

Conservation recovery of *Batagur kachuga* and *Batagur dhongoka* turtles in India: Development and operation of a head-starting facility

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ABSTRACT - In 2006, a long-term conservation project was initiated for the recovery of endangered turtles *Batagur kachuga* and *Batagur dhongoka* along the lower Chambal river. This is based on the collection of eggs from the wild, incubation in a riverside hatchery, and then for most hatchlings release back into the wild within 24 hours of hatching. A sub-set of these hatchlings are reared at the Turtle Conservation Centre, in a specially designed head-starting facility until they weigh up to 1 kg, before release into the wild. A detailed description is given of the design, development and operation of the head-starting facility. Up to 2020, the project had successfully head-started 786 *B. kachuga* and 66 *B. dhongoka*. Moreover, this head-starting facility has supplied two conservation colonies, consisting of 50 subadult *B. kachuga* within the species' historical range, Kukrail Gharial Rehabilitation Centre and Kanpur Zoological Park, both under the aegis of the Uttar Pradesh Forest Department. The long-term aim of the project is to restore *B. kachuga* to its former range.

INTRODUCTION

The Chambal River, within the National Chambal Sanctuary (NCS), holds the last known wild population of red-crowned roofed turtles *Batagur kachuga* (Fig. 1) and possibly the most viable wild population of the three-striped roofed turtle *Batagur dhongoka*, both Critically Endangered species. The drastic decline in the population of *Batagur* spp called for immediate recovery options for these two important turtles of the Gangetic plain. Following the recommendations of the 'Conservation Action Plan for Endangered Freshwater Turtles and Tortoises of India' (CFH/MCBT, 2006), recovery efforts were initiated in 2006 with a specific goal of raising juvenile survivorship through nest protection, hatch-and-release at riverside hatcheries, and a head-starting initiative at a nearby facility for future conservation and research initiatives.

A total of 0.35 acres of land within the protected area limits of the NCS, along the lower stretch of the Chambal River and vegetated with Mexican mesquite *Prosopis juliflora*, was procured for the development of the rearing facility and complimentary structures to support project activities (Fig. 2). The existing nursery facilitated the rearing-and-release of, on average, 100 hatchlings every year between 2006–2010. However, a larger facility was required to rear juvenile *B. kachuga* until they attained a weight of up to 1 kg, so that various size classes could be supplemented. Moreover, some of the individuals were used to develop conservation colonies within the distribution range of the species. This article focuses on our experiences of developing the field based retention and rearing facilities.



Figure 1. Adult female red-crowned roofed turtle *Batagur kachuga* from the lower Chambal river which supports the last known population of this species

MATERIALS & METHODS

Riverside Turtle Hatcheries

Between February to May every year, there is a *Batagur* nest protection programme. In 14 nesting seasons (2006 through 2020), the programme has successfully protected over 6,500 vulnerable nests of *B. kachuga* and *B. dhongoka*. All nests were translocated, as per appropriate procedures (Başkale & Kaska, 2005), and incubated in riverside hatcheries along the Chambal River. Methods were refined every year with the experiences gained from this project. At the hatchery,

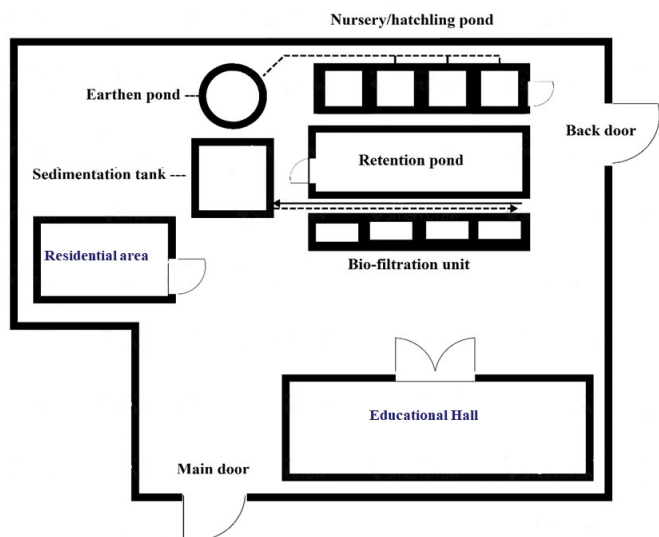


Figure 2. A diagram showing the final design of the ponds and facilities of the Turtle Conservation Centre (TCC) used for the head-starting programme, near Garhaita village, National Chambal Sanctuary, Uttar Pradesh



Figure 3. Hair-pin shaped hatchling nursery, this is the initial design which was superseded by the four separate tanks

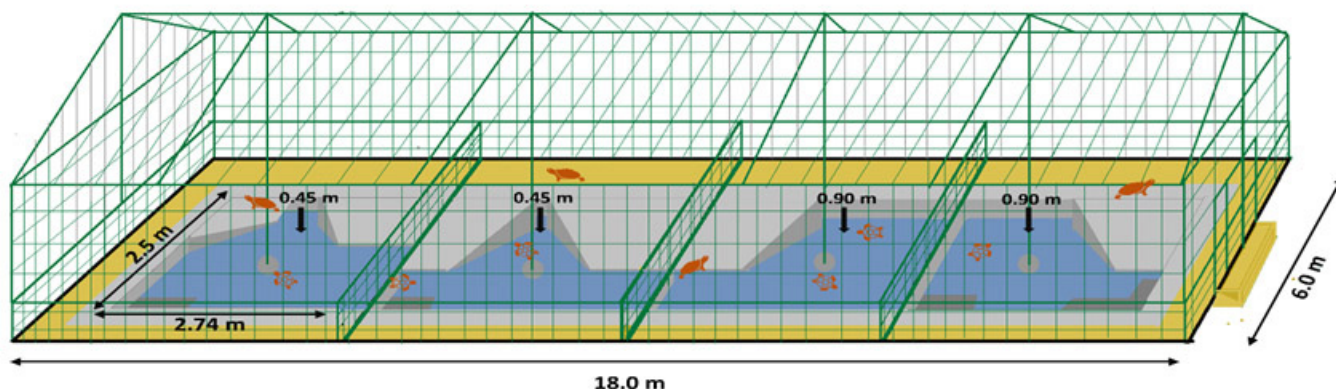


Figure 4. The improved hatchling nursery of four separate tanks with a margin of sand (in yellow) provided as a basking/burrowing area

clutches are incubated in holes excavated 1 m apart and buried at the same depth and placed in the same orientation as recorded for each wild nest. The incubation temperature in these outdoor hatcheries simply follows ambient conditions. Over 120,000 hatchlings have been released at the precise location of nest collection in the Chambal River. The majority of these hatchlings are released within 24 hours of hatching. After hatching, a subset of 50–100 *B. kachuga* hatchlings are moved to the head-starting facility of the Turtle Conservation Centre (TCC) (Fig. 1) for the short term (1–2 years) head-starting programme. In early years (2006–2007) an additional set of 100 hatchlings of *B. dhongoka* were head-started at the facility.

Head Starting Facilities

On arrival at head-starting facility the hatchlings are placed in the hatchling nursery.

Hatchling nursery

The first hatchling nursery developed in 2006 was hairpin-shaped (Fig. 3) but in 2009 this was reconstructed as four

traditional square tanks as it had been challenging to maintain the turtle cohort in the former structure due to its shape. A set of four tanks was developed within the enclosure with a surrounding strip filled with river sand (Fig. 4). All four tanks were constructed in a row with a single service entrance. Two of the tanks (2.5 m long x 2.7 m wide x 0.9 m deep) closest to the service access have a capacity of ~6.7 m³ of water and are used for the retention of a maximum of 50 hatchlings (7.5 hatchlings/m³) for two months. The other two tanks (2.5 m long x 2.7 m wide x 0.45 m deep) with a capacity of ~3.3 m³ are used to isolate weak turtles, holding a maximum of 30 turtles each (9 hatchlings/m³). All tanks are separated from each other using iron mesh (1.25 cm x 1.25 cm) frames to avoid mixing of hatchlings. The sand-filled areas (2.5 m x 1 m) by the tanks are used for basking/burrowing and access to them from the water is by mounting a stairway (Fig. 5) which itself allows turtles to rest at different levels in the water. In the initial year of the project, the hatchlings were observed burrowing in the sand areas during the first few weeks. We kept this sand moistened in order to avoid any unwanted desiccation of hiding hatchlings but, despite this



Figure 5. A stepway in each nursery tank allows turtles to thermoregulate at different water depths and to access the sand margins of the enclosure

care, seven of the hatchlings that stayed longer in the sand and did not return to water became desiccated and died. From 2016–2017, hatchlings were shifted to the retention pond after monsoon to provide them with a large area with varying depths to thermoregulate and swim prior to the winters. Since 2018, hatchlings were retained only for two weeks in nursery and have been prevented from leaving the water and burrowing in the sand margin by the construction of a temporary brick wall at the highest step of the stairway.

The water quality in nursery tanks is maintained by simple drain and fill processes. During the initial phase of the project (2006–2009) this was done once a month. The tanks are filled with ground water using a submersible pump. Each tank has a drain outlet (10 cm diameter) at its deepest end to allow complete drainage of waste water, which is collected in a shallow earthen pond created behind the facility. This water is used to grow aquatic plants such as water spinach *Ipomoea aquatica*, to feed to the turtles reared in the facility. Tanks are further equipped with an outlet to drain excess rainwater

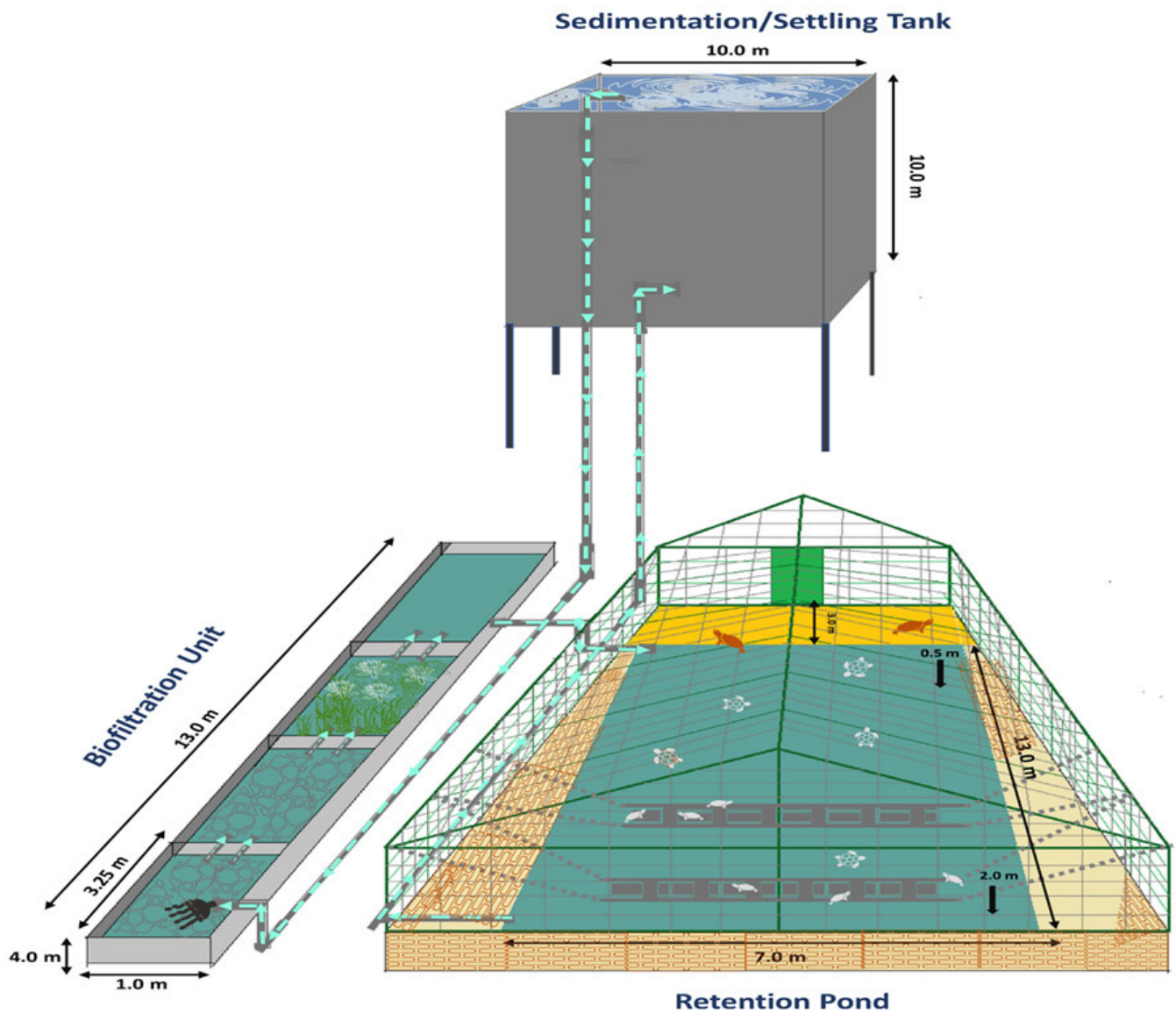


Figure 6. Large retention pond with a water circulation system to rear turtles for the head-starting programme, the far end of the enclosure has a sand filled area for turtle basking and a service entrance. For full layout see Figure 2.

during the monsoon. All pipework and the pump are provided with nets on both ends to prevent any turtles entering them accidentally. Since 2010 water quality in the tanks has been monitored using a Jal-TARA mini water testing kit (Development Alternatives) to test basic parameters such as pH, total dissolved solids (TDS), chloride, ammonia and nitrite/nitrate. This testing indicated that from June to September the water quality was dropping below optimum levels and so for these months of the year the water is changed three times a month instead of once.

Retention pond

A large enclosure with a retention pond (13 m long x 7 m wide x 0.5–2.0 m depth) was developed mainly to retain the larger hatchlings and yearlings turtles (Fig. 6). The pond can hold approximately 136 m³ of water and houses between 150–200 hatchlings (0.68m³/hatchling) (Kuchling, 2000; Whitman, 2009; Kanghae et al., 2016). To ensure a robust concrete structure, which would withstand the temperature extremes of the region, the enclosure was built below ground level with 10 cm thick exterior walls and a 22.5 cm thick concrete base. The enclosure is bounded by a 3.75 cm iron mesh cage to make it predator-proof. A depth gradient was created in the pond from 0.5 m to a maximum of 2 m to create a temperature gradient. During the summer, water temperatures at the shallow end range from 25–28 °C in the daytime to 20–22 °C at night time; the deep area remains more or less a constant 25–29 °C. Two floating platforms (3.6 m x 0.5 m), made out of split bamboo and stone tiles, are anchored in the middle of the pond where turtles can bask on top or hide beneath them (Fig. 7). These platforms are tethered and adjust themselves according to the prevailing water level. A sand-filled area (3 m x 4.5 m) is also allocated at the shallow far end of the pond as a disturbance-free basking space, the same end as the service entrance.

Feeding the turtles

The captive turtles are fed a balanced diet consisting of fish, soya and fresh vegetables, such as pumpkin, bottle gourd, cucumber, mulberry leaves, aquatic macrophytes (mainly *Chara* species, *Hydrilla* species), as well as a feed prepared from small fish and Pedigree® dog food to which is added multi-vitamin (Mayvit T Syrup) and calcium supplements (Calcwin T Syrup) at the rate recommended by the manufacturer.

Water supply and circulation to the retention pond

Regular water changes of the retention pond were problematic due to its large water capacity, the scarcity of water in this semi-arid region and the irregular supply of electricity. Consequently, it was necessary to maintain optimum water quality using a water treatment system. This is powered by a solar-powered 1 HP submersible pump (22 TECH 12v DC pump with 700 litres/hour pumping capacity) equipped with 6 solar panels; in sufficient sunlight one panel produces 250 watts/h (i.e. 250 x 6 = 1500 watts/h used to operate the 1 HP pump). The system is equipped with a battery pack that acts as both storage and additional start-up power to the unit. The solar panels are installed on the top of the sedimentation tank (Fig. 6). Water is pumped into the overhead settling/



Figure 7. Floating platforms suspended in the retention pond on which turtles could bask or alternatively hide beneath

sedimentation tank (3 m long x 3 m wide x 3 m high), through a 2.5 cm diameter pipe, for settling coarse suspended solids, prior to the treatment through the biofiltration system. Supernatant from the tank passes through an outlet pipe to the biofiltration unit. A valve operated at the base of the tank allows it to be drained for cleaning and an area below the tank is used occasionally to incubate turtle nests outside the *Batagur* hatchery season and prepare the turtle feed.

The biofiltration unit (13 m long x 1 m wide x 4 m high) has 22.5 cm thick walls and is divided into four chambers, built parallel to the retention pond (Fig. 6). The chambers are connected to each other by means of small circular openings. Supernatant from the sedimentation tank is discharged directly into the first tank and subsequently passes through the three interconnected tanks before returning to the retention pond. In order to improve aeration, water from the settling tank is trickled over the filter media in the first chamber using shower-heads. The first two chambers function as rough filters containing chiefly brick ballast and coarse gravel as filter media to retain suspended solids. The third and fourth chambers contain water hyacinth *Eichornia crassipes* which helps to remove excess nitrogen from the system and also contain small fish (guppy, zebra fish, gourami and Indian potasi) to be used as supplemental feeding for the turtles. At night, when solar panels are not functional, outflow is restricted to a 1.25 cm pipe that reduces the influx of filtered water and so maintains the overall circulation.

Winter preparations

The winter period starts in mid-November and by December–January temperatures drop to 1–2 °C at night and most days are foggy with limited sunshine; by mid-February ambient day time temperatures have returned to 29–30 °C (Singh S., personal observation, 2006–2010). At the beginning of the project during the cold period, we experienced mortalities and pneumonia, eye swelling and other infections in the turtles. To prevent these, the retention pond is insulated using thick plastic sheets from the beginning of November to retain heat during chilly nights. Overnight, the water temperature in the retention pond may drop by several degrees (10 to 11 °C). Additionally some freshwater was added on cold nights to achieve optimum temperature. Further, two room heaters of

1 kg watt are employed to regulate temperatures within the enclosure, especially on days with prolonged overcast skies (usually late December, early January). On sunlit days the sheets are removed so that turtles can bask in the sunlight, which also helps to increase the temperature of the pond water. Finally, the sheets are removed completely by mid-February.

Summer preparations

The peak summer (May–June) temperatures can often reach 48 °C. To prevent the pond water becoming too hot, the cage enclosing the western side of the retention pond is covered with a green woven sun cloth to prevent direct sunlight exposure, while on the eastern side the cage is not covered so that the turtles have access to morning sunlight for basking. The sun cloth is made of ‘breathable’ fibres that facilitate temperature exchange.

RESULTS

Impacts over the Years

Initially, during the head-starting period, all individuals were kept together in nursery/hatchling ponds for the first two months and this practice of mixing hatchlings of different age groups/size classes was compromising their health and growth. Larger individuals were outcompeting smaller, and therefore younger, individuals for resources (basking preference, food, etc.). This competition led to health issues such as shell softening, eye infections, and injuries from conspecifics, which may lead to a higher rate of mortality. On average, 15–20% of the annually-retained individuals showed shell softening and 1–2% had signs of eye infections in the initial years of the project. The solution to this problem was to separate individuals in different nursery/hatchling tanks based on the batch, size and whether or not they were healthy. Eye infections may often be linked to poor water quality, hence we attempted regular monitoring of water parameters which led us to change the water more frequently. These measures helped us achieve significant growth rate, improve health condition, reduce infection (50–60% reduction in shell softening and eye infection cases) and reduced mortality.

Over the 14-year period, the project successfully head-started and released into the Chambal 786 *B. kachuga* and 66 *B. dhongoka* 1–2 year-old turtles. The mortality rate during head-starting between 2014–2020 was low, only 1.9% (14 *B. kachuga* & 3 *B. dhongoka*), benefiting from the addition of the retention pond and improvements in husbandry practice. From 2017, weight gain (Fig. 8) and body dimensions were routinely recorded for *B. kachuga*. Between 2017–2020, during the six-month head-starting period (June–November), the average total weight gain (\pm SD) by hatchlings ($n = 100$ per year) in 2017 was 58.75 ± 27.10 g, in 2018 was 69.82 ± 26.04 g, in 2019 was 78.34 ± 31.11 g and in 2020 was 95.07 ± 38.05 g. In the four years (2017–2020), the average total weight gain (\pm SD) of hatchlings ($n = 100$ per year) was 75.50 ± 13.27 g. Similarly, the average straight carapace length (\pm SD) of hatchlings ($n = 100$ per year) (SCL) increased by 32 ± 4.12 mm, and the average straight carapace width (SCW) increased by 25 ± 5.24 mm.

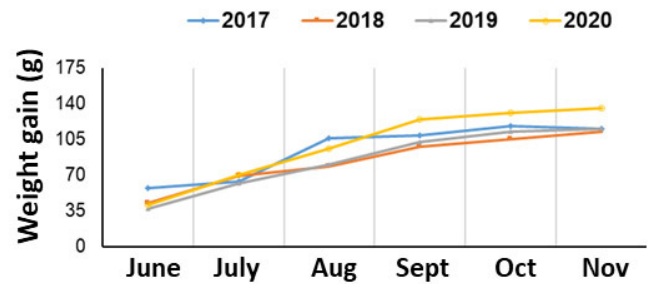


Figure 8. The average weight gain for *B. kachuga* hatchlings ($n = 100$) during the six month head-starting period from 2017–2020

Establishment of *Batagur* Assurance Colonies

In 2006, over 50 individuals were retained for the establishment of captive colonies at regional zoos (Lucknow and Kanpur) and a recognised captive breeding centre (Kukrail Gharial Rehabilitation Centre, Lucknow). Fifty subadults *B. kachuga* were selected – 30 went to Kukrail and 20 went to Kanpur Zoo in years 2015 and 2016, respectively. Of these subadults, only one was male, which was sent to Kanpur Zoo, suggesting that our stock has a significant female bias due to high temperatures during incubation. In 2020, ten animals from Kukrail were translocated to Nawab Wajid Ali Shah Zoological Garden, Lucknow, to create an additional conservation colony. These robust captive populations of this Critically Endangered species serve as a hedge against extinction and will aid in the recovery of its wild populations to their former strength. The Madras Crocodile Bank Trust has a successful conservation breeding of *B. kachuga* using the founders that are on breeding loan from Kukrail Gharial Centre, Lucknow. To redress the male imbalance the eventual goal of the project is to acquire more males from the Madras Crocodile Bank Trust for all three colonies in Uttar Pradesh and initiate captive breeding as part of an integrated conservation recovery programme for this species.

DISCUSSION

In 2006, we initiated a head-starting programme with a basic rearing facility and subsequently developed it based on needs and experience. We made several important improvements including the development of a biofiltration unit to reduce water wastage and improve water quality. We diagnosed that the previously used hatching nursery needed to offer more housing space for the turtles and also that routine maintenance needed to be made easier in order to implement better hygiene. We did this by dividing the initial single facility into four square tanks that were easier to maintain and allowed an increase in stocking density. Additionally, a major issue faced during the initial years (2006–2010) was the high rate of mortality among rearing cohorts. To mitigate this problem, the husbandry practices were improved and individuals were separated in the nursery based on age class and size, and a balanced diet with micro-nutrient supplementation was provided. At the same time, regular monitoring of water parameters was started and both these steps helped to improve health and increase survivorship. In addition, health benefits have been obtained by maintaining the retention

pond in the optimum range of water temperatures (20–25°C) during the coldest and hottest times of the year.

The Chambal River has an estimated 500 adult nesting females (Sirsi et al., 2017; Praschag et al., 2019); if we assume a sex ratio of 1:1 then there should be around 1000 adult *B. kachuga* in the wild. In the last 14 years, we have successfully added a total of 722 individuals to the wild. A release of ten 8 year-old captive-raised *B. kachuga* along the middle Chambal indicated at least 70% survival for first two years. A release of 2.5 year-old *B. kachuga* individuals from this (TCC) facility in April 2023 shows 80% survival in the following four months (Singh et al., in preparation). Furthermore, our annual nest protection efforts indicate that there has been a gradual rise in numbers of nests in the area and an increase in the number of juveniles sightings.

Here, we have presented information based on the 14 years of work and the project is still in progress with new objectives and goals. Currently, we are evaluating the diet preference of hatchlings and juveniles under captive conditions, which will aid future captive propagation efforts. For *B. kachuga* the only surviving population is that on the Chambal River. The long-term aim should be to fully restore the species so we are currently scoping the reintroduction of *B. kachuga* to its historic range. Such reintroductions will follow strict guidelines and will be subject to prior assessment of the selected site with respect to food availability as well as potential population density. The biosecurity of the native species present in the release habitat will be safeguarded by comprehensive health assessment of release cohorts (Huber et al., 2022). To achieve all this will require further research. This should include investigation of the optimum duration of the head-starting/retention, the post-release survival rate and health performance in the wild, efficient method of release, either 'hard release' without pre-conditioning to the release environment or 'soft release' with pre-conditioning, and a suitable release site selection methodology.

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