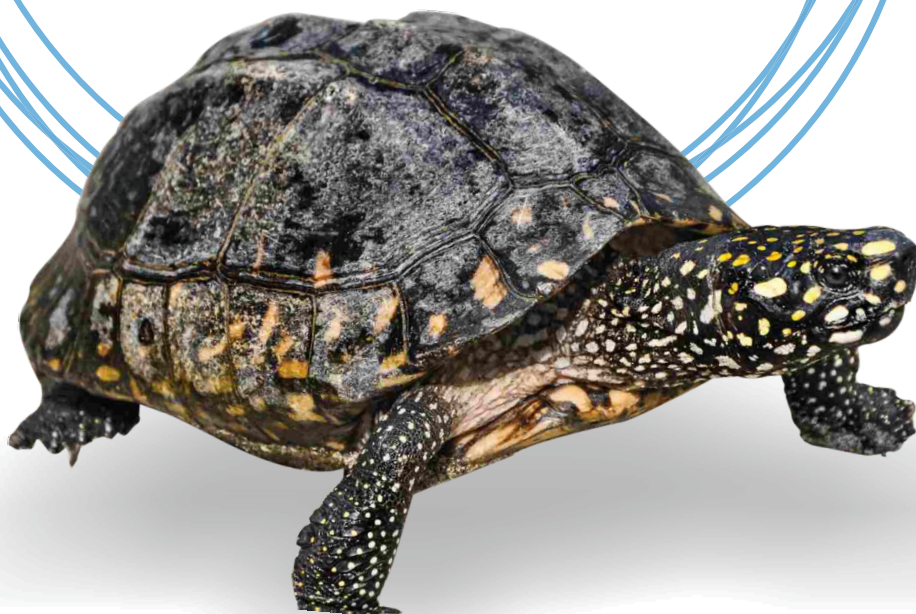


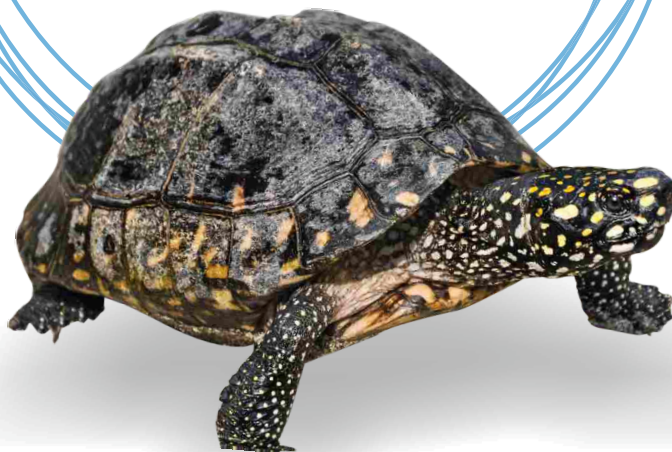
CONSERVATION REFERENCE GUIDE

RESCUE AND
REHABILITATION
OF FRESHWATER
TURTLES AND
CROCODILIANS



CONSERVATION REFERENCE GUIDE

RESCUE AND REHABILITATION OF FRESHWATER TURTLES AND CROCODILIANS





Team Leaders

V.B. Mathur and G.S. Rawat

Contributing members

Suvarnagowri Mallapur,
Animesh Talukdar,
Parag Nigam, Syed Ainul Hussain,
P.K. Malik

Additional inputs

Himanshu Joshi and Sanath Krishna M.K.

Published by

Ganga Aqualife Conservation Monitoring Centre
(GACMC)

Wildlife Institute of India

Chandrabani

Dehra Dun, 248001

Uttarakhand, India

ISBN: 81-85496-42-0

January 2019

© Wildlife Institute of India

Post Box # 18

Dehra Dun, 248001

Uttarakhand, India

Tel. +91-135-2646100; 2640114-115

Fax: +91-135-2640117

E-mail: wii@wii.gov.in; gacmc@wii.gov.in

<http://www.wii.gov.in/nmcg/national-mission-for-clean-ganga>

Citation:

Mallapur, S., Talukdar, A., Hussain, S.A. and
Nigam, P. 2019. Conservation Reference Guide:
Rescue and Rehabilitation of Freshwater Turtles
and Crocodilians, Wildlife Institute of India,
Dehra Dun. Uttarakhand, India. WII-NMCG.
Pp 100

Designed and Printed by
XPRESSIONS

"The hope of the future lies not in curbing
the influence of human occupancy - it is
already too late for that - but in creating a
better understanding of the extent of that
influence and a new ethic for its
governance."

Aldo Leopold



FOREWORD

Aquatic ecosystems are home to an astounding diversity of flora and fauna. These systems have additionally supported human civilization for many centuries. However, unsustainable anthropogenic pressures have led to a subtle loss in the biodiversity value of these fragile ecosystems.

The success of any conservation initiative is its ability to be inclusive and sustainable. Rescue and rehabilitation is today gaining prominence as a viable conservation tool and I have great pleasure in presenting the Conservation Reference Guide: Rescue and Rehabilitation of Freshwater Turtles and Crocodilians.

This guide presents concise and practical information on the protocols and processes for the scientific and ethical handling of Freshwater Turtles and Crocodilians and managing distress situations.

I compliment the effort of the team in producing this reference guide and hope that this document is a value addition to the actions at field level.


(V.B. Mathur)





PREFACE

The earth, two-thirds of which is covered by water, looks like a planet of "blue" from space. The world's lakes and rivers are probably the planet's most important freshwater resource. However, the amount of freshwater accounts for only 2.53% of the earth's water, and these ecosystems represent a substantial sector of the earth's biological diversity. The association of man and freshwater ecosystems is ancient with major human civilizations developing along rivers. The Indo-Gangetic floodplain was one of the first areas to be colonized, as it provided man with all his basic necessities and allowed for prosperity.

Freshwater biodiversity has been declining at a faster rate than its terrestrial and marine counterparts. The same is true for wildlife in the Ganga River and its basin, which is subject to various anthropogenic threats. Once abundant, populations of larger species are now facing a decline or are locally extirpated due to hunting, illegal trade, habitat loss and fragmentation. Large-scale development activities, commercial fishing, sandbank agriculture, structures responsible for change in the fluvial and hydrological elements of freshwater systems, disposal of untreated effluents and associated pollution, unregulated tourism, waterways and associated traffic, continue to influence the quality and extent of habitat available to the biota that draws sustenance from the riverine system. The impacts of these activities may also present indirectly as a loss of ecological habitats and niches.

South-Asian countries, including India, are believed to be disproportionately large sources of wild tortoises and freshwater turtles in the illegal international markets. However, the nature and dynamics of this trade in India are poorly understood. 15 of India's 28 freshwater turtle and tortoise species, including about 10 IUCN threatened species, are illegally harvested, with over 58,000 live individuals seized between 2011-15. Given the large-scale and nature of this trade, and the forever increasing pressures of fishing, sand mining and development projects, not only do rescue and rehabilitation come to the forefront, but it also brings to light the clear need for improved coordination among different agencies, as well as coordination across international borders. The issues further demonstrate an immediate and urgent need for protocols for scientific management and ethical handling of aquatic animals in distress.

The process of rescue and subsequent rehabilitation has to be an organized effort of professionals done with informed interventions and through need-based assessments of the available natural habitats. Additionally, monitoring of the released animals to ensure their survivability and recruitment into populations is indispensable. Furthermore, these processes must become integral parts of inclusive conservation management plans drawn up for freshwater ecosystems.

This kind of "conservation" initiative is a novel step in the ongoing efforts to protect and manage aquatic fauna. It can be described as the way forward to create an inclusive network of conservation practitioners and organizations working together to take responsibility for developing, supporting, and implementing the necessary solutions for aquatic biodiversity conservation. Without such concerted, inclusive conservation strategies, the pressures on the aquatic system and its species may lead to an irreparable loss of this unique and bio-diverse ecosystem resource. The document is an attempt to provide insights into the multifaceted science of rescue and rehabilitation of turtles and crocodilians.

Editors



CONTENT

ACKNOWLEDGEMENT

Ministry of Water Resources,
River Development and Ganga Rejuvenation
National Mission for Clean Ganga (NMCG)
Uttar Pradesh Forest Department
Nuclear Power Corporation of India
Narora Atomic Power Station (NAPS), Narora
Faculty colleagues and Friends at Wildlife
Institute of India

Special Thanks to

Debaprasad Sengupta, Akshay Bajaj, Brijesh,
Ishu, Pyarelal, Jyoti and Pintu

Photo credits

Abhijit Das, Anuja Mittal, Dinesh Vineherkar,
Kedar Bhide, Devanshi Kukadia and Niladri
Dasgupta

ANIMAL RESCUE



003

1.1	Rescue	003
1.2	Capture and Handling	009
1.3	Crating and Transport	017
1.4	Management Animal in Distress: Triage	021

NEST RESCUE ESSENTIALS



025



Foreword	i
Preface	ii
Acknowledgement	iii
Introduction	001

CAPTIVE CARE,
HUSBANDRY
AND UPKEEP



031

3.1	Enclosure Design and Enrichment	031
3.2	Sanitation and Hygiene	035
3.3	Quarantine	037
3.4	Health Management	039
3.4.1	Pre- Release Health Assessment	039
3.4.2	Common Diseases and Emergencies	041
3.4.3	Biological Sampling and Laboratory Essentials	042

RELEASE
STRATEGIES



045

4.1	Release Strategies and Post-Release Monitoring	045
4.2	Marking and Identification	048
4.3	Laws and Permissions	052

SPECIES
ATTRIBUTES



055

5.1	Freshwater Turtles and Tortoises of the Ganga Basin	055
5.2	Crocodilians of the Ganga Basin	074

Bibliography	078
Annexures	086
Annexure I: Medications used on confiscated Asian turtles at triage and immediately post triage for rehabilitation	087
Annexure II: Admission Form	088
Annexure III: Equipment List required for sampling for pre-release health assessment and monitoring	089
Annexure IV: Common diseases of chelonians and crocodilians	090
Annexure V: Available phlebotomy options in chelonians and crocodilians	095
Annexure VI: Importance of biochemical parameters in reptilian disease diagnosis	096
Annexure VII: Drugs and Dosages	098

INTRODUCTION

The Ganga River is the largest river in India and the fifth longest in the world. Jawaharlal Nehru wrote in his will; "The Ganga, is the river of India, beloved of her people, round which are intertwined her racial memories, her hopes and fears, her song of triumph, her victories and her defeats. She has been a symbol of India's age-long culture and civilization, ever-changing, ever-flowing and yet ever the same Ganga".

In ancient Indian culture, the Ganga is associated with fecundity and biodiversity, providing sustenance to all living along its banks. The goddess's visual identification is Makara, which has dual symbolism. It represents the life-affirming waters and plants of its environment on one hand and; on the other it represents fear of the unknown. On the heels of this deep mythological connect, the riverine ecosystem, where heavy demand is placed on freshwater, has suffered from intense human intervention resulting in habitat loss and degradation, and as a consequence many freshwater species have become endangered. Additionally, there is tremendous pressure on the faunal diversity from hunting, low flows due to unsustainable water extraction, modern and consumptive agriculture practices and pollution. To maintain a healthy ecosystem, rescue and rehabilitation encompassing scientific, ethical and humane handling of all animals and ensuring survival of individuals has gained increasing popularity.

A strong thrust towards standardizing protocols and operating procedures for rescue and subsequent rehabilitation and release of animals has therefore gained prominence. There is a growing understanding about the importance of the lives of animals and also the long term impact and far-reaching ecological consequences of rehabilitation and release of animals into the wilderness. This is in tandem with emphasis on the ethical handling of animals and a professional and scientific approach taking due care of welfare considerations.

Though there is a strong background of many decades of research on turtles and crocodilians in the Indian context, there appears to be a lacuna in comprehensive compilations relating to rescue and rehabilitation of these species in our scenario. This "Conservation Reference Guide; Rescue and Rehabilitation of Freshwater Turtles and Crocodilians" is an attempt to bridge this gap. The purpose of this field guide is to provide a reference for field practitioners working with chelonians and crocodilians in the wild and in captivity. An attempt has been made to comprehensively present information that will be useful for procedural and practical implementation.





ANIMAL RESCUE

1.1

Rescue

Animals can often be injured or be threatened with injuries as a result of natural or human-related accidents, thus warranting their "rescue". Taking from the Webster Dictionary, Rescue is; "to free or deliver from any confinement, violence, danger or evil; to liberate from actual restraint; to remove or withdraw from a state of exposure to evil". Wildlife rescue refers to operations that usually involve saving the life of the animal, or prevention of additional injury to the animal i.e. extricating wild animal from an undesirable state. Rescue can be opportunistic; or it could be a targeted rescue, where the situation is hazardous or it could be undertaken in response to specific events.

Situations of 1)injuries from encounters with propellers of boats in waterways, 2) entanglement in fishing nets sometimes leading to drowning, 3) stranding in concrete canals and 4) poaching for consumption and for trade in international markets, are now more and more commonplace. wildlife, mainly turtles and crocodiles, (sometimes dolphins too) fall prey to the growing consumptive and unsustainable practices warranting intervention and their rescue.



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A rescue operation can have several stakeholders who could operate independently or be involved in a combined effort. Each entity however has a role and a specific skill along with a specific task to accomplish that are briefly discussed below-

1	First responders	Are first on site and assist with a quick responsive operation that usually involves combating stress followed by separation of the animals as per their species and condition, and holding them in the best possible way until further process is confirmed.
2	Enforcement agencies	These are enforcement agencies like the forest department, railway authorities, airport customs officials, officials of the Wildlife Crime Control Bureau who encounter situations warranting rescue(confiscations, human wildlife conflict mitigations, etc.)
3	Veterinary Health Professionals	Veterinarians trained to deal with emergencies in aquatic macro fauna
4	Non- Governmental Organisations	Organisations that work with the intention of bridging the gaps between the bureaucracy and on ground implementing agencies. Volunteers from NGOs are often the back bones of successful rescue and rehabilitation operations.

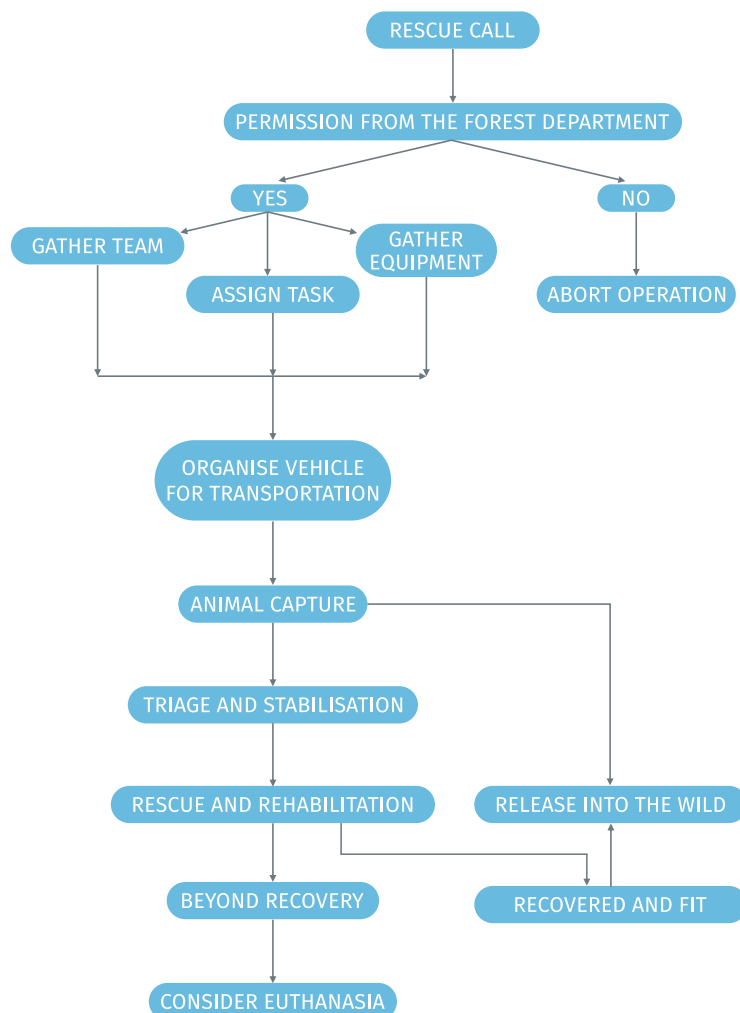




Preparedness and Action items

Rescue operations are essentially a team effort and often involve a complex web of events that run their course as the exercise is executed. Organizations or individuals involved in rescue operations must be prepared at all times to manage emergencies and respond at the earliest to any information involving managing animals in distress. It is considered part of a protocol to always have all the equipment ready at hand and a vehicle with the driver on standby. The sequence of events further to receiving information of a distress situation is summarized below;

	Responsibilities/ Action Items Agencies			
Situations	First Responders/ Community Citizens	Confiscating Agencies Including Forest Department Personnel	Trained Veterinary Health Professionals	Non-Governmental Organizations
As the information of a distress situation needing intervention is received.	Promptly pass message on to the relevant forest department officials or identified rescue teams.	Ensure appropriate range officers are informed and contact veterinary wildlife health professionals and identified and trained rescue teams. Approach civil authorities like police departments for support.	Ensure due paperwork by the officials of the forest department and confiscating agencies, is received and proceed promptly to site of rescue. Permits should be in place for handling the animals, processing (treating) the confiscated animals and also to move them away from the site of the confiscation to an appropriate location.	Enlist needs and put together a team for assisting in various areas of the operation.
On reaching the rescue site	1) Crowd control to ensure safety of the animals and people in the area.	1) Assess the situation and communicate with the veterinary professionals.	1) Assess the situation and intervene based on scientifically sound justifications.	1) Support in crowd control.
	2) Engage the public and use this as an opportunity to spread awareness.	2) Assign roles for crowd control to the first responders and NGO volunteers.	2) Animals should be removed from the distress situation (e.g., released from any ties or binds, removed from gunny sacs or bags etc.) and confined in a secure area.	2) Support in animal care if deemed necessary by veterinary health professionals.
	3) Communication with teams from forest department, implementing agencies, veterinarians and trained rescue teams.	3) Prepare site for triage (If essential in rescue operation). 4) Organize for transport vehicle. 5) Communicate regarding destination of animals and course of action to be initiated via correct channels.	3) On assessing the animals and satisfying all administrative requisites, the animals can be crated for further transport to a rehabilitation center or release site as deemed fit.	3) Support in crating and transport as instructed by veterinary professionals.



Selection of Release Sites:

The release sites have to be assessed and identified based on attributes and ecological needs that supports species survival with special emphasis on existing pressures and potential challenges. The criteria for selection of release sites should check for the following-

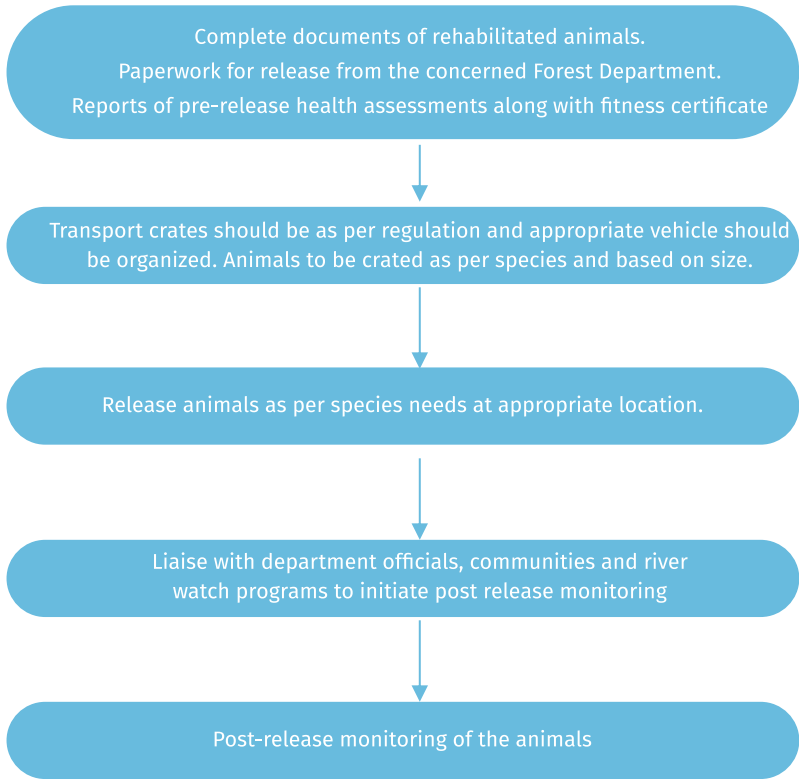
- 1) Presence or absence of geographical attributes like sand banks, appropriate substrate.
- 2) Flow and dynamism of the river and width of the channel including seasonal variations.
- 3) Type of vegetation in the water and on the sand bank.
- 4) Anthropogenic pressures (presence or absence) and their seasonality like fishing, large netting operations.
- 5) Presence of predators.
- 6) Possibility of infighting.



It is prudent to understand the local people's perception to the initiatives before the site is selected and finalized.



The release procedure would involve the following steps-



Post-release monitoring of the animals

Equipment and supplies essential for rescue operations:

Temporary facility equipment	Motorboat, blankets, stretcher, toolbox, water bottles, loading vehicle, transportation vehicle, morphometric equipment, tags for identification and marking, sample collection kit.
Veterinary equipment	Emergency and supportive care medications and all other related equipment (syringes, needles, intravenous sets etc.)
Capture and collection equipment	Species specific equipment like catch pole hold, bamboo poles, ladder, ropes, rubber gloves, tongs, nets, plastic tubs, crates, gunny sacs, towels
Communication equipment	Loudspeaker, mobile phones
Others	Searchlight, binoculars, GPS, digital camera for documentation, personal protective gear, life jackets, torches, release sitemaps, first aid box

Summary

Wildlife rescue is a process of extricating wild animal from an undesirable state. A rescue operation can be successful if the team is prepared, equipped, appropriately informed and trained. The rescue operation ends when the animal is removed from the distress situation. However, rescue is incomplete until the animal is rehabilitated and eventually released back to the natural habitat. The release sites may be predetermined and graded based on suitability of attributes and ecological needs of the species, existing pressures and potential challenges. When the site is being selected and finalized it is prudent to understand the local people's perception to the initiatives. It would be of help to the concerned local authorities and a local support group informed. The release protocol will be completed on the initiation of post-release monitoring.



1.2

Capture and Handling

Freshwater turtles and crocodilians often need to be captured and handled as part of rescue operations, research projects or ex-situ management programs. Animals outside their natural environment are mostly presented in a compromised state, they require scientific and humane approaches to capture and handle. The choice of the procedure, however, depends on the species to be handled, the skill of the team, the experience of handling the equipment and locally available resources and logistics.

Manual or physical capture is usually preferred for both chelonians and crocodilians and this calls for a detailed understanding of the factors influencing welfare viz., species biology, physiological status, season and critical needs. For e.g., if the recuse is at a time when the nesting season is ongoing; the chances of the animals being gravid cannot be excluded and would require handling with utmost care.

Turtles

This section provides a basic understanding of the capture methods for freshwater turtles and tortoises for managing any emergencies, confiscations as well as for research projects. Capturing turtles allows for the detailed assessment of demographic structure, sex ratio, fecundity, morphometric variation, and individual parameters (age, growth, health, injury, diet, movement) besides allowing detailed examination of animal for health and disease. The options for turtle capture include physical trapping or capture using hands.

Trapping

Trapping is an art based on science and is quite effectively used to capture turtles in still waters such as lakes, reservoirs, ponds, or vernal pools and even in backwaters or other slow-water portions of rivers and streams. Abundant aquatic vegetation, poor water clarity and muddy substrates pose challenges. Trapping is less effective in flowing portions of streams and rivers. Understanding activity and spatial utilization improves chances of success. It is important to camouflage the traps and place them in a manner that they are inconspicuous yet accessible. Though trapping is not a common practice in the Indian scenario, it is important to understand the tools available to best design efficient and professional operations.

The different trap designs are briefly discussed below;

Hoop Trap

It is a 'V' shaped mesh trap with a wide open mouth secured by a metal ring. In standing water with a mud bottom, the turtle hoop trap is pulled taut by driving a stake in front through the front hoop or using the cord to tie it to a stake in front. A rope is tied to the back "V" area of the trap (which itself is tied in a big knot and used to access the trap) then another stake or to objects on shore and pulled tautly.

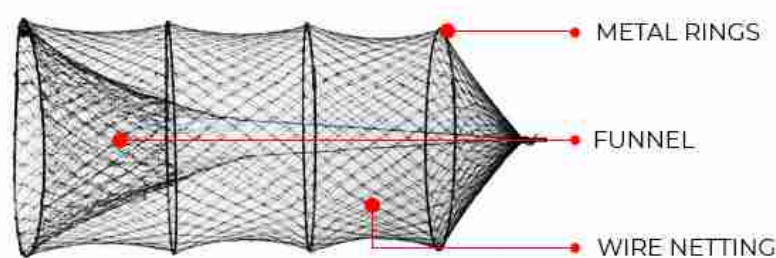


Fig. 1. Hoop Trap



Drift Fence Traps ('Tyke" Traps)

Drift fences may be used to increase captures in baited traps but can also be used without bait. A mesh drift fence (1 m tall X 10 to 20 m long) with floats on top and sinks on the bottom can be stretched tight across a pond, canal or bay. The ends of the drift fence are attached to openings of turtle traps at each end of the fence. The fence is pulled tight by driving in wood stakes at the rear of each trap. Turtles that encounter the drift fence are guided into the traps. Variation in design is with the addition of one wing set at an angle from a trap at the edge of stream, river, or pond. Turtles can be intercepted as they move along the water edge and the wings guide them into the trap. These traps may be 1.0+ m tall and 2+ m wide with long wings or drift fences.

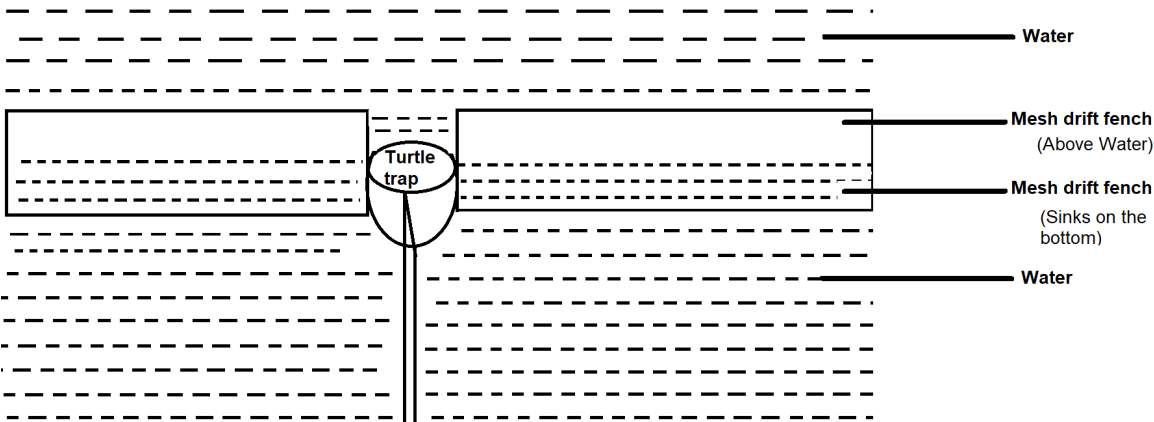


Fig. 2. Drift fence

Basking Traps

Basking traps are not commonly used but are effective under certain conditions. These are constructed of floating wood or plastic tubes that trap turtles in a net basket when they dive off a basking platform. Turtles need to crawl up the ramp designed as a treadle that can flip inward when a turtle moves over the trap but then drops back to its original position. As the top of the basket is at water level, turtles can leave at will in case the trap is unattended. When ready to catch turtles, a person can startle or run towards the basking turtles, causing the turtles to dive off into the mesh trap. The traps are usually placed in or near cover or near basking sites.

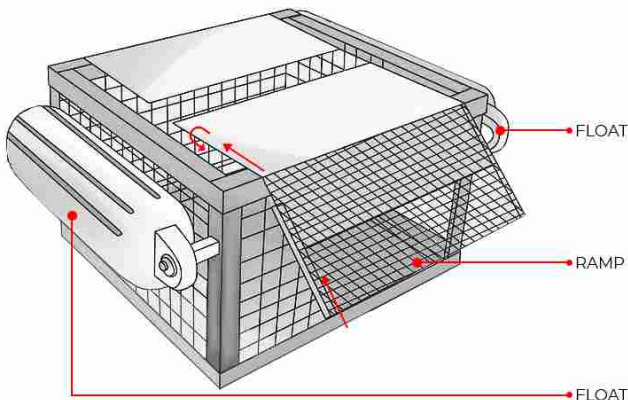


Fig. 3. Basking trap



Baited funnel traps and drift fence with funnel traps

In flowing aquatic systems baited traps can be placed with the opening facing down the current so that the drifting scent of the bait will encourage turtles towards the opening. Traps can also be made more effective by the addition of drift fences to guide turtles towards and into the trap opening. All traps are usually constructed with non-stretch fine-mesh netting (2.5- cm size) to ensure that the turtles do not get entangled. It is essential not to keep loose areas or sharp edges that could cause accidents. Special care is needed to ensure that the top of the trap remains above water to allow captured turtles to surface for air. This can be done using reliable floats.

Bait for Traps

Turtles can be attracted to the traps by the scent of bait that is suspended in the middle of the trap in a bait bag. The cans of bait are punctured to release the juices taking care not to open the can completely as the turtles or fish can eat the bait. Based on the work done by Voorhees et al (1991), freshwater mussels, fresh chopped fish or commercial dog food (sauce cubes) or cat food (salmon, tuna) and chicken entrails work well as baits. Although it is widely felt that putrid baits are best to attract turtles, fresh baits are by far the most productive in traps. It is interesting to keep in mind that studies have shown that turtles did not enter un-baited traps or those with bait more than 1 to 2 days old.

Hand Capture

Capture by hand is usually employed in flowing waters where trapping can be inefficient or not possible. Turtles can be captured by wading through shallow water and feeling with hands through algal mats, vegetation, undercut banks, under boulders, or other cover objects with hands. Muddling can also be useful to locate juveniles.

Handling of Turtles and Tortoises

Handling considerations for chelonians vary with size and shell type (softshell or hardshell). It is important to ensure that the procedure is safe for the handler and animals to minimize stress, pain and anxiety. A pertinent consideration is to understand that the shell is not impervious and is basically a growing, living entity that can break or be otherwise injured if improperly handled.

Fig 4.: Handling of a tortoise





Points to bear in mind

1. Chelonians do not have teeth but their beak is strong and sharp. It is advisable not to reach across a large turtle or tortoise that is not adequately restrained. They can deliver a firm bite and demonstrate a reluctance to release. The head should face in a direction that is away from the handler when restrained.
2. The nails of some chelonians can inflict painful scratches.
3. An agitated or frightened chelonian may urinate as it is picked up. Such voiding, in extreme situations may go to the extent of making the animal dehydrated.

Fig 5: Handling of small turtles



Fig 6: Handling of large turtles



Most small to medium-sized chelonians are easily held by the shell with both hands on either side of the body (between the fore and hind limbs). Larger turtles or tortoises can be grasped with both hands, one on each side of the shell, but semi-aquatic turtles kick strongly and can cause minor scratches. A large, hardshell turtle can be held by the carapace in the nuchal area and at the posterior end of the carapace above the tail; keeping the top shell and neck directed away from the handler. Large softshell turtles of some species exceed 15- 20 kgs. They are aggressive and can pose challenges for handling. Softshell turtles are most safely handled by grasping them firmly at the rear of the top shell with both hands (and sometimes at the front and rear).



Physical Restraint of Turtles and Tortoises

Healthy chelonians can be quite strong and uncooperative; the same holds true even for debilitated animals, particularly in case of large tortoises. Restraint techniques differ between small and large chelonians, as the individuals and species vary dramatically in size and strength. Most small to medium-sized chelonians eventually tire and allow the handler to extend the body part with time, however, the procedures should not be prolonged. Limb fractures can occur with rough handling, particularly in individuals suffering from nutritional hyperparathyroidism or metabolic bone disease. A tongue depressor, rubber spatula, or large flat object to serve as a "beak blocker" can be used to avoid biting, while carrying out various procedures".

Summary

Traps may be used in still water, trapping is less effective in flowing portions of streams and rivers. Understanding activity times and spatial utilization improves chances of success. It is important to camouflage the traps and place them in a manner that they are inconspicuous yet accessible. Baited Traps using freshwater mussels, fresh chopped fish or commercial dog food (sauce cubes) or cat food (salmon, tuna) and chicken entrails as baits work most efficiently. Capture by hand is usually employed in flowing waters where trapping can be inefficient or not possible. Handling considerations for chelonians vary with size and shell type (softshell or hardshell). It is important to ensure that the procedure is safe for the handler and animals to minimize stress, pain and anxiety. Chelonians do not have teeth but their beak is strong and sharp, their nails can inflict painful scratches. Hatchlings of any kind can be encircled with the fingers and thumb, and physically lifted. The animal can be placed on hand with some level of restraint to avoid slipping or dropping. Larger turtles or tortoises can be grasped in both hands, one on each side of the shell. Softshell turtles are most safely handled by grasping them firmly at the rear of the top shell with both hands (and sometimes at the front and rear). A tongue depressor, rubber spatula, or large flat object to serve as a "beak blocker" can be used to avoid biting, while carrying out various procedures.



Manual Capture: Crocodilians

Rescue of crocodiles is attempted in situations where the animal has accidentally strayed from its natural habitat or is encountered during emergencies resulting from entanglement in fishing gear or accidents. Planned captures in free-ranging situations are integral to monitoring and research programs.

A challenge in catching and handling crocodilians is their extraordinary range of body sizes; from 5 cm hatchlings weighing about 25 g to 5 m plus animals weighing close to 500 kgs. The choice of the technique depends on the animals' size, wariness and habitat. Smaller crocodilians (less than 1 m total length) can be captured by hand, tongs, nooses and small weighted treble hooks, dip nets, cast nets and seine nets. Larger crocodilians however need to be captured using nooses, small harpoons, small treble hooks, traps and nets.

Capture techniques are briefly discussed in the subsequent section. Sound ecological understanding of the species and presence of mind are essential for trapping crocodilians. Information on the spatial use of the habitat (e.g. utilization of deep pools by Gharial; dens by mugger) is important.

Trapping: Various kinds of traps may be used for the capture of animal in-situ in case of crocodiles. Traps are not preferred for use in case of Gharial as these may damage the snout. Traps are generally in the form of metal cages or fortified nets. There are several designs for traps and modifications may be implemented based on habitat and species. Traps are best set at the site of animal sighting or basking site. Baits are a good addition to the traps. It is reported that the baits are advantageous as they may be attached to a triggering device to hasten the closing of the trap. However, the limitation includes consumption by non-target animals. Trapped crocodiles are vulnerable and at a risk of injury from struggling, drowning, overheating or being attacked and thus frequent checks of the traps once set are mandatory. Trap site transmitters deployed along with the trapping device may be effective to provide information of trapping. The descriptions below are mainly suited to Indian conditions and the aquatic systems.





Box or cylinder traps: Box or cylinder traps have been used for capturing crocodilians however are unwieldy, and the animals readily become trap-shy and easily hurt themselves while struggling.

Handgrab/ Tongs

This involves grabbing the animal from behind the head or using tongs. Pilstrom tongs (used for snakes) may be used to catch an animal up to 90 cm long. The plier-end clamps are applied to the crocodilian's neck or tail so it can be lifted into a bucket or be grabbed by hand. Grabbing by hands and tongs is not effective for crocodilians larger than 1.25 m as it can easily struggle free and bite. Use of tongs or pliers is not advisable for use in Gharial.

Nets

Floating nets may be set across rivers, creeks, canals or in ponds. Nets, however, must be monitored continuously to prevent crocodilians or other animals from drowning and asphyxiation. Crocodilians less than 1.2 m length can be caught with dip nets. Dip nets can be constructed with the net in line with the handle for scooping, or with an angle to the handle, to press down over the crocodilian from above.

Noosing

Nooses prove effective for large crocodilians, cause minimal injury, and are reusable. Noosing is a common technique and works well when it is possible to approach the animal close enough to place a noose around the animal's neck. It is best to attach the noose so that it breaks free from the pole and allow the animal to tire itself out prior to being brought onto a manageable flat area. The poles can be made from wood, bamboo, fiberglass, plastic, and other materials depending on preference and availability. Poles should be stiff and lightweight, and with certain amount of flexibility.

Darting

Darts are modified harvest harpoons where the size of the penetrating head is reduced so the depth of penetration into the target animal is shallow. Such modifications minimize the chances

of injury to the darted animal. Darts are attached to the end of a pole that is thrust by hand. The dart, attached to a line, then separates from the pole. Accuracy and power are critical components of a successful dart- harpooning. Darts should be placed away from internal organs. The jowls and sides of the tail are the best places to set the dart. As darts can pull free when an animal struggles, they are used primarily to keep a line on the animal until it can be noosed.

Handling crocodilians

Once the animal has been noosed, the animal must be blindfolded by having a heavy sack thrown over its head ensuring that the nostrils are open as it reduces struggling. The identified team member can then jump onto the neck of the crocodile, approaching from behind. The first team member must pin the crocodile's neck and head down to stop it from being able to spin around, whilst another member of the team can put the weight on the pelvic area. Other members can then move in (almost synchronously) to secure the tail. The force used to pin the animal should be in proportion to the size of the animal as heavy force can injure the animal.





Large crocodiles > 2.5m: These animals can cause fatal injuries and capturing them is a specialized task. A large capture team with one person in charge is critical to avoid accident. The jaws may be secured with several strong bands or ropes and the head remains covered at all times.

The first procedure involves securing the mouth prior to handling to prevent biting or self-injury (breaking of teeth) as well as to keep the handler safe. Plastic cable ties, and rubber bands may be used to close the mouth. Once the mouth is closed shut, it is important to ensure that the eyes and ears are covered. This stimulates an oculo-cardiac reflex- a vagal response which acts on the parasympathetic nervous system, calming the body and even slowing the heart rate. If required, the animal may be fastened onto a board or other suitable hard object like a metal ladder. It may be further secured by raising the hind legs off the ground. The procedure of capture is reversed in the same order. The mouth tie may be removed last in case the animal is to be released. Under no circumstances should a crocodilian be allowed to escape or be freed with the mouth still secured.

Animals that are captured, processed and released quickly show little ill effects of capture. Crocodilians that have been immobilized, or that have struggled in a trap for any length of time need a recovery period from the buildup of lactic acid in the muscles. Crocodilians that have been handled after trapping should be allowed to recover on their own. They should not be allowed to get too hot or too cold during the handling and recovery stage.

Summary

Various kinds of traps may be used for the capture of animals in-situ in case of crocodiles. Traps are not preferred for use in case of Gharial as these may damage the snout. Traps are generally in the form of metal cages or fortified nets. There are several designs for traps and modifications may be implemented based on habitat and species. Traps are best set at the site of animal sighting or basking site. Baits are a good addition to the traps. Pilstrom tongs (used for snakes) may be used to catch an animal up to 90 cm long. Floating nets may be set across rivers, creeks, canals or in ponds. Nets, however, must be monitored continuously to prevent crocodilians or other animals from drowning and asphyxiation. Crocodilians less than 1.2 m length can be caught with dip nets. Nooses prove effective for large crocodilians, cause minimal injury, and are reusable. Noosing is a common technique and works well when it is possible to approach the animal close enough to place a noose around the animal's neck. Safety of animals and the capture team is paramount.

Approaching from the side of the animal must be avoided at all times as the crocodile can turn to the side faster than people can react.

Prolonged struggling can cause lactic acidosis and can become fatal and thus all capture must be done quickly and efficiently.

A crocodile should never be lifted just by its limbs as the joints can dislocate.



1.3

Crating and Transport

Transport of freshwater turtles, tortoises and crocodilians constitutes an unnatural situation for the animal and is most likely to cause it some degree of stress. Often the animal may need to be moved over a substantial distance to be housed in the appropriate location for optimal care and management. Transport regulations and guidelines have thus been developed such that welfare of the species is considered and meticulously followed in all kinds of situations.

The transport containers are designed to cater to the needs of species such that the animals undergo minimal stress and can be monitored through the transportation process. The most important consideration in the design of the crates/ transport carriers is the availability of adequate ventilation while maintaining a dark and quiet environment and the provision to maintain reptiles as close to their preferred optimal thermal zones as possible.

These guidelines include specifications for carriers and advise on plan of action for the actual transport (IATA Guidelines, CITES regulations). Supporting documentation regarding the transport (permits, number of animals, temperature control if any) as required should be affixed to the box. Labels should provide clear information to inform the handlers about the species is in the box. A 'This Way Up' sign is invaluable.

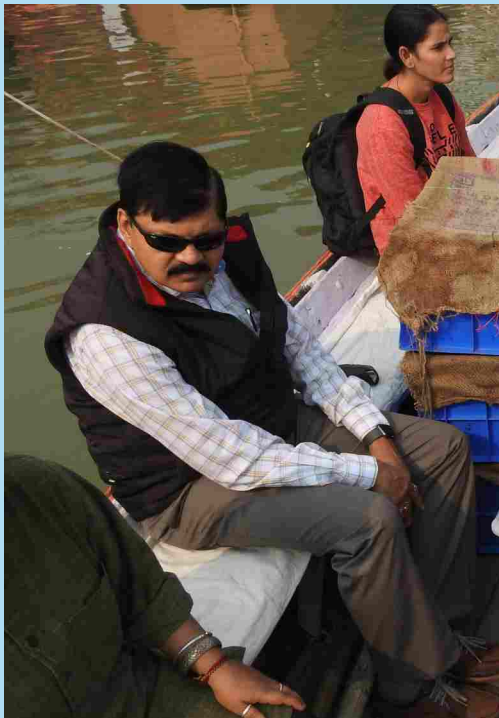


Fig 7. Turtle (Lissemys sp.) are crated and ready for transport to release site



Transport consideration: Freshwater Turtles and Tortoises



Fig 8. Turtles crates stacked for transport to release sites

Transport Containers

The containers can be made preferably of wood or temporary with hardboard, expanded polystyrene, or other material of similar strength, and there must be an adequate frame to ensure that the containers themselves are strong enough to house the animals and to withstand the handling involved during transport. There must be no sharp edges or projections on the inside surfaces of the containers. The containers should be sufficiently deep to prevent animals climbing out and the size should be such that there is not undue movement, which consequently minimizes the risk of injury. The container covers should close completely and must be fitted with a secure fastening device. Ventilation holes must be available in all walls/sides and the lid of the container to ensure an adequate ventilation at all times. These ventilation holes can be covered with fine mesh. Suitable gripper bars or lifting handles should be provisioned for easy handling.

The animals may be crated alone in case of bigger individuals or together in individual bags in case of

smaller specimens. If necessary, dampened sphagnum moss or foam chippings may be packed around the animals to be transported, especially in summers when temperatures can soar.

Transport considerations

Transport of live animals must be well planned, effectively executed with care that only animals in good health are transported. However, sick and/or injured animals may be transported under veterinary supervision for following veterinary treatment or diagnosis, (i.e., the animal is being transported to receive medical treatment for its condition, etc.). Freshwater Turtles and Tortoises do not need to be sedated during transportation and should be left undisturbed as far as possible. It is recommended that different species are not transported in the same transport container or bag. Feeding is not recommended or necessary during transport (In pre-planned situation, animals may be kept off food for at least 48 hours prior to transport).

Transport containers must be secured within the transport vehicle and should at all times be maintained in an upright position. The estimated time of arrival at destination and possible route should be notified in advance. It may be best to make adequate arrangements for prompt collection at the final destination, and for any necessary movement at transit points, in advance. In case of delay in collection, alternative arrangements for housing should be put in place in advance.



Fig 9: Transport crates at release site



Transport Consideration: Crocodilians

Transport cage/containers

Crocodilians require solid wooden boxes/containers. The size of the container must allow the animal to stretch to full length but not be so wide as to allow the animal to turn around. The sidewalls and floor must be wooden and smooth to avoid injuries during transportation. The container should be free of sharp edges, screws or nails that may be projecting inside the box. The container should be dark, with holes to facilitate ventilation and must have a proper, functional, lockable door to facilitate entry and unhindered release. It is considered good practice to provide at least one examination window that may be used for visual examination and pose as an option for providing treatment if required. The supporting framework outside of the box should be strong. Handles can be placed to facilitate manual carrying. Opening of the box can be from the sides and should allow unaided release.

Narrow-snouted species, particularly the Gharial, should have foam padding on the insides of the box on all the sides. This will help protect the narrow jaws from fracture if the animal struggles or is startled during transport.

PVC tubes (sections of plastic piping) having air holes drilled into them (the edges of the holes are smoothed) with ends secured with suitable plastic cover have been used for transporting small animals. These however need to be used with caution as the animals can be subjected to extreme stress due to difficulty in maintaining hydration and temperature during long journeys. The crocodile when placed into the tube remains secure and unable to harm itself however the tube requires proper positioning and handling to avoid rolling over. The head side should be properly marked to facilitate unhindered release.



Fig 10:Crate for transporting crocodiles



Transport considerations

Crocodilians should be maintained close to the range of 25°C to 28°C at all times. Temperatures over 35°C can be fatal, whilst temperatures below 15° C can also be detrimental. It is important to avoid transportation of crocodilians during extreme temperatures (cold winters or extreme hot summers). Crocodiles perceive threat mainly through ocular and auditory means and it is thus beneficial to keep the animal's head covered and nostrils open till it is in its transport box.

Release from the container

It is important to understand the release situation of the crocodile prior to reaching the destination, whilst animal is in container. It is easier and safer to place a transport box at the release site with one end open to allow the animal to exit on its own. The transport container should open from the ends only and not the top.



Summary

Principals of transport of freshwater turtles and tortoises and crocodilians remain the same but the modalities, crate types and crating methods vary depending upon the species, the number of animals, the size of the animals and the distance of travel. All crates should be well ventilated, secure and safe for the animals (without projections, bolts etc. that may injure the animals. Special precautions like padding the insides of the crates is essential for transport in Gharial.

Sedation of animals and feeding prior and during transport is not recommended.

Transport should be carried out during cooler parts of the day and precautions should be taken to avoid overheating and stress to the animals.



1.4

Managing Animal in Distress: Triage

Introduction

Illegal trade of wildlife can be considered one of the biggest threats to many endangered species. Although trade control has been attempted by laws created by member countries of the Convention on International Trade in Endangered Species (CITES), illegal trade continues. Trade in freshwater turtles and tortoises threatens to undo decades of conservation interventions globally. The general awareness about trans-boundary species trade especially in reptiles and a unified effort between enforcement agencies has brought to light the immense conservation challenge this unsustainable and illegal trade presents. This in-turn has led to more vigilance and a large number of confiscations have been recorded. Distress situations in wilderness and confiscations from trade vary in their presentations (from a few animals to thousands at a single time). There is no saying how animals will be found at the site. There

could be a truckload or animals stuffed into small backpacks or even socks and stockings. Interventions with crocodilians have been few and far between and large shipments of crocodilians needing triage are a rarity.

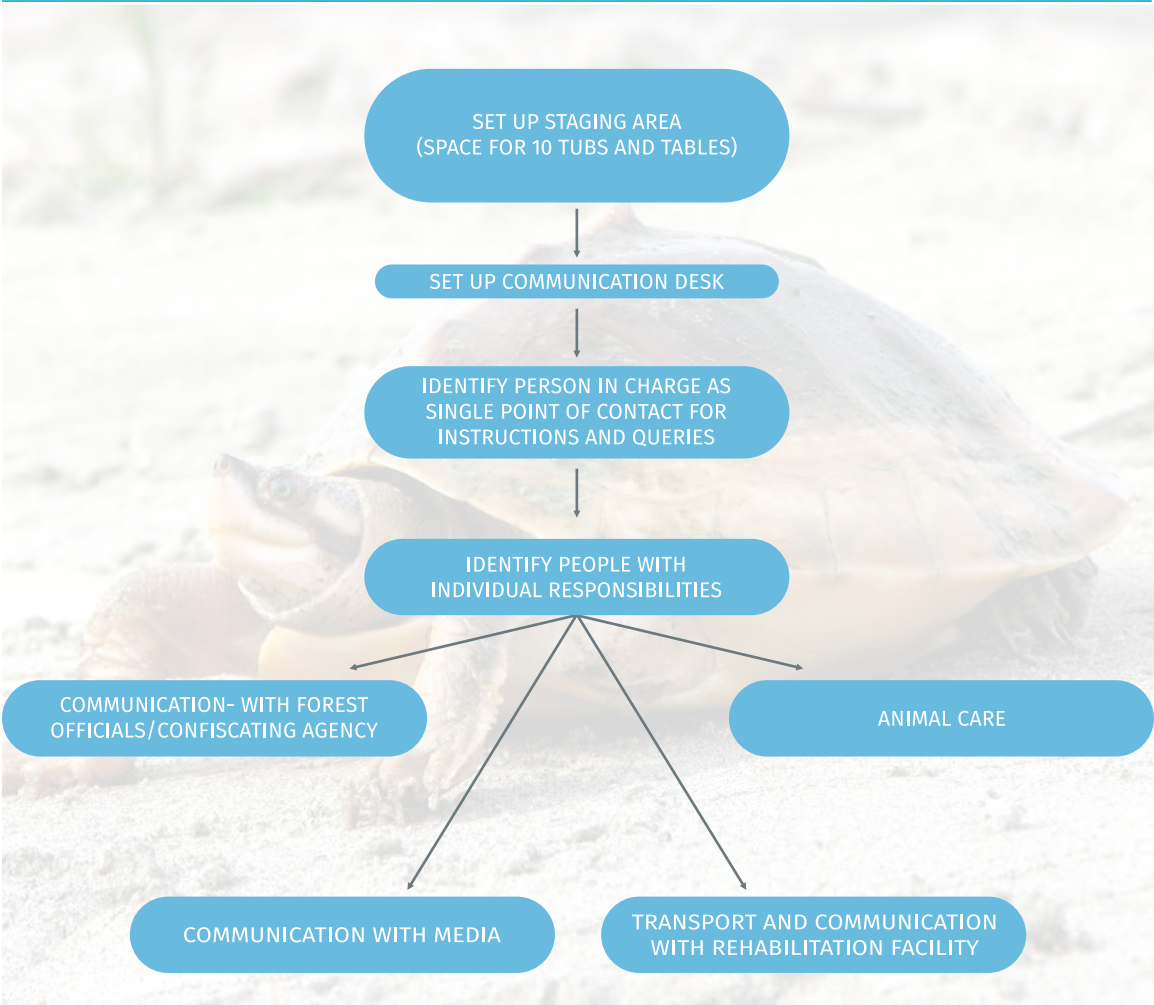
'Triage' is the process of determining the priority of patients' treatments based on the severity of the animals' condition, that rations patient treatment efficiently when resources are insufficient for all to be treated immediately. It becomes most important to efficiently segregate the animals as per the demand on time of the personnel, available resources on site, the species in question and the seriousness of the patient at hand.

MANAGING ANIMALS IN DISTRESS





TRIAGE PROCESS AND PROTOCOLS



Individual animal identification (species, sex and age class) is initially recorded followed by assessment of body parameters including weight and morphometry. At triage, each animal is handled by one person, who becomes responsible for the animal and for maintaining proper records until completion of all procedure. A priority classification of 1 to 5 (1=healthy, 5=dead) can be assigned to each animal.

Triage Categorisation

Category I	Healthy, no ocular, nasal discharge, nil to slight dehydration, no external or debilitation injuries
Category II	Mild dehydration, fish hook injuries, mild respiratory distress, external parasites.
Category III	Sunken eyes, ocular and/or nasal discharge, blood from nostrils/mouth/vent, injuries.
Category IV	Severe and debilitating injuries,-laceration fractures, frank blood from orifices, severe dehydration,
Category V	Dead on Arrival



Subsequent to this, if the animals are in triage categories 1 and 2, they can be released immediately while others requiring first aid, treatment or veterinary support may be handled accordingly. For critical injuries in animals, that compromises their fitness or wellbeing and limits chances of further survival, it is important to either shift them to rescue centers for intensive care or explore humane methods of euthanasia to avoid unnecessary suffering.

Biologists/ trained volunteers can assist with unloading the crates/baggage and presenting the confiscations in a manner that the animals can be properly examined and information recorded. Temporary enclosures and containers with adequate provisioning of water can be done. Each animal must be provided with an ID number and marked by appropriate marking procedures (digital photographs, notching or clipping scutes/ toe tags/ paint etc.). Animals that arrive dead must also be given an ID.

On admission

- a) Gather history
- b) Record all information
- c) For hatchlings and juveniles, determine if the animal is in need of rehabilitative care or released back to natal site. If the latter, arrange return of the animal (s) accordingly

Stabilization of the Animal

- a) Evaluate the animal quickly when transferring to a holding space.
- b) Examine for critical conditions and administer emergency care as needed
- c) Provide warmth (unless animal is showing signs of heat stress and dehydration)
- d) Provide quiet rest space
- e) Before handling the animal for the full exam, observe quietly.

Animals determined to be Triage category III or higher must be placed in holding areas where they can be treated and monitored.

Animals must be stabilized with subcutaneous or intra-coelomic infusion of rehydrating fluids. A basic dose of a broad-spectrum antibiotic like a third generation cephalosporin, to combat infection often proves beneficial. Depending on specific cases, antifungal agents, nutrient

supplementation, critical care formulae and medications can be given. The animal must be examined for external parasites like mites, leeches etc. and appropriately treated using ectoparasiticides. The common diseases that can be encountered in confiscated animals include severe emaciation/ malnutrition, bacterial pneumonia and septicemia, presence of invasive foreign body like fish hook (commonly identified in the mid to distal esophagus)/ net entanglement injuries associated with penetrating fibrinonecrotic lesions and endoparasitism. Anesthesia and surgical removal of the hooks and any other procedures may be performed post processing and before the animals are housed for long term care.

If animals are presented as Dead On Arrival (DOA), a subset of the animals should be necropsied by veterinary health professionals.

Formal triage, short-term care of wildlife casualties, ends at this stage. Rehabilitation facilities have staff with adequate knowledge and experience to deal with casualties. The suitability of a facility could be very species-specific and isolation facilities should be available. Enclosures designed to allow animals to fully regain fitness and develop natural behavior traits prior to release are an added advantage.

Even after triage and often heroic efforts, it is difficult to comment specifically about the survivability of the animals that were confiscated other than to say it is dependent upon the species. The rehabilitation process can be intensive or just maintenance for basic observation with minimum intervention prior to release back to the natural habitat. This process though is essential to ensure fitness and to afford them the best chance at survivability in their natural habitat.

The admission form at triage and immediately post triage for rehabilitation is provided in **Annexure II**.



Initial Treatment

The list of medications used on confiscated Asian turtles at triage and immediately post triage for rehabilitation are provided in **Annexure I**.

Essentials

- a) Provide fluids
- b) Clean and treat any wounds
- c) External examination and radiograph for detecting fracture of carapace and hard tissues.
- d) Administer medications (antibiotics, analgesics, remedies, etc.), remove external parasites
- e) Provide appropriate, palatable nutrition for species and status
- f) Conduct or schedule any ancillary diagnostics (radiographs, blood work, fecals, etc.) and any additional treatments (surgeries, follow-up changes, etc.)

Summary

'Triage' is the process of determining the priority of patients' treatments based on the severity of their condition, that rations patient treatment efficiently when resources are insufficient for all to be treated immediately. Trained personnel contribute positively to efficient triage processes. At triage animals should be classified into categories based on the condition of the animals and thus prioritizing treatment and allocation of resources. Animals are in triage categories 1 and 2, they can be released immediately while others requiring first aid, treatment or veterinary support may be handled accordingly. For critical injuries in animals, that compromises their fitness or wellbeing and limits chances of further survival, it is important to either shift them to rescue centers for intensive care or explore humane methods of euthanasia to avoid unnecessary suffering.





NEST RESCUE: ESSENTIALS

2.1

Nest Rescue: Essentials

Freshwater species may be the most threatened in India and have been facing declines due to multiple factors; habitat destruction being the most prominent. With the burgeoning of development activities and projects along the river banks, the fluvial dynamics are changing rapidly, compromising nesting habitats due to inundation. The sandbank agricultural practices also affect the geomorphology of the sandbanks. Additionally, a large number of predators often excavate the nests and leave them open to elements. These challenges necessitate considerations for the rescue of nests and subsequent processing including the appropriate incubation till hatching and release is done. However, this requires an in-depth understanding of the nesting ecology and strategies for retrieval.





Riverside hatcheries

These are *in-situ* hatcheries and can form the first line of defence upon rescuing nests. However, these require intensive management in terms of a work-force and financial inputs. This method is mainly used for turtles using the riverine sandbanks.

Crocodile nests are generally protected at the nest site using mesh cages or locally available materials and very rarely moved to hatcheries (except in cases of the rear and release programs).

The nests that need to be rescued are excavated from the sand. Each nest is numbered and its location is recorded. Following details are recorded for individual nests; surface temperature before excavation, depth of first egg, temperature and humidity at first egg, depth of last egg, temperature and humidity at last egg and total depth of nest.

Each egg is marked for its orientation and assigned an individual number. The eggs are placed in a tray that should essentially have natal (sand from nest site). This tray is to be carried to the riverside hatchery. The site chosen should be on an elevated sandbar to keep the nests safe. The hatchery perimeter is covered by chain link fence for safety and individual nests are recreated based on the data collected.

Each egg is weighed, measured and then placed in the manner as in the natural nest. Each nest is then given the same number as documented at the time of collection. The hatchery needs meticulous and continuous monitoring. Temperature and humidity are critical for the

duration of incubation and need to be properly recorded. The nests can be given shade and sprinkled or misted with water to maintain temperature between 28°C to 32°C and 60- 80% humidity. This allows for accommodation of Temperature Dependent Sex Determination (TSD) and a good ratio of male and female hatchlings from the nest. Each nest is enclosed in a bamboo lattice which is removed at the time of hatching. The hatchlings can then be released at appropriate locations or become a part of a head starting initiative.

Ex situ incubation

Often, *in-situ* incubation at hatcheries is not possible and the eggs need to be shifted to *ex-situ* facilities for further processing and incubation till hatching.

The nests in precarious situations are collected in the same manner as mentioned above. Recording of the nest attributes and location is essential. In the case of transport to an *ex-situ* facility for incubation, the transport containers for the eggs must have a sand base. Natal sand is added to this when the eggs are placed. They must allow for carrying the eggs without movement so as not to dislodge the chalaza and cause embryonic death. Each egg is marked for its orientation and given an individual number and then placed in a container. The container is then transported to the incubation facility. The eggs are weighed and candled to check for viability once in a fortnight. A full clutch can be placed in a single incubator or divided taking due care of maintaining temperature and humidity as close as possible to that of the natural nest.

Head starting programs for crocodiles, mainly for *Gavialis gangeticus* have warranted movement of eggs to ex-situ incubation facilities. The process of collection of eggs, packing in transport containers and transport is the same as mentioned above.

Incubation methods

It is good practice to keep the clutches separate based on nest records. The eggs should be placed as they were retrieved and carefully monitored. Artificial incubation can be carried out using different procedures as mentioned below.

- 1) The conventional method for crocodile and turtle egg incubation is in wooden boxes filled with river sand. These boxes may be kept at room temperature and moisture is added



when the humidity goes below 80%. This is checked with a thermo-hygrometer.

- 2) Nesting chambers (3 ft x 3 ft x 3 ft) filled with river sand can also be used. These are designed to hold multiple clutches together.

The temperature and humidity can be monitored with thermo-hygrometers.

The limitation of these techniques is mainly poor control over the temperature and humidity that can eventually affect the hatchability of the egg and survivability of the hatchlings. Due to Temperature-Dependent Sex Determination (TSD)

in turtles and crocodilians, the recording of temperature and maintaining the ranges from 28°C to 32°C is critical.

- 2) Artificial incubation can also be done using media like vermiculite which is a hydrous phyllosilicate mineral. It is valued for its high absorbency and is mainly used in nurseries and gardening operations among other things. Vermiculite is available in various sizes (also called grains) and can be used depending upon the need for humidity during incubation. This may be a good medium to use with smaller clutches.



Fig 11: Vermiculite incubation of turtle eggs

Image source: Fishtanx.wordpress.com

The procedure with vermiculite is to moisten it till it clumps and holds. This vermiculite may be spread as a layer in boxes and then the eggs are placed in the boxes. The eggs are "buried" in similarly moistened vermiculite. Temperature and humidity are monitored with thermo-hygrometers.

- 3) Styrofoam boxes can be easily modified to serve as incubators. They are lined with materials called dry lock (3 coats) to prevent water leaching. In each box, a 3 inch PVC pipe is placed at each corner. This acts as a stand for placing the eggs. Water is filled till 3" mark and a small aquarium heater with a thermostat is placed to maintain temperature. A mesh is placed on top of the PVC pipe as a frame and the box containing eggs placed in

1/4" of vermiculite or peat moss are placed on the frame. A wireframe covered with tin foil (bent into a "u") can be used to covers the box



Fig 12: Turtle egg incubation in Styrofoam

Image source: turtleforum.com



of eggs so that the condensation will run off on the sides and not fall into the eggs. A thermohygrometer is used to measure the temperature and humidity.

- 4) Artificial incubators that incubate upto 90 eggs at a time are available. They have been fabricated to allow for all measurements and monitoring. Examples may be located at <https://www.incubators.org/reptile-incubators.html>

Temperature Humidity Essentials Chart

Species	Humidity (%)	Temperature (°C)
Hardshell Turtles	60-70	26-32
Softshell Turtles	65-85	26-32
Tortoises	60-70	25-32
Crocodilians	70-85	28-32

**Lower temperatures require longer incubation times whereas higher temperatures produce shorter hatch times.

Hatching

In the natural hatching process, immediately prior to hatching, the yolk sac is internalized into the coelomic cavity of the hatchling. After successful yolk internalization, the body wall closes around the navel. From this point, gas exchange can no longer take place through the membranes and the embryo must initiate gas exchange through its lungs. It is hypothesized that hypoxic conditions in the embryo during yolk internalization cause contraction of muscles in the neck of the hatchling, leading to pipping. Pipping occurs when the egg tooth, or caruncle, is forced through the egg shell. Once the egg shell is broken, the process of emergence of the hatchling from the shell can take 24 hours to 48 hours.

In many instances, the specific hatch time is not known and constant observation should be performed to investigate when the process should be expected. In some species of crocodilians, embryos begin vocalizing from within the egg prior to pipping. More than 20 eggs from the same clutch are expected to hatch within a few days of each other. Manual pipping and intervention in the natural events of hatching should be reserved for situations where the viability of the embryo is at risk.





Summary

In-situ hatcheries form the first line of defence upon rescuing nests. The nests that need to be rescued are excavated from the sand, numbered and locations are recorded. Following details are recorded for individual nests; Surface temperature before excavation, depth of first egg, temperature and humidity at first egg, depth of last egg, temperature and humidity at last egg and total depth of nest should be recorded for all nests. Each egg is marked for its orientation and assigned an individual number. The eggs are placed in a tray that should essentially have natal sand and carried to a hatchery. Each egg is weighed, measured and then placed in the manner as in the natural nest. In Ex-situ incubation facilities. Recording of the nest attributes and location is essential. The transport containers for the eggs must have a sand base. The eggs should be weighed and candled to check for viability once in a fortnight. A full clutch can be placed in a single incubator or divided taking due care of maintaining temperature and humidity as close as possible to that of the natural nest. Due to Temperature-Dependent Sex Determination (TSD) in turtles and crocodilians, the recording of temperature and maintaining the ranges from 28° C to 32°C is critical. Humidity to be maintained between 65-80%.





CAPTIVE CARE, HUSBANDRY AND UPKEEP

3.1

Enclosure Design and Enrichment

Enclosure design is a multifaceted science and is considered as the most elemental factors in captive environments; from zoological facilities to rescue centres and even the temporary transit facilities. Managing animals in captive facilities is a challenge as it often compromises the physiological and psychological well-being of animals. It is essential that enclosure design includes attributes that address welfare concerns and are suited to effectively minimize stress. Environmental enrichment plays an important role in addressing these concerns. Modifications that create niches allowing animals to thermoregulate and exhibit normal behaviours of swimming, diving, basking etc. are essential to be incorporated into the environmental enrichment and design paradigms.

Basic principles of enclosure design

The foremost thing to keep in mind when designing an enclosure is the ecology and behavior of the animal. There are some essential elements to consider though and the same are listed below;

- 1) Topography: Contour maps of the preferred site allow for the design to be chosen based on the natural features. The elevations and depressions, boulders, rock faces can be used for features based on the species in question.

This allows for the excavation work to create ponds and banks to be handled efficiently.

- 2) Shape, Size, And Orientation: The enclosure should be planned taking into account the natural history of the species to decide the depth of the ponds and orientation. Access to sunlight is most essential for all chelonian and crocodilians enclosures to achieve the physiological preferred optimal thermal zones





(POTZ). Enclosures for aquatic species can be built to exclude sharp corners. Curvilinear designs allow for better use of space by animals. The masonry work can be camouflaged by use of boulders, vegetation, and ferocement structures. The sizes of the enclosures depend on the species to be housed and also the number of individuals.

- 3) Vegetation: Design should be preservative in nature and maintain the natural vegetation and tall trees as much as is possible. Additional vegetation, especially aquatic macrophytes, from the ecological zones of the animal and as per species distribution may be incorporated.
- 4) Viewing area: Visitor entry is not permitted in rescue and rehabilitation facilities. But as these animals are under a care regimen and are to be released back into natural habitats, constant observations by animal care staff without disturbing the animals is an important design consideration. All enclosures should be screened from each other in an appropriate manner.
- 5) Placement of enclosures: In rescue and rehabilitation centres, the enclosure arrangement is varied; quarantine enclosures are the farthest, the hatchling ponds should be placed close to the incubation set up and to keeper areas for better control, the holding ponds can be far away from activity areas to allow for least disturbance.

Characteristics of Animal Enclosures

Enclosures must have appropriately sized areas, both land, and water that are suited to the ecological, behavioral and biological needs of the animal. For chelonians and crocodilians, criteria to consider include swimming, diving, basking, nest building (sandbanks and leaf litter where necessary as per species) etc. Enclosures can have separate ponds for animals to retreat, should a circumstance of discord between the animals arise. Quarantine/ animal care setups can include the use of easily manageable artificial items like bathtubs to house single or smaller animals. These are easy to maintain and keep clean.

While constructing enclosures it is important meticulously remove sharp areas, projections etc. that can cause injury or harm to the animals. The

enclosures must be secure from animal escape and also from miscreants being able to enter the enclosure. Height and specifics of the mesh should be appropriate to prevent even the smallest animal from escape. The mesh with adequate grouted support structures must be dug into the ground upto 3 feet to prevent animals from excavating out of the enclosure.

The enclosure plans should have a walkway along the entire edge of the enclosure for all rounded access to the keeper. Keeper access must be considered for convenience during feeding routines and cleaning and maintenance of enclosures. This can be achieved by creating pathways and safe areas for the keepers to access animals especially large crocodilians.

For aquatic and semi aquatic species like crocodilians and turtles, availability of adequate water is the key. Ideally there should be a storage facility connected to the enclosure for uninterrupted supply. Water filtration and recycling are valuable in water conservation and maintaining water quality. The drainage system must be maintained regularly and the water that is drained should ideally be treated so that there is no chance of any spread of diseases from the captive facilities.

It is essential to ensure rodent proof enclosures. An R.C.C bottom below an earthen substrate of sufficient depth can be used. Additionally, fittings to prevent rodents from entering from other routes (from the beams, support structures or pillars) are essential. Smoothing of the of the plinth and appropriate size of the mesh will keep out snakes, civets and other free ranging animals that may be causes of concern.

Barriers: They are essential to keep the animals inside and safe, and also to keep people out. Barrier construction depends on the animals housed within the enclosure. In case of chelonians and crocodilians, especially the Gharial, The Central Zoo Authority recommends; Moated enclosures or partly moated enclosures both wet & dry of 3m width & 1.5m depth. The back can have rubble walls of 2m height. When dry moat is provided the water body should be away from the same. Other two species of Indian crocodilians i.e. mugger and estuarine crocodile can have similar moats with 2m deep moats with rubble walls at the back. (Gupta- Zoo Barrier Designs; CZA Publication 2004).



Types of barriers	Materials used for barrier construction (based on climate, topography, aesthetic, cost, availability of materials and animals being housed as per CZA guidelines)
Steel vertical bars	Acrylic/ Fiberglass
Chain link/ welded mesh	Cement/ Concrete Brick/ Rubble/ Laterite Blocks and mortar/ Ferro-cement / Loose Boulders
Glass	Chainlink mesh and angle iron/rails/welded mesh
Horizontal pipes	Pipes/Angle iron/Channels etc
Vertical concrete stone wall or Rubble wall	Aluminium, Mild steel, Stainless steel, steel wire
Natural cliffs	Wrought iron
Dry/wet moats	Nylon Nets
Wooden stockade	laminated toughened glass/ ordinary glass
Solar powered fences	Wood, Bamboo
Shrubbery	Rubble masonry
Psychological barriers	Vegetation

Exhibits and Environment Enrichment

Enclosures are in public view (zoological facilities are open to the general public and rescue rehabilitation centres to various technical experts and officials) and have to follow norms set in by the regulating authorities. All enclosures, in going with the global trend, are now modeled as "immersion exhibits". This is where the enclosure is designed to recreate the natural habitat of the animals or get as close as possible. The design philosophy of enclosures moves away from being anthropocentric and prioritizes the need of the animals. Species-specific enclosures are designed along with the areas used for viewing as independent entities. The use of signage and live interpretation media like sounds and natural history films augments the experience in each enclosure. In rehabilitation centre enclosures; be it quarantine enclosures or enclosures for acclimatization prior to release, the functionality is the most important consideration. Signage is used in rescue and rehabilitation centres as well but serves the purpose of keeping track of species, number of animals, diet charts, temperature data and so on. This is to assist with management of the space and the animals. It is accepted that enclosure enrichment plays a vital role in the physical, physiological and psychological well-being of the animals.

Environment Enrichment

"Environmental enrichment is a dynamic process in which changes to structures and husbandry practices are made with the goal of increasing the behavioral choices available to animals and drawing out their species-appropriate behaviors and abilities, thus enhancing their welfare. As the term implies enrichment, typically involves the "identification and subsequent addition to the zoo environment of a specific stimulus or characteristic that the occupant(s) need but which was not previously present". From modest beginnings, the process of environment enrichment has now developed into a precise science with lasting impacts on all spheres of animal care in captivity and even for rehabilitation.

General materials used for enrichment in enclosures for chelonians and crocodilians-

Logs/branches, Vegetation groves/ bushes, Water pools with flowing water systems, Fountains converted to waterfalls, Artificial sand banks and islands and Nesting material.

In all rescue and rehabilitation facilities successful return of species to the wild is considered the key. There has not been too much work done on the role of environment enrichment in this sphere and even less so when it comes to reptiles. Coelho, Schetini de Azevedo, & Young, 2012 have studied



this aspect specifically intended to enhance preparations for reintroduction. They say that many of the goals of environmental enrichment are consistent with the skills needed for survival in the wild. For example, enrichment strategies that promote species-typical behavior such as foraging, shelter-building or seeking, and successful reproduction in pre-release settings, in turn, increase the likelihood of those behaviors occurring in post-release settings and ultimately enhance the rate of survival. Enrichment has thus become an important part of reintroduction programs. It is critical that good methods are developed for evaluating the effectiveness of enrichment strategies designed to support natural behaviors that allow animals to successfully transition to wild habitats.



3.2

Sanitation and Hygiene

Introduction

Sanitation is defined as the combination of both cleaning and disinfection and is a requirement for all captive facilities. Good quality sanitation is deemed as an essential and important part of animal housing as it helps in reducing the transmission of infectious diseases to both animals and people, and results in a cleaner and healthier environment.

Sanitation protocols may be extrapolated from many sources, protocols must be based on current knowledge and agents for achieving the goals of both cleaning and disinfection. Adequate staff must be assigned to complete sanitation tasks swiftly and efficiently each day. Disinfectants must be chosen that are effective under the conditions present in a given environment (e.g., presence of organic matter) and with demonstrated action against the pathogens which may pose a threat to the animals.

In general, the order of cleaning and care of animals should start with healthy newborns/ hatchlings and gravid animals followed by healthy adult male and females and unhealthy animals undergoing treatment and lastly the quarantined animals.

Following points should be considered for a captive facility;

1. Separate cleaning supplies and accessories must be designated for each enclosure.
2. Appropriate protective clothing like gloves, gowns, and/or boots should be used in each area and removed before proceeding to other enclosures, especially in case of quarantine facilities.
3. Systematic sanitization of primary enclosures before a new animal enters is very important.
4. Sanitation protocols must include removal of gross organic matter including food leftover, pre-cleaning of surfaces by scrubbing, application of a disinfectant at the correct concentration and for a sufficient time, rinsing, and drying.
5. When water or cleaning and disinfecting products are sprayed in or near the area of the primary enclosure, animals must be removed from the enclosure and must be separated from the area. Sufficient drainage and disposal of the waste water is essential.
6. Since apparently healthy animals as well as those who are obviously ill could be shedding



- pathogens, any complete sanitation protocol must address proper hygiene of shelter staff, volunteers, and visitors, including signage. Proper hand sanitation is one of the best ways to prevent disease transmission and must be mandated before and after handling animals. Hand sanitation is achieved through hand washing with soap, use of hand sanitizers and gloves.
7. Sinks should be available in all animal housing and food preparation areas, and must be equipped with soap. Hand sanitizers are to be used only on hands that become visible clean and should contain at least 60% alcohol. Clothing, even if visibly clean, may still carry pathogens. Protective garments (e.g., gowns, gloves, and boots or shoe covers) can be worn during cleaning or other intensive animal-handling activities and changed before going on with other activities of the day.
 8. All equipment that comes in contact with animals (care and treatment) including cleaning supplies must be such that it is either readily disinfected or discarded after use with a single animal.
 9. Transport cages and traps, as well as vehicle compartments used for animal transport must be thoroughly disinfected before and after each use. Certain areas of the shelter, like isolation and quarantine areas, may be restricted to a small number of shelter staff.
 10. Many rodents and insects harbor bacteria and other pathogens that can contaminate food products, resulting in food spoilage or direct transmission of disease to the animals (Urban 1998). Areas of food storage are particularly vulnerable to infestation. All food should be kept in sealed bins or containers that are impervious to rodents and insects.

Sanitization and hygiene protocol to be followed in a captive facility

Type of facility/food and person concerned	Sanitization and hygiene techniques
Foot bath outside enclosure	Foot baths have dilute Potassium Permanganate solution. The foot bath must be cleaned every alternate day along with a change in solution.
Leftover food	Ensure cleaning of leftover food and debris should be assured every morning.
Water change	Partial water should be changed every 3 days with complete water change following scrubbing and cleaning of the ponds every fortnight along with water testing onsite. The water from enclosures should be pumped out into the sump outside of the enclosures. Scrubbing can be done with a brush where possible. Where there is sand substratum use of any chemicals must be avoided.
Sand substratum	Should be thoroughly washed with running water every fortnight when the pond water is changed. The sand can be changed every three months based on availability and degradation of quality.
Feeding utensils for food distribution	Must be kept separate and must be thoroughly cleaned before and after use with soap. Soaps are sodium or potassium salts of fatty acids (e.g. oleic, palmitic and stearic acids) and are inactivated in the presence of calcium or molybdenum ions. Although soaps are not antibacterial, the cleansing action removes large numbers of microorganisms. After



Type of facility/food and person concerned	Sanitization and hygiene techniques
	cleaning with soaps, feeding utensils and containers must be thoroughly rinsed. Diluted solution of cooking vinegar (1-part vinegar to 5 parts waters) may also be used.
Crates/ Boxes/ Tubs used to carry turtles for routine procedures and treatment	Must be thoroughly disinfected with solutions like Chlorhexidine 30 ml in 4 litres of water or isopropyl alcohol, dried and stored outside the enclosures after use everytime.
For keepers before and after feeding animals	Must wash hands thoroughly with carbolic soap before and after feeding
For keepers after handling animals	Must wash hands thoroughly with soap before and after handling any animals.
Equipment used for animal treatment and procedures	Must be cleaned and disinfected before and after use with 70% isopropyl alcohol and stored separately.

Summary

Sanitation protocols must be based on current knowledge and agents for achieving the goals of both cleaning and disinfection. Adequate staff must be assigned to complete sanitation tasks swiftly and efficiently each day. In general, the order of cleaning and care of animals should start with healthy newborns/ hatchlings and gravid animals followed by healthy adult male and females and unhealthy animals undergoing treatment and lastly the quarantined animals. Sanitation and hygiene protocols include not only the enclosures but the surrounds and the animal caregivers too. Routines set for the sanitation and hygiene and standardized and dedicated equipment for various enclosures along with equipment for the caregivers will ensure that protocols are followed.



Quarantine

Introduction

Quarantine includes maintaining a group of aquatic animals in isolation with no direct or indirect contact with other aquatic animals, to undergo observation for a specified length of time. During this period, testing and treatment of animals that might have disease is followed. Quarantine measures should first and foremost take into account epidemiological factors like host agent and environment. The quarantine enclosures must take into account the thermal requirements of the species and allow for thermo-regulatory behavior. They must include adequate access for regular visual checks, clinical examination, sampling and restraint. Isolation must be ensured from all possible sources of infection. The major prerequisite is that wild animals or a single wild animal under quarantine must be isolated from all others of its own or closely related species in captivity. In almost all cases it is recommended that quarantine be carried out on an "All in, All out" basis.



Situations warranting quarantine

It is mandated that quarantine be followed for animals once they come into captivity from an outside location, pre-release, or even for captive wild animals being returned to the wild. The quarantine process is mandated for at least 30 days prior to release and in most cases is to be supervised by a veterinary health professional.

Quarantine measures to be followed at a facility

The main requirement is that a group of wild animals (or a single animal) under quarantine must be isolated from closely related species and if possible, from all other species, wild and domestic. It is important to keep in mind the following;

- 1) Quarantine premises must be species appropriate keeping in mind epidemiological factors.
- 2) The premises must allow adequate visual access and permit clinical examination, sampling and when necessary, restraint and isolation from all possible sources of infection.
- 3) Equipment used for feeding, cleaning the enclosure and for enrichment must be handled by a single care-taker and must be

regularly disinfected with an appropriate disinfectant, approved by the attending veterinary professional.

- 4) If an animal or group undergoing quarantine with others of the same species contracts an infectious disease or tests positive for an infectious disease while in quarantine, they must be detached from the group and placed in further isolation for 30 days or more. This is dependent upon the disease incubation period with appropriate testing.
- 5) Precautions must be taken to minimize the risk of exposure of the quarantine facility staff to zoonotic diseases that may be present in the newly acquired animals. These precautions include the use of disinfectant foot baths, wearing appropriate protective clothing, masks and gloves and minimizing physical exposure.
- 6) When it is decided to release the animals into the wild, it is predominantly important to screen them cautiously, to minimize the risk of introducing an infection into the wild population.

Quarantine protocols on receiving animals at a facility

On receiving confiscated or rescued animals a health assessment must be carried out as follows;

Stage 1

Examinations	Techniques	Findings	Interventions
Physical examination	Visual	Injuries, ecto-parasites and dehydration.	Physical restraint, sedation, medical intervention, surgical interventions removal of external parasites, fluid therapy.
Hematology and serum biochemistry	Blood smear and serum biochemistry analysis at a laboratory.	Infections, anaemia, gout, imbalance in minerals, metabolic bone disease and hypoproteinemia .	Antibiotics and supportive medication.
Blood examination for microbiology and virology	PCR and blood cultures.	Salmonellosis, herpes virus, cryptosporidiosis, mycobacteria, mycoplasma.	Antiviral drugs, antimicrobial drugs following a culture sensitivity test.
Faecal examination	Direct, sedimentation and flotation method and under microscope.	Endo-parasites like coccidiosis, ascariasis, etc.	Anthelmintics and supportive medication.



Stage 2

The animals are to be maintained in isolation in species specific and size specific holding ponds which allows for observation of normal/abnormal behavior like thermoregulation, swimming, diving etc. During this stage, intervention (medical or supportive) is performed only when essential. Regular assessment of morphometry, diet and health is carried out. The enclosures are provided with filtration and aeration systems and basic furniture, to allow for thermoregulation and for the animals within to have access to temperature gradients and niches.

Stage 3

Pre-release health assessment to be done to ensure optimal health. Animals designated fit to release can be returned to wilderness habitats.



Health Management

3.4.1 Pre- Release Health Assessment

As per the guidelines of the re-introduction specialist group of the IUCN, at the time of release of animals one must take into account disease risk: as no translocated organisms can be entirely free of infection with micro-organisms or parasites. This may give rise to a consequent risk of their spread and disease risk assessment should start at the planning stage. A pre-release health assessment thus plays a critical role.

Process

1 month prior to planned release, animals should be quarantined and undergo pre-release examination and testing consisting of:

- Thorough physical exam
- Complete blood counts, serum biochemistries

Summary

Quarantine includes maintaining a group of aquatic animals in isolation with no direct or indirect contact with other aquatic animals, to undergo observation for a specified length of time. During this period, testing and treatment of animals that might have disease is followed. Quarantine premises must be species appropriate keeping in mind epidemiological factors, must allow adequate visual access and permit clinical procedures. Equipment used for feeding, cleaning the enclosure and for enrichment must be handled by a single care-taker and must be regularly disinfected. If an animal or group undergoing quarantine with others of the same species contracts an infectious disease or tests positive for an infectious disease while in quarantine, they must be detached from the group and placed in further isolation.

Precautions must be taken to minimize the risk of exposure of the quarantine facility staff to zoonotic diseases. It is predominantly important to screen them cautiously, to minimize the risk of introducing an infection into the wild population.

and blood smears for haemoprotozoa

- Fecal examination for endoparasites

Animals found to be injured or animals that are ill should not be considered eligible for transport and release. Conditions such as, but not limited to, elevated white blood cell counts, low PCV, abnormal total protein and positive fecal results may be cause for extending the period for evaluation and not releasing the animals into the wild until treatment is completed and results are normalized. Animals with endo-parasites can be treated appropriately and re-tested until there is assurance of negative status prior to release.

General Recommendations for Pre-Release Examination

- The examination area should be set up under a shade/ canopy and all examination and sampling equipment should be kept ready before any animals are caught.



- An area where animals that have already been examined can be placed should be identified and cordoned off. It should be separate from the space that holds the animals yet to be handled. This will avoid a wastage of time from recapture of already sampled animals and lower the stress on the animals.
- Microchip transponder power and all equipment availability may be checked prior to sampling.
- Coordinator should brief the team on the process of capture, examination and sample collection prior to any animals being caught.
- Capture, exam and sampling of the animals should be done early in the day. This avoids the hottest period of the day and enables the team to process samples as necessary.
- Biological samples should be taken and labeled and packaged such that they reach the appropriate laboratory ideally on the same day.

Health Check and Examination

- No animal must be assumed healthy. All external body parts of the animal should be examined carefully.
- If an animal has an injury, the site of the injury, freshness and severity should be detailed. In

addition, it is important to note how/if this is affecting the animal's physical and physiological ability to function normally.

- In addition to the veterinary examination, information on observations of any abnormal animal behaviour can be recorded.
- Sex and weight of all animals must be re-confirmed where possible.
- Blood samples can be collected from the animals as mentioned below

Crocodilians

The caudal or ventral tail vein

The occipital venous sinus/ supravertebral vessel.

Chelonians

Jugular vein (under anaesthesia)

Sub-carapacial vein and plexus

Caudal or dorsal tail vein

Brachial vein/plexus

Calculate blood volume of animal as 5% of body weight. Up to 5-10% of blood volume may be drawn from healthy reptiles.

Fecal sample collection can be attempted by a colonic wash or cloacal swab.

Method: A lubricated rigid or semi-rigid catheter filled with sterile saline and attached to a syringe containing saline is passed into the colon via the cloaca. Once the catheter has been inserted into the colon, several milliliters of saline is flushed into the colon, followed by aspiration. This may be repeated several times. Once a sample has been collected it is placed into a plain sample tube.

The list of equipment required for sampling is provided as *Annexure III*.

Diagnostics

Fecal (colonic wash) analysis

- Direct wet mount for protozoa and helminthic ova
- Sediment following centrifugation for protozoa, cestode and trematode ova
- A flotation specimen using similar techniques to those in domestic animals for identification of nematode ova

Differential white blood cell count (On stained microscope slide) Staining by Diff Quik or Leishmans or Giemsa Stains to be specified as per use.



Haematology	Biochemistry
WBC count (microlitre)	Total Cholesterol (mg/DL)
RBC count (microlitre)	Triglyceride (mg/DL)
Hemaglobin (g/DL)	Creatinine (mg/DL)
Hematocrit (PCV) (%)	Calcium (mg/DL)
MCV (fL)	Phosphorous (mg/DL)
MCH (pg)	Sodium/ Na (mmol/l)
MCHC (%)	Potassium/ K(mmol/l)
Heterophils (microlitre)	Total Protein (g/DL)
Eosinophils (microlitre)	Albumin (g/Dl)
Basophils (microlitre)	Globulin (g/Dl)
Lymphocytes (microlitre)	Total Bilirubin (mg/ DL)
Azurophils	Urea (BUN) (mg/DL)
Monocytes (microlitre)	ASAT (UI/l)
Platelets (GigaL)	ALAT (UI/l)

Summary

A pre-release health assessment thus plays a critical role prior to planned release and testing consisting of a thorough physical exam, Complete blood counts, serum biochemistries and blood smears for haemoprotezoa as well as Fecal examination for endoparasites is essential. Animals found to be Injured or animals that are ill should not be considered eligible for transport and release.

3.4.2 Common Diseases and Emergencies

Reptiles are ectotherms and all their physiological activities including their immunological responses may be influenced by environmental temperature. Being poikilotherms crocodiles and turtles use the thermal gradient in their natural environment consisting of sunshine and shade, warm surface and cold deep water, as well as burrows to maintain their body temperature within a narrow range of 280C- 330C. This may heavily influence their physiological responses as well as immune responses.

In captive conditions inappropriate enclosure design and husbandry practices may pose challenges for thermoregulation. Inordinate





3.4.3 Biological Sampling and Laboratory Essentials

Introduction

exposures to fluctuating temperatures may be attributed to common sources of stress. In the wild, the factors that potentiate stress are detrimental alterations to the hydrological features of habitat and anthropogenic activities like fishing, sand bank agriculture and release of toxins from agriculture and industrial activities. These factors may make aquatic species susceptible to diseases. Infectious diseases may be attributed to aetiological agents like virus, bacteria, fungi and parasites. Non-infectious causes may be congenital, nutritional, behavioural or husbandry related.

Chelonians

Considering the physiological requirements of fresh water turtles and tortoises, common causes of diseases and disorders may be improper diets, inability to thermoregulate and poor husbandry operations. These factors can result in a weak immune response leading to problems of eye, skin, shell and weak bones manifesting in signs like loss of appetite, lethargy, buoyancy problems (e.g., floating sideways), swollen eyes, and runny nose. These signs are not specific to any particular disease, but are symptoms of disease.

Infectious diseases

Many species of bacteria and fungi may reside as commensals in the mouth and digestive system as a part of the normal environmental flora in their habitats. However, when under stress these organisms may trigger infections and may spread rapidly via the circulatory system affecting the shell, skin, respiratory tract and digestive tract.

A list of common diseases of chelonians and crocodylians is provided as **Annexure IV**.

To prevent predation and increase their chances of survival, reptiles have evolved to be stoic, mastering the art of masking illness, which makes their diagnosis and treatment challenging. Further, they have anatomical biological and physiological peculiarities that differ both between and within major groups. Therefore, reliance on biological sampling and laboratory examinations is crucial to reach a definitive diagnosis. The tests may hematologic, cytologic, fecal and urinalysis, and serologic evaluations for ante-mortem diagnoses, whereas a necropsy followed by histopathology, microbiology and toxicologic examinations is used for arriving at conclusive diagnoses postmortem.

Biological sampling

The first imperative step for any laboratory investigation must be proper biological sampling. Samples can be taken from animals or the environment for disease diagnosis, disease surveillance, health evaluation, monitoring response to treatment or even for establishing baseline values for certain parameters. The samples collected must thus be appropriate for the intended purpose, and adequate in number and amount to provide valid result.

Fig 13. Blood sample collection





Table 1. Minimum recommended equipment required for biological sampling in Chelonians and Crocodilians.

Sr. no	Equipment	Minimal recommended quantity
1.	Disposable syringes (1 ml & 3 ml)	1 box each
2.	20G/21G needles	1 box
3.	Sterile Ziplock bags	100 nos
4.	Vacutainer (Lithium heparin Coated)	1 Box
5.	Vacutainer (Plain/ with clot activator)	1 box
6.	Cryo vials	100 nos
7.	Sterile swabs	100 nos
8.	Glass slide	1 box
9.	Slide container	2
10.	Cover glass	
11.	Plastic screw cap/ tight fitting wide mouth containers (for tissue samples)	50 nos
12.	Aluminium foil	2 rolls
13.	Labels/ labeling tape	2 sheets

Heamato-Biochemical Evaluation

In chelonians and crocodiliansowing to nucleated erythrocytes and thrombocytes which interfere with accurate measurement of certain other parameters haematologyanalysis must be done manually.Intrinsic (e.g., species, gender, age, physiological status, breeding season, hibernation) and extrinsic factors (e.g., season, temperature, environmental conditions, husbandry, diet, living conditions, sample collection site, technique of analysis) may cause significant variations in hemato-biochemical parameters in reptiles (Anderson, 1997; Calle, 1994; Stacy and Whitakar, 2000, Machado et al., 2006, Saggese, 2009). Published information can provide only a baseline

for interpretation, and calls for an understanding of crucial factors to accurately interpret and correlate hemato-biochemical and clinical findings.

Processing and preservation

Reptile blood is much more fragile compared to mammalian blood and must be placed in appropriate collection tubes and processed as early as possible (Scott, 2006). The following considerations are applicable

- For haematological evaluation, blood samples should be collected directly into lithium heparin coated vacutainer. EDTA coated vacutainer should be avoided as it may cause the blood to lyse in some species of reptiles (as in chelonians).
- Blood samples for evaluation of biochemical values can be collected in lithium heparin coated vacutainer or separately into a sterile/clot activator coated vacutainer, based on decision to analyse either plasma or serum.
- Since heparin often imparts a blue tinge to the overall staining of the blood film and causes clumping of leukocytes and thrombocytes, fresh blood smears should also be made immediately without any preservative for differential leukocyte count (Campbell, 2006).
- In wedge smear method, the use of a bevel-edged slide is crucial to avoid artificial cell damage.





- Frequent preparation mistakes include inadequate volumes of blood and interruption of the smear movement, which result in the loss of the monolayer area.
- A routine preparation of at least three smears per blood sampling is recommended to be prepared for additional examinations, such as suspected parasitemia or failure of proper staining.

Diagnostic Test	Samples	Preservation	Labeling and Dispatch
Blood profiles	Whole blood and serum for heamto-biochemical tests	Thin Blood smears for haemoprotozoa vacutainers	Lithium Heprin coated The labeling should include: 1) Species name 2) Individual identification 3) Sex of Individual 4) Date and time of collection 5) Location where sample is being sent from 6) Medical History of animal if available 7) Copy of permission for sample collection and testing The samples should be dispatched to concerned laboratories (as directed by Veterinary health professional) by the fastest route with a covering letter to the concerned authority, and name and contact number of the sender
Ecoto-parasites	Parasite samples of ticks, mites, leeches etc	70% alcohol	
Faecal Analysis	Stool samples (individual or pooled sample) for testing for endoparasites by collection of direct defaecation or cloacal wash	No preservative is used for direct smears and sedimentation or floatation tests. Formalin can be used to preserve samples for future analysis of eggs and non-dividing schizonts	
Bacteriology and Virology	Blood, urine, Stool, Nasal wash, Nasal and rectal swabs	Stored in ice or refrigerated for short term storage. Stored at -20deg C for long term storage	
Nurtition	Gut content, faeces, feed	Nil	
Biopsy by Fine needle aspiration cytology or impression smears	Tissue sample in case of masses, tumours etc	Refrigeration at -20 °C	

Summary

Sample collection for diagnostic tests is an invaluable tool for reaching a confirmatory diagnosis of a disease or for epidemiological monitoring of animals and populations as a whole. Biological samples; blood urine, faeces, tissue samples etc. should be collected and preserved appropriately using preservative agents or even simple refrigeration to attain a correct and rapid diagnosis.

Samples can be taken from animals or the environment for disease diagnosis, disease surveillance, health evaluation, monitoring response to treatment or even for establishing baseline values for certain parameters. Thus the samples collected must be appropriate for the intended purpose, and adequate in number and amount to provide valid result.



RELEASE STRATEGIES

4.1

Release Strategies and Post-Release Monitoring

In the current scenario in India, Aquatic Fauna conservation action terminates with the release of animals. This action essentially involves taking individuals of a species from one place and releasing them at another "safe" location; either to establish a new population, augment an existing one, or remove animals from distress. This process is akin to relocation or translocation of the species. For complete conservation efficacy it is essential to monitor the released animals to assess recruitment into populations. Animal release is a challenging endeavor in which difficult decisions often need to be made based on limited data. It is pertinent to remember that primary goal is to restore ecosystem function rather than species composition.

Release protocols have been set through specialised groups for most taxa and are stringently followed. The same is not true for reptiles though, especially freshwater turtles and crocodilians. So far the practices followed have been essentially hard release; where the animals are released into the wilderness without an in-situ acclimatisation period. The aim here is to outline the two available strategies for release of freshwater turtles and crocodilians. Release strategies are being considered as important

criteria in the dispersal of animals and their future spatial utilization. Soft release protocols give animals time for acclimatization to the space and animals tend to stay in the area. Dispersal is higher and farther with hard release programs.

Hard Release- In the Indian scenarios, hard release is often done at the end of the winter months (January-February).The process here is to first identify a specific location suited to the biological attributes of the species and release the animals





at that site. Basic habitat attributes, like presence/absence of shallow channels, deep pool, sand banks and aquatic vegetation, anthropogenic pressures, predators and sympatric species etc. should be taken into account whilst the site is assessed for suitability. This process does not include an acclimatization period in the wild.

Soft Release- Soft release protocols are as yet not formalized for fresh water aquatic reptiles in India. The proposed process involves building a temporary enclosure in a river channel (similar to ocean fish rearing ponds) that includes a sand beach. The animals are marked and released in this enclosure. They are exposed to the natural elements, water current and also get acclimated to feeding on live prey. They get exposed to the presence of predatory species and learn the use of spatial attributes like sand bank vegetation, channels, rock crevices, hides etc. The part of the enclosure that is in the water is slowly expanded in size moving toward the main water channel. Eventually (before monsoons) the enclosure can be opened and the animals are allowed to move away from the enclosure in their own time. This process is labor and cost intensive and often this is the over-riding factor in the choice of release methods.

Post-release monitoring strategies, especially for aquatic fauna, are in their nascent stages. With active focus on the global decline in chelonian species and increased interaction with crocodilians mainly in riparian communities rescue, release/relocation/ translocation of animals has become inevitable. Ecological studies on the Indian species and their spatial needs and use are at a slower pace. Release programs thus often lack the information required to make informed decisions when planning release strategies keeping in mind home range and spatial utilization by the species. Thus active monitoring of animals post release in any circumstance is now important. Designing monitoring strategy to address questions, identified a priori, will increase the amount of useful knowledge obtained from limited conservation funds.

Marking systems are varied and range from simple colour and paint to complex radio telemetry attachment. Detailed description of marking systems is being covered in "Marking and Identification".

Marking for monitoring

Monitoring of aquatic species can be done using externally attached tags visible to the naked eye. This allows for identification of the animals and monitoring their dispersal from the location of release in cases of both hard and soft release programs. The externally attached tags are susceptible to loss, this aspect should be kept in mind when designing the study for monitoring species and data recording. It is considered valuable in all cases of external tag attachment to have an alternative system of marking in the animal so as not to have a total loss of monitoring data.

Marked Recapture studies

Radio or satellite telemetry: This is a powerful tool to track a wide variety of animals and their movement and dispersal with minimal interference. It allows for detection of animals that are elusive and have cryptic behaviors to avoid detection. This allows for recording data related to life history parameters and understanding the survival and adaptability to changed circumstances.

Acoustic Telemetry: This is a passive form of telemetry currently being attempted in freshwater turtle species. Acoustic transmitters, and static underwater receivers are deployed to continuously record the presence and absence of turtles.

For post release monitoring of species the monitoring plan/ study will have to be designed keeping in mind the biological attributes of the





species (diurnal, nocturnal, crepuscular), season of release, method of release, size class of animals released (smaller animals may tend to disperse more on hard release), marking method, fluvial dynamics and seasonality.

In the initial phase after hard release or after removing the barriers of the soft release enclosure, intensive monitoring is warranted. Larger individuals may travel closer to mating and nesting season in the lookout for mates and appropriate nesting sites. This may also be the

time for clashes between resident animals. These time periods may also need greater and more intensive monitoring strategies.

Liaising with local communities at and around the release site and use of river watchers may assist the monitoring programs especially when the animals have externally attached tags. This also allows for the development of an inclusive conservation model, encouraging a sense of attachment to the species that have been release.

4.2

Marking and Identification

Marking of animals for identification is a good tool for all in-situ ecological studies, for monitoring populations and for captive facilities. In this section we aim to cover a few techniques that may be used in ex-situ facilities or in-situ conservation initiatives.

Marking for identification can be done using

Natural Marking or Acquired Marks

Natural color or spots or design pattern, scars that can be photographed and subsequently recognized). The use of patterns or distinguishing marks for identification may not be as common as it is in other groups of vertebrates. Thus these marks may be used to complement, rather than replace, other marking methods.

The surface details of turtle carapace scutes, such as patterns of grooves and ridges, arrangements of spots, whorls, reticulations etc. will prove adequate for individual recognition. In case of crocodilians individuals have been identified by comparing the shapes and positions of natural blotches and markings on the lateral scutes of the tail and also by using additional cues like injuries and scars. Patterns can be recorded in photographs, photocopies, graphite rubbings, and dental cast molds and may be taken into the field for subsequent comparisons and identifications.

Essentials

Marking must not interfere with the animal's behavior, growth, survival or probability of recapture. The process must be simple and easily implemented in a field setting. The marking device should be physiologically inert and provide positive, accurate identification. Identification systems can be group specific (e.g., age cohort, sex, location) or individual specific.

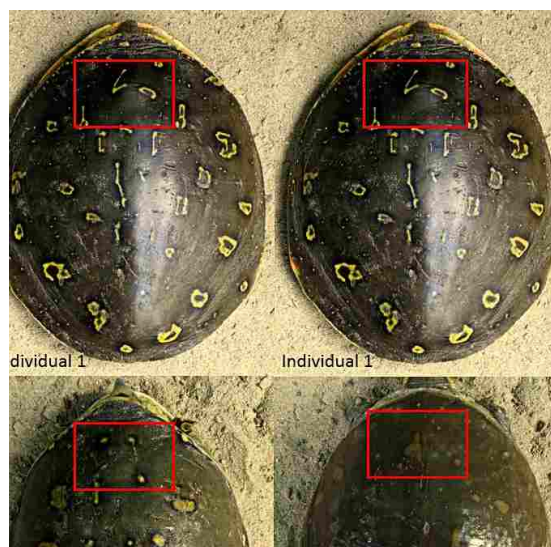


Fig 14: Photographic ID in *Lissemys punctata andersonii*



Progress in technology has made available tools like pattern recognition software that takes away the tedious process of comparing photographs. This also makes the process less prone to error. This method is currently being tested for Box Turtles and can hopefully be tried on Indian species with distinct patterns like Indian Star Tortoise (*Geochelone elegans*), Spotted Pond Turtle (*Geoclemys hamiltonii*), Indian Narrow Headed Softshell Turtle (*Chitra indica*) and Indian Flapshell Turtle (*Lissemys punctata andersonii*) to name a few. Natural marking on the lateral scutes of the tail been used successfully in wild *Gavialis gangeticus* in India and Swanepoel used natural tail marks to individually identify Nile crocodiles in the wild.

Tagging

Permanent, external tagging devices include plastic, metal and spaghetti tags, beads, buttons, spangles, wire, tape, aluminum rings, bells and rivets.



Fig 15: Metal tagging in *Nilssonina gangetica*

A permanent tag is intended to remain on an animal throughout its life or at least for the length of the study. Loss is known to occur at various rates for all types of attached or implanted tags. Tag loss can be minimized, but loss must be recorded and included in analyses for mark-recapture in research studies.

Various types of metal and plastic tags have been attached to hard-shelled turtles. The preferred site is the posterior carapace, to which tags can be attached with screws, glue, or wires running



Fig 16: Plastic tagging in Crocodilian spp.

through holes drilled in the shell. These tags may be seen from a distance with a binocular or spotting scope. Tags can be numbered or colored differently for remote identification. Metal tags with numbers (Strap Tags) have been attached to the webbing between toes in softshell turtles. Additionally, Petersen Tags; Round discs attached with metal wires can be used in softshell turtles. These methods need some experience as it is considered moderately invasive. The size of the metal tag has to be suitable for the size of the animal as an incorrect size not only hampers swimming and burrowing but also may get caught in bank-side vegetation and nets.

In crocodilians the large projecting scutes provide plenty of opportunities for attaching tags. Bayliss (1987), for example, inserted harpoon tags into the neck scutes of subadult and adult Australian crocodilians. Cattle tags with numbers on them have been used on the tail scutes of crocodilians in the rear and release programs in India. These colored, numbered tags, large enough to be read from a distance, allow for identification of animals. In earlier studies on population abundance by mark-recapture, tags have also been attached to foot webbing in crocodilians.

Visible Implant Fluorescent Elastomer (VIFE) Tags: These were first used for marking fish and amphibians and were found to be quite effective. The use has been tried in the Chinese Softshell Turtle (*Pelodiscus sinensis*) with a fair degree of success. The implant is done on a transparent membrane, usually the 4th or 5th dactyls of the hind foot. The tags are visible to the naked eye and those that are not can be found using uv light. UV light can also be used underwater to spot the marked animals.



Morphological Modifications (Tissue marking)

The marginal scutes on the carapacial edge have been used to create various coding schemes to provide unique identification marks. This is called scute notching. Scute notching can be done by using a sharp blade or a dremel tool for creating a 'V' shaped notch on the marginal scutes. Consequently, it is essential to remember that the carapacial edge is also subject to natural injury. Such injuries can obliterate or modify "markings" and may then lead to errors in analyses,

There are several scute notching formulae in practice today. It is essential to follow one system that is understood by all conservation practitioners working on that site. Cagle (1939) assigned a number to each marginal scute from anterior to posterior on each side of the carapace so that he could designate the scutes that he notched. Buhlmann (1979) has used the "1-2-4-7 multiple numeric system" to mark the marginal scutes. Some researchers have used a sequential system employing letters, rather than numbers.

In Softshell turtles, coding is more difficult because of the lack of discrete marking sites. The marking is done on epidermal scutes and dermal bone at the carapacial edge. They are marked by removing small V-shaped pieces of carapace with a sharp knife or punching holes in the carapace with a paper punch. The V-shaped or circular marks quickly fill out to the carapacial edge as healing progresses but persist as distinct whitish scars best seen from the ventral surface.



Fig 17: Scute Notching in Hardshell Turtles (*Batagur kachuga*)

The tail scutes on crocodilians are notched/cut in several accepted marking schemes, but there is as yet no standardized marking system. This lack of standardization is probably due to the different marking needs of wildlife management agencies and investigators carrying out population studies and the large number of scutes available for marking. A proposed scheme that has been used in some research programs in India is shown below.

Color marking with paint

Small amounts of quick-drying, nontoxic paints applied with a brush, spray can, or paint pen/marker work well and have been used on turtles. Color marks on hard body parts persist the longest. The turtle carapace is an obvious place to paint identification numbers and letters. Paint may be applied sparingly to small turtles with rapidly growing unossified carapaces, because the paint may hinder growth and cause disfigurement. Color marking allows for quick recognition of marked animals at a distance.



Fig 18: Temporary marking in *Lissemys* spp.

Internal Implants

The passive integrated transponder (PIT) tag is implanted for permanent tagging and has been in use since the 1980s'. It is an electronic microchip encased in biocompatible glass that varies in size, usually between 8 and 14 millimeters long and about 2 millimeters in diameter. The glass casing protects the electronic components and prevents tissue irritation. PIT tags are injected with a 12-gauge needle or inserted by surgical incision under the animal's skin, usually into muscle or the body cavity and may serve functionally as a reliable fingerprint for identification of an individual. PIT



Tags are internal, permanent, and have virtually no negative impact on animals, provided the organism has sufficient body size. The power source for the PIT tag is contained in the reader, which generally uses a 9-volt battery and is portable and light- weight. The implication of the term passive is that the tag is dormant until activated by a handheld reader. The unique alphanumeric code of PIT Tags permits a tagged individual to be distinguished from every other one, whether in a population or on a global scale.



Fig 19: Pit tag reader

Fig 20: Pit tag

A drawback of PIT tagging in some species is that the tag can actually move within the body of the animal. This migration has been documented for many animal groups. Tag migration complicates code checking when an investigator cannot find the tag where it is expected to be and interprets it as lost. Thus, the success of the tagging technique is determined almost solely by the placement of the tag.

In Chelonians the PIT tag can be inserted in the left hind leg, sub-cutaneously, on the medial aspect. The 8 mm PIT Tag is used with a 12 G Needle. The opening is sealed with surgical glue.

In Crocodilians PIT Tags can be injected into the base of the tail just behind the insertion of the hind limb. PIT tags should not be injected

intraperitoneally, because of possible migration in the body cavity, which, in these large animals, could move the tag out of detection range of the reader. Some workers have inserted PIT Tags in the left hind leg sub-cutaneously but these end to migrate in the leg and sometimes are not detected.

Telemetric devices

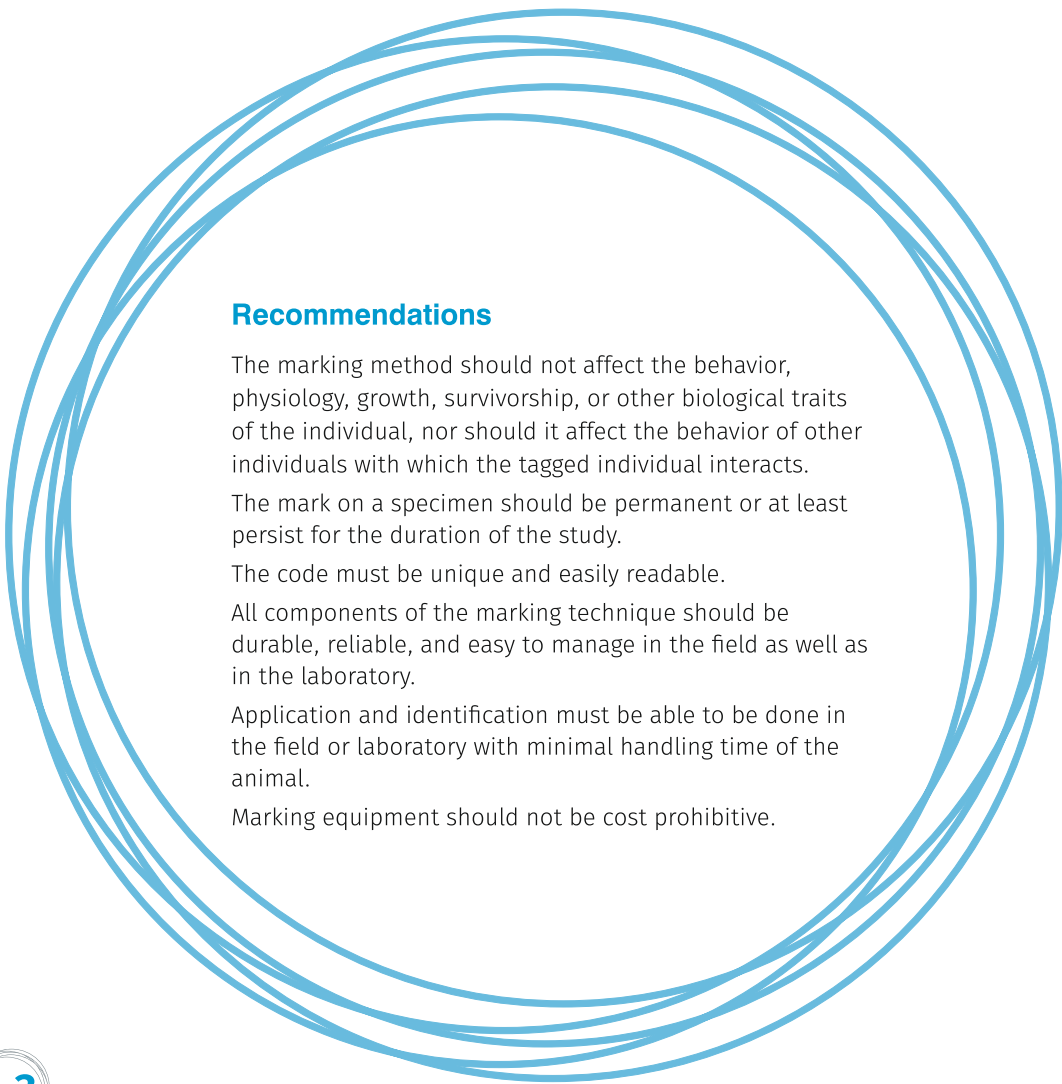
VHF radio-frequency transmitters and GPS transmitters are now gaining popularity with spatial ecology and monitoring programs for freshwater turtles and crocodilians. Low-frequency (sonic) transmitters designed for fish transmit well under water and have been used on freshwater turtle species.

In freshwater turtles, detailed reviews of previous studies have allowed for grouping attachment methods into six categories: (1) adhesives (e.g., dental acrylic, epoxy, silicone sealant), (2) harnesses, (3) wire, screws, bolts, cable, nylon ties, or monofilament line passed through holes drilled in the carapace, (4) surgical implantation, (5) sewing, and (6) taping. Transmitters may be flat and closely conform to the carapace to prevent entanglement and obstruction.

In softshell species, transmitters may be loosely attached to the fleshy, highly vascular portions to minimize shell necrosis and subsequent transmitter loss. Studies show that transmitters have been attached to the posterior edge of the carapace of softshells with a single stainless-steel wire punched through the carapace and held loosely in place on the underside with a plastic button. The cigar-shaped transmitter is loose enough to pivot freely. Both transmitters and data-loggers have been implanted into the body cavities of soft- shells.

In India, radiotelemetry studies in Crocodilians have now been ongoing for several years and have yielded valuable ecological and natural history data. The transmitter may be attached to the nuchal scutes with wires and held in place with epoxy or attached to the tail at the beginning of the single scute arrangement.

Temporary Marking	Non- Toxic Paint
Semi- Permanent Marking	Metal Tags and plastic tags. Petersen Tags, Cattle tags, Visible Implant Elastomers. Radio telemetry devices.
Permanent Marking	Scute notching/ Clipping, PIT Tags



Recommendations

The marking method should not affect the behavior, physiology, growth, survivorship, or other biological traits of the individual, nor should it affect the behavior of other individuals with which the tagged individual interacts.

The mark on a specimen should be permanent or at least persist for the duration of the study.

The code must be unique and easily readable.

All components of the marking technique should be durable, reliable, and easy to manage in the field as well as in the laboratory.

Application and identification must be able to be done in the field or laboratory with minimal handling time of the animal.

Marking equipment should not be cost prohibitive.

4.3

Laws and Permissions

Applicable Legal provisions

Rescue and rehabilitation of all wild animals in India is governed by the Wildlife Protection Act, 1972 ("Act"). The term "hunting" as defined under Section 2(16) of the Act, has been given a wide interpretation to include not only killing of wild animals which are listed under Schedule I-IV of the Act, but also covers the acts (including every attempt made to do these acts) of -

- (a) *"Capturing, coursing, snaring and trapping, driving or baiting any wild or captive animal";* and

- (b) *"Injuring or destroying or taking any part of the body of any such animal or reptiles, or disturbing the eggs or nests of such birds or reptiles"*

Thus any of these acts, though done with purpose of rescue or rehabilitation of the wild animals, will be held as "hunting" for the purpose of the Act. Section 9 of the Act prohibits 'hunting' of wild animals specified in Schedule I-IV of the Act and any violation of this provision will be considered as a punishable offence under Section 51 of the Act.

However, the Act has made provisions under Section 11 and Section 12, to allow capture of wild animals listed under Schedule I-IV, as an exception to *hunting*

Section 11 - Rescue of wild animals in cases of human-wildlife conflict

Permit from CWW of the state for all animals falling under schedule I For wild animals listed under Schedule II-IV, the Chief Wildlife Warden or the authorised officer has the authority to permit

Report it to the nearest police station and/ or authorised officer, within forty-eight hours of obtaining such possession.
(Section 39 of the Act)



Section 12 - <i>Capture of wild animals for special purposes</i> [(a) education; (b) scientific research; (c) scientific management (including translocation or population management of wildlife); (d) collection of specimens (for zoos, museums and similar research institutions); or (e) for collection of snake-venom for the manufacture of life saving drugs].	Permit from Chief Wildlife Warden of the State to grant a permit to any person subject to the terms and conditions specified in the permit. is given after taking due permission of the Central Government in respect of wild animals in Schedule I; or of the State Government in respect of any other wild animal.
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Procedure to obtain permit of Rescue and Rehabilitation

Crocodilians (such as Muggers, Saltwater Crocodiles and Gharials) and Fresh Water Turtles (such as *Lissemys punctata*, *Pangshura tecta*, *Batagur kachuga* and *Geoclemys hamiltoni*) which are found in the Gangetic basin are categorised under Part II of Schedule I of the Wildlife Protection Act, 1972.

Thus, to obtain a permit under Section 11 or Section 12, as required, an application letter must be submitted to the Chief Wildlife Warden of the State, along with necessary supporting documents detailing

- (a) professional profile and past experience of the rescuer and
- (b) the necessity for carrying out rescue and rehabilitation.

The entire rescue and rehabilitation process must be duly documented and reported back to the forest department.





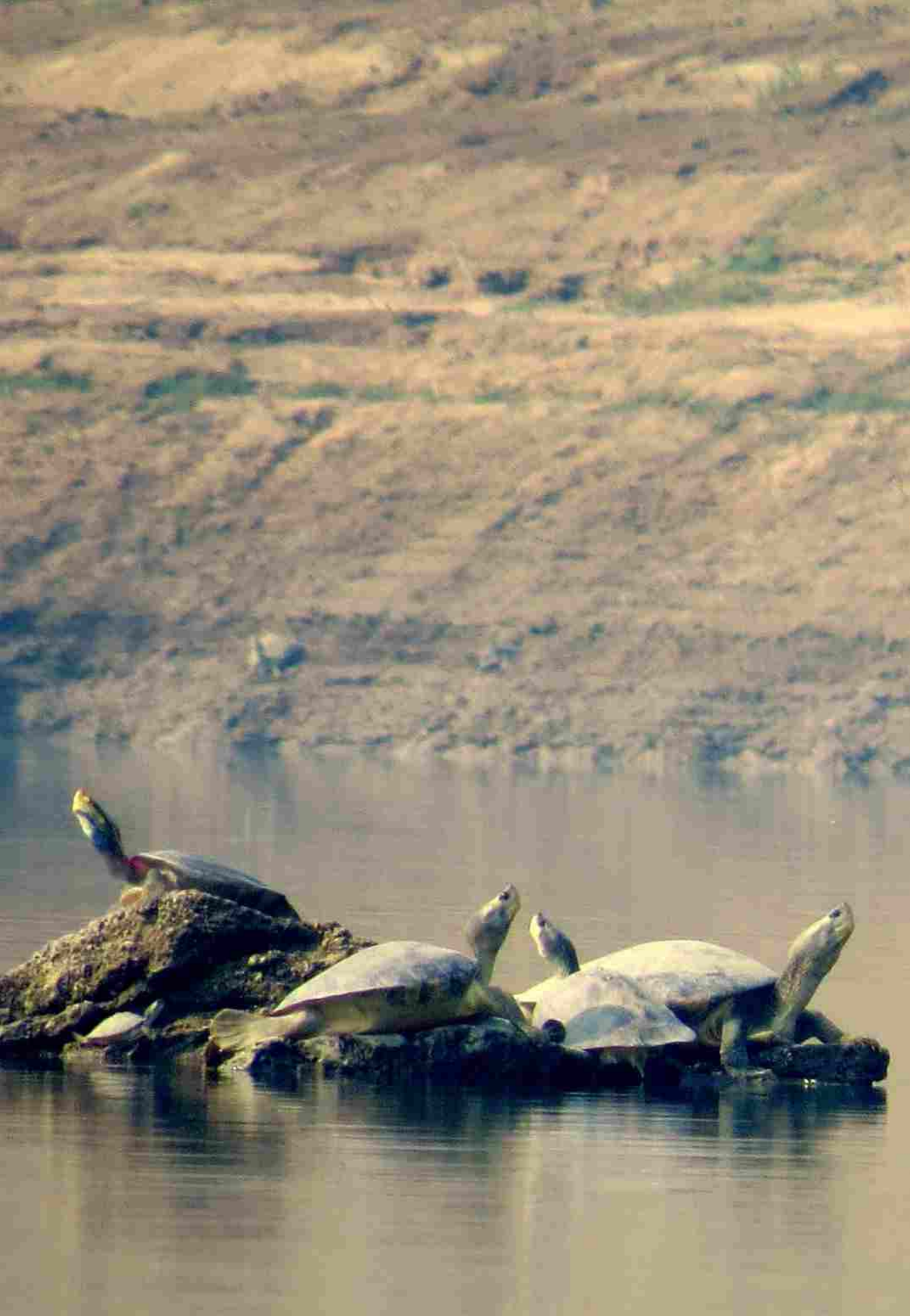
SPECIES ATTRIBUTES

5.1

Freshwater Turtles and Tortoises of the Ganga Basin

“There is no vertebrate group facing greater survival problems today. Turtles saw the great dinosaurs come and go and are now facing their own Extinction Crisis”.

- John L. Behler





Systematics

Kingdom: Animalia

Phylum: Chordata

Subphylum: Vertebrate

Superclass: Tetrapoda

Class: Reptilia

Order: Testudines

Chelonians are diapsids of the class Reptilia. They fall under the order of Testudines (formerly Chelonii) and include turtles, terrapins and tortoises. In Testudines the body is covered with dermal bony plates enclosing the soft body parts. The dorsal plate is known as carapace and the ventral plate is known as plastron. The structural pattern of these plates is the most important character for this group.

Turtles are water dwelling and their body is streamlined for an aquatic existence with webbed digits that may or may not have well developed claws. Terrapins are select species of fresh water turtles that live in water (some have adapted to being close to brackish water systems) and have also adapted to a burrowing (mainly in mud) lifestyle. Tortoises live exclusively on land and they have stumpy feet designed to walk on solid ground.

Freshwater turtles can be considered as ecological engineers; they maintain aquatic macrophytes in a suitable balance. Further, softshell turtles are important scavengers and contribute to maintaining clean aquatic ecosystems. Tortoises are primarily herbivorous and play a role in vegetation control in ecosystems.

Freshwater turtles and tortoises face an enormous threat from illicit trade sometimes crossing international borders other than the ecosystem pressures. Limited data is available to estimate and analyse these trade parameters and their impact on the survival of the species.

Most of the freshwater turtles and tortoises are protected by the Wildlife (Protection) Act 1972 and their international trade is governed by Convention for International Trade in Endangered Species of Wild Flora and Fauna (CITES) to which India is a signatory since 1972.

Considering the overall lacunae in information about these species in India there is an immediate need to create more awareness among the populace at large regarding conservation and protection of freshwater turtles and tortoises. Conservation monitoring and conservation action are constant; extinction is permanent.

Turtles and tortoises also play an important cultural role in human history, depicted in art and as icons of longevity and virility in many societies. Losing them would not only degrade ecosystems and contribute to the widespread loss of biodiversity; it would destroy an important piece of our culture. There is no better time to raise awareness and take collective conservation action.



Northern River Terrapin *Batagur baska* (Gray, 1830)



Conservation Status

IUCN: Critically Endangered

WLP: Schedule I

CITES: Appendix I

Distinguishing features

It has a deep, large heavily buttressed shell, large powerful limbs, and broad, fully webbed feet characterized by four claws, rather than 5 on the forefeet which separate this species from others of its range. During the breeding season, the coloration on the head of the males becomes jet black with a large white iris.

Species Description

The carapace is uniformly olive grey or olive brown. The head is small to moderate in size with an up-turned pointed projecting snout and a medially notched upper jaw characterized by two denticulate ridges on the triturating surface of the upper jaw. The adult shell is smooth, lacking the marginal spines and vertebral keel, which is present in juveniles. Recorded length of 560 mm.

Habitat

These turtles inhabit large, deep, flowing rivers and leave the water only to bask or nest.

Distribution

In India, the species current range is the Sunderbans in West Bengal. The species was additionally known to inhabit estuarine habitats in Odisha. The species also occurs in Bangladesh.

Natural History

Males are smaller than females. Communal nesting occurs from late December to early March on sandbars and banks far upstream from the normal estuarine habitat. Females nest around three times a season laying 13-34 eggs each time.

Diet

Typically omnivorous, it has an affinity for fruits rhizomes and leaves of mangrove species as well as certain mollusks, crustaceans and fish.

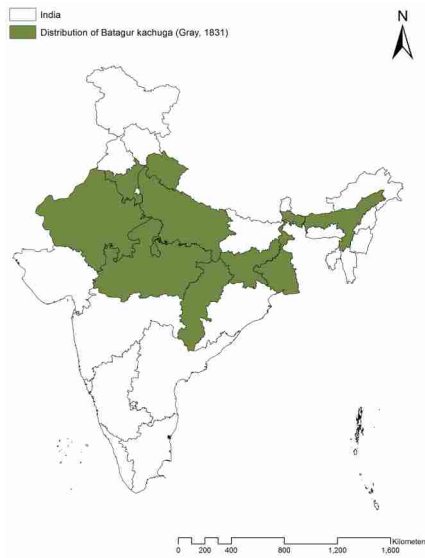
Threats

The species has declined due to harvesting of eggs by the local communities for consumption. Additionally the habitat is heavily degraded.



Red Crowned Roof Turtle

Batagur kachuga (Gray, 1831)



Conservation Status

IUCN: Critically Endangered

WLP: Schedule I

CITES: Appendix II

Distinguishing features

The male's head is red dorsally and bluish grey on the sides. The female's head is olive blue

The top of the head is covered with fine soft skin and it bears a reddish crown (thus the name) although some animals may have just a brown head.

Species Description

Elliptical carapace which is widest in the middle, has an arch and the carapace rim is mainly smooth with a slightly serrated posterior rim. There may be a vertebral keel which diminishes with age. The plastron is long and narrow and is entirely orangish-yellow. There is a slight anal notch. The



mouth is short and the jaws are bright yellow in color with numerous serrations.

The sexual dichromatism is exaggerated during the breeding season. The head of the male becomes a deep blue with a red area that extends from the nostrils to the top of the head, whereas that of the female remains dark brown with yellow jaws.

Recorded length of 560 mm

Habitat

These turtles inhabit deep, flowing rivers with terrestrial nest sites on high sand banks. They are known to be powerful swimmers.

Distribution

In India it is reported from Assam, Bihar, Chattisgarh, Haryana, Jharkhand, Madhya Pradesh, Uttarakhand, Uttar Pradesh, Rajasthan and West Bengal. It resides primarily in the watershed areas of the Ganges River.

The species ranges from Central Nepal southwards through Bangladesh, adjacent North Eastern India and there are some unconfirmed reports from North Western Burma.

Natural History

Nesting occurs on high sandbanks or on the river islands in March and April with the young emerging in May or June. The clutch size is up to 25 eggs of large size (68 x 45mm).

Diet

The adults are mainly herbivorous feeding on aquatic greens and fruits. The young have a more omnivorous diet with a higher protein intake from river biota.

Threats

There is an alarming loss of critical habitats for the turtle in its range.



Three Striped Roofed Turtle *Batagur dhongoka* (Gray, 1832)



Conservation Status

IUCN: Endangered

WLP: Not Listed

CITES: Appendix II

Distinguishing features

The general color of the carapace is greyish to brown to olive with a black band along the keel, as well as two lateral bands along the traces of the lateral keels.

The head is olive to brown which bears a yellow stripe from the extreme front of the nostrils over the orbit and tympanum to the beginning of the neck.

Species Description

It is characterized by an elliptical carapace which is widest behind the middle, depressed and has a smooth posterior rim. A medial keel is present but



reduced to only a posterior projection on the 2nd and 3rd vertebral in adults. The plastron and bridge are yellow and a brownish red blotch occurs on each scute in juveniles. The head is moderate in size with a projecting pointed snout and an upper jaw with a shallow notch bordered on each side by a tooth-like projection. Lateral jaw rims are serrated.

Recorded length of 480 mm.

Habitat

These turtles inhabit large, deep flowing rivers and leave the water only to bask or nest.

Distribution

In India, it is reported from Bihar, Chattisgarh, Haryana, Jharkhand, Madhya Pradesh, Uttar Pradesh, Rajasthan and West Bengal.

The species occurs in Nepal, Bangladesh, and northern and north eastern India; in the Ganges and Brahmaputra River Systems.

Natural History

In the Northern part of its range, these turtles hibernate in the mud at the bottom of dry rivers. They lay 20-35 eggs per clutch from March to April along the banks of the rivers or in mid-rivers and islands. The eggs are hard-shelled and are about 55 x 36 mm in size.

Diet

These turtles prefer a wider diet range and are omnivorous. They enjoy freshwater mussels and various aquatic vegetation.

Threats

The species has declined over much of its former range in India but the populations in the Chambal River in North India are still strong. It is severely threatened in Bangladesh. In Nepal the species is almost extirpated from its distribution range.



Spotted Pond Turtle

Geoclemys hamiltonii

(Gray, 1830)



Conservation Status

IUCN: Vulnerable

WLP: Schedule I

CITES: Appendix I

Distinguishing features

The carapace and skin are decorated with yellowish spots on a dark background giving it a striking appearance. The carapace is black, elongated, oval, three keeled and well domed. The keels are interrupted into a series of elevated protuberances one on each vertebral and pleural scutes.

Species Description

The skin has yellowish spots on a dark background. These are multiple light streaks or spots, cream or yellow in colour and well separated on each scute on the carapace. The hinge-less plastron is yellow with numerous dark radiations. The snout is short



and stubby.

The hatchlings are brightly coloured with brilliant yellow or white spots.

Recorded maximum length 350 mm.

Habitat

These turtles prefer to stay in the main river but are sometimes seen in the forest lakes where the water is calm and well shaded and there is dense aquatic vegetation. During summers they bask for a long time on emergent and floating wood while in winters they hide in burrows or under vegetation.

Distribution

In India it is recorded from Assam, Bihar, Haryana, Jammu and Kashmir, Jharkhand, Madhya Pradesh, Meghalaya, Punjab, Rajasthan, Uttarakhand, Uttar Pradesh and West Bengal.

The range of this species is wide but is discontinuous, restricted mainly to the Indus and Ganges River System of Southern Pakistan, Northern India and Bangladesh.

Natural History

Nesting has been noted from May to June in India, and in December and January in Bangladesh (a second nesting may occur in February or March). The nest contains 19 eggs on an average which are oval and white measuring 50 x 22 mm.

Diet

Typically carnivorous feeding on snails and other invertebrates and probably on fish and tadpoles.

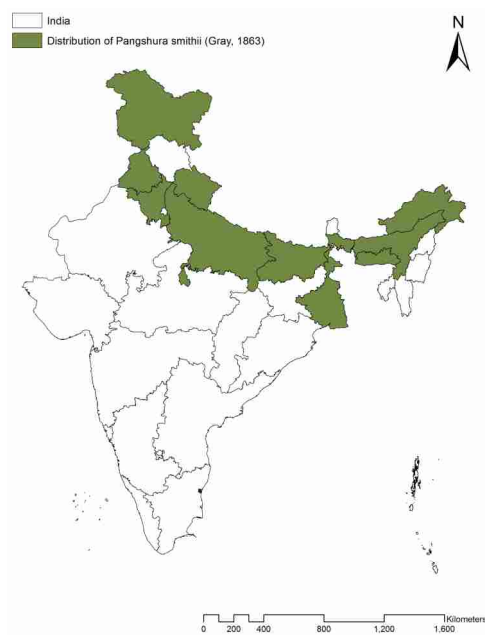
Threats

Illegal trade for consumption and for the pet market is the key threat.



Brown Roofed Turtle

Pangshura smithii (Gray, 1863)



Conservation Status

IUCN: Lower Risk/ Near Threatened

WLP: Not Listed

CITES: Appendix II

Distinguishing features

The carapace is tan to brown with a dark medial stripe. The head is yellowish grey or pinkish grey and is medium size with a reddish-brown spot on the temple and a slightly elevated dark snout.

The neck is grey with yellow stripes.

Species Description

The carapace is tan to brown with a dark medial stripe. It is elliptical and wider towards the rear. The vertebral scutes are narrow and keeled.

The plastron is yellow with black spots that are large or small.

Recorded maximum length 230 mm.

Habitat

The species is common in river channels, large canals and occasionally found in lakes, ponds connected to rivers. They are also noted in muddy waters with slow current where there are logs and other protruding objects for basking.

Distribution

In India it is reported from Arunachal Pradesh, Assam, Bihar, Haryana, Jammu and Kashmir, Meghalaya, Nagaland, Punjab, Uttarakhand, Uttar Pradesh and West Bengal.

Also found from Pakistan, through Southern Nepal to Bangladesh.

Natural History

Nesting probably occurs from September through November. Eggs are white, elongated (43 mm x 24 mm). A normal clutch is 5-8 eggs.

Diet

It is omnivorous, but generally prefers vegetable matter. It is known to consume insects, tadpoles, fish and sometimes even feeds on carrion.

Threats

The species is heavily collected and consumed in some places. It is gaining popularity in the pet trade due to its bright colors.



Indian Roofed Turtle

Pangshura tecta (Gray, 1830)



Conservation Status

IUCN: Lower Risk/ Least Concern

WLPA: Schedule I

CITES: Appendix I

Distinguishing features

This turtle has a roof-like or tectiform (tent shaped) formation on that carapace.

The arched, elliptical carapace is widest behind the middle with unclear serrations posteriorly.

Species Description

The carapace shows a roof-like or tent-shaped formation. It is elliptical and wider towards the rear. The plastron and bridge are yellow with at least one black elongated blotch on each scute. Dorsally the head is black with a large



crescent-shaped orange to a yellowish blotch on each temple. These may meet posteriorly to form a "V".

Recorded maximum length 240 mm.

Habitat

The species is common in streams, canals, oxbows, ponds, and man-made water tanks. A soft bottom and abundant aquatic vegetation are preferred by the species.

Distribution

Within India it is reported from Arunachal Pradesh, Assam, Bihar, Chhatisgarh, Gujarat, Haryana, Jammu, Jharkhand, Madhya Pradesh, Manipur, Meghalaya, Mizoram, Odisha, Punjab, Rajasthan, Tripura, Uttar Pradesh, Uttarakhand and West Bengal.

Also reported from Pakistan, Bangladesh and Nepal.

Natural History

Nesting is noted in February- March and the female lays clutches of 3 to 12 eggs sometimes twice per season. The eggs measure 42 mm x 27 mm.

Diet

The turtle is primarily herbivorous and occasionally eats insects, carrion and snails.

Threats

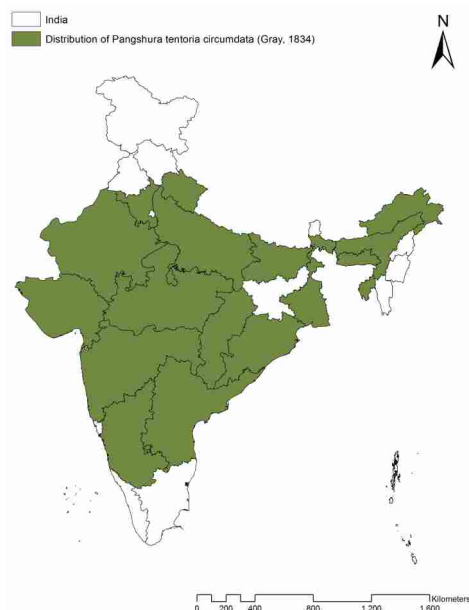
The species is heavily collected for consumption and for the pet trade.



Indian Tent Turtle

Pangshura tentoria circumdata

(Gray, 1834)



Conservation Status

IUCN: Lower Risk/ Least Concern

WLP: Not Listed

CITES: Appendix II

Distinguishing features

This turtle has a roof-like or tectiform (tent shaped) formation on that carapace but is less defined than *Pangshura tecta*.

The head is olive to grey with a conspicuous red/pink patch behind the tympanum.

A pink circular ring is generally seen on the carapace (*Pangshura tentoria circumdata*).

Species Description

Young of the species display a highly tectiform

carapace and a well-developed spine on the third vertebral scute. Fine white lines run from the orbit to the base of the neck. In adults the neck is brightly coloured but the head is blackish and loses its markings. The marginal scutes are not serrated and are significantly wide at the posterior end. The carapace is brown to dark beige with a reddish or brownish vertebral line which runs along the central keel.

Habitat

The species occurs in large rivers and may be seen in smaller tributaries.

Distribution

In India it is found in the Ganges, Brahmaputra and Indus River drainages, and reported from Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Meghalaya, Odisha, Rajasthan, Telangana, Tripura, Uttar Pradesh, Uttarakhand and West Bengal.

The species is also recorded from Bangladesh, Pakistan and Nepal.

Natural History

Nesting is noted in February- March and the female lays clutches of 4 to 12 eggs sometimes twice per season. The eggs measure 42 x 27mm.

Diet

The turtle is primarily herbivorous and occasionally eats insects and animal protein. The juveniles are more carnivorous in their diet preference.

Threats

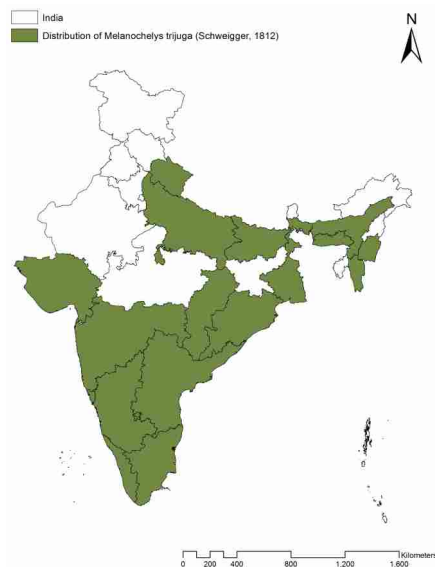
The species is heavily collected for the pet trade.



Indian Black Turtle

Melanochelys trijuga

(Schweigger, 1812)



Conservation Status

IUCN: Lower Risk/ Near Threatened

WLP: Not Listed

CITES: Appendix II

Distinguishing features

The general color varies from reddish brown to black. There are three prominent keels on the carapace which are often yellow in color. The plastron is uniformly dark brown or black but may have a yellow border.

The hatchlings often have colourful spots on the head which disappear or become lighter with age.

Species Description

Their general color varies from reddish brown to black. The carapace is elongated and slightly depressed. The head varies from brown to black and may contain orange to yellow colored patterns



at the temporal region. The jaw appears to be medially notched.

The hatchlings often have colorful spots on the head which disappear or become lighter with age.

Recorded maximum length 383 mm.

Habitat

These turtles inhabit ponds, streams, rivers as well as marshes and lakes

Distribution

In India it is reported from Andhra Pradesh, Assam, Bihar, Chattisgarh, Goa, Gujarat, Karnataka, Kerala, Maharashtra, Manipur, Meghalaya, Mizoram, Odisha, Tamil Nadu, Telangana, Uttarakhand, Uttar Pradesh and West Bengal.

The species occurs in Northern Bangladesh, Central Myanmar and Sri Lanka. It was introduced in Maldives and the Chagos islands. It may also be found in Nepal.

Natural History

Courtship, copulation and nesting may take place throughout the year. A typical clutch consists of a dozen eggs. The eggs are elongated, white and are rather large measuring up to 48 x 35 mm.

Diet

These turtles are omnivorous and feeding on plant and animal matter, often scavenging when the opportunity presents itself.

Threats

In some places in the world these turtles are collected for trade. They are rarely consumed due to a strong pheromonal odor emitted when handled. Habitat loss may present as a threat in the future.



Tricarinate Hill Turtle

Melanochelys tricarinata

(Blyth, 1856)



Conservation Status

IUCN: Vulnerable
WLP: Schedule I
CITES: Appendix I

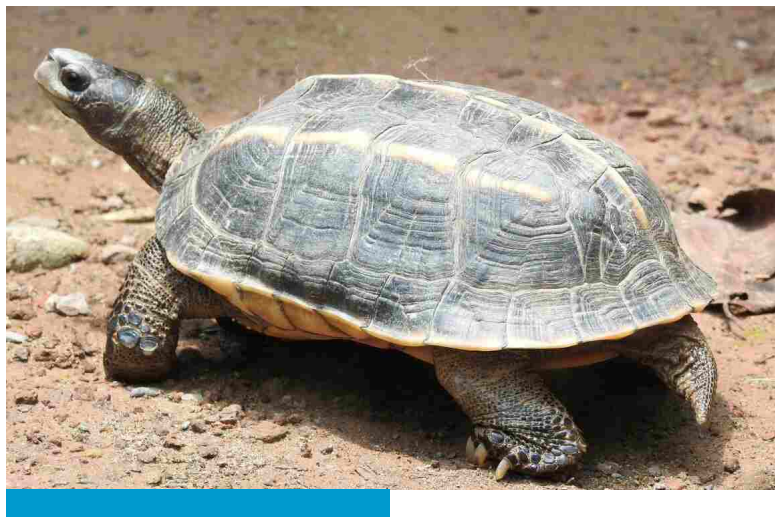
Distinguishing features

The carapace has three ridged keels (tricarinate). The vertebral keel being the most prominent, the lateral keels serve to demarcate the ridge at which the nearly horizontal vertebral area joins the vertebral flanks.

Species Description

The carapace is dark olive grey, grey black or reddish brown with pale yellow keels.

The plastron is yellow or orange and usually as



long as the carapace and notched posteriorly. The head and neck are grey-black.

The forelimbs are enlarged and almost square with somewhat pointed scales.

The snout is short and the upper jaw is feebly notched.

Recorded Length: 174 mm.

Habitat

This turtle is terrestrial and mainly inhabits deciduous and evergreen forests and riverine grasslands of the Northern Indian sub-continent. Its habitat includes the Terai region (foothills of the Himalayas).

Distribution

In India, it is reported from Arunachal Pradesh, Assam, Bihar, Jharkhand, Manipur, Mizoram, Uttarakhand, Uttar Pradesh and West Bengal.

The species occurs in Bangladesh and Bhutan.

Natural History

Nesting occurs in winter months in Assam and North Eastern India.

The clutch size is at least three and the eggs are elongate measuring 42 x 25 mm.

Hatching takes place in February, April and May.

Diet

These turtles are omnivorous and consume insects, carrion, berries and fruits.

Threats

It is considered Vulnerable in India, the main range country. It is sought after for collection by hobbyists.



Crowned River Turtle

Hardella thurjii (Gray, 1831)



Conservation Status

IUCN: Vulnerable

WLPA: Schedule I

CITES: Appendix II

Distinguishing features

The carapace is dark grey, brown or black with a yellow line on the outer rim (at least in young individuals) and yellow pigment at the junction of pleural and marginal scutes.

The throat and snout are brightly marked yellow

The head is highly distinctive with bright yellow spots spaced irregularly over the snout and neck. Sexual dimorphism in this species is extreme. Adult females may reach three times the length of the male.

Species Description

Shell is thick and heavy in adults, moderately depressed with a single weak vertebral keel. The



bridge is well developed with the carapace fully sutured at the plastron. Their carapace is more serrated and the vertebral keel is more pronounced. The head is large with a projecting but short snout. The iris is black with golden dots. Hatchlings are brighter in colour than adults.

Recorded length of 650 mm.

Habitat

This species is restricted to still slow-moving water bodies including pools, ponds, canals and oxbow lakes with abundant aquatic vegetation.

Distribution

The species is distributed over the lower and middle reaches of the northern river systems in the Indian sub-continent comprising of the Indus, Ganges, Brahmaputra and its tributaries,

It is found in Assam, Bihar, Jharkhand, Madhya Pradesh, Manipur, Meghalaya, Mizoram, Punjab, Rajasthan, Tripura, Uttar Pradesh and West Bengal.

This species is also recorded from Bangladesh, Pakistan and Nepal.

Natural History

Courtship is mainly noted from April to July. Nesting occurs from November to January. A single clutch may have 12-16 eggs measuring about 60 X 34 mm.

Diet

This turtle is primarily herbivorous and feeds on aquatic plants and vegetative debris that fall into the water. However it may occasionally snack on freshwater shrimp or small fish.

Threats

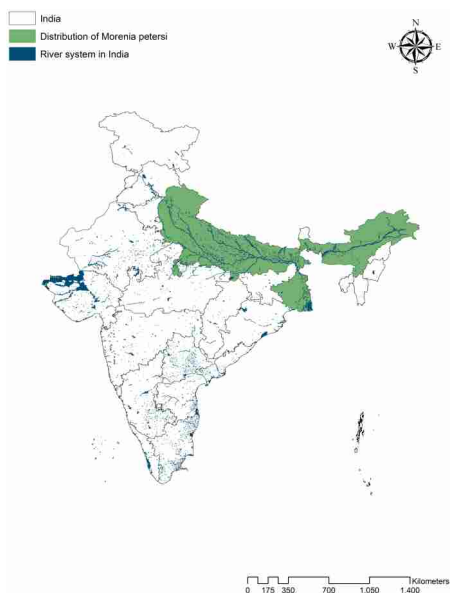
The species was extensively exploited in eastern India and Bangladesh till the 1980's. Heavy exploitation for flesh and as pet has resulted in possible declines.



Indian Eyed Turtle

Morenia petersi

(Anderson, 1879)



Conservation Status

IUCN: Vulnerable
WLP: Not Listed
CITES: Appendix II

Distinguishing features

Carapace has conspicuous ocelli and distinct yellow triangle on top of the head.

Species Description

The overall coloration is olive to dark brown or black. The carapace is slightly domed and has a relatively low keel and an unserrated posterior rim. Head is small with a pointed and protruding snout. The head is olive with yellow stripes on each side. The plastron is uniformly yellow though there may be some dark blotches on the bridge and the

underside of some marginals. SCL 220mm

Habitat

Sluggish rivers, swamps and lakes.

Distribution

North and Northeast India (Arunachal Pradesh, Assam, Bihar, Meghalaya, Uttarakhand, Uttar Pradesh and West Bengal. It is also recorded from Bangladesh and Nepal.

Natural History

It is essentially diurnal and spends long periods basking on floating objects or swimming at the surface. Nesting is recorded in December and January and occurs at night. The clutch has 6 to 10 elongate eggs, measuring 45x20mm

Diet

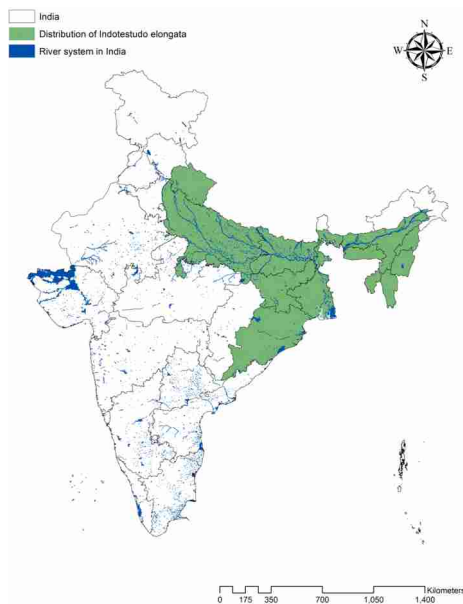
It is herbivorous feeding on floating macrophytes.

Threats

Habitat Degradation and Trade.



Yellow Tortoise/ Elongated Tortoise *Indotestudo elongata* (Blyth, 1853)



Conservation Status

IUCN: Endangered

WLPA: Schedule IV

CITES: Appendix II

Distinguishing features

The carapace is elongated and well domed and flattened dorsally with descending sides. The carapace is yellowish brown mainly with black blotches on the vertebrals and pleurals.

In mating season, the skin becomes bright yellow or pink.

Species Description

The carapace may be depressed along the 3rd or 4th vertebral scute. The plastron is well developed and has a deep anal notch. The plastron and bridge are yellow and usually are plain (with no pattern). The carapace is narrower in males and



wider and more rounded in females. The head is moderate with a non-protruding snout. The snout has a weakly hooked tricuspid upper jaw. During mating season the males and females develop a bright pink colouring around their nostrils and eyes.

Habitat

They live in humid tropical evergreen and deciduous forests on hills, mountains or plateaus. Although partial to cooler humid forests this tortoise may also be found in rocky and moderately dry habitats.

Distribution

In India it is recorded from Assam, Bihar, Jharkhand, Manipur, Meghalaya, Mizoram, Nagaland, Odisha, Tripura, Uttarakhand, Uttar Pradesh and West Bengal.

The species is also found in Bangladesh, Bhutan, Cambodia, China, Laos, Malaysia, Myanmar, Nepal, Thailand and Vietnam.

Natural History

Nesting has been noted from July to October with 2 to 3 clutches being laid by a female per year. The eggs are large (50mm x 40mm) elliptical and few in number compared to some freshwater turtles (2 to 9 eggs per clutch).

Diet

They are omnivorous, primarily frugivorous and feed on flowers, leafy greens, worms, slugs and carrion.

Threats

Illegal trade for international consumption in the Chinese medicine market. The protection status in the WLPA and in CITES may need to be reconsidered.



Indian Softshell Turtle

Nilssononia gangetica (Cuvier, 1825)



Conservation Status

IUCN: Vulnerable

WLP: Schedule I

CITES: Appendix I

Distinguishing features

The head is greenish with black oblique lines in the form of a forward directed 'Y'. Sometimes these lines are broken or are incomplete. The jaws are underlined by fleshy extensive pads that facilitate seizing of prey.

Species Description

The carapace is round to oval and is olive or green, with or without black reticulations and is modestly domed. There are several longitudinal rows of tubercles in juveniles which smoothen out in the adult stages.

The plastron is grey to white with well-developed callosities.



The head is wide and the snout is rather short and ends in a pair of prominent nostrils.

The young have 4-6 ocelli on the carapace.

Recorded length of 700 mm.

Habitat

This large softshell inhabits deep rivers, streams and large canals with muddy and sandy floors.

Distribution

In India, the species is reported from Assam, Bihar, Chattisgarh, Gujarat, Haryana, Himachal Pradesh, Jharkhand, Madhya Pradesh, Meghalaya, Odisha, Punjab, Rajasthan, Uttar Pradesh, Uttarakhand and West Bengal.

Globally it occurs in Afghanistan, Pakistan, Nepal and Bangladesh.

Natural History

Courtship coincides with the start of monsoons.

Nesting occurs in the month of October and November. Clutch number is from 8 to 32 eggs. Eggs measure about 23-32 mm in diameter and are hard shelled, white and spherical.

Diet

The species is omnivorous and opportunistic. The diet includes insects, aquatic vegetation, mollusks, fish, frogs and even small aquatic birds.

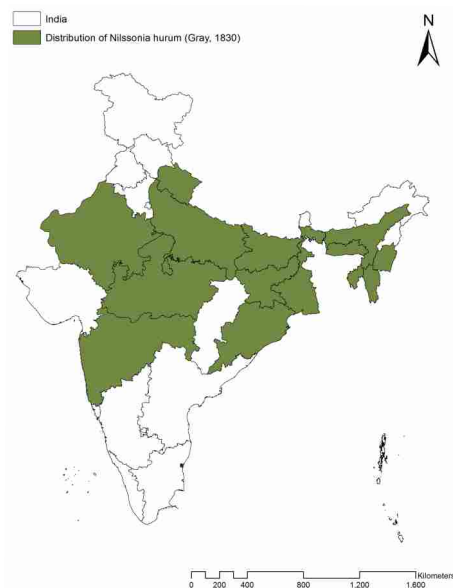
It feeds in carrion and sometimes has been known to show cannibalistic tendencies (feeding on eggs, hatchlings, juveniles of its own species).

Threats

This is a large turtle and is exploited for meat. This species is traded in East Asian Markets in large volumes and is mainly smuggled out to international markets. Eggs are collected for consumption across its range.



Indian Peacock Softshell turtle *Nilssonia hurum* (Gray, 1830)



Conservation Status

IUCN: Vulnerable

WLP: Schedule I

CITES: Appendix I

Distinguishing features

The juvenile carapace is rounded with distinctive 4-6 dark-centered, yellow-bordered concentric ocelli and numerous yellowish spots on a dark green background which eventually fades with age.

The adult carapace is depressed, more oval, darker green with black reticulations.

Head is large with a longish snout that is strongly turned downwards.

Species Description

The carapace is characterized by several



longitudinal rows of tubercles and a series of enlarged blunt tubercles occur above the neck on the anterior marginal rim. The plastron is light brown or grey and includes five well developed callosities.

Recorded length of 600 mm.

Habitat It is found in rivers and streams with mud or sand bottoms.

Distribution

It occurs in eastern and central India including the states of Assam, Manipur, Meghalaya, Mizoram, Tripura, Jharkhand, Uttarakhand, Bihar, Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, Bengal and Odisha (in the Brahmaputra and Ganges river systems and the Terai Arc landscape).

Outside of India, it can be found in Nepal, Bangladesh and Pakistan.

Natural History

This species is mostly nocturnal, living on riverbeds and also in lakes with muddy or sandy bottoms where it can hide.

Courtship display involves much biting by the males. The males are known to be very aggressive and emit loud sounds during copulation.

Diet

The diet is mostly omnivorous, comprising of snails.

Threats

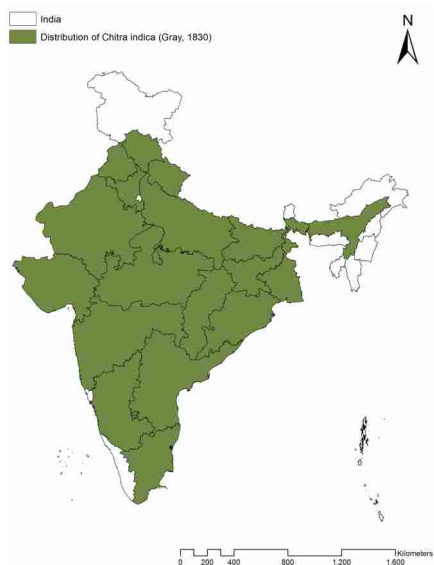
This species is exploited across its distribution range mainly in southeast Asia and Bangladesh.

The flesh is consumed for its alleged "medicinal value".



Indian Narrow Headed Softshell Turtle

Chitra indica (Gray, 1830)



Conservation Status

IUCN: Endangered

WLP: Schedule II

CITES: Appendix II

Distinguishing features

Shell is widely oval and flattened with distinctive 'V' shape marking from the nape (back) of the neck to the anterior part of the carapace.

Species Description

The carapace is dull olive or bluish-grey with a complex pattern of wavy reticulations. The head is very small, and the neck is slightly conical and quite thick at the shoulders. The eyes are small and located close to the snout.

The plastron is cream or pale pink. This turtle does not show any distinguishing sexually dimorphic characters.

Recorded length of 1150 mm.



Habitat Optimal habitat is medium to large rivers, with low turbidity and sandy bottoms. The species is highly aquatic.

Distribution

In India, it is found in Andhra Pradesh, Assam, Bihar, Chhattisgarh, Gujarat, Haryana, Himachal Pradesh, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Uttarakhand, Uttar Pradesh, Tamil Nadu, Telangana and West Bengal occurring in the Ganges, Godavari, Mahanadi and Sutlej Rivers.

Found in Pakistan, Nepal and Bangladesh southward through Burma to western Thailand.

Natural History

Females come ashore to nest. They can spend long periods of time at the bottom of the water body due to their ability for cutaneous respiration. The turtle often buries itself with only small eyes and nostrils showing and is active during daylight hours. It is an aggressive species and strikes violently when disturbed, inflicting serious bites.

Nesting takes place almost throughout the year, with a peak in August and September. The nest is flask shaped and the clutch size ranges from 60-178 eggs.

Diet

Primarily carnivorous and eats fish, mollusks, crabs, shrimp and, on some occasions, aquatic plants and vegetables.

Threats

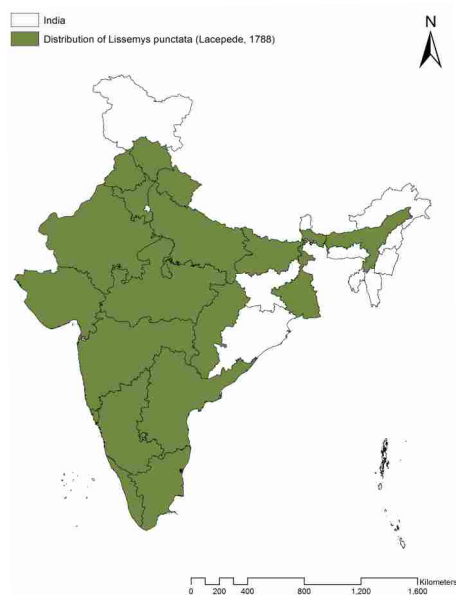
At present *Chitra indica* comprises about 2-3% of the total softshell turtle market volume. Significant numbers of this species were traded in India for its flesh up to the 1980's.

The species is now extensively hunted for its calipee.



Indian Flapshell Turtle

Lissemys punctata (Lacepede, 1788)



Conservation Status

IUCN: Lower Risk/ Least Concern

WLPA: Schedule I

CITES: Appendix II

Distinguishing features

The adult carapace varies from uniform brown to dark green with small dark brown or large yellow spots. Flaps are present on the plastron that gives the species its name.

Species Description

Adults have an oval domed carapace which is unique among softshell turtles. It varies from uniform brown to dark green with small dark brown or large yellow spots (*L.p andersonii*).

The plastron is cream coloured.



Recorded maximum length 270 mm.

Habitat

It lives in shallow, calm and often stagnant waters of rivers, streams, marshes, ponds, lakes and irrigation canals with a muddy or sandy bottom.

It is often seen basking on banks or floating vegetation.

Distribution

In India it is found in the Ganges and Indus River systems and is reported from Andhra Pradesh, Assam, Bihar, Chhatisgarh, Goa, Gujarat, Haryana, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Punjab, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, Uttarakhand and West Bengal. It was introduced into the Andaman Islands.

Reported globally from Pakistan, Sri Lanka, Nepal and Bangladesh and Myanmar (Irrawady and Salween Rivers).

Natural History

Courtship and mating are observed during April. The spherical eggs numbering 3-14 are laid in shallow nests with vegetative debris, several nests may be laid in a season by one female. Incubation lasts up to 270 days.

Diet

This species is mainly carnivorous feeding on frogs, tadpoles, fish, crustaceans, snails, worms and sometimes aquatic vegetation. It also consumes carrion.

Threats

The species is heavily collected for consumption.



5.2

Crocodilians of the Ganga Basin

**"The crocodile cannot turn its head.
Like all science, it must always go
forward with all-devouring jaws."**

- Pyotr Kapitsa

Systematics

Kingdom: Animalia

Phylum: Chordata

Subphylum: Vertebrate

Superclass: Tetrapoda

Class: Reptilia

Order: Crocodilia

Family:

Crocodylidae- True Crocodiles

Alligatoridae- Alligators and Caimans

Gavialidae- Gharial

Crocodiles are a dynamic species and top predators in aquatic systems. They have an undeniable role in maintaining the health and viability of fragile ecosystems. Crocodile conservation was started in India with Project Crocodile in 1974 and has come a long way forward despite several challenges during this journey.

There are 25 extant species of Crocodilians, belonging to the family Crocodylidae. India is home to 3 species, 2 of which are true crocodiles Mugger (*Crocodylus palustris*) Saltwater Crocodile (*Crocodylus porosus*) and one species belongs to the family Gavialidae; Gharial (*Gavialis gangeticus*).

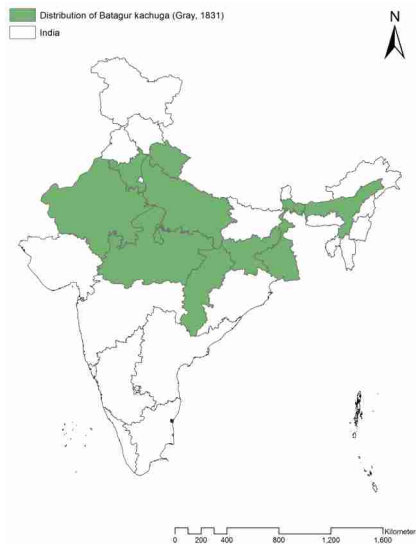
After surveys in the 1970's showed a decline in the 3 Indian crocodilian species in the wild, Project Crocodile was initiated and went ahead with the establishment of recovery centres running rear and release programs to help with repopulating crocodile habitats. A Crocodile Breeding and Management Training Institute was also established by the Government of India in Hyderabad in 1980 to aid with capacity building of managers and research staff.

The project has been successful in re-establishing the populations to a significant degree. But crocodilians have some unique aspects of natural history and biological attributes that create special challenges for their conservation. Anthropogenic pressures, alteration in habitats critical to the natural history of the species have posed further hurdles.

Economic values and benefit do not feature in the current conservation paradigm for crocodilians. It is thus prudent to persist and persevere with continued education, awareness and build on intrinsic and cultural values such as pride, and curiosity. These, in fact, could offer a more realistic and grounded foundation to preserve the species.



Indian Gharial *Gavialis gangeticus* (Gmelin, 1789)



Conservation Status

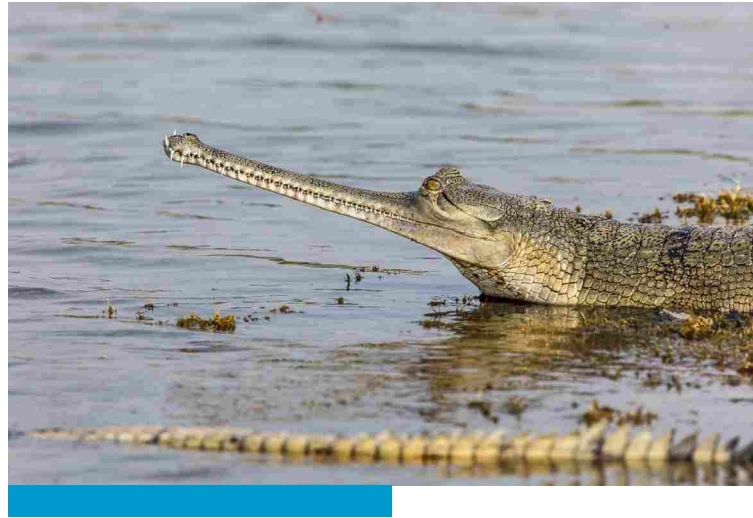
IUCN: Critically Endangered

WLP: Schedule I

CITES: Appendix I

Species Description

It has a characteristic elongate, narrow snout. The elongated jaws are lined with interlocking teeth. Their jaws and teeth are perfectly adapted to their piscivorous diet. The gharial is largely aquatic in nature and poorly equipped for locomotion on land as an adult. They push their body forward across the ground ('belly-sliding'). The tail is well-developed and laterally flattened, and the rear feet possess extensive webbing. The body color of adult gharial is dark olive or brownish olive in upper part and white or yellowish white below. Youngs are grayish brown with five irregular transverse bands on the upper body and nine on the tail.



Habitat

Gharial inhabit calmer areas of deep, fast-moving rivers. They are heavily dependent on sandbanks and sand bars for nesting and basking and congregate around those nesting beaches during breeding season.

Distribution

Known populations exist only in India and Nepal. Breeding populations in India are found in the Chambal River- National Chambal Sanctuary, Girwa River- Katarniaghat Sanctuary, Ghagra River, Son River, Mahanadi River, Ramganga Reservoir, Gandak River, Yamuna and Brahmaputra Rivers.

Natural History

Mating occurs during November, December and into January. Nesting occurs in March, April and May (the dry season) where the females dig hole nests on the high sandbanks. Clutch Size is 30 to 50 eggs weighing on average 160 grams. The incubation period is 83 to 94 days. The females have not been observed assisting the hatchlings to the water, however parental care is seen. The male also plays a significant role in caring for their hatchlings and occasionally have been seen closely guarding several hundred hatchlings (possible multiple clutch crèches).

Diet

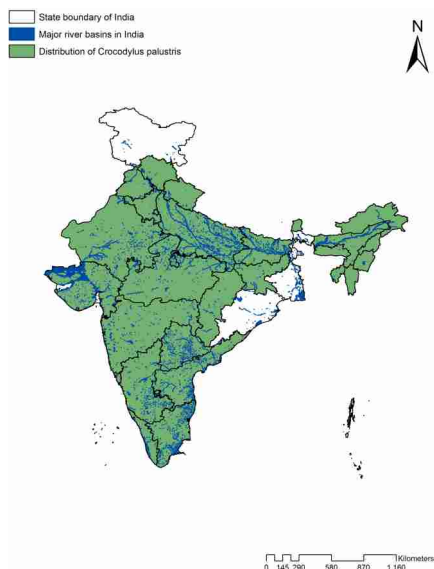
Adults are almost exclusively fish-eaters, while juveniles prey insects, smaller vertebrates such as frogs.

Threats

The major threats are habitat loss due to flow reduction in rivers, loss of basking and nesting sites to agricultural encroachment, sand mining, grazing, and accidental killing in unsustainable fishing practices.



Marsh Crocodile/ Mugger *Crocodylus palustris* (Lesson, 1831)



Conservation Status

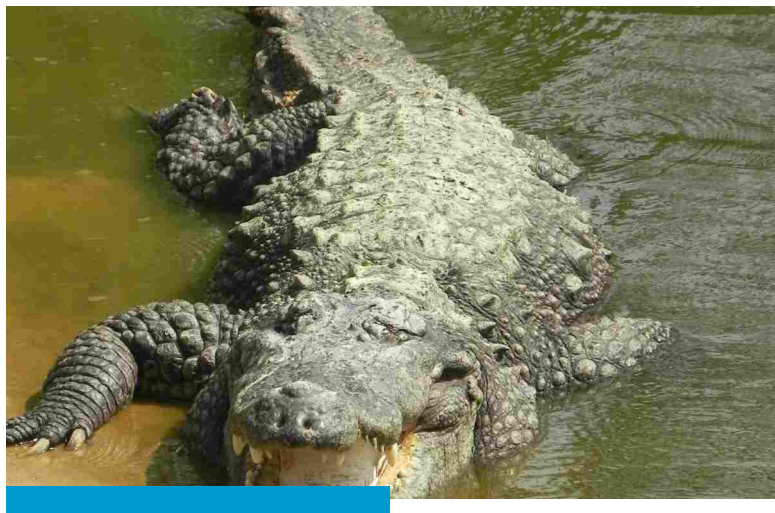
IUCN: Vulnerable
WLPA: Schedule I
CITES: Appendix I

Species Description

Juveniles have black cross-banding on body and tail and are light tan in color. Adults are generally grey to brown, with minimal banding. Muggers are believed to grow up to 4-5 meters. They have the broadest snout of the *Crocodylus* genus. The scutes around the throat area are enlarged. They have a protective function during locomotion in swampy areas.

Habitat

Muggers are found in freshwater rivers, lakes and marshes. They seem to prefer slow-moving,



shallower areas. This species has adapted to the development and has been thriving in reservoirs, irrigation canals, and other man-made bodies of freshwater. In some states of India, they have been reported from brackish areas. There are records of Muggers burrowing in drier months and they are known to travel considerable distances over land (several km) in search of suitable habitat.

Distribution

This species is recorded in almost all states in India except Odisha, West Bengal and the Andaman Islands.

Natural History

Copulation is noted from October to December and nesting occurs in the dry season from December to February. Muggers are hole nesters and commonly use the sloping sandbanks to deposit eggs. Clutch size is 25 to 30 eggs. The incubation period is relatively short (55-75 days). The parents, mainly the females guard the nest aggressively and the female often assists in opening the nest cavity and transporting the hatchlings to water.

Diet

The diet of juveniles consists mainly of crustaceans, insects and small fish. Adults consume larger fish, amphibians, reptiles (possibly turtles), birds and mammals. Large adults have been known to take deer and cattle on occasions.

Threats

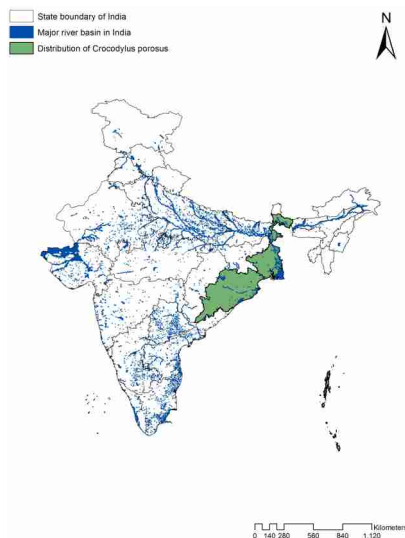
This species seems to be faring well despite several pressures and is often found to be in conflict situations with people across its distribution. The major threat at present is habitat loss due to human encroachment and alteration of habitat.



Saltwater Crocodile

Crocodylus porosus

(Schneider, 1801)



Species Description

This species is considered to be one of the largest species of crocodilians and adult males grow up to 6 meters. Females of this species are smaller, growing up to 2.5 m to 3 m. They have a large head and well-developed jaws. The flank scales are more oval and belly scales are rectangular and relatively small. Juveniles of the species are pale (almost yellowish) and have black stripes and spots on the body and tail. Their color becomes darker with age. Adult coloration is dark with lighter yellowish or greyish areas. The belly is extremely light in color, tending to white.

Habitat

The saltwater crocodile has a high tolerance for saline conditions and is found in brackish water around coastal areas and rivers. They use freshwater areas for drinking and even nesting. The



juveniles are reared in freshwater areas and as they attain maturity they may be pushed out by dominant individuals of the species.

Distribution

In India, the species is found in Odisha (Bhitarkanika), West Bengal (Sunderbans) and the Andaman Islands.

Natural History

Freshwater areas are usually preferred for breeding. Sexual maturity in females is at lengths of 2.2 to 2.5 m (10 to 12 years old). Males tend to mature later (3.2 m, at around 16 years old). The clutch size is 40 to 60 eggs in mound nests made from vegetation (usually grasses and vines) and mud. Nesting occurs from November and March, but this varies geographically. The incubation period is about 80 to 90 days but this varies with temperature. The female assists with nest excavation and carries hatchlings to the water.

Diet

Saltwater crocodiles have an extended palate but small prey still form a major portion of it. Prey items include crustaceans (e.g. mudcrabs) and vertebrates (e.g. turtles, snakes, shore and wading birds). Large adults occasionally take much larger prey like domestic livestock, wild boar, etc. The juveniles are restricted to insects, amphibians, crustaceans, small reptiles and fish.

Threats

This species has a wide global distribution and the numbers seem to be secure at the moment. This is an aggressive species and often in conflict with people giving rise to a level of antipathy and making conservation measures a challenge. Habitat destruction and illegal hunting can be major problems.



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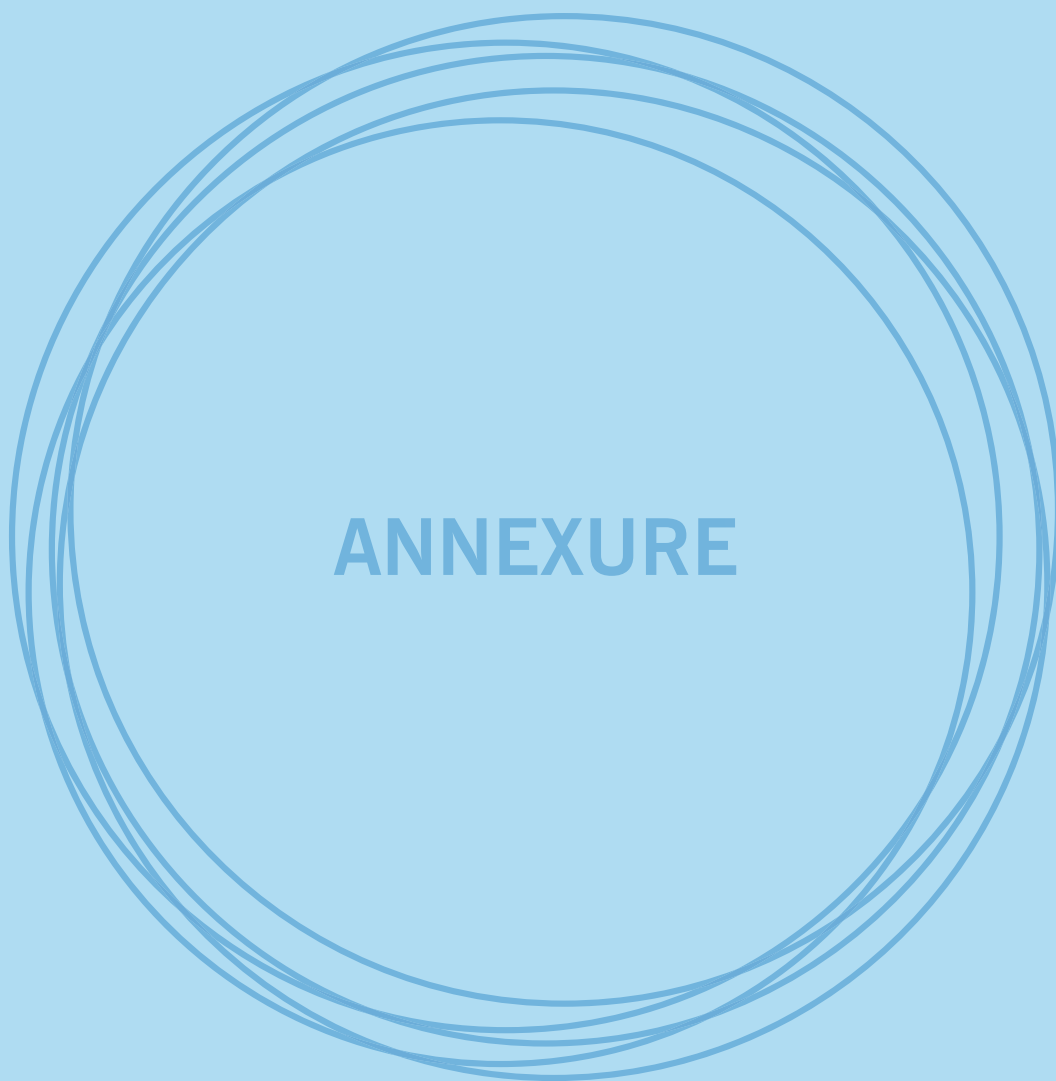
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Further reading

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ANNEXURE



ANNEXURE I

Medications used on confiscated Asian turtles at triage and immediately post triage for rehabilitation

Medication	Dose/frequency	Route
Ceftazidime	20 mg/kg q72h	ICe, IM, SQ
Balanced electrolyte solution	20 ml/kg	ICe, SQ
Amikacin	5 mg/kg q72h	ICe, SQ
Levamisole hcl	5 mg/kg repeat in 10-14d	ICe
Lodohydroxiquinol	50 mg/kg SID X 2-3d	PO
Gavage formula		
Fluconazole 1 mg/ml	10ml/kgSIDX2-3d	PO
Metronidazole 5 mg/ml		
Fenbendazole 5 mg/ml		
Iodothyroquinol 5 mg/ml		
omnivore diet		
Intracoelomic fluids:		
Balanced electrolyte Solution		
Ceftazidime lmg/ml		
Levamisole 0.5mg/ml	20 mg/kg once	ICe

Abbreviation: ICe: Intra- coelomic, IM: Intra- muscular, SQ: Sub-cutaneous, PO: Per-os (oral)



ANNEXURE II

Admission Form

Case Number: _____

Incharge: _____

ADMITTANCE RECORD - NATIVE SPECIES

Species: _____ Sex: M / F _____ Age: Adult/Juvenile/ Hatchling _____

Date: _____

Finder's Name: _____

Address: _____

Phone: _____

Location of where the animals were found: _____

History of capture/ Seizure: _____

TRIAGE CATEGORY: I / II /III/ IV/ V

RESULT

DOA _____ Euthanized: _____

Died within 24 hours _____ Died: _____

Transferred: _____

Released: _____

Place of release: _____



ANNEXURE III

Equipment List required for sampling for pre-release health assessment and monitoring

1	Microchip transponder/ reader	15	Alcohol
2	Blank worksheets in folder	16	Gauze swabs (several boxes)
3	Clipboard	17	Povidone Iodine
4	Black waterproof marker pens (thin-medium thickness)	18	Cooler with ice/ ice packs
5	Sharpened pencils and eraser	19	Ziplock bags
6	Ballpoint pens	20	Paper towels
7	Weighing scales	21	Trash bags (dispose of clinical waste appropriately)
8	Bandaging materials for mouth and eyes	22	Sharps bin
9	Needles:	23	Sterile saline- several litres
	21, 22 and 23 Gauge 1 1/2inch long	24	Rigid or Semi- Rigid catheters size 6 x 3 (e.g. French catheters)
	21, 22 and 23 Gauge 2 inch long	25	10ml and 20ml syringes
10	Syringes: 5 ml	26	Disposable latex gloves
11	Glass microscope slides	27	Plain sample tubes for colonic wash sample.
12	Slide box	28	PIT Tags and Cattle Tags in different colours
13	10ml Vacutainers plian or with clot activator (allows blood to clot)	29	Tag Applicators
14	10ml vacutainers with green top (contains Heparin to prevent clotting)	30	Scalpel blades and handles



ANNEXURE IV

Common diseases of chelonians and crocodilians (information compiled and edited by Dr. Himanshu Joshi from Flanagan, 2012)

Viral and Bacterial diseases of chelonians

Disease	Etiology	Epizootology	Signs	Diagnosis	Management
Herpesviral infection	Herpesvirus	Animal-to-animal and contaminated environment	Nasal discharge, weight loss, necrotizing bronchitis, hepatitis, conjunctivitis, stomatitis, tracheitis, pneumonia, dermatitis, plasma fibropapillomatous tumors, and death	Histopathology: intranuclear inclusions in a variety of tissues; plasma neutralization and ELISA; isolation of virus in viral culture	Isolate infected animals. Excise tumors Supportive care
Salmonellosis	Salmonella spp	Found commonly in asymptomatic May cause disease animals when new serotypes are encountered or with concomitant stressors	Enteritis and sepsis	Blood culture and cloacal culture	Appropriate systemic antibiotic and supportive treatment
Septicemic cutaneous ulcerative disease (SCUD)	Bacteria, including Citrobacter freundii and Pseudomonas spp.	Animals in contaminated environment or with chronic environmental stressors	Cutaneous ulceration, sloughing skin, septicemia, dehydration, and death	Clinical signs; blood culture; and cutaneous culture	Antibiotic therapy; increase environmental temperature; increased salinity of the water temporarily; medicated baths; and supportive care
Upper respiratory disease (URD)	Mycoplasma spp.	Animal to animal contact, possibly fomites	Nasal and ocular discharge, pneumonia, weight loss, unthriftiness, and death	PCR of nasal flush, rising serological titers, and culture	Isolate seropositive animals. Attempt treatment with systemic antibiotics Supportive care

Parasitic Diseases in Chelonians

Disease	Etiologic? Life? Cycle	Location? in? Host	Diagnosis	Clinical? Signs	Management
Acariasis (ticks)	Nymphs and adults on chelonians They drop off to lay eggs	Axilla, inguinal region, neck, and shell	Visual	May cause dermatitis	Resmethrin and Pyrethrin Spray is approved for use in chelonians. Do not use Ivermectin



Disease	Etiology	Epizootology	Signs	Diagnosis	Management
Amebiasis	Direct	Colon, liver, and portal vessels	Direct fecal and histopathologic examinations	Weight loss, enteritis, and death	Keep terrestrial and aquatic separate Treat with metronidazole, paromomycin, or iodochlorhydroxyquin
Coccidiosis	Direct; may intermediate host	Intestine and renal	Fecal and histopathologic examination	Renal failure, enteritis, weight loss, and death	Treatment of renal coccidia with Toltrazuril and enteric coccidia with Sulfonamides
Cryptosporidium spp.	Direct	Mucosa of stomach and intestine	Fecal, gastric wash Immuno Fluroscent Antibody and direct plasma Enzyme Immuno Assay	Usually none; may be associated with chronic weight loss	No treatments are proven; Toltrazuril has been used
Nematodes	Direct and/or intermediate host	Gastrointestinal tract, vascular microfilaria, and lungs	Fecal flotation, direct, lung wash, and blood smear	Weight loss, enteritis, gastrointestinal blockage, pneumonia	Anthelminthic and supportive therapy Do not use Ivermectin
Trematodes	Amphibians, crustaceans are intermediate hosts	Liver, gall bladder, lungs, and vascular system	Direct visualization, lung washes, and sedimentation fecal exams	Pneumonia, granulomatous inflammation, and enteritis	Treatment with albendazole and praziquantel

Nutritional Diseases:

Diseases with nutritional aetiology may be more common in captive conditions and are caused by poor nutrition or inappropriate husbandry practices.

Nutritional diseases of chelonians:

Disorder	Cause	Signs	Treatment
Hypervitaminosis A	Iatrogenic, administration of too high a dose of vitamin A parenterally, or chronic dietary oversupplementation	Flaking and sloughing skin	Adjust dose of Vit A. Treat sloughed skin locally and prevent infection until skin is healed
Hypovitaminosis A	Deficiency of vitamin A in diet	Squamous metaplasia blepharoedema, nasal discharge, and pneumonia	Give vitamin A parenterally once or twice, followed by addition of vitamin A to diet
Metabolic bone disease	Low calcium diet, inadequate exposure to ultraviolet radiation, chronic low environmental temperatures, and renal failure	abnormal shell formation and texture of carapace, inability to raise body off of ground, and hypocalcemic tetany	Increase dietary calcium without increasing phosphorus; provide a source of ultraviolet radiation; administer calcium gluconate parenterally; increase environmental temperatures; address cause of renal failure; and treat symptomatically



Disorder	Cause	Signs	Treatment
Organ prolapse	General debility, neurological dysfunction, ceolomic space occupying lesion, any cause of straining, dyspnoea, constipation, egg retention, cystic calculi, cloacal hypertrophy, obesity, excessive libido, bacterial, viral and gastric infections of lower genito-urinary tract or digestive tract	Protrusion of organs like penis, clitoris, bladder or the proctodeum from cloaca	Medical management (cold compress, saturated sugar solution) is used to reduce any swelling. If medical intervention does not work, the organ may be replaced and the vent is partially closed with purse string sutures. Sometimes amputation may need to be performed if the organ cannot be salvaged.

Crocodilians

Infectious diseases:

Crocodilians may be susceptible to a variety of bacterial, viral, parasitic, and fungal diseases; however, captive crocodilians appear to exhibit minimal infectious disease if held in appropriate social and environmental settings.

Table 1 provides an overview of common infectious diseases in captive and wild crocodilian species.

Dermatophilosis	Dermatophilus?sp	Filamentous? environmental? pathogen,? found?in? poor?sanitary? conditions	Brown? discoloration? of? ventral? scutes	Ventral?lesions? with? cytology? or?histology? or?culture	Treatment?with? tetracycline? (1?g?per? 1?kg? of?dry?feed),?or? topical?copper? sulfate,? hygienic? conditions
Pox?virus	Parapox?sp	Juvenile? crocodilians? with?skin? lesions	White?to? brown?crust? in?oral?cavity? and? ventral? scutes	Histology?with? Bollinger?bodies? and? Borrel? bodies	Self-limiting,? surgical? removal? of?any?large? lesions
Adenoviral? hepatitis	Adenovirus?sp	Hatchlings? under?5? months?of? age,? vertical? and?horizontal? transmission	Hepatitis	Virus?may?be? found?in? liver,? lung,?pancreas,? and?intestines	No treatment, supportive?care? for? secondary? bacterial? infection
Fungal?Disease	Numerous? species? including Mucor?sp.,? Aspergillus?sp.,? Fusarium?sp.,? Cladosporium?sp.	Dermatitis,? gastric,?oral,? and?respiratory? mycosis	Related?to? poor? sanitation? and? environmental? conditions	Culture?and? histopathology	Improvement of Sanitary?conditions,? topical?and?systemic? antifungal?treatment Poor?prognosis?for? systemic?mycosis



Coccidiosis	Eimeria?and? Isospora (Many?are? species? specific)	Fecal?-oral? transmission,? morbidity?is? variable	Intestinal? coccidiosis? with?secondary? bacterial?infection,? may?result?in? intestinal? blockage	Direct?saline? fecal? examination? or? identification Histopathology	Screen?incoming? crocodilians Treat? with?sulfa? derivative?drugs? (i.e.,? sulfachloropyrazine,? sulfadiazine,?and? toltrazuril;?Hutz?188)
Hepatozoonosis	Hemogregarines	Blood?parasites? transmitted?by? arthropods	Asexual?schizonts? may? be?found? in?the?liver? while?gametes? found? in?the? blood? Sexual? reproduction? takes?place? in?the? arthropod	Blood?smears? Usually?none? pathogenic? unless? immune? suppression?or? chronic?disease? is? present	Impossible?to? control?in? outdoor?setting
Ascarids	Over?40?species? identified	Intermediate? host? involved	Usually?no? clinical? signs,? stomach? ulcers,? mucosal? lesions? of? gastrointestinal ?tract	Fecal? examination	Indoor? housing? eliminates? ascarids Fenbendazole? successful Freezing? food?for?72? hours? may?eliminate? larvae
Trematodes	Over?80?species? identified	Intermediate? host? required Internal? (digenetic)?and? external?species	Limited?pathology? with? the? exception? of? concurrent? infection? with? other?diseases	Direct? visualization? of? parasite? both? antemortem? and? postmortem	Usually?not?treated? due?to?limited? pathology.?Reduce? feeding?fresh?water? fish?from?the?same? habitat
Pentastomes	Sebekia?sp. Alofia?sp. Liperia?sp.	Intermediate? host Inhabit? the?upper? respiratory? tract?and? lungs	May?cause? morbidity?or? mortality?in? young? crocodilians Secondary? infections?at? attachment? sites	Eggs?may? be?seen?in? feces	Endoscopic?removal

Disorder	Cause	Signs	Treatment
Metabolic bone disorder: (osteomalacia, rickets and osteoporosis)	Mismanagement of diet or environment or both. The condition may be aggravated by a lack of Vitamin D3 when the hatchlings are kept in pools with low sunlight, imbalanced ratio of phosphorous and calcium in diet or its malabsorption (Foggin, 1992).	Soft jaws, diaphanous appearance of teeth and soft pliable ribs with extreme weakness, sluggishness, inability to swim for a long time and seizures are observed. Glassy teeth, rubber jaws and extreme weakness may also be indicators	Rectify diet. Increase dietary calcium without increasing phosphorus; provide a source of ultraviolet radiation; administer calcium gluconate parenterally; increase environmental temperatures



Emergencies in chelonians and crocodilians:

Emergencies in chelonians and crocodilians are mostly due to entanglement in fishing nets, engulfment of foreign bodies particularly fish hooks and trauma.

Disorder	Cause	Signs	Treatment
Drowning	Entanglement in fishing nets	Dyspnea or apnea, raspy respirations followed by coma and death in prolonged conditions (Fig.7 and 8).	In acute cases where animal is rescued in time, the animal may be kept in a head low position and gentle pressure is applied to the chest cavity. X rays help in identifying extent of lung involvement. Treatment with antibiotics for aspiration pneumonitis and supportive therapy
Foreign bodies	Ingestion of coins, jewellery, stones or fish hooks with fishing lines	Obstruction leading to weight loss. Objects like fish hooks may get lodged in the oral cavity, oesophagus or in severe conditions at the base of the heart with fishing line extending into the intestinal	The exact position of the object may be determined by radiography and the fish hook can be extricated. Endoscopy can be used to extricate FB from stomach and upper intestines.
Trauma:	Injury by boat, sticks, nets or bites by dogs and rodents in case of turtles In crocodilians, infighting amongst large animals and injuries from coming in contact with humans are the most common causes for trauma.	Fractured or displaced shell with blood loss, low heart rate and severe pain	surgical interventions to repair the shell involving debridement and cleaning Repair may be done with external fixatives like acrylics, wires, and tape (Flanagan, 2012). Crocodilians will need rehabilitative care and pain management along with basic wound management.



ANNEXURE V

Available phlebotomy options in chelonians and crocodilians
Compiled and edited by Dr Sanath Krishna M.K.

Chelonians	Site	Anatomical location	Technique	Precautions
	Jugular vein			
	Located laterally in the neck region and can be made visible if occluded with digital pressure at the base of the neck	The needle is advanced behind the tympanum and directed in a caudal direction with slight negative pressure maintained.	Post venipuncture pressure should be applied to prevent hematoma formation. Mainly done under anaesthesia.	
	Sub-carapacial venous plexus	Located just caudal to the skin insertion on the ventral aspect of the cranial rim of the carapace	The needle positioned in the midline just caudal to the skin insertion on the ventral aspect of the cranial rim of the carapace and advanced in a caudodorsal direction, with slight negative pressure until plexus is contacted.	
	Dorsal cervical sinuses	Located relatively dorsal and superficial in the neck, lateral to the cervical vertebrae	Pull the head gently forward and downward until it is fully outstretched to facilitate the filling of the bilateral cervical sinus. Insert the needle on either side of the midline of the neck (depending on the size of the turtle, from 0.5 - 3.0 cm lateral to the midline) about 1/3 to 1/2 of the distance between the back of the head from the anterior edge of the carapace.	
Crocodilians	Occipital sinus	Located caudal to the occiput and immediately dorsal to the spinal cord	Can be entered with the needle positioned in the dorsal midline, just caudal to the occiput, and perpendicular to the surface of the skin, with gentle suction until sinus is contacted.	Care must be taken, not to pass the needle too deep as it may lead to spinal cord injury and contamination of blood with CSF.
	Coccygeal vein (ventral approach)	Located on the ventral midline of the tail.	The needle is positioned in the ventral midline between 20% and 80% down the tail and advanced at 45 to 90 degrees in a craniodorsal direction, with slight negative pressure maintained.	
	Coccygeal vein (Lateral approach)	Located lateral to the ventral midline of the tail.	The needle is advanced at 45 to 90 degrees in a craniomedial direction, aiming just ventral to the lateral processes of the coccygeal vertebrae.	Possibility of lymphatic contamination is more with this approach. Sample must be discarded in such cases and procedure has to be repeated.



ANNEXURE VI

Importance of biochemical parameters in reptilian disease diagnosis.

Compiled and edited by Dr Sanath Krishna M.K.

Parameter	Observed range	Diagnostic indications
Total Erythrocyte count	0.3 to 2.5 X 10 ⁶ /μl	An increase in polychromasia and the number of immature erythrocytes is seen as response to anemic conditions.
Hemoglobin	6 and 10 g/ dL	Decreased in cases of chronic disease
Packed Cell Volume	20% to 40%	PCV less than 20% is suggestive of anemia and greater than 40% suggests either hemoconcentration or erythrocytosis
TLC	2 -10 X 10 ⁹ /μl	Higher TLC is usually associated with severe inflammation or in infectious diseases that result in antigenic stimulation
Thrombocytes	25 to 35 %	Thrombocytopenia has been associated with bleeding disorders in reptiles
Heterophils	? 40%	Significant increases are usually associated with inflammatory disease of microbial and parasitic origin or tissue injury
Eosinophils	? 20%	Associated with parasitic infections and stimulation of the immune system
Lymphocytes	Highly variable (80% or more)	Lymphocytosis occurs during wound healing, inflammatory disease, parasitic infection, viral infections and ecdysis. Lymphopenia is associated with malnutrition or secondary to diseases caused by stress and immunosuppression.
Monocytes	0 - 10%	Monocytosis is suggestive of inflammatory diseases, especially granulomatous inflammation.
Basophils	0 - 40%.	Basophilias are mostly associated with parasitic and viral infections
Aspartate Aminotransferase	Less than 250 IU/L	Increased plasma AST activity suggests hepatic or muscle injury
Total Protein	3 - 7 g/dL	Hyperproteinemia (?7 g/dL) occurs with dehydration or hyperglobulinemia associated with chronic inflammatory diseases. Hypoproteinemia, (?3 g/dL), is commonly associated with chronic malnutrition in reptiles.
Uric Acid	? 10 mg/dL	Hyperuricemia associated with renal disease most likely reflects loss of two thirds or more of the functional renal mass, associated with gout or recent ingestion of a high protein diet.



Parameter	Observed range	Diagnostic indications
Potassium	2 - 6 mEq/L	Hypokalemia can be associated with severe alkalosis. Hyperkalemia can result from excessive dietary potassium intake or severe acidosis.
Sodium	120 to 170 mEq/L	Hyponatremia can result from excessive sodium loss associated with disorders of the gastrointestinal tract (i.e., diarrhea), Hypernatremia results from dehydration, either from excessive water loss or inadequate water intake, and excessive dietary salt intake.
Chloride	100 to 130 mEq/L	Hypochloremia in reptiles is rare and suggests excessive loss of chloride ions or over-hydration with fluids low in cl. Hyperchloremia is associated with dehydration and possibly renal tubular disease or disorders of the salt glands.
Calcium	8 - 11 mg/dL	Hypocalcemia can occur with dietary calcium and vitamin D3 deficiencies, excessive dietary phosphorus, alkalosis, hypoalbuminemia, or hypoparathyroidism. Hypercalcemia occurs with excessive dietary or parenteral vitamin D3 and calcium.
Phosphorus	1 - 5 mg/dL.	Hypophosphatemia may result from starvation or nutritional deficiency of phosphorus. Hyperphosphatemia may result from excessive dietary phosphorus, hypervitaminosis D3, renal disease and severe tissue trauma and osteolytic bone disease.

ANNEXURE VII

Drugs and Dosages
Compiled and edited by Dr Himanshu Joshi from Exotic Animal Formulary- M.J. Carpenter V (Edn.)

Drugs	Dosage (mg/kg)	Routes of administration		Interval (hrs)	Suggested Duration of therapy
	Chelonians	Crocodilians			
Antimicrobials					
Amikacin	2.5-5	2.25	IM	48-72	5-10 days
Ampicillin	20-50	10 to 20	IM	12-24	7-14 days
Carbenicillin	200-400	-	IM	48	5-7 days
Ceftazidime	20-40	20-40	IM	48-72	5-14 days
Ceftiofur sodium	2.2-4	-	IM	24	7-21 days
Chloramphenicol	25-50	40	IM or PO	24	7-14 days
Ciprofloxacin	0.30%	0.30%	Topical		-
Clarithromycin	15	-	PO	48-72	5-7 days
Doxycycline	50 once then 25	5 to 10	IM	72	5-7 days
Enrofloxacin	2.5-10	5 to 10	IM or PO	24-96	7-21 days
Gentamicin	5-10	1.75-2.25	IM	48-72	5 days
Metronidazole	20-50	50	PO	24	5-14 days
Oxytetracycline	5-10	10	IM	24	5-10 days
Penicillin G	10000-20000 U	10000-20000 U	SC, IM, IV, ICe	8-12	-
Penicillin, benzathine	10,000-20,000 U	10,000-20,000 U	IM	48-96	-
Trimethoprim-sulfamethoxazole	30	10 to 30	PO	24	7-10 days
Tylosin	5	5	IM	24	10-60 days
Antifungals					
Fluconazole	5	-	PO	24	10-40 days
Ketoconazole	15-30	15	PO	24	7-21 days
Terbinafin	3.4	-	PO	-	-
Antivirals					
Acyclovir	40-80/5%	40-80/5%	PO/Topical	12	-
Famcyclovir	10 to 30	10 to 30	PO	24	-
Anthelmintics					
Albendazole	50	50	PO		Repeat in 2 weeks

Drugs	Dosage (mg/kg)	Routes of administration		Interval (hrs)	Suggested Duration of therapy
	Chelonians	Crocodilians			
Fenbendazole	25-50	25-100	PO	1-3 days;	repeat in 10-14 days
Paromomycin	35-100	35-100	PO	Every 24 hours for	Upto 4 weeks
Permethrin	1 sec/square foot	1 sec/square foot	Topical spray	Axillary and inguinal regions 1-5 seconds	-
Piperazine	40-60	100-200	14		-
Praziquantel	8 or 25	8 or 25	SQ, IM or PO	One time only	Repeat in 2 weeks
Pyrantel pamoate	5 to 25	5 to 25	24	Once in 24 hrs for 3 days;	Repeat in 14 days Repeat in 3 weeks for crocodilians
Sulfadimethoxine	90 once then 45	50-90	PO	Every 24 hours	For 5-7 days
Toltrazuril	15	-	PO	Every 3 weeks	-
Analgesics					
Meloxicam	0.1 to 0.5/ 0.22	0.1-0.2	PO,IM/IV	-	5 to 7
Tramadol	5 to 10	5?	PO/SC	-	3 to 5
Flumixine meglumine	0.5-2	0.5-2	IM	12 to 24	3
Anaesthetics/ Tranquilizers/Sedatives					
Bupivacaine	1 to 2 local infiltration maximum dose	-	IM	-	-
Buprenorphine	0.075	-	S/c	-	-
Butorphanol (Torbugesic)	0.2	0.5-2/ 0.2-0.5	IM/IV, IO	-	-
Dexmedetomidine (Dexdomitor)	0.03 to 0.075	-	IM	-	-
Diazepam (Valium)	0.2 to 1.0	0.2 to 1.0	IM	-	-
Doxapram	4 to 12	5 to 10	IM, IV	-	-
Isoflurane (IsoFlo)	3% to 5%	-	Intra nasal	-	-
Ketamine HCl (Multiple)	5 to 25/20 to 60	20 to 40	IV/IM	-	-

Drugs	Dosage (mg/kg)	Routes of administration		Interval (hrs)	Suggested Duration of therapy
	Chelonians	Crocodilians			
Lidocaine (0.05-2%) (Multiple)	Up to 2 total dose/ 1 mL 2%/20	-	IM/Epithelial	-	-
Medetomidine (Dormitor; Zaloprim)	0.1 to 0.15	0.15	IV/IM	-	-
Propofol (Deprivan)	5 to 10	10 to 15	IV	-	-
Tiletamine/ zolazepam (Telazol)	5 to 10	1 to 15	IV/IM	-	-
Xylazine	0.1 to 1.25	0.1 to 2	IV/IM	-	-
Atipamezole (Antisedan)	5× dose of medetomidine, 10× dose of dexmedetomidine	-	IM	-	-



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Wildlife Institute of India

Post Box #18,
Chandrabani
Dehradun - 248001
Uttarakhand, India
t.: +91 135 2640114-15,
+91 135 2646100
f.: +91 135 2640117

