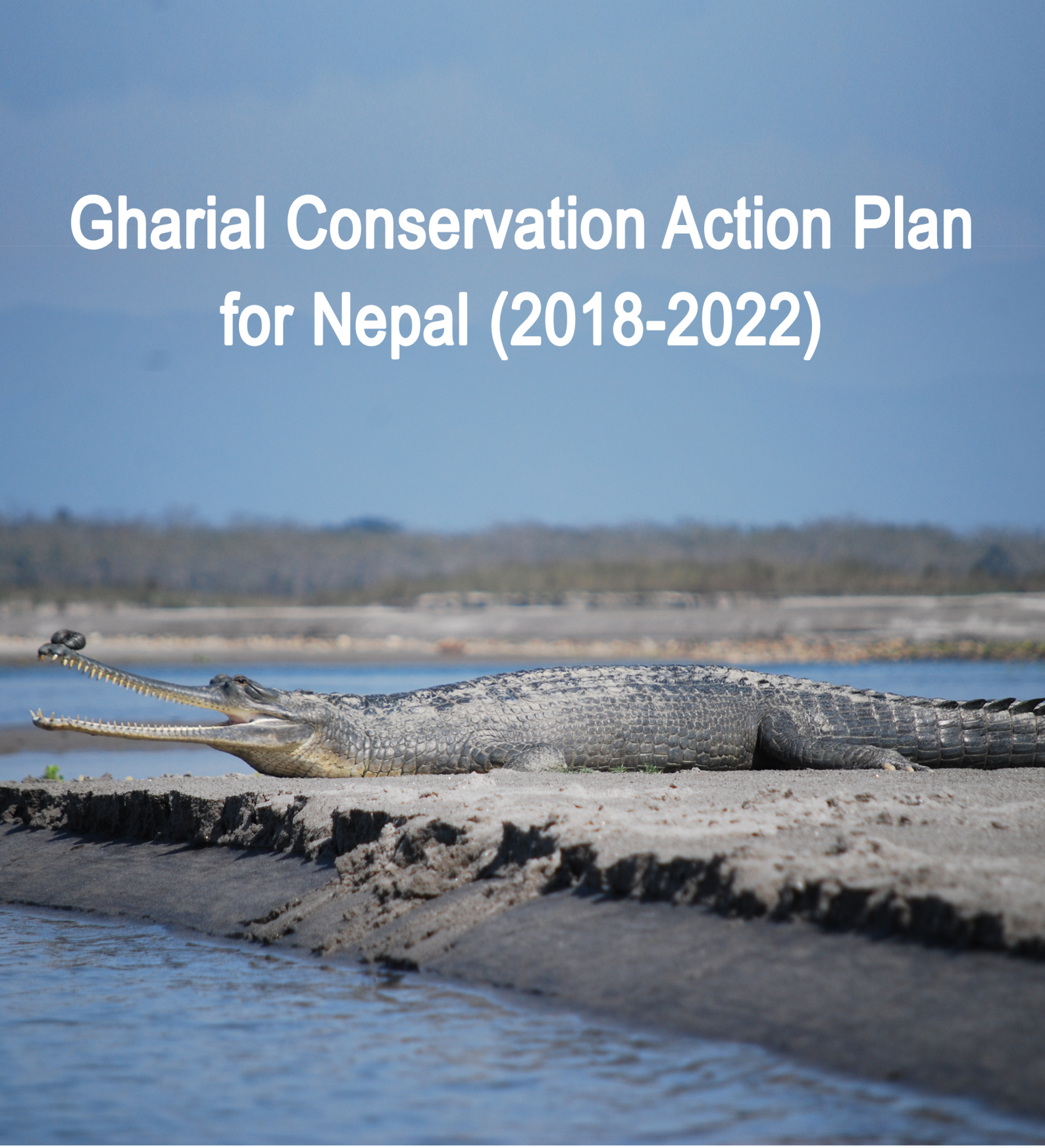
Gharial Conservation Action Plan for Nepal (2018-2022)



Government of Nepal
Ministry of Forests and Soil Conservation
Department of National Parks and Wildlife Conservation
2018

Gharial Conservation Action Plan for Nepal

(2018-2022)

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Ministry of Forests and Soil Conservation

Department of National Parks and Wildlife Conservation

2018

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Department of National Parks and Wildlife Conservation

Foreword

Gharial is considered as an indicator species of healthy freshwater ecosystems. It is listed as a "Critically Endangered" species in IUCN Red Data Book and appendix I species of Convention on International Trade in Endangered Species of wild fauna and flora (CITES). Historically, Gharial was found in Myanmar, Pakistan, Bhutan and Bangladesh, but now it has been said to be only confined in India and Nepal. Considering its critical status, diet and special nature of habitat, the species is listed in schedule I of National Parks and Wildlife Conservation Act 1973 as a protected reptile.

Nepal has a long history of Gharial Conservation both in in-situ and ex-situ environment. Since the establishment of Gharial Conservation and Breeding Centre in 1978, enormous efforts have put forth to recover the population in natural environment by releasing them in the wild. In Nepal, the ever looming threats such as habitat loss and degradation owing to sand and gravel mining; construction of dams and barrages; encroachment of sand banks, prey depletion have made fairly difficult to restore the habitat and recover the population in the wild.

On the backdrop of having various threats and challenges, the Government of Nepal has produced the first Gharial Conservation Action Plan (2018-2022) which guides holistic efforts towards conserving the most threatened species in in-situ and ex-situ environments. The plan has adopted the priority actions guided by National Biodiversity Strategy and Action Plan (2014-2020), Forest Policy (2015), and Protected Area (PA) management plans of Gharial bearing protected areas of Nepal. Besides, this plan has incorporated the actions included in "operational plan for managing Gharial Conservation and Breeding Center and conserving the gharials in natural environment" approved by MFSC in 2072 B.S.

Gharial Conservation Action Plan (2018-2022) aims to maintain and manage the viable population of Gharial in Nepal. This plan focuses on enhancing scientific knowledge through research on Gharial, its prey base and habitat. In addition, the plan focuses on strengthening in-situ conservation of Gharials by reducing anthropogenic pressures and maintains ex-situ conservation to secure future breeding stock.

I sincerely thank the technical team of the Department of National Parks and Wildlife Conservation for preparing this Action Plan and I am equally thankful to review team for providing constructive comments to make the document robust. I thank to NTNC for providing technical assistance, WWF Nepal and ZSL Nepal for providing financial and technical support to produce this document. The Government of Nepal greatly acknowledges the contribution of wildlife conservation partners and requests for their continuous support and commitment for the successful implementation of this plan.

I am confident that this action plan will contribute to secure the Gharial habitats against emerging threats and recover the critically endangered population in the country.

29 Jan 2018

Man Bahadur Khadka

Director General

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Acronyms and Abbreviations

BNP	Bardia National Park
BZMC	Buffer Zone Management Committee
BZUC	Buffer Zone User Committee
CBAPU	Community Based Anti -Poaching Unit
CBO	Community Based Organization
CCC	Crocodile Conservation Centre
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CNP	Chitwan National Park
DCC	District Coordination Committee
DNPWC	Department of National Parks and Wildlife Conservation
DoF	Department of Forests
FDB	Fonds De Dotation Pour La Biodiversite
GCA	Gharial Conservation Alliance
GCBC	Gharial Conservation and Breeding Centre
GSRP	Gharial Species Recovery Plan
IGA	Income Generating Activity
I/NGO	International/Non-Governmental Organization
IUCN	International Union for Conservation of Nature
NTNC	National Trust for Nature Conservation
PA	Protected Area
PABZ	Protected Area Buffer Zone
TAL	Terai Arc Landscape
TSD	Temperature Dependent Sex Determination
UNEP	United Nation Environment Program
WWF	World Wildlife Fund
ZSL	Zoological Society of London

Executive Summary

The Gharial (*Gavialis gangeticus*) is the sole member of the family Gavialidae and is listed as a "Critically Endangered" species in IUCN Red Data Book, 2007. Gharial is an indicator species of healthy freshwater ecosystems, and is one of the protected reptiles of Nepal under Schedule I of National Parks and Wildlife Conservation Act, 1973. Although, previously Gharial was found in Myanmar, Pakistan, Bhutan and Bangladesh, the species is probably extinct from these countries. Currently, it is only found in India and Nepal where it breeds. In 2006, Gharial Conservation Alliance (GCA) formerly known as the Gharial Multi-Task Force urged all range states to undertake Gharial conservation as a priority action and to prepare conservation action plans to protect the species from extinction.

Nepal's Gharial conservation breeding program was initiated in Chitwan National Park (CNP) in the year 1978. This program has been successful in hatching, rearing and releasing Gharials in the main Rivers of the country to enhance the remnant population of the species in the wild. Nepal has reintroduced over 1246 captive bred Gharials since 1981 and given several Gharials to international crocodile breeding centers like Atagwa Alligator Garden in Japan and La-Forme aux Crocodiles in France for promoting ex-situ conservation of the species. Presently, there are 84 Gharials in Narayani River, 82 Rapti River, 31 in Babai and 1 in Karnali River, totaling 198 Gharials in Nepal.

Dams and barrages, mining, floods and pollution have always been major sources of threats to Gharial conservation. Dams and barrages stop free movement of the species in the River. Once Gharial passes through the barrage, there is no route to move back to upstream section. In order to address this, coordination among different departments and ministries and also transboundary cooperation between Nepal and India is utmost important but is a great challenge. Habitat loss and degradation, prey depletion, sand and gravel mining and encroachment of sand banks are other threats to Gharial in the country. Being a freshwater species, climate induced impact can be possible threat to this species as it might have direct impacts on water resources. However, with the increasing estimated number of Gharial from 102 in 2011 to 198 in 2016, there are hope and enthusiasm in conserving this endangered species.

In this context, the Gharial conservation action plan (2018-2022) has been prepared to maintain and manage viable population of Gharial in Nepal. The plan identifies three objectives toward achieving this goal:

- Enhance scientific knowledge through research on Gharial, its prey base and habitat
- Strengthen in-situ conservation of Gharials by reducing anthropogenic pressures
- Maintain ex-situ conservation to secure future breeding stock and systematize reintroduction of the Gharials

This plan further highlight threat, challenges and opportunities to implement the identified action under each objective. As the custodian of the plan, Department of National Park and Wildlife Conservation (DNPWC) has the responsibility of implementing the identified actions in collaboration with Department of Forests and multiple conservation partners, and local communities. The total estimated budget for the implementation of the plan is NPR **147,885,505.**

1. Introduction

1.1 Relevance of the Action Plan

Gharial Conservation Action Plan (2018-2022) has been prepared with the aim of securing and maintaining viable population of Gharial in Nepal by addressing the threats and challenges including the impacts of climate change and development activities. This plan includes actions for all strategically identified objectives so that all these activities, in consonance with each other, will contribute to maintain viable population of Gharial in the country. This action plan will be a milestone in Gharial conservation initiative in Nepal and will show a trajectory to improve the habitats of the species, reduce the threats and ultimately conserving them in Nepal.

1.2 Action Plan Development Process

The action plan was developed through review of published and unpublished relevant literatures on Gharial conservation, field assessment and feedback obtained from the local and central level consultations.

The preliminary local level focus group meetings were conducted at Chitwan and Bardia National Parks with the participation of representatives from different organizations like National Parks, District Forest Offices, communities of buffer zone institutions, National Trust for Nature Conservation (NTNC) field offices, Hotel Associations and Guide Associations. The meeting was focused on the issues, threats and opportunities for Gharial conservation in Nepal. Several field visits were conducted in habitats of Gharials and its breeding centers in Chitwan and Bardia and gathered information on current practices and issues. Consultations with Department of National Parks and Wildlife Conservation (DNPWC), Department of Forests (DoF), local government bodies, National Trust for Nature Conservation (NTNC), World Wildlife Fund (WWF) Nepal and Zoological Society of London (ZSL) Nepal officials were also carried out at central level. The draft action plan was prepared, shared among the experts for review and presented at the national level workshop for wider consultations. All the relevant comments and feedbacks were incorporated in the final action plan.

1.3 Scope of the Action Plan

The action plan has fully adopted priorities provisioned by National Biodiversity Strategy and Action Plan (2014-2020), Forest Policy (2015), and Protected Area (PA) management plans of Gharial bearing protected areas of Nepal. This action plan will be implemented in Gharial bearing protected areas and Gharials dwelling River systems outside PAs.

The action plan consisted of seven chapters. First chapter is introduction, second chapter summarizes the national and international status and context of Gharial conservation, third chapter highlights the conservation efforts and achievements for Gharial conservation in Nepal. Fourth and fifth chapters summarize the conservation threats, challenges and opportunities of the species. The sixth chapter deals with the Gharial Conservation Action Plan 2018-2022. The plan is presented with goal, objectives, outputs and actions. The seventh chapter includes implementation mechanisms and monitoring plan.

2. Background

2.1 Global Status and Distribution

The Gharial (*Gavialis gangeticus*) belongs to the family Gavialidae and is listed as a Critically Endangered species by IUCN (Choudhury et al. 2007). Gharial is considered as keystone species of healthy freshwater ecosystems due to the role it plays in maintaining the ecosystem and its function through its activities (Behera *et al*. 2014, Singh and Rao 2017). Until 1940s, Gharials were widely distributed in the major River systems from Indus River in Pakistan in the west to the Gangetic flood plains of India, Nepal, Bangladesh, Bhutan, and to Irrawaddy in Myanmar in the east (Neil 1971, Maskey 2008) (Figure 1). The Gharial population was estimated from 5,000 to 10,000 during that period (Whitaker et al. 1974 and Thapaliya et al. 2009). But since 1940's, or in just 3 generations, there has been about 96% decline in Gharial populations (Whitaker and Daniel 1978, Maskey 1989, Choudhury et al. 2007). And by mid-1970s, the species became limited to only 2% of its historical range and pushed to the verge of extinction. Currently, Gharials are found only in Nepal and India, and are possibly extinct from Bangladesh, Bhutan, Myanmar and Pakistan (Behura and Singh 1978, Maskey 1989, Choudhury et. al 2007).

Present global Gharial population is estimated to be around 550 breeding adults with 88% confined within National Chambal Sanctuary, India (Lang 2016). Despite the release of over 3000 Gharials in India from 1979-1993 (Ross 1998, Messel et al. 1992) and 1156 in Nepal from 1981-2016, the growth of the species has not been significant.

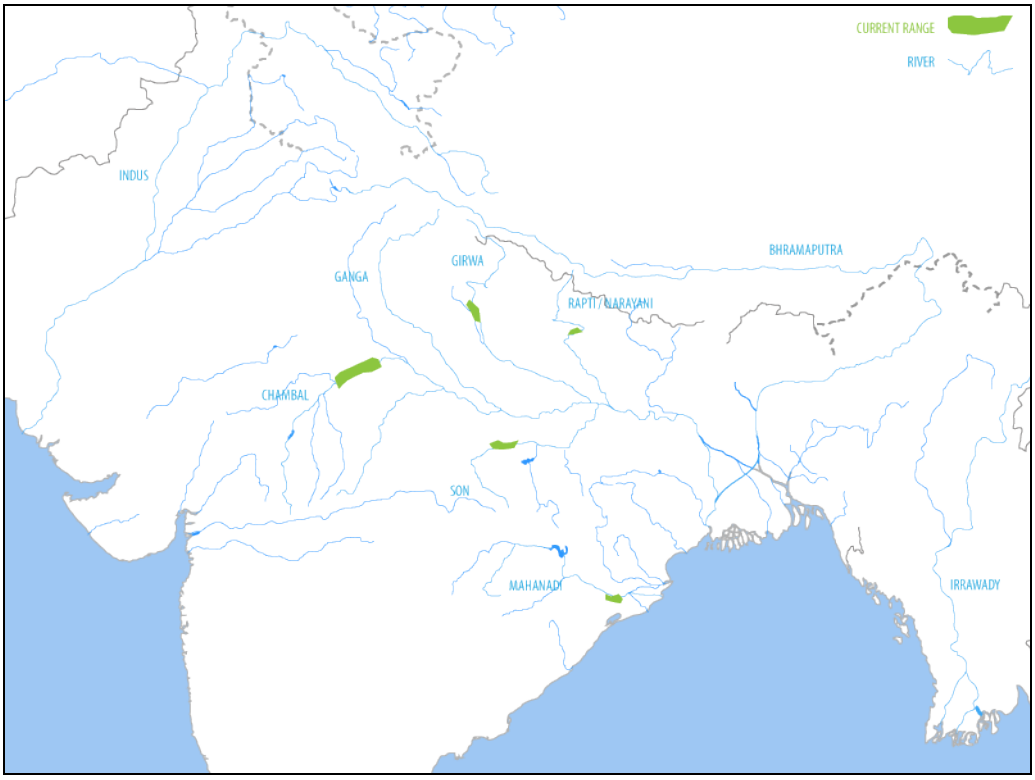

Figure 1: Global distribution of Gharial (Source: GCA)

In Nepal and India, the populations are scattered and isolated, being restricted to small stretches of Rivers and streams. The Chambal, Girwa and Son Rivers are the main remaining Gharial habitats of Mahanadi and Ganges River basin in India. Both Chambal and Son Rivers have been declared as National Sanctuaries for Gharial conservation. In India, breeding populations of Gharial only occur in Girwa in Katerniaghat Wildlife Sanctuary and Chambal River in National Chambal Sanctuary.

2.2 National Status and Distribution

Gharial (*Gavialis gangeticus*) and the Marsh Mugger (*Crocodylus palustris*) are the two species of crocodilians found in Nepal. Gharial is one of the protected wildlife listed in Schedule I of National Parks and Wildlife Conservation Act, 1973. Current population of Gharial is estimated to be 198 individuals in Nepal with the adult population of 85 individuals (6 males and 79 females) (Acharya et al. 2017). Table 1 provides detail status of Gharial distribution in Nepal. The core population of Gharial is confined only to Rapti and Narayani in Chitwan National Park (Figure 2) and Babai & Karnali Rivers in Bardia National Park (Figure 3). The current Gharial populations surviving in Rapti and Babai Rivers are the introduced population from the Narayani River. Gharials have also been reported seasonally from Mohana River in Kailali District, Reu River, Khageri and Budhi Rapti River in Chitwan.

Table 1: Status of Gharial in four Rivers (Narayani and Rapti Rivers in Chitwan National Park, and Babai and Karnali Rivers in Bardia National Park) of Nepal, from 2004 to 2016.

Year	Males	Females	Total adults	Subadults	Hatchling/ immature	Not sexed	Total	Survey period	Reference
Narayani River									
1987/88							50		Maskey et al. 2006
2004							31		Maskey et al. 2006
2005	2	12	14	4	6		24	December	Ballouard and Cadi 2005
2006							22		Maskey et al. 2006
2008	2	9	11	14	9		34	January–February	Khadka et al. 2008
2010				22	1		23	November	Khadka 2011
2011	2	14	16	24	3	5	48	February–March	WWF Nepal 2011
2012			14	34	4		52	November	Khadka 2013b
2013	1	14	15	20	3		38	January	Rajbhandari and Acharya 2013
2014			12	47	1		60	February	Rajbhandari and Acharya 2013
2016	1	48	49	35			84	March	2016 survey data[a]
Rapti River									
2004							30		Maskey et al. 2006
2005	2	6	8	6	1		15	December	Ballouard and Cadi 2005
2006							25		Maskey et al. 2006
2008	2	19	21		2		23	February–April	Bhatta 2009
2010				23	3		26	November	Khadka 2011
2011		1	1	29		3	33	February–March	WWF Nepal 2011
2013			4	31			35	January	Rajbhandari and Acharya 2013
2016		20	20	52	5	5	82	March	2016 survey data[a]
Babai River									
2008	1	1	2	8			10		Khadka et al. 2008
2011	2	5	7	10			17	February–March	WWF Nepal 2011
2016	5	10	15	13		3	31	March	2016 survey data[a]
Karnali River									
2008							6		Khadka et al. 2008
2011	0	1	1	1	2	3	7	February–March	WWF Nepal 2011
2016	0	1	1				1	March	2016 survey data[a]

[a] Department of National Parks and Wildlife Conservation, Nepal.

(Source: K.P Acharya et al. 2017)

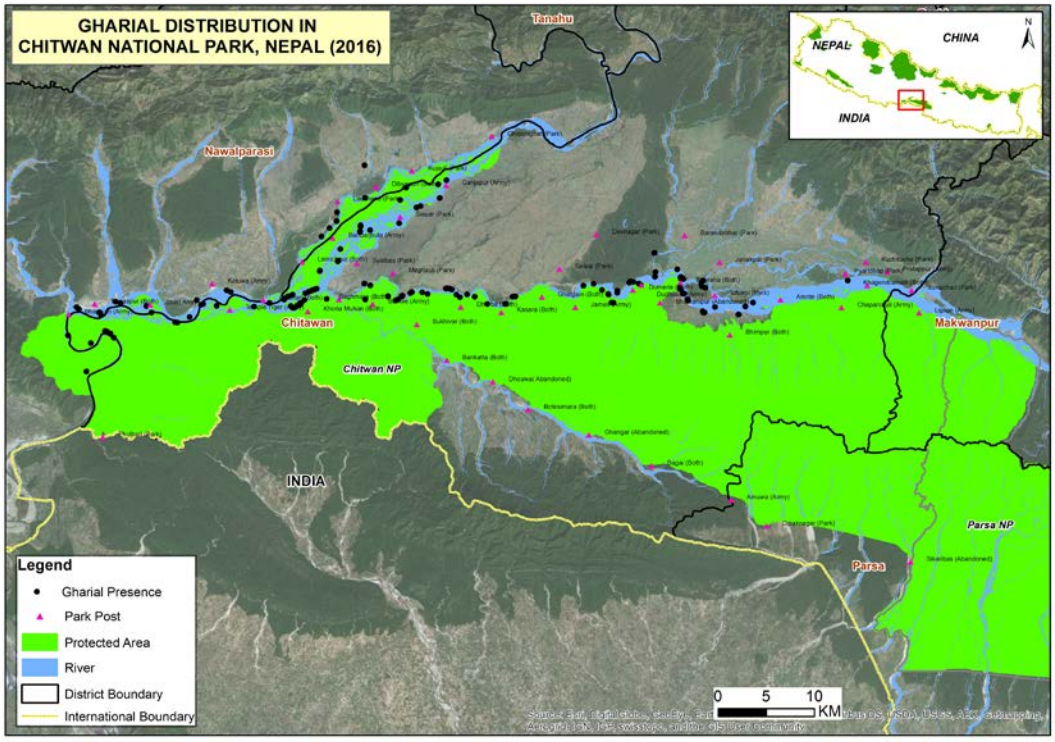

Figure 2: Gharial distribution in Rapti and Narayani River

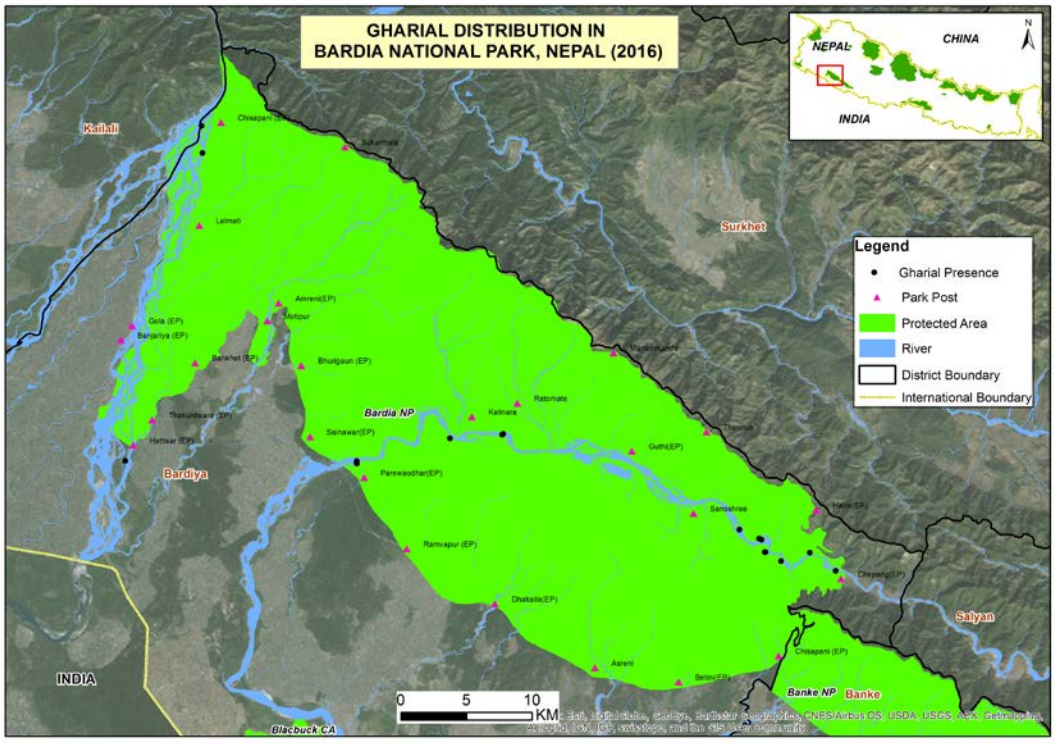

Figure 3: Gharial distribution in Babai and Karnali River

Historically, Gharials were distributed across all the major River systems of Nepal (Koshi, Gandaki, Karnali and Mahakali) (Maskey 1989). The disappearance of Gharial from their historical range can be attributed to construction of barrages, excessive use of gill nets and habitat loss (*Ibid.*). The 1987 survey confirmed 9 Gharials near Chisapani gorge of the upper Karnali River and 57 Gharials were estimated to be concentrated within the stretch of Narayani River in 1977 (*Ibid.*). A total of 95 individuals were released between 1981 and 2010 in an attempt to restock the wild Gharial population in Koshi River. However, the Gharials have not been recorded from Koshi River during the Gharial survey of 2008 and 2011 (Khadka et al. 2008, WWF Nepal 2011). The last sighting of Gharial in Koshi was in 1998 when four individuals were recorded (Thapaliya et al. 2009).

2.3 Natural History

Gharial is considered as keystone species of the healthy fresh water ecosystems (Behera et al. 2014). It is considered as a 65 million years old crocodilian (White 2009) and is one of the rarest and most aquatic of all crocodilians (Maskey et al. 2006). It belongs to the family *Gavialidae* and the genus G*avialis*. It is the sole member of Gavialidae belonging to a long established group of Crocodylidae family (Maskey and Percival 1994).

Gharial is easily distinguishable from other crocodiles by its long, narrow and slender snout. The name Gharial is derived from Nepali/Hindi name 'Ghara' which means an earthen jar pot. The mature male possesses a 'Ghara' which is a cartilaginous protuberance, on the tip of the snout above the nostrils (Smith 1931). An adult male can grow up to 7 meters long while an adult female can grow up to 5 meters only (Maskey and Percival 1994). The grown up Gharials have jaws with interlocking set of 27 - 29 undifferentiated teeth on each side of upper jaw and 25 - 26 teeth in the lower jaw adapted for capturing fish (Shah and Tiwari 2004). They have short legs feebly equipped for locomotion on land and adults cannot lift their bodies clear off the ground.

2.4 Ecology

Gharials are habitat and diet specialists. They prefer confluence of fast flowing Rivers and spend most of the time in water (Nair et al. 2012). Nearby high sand banks are used for basking, nesting and laying egg and largely spend day time basking on the sand banks in winter. They are very well adapted to aquatic life style. They have weak limbs and hence do not have the ability to walk in the semi-upright position as other crocodilians do and can only move in forward sliding motion (Nawab et al. 2013). They exclusively feed on fishes, though juveniles may feed on a variety of invertebrate prey species such as insects and smaller vertebrates such as frogs (Whitaker 2007).

Like all other crocodilians, Gharials are cold blooded animals and uses sun basking to warm up and water to cool down their bodies (GCA 2009). Gharials prefer water of shaded forest areas where fish is abundant and which is cooler during hot season and warmer in winter than the main Rivers.

Gharial population is known to be spatially structured and its movement is primarily dependent on size/age of the animals. Adult reproductive females routinely move as far as 80-120 km each season to join basking breeding aggregations and to locate suitable nesting areas where they nest communally and remain with

eggs/young until monsoon floods. They also rapidly and routinely move upstream and downstream. On the other hand, sub-adult Gharials are more or less sedentary with localized and restricted movement patterns of about 10-30 km seasonally and occupy 5-15 km of seasonal residencies (Lang and Kumar 2013).

Studies report that Gharials occupy River stretch where there is zero to very low level of disturbance, presence of fine sand banks, especially deep pools with River confluence and greater prey availability (Nair 2010, Malla et al. 2012). Gharial feed primarily during the monsoonal months of June through September and basks daily for long periods during the winter months of November to February.

Gharials reach sexual maturity at the age of 13 to 16 years when they are about three meters long (Maskey and Mishra 1981). The mating period occurs for two months during November- December and sometime extends till January. The mating occurs in water and the female lays 20 to 95 eggs in a clutch which are laid in 50-60 cm deep pits in sand banks that are 1-5m away from waterline (Whitaker and Basu 1983). The eggs are incubated for 70-90 days in the wild and young Gharials hatch in July just before the onset of the rainy season (Whitaker and Basu 1983). Female Gharials dig up the young in response to hatching chirps, but do not assist the hatchlings to reach the water. Female Gharials will stay near their young and protect them for a period of several weeks to several months. During this time the hatchlings usually stay together in groups near the female (Lang and Kumar 2013).

Gharial has temperature dependent sex determination (TSD) and the TSD pattern is female-male-female. Fertile eggs incubated at set constant temperatures from 29 -31.5^{o} produced only females and at 32^{o}C 89% were males. At 33 and 33.5^{o}C, 20% and 15% males were produced (Lang and Andrews 1994).

Gharials live for about 40-60 years of age (Sharma et al. 1995). Currently, the first batch of Gharials in Gharial Conservation and Breeding Center (GCBC) are 38 years old.

3. Major Conservation Efforts and Achievements

3.1 National Conservation Policy

Gharial is listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix-I imposing ban on international trade of Gharials or their body parts. Nepal is also a state member to the convention of wetlands known as (RAMSAR Convention) since 1987. The principal guiding policy documents such as National Biodiversity Strategy and Action Plan (2014-2020), Forest Policy (2015), Wetland Policy (2012) have made the strong provision to conserve the critically endangered aquatic species. Moreover, the National Parks and Wildlife Conservation Act (1973) has listed Gharial as a protected species. The Aquatic Animal Protection Act (1961) prohibits the use of poison, toxic or explosive materials in a water source, or destroying dam or water system with the intent to catch or kill aquatic life. Thus, it is illegal to kill Gharials or destroy/collect eggs to consume or for sale. The highest penalty for killing Gharial is NRs. 500,000 fine and 10 years of imprisonment as provisioned in NPWC act, 1973. In addition, Act on control of International Trade in Endangered Fauna and Flora, 2017 has made provisions maximum of NRs. one million fine and 15 years of imprisonment if any person convicted to crime of Gharials in Nepal. The Gharial bearing protected areas also highlights the key activities to conserve the Gharials and its habitat. Hence, the Gharials have been given priority for strict protection and implementing various programs to enhance Gharial conservation after the establishment of the protected areas.

3.2 Updated Population and Habitat Monitoring

The recent count estimated a total of 198 individuals in Nepal (Acharya et al. 2017). There has been a gradual increase in Gharial population since 2011. The surveys in 2011 and 2013 confirmed 102 and 124 Gharials respectively (Achyarya et al. 2017). Increasing emphasis has been given to periodic updating, monitoring and study on the species and their habitats.

The population status of Gharial in Nepal is updated through intensive monitoring of Gharials since 2008 in Rapti, Narayani, Koshi, Karnali and Babai Rivers using standard methods.

3.3 Gharial Conservation and Breeding Center (GCBC)

To protect Gharials from extinction, Government of Nepal with the support from the Frankfurt Zoological Society, Germany launched the “Gharial Conservation and Breeding Center” as a project at Kasara, Chitwan National Park in 1978. The center was established at the time when the Gharial population was below 81 and the hatchlings’ survival rate was as low as 1% in the wild. Later, several international and national conservation organizations joined hands with Nepal in further development of physical infrastructure of the Center. The major developments such as construction of the large breeding pools, upgraded visitor Center, health laboratory and fish farm took place between 2010-2013 with the support from WWF Nepal and Save Your Logo program joint initiative of LACOSTE and Fonds De Dotation Pour La Biodiversite (FDB), French based NGO. In addition, the Zoological Society of London (ZSL Nepal) provided the financial support to renovate the GCBC infrastructure in 2017.

Apart from supporting breeding stock of Gharials for re-introduction program, this Center also plays major role in outreach and awareness on Gharials. A small information section depicting the Center's various activities, including *in-situ* Gharial conservation efforts are been set up. The major activities of the GCBC include egg collection, captive rearing of hatchlings, release of young and periodic monitoring of wild and released Gharials.

GCBC had 664 Gharials of all age/size classes in 2016. There were a total of 14 adult Gharials of which 12 were females and two were males. Of the two males one was relatively old, almost 35 years old (born in 1979). The other male was 30 years old, had both frontal limbs broken and was therefore unable to perform courtship. During 2015, the GCBC recorded zero hatchling success and the reasons are yet to be investigated (Ranabhat et al. 2016). At present, GCBC houses a total of 645 Gharials of which 13 are adults (including one male), 30 sub-adults, 504 Juvenile and 98 hatchlings.

3.4 The Gharial Monitoring Center (GMC)

The Gharial Monitoring Center was established to facilitate egg collection, nest guarding and monitoring of Gharials in the wild. It is situated on an island in the Narayani River which is about 4 km from the nearest village and 45 km from the Gharial breeding center in Kasara and can only be reached by boat.

The nest watchers are hired to locate nests in Narayani River. The eggs from the Gharial nests are transported to GMC and incubated in natural conditions. The nest watchers guard the nests at GMC, so that no eggs are stolen. Some eggs are brought to GCBC and eggs are incubated in the sand of breeding pools. Hatchlings are reared in GCBC with great care resulting 80% of the hatchling survival. The first batch of 50 Gharials was released in Narayani in 1981.

3.5 Reintroduction Program

The GCBC first batch of 50 captive bred Gharials was released in Narayani in 1981. Since then a total of 1246 Gharials have been released till 2017 to different River systems of Nepal (Figure 4). Among released Gharials, the fewer numbers were released in Kali Gandaki River where as the greater numbers of Gharials have been released in Rapti River of Chitwan.

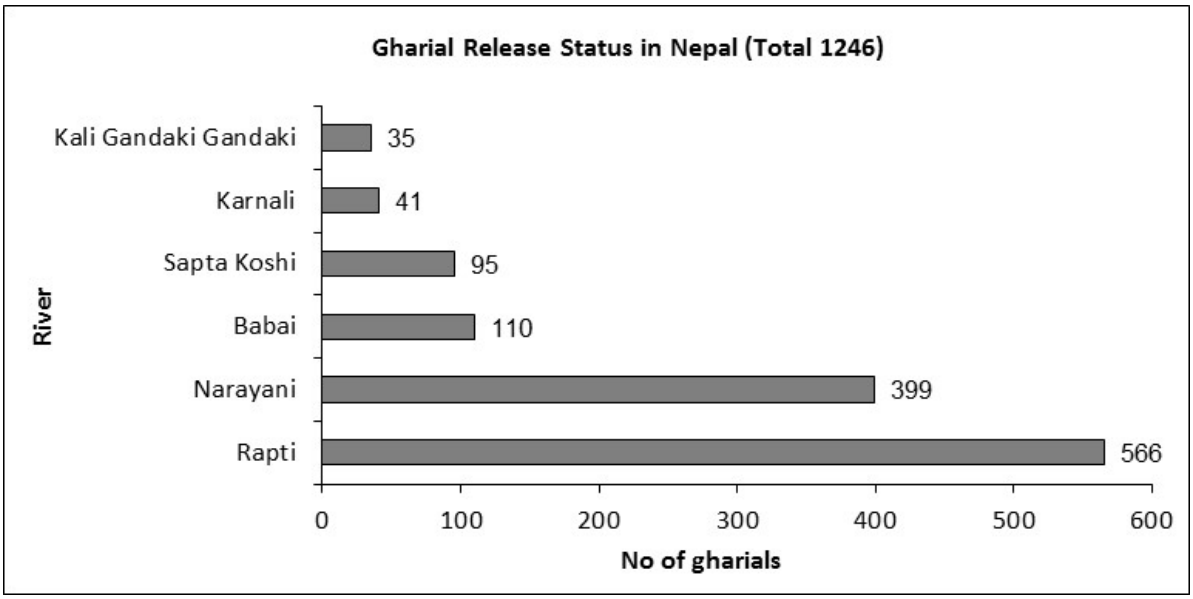

Figure 4: Gharial released in different River systems of Nepal (1981-2017)

3.6 Crocodile Conservation Center (CCC), Bardia

The Crocodile Conservation Center at Thakurdwara in Bardia National Park was established in 1982 with 25 Gharial eggs collected from Kalinara area of Babai River suggesting that the breeding population of Gharial existed in Babai River during 1980s (per.comm. with K.M. Shrestha, former Chief Conservation Officer of Bardia National Park, 2011). Later, about 10 captive bred Gharials were brought from Chitwan National Park as a startup population for breeding in 2010. The large pools were constructed in 1989 and 2013. There are 10 fully-grown Gharials kept in a large, deep pool constructed in 2010 for breeding.

3.7 Learnings from Ex-situ Conservation

3.7.1 Egg collection: Gharials lay eggs in the wild from the last week of March to first week of April. Experienced nest watchers are hired from local fishing communities to follow the breeding Gharials and take records of observed nesting sites and egg laying dates. Nesting occurs at night and is located the following morning based upon the fresh tracks of Gharial on the sand. Once the nests are located, the nest watchers inform the GCBC.

3.7.2 Incubation/hatching: The eggs from the nesting sites of Narayani and Rapti Rivers are mostly transported to the Center (GMC and GCBC) via boats. The eggs are re-buried in a natural sand bank of Gharial Monitoring Center, Amaltari and GCBC in the same orientation the eggs were in the nest and are sprinkled with few drops of water to maintain humidity. During the hatching period, the hatchlings produce chirping sound from inside the nest. On hearing the call, keepers help the young Gharials come out of the eggs and nest. In the breeding center, adult females are observed helping the hatchlings come out of the nest and lead them to the pools. Most of the eggs, on average are hatched within 67 to 75 days but may take longer in the nests located in shaded (cool) conditions.

3.7.3 Rearing and management: During the first week, hatchlings are seen with the adult Gharials. Both male and female provide parental care to the hatchlings. Males are seen to produce hissing sounds to call the hatchlings and in response, the hatchlings follow the males. After one week, hatchlings are relocated to separate hatchling pools. Hatchlings begin to eat small fresh fish at night when they are about two months old, and gradually begin to eat during the day. Those Gharials that do not feed on their own are hand fed until 3 months. Hatchlings are segregated based upon their size to different pans; generally, hatchlings that feed themselves get larger in size compared to those that are hand-fed. The smaller ones are continued to be hand fed until October, and are also given vitamin supplement (0.2 ml per hatchling) in every second day until November.

During winter, the hatchling pools are covered with plastic sheets to conserve heat and keep the juveniles warm to reduce mortality. The pond is cleaned everyday by removing the leftover fishes and brushing the surfaces with wire brushes. Potassium permanganate is added once a week to the water to control bacterial growth. Twice a month during the rainy season (June-September), hatchlings' teeth and skin are brushed using water treated with potassium permanganate to control teeth and skin fungus. It has been noticed that hatchlings are more prone to fungal diseases during the rainy season because of contaminated water. With precautionary measures, hatching success has increased to around 87%, which is relatively higher as compared to the past. The reasons for mortality of fully grown hatchlings are unknown but the presence of red ants (*Dorylus orientalis*) in the nest is suspected.

3.7.4 Gharial release: Generally Gharials are released post monsoon after September. This allows them to get adapted to the natural conditions. Gharial release is carried out almost every year in Rapti River of Chitwan. For this, Gharials are loaded in a specially designated ventilated wooden box of size 20 cm x 30 cm x 180 cm and are transported to the soft enclosure built in an area close to GCBC with low water current. These enclosures are made up of elephant grass. Gharials remain in the soft enclosure for a week's period until they break open the enclosure and are finally released into the wild. Till 2017, a total of 1246 gharials have been released into different River systems of Nepal.

3.8 Awareness, Capacity Building and Research

The GCBC in Chitwan and CCC in Bardia are attractive destination to domestic and foreign tourists. These centers are also research sites to students and conservationist. Besides, these centers are also functioning as demonstrate site to raise conservation awareness and interest at all levels, and encourage to take immediate conservation actions of gharials. As a part of capacity building program, the PA staff are trained on captive management and monitoring techniques of Gharials.

3.9 Community Iinvolvements in Gharial Conservation

Several communities are involved in Gharial conservation in Chitwan and Bardia. Buffer zone user groups of Chitwan and Nawalparasi districts were sensitized on Gharial conservation. Under Buffer Zone Management Committee (BZMC), Gharial and River Conservation Sub-Committees have been formed under which Smart River Rangers program was implemented for regular monitoring and patrolling of Narayani and Rapti Rivers in CNP.

To garner community support in Gharial conservation in the past, River dependent communities were brought into the mainstream of Gharial conservation. Several income generating activities and alternative livelihood options were provided to the River dependent communities (bote, majhi and mushars) through Terai Arc Landscape Program from 2010-2013. A Darwin Initiative funded project is currently being implemented with CNP's lead role by NTNC and ZSL Nepal to support River dependent communities in the buffer zone area.

3.10 Management of GCBC, Kasara and CCC, Bardia

The Chitwan National Park and Bardia National Park allocate the budget in their annual program to manage the GCBC and CCC respectively. In addition, these centers also collect donation from visitors. The donation generated is managed by NTNC for maintenance of the center and salary of the keepers in close coordination with respective protected areas. The GCBC and CCC management committee are formed under the chairmanship of Chief Conservation Officer of the respective park. The other members of the committee include Project Manager of NTNC field office, Assistant Conservation Officer, Veterinary Officer and administration and finance officials of NTNC field office. This committee is responsible for the overall management of this fund.

4. Conservation Threats

Specialized feeding behavior and habitat, limited distribution and low survival rate in the wild poses huge challenge to the long term survival of Gharials. The exact impacts of climate change to the species and its habitat is still not determined but species being highly dependent on River, River ecology and temperature, the species could face severe impact on its habitat, sex ratios, and survival strategies.

4.1 Habitat Loss and Degradation

4.1.1 Dams and barrages

Major Gharial inhabited River systems in Nepal are already dammed and high dams in Koshi and Karnali are proposed for mega hydropower generation and irrigation. The construction of dams without fish passages interrupt the longitudinal connectivity of River and block seasonal migratory routes of fishes and other aquatic species, including crocodiles, turtles and dolphins. These dams prevent upstream-downstream dispersal, spawning migrations and also alter suitable habitats for nesting and basking. All these factors will lead to a decrease and deterioration of suitable Gharial habitats and abundance of their prey species in the Rivers. The Babai irrigation weir is already an impediment for upstream migration of Gharial.

The Bheri River diversion to Babai in Bardia National Park, which is currently under construction has not considered sufficiently regarding the negative impacts on Gharial population due to change of River ecosystem. Similarly, the Rani Jamara Kulariya irrigation in Karnali River has already posed a serious threat to the survival of Gharial, dolphin and other aquatic species due to the low water level and flow. Furthermore, regulation of barrage gates with higher number of gates opened in peak monsoon and closure of the gates during dry season changes the water flow of major River system thus adversely affecting free movement of Gharial and other aquatic species.

4.1.2 Pollution

In Nepal, Rivers are usually used as a common disposal site for both domestic sewage and industrial waste. The Rivers are polluted with sewage, garbage and chemical effluents coming from industries like paper and pulp, cement, rubber factories and distilleries. Another source of River pollution is the excessive use of pesticides and chemical fertilizers in agriculture that are ultimately drained into Rivers. Although Ministry of Population and Environment has developed Tolerance Limits for Industrial Effluents to be discharged into Inland Surface Waters (2001), most of the industries do not follow the standard due to weak monitoring mechanism of government.

4.1.3 Intensive mining of gravel and sand

In most of the River systems, sand and gravel extraction is increasing to meet the demand of domestic and commercial developments. Similarly, commercial stone crusher industries are flourishing in many of the Riverbanks. The huge volume of gravel and sand is exported across the border. Such large-scale mining activity has deteriorated prime Gharial habitats by preventing them from basking and nesting.

4.1.4 Shifting encroachment of sand banks by the fishermen

Bote, Majhi and Musahar along with their families are found to pitch the plastic tents in the most potential Gharial basking sand banks along the stretch of Narayani River, where they stay for extended days carrying out fishing activities. This activity not only depletes the fish stock from the River but also triggers in Gharials abandoning the area. In Amaltari, the sand banks in Gharial monitoring center were the most potential sand banks for nesting every year but no nesting occurred in 2013 due to high temporary settlements of fishermen in the area (TAL PABZ 2013).

4.2 Prey Depletion and Incidental Killing of Gharials

Among the anthropogenic activities, increasing practice of using gill nets by fishermen not only result in over-harvest of fish, but in many occasions, Gharials get entangled in the fishing nets ultimately starving to death.

The fish resource has declined due to the use of poison, explosives and electrocution for fishing. The situation has been further aggravated by increasing market demands of freshwater fish and rising human population along the Riversides. It has subsequently resulted in scarcity of basic food resources for Gharials and other aquatic species like dolphins and otters. Although Aquatic Animal Protection Act (1961) restricted using electric current, explosive substance or poisonous substance with intention of catching and killing any aquatic animal in any water, it doesn't seem to be followed by people. So, strict law enforcement should be made from the concerned government agencies.

4.3 Climate Induced Impact

The impact of climate change on wetlands and species are presumed to be formidable. However, its impact will be huge if some precautionary mitigation and adaptive actions are not undertaken in advance. Since Gharials are considered as climate sensitive (Thapa et al 2015) and some Gharials riparian habitats are snow fed Rivers; it is inevitable that the impacts of global warming on the mountains will affect the aquatic biodiversity. The United Nation Environment Programme (UNEP) foresees that high temperature and decreased rainfall could result in lower flows, stagnant pools, and warmer water temperature that could eventually result in eutrophic conditions that affect water quality.

5. Challenges and Opportunities

5.1 Gharial and its Prey

On the backdrop of a skewed sex ratio of two males to 10 females, low relative density of 0.29 individual/km in Narayani River and one percent survival rate of Gharials in wild, sustaining abundance of Gharials and its prey is one of the major challenges. Persisting threats from dams and increasing anthropogenic activities like the use of gill nets for fishing have exacerbated the challenges to conservation. Market outlets along the highway close to Rivers are increasing, promoting the growth of an already unsustainable fishery practice. The consequence has been a drastic decrease in the prey availability for Gharials. There is a need to regulate fishing permits based on a scientific study, and strict control of unauthorized and non-conventional fishing methods.

The River pollution due to poisoning and disposal of solid and chemical wastes has caused further deterioration of both water and food quality of the Gharial habitats. Reverting Geruwa River to its original course is a massive task. However, regulating water flow by opening gates of dams at certain times of the year to allow upstream migration of spawning fishes, and during high or flash flood will provide some respite in improving the situation for Gharials and its prey. A strong policy level advocacy with the Government of India officials will be necessary for convincing the counterparts of this need.

In captivity, presence of parasital disease (in dormant stage) in less than one year old hatchlings and dirty water in the pool is the main cause of high mortality of hatchlings. The yolk sack and bacterial infections occur from parasite called "*Exotidendrium*" detected in 1930 (Gaire 2009). The mortality is high in the month of March and April. Clean water (boring water) and sanitation in the breeding center is required to avoid water borne disease and reduce mortality.

5.2 Habitat Condition

There is tremendous pressure on Gharial habitats both from natural forces and anthropogenic factors leading to alteration or degradation. Little or virtually nothing can be done to natural process such as yearly flooding but major management interventions need to be undertaken to reduce anthropogenic pressure in Gharial habitats so that enough sandbanks for nesting and basking are protected. If certain amounts of natural flow of the Rivers are maintained while construction of mega dams, it will ease upstream and downstream movement of aquatic fauna. Regulation of solid and industrial waste disposal into Rivers controlled mining of gravel and sand from the selected sites, and strict law enforcement in the River segments needs to designate as "Restricted/No-Go Zone" in the prime Gharial habitats in low favorable habitat for Gharial can help to improve the situation. This kind of regulatory system may help revival of degraded habitat as well as reduce stress on Gharials and their prey.

5.3 High Pressure on Habitat and Prey

The growing human population and anthropogenic activities have consequence negative effects to Gharial population depletion. Over fish harvesting, poising for fishing, extensive agriculture, firewood collection,

cattle grazing, grass cutting and heavy traffic in the river courses and riverbanks for mining gravel and sands are major challenges to Gharial conservation.

Involvement of local people in conservation is an opportunity to conserve Gharial habitat through joint monitoring, river patrolling, and habitat conservation activities. However, it is difficult to generate the adequate benefits to the local people. Possibility of illicit and unwarranted disturbance is another challenge. Similarly, the extraction of stone, sand mining and boulder extraction has another negative consequence to Gharial conservation. Complete ban of these activities in Gharial habitats should be imposed. Integration of Gharial conservation activities together with other protected area management is indispensable.

5.4 Strength and Capacity in ex-situ Conservation

GCBC in Chitwan and CCC in Bardia, two breeding centers are ex-situ conservation of Gharial in Nepal. These centers are recognized the most successful conservation efforts. However, Gharial keepers are still on daily wage basis. It has fairly motivated dedicated staffs who have been engaged for Gharial husbandry and management in GCBC and CCC. There is not adequate capacity building program for their skill improvement or career development. There is a need to create additional positions with specific job description or to revise the existing job description of protected area staff. Creating a Citizen Investment Trust could help support the fringe benefits to senior keepers in days to come. Follow-up action is necessary to increase efficiency of the breeding centers and strengthen captive populations. Design and approval of permanent organization structure is essential to sustain the GCBC in Chitwan and CCC in Bardia.

5.5 Awareness, Research and Monitoring

Conservation is a passion and it always requires an advance level of understanding. Such passion and higher level of understanding are depend on the level of awareness of the person. In the past, local communities had little awareness about the importance of Gharial and their understanding in maintaining healthy wetland ecosystem. There is still vast knowledge gap about Gharial conservation biology and their significance to society. Though, communities have been sensitized about the importance of Gharial conservation and are gradually showing interest to participate in conservation activities, more is required to reverse the declining trend of the species. Several research projects on Gharials and their habitats are in progress and regular participatory monitoring is in place, but still more needs to be done in this front.

Preliminary research though has been carried out; specific research answering the fate of re-introduction program, Gharial ecology and biology needs to be carried out in greater detail. Such research methods should use the state-of-the-art conservation technology and tools including satellite transmitters, DNA studies etc. as per the need for conservation of the Gharials.

5.6 Sustaining GCBC in Chitwan and CCC in Bardia

Financial and institutional sustainability are two major challenges to Gharial breeding center. Financial backup to operate GCBC and CCC is uncertain. The government provides annual budgets for buying fish and or minor maintenance only, but this fund flow is not regular and is inadequate to meet the annual expense for feeding Gharials. The monthly salary of keepers is met from the donation raised from the visitors in the Centers. Major renovation of enclosures, breeding pools and construction of such facilities are supported

from national and international partner organizations. Moreover, to sustain the Centers, permanent structure of organization and allocation of sufficient staff are fundamental. Increasing the satisfaction of visitors, and encouraging donations and support to GCBC through a recognised institution may help raise the much-needed funds.

5.7. Global, Regional and Trans-boundary Cooperation

The major Rivers where Gharials occur are dammed along the Nepal-India international border or close to it. There is no chances of returning upstream once Gharials and dolphins pass through these dams. Promotion of trans-boundary cooperation between Nepal and India is required to ensure protection of migratory species, sharing information and experience, and implementing complementary conservation and monitoring programs. The collaboration with GCA is essential for implementing Gharial Species Recovery Plan (GSRP) and reinforcement of Gharial conservation in Nepal. International and regional collaboration among Gharial range countries is required for capacity building, research and overall conservation of Gharials and their habitats for long-term survival of this critically endangered species.

6. Gharial Conservation Action Plan (2018-2022)

6.1 Goal

Viable population of Gharial maintained and managed in Nepal

6.2 Objectives

6.2.1 Enhance scientific knowledge through research on Gharial, its prey base and habitat

Rationale

The scientific studies on Gharial began in Nepal during 1980s by Dr. Tirtha Man Maskey on status and ecology of Gharial mostly concentrating on movement and survival of captive reared Gharial in Narayani River (Maskey 1989). Later other studies (Ballouard and Cady 2005, Bhatta 2009, Thapaliya et al. 2009, Gaire 2007, Khadka 2010, Khadka 2011, WWF Nepal 2011, Malla et al. 2012, Acharya et al. 2017) were mostly focused on population status, threats and monitoring of the species. The details studies on behavioral and spatial ecology on Gharials exist primarily in Chambal River, National Chambal Sanctuary, India, following the mass die-off in 2008 (GCA 2008). Yet, the Gharials, their habitat and prey population dynamic is not yet fully understood. Long-term ecological monitoring covering several aspects such as survival, dispersal and migration, impacts of River flow regulation, fishing, pollution, sand and gravel mining and climate change is required for long term conservation of Gharial.

Similarly, the research should also be focused on understanding the skewed sex ratio of Gharials, high mortality of hatchlings in captivity and in wild. Likewise, feasibility study to identify additional Gharial habitat for restocking in other River systems such as Kali Gandaki River (Upstream of Devghat), Trishuli River (Devghat to Muglin), Karnali River (Upstream of Chisapani bridge) should be carried out.

Outputs

1. Standard 'National Protocol for Gharial Monitoring' developed
2. Status and threats of Gharial and its prey and habitats understood
3. Ecological understanding of Gharials, their prey base and habitats enhanced
4. Possible alternative habitats for future release of Gharials identified
5. Strategic collaboration with international and regional conservation organizations enhanced

Actions

1. Prepare standard monitoring Protocol for Gharial Conservation in Nepal
2. Conduct nationwide periodic survey of Gharial
3. Conduct research on Gharial ecology, behavior, movement, habitat dynamics, and prey-predator relationship using new technology such as satellite transmitters, genetic studies.
4. Carry out study focusing on Gharial's skewed sex ratio and survival rate
5. Carry out research on socio-ecological dynamics of River dependent communities, Gharial, its prey and habitat

6. Mapping point and non-point sources of water pollution in Gharial habitats
7. Assess river water quality and industrial effluents in Gharial Dwelling River systems
8. Assess and maintain environmental flow requirement for Gharials and their prey base in all the Rivers inhabiting Gharials
9. Conduct research on climate induced impact on Gharials, their prey and habitat and establish hydro-met stations
10. Identify potential alternative habitats for future release of captive bred Gharials in Kali Gandaki, Narayani, Karnali and other River systems
11. Release and assess the post-performance of Gharial in fresh water reservoirs such as Jagadishpur and Ghoda ghodi lake and hydropower dams
12. Collaborate with national, international academic institutions/NGOs, donors and local communities in research and monitoring
13. Conduct survey on "willingness to pay" with national and international tourists, donors for sustainable management of GCBC
14. Conduct long term study on climate variation at GCBC and Natural habitat of Gharials.

6.2.2 Strengthen *in-situ* conservation of Gharials by reducing anthropogenic pressures

Rationale

Gharial conservation though dates back to 1970s with dedicated conservation breeding and rehabilitation programs for a period of 4 decades; the *in-situ* conservation has not been successful as expected. The gharial release program has helped prevent the complete extinction of gharial from the wild. Between 1981 and 2017, a total of 1246 gharials were released in different River systems of Nepal with estimated surviving population of approximate 17%. However, in spite of these good efforts, the gharial population has not increased satisfactorily in the wild.

The major challenge in *in-situ* conservation is the inadequate allocation of government budget for conservation of Gharial, its habitat and prey. The unsustainable methods of harvesting fishes, sand and gravel mining, sand bank encroachment have also contributed to the decline of Gharial population. Similarly, the flash flood also washes away sand banks that are potential sites for nesting and basking. Confinement of Rivers along River training walls is also a major hurdle for dispersal of Gharial in stretches of the River outside their concentration spot.

In addition, collection of most eggs from the wild for incubation in GCBC might have disrupted the natural balance contributing to skewed sex ratio. Therefore, current conservation action plan focusses on habitat protection, enforcement of the existing laws, capacity building, education and outreach, creation of artificial sand banks, gaining political support, ensuring offset measures in water infrastructure and transboundary cooperation.

Outputs

1. Gharial conservation integrated in national and local development planning process as a priority program
2. Protection of Gharial, its prey and habitat ensured
3. National and local capacity strengthened to conserve and protect Gharial

4. Offset measures in water infrastructures in place
5. Potential Gharial habitat identified and historical range restored
6. Alternative income generating activities promoted for River dependent communities
7. Trans-boundary cooperation enhanced in Gharial conservation

Actions

1. Organize regular meetings/workshops to influence planners and decision-makers in prioritizing Gharial conservation in national development plan, PA annual plan
2. Prepare and implement site specific River conservation plan for managing Gharials and its habitat along with other aquatic species in all Gharial bearing PAs
3. Facilitate workshops to declare "No-Go Zones" / Restricted zone for all the critical stretches of Rivers to prohibit human interference
4. Regulate fishing, mining and other activities (tourism) in the designated "Utility Areas"
5. Collaborate and coordinate with experts within and outside country for learning and sharing Gharial conservation
6. Promote exposure visits for sharing of experiences on Gharial conservation
7. Facilitate dialogues to place offset measures such as fish passage, flow regulation to mitigate the impact of River diversion, dams, irrigation canal
8. Introduce male Gharial in Rapti and Narayani River, Chitwan to address skewed sex ratio
9. Create and manage artificial sand banks for basking and to provide refuge against climate induced impacts
10. Promote alternative income generating activities (IGAs) to River dependent communities
11. Design and conduct intensive outreach programs to school children, eco-clubs and River dependent communities
12. Prepare Gharial conservation documentary film to reach the wide audience emphasizing on the critical situation of species as an indicator of healthy River system
13. Conduct regular workshops and meetings on Gharial conservation issues to sensitize relevant stakeholders such as Buffer Zone Institution, District Coordination Committee(DCC), Municipalities, Rural municipalities, industries, hoteliers and developmental projects
14. Celebrate national and international conservation days with clear message by highlighting the issues and challenges of Gharial conservation
15. Engage community based organizations to monitor Gharial, its nests /eggs and habitat.
16. Conduct regular trans-boundary meetings and coordination among trans-border PAs of Nepal and India
17. Conduct joint monitoring of Gharials in trans-border River system of Nepal and India.
18. Deploy the staff to monitor Gharials, their nests /eggs and habitat.
19. Identify and manage the alternative livelihood options of fishing to river dependent communities and initiate to amend the provision of fishing on legal and policy instruments.

6.2.3 Maintain *ex-situ* conservation to secure future breeding stock and systematize reintroduction of the Gharials

Rationale

Captive breeding facilities provide important genetic pool for any kind of losses against disease and probable stochastic events/water induced disasters such as floods. At present, GCBC holds large number of captive reared Gharials demanding huge financial and human resources for its management. Every year, large

expenditure is required to feed the existing Gharial stock in captivity. In addition, inadequate budget for the construction and maintenance of the pools, the lack of proper husbandry and management guideline, proper clinical laboratory facilities and trained man power to monitor the health of Gharials and over stocking has conceded the well-being of the animals in captivity. Likewise, the ceremonial release without proper monitoring and release protocol is another hindrance to the survival of Gharials in the wild. Therefore, restocking of Gharials is crucial by addressing the issues, threats and challenges in the wild.

Outputs

1. Gharial husbandry and management guidelines for ex-situ conservation developed
2. Health and well-being status of Gharial improved
3. Institutional capacity of *ex-situ* Gharial conservation strengthened
4. GCBC and CCC infrastructure facilities upgraded
5. Gharial re-introduction protocol in place
6. Best practices promoted and replicated and experience shared to improve in *ex-situ* conservation.

Actions

1. Prepare and follow Gharial husbandry and management guidelines for ex-situ conservation
2. Maintain sanitation of pools, regular water flow with proper inlet and outlet at GCBC and CCC
3. Reduce number of Gharials and maintain the minimum stock in GCBC considering the bearing capacity of pools
4. Train and capacitate staff on animal husbandry and management techniques to ensure quality handling of animals and management of the center
5. Ensure adequate number of staff and their motivation at GCBC and CCC
6. Strengthen laboratory facilities equipped with artificial incubator and other accessories in breeding centers and deploy required technicians
7. Establish clinical facilities and deploy veterinary staff to monitor regular health status and basic treatment
8. Upgrade visitor and Conservations centers of the breeding center as an integrated information center in Chitwan
9. Ensure the budget for regular maintenance of the GCBC and CCC
10. Construct additional fish farms at GCBC to promote live fish feeding to Gharials
11. Prepare and implement re-introduction protocol covering all aspects of capture, handling, size and sex of the animals, release site, time and season
12. Promote to release most hatchlings soon after hatching and encourage release after monsoon
13. Follow-up studies to understand causes of mortality of Gharial and their sex determination
14. Conduct molecular sexing of Gharials born in each batch with reference to nest temperatures in GCBC and in the wild
15. Conduct post monitoring of the released Gharials
16. Prepare the operational procedure of GCBC and CCC
17. Ensure the adequate budget in government annual program for feeding the captive gharials of GCBC and CCC
18. Ensure the additional male Gharials to GCBC with intensive discussion among national and international experts.

7. Plan Implementation and Monitoring

7.1 Implementing Agency

Most of the activities will be directly managed through the Department of National Parks and Wildlife Conservation (DNPWC) and Gharial bearing protected areas management authorities. All the common and cross-cutting activities will be managed by the department whereas activities specific to protected areas will be managed by the concern protected area management authority. The activities specific to outside protected areas will be managed by forest offices at local level. Most of the researches and studies will be conducted by NTNC, IUCN, WWF, ZSL, universities in partnership and coordination with DNPWC and DoF. Similarly, other research organizations will also be encouraged to support and conduct research on Gharials conservation. Technical and financial support from conservation partners such as NTNC, IUCN, WWF, and ZSL will be acquired while implementing the plan. Besides, province and local government, BZMC, BZUC and local communities, CBAPUs, security forces and various government and non- government agencies will also have great contribution in the implementation of this plan.

7.2 Financial Plan

Total estimated cost for the implementation of the action plan is NPR 147,885,505 (Table 2). The fund will be managed from government regular budget, existing conservation partners such as NTNC, IUCN, WWF, and ZSL. The other national and international conservation organizations will be encouraged to seek the fund for the plan implementation. Detail breakdown of the budget is presented in the annex-1.

Table 2: Summary of the Indicative budget

Goal: Viable population of Gharial maintained and managed in Nepal		
Objectives	**Total Indicative Budget**	
	Amount (NPR)	**Percentage Weight**
1: Enhance scientific knowledge through research on Gharial, its prey base and habitat	35,086,050	24%
2: Strengthen in-situ conservation of Gharials by reducing anthropogenic pressures	62,037,480	42%
3: Maintain ex-situ conservation to secure future breeding stock and systematize reintroduction of the Gharials	50,761,975	34%
Total (NPR)	**147,885,505**	100%

7.3 Monitoring of the Plan Implementation

To develop a detail action steps under each activity is beyond the scope of this action plan. Timeline for each activity has been indicated on yearly basis. Each of the responsible institution for implementation will work out a detailed work plan for every activity prior to the beginning of fiscal year.

The DNPWC, DoF, CNP and BNP, and concerned DFOs compile all their progress and present at central level review annually. Review will be focused on the achievements made on planned activities in that fiscal year, issues while implementing the plan and development of a detailed work plan for forthcoming year's activities. Major conservation partners will be invited in the review meeting.

A mid-term and final review of the action plan will be conducted by a team of independent experts who will be outsourced by the DNPWC. Both the mid-term and final review findings will be shared in national level workshops. Detailed log frame is presented in Annex- 2.

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Annex 1: Logical Framework of Goal, Objectives and Indicators

Narrative summary	Objectively verifiable indicators	Means of verification	Assumptions
Goal: Viable population of Gharial maintained and managed in Nepal	• Gharial Population (Gharial number, Breeding population in the wild, nest numbers) • Kms of habitat stretch safe for nesting and basking	• DNPWC & PAs official • documents and monitoring reports • GIS data & map • Academic Institutions & partners' research reports • Census report • Progress report • Annual report	• Local communities show enduring interest and participation • Conducive working environment prevails • No large scale natural calamities like flood
Objective 1: Enhance the scientific knowledge of the species, its prey base and habitat	• Number of research and monitoring carried out on Gharials, their prey and habitat	• DNPWC, PA, academic and conservation partner Organizations official records • Population estimation report, • Progress/Technical reports, • Annual reports • Research Papers	• Encouraging government research policy • Academic institutions and conservation partners support continued in research
Outputs: • Standard 'National Protocol for Gharial Monitoring' developed • Ecological understanding of Gharials, their prey and habitats enhanced • Status and threats of Gharial and its prey and habitats understood	• Government endorsed national Gharial monitoring protocol • Ecological data of all Gharial habitats and standard database system in place • Number of research papers/		

• Possible alternative habitats for future release of Gharials identified • Strategic collaboration with international and regional conservation organizations enhanced	reports prepared • Number of additional habitats where captive bred Gharials are released		
Actions: 1. Prepare standard National Protocol for Gharial Monitoring 2. Conduct periodic nationwide survey of Gharial 3. Conduct research on Gharial ecology, behavior, movement, habitat dynamics, and prey-predator relationship using new technology such as satellite transmitters, genetic studies. 4. Carry out study focusing on Gharial's skewed sex ratio and survival rate 5. Carry out research on socio-ecological dynamics of River dependent communities, Gharial, its prey and habitat 6. Map point and non-point sources of water pollution in Gharial habitats 7. Assess periodic River water quality and industrial effluents in Gharial dwelling River systems 8. Assess and maintain environmental flow requirement for Gharials and their prey base in all the Rivers inhabiting Gharials 9. Conduct research on possible impacts of climate change on Gharials, their prey and habitat and establish hydro-met stations 10. Determine potential alternative habitats for future release of captive bred Gharials in Kali Gandaki, Narayani, Karnali and other River systems 11. Release and assess the post-performance of Gharial in fresh water reservoirs such as Jagadishpur and Ghoda ghodi lake and hydropower dams 12. Collaborate with national, international academic institutions/NGOs and local communities in research, monitoring and Gharial conservation 13. Conduct survey on "willingness to pay" with national and international tourists, donors for sustainable management of GCBC 14. Conduct long term study on climate variation at GCBC and Natural habitat of Gharials.			
Objective 2: Strengthen *in-situ* conservation of Gharials by reducing anthropogenic pressures	• Participation of local communities in Gharial conservation increased • The community groups at local level are formed and institutionalized • Several livelihood programs under sharing of conservation benefits implemented	• DNPWC, PA, Buffer Zone and Partner Organizations official records • Presence of CBOs at grassroots level	• Constant community supports prevail to conservation initiatives
Outputs: 1. Gharial conservation integrated in national and local development planning process as a priority program 2. Protection of Gharial, its prey and habitat	• Number of plans and policies that prioritized Gharial conservation • Number of habitats restored • Illicit activities in prime Gharial habitat significantly reduced	• PA annual plan • PA official records of offences • Partner Organizations and	• Relevant government line agencies and local government agencies extend their support to manage waste

ensured 3. National and local capacity strengthened to conserve and protect Gharial 4. Offset measures in water infrastructures in place 5. Potential Gharial habitat identified and historical range restored 6. Alternative income generating activities promoted for River dependent communities 7. Trans-boundary cooperation enhanced in Gharial conservation	• Fishing permit to local River dependent communities regulated • Water infrastructures with appropriate fish passage • Disposal of solid waste, domestic sewage and industrial effluents in Rivers regulated • River water quality improved and maintained • Number of critical habitats and climate refugia identified • Increased income generation of River dependent communities • Number of conservation education, outreach programs organized • Number of various print and AV extension materials produced and distributed • Information centers at Chitwan and Bardia are upgraded • Number of transboundary meetings held	Buffer Zone Institutions • DNPWC, PA, Development projects report, • River water quality reports • Eco-club and green clubs in schools • Central Zoo • Transboundary meeting minutes	• River dependent communities are willing to conserve Gharial
Actions: 1. Organize regular meetings/workshops to influence planners and decision-makers in prioritizing Gharial conservation in national development plan, PA annual plan 2. Prepare and implement site specific River conservation plan for managing Gharials and its habitat along with other aquatic species in each Gharial bearing PAs 3. Facilitate workshops to declare “No-Go Zones” / Restricted zone for all the critical stretches of Rivers to prohibit human interference 4. Regulate fishing, mining and other activities (tourism) in the designated “Utility Areas” 5. Collaborate and coordinate with experts within and outside country for learning and sharing Gharial conservation 6. Promote exposure visits for sharing of experiences on Gharial conservation 7. Facilitate dialogues to place offset measures such as fish passage, flow regulation to mitigate the impact of River diversion, dams, irrigation canal 8. Introduce male Gharial in Rapti and Narayani River, Chitwan to address skewed sex ratio 9. Create artificial sand banks to provide refuge against flash flood and climate change 10. Promote alternative IGAs to River dependent communities 11. Design and conduct intensive outreach programs to school children, eco-clubs and River dependent communities			

12. Prepare Gharial conservation documentary film to reach the wide audience emphasizing on the critical situation of species as an indicator of healthy River system 13. Conduct regular workshops and meetings on Gharial conservation issues to sensitize relevant stakeholders such as Buffer Zone Institution, DCC, Municipality, Rural municipality, industries, hoteliers and developmental projects 14. Celebrate national and international days with clear message by highlighting the issues and challenges of Gharial conservation 15. Engage community based organizations to monitor Gharial, nests /eggs and its habitat. 16. Conduct regular trans-boundary meetings among trans-border PAs of Nepal and India 17. Conduct joint monitoring of Gharials in trans-border River system of Nepal and India. 18. Deploy the staff to monitor Gharials, their nests /eggs and habitat. 19. Identify and manage the alternative livelihood options of fishing to river dependent communities and initiate to amend the provision of fishing on legal and policy instruments.			
Objective 3: Maintain *ex-situ* conservation to secure future breeding stock and systematize reintroduction of the Gharials	• Standard protocols for reintroduction and managing Gharial breeding centers in line with IUCN Reintroduction Specialist Group guidelines is approved • Annual survival rate of released Gharial	• DNPWC, PA, Gharial Breeding Centers and Partner Organization • Progress Report • Annual Report • Monitoring Report	• PA will have full strength of competent staff • Government wishes to increase annual budget
Outputs: 1. Animal husbandry and management guideline for ex-situ conservation developed 2. Health and well-being status of Gharial improved 3. Institutional capacity of *ex-situ* Gharial conservation strengthened 4. GCBC and CCC infrastructure facilities upgraded 5. Gharial re-introduction protocol in place 6. Best practices promoted and replicated and experience shared to improve in *ex-situ* conservation.	• Animal husbandry and management guideline in place • No. of healthy Gharials in captive breeding center • No of dedicated staff • No of physical infrastructure in place • Hatchling survival rate in captivity • Survival rate of released Gharial • No of post monitoring studies • No of capacity building programs for GCBC staff	• DNPWC & PA's annual program and budget (Red book) • DNPWC, PA annual report • Official records • Annual reports	• Ministry of Federal Affairs and Local Development and Ministry of Finance support is available
Actions: 1. Prepare and follow animal husbandry and management guideline for ex-situ conservation 2. Maintain sanitation of pools, regular water flow with proper inlet and outlet at GCBC and CCC			

3. Reduce number of Gharials and maintain the minimum stock in GCBC considering the bearing capacity of pools
4. Train and capacitate staff on animal husbandry and management techniques to ensure quality handling of animals and management of the center
5. Ensure adequate number of staff and their motivation at GCBC and CCC
6. Establish clinical facilities in breeding centers and deploy technical veterinary staff to monitor regular health status and basic treatment
7. Strengthen laboratory facilities equipped with artificial incubator and other accessories in breeding centers and deploy required technicians
8. Upgrade visitor and Conservations centers of the breeding center as an integrated information center in Chitwan
9. Regular maintenance of the GCBC and CCC
10. Additional fish farms at GCBC to promote live fish feeding to Gharials
11. Prepare and implement re-introduction protocol covering all aspects of capture, handling, size and sex of the animals, release site, time and season
12. Promote to release most hatchlings soon after hatching and encourage release after monsoon
13. Follow-up studies to understand causes of mortality of Gharial and their sex determination
14. Molecular sexing of Gharials born in each batch with reference to nest temperatures in GCBC and in the wild
15. Post monitoring of the released Gharials
16. Prepare the operational procedure of GCBC and CCC
17. Ensure the adequate budget in government annual program for feeding the captive gharials of GCBC and CCC
18. Ensure the additional male Gharials to GCBC with intensive discussion among national and international experts.

Annex 2: Five Year Annual Indicative budget for Gharial Conservation Action Plan

Objectives	Amount (NPR)					Total
	2018	2019	2020	2021	2022	
Objective 1: Enhance the scientific knowledge of the species, its prey base and habitat	**6,500,000**	**7,050,000**	**8,255,000**	**6,755,500**	**6,525,550**	**35,086,050**
Prepare standard National Protocol for Gharial Monitoring	1,000,000		-	-	-	1,000,000
Conduct periodic nationwide survey of Gharial	1,000,000	-	1,200,000	-	1,400,000	3,600,000
Conduct research on Gharial ecology, behavior, habitat dynamics, and prey-predator relationship	2,000,000	1,000,000	2,500,000	3,000,000	3,500,000	12,000,000
Carry out study focusing on Gharial's skewed sex ratio and survival rate	500,000	500,000	1,000,000			2,000,000
Carry out research on socio-ecological dynamics of River dependent communities, Gharial, its prey and habitat	500,000	500,000	500,000	500,000	500,000	2,500,000
Mapping point and non-point sources of water pollution in Gharial habitats	-	400,000	-	-	-	400,000
Assess periodic River water quality and industrial effluents in Gharial dwelling River systems	-	600,000	-	600,000	-	1,200,000
Assess and maintain environmental flow requirement for Gharials and their prey base in all the Rivers inhabiting Gharials	1,000,000	1,000,000	1,000,000	100,000	100,000	3,200,000

Conduct research on possible impacts of climate change on Gharials, their prey and habitat and establish hydro-met stations		1,000,000	1,000,000	1,500,000	400,000	3,900,000
Identify potential alternative habitats for future release of captive bred Gharials in Kali Gandaki, Narayani, Karnali and other River systems	-	1,000,000	-	-	-	1,000,000
Release and assess the post-performance of Gharial in fresh water reservoirs such as Jagadishpur and Ghoda ghodi lake and hydropower dams	-	500,000	500,000	500,000	-	1,500,000
Collaborate with national, international academic institutions/NGOs and local communities in research, monitoring and Gharial conservation	500,000	550,000	555,000	555,500	625,550	2,786,050
Conduct survey on "willingness to pay" with national and international tourists, donors for sustainable management of GCBC			1,000,000	1,000,000		2,000,000
Conduct long term study on climate variation at GCBC and Natural habitat of Gharials.	500,000	500,000	500,000	500,000	500,000	2,500,000
Objective 2: Strengthen in-situ conservation of Gharials by reducing anthropogenic pressures	**8,900,000**	**12,650,000**	**13,015,000**	**14,496,500**	**12,975,980**	**62,037,480**
Organize regular meetings/workshops to influence planners and decision-makers in prioritizing Gharial conservation in national development plan, PA annual plan	400,000	400,000	500,000	600,000	600,000	2,500,000
Prepare and implement site specific River conservation plan with budget for managing Gharials and its habitat along with other aquatic species in all Gharial bearing PAs	-	1,000,000	1,800,000	1,800,000	1,800,000	6,400,000

Facilitate workshops to declare “No-Go Zones” / Restricted zone for all the critical stretches of Rivers to prohibit human interference	200,000	400,000	-	-	-	600,000
Regulate fishing, mining and other activities (tourism) in the designated “Utility Areas”	400,000	400,000	400,000	400,000	400,000	2,000,000
Collaborate and coordinate with experts within and outside country for learning and sharing Gharial conservation	300,000	300,000	300,000	300,000	300,000	1,500,000
Promote exposure visits for sharing of experiences on Gharial conservation	-	1,000,000	-	1,100,000	-	2,100,000
Facilitate dialogues to place offset measures such as fish passage, flow regulation to mitigate the impact of River diversion, dams, irrigation canal	200,000	200,000	200,000	200,000	200,000	1,000,000
Introduce male Gharial in Rapti and Narayani River, Chitwan to address skewed sex ratio	500,000	600,000	700,000			1,800,000
Create and manage artificial sand banks for basking and to provide refuge against climate induced impacts	1,000,000	1,000,000	1,000,000	1,100,000	1,100,000	5,200,000
Promote alternative income generating activities (IGAs) to River dependent communities	1,000,000	1,000,000	1,000,000	1,100,000	1,100,000	5,200,000
Design and conduct intensive outreach programs to school children, eco-clubs and River dependent communities	1,000,000	1,100,000	1,200,000	1,300,000	1,400,000	6,000,000

Prepare Gharial conservation documentary film to reach the wide audience emphasizing on the critical situation of species as an indicator of healthy River system	-	1,000,000	-	-		1,000,000
Conduct regular workshops and meetings on Gharial conservation issues to sensitize relevant stakeholders such as Buffer Zone Institution, District Coordination Committee(DCC), Municipalities, Rural municipalities, industries, hoteliers and developmental projects	500,000	500,000	600,000	700,000	700,000	3,000,000
Celebrate national and international conservation days with clear message by highlighting the issues and challenges of Gharial conservation	400,000	400,000	500,000	600,000	600,000	2,500,000
Engage community based organizations to monitor Gharial, its nests /eggs and habitat.	1,500,000	1,650,000	1,815,000	1,996,500	2,175,980	9,137,480
Conduct regular trans-boundary meetings and coordination among trans-border PAs of Nepal and India	500,000	500,000	600,000	700,000	700,000	3,000,000
Conduct joint monitoring of Gharials in trans-border River system of Nepal and India.			1,000,000	1,000,000		2,000,000
Deploy the staff to monitor Gharials, their nests /eggs and habitat.	500,000	600,000	700,000	800,000	1,000,000	3,600,000
Identify and manage the alternative livelihood options of fishing to river dependent communities and initiate to amend the provision of fishing on legal and policy	500,000	600,000	700,000	800,000	900,000	3,500,000

instruments.						
Objective 3: Maintain ex-situ conservation to secure future breeding stock and systematize reintroduction of the Gharials	**9,200,000**	**10,700,000**	**11,600,000**	**10,061,975**	**9,200,000**	**50,761,975**
Prepare and follow animal husbandry and management guideline for ex-situ conservation	-	700,000	-	-	-	700,000
Maintain sanitation of pools, regular water flow with proper inlet and outlet at GCBC and CCC	500,000	500,000	500,000	600,000	600,000	2,700,000
Reduce number of Gharials and maintain the minimum stock in GCBC considering the bearing capacity of	400,000	400,000	500,000	500,000	500,000	2,300,000
Train and capacitate staff on animal husbandry and management techniques to ensure quality handling of animals and management of the center	500,000	500,000	500,000	500,000	500,000	2,500,000
Ensure adequate number of staff and their motivation at GCBC and CCC (for instance allocating Citizen Investment Trust)	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	5,000,000
Strengthen laboratory facilities equipped with artificial incubator and other accessories in breeding centers and deploy required technicians		500,000	1,000,000	500,000		2,000,000
Establish clinical facilities in breeding centers and deploy technical veterinary staff to monitor regular health status and basic treatment	1,500,000	2,000,000	2,500,000	2,861,975	2,500,000	11,361,975
Upgrade visitor and Conservations centers of the		500,000			500,000	2,500,000

breeding center as an integrated information center in Chitwan	500,000		500,000	500,000		
Regular maintenance of the GCBC	500,000	500,000	500,000	500,000	500,000	2,500,000
Construct additional fish farms at GCBC to promote live fish feeding to Gharials		1,000,000	1,000,000			2,000,000
Prepare and implement re-introduction protocol covering all aspects of capture, handling, size and sex of the animals, release site, time and season	700,000	-	-	-	-	700,000
Promote soft release of gharials after monsoon	300,000	300,000	300,000	300,000	300,000	1,500,000
Follow-up studies to understand causes of mortality of Gharial and their sex determination	200,000	200,000	200,000	200,000	200,000	1,000,000
Molecular sexing of gharials born in each batch with reference to nest temperatures in GCBC and in the wild	300,000	300,000	300,000	300,000	300,000	1,500,000
Post monitoring of the released gharials	300,000	300,000	300,000	300,000	300,000	1,500,000
Prepare the operational procedure of GCBC and CCC	500,000					500,000
Ensure the adequate budget in government annual program for feeding the captive gharials of GCBC and CCC	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	10,000,000

Ensure the additional male Gharials to GCBC with intensive discussion among national and international experts.			500,000			500,000
Total	**24,600,000**	**30,400,000**	**32,870,000**	**31,313,975**	**28,701,530**	**147,885,505**

The Gharial Conservation Action Plan for Nepal (2018-2022) has been prepared in collaboration with NTNC, WWF Nepal and ZSL Nepal.

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