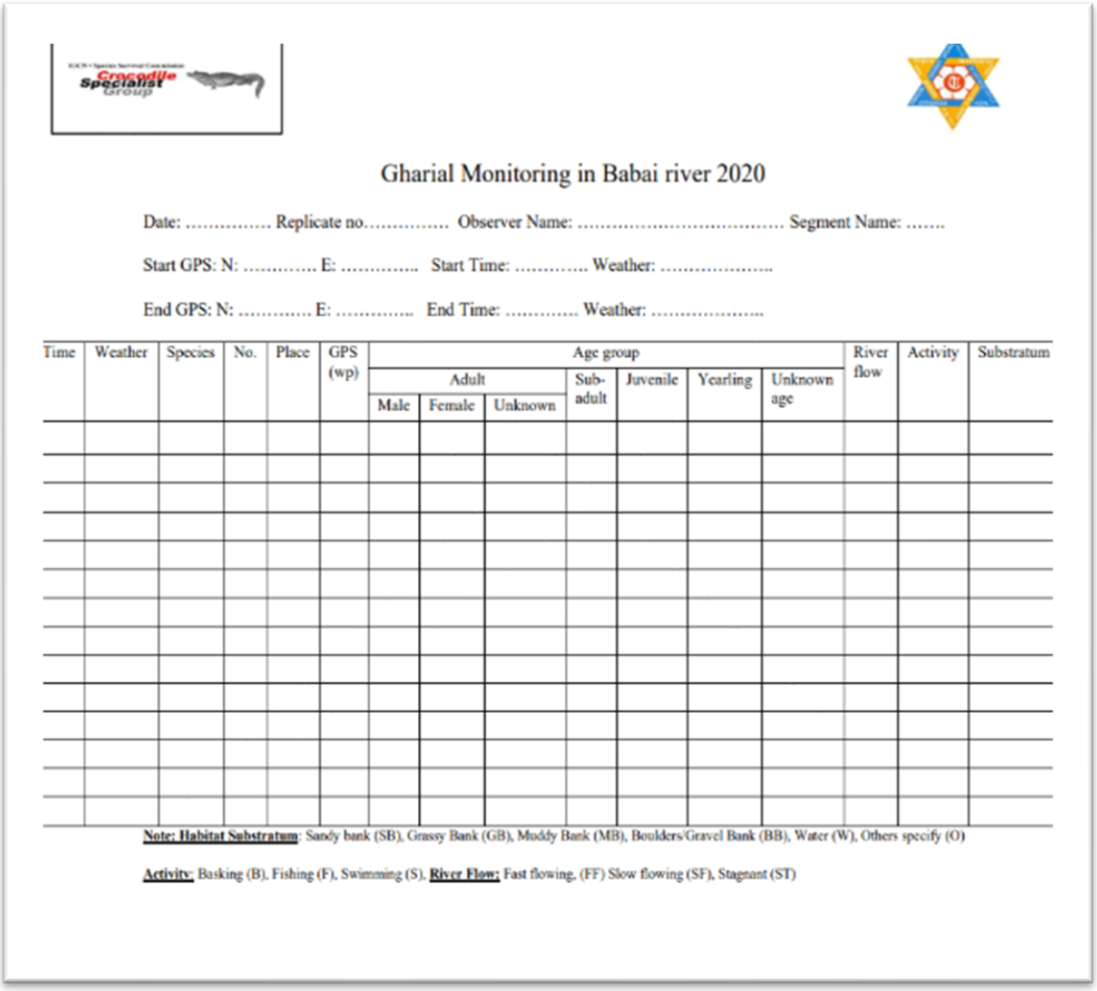


Gharial basking at Gaile.



U-shaped marking

Gharial Population Monitoring sheet



Gharial Monitoring in Babai river 2020

Date: ..... Replicate no..... Observer Name: ..... Segment Name: .....

Start GPS: N: ..... E: ..... Start Time: ..... Weather: .....

End GPS: N: ..... E: ..... End Time: ..... Weather: .....

Time	Weather	Species	No.	Place	GPS (wp)	Age group							River flow	Activity	Substratum
						Adult			Sub-adult	Juvenile	Yearling	Unknown age			
						Male	Female	Unknown							

Note: Habitat Substratum: Sandy bank (SB), Grassy Bank (GB), Muddy Bank (MB), Boulders/Gravel Bank (BB), Water (W), Others specify (O)

Activity: Basking (B), Fishing (F), Swimming (S). **River Flow:** Fast flowing, (FF) Slow flowing (SF), Stagnant (ST)