eventually a large section of the scute broke away from the carapace. Had the turtle been alive, it may have been seriously injured. We had similar results when trying to remove a radiotransmitter from the remains of a second individual that was killed by land-clearing equipment. These observations reinforce the caution made by Belzer and Reese (1995), who noted that prying off radiotransmitters bonded to turtles with epoxy can tear scutes. However, in May 1999, approximately 12 months after the start of our study, radiotransmitters that had been attached to turtles for 347–366 days were easily removed without damaging scutes (M. Ciaranca, *pers. comm.*). Whether the putty degraded over time or whether natural sloughing of scute material, or both, caused the radiotransmitters to loosen over time is unknown. Regardless of cause, it appears the putty base method of attachment is acceptable if radiotransmitters are expected to remain attached to turtles for extended periods of time, such as the 11–12 months that elapsed between attachment and removal in this study. However, we are hesitant to recommend this method in cases where radiotransmitter life is shorter, incidence of radiotransmitter failure is high, or recovery of radiotransmitters after only brief periods of attachment is otherwise anticipated.

Because attempts to remove radiotransmitters from two dead turtles resulted in damage to scutes, we further modified the method used by Boarman et al. (1998) in order to minimize the amount of putty in contact with the carapace. Our silicon base method created a space between the radiotransmitter and carapace that provided working room for tools that would later be used to remove the radiotransmitter. We anticipated that a carefully used cordless rotary hobby tool (e.g., Dremel) with a cutting disk could readily cut through the strips of epoxy putty along the sides of the radiotransmitter. Because the radiotransmitter was not in direct contact with the carapace (due to the silicon pad) the cutting disk would not contact the scute and therefore would not damage the turtle. After the old radiotransmitter was removed, a new radiotransmitter could be attached to the putty that remained bonded to the carapace.

We believe the silicon base method appropriate for both long and short-term attachment of radiotransmitters. One turtle with a silicon base mounted radiotransmitter was relocated 357 days after attachment, indicating that the longevity of this attachment method is comparable to that of the putty base method. The main benefit of the silicon base method is that it permits the safe removal of radiotransmitters at any time without requiring either the epoxy or scute surface to degrade. The ability to remove radiotransmitters shortly after attachment may be especially important in the event of premature radiotransmitter failure. We recommend this approach for all applications because it minimizes the likelihood of turtles being injured during the radiotransmitter removal process.

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Rediscovery of the Critically Endangered River Terrapin, *Batagur baska*, in Cambodia, with Notes on Occurrence, Reproduction, and Conservation Status

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The river terrapin, *Batagur baska* (Gray, 1831), inhabits coastal rivers, estuaries, and mangrove swamps from eastern India and Bangladesh, to Myanmar, southern Thailand, Cambodia, Cochinchine (southern Vietnam), peninsu-

Figure 1. Map of Cambodia showing localities mentioned in the text.

lar Malaysia, and Sumatra (Ernst and Barbour, 1989; Iverson, 1992). There are, however, few records of the occurrence of *B. baska* in Cambodia (Groombridge, 1982; Iverson, 1992). Bourret (1941) stated that *B. baska* was common in Cochinchine and Cambodia, based on the accounts of Tirant (1884) and Pavie (1904), who reported villagers collecting eggs along the Prek Tap Kiéang, a coastal river in southern Cambodia now known as the Sre Ambel. Jenkins (1995) noted that recent records of *B. baska* from Cambodia were lacking, and others (van Dijk, 1998; Tana et al., 2000) concluded the species was extirpated in the country. We herein provide recent distributional records and assess the current conservation status of *B. baska* in Cambodia.

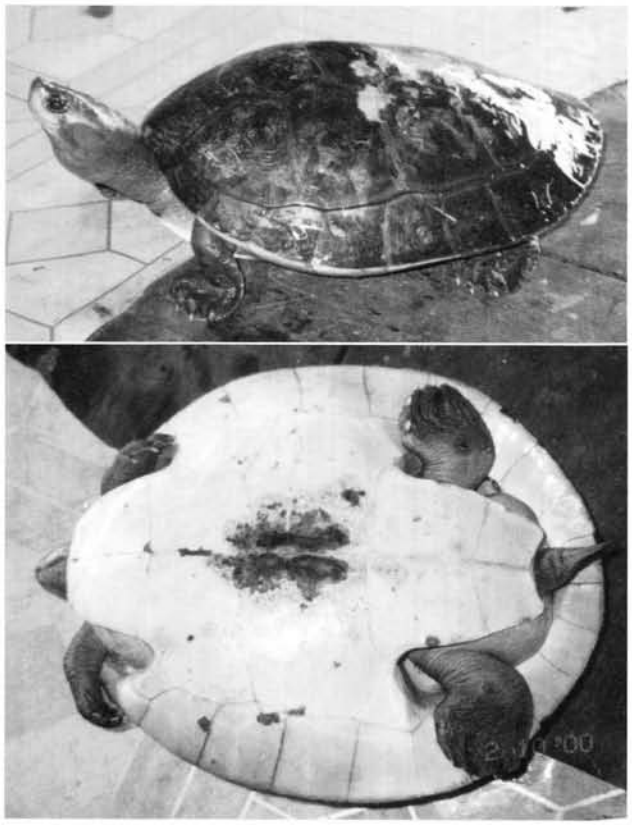

Figure 2. Subadult *Batagur baska* (mass = 2.8 kg) photographed on 2 October 2000 at a wildlife market in Sre Ambel Town, Koh Kong Province, Cambodia. The turtle was captured by fishermen in the Sre Ambel estuary. Photo by Heng Kimchhay.

Historically, *B. baska* occurred in the Tonle Sap (Fig. 1), an inland freshwater lake comprising 250,000 to 300,000 ha and surrounded by seasonally inundated wetlands (Scott, 1989). The Tonle Sap River connects the Tonle Sap with the Mekong River and extensive backwater flooding occurs during the annual wet season (Scott, 1989). The complete shells of two adult *B. baska* (carapace length [CL] = 525 and 425 mm), obtained from local fishermen in 1985 (Nao Thuok, Director, Fisheries Department, *pers. comm.*), are on display at the Department of Fisheries Office in Siem Reap. These shells were found buried in lake sediments and are not believed to represent recent occurrences. According to elderly residents, small numbers of *B. baska* were present in the Tonle Sap during the early 1900s (Nao Thuok, *pers. comm.*). However, surveys conducted in 2000–01 found no evidence for the continued persistence of *B. baska* in the Tonle Sap (Platt et al., unpubl. data), and the species has almost certainly been locally extirpated.

More recently, in September 2000 an adult male *B. baska* (CL = 490 mm; voucher photograph archived in the Campbell Museum, Clemson University, Clemson, South Carolina, USA; CUSC 1952) was noted in a turtle pond at a zoo in Kampot. The animal was reportedly obtained from another zoo in Prey Veng Town, Prey Veng Province (Gavin Bourchier, *pers. comm.*); however, its original provenance could not be ascertained.

On 2 October 2000 one of us (HK) photographed a subadult *B. baska* (mass = 2.8 kg; voucher photograph CUSC 2028), reportedly captured by fishermen in the Sre Ambel estuary, at a wildlife market in Sre Ambel Town (Fig. 2). Subsequent to this observation we conducted surveys 6–12 January, 3–9 February, and 8 June 2001, and 24–31 January 2002 to verify the occurrence and identify nesting areas of *B. baska* in the Sre Ambel River system.

Currently, the only known extant population of *B. baska* in Cambodia occurs in the Sre Ambel River system (Fig. 1). The Sre Ambel watershed encompasses parts of Koh Kong, Kampot, and Kampong Spue Provinces, and drains the southwestern slopes of the Damrei and Cardamom Mountains before flowing into Kampong Saom Bay. A number of smaller tributaries feed the Sre Ambel River, including the Stõeng Kaaong, which meets the main channel approximately 16 km upstream from the river mouth. Salinity in the estuary ranges from 0.0 to 20.0 ppt during the wet (May–October) and dry (November–April) seasons, respectively (Platt et al., unpubl. data). Extensive mangrove swamps dominated by *Rhizophora* sp., *Avicennia* sp., and *Sonneratia* sp. occur near the river mouth, while less saline sections of the estuary are characterized by stands of *Melaleuca leucadendron* and *Nipa fruticans* (Ashwell, 1997). Upstream from the estuary, riverside vegetation is character-

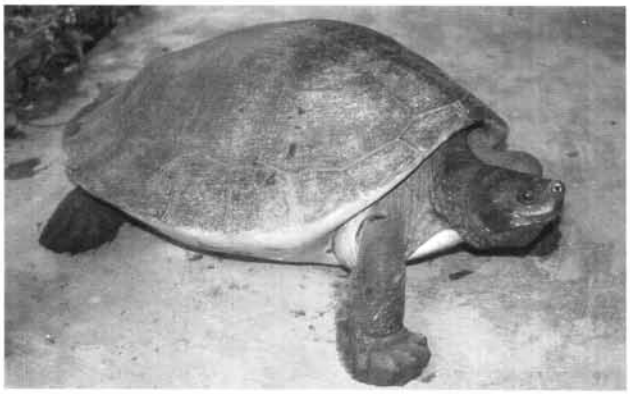

Figure 3. Adult female *Batagur baska* (CL = 587 mm) confiscated by the Sre Ambel Fisheries Department in late January 2001 after being accidentally caught in a fishing net in the Sre Ambel River, Koh Kong Province, Cambodia. Photo by Steven G. Platt.

Figure 4. *Batagur baska* nesting site along the Sre Ambel River, Koh Kong Province, Cambodia, photographed in early February 2001. Note low water level of river. Photo by Steven G. Platt.

ized by evergreen riparian forest and extensive sandbars are exposed as river levels fall in the dry season.

During our surveys we examined 7 living *B. baska* (6 juveniles and 1 adult) and a carapace, which originated from the Sre Ambel River. Four juveniles were confiscated by the Fisheries Department in January 2001 after being caught in a *pong pang* net set at the mouth of the Sre Ambel River (12°51.204' N; 107°48.994' E). These large funnel-shaped nets are positioned in the lower estuary and catch fish using the tidal flow. When the tide reverses, water flows through the net, and fish, shrimp, and crabs become trapped in an elongated funnel-like pocket. A fifth juvenile was turned over to the Fisheries Department in early June 2001 after being accidentally entangled in a fishing net, and we obtained a sixth juvenile from a villager in January 2002. One juvenile (CL = 75 mm) was probably a yearling, two (CL = 94 and 108 mm) were estimated to be two years old, and the other three (CL = 111, 116, and 139 mm) were probably three to four years old. The adult turtle (Fig. 3) was a large female (CL = 587 mm; mass = 29 kg) also confiscated by the Fisheries Department after being captured in a fishing net in late January 2001. Additionally, we examined the carapace of a large (CL = 528 mm) female that was killed and consumed by a fisherman on 22 January 2002. According to the fisherman, this female contained 38 shelled eggs and "about 50" enlarged follicles. These undoubtedly represent multiple clutches as *B. baska* is known to produce as many as three clutches per season (Moll, 1980a).

We also located 12 sandbars along the Sre Ambel and Stõeng Kaaong rivers where *B. baska* nest (Table 1; Fig. 4). Nesting sites along these rivers are located 39–50 and 36–61 km, respectively, upstream from Kampong Saom Bay. During January 2002 we examined six nests on these sandbars (Table 1); mean (± 1SD) clutch size was 11.3 ± 4.4 eggs (range = 6 to 19 eggs). Furthermore, we monitored a nesting beach near our camp from 25 to 30 January 2002; on 26 January (0400 hrs) an adult turtle (presumably a female) emerged from the river and investigated the beach for about 2 min before returning to the water without laying eggs, and on 28 January (0300 to 0400 hrs) another adult was observed swimming near the beach, although it did not leave the river. Both observations occurred after the moon had set.

These nesting beaches are well known to villagers, who collect eggs from late January to early March. Eggs are consumed by villagers or sold locally for approximately US$0.08 per egg. At two nesting sites we found broken eggshells indicating that eggs were recently collected. Villagers locate nests by searching for tracks of female turtles and then probing the sand with sharpened sticks. According to villagers, the number of clutches annually removed from

Table 1. Location of sandbars used for nesting by *Batagur baska* along the Sre Ambel and Stõeng Kaaong rivers, Koh Kong Province, Cambodia. Information on egg collection obtained during interviews of local villagers. Nests found in 2002 were protected from local harvest.

River	Lat. (N)	Long. (E)	Notes
Sre Ambel	11.2821°	103.7671°	One excavated nest and broken eggs found in January 2001.
	11.2843°	103.7673°	Four excavated nests and broken eggs found in February 2001.
	11.3275°	103.7288°	No evidence of recent egg collection; two nests collected by villagers in 2000.
Stõeng Kaaong	11.1569°	103.8896°	One nest (11 eggs) found in 2002.
	11.1542°	103.8908°	One nest (12 eggs) found in 2002.
	11.1528°	103.8803°	Two nests and a nesting female harvested by villagers in 2000.
	11.1470°	103.8780°	One nest (19 eggs) found in 2002.
	11.1431°	103.8691°	One nest harvested in 2000.
	11.1404°	103.8759°	One nest (8 eggs) found in 2002.
	11.1402°	103.8727°	Two nests (6 and 12 eggs) found in 2002.
	11.0890°	103.8425°	Fresh turtle tracks (nesting female?) found in January 2001.
	11.0901°	103.8420°	One nest collected by villagers in 2000; two nests collected by villagers in January 2001.

each sandbar ranged from one to four (Table 1). Based on the number of nests reportedly collected each year, it is unlikely that more than 20 mature females currently inhabit the Sre Ambel River system. In addition to egg collectors, domestic water buffalo (*Bubalus bubalis*) reportedly trample some nests while others are lost to water monitor (*Varanus salvator*) predation. It is unknown how many nests successfully hatch, but the recent capture of five juveniles indicates that at least some nests produced offspring during the past two years. Given an incubation period of 66 to 84 days (Moll, 1980a), eggs probably hatch from late March to May, coinciding with the end of the dry season.

In addition to egg harvesting, interviews with fishermen indicate that turtles are captured in nets and traps incidental to routine fishing operations. Fishermen stated that large juveniles and adults are generally consumed, while smaller turtles are released; however, most of the captured turtles we examined were small juveniles suggesting the harvest of this size class may be greater than indicated by our interviews. Although difficult to quantify, the incidental harvest appears small and most fishermen reported an annual catch of less than one large juvenile or adult *B. baska*. However, some fishermen reportedly target adult *B. baska* using set-lines baited with *Sonneratia* sp. fruit. Additionally, one villager reported harvesting nesting female turtles following clutch deposition. Others told of a group from another village who collected about 60 nesting females on a single night in 1999. We were unable to verify this account, but if true, this single act is likely responsible for reducing the *B. baska* population in the Sre Ambel River system to its current critically endangered status. Most harvested turtles are consumed locally, but the observation of an adult at a wildlife market in Sre Ambel Town indicates that some are entering the trade. *Batagur baska* meat reportedly sells for about US$1.00/kg in local markets. Additional mortality probably results from the use of hand grenades and other explosive devices for fishing, a common practice in this formerly heavily militarized area. Given the lack of any previous population data it is difficult to predict current population trends; however, the general consensus among fishermen is that living *B. baska* and nests are becoming more difficult to find each year.

Populations of *B. baska* throughout Asia have drastically declined or been extirpated by a combination of habitat destruction and chronic over-harvesting of eggs and adult turtles (Nutaphand, 1979; Moll, 1980a, 1980b; Groombridge, 1982; Das, 1995; Bhupathy, 1997; Moll, 1997; van Dijk, 1998; Platt et al., 2000; Thorbjarnarson et al., 2000). *Batagur baska* is considered Critically Endangered ("facing a high risk of extinction in the wild in the near future") by the IUCN (2000) and regarded by Das (1997) to be among the most threatened chelonians in Asia. The Cambodian population of *B. baska* may be the only extant population remaining in former Indochina and is thus of particular global conservation significance.

Undoubtedly, continued harvesting of eggs and living turtles is the single most important threat to the long-term viability of the *B. baska* population in the Sre Ambel River system. *Batagur baska* are especially vulnerable to egg collection as females predictably return to the same communal nesting sites each year. Even where adult *B. baska* are protected, chronic over-collecting of eggs has resulted in severe population declines or extirpation (Moll, 1980; van Dijk, 1998; Platt et al., 2000; Thorbjarnarson et al., 2000). Furthermore, demographic and stochastic processes render small populations particularly vulnerable to local extinction (Gilpin and Soulé, 1986), and the loss of even a few mature turtles can have severe negative demographic consequences (Congdon et al., 1993). Therefore, we regard the *B. baska* population in the Sre Ambel River system as critically endangered with a high probability of extinction unless conservation measures are rapidly implemented.

Foremost is the need to control the harvesting of eggs and living turtles. *Batagur baska* was protected by royal decree prior to 1975 and the egg harvest was reserved solely for the king. During this period the king employed guards to protect the nesting beaches, and violators were subject to stiff fines administered by the Fisheries Department. Villagers still refer to *B. baska* as the "royal turtle." Royal protection was reinstated in 2001 and will probably do much to halt the purposeful harvest of living turtles and eggs. Furthermore, a nest protection program was recently initiated in the Sre Ambel River system (Kalyar and Sovannara, unpubl. data); local villagers were hired to guard beaches, and nests were enclosed by bamboo fencing. A full evaluation of this program will be presented elsewhere. Additionally, existing legislation prohibiting the use of *pong pang* fishing nets should be enforced. Besides catching *B. baska*, these nets decimate local fish stocks and ultimately threaten the livelihood of those who depend on this resource. Finally, it is imperative for enforcement authorities to curtail the illegal trade in turtles from this region of Cambodia.

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Effects of Sand Hardness and Human Beach Use on Emergence Success of Loggerhead Sea Turtles On Yakushima Island, Japan

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Although the substrate of loggerhead sea turtle (*Caretta caretta*) nesting beaches varies (Hendrickson and Balasingam, 1966; Stancyk and Ross, 1978; Mortimer, 1982), few studies have examined how substrate characteristics influence the biology of nesting females or developing eggs. Laboratory experiments have shown that temperature, moisture, and gas conditions to which reptilian eggs are exposed affect growth and sexual differentiation (Packard and Packard, 1988).

Studies of egg development of *C. caretta* have shown that the primary causes of egg failure are infertility, early embryonic mortality, and microbial infection (Blanck and Sawyer, 1981; Wyneken et al., 1988). These results were obtained mostly from eggs incubated in artificial hatcheries; there are few comparable data on eggs from natural nests.

Even when embryonic development successfully leads to hatching, some hatchlings fail to emerge from the sand. In the green turtle (*Chelonia mydas*), the proportion of hatchlings involved in such failures is known to be small (Fowler, 1979). However, the extent to which *C. caretta* hatchlings fail to escape from their nests has not been reported previously.

We examined relationships between the hardness of the nesting substrate and human beach use on the emergence success of loggerhead sea turtle hatchlings on Yakushima Island, Japan.

Methods.—From 1 to 31 August 2000, we recorded the emergence of *C. caretta* hatchlings on Nagata Beach, Yakushima Island, Japan (130°30'E, 30°20'N). Nagata Beach is divided into two parts, one restricted from public access (restricted area; 15.5 x 412.0 m^2), and the other freely accessible to the public (free-access area; 30.0 x 300.0 m^2).

We looked for emerging nests every morning and marked those that we found in each area. We measured the hardness of the surface sand at the center of each nest with a Yamanaka-shiki soil hardness tester with resistance (25.0 mm x 30.0 mm) every day from the time found until