

Setting Priorities for the Conservation of Asia's Tortoises and Freshwater Turtles: A Ten-Year Update

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On the cover

Centre: *Batagur affinis* by Chris Poyser. Clockwise from top right: *Cuora aurocapitata* by Jordan Gray; *Geochelone platynota* by Cris Hagen; *Chitra chitra* by Gerald Kuchling; *Batagur kachuga* by Sheena Koeth; *Cuora galbinifrons* by Cris Hagen; *Batagur baska* by Maksudur Rahman.

Back cover: *Batagur dhongoka* by Pawan Pareek

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Introduction

This report is a ten-year update of the first set of priority recommendations generated from the workshop “Conservation of Asian Tortoises and Freshwater Turtles: Setting Priorities for the Next Ten Years,” co-organised by Mandai Nature and the Wildlife Conservation Society (WCS) at Singapore Zoo over 21–24 February 2011 (Horne et al. 2012). It builds on the subsequent South-East Asia Tortoise and Freshwater Turtle Red List workshop co-organised by the IUCN SSC Asian Species Action Partnership (ASAP) and the International Union for Conservation of Nature’s Species Survival Commission (IUCN SSC) Tortoise and Freshwater Turtle Specialist Group (TFTSG), hosted at Singapore Zoo in March 2018.

Ten years ago, the turtle conservation community gathered in Singapore to formulate plans to address the rapidly dwindling turtle populations across Asia. The community quickly prioritised Asia because it has the most Critically Endangered turtle species; thus, conservationists raced to ensure that species across the region would not become extinct. In the decade since the first workshop, there has been much progress in conserving Asia’s freshwater turtles and tortoises, and most importantly, not one species of turtle has gone extinct.

Today, the turtle conservation community is more proactive rather than reactive, both in preventing additional species from becoming Critically Endangered and, more importantly, working towards improving the status of species currently recognised as Critically Endangered. Rewilding species

such as the Burmese Star Tortoise *Geochelone platynota* in Myanmar and the Southern River Terrapin *Batagur affinis* in Cambodia are two excellent examples of programmes making progress at recovering viable wild populations. The term ‘rewilding’ is used here for the return of wildlife species to areas where they have been lost, actively augmenting populations where needed, and restoring ecosystems’ essential functions and adaptive capacity.

However, many species are still losing ground, and without directly addressing the threats to their survival, there is little hope for stopping their declines or initiating their recovery. In addition, while the scale of turtle conservation in Asia has also increased to cover more species, many species still have had little to no conservation effort during the past ten years and remain in decline. A significant driver of this is the limited funding for species-focused conservation. However, there is also a need to increase awareness further and recruit more conservationists, locally and regionally, to work with turtles.

The report resulting from the 2011 meeting listed 36 Critically Endangered turtles; today, there are 42. More than 50% of all Asian turtles are now identified as being perilously close to extinction. Hunting, for consumption and the international pet trade, and habitat loss remain the primary causes for turtle declines across Asia, just as they were a decade ago. This report puts forth updated recommendations that are action-based and aimed at halting species from further decline, and to begin the recovery process.



Photo by Steven Platt

Taxon-specific Updates and Recommendations for Critically Endangered Species

The following accounts summarise the major conservation updates for each species over the last ten years and how they have impacted the species; this is followed by a set of priority conservation recommendations for advancing the recovery of the species over the next ten years. Taxonomy is based on the recommendations of the IUCN SSC Tortoise and the Freshwater Turtle Specialist Group Turtle Taxonomy Working Group (Turtle Taxonomy Working Group 2021). The current IUCN Red List category follows Turtle Taxonomy Working Group (2021), Rhodin et al. (2018), the IUCN Red List of Threatened Species IUCN (2021), and the current CITES status follows the Checklist of CITES Species (UNEP-WCMC 2021).

Platysternon megacephalum

Asian Big-headed Turtle

Red List: Critically Endangered 2021

CITES: Appendix I



Photo by Clinton Deak



Photo by Me Me Soe



Photo by Cris Hagen



Photo by Me Me Soe

An assurance colony has been established from 100 turtles confiscated in 2017 in Myanmar, with the remainder destined for reintroduction into an identified protected area. In Vietnam, a few dozen animals have been repatriated after post-genetic confirmation that they were the Vietnamese form. These were held at Cuc Phuong until cleared as healthy by veterinarians. However, more than 200 additional turtles are still being held at Cuc Phuong, awaiting genetic results and, if they are genetically appropriate individuals, permissions to release them back into the wild.

Conservation Recommendations

- Further surveys are needed, particularly in suitable protected areas in Myanmar, Thailand, China, and Cambodia.
- There are currently three described subspecies, but genetic mapping is needed to resolve these lineages (or species?) and inform managers of future confiscations about where animals should be repatriated.
- Increased efforts to protect this species in the wild and decrease wildlife trafficking are needed: it does not lend itself well to captive breeding, because of its low fecundity and aggressive nature.



Photo by Rachael Hairf

Batagur affinis
Southern River Terrapin

Red List: Critically Endangered 2019
 CITES: Appendix I



Photo by Eng Heng Chan

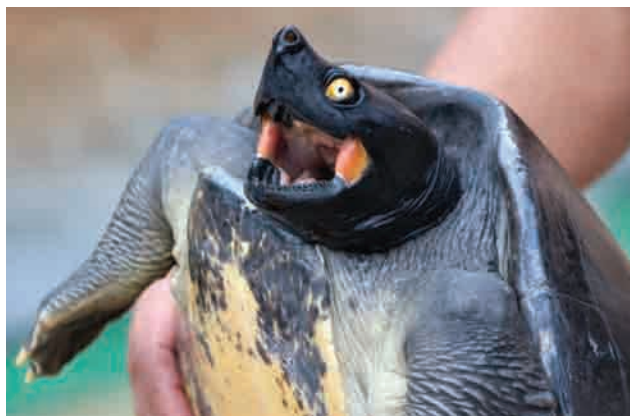


Photo by Niek Sreykeak



Photo by WCS Cambodia

A nest protection and head-starting programme was initiated for *B. a. edwardmollii* on the Sre Ambel River, Cambodia, in 2003, where the last population, believed to be fewer than five breeding females, survives. Since 2015, 96 head-started individuals have been released, and a 'Fisheries Management and Conservation Zone for the Royal Turtle' was established in 2019. Telemetry monitoring has shown that survivorship is high, upwards of 80%, and in 2020, two head-started females possibly nested. Two ex-situ facilities in-country hold 220 animals, and in 2021 six nests were recorded, the first time

clutches of eggs were produced in captivity for this species in Cambodia. A single hatchling was produced; this low hatch success is perhaps due to the young age of the adult females. Community engagement, nest protection, and head-starting of *B. a. edwardmollii* in Peninsular Malaysia protect between 20 and 40 nests per year. Since 2011, more than 3,500 juveniles have been released; however, long-term trends show a marked decrease in nesting females. The species has not been recorded recently from the wild in Vietnam and surveys in Sumatra have failed to find any recent evidence of it. No current information on the breeding status of *B. a. affinis* is known, although rumours suggest that the western Peninsular Malaysia population is no longer extant.

Conservation Recommendations

- Continued protection and awareness programmes on the Sre Ambel River and further development of community-based fisheries are needed to reduce hunting pressure.
- Sand mining on the Sre Ambel River remains a threat and should be stopped permanently.
- Expansion of the carrying capacity and infrastructure of the Cambodian facilities to increase assurance colony output is needed.
- Continued annual releases of suitably sized individuals into the Sre Ambel population, and regular testing of the parentage of wild hatchlings to determine if head-started turtles, both male and female, are reproducing post-release is needed.
- Continued efforts focused on community education and engagement around the extant populations in several rivers of eastern Peninsular Malaysia, for *B. a. edwardmollii*.
- Historical data documented large nesting populations in western Peninsular Malaysia of *B. a. affinis*; however, thorough surveys are immediately needed to see if any populations remain.
- Additional surveys in southern Sumatra to confirm if the species is genuinely extirpated, including ascertaining if any individuals are maintained in ponds in villages and at places of worship.
- Surveys to ascertain if wild *B. affinis* is still nesting in southern Thailand are needed, along with an assessment of the breeding programme at Chanthaburi.

Batagur baska **Northern River Terrapin**

Red List: Critically Endangered 2019

CITES: Appendix I



Photo by Shaileendra Singh



Photo by Maksudur Rahman

- Conduct a trial release with satellite transmitters of large head-started animals in a more protected core area, further inland with less fishing pressure.
- Every wild- or captive-sourced hatchling and adult is critical to the genetic diversity of this programme as it is working with fewer than a combined 15 founder females. As such, some level of effort should be expended towards finding additional founder animals, particularly in temple and village ponds.
- Any animals remaining in Myanmar would be new bloodlines; thus it is critically important to incorporate them into the conservation efforts for this species.
- Genetic testing of both head-started animals and wild hatchlings to determine if the released head-started turtles are genetically integrating into the population is an important metric for determining the success of the head-starting programme.



Photo by Abdur Rob

This species is functionally extinct in the wild, and there are no known nesting sites. Assurance colonies have been established in India and Bangladesh from previously captive animals, with successful captive breeding annually since 2012, and a combined total of more than 700 juvenile turtles being head-started. In Bangladesh, two releases, each of five head-started males equipped with transmitters, showed that all released turtles were captured or lost within two months. In India, all released turtles were lost within 24 hours. In addition, two females have been identified in pagoda ponds within Myanmar.

Conservation Recommendations

- Maintain the assurance colonies in India and Bangladesh, and head-start individuals to a size suitable for release.
- Surveys are needed to find any potentially remaining nesting females, so that nesting sites can be protected accordingly, and captive populations can be genetically diversified, and provide a focal point for conservation efforts.
- Genetic analysis of all founder stock in India and Bangladesh to minimise inbreeding and make recommendations for animal exchange between the programmes is needed.



Photo by Anton Weissenbacher

Batagur borneoensis
Painted River Terrapin

Red List: Critically Endangered 2021
 CITES: Appendix II



Photo by Joko Guntoro



Photo by Joko Guntoro

A nest protection programme was initiated in Aceh Tamiang, Indonesia, in 2009, with a Painted Terrapin Information Center established to raise awareness. Recently, an ecotourism enterprise was established to focus on the biodiversity of the mangrove forests, with the Painted River Terrapin as the flagship species. In Malaysia, a nest protection programme protects approximately 80 nests per year, producing about 600 hatchlings.

Conservation Recommendations

- Additional surveys and expansion of both the above projects into other river drainages in Malaysia and Indonesia are warranted.
- There is a need to assess the nest protection and head-start programmes to help guide future conservation efforts.
- Genetic analysis of populations in Malaysia and Indonesia is warranted to determine if there is more than one species: physical and biological differences suggest divergence.
- Increased awareness activities with fishers in offshore, coastal, and riverine environments are needed, to reduce hunting of adults as well as reduce egg collection.
- Mangrove habitats in areas with remaining turtle populations need better protection.

Batagur dhongoka
Three-striped Roof Turtle

Red List: Critically Endangered 2019
 CITES: Appendix II



Photo by Shalendra Singh



Photo by Bhasker Dixit

The Chambal River hatch and release programme since 2008 has produced nearly 100,000 hatchlings. The remaining populations are now only in the Chambal River and the Ganga Farakka. They are thought to be in decline, based on long-term observations, because of drowning in fishing nets and loss of nesting habitat to sand mining.

Conservation Recommendations

- Increased protection in the Chambal River, emphasising the removal of illegal fishing nets and halting of sand mining, is needed.
- Additional range-wide surveys to identify additional populations and establish baseline population levels are needed.
- The hatch and release programme should be expanded to include releases of juveniles into rivers that once had the species, but only after effective community engagement and anti-hunting measures have been put in place.
- The species has recently appeared in the international pet trade; it needs to be determined if this is a growing threat or a limited-time occurrence.
- Efforts should be made to develop assurance colonies for this species within India.

Batagur kachuga Red-crowned Roofed Turtle

Red List: Critically Endangered 2019

CITES: Appendix II



Photo by Kunal Jain

A nest-protection programme on the Chambal River, India, has released thousands of hatchlings since 2008, and head-starts 200 hatchlings each year. In 2010, the Chambal Conservation Center was established to provide education and outreach to the surrounding villages. Small Assurance Colonies are at the Kukrail Conservation Center (Uttar Pradesh) and the Madras Crocodile Bank and Trust (Tamil Nadu). However, long-term trends demonstrate a decline in the number of nesting females, as turtles are lost by intentional capture and accidental death each year. The males' bright coloration makes the species highly regarded in the international pet trade.

Conservation Recommendations

- There is a need to assess the effectiveness of the nest protection programme. Now in its 13th year, the first cohort of hatchlings should be nearing maturity. Successful elements should be expanded.
- The release of head-started juveniles should be expanded to additional river systems within the historical range of the species.
- Greater enforcement of fishing regulations is needed, involving patrols to remove all nets and other fishing equipment encountered.



Photo by Sheena Koeth

- Surveys of historical locations in India (particularly tributaries of the Chambal River, such as the Son River) and Bangladesh to assess current status. If it is no longer present, new populations should be established by recruitment via hatchlings, as well as head-started individuals.
- An assessment of the assurance colony at Kukrail Gharial Rehabilitation Center is needed to ascertain its genetic diversity, as well as the number of individuals, and what can be done to increase reproductive output.
- Genetic testing of both head-started animals and wild hatchlings should be completed to determine if the released head-started turtles are genetically integrating into the wild population.
- Counter wildlife trafficking efforts should focus on the international pet trade.



Photo by Shalendra Singh



Photo by Shalendra Singh

Batagur trivittata
Burmese Roofed Turtle

Red List: Critically Endangered 2019
CITES: Appendix II



Photo by Brian Horne



Photo by Kaiyar Platt

This species was assumed to be extinct until a remnant population was identified in 2002. A nest protection and head-starting programme was initiated on the Upper Chindwin River in 2006, where the last population, believed to be fewer than five breeding females, survives. Over 1,000 animals are now held in assurance colonies at four locations in Myanmar, plus 23 in Singapore. Breeding has been very successful, and in 2021, 235 hatchlings were produced. Since 2015 over 100 head-started animals have been released into the Upper Chindwin River. The reintroduction of head-started males has resulted in viable eggs being produced for the first time from a wild female who had not produced viable eggs since the programme began.

Conservation Recommendations

- Continued releases of suitably sized individuals into the Chindwin population along with head-starting, and outreach, mainly aimed at local fishers, to ensure that released animals are not captured in fishing gear.
- Sustained investment in multiple assurance colonies inside and outside Myanmar to increase the number of animals for release.
- Genetic testing of both head-started animals and wild hatchlings needs to be conducted to determine if the released head-started turtles are genetically integrating into the population.

Cuora aurocapitata
Yellow-headed Box Turtle

Red List: Critically Endangered 2000
CITES: Appendix II



Photo by Cris Hagen



Photo by Jordan Gray

This species is considered functionally extinct in the wild because of collection for the pet and medicinal trades. It has suffered from sand mining, river channelisation, hydroelectric dams, and harmful fishing practices. Repeated visits to known former habitat lend some promise that a remote population may still exist, but further investigation is needed. Several zoos and private institutions are maintaining specimens and are starting to have some breeding successes.

Conservation Recommendations

- Intensive management of the captive populations is needed to maintain genetic diversity, including the exchange of captive-born offspring between these collections worldwide.
- If the species is indeed extinct in the wild, surveys are needed with the hope of finding more specimens for captive breeding in assurance colonies.
- Restoration and protection of suitable habitats destroyed by extensive sand mining are needed. Currently, little suitable habitat exists to reintroduce captive-produced offspring.

Cuora bourreti
Bouret's Box Turtle

Red List: Critically Endangered 2020
 CITES: Appendix I



Photo by Cris Hagen



Photo by Cris Hagen

This species has declined substantially through hunting for the food, pet, and medicinal trades. Additionally, much of its former habitat has been converted to agriculture. Although regular captive breeding of this species has often been difficult, several institutions holding captive populations can now successfully breed the species. This species is almost restricted to Central Vietnam, with only two records from Lao PDR.

Conservation Recommendations

- Additional surveys are needed to identify other populations, particularly in Lao PDR, where nothing is known of the status. Initial efforts in Lao PDR should focus on protected areas. If found, adequate protection is urgently required.
- Determine if there are enough founder individuals in the Vietnam assurance colony as well as in colonies in the USA and Europe, and offspring need to be exchanged to maximise genetic diversity within these captive groups.
- An expanded captive breeding programme at Cuc Phuong, Vietnam, with confiscated animals is warranted. Repatriation of captive-born turtles from international sources to Cuc Phuong could begin once suitable facilities are available.
- Suitable areas for reintroduction need to be identified and the release of captive-bred turtles can begin once effective protection measures are put in place.

Cuora cyclornata
Vietnamese Three-striped Box Turtle

Red List: Critically Endangered 2000*
 CITES: Appendix II

*As part of *Cuora trifasciata*. TFTSG Draft Red List: Critically Endangered 2016 (Turtle Taxonomy Working Group 2021)



Photo by Torsten Blanck

Recently recognised as a distinct species, nothing is known about its current status in the wild. However, no new animals have entered the trade in years, indicating it could already be functionally extinct. Any found are quickly sold to the large turtle farms in China and do not make their way into conservation breeding programmes. It is not known if any remain in Lao PDR.

Conservation Recommendations

- An assessment of historical records, publications, and institutional holdings is needed as currently little is known about this species.
- This species is bred readily in captivity, and pure genetic lineages are known to occur in only a few institutions. However, additional genetic work is required to ensure hybrids are not included when forming conservation-based breeding programmes that plan to reintroduce turtles into the wild.
- Most breeding colonies for this species are in private for-profit holdings and not in conservation colonies designed for the species' long-term survival. Hence, there is a need to expand conservation breeding programmes.
- Fieldwork should focus on finding additional wild animals for increasing the genetic diversity of conservation breeding programmes.
- A new Red List assessment needs to be made due to the changes in taxonomy. This assessment needs to proceed to officially accepted status quickly.

Cuora flavomarginata
Yellow-margined Box Turtle

Red List: Endangered 2000*
 CITES: Appendix II



Photo by Lauren Ottemess

Populations in mainland China appear to be functionally extinct, leaving only populations in Taiwan and southern Japan. However, recently these mainstays have become under threat from the international pet trade. This species is bred by turtle farmers in China, private breeders, and institutions in the USA and Europe.

Conservation Recommendations

- Genetic analysis of the three subspecies is needed because there is debate about their validity and whether mainland animals represent a separate species.
- After these results resolve genetic identities, both regionally and in captive colonies, assurance colonies need to be reorganised.
- There is genetic variation across this species's range. With some populations receiving subspecies recognition, it is essential to identify suitable protected habitats based on the genetics of both remaining wild and captive-bred individuals set to be released. The captive stock needs to be analysed to determine if subspecies have been hybridised with one another. If such has occurred, this should be halted to avoid possible outbreeding depression. The resulting hybrids should be removed from the breeding programme.
- Increased protection is needed for the populations in Taiwan and the southern Japanese islands to prevent illegal hunting.
- The draft Red List assessment of Critically Endangered needs to be formally accepted.
- Counter wildlife trafficking actions need to focus on movement of wild-caught turtles from Taiwan and Japan into mainland China.

Cuora galbinifrons
Indochinese Box Turtle

Red List: Critically Endangered 2020
 CITES: Appendix II



Photo by Cris Hagen



Photo by Cris Hagen

Populations have declined substantially, because of human consumption and the pet and medicinal trades. Habitat loss has also resulted in population declines. However, recent surveys in northern Vietnam found the species to be more abundant than previously thought.

Conservation Recommendations

- Continued surveys in northern Vietnam, particularly in protected areas, are needed. Surveys are also needed in Lao PDR, where little is known of the species's distribution and abundance. If viable populations are found, protection measures need to be put in place.
- Genetic studies are needed to differentiate animals from Hainan from those from the mainland as there are apparently some differences. Captive breeding programmes may need to maintain separate lineages, to avoid possible ill-effects of hybridisation.
- Assistance is required at Cuc Phuong in establishing a captive breeding programme with confiscated animals, and the transfer of captive-bred turtles back to Vietnam from international zoos and conservation organisations.
- The release of captive-bred turtles head-started at Cuc Phuong can begin once suitable sites are identified and adequate protection is in place.
- Current captive holdings should be examined genetically to determine where founder stock originated from and the founder stock interrelatedness.

Cuora mccordi
McCord's Box Turtle

Red List: Critically Endangered 2000
CITES: Appendix II



Photo by Rachael Harff



Photo by Jordan Gray

This is an extremely range-limited species that is likely to be extinct in the wild, with only a small amount of habitat remaining, most of which has been logged and converted to agriculture or plantations. This species is being captive-bred by only a few private breeders and institutions.

Conservation Recommendations

- Surveys need to be conducted to determine if any turtles remain in the wild, and where habitat can be restored and protected for potential future reintroductions.
- Private individuals do most captive breeding. Institutions need to source and begin captive breeding this species to increase numbers of animals in assurance colonies.
- Creating a suitable protected area within the range is required for the repatriation of animals in the future. However, without 24-hour protection, the species cannot be returned to the wild because of the current high prices paid for individuals.
- A reanalysis of the Red List status may deem the species Extinct in the Wild; it has been over two decades since the original assessment was made.

Cuora pani
Pan's Box Turtle

Red List: Critically Endangered 2000
CITES: Appendix II



Photo by Jordan Gray

This is another highly aquatic member of the genus *Cuora*, similar to *C. aurocapitata*, with a limited range. It has been heavily collected for the international pet trade. Only a few (fewer than 10) wild individuals are observed per year, and very few animals are in captive collections. In recent years, a few private breeders and institutions have bred the species with some success.

Conservation Recommendations

- Animals in collections need to be consolidated, and assurance colonies established and managed for genetic diversity.
- Surveys of remaining habitats are needed to find extant population(s) that can hopefully be protected and managed.
- If an effective in-range protected area could be established, captive-bred animals could then be released.

Cuora picturata
Southern Vietnamese Box Turtle

Red List: Critically Endangered 2020
 CITES: Appendix I



Photo by John Greene



Photo by Nathan Halslip

Little known, only discovered in the wild in 2010. It has been heavily collected for the international pet trade, and much of the remaining habitat has been lost. A few small captive colonies exist for this species in the USA and Europe, with additional animals with private breeders. However, these are not fully functional assurance colonies: although progress has recently been made, it is difficult to maintain and breed this species in captivity.

Conservation Recommendations

- Surveys are needed to determine the extent of this species's distribution and estimated population size.
- Support for Cuc Phuong is needed to create a captive breeding programme with confiscated animals. An additional in-range breeding centre is needed in central Vietnam to handle regionally confiscated animals, and for the use of captive-bred animals for release.
- Begin repatriation of captive-born turtles from international sources to Cuc Phuong, where the turtles can be held before rewilding them into areas with adequate protection.
- Highly sought after in the pet trade, counter-wildlife trafficking programmes should be vigilant for any individuals entering the international trade: these are most likely wild-caught animals, because few are being captive bred.

Cuora trifasciata
Chinese Three-striped Box Turtle

Red List: Critically Endangered 2020
 CITES: Appendix II



Photo by Peter Praschag

Currently one of the most highly sought turtles in the international pet and Traditional Chinese Medicine trades, and as a result, wild populations are effectively extirpated except in fully protected areas. During the past decade, the stronghold population in Hong Kong was devastated by collection for the pet trade. Large numbers are bred on Chinese turtle farms. However, hybridisation means that few, if any, are thought to be true *C. trifasciata*. As such, these animals are functionally lost to conservation efforts.

Conservation Recommendations

- Assurance colonies of known-origin animals and ones that were genetically tested to be pure *C. trifasciata* should be established in China with appropriately identified partners.
- Surveys should be conducted to ascertain if indeed this species is extinct in the wild.
- Habitat protection, even of degraded habitat that can be restored, should move forward for the future release of captive-bred animals.

Cuora yunnanensis

Yunnan Box Turtle

Red List: Critically Endangered 2010

CITES: Appendix II



Photo by Rao Dingqi

The wild locality of this species was discovered only in 2008. However, since this discovery, it has been heavily hunted for the high-end pet trade. Compounding this impact on the species's wild populations, much of its former habitat has suffered urban development. In the mid-2000s, some animals were assembled, and an assurance colony was established, albeit with limited breeding success.

Conservation Recommendations

- There is an immediate need to re-assess the current captive population and move some animals to additional holding facilities because, currently, all animals are at one facility, thereby elevating the risk of catastrophic failure.
- The number of animals held in captivity does not represent a fully adequate assurance colony that minimises loss of genetic diversity; genetic assessment of the current stock is needed to inform pairing for breeding.
- Field surveys are needed to determine if there are remaining populations, or individuals that could be incorporated into the assurance colony to increase genetic variability.
- Only about 2% of its former habitat is thought to remain; this habitat needs to be protected now and managed/restored for rewilding efforts in the future.

Cuora zhoui

Zhou's Box Turtle

Red List: Critically Endangered 2000

CITES: Appendix II



Photo by Torsten Blenck

Despite extensive searches in southern China and northern Vietnam, this species's wild distribution has yet to be discovered. No new individuals have been discovered in markets or elsewhere in the past decade, leading to concerns that the species may be extinct in the wild. Most of the wild-caught founder population has died of old age and captive management issues. Although there has been some breeding success in Europe and the USA, genetic diversity is very low because most captive offspring have come from fewer than five pairs.

Conservation Recommendations

- There is a great need for additional survey efforts to find the wild range of this species, for both finding additional animals that could add genetic diversity to the captive populations, and to identify areas that need protection and management for future reintroductions.
- Genetic analysis of all captive stock, and genetic exchange of animals for careful management of the population, is needed.
- Counter wildlife trafficking networks should be diligent for the possibility of additional wild-caught turtles entering the global trade. Any turtles found need to be placed in appropriate assurance colonies that can provide the best captive husbandry care. It would also be crucial to gain information on where the turtles originated.

Heosemys annandalii Yellow-headed Temple Tortoise

Red List: Critically Endangered 2021

CITES: Appendix II



Photo by Cris Hagen

Although still encountered in the wildlife trade, there have been no population surveys to determine distribution and size. There are no managed assurance colonies for this species outside a few captive animals from confiscations maintained in Cambodia and Lao PDR.

Conservation Recommendations

- Surveys are needed to identify remaining healthy populations that can be protected, particularly in Thailand, but also in other range countries.
- Captive breeding of confiscated animals is recommended to aid reintroductions in Cambodia and Vietnam, where the populations are greatly depleted.
- An assessment of the population in Lao PDR is needed, both in the wild and in captivity.

Heosemys depressa Arakan Forest Turtle

Red List: Critically Endangered 2020

CITES: Appendix II



Photo by Steven Ives



Photo by Scott Trageser

Once considered to be endemic to Myanmar, this species was recently documented in neighbouring areas of Bangladesh, and it may occur in remote parts of neighbouring India. Research in Myanmar has shown that the species is inactive for large portions of the year and is active only during the rainy season. This has led to the finding of more animals, and the species is now considered more abundant and widely distributed than previously thought. An in-range assurance colony was established in Myanmar with confiscated animals in 2012. There has been some breeding success.

Conservation Recommendations

- Additional surveys and research are needed for a full understanding of the extent of the distribution and biology of the species.
- Additional assurance colonies may be warranted in Bangladesh.
- Anti-hunting campaigns need to be directed at reducing the use of domestic dogs to find the turtles, as this practice is highly effective.

Heosemys grandis Giant Asian Pond Turtle

Red List: Critically Endangered 2021
CITES: Appendix II



Still internationally traded for consumption but not highly prized by collectors. Confiscations continue in Vietnam and Cambodia, and the best remaining populations may be in Thailand.

Conservation Recommendations

- Surveys to determine population trends, how far remaining isolated populations are from one another, and areas for the establishment of protected populations.
- The establishment of assurance colonies is also needed.

Leucocephalon yuwonoi Sulawesi Forest Turtle

Red List: Critically Endangered 2021
CITES: Appendix II



Endemic to northern Sulawesi. Recent surveys found turtles at most survey sites, including age classes; although, one population surveyed had few adult animals suggesting poaching pressures. A telemetry study was conducted to ascertain activity and movement patterns and found that they were primarily active at night and had limited movements.

Conservation Recommendations

- Preliminary work suggests that populations of this species are robust, at least in the areas surveyed, and do not currently need population supplementation; however, more range-wide surveys are warranted as only a few locations have been visited.
- A long-term monitoring and anti-poaching plan must be put in place because the species could be depleted quickly.
- Counter wildlife trafficking efforts need to be directed towards thwarting bogus claims of captive breeding as this is a means for laundering wild caught animals into the international trade.

Mauremys annamensis **Vietnamese Pond Turtle**

Red List: Critically Endangered 2020
CITES: Appendix II



Photo by Rick Reed



Photo by Chris Hagen

This central Vietnamese endemic is considered functionally extinct in the wild due to collection for the medicinal trade and habitat loss. In the few protected areas within its former range, no turtles remain. A group of captive-bred animals from Europe were transferred to Cuc Phuong for release; however, as no suitable fully protected area has yet been identified, these animals continue to reside at Cuc Phuong. Hundreds of offspring are produced each year in the US and Europe; however, often through lack of space, many institutions have stopped breeding them.

Conservation Recommendations

- A well-structured reintroduction programme is required; however, there is currently no suitable place that is sufficiently protected for rewilding to begin. A dedicated protected area with active anti-poaching programmes seems to be the only way forward.
- Genetic analysis of founder stocks (to ensure they are pure; they hybridise readily with other species) is needed to inform future breeding programmes.
- Producing genetically diverse captive-bred turtles is necessary to ensure negative impacts of inbreeding do not become an issue.

Mauremys mutica **Yellow Pond Turtle**

Red List: Critically Endangered 2021
CITES: Appendix II



Photo by Tien-Hsi Chen

This species has been aggressively collected for turtle farms to supply human consumption demand; its care and large-scale commercial breeding are easy. Most of its former habitat has been lost to agriculture and urbanisation. It is probably approaching functional extinction in the wild.

Conservation Recommendations

- Genetic analysis of animals is needed to identify pure animals because this species hybridises readily with other species of *Mauremys* and several other genera.
- Surveys for wild populations are needed, focused on existing protected areas, with the establishment of protected areas for any newly discovered populations.

Mauremys sinensis
Chinese Stripe-necked Turtle

Red List: Critically Endangered 2021
 CITES: Appendix III



Photo by John B. Iverson

Natural populations have been devastated in Vietnam and southern China. Although millions are in turtle farms in China, these turtles are lost to conservation because of hybridisation within the farms. The Vietnamese form is more highly prized because it is believed to taste better than the farm-raised ones from China. No wild populations are being managed for conservation, and there are no assurance colonies, although large numbers exist in private collections globally.

Conservation Recommendations

- Secure any remaining wild populations in Vietnam. If populations are non-viable and consist only of scattered individuals, these lone animals should be integrated into assurance colonies.
- If a viable population is found in the wild, then efforts should be made to protect it and ensure that the animals are not poached.
- Genetic analyses need to determine how much hybridisation has occurred between closely related species. Determine how much variation occurs across Vietnam and China to determine if there is enough genetic variation for subspecies or species designation.
- Creating in-country assurance colonies of pure genetic stock is needed in Vietnam, China, and Taiwan.
- The species should be elevated to CITES Appendix II to assist in trade regulation.

Orlitia borneensis
Giant Asian River Turtle

Red List: Critically Endangered 2020
 CITES: Appendix II



Photo by Cris Hegen



Photo by Jeko Guntoro

Little is known of this species because it is not a colonial nester, nor does it congregate in numbers at any time during the year. Surveys in South Sumatra in 2020 documented that the species is still present, but no information on abundance was gathered. It is suspected that populations have been severely impacted by harvest for meat and habitat conversion of peat swamps.

Conservation Recommendations

- Conduct range-wide surveys, prioritising existing protected areas to determine current distribution and identify populations amenable to conservation action.
- No in-range assurance colony exists for this species, but several US and European zoos have small colonies, and some breeding has occurred at a rescue centre on Java. However, limited numbers of zoos can hold this turtle: intraspecific aggression means large aquatic enclosures, which must be at tropical temperatures, are required.
- Genetic analyses of wild populations are needed to determine if significant differences exist across the widely disjunct populations, and if captive-bred animals from assurance colonies in USA and Europe can be used in future rewilding efforts.

Pangshura sylhetensis
Assam Roofed Turtle

Red List: Critically Endangered 2021
 CITES: Appendix I



Photo by Rajeev Basumaitry

Habitat loss and exploitation mean that this species is now found only in small, isolated populations. It is both locally consumed and also hunted for the pet trade, as this species is highly valued by international collectors. It is difficult to breed in captivity, and many of the claims of captive-bred offspring in the pet trade are probably falsehoods.

Conservation Recommendations

- Surveys to identify remaining populations (including estimates of their size and distribution) are warranted.
- The remaining populations need to be protected and managed for recovery.
- The applicability and effectiveness of nest protection programmes need to be determined because of the long incubation period. Alternatively, the head-starting of hatchlings may also be warranted, focusing on collecting hatchlings from the wild rather than protecting nests.
- Assurance colonies should be created as soon as possible.
- Counter wildlife trafficking actions need to focus on the illegal pet trade of hatchlings and adults both within India and internationally.

Sacalia quadriocellata
Four-eyed Turtle

Red List: Critically Endangered 2021
 CITES Appendix II



Photo by Nathan Heislop



Photo by Chris Hagen

The species is under intense collection pressure, particularly of individuals with unique colour patterns, for the international pet trade. Some animals are held and bred by individuals and institutions. However, there are currently no known assurance colonies. Little is known of this species in the wild. In Lao PDR, only a single record of this species is known (from the north), but potential habitat also occurs along the border with Vietnam. Vietnam has the majority of historical records, thus making it a priority for increases in *in-situ* conservation with an emphasis on preventing poaching. Large areas of potential habitat are within southern China, including Hainan Island, but there are only scattered museum records.

Conservation Recommendations

- Surveys are needed to identify remaining populations for improved protection. If viable populations are found, animals could also be acquired for in-country assurance colonies in each range country.
- Genetic analysis of the species across its range is needed to determine if what is currently known as *S. quadriocellata* is one or more species: there is some evidence of variation between mainland populations and island populations.

Siebenrockiella leytensis **Philippine Forest Turtle**

Red List: Critically Endangered 2021

CITES: Appendix II



Photo by Roland Wirth

This species is endemic to the island of Palawan and its nearby surrounding islands and was only rediscovered in 2001. A 2015 confiscation of more than 2,500 individuals exceeded the then total global population estimate. A global effort was able to repatriate most of these animals back into their native range. Follow-up surveys found marked individuals, indicating that some survived.

Only one small assurance colony exists on Palawan: keeping this species is difficult because of its aggressive nature. An 1,890-acre preserve was established in part to protect this species and its habitat. The first captive breeding occurred in 2018, and now 20 offspring have been produced, with the first head-started pair released back into the wild in 2021.

Conservation Recommendations

- All efforts must be focused on maintaining adequate populations in the wild, particularly the establishment of effectively managed protected areas for the species.
- The above efforts should be combined with increased anti-poaching enforcement and community education to promote the species as a national treasure.
- Counter wildlife trafficking efforts should focus on preventing the species from leaving the island. Individuals confiscated at ports of departure/arrival should be integrated into assurance colonies.
- For better understanding of survival rates and population size, additional surveys should be carried out to determine the number of marked versus unmarked animals in the wild.
- Further efforts are required to refine the breeding of the species in captivity to increase the size of the in-range assurance colony. The development of an out-of-range colony, if politically feasible, is also warranted.
- Surrounding islands (islands of Coron, Culion, and Busuanga in the Calamian Island group) should be surveyed, to understand the species's distribution.

Geochelone platynota **Burmese Star Tortoise**

Red List: Critically Endangered 2020

CITES: Appendix I



Photo by Steven Platt



Photo by Cris Hagen

The Burmese Star Tortoise conservation project is one of the most successful turtle conservation projects anywhere in the world to date. Thus far, three assurance colonies, established initially with confiscated animals, have produced over 17,000 tortoises during the past 12 years. More than 3,000 head-started tortoises have been released in two protected areas since 2013, with a third release site in development. Radio-telemetry monitoring has shown that the survival of released animals is high, and reproduction by reintroduced tortoises has now been confirmed on several occasions. In 2017, a programme of transplanting clutches of eggs from the assurance colonies into the wild was begun, and monitoring has shown hatching rates comparable to those of clutches in the assurance colonies. These initiatives have not been without issues, including theft of reintroduced animals and a hyper-predation event in one instance.

Conservation Recommendations

- Continued management of the captive assurance colonies and production of hatchlings is still needed to continue the on-going reintroduction efforts in current protected areas and expand to further protected areas.
- Continued investment in protection and community engagement in and around assurance colonies and protected area release sites is essential to reduce poaching and theft.

Indotestudo elongata

Elongated Tortoise

Red List: Critically Endangered 2019

CITES: Appendix II



Photo by Caesar Rahmaan



Photo by Scott Trageser

This wide-ranging species faces high collection pressure from the international wildlife trade. It is also affected by local subsistence hunting, with exploitation heavier in the eastern part of the species's range. It was thought that potentially more than one species existed, given its vast range, but recent genetic work has demonstrated that there is indeed only one. An assurance colony in Cambodia is successfully breeding the species, with 374 captive offspring to date.

Conservation Recommendations

- A release programme into suitably protected areas in Cambodia, which have been depleted of tortoises, is a priority for both confiscated animals and assurance colony offspring.
- This species is still confiscated from trade, and a strategy is required for using these animals in assurance colonies throughout its range.

Indotestudo forstenii

Forsten's Tortoise

Red List: Critically Endangered 2021

CITES: Appendix II



Photo by Bill Ninesing

Endemic to northern Sulawesi and under extreme threat from both collection for the international pet trade and habitat loss. During the past five years, formal surveys found only one wild individual, and local hunters now report they must travel long distances to find them. It is being bred in captivity in the USA and Europe, but unfortunately, the low reproductive output of this species makes population augmentation less effective in recovering this species.

Conservation Recommendations

- The species should be uplisted to CITES Appendix I to stop the legal trade as there currently remains a quota for export.
- Surveys of Halmahera are needed to check if this species occurs on this island.
- Surveys of Sulawesi, particularly in protected areas, are needed, as it seems that this species has been harvested to extremely low population levels and is extirpated from much of its range.
- An assurance colony/captive breeding facility on Sulawesi is needed to begin captive management and eventually population supplementation. Captive-bred animals from international collections could also be returned under proper biosecurity, in ways similar to the Rote Island Snake-necked Turtle project.
- Disease testing of any remaining wild animals is needed as this will form a baseline for disease testing for releasing head-started animals in the future. This testing is crucial as tortoises are more susceptible to various pathogens than are aquatic turtles, and this species seemingly has many pathogen issues.

Manouria emys
Asian Giant Tortoise

Red List: Critically Endangered 2019
 CITES: Appendix II



Photo by Scott Trageser



Photo by Sushmita Kar

Two subspecies exist, the northern *M. e. phayrei* and the southern *M. e. emys*. Populations of *M. e. phayrei* in India, Bangladesh, and Myanmar are under threat from high local hunting pressure. Assurance colonies are now maintained in each of these countries but have had limited success with breeding each year, only producing a few hatchlings. The widely disjunct population of *M. e. phayrei* of eastern Myanmar and Thailand has received minimal attention, but was documented in Thung Yai Naresuan Wildlife Sanctuary, Thailand, recently. Populations of *M. e. emys* have largely been ignored, and no in-range assurance colonies exist.

Conservation Recommendations

- Existing assurance colonies of *M. e. phayrei* need supplementation with additional animals and a genetic analysis to recommend pairings suitable to maintain genetic diversity within the assurance colonies. There is also a need to further improve survival of eggs during incubation, and of hatchlings to a size less susceptible to depredation.
- There is an urgent need for surveys to locate and protect wild populations of *M. e. phayrei* in India, Bangladesh, Myanmar, and Thailand.
- Surveys for *M. e. emys* in southern peninsular Malaysia, Sumatra and Borneo should start in existing protected areas, to establish if any extant populations are protected.

Chitra chitra
Asian Narrow-headed Softshell Turtle

Red List: Critically Endangered 2019
 CITES: Appendix I



Photo by Gerald Kuchling

No efforts have been extended towards this species in the wild for decades. Surveys 20 years ago in Thailand suggested the population is declining, and other populations in Malaysia and Indonesia have had only a few individuals reported over the past 80 years. A breeding programme at Kanchanaburi, Thailand, was established in the 1990s and successfully produced offspring previously, but no recent information is available.

Conservation Recommendations

- Surveys are needed throughout the range as none has been conducted for 20 years.
- The status of the breeding programme at Kanchanaburi needs to be better understood.
- There is a need to investigate the potential for captive breeding programmes in Indonesia and Malaysia.

Chitra vandijki

Burmese Narrow-headed Softshell Turtle

Red List: Critically Endangered 2021

CITES: Appendix I



Photo by Win Ko Ko

Surveys for this Myanmar endemic have revealed that it is more plentiful than previously thought. A few confiscated individuals are being maintained in Mandalay.

Conservation Recommendations

- Further surveys are required to truly ascertain how frequently this species is encountered, document the level of threats, and begin a nesting area protection programme.
- In the areas where the species is still frequently encountered, community awareness and education are needed, along with community fishing agreements or similar measures.

Nilssonina formosa

Burmese Peacock Softshell Turtle

Red List: Critically Endangered 2021

CITES: Appendix II



Photo by Peter Paul van Dijk

Little is known about this Myanmar endemic, but it is likely to be threatened by subsistence harvest and trade to China. A few captive animals are maintained in Mandalay, and one clutch has hatched successfully.

Conservation Recommendations

- Surveys and population estimates are needed to identify critical stretches of rivers for the species.
- Pending survey results, there may be a need for an assurance colony of this species.

Nilssonia leithi
Leith's Softshell Turtle

Red List: Critically Endangered 2021
 CITES: Appendix II



Photo by Shalendra Singh



Photo by Shaashwat Sisti



Photo by Shaashwat Sisti

Limited surveys have been conducted for this southern Indian endemic, with only a few animals found in two protected areas: it appears to be rare. It is harvested for meat and cartilage, but little other information is available.

Conservation Recommendations

- Further surveys are needed to quantify the species's distribution and populations more accurately, as well as to collect genetic samples to resolve variability that could distinguish subspecies or full species.
- Actively and effectively protecting the species in existing protected areas should be prioritised, but an assurance colony should be established if the former is not possible.

Nilssonia nigricans
Black Softshell Turtle

Red List: Critically Endangered 2021
 CITES: Appendix I



Photo by Arpita Dutta



Photo by Scott Trageser

Once considered extinct in the wild, recent surveys in northeastern India on rivers draining into the Brahmaputra River have discovered a few individuals, including hatchlings. Most of the other known animals occur in ponds at places of worship in Bangladesh and northern India. Several places of said worship have collaborated with conservationists in recent years, leading to increased nesting success at temple ponds. In 2020, one temple in northern India permitted about 20 hatchlings to be removed from the temple ponds and head-started before being rewilded into the tributaries of the Brahmaputra River. In 2021, a state-temple-NGO vision statement for this species was drafted and approved, opening the door for further conservation efforts and collaborative efforts with temple authorities.

Conservation Recommendations

- Additional surveys are needed to understand the extent of the wild populations and protect these remaining animals.
- Genetic analysis of temple pond animals is needed as there are three species of *Nilssonia* residing in some of these ponds, thus the potential for hybrids exists.
- Continued collaboration with places of worship to improve conditions and help increase the captive populations is of great importance. The offspring can be used to establish a better-protected assurance colony and used for future rewilding efforts.

Palea steindachneri
Wattle-necked Softshell Turtle

Red List: Critically Endangered 2021
 CITES: Appendix II



Photo by Torsten Blanck

Native to China, Lao PDR, and Vietnam with introduced populations in Hong Kong, Mauritius, and Hawaii, it is heavily affected by hunting for the food trade as well as for supplying turtle farms with breeding stock. Limited population data are available, but it is absent from some parts of its former range, and the remaining populations are small and presumed to be isolated.

Conservation Recommendations

- Surveys to find and identify remaining populations and identification of actions that will protect them from further exploitation are needed.
- The creation of new protected areas may be warranted, but surveys should first prioritise determining if any populations already exist in protected areas.
- Introduced populations need to be surveyed and their viability determined: they may be increasingly important, potentially crucial, for the survival of the species.
- An analysis of the trade of turtles from the established introduced populations should be investigated. These introduced populations could also potentially be a source of animals for reintroduction to appropriate native sites.

Pelochelys cantorii
Cantor's Softshell Turtle

Red List: Critically Endangered 2021
 CITES: Appendix II



Photo by Steven Platt



Photo by Annette Olsson

This widespread species has a single conservation initiative running for more than ten years on Cambodia's Mekong River. It focuses on nest protection. In 2020, it protected 48 nests and released 657 hatchlings. Head-starting has proven difficult for the species, so it is currently no longer practiced in Cambodia. Recent survey work in India has found a few specimens and documented nesting in Kerala, India.

Conservation Recommendations

- Range-wide surveys with genetic analyses, from eastern China, south to Borneo and Sumatra, across to southern India, are needed. It is doubtful that what is recognised as *P. cantorii* is only a single species.
- Additional surveys to locate new nesting areas along the Mekong and other large river systems are needed. Once new areas are found, nest-protection, outreach and education activities will be required.
- The nest-protection programme on the Mekong should be assessed to determine if it is resulting in increased recruitment.

Rafetus swinhoei
Yangtze Giant Softshell Turtle

Red List: Critically Endangered 2021
 CITES: Appendix I



Photo by Tim McCormack

An attempted breeding programme in China via artificial insemination abruptly ended with the death of the lone captive female, and now only a single captive male remains in China. Increased efforts in 2020 led to the capture and release of an individual animal in Dong Mo Lake, Hanoi. It was determined that this animal is a female due to enlarged follicles visible on ultrasound examination. Additional survey and trapping efforts at Dong Mo Lake have identified at least one other large softshell, and work is currently underway to capture and confirm its identity and gender. Similarly, work is underway to trap at Xuan Khanh Lake, Hanoi, where a positive eDNA sample and visual ID suggest another animal is present. Surveys in northern Vietnam's Red and Da River catchments have also provided credible reports of other animals present in recent years.

Conservation Recommendations

- Additional surveys are urgently needed, particularly in the Da and Red River catchments, where credible evidence suggests the presence of the species in 2018-2019.
- Searches for the species are also recommended in adjacent parts of Lao PDR and China.
- Further development and testing of mobile eDNA technologies are required to assist in the search for and confirmation of additional individuals.
- Some level of official protection is required at Dong Mo and Xuan Khanh Lakes, including the creation of nesting areas if there is a breeding pair in either lake or both.
- If male and female animals are confirmed in different lakes in Vietnam, then a managed breeding programme will be required to bring the animals together. This action could be either in the wild or in a dedicated captive breeding facility.

Chelodina mccordi
Rote Island Snake-necked Turtle

Red List: Critically Endangered 2019
 CITES Appendix II



Photo by Cris Hegen

Over the past ten years, extensive surveys have demonstrated that the species is extinct in the wild. This population collapse resulted from hunting of adults for the pet trade, the introduction of non-native predatory fishes that fed on the juveniles, and changes in land use that has caused aridification of its aquatic habitats. A collaborative project to restore the species was initiated in 2016, involving secure holding facilities for captive-bred animals in the US and Singapore and a specially designed facility in Kupang. A non-native fish removal programme in some of the formerly occupied lakes on Rote has begun. A governor's decree was ordered to protect these lakes as critical areas for the species.

Conservation Recommendations

- Continuation of the transfer of juvenile animals from Singapore to the holding facilities in Kupang, to have a robust representation of the species's genetic diversity. The first transfer of animals occurred in 2021.
- Reintroduce juvenile animals back into these protected lakes in fenced soft-release areas.
- Continue to source captive-bred animals internationally to supplement the project. However, CITES permits have been challenging to obtain and the permitting process needs to be streamlined to improve the effectiveness of this captive breeding programme.
- Increase the size of the breeding group in Kupang to increase the number of turtles available for reintroduction.
- After releases of head-started turtles have begun, there is a need for genetic testing of the parentage of wild hatchlings to see when and how head-started turtles are breeding amongst themselves.

Conclusion

There have been many successes during the last decade, and the turtle conservation community has expended great efforts and resources to ensure that no species becomes biologically extinct. Yet, unfortunately, today there are more Critically Endangered turtle species than ten years ago, and much as the recommendations stemming from the 2011 workshop, the main threats to the survival of Asia's turtles remain the same, primarily hunting and habitat loss. In the 2011 workshop report, several emerging threats and opportunities were identified: all remain as major factors influencing the decline of turtles across the region.

Below are some key issues and recommendations from this current overview.

■ Wildlife Trafficking and Confiscations

There needs to be a significant increase in activities countering the rampant removal of turtles from the wild, particularly for international trade. Such actions are required both in and around protected areas and at markets and trade nodes. The last decade has seen increased numbers and volumes of turtle confiscations from the illegal wildlife trade, sometimes involving tens of thousands of turtles in a single event.

However, international assistance is often needed to respond in an emergency fashion because many countries lack the infrastructure, resources, and expertise to manage such large confiscations successfully. Local and regional capacity needs to be built to improve the handling and care of confiscated turtles and repatriate them properly. Priority should also be given to species where there is an opportunity or need to incorporate them into assurance colonies. New partnerships should forge better relationships with animal welfare organisations and appropriate facilities regionally to help address these needs.

■ Habitat Protection

Habitat loss continues to be a fundamental threat to many species, driven largely by deforestation and the conversion of wetlands. Many of the Critically Endangered species listed within this report are not known from any protected areas. For those species, the creation of new protected areas is a priority but will not, alone, recover a species. All protected areas need active, effective management and appropriate enforcement. The increased engagement of local communities and Indigenous Peoples in turtle conservation, along with improved effectiveness of government management of legally protected areas is critical.

Sand mining also remains a core concern, as it was a decade ago. Demand for sand for use in construction continues to increase with development across the region, severely affecting riverine turtle species. Regulations and legislation around sand mining need to recognise and manage the broader ecological impacts on riverine ecosystems, including on species such as turtles.



A large Burmese Roofed Turtle *Batagur trivittata* individual, which is part of a breeding programme for the species in Myanmar.

■ Species Protection

For many species, nest guarding – the physical protection of the nest, nesting area, or more specifically the eggs, with the goal of increasing hatching success – and head-starting – hatching and raising hatchlings to a size suitable for release back into the wild – have proven very successful strategies. These should be continued, prioritising species with comparatively high annual fecundity over those with limited annual fecundity. For species with low fecundity, priority should be given to protecting adults from human-induced mortality.

In addition, for many Critically Endangered species, forming an assurance colony or colonies for long-term captive management has been essential. These require an intensive management programme – the typical genetic goal of an assurance colony is to maintain 90% gene diversity for 100 years – but buy time for those species that currently have little or no chance of survival in the wild.

■ Rewilding

Over the last decade, many assurance colonies that have been established have been very successful. In several cases, the animals are now reproducing at a rate that exceeds the facility's capacity. This opportunity is a pivot point in many species' fortunes. It creates a path to begin recovering the species in the wild, affording the species new hope, especially when the species is functionally extinct, or its wild populations are so low that they have little chance of being viable over the long-term.

The next decade needs a much greater focus on releasing turtles from captive breeding programmes to establish new populations within suitable habitats of the species' historical range, as well as bolstering endangered existing populations through supplementation. Therefore, protecting the remaining suitable habitat is crucial, and where none is available, habitat restoration will be required. This latter can involve anything from controlling competing or predatory invasive species, to restoring sandbar nesting areas damaged by sand mining.

Priority should be given to species with habitat protection in place and where threats to wild turtles have been greatly reduced. Specific focus on protecting those animals released into the wild is needed: the act of releasing turtles is not by itself enough to recover the species. Releases must be accompanied by adequate funding for research and monitoring until the populations are demonstrated to be successfully reproducing and experiencing few losses. The time-scale for the recovery of turtle species may exceed decades because of the lengthy maturation period for many species, combined with low fecundity in some of the smaller species. Thus, if human-induced mortality of adults is not curtailed in a recovery programme, it will never be successful.

■ Research and Monitoring

High priority should be given to research on species with significant gaps in knowledge regarding population demographics (sex ratios, age structure, size, health), abundance, distribution, or trends, particularly where such efforts or similar research will increase the capacity and effectiveness of conservation efforts.

One area that has advanced little over the past decade is the need to develop methodologies for creating accurate population estimates for turtle species. Such data provides vital metrics for prioritising conservation efforts and measuring the effectiveness of interventions. There are proxies for estimating populations, such as counting nests of aggregate nesters, but these too need to be improved. Aquatic species that are solitary nesters are uniquely challenging without engaging in long-term mark-recapture studies. Turtle biologists should also be encouraged to think beyond their immediate study area and build collaborations to better document habitat use and distribution. From these data, research can then be expanded to illustrate potential future threats to habitats from climate change.

There are also a number of species where the taxonomic status is unclear and therefore for which conservation priority cannot be assessed, particularly where sub-populations, if taxonomically distinct, could be of significantly heightened conservation concern. High priority should be given to such research where there are valid questions regarding species status.



Photo by Rupert Kainrad

A Northern River Terrapin *Batagur baska* with a satellite transmitter glued to its carapace.

■ Conservation Prioritisation and Investment

Conservation investment in the region's turtles should not be limited to Critically Endangered species. Endangered species need greater engagement so that they do not become Critically Endangered, and increased efforts are required to ensure that common species remain common. In the next decade, turtle conservationists need to be more proactive when prioritising conservation measures because species recovery is far less complicated and less expensive when there is no need for intensive conservation interventions such as captive breeding.

These actions all depend on resources, but funding for species-based conservation, particularly turtles, has always been limited. It is critical to raise the profile of turtle and tortoise conservation amongst donors and communicate how effective turtle conservation can be with limited resources, especially when compared with taxa like large mammals. Furthermore, the IUCN Red List status of all species must be kept up to date. Over the past 10 years, some species fell off the radar because their Red List assessments became outdated, potentially affecting legal protection and funding allocations. Recently, an effort has been made to ensure the Red List accounts are updated and published, and this action should continue.

■ The Next Ten Years

The last decade of turtle conservation in Asia has demonstrated that it is possible to prevent extinction and recover populations. The goals of turtle conservationists in Asia over the next ten years should be to see a reduction in the number of species listed as Critically Endangered and more imperilled turtle species restored to their role in functioning healthy ecosystems. We hope to celebrate further progress in recovering Asia's turtles over the next ten years.

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Photo by Abdul Hakim

Painted Terrapin *Batagur borneoensis* hatchlings being released as part of a conservation breeding programme in Indonesia.



Photo by Scott Trageser

Black Softshell Turtle *Nilssonina nigricans* hatchlings from a turtle conservation breeding centre in Bangladesh.

