

Status of the Siamese crocodile in Vietnam

Steven G. Platt and Ngo Van Tri

Abstract The Siamese crocodile *Crocodylus siamensis*, now regarded as one of the world's most endangered crocodylians, was formerly common in the wetlands of southern Vietnam. Populations are thought to have declined in recent years, although quantitative status assessments are unavailable. We surveyed five areas previously believed to harbour the only remaining Siamese crocodile populations in Vietnam, and our results strongly suggest that viable populations are no longer extant. Crocodiles were not observed during spotlight counts of Crocodile Swamp (Nam Cat Tien National Park) or Lac Lake. Crocodiles do not occur in

Upper or Lower Krong Pach Reservoirs, and these degraded sites no longer constitute suitable habitat. Remnant populations may exist in the Sere Pok River and Tay Son Lake, but these crocodiles remain subject to persecution. Population declines are attributed to a combination of hunting, habitat destruction, incidental capture in fishing nets and collecting for crocodile farms. Reintroduction to Nam Cat Tien National Park is recommended.

Keywords Conservation, endangered species, population survey, Siamese crocodile, Vietnam.

Introduction

The Siamese crocodile *Crocodylus siamensis* occurs or formerly occurred in Thailand, Cambodia, Laos, Vietnam, and possibly Indonesia and Malaysia (Sabah and Sarawak), and is currently regarded as one of the most endangered crocodylians in the world (Thorbjarnarson, 1992; Ross, 1998). The Siamese crocodile is listed in Appendix I of the Convention on International Trade in Endangered Species (CITES) of Fauna & Flora and is considered Critically Endangered by The World Conservation Union (IUCN) (Ross, 1998). The ecology of the Siamese crocodile is virtually unknown and quantitative assessments of its current status in the wild are completely lacking (Ross, 1998). While individuals persist in isolated localities, viable populations no longer exist in Thailand (Suvanakorn & Youngprapakorn, 1987; Kreetiyuntanont, 1993; Ratanakorn *et al.*, 1994; Ross, 1998). Remnant populations are believed to occur in remote areas of southern Laos, although field surveys have yet to be conducted (Sawathvong, 1994). Relatively large populations may remain in Cambodia,

but security concerns have hampered field investigations (Nao, 1998).

The Siamese crocodile was formerly common throughout southern Vietnam in rivers, lakes and swamps (Cuc, 1994; Sang & Cuc, 1996). However, habitat destruction, egg collecting, and hunting for skins and meat have greatly depleted populations (Cuc, 1994; Cao & Jenkins, 1998). Large numbers are maintained at private breeding facilities for the production of skins, meat and hatchlings, although export is currently banned (Cao & Jenkins, 1998). The Siamese crocodile is now afforded complete protection in Vietnam as a Group I species under the Council of Ministers Decree No. 18, which prohibits hunting and export (Cao & Jenkins, 1998).

The current status of the Siamese crocodile in Vietnam remains largely unknown and surveys have been accorded high priority by the IUCN Crocodile Specialist Group (Thorbjarnarson, 1992; Ross, 1998). Lac Lake, Upper and Lower Krong Pach Reservoirs, and the Sere Pok River (Dak Lak Province), Crocodile Swamp (Dong Nai Province), and Tay Son Lake (Phu Yen Province) are the only areas believed to currently harbour Siamese crocodile populations in Vietnam (Fig. 1; Cao, 1998; Cao & Jenkins, 1998).

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Methods

An investigation into the status of the Siamese crocodile in Vietnam was conducted from 14 April to 10 May 1999. A combination of daylight surveys, nocturnal spotlight counts and village interviews was employed to census crocodiles. Spotlight counts are used in



Fig. 1 Map of Vietnam showing the approximate location of areas mentioned in the text. 1: Crocodile Swamp; 2: Lac Lake; 3: Upper and Lower Krong Pach Reservoirs; 4: Sere Pok River; 5: Tay Son Lake; and 6: U Minh Swamp.

crocodile surveys world-wide involving many species, and other population estimation techniques such as mark-recapture have confirmed the validity of the method (Bayliss, 1987).

Spotlight counts were conducted with a 12-V headlight from either a 4-m dugout canoe or a 5-m fibreglass boat equipped with an outboard motor. Potential survey routes were traversed during the day to assess habitat and navigability. The co-ordinates (latitude and longitude in degrees, minutes and tenths of minutes)



Plate 1 Crocodile Swamp, Nam Cat Tien National Park, Dong Nai Province. This heavily vegetated wetland is excellent crocodile habitat, and reintroduction of captive-bred Siamese crocodiles is recommended (Steven G. Platt).

were determined for the beginning and endpoints of each survey with a Garmin 48 Global Positioning System (GPS). Boat speed was measured with the GPS and used to determine the distance travelled in each survey. Encounter rates were then calculated as the number of crocodiles observed per kilometre of survey route, allowing quantitative comparison with other survey data and providing a means to assess population trends (Bayliss, 1987). A detailed description of each survey route is provided in Platt (1999), copies of which have been archived in: the Campbell Museum, Clemson University, Clemson, SC, USA; the Institute of Ecology, Resources, and Environmental Studies, Ho Chi Minh City, Vietnam; and the Institute of Ecology and Biological Resources (IEBR), Hanoi, Vietnam. Fishermen, villagers and local conservation personnel were also questioned concerning past hunting practices, recent sightings and general knowledge of crocodiles.

Results

Crocodile Swamp

This extensive seasonal wetland ($11^{\circ}27'N$, $107^{\circ}20'E$), located within Nam Cat Tien National Park, comprises 250–500 ha during the dry season, increasing to over 2500 ha by mid-wet season. Excess water from the swamp drains into the Đông Nai River during the wet season. Crocodile Swamp (Plate 1), a relatively shallow (*c.* 2–3 m) and heavily vegetated lagoon, appears to be excellent crocodile habitat. A permanent ranger station is located along the northern shoreline. Crocodiles were formerly abundant in this wetland, but intensive hunting and egg collecting continued even after the area was designated a nature reserve in 1978 (Cuc, 1994). A juvenile (IEBR 3) in the IEBR museum was collected in

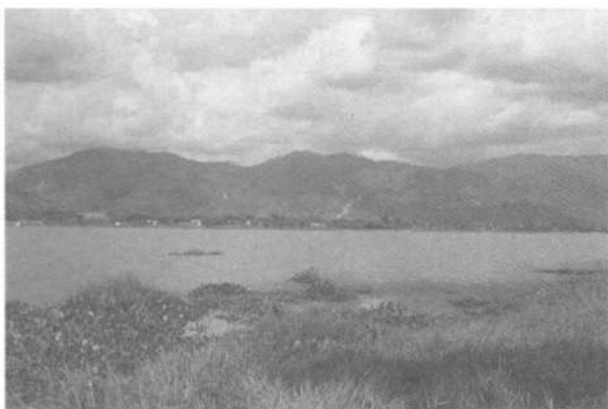


Plate 2 Lac Lake, Dak Lak Province. This lake formerly supported the largest remaining population of Siamese crocodiles in Vietnam (c. 2000 in 1985). However, conversion of shoreline habitat and widespread use of monofilament fishing nets are incompatible with population recovery at this site (Steven G. Platt).



Plate 3 Lower Krong Pach Reservoirs, Dak Lak Province. This man-made agricultural reservoir does not constitute suitable crocodile habitat (Steven G. Platt).

1986, and according to park rangers the last known crocodile was killed in 1995.

A spotlight survey was conducted on 18 April 1999. A 4.25-km survey route was traversed along the lakeshore, but no crocodiles were encountered. Moreover, park staff living at the ranger station have not observed crocodiles in recent years.

Lac Lake

This shallow (c. 1.5–2.0 m) lake (12°24'N, 108°11'E) is protected as a nature reserve by the Vietnamese Government (Cuc, 1994; Cao, 1998). Lac Lake (Plate 2) comprises 580 ha and flows into the headwaters of the Sere Pok River during the wet season. The shoreline is heavily grazed by cattle and utilized for rice cultivation; consequently, little emergent vegetation remains.

A village on the north-west shore supports an intensive fishery, and numerous fish traps and monofilament gill nets are deployed throughout the lake. Cao & Jenkins (1998) estimated a population of 2000 Siamese crocodiles based on 1985 survey data.

A spotlight count was conducted on 23 April 1999; a 15.4-km survey route was traversed, but no crocodiles were encountered. Furthermore, numerous local fishermen and villagers stated that, in the past, crocodiles were occasionally captured and drowned in fishing nets, but are now extremely rare. Given the current levels of intensive fishing, absence of suitable shoreline habitat and lack of sightings during spotlight counts, a viable crocodile population is no longer believed to occur in Lac Lake, although scattered individuals may persist.

Upper and Lower Krong Pach Reservoirs

These reservoirs were constructed in the late 1970s to provide irrigation water for surrounding farmland (Plate 3). Upper Krong Pach Reservoir (12°40'N, 108°18'E) comprises about 80 ha, while Lower Krong Pach Reservoir (12°46'N, 108°21'E) fluctuates from c. 100 ha during the wet season to less than 20 ha in the dry season. A daylight reconnaissance of these lakes was conducted on 24 April 1999, and neither represents suitable crocodile habitat. The surrounding land is intensively farmed and grazed, vegetated shoreline habitat is almost non-existent and numerous monofilament gill nets were noted at both sites. Furthermore, none of the many fishermen, farmers and villagers we interviewed had ever encountered crocodiles at these reservoirs.

Sere Pok River

This major river originates in the Central Highlands of Vietnam and flows into north-eastern Cambodia. A



Plate 4 Sere Pok River, Yok Don National Park, Dak Lak Province. A remnant population may persist in this river, although crocodiles remain subject to exploitation (Steven G. Platt).

remnant population of Siamese crocodiles may occur in the Sere Pok River in Yok Don National Park (Plate 4), but numerous rapids and a lack of suitable boat landing sites precluded a spotlight count. According to park staff, a tourist recently (<1 year ago) observed a crocodile at the Seven Branch Waterfall (12°51.20'N, 107°48.98'E) and a resident of nearby Lao Village reported catching and eating two juvenile crocodiles in 1998. In addition, we photographed a juvenile (total length = 62 cm) at a crocodile farm in Buôn Ma Thuôt, reportedly captured in the Sere Pok River.

Tay Son Lake

This 80-ha lake, located within the Krong Trai Nature Reserve (13°20'N, 106°26'E), formerly supported an estimated 200 Siamese crocodiles (Cuc, 1994; Cao & Jenkins, 1998). Unfortunately, we were denied permission by local civil authorities to enter the reserve and conduct a spotlight count. However, according to Mr Cao Huu Loc (Chief of Phu Yen Provincial Forestry Control Department, pers. comm.), crocodiles are now rare within the reserve and subject to continuing exploitation. Crocodiles are killed by local villagers for food and because of a perceived threat to humans and livestock.

Conclusions and recommendations

The results of our survey strongly suggest that viable wild populations of Siamese crocodiles no longer occur in Vietnam. No crocodiles were observed during spotlight surveys of Crocodile Swamp or Lac Lake, and while this cannot be interpreted as a complete absence of crocodiles from a site, it does indicate that densities are so low that the probability of an encounter during a survey is very small. Our data indicate that a precipitous decline has occurred at Lac Lake, which formerly supported the largest remaining Siamese crocodile population in Vietnam (Cao & Jenkins, 1998). Likewise, reports of conservation authorities indicate that few crocodiles remain at Tay Son Lake. A remnant population may persist in the Sere Pok River, although crocodiles remain subject to exploitation. Upper and Lower Krong Pach Reservoirs do not constitute suitable crocodile habitat.

There is little evidence that extant populations of Siamese crocodile occur in the Mekong Delta (Fig. 1) of southern Vietnam (Cuc, 1994; Cao & Jenkins, 1998). While downstream dispersal from populations in Cambodia is possible, the human population density in the Mekong Delta is among the highest on earth and the region is intensively used for fishing and wet rice agriculture (Hammond, 1993). Any crocodiles immig-

rating into this region would undoubtedly be killed or captured quickly. Cao & Jenkins (1998) speculate that a remnant population of estuarine crocodiles (*C. porosus*) inhabits the U Minh Swamp in the Mekong Delta (Fig. 1). However, field surveys have yet to be conducted and the status of this population must be regarded as tenuous at best. We therefore strongly recommend immediate surveys of suitable habitat in the Mekong Delta to determine if extant populations of either *C. siamensis* or *C. porosus* remain in the region. Such surveys are a necessary prerequisite for formulating an effective crocodile conservation strategy. We are unaware of any reports of hybridization between *C. siamensis* and *C. porosus* in the wild.

Population declines are attributed to a combination of hunting, habitat destruction, drowning in monofilament fishing nets and collecting for crocodile farms. Crocodiles of any size are vulnerable to entanglement and drowning in monofilament gill nets (Platt & Thorbjarnarson, 1997), and the extensive net fisheries we observed at several sites are incompatible with the continued survival of crocodiles and will severely hamper any future recovery efforts. Crocodile farms probably contributed to the decline of Siamese crocodiles by providing a ready market for captured crocodiles and an economic incentive for the continued exploitation of wild populations. With the demise of wild stocks in Vietnam, crocodiles are now obtained through purchase from other farms or in markets of the Mekong Delta. A considerable cross-border crocodile trade apparently exists between Vietnam and Cambodia (Platt, 1999). Crocodiles are transported down the Mekong River from Cambodia and sold in markets near Ho Chi Minh City. The extent of this trade is difficult to quantify and it may be somewhat curtailed following the recent Asian economic crisis. The effect on wild populations in Cambodia remains unknown (Platt, 1999).

More than 2000 Siamese crocodiles are currently held on 15 farms, and at least four have breeding programmes (Cao & Jenkins, 1998). Hybridization (*C. siamensis* × *porosus*; *C. siamensis* × *rhombifer*) among Vietnamese crocodile stocks is reportedly widespread, and concern has been expressed over the possibility of hybrids escaping and becoming established in the wild or further hybridizing with wild Siamese crocodiles (Cuc, 1994; Cao & Jenkins, 1998; Jacob Gratten, University of Queensland, *in litt.*). However, given the absence of wild populations in Vietnam, we regard the latter scenario as highly unlikely. Moreover, we concur with Cao & Jenkins (1998), who state there is little likelihood of hybrids becoming established, as crocodile farms are located in densely populated regions and escaped animals would be quickly killed.

Serious consideration should be given to reintroduc-

ing Siamese crocodiles to Nam Cat Tien National Park. The species formerly occurred in Crocodile Swamp, which is excellent habitat wholly encompassed by park boundaries. In addition, the lakeside ranger station provides a base for monitoring the reintroduction and confers an added degree of protection from poaching. Captive Siamese crocodiles on crocodile farms within Vietnam represent a potential source of animals for reintroduction. However, it is critical to ascertain, preferably through genetic analysis, that crocodiles selected for reintroduction are indeed *C. siamensis* and not hybrids. It would also be advisable to isolate and establish a captive-breeding group of pure Siamese crocodiles and use their progeny for any reintroduction programme. An established crocodile population would represent a significant ecotourist attraction for the National Park.

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References

- Bayliss, P. (1987) Survey methods and monitoring within crocodile management programmes. In *Wildlife Management: Crocodiles and Alligators* (eds G. J. W. Webb, S. C. Manolis and P. J. Whitehead), pp. 157–175. Surrey Beatty and Sons Pty. Ltd., Sydney.
- Cao, V.S. (1998) The system of protected areas in Vietnam. In *Environment and Bioresources of Vietnam: Present Situation and Solutions* (ed. V. S. Cao), pp. 57–128. Gioi Publishers, Hanoi.
- Cao, V.S. & Jenkins, R.W.G. (1998) Crocodile conservation and development in Vietnam. In *Crocodiles: Proceedings of the 14th Working Meeting of the Crocodile Specialist Group*, pp. 135–140. IUCN Publications, Gland.
- Cuc, H.T. (1994) Status and conservation of crocodiles in Vietnam. In *Crocodiles: Proceedings of the 12th Working Meeting of the Crocodile Specialist Group*, pp. 28–34. IUCN Publications, Gland.
- Hammond, A. (1993) *Environmental Almanac*. Compiled by World Resources Institute. Houghton Mifflin Co., New York.
- Kreetyuntanont, K. (1993) Siamese crocodile (*Crocodylus siamensis*) in Khao Ang Ru Nai Wildlife Sanctuary. *Natural History Bulletin of Siam Society*, **41**, 135–137.
- Nao, T. (1998) Current status of crocodile in Cambodia in captivity and in the wild. In *Crocodiles: Proceedings of the 14th Working Meeting of the Crocodile Specialist Group*, pp. 141–154. IUCN Publications, Gland.
- Platt, S.G. (1999) *Investigation into the status of crocodiles and turtles in Vietnam and Cambodia*. Unpublished Report, Wildlife Conservation Society, Bronx, New York.
- Platt, S.G. & Thorbjarnarson, J.B. (1997) *Status and life history of the American crocodile in Belize*. Unpublished Report, United Nations Development Programme—Global Environmental Facility. Belize Coastal Zone Management Project BZE/92/G31.
- Ratanakorn, P., Amget, B. & Otley, B. (1994) Preliminary surveys of crocodiles in Thailand. In *Crocodiles: Proceedings of the 12th Working Meeting of the Crocodile Specialist Group*, pp. 35–49. IUCN Publications, Gland.
- Ross, J.P. (1998) *Crocodiles: Status Survey and Conservation Action Plan*. IUCN, Gland.
- Sang, N.V. & Cuc, H.T. (1996) *Checklist of Amphibians and Reptiles of Vietnam*. Government Printers, Hanoi [in Vietnamese].
- Sawathvong, S. (1994) The status of crocodiles of the Lao PDR. In *Crocodiles: Proceedings of the 12th Working Meeting of the Crocodile Specialist Group*, pp. 16–23. IUCN Publications, Gland.
- Suvanakorn, P. & Youngprapakorn, C. (1987) Crocodile farming in Thailand. In *Wildlife Management: Crocodiles and Alligators* (eds G. J. W. Webb, S. C. Manolis and P. J. Whitehead), pp. 341–343. Surrey Beatty and Sons Pty. Ltd., Sydney.
- Thorbjarnarson, J. (1992) *Crocodiles: An Action Plan for their Conservation*. IUCN Publications, Gland.

Biographical sketches

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