Population status, distribution and conservation issues of Gharial (*Gavialis gangeticus*) in Rapti River of Chitwan National Park, Nepal

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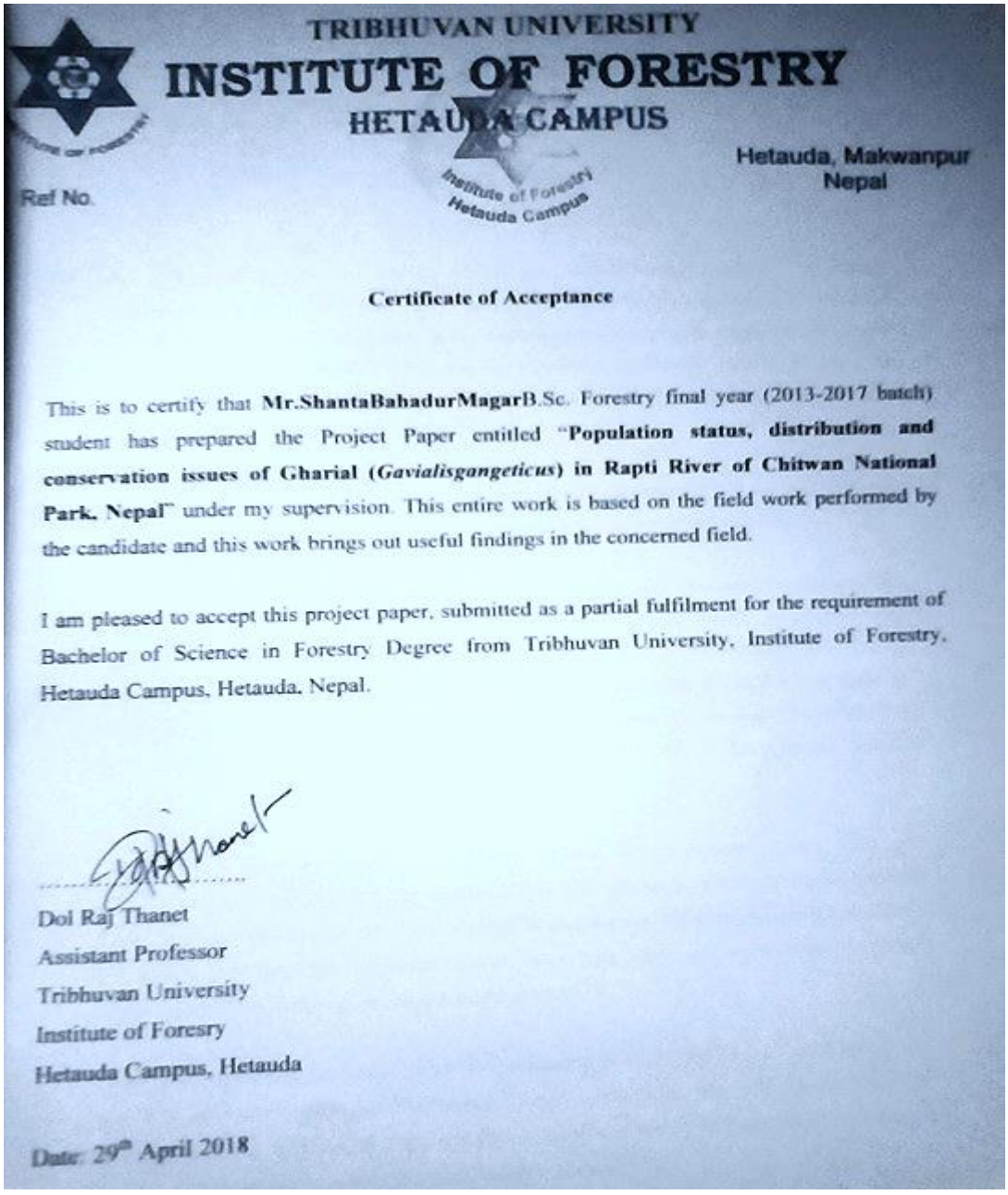
Declaration

I, Shanta Bahadur Magar, hereby declare that this project report entitled **"Population status, distribution and conservation issues of Gharial (*Gavialis gangeticus*) in Rapti River of Chitwan National Park, Nepal"** is my original work and all other sources of information used are appropriately acknowledged. I have not submitted it or any of its part to any other university for any academic award.



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Certificate of Acceptance



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Certificate of Acceptance

This is to certify that **Mr.ShantaBahadurMagar**B.Sc. Forestry final year (2013-2017 batch) student has prepared the Project Paper entitled "**Population status, distribution and conservation issues of Gharial (*Gavialisgangeticus*) in Rapti River of Chitwan National Park, Nepal**" under my supervision. This entire work is based on the field work performed by the candidate and this work brings out useful findings in the concerned field.

I am pleased to accept this project paper, submitted as a partial fulfilment for the requirement of Bachelor of Science in Forestry Degree from Tribhuvan University, Institute of Forestry, Hetauda Campus, Hetauda, Nepal.

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ACRONYMS

BNP	Bardia National Park
CITES	Convention on International Trade of Endangered Species of Flora and Fauna
CNP	Chitwan National Park
CSG	Crocodile Specialist Group
DNPWC	Department of National Park and Wildlife Conservation
GCBS	Gharial Conservation and Breeding Centre
GPS	Global Positioning System
IGA	Income Generation Activity
IUCN	International Union for Nature Conservation
NGO	Non-Governmental Organization
NTNC	National Trust for Nature Conservation
UNESCO	United Nations Educational Scientific and Cultural Organization

ABSTRACT

The gharial is considered to be one of the most critically threatened of all crocodilians, becoming alarmingly close to extinction in the 1970s. Because of the evidence of widespread and rapid population decline, gharial was listed by IUCN 2007 Red List as „Critically Endangered" which is the highest category of endangerment.

This project was conducted to update the population status of gharial in Rapti River especially after the cloudburst on mid-August 2017, determine their distribution along various sections of the Rapti River and outline the issues on gharial conservation in order to suggest some appropriate actions for long-term management. Primary data were collected through population survey, questionnaire survey and key-informant interviews followed by secondary data collection from research reports, journal articles, books and records from DNPWC. Initially the population survey was carried out on three sections of Rapti River viz Jindagani ghat to Sauraha, Sauraha to Kasara and Kasara to Golaghat (Rapti/Narayani confluence) from February 23 to 25, 2018 with three replication on each sections. Later, upon call from local people on presence of Gharial in Lothar area, the population survey was carried out on the fourth section viz Lothar to Jindagani Ghat from March 2 to 4, 2018 with three replication. Surprisingly, a total of 111 individuals of gharials were directly sighted in the Rapti River compared to 80 individuals in 2016. The recent release of 48 gharials in Kasara from the breeding center on February 14 and 16, 2018 may have influenced the count as no gharials were seen in the enclosure constructed for their soft release.

The trend of gharial population was found increasing by both field survey and questionnaire survey. Use of gill nets, night fishing and river pollution serve as major issues for gharial conservation.

Keywords: Gharial conservation, Population survey, issues, Rapti River

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CHAPTER - I
INTRODUCTION

1.1. General Background

The gharial, *Gavialis gangeticus*, the only survivor of the Gavialidae familiy (Maskey and Percival, 1994), is considered to be one of the most critically threatened of all crocodilians becoming alarmingly close to extinction. In spite of its wide distribution and its previous abundance, it is the least known of the 23 crocodilian species in the world (Whitaker and Basu, 1983). Gharial is one of the seven of the most threatened crocodiles in the world. Within the Crocodilians, only two species are found in Nepal, the gharial crocodile (*Gavialis gangeticus*) and Mugger crocodiles (*Crocodilylus palustris*). Because of the evidence of widespread and rapid population decline, gharial was listed by IUCN, the World Conservation Union, as „Critically Endangered" in the Red List 2007, which is the highest category of endangerment.

Previously occurring across the Indian sub-continent, including rivers of Pakistan, Burma, North India, Nepal and Bhutan, its population suddenly fell at the beginning of seventies and concentrated to only in few rivers of Nepal and northern India. Until the early 1960s, gharials were found in all the major river systems of Nepal including the Mahakali, Karnali, and Babai River in western Nepal, the Kali Gandaki and Narayani River in central Nepal and the Koshi River in eastern Nepal. Currently they are distributed in isolated remnant population in Karnali, Babai, Narayani and Rapti River system. In the first half of the 20th century the gharial was common throughout its range, with an inferred population in the 1940s of between 5000 and 10000 (Whitaker et al., 1974). The decline from an estimated 436 adult gharials in 1997 to 182 in 2006 represents a 58% drop across its range (IUCN, 2007). Habitat losses have been leading cause for Nepal"s declining crocodile population. The drastic decline in the Gharial population over the last 60 years (three generations for the gharial) can be attributed to a variety of causes including over-hunting for skins and trophies, egg collection for consumption, killing for indigenous medicine, and killing by fishermen across its range (Biswas 1970 and Whitaker 1975).

However, the gharial probably would be on the verge of extinction if proper attention on gharial conservation program were not implemented in India (Bustard, 1979) and Nepal (Maskey and Mishra, 1981) in 1970s and 80s. Fortunately, there has been some recovery through conservation programs, and a reasonable amount of hope lies with the conservation and management programs which are now in place. Full protection was granted in the 1970s in the hope of reducing poaching losses, although these measures were slow to be implemented at first.

1.2. Rationale of Study

Gharials are highly specialized crocodile having extremely narrow niche with 1% survival rate and limited distribution in the wild. It is a keystone species of running freshwater ecosystem and hence it is important in biodiversity conservation. Crocodiles help to distribute nutrients from the bottom of the riverbed to the surface water. So, they increase primary production and fish population and maintain aquatic ecosystem (CSG, 1998). Also, it is an indicator species to understand the health of the river ecosystem. Listed among the species of special concern by the WWF, it has been assumed that 50% of the gharials will be extinct in 10 years. The IUCN Red List classifies gharial as Critically Endangered on the basis of long-term decline as well as low remnant wild global population of fewer than 235 individuals. Having been virtually extirpated from Pakistan, Bhutan, Bangladesh and Myanmar, their distribution is now limited to only 2% of their former range. An interesting problem in gharial conservation in Nepal is that 75% of the released crocodiles had already flowed to India in search of their prey fish but cannot come across due to particular dam and barrage design.

Habitat degradation due to excessive and unmanaged collection of sand, gravel and stone from river and other development work as dam construction for different purpose which cause habitat loss along with intensive fishing using gill nets has been a leading cause for Nepal‟s declining crocodile population. As gharial habitat is clean and fresh running water but running water are becoming worst and impure due to human activities. The gharial was on the verge of extinction with less than 150 adults surviving throughout its range in 1974 (Whitaker, 1987). It is listed as endangered and on Appendix I of the CITES. Legal protection began in 1973, under the National Parks and Wildlife Conservation Act.

The limited distribution of gharial is a threat to the conservation itself. The Department of National Park and Wildlife Conservation through its Gharial Conservation and Breeding Program since the establishment of Gharial Conservation and Breading Center in 1978 at Kasara, CNP Chitwan, by regularly releasing the gharials in the rivers but the population has not stabilized. It clearly shows that rearing and releasing of gharials is not enough for gharial conservation. Understanding the population status and distribution, identifying the threats and assessing the threats to determine the vulnerability is foremost step to start conserving a species.

1.3 Objectives of the Study

The general objective of this study is to assess the status, distribution and conservation issues of Gharial in Rapti River, all of which contribute to conservation of gharial in its few of the remaining but disturbed habitat. The specific objectives are to;

1) Update and document gharials population status in Rapti River.
2) Map out their distributions along various sections of the river.
3) Outline conservation issues in gharial conservation in Chitwan National Park.

1.4 Limitations of the Study

- Only the visible gharials outside the river water were counted.

CHAPTER - II
LITERATURE REVIEW

2.1 Morphology and Ecology of Gharial

The gharial (*Gavialis gangeticus*) is the only surviving member of a once well represented family, Gavialidae (Maskey, 1989). It mostly inhabits large bodied, deep fast-flowing rivers in the plains (Shah and Tiwari, 2004). The species is characterized by its long and slender snout. Its name has been derived from the large, cartilaginous protuberance on the end of the adult male‟s snout resembling to a *Ghara* or earthenware pot common in India and Nepal (Smith, 1931). There are lots of mystical beliefs associated with the protuberance or *Ghara* present at the snout of the adult male, thereby tracing its popular name from it. However, the species is also called upon differently in different localities. Different names used to resemble Gharial include- *Gharial Gohi, Nakata, Chimta Gohi, Nakair, gahawa and Lamthodi*. Most of its names have originated from the resemblance of its long, narrow and slender snout. A lower and upper jaw resembling a shape of forceps is attributed to its name *Chimta* (Forcep in Nepali and hindi) *Gohi.*

The gharial is unique as it is the only crocodilian which is sexually dimorphic (males look obviously different from females). They have short legs and spend most of their time in the water. Adults feed primarily on fish for which jaws and interlocking set of 27- 29 undifferentiated teeth on each side of upper jaw and 25-26 teeth in the lower jaw (Shah and Tiwari, 2004) have adapted perfectly for holding struggling prey (CSG, 2000). The thin shape gives the snout low resistance under water, which is suited to fast lateral snatching movements underwater. Usually gharials will not reach sexual maturity before 13 years for the male and 16 years for the female, when they are nearly three meter in length (Maskey and Mishra, 1981; Bustard, 1984; Singh, 1999; Whitaker, 1987). One male will guard a harem of several females and will mate with all of them. The mating period occurs for two months during November, December and into January, while nesting happens in March, April and May (Whitaker, 1983). Nesting is done during the dry season in holes excavated in river sandbanks (Whitaker and Basu, 1983; Groombridge, 1987; Bustard, 1980).

The breeding life of gharial is considered to be 50 years and the life span 100 years (Whitaker and Basu, 1983; Singh, 1999). Individuals with < 90 cm are considered Yearlings; between 90 to 180 cm Juvenile; between 180 to 300 cm Sub-adults; and those larger than 300 cm are considered Adults (Khadka, 2011). Breeding females may lay eggs from 14 to 62 in numbers in one clutch (Maskey, 1989). In the wild, the survival rate of young hatchings is not more than one percent (Singh, 1978; Murthy and Menon, 1977; Roy et al., 1982). As all reptiles, gharials practice a thermo taxis activity (basking) catching sun ray, upon which their energy depends. Beaches, next to clean and deep water, are the preferred habitat of gharials (Maskey et al., 1995).

Gharials bask on the sand banks for long periods during the winter when water temperatures and water level is low. Whitaker et al. (1974) remarked on the gharial‟s predictable habit of returning to the same spot every day for basking, which contributes to their vulnerability to poaching. Sand banks for both basking and nesting are important habitats for gharial survival. The highest densities of gharial in the Narayani were observed in areas where the maximum occurrence of sand banks and deep channels were available. In winter, gharials appear to spend most of their time basking and less time feeding, presumably to avoid the coldness of the water. In contrast, in summer, they spent most of their time in water to avoid the heat of the day. Thermoregulation and dietary needs appear to be important factors in determining their use of sand banks (Maskey, 1989).

2.2 Gharial Distribution

Gharial, the marvelous piscivorous reptile, inhabited most of the river systems of the Indian sub-continent. Its range extended throughout the gangetic plain, west to the Indus River in Pakistan, North and Northeast to Nepal and Bhutan, east to Myanmar, and south to Orissa in India (Neill, 1971). The major river systems occupied by the gharial included the Indus in Pakistan; the Mahanadi, Chambal, Brahmani and Bhima of India; the Ganges and its tributaries of India, Nepal and Bangladesh (Neill, 1971; Whitaker et al., 1974; Behura and Singh, 1978). It was also reported to occur abundantly in the Jamuna River in Uttar Pradesh, India (Hornanday, 1885) and the Koshi River (Shortt, 1921). In Myanmar, it was recorded from the Maingtha River, a part of Irrawady River and Kaladan River (Smith, 1931). The

wide range distribution of gharial traces its history from the late 1800s and early 1900s centuries (Shortt, 1921).

The gharial population plummeted due to organized hunting for skin in the 1950s and 1960s in very short time (Whitaker, 1987) leading to scattered and isolated population in India, Nepal, Pakistan and Bangladesh (Behura and Singh, 1978). Gharial is now considered to be confined within the river systems of the Brahmaputra (India and Bhutan), the Indus (Pakistan), the Ganges (India and Nepal), and the Mahanadi (India), with small populations in the Kaladan and the Irrawady in Myanmar (CSG, 2007).

Distribution in Nepal:

In Nepal, the species inhabited Koshi, Kali Gandaki, Gandaki, Narayani, Rapti, Karnali and Babai River systems. Maskey (1984) reported extinction of gharial from Koshi River of Nepal.

2.3 Previous Studies in Gharial in Nepal

Gharial monitoring has been conducted periodically by the Department of National Parks and Wildlife Conservation in collaboration with partner NGOs and other stakeholders. Gharial and its habitat study have been carried out by different workers (Maskey, 1989; Maskey, 1998; Mishra, 2002; Ballouard and cadi, 2005, and Khadka et al., 2008) for varied purposes complementing the conservation effort of Nepal to save the species from extinction.

Maskey (1998) reported a minimum of 55 wild gharials and 50 released gharials surviving in Narayani, Kali Gandaki Gandaki, Karnali and Babai river system. A field study in 1997 showed a decreasing population status and a distorted sex ratio of gharial in Nepal (Mishra, 2002). The sex ratio of male to female in the wild was estimated at 1:6 in 1984, whereas this had increased to 1:9 in 1987 and 1:10 during 1997. The low number of male was attributed to heavy poaching of males (Maskey, 1998), because local people believe in various mystical power of the "*Ghara*" of males found in their snouts (Maskey and Mishra, 1981).

Mishra (2002) recorded 12 individuals in Chitwan National Park between Sauraha and Kasaraghat in the Rapti River and estimated minimum 50 gharials were in the Narayani River on the basis of park staff information. In Bardia National Park (BNP), eight individuals were directly observed in the sample segments of Karnali and Babai Rivers and 28 more animals were added in estimation through interview from concerned people (Mishra, 2002)

Ballouard et al. (2005) counted 49 individuals in December of 2005 which was the highest number compared to the similar census done in 2003 and 2004 that resulted 38 and 34 individuals in Chitwan population.

According to Khadka et al. (2008), the total population of gharial in Nepal was found to be 81 individuals. The census revealed that a minimum of 58 wild and released gharials were surviving in Chitwan population which included 34 individuals in Narayani and 24 individuals in Rapti Rivers. Through the indirect evidences seven additional gharials were summed up with minimum population that yielded 65 individuals in Chitwan population. Mid-western population (Karnali and Babai rivers) of Bardia National Park supported very small population of six and ten individuals respectively. However, the intensive survey conducted in Eastern Nepal (Koshi River) confirmed extinction of gharial from Koshi River. The sex ratio in Chitwan population (1 Male: 6 Female) was further deteriorated as compared to study carried out by Maskey 1989 (1 Male: 9 Female). Over 60 percent of the population was under the age group incapable for breeding at present. However, age and sex of 11 percent individuals could not be identified. The high disparity in sex ratio and existence of only 27 percent of the identified adult breeding population poses hindrance for its natural multiplication.

The national gharial census (DNPWC, 2016) revealed a total of 198 individuals in major river systems of Nepal with 84 in Narayani; 80 in Rapti; 2 in Budhi Rapti and Khageri; 1 in Karnali; 31 in Babai and no individuals in Koshi. Out of them only 6 individuals were Male with 1 in Narayani and 5 in Babai.

CHAPTER - III
METHODOLOGY

3.1 Study Area

Chitwan National Park is one of the world‟s outstanding protected area located in the flood plains of the west-flowing Rapti, Riyu tributaries of the great Narayani River and over the intervening Sumeswar and Churia hills and is the part of eastern Himalayan ecosystem. Having been established in 1973, it is the first national park of the country recognized as UNESCO‟s World Heritage Site in 1984. It spreads over Chitwan, Nawalparasi, Parsa and Makawanpur districts. The geographical location of the National Park is between 27° 20' 19" to 27° 43' 16" N and 83°44' 50" to 84°45' 03"E. It covers an area of 952.63 sq. km. and an additional area of 729.37 sq. km. as Buffer Zone.

3.1.1 Study site

The 56.72 km of the Rapti River from Lothar to Golaghat (Rapti/Narayani confluence) comprises my study area.

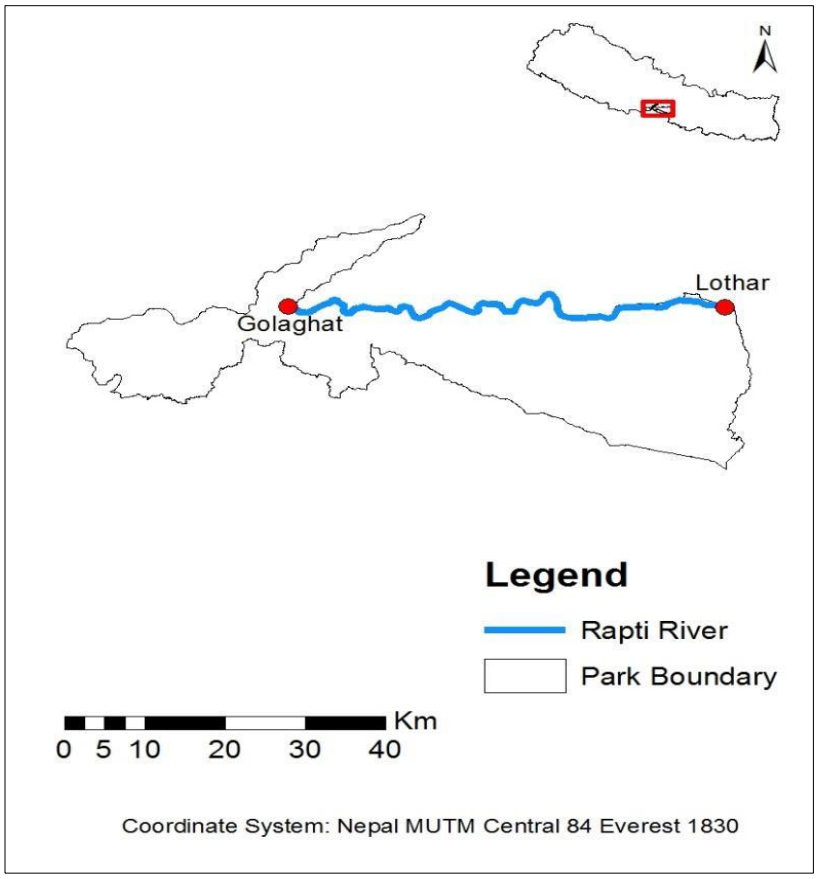


Figure 1: Map showing the study area and site

3.1.2 Climate

Climatic condition of Chitwan valley is tropical and subtropical dominated by the summer monsoon. Park experiences three distinct seasons every year, *viz.* winter, summer and monsoon. The average annual rainfall in the park reaches to 2600 mm and about 80% of rainfall occurs within four months of rainy season. July and August months receive maximum amount of rain. Rains are scanty in winter season although few intermittent showers take place during the period. Summer season is usually dry but instances of rains, storm with thunder occurs in March and April. Due to summer rain, water level increases throughout the park. Monsoon rains cause dramatic floods and changes in the character and courses of rivers. The average maximum temperature during April is 35°C, but the maximum temperature can reach 37°C. Temperature declines very little until October, and then declines rapidly to an average maximum temperature of 24°C during December. The average minimum temperature is 8°C during January.

3.1.3 Hydrology

Narayani, Rapti, and Reu Rivers flowing through the park are the major water sources. The Narayani River is a snow fed River, which originates in the high Himalaya. The Rapti is bordered by the Mahabharat Range on the north. Both the Rapti and Reu flow westwards and drain into the Narayani, which flows southwards for about 25 km through a narrow gorge between the Someswar and Daunne hills until it reaches Triveni.

3.1.4 Major flora and fauna

The Chitwan Valley consists of tropical and sub-tropical forests with mostly Sal (*Shorea robusta*) forests covering about 80% of the area while grasslands cover about 12 %. There are more than 68 different types of grasses. The park is home to more than 68 species of mammals, 55 species of amphibians and reptiles 546 species of birds and 120 species of fish. The endangered fauna found in the park include One- horned rhinoceros, Gaur bison, Royal bengal tiger, Wild Elephant, Four-horned antelope, pangolin, Golden monitor lizard, Python, Bengal florican, Lesser florican, Gaint hornbill, Black stork and White stork.

3.2 Data Collection

Multi-method research approach was used for this study. Appreciative inquiry method was employed because it encourages it the local residents and CNP staffs to express the realities even to researcher who is from outside their community. This study basically relies on the primary data collected in the field. Primary data constitutes reconnaissance survey, population survey via direct sighting and questionnaire survey. Secondary information was collected through literature review. The literatures reviewed included research reports, journal articles, books, records from DNPWC, relevant websites etc. Secondary data were of immense importance for analyzing primary data and comparing the results with the previous findings.

3.2.1 Primary data collection

3.2.1.1 Reconnaissance Survey

To understand the field more critically and for primary data collection, reconnaissance field visits was done. Field reconnaissance survey also included informal interview with key informants, local leaders, local people and direct observation. General information about the study sites was obtained during reconnaissance visit. This visit was useful for establishing rapport with local people. Simultaneously, it was beneficial for planning census.

3.2.1.2 Population Survey

To determine the gharial population status and their distribution along the Rapti River in Chitwan National Park, monitoring was conducted in February- March 2018 with three times replication. Initially, the river was divided into three sections from Jindagani ghat to Golaghat (Narayani/Rapti confluence) and monitoring was done there wise from 23 to 25 February. Later, upon receiving information from public regarding Gharial sighting in Lothar area, a fourth section was added later on from Lothar to Jindagani Ghat and the monitoring was done from 2 to 4 March.

Gharial population survey along the Rapti Tiver was conducted through three dugout canoes and a rubber boat with the team consisting of eight observers and eight boatmen (bote) who belonged to the local ethnic group. The main livelihood of the bote is derived from fishing in

Rapti River, and consequently, they are very familiar with the habits and natural history of gharials.

In each section, there were two observers and two boatmen and monitoring was conducted simultaneously in every section. Binoculars, Camera and GPS were used to count, capture and locate the gharials. All gharials recorded were directly sighted and their GPS points were taken. During each survey, the estimated size, sex and location of sighted gharials were recorded.

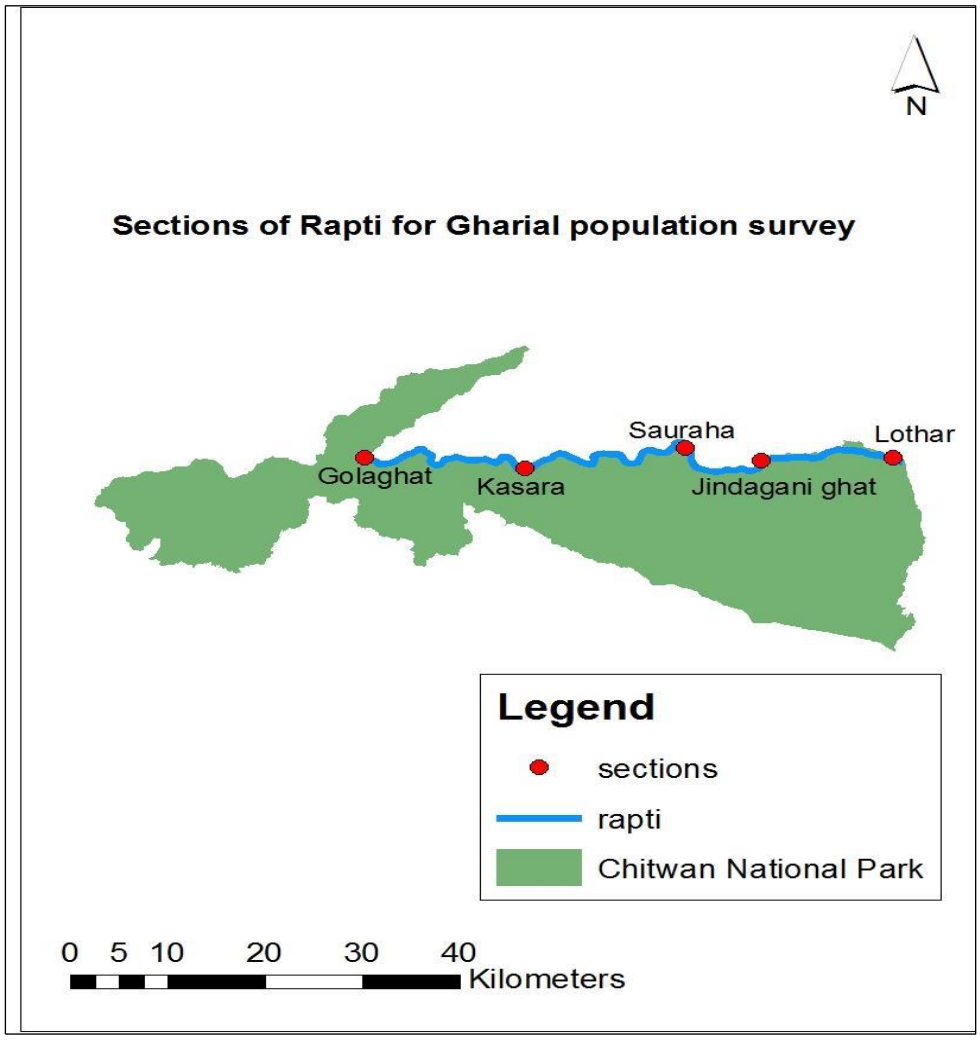


Fig:2 Map showing the 4 sections along Rapti River for population survey

Maturity differentiation and sex identification were done according to the standard procedure (Khadka, 2011).

1. Yearling < 90 cm
2. Juvenile > 90 - 180 cm
3. Sub-Adult > 180 – 300 cm
4. Adult > 300 cm

It is important to note that the quality of the sex and size estimation depends on factors like distance, light, weather conditions and field experience.

Crocodilians, being amphibious in nature, can be counted directly both on land and in water. Crocodiles basking on land during daytime are easier to count and their size can be estimated. The best season for crocodile survey is post winter and pre summer month, i.e. January-March. During this period the temperature conditions are such that crocodiles bask for longer periods and visibility is good for sighting. This is also the courtship season and breeding groups tend to bask in groups (Choudhary and Roy, 1982; Rodgers, 1991).

For indirect evidence of gharial presence in an area "U" shaped marking was checked. Generally gharials leave "U" shaped marking on the sand bank along the riverbanks (Whitaker and Basu, 1983). To confirm if the mark signifies presence of particular individual in the site, gharial monitoring staffs and other local people were also enquired before considering it as one gharial. Fresh signs of gharial on sand banks farther than 500m away from observed animals would be counted as different animals. If signs were seen within the location < 500 m as the animal located, then those would be classified as same individual and would not be counted again. However, we did not encounter this condition during the census all gharials encountered were directly sighted.

3.2.1.3 Questionnaire Survey

After making rapport with local people through reconnaissance survey semi- structured questions were prepared based on existing knowledge and field experiences to extract information from the respondents.

The main objective of the questionnaire survey was to identify the threats to gharial and its habitat in the respective river systems of the study area. Questionnaire was designed such a way that local knowledge and attitudes pertaining to gharial‟s past history, present status and future conservation objectives would be reflected. Therefore the target respondents were primarily local ethnic group viz. *majhi, bote,* etc who compete with gharial to earn their living through fishery. Besides, the people living in proximity to the river who are directly/indirectly affected or beneficiary of the protected areas and the rivers where gharial conservation is sought served as respondents regardless of their caste or profession. The place and time for interview was fixed considering the convenience of respondents. Altogether 56 respondents were interviewed. The characteristics of respondents interviewed are presented in Table 1.

S.N	Respondent Category	Male	Female	Total
1	Park Staff	5	0	5
2	Bote	16	3	19
3	Darai	9	1	10
4	Chaudhary	5	0	5
5	Tamang	4	0	4
6	Majhi	2	0	2
7	Kumal	4	0	4
8	Others	7	0	7
	Total	52	4	**56**

Table 1: Characteristics of the respondents

3.2.1.4 Key informant interview

Since questionnaire survey is not the only reliable instrument especially when the fishing communities are adjacent to the habitat of gharials, so key-informant interviews were also conducted to outline the conservation issues. It involved interviews with gharial expert, National Park officials, BZMC members and staffs of Gharial Conservation Breeding Center and officials of NTNC. The time and venue were fixed as per their convenience.

3.2.2 Secondary data collection

The study was further supplemented with secondary information from different sources. The past and present status and distribution of gharial of the Indian sub-continent and the country is based on secondary information like literature review, CSG‟s newsletters, and other publications, personal communication with park staffs and wardens.

3.3 Data Analysis

Qualitative and quantitative analysis methods were applied to analyze the data in this research. Information in the field was carefully recorded in terms of diaries and structured questionnaires forms. After each interview and survey, major points raised related to the research objectives were recorded as bullet points and elaboration of those points were made every evening. Those interviews and group discussions were later compiled and categorized in each of the questions. Compilation, categorization and tabulation were the basic steps taken prior ro analyze the data collected from reconnaissance survey, questionnaire survey and population survey. Information received through different methods were compiled and tabulated accordingly and analyzed according to the nature of the information with context to its representation.

Information from surveys was digested in the form of digital codes using Microsoft Excel program for further analysis. With coding, processing and decoding the responses qualitative forms became more objective. Qualitative and quantitative nature of information analysis together gave numbers which were presented in the form of tables, pie charts, bar-diagram and maps according to the nature of the topics under discussion.

CHAPTER - IV
RESULTS AND DISCUSSIONS

4.1 Population Status of Gharials in Rapti River

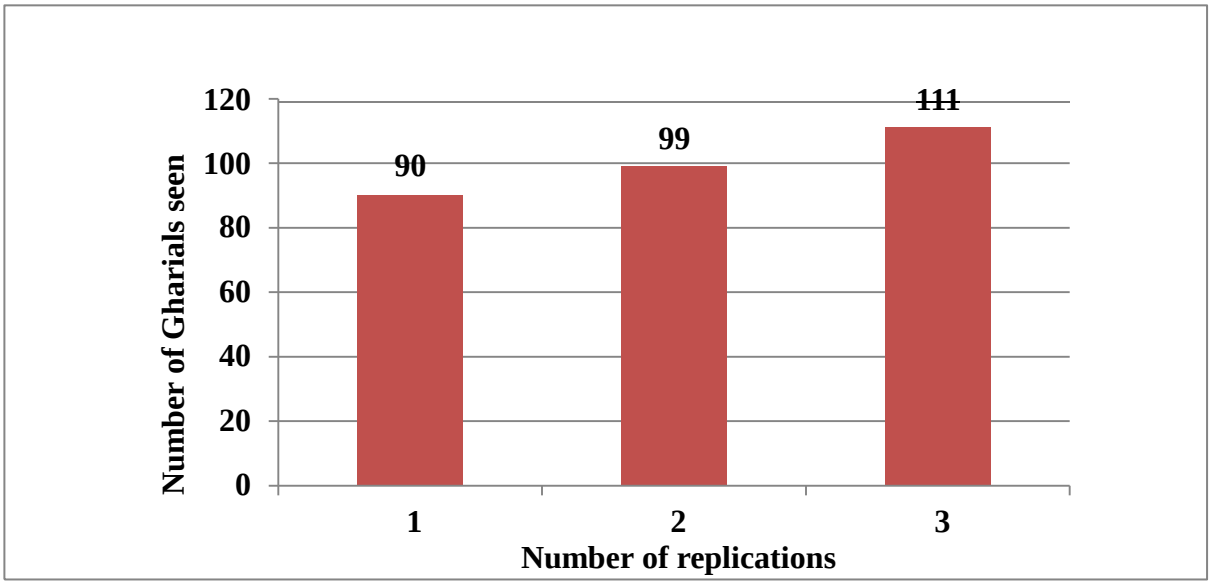


Fig:3 Population of Gharials recorded at each replication

Our study revealed 90, 99 and 111 gharials recorded in 1st, 2nd and 3rd replication respectively. The increase in the sightings of gharials at each replication was accounted to gradual clearance of foggy weather in the subsequent days. The maximum recorded sighting of the 3rd replication i.e. 111 was taken as the total number of gharials in the Rapti River for our study.

The result may come as a surprise as the 2016 gharial census by DNPWC revealed only 80 individuals in the Rapti River. But that study was conducted in early January in mid-winter, the season when the intense cold wave and thick blanket of fog in the Terai region blocks sunlight for larger part of the day inhibiting gharials to come out of river to bask in the sun.

Our survey was most likely to have been influenced by the recent release of 48 gharials in Kasara of Rapti River on February 14 and 16, 2018. Also, no gharials were seen in the enclosure constructed for their soft release during our field survey.

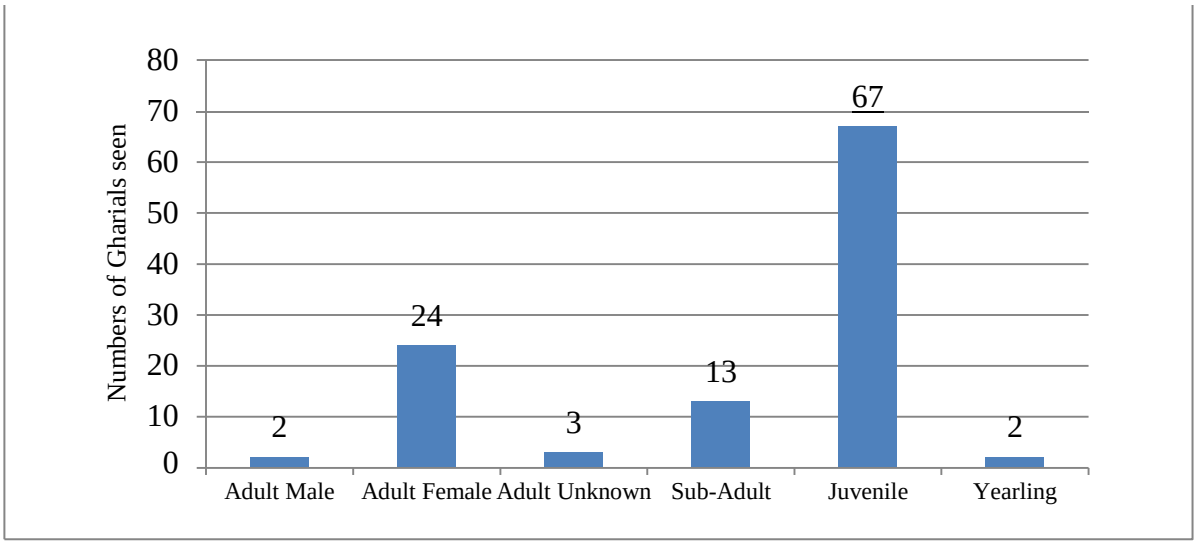


Fig:4 Population Composition of Gharials in Rapti River

One of the interesting revelations of our study was the sighting of two male gharials in Rapti River. The 2016 National gharial census by DNPWC reported no male gharials in Rapti River with only one male gharial in Chitwan river system in Narayani. One of the male gharials sighted this year might be the one translocated from Bardia last year.

Although the male to female sex ratio has improved a little bit but it is still discouraging i.e. 1 Male: 12 Female. The 29 adult gharials i.e. 26% of population can be considered as breeding population in the Rapti River.

Year	Adult Male	Adult Female	Adult Unknown	Sub-Adult	Juvenile	Yearling	Hatchling	Age Unknown	Total	Remarks
2016	-	18	-	24	28	-	5	5	**80**	**National Survey**
2018	2	24	3	13	67	2	-	-	**111**	

Table 2: Gharial population status in Rapti River since 2016

4.2 Distribution of Gharials in Rapti

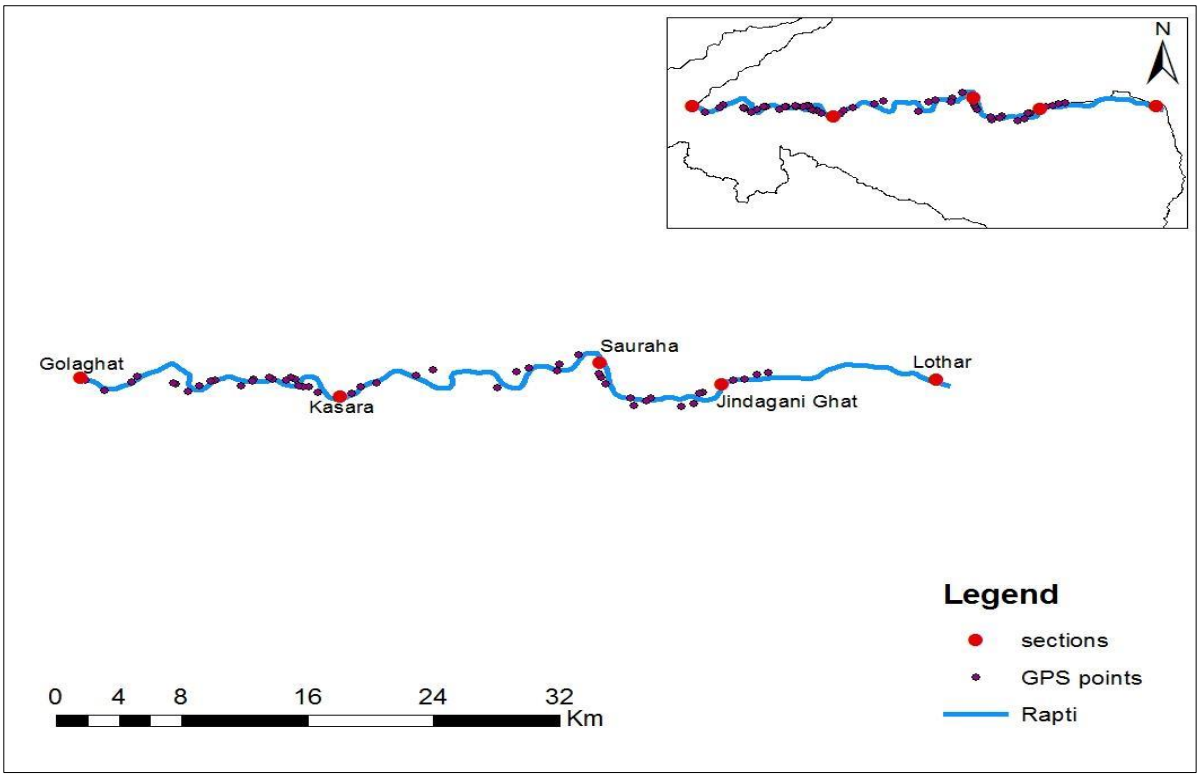


Fig: 5 Distribution of Gharials along various sections of Rapti River

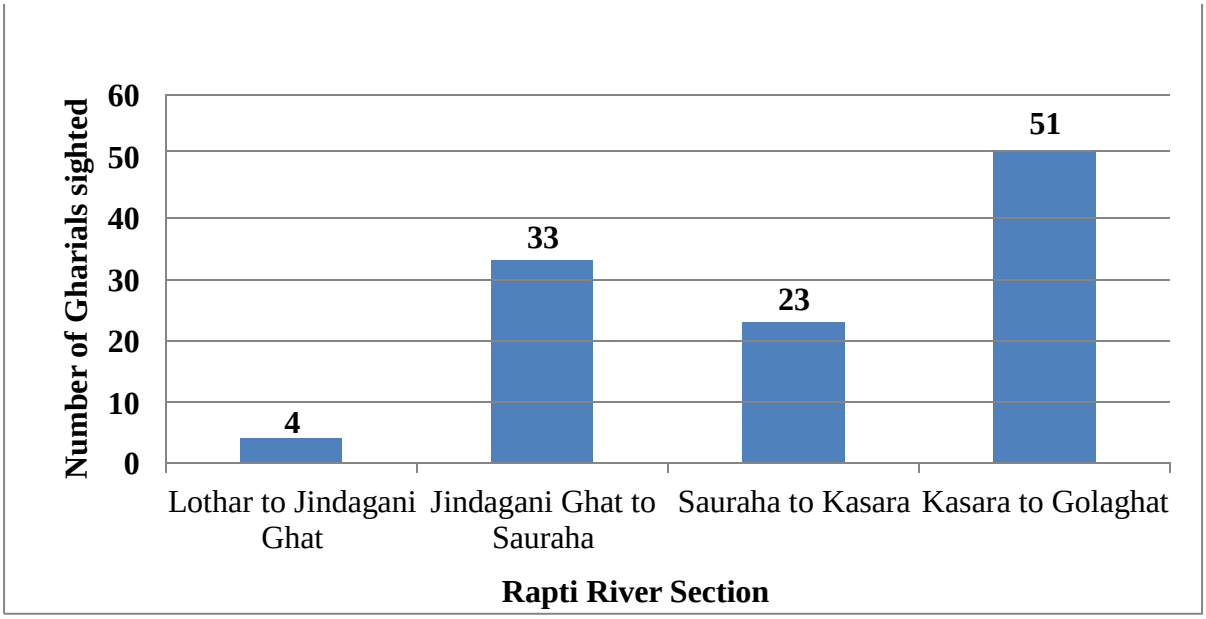


Fig: 6 Number of Gharials in 4 sections of the Rapti River

Since no gharials were sighted in Lothar area for many years, this section was omitted by monitoring in the prior years. The presence of 4 gharials in this area shows that the rigorous conservation efforts are slowly paying off. The intense field survey along the stretch of Rapti River has also shown that the disturbances has really been less severe than that was few years back. The high number of gharials along kasara – Golaghat section can be attributed to the recent release of gharials in Kasara and the flow of Rapti River towards Golaghat of Rapti and Narayani confluence.

River Sections	Adult Male	Adult Female	Adult Unknown	Sub-Adult	Juvenile	Yearlings	Total
Lothar to Jindagani Ghat	-	2	1	1	-	-	**4**
Jindagani Ghat to Sauraha	1	7	-	-	25	-	**33**
Sauraha to Kasara	-	4	2	2	15	-	**23**
Kasara to Golaghat	1	11	-	10	27	2	**51**

Table 3: Population Composition and distributions of Gharials along various sections of Rapti River

4.3 Conservation Issues of Gharials in Rapti

4.3.1 Trend of Gharial Population

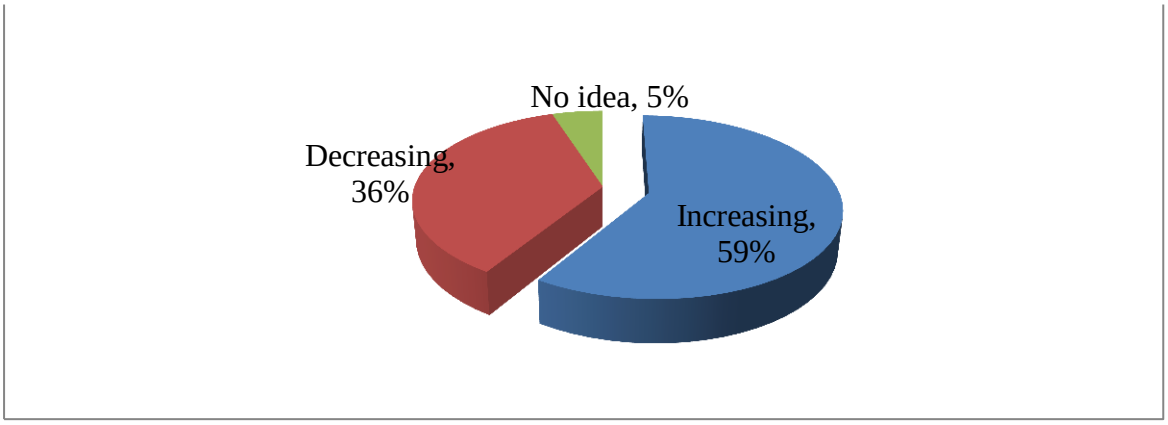


Fig 7: Responses of respondents on trend of Gharial population in Rapti River

Among 56 respondents, majority (33 individuals) were in favor of statement that "Gharial population was increasing" and stated that the causes of increasing were park"s and people"s conservation effort, increased level of awareness among local communities, licensed fishing and adequate release of Gharials. Around 20 individuals who responded gharial population as decreasing attributed to use of gill nets, dam construction, illegal egg collection and flood as causes of their declination. Only about 3 individuals did not have any idea regarding trends of gharial population.

4.3.2 Threats on Gharial population

According to (Priol et al., 2003) young Gharials were not found within the Park"s limit and adults continued to disappear. Similarly, according to (Madhu and Sharma, 1997) causes of the gharial"s decline have changed with time quantitatively and qualitatively. Findings about factors responsible for decreasing gharial populations are based on questionnaire survey with community people as well with park staff.

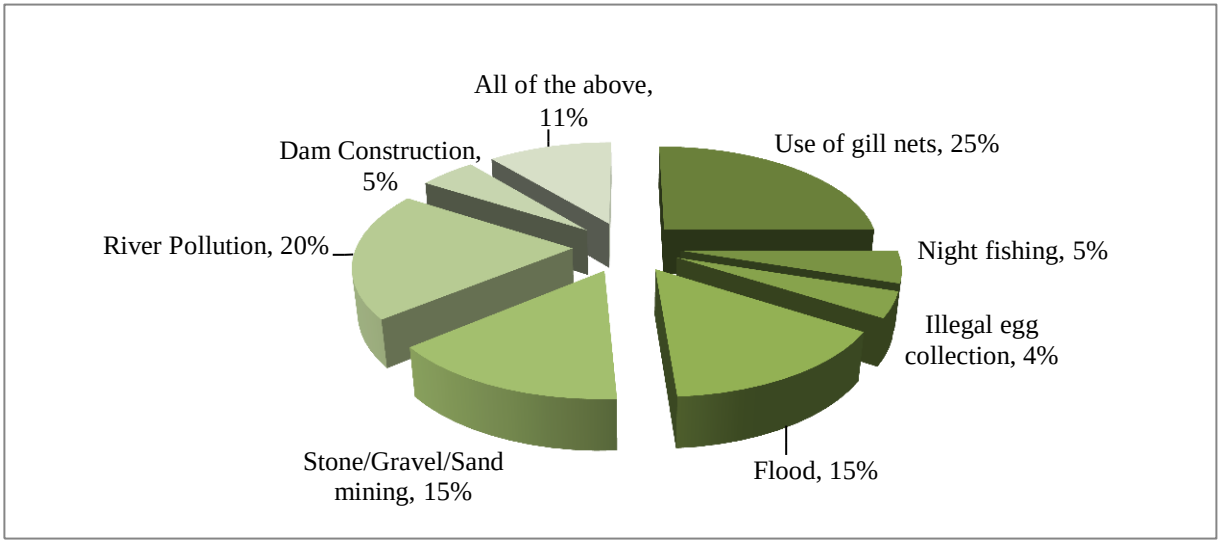


Fig8: Responses from questionnaire survey on threats for Gharial conservation

Result of the questionnaire survey shows use of gill nets, river pollution, stone quarrying and flood as the major factors that continue to pose threats on Gharial population. It is interesting to note the results obtained from key informant interview on this issue. The discussion with key officials and people and from my own field observation it was concluded that although

day fishing except the licensed fishing has reduced to minimum, the night fishing has emerged as a major issues for gharial conservation these days. Since few park staffs from the breeding center and more people from fishing communities were incorporated, so the survey has revealed night fishing as a minor threat accounting to only 5%.

During field survey I found improper disposal of garbage near Rapti River, sand mining, stone collection from Rapti River, livestock grazing and fishing by using gill nets which shows direct threat to gharial conservation. Improper construction of dam and irrigation cannel for agriculture purpose.

4.3.3 Activities to be done for Gharial Conservation

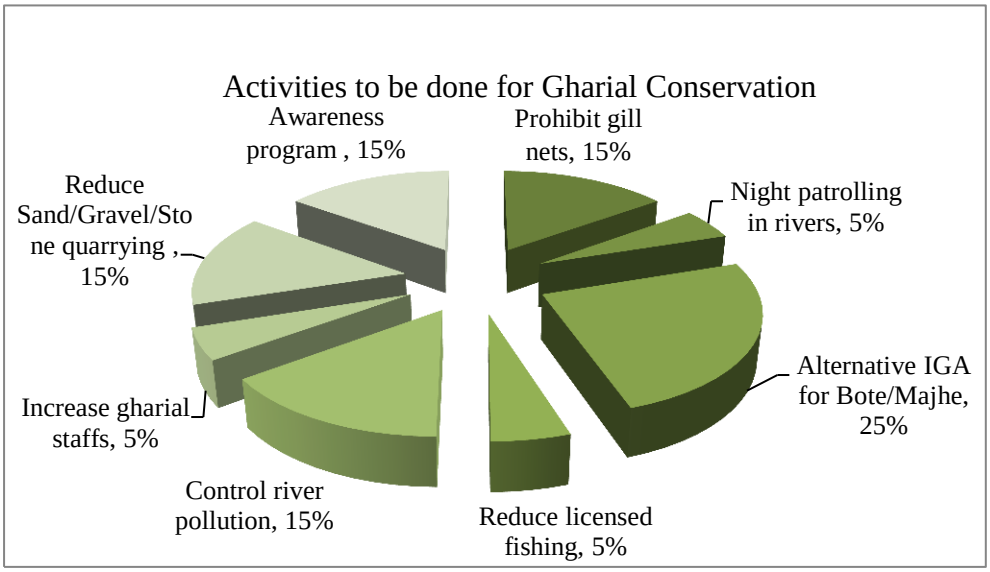


Fig 9: Responses from respondents on activities to be done for Gharial conservation

Majority of respondents stated Alternative Income Generation Activities for bote/majhi, prohibition of gill nets, controlling river pollution and reducing sand/stone mining as major activities to be done for gharial conservation. This level of responses and desire for more awareness programs (15%) shows that they are willing to collaborate with park for gharial conservation. Also the results from key-informant interviews are important to note here. It showed that night patrolling in river and increase in gharial staffs for logistics should be immediately considered by the Park for Gharial conservation.

CHAPTER - V

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

From the above results and discussion, following conclusions can be drawn;

- A total of 111 individuals of gharials were recorded along the Rapti River with highest 51 along Kasara to Golaghat section and lowest 4 along Lothar to Jindagani Ghat section.

- Although gharials were recorded in Lothar area after many years, the number is still very low due to frequent stone/gravel/sand mining and shallow water.

- Even though the population survey may have been influenced by the recent release of gharials in Rapti River, the general field observation; results from key - informant interviews and questionnaire survey shows that the population trend in Rapti River seems to be increasing.

- The heavy flooding in August last year has not severely affected the gharial population as compared to the other fauna. It may be accounted to the fact that these are well adapted to major river systems of Indian sub-continent since ages.

- The use of gill nets continues to be the major threats in gharial conservation although park has prohibited its use. Last year a male gharial died and during my field stay in CNP there were two incidents of entrapment of gharials in gill nets.

- River pollution and habitat disturbances due to stone/gravel extraction though less severe now a days, are also the major threats for gharial conservation.

- In response to the strict park regulation against fishing and allowing only licensed fishing, fishing at nights has acutely increased.

- Other important cause in the declining number of gharials is dam construction.

5.2 Recommendations

- The count during gharial monitoring/census should be replicated at least two times for better accuracy and precision since errors are more likely for this river animal. Also valid and scientific inferences can be drawn with increase in replication.
- Restocking gharials in all the potential gharial habitats should be continued for long term and in systematic manner. Frequency of release programs, site for releasing gharials, season and number should be predetermined with adequate scientific justification of overall schedule and actions. Thus future restocking should be determined by assessing the fate of previously released individuals.
- Alternative IGA for fishing communities should be provisioned so that harvesting of fish in river lessens since Gharials feeds only on fishes. Also licensed fishing should be decreased.
- Strong legal actions should be taken for using gill nets and illegal fishing. Cases/incidents related to killing and entrapment of gharials should be given as much as priority as given to rhino and tiger.
- The sections of the river where gharials are found should be declared as sensitive zone and anthropogenic disturbances should be kept at minimum.
- Night patrolling of the river should be done to curb acutely increasing night fishing and number of staffs in Gharial Conservation Breeding Center should be increased.
- Gharial Conservation efforts should be backed by thoroughly prepared conservation action plan.
- We should not forget that **"Conservation is good but participatory conservation is better."**

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ANNEXES

Annex- 1 Data Sheet for Gharial Monitoring 2018

Date: _____ Replicate Number: ___ Observers Name: _____

River Name_____ Segment Name_____

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

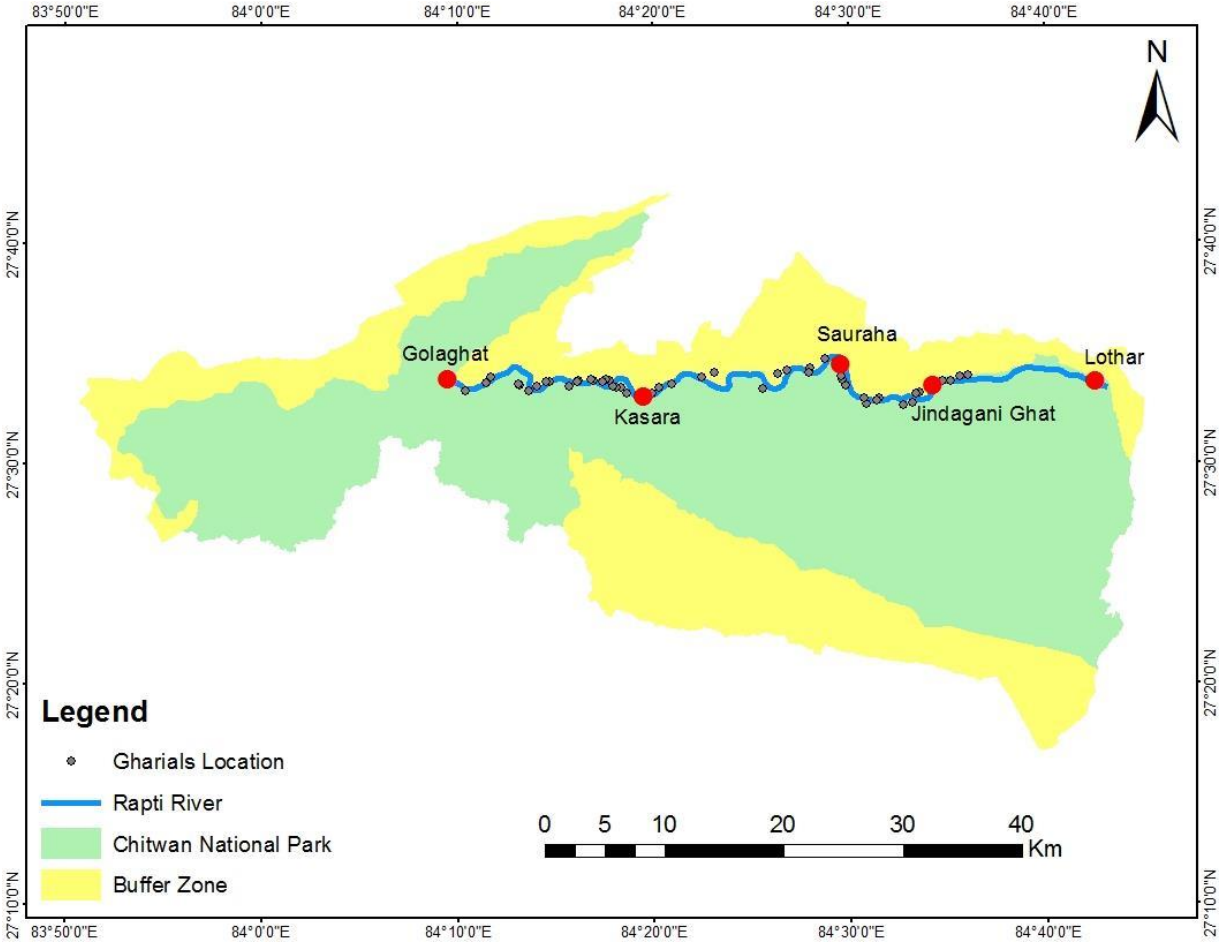
End GPS: Wpt: _____ N _____E _____End Time: _____Weather: _____

S.N	Time	Weather	Gharial Sighting	Location	GPS	Age group						
						Adult (>300cm)			Sub-adult (180-300cm)	Juvenile (90-180cm)	(90-180cm) Yearling	Unknown
						Male	Female	M/FUnknown				
					N:							
					E:							
					N:							
					E:							
					N:							
					E:							
					N:							
					E:							
					N:							
					E:							
					N:							
					E:							

Annex- 2 Population Distribution of Gharials in various sections of Rapti River

Number of Replication	River Section	Adult Male	Adult Female	Adult Unknown	Sub- Adult	Juvenile	Yearling	Total
1st	Lothar to Jindagani Ghat	-	1	1	1	0	-	3
	Jindagani Ghat to Sauraha	1	7	1	4	24	1	38
	Sauraha to Kasara	-	4	1	1	9	-	15
	Kasara to Golaghat	-	7	1	11	15	-	34
	Total	1	19	4	17	48	1	**90**
2nd	Lothar to Jindagani Ghat	-	3	2	-	-	-	5
	Jindagani Ghat to Sauraha	-	5	-	1	26	-	32
	Sauraha to Kasara	-	2	3	4	16	-	25
	Kasara to Golaghat	-	9	3	7	16	2	37
	Total	-	19	8	12	58	2	**99**
3rd	Lothar to Jindagani Ghat	-	2	1	1	-	-	4
	Jindagani Ghat to Sauraha	1	7	-	-	25	-	33
	Sauraha to Kasara	-	4	2	2	15	-	23
	Kasara to Golaghat	1	11	-	10	27	2	51
	Total	**2**	**24**	**3**	**13**	**67**	**2**	**111**

Annex- 3 Distribution Map of Gharials along various sections of Rapti River



Annex- 4 Questionnaire for Social Survey

Name: Sex: M/F

Occupation:

Address:

District: Rural municipality: Ward No.

1. Do you go for fishing in the river?

a. Yes b. No

2. How often do you go for fishing?

a. Daily b. Once a week

c. Twice a week d. Others

3. How much fish do you harvest per day?

a. 1-5 kg b. 5-10 kg c. 10-15 kg d. >15 kg

4. What type of fish species do you have seen in the river?

a. Kattla b. Sahar c. Mungri d. Asala d. Bhoti e. Others

5. What methods do you use for fishing?

a. Net b. Water draining c. Electricity d. Poisoning e. Hook f. Blasting g. Others

6. Are there any rules and regulations for fishing set by National Park?

7. Do you follow them?

a. Yes b. No

8. Have you seen Gharial in the river?

a. Yes b. No

9. If yes, then particularly at which place?

10. What do you think is the population trend of gharial in Rapti?

a. Decreasing b. Increasing c. Constant d. Others

11. If decreasing, what do you think are the causes?

12. Do you have any information about Gharial poaching?

13. Do you think the conservation of Gharial is necessary?

a. Yes b. No

14. What activities need to be done to conserve Gharial?

15.Is there any role of local people for Gharial conservation?

16. Is there is any conflict between Gharial and people?

17. Do you know about the National Park's activities/strategies for Gharial conservation?

a. yes b. No

18. If yes, what activities/strategies?

19. What you see in the river disturb for Gharial?

a. Fishing b. Human disturbance c. Pollution

20. Suggestion/ feedback if any?

Thank you !

Household Survey with Bote, Darai, Chaudhary and women.









Key informant interview with CSG member and GBC Staff





Researcher and research assistant during gharial population monitoring in the field









Photos of Gharial















