Research Fellowship Program Report

Natural History Notes on the River Terrapin *Batagur baska* (Gray, 1831) in Cambodia

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REPORT SUMMARY

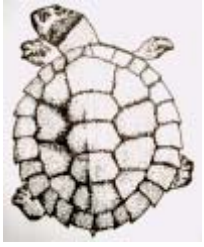
The River Terrapin, *Batagur baska*, is critically endangered throughout its range and was though to be extinct in Cambodia until its rediscovery in 2001. WCS swiftly initiated a conservation program to safeguard nests and work with the local community to address conservation issues for the species. This research project aims to discover areas, in addition to nesting beaches that are important for the River Terrapin so that conservation efforts can be most effectively targeted.

To achieve these aims, methods used included a capture-mark-recapture, radio tracking, interviews with local fishermen and traders, and monitoring of nests and hatchlings.

Within the study period, one adult female, one adult male, five juveniles, and 59 hatchlings were seen. From analysis of track measurements, only four individuals may have laid the eight nests of 2002/2003. Only one nest was laid on the larger Sre Ambel River and was predated. Of the seven nests laid on the Kaaong River, one was infertile and another was not discovered until the hatchlings emerged. Emergence occurred between 119 and 123 days, and occurred just days before the rise in river level at the beginning of the wet season.

From the results of interviews, observations, and radio tracking, it appears that the section of the Kaaong River between approximately 30 km from the sea until its junction with the Sre Ambel River is the most important for the remaining *B. baska*. While it appears that some animals are still utilizing the upper and possibly lower Sre Ambel River, the Kaaong is certainly a high priority, along with its tributary the Prek Kompong Seila.

While radio tracking may reveal movements of tagged turtles, its shortcomings in saline water limited the value of this method of tracking in this instance.



INTRODUCTION

Batagur baska is a large estuarine turtle, critically endangered throughout its range and thought to be extinct in many parts. Throughout its range from India to Vietnam and south to Sumatra, the species has fallen victim to harvesting of eggs and individuals, habitat loss and alteration, and incidental mortality from other human activities. *B. baska* in Cambodia is presently only known from a small population in the Sre Ambel drainage of southeastern Koh Kong province and is unlikely to number more than 50 adult animals. *Batagur baska* was relatively more common until very recently. Platt et al (in press) interviewed locals who said that one village had harvested about 60 nesting females in a single night in 1999. The occurrence of this species in Sre Ambel was unknown to the international community between the 1880s expedition of Auguste Pavie and the year 2000. In 2001, WCS Cambodia initiated a conservation program to address the factors causing the problems for the population. This study set out to gain a more complete understanding of the population dynamics, movements, and habitat use of *B. baska* in the Sre Ambel drainage.

STUDY AREA

In Cambodia's southwest, Sre Ambel (literally "Salt Fields"), due to the rice fields in the area which somehow manage to grow rice despite the salt water that fills them) is a locality (UTM 48P 0363500 1229750) close to the mouth of the Sre Ambel River, which drains into the Gulf of Thailand. The Sre Ambel River is variously referred to as Prek Kampong Saom (US Army Topographic Command, 1970) and Prek Ban Lun. The Sre Ambel Drainage essentially consists of Sre Ambel District, and covers over 2500km^2. The second major river in the drainage is Stoeng Kaaong, which, higher in its course is called Prek Kompong Leu or simply Prek Leu. Five major villages exist along these two rivers, consisting of 55 families (Kalyar and Heng, 2002).

Human disturbance is most obvious along the Sre Ambel River, with an observed disturbance (plantations, rice fields, and houses) of 34% of its distance (16% Kaaong, 10% Stung Poong Rool). Timber is frequently transported down the river, but rarely are the trees more than 15cm in diameter. Large logs (up to 1m diameter) are occasionally seen and part of the catchment is a logging concession under the control of the Malaysian logging group Sam Ling. Charcoal production is another source disturbance, using local timber and large in-ground kilns.

While some erosion is expected in this dynamic river system, land clearance has obviously accelerated soil loss in areas. Some areas are prone to drought, one locality known as Trapeang Reang, or "Drought Pond", where locals say that their rice crop often fails and in such years, they rely more on wildlife than they would otherwise. Upriver, the wet season brings the river level up some 3-4 meters in areas that are still under tidal influence in the dry season.

Livestock kept by people upriver comprises mainly of chickens and water buffalo, although pigs and cows are also kept. The buffalo often utilize sandbanks to access the river and the subsequent trampling is obvious. Fishing takes place year-round, as it is the main, and in most cases the only form of protein for the rural population. Fishing methods include fyke nets, gill nets, crab-pots, long-line and bamboo traps. Illegal fishing methods, which are still used by some people, include grenade fishing and electro fishing.

Boat traffic is heaviest between Gulf of Thailand and the town, where large sea going boats dock. A new, port has also commenced development, seaside of Sre Ambel. This new port is attempting to compete with Sihanoukville as Cambodia's most important port (Kong, 2003).

The most abundant mangrove species are *Rhizophora* sp. and *Sonneratia caseolaris*. Associated with these are the same species described in Malaysia by Moll (1980): *Nypa fructicans* and *Acanthus ebracteatus*. Mangroves remain dominant until 40km from the river

mouth, after which point, the most common trees are *Melaleuca leucadendron, Barringtonia racemosa, Syzygium* sp., and *Hibiscus tiliaceus.*

Several endangered turtle species also exist in the area, including Elongated tortoise (*Indotestudo elongata*) and Giant softshell (*Pelochelys cantorii*) (Swan, 2000) and probably also the Yellow-headed terrapin (*Hieremys annandalei*).

Other turtle species known to occur in the Sre Ambel drainage include *Cuora amboinensis, Cyclemys pulchristriata, Heosemys grandis*, and the softshell *Amyda cartilaginea*. Another species likely to occur is *Malayemys subtrijuga*, which is common throughout Cambodia. For species other than turtles, among the most important known to remain in the lowlands of Sre Ambel include the Siamese crocodile (*Crocodilus siamensis*), Asian elephant (*Elephas maximus*), and Lesser adjutant (*Leptoptilos javanicus*). The Indochinese tiger (*Panthera tigris*) may also remain in the area, but with ten tigers killed by landmines in 1993 alone, they may only remain in the mountains, as locals say. Wildlife confirmed in the area is presented in Appendix III.

The market in Sre Ambel previously openly dealt in live turtles but recent confiscations by the department of fisheries has driven this trade underground. In November 2001, one dealer in Sre Ambel town said that he was still dealing turtles but he wouldn't show them to a foreigner due to a confiscation the previous week. More recently, the only turtle product openly sold at the market was ground turtle shell (species unknown) for use in traditional medicine. The Cardamom mountains survey (Daltry and Momberg, 2000) identified many other animal species of concern to conservation and concluded that the region is highly important for biodiversity in the region.

METHODS

River distances were estimated from aerial photographs obtained from the Cambodian National Mekong Committee and maps (US Army Topographic Command, 1970) and was ground-truthed using GPS. Distance from the river mouth is expressed in kilometers as the Adopted Middle Thread Distance (AMTD). Salinity was measured with a Samwa multitester, with the conductivity converted to a percentage of seawater (100% = 35000ppm). Salinity was measured at surface level, with several areas in the mixing zone also measured at 2m depth to assess the presence of an underlying saline layer.

Habitat disturbance and human presence was estimated from river-level observations per km. The most recent aerial photographs available were taken in 1994, since which time, the vegetation and human population patterns have changed substantially.

All beaches observed were marked on a map, with their distance from river-mouth measured by map and their grid coordinates recorded. Each beach was mapped with its height, slope range, aspect range, depth of adjacent water, and distance to the opposite bank. Also noted were vegetation on and surrounding the beach, obstructions and refugia on the beach and in the water, and human and animal disturbance.

To date, turtles examined have all been handed in or confiscated from fishermen who had caught them (incidentally or intentionally), traders, and hatchlings from nests that were located. Linear measurements were taken using either 20cm or 30cm calipers to the nearest millimeter. Carapace measurements (length and width) of larger animals were taken as curved distance with a 2m tape measure to the nearest millimeter. For animals with obvious annuli, measurements were taken of each of the annuli on all vertebral scutes as annuli on plastral scutes tended to wear more quickly. In all animals, total shell height, carapace width, central plastral length, and mid-line length of each of the plastral and carapacial scutes. Turtles under 3kg were weighed using an Issco 3000 electronic balance. Animals over this weight were weighed with 10, 30, or 100kg spring scales. Sex of the animal was recorded where it could be determined, with animals

otherwise recorded as juveniles. Sex was determined by probing of the cloaca for the presence of a penis (Blanco et al, 1990) and through identification of secondary sexual characteristics including long pre-anal tail length, yellow or white eyes, and darker coloration (Moll, 1980). Pre- and Post-anal tail lengths were measured, which is an effective method of identifying sex in mature animals unless they are newly mature, when sex is less obvious (Kostel, 1986).

Turtles were marked using a carapacial notching system similar to that of Cagle (1939). In addition, microchips were injected into all animals in the body cavity of the inguinal area on the animal's right side. Identifying marks were also noted on each turtle's individual record.

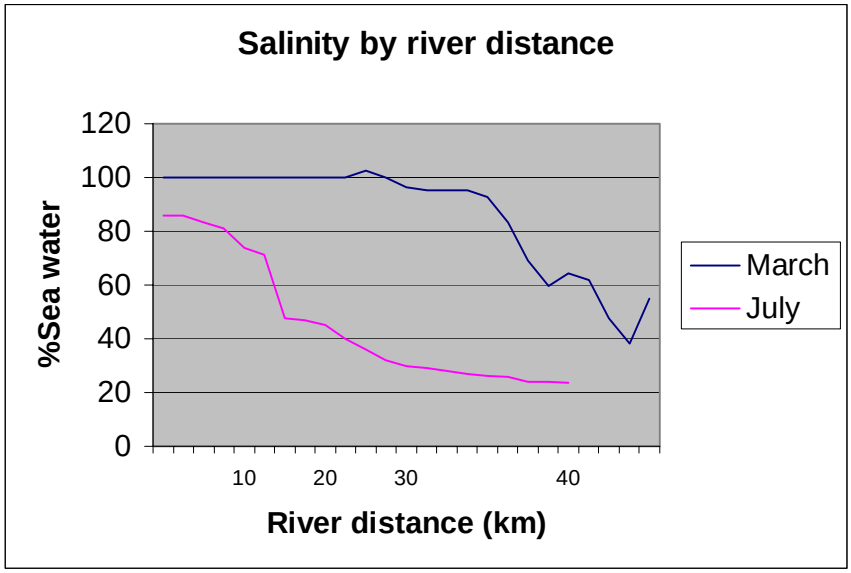
Growth rings were counted and measured on carapacial scutes as plastral scutes were often worn such that accurate measurements could not be taken.

All tracks seen on nesting beaches were measured from distance between the outside of the feet, the distance between the inside of the feet, and the width of the plastral drag. In most instances only two out of these three measurements were observable. One female of known size was released and its tracks subsequently measured. A ratio of track width to carapace length was then calculated and applied to other tracks for estimates of animal size of the other tracks measured.

Radio-transmitters were fitted to four animals with Selley's "Knead-it" waterproof putty. The four animals included an adult female and male, and two juveniles. The two adults were fitted with Sirtrack two-stage transmitters on a duty cycle of five days on, two days off. The juveniles were fitted with Sirtrack one-stage transmitters. All were tracked with a Telonics TR-4 receiver and Sirtrack Yagi antenna. At each fix, date and time were recorded, along with the depth of the water, UTM location, air and water temperature, boat traffic, cloud cover, and tide level.

HABITAT

Salinity gradient. During the dry season, the river remains at a salinity of 100% (of sea water) until a distance of 25km AMTD and remaining above 95% until 35km AMTD. Even at the nesting beaches, between about 40 and 56km AMTD, water is 30% and the rivers are not navigable beyond these beaches in the dry season. In the wet season, water at the river mouth is still not at 100% even when the river is low.



Human impacts. The majority of human impacts on the river that were observed were the result of subsistence farming and small-scale logging. Farming along the river is mostly of mixed

gardens of fruit and vegetables, with some wet-rice cultivation also occurring. The majority of logging observed was of *Melaleuca leucadendron* but larger forest trees were also occasionally moved along the river.

Subsistence fishing is the other main source of human disturbance along the river. Fishing methods include hooks, bamboo traps, gill nets, and a variety of other manned and non-manned nets. Among these other nets are *Pong-pang*, large nets placed across the river in the wide estuarine area, which rely on tidal and river currents to trap animals and are a major cause of *Batagur* mortality (Platt et al, *in press*; Kalyar and Heng, 2002). Observed once in the upper regions of the Kaaong river (50km AMTD) was electro-fishing, which is a non-discriminant and illegal fishing method that can facilitate capture of all river animals.

Vegetation types. The primary area where *Batagur* was found to inhabit during the dry season was a tributary of the Kaaong River, called the Kompong Seila River. This river is sparsely populated and retains healthy riparian vegetation. Along the 8.5 km of this river that was surveyed, it ranges from 60m width to 10m. Average depth was 2.9m, (1-4.1), with vegetation height at approximately 4m. Salinity along this 8.5km ranged between 13333-22500ppm (38-64% of sea water) in the dry season and around 20% in the wet season in times of low flow. The main tree species here are the fresh-water mangrove (*Barringtonia racemosa* and *B. asiatica*), and *Syzygium* sp.

Along the intermediate part of the river (15-30km AMTD), the dominant mangrove is the mangrove apple (*Sonneratia caseolaris*), which is found in association with sea holly (*Acanthus ebracteatus*), hibiscus (*Hibiscus tiliaceus*), and paperbark (*Melaleuca leucadendron*).

Near the river mouth, the dominant mangrove species are *Rhizophora* sp., *Osbornia occidonta* and *Avicennia* sp.

Nesting beaches. Kalyar and Heng (2002) noted the presence of 15 sandy beaches along the Sre Ambel and Kaaong rivers and Platt et al (in press) noted that only 12 of these have been used by *B. baska* (Appendix IV). Five of these beaches were reported with nests in 2001-2002 (Along Tamor, Ksaik Ta Aok, Ksaik Chaot, Ksaik Seila, Mounpiam Sre Kondol). In the 2002-2003 nesting season, five beaches had nests on them, but only three of these (Ksaik Chaot, Ksaik Seila, and Mounpiam Sre Kondol) had been nested on the previous year. In addition, a destroyed nest was seen on Ksaik Boh Toh, on the Sre Ambel River and a nest was found on Ksaik Onlooung Yuen. When the nest was found on Ksaik Onlooung Yuen, 30 old shells were found in the sand, probably from an undetected nest the previous year.

All of the beaches lay within tidal limits and ranged from 43 to 56 km AMTD. Maximum beach height ranged from 135-227cm above high tide (mean = 162.125) and maximum beach width ranged from 800-2230cm from high tide mark (mean = 1270). Average slope of these beaches ranged from 0.8/10 to 1.9/10 or 4.6˚ to 10.8˚ from horizontal. Grasses, with varying distance to forest beyond the grass, predominantly surround the beaches. While depths of the river can be less than a meter in areas during the dry season, several areas exist where the water remains deep throughout the year. The deepest water adjacent to beaches ranged from 140 to 690cm and minimum width of river adjacent to beaches ranged from 10 to 30m.

Several beaches were connected to areas of flat, bare dirt and in one instance in the 2001-2002 nesting season, at Ksaik Seila; Batagur utilized this for nesting. Disturbance observed on the beaches varied from negligible to high disturbance. Two beaches (Along Tamor and Ksaik Ta Aok) are connected to pathways used by villagers and cattle to access the river. Another beach (Ksaik Onlooung Yuen) is connected to a road and car tracks are regularly seen.

It is likely that when population size of *Batagur* was large, all available beaches were used for nesting. No one feature appears to be drawing preference for nesting, instead a variety of beach types are being used, including non-sandy areas.

Average temperatures, at 50cm depth, ranged from 27.9 to 34.3°C. The coldest beach has not been recorded to have nesting on it and is shaded by trees for much of the day. The hottest beach measured was predominantly of hard dirt and could only be measured at 40cm depth. Accordingly, this beach measured an average of 34.3°C but had been nested on the past two years but depth of nest cavities was not measured in these years but was reported to be around 50cm. Without these outliers, the temperature range is 29.3 to 30.6°C

POPULATION

In the past year and a half, seven *Batagur* have been obtained from local fishermen or traders. This includes one adult male, one adult female, and five juveniles less than 20cm CL (Appendix III). Of the seven nests that were located in 2003, based on track measurements, it is possible that four or less individuals laid them.

Growth. Three of the four non-hatchling juveniles were available for measurement (the fourth was claimed by a Department of Fisheries official in Koh Kong town). Growth rings were measured and, assuming that these are annual, growth rates averaged 20mm per year (range 15-36). With the drop-off in growth at maturity as estimated by Moll (1980), and lack of subsequent fusion of scutes in the large female, she was probably about 30 years of age, with a large size but no fusion observed. Similarly, the male, at 51cm was near maximum length but didn't yet exhibit scute fusion. The shell of a female killed by a local in 2002, was smaller than the released adult female but fusion of vertebral scutes two, three, and four had already taken place.

Of three juveniles that could be measured, one with only one scute ring, the other two with three scute rings, the mean of the first growth ring was 43.5mm. The means for second and third year scute rings were 29 and 32.5mm respectively. Although long-term studies are lacking, it appears likely that these scute rings are annually deposited and are comparable to the growth rates recorded by Moll (1980). Total mean annual growth was 36.2mm/year. These values compare with the approximate 20mm estimated by Moll (1980) for wild individuals and 34.2mm measured in captive-raised individuals. Scute rings, although not a definite is a useful non-invasive tool for the estimation of juvenile turtles (Germano and Bury, 1998).

REPRODUCTION

Nesting in the season of 2002 and 2003 began with a destroyed nest found on the Sre Ambel River on 21 December. The first nest in the Kaaong river was laid on the 19th of January, which coincided with springtide, as did all subsequent nesting except for one (the infertile nest laid three days before full moon). One clutch was laid in an extreme low tide period was below the water level the next day and was successfully trans-located with 12 out of 14 eggs hatching. It remains to be seen whether the eggs of *B. baska* can withstand such inundations, but this may be another adaptation by the species to the riverine environment.

Nests. Nesting season 2002-2003 saw 8 nests discovered, one of which was not known until after the hatchlings had emerged. Only one nest was seen on the Sre Ambel River, and the three eggs had already been destroyed when found. It is possible that a predator destroyed these, but another theory goes that the mother was disturbed and crushed the eggs when retreating to the water. One of the nests was infertile, with none of the six eggs showing any development at all. Mean clutch size (n=8 nests) (± 1SD) was 10.25 ± 5.18 eggs (range = 3 to 17 eggs) compared with the previous year of 11.3 ± 4.4 eggs (range = 6 to 19 eggs). In Malaysia, Moll (1980) reported a mean clutch size of 26.4 eggs (range = 5 to 38).

The mean weight of eggs measured in 2003 (n=65) was 84.58 ± 7.49g (range = 68 to 97g) is somewhat larger than Moll's (1980) mean (n=1229) weight of 64.16 ± 6.33g (range = 43 to 80g).

Egg length was similarly larger in this study, with a mean of 70.45 ± 3.09mm (range = 61 to 79mm) compared with 65.78 ± 4.69mm (range = 50 to 81mm) (Moll, 1980).

Total nest mass (n=6) averaged 842g (261-1467), compared with Moll's measurements of nest mass (n=231), with none less than 1050g. For a female of 28kg (average estimated female size: see size estimates below), 842g represents 0.03 of body weight, comparing with the mean 0.09 ± 0.017 (range = 0.03 to 0.12) found by Moll (1980) as a normal amount.

The larger individual eggs and relatively smaller clutches indicate an investment of more resources into each egg and the accompanying greater size of each individual at the time of its emergence from the nest. Hatchling carapace length had a mean of 70 ± 2.25mm (range = 65 to 75mm). This suggests the pattern of smaller egg size and larger clutch size with latitude as described by Iverson et al (1993), when compared with Malaysia, but does not explain the difference with India, which is at higher latitudes still.

Animal size estimates. Estimates of animal size by track measurements are shown in Table 1. Error in measurement, and individual variation in locomotion limit the reliability of these estimates but it is still useful to see the approximate sizes of the animals that created the tracks and observe that almost all of these estimated sizes are relatively large for the species.

Only tracks 2, 3, 4, and 6 were associated with nests the other two nests being located after tracks had already gone from the sand.

From measurements taken from the released female, the distance between the outside of each foot was 0.84 of carapace length (CL). Weight was then estimated from the regression provided for females by Moll (1980): Wt= -29.89 + 0.098CL

Table 1: Size estimates from tracks measured in 2003

	O-O (mm)	I-I (mm)	Plastron	CL est. (mm)	Weight est. (g)
1	440	200	-	524	21
2	470	220	-	560	25
3	480	240	-	571	26
4	490		150	583	27
5	490	190	178	583	27
6	500	-	180	595	28
7	500	190	180	595	28
8	500	190	180	595	28
9	512	161	165	610	30
10	520	-	161	618	31
11	540	200	208	643	33

Note: shaded row represents the released female

In 2003, 59 of the 82 eggs (72%) laid emerged successfully from incubation. One additional hatchling began to hatch but was found dead in the nest when the other hatchlings emerged. One nest, with seven eggs, was infertile. These eggs were larger after incubation, having gained about two millimeters in length and width.

With one infertile clutch, it makes it seem that if these females are laying two or three clutches that there were very few females nesting and may be even less males to fertilize them. Without actual observation and marking of nesting females, it is not possible to confirm multiple clutches within the nesting season. As two or three clutches have been observed in elsewhere for *B. baska*, it is alarming that the eight nests may represent as few as four individuals.

Eggs were observed between 12 hours and 10 days after being laid. The concurrent growth in the patch of attachment matched that described by Moll (1980). 24 hours after laying only 80% had developed patches. The majority of these were completely infertile and were found at the time of emergence to not have developed at all. 5% (3 eggs) developed patches after being observed, less than 24 hours after laying. Moll (1980) found that viable all eggs had developed the white patch after 24 hours. Thus, better estimates of fertility may be made if examination of eggs is more than 24 hours after laying.

Incubation times observed between 119 (n=4) and 123 days (n=1) are longer than those reported from other areas (one nest was infertile and another nest was not detected until it hatched). It seems likely that hatching took place some time before emergence, as all hatchlings had completely absorbed the extra-embryonic membrane. The previous year, nests were dug up at 100 days and all eggs had already hatched. Emergence, as reported by locals, usually coincides with the rise in river level that accompanies the onset of the rainy season. This year may have been a later than usual rainy season, thus explaining the later emergence. This year, four of the nests were laid on the one beach (Ksaik Chaot); the other three intact nests were trans-located by local staff to the same beach, thus providing all nests with the same temperatures and the matching incubation time. From temperatures measured at 50cm depth of all beaches, Ksaik Chaot proved to be one of the colder beaches (mean 29.5 ± 0.49°C), thus giving a longer incubation than other beaches may have if eggs had been left intact. Should *B. baska* possess temperature-dependent sex determination (TSD), this will have severe effects on sex ratio, producing a male-biased population. There is, however, only circumstantial proof that the species does have TSD (Blanco et al, 1990). Closely related species *Kachuga smithii* and *Siebenrockiella crassicollis*, however, do not have TSD but ZW (female heterozygosity) and XY (male heterozygosity) respectively (Ernst et al, 2000).

Fig. 2. Hatchlings generally emerged at nighttime although several of the nests opened their own nests in daylight.

At the time of emergence, all hatchlings had absorbed their extra-embryonic membrane, or yolk sac. Two of these animals still possessed a slight split in the abdominal scutes of the plastron where the yolk sac formerly protruded.

Predation. One nest in the 2002/3 nesting season was found destroyed. The original theory placed by the local conservation team was that a mongoose predated the nest. A later theory was that the female was disturbed while nesting and subsequently crushed the eggs in her escape. There were only three eggs in the nest, so the latter theory seems more probable but both theories are simply conjecture.

Abnormalities. Abnormalities were observed in the carapacial scute count and one individual exhibited a curved shell that didn't flatten out in the following 20 days before it was released. Five individuals exhibited extra carapacial scutes, ranging from an extra vertebral to five extra scutes, including vertebrals, costals, and marginals.

Rainfall and hatching. The first hatchlings emerged without any great amount of rain preceding it (20 mm the previous week). Following hatchings emerged after 92mm of rain fell the day prior. The similar incubation times tend to devalue the local belief that the hatchlings only emerge after heavy rain and when the river rises. The last hatchlings did, however emerge as the river began to rise (rising 1.5m in three days).

MOVEMENT

Local fishermen report that *Batagur* occurs in the estuary, less than 30km AMTD in the wet season. They additionally report that the turtles move upstream after the dry season has begun and the salinity gradient moves further up. The fishermen in this area, around 35km AMTD, often see individuals of all sizes feeding at night on the fruit of "Chum poo", the mangrove *Sonneratia caseolaris*. The movement upriver appears to encompass all individuals in the population as they seek moderately fresh water to regulate their water intake (Davenport et al, 1986)

Four individuals with radio transmitters were released upstream at a beach (49.8km AMTD) with an adjacent deep pool on March 5, 2003. This was the area where fishing activity was continually monitored. The capture area was not known for two of the animals and thus, the release site was deemed suitable for release.

Radio tracking. In moving from the release site, the adult male was the fastest, with the adult female more cautious and the two juveniles taking much longer to move downstream. The adult male (#6) moved almost 3.5km in 27 hours. Within the next 21.5 hours, this animal must have moved the remaining 9 km to where the salinity of the water prevents a signal reaching the receiver. The adult female (#1) was more cautious, only moving at night time high tides, spending daylight hours in deep holes of around 5 meters depth. For the first two and a half days, she remained in the deep pool by the release site. In the next night high tide, she moved a

kilometer downriver to the next deep pool, where she spent the next day. At high tide the next morning before sunrise, she moved an additional kilometer, moving down into the more saline water in the following days. Almost a month later, the female was tracked to an area of relatively high salinity (22000ppm or ~60% of sea water, 40km AMTD).

The two juveniles were still within the relatively fresh water 17 days after being released. At this time one of them, who had initially moved upriver was three kilometers straight distance, or 4.5 km river distance.

In the following months, a total of 200 hours were spent, covering a distance of 500km, with 3 captures and 7 interference signals. The two most informative signals were of the adult female who surfaced for approximately 10 seconds two hours apart. This was a month after the release and she had remained in the upper reaches of the river. Although the animal wasn't sighted, signal disappeared the when she sumberged. This point was at UTM 48P 0375495E 1225187N, on the Kompong Seila River at 39km AMTD. Salinity at this point was 95% of seawater.

The large distances, combined with difficulty in tracking more than one animal, made radio-telemetry in saline water ineffective. In future, constant tracking of one animal would allow greater effectiveness of tracking with radio-telemetry. Alternatively, sonic telemetry may provide a simpler alternative, negating the effect of saline water.

FUTURE DIRECTION

The major difference found in Cambodia's population of *B. baska* is that the size of eggs and hatchlings are larger and total nest mass smaller than observed elsewhere. This may be a response to small population size, although the data from the Sunderbans of India and Bangladesh also come from a very small population. Alternatively, this may simply be a form of variation as the overlap between the regional figures occurs.

Conservation measures can be applied using this information in allowing hatchlings full incubation time before being released into the river, thus allowing them to be fully ready to cope with the habitat. The importance of times of migration can be applied to patrolling of fishing grounds along this route. This may be extended to the upstream areas where animals appear to remain during the dry season.

Activities for the next year will include continuing monitoring of the habitat and continued capture and radio-tracking efforts. In conjunction with WCS's local conservation team, monitoring of nests will include data loggers for complete nest temperature records and hatchlings will be internally examined for sex. This will contribute to answering whether *B. baska* has TSD or not. It is proposed that sonic telemetry will be used for further movement studies.

The use of sonic telemetry is proposed to overcome the difficulties found with radio tracking and to provide much-needed information on feeding grounds and migrations. The local conservation team will also commence patrolling of the rivers, gathering information on fishing methods and densities and interviewing about sightings and knowledge of *B. baska*. In addition, a GIS analysis of suitable habitat for *B. baska* will be carried out prior to a river survey for other populations of the species.

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Appendix I: Turtle species identified from interviews with former hunters

Scientific Name	Local Name	Meaning of Local name	Estimated size
Amyda cartilaginea	Gonteeay	Softshell turtle	
Batagur baska	Ondauk Luong	Royal turtle	30kg
Batagur baska	Ondauk Sorsei	Refers to the royal law protecting this species	
Cuora amboinensis	Ondauk Butmook	Closed-face turtle	1kg
Cyclemys pulchristriata	Ondauk Kaek	Crow turtle	
Cyclemys pulchristriata	Ondauk Kul		
Heosemys grandis	Ondauk Kromooun	Honeycomb turtle	1-2kg
Heosemys grandis	Ondauk Ontheeah		2kg
Heosemys grandis	Ondauk Saom		8kg
Hieremys annandalei	Ondauk Aek		
Hieremys annandalei	Ondauk Sarkol	Motionless turtle	
Indotestudo elongata	Ondauk Prich	Bamboo turtle	1-2kg
Manouria impressa	Ondauk Dombouk		3-4kg
Pelochelys cantorii	Gonteeay	Softshell turtle	
Siebenrockiella crassicollis	Ondauk Kaek	Crow turtle	1.5kg

Note: often one common name applied to more than one species or different common names given to different sizes of one species

Appendix II: Wild turtle sightings (includes shells from locals who caught them nearby)

Species	River	UTM	Date
Amyda cartilaginea	Stung Poong Rool	0369810 1240023	14 Nov 02
*Cyclemys pulchristriata**	Stung Poong Rool	0368243 1239670	14 Nov 02
*Heosemys grandis**	Stung Poong Rool	0369531 1240182	18 Jan 03
*Indotestudo elongata**	Stung Poong Rool	0368243 1239670	14 Nov 02
*Siebenrockiella crassicollis**	Kaaong		
Siebenrockiella crassicollis ♂	Kaaong		
Hieremys annandalei ♂	Kaaong		
Cyclemys pulchristriata juve	Kaaong		

*Shell only

Appendix III: Batagur baska measured in this study (excludes hatchlings)

#	Source	Sex	Weight (g)	CL (cm)	CW (cm)
1	Speared: Kaaong river	Female	31000	61.2	50.1
2	Fisherman: Kaaong river	Juvenile: unknown	760	17.5	15.5
3	Fisherman: Kaaong river	Juvenile: unknown	420	14.2	13.1
4	Fisherman: Kaaong river	Juvenile: unknown	800	18.3	15.9
5	Speared: Kaaong river	Juvenile: unknown	285	12.6	11.7
6	Trader: origin unknown	Male	18000	48.3	40.0
DoF1	Killed on Kaaong	Female	4957	52.5	42.5

Note: DoF1 is a shell only, held in the Department of Fisheries in Phnom Penh

Appendix IV: Nesting beach locations and known nesting records.

Local Name	UTM	AMTD (km)	2000	2001	2002	2003
Sre Ambel River						
Ksaik Boh Toh 1	48 P 0365395 E 1247630 N	43.6		1		1
Ksaik Boh Toh 2	48 P 0365456 E 1247659 N	43.7		4		

	48 P 0361272 E 1254150 N	56	2			
Kaaong River						
	48 P 0373526 E 1226187 N	39	1	2 (1)		
	48 P 0377218 E 1230989 N	48.7				
Ksaik Chaot	48 P 0376845 E 1232076 N	49.8			**1** (2)	**4** (1)
Ksaik Seila	48 P 0376501 E 1232024 N	50.3	1		**2** (4)	**1*** (5)
Spian Chrose	48 P 0377335 E 1231825 N	51.5	2		(4)	
Ksaik Ta Aok	48 P 0377771 E 1233138 N	52.8			**1*** (1)	
Onlooung Yuen	48 P 0380813 E 1234400 N	56.2				**1***
Mounpiam Sre Kondol	48 P 0378885 E 1233267 N	53.2			1 (2)	**1***
Along Tamor	48 P 0378759 E 1233563 N	53.5			**1*** (1)	

Note: Bold numbers are uncollected, unpredated nests; regular numbers represent collected or predated nests; numbers in brackets represent tracks seen on the beach without an associated nest; * represents nests that were trans-located