

Editorial—Only for zoos? The involvement of rescue centres in captive breeding programmes for wildlife conservation in Southeast Asia

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Captive breeding programmes for species reintroductions can maintain animal populations whose wild counterparts are severely threatened once the causes of declines have been mitigated (IUCN SSC, 2013). As early as the 1960s, zoos began implementing captive breeding programs to guard species against extinction in an ‘Ark’ paradigm (Zimmermann, 2010; Keulartz, 2015). This resulted in the reestablishment of species in habitats where they had become locally extinct, such as the golden lion tamarin *Leontopithecus rosalia* (Kierulff *et al.*, 2012), Arabian oryx *Oryx leucoryx* (Spalton *et al.*, 1999) and Père David’s deer *Elaphurus davidianus* (Cheng *et al.*, 2021). By the turn of the century however, the challenges faced by *ex situ* zoos to achieve this with consistent success were becoming apparent. These included limitations in appropriate space, unsuitable climates, shortfalls in funding and securing adequate numbers of founders to ensure genetic variability (Ralls & Ballou, 1992; Zimmerman, 2010).

Further complications include the difficulty in maintaining captive collections of species with strict dietary or habitat requirements outside of their country of origin. Examples include douc langurs *Pygathrix* spp., which require specialized foliage that is difficult and expensive to obtain outside of range countries (Schwitzer *et al.*, 2006; Hale *et al.*, 2018), and pangolins *Manis* spp., where the difficulty of catering to their insectivorous diets in captivity has often resulted in animals dying within six months (Yang *et al.*, 2007). These experiences led to zoos increasingly shifting their breeding and reintroduction programmes to native species (Jakob-Hoff *et al.*, 2015; Olive & Jansen, 2017) and employing a more integrated approach towards non-native species. This includes

research and training with exposure and providing support to *in situ* projects in natural habitats with local wildlife rescue centres (Cuarón, 2005; Zimmermann, 2010; Conde *et al.*, 2011; Keulartz, 2015; Spooner *et al.*, 2023).

Wildlife rescue centres situated in countries with rich biodiversity but limited finances are in a different position to *ex situ* zoos. Unlike most zoological gardens, the number of animals in rescue centres in developing countries can differ vastly in a given year depending on the number of rescues or confiscations. Due to poor facilities or a lack of finances, many arrivals may not survive or contribute further to the conservation of their species. However, their potential for conservation should not be discounted. With funding, enhanced capacity, good animal husbandry and protocols for rehabilitating rescued wildlife, these centres can have a positive conservation impact. For instance, while western zoos must ensure they have sufficient space to display a diverse range of charismatic animals so as to attract visitors, wildlife rescue centres can specialize to a greater extent or dedicate their resources to larger numbers of a single species (Gilbert *et al.*, 2017; Hosey *et al.*, 2020). Further, they are better placed to promote public understanding of the importance of conserving rare, threatened and often understudied species in their own countries.

To help rescue centres determine the best outcomes for animal arrivals, the *IUCN Guidelines for the Placement of Confiscated Animals* details the decision-making process on whether to release, euthanize or permanently house displaced wildlife (IUCN, 2002). Rehabilitation and reintroduction of animals rescued from the illegal wildlife

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Table 1 Mammal species rehabilitated or captive born at Phnom Tamao Wildlife Rescue Center and later released into forests surrounding Phnom Tamao, Takeo, Angkor Archaeological Park, Siem Reap, or Wildlife Release Station (WRS), Koh Kong.

Common Name	Scientific Name	IUCN Listing	Release Site
Sunda pangolin	<i>Manis javanica</i>	Critically Endangered	Phnom Tamao, WRS
Germain's silvered langur	<i>Trachypithecus germaini</i>	Endangered	Angkor
Long-tailed macaque	<i>Macaca fascicularis</i>	Endangered	Phnom Tamao
Pileated gibbon	<i>Hylobates pileatus</i>	Endangered	Angkor
Siamese Eld's deer	<i>Rucervus eldii siamensis</i>	Endangered	Phnom Tamao
Bengal slow loris ¹	<i>Nycticebus bengalensis</i>	Vulnerable	Phnom Tamao, WRS
Binturong	<i>Arctictis binturong</i>	Vulnerable	WRS
Sambar deer	<i>Rusa unicolor</i>	Vulnerable	Phnom Tamao
Smooth-coated otter	<i>Lutrogale perspicillata</i>	Vulnerable	Angkor
Common palm civet	<i>Paradoxurus hermaphroditus</i>	Least Concern	Phnom Tamao
Golden jackal	<i>Canis aureus</i>	Least Concern	Phnom Tamao
Leopard cat	<i>Prionailurus bengalensis</i>	Least Concern	Phnom Tamao, Angkor, WRS
Lesser mouse deer ¹	<i>Tragulus kanchil</i>	Least Concern	Phnom Tamao
Malaysian porcupine	<i>Hystrix brachyura</i>	Least Concern	Phnom Tamao
Muntjac	<i>Muntiacus vaginalis</i>	Least Concern	Phnom Tamao, Angkor, WRS
Small Indian civet ¹	<i>Viverricula indica</i>	Least Concern	Phnom Tamao, Angkor
Wild pig	<i>Sus scrofa</i>	Least Concern	Phnom Tamao

¹ Only rescued and rehabilitated individuals of this species have been released.

trade has become an accepted component of conservation plans for many species (Cheyne, 2009; Saran *et al.*, 2011; Molinari-Jobin *et al.*, 2024). Apart from the ethical and in some countries legal concerns with euthanasia, this can lead to the loss of individuals of species that may be perceived as common when their wild populations are actually declining significantly. This was the case for long-tailed macaques *Macaca fascicularis* whose arrivals at rescue centres overwhelmed some to the extent that they could no longer accept new animals during the same 14-year period that the species moved from being regarded as Least Concern to Endangered (Hansen *et al.*, 2022). There is also potential for rescued animals that cannot be released due to injury or familiarisation with humans to take part in captive breeding programs while being retained in permanent housing. This is especially appropriate for species that are difficult to maintain outside of their native habitats.

Many wildlife rescue centres in Southeast Asia have been at the forefront of research, rehabilitation and release of rare species targeted by the illegal wildlife trade. These facilities are often run by non-government organizations that collaborate with international experts (including accredited zoos) and local governments and target specific threatened species. As these centres

became more established, many have begun captive breeding programmes for target species that enter their facilities. Examples include Save Vietnam's Wildlife, which focuses on the rehabilitation and release of trafficked Sunda pangolins *M. javanica* and Chinese pangolins *M. pentadactyla* and has begun captive breeding of the latter (Challender *et al.*, 2011; Gray *et al.*, 2023); the Endangered Primate Rescue Center (Vietnam), which has undertaken extensive research on the husbandry of douc langurs in captivity and the wild, as well as captive breeding and release programmes for Delacour's langurs *Trachypithecus delacouri* (Nadler, 2012, 2013, 2023); and the Angkor Center for Conservation of Biodiversity (Cambodia), which rehabilitates and captive breeds endangered bird and reptile species, including the white-shouldered ibis *Pseudibis davisoni* (Woesner *et al.*, 2021; CIWG, 2023). Because many of these programmes are still in their infancy, it is difficult to define their success in terms of large-scale reintroduction efforts. Unfortunately, this is not an isolated issue as the fate of most rehabilitated animals released back into the wild remains unknown (Quaglia, 2024). However, as wild populations continue to decline these relatively small-scale programmes will undoubtedly become an increasingly



Fig. 1 The first gibbon born in Angkor (*Ping-peeung*) with her first-born (*K'mum*), Angkor Archeological Park, Siem Reap, April 2024 (© Jeremy Holden).

important component of future captive breeding efforts and conservation plans.

One such example is the Phnom Tamao Wildlife Rescue Centre and Zoological Garden (Phnom Tamao), which accepts all rescued wildlife and is managed by the Cambodian Forestry Administration (FA). The decision in 1995 by the Ministry of Agriculture, Forests and Fisheries (MAFF) to create Cambodia's first national zoo and wildlife rescue centre in a regenerating area of forest south of Phnom Penh was inspired. The centre is open to visitors, although not all the animals are on display (a non-visitor or 'off show' area exists for rehabilitation and release) and almost all have come from the illegal wildlife trade. In the early days, a lack of amenities including electricity and a reliable water source meant that improving conditions for some of the animals took time. However, collaboration between FA/MAFF and several non-governmental organisations (Wildlife Alliance, Free the Bears and Fauna & Flora) has ensured better care for the animals and enabled successful breeding programmes for many species. This has culminated in the release of appropriate animals via responsible protocols into protected natural habitats, often forests where they previously occurred. This includes countless numbers of birds and reptiles

and several noteworthy mammal species (Table 1). In future, similar efforts should enable the repopulation of areas where species have been extirpated, provided appropriate management of Phnom Tamao and adequate protection of the forests can be assured.

The benefits that wildlife rescue centres such as Phnom Tamao can provide for wildlife conservation are demonstrated well by a male pileated gibbon *Hylobates pileatus* which was rescued in 2006. Because the individual (named *Pompoi*) had been hand-raised, he was accustomed to people and so not appropriate for release. Following a badly-broken arm post-rescue and setbacks including repeat fractures, the pin of the repaired radius bone in his left arm was removed in 2009 and he was paired with a female of a similar age. Subsequent cooperation between FA, APSARA (which manages the Angkor Archaeological Park in Siem Reap Province) and Wildlife Alliance led to the release of suitable wildlife species into the forests of Angkor in June 2013. This began with the acclimatization of the first pair of pileated gibbons (*Baray* and *Saranick*, which were captive born at Phnom Tamao) and was followed by their release six months later (Leroux *et al.*, 2019).

Two years later, *Pompoi* and his mate produced a baby at Phnom Tamao and although they were not considered suitable for release, their mother-raised daughter exhibited appropriate behaviour including a wariness of humans. Consequently, she was paired with a male in a remote area of Phnom Tamao for one year, after which both gibbons were moved to an acclimatization enclosure in Angkor in November 2018. In July 2020, they became the third pair of gibbons from Phnom Tamao to be released in the forests of Angkor. At the time of writing, they have produced two offspring (*Mey-ambough* in September 2021 and *K'touy* in May 2024) and there are four pairs of gibbons living free in Angkor, all of whom can trace their origins back to Phnom Tamao. These have borne 11 gibbons to date. The first of these, a female named *Ping-peeung*, was paired with a young male from Phnom Tamao and their first infant (*K'mum*) was born in January 2024 (Fig. 1). *A-ping* and *Chung-ruth* represent the fourth and final pair of gibbons and were born in Angkor to different parents. Their first child (*Omal*) was born in April 2024.

This summary of rescued gibbons from Phnom Tamao that went on to play a role in restoring the species to an area where it once occurred is an example of what can be achieved when the right balance of circumstances and partners coincide. With wildlife threatened by so many factors, including habitat loss, exploitation and climate change, this demonstrates what rescue centres such as Phnom Tamao can achieve when located as they should be. In natural habitat, not just to give some kind of life to a few less fortunate wild animals, but to enable these animals to play an important role in maintaining and restoring the country's national history and heritage. This is surely something worth hanging on to everywhere, whatever the cost.

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