

KARNATAKA NEERAVARI NIGAM LTD



**Karnataka Integrated and Sustainable
Water Resources Management Investment Program**

ADB LOAN No. 3172-IND

**VIJAYANAGARA CHANNELS
FEASIBILITY STUDY REPORT**

Volume 2b: Rapid Biodiversity Assessment



Project Management Unit, KISWRMIP
Karnataka Neeravari Nigam Ltd.

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ABBREVIATIONS

BOD	Biological Oxygen Demand
DO	Dissolved Oxygen
DPR	Detailed Project Report
DSLR	Digital Single Lens Reflex
GPS	Global Positioning System
IUCN	International Union for Conservation of Nature
KFD	Karnataka Forest Department
KM	Kilometer
KNNL	Karnataka Neeravari Nigam Limited
MSL	Mean Sea Level
TCM	Traditional Chinese Medicine
TMC	thousand million cubic feet
TOCR	Tungabhadra Otter Conservation Reserve
RET	Rare, Endangered, Threatened
VNC	Vijayanagara Channels / Canals
WPA	Wildlife (Protection) Act, 1972

EXECUTIVE SUMMARY

Rivers are the cradles of human evolution and civilization. Man began exploiting water from river for agriculture and domestic uses. He diverted the river water for farmlands by constructing barrages across the river and dug canals to feed water to far away drylands. During the Vijayanagara dynasty, so many such canal structures were constructed across the River Tungabhadra in various locations from Hadagali to Raichur. These barrages that divert the river water to far off farmlands through channels are called as *anicuts* in local Kannada language. Among the 12 *anicuts* and 16 Vijayanagara Channels (VNCs), 9 *anicuts* come under the control of the recently formed 'Tungabhadra Otter Conservation Reserve' (TOCR) formed under the Indian Wildlife (Protection) Act, 1972 to conserve the Rare, Endangered and Threatened (RET) species of flora and fauna found in the river stretch from Holey Mudlapura village to the bridge of Kampli town in Hospet taluk of Bellary district. As these ancient *anicuts* and VNCs have deteriorated due to aging and other reasons, the concerned authority has planned to take up revival and renovation of the ancient *anicuts* to maximise utilization of the river water for irrigation and civic use. But the formation of the TOCR in the year 2015 compelled the authorities to recognize the faunal diversity within the *anicuts* and to explore strategies for taking up the project without disturbing the existing faunal diversity in the proposed project areas.

Therefore, the Rapid Biodiversity Assessment of the 'Tungabhadra Otter Conservation Reserve' was conducted from 'Holey Mudlapura' to 'Kampli' with main focus on the ecology of the major faunal species within the ancient *anicuts* of the Vijayanagara period in May-June 2017. The broad objective of the rapid assessment is to estimate the population, abundance and ecology of major faunal species like, Smooth-coated Otter *Lutrogale perspicillata*, Muggar Crocodile- *Crocodylus palustris*, Giant Soft-shelled Turtles like *Chitra indica* and *Nilssonina lethii* and fish fauna in entire stretch of the 'Tungabhadra Otter Conservation Reserve' (TOCR) beginning from Holey Mudlapura village near the reservoir in Koppal taluk of Koppal district to the Bridge at Kampli in Hospet taluk, Bellary district. The study aimed at understanding the ecology of the major faunal species within the vicinity of 9 ancient *anicuts* located within the TOCR area to assess the likely impact on these species during renovation of the *anicuts* and to explore mitigation solutions. The outcome of the study is aimed at guiding the planning, execution and monitoring the process of renovation of ancient *anicuts* of Vijayanagara period.

Under the rapid assessment study, the entire stretch of the river is surveyed for the major faunal species, their sign and marks are recorded with intensive focus within the vicinity of the *anicuts*. Trained field staff scouted the selected route in the river with the help of local fishermen and knowledgeable people. Location was recorded using Garmin GPS instrument, images of animals were documented using DSLR cameras, powerful binoculars were used to spot the wildlife in the river, non-invasive methods of observing 'mass latrine' spots and grooming areas of Otters were helpful in determining their population density and behavior.

Major findings

Ecology of major faunal species

The main focus of the study was to explore the habitat use and spatial behavior of the Smooth-coated Otter- *Lutrogale perspicillata*, Muggar Crocodile- *Crocodylus palustris* and other species. Accordingly, it was found that the Smooth-coated Otters is more abundant within the vicinity of the *anicuts* than outside of the *anicuts*. Assured availability of water in the *anicuts* helps Otters, crocodiles and other faunal species to hunt for fish and flourish. The Smooth-coated Otters are shy creatures which avoid human beings. After a good hunt, they rest on the elevated rocky banks and bask in the sun. Sometimes they play/groom on the sandbanks and on rocks. They defecate collectively in a given location as a mark of delineation of their territory. These sprint marks are generally found at the entrance of their nesting areas, near the basking/resting/grooming areas. About 142

positive sites of Smooth-coated Otters were found in and around 9 *anicuts*: among them, about 74 mass latrine sites (52.11%) and 21 den sites or holts (14.78%) and 47 resting/playing/ grooming sites (33.09%) were identified. It is also found that the Otters prefer rocky area (61.26%), to mud banks (23.23%) and Sand banks (15.49%). The reason for this may be that most of the TOCR stretch has rocky surface and banks than mud and sand.

Muggar Crocodile-*Crocodylus palustris* is also found in abundance in the TOCR area in the ancient *anicuts*. Large water bodies and pools within the river in and around ancient *anicuts* surrounded with thick vegetation provide a safe haven for the Muggar crocodiles. Availability of large fish species like Deccan Masheer *Tor khurdee*, introduced species like Ruhu, Catla, Tilapia etc. which provide sufficient food for them. During the rapid assessment, about 30 (40.54%) crocodiles were sighted directly in different locations of the TOCR, about 10 (13.51%) nests and nesting sites were found and 34 (45.94%) indirect signs and evidences were recorded. The study was conducted during hot summer and water in all the *anicuts* had either reduced to the bottom or totally dried up, and invaded by the water hyacinth. Hence sighting of a crocodile in such a hostile condition was very difficult. As the crocodiles are nocturnal hunters, it was planned to survey crocodiles during the night. Accordingly, a powerful torch was used to spot the crocodiles in selected locations and found gleaming reflections of crocodile's eyes in the water body. About 12 crocodiles were found near the newly built bridge between Bukkasagara and Kadebagilu, during one of the patrolling nights.

Apart from Otter and *crocodiles*, there are many rare faunal species recorded in the TOCR area. Among the 62 recordings of the other major faunal species were 17 Jackals (27.41%), 6 Jungle cats (9.6%), Small Indian Civet 9 (14.51%), Porcupine 2 (3.22%), Leopard 2 (3.22%), Sloth Bear 13 (20.96%), Monitor Lizard 4 (6.45%), and Black Turtle 9 (14.51%).

Recommendations

Otters and *crocodiles* are the major predators of the river apart from the rare Soft-shelled Turtles and fish fauna. The civil works of restoration of the old and dilapidated *anicuts* or barrages can be disastrous to the life of these RET species. But restoration of the *anicuts* would also support these RET species and other forms of life in the long run. Hence, the following recommendations are made to take up restoration activities with zero or minimal disturbance to the wildlife within the TOCR area:

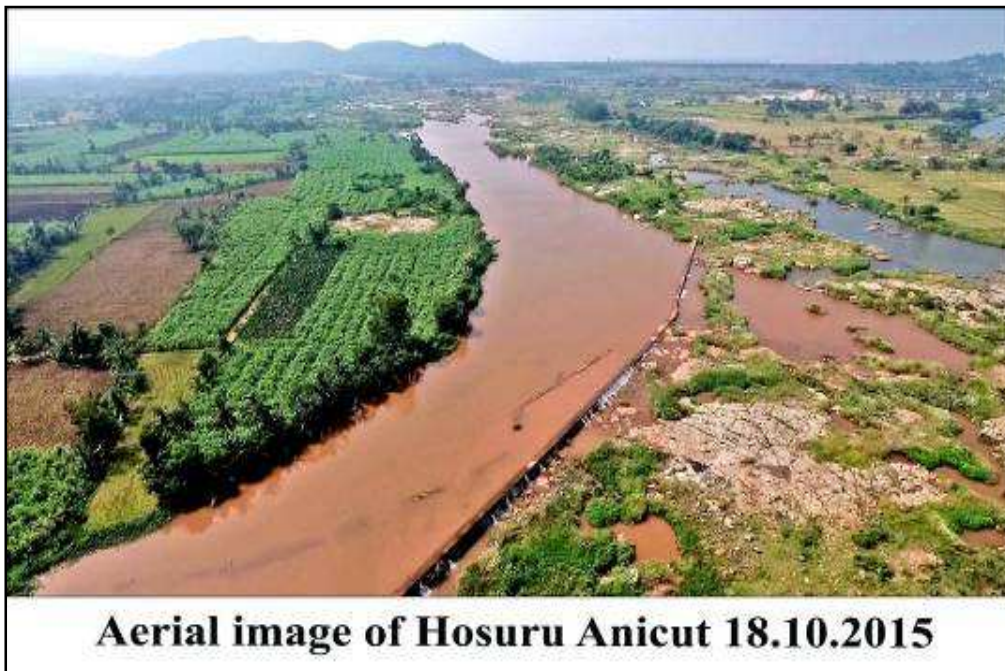
1. The restoration work should be taken up during the period December to June only so as to avoid disturbances to the aquatic fauna.
2. Before commencement of the restoration activities, a temporary barrage to be built using sand bags or any such barrier across the *anicut* about 100 meters away to store water for the wildlife till the completion of the restoration as well as make adequate space for the restoration work.
3. The restoration work should start after 9 am and closed by 5 pm so as to make way for the feeding of crepuscular and nocturnal animals.
4. De-silting and de-weeding activities should be taken up in the front portion of the *anicuts* only; however, the existing native species of bushes and shrubs in the habitat other than restoration area to be retained intact.
5. Retain the rocky islands, sand dunes and mud banks in the middle of the *anicut*, which will help the wildlife like Smooth-coated Otters and crocodiles to bask and rest.
6. De-weeding of the invasive alien weeds such as *Water Hyacinth* and *Ipomoea* *cornea* is to be taken up in the *anicuts* on regular basis to prevent siltation and to maintain healthy ecosystem.

7. During the restoration of the VN channels, it is advised to build a stone wall along the canal road and leave the other end/ bank of the canal as it is with its mud bank and vegetation wherever possible. This will help endemic life forms like crabs, amphibians, snakes, turtles and birds to feed, nest and live using the available resources.
8. While de-silting and removing the existing structures of the *anicuts*, precaution should be taken to avoid any kind of harm or disturbance to the wild life forms like turtles, snakes, monitor lizards, crocodiles, amphibians and fishes. All these to be rescued and shifted to safer locations. In case a nest of a Crocodile or a Turtle is located, it should be protected or shifted scientifically to a safer location. A Naturalist or Wildlife researcher may be appointed on an ad hoc basis to advise and monitor such instances.
9. An Awareness program on 'the wild life of the river and conservation' should be conducted for workers, supervisors and managers in the beginning of the restoration work so as to minimize possible harm to the wildlife forms.
10. After completion of the restoration work, all the debris comprising sand bags, plastic, oily soil, metals and any such harmful materials to be removed and cleaned in and around the *anicuts*.
11. Hoardings, signage, bill boards, etc. to be installed depicting the heritage of *anicuts* and the biodiversity within these areas.
12. Water Users Society should be formed for each *anicut* comprising the end users, officials of KNNL, KFD and local NGO involved in conservation to monitor and take care of maintenance of the *anicuts* and VNCs in the long run.
13. Take service of suitable biodiversity and ecology experts to advise and oversee the well-being of the major fauna during restoration activities.
14. Take up follow up activities for achieving substantial changes in irrigation, ecology and behavior of wild fauna in the project area as also research, documentation and publication.
15. Make a special budgetary provision for Environment and Ecology in the DPR to be revised.

1. INTRODUCTION

1.1 Overview

Water is the elixir of life. The human civilization evolved along the banks of rivers and other water bodies, and hence rivers are considered as the cradle of evolution of human civilization. Major human settlements have flourished along the river banks and its watershed areas. Water is synonymous with prosperity. Early human society majorly depended upon rainwater but gradually began diverting the river flow for agriculture and civic needs. Thus, the river water harvesting technology evolved over thousands of years under various dynasties and kingdoms. Almost all rivers in the world have undergone such transformation leading to betterment of human society. One such effort is exploitation of the river water seen in the form of ancient anicuts (Kannada word for 'barrage' like structures) built during the mighty Vijayanagara dynasty in Tungabhadra River between 13th and 15th century AD.



These ancient anicuts are constructed at different locations in Tungabhadra River between Tungabhadra Reservoir in Hospet taluk and Deshanur in Siruguppa Taluk. The anicuts built some 500 to 600 years ago are still functional and providing water for irrigation in Hospet, Koppal, Gangavati, Kampli, and Sindhanur taluks. Around 20,000 ha of farmland is irrigated utilizing the water from the ancient anicuts without a glitch. Hundreds of small and big villages also use water from these anicuts for domestic purposes.

“As a capital of a successful kingdom, the city of Vijayanagara flourished, dominating the political and cultural milieu of South India for 229 years. Vijayanagara could not have operated as a capital in the hostile, semi-arid environment of the Deccan without effective water supply systems to provide for practical and ritual needs of its inhabitants” 1 (Dominic J Davison-Jenkins, 1994).

But with lapse of time, these ancient structures that provided water for irrigation for more than six centuries have undergone drastic changes due to natural degradation and anthropogenic activities. Most of the anicuts lost their capacity of meeting the needs of the command area. Physical damage includes damage to the barrages and

excessive siltation. Excessive growth of weeds resulted in decreased water storing and carrying capacity of these anicuts.

Figure-1



Therefore, the Karnataka Neeravari Nigam Limited (KNNL) has prepared a Detailed Project Report (DPR) for restoration and renovation of these *anicuts* while the Vijayanagara Channels (VNCs) cater to the irrigation needs of the command area in Hospet, Koppal and Raichur districts.

The river stretch from Holey Mudlapura in Koppal taluk near the reservoir to the bridge of Kampli in Hospet taluk has been declared as the 'Tungabhadra Otter Conservation Reserve' by the Government of Karnataka under the Indian Wildlife (Protection) Act, 1972, to conserve the rare, endangered and threatened (RET) species like Smooth-coated Otter-*Lutrogale perspicillata*, Muggar Crocodile-*Crocodylus palustris* and many more major aquatic flora and fauna. As the restoration and renovation work need enormous quantity of man power and huge machinery, it is desired to prevent any instances of possible disturbances to the natural behavior of these species and destruction to their natural habitat. Therefore, this 'rapid assessment of major faunal species' within the *anicuts* of TOCR has been taken up to evaluate the habitat use and ecology of these RET species.

1.2 Objectives of Bio-diversity Assessment

- i. Rapid survey and documentation of major fauna of Tungabhadra Otter Conservation Reserve with major thrust on following Rare, Endangered and Threatened (RET) species:
 - a) Smooth Coated Otter
 - b) Crocodiles
 - c) Turtles, and
 - d) Major fish species.
- ii. Study of movement and behavior of the major faunal species with respect to habitat use within the said anicut areas.
- iii. Exploring strategies for restoration of anicuts by using non-invasive methods to prevent any instances of disturbances to the natural behavior of RET faunal species.

1.3 Scope of Bio-diversity Assessment

As the human population increases, the pressure on nature and natural resources multiplies resulting in irreparable damage to the fragile ecosystem. There is an urgent need for exploring strategies to exploit natural resources without disturbing the wild flora and fauna in their habitat. The current study is aimed at identifying conflict mitigation strategies and actions to be taken up while renovating the ancient *anicuts* within TOCR. The present 'rapid assessment' is defined here as a synoptic assessment, that has been taken up as a matter of urgency, within the available minimum timeframe striving to come out with reliable and applicable results for its designed objectives. The unfriendly terrain, hot summer and excessive growth of weeds in the *anicuts* put a challenge to the team during data collection. Yet, within the given time, the survey team gathered maximum data in the TOCR area including *anicuts*.

The aim of the rapid assessment may be stated as identification of locations of RET faunal species, their behavior pattern, habitat use and strategies for mitigating any instances of disturbances to their natural behavior. The bio-diversity data collected is most useful in planning interventions to avoid threat to existence of wildlife. The scientific process of collection of data included use of binoculars, cameras, and GPS equipment.

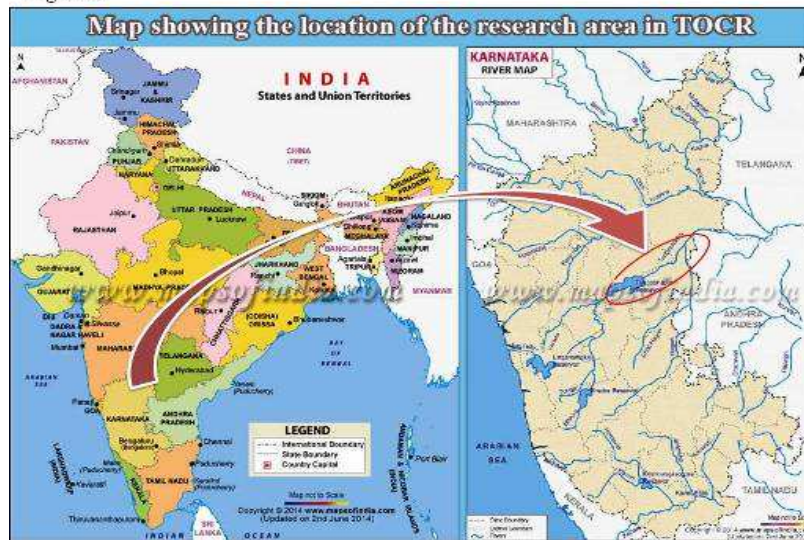
The study also noted the degradation of aquatic habitat due to excessive siltation, *eutrophication* or excessive growth of invasive alien species of weeds such as Water Hyacinth-*Eichhornia crassipes*, and Pink morning glory-*Ipomoea carnea*. The proposed renovation of *anicuts* has the dual objectives of helping improve people's quality of life and supporting the Flora and Fauna of the river. The study of the Environmental Social Impact Assessment (ESIA) demands a forum of multi-stakeholder engagement for long term monitoring and evaluation of these structures and processes

2. STUDY AREA

2.1 Over view and geography of study area

Deccan Plateau is the oldest geographical landscape comprising parts of Maharashtra, Eastern Plains of Karnataka, parts of Telangana and Tamil Nadu. The Deccan Plateau is located in the tropic zone comprising hot climate and dry scrub jungle. The east flowing rivers that originate in Western Ghats flow through the Deccan Plateau as life lines and cater to the needs of man and animals.

Figure-2



River Tungabhadra is a major tributary of river Krishna. Two rivers, namely, Tunga and Bhadra, originate from different locations in Western Ghats situated at an altitude of 1198 MSL and combine at Kudigi near Shimoga to become Tungabhadra. River Tungabhadra flows about 531 km in the north-east direction through central Karnataka and erstwhile Andhra Pradesh state.

There is no gainsaying that all civilisations have evolved around perennial rivers owing to availability of water. Man learnt techniques of harvesting rain water as well as diverting the flow of rivers for meeting farming needs and for civic use. During the Vijayanagara Dynasty, the rulers diverted the river water to the towns and for farming by constructing *anicuts* or weirs. There were about 19 *anicuts* and Channels built across the river to carry water for more than 20 km. There are 16 weirs; 9 out of the 13 *anicuts* fall under the purview of the recently formed 'Tungabhadra Otter Conservation Reserve' (TOCR).

These 9 *anicuts* are located in the TOCR area that starts from Holey Mudlapura village in Koppal taluk to the bridge at Kampli in Hospet Taluk, Bellary District, northern Karnataka. The geographical location is at latitude 15°16'N and longitude 76°20'E near Holey Mudlapura and latitude 15°25'N and longitude 76°34'E at the bridge between Kampli and Chikka Jantakal in Gangavati taluk. The glorious capital of Vijayanagara, namely, Hampi, is located at about 15 km from the Tungabhadra reservoir. The nearest city is Hospet located at 5 km from the reservoir.

2.2 Tungabhadra Otter Conservation Reserve

River Tungabhadra hosts a repertoire of animals including giant Turtles, Otters, crocodiles and hundreds of species of fishes and so on. Smooth-coated Otter or Indian Smooth-coated Otter *Lutrogale perspicillata* lives along the entire length of the river in considerable numbers. This riparian mammal is listed as Schedule-1 species under Indian (Wildlife) Protection Act, 1972 and as Vulnerable (VU) by IUCN. These Otters breed during

late winter-summer, litter in burrows made under the bushes on the river banks or inside the rocky caves within the river. The Otters are also facing threat from poachers as they trap the animal and club it to remove its skin intact. A decade ago, there were reports of poachers killing hundreds of Otter and transporting tanned skins in bundles for jackets in the far eastern markets. But the activists of Wildlife SOS and SWa¹-local NGO-patrolled the riparian habitat and alerted the local fishermen on such Otter hunters.

The Mugger Crocodile or Indian Marsh Crocodile (*Crocodylus palustris*) is a fresh water crocodile that is commonly seen in the Indian rivers. The other species of crocodiles found in India are *Gharials* and *Salt-water Crocodiles*. The Mugger Crocodile is a medium sized one that is seen in fresh water lakes, rivers, ponds, sluggish rivers, swamps, marshes etc. The crocodiles lay eggs in the sand banks and islands in the river in summer. During monsoon, when fresh water flows into these sand dunes, the young ones come out and begin their own life in the river. The male grows up to 13-16 feet in length. They are generally seen basking on rock outcrops and river banks in the Tungabhadra River near Anegundi, Hampi, Kariyammangadde and Bukkasagara river. Often villagers kill the crocodiles as vengeance for preying on their goats and sheep in the river. There were also reports that some hunters were killing the crocodiles and taking away their skin for making shoes, bags, etc.

Some rare species of Turtles reportedly grow to a huge size such that during the Vijayanagara Empire, soldiers were using their carapace which is light but strong as a shield in war, and their meat as speciality food. Accordingly, there are three distinct species of soft shelled turtles found in this river, Leithi's Soft-Shell Turtle (*Nilssonia leithii*) also called as *lagala* by fishermen, Indian Narrow-headed Soft-shell Turtle (*Chitra indica*), Indian soft-shelled turtle (*Lissemys punctata*). Another species of turtle-the Indian Black Turtle or Indian Pond Terrapin (*Melanochelys trijuga*) also found here, which is called as *tismurga* by locals. Among all, *Chitra indica* grows to a great width and length. During 2011, the forest department seized a live specimen of *Chitra indica* from a poacher which weighed around 125 kgs and with the width of 1 meter. *Lagala* (*Nilssonia leithii*) is much hunted along with *Chitra indica* by the Bengali poachers.

Leith's softshell turtle (*Nilssonia leithii*) is listed as Vulnerable (VU) under Threatened category of IUCN red list. It was a most common turtle until a few decades ago, but now facing extinction due to illegal trade, sand mining, excessive siltation, eutrophication and drying up of Rivers during summer. Likewise, another species of turtle Indian soft-shelled turtle (*Lissemys punctata*) also called as *haalaame* which is listed as Schedule 1 species [part II (8)] in Indian Wildlife Protection Act, 1972.

There are about 100 species of fishes including endemic *Deccan masher*, *Tunga Garr* are found in the Tungabhadra River, some of them are listed under threatened category by IUCN and listed under Schedule-I and II under Wildlife Protection Act, 1972. These are widely hunted leading to some of these rare fishes becoming extinct.

Therefore, Society for Wildlife and Nature (SWa¹) conducted a research on the river fauna and prepared a proposal to declare the river stretch from Holey Mudlapura to Kampli as a 'Conservation Reserve' and lobbied for the same. Finally, the 34 km stretch of river from Holey Mudlapura near Tungabhadra Dam reservoir to the bridge of Kampli is declared as the "Tungabhadra Otter Conservation Reserve" vide notification No. FEE66: FWL-2015 dated 25.4.2015 by the Government of Karnataka to protect the rare wildlife species from hunting and consequent damage to habitat.

¹ Society for Wildlife and Nature (SWa¹)-Hospet has been working for conservation of wildlife in Bellary district and rest of North Karnataka for one and half decades.

2.3 Ancient Irrigation Systems in Vijayanagara Empire

Rivers are considered as the cradle of human civilization. All ancient human settlements were flourished along the river banks. Water is necessary for agriculture, animal husbandry and for human use. Hence, technique of rain water harvest in the form of lakes and tanks is evolved. At the same time the method of diversion of rivers for irrigation was also developed across the world for agriculture and assured food production.

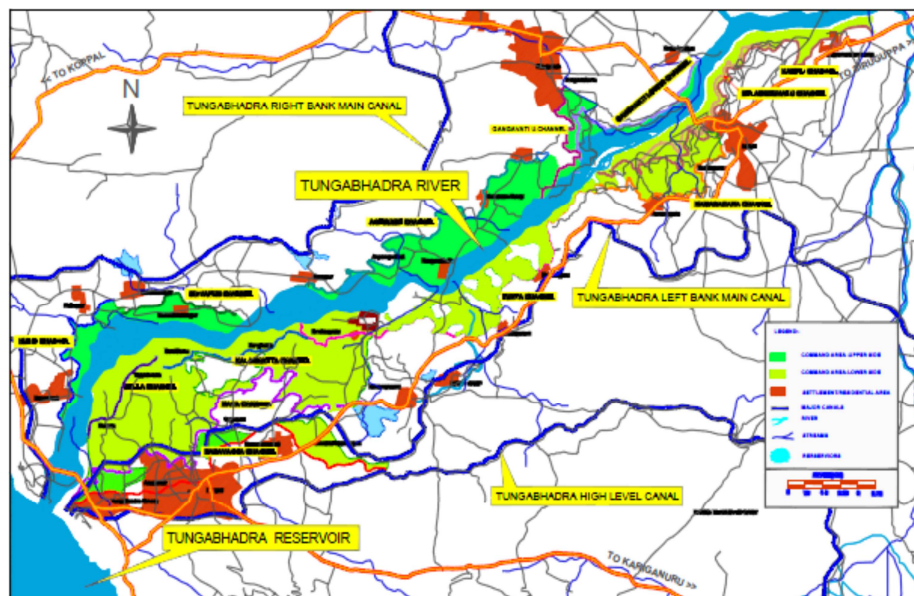


Figure 3: Map of Anicuts and Vijayanagara Channels

During the 13th Century, Vijayanagara dynasty was established with the present day Hampi as the capital city on the banks of River Tungabhadra. The capital city was quite big with a large population for which supply of water was so important especially during the hot seasons. Therefore, the emperors of the dynasty explored ways to ensuring adequate water supply to their population. As a part of this, they adopted techniques of diversion of Tungabhadra River water by building a weir or barrage at a strategic location across the river. These weirs are called as anicut in Kannada language. Water from these anicuts flowed through the long stretches of canals which are popularly called as Vijaya Nagara Canals (VNCs). During the Vijayanagara dynasty (1335 -1565), about 12 weirs or anicuts and 19 Channels (VNCs) were built in different locations of the river, including near Hampi to cater the needs of agriculture and gardening. The Vijayanagara Channel (VNC) irrigation system is spread over certain locations of Bellary, Raichur and Koppal districts. The geographical area lies between Latitude 14° 30' to 16° 34' N and Longitude 75° 40' to 77° 35' E.

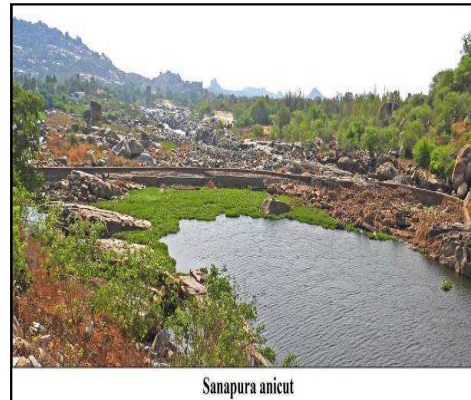
Table 1: Details of the anicuts (weirs) within TOCR area

S. No.	Name of the <i>anicut</i> (Weir)	Length of the anicut or Weir (km)	Distance from the TB Dam reservoir (km)
Right Bank of TB River			
1	Hulugi <i>anicut</i>	0.518	2.4
2	Shivapura <i>anicut</i>	0.17	8
3	Anegundi <i>anicut</i>	0.518	16
4	Upper Gangavathi <i>anicut</i>	9	27.2

5	Lower Gangavathi <i>anicut</i>	9.54	30.4
Left Bank of TB River			
6	Bella <i>anicut</i>	0.602	2.4
7	Turtha <i>anicut</i>	3.048	16
8	Ramasagara <i>anicut</i>	2.042	28.8
9	Kampli <i>anicut</i>	0.94	30.4

A fascinating fact is that all these anicuts and VNCs are still in use (except a few that submerged in the reservoir) and are currently irrigating around 16,000 ha in Hospet, Koppal, Gangavathi and Siruguppa taluks. This reflects not only creativity of people during Vijayanagara dynasty, but also the foresight of the kings and individuals in ensuring robust economy, sustainable food production and prosperity of the people.

One of the oldest anicuts is Turtha anicut built in 1399 A.D by Bukka Raya on the right bank of Tungabhadra river close to Hampi. The canal from this anicut is called as Turtha canal (Turtha means fast, swift) owing to the swift current of water that passes through rocky and steep terrain. This canal is functional till date feeding water to hundreds of acres of farmland around Kaddirampura and Hampi. Multiple weirs are constructed between the rocks to divert the water into canal.



Sanapura anicut

2.4 Role of Anicuts around Hampi

For more than 600 years, the anicuts and the canals have been providing irrigation water for agricultural crops such as paddy, sugar cane, banana, coco-palm, cereals, pulses and vegetables. Farming continues to be the most predominant occupation in the VNC system which has been sustaining thousands of agrarian families over the centuries and has been the main cause for the economic prosperity of the region.

A repertoire of life forms is flourishing in and around the anicuts and VN Channels. Smooth-coated Otters, Muggar crocodiles, Turtles, fishes and hundreds of species of birds, different species of Reptiles inhabit the anicut areas and along the channels. A number of birds including 3 species of Kingfishers, Bee-eaters, Owls make hole nests along the dried banks of VNCs during summer. Other life forms also make use of the canal bank for their food and shelter.

The anicuts or weirs are the perennial source of water for the livestock, wildlife and for human beings. While water dries up elsewhere during summer, the anicuts hold sufficient water.



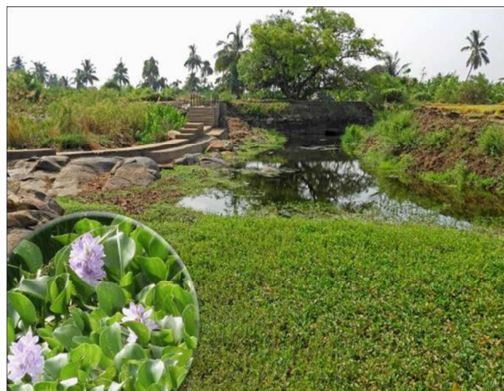
2.5 Present status of the Anicuts

Over centuries, the ancient anicuts have been degraded and destroyed. Nevertheless, the structures are still in good condition save for breach here and there which render *anicuts* to lose water leading to decreased storage capacity. Farmers and water user communities sometimes made some efforts to renovate and repair these

*anicut*s; however, lack of a holistic approach resulted in the degradation of these ancient structures. Disputes arise sometimes between the farmers of upper and lower *anicut*s over sharing of water; the farmers of upper *anicut* retort by blocking and diverting the flow of water to their Channels.

i) Invasive alien weeds

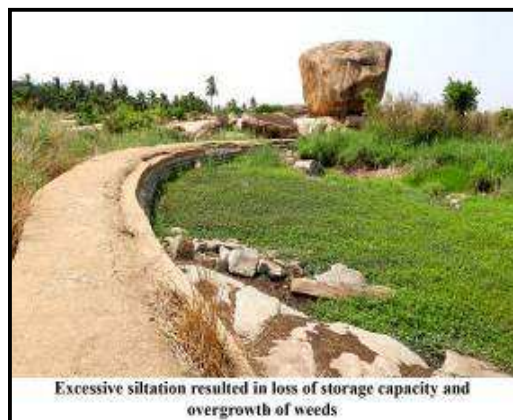
Some *anicut*s have been excessively silted up thus reducing their carrying capacity significantly. In some *anicut*s, there is an alarming growth of invasive alien weeds like *water hyacinth*, *Ipomoea aquatica* and *Ipomoea cornea* which is choking the aquatic life forms to eutrophication. Water hyacinth spreads rapidly forming a blanket of vegetation on the surface of the water body thus blocking the sun light. Lack of sun light in the water results in highly reduced photosynthesis for phytoplankton, unicellular and multi cellular algae and other aquatic flora. The poor Dissolved Oxygen (DO) in the water leads to decline of zooplanktons, and aquatic fauna including fishes and amphibians. The decreased food base in the form of fishes, frogs and Crustaceans results in decline of major faunal species such as Otters and Crocodiles. Therefore, a separate strategy is to be worked out to contain the vicious invasive alien weeds like Water Hyacinth and *Ipomoea species* on regular basis in and around the *anicut*s. At the same time, awareness is to be created among farmers in the catchment area for controlled use of chemical fertilizers. They should be motivated to use more of organic manure for their agricultural crops. Use of optimal quantities of chemical fertilizers, and switching over to organic fertilizers will reduce river contamination-reducing the nitrates and phosphates responsible for *Eutrophication* (excessive growth of weeds in water). Sewage from human settlements and effluents from industries also contains an enormous quantity of *nitrates*, *phosphates* and *sulfates*-which are also responsible for excessive weed growth in the *anicut*s. Turtha, Upper Gangavathi, Lower Gangavathi and Kampli *anicut*s have been totally covered with water hyacinth and *Ipomoea species*. This also resulted in siltation of the *anicut*s. The overgrowth of weed combined with lack of water results in adverse effects on population of fishes, Otters, Crocodiles.



Eutrophication-hazrdous groth of Water Hyacinth on surface of water at Kampli anicut

ii) Excessive Siltation

Flooding of a river is always good for the health of the river. The flood water currents clean the river by washing away all the excessive weeds, overgrowth, silt etc. But the absence of flood in the last three years resulted in an overgrowth of weeds and bushes, which dried up seasonally, their biomass being converted into soil and settled in the bottom of the *anicut* and natural ponds within the river. Now, enormous quantity of silt is seen in almost all the *anicut*s including Turtha and Upper Gangavathi. Hence, there reports of very small number of wildlife owing to non-availability of water and food. Therefore, the siltation due to the invasive alien species should be taken seriously and suitable interventions taken up from time to time.



Excessive siltation resulted in loss of storage capacity and overgrowth of weeds

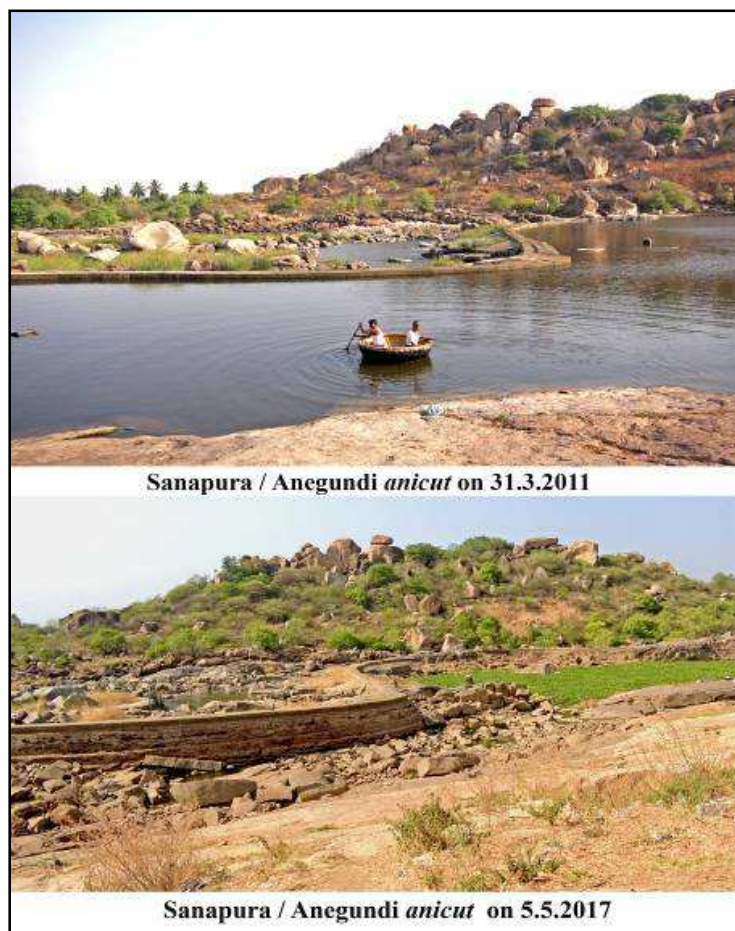
iii) Lack of maintenance

After the collapse of the Vijayanagara Empire, not much attention has been paid towards maintenance of the VNC structures; however, a farmer continued to repair the weir and canals themselves wherever necessary. Overall, the irrigation system of Vijayanagara period has suffered utter negligence combined with absence of sound management practices. As a result, most of the *anicuts* have lost their carrying capacity due to leakages, breaches, excessive siltation, *eutrophication*, pollution etc.



Lack of maintenance resulted in destruction of barrages (Turtha anicut)

2.6 Need for restoration of ancient Anicuts



Sanapura / Anegundi anicut on 31.3.2011

Sanapura / Anegundi anicut on 5.5.2017

The ancient anicuts have not only served to divert the river water into canals, but also helped store enormous quantity of water throughout the year. Hence, these weirs with abundant water turned ideal habitat for a number of riparian fauna including Smooth-coated Otter, Muggar Crocodile, Turtles and Fishes. The rocky islands, mud-sand banks and islands with thick vegetation became a favorite home for Otters and Crocodiles, where they bask, groom and nest. Over time, weirs have developed a number of leakages and breaches; floods affected the structures and canals. All this resulted to significantly reduced storage in the anicuts. To top it, excessive growth

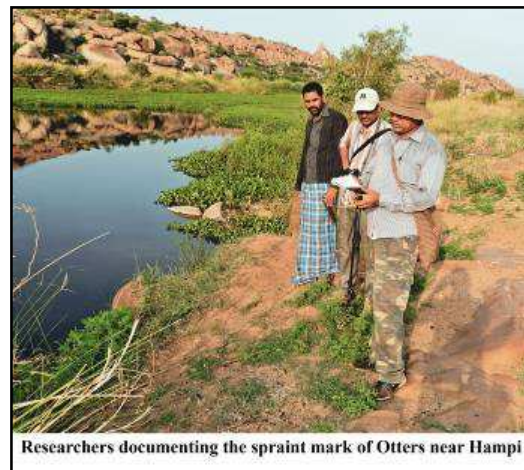
of invasive alien species of weeds and resulting siltation further deteriorated the anicuts and in turn adversely affected major Fauna.

Thus, there is an urgent need for restoration and renovation of these anicuts and the channels to ensure availability of water throughout the year. Abundance of water will result in availability of sufficient food for apex predators of aquatic ecosystem like Otter and Crocodiles. Restoration of these structures promises protection and growth of the wildlife in the River.

2.7 Relevance of the present study

As the stretch of Tungabhadra River from Holey Mudlapura to Kampli has been declared as the “Tungabhadra Otter Conservation Reserve” (TOCR), under the Indian (Wildlife) Protection, Act, 1972, (section 26 A (b)) for conservation of RET species, it is essential to explore ways and means of taking up restoration of anicuts without disturbing the ecology of RET fauna and ecosystem. Though the ownership of the anicuts and channels is with KNNL, due to the notification of TOCR in 2015, the protection of the wildlife is governed under the rules of WPA 1972. The Smooth-coated Otters, Muggar Crocodile, Indian Soft-shelled Turtle, Deccan Masheer fish and many more species are listed as Schedule-1 and II species under WPA 1972. Loss of life or destruction of habitat of these species listed under different Schedules of WP Act, 1972 (Section 29) attracts legal actions against individuals and groups.

Therefore, PSC has taken up a scientific survey of RET species in the form of Rapid assessment as part of the Feasibility Study of Modernization of Vijayanagara Channels under KISWRMIP Tranche 2.



Researchers documenting the spraint mark of Otters near Hampi

The key focus of rapid biodiversity assessment is to carry out survey of smooth coated otters, Crocodiles, Turtles and fish fauna and their dependence and use of the habitat in and around the ancient anicuts to explore strategies of restoration without damaging their natural behavior and ecology.

3. MATERIALS AND METHODS

To begin with, a preliminary visit was made to all the anicuts and focus areas along the river were identified. Further, with the help of local knowledgeable people, farmers and fishermen, these areas were refined, and expanded to arrive at a comprehensive list. Data sheets for recording the sightings and indirect signs were prepared, and GPS instruments and DSLR/ digital cameras etc. were organized for documentation. Finally, research and documentation was undertaken in the TOCR area.

3.1 Trail monitoring and data collection

After the preliminary visit, regular monitoring of anicuts and data collection was initiated with the help of four trained field assistants. To begin with, survey of direct and indirect evidences of wildlife species was taken up along the weir or barrage of each of the 9 *anicuts*. Some of them have a short weir of 50–100 meters and others longer than 2 km. In this trail, direct encounter of Smooth-coated Otters, Muggars, Turtles and other faunal species is recorded. Indirect and positive evidences such as pug mark, scat, spraint marks, left over kill, nesting – denning or natal sites were recorded. Random survey of the upstream and downstream areas of each *anicut* was also undertaken assuming that the Otters move to a considerable distance from their homes in search of food, as well as grooming sites. The total length of the TOCR is about 35 km; average width is about 1.5 km. The average length of each *anicut* and its upstream and downstream is about 2 km. About 18 km of length and breadth of the river was covered in this survey as also each of the *anicuts* and their surroundings. The total area covered in this rapid assessment was about 25% of the TOCR area.

3.2 Monitoring of anicuts

Each *anicut* was monitored the whole day for the purpose of understanding the habitat use by Smooth Coated Otter and Crocodiles. Sightings or indirect evidences were recorded using GPS instrument in the specific format. Spraints, scats, pug marks, etc. were photographed by placing a scale by the side of them to measure their size. The presence of Holts (the shelter homes, breeding dens or burrows), nests, basking and grooming sites were also recorded. Each site was visited and revisited once in three days for four weeks to search for new evidences and sightings. Islands and lakes were also explored using generic coracle (bamboo boat).

Otter-Crocodiles sites were classified by the following parameters:

- i) Preferred location: rock, marsh, sand bank, mud banks.
- ii) Distance of the preferred location from edge of water.
- iii) Presence or absence of holts, nests or breeding areas.

3.3 Documentation

Most of the direct sightings were recorded using DSLR cameras. The same cameras were used to photograph different species of fishes present in different *anicuts* of TOCR. The scats, spraint marks, pug marks and marks of grooming in the mud banks and sand banks were also recorded using a wooden scale to measure the size of the site of the marking. The spraint marks of the otters are conspicuous by their pungent smell and shape. Digital cameras with super zoom lens were used to video graph the natural behavior of otters and other wildlife forms. Under water cameras were used to document the natural behavior of fishes.

4. RESULTS AND DISCUSSIONS

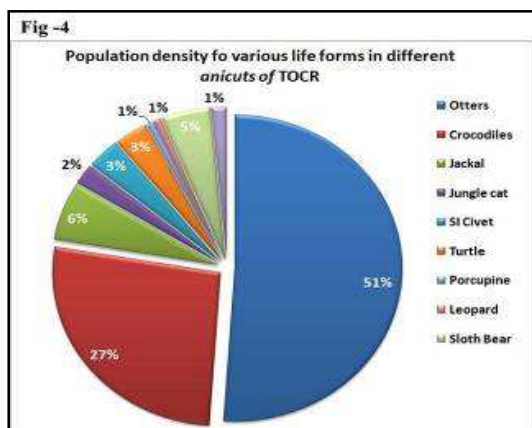
The rapid bio-diversity assessment was carried out for four weeks with another 4 weeks for documentation and extended survey. In the initial four weeks, most of the positive sites of Smooth-coated otters and Mugger Crocodiles were identified in and around the ancient *anicuts*. The smooth coated otters are crepuscular and nocturnal animals, avoid encounter with humans. Therefore, direct sighting of otters was relatively less; hence the study depended upon indirect evidences like Scat, Spraint mark, holts, breeding-nesting sites, pug marks and grooming marks.

4.1 Population density of various major fauna

The assessment revealed that the entire stretch of TOCR including the ancient *anicuts* have had provided an ideal habitat for the Rare, Endangered and Threatened (RET) species like Smooth Coated otter, Mugger Crocodile, Giant Soft-shelled turtles, various fish fauna and other wildlife forms. As the season of this study was hot summer with parched river bed in most of the areas of the TOCR, it was not possible to encounter many wildlife forms in the *anicuts* infested with invasive alien weeds and excessive siltation. Nevertheless, the study basically relied upon indirect evidences based upon which positive sites were identified. Within a short period of time, maximum man power was deployed for scouting the length and breadth of each *anicut* and identifying the existence of a healthy population of the Smooth-coated otters, Mugger Crocodiles, Soft-shelled Turtles and fish fauna. Due to excessive growth of water hyacinth, the sighting of Crocodiles was not possible during the day. Hence, night patrolling was under taken to scan the river and the *anicuts* to search for reflection of eyes of crocodiles using powerful torches and accordingly recorded the sightings.

Though the positive sites of otters and crocodiles were found apart from a few direct sightings, both Soft-shelled Turtles and Giant Turtles were not sighted directly due to the parched river beds, suffocation caused by proliferation of alien invasive weeds and probably summer hibernation. Nevertheless, some shells of the dead Indian Black Turtles were found in the dried river bed.

An interesting fact is that the river has a typical dense scrub jungle within its islands. A large island exists between Turtha anicut and Sanapura anicut called as Kariyammanagadde, where considerable number of Sloth Bears, Leopards, Jackals, Porcupines, Small Indian Civet, Jungle Cat etc. live. Therefore, while scouting in and



around *anicuts*, the survey team came across the scat, pugmarks, evidences of destruction of termite mound by bears etc. and all these evidences were promptly recorded. Interestingly, 2 positive signs of Leopards (0.71%), 13 positive signs of Indian Sloth Bear (4.67%), 2 positive signs of Porcupine (0.71%), 4 positive signs of Monitor Lizard (1.43%), 9 positive signs of Small Indian Civet (3.23%), 6 positive signs of Jungle Cat (2.1%), 17 positive signs of Jackal (6.11%) were found. About 9 carapaces of dead turtles (3.23%) were found in different parts of the river.

Among all the above life forms, the population of Smooth-coated otters is flourishing in and around the *anicuts* in TOCR area. There are about 142 evidences of this mammal which has the highest population density (51.07%). The occurrence of healthy population of this apex predator of aquatic habitat indicates the health of the habitat and the ecosystem.

The population of Muggar Crocodile is also flourishing in the river with 74 evidences (26.61%) indicating good health of the ecosystem.

4.2 Species Profile

4.2.1 Smooth-coated otter–*Lutrogale perspicillata*

“Otters are the ambassadors of wetlands”

Classification:

Kingdom	:	<i>Animalia</i>
Phylum	:	<i>Chordata</i>
Class	:	<i>Mammalia</i>
Order	:	<i>Carnivora</i>
Family	:	<i>Mustelidae</i>
Subfamily	:	<i>Lutrinae</i>
Genus	:	<i>Lutrogale</i>
Species	:	<i>L.Perspicillata</i>



Binomial nomenclature: *Lutrogale perspicillata* (Geoffroy Saint Hilaire, 1826)

IUCN status : VU (Vulnerable)

WPA, 1972 status: Schedule-II

Description

There are 13 species of otters in the world and five species in Asia. Smooth-coated otter *Lutrogale perspicillata* is the largest among Asian otters. This is strong and sturdy, with long, thick body, short legs, webbed feet with sharp claws, wide neck, round head, small round eyes, short ears, and short hairless muzzle with thick whiskers. The dark brown to reddish brown at the upper part and light brown lower parts, fur is thick and velvety which has two layers, which help to keep the body warm. Thick, long and conical tail which is more flattened at the end than other otters. Fore limbs are shorter than the hind limbs. Males are larger than females.

Range Description

The Smooth-coated otter is distributed throughout South-east Asia, from Indonesia in the East to India and Pakistan. However, recent evidences indicate that their range and population is shrinking due to reasons of poaching and loss of habitat. They attain weight between 7 and 11 kg, and body length between 1 and 1.3 meters.

Habitat and Ecology

As aptly said, **“Otters are the ambassadors of wetlands”**, the Smooth-coated otter prefers an aquatic habitat in the plain land and semi-arid region of North-west India and Deccan Plateau (Prater, 1971). It prefers large rivers, lakes, swamps, mangroves and estuaries. It forages in rice fields also (Foster-Turly, 1992). They prefer rivers with rocky terrain and sand/ mud banks, or islands that provide a place for resting, grooming and littering. The islands and river banks with thick vegetation provide cover during travelling, foraging, resting and grooming.

They avoid open islands and sand/ mud banks due to lack of escape opportunities (Hussain, 1993; Hussain and Choudhury, 1995). During breeding season, they use swamps and rocky crevices as natal den sites and nursery sites. During summer, they move to ponds with slow or stagnant water, and islands with vegetation in the perennial rivers (Hussain and Choudhury, 1997).



The diet of Smooth-coated otters predominantly feed on large fishes with ½ to 1 foot in length which they hunt and eat while swimming in the river. Sometimes, they hunt large fishes too. They also prey upon shrimps, crabs, frogs and insects and sometimes upon birds and rats also (Prater, 1971, Foster-Turly, 1992). This indicates their opportunistic feeding behavior. The scales and bone remains of the devoured fish and shell of the crabs can be seen in their defecation called as spraints. The major fish species they devour in TOCR consists of *Tilapia*, *Ruhu*, *Catla*, *Deccan Masheer* etc.-fishes that fishermen harvest for their livelihood. This indicates that the Smooth-coated otters diet depends upon the availability of the food base as listed above. It is observed that they attain sexual maturity at the age of twenty-two months in captivity (Desai, 1974). They breed once a year and the breeding season varies from one place to another, majorly depending upon the favorable conditions, natal areas, abundance of prey base etc. The gestation period is 61-65 days.

They give birth to the young ones in a burrow or rocky crevices near water. They remain blind and helpless for one month and start swimming after 2 months. The cubs wean for 4-5 months and live with the mother for one year, after which they disperse to live independently and attain sexual maturity at the age of two years. The size of the litter varies from two to five. Home range varies from 5.5 km to 17 km in low density habitats (Hussain, 1993).

The Smooth-coated otters use scent marks for demarcation of their territory and for communication. They have a pair of scent glands at the base of their tail. Together with this scent and the faeces, they mark on vegetation, rocks, shorelines etc. near their feeding, grooming and natal areas. This behavior is known as sprainting. They are known to live up to 20 years in captivity but less than 10 years in the wild (Ronald Nowak, 1999) which is to be confirmed. This is also governed by the availability of abundance of prey base. They form small family groups consisting of a pair with 2-5 offsprings. Male helps to gather food for the young ones.

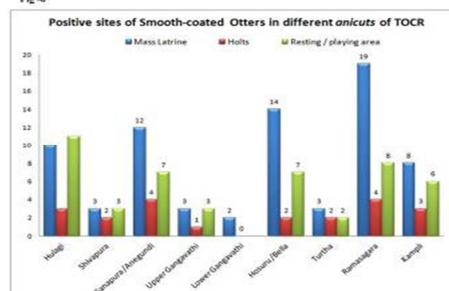
Fig -5



4.2.2 Population dynamics of Smooth-Coated Otter in anicuts in TOCR

During the rapid biodiversity assessment, it is found that the population of Smooth-coated otters is high compared to rest of the major fauna. In 142 positive signs of otters, about 74 (52.11%) mass latrine or mass sprainting sites, 21 (14.78%) natal sites or Holts and 47 (33.09%) resting and grooming sites found in different *anicuts* within the TOCR area. The largest population of otter is found in Ramasagara *anicut* vicinity with 31 (21.83%) positive sites. Next largest population is found in Hulagi *anicut* where 24 (16.90%) positive sites found. The Bella and Anegundi *anicuts* have 23 (16.19%) of the

Fig -6



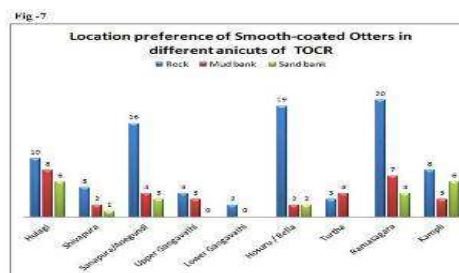
Otter population, while Kampli *anicuts* has revealed 17 (11.97%) positive sites. Owing to excessive growth of weeds, over siltation and non-availability of fair water body with prey base, very few positive sites of otters are found in Shivapura 8 (5.6%), Upper Gangavathi 7 (4.9%), Lower Gangavathi 2 (1.4%) and Turtha 7 (4.9%). This indicates the decline of otters population due to unsupportive and unhealthy habitat.

Table 2: Smooth coated otter: Population density

SI No.	Name of the <i>anicut</i>	Mass Latrine	Holts	Resting / grooming area	Total	%
1	Hulagi	10	3	11	24	16.9
2	Shivapura	3	2	3	8	5.63
3	Anegundi	12	4	7	23	16.19
4	Upper Gangavathi	3	1	3	7	4.929
5	Lower Gangavathi	2	0	0	2	1.4
6	Bella	14	2	7	23	16.19
7	Turtha	3	2	2	7	4.92
8	Ramasagara	19	4	8	31	21.83
9	Kampli	8	3	6	17	11.97
	Total	74	21	47	142	
	%	52.11	14.78	33.09		

Location preference

Generally, the Smooth-coated otters are shy animals and avoid human presence. They need fairly deep and fresh water body with sufficient prey base. Normally they go for foraging early morning and evenings. Sometimes, hunt during the night and in broad day light also. After the hunt, they rest on the rock, mud – sand mounds in the middle of the water covered with vegetation. Also use sand banks for basking, playing and grooming. It is found that they prefer rocky islands and crevices for mass latrine, resting and grooming and for breeding also. Of 142 signs 87 (61.26%) positive signs found on rocky terrain. 33 (23.23%) positive signs found on mud banks or islands and 22 (15.49%) found on the sand banks. The preference of rocky islands and crevices is basically depends upon the availability. They use the rocky, mud and sand dunes and banks which is covered with thick vegetation.

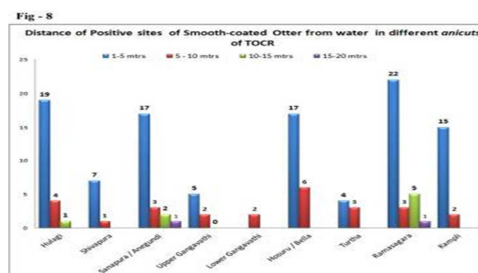


Distance from water

The Smooth-coated otters prefer to stay near a water body so as to escape into water in case of any threat. However, they do move away for foraging and for marking their territories.

During the study period, 142 positive sites were observed out of which 106 sites are very close to the water body 1- 5 meters (74.64%). About 26 sites were found within 5-10 meters from the edge of the water (18.30%).

Eight positive sites were found about 10-15 meters away from water (5.63%) and only 2 sites found away about 15-20 from the edge of the nearest water body (1.4%). This indicates their preference to be in proximity to a water body.



Project specific Impact assessment: Smooth-coated Otter

It is observed in the field that, the Smooth-coated Otters are highly adoptable to the changed geo-physical landscapes. It is evident by the prolonged observation of their behavior in the field. As the water starts flowing and the rivers swells, they move to the extreme end of the bank and dig burrow under the bushes. As the water recedes, they gradually move towards the edge of the water and when river turns into trickle in late winter and summer, they give birth to young ones in the holts in the middle of the water or under the thick bush in the mud banks of the river. They also adapted to the human disturbances like, fishing, harvesting the crop at the bank where they roam, etc.

During the project a temporary barrage to be built by using sand bags or any such materials to retain the pool of water to facilitate the restoration of the anicuts and de-siltation.

During this period following Specific Impact may be exerted on Otters:

1. The movement of people and machinery would drive them away from their routine path.
2. They may temporarily change their grooming and resting areas to the nearest safe location at the edge of the water.
3. The change in behavior may occur by the displacement. Otters are territorial social animals. Each group has its own territory which they demarcate using spraint marks. When one group enters into another's territory, a clash may take place. In fight each of them scratches their noses or bites the body parts. Most of the cases, they escape the confrontation.

Impact mitigation strategies:

1. Start the restoration work in January and complete it by June during which, the Otter would have given birth to young ones and shift the location after a month to safe zone.
2. The work in the anicut areas to be taken up between 9 am to 5 pm, as the Otters are crepuscular animals, i.e active in the morning and evening, hunting for fish and other food sources.
3. A separate watcher should be appointed to each *anicuts* to monitor the movement of the Otters and other faunal species.

4.3 Mugger crocodile – *Crocodylus palustris*

Classification:

Kingdom	:	<i>Animalia</i>
Class	:	<i>Sauropsida</i>
Order	:	<i>Crocodylia</i>
Family	:	<i>Crocodylidae</i>
Subfamily	:	<i>Crocodylinae</i>
Genus	:	<i>Crocodylus</i>
Species	:	<i>C. palustris</i>
Scientific Name	:	<i>Crocodylus palustris</i> (Lesson, 1831)
IUCN status	:	VU (Vulnerable)
WPA, 1972 status	:	Schedule-I (part II, 1D)



Table 3: Population of Muggar crocodile

SI No.	Name of the anicut	Direct sightings	Nesting areas	Scat/ sign marks	Total	%
1	Hulagi	1	0	2	3	4.054
2	Shivapura	3	3	2	8	10.81
3	Anegundi	3	2	9	14	18.91
4	Upper Gangavathi	1	1	3	5	6.75
5	Lower Gangavathi	0	0	0	0	0
6	Bella	3	0	1	4	5.4
7	Turtha	0	0	3	3	4.05
8	Ramasagara	11	2	8	21	28.37
9	Kampli	8	2	6	16	21.62
	Total	30	10	34	74	
	%	40.54	13.51	45.94		

General characteristics

There are three species of crocodiles in India, viz, Mugger Crocodile, Gharial and Salt water Crocodile. Mugger Crocodile is also known as 'Marsh Crocodile', 'Indian Swamp Crocodile' etc. Adult crocodiles are dark grey to bright olive in color and the young ones are light colored. Their entire body is covered with black spots and large scales. It has a long, flattened body, with thick, long tail comprising sharp scales. Snout is broad and heavily armed with large scutes around the neck. Fingers and toes are webbed. Male attain 4-5 meters (13-16 ft) length and up to 200 kilogram weight. Females are smaller.

Geographical distribution

Mugger crocodile belongs to a fresh water species distributed in India and south-east Asian countries, namely, Pakistan, Bangladesh, Sri Lanka, Nepal, Iran and Indo-China region.

Natural Habitat

Mugger Crocodile is found in fresh water rivers, lakes and marshes. It prefers slow-moving shallow rivers and canals, reservoirs and marshy lakes with rocky boulders or mud banks.

Behavior

Mugger crocodiles can swim at a speed of 13 km per hour while hunting the prey. In case of emergency, they can swim at 19 km per hour. Normally, they move gently or leisurely in still water.

Hunting and diet

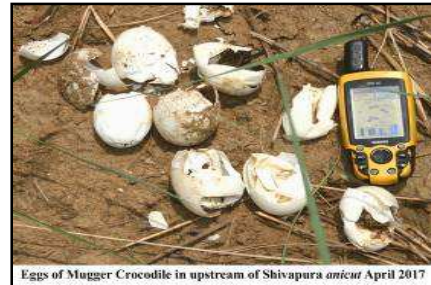
Mugger Crocodile eats fishes, snakes, turtles, birds, and small mammals like monkeys, squirrels, ungulates, otters and livestock. It is a cunning predator, waits in the water bodies and ambushes gullible animals that come to drink water. It drags the prey into water and devours. During dry season, it digs a burrow of around 6 feet depth and equally wide under the thick vegetation and rests (field observations).



Nest and den of Mugger Crocodile in Shivapura anicut April 2017

Reproductive behavior

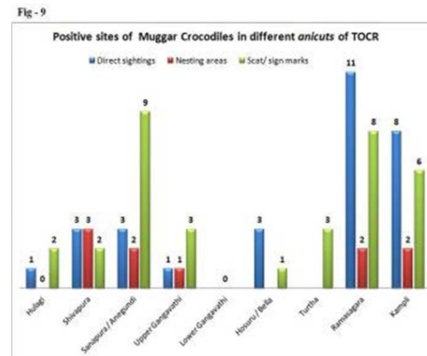
Male crocodiles attain sexual maturity at the age of 10 years and female at 6 years. The female digs a deep and wide hole in dried puddles by the side of a pool or perennial water body and lays up to 30 eggs at a time and guards them. The eggs are large with thick shell. The incubation period is 55 to 75 days. The female carries the hatchlings in mouth and release them in water.



4.3.1 Population dynamics of Mugger Crocodile in anicuts

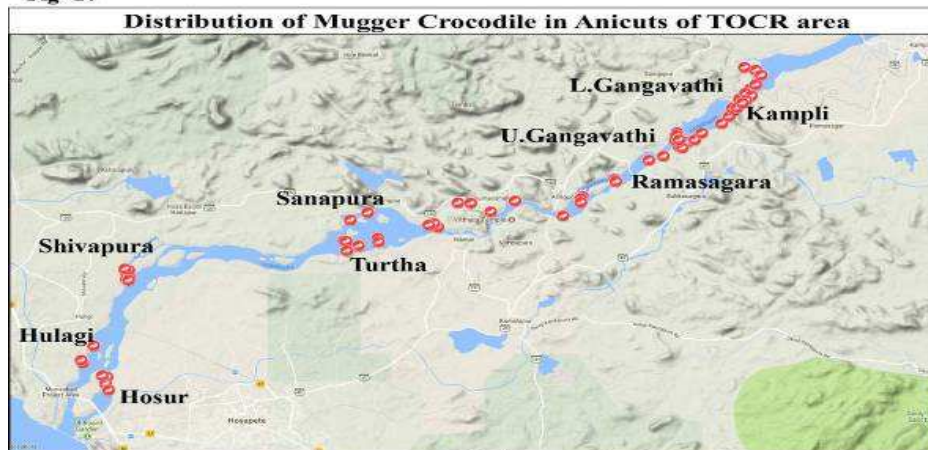
In the course of rapid assessment, it is found that the Mugger Crocodile is the second largest major fauna in all *anicuts* of TOCR area. The availability of favorable habitat, abundance of prey base, ideal nesting and nursing site etc. induced the crocodile population to flourish.

During the rapid assessment, 74 positive signs of crocodiles in different anicuts of TOCR found. About 30 crocodiles were sighted directly (40.54%), 10 nesting sites (13.51%), and 34 scat and signs were found (45.94%).



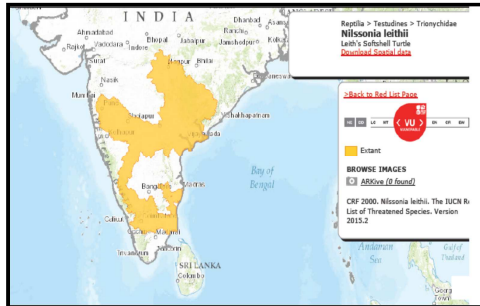
Largest population of otter is found in Ramasagara anicut vicinity with 21 (28.37%) positive sites followed by Kampli anicut where 16 (21.62%) positive sites found. Anegundi anicut has 14 (18.91%), Shivapura 8 (10.81%). Upper Gangavathi 5 (6.75%), Bella has 4 (5.40%), and Hulagi and Turtha 3 positive sites each (4.05%) of the crocodiles. Lower Gangavathi has no positive sites of crocodiles. The reason for low population density is due to excessive growth of weeds, excessive siltation and non-availability of fair water body with prey base. Hence, there is an urgent need to intervene and explore positive solution to clear the lake off weeds.

Fig- 10



Location preference

Generally, Mugger crocodiles avoid human beings. They prefer rocky islands or sand dunes covered with vegetation in the middle of a water body, stagnant pools of river, or fresh water body with prey base. Normally, they go for foraging during early morning and evenings. They hunt during night generally, but also during day



time as necessary. After the hunt, they rest on the rock, and mud-sand mounds in the middle of the water covered with vegetation.

About 31 positive sights are found on the rocks or rocky terrain (41.89%), which proved as the most preferred location for them. Second choice of preference is Mud/Sand mound in the middle of the still waters. About 25 such observations were made (33.78%). During winter and dry seasons they prefer to

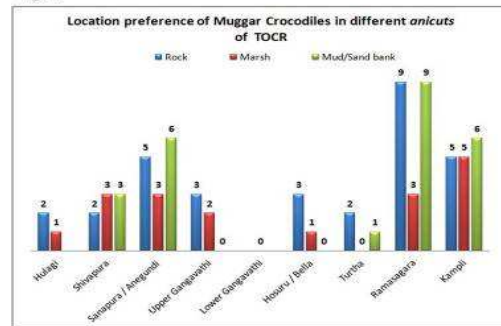
hide under the cover of marshes. About 18 such sights are observed (24.32%).

Distance from water

Mugger crocodiles prefer to stay as close to water body as possible. The reason for this may be access to food base; proximity to water also provides an easy escape from any kind of threats.

Of the 74 positive sites and observations, 58 sites are found within 1-5 mtrs distance from the shore. (78.37%). In about 15 instances, positive sites were found within 5-10 mtrs (20.27%). Only 1 site was found at about 10-15 mtrs away from the shore of the water body (1.35%). During breeding season, they make nest little away from large pool in a dried puddle. This helps them to hunt for food and protect the nest as well as carry the hatchlings from nesting site to the nursing site in the water body.

Fig -11



Project specific Impact assessment: Mugger Crocodiles

Mugger Crocodiles are sensitive to the human disturbances. Though they tolerate human presence in safe distance, but move away to increased disturbances. It is observed that the Crocodiles lay eggs by the side of the perennial water pools, at the edge of the partially dried puddles. They make burrow at the side wall of the puddle and lay up to 30 eggs and cover them with soil. Generally they prefer sandy banks. After laying eggs they burrow a deep and wide cavity under the thick grass and stay there protecting their eggs. As the eggs hatch after a month, the mother picks up each hatchling in its mouth and releases them in the nearby perennial pool.

But it is found that except Hosuru / Bella *anicut* most of the nests of the crocodiles found away from anicuts. Hence the restoration activities may not directly hamper the nesting behavior of Crocodiles. Yet the restoration activities may exert the following specific impacts on Crocodiles:

1. The excessive movement of massive machinery and a large number of workers may drive the crocodiles away from the pools.
2. They may shift their location temporarily to the safe marshy area nearby.
3. People / the workers out of curiosity may chase the crocodile or sometimes (if not informed the importance of wild fauna to the laborers) they may try to kill the animal out of fear and prejudice.

Impact mitigation strategies:

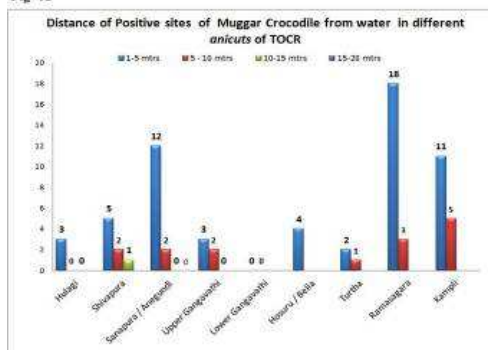
1. Start the restoration work in January and complete it by June. During this period the water level will go down and the crocodiles also go to the deep water pools.

2. The work in the *anicut* areas to be taken up between 9 am to 5 pm, as the Otters are crepuscular animals, i.e active in the morning and evening, hunting for fish and other food sources.
3. Awareness about the wildlife and their conservation be created among the staff including site managers, contractors, laborers etc., well in advance before commencement of the restoration activities.

4.4 Turtles and Tortoises

About 24 species of fresh water turtles and 4 species of Tortoises are found in India. The 'Tungabhadra Otter Conservation Reserve' (TOCR) and its islands with scrub jungle have 4 turtles and one tortoise. Fresh water Turtles like Indian Black Turtle-*Melanochelys trijuga*, Indian Soft-shelled Turtle-*Lissemys punctata*, Leith's softshell turtle-*Nilssononia leithii* and Indian narrow-headed soft-shell turtle-*Chitra indica* are found in the TOCR area. Only one Tortoise species, Indian star tortoise-*Geochelone elegans* is found on the islands and in surrounding scrub jungles.

Fig-12



It is said that during the Vijayanagara Empire, soldiers were killing the giant turtles in the river, eating the meat and using the carapace as a shield in the war. The carapace is light and strong. At present, the population of the giant turtles has declined drastically-becoming endangered in this part due to illegal hunting and poaching.

There are two distinct species of 'Giant Soft shelled turtles' found in the river.

4.4.1 Leith's Soft-shell Turtle-*Nilssononia leithii*

Classification:

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Reptilia
Order	:	Testudines
Sub order	:	Cryptodira
Family	:	Trionychidae
Genus	:	<i>Nilssononia</i>
Species	:	<i>N.leithii</i>
Scientific Name	:	<i>Nilssononia leithii</i> (Grey, 1872)
IUCN status	:	VU (Vulnerable)
WPA, 1972 status	:	Schedule-I



Leith's Soft-shell Turtle is also called as *lagala* in local language which is listed in the Vulnerable under Threatened category of IUCN red list, and also listed as Schedule-I species of Indian Wildlife Protection Act, 1972. This species is endemic in Central and South Indian rivers in Madhya Pradesh, Maharashtra, Odisha, Karnataka, Andhra Pradesh, Tamil Nadu and Kerala. It is commonly found in rivers like Godavari, Bhavani, Ghataprabha, Tungabhadra, Cauvery, Moyar etc. (Das, I., Sirsi, S., Vasudevan, K., and Murthy, B.H.C.K. 2014). It was most commonly found turtle till a few decades ago; now it is facing extinction due to illegal trade, siltation and drying up of Rivers during summer.

(2) This rare turtle is found in the shallow waters of the Tungabhadra River throughout the TOCR area. Hunters from “Bangladesh” rehabilitation camp near Sindhanur in Raichur district are noted hunters of turtles. They use a rope with hundreds of hooks and drag it across the shallow waters of the river during winter and summer to capture this rare Turtle that dwells in under water sand in the shallow rivers. It is learnt that the carapace of this turtle is being smuggled to China for making TCM. During the study, the team was unable to see or observe these species owing to low water level and over growth of weeds in the *anicuts*. However, local fishermen confirmed that the turtle population is still significant throughout the river.



Leith's softshell turtle - Nilssonina leithii

4.4.2 Indian Narrow-headed Soft-shell Turtle–*Chitra indica*

Classification:

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Sauropsida
Order	:	Testudines
Sub order	:	Cryptodira
Family	:	Trionychidae
Genus	:	<i>Chitra</i>
Species	:	<i>C.indica</i>
Scientific Name	:	<i>Chitra indica</i> (Grey, 1831)
IUCN status	:	EN (Endangered)
WPA, 1972 status	:	Schedule-I



Indian Narrow-headed Soft-shell Turtle or Small-headed Soft-shell Turtle–*Chitra indica*, is also listed in the Endangered under Threatened category by IUCN red data book. This turtle is listed as Schedule 1 species under Indian Wildlife Protection Act, 1972. A rare turtle, generally found in Indus and Sutlej rivers in Pakistan, Ganges, Godavari, Mahanadi in India and some rivers of Nepal and Bangladesh (Das, I., Singh S., 2009) also found in Tungabhadra Otter Conservation Reserve (TOCR).

It is also found in some South Indian Rivers. It prefers clear, large or medium rivers with sandy bottoms where it spends most of the time concealed under the sand exposing its nose and eyes only. It feeds upon fish, frogs, crustaceans, mollusks etc. and attains very large size-up to 1.1 meters width, weighing up to 120 kilograms. It is widely hunted by the local tribal community (*Budga Jangama, Shikari, Sindholu, Hakki pikki etc.*) and Bangla poachers for its meat and carapace which is believed to be used in Traditional Chinese Medicine. It is found that the latter poachers are more active than the former. One such large specimen is rescued from the poachers on 15th August 2011. This is probably the largest living specimen found in India, which is reported by Samad Kottur and published in Zoological Survey of India newsletter in 2011 (Samad Kottur-ZSI Newsletter: Volume-03: Number-08 August 2011). The study collected indirect evidences and secondary data which was corroborated with the local community and fishermen. They also confirmed that the population is significant which however needs to be confirmed by conducting detailed studies.

4.4.3 Indian flapshell Turtle–*Lissemys punctata*

Classification:

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Reptilia
Order	:	Testudines
Sub order	:	Cryptodira
Family	:	Trionychidae
Genus	:	<i>Lissemys</i>
Species	:	<i>L. punctata</i>
Scientific Name	:	<i>Lissemys punctata</i> (Lacepede, 1788)
IUCN status	:	LC (Least Concerned)
WPA, 1972 status	:	Schedule-I (Part II (8))



Indian flapshell turtle - *Lissemys punctata*

The Indian flap-shell Turtle or Indian Soft-shell Turtle is also a fresh water turtle found in South Asian Rivers and water bodies. This is a most common and widespread species of turtles in South Indian rivers as well as in the Tungabhadra river within the TOCR area. It can be easily identified by its soft pale olive green rounded shell or carapace, pale yellow plastron and a pair of flaps and conspicuous short proboscis like nose resembling like that of a pigs snout, large head and black eyes with white eye ball that looks like human eyes. It can withdraw the head and limbs into its shell and front plastron. The carapace length of grown up adult is 37 mm. This is omnivorous, feeds upon aquatic plants, invertebrates, small vertebrates, and scavenges the carrion.

During the study, some individuals were sighted in the *anicuts*. However, their population is declining due to illegal hunting and trapping by fishermen and tribal hunters.

4.4.4 Indian Black Turtle–*Melanochelys trijuga*

Classification:

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Reptilia
Order	:	Testudines
Family	:	Geoemydidae
Genus	:	<i>Melanochelys</i>
Species	:	<i>M. trijuga</i>
Scientific Name	:	<i>Melanochelys trijuga</i> (Schweigger, 1812)
IUCN status	:	NT (Near Threatened)
WPA, 1972 status	:	Schedule-I (Part II (8))



Indian Black Turtle -*Melanochelys trijuga*

Indian Black Turtle also called as Indian Pond Terrapin is a most common turtle found in Indian rivers, ponds, lakes and other freshwater bodies. Shell is dark and plastron is brown with yellow streaks. The adult grows up to 45 cms. It is a crepuscular reptile that indulges in active foraging the morning and evening, and seen basking on the tip of a rocky outcrop or on dead wood during the day.

It is an omnivorous which feeds upon the aquatic plants, insects etc. and also scavenges the carrion. During the rapid assessment, local fishermen revealed that it comes out of water on to the river bank in search of cattle dung and feeds upon it.

4.4.5 Indian Star Tortoise–*Melanochelys trijuga*

Classification:

Kingdom	:	Animalia
Phylum	:	Chordata
Class	:	Reptilia
Order	:	Testudines
Family	:	Testudinidae
Genus	:	<i>Geochelone</i>
Species	:	<i>G.elegans</i>
Scientific Name	:	<i>Geochelone elegans</i> (Schoepff,1795)
IUCN status	:	VU (Vulnerable)
WPA, 1972 status	:	Schedule-IV (Part II)



Indian Star Tortoise is a terrestrial reptile that lives in the dry scrub jungle of the Deccan Plateau. It has a convex dorsal shield appearing like a hump. Its black carapace with pale yellow streaks resembles a star; hence, it is called as Star Tortoise. The tortoise does not have web feet and it is unable to live in aquatic conditions. The limbs are pointed and bony tubercles (similar to claws). It feeds upon the succulent plants, grass, fallen fruits, flowers etc. Sometimes, it devours upon carrion also; lives in the dry scrub jungle, and takes shelter among the rocky boulders and tufts of grass.

In TOCR area, Star Tortoises can be seen in the islands of Kariyammangaddi and surrounding forests namely Sanapura Reserve Forest and Bukkasagara Reserve Forest of Daroji Bear Sanctuary.

Project specific Impact assessment:

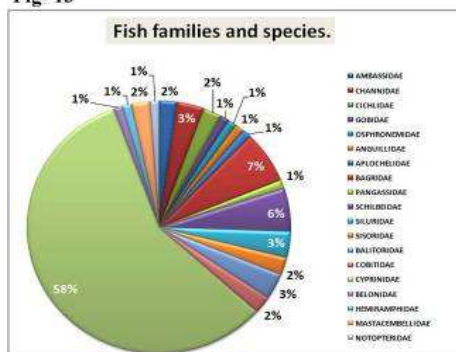
The turtles are shy animals and avoid human presence and interference. They lay eggs in the sand mounds and banks during late summer, and the young ones come out of their nests during the first floods of monsoon. The Giant turtles and Soft-shelled Turtles rest in the bottom of the shallow river while Flop-shelled Turtle and Indian Black Turtle bask or rest on the sand/mud banks and rocky outcrops.

The restoration activities may exert the following specific impacts on Turtles:

1. The excessive movement of massive machinery and a large number of workers may drive the Turtles away from their resting mud banks and rocky outcrops in the river.
2. They may shift their location temporarily to the safe sand / mud banks /marshy area nearby.
3. People / the workers out of curiosity may capture the Turtles and disturb their movement.
4. People may kill them whenever they come across the turtles for consumption.

Impact mitigation strategies:

1. Not to disturb the sand / mud banks and rocky islets.
2. The staff and workers are to be well educated about the Turtles and their conservation.
3. All the staff and workers are to be informed not to kill any snakes, not to hunt fishes, and so on.



IUCN.

During the RBA study, quick survey of the fish fauna was conducted in different parts of the TOCR area; information was compiled from the previous studies. A total of ninety species of fish fauna were identified belonging to 8 Orders and 19 Families. About 58% of the fish fauna belong to Order Cypriniformes, 7% belong to Order Siluriformes.

On the basis of the population dynamics of the species, International Union for Conservation of Nature (IUCN) lists the living organisms under different categories in Red Data book. Under this, one fish (1.1%) is listed as Critically Endangered (CR), 6 fishes species each (6.66%) listed under Endangered (EN) and Vulnerable (VU) category respectively, and 8 fishes (8.88%) under Near Threatened (NT) category. About 63 fishes (70%) are listed as Least Concern (LC) and while the rest of 6 fish species (6.66%) are listed under Not Evaluated (NE) and Data Deficient (DD). During the RBA, the team was able to find about 25 different species of fishes only due to dried river. The year-long study will definitely result in more valid information about the fish fauna in the TOCR area.

Table 5: IUCN status of Fish Fauna with in TOCR

SI No	IUCN Status	Numbers	Percentage
1	EX (Extinct)	0	0
2	EW (Extinct in Wild)	0	0
3	CR (Critically Endangered)	1	1.11%
4	EN (Endangered)	6	6.66%
5	VU (Vulnerable)	6	6.66%
6	NT (Near Threatened)	8	8.88%
7	LC (Least Concerned)	63	70%
8	NE (Not Evaluated)DD (Data Deficient)	6	6.66%
Total		90	

Fishes listed under Critically Endangered (CR) by Red data book of IUCN

1. Ray-finned Fish – *Hypselobarbus pulchellus*

Fishes listed under Endangered (EN) by Red data book of IUCN

1. White catfish- *Silonia children*
2. Zebra Loach-*Botia striata*
3. Deccan labeo-*Labeo potail*
4. Sandkhol carp – *Thynnichthys sandkhol*
5. Deccan / Black Mahseer-*Tor khudree*
6. Hump back mahseer-*Tor mussullah*

Fishes listed under Vulnerable (VU) by Red data book of IUCN

1. Spike-tail paradise fish- *Macropodus cupanus*
2. Deccan nangra- *Gagata itchkeea*
3. Mrigal carp-*Cirrhinus cirrhosa*
4. Wild common carp-*Cyprinus carpio carpio*



5. Gobi-Glossogobius giuris
6. Kolus – Hypselobarbus kolus

Fishes listed under Near Threatened (NT) by Red data book of IUCN

1. Tilapia-Oreochromis mossambica
2. Butter cat fish-Ompok bimaculatus
3. Pabo catfish-Ompok pabo
4. Great white sheatfish-Wallago attu
5. Gangetic goonch-Bagarius bagarius
6. Tunga garra-Garra bicornuta
7. Pangusia labeo-Labeo pangusia
8. Manipur osteobrama-Osteobrama belangeri

The department of fisheries releases a number of species of fry into the dam and rivers to help the fishermen community harvest fish commercially for their livelihood. One such commercial exotic fish species is Tilapia-Oreochromis mossambica. The species has its origin in Cichlidae in Africa. It was introduced to Indian rivers and ponds in 1952. Within a few years, the fish adopted and flourished in the entire Indian Fresh water ecosystem. Fast growing Tilapia is popular among the fish eaters as 'aquatic chicken'. Other species of economic value include Rohu, Catla, Common Carp etc, the fry of which is being released in the T.B. Dam reservoir and the river to help the fisherman community. A large quantity of fish is harvested and sold in and around Bellary and Koppal districts. Thousands of families of fishing community are dependent upon fishing both in the reservoir and in the river. As of now, the fishing community harvests the fishes without any regulations. It is not advisable to harvest fish during mating and breeding season; also the RET species should not be allowed to harvest. If eliminated accidentally, harmful fish species like African Catfish, which devours endemic fish fauna and crustaceans will flourish. Hence, there is a need to regularise fishing in Tungabhadra river.



Project specific Impact assessment: Fishes

The Fishes are not affected as long as there are in water. There is unorganized fishing is going on at present, where all kinds of big fishes including Endangered Mahseers are hunted. Yet the project may put forth following specific impacts on Fish Fauna:

1. During the restoration, as the water goes down or drains down, all the fishes big and small are get exposed and the people / villagers, workers and so on may capture / hunt them. A large number of people may gather to harvest these vulnerable fishes.
2. Gathering of large number of people and fishermen may wipe out the fish fauna as some fish species lay eggs in summer and early monsoon.
3. Free movement of fishes in their nesting places like swamps, submerged flora, crevices etc may hamper.

Impact mitigation strategies:

1. A lot of care is to taken up during construction of temporary barrage by sand bags or any such materials which should not have chemicals that may destroy the fingerlings.

2. While construction of the temporary barrage or during restoration of the anicuts and desiltation, any wild fauna including fish found under the mud or stones, it should be released into the temporary pool.
3. No oil or chemical shall be released in the anicuts area. After completion of the restoration each and every corner should be cleaned and all the debris and materials should be removed completely.

4.6 Avi fauna

Birds are the part and parcel of our biodiversity. This is the most common wildlife that everyone sees in their life. Birds are adapted to different habitats according to their feeding and nesting habits. In the quick survey of biodiversity assessment, it is found that about 156 species of birds of different habitats found in the breadth and length of Tungabhadra Otter Conservation Reserve. Water fowls like Purple Swampphen, Bronze-winged Jacana, White-breasted water hen etc adapted to the habitat of swamps. Their long slender toes help to move on the floating leaves on the surface of water. These birds build floating nests during monsoon and breed. Spot-billed ducks, Lesser Whistling Ducks etc breed in the islands and on the banks of the river. Different species of Egrets, Ibis, Herons, Storks, Sandpipers, Lapwings etc., are seen along the river banks. They feed upon the crustaceans, insects, molluscs, fishes etc., from the riparian habitat. In the islands like Kariyammana Gadde, Virupapura



Gadde and rocky scrub jungle along the river lives a rare bird Yellow-throated Bulbul. It is found only in few pockets of South India. This rare bird is also listed as Vulnerable (VU) by IUCN. Painted Spurfowl, Indian Peafowl, different species of quails, Sandgrouse etc. also found in the scrub rocky habitat is also found in the islands. Large birds like, Woolly necked Storks, Asian Openbill, Cormorants, Herons etc., birds roost on the rocks in the middle of the river or in the islands in the river. Sometimes the Vulnerable species like Lesser Adjutant found in the islands of the river. Raptors like, Short-toed Snake Eagle, Brahminy Kite, Black Kite, Black-shouldered Kite, Shikra also found along the river. Rare bird like Oriental Darter (NT) is seen in some anicuts like Hosuru, Hulagi etc.

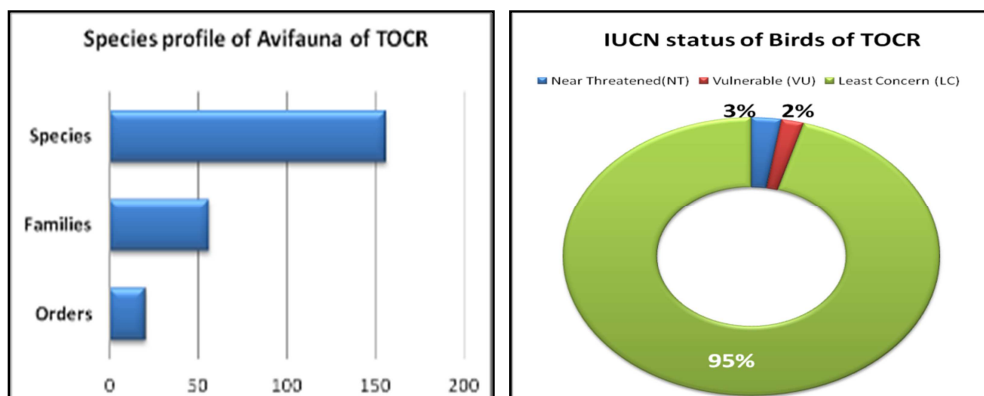
Project specific Impact assessment: Birds

Compare to the rest of aquatic fauna, the avifauna is less affected by the restoration activities. The birds like Purple Swampphen, Bronze Winged Jacana, Little Grebe, Spot-billed Ducks, Yellow Bittern, etc make floating nests in the monsoon. Hence they are not affected as long as there is water in the river even away from the anicuts. During the restoration the birds move to another safe location. Yet the possible impacts of the restoration activities are listed as follows:

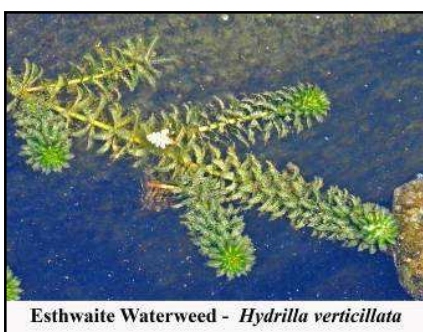
1. The regular foraging and roosting behavior may be disturbed.
2. The migratory birds may change their regular roosting ground and transit locations.

Impact mitigation strategies:

1. Swamp and marshy banks in the upstream of the anicuts shall be retained.
2. The staff and the workers are well informed about the protection of all wildlife including birds.



4.7 Aquatic flora: *Macrophytes*



typical ecosystem is evolved in and around the fresh water environment, where aquatic plants play a vital role in supporting the biodiversity and health of riparian ecosystem. Fresh water plants also called as macrophytes have evolved by adapting to different strata of the aquatic ecosystem such as submerged, emergent, free floating, rooted floating etc. The role of the submerged macrophytes is crucial to the maintenance of aquatic ecosystem. These submerged macrophytes as well as phytoplankton and algae produce oxygen for the aquatic faunal species. The species abundance and faunal diversity is depended upon the presence of submerged aquatic flora and DO.



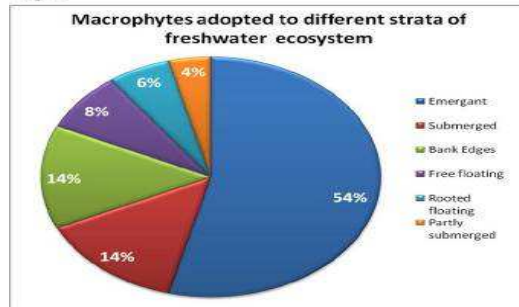
The study has also identified some key species of aquatic flora in and around the TOCR area. While the submerged flora provides oxygen and food for the faunal species, the emerged flora provides protection from exposure to animals like Smooth-coated otters, crocodiles etc. Otters make burrows in the thick bushes on the banks of the river and crocodiles hide under the marshes in the banks. Some fish species take refuge in the submerged flora to protect themselves from predators.

Though the aquatic flora is supporting the ecosystem, the hazardous growth of water hyacinth-*Eichornia crassipes* has covered the surface of water like a carpet in almost all *anicuts* and pools within the TOCR area. The thick carpet of water hyacinth does not allow sunlight to enter into water. Non-availability of sunlight hampers the process of photosynthesis of submerged flora. As there is no photosynthesis, no oxygen is produced resulting in reduced DO. The lack of dissolved oxygen leads to death of planktons, and small and large aquatic fauna including crustaceans and fishes. The death and decay of underwater flora results in pollution of water,

which later begin stinking. The overgrowth of water hyacinth also helps sudden burst of mosquito population resulting in deadly diseases like Malaria, Dengue, Chikungunya, Filariasis etc. among people living around the river. Excessive growth of water hyacinth also results in siltation of the *anicuts* and pools, leading to lack of storage of water.

In Upper and Lower Gangavathi *anicuts*, water spinach-*Ipomoea aquatica* has grown hazardously covering the surface of these *anicuts*. The hazards are similar to that of water hyacinth.

Fig-14



5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of Conclusions and Recommendations

The rapid bio diversity assessment of all the nine *anicuts* present within TOCR area revealed that the entire TOCR area has an ideal habitat for RET species like Smooth-coated otter, mugger crocodile, four species of Turtles, hundreds of species of fish fauna and also supporting a repertoire of avifauna. Based on the data collected and analyzed, it is observed that all the nine *anicuts* within TOCR area have deteriorated resulting in reduced storage capacity in view of the following:

1. Natural degradation of the weirs due to aging and destruction due to floods and corrosion.
2. Leakages.
3. Excessive siltation.
4. Eutrophication i.e. excessive growth of invasive alien weeds.
5. Lack of systematic monitoring and management protocols.
6. Lack awareness.

The degradation of the Anicuts resulted in:

- Low water storage capacity.
- Poor supply for irrigation through VNCs which are also degraded and destroyed
- Low production of the cash crop like sugar cane, Banana and paddy.
- Depleting prey base for the apex predators.
- Loss of habitat for major fauna and resulting low population density.
- Loss of livelihood for the fishermen community.
- Loss of endemic aquatic flora and resulting low DO levels.
- Loss of ecosystem and collapse of food chain.
- Man-animal conflict, for example, crocodiles may enter inhabitations and prey upon the livestock due to lack of food base.
- Loss of bio-diversity.

The following recommendations should be adopted during execution of works so as to cause minimal or zero disturbance to the wildlife within the TOCR area:

General recommendations

1. There is a need for taking precautions to protect the RET species and other life forms during execution of restoration works on the *anicuts* or barrages. Restoration of *anicuts* would support the RET species and other life forms and help their proliferation in the long run.
2. Restoration work should be taken up during December to June period only so as to avoid disturbance to the aquatic fauna. During this period, the flow of water in the river is minimal and chances of floods are very less.
3. Before commencement of the restoration activities, a temporary barrage should be built 100 meters away from the anicut using sand bags or any such material across to facilitate storage of water for the wildlife. Water should be ensured till the completion of the restoration work to enable major fauna, fishes and amphibians to remain in their habitat; otherwise they may migrate to other locations that may cause conflicts.

4. Restoration work should start after 9 am and should be closed by 5 pm so as to make way for the feeding of crepuscular and nocturnal animals.
5. De-silting and de-weeding to be taken up in the frontal portion of the *anicuts* only, but the existing native species of bushes and shrubs in the shore line are to be retained. This will help the animals to take shelter and hide under the cover of vegetation.
6. Retain the rocky islands, sand dunes and mud banks in the middle of the *anicut* which will help wildlife such as Smooth-coated otters and crocodiles to bask and rest.
7. De-weeding of invasive alien weeds like *water hyacinth* and *Ipomoea cornea* is to be taken up in the *anicuts* on regular basis to prevent siltation and to maintain healthy ecosystem.
8. During restoration work, it is advised to build a stone wall or a concrete wall along the road side of the canal and leave the other end/ bank of the canal as it is with its mud bank and vegetation wherever possible. This will help the endemic life forms such as crabs, amphibians, snakes, turtles and birds to feed, nest and live making use of the available resources.
9. While de-silting and removing the existing structures of the *anicuts*, precaution should be taken to avoid any kind of harm or disturbance to the wild life forms such as turtles, snakes, monitor lizards, crocodiles, amphibians, and fishes which generally hide under the crevices of the walls. All these to be rescued and shifted to safer locations. In case any nest of Crocodile or Turtle is spotted, it should be protected or shifted scientifically to a safer location. A Naturalist/ Wildlife researcher to be appointed on ad hoc basis to advise and monitor such instances.
10. Awareness program on 'the wild life of the river and conservation' should be conducted for workers, supervisors and managers before the restoration work is begun.
11. After completion of the restoration work, all debris of sand bags, plastic, oily soil, and metals should be removed and cleaned.
12. Hoardings, signage, bill boards, etc. to be installed depicting the heritage of *anicuts* and the biodiversity within these areas.
13. Water Users Societies should be formed for each *anicut* comprising the end users, officials of KNNL, KFD and local conservation NGO to monitor and to take care of maintenance of the *anicuts* and VNCs.
14. Take service of suitable biodiversity and ecology experts to advise and oversee the well-being of the major fauna during restoration activities.
15. Take up follow up activities for substantial changes in irrigation, ecology and behavior of wild fauna in the project area and take up research, documentation and publication.
16. Make a special provision for Environment and Ecology in the Budget of DPR to be revised.



5.2 Site Specific recommendations: *Hulagi anicut*

Located in the Left bank of Tungabhadra river near Holey Mudlapura and Matti Mudlapura, the Hulagi anicut shelters significant population of smooth coated otters, crocodiles and other major fauna. The sand dunes and mud islands serve as a very good resting and grooming site for Otters. About 3 holts have been observed with 24 positive sites. This indicates that the otters depend upon the habitat of *Hulagi anicut*. But destruction of bunds and excessive siltation and Eutrophication have deteriorated the *anicut*.

The following recommendations are made:

- Strengthen the weir of the *anicuts* in the following manner without disturbing the habitat and natural behavior of the major fauna.

The otters are found to rest and groom in the middle mud islands and breeds in the rocky holts around this *anicut*. Therefore, it is advised to build a temporary barrage of sand bags or any such barrage to hold water during the restoration period. As the terrain is rocky, it is advised to use man power and small machines to remove silt and reconstruct the weirs.

All the general recommendations mentioned in the foregoing are also applicable to this site.

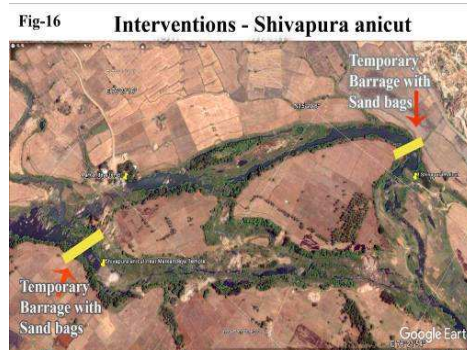
Fig -15



5.3 Site Specific recommendations: *Shivapura anicut*

Located in the Left bank of Tungabhadra River, Shivapura anicut is sheltering smooth coated otters, crocodiles and other major fauna. Though the weir across the left bank river is small, its upstream site has several mud banks and large pools. The sand dunes and mud islands provide a very good resting and grooming site for otters. Here, 2 holts have been observed with 8 positive sites. This indicates that the otters depend upon the habitat of *Shivapura anicut*. It is found that this anicut is the

Fig-16



most favorable site for the crocodiles to breed. By the side of a large pool on the upstream side, 3 nests of crocodiles with 30 eggs are found in each nest. This indicates the importance of this *anicut* for the crocodiles.

Therefore, following recommendations are made:

- The main *anicut* or the weir of Shivapura is only 0.17 km at the tail end of a narrow stream on the left bank. The river in the upstream takes the shape of a canal due to the presence of a large island in the middle of the river. Another weir is located near the Markandeya Temple. Before taking up of reconstruction of the weirs, it is advised to build a temporary weir across the river about 75-100 meters from the *anicut*. It was observed that there was very less activity of major fauna around these two weirs. Moreover, this part of *anicut*s has a lot of disturbance due to activity agricultural and religious activities. Therefore, use of large machinery may not pose any threats to the major fauna.

All the other general recommendation made in previous pages is to be strictly followed.

5.4 Site Specific recommendations: Anegundi *anicut*

Fig - 17

Interventions- Sanapura /Anegundi *anicut*



Located on the Left bank of Tungabhadra River, Anegundi *anicut* shelters the smooth coated otters, crocodiles and other major fauna. The weir is built across the left bank river using a natural structure of rocks. There are large pools of water and a rocky terrain on the upstream side of this *anicut*. Sand dunes and mud islands here provide a very good resting and grooming site for otters. During the study period, 4 holts were located with 23 positive sites. This location is also favorable site for breeding crocodiles; 2 nests were found in this area. Apart from these, there are indirect evidences of leopards and sloth bear. This indicates the importance of this *anicut* for the major fauna.

The following recommendations are made,

The main *anicut* or the weir of Anegundi is about half a kilometer. A crescent shaped primary barrage is built using large granite slabs on the naturally existing rocky terrain. Water is diverted to the VNC by a long weir built parallel to the river which, towards the end deviates from the river.

Before taking up of reconstruction of the weirs, it is advised to build a temporary barrage across the river about 75-100 meters from the front primary *anicut*.

General recommendations made in the foregoing are to be strictly followed.

5.5 Site specific recommendations: Upper Gangavathi *anicut*

Located on the Left bank of Tungabhadra River, Upper Gangavathi *anicut* also shelters the smooth coated otters, crocodiles and other major fauna but comparatively less in number due to the deteriorated condition of the *anicut*. There are large pools and rocky terrain on the upstream side of this *anicut*, but all are excessively silted up and covered completely with

Fig-18

Interventions - Upper Gangavathi



invasive alien weeds like *water hyacinth*, and *Ipomoea cornea*. In addition, illegal sand mining is rampant which has also weakened or damaged the weirs. There are a number of weirs in different locations which are severely damaged over time and with leakages. Therefore, this *anicut* has lost its storage capacity. During the study, only one holt of smooth coated otter was found with 7 positive sites. Only one nesting site of crocodiles was found with two positive sites. Apart from these, indirect evidence of jackals and sloth bears was found. This indicates the importance of this *anicut* for the major fauna.

The following recommendations are made:

The *anicut* of the Upper Gangavathi is about 0.78 km running parallel to the river. Hence, there is a need for careful planning while taking up the implementation work.

Before taking up reconstruction of the weirs, it is advised to build temporary barrages across the river about 25-50 meters from the primary *anicut*.

The general recommendations made in foregoing is to be strictly followed.

Site Specific recommendations: Lower Gangavathi anicut



Located on the Left bank of the Tungabhadra River, Lower Gangavathi anicut is the last *anicut* on the left bank. Though the location is ideal for the major fauna, very less positive sites were found in its vicinity. There are large pools and rocky terrain on the upstream side of this *anicut*; but, all are excessively silted up, and covered completely with invasive alien weeds like *water hyacinth*, and *Ipomoea cornea* at the end of the *anicut*. Due to this reason, very less positive sites were found during the rapid assessment. Only two positive

sites of Smooth coated otter were found here and no indication of crocodiles. However, local people emphasized the presence of a number of crocodiles hidden under the carpet of weeds. Therefore, following recommendations are made:

There is a long *anicut* or weir built parallel to the river with sluice gates. The length of this weir is 0.45 km. Here, it is necessary to build 3 temporary barrages of sand bags to store water during restoration works. Another barrage or weir is located at the extreme end of the *anicut* at the eastern end from where water deviates from the river. Here, it is necessary to build a temporary barrage of sand bags to store water during bund renovation.

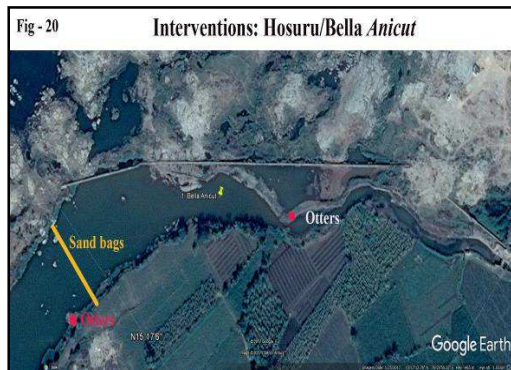
The general recommendations stated in the foregoing are applicable to this site also and need to be followed strictly.

5.6 Site Specific recommendations: Bella / Hosur anicut

Bella or Hosur anicut is located on the right bank of Tungabhadra River near Hosur village in Hospet taluk, Bellary district. The ancient *anicut* is an ideal home for smooth coated otters, crocodiles and other major fauna. The weir is built across the right bank river and has a large pool with rocky and mud banks. The rocky boulders present in the right bank provide a favourable site resting, grooming and holt site for otters. During the study, 2



Holts were located with 23 positive sites. This *anicut* has 3 positive sites of crocodiles. Located very near to the buzzing highway and human settlements, it is surprising to find both otters and crocodiles existing without get disturbed.



The following recommendations are made:

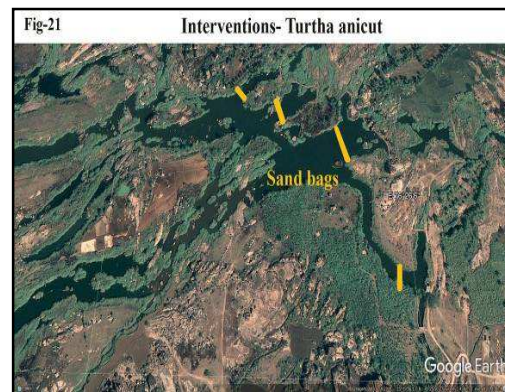
The main *anicut* or the weir of the Hosur is 0.602 kilometer. The long barrage was built along the granite surface of the river, supported with large granite slabs.

Before taking up reconstruction of the weirs, it is advised to build a temporary barrage on front portion of the *anicut* to store water for the existing wildlife.

The general recommendation stated in the foregoing are applicable to this site and should be strictly followed.

5.7 Site Specific recommendations: *Turtha anicut*

Turtha anicut is the first barrage built by the 2nd Emperor of the Vijayanagara Empire, Bukka Deva Raya II in 1399-1406 to provide water to Hampi-the capital city. It is located on the right bank of the Tungabhadra River about 1 km away from Hampi in Hospet taluk. The ancient *anicut* is an ideal home for smooth coated otters, crocodiles and other major fauna. The length of the weirs is 3.048 km with a chain of small and large bunds built across the river taking advantage of the rocky terrain and boulders. A number of pools is also present. However, due to excessive siltation and over growth of invasive weeds, leakages and breakages, the entire *anicut* is in a poor physical state. Nevertheless, the rocky boulders and mud banks provide resting, grooming and holt site for otters. During the study, 2 Holts were found with 7 positive sites of smooth coated otters. This *anicut* has 3 positive sites of crocodiles. If renovated scientifically, this anicut will become an ideal haven for RET species.



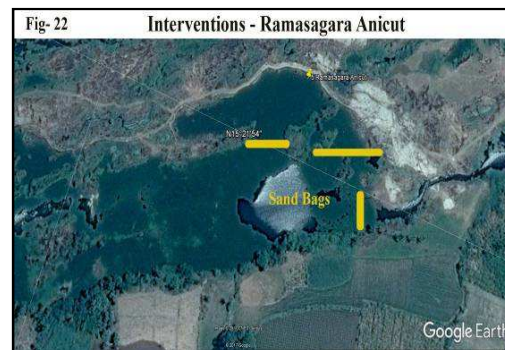
The following recommendations are made:

Before taking up reconstruction of the weirs, it is advised to build a number of temporary barrages in front of the weirs to store water for the existing wildlife.

All the other general recommendations made are applicable and are to be strictly followed.

5.8 Site Specific recommendations: *Ramasagara anicut*

Ramasagara anicut is another *anicut* with a long bund that runs about 2.042 km from the center of the river, near Ramasagara in Hospet taluk. It is located on the right bank of Tungabhadra River and serves as an ideal home for Smooth Coated otters, crocodiles and other major fauna.



Though there are issues like excessive siltation and over growth of weeds, wildlife is flourishing here. During the study, 4 holts were found with 31 positive sites of smooth coated otters. About 2 nesting sites of Crocodile with 21 positive sites were also found.

Therefore, following recommendations are made:

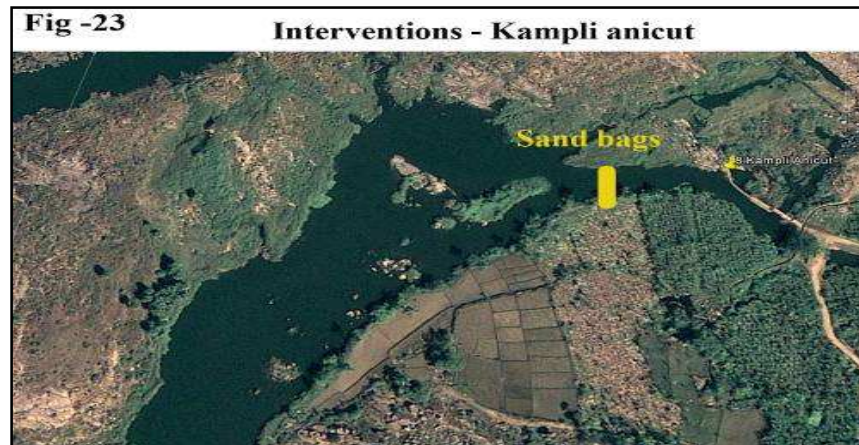
Before taking up reconstruction of the weirs, it is advised to build a number of temporary barrages in front of the weirs to store water for the existing wildlife.

All the other general recommendations made are applicable and are to be strictly followed.

5.9 Site Specific recommendations: *Kampli anicut*

Kampli anicut is the last *anicut* on the right bank of the river within the TOCR area. It has a bund of 0.94 km that runs from the center of the river, near Ramasagara in Hospet taluk. The pools and the bund present in this anicut serve as an ideal home for Smooth Coated otters, crocodiles and other major fauna. During the study, 3 holts were found with 17 positive sites of smooth coated otters. About 2 nesting sites of Crocodile with 16 positive sites were also located.

Therefore, the following recommendations are made.



Before taking up reconstruction of the weirs, it is advised to build a temporary barrage in front of the weirs to store water for the existing wildlife.

All other general recommendations remain the same and are to be strictly followed.

6. APPENDICES

Appendix -1 Some images of Otter habitat and its behaviour



Otters Holt at Hulagi anicut



Otter spraint (defecate) at the entrance of the Holts *en mass*



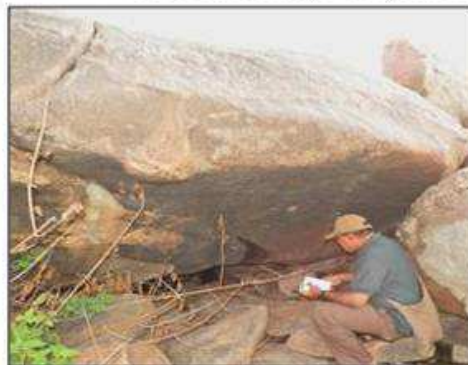
Otters mass latrine or spraint and grooming site at Hulagi anicut



Otters defecate *en mass* at the grooming and basking sites to demarcate their territory.



Otter's mass latrine or spraint marks in different *anicuts* of TOCR.



Otters Holt near *Hole Mudlapura* village very close to human habitation.



Otters hunt for large fishes like this *Deccan Masheer* and litter tail end at the bank which is scavenged by Kites and Crows.

Appendix- 2 Fish fauna of Tungabhadra River

Note: During the rapid assessment the following fishes are documented.



Oreochromis mossambica IUCN- NT



Pseudotropheus maculatus IUCN- LC



Parambassis ranga IUCN- LC



Tor khudree IUCN- EN



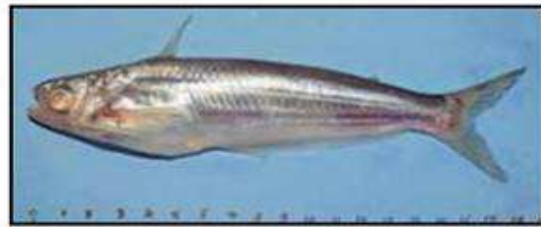
Labeo rohita IUCN- LC



Catla catla IUCN- LC



Wallago attu IUCN- NT



Silonia childreni IUCN- EN



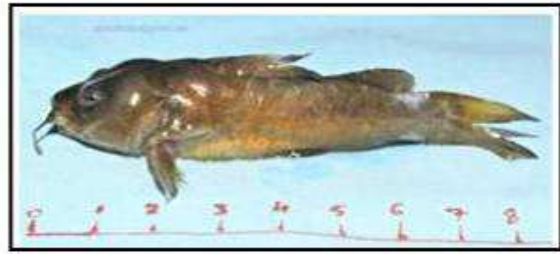
Gagata itchkeea IUCN- VU



Mystus cavasius IUCN- LC



Osteobrama belangeri IUCN- NT



Rita gogra IUCN- LC



Garra fuliginosa IUCN- LC



Garra bicornuta IUCN- NT



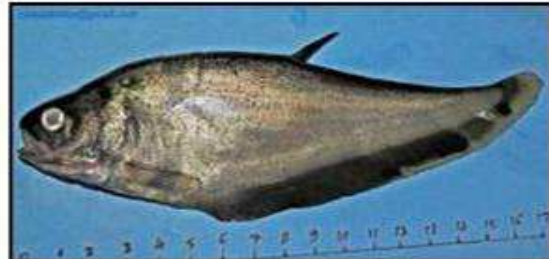
Xenentodon cancila IUCN- LC



Hyporhamphus limbatus IUCN- LC



Neotropius khavalchor DD

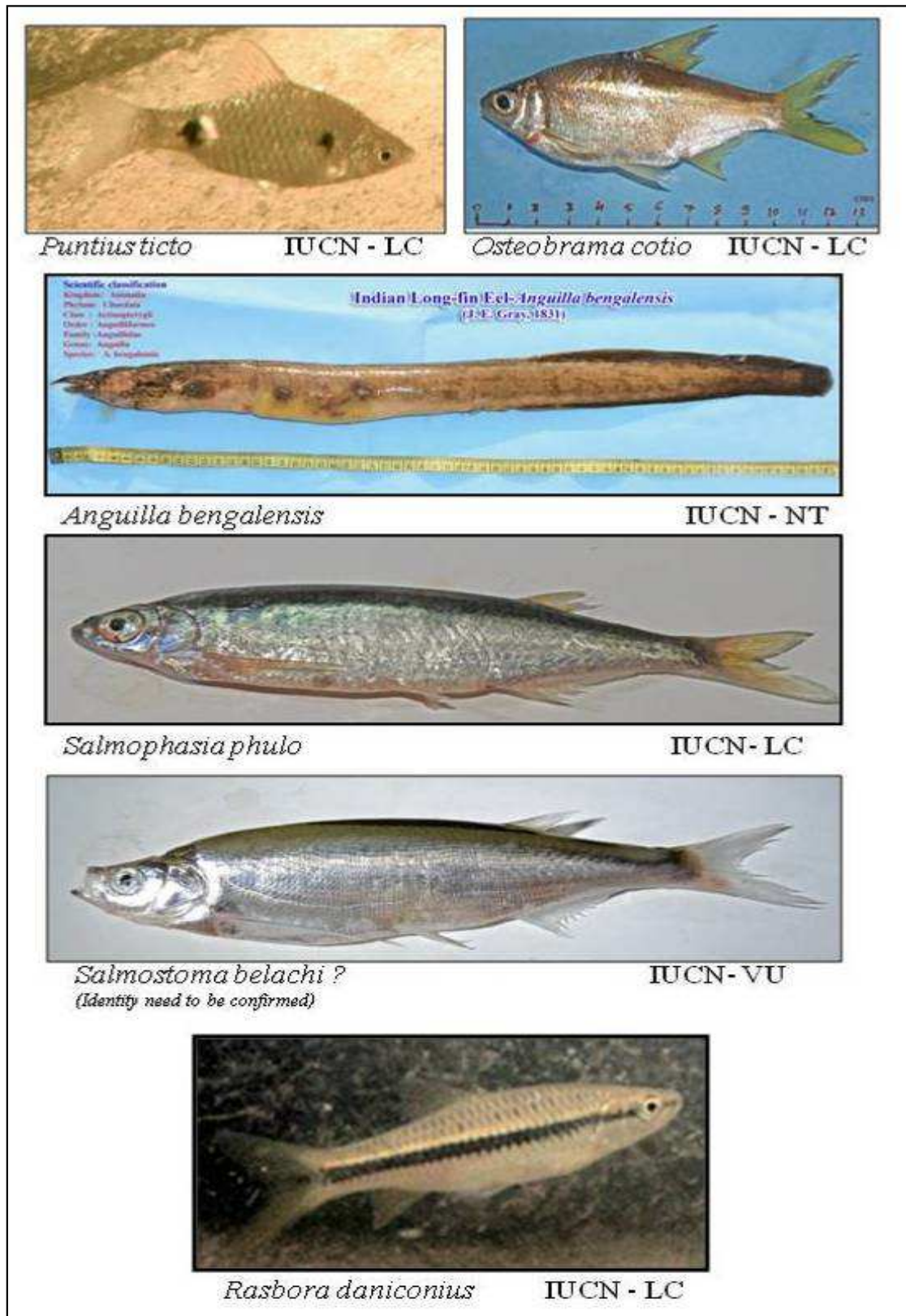


Notopterus notopterus IUCN- LC



Channa marulius

IUCN- LC



Appendix-3 Some Birds of aquatic habitat of TOCR



Purple Heron



Oriental Darter



Grey Heron



Lesser Whistling Duck



Common Coot



Small Kingfisher



Spot-billed Duck



River Tern (Juvenile)



Little Grebe



Greater Cormorants Roosting in the middle of the river



Black-winged Stilt



Black-crowned Night Heron



Little Egret



Black-headed Ibis



Blue-tailed Bee Eater



Asian Openbill



Baya Weaver



Streaked Weaver



Purple Swanphen

Appendix -4 Some mammals in and around TOCR



Indian Leopard



Smooth-coated Otter



Jungle Cat



Indian Jackal



Indian Sloth Bear



Hanuman Langur



Bonnet Macaque



Indian Porcupine



Small Indian Civet



Indian Flying Fox



Indian Palm Squirrel



Common Palm Civet



Leaf nosed Bat



Black-naped Hare



Indian Grey Mongoose

*File photos for reference, only some of them photographed during the research period.

Appendix -5

Some amphibians and other species found in TOCR area



Common Indian Tree Frog



Indian Skipper Frog



A tiny Bush Frog



Common Indian Toad



Rack Agama – Male



Fresh water crab



Rock Agama- Female

Appendix-6

Some aquatic plants of TOCR



Dwarf copperleaf - *Alternanthera sessilis*



Esthwaite Waterweed-*Hydrilla verticillata*



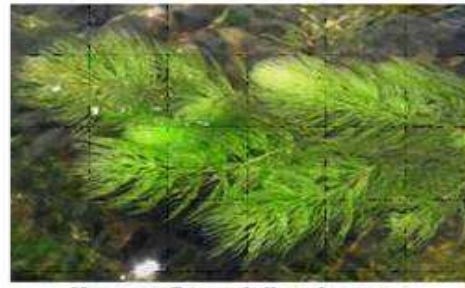
Water Lettuce - *Pistia stratioides*



Duck weed - *Lemna perpusilla*



Water silk - *Spirogyra indica*



Hornwort - *Ceratophyllum demersum*



Lesser Indian Reed Mace - *Typha angustata*



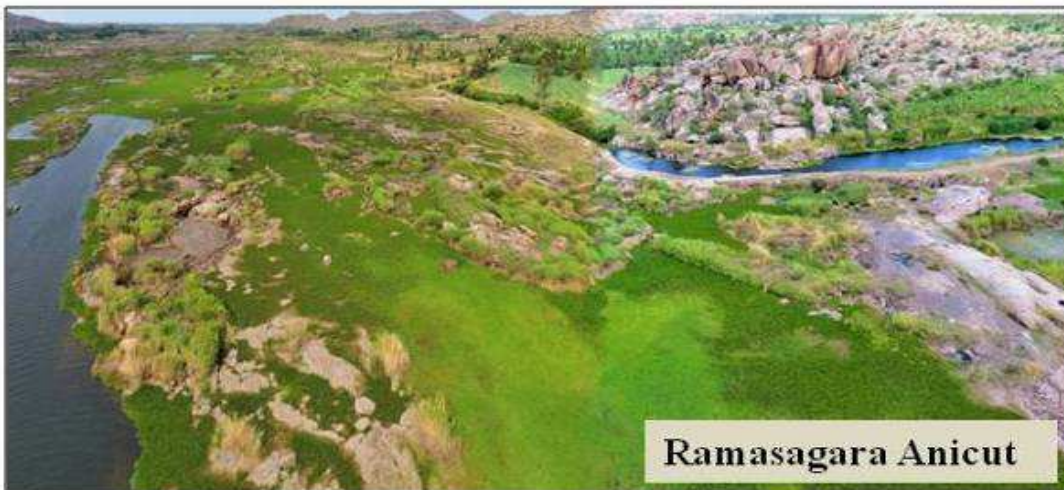
Spotted Knotweed - *Persicaria lapathifolia*



Common Sopubia - *Sopubia delphinifolia*

Appendix-7: Some aerial images of the *anicuts* in TOCR





Annexure 1: Checklist of Mammals in and around Tungabhadra Otter Conservation Reserve

S. No	Common name	Scientific name	IUCN Status	Location
1	Smooth-coated Otter	<i>Lutrogale perspicillata</i>	VU	Throughout the River
2	Indian Leopard	<i>Panthera pardus</i>	CR	Adjacent forest and islands
3	Indian Sloth Bear	<i>Melursus ursinus</i>	EN	Adjacent forest and islands
4	Striped Hyena	<i>Hyaena hyaena</i>	NT	Sanapura Forest
5	Indian Wolf	<i>Canis lupus</i>	LC	Sanapura Forest
6	Indian Jackal	<i>Canis aureus</i>	LC	Islands
7	Indian Fox	<i>Vulpes bengalensis</i>	LC	Adjacent forests
8	Eurasian Wild Pig	<i>Sus scrofa</i>	LC	Adjacent forests / Islands
9	Indian Crested Porcupine	<i>Hystrix indica</i>	LC	Adjacent forests and Islands
10	Jungle Cat	<i>Felis chaus</i>	LC	Adjacent forests and Islands
11	Rusty-spotted Cat	<i>Prionailurus rubiginosus</i>	NT	Sanapura Island
12	Small- Indian Civet	<i>Viverricula indica</i>	LC	Around River
13	Common Palm Civet	<i>Paradoxurus hermaphroditus</i>	LC	Islands
14	Common Mongoose	<i>Herpestes edwardsii</i>	LC	Around river
15	Ruddy Mongoose	<i>Herpestes smithii</i>	LC	Around river and Forest
16	Indian Pangolin	<i>Manis crassicaudata</i>	EN	Adjacent forest and Islands
17	Bonnet Macaque	<i>Macaca radiata</i>	LC	Around River
18	Hanuman Langur	<i>Semnopithecus dussumieri</i>	LC	Around River
19	Indian Black-naped Hare	<i>Lepus nigricollis</i>	LC	Around River and forests
20	Three-striped Palm Squirrel	<i>Funambulus palmarum</i>	LC	Around River and Forests

Annexure 2: Checklist of common reptiles found in and around Tungabhadra Otter Conservation Reserve

S. No.	Common name	Scientific name
Geckos and Lizards		
1	Giant Leaf-toed Gecko	<i>Hemidactylus giganteous</i>
2	Rock Gecko	<i>Pristurus rupestris</i>
3	Termite Hill Gecko	<i>Hemidactylus triedrus</i>
4	Rock Agama	<i>Psammophilus dorsalis</i>
5	Common Garden Lizard	<i>Calotes versicolor</i>
6	Forest Calotes	<i>Calotes rouxii</i>
7	Indian Chameleon	<i>Chameleo zeylanicus</i>
8	Spotted Supple Skink	<i>Lygosoma punctata</i>
9	Monitor Lizard	<i>Varanus albigularis</i>
Snakes*		
1	Spectacled Cobra	<i>Naja naja</i>
2	Red Sand Boa	<i>Eryx johnii</i>
3	Russel's Boa	<i>Gongylophis conicus</i>
4	Checkered Keelback	<i>Xenochrophis piscator</i>
5	Common Krait	<i>Bungarus caeruleus</i>
6	Indian Rock Python	<i>Python molurus</i>
7	Common Rat Snake	<i>Ptyas mucosa</i>
8	Russell's Viper	<i>Daboia russelii</i>
9	Saw-scaled Viper	<i>Echis carinatus</i>
10	Common Indian Cat Snake	<i>Boiga trigonata</i>
11	Common Wolf Snake	<i>Lycodon capicunus</i>
12	Green Vine Snake	<i>Oxybelis fulgidus</i>
13	Bronze-backed Tree Snake	<i>Dendrelaphis tristis</i>
Tortoise and Turtles		
1	Starred Tortoise	<i>Geochelone elegans</i>
2	Indian Flap Shell	<i>Lissemys Punctata</i>
3	Indian Black Turtle	<i>Melanochilys trijuga</i>
4	Leith's Soft-shell Turtle	<i>Nilssonia Leithii</i>
5	Indian Narro-headed Soft-shell Turtle	<i>Chitra indica</i>
Crocodiles		
1	Mugger Crocodile	<i>Crocodylus palustris</i>

* More number of snakes are there, need to identify.

Annexure 3: Checklist of Fish fauna of Tungabhadra River

S. No	Scientific name	Common name	Local name	IUCN Status
ORDER: I PERCIFORMES		FAMILY: 1. AMBASSIDAE		
1	<i>Chanda nama</i> (Hamilton, 1822)	Elongate glass perchlet	Bachanike meenu	LC
2	<i>Parambassis ranga</i> (Hamilton, 1822)	Indian glassy fish	Bachanike meenu	LC
		FAMILY:2 CHANNIDAE		
3	<i>Channa marulius</i> (Hamilton, 1822)	Giant snake head	Murrel/ Avlu mottu	LC
4	<i>Channa striata</i> (Bloch, 1793)	Striped snake	Kutchchu	LC
5	<i>Channa punctatus</i> (Bloch, 1793)	Bloch / snake head	Murrel	LC
		FAMILY: 3 CICHLIDAE		
6	<i>Pseudotropheus maculatus</i> (Bloch, 1795)	Orange Chromide	Eli meenu/ Harishina meenu	LC
7	<i>Oreochromis mossambica</i>	Tilapia	Jilebi meenu	NT
		FAMILY: 4 GOBIDAE		
8	<i>Glossogobius giuris</i>	Bar-eyed Gobi	Bhangi sidda	VU
		FAMILY: 5 OSPHRONEMIDAE		
9	<i>Macropodus cupanus</i> (Cuvier, 1831)	Spike-tail paradise fish	Champarke	VU
ORDER: II ANGUILLIFORMES		FAMILY: 6 ANGUILLIDAE		
10	<i>Anguilla nebulosa</i> (Mc Clelland, 1894)	Mottled eel	Havu meenu	LC
ORDER: III CYPRINODONTIFORMES		FAMILY:7 APLOCHELIDAE		
11	<i>Aplocheilichthys lineatus</i> (Valenciennes, 1840)	Golden wonder killi fish	Moogu malli	LC
ORDER: IV SILURIFORMES		FAMILY: 8 BAGRIDAE		
12	<i>Sperata seenghala</i> (Sykes, 1839)	Giant river catfish	Dodda bale meenu	LC
13	<i>Hemibagrus maydelli</i> (Rossel, 1964)	Krishna mystus	Haddu meenu	LC
14	<i>Mystus aor</i> (Hamilton, 1822)	Long whiskered cat fish	Suragi	LC
15	<i>Mystus cavasius</i> (Hamilton, 1822)	Gangetic mystus	Meese giria	LC
16	<i>Rita hastata</i> (Valenciennes, 1840)	Deccan rita	Gokra	LC
17	<i>Rita gogra</i> (Valenciennes, 1840)	Gogra rita	Arshina Goggarike	LC
		FAMILY: 9 PANGASSIDAE		
18	<i>Pangassius pangassius</i> (Hamilton, 1822)	Pangas cat fish	Polgeker / Pangas	LC
		FAMILY: 10 SCHILBEIDAE		
19	<i>Neotropius khavalchor</i> (Kulkarni, 1952)	Khavalchor cat fish	Ili meenu	DD
20	<i>Pseudeutropius goongwaree</i> (Sykes, 1839)	Indian potasi	Halathi	DD
21	<i>Pseudeutropius takree</i> (Sykes, 1839)	Indian takree	Halathi	LC
22	<i>Silonia childreni</i> (Sykes, 1839)	White catfish	Bili-halathi	EN
23	<i>Silonia silondia</i> (Hamilton, 1822)	Silond catfish	NS	LC

FAMILY: 11 SILURIDAE				
24	<i>Ompok bimaculatus</i> (Bloch, 1794)	Butter cat fish	Godli / Pabda	NT
25	<i>Ompok pabo</i> (Hamilton, 1822)	Pabo catfish	NS	NT
26	<i>Wallago attu</i> (Bloch & Schneider, 1801)	Great white sheatfish/boal	Baale meenu	NT
FAMILY: 12 SISORIDAE				
27	<i>Bagarius bagarius</i> (Hamilton, 1822)	Gangetic goonch	NS	NT
28	<i>Gagata itchekea</i> (Sykes, 1839)	Deccan nangra	Bande garlu	VU
ORDER: V CYPRINIFORMES		FAMILY: 13 BALITORIDAE		
29	<i>Homaloptera maculata</i> (Gray, 1820)	Rock carp / Loach	Kalla	LC
30	<i>Indoreonectes evezardi</i> (Day, 1872)	Ray finned fish	Murangi	LC
31	<i>Schistura semiarmata</i> (F. Day, 1867)	Dotted loach	Murangi	LC
FAMILY: 14 COBITIDAE				
32	<i>Botia striatus</i> (Narayan Rao, 1920)	Zebra / Tiger loach	Handi meenu	EN
33	<i>Lepidocephalichthys thermalis</i> (Valenciennes, 1840)	Common spiny loach	Hunase	LC
FAMILY: 15 CYPRINIDAE				
34	<i>Amblypharyngodon mola</i> (Hamilton, 1822)	Mola carplet	Enapu pakke	LC
35	<i>Cabdio morar</i> (Hamilton, 1822)	Aspidoparia	Ola halale	LC
36	<i>Barilius barila</i> (Hamilton, 1822)	Barred baril	Chalake	LC
37	<i>Barilius barna</i> (Hamilton, 1822)	Barna baril	Kere kalyani	LC
38	<i>Barilius bendelisis</i> (Hamilton, 1807)	Mirror fish	Belichi	LC
39	<i>Catla catla</i> (Hamilton, 1822)	Catla	Katla	LC
40	<i>Chela cachius</i> (Hamilton, 1822)	Silver hatchlet chela	Barle	LC
41	<i>Cirrhinus cirrhosa</i> (Bloch, 1795)	Mrigal carp	Arja	VU
42	<i>Cirrhinus fulungee</i> (Sykes, 1839)	Deccan white carp	Arja	LC
43	<i>Cirrhinus mrigal</i> (Hamilton, 1822)	Mrigal	Mriga	LC
44	<i>Cirrhinus reba</i> (Hamilton, 1822)	Reba carp	Arja	LC
45	<i>Ctenopharyngodon idella</i> (Valenciennes, 1844)	Grass carp	Hullu gende	NE
46	<i>Cyprinus carpio carpio</i> (Linnaeus, 1758)	Wild common carp	Samanya gende	VU
47	<i>Danio aequipinnatus</i> (Mc Clelland, 1839)	Giant danio	Bidirele	DD
48	<i>Esomus danrica</i> (Hamilton, 1822)	Flying barb	Meese pakke	LC
49	<i>Garra bicornuta</i> (Narayan Rao, 1920)	Tunga garra	Mukudigya	NT
50	<i>Garra fuliginosa</i> (Fowler, 1934)	Single horn Garra	Mukudi	LC
51	<i>Labeo bata</i> (Hamilton, 1822)	Minor carp/ blackline	Kolchu meenu	LC
52	<i>Labeo boga</i> (Hamilton, 1822)	Boga labeo	NS	LC
53	<i>Labeo boggut</i> (Sykes, 1839)	Boggut labeo	Gubbali	LC
54	<i>Labeo calbasu</i> (Hamilton, 1822)	Karnataka labeo	Kage	LC

55	<i>Labeo fimbriatus</i> (Bloch, 1795)	Fringe-lipped peninsula carp	Kemmeenu	LC
56	<i>Labeo kontius</i> (Jordon, 1849)	Pigmouth carp	Moogi halale	LC
57	<i>Labeo pangusia</i> (Hamilton, 1822)	Pangusia labeo	Pangus	NT
58	<i>Labeo porcellus</i> (Haeckel, 1844)	Bombay labeo	Kaki dindu	LC
59	<i>Labeo potail</i> (Sykes, 1839)	Deccan labeo	Argaleo mosu	EN
60	<i>Labeo rohita</i> (Hamilton, 1822)	Rohu	Rohu	LC
61	<i>Osteobrama belangeri</i> (Valenciennes, 1844)	Manipur osteobrama	Kambagi	NT
62	<i>Osteobrama cotio</i> (Hamilton, 1822)	Ray finned fish	NS	LC
63	<i>Osteobrama neilli</i> (Day, 1873)	Nilgiri	Koona	LC
64	<i>Osteobrama vigorsii</i> (Sykes, 1839)	Godawari osteobrama	Koera / Parake	LC
65	<i>Osteochilus nashii</i> (Day, 1869)	Konti barb	Kantaka / Bagasi	LC
66	<i>Oxygaster clupeoides</i> (Bloch, 1795)	Razor belly minnow	NS	LC
67	<i>Puntius amphibius</i> (Valenciennes, 1842)	Scarlet banded barb	Pakke meenu	DD
68	<i>Puntius carnaticus</i> (Jordon, 1849)	Carnatic carp	Machalu	LC
69	<i>Puntius chola</i> (Hamilton, 1822)	Chola barb	Dodda karse	LC
70	<i>Hypselobarbus dobsoni</i> (Day, 1876)	Krishna carp	Say meenu	DD
71	<i>Puntius dorsalis</i> (Jordon, 1849)	Long snouted barb	Mooti gende	LC
72	<i>Hypselobarbus kolus</i> (Sykes, 1839)	Kolus	Kolsu	VU
73	<i>Puntius narayani</i> (Hora, 1937)	Narayan barb	Narayani / pakke	LC
74	<i>Puntius bimaculatus</i> (Bleeker, 1863)	Long snout bard	Pakke	LC
75	<i>Hypselobarbus pulchellus</i> (Day, 1870)	Ray -finned Fish	Harigi / Saymeen	CR
76	<i>Puntius sarana</i> (Hamilton, 1822)	Olive barb	Did pakke / gende	LC
77	<i>Puntius sophore</i> (Hamilton, 1822)	Spot fin swamp barb	Gude pakke	LC
78	<i>Puntius ticto</i> (Hamilton, 1822)	Ticto barb	Bud pakke/naya pais	LC
79	<i>Rasbora daniconius</i> (Hamilton, 1822)	Slender / blackline barb	Golai	LC
80	<i>Rohtee ogilbii</i> (Sykes, 1839)	Vatani rohtee	Batte garra / Bipsi	LC
81	<i>Salmophasia phulo</i> (Hamilton, 1822)	Fine scale minnow	Malli meenu	LC
82	<i>Schismatorhynchus nukta</i> (Sykes, 1839)	Moray/double mouth tor	Mukarthi	LC
83	<i>Thynnichthys sandkhol</i> (Sykes, 1839)	Sandkhol carp	Banga	EN
84	<i>Tor khudree</i> (Sykes, 1839)	Deccan / black Mahseer	Kaage meenu	EN
85	<i>Tor mussullah</i> (Sykes, 1839)	Hump back mahseer	NS	EN
ORDER: VI BELONIFORMES		FAMILY: 16 BELONIDAE		
86	<i>Xenentodon cancila</i> (Hamilton, 1822)	Needle nose fish	Sooji meenu	LC
FAMILY: 17 HEMIRAMPHIDAE				
87	<i>Hyporhamphus limbatus</i>	Congaturi halfbeak	Sanna suji meenu	LC
ORDER: VII SYNBRANCHIFORMES		FAMILY: 18 MASTACEMBELLIDAE		

88	<i>Mastacembelus armatus</i> (Lacepede, 1800)	Spiny eel	Haavu meenu	LC
89	<i>Macrogathus pancalus</i> (Hamilton, 1822)	Striped spiny eel	Haavu meenu	LC
ORDER: VIII. OSTEOGLOSSIFORMES		FAMILY: 19 NOTOPTERIDAE		
90*	<i>Notopterus notopterus</i> (Pallas, 1769)	Bronze feather back	Chappali meenu	LC
(CR -Critically Endangered, EN-Endangered, VU-Vulnerable, NT-Near Threatened, LC-Least Concern, DD-Data deficient, NE = Not Evaluated) . NS = No specific name)				

* Around 120 species of Piscifauna is there, need to explore in detailed survey.

Annexure 4: Checklist of Birds in and around Tungabhadra Otter Conservation Reserve

S. No	Common Name	Scientific Name	Frequency	Residential Status	IUCN Status
Order: 1. Podicipediformes					
Family: 1. Podicipedidae					
1	Little Grebe	<i>Tachybaptus ruficollis</i>	Common	Resident	LC
Order: 2. Pelecaniformes					
Family:2. Anhingidae					
2	Oriental Darter	<i>Anhinga melanogaster</i>	Uncommon	Seasonal	NT
Family:3. Phalacrocoracidae					
3	Little Cormorant	<i>Phalacrocorax niger</i>	Common	Resident	LC
4	Great Cormorant	<i>Phalacrocorax carbo</i>	Rare	Seasonal	LC
5	Indian Cormorant	<i>Phalacrocorax fuscicollis</i>	Very Rare	Seasonal	LC
Family:4. Ardeidae					
6	Grey Heron	<i>Ardea cinerea</i>	Common	Resident	LC
7	Purple Heron	<i>Ardea purpurea</i>	Common	Resident	LC
8	Green-backed Heron	<i>Butorides striata</i>	Rare	Resident	LC
9	Indian Pond Heron	<i>Ardeola grayii</i>	Common	Resident	LC
10	Cattle Egret	<i>Bubulcus ibis</i>	Common	Resident	LC
11	Little Egret	<i>Egretta garzetta</i>	Common	Resident	LC
12	Intermediate Egret	<i>Mesophoyx intermedia</i>	Common	Resident	LC
13	Eastern Great Egret	<i>Ardea alba modesta</i>	Common	Resident	LC
14	Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	Uncommon	Resident	LC
15	Cinnamon Bittern	<i>Ixobrychus cinnamomeus</i>	Rare	Resident	LC
16	Black Bittern	<i>Dupetor flavicollis</i>	Rare	Resident	LC
17	Yellow Bittern	<i>Ixobrychus sinensis</i>	Rare	Summer Migratory	LC
Order: 3. Ciconiiformes					
Family: 5.Ciconiidae					
18	Painted Stork	<i>Mycteria leucocephala</i>	Uncommon	Seasonal	NT
19	Asian Openbill	<i>Anastomus oscitans</i>	Uncommon	Seasonal	LC
20	Woolly-necked Stork	<i>Ciconia episcopus</i>	Uncommon	Seasonal	VU
21	Lesser Adjutant	<i>Leptoptilos javanicus</i>	Very Rare	Seasonal	VU
22	Black-headed Ibis	<i>Threskiornis melanocephalus</i>	Common	Resident	NT
23	Red-naped Ibis	<i>Pseudibis papillosa</i>	Common	Resident	LC
24	Glossy Ibis	<i>Plegadis falcinellus</i>	Common	Resident	LC
25	Eurasian Spoonbill	<i>Platalea leucorodia</i>	Uncommon	Seasonal	LC
Order: 4. Anseriformes					

Family: 6. Anatidae					
26	Lesser Whistling-duck	<i>Dendrocygna javanica</i>	Uncommon	Resident	LC
27	Knob-billed Duck	<i>Sarkidiornis melanotos</i>	Common	Resident	LC
28	Indian Spot-billed Duck	<i>Anas poecilorhyncha</i>	Common	Resident	LC
Order: 5. Accipitriformes					
Family: 7. Accipitridae					
29	Oriental Honey-buzzard	<i>Pernis ptilorhyncus</i>	Uncommon	Seasonal	LC
30	Black-winged Kite	<i>Elanus caeruleus</i>	Common	Resident	LC
31	Black Kite	<i>Milvus migrans</i>	Common	Resident	LC
32	Brahminy Kite	<i>Haliastur indus</i>	Common	Resident	LC
33	Short-toed Snake Eagle	<i>Circaetus gallicus</i>	Common	Resident	LC
34	Western Marsh-harrier	<i>Circus aeruginosus</i>	Common	Winter Migratory	LC
35	Shikra	<i>Accipiter badius</i>	Common	Resident	LC
36	White-eyed Buzzard	<i>Butastur teesa</i>	Uncommon	Resident	LC
Order: 6. Falconiformes					
Family: 8. Falconidae					
37	Common Kestrel	<i>Falco tinnunculus</i>	Uncommon	Winter Migratory	LC
Order: 7. Galliformes					
Family: 9. Phasianidae					
38	Grey Francolin	<i>Francolinus pondicerianus</i>	Common	Resident	LC
39	Jungle Bush Quail	<i>Perdica asiatica</i>	Common	Resident	LC
40	Indian Peafowl	<i>Pavo cristatus</i>	Common	Resident	LC
41	Painted Spurfowl	<i>Galloperdix lunulata</i>	Rare	Resident	LC
Order: 8. Turniciformes					
Family: 10. Turnicidae					
42	Barred Buttonquail	<i>Turnix suscitator</i>	Common	Resident	LC
Order: 9. Gruiformes					
Family: 11. Rallidae					
43	Brown Crake	<i>Amauornis akool</i>	Uncommon	Resident	LC
44	Ruddy-breasted Crake	<i>Porzana fusca</i>	Uncommon	Resident	LC
45	White-breasted Waterhen	<i>Amauornis phoenicurus</i>	Common	Resident	LC
46	Purple Swampphen	<i>Porphyrio porphyrio</i>	Common	Resident	LC
47	Common Moorhen	<i>Gallinula chloropus</i>	Common	Resident	LC
48	Common Coot	<i>Fulica atra</i>	Common	Resident	LC
Order: 10. Charadriiformes					
Family: 12. Charadriidae					
49	Little Ringed Plover	<i>Charadrius dubius</i>	Uncommon	Resident	LC

50	Kentish plover	<i>Charadrius alexandrinus</i>	Uncommon	Resident	LC
51	Yellow-wattled Lapwing	<i>Vanellus malabaricus</i>	Common	Resident	LC
52	Red-wattled Lapwing	<i>Vanellus indicus</i>	Common	Resident	LC
Family: 13. Scolopacidae					
53	Common Sandpiper	<i>Actitis hypoleucos</i>	Uncommon	Winter Migratory	LC
54	Wood Sandpiper	<i>Tringa glareola</i>	Uncommon	Winter Migratory	LC
55	Common Green shank	<i>Tringa nebularia</i>	Uncommon	Winter Migratory	LC
56	Common Redshank	<i>Tringa totanus</i>	Uncommon	Winter Migratory	LC
57	Pin-tailed Snipe	<i>Gallinago stenura</i>	Uncommon	Winter Migratory	LC
Family: 14. Recurvirostridae					
58	Black-winged Stilt	<i>Himantopus himantopus</i>	Uncommon	Resident	LC
Family: 15. Sternidae					
59	River Tern	<i>Sterna aurantia</i>	Common	Resident	NT
60	Whiskered Tern	<i>Chlidonias hybrida</i>	Common	Winter Migratory	LC
Order: 11. Columbiformes					
Family: 16. Columbidae					
61	Laughing Dove	<i>Streptopelia senegalensis</i>	Common	Resident	LC
62	Eurasian Collared Dove	<i>Streptopelia decaocto</i>	Common	Resident	LC
63	Red Turtle Dove	<i>Streptopelia tranquebarica</i>	Uncommon	Resident	LC
64	Spotted Dove	<i>Streptopelia chinensis</i>	Uncommon	Resident	LC
Order: 12. Psittaciformes					
Family: 17. Psittaculidae					
65	Plum-headed Parakeet	<i>Psittacula cyanocephala</i>	Uncommon	Resident	LC
66	Rose-ringed Parakeet	<i>Psittacula krameri</i>	Common	Resident	LC
Order: 13. Cuculiformes					
Family: 18. Cuculidae					
67	Blue-faced Malkoha	<i>Phaenicophaeus viridirostris</i>	Uncommon	Resident	LC
68	Sirkeer Malkoha	<i>Taccocua leschenaultii</i>	Uncommon	Resident	LC
69	Jacobin Cuckoo	<i>Clamator jacobinus</i>	Common	Monsoon Migratory	LC
70	Common Hawk-Cuckoo	<i>Hierococcyx varius</i>	Common	Resident	LC
71	Asian Koel	<i>Eudynamys scolopacea</i>	Common	Resident	LC
72	Greater Coucal	<i>Centropus sinensis</i>	Common	Resident	LC
Order: 14. Strigiformes					
Family: 19. Strigidae					
73	Indian Eagle Owl	<i>Bubo bengalensis</i>	Uncommon	Resident	LC
74	Spotted Owlet	<i>Athene brama</i>	Common	Resident	LC
Order: 15. Caprimulgiformes					

Family: 20. Caprimulgidae					
75	Jungle Nightjar	<i>Caprimulgus indicus</i>	Common	Resident	LC
Order: 16. Apodiformes					
Family: 21. Apodidae					
76	Asian Palm Swift	<i>Cypsiurus balasiensis</i>	Common	Resident	LC
Order: 17. Coraciiformes					
Family: 22. Alcedinidae					
77	Common Kingfisher	<i>Alcedo atthis</i>	Common	Resident	LC
Family: 23. Halcyonidae					
78	White-throated Kingfisher	<i>Halcyon smyrnensis</i>	Common	Resident	LC
Family: 24. Cerylidae					
79	Pied Kingfisher	<i>Ceryle rudis</i>	Common	Resident	LC
Family: 25. Meropidae					
80	Asian Green Bee-eater	<i>Merops orientalis</i>	Common	Resident	LC
81	Blue-tailed Bee-eater	<i>Merops philippinus</i>	Uncommon	Seasonal	LC
Family: 26. Coraciidae					
82	Indian Roller	<i>Coracias benghalensis</i>	Common	Resident	LC
Order: 18. Bucerotiformes					
Family: 27. Upupidae					
83	Hoopoe	<i>Upupa epops</i>	Common	Resident	LC
Family: 28. Bucerotidae					
84	Indian Grey Hornbill	<i>Ocyrceros birostris</i>	Common	Resident	LC
Order: 19. Piciformes					
Family: 29. Megalaimidae					
85	Coppersmith Barbet	<i>Megalaima haemacephala</i>	Common	Resident	LC
Family: 30. Picidae					
86	Brown-capped Pygmy Woodpecker	<i>Dendrocopos nanus</i>	Common	Resident	LC
87	Black-rumped Flameback	<i>Dinopium benghalense</i>	Common	Resident	LC
Order: 20. Passeriformes					
Family: 31. Alaudidae					
88	Singing bush Lark	<i>Mirafra cantillans</i>	Common	Resident	LC
89	Indian bush Lark	<i>Mirafra erythroptera</i>	Common	Resident	LC
90	Ashy-crowned Sparrow-lark	<i>Eremopterix grisea</i>	Common	Resident	LC
91	Rufous-tailed Lark	<i>Ammomanes phoenicura</i>	Common	Resident	LC
92	Sykes's Lark	<i>Galerida deva</i>	Common	Resident	LC
Family: 32. Hirundinidae					
93	Barn Swallow	<i>Hirundo rustica</i>	Common	Winter Migratory	LC

94	Wire-tailed Swallow	<i>Hirundo smithii</i>	Common	Resident	LC
95	Red-rumped Swallow	<i>Hirundo daurica</i>	Common	Resident	LC
96	Streak-throated Swallow	<i>Hirundo fluvicola</i>	Common	Resident	LC
Family: 33. Motacillidae					
97	White Wagtail	<i>Motacilla alba</i>	Common	Winter migratory	LC
98	White-browed Wagtail	<i>Motacilla maderaspatensis</i>	Common	Resident	LC
99	Grey Wagtail	<i>Motacilla cinerea</i>	Common	Winter migratory	LC
100	Yellow Wagtail	<i>Motacilla flava</i>	Common	Winter migratory	LC
101	Paddyfield Pipit	<i>Anthus rufulus</i>	Common	Resident	LC
Family: 34. Campephagidae					
102	Black-headed Cuckooshrike	<i>Lalage melanoptera</i>	Common	Resident	LC
103	Small Minivet	<i>Pericrocotus cinnamomeus</i>	Common	Resident	LC
Family: 35. Pycnonotidae					
104	Red-vented Bulbul	<i>Pycnonotus cafer</i>	Common	Resident	LC
105	White-browed Bulbul	<i>Pycnonotus luteolus</i>	Common	Resident	LC
106	Yellow-throated Bulbul	<i>Pycnonotus xantholaemus</i>	Rare	Resident	VU
Family: 36. Aegithinidae					
107	Common Iora	<i>Aegithina tiphia</i>	Common	Resident	LC
Family: 37. Laniidae					
108	Brown Shrike	<i>Lanius cristatus</i>	Common	Resident	LC
109	Bay-backed Shrike	<i>Lanius vittatus</i>	Common	Resident	LC
110	Long-tailed Shrike	<i>Lanius schach</i>	Common	Resident	LC
111	Southern grey Shrike	<i>Lanius meridionalis</i>	Common	Resident	LC
Family: 38. Muscicapidae					
112	Oriental Magpie-robin	<i>Copsychus saularis</i>	Common	Resident	LC
113	Indian Robin	<i>Saxicoloides fulicatus</i>	Common	Resident	LC
114	Black Redstart	<i>Copsychus saularis</i>	Common	Winter Migratory	LC
115	Common Stonechat	<i>Saxicola torquatus</i>	Common	Winter Migratory	LC
116	Blue Rock-thrush	<i>Monticola solitarius</i>	Uncommon	Winter Migratory	LC
117	Pied Bushchat	<i>Saxicola caprae</i>	Common	Resident	LC
Family: 39. Timaliidae					
118	Tawny-bellied Babbler	<i>Dumetia hyperythra</i>	Uncommon	Resident	LC
Family: 40. Sylviidae					
119	Yellow-eyed Babbler	<i>Chrysomma sinense</i>	Uncommon	Resident	LC
Family: 41. Leiothrichidae					
120	Common Babbler	<i>Argya caudata</i>	Uncommon	Resident	LC

121	Large grey Babbler	<i>Argya malcolmi</i>	Common	Resident	LC
122	Jungle Babbler	<i>Turdoides striata</i>	Common	Resident	LC
123	Yellow-billed Babbler	<i>Turdoides affinis</i>	Common	Resident	LC
Family: 42. Cisticolidae					
124	Zitting cisticola	<i>Cisticola juncidis</i>	Common	Resident	LC
125	Rufous-fronted Prinia	<i>Prinia buchanani</i>	Common	Resident	LC
126	Grey-breasted Prinia	<i>Prinia hodgsonii</i>	Common	Resident	LC
127	Jungle Prinia	<i>Prinia sylvatica</i>	Common	Resident	LC
128	Ashy Prinia	<i>Prinia socialis</i>	Common	Resident	LC
129	Plain Prinia	<i>Prinia inornata</i>	Common	Resident	LC
130	Common Tailorbird	<i>Orthotomus sutorius</i>	Common	Resident	LC
Family: 43. Acrocephalidae					
131	Clamorous Reed-Warbler	<i>Acrocephalus stentoreus</i>	Common	Winter Migratory	LC
132	Blyth's Reed-warbler	<i>Acrocephalus dumetorum</i>	Common	Winter Migratory	LC
Family: 44. Phylloscopidae					
133	Greenish Warbler	<i>Phylloscopus trochiloides</i>	Common	Winter Migratory	LC
Family: 45. Muscicapidae					
134	Asian brown Flycatcher	<i>Muscicapa dauurica</i>	Common	Resident	LC
Family: 46. Paridae					
135	Great Tit	<i>Parus major</i>	Common	Resident	LC
Family: 47. Dicaeidae					
136	Thick-billed Flowerpecker	<i>Dicaeum agile</i>	Common	Resident	LC
137	Pale-billed Flowerpecker	<i>Dicaeum concolor</i>	Common	Resident	LC
Family: 48. Nectariniidae					
138	Purple-rumped Sunbird	<i>Leptocoma zeylonica</i>	Common	Resident	LC
139	Purple sunbird	<i>Cinnyris asiaticus</i>	Common	Resident	LC
Family: 49. Ploceidae					
140	Red Avadavat	<i>Amandava amandava</i>	Common	Resident	LC
141	Indian Silverbill	<i>Euodice malabarica</i>	Common	Resident	LC
142	Scaly-breasted Munia	<i>Lonchura punctulata</i>	Common	Resident	LC
143	Tricoloured Munia	<i>Lonchura malacca</i>	Common	Resident	LC
Family: 50. Passeridae					
144	House Sparrow	<i>Passer domesticus</i>	Common	Resident	LC
Family: 51. Ploceidae					
145	Baya Weaver	<i>Ploceus philippinus</i>	Common	Resident	LC
146	Streaked Weaver	<i>Ploceus manyar</i>	Common	Resident	LC
Family: 52. Sturnidae					LC

147	Common Myna	<i>Acridotheres tristis</i>	Common	Resident	
148	Brahminy Starling	<i>Sturnia pagodarum</i>	Common	Resident	LC
149	Rosy Starling	<i>Pastor roseus</i>	Common	Winter Migratory	LC
150	Chestnut-tailed Starling	<i>Sturnia malabarica</i>	Common	Winter Migratory	LC
Family: 53. Oriolidae					
151	Indian golden Oriole	<i>Oriolus kundoo</i>	Common	Resident	LC
Family: 54. Dicruridae					
152	Black Drongo	<i>Dicrurus macrocercus</i>	Common	Resident	
Family: 55. Corvidae					
153	House Crow	<i>Corvus splendens</i>	Common	Resident	LC
154	Indian jungle Crow	<i>Corvus macrorhynchos culminatus</i>	Common	Resident	LC
Family: 56. Emberizidae					
155	Black-headed Bunting	<i>Emberiza melanocephala</i>	Common	Winter Migratory	LC
156	Red-headed Bunting	<i>Emberiza bruniceps</i>	Common	Winter Migratory	LC
* More species are to be explored in detailed yearlong survey.					

Annexure 5: Checklist of common aquatic flora / Macrophytes of TOCR

S. No.	Common name	Botanical name	Family	Life Forms	IUCN status
1	Floating lace plant	<i>Aponogeton natans</i>	Aponogetonaceae	Submerged	LC
2	Common stonewort	<i>Chara sps</i>	Characeae	Submerged	NE
3	Hornwort	<i>Ceratophyllum demersum</i>	Ceratophyllaceae	Submerged	LC
4	Esthwaite Waterweed	<i>Hydrilla verticillata</i>	Hydrocharitaceae	Submerged	LC
5	Guppy Grass	<i>Najas indica</i>	Hydrocharitaceae	Submerged	LC
6	Fennel Pondweed	<i>Potamogeton pectinatus</i>	Potamogetonaceae	Submerged	LC
7	Tape grass/ Eel grass	<i>Vallisneria spiralis</i>	Hydrocharitaceae	Submerged	LC
8	Water Shamrock	<i>Marsilea quadrifolia</i>	Marsileaceae	Partly Submerged	LC
9	Duck-lettuce,	<i>Ottelia alismoides</i> ,	Hydrocharitaceae	Partly submerged	LC
10	Dwarf copperleaf	<i>Alternanthera sessilis</i>	Amaranthaceae	Emergent	LC
11	Blistering ammania	<i>Ammania baccifera</i>	Lythraceae	Emergent	LC
12	India joint-vetch	<i>Aeschonemene indica</i>	Fabaceae	Emergent	LC
13	Water Hyssop	<i>Bacopa monnieri</i>	Scrophulariaceae	Emergent	LC
14	Aquatic Job's tears	<i>Coix aquatica</i>	Poaceae	Emergent	NE
15	Bengal day flower	<i>Commelina benghalensis</i>	Commelinaceae	Emergent	LC
16	Carolina day flower	<i>Commelina hasskarlii</i>	Commelinaceae	Emergent	LC
17	Nut grass	<i>Cyperus rotundus</i>	Cyperaceae	Emergent	LC
18	Bermuda grass	<i>Cynodon dactylon</i>	Poaceae	Emergent	LC
19	Purple bane	<i>Cyathocline purpurea</i>	Asteraceae	Emergent	LC
20	Suryavarthi	<i>Crozophora rotlerii</i>	Euphorbiaceae	Emergent	LC
21	Rushlike dopatrium	<i>Dopatrium junecum</i>	Scrophulariaceae	Emergent	LC
22	Canada spikesedge	<i>Elaeocharis geniculata</i>	Cyperaceae	Emergent	LC
23	Spike-rush	<i>Elaeocharis capitata</i>	Cyperaceae	Emergent	LC
24	Pipewort	<i>Eriocaulon cinereum</i>	Eriocaulaceae	Emergent	NE
25	Wild grass	<i>Echinochloa calorum</i>	Poaceae	Emergent	LC
26	Gomphrena weed	<i>Gomphrena celosioides</i>	Amaranthaceae	Emergent	NE
27	Lotus Sweet juice	<i>Glinus lotoides</i>	Molluginaceae	Emergent	NE
28	Pinyuin	<i>Gnaphalium pulvinatum</i>	Asteraceae	Emergent	NE
29	Dwarf heliotrope	<i>Heliotropium supinum</i>	Boraginaceae	Emergent	LC
30	Asian Marshweed	<i>Limnophylla sessiflora</i>	Plantaginaceae	Emergent	LC
31	Marsh buckwheat	<i>Polygonum glabrum</i>	Polygonaceae	Emergent	NE
32	Turkey Tangle frogfruit	<i>Phyla nodiflora</i>	Verbinaceae	Emergent	LC
33	Rotala	<i>Rotala serpillifolia</i>	Lythraceae	Emergent	LC
34	Sesbania pea	<i>Sesbania bispinosa</i>	Fabaceae	Emergent	LC

35	East Indian Globe Thistle	<i>Sphaeranthus indicus</i>	Asteraceae	Emergent	LC
36	Reed Mace/Aapu	<i>Typha angustata</i>	Typhaceae	Emergent	NE
37	Water hyacinth	<i>Eichornia crassipes</i>	Pontederiaceae	Free floating	NE
38	Duck weed	<i>Lemna perpusilla</i>	Lemnaceae	Free floating	LC
49	Water Lettuce	<i>Pistia stratioides</i>	Araceae	Free floating	LC
40	Floating Crystalwort	<i>Riccia fluitans</i>	Ricciaceae	Free floating	NE
41	Water Spinach	<i>Ipomoea aquatica</i>	Convolvulaceae	Rooted floating	LC
42	Water silk	<i>Spirogyra indica</i>	<u>Zygnemataceae</u>	Rooted floating	LC
43	Duck Lettuce	<i>Ottellia alismoides</i>	Hydrocharitaceae	Rooted floating	LC
44	False daisy/Bhringraj	<i>Eclipta abla</i>	Asteraceae	Bank edges	LC
45	Lesser Fimbristylis	<i>Fimbristylis milliacea</i>	Cyperaceae	Bank edges	LC
46	Madras carpet	<i>Grangea maderaspatana</i>	Asteraceae	Bank edges	LC
47	Pink morning glory	<i>Ipomoea carnea</i>	Convolvulaceae	Bank edges	NE
48	Swamp shield-fern	<i>Cyclosorus interruptus</i>	<u>Polypodiales</u>	Bank edges	LC
49	Chinese Mullein	<i>Verbascum chinense</i>	Scrophulariaceae	Bank Edge	LC
50	Common Sopubia	<i>Sopubia delphinifolia</i>	Scrophulariaceae	Bank edge	VU

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