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An Overview of the Current Population and Conservation Status of the Critically Endangered River Terrapin, *Batagur baska* (Gray, 1831) in Myanmar, Thailand and Malaysia

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ABSTRACT.– The river terrapin, *Batagur baska* (Gray, 1831) formerly occurred in large rivers from western India and Bangladesh, through much of Southeast Asia. Populations throughout much of this region have declined or been extirpated as a result of chronic over-harvesting of eggs and adults, destruction of nesting beaches due to sand mining and sedimentation, and mangrove forest clearance. Consequently, *B. baska* is regarded as Critically Endangered throughout its geographic distribution. Herein, we provide an overview of the conservation status of *B. baska* in Myanmar, Malaysia, Thailand and the results of recent surveys in these countries. Owing to the paucity of recent records, the IUCN regards *B. baska* as extinct in Myanmar. However, our surveys indicate that small populations persist in coastal regions of Mon and Rakhine States, and Ayeyarwady and Tanintharyi Divisions where a combination of local religious beliefs and areas of armed conflict confer some degree of protection. Peninsular Malaysia represents the last stronghold of *B. baska* and relatively large populations occur in several rivers on both the east and west coasts. Captive breeding programs have been conducted in Malaysia since the late 1960s. Despite the release of thousands of head-started hatchlings since the inception of these projects, populations of *B. baska* in the Perak River continue to decline. Recent estimates indicate that less than 50 breeding females remain in the river. There is little information on the historic occurrence and distribution of *B. baska* in Thailand. As late as the 1970s remnant populations were known to occur at Pak Payoon, Amphur Ranote, and some rivers of Ranong Province. A captive propagation center was established in 1983 at Satun Inland Fisheries Station. Our survey of the Langu Canal found small numbers of *B. baska*, and documented the occurrence of at least three nests; other potential nesting beaches are located along the river.

KEY WORDS: *Batagur baska*, mangrove terrapin, river terrapin, distribution, population, conservation, head-starting

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INTRODUCTION

The mangrove terrapin or the river terrpin, *Batagur baska* (Gray, 1831) is a

large aquatic turtle that formerly ranged from the Sunderbans region of the Ganges-Brahmaputra Delta in India and Bangladesh, eastward through Myanmar, southern Thailand, Cambodia, and Vietnam, and south to Peninsular Malaysia and Sumatra (Ernst and Barbour, 1989; Iverson, 1992). Within this distribution, *B. baska* inhabits large rivers, estuaries, coastal mangroves, and inshore beds of marine vegetation. During the reproductive season adult turtles travel far upstream to reach nesting beaches that are often located well above tidal influence.

Historically large numbers of females returned each year to deposit eggs on well-known nesting beaches, but populations have drastically declined throughout this range due to a combination of chronic removal of eggs from nesting beaches, destruction of nesting beaches, over-harvesting of adults, incidental drowning in active and discarded fishing nets, and widespread habitat degradation or loss from dam construction, water pollution, mangrove deforestation, and sand dredging and mining (Platt et al., 2006). Today, extant populations of *B. baska* no longer occur in Indonesia and Vietnam, scattered individuals persist in Thailand, Myanmar, and Cambodia, and the viability of populations in Bangladesh and India is doubtful (Platt, et al., 2006). Malaysia is the only remaining country that appears to harbor viable wild populations of *B. baska*. Moreover, conservation efforts to date have proven largely unsuccessful and various reports strongly suggest that the remaining populations continue to decline (Bhupathy, 1997; Das, 1997; Rashid and Swingland, 1997; Thorbjarnarson et al., 2000; Platt et al., 2003; Platt et al., *in press*). Consequently, *B. baska* is now regarded as one of Southeast Asia's most threatened chelonians (Das, 1997), considered Critically Endangered by IUCN (2004), Nabhitabhata and Chan-ard (2005) and Turtle Conservation Fund (2002), and prioritized by the Turtle Conservation Fund (2002) as one of 25 chelonians in urgent need of conservation action if extinction of wild populations is to be prevented.

As noted at a recent mangrove terrapin conservation workshop, there is an urgent need for data on the distribution and conservation status of *B. baska* in the various countries where it occurs (Platt et al., 2006). Acquiring such data is an essential first step towards implementing effective conservation programs and evaluating their success. To this end, we herein review the current conservation status of *B. baska* in Myanmar (Burma), Thailand and Malaysia.

MATERIALS AND METHODS

Field surveys were conducted during 2002 through 2004 to obtain data on the current population status of *B. baska* in Myanmar, Thailand and Malaysia. In Myanmar, we distributed 100 questionnaires to local fishery stations in coastal regions where *B. baska* were historically found and requested information on the recent occurrence of these large conspicuous turtles. Based on answers to the questionnaire, we conducted field surveys from January through July 2004 in coastal regions of coastal regions of Mon State, and Tanintharyi and Ayeyarwady Divisions to verify reports and search for viable wild populations. We also searched ponds at Buddhist pagodas for *B. baska*; however, because the provenance of these turtles is unknown, distributional records based on

pagoda ponds must be interpreted with caution.

In Thailand, we conducted surveys for wild *B. baska* on Langu Canal, in Satun Province during January to April 2003, August to September 2004, and May to August 2005. These surveys encompassed a section of the canal 23 km long (6.4 km upstream from the fishery station and 16.6 km downstream to the river mouth). Average temperature in this region is 27.5°C (range = 17°C in February to 38.9°C in April) and mean annual rainfall is 2,280.9 millimeters (range = 7.2 mm in January to 377.8 mm in September). Our survey team consisted of staff from the Department of Fisheries and local fisherman. We searched for basking turtles and attempted to trap adults using nylon fishing nets (mesh size = 20.3 cm). Additionally we interviewed people living along waterways in coastal areas to seek information on recent sightings and possible nesting activities.

During field investigations in Myanmar and Thailand we obtained information on the local occurrence and exploitation of *B. baska* largely through interviews of fishermen, turtle egg collectors, and villagers. Such individuals are generally excellent sources of information on the local chelonian fauna, especially species of cultural or economic significance (Thirakhupt and van Dijk, 1994). Additionally, we accompanied informants to specific areas where *B. baska* were captured to obtain habitat information.

In Malaysia, we conducted a field survey of the Perak River in Perak State from November 2004 to March 2005 to assess potential nesting and foraging habitat along the river, identify potential sources of water pollution that might impact turtles, and describe limnological parameters and riverine vegetation. During this survey we monitored potential nesting beaches, including a government-owned nesting beach and others belonging to licensed egg collectors. Potentially suitable nesting beaches were marked on a map, with the distance from river-mouth and GPS coordinates. We were unable to deploy fishing nets to capture turtles in the Perak River owing to the extremely swift current. To evaluate long-term population trends we obtained records of nesting activity at sandbars and beaches along the Perak River for the years 1996 through 2005 from PERHILITAN (Wildlife Department of Malaysia).

During field surveys in all countries we determined geographic coordinates with a Garmin® GPS 12; these units were also used to calculate distance traveled during surveys of sinuous coastal waterways. Human disturbance and river traffic was recorded at all survey locations. Likewise we noted the presence of beaches that might serve as suitable *B. baska* nesting habitat along coastal waterways, and described vegetation at these sites.

In addition to field surveys, we collected morphometric data on captive B. baska at the Satun Inland Fisheries Station in Thailand and the Perak River Station in Bota Kanan, Perak State, Malaysia. We measured the following on each turtle using calipers: straight-line carapace length (CL), maximum carapace width (CW), plastron length (PL), plastron width (PL), shell depth (SD) and Body Mass (BM). Turtles <3 kg were weighed using an electronic balance; larger turtles were weighed with a spring scale. Sex was determined based on head, neck, and iris coloration, as well as tail characteristics. During the breeding

FIGURE 1. A female *B.baska* inhabiting pagoda pond in Myanmar.

season the skin on the head, neck, and legs of the male turns dark black, while females remain drably colored, and the iris color of male changes from yellowish to pure white, while the female iris is black; males also have longer, thicker tails than females (Moll, 1978; Moll, 1980; Ernst and Barbour, 1989).

Batagur baska nests at captive breeding facilities in Thailand and Malaysia were monitored from 2002 through 2005. We determined length, width, and mass of each egg before burying them in the standard artificial nests used at these facilities. Nest temperatures were determined by placing a Maxim/Dallas IButton® thermal data logger in each nest, but not in physical contact with the eggs. Meteorological data for different regions was obtained from the respective national meteorological services of Thailand and Malaysia.

Statistical analyses were conducted using Microsoft Excel for Windows 2006. Locality records for B. baska and the location of potential nesting habitat were incorporated into revised distribution maps for each range country using Global Information System (ArcView GIS 3.2a). The location of potential nesting beaches were marked on a map along with the estimated area, a description of vegetation, and notes on the level of human disturbance and river traffic.

RESULTS AND DISCUSSION

Myanmar

Historic accounts indicate that *B. baska* was common in the Ayeyarwady Delta where large numbers nested each year on islands at the river mouth and sandbars as far upstream as Hinthada (formerly Henzada) District (Maxwell, 1911). At that time “herds” of 100 to 500 nesting females could be seen basking on beaches in the late afternoon and Maxwell (1911) estimated a nesting population of at least 1,175. The Colonial Administration leased the turtle nesting beaches to local businessmen, who hired laborers to collect

eggs that were later sold in local markets or exported to Rangoon (Yangon). The annual harvest of 165,000 eggs during the early 1890s had declined to approximately 77,000 by 1897-98, and by the early 1980s only a few terrapins continued to nest on these islands (Salter, 1983). A survey in 1999 found no evidence of nesting activity and Thorbjarnarson et al. (2000) concluded *B. baska* was no longer extant in the lower Ayeyarwady River.

Elsewhere in Myanmar *B. baska* reportedly occurred in the Salween and Sittaung (formerly Sittang) rivers and museum specimens collected during the late 1800's and early 1900's are available from both rivers (Iverson, 1992). Gordon (1875) described large "river turtles" floating on the surface of the latter river that were most likely *B. baska*. Indeed, the extensive beaches along the Sittaung River described by Abreu (1858) would appear to be near-ideal nesting habitat. Even today there are few villages along either river and consequently fishing activity and riverside agriculture are minimal in comparison to other comparably large rivers in Myanmar, thereby increasing the likelihood that populations continue to survive. However, survey data are unavailable and the current conservation status of these populations remains unknown. Given the paucity of recent records, the IUCN (2004) regards *B. baska* as extinct in Myanmar. However, Salter (1983) and Platt et al. (in press) received apparently reliable descriptions of *B. baska* from villagers inhabiting the coast of Rakhine State, suggesting the IUCN conclusion is somewhat premature.

During this study, we verified the occurrence of *B. baska* at one location in Mon State and two localities in Tanintharyi Division where we obtained the carapace of a recently killed *B. baska*, examined a clutch of eggs, and were shown photographs of a large female recently captured by fishermen. The carapace (CL = 52.8 cm; CW = 42.4 cm) was obtained from fishermen residing at Khaw Za Town, a fishing village on the border between Mon State and Tanintharyi Division; the turtle was captured nearby on 11 January 2004 and consumed shortly thereafter by villagers. Security considerations prevented us from visiting Khaw Za Town, but according to fishermen, *B. baska* are regularly taken incidental to fishing activities; most are eaten by villagers. Villagers attribute the continued survival of *B. baska* to armed conflict between government forces and Mon insurgent groups which discourages fishing in this area.

We accompanied an egg collector to a *B. baska* nesting area on Pyin Won Beach along the Tanintharyi River on 5 February 2004. This individual excavated a single *B. baska* nest containing 12 eggs that were collected and later eaten. This practice appears widespread as other villagers likewise report similar egg collections. Additional nesting beaches are thought to occur further upstream.

Additionally, the residents of Sinzeik Village provided us with photographs of a large (CL ca. 55.0-60.0 cm) female mangrove terrapin captured after it became entangled in a fishing net set in the Dawei River, approximately 38 km upstream from the river mouth. The turtle was captured on 26 January 2004 and released the following day. Fishermen regard *B. baska* as extremely rare in the Dawei River. *Batagur baska* also reportedly occur in the Par Chan River, which separates southern Tanintharyi Division from Thailand, and its

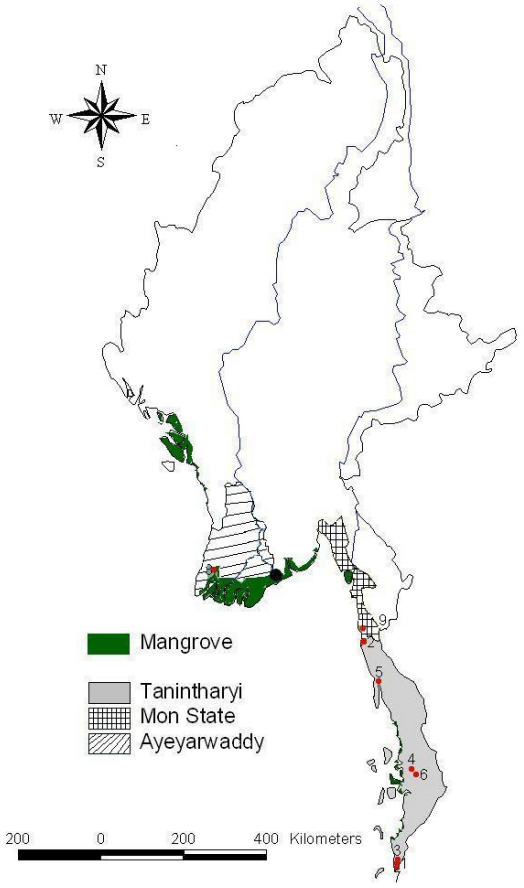

FIGURE 2. Locations in southern Myanmar where *Batagur baska* were found during surveys in 2003. Numbers correspond to list of geographic coordinates in Table 1.

tributary creeks. According to inhabitants of the riverside villages of Thaung Phyu and Kan Paw Gyi, juvenile *B. baska* are frequently taken in crab traps placed beneath mangrove trees and baited with salted fish. Small terrapins are generally released, while larger specimens are kept for local consumption.

We obtained only a single recent record of *B. baska* from Ayeyarwady Division; fishermen in Wet Bu Village reported the inadvertent capture of an adult in the Tha Baung River during January 2004. The turtle became entangled in a shad (*Tenualosa ilisha*) net and was released the following day. Although occasionally taken in fishing nets (1-2 turtles/year), fishermen regard *B. baska* as uncommon in the Tha Baung Estuary. Our surveys elsewhere in Ayeyarwady Division failed to find any evidence for the continued occurrence of *B. baska*.

Finally, we examined an adult female *B. baska* (CL = 55.8 cm; CW = 44.4 cm; PL = 53.7 cm; SD = 23.1 cm) inhabiting a pond on the grounds of Botahtaung Pagoda in Yangon (Fig. 1). The provenance of this turtle is unknown, but we speculate that it originated from the now extinct (or nearly so) population that formerly inhabited the lower Ayeyarwady Delta (Maxwell, 1911; Thorbjarnarson et al., 2000).

To summarize, our survey and others (Platt et al., *in press*) indicate that populations of *B. baska* persist in coastal regions of Rakhine and Mon States, and Ayeyarwady and Tanintharyi Divisions of Myanmar (Table 1; Fig. 2). As reported by Platt et al. (in press), a small number of *B. baska* probably occur near Ramree Island in Rakhine State, but are threatened by the continued harvest of eggs and adults. Although the large population that once nested at the mouth of the Ayeyarwady River was decimated by the late 1980's (van Dijk, 1998; Thorbjar-narson et al., 2000), our survey suggests that small numbers remain in the Tha Baung River and its tributaries. Given the intense levels of fishing activity in this river and the risk of drowning associated with the widespread use of fishing nets the long-term persistence of this population is unlikely.

The last stronghold of *B. baska* in Myanmar appears to be in Tanintharyi Division where a combination of local religious beliefs and areas of armed conflict

TABLE 1. Coordinates of localities mentioned in the text where evidence of *Batagur baska* was found in Myanmar. Numbers correspond to Figure 2. (NA = coordinates not available. Khaw Za Town is located approximately 16 km south of Ye Town)

Location	Latitude (N)	Longitude (E)
1. Kan Paw Gyi	10°16' 38.6"	98° 59' 74.3"
2. Khaw Za Town	NA	NA
3. Par Chan River	10° 24' 41.3"	98° 60' 42.9"
4. Pyin Won Beach	12° 20' 84.8"	98° 91' 05.5"
5. Sinzeik Village	14° 11' 02.8"	98° 19' 48.2"
6. Tanintharyi Town	12° 09' 13.3"	99° 01' 30.3"
7. Thaung Phyu	10° 06' 27.5"	98° 58' 54.0"
8. Wet Bu Village	16° 53' 66.6"	94° 61' 38.0"
9. Ye Town	15° 25' 17.3"	97° 86' 21.8"

confer some protection on remaining populations. Religious beliefs protecting *B. baska* are strong, but localized in Tanintharyi. Because *B. baska* often traverse great distances between foraging and nesting habitats (Moll, 1980; Platt et al., 2003), these localized beliefs prohibiting capture offer only limited protection.

Malaysia

The historical distribution of *Batagur baska* in Peninsular Malaysia is poorly documented (Moll, 1980). Boulenger (1912) stated *B. baska* was common in the larger rivers of Malaysia. Hendrickson (1961) used interview data from fishermen and egg collectors to identify nine *B. baska* nesting areas in Malaysia; however, owing to the similarity of *B. baska* and *Callagur borneoensis* eggs and because both species are known locally as tuntong, Moll (1980) suggested that some of the areas identified may actually be *C. borneoensis* rather than *B. baska* nesting sites. Moll (1980) verified the occurrence of *B. baska* in the Perak, Kedah, and Terengganu River systems, and considered reports from the Setiu-Chalok and Pahang River systems valid.

The Perak River on the west coast of Peninsular Malaysia harbors the best studied population of *B. baska*. Eggs have always been considered property of the Sultan and collecting was only carried out under royal license (Swettenham, 1993). In the years prior to World War II, up to 650,000 eggs were collected from beaches along the river (Moll, 1978). During the war the carefully regulated system collapsed and egg collecting as well as the harvest of adult turtles became widespread (Moll, 1978). Beside exploitation of eggs, habitat alteration and destruction have also played an important role in the decline of terrapin populations (Moll, 1997). Sand mining and dam activities along the river or upstream has change the river physically and effecting the nest and feeding areas.

Even so, Loch (1951) stated that "hundreds of turtles" remained in the Perak River in the early 1950s. This population declined steadily (Mohamed Khan, 1964), and Balasingam and Mohamed Khan (1969) estimated a breeding population of only 220 females. Using nesting records from the Department of Wildlife and National Parks (PERHILITAN), Moll (1980) revised this estimate and suggested that 401 to 1204 females remained, somewhat more than previously believed. Assuming that females comprise 33% of the Perak River population, then the total population numbered between 1200 and 3600 turtles (Moll, 1980). However, Chan (unpubl.) recently estimated that less than 50 breeding females and probably no more than 150 *B. baska* remain in the river.

Malaysia has a long history of active river terrapin conservation efforts and the

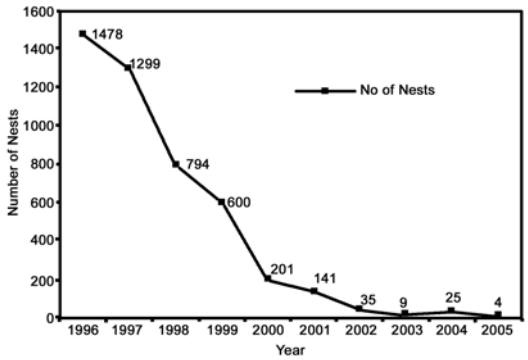

FIGURE 3. Long-term trends in the number of *Batagur baska* nesting along the Perak River in Malaysia (1996-2005). These figures are based on nests collected by PERHILITAN staff and licensed egg collectors. Undoubtedly some nests collected by egg collectors are not reported so the actual number of turtles nesting in a particular year is probably somewhat greater than indicated.

country is the principal stronghold for *B. baska* in Southeast Asia today. Egg collection, although legal, remains under the control of local state governments. Conservation efforts have largely focused on *ex-situ* incubation of eggs and release of head-started juveniles. The Bota Kanan River Terrapin Conservation Center was established in 1975 along the Perak River in northeastern Perak State. The facility is administered by the State Wildlife and National Park Department. Although there is a modest visitor center and accommodations on site, the main focus is on captive breeding of *B. baska*, and head-starting juveniles from captive and wild sources. Currently 75 breeding turtles are housed at the station; this total includes 20 males (mean CL= 40.8 $\pm$ 3.31 cm) and 55 females (mean CL = 46.6 $\pm$ 2.44 cm). Additionally, 279 sub-adults, 778 juveniles and 114 hatchlings were housed at the center during 2004-2005. Of this cohort of 279 turtles, 183 were females and 96 were males (1 Female: 0.52 Males). We noted that turtles displayed sexually dimorphic breeding coloration and were observed mating at 18 years of age.

Egg collection data from PERHILITAN indicate significant declines the number of female *B. baska* nesting along the Perak River within the last decade; 1478 nests were recorded in 1996, while only 36 nests were collected in 2004-2005 nesting season, a decline over 95% (Fig. 3). Of the 36 nests, four were collected by PERHILITAN and 32 by licensed egg collectors; none of the latter was made available to PERHILITAN for incubation.

This dramatic decline has occurred despite the release of 35,436 head-started juvenile *B. baska* into the river from 1969 to 2004. The reasons for this decline are unclear; however, but it is obvious that few if any of these turtles are surviving to augment the breeding population, calling into question the effectiveness of head-starting as a conservation strategy. Because head-starting programs have failed to achieve even basic population recovery goals, Platt et al. (2006) recommend a rigorous evaluation of their conservation merits before additional assets are expended.

Upstream dam construction and tin mining operations on the Perak River have intensified in recent years, likely resulting in significant changes to river morphology. Our survey and those of others (Moll, 1980) indicates *B. baska* inhabit tidal sections of the Perak river throughout the year except during the nesting season. The river mouth is wide with a mud bottom in most places, although sandy areas occur at several locations. The vegetation of the tidal reaches of the river is characterized by extensive stands of mangrove apple, *Sonneratia caseolaris*.

Owing to logistic constraints, we were unable to conduct a mark-recapture study to estimate the current wild population of *B. baska* in the Perak River; instead we follow previous workers and base our estimates on the number of nests recorded along the river. We identified 7 beaches where *B. baska* nesting occurred along the Perak River (Table 2; Fig. 4). Many apparently suitable beaches along the river were not utilized by nesting females, probably because of a thick growth of vegetation. Vegetative growth is thought to be due to upstream dam construction that reduced scouring of the beaches by yearly floods that formerly occurred (Platt et al., 2006). Five known nesting beaches were manually cleared by egg collectors to encourage nesting; no effort was made by egg collectors to clear the other two known nesting beaches. According to the collectors, the latter beaches have not been used by nesting turtles for the past five years and consequently the cost of clearing vegetation can no longer be justified.

In addition to clearing vegetation, egg collectors construct small hillocks on nesting beaches and submerge bunches of bananas in shallow water at the beach to attract female *B. baska*. The efficacy of these practices is unclear, but these methods have a long tradition on the river (Moll, 1978, 1980). We also observed egg collectors pouring alcohol on small fires ignited on the beaches under the belief that the smell would provide further incentive to lure nesting turtles.

Licensed egg collectors found one nest on Pulau Pisang 1, another on Lope Salleh beach in Kampung Tanjun Aur and 30 nests on Pulau Padang beach north of Pulau Pisang village. In previous years, many of these eggs were sold to PERHLITAN to be incubated at the Bota Kanan station. However, egg collectors now sell their catch for local consumption and PERHLITAN has been unable to obtain eggs for head-starting during the 2004-05 nesting season. Notably, data were unavailable for Pentai Jambatan beach near the bridge linking Bota Kanan with Bota Kiri. In the past, this beach produced the majority of eggs collected from the river, but was abandoned and no longer cleared of vegetation following the death of the owner. The beach is now overgrown with dense vegetation and unlikely to be used by nesting females in the future.

During our survey of the Perak River we examined 36 clutches, including 32

TABLE 2. Coordinates of *Batagur baska* nesting beaches on Perak River, Malaysia. Numbers correspond to Figure 4. The name of the individual leasing the egg collection rights at each beach is in parentheses.

Location (Egg collector)	Latitude (N)	Longitude (E)
1. Pentai Jabatan (Station Beach)	04° 20' 50.8"	100° 52' 42.5"
2. Pentai Jambatan (Mustafa M. Shah)	04° 21' 11.9"	100° 52' 28.7"
3. Pulau Pisang beach 2 (M.Abd. Majid)	04° 21' 48.9"	100° 52' 53.7"
4. Pulau Pisang beach 1(Mohamad Kassim)	04° 22' 01.1"	100° 53' 31.1"
5. Pulau Padang (Haji Hasnat)	04° 22' 08.4"	100° 53' 42.0"
6. Kampung Tanjun Aur (Lope Salleh)	04° 22' 49.7"	100° 53' 00.2"
7. New Beach (Owner undetermined)	04° 18' 36.3"	100° 54' 01.7"

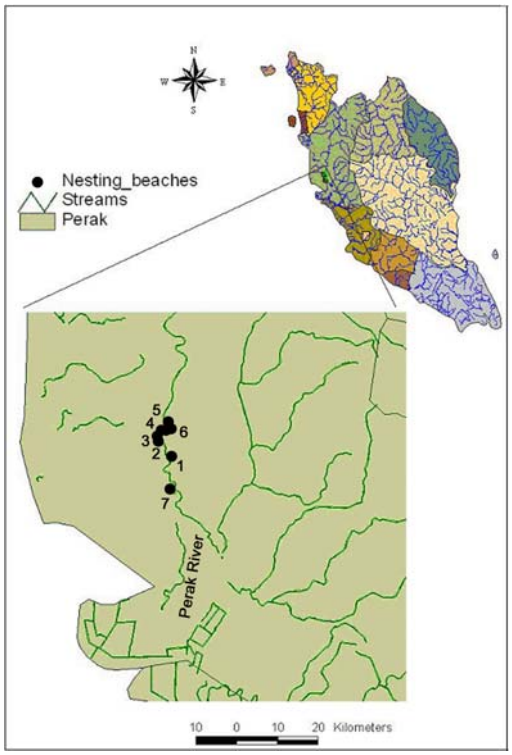

FIGURE 4. Map of Perak River in Perak State, Malaysia. Numbers indicate *Batagur baska* nesting beaches identified in 2004-2005 and correspond to geographic coordinates in Table 2.

deposited by wild females on license collector beaches and 4 nests deposited on Bota Kanan Wildlife Department Station beach. Based on nest counts, it thus appears likely that less than 50 breeding females remain in the river. Four nests from the PERHILITAN, Wildlife Department station beach (Pentai Jabatan; N 04° 20' 50.8", E 100° 52' 42.5") had a mean clutch size of 19.2 ± 1.5 eggs (range = 17 to 20 eggs). These eggs averaged 68.5 ± 3.65mm long × 43.2 ± 1.32 mm wide and weighed 75.92 ±6.84 g. Forty eggs from the first two clutches deposited were moved to the station beach and incubated under natural conditions in sand at an average temperature 30.3˚ C. Thirty-seven eggs from the remaining two nests were placed in Styrofoam boxes and incubated at an average temperature of 29.5 ˚C. Hatching success of the four nests ranged from 0 to 94.1% (natural nests = 0 and 45%; Styrofoam boxes = 60 and 94.1%). Incubation periods for the three nests that produced hatchlings ranged from 70 to 75 days. Based on this very limited sample, eggs incubated in Styrofoam boxes appear to require longer to complete development than eggs incubated in sand, most likely due to the cooler incubation temperatures of the Styrofoam boxes.

We made several observations of *B. baska* and their sign (tracks, slides, etc.) while conducting surveys along the Perak River. On 26 Dec 2004, we observed a *B. baska* feeding on *Alocasia* spp. near Kampong Palau Pisang (N 04˚ 22' 13.9", E 100˚ 53' 82.0"). Another adult *B. baska* was observed swimming near the nesting beach adjacent to the Bota Kanan station at approximately 1900 hours on the same day. On 27 Dec 2004 we found numerous fresh tracks on a small beach downstream from the station (N 04° 18' 36.3", E 100° 54' 01.7") where nesting has not been previously reported. Finally, according to fishermen, juvenile *B. baska* are occasionally taken in fishing nets set in irrigation channels and small creeks that feed into the main river channel near Bota Kiri.

Thailand

There is scant information on the historical occurrence of *B. baska* in Thailand. The first Thai record of this species resulted from a survey of northern Malaysia and Southern Thailand by Nelson Annadale and Herbert Robinson in 1901 and 1902 (Boulenger, 1912). A small *B. baska* was collected in the lower beaches of the Patani River. As late as the 1970s

remnant populations were known to occur at Pak Payoon District in Phattalung Province, Ranote District in Songkhra Province, and some rivers of Ranong Province (Nutaphand, 1979; Moll, 1985). Moll (1985) considered these populations to be small remnants of once larger breeding populations that were decimated after many years of intense exploitation of eggs and adults. The few turtles remaining in the wild were threatened by continued collection by local fishermen (Moll, 1980). Thailand lists *B. baska* as a protected species in the first category according to Ministerial Regulation Chapter 14 (B.E. 2535) written in accord with the Reserves and Wildlife Management Act of B.E. 2503.

In 1983, a captive breeding facility was established on Klong Langu River at the Satun Inland Fisheries Station in southern Thailand. The facility was constructed on a known *B. baska* nesting beach along the Langu River and stocked with locally obtained turtles from one of the only remaining wild populations; females were captured as they came ashore to nest and males were netted in the river. Undoubtedly the collection of these adult turtles to stock the Fisheries Station hastened the demise of this population. By 1990, 29 females and 23 males were held at the Satun Inland Fisheries Station. According to breeding records from the 1987/88 season, 210 eggs were laid and 133 hatched (63% hatching success), while during 1988/89 season, 394 eggs were laid and 143 hatched (36% hatching success). Currently, the facility houses 25 males (mean CL = 44.9 ± 1.44 cm), 25 females (mean CL = 51.14 ± 2.65 cm), 236 subadults, 594 juveniles, and 141 hatchlings. Of this cohort of 236 subadult turtles, 73 were females and 163 were males (1 Female: 2.23 Males). Only a few eggs hatched during the early years of the program, but following improvements in husbandry, approximately 200 hatchlings are now produced each year. According to station records, 1,649 hatchlings have survived to adulthood during the 23 years of the program.

Experiments conducted to determine effects of incubation temperature on hatching success determined that eggs incubated in natural beach sand with an average incubation temperature of 28.8°C hatched in 100-110 days; 40 of 98 eggs hatched (40.8%). In a concrete pond, with an average incubation temperature of 30.5°C, incubation periods ranged from 74-84 days; 57 of 98 eggs hatched (58.16%). Eggs placed in Styrofoam containers with an average temperature of 29.7°C hatched after an incubation period of 90-100 days; 54 of 98 eggs hatched (55.1%) (Satun Fisheries Station, unpubl. data). We found that turtles ranging in age from 17 to 19 years old displayed sexually dimorphic breeding coloration.

TABLE 3. Coordinates of potential *Batagur baska* nesting beaches located along the Langu Canal in southern Thailand. Numbers correspond to Figure 5.

Location	Latitude (N)	Longitude (E)
1. Station Beach	06° 55' 11.5"	99° 51' 33.2"
2. Beach 1	06° 56' 07.6"	99° 51' 46.4"
3. Beach 2	06° 55' 34.6"	99° 51' 38.7"
4. Beach 3	06° 55' 05.0"	99° 51' 27.4"
5. Beach 4	06° 54' 43.9"	99° 51' 23.2"
6. Beach 5	06° 54' 48.3"	99° 50' 48.0"
7. Beach 6	06° 54' 32.1"	99° 49' 56.9"
8. Beach 7	06° 54' 14.8"	99° 49' 33.7"

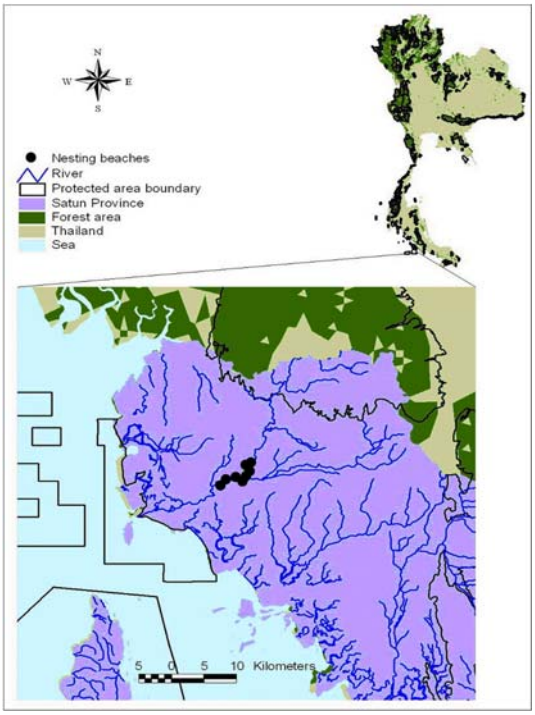

FIGURE 5. Map of area in southern Thailand indicating locations (black dots) of potential *Batagur baska* nesting beaches along the Langu Canal.

From 1996 to 2004, all 411 head started turtles from Satun Fisheries Station were released into a pond at monastery near Songkhra Lake, Haad Kai Tao and Thalae Luang in Pattalung District. Forty turtles were released into Langu River in 1999 as a river terrapin conservation project for reintroduction into the wild. Although efforts are currently underway to evaluate several potential reintroduction sites, a long-term conservation strategy for head-starting and reintroduction remains to be developed and is urgently needed. Alarmingly the breeding facility is situated on a low-lying bend along the river and subject to flooding during exceptionally wet years. Indeed, a number of *B. baska* escaped during a flood in 2003 and future unplanned liberation of *B. baska* is highly probable during wet years.

Our surveys were made at Langu River, Pakbara River in Satun Province and Haad Kai Tao, Thalae Luang in Pattalung Province. Although, viable wild populations of *B. baska* are no longer thought to occur in Thailand, our survey indicated that scattered individuals persist in the Langu River and perhaps elsewhere in the southernmost region of the country. We found evidence of a small number of wild *B. baska* in the Langu River; three nests were harvested by villagers in January 2003 and a basking adult was photographed in August, 2004. We also identified eight potential nesting beaches along the river (Table 3; Fig. 5). The beaches are composed of medium quartz sand, soil, and rocks. Local inhabitants engage primarily in small-scale gardening, plantation agriculture, and fishing. Both plantation agriculture and fishing activities cause considerable disturbance to the river; the former results in significant inputs of agro-chemicals and fishing nets inadvertently capture turtles. We placed fishing nets (mesh = 20.3 cm) across the canal at five locations near *Sonneratia* trees in an attempt to capture feeding *B. baska*. These nets were checked each hour, but no turtles were captured during our survey. Encouragingly however, a local villager fishing in a mangrove canal in TaKua Tung District in western Thailand captured a large adult *B. baska* (CL = 50 cm; mass = 28 kg) on 1 January 2006. Collectively, our observations and reports from villagers suggest that small numbers of *B. baska* continue to survive in southern Thailand, although the viability of these small populations is questionable.

GENERAL RECOMMENDATIONS

Myanmar

Conduct public awareness and education programs in fishing communities of coastal Ayeyarwady Division and Rakhine State. Conduct additional surveys in coastal regions of Ayeyarwady and Tanintharyi Divisions, and Mon and Rakhine States. Law enforcement training for government fisheries staff and local authorities is needed in coastal regions of Ayeyarwady Division and Rakhine State. Establish captive breeding program if a coterie of suitable *B. baska* can be located.

Malaysia

Perak River at Bota Kanan and Bota Kiri including all nesting beaches should be gazetted as a wildlife sanctuary. Ban collection of *B. baska* eggs and their sale in markets. Ban destructive fishing methods and provide means of enforcement. Control speedboat traffic in terrapin habitat. Designate all nesting sites, home-ranges, and foraging areas as protected habitat. Sand mining should be banned in these areas. Establish buffer zones for agricultural and aquaculture use in mangrove areas and along river channels. The clearing vegetation on nesting beaches annually should be encouraged.

Thailand

Designate the Langu River as protected area owing to the presence of a remnant *B. baska* population. The potential seven nesting beaches along Langu River should be protected during the nesting season. Evaluate the river with a view towards possible augmentation of existing population using captive reared terrapins from Satun Inland Fisheries Station.

Reintroduction of *B. baska* to Taleban National Park and should closely adhere to IUCN Guidelines. In particular, sites selected should be areas where *B. baska* was historically known to occur. Factors causing the original extirpation should be determined and addressed. Moreover, habitat evaluations must be undertaken prior to release to determine if the area remains suitable. Increase law enforcement presence at potential reintroduction sites.

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