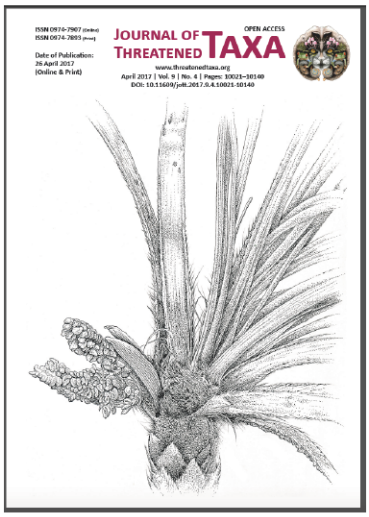

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ARTICLE

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CONSERVATION OF THE SOUTHERN RIVER TERRAPIN *BATAGUR AFFINIS* (REPTILIA: TESTUDINES: GEOEMYDIDAE) IN MALAYSIA: A CASE STUDY INVOLVING LOCAL COMMUNITY PARTICIPATION

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Abstract: It is evident that the participation of the local community plays a crucial role in the success of a conservation project. Despite initiating and leading the oldest *Batagur affinis* conservation project in Malaysia since 1967, which involved egg protection, head starting and reintroduction programs, the Department of Wildlife and National Parks did not involve the participation of the local community. This study provides the first account of the involvement of local villagers in *B. affinis* research and conservation project in the Kemaman River, Terengganu, Malaysia. As a result of involving this group of local villagers, the Village Development and Security Committee was recruited to be involved in the conservation project. From 2012 to 2016, we hand captured and processed 102 post-nesting females. The Schnabel mark-recapture method estimated at least 186 wild female *B. affinis* in the river. We collected 2,542 *B. affinis* eggs from 205 nests for incubation, and produced 1,723 hatchlings (mean hatching success 67.8%). Survivorship of head started *B. affinis* hatchlings in captivity ranged from 96.7–100 % among cohorts. Head started hatchlings recorded a 467% increase in body mass and 90% increase in straight carapace length. We reintroduced 1,690 *B. affinis* juveniles into the river. We also initiated a symbolic adoption program to raise funds and ensure the sustainability of the conservation project. This study proves that local communities are capable of managing their own resources, given sufficient training in conservation techniques.

Keywords: *Batagur affinis*, community, conservation, head starting, Kemaman, Malaysia, population, reintroduction, Southern River Terrapin, status.

Abbreviations: ANOVA - Analysis of Variance; BM - Body mass; DID - Department of Irrigation and Drainage; DWNP - Department of Wildlife and National Parks; LSD - Least Significant Difference; MANZA - Malaysia, Australia and New Zealand Association; MYR - Malaysian Ringgit; PE - Polyethylene; SCL - Straight carapace length; SCW - Straight carapace width; US$ - US Dollars.

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Competing interests: The author declares no competing interests.

Author Details: Pelf-Nyok Chen has been involved in the field of turtle research and conservation since 2004. Her research focuses on the nesting, reproductive and hatchling ecology and conservation of the Southern River Terrapin *Batagur affinis*. In 2011, she co-founded Turtle Conservation Society of Malaysia, a non-profit and non-governmental organization dedicated to turtle conservation in Malaysia.

For **Malay abstract** see end of this article.

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INTRODUCTION

The Southern River Terrapin *Batagur affinis* is a freshwater turtle that is listed as one of the top 25 most Critically Endangered tortoises and freshwater turtles in the world (Turtle Conservation Coalition 2011). The species is found only in southern Thailand, Cambodia and peninsular Malaysia (Praschag et al. 2007, 2008; Moll et al. 2015). Wild populations of *B. affinis* have been extirpated and are depleted in much of the species' former range in southern and southeastern Asia, which extended into the Mekong delta in Vietnam and Tonle Sap in Cambodia (Moll 1980; Platt et al. 2003; Kalyar et al. 2007; Moll et al. 2015) and Malaysia currently seems to harbor the only viable wild populations of this species (Platt et al. 2006). In peninsular Malaysia, wild *B. affinis* populations have been documented in the Kedah and Perak Rivers on the west coast (*B. affinis affinis*), and in the Terengganu, Dungun (Edward Moll unpub.), and Setiu Rivers on the east coast (*B. affinis edwardmolli*) (Soh 2004; Chan & Chen 2011).

The decline of *B. affinis* populations in Malaysia is attributable to various forms of natural, accidental and deliberate destruction, overexploitation and alteration of habitat (Moll et al. 2015). Besides being hunted for its meat (Eng Heng Chan & Pelf Nyok Chen unpub.), *B. affinis* is also pursued for its eggs and juveniles (Moll 1980). Its distribution in the major rivers in the states of Kedah, Perak, and Terengganu has made it a good source of income and food for local villagers. Individuals are occasionally captured in fishing nets set across rivers to catch freshwater fish. Terrapins may drown in the nets or, if caught alive, are either released or consumed (Eng Heng Chan & Pelf Nyok Chen unpub.).

In Malaysia, *B. affinis* is listed as a 'Totally Protected' species, and according to Wildlife Conservation Act 2010, it is illegal to kill, destroy, possess, trade or harass *B. affinis*, regardless of whether it is mature adults, juveniles, hatchlings, or eggs (Image 1).

There is a growing body of evidence that community participation plays a crucial role in promoting conservation success (Campbell & Vainio-Mattila 2003; Ghimire et al. 2004; Strusaker et al. 2005) because these projects see the local rural people as the solution rather than the problem (Horwich & Lyon 2007). By combining the knowledge gained through scientific investigations, with the insights of the local population, we stand a much better chance of succeeding in recovery efforts (Bird et al. 2003). The inclusion of local people in resource management can provide many benefits. Stronger conservation alliances based on the mutual sharing of knowledge, along with the combination of local science and structured monitoring, may produce the greatest conservation benefits (Bird et al. 2003). Community-based conservation projects have been initiated in numerous wildlife conservation projects (Vieitas et al. 1999; Nichols et al. 2000; Bernstein & Christiansen 2011; Hamilton et al. 2011; Şekercioğlu 2012). In recent years, community-based conservation projects have been carried out across numerous disciplines, i.e., wildlife reintroductions, ecotourism, conservation of wildlife, mangrove forests and wetlands, creation of protected areas, and to varying degrees of success (Horwich & Lyon 2007).

Image 1. Adult Southern River Terrapin *Batagur affinis*, on the bank of Kemaman River in the east coast state of Terengganu, Malaysia.

The involvement of the local community is necessary in *B. affinis* conservation due to conflicts in resource utilization (i.e., consumption of *B. affinis* eggs for their alleged aphrodisiac properties, the use of indiscriminate fishing gear for their own convenience, etc.). It also ensures that the local community will protect their resources, and in the long term, ensures the sustainability of the project. While various *B. affinis* conservation efforts have been carried out by the Malaysian Department of Wildlife and National Parks (DWNP), including egg protection programs, head starting, captive breeding and reintroductions, none of these involved the participation of the local communities.

Despite *B. affinis* being listed as Critically Endangered and although Malaysia has been hypothesized to harbor the remaining viable wild populations of the species (Platt et al. 2006; Moll et al. 2015), there has been no systematic attempt to quantify the sizes of *B. affinis* populations in Malaysia. Previous capture-release surveys conducted in the Perak River in the late 1970s showed no consistent population estimates of wild

B. affinis and too few collections were made in the Terengganu River to provide any population estimates (Moll 1980). Population sizes were estimated based on the number of eggs collected for incubation, rather than from a direct count of individuals (Moll 1980).

The DWNP recognized the critical roles played by *B. affinis* egg protection and head starting programs, which led to the establishment of three head starting facilities in Peninsular Malaysia since 1967 (Edward Moll unpub.). Other egg protection programs have also been initiated in the Dungun and Setiu River (Chan & Chen 2011) populations; however, in all these conservation programs, a continued decline in the populations has been recorded (Table 1), except in 2008, where 99 nests from 95 females were recorded, representing the highest nest numbers since monitoring in the Terengganu River began in 1977 (Chan & Chen 2011; Eng Heng Chan & Pelf Nyok Chen, unpub.). The DWNP has also been reintroducing head started *B. affinis* into the wild, but the success of these reintroduction programs have not been assessed.

The goal of this study was to document the participation of a local community in a *B. affinis* research and conservation project in the Kemaman River, Malaysia. It was demonstrated that the participation of the local community is not only a viable conservation strategy, but also ensures the sustainability of the *B. affinis* conservation project, and both the ecological and non-ecological achievements and milestones of the project were highlighted. Specific objectives were to document: (1) the population size of wild, female *B. affinis*; (2) the egg protection and head starting programs; and (3) the reintroductions of juvenile *B. affinis* into the Kemaman River.

Table 1. Number of wild *Batagur affinis* eggs deposited in the Terengganu, Dungun and Setiu Rivers in Terengganu, Malaysia, since 1977.
***Unpublished data provided by the Malaysian Department of Wildlife and National Parks. **Chan & Chen (2011).**

Year	Terengganu River*	Dungun River*	Setiu River**
1977	141	–	–
1978	629	–	–
1979	838	–	–
1980	398	–	–
1981	982	–	–
1982	905	–	–
1983	976	–	–
1984	863	–	–
1985	539	–	–
1986	531	–	–
1987	558	–	–
1988	133	–	–
1989	–	–	–
1990	108	348	–
1991	164	729	–
1992	391	945	–
1993	709	598	–
1994	806	856	–
1995	619	669	–
1996	1,172	422	–
1997	949	481	–
1998	1,064	388	–
1999	1,020	472	–
2000	1,221	160	–
2001	1,251	22	–
2002	1,132	–	–
2003	300	–	–
2004	367	–	847
2005	585	–	752
2006	769	564	685
2007	669	337	304
2008	1,373	165	661
2009	–	–	438

MATERIALS AND METHODS

Study Area

Kemaman is the southern-most district in the east coast state of Terengganu in Peninsular Malaysia. The Kemaman River, measuring approximately 166.7km in length, is the third longest river in Terengganu (Fig. 1). This study was conducted in Pasir Pok Yok ($4^0$14'32.1936"N & $103^0$17'1.9536"E), one of the major *B. affinis* nesting banks in the Kemaman River. Pasir Pok Yok measures approximately 250m in length, and approximately 30m at its widest. It is backed by a palm oil plantation and is not accessible by road. Outside of the *B. affinis* nesting season, this sand bank is largely unused by the local fishermen.

River depths range from three to seven meters. The Kemaman River merges with the Chukai River at the estuary and both flow into the South China Sea. There are approximately 15 sand banks along the Kemaman River, but Pasir Pok Yok, which is located near Kg. Pasir Gajah, is the major *B. affinis* nesting bank in the river (Chan & Chen 2010). It is located approximately 30km

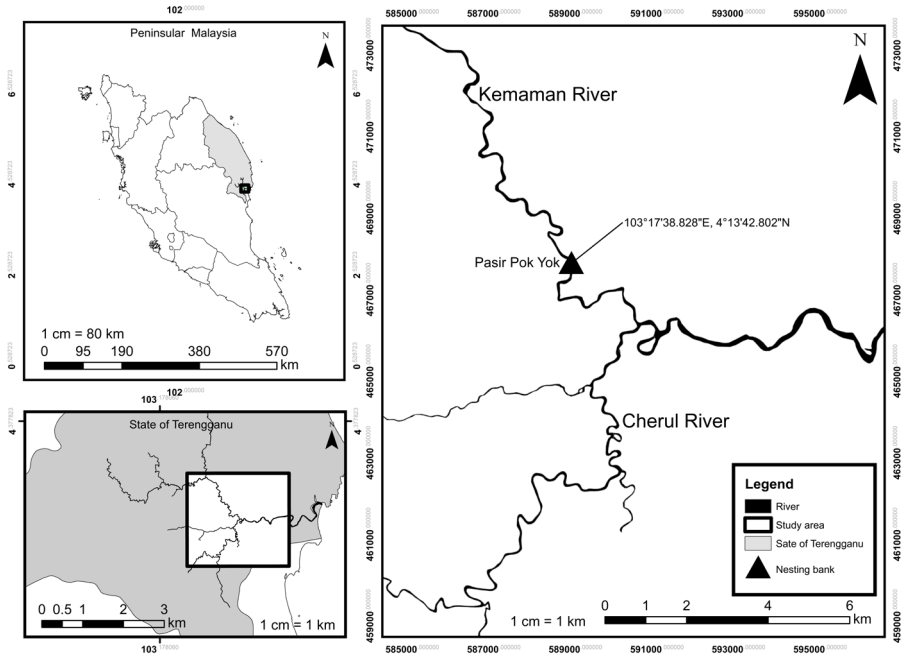

Figure 1 . The Kemaman River, showing Pasir Pok Yok, one of the major nesting banks for the Southern River Terrapin, *Batagur affinis*. The inset is a map of Peninsular (West) Malaysia, showing the location of the east coast state of Terengganu.

from the estuary. A dam was erected 5km downstream from Pasir Pok Yok for paddy irrigation as well as to provide freshwater supply to the residents in the nearby town of Chukai, with a population of more than 160,000 (Malaysia 2010).

Participation of local community

Five local villagers were recruited at the initiation of the *B. affinis* conservation project. For decades, these villagers have been collecting *B. affinis* eggs for their own consumption, which they considered a local delicacy (Mohd. Nasir b. Abdul Hamid pers. comm. October 2010). However, after learning about the proposed conservation efforts, they agreed to collaborate on this work and to give up their own consumption of *B. affinis* eggs in the future.

After oviposition, we hand-captured the females and brought them to the campsite. At the campsite, local villagers were trained to weigh and measure the straight carapace length (SCL) and straight carapace width (SCW) of the *B. affinis* (Image 2). They were taught how to microchip the females as a permanent method to identify the individuals. As we measured and microchipped the female, two other local villagers retrieved the eggs and placed them into a bucket lined with sand. This was to prevent the eggs from moving around during transportation to the hatchery the next morning.

There has been much debate over the effect of moving nests from their original location to modified environments (Mrosovsky 2008). Such nests may experience differences in hatching success (Garcia et al. 2003) and sex ratios (Dutton et al. 1985) compared with those left in situ. We transferred all *B. affinis* eggs to the hatchery because the eggs cannot be left in situ on the nesting bank due to the presence of predators such as wild boars and monitor lizards (Wazel b. Mahad pers. comm. October 2010). Furthermore, it was likely that other local villagers would poach the eggs that were left on the nesting bank due to the high demand for the eggs (Mohd. Zulkifli b. Mohd. Noor pers. comm. October 2010). It was more practical to incubate the eggs in a hatchery in the village.

Image 2. Local villagers involved and trained in the various aspects of the *Batagur affinis* research and conservation project in Kemaman, Terengganu, Malaysia.

The next morning we transferred all the *B. affinis* eggs from the buckets into the hatchery and marked and labeled all the nests accordingly. We hired the same villager to monitor the incubation process by checking the nests at least twice daily. When the *B. affinis* hatchlings emerged, the villager was trained to mark, weigh and measure all the hatchlings before placing them into polyethylene (PE) water tanks for head starting.

Population studies

Population studies were conducted during the *B. affinis* nesting season, from February to March 2012 to 2016. Beginning on 1 February, a group of five local villagers and the author proceeded to the *B. affinis* nesting bank every evening. Upon arrival at the nesting bank, we began to patrol the nesting bank for nesting females. Once a nesting female was detected, we observed the nesting process at the edge of the vegetation, and sometimes behind makeshift blinds; females were allowed to nest undisturbed.

After the nesting process was completed, we hand-captured and brought the female to the camp site, where we checked her for injuries and abnormalities, recorded her body mass with a 50kg spring balance, and measured her SCL and SCW with a pair of 80cm stainless steel calipers. Then, we scanned her for the presence of a microchip. In the absence of a microchip, we assigned a new microchip (ProID). We cleaned the point of insertion, sanitized it with alcohol and implanted a passive integrated transponder (AVID, Avid Identification Systems, Inc., Norco, CA, USA) subcutaneously with a disposable syringe into the left inguinal region of the female. Then, we disinfected the point of insertion with alcohol and iodine. Microchips have been used for the identification and monitoring of various wildlife, e.g., in tortoises (Hellebuyck et al. 2013), snakes (Webb & Shine 1998), penguins (Renner & Lloyd 2000), and birds (Granzow 2008).

Processed females were marked for visual identification with a running alphabet letter (A, B, C, etc.) on the fourth vertebral scute using a non-permanent correction pen. In the event that any microchipped females returned to nest on a subsequent night we could eliminate the repetitive processing.

Head starting techniques

We maintained the head started *B. affinis* in 800L polyethylene (PE) water tanks, in groups of approximately 100 hatchlings. A local villager was trained to feed the hatchlings twice a day, i.e., once in the morning at about 0900, and once in the evening at about 2100. Water was changed twice daily, i.e., once before the first feeding, and once before the second feeding. We placed pieces of bricks into the tanks to serve as "platforms" for the hatchlings. As the hatchlings grew bigger, we increased the water level in the tanks to provide them more space to move about.

Hatchlings were fed with commercially available fish pellets daily. We supplemented the diet with water spinach (*Ipomoea aquatica*), water hyacinth (*Eichhornia crassipes*) and Chinese mustard or Kai Choi (*Brassica juncea*) thrice a week. A month before the hatchlings were released, we fed them all with only *I. aquatica*, *E. crassipes* and *B. juncea*. We weighed and measured all hatchlings before they were reintroduced into the Kemaman River.

Annual reintroductions events

We co-organized the annual reintroduction events every September with the local community. All head started *B. affinis* juveniles of the current cohort were released into the Kemaman River. Symbolic adoptions were introduced and members of the public were encouraged to financially support the conservation project to ensure its sustainability.

Data analyses

The population size of wild, female *B. affinis* in the Kemaman River was estimated using the Schnabel mark-recapture method because it allows for more than two capture-recapture encounters (Krebs 1989). For the calculation of growth of *B. affinis* in captivity, the measurements of some hatchlings were not considered due to their deformed or under-developed carapace (e.g., carapace that was not fully opened, and was still constricted to the shape of the terrapin egg). One-way ANOVA and Fisher's Least Significant Difference (LSD) test were used to compare the differences in the morphometric measurements of the females among years. All statistical analyses were run using StatPlus:mac PRO with alpha set at 0.05 for all statistical procedures.

RESULTS

Participation of the local community

For their participation during the *B. affinis* nesting season, the project compensated the local villagers with a one-month allowance. Four of these local villagers have asserted, on separate occasions, that they have stopped poaching *B. affinis* eggs. After one *B. affinis*

nesting season, the local villagers called themselves the 'Terrapin Guardians'.

As a result of recruiting the "Terrapin Guardians," we had the opportunity to invite the Village Development and Security Committee to be involved in the *B. affinis* project. Our initial cooperation was in the form of co-organizing our first *B. affinis* reintroduction event in 2012. Subsequently, the Village Committee became gradually invested in the project. For example, the Committee members assisted in the construction of our new hatchery in 2014, as the old hatchery—which was built on a low budget prior to the initiation of the project in 2011—was beginning to give way.

In 2016, the Village Committee had offered us the use of a utility room adjacent to the Community Hall, which we could convert into a Mini Terrapin Museum. This was evidence that the Village Committee was taking the collaboration seriously, and wanted to contribute to the *B. affinis* conservation project.

Table 2. Summary data on adult female *Batagur affinis* captured from 2012 to 2016 in the Kemaman River, Terengganu, Malaysia. Values for number of gravid females (N), body mass (BM), straight carapace length (SCL) and straight carapace width (SCW) are given as mean ± standard deviation (SD).

	2012	2013	2014	2015	2016
N (new captures)	58 (58)	19 (13)	23 (9)	16 (10)	16 (12)
BM (kg)	25.1 ± 2.8	25.9 ± 2.5	26.5 ± 4.0	25.1 ± 2.5	25.9 ± 4.3
SCL (cm)	55.2 ± 2.8	54.1 ± 2.1	54.2 ± 3.8	53.1 ± 2.0	53.9 ± 3.0
SCW (cm)	43.1 ± 2.4	41.6 ± 1.4	42.5 ± 3.0	41.4 ± 1.7	41.7 ± 2.5

Table 3. A summary of the number of *Batagur affinis* nests, eggs and hatchlings produced as a result of the participation of the local community from 2012–2016 in the Kemaman River, Terengganu, Malaysia.

	2012	2013	2014	2015	2016
Total no. of nests	97	29	27	24	28
Total no. of eggs	1,135	369	346	335	357
No. of hatchlings	712	275	243	257	236
Hatching success (%)	62.7	74.5	70.2	76.7	66.1

Population estimates

We captured and processed a total of 102 post-nesting female *B. affinis* from 2012 to 2016 (Table 3). Using the Schnabel mark-recapture method, a total of 186 wild female *B. affinis* in the Kemaman River was estimated (95% CI; 127–273).

Average body mass of the female *B. affinis* was 25.0kg (SD = ±3.0) (range 18.8−33.5 kg). The females averaged 54.6cm (SD = ±2.8) (range 47.5−60.2cm) in SCL and 42.4cm (SD = ±2.7) (range 29.0−48.3 cm) in SCW. There was no significant difference in body mass, SCL and SCW of the female *B. affinis* among years.

Egg protection program

In 2012, we collected 97 *B. affinis* nests for incubation. The following year, we recorded a drop of approximately 70% and only managed to collect 29 nests. Subsequently, we collected a consistent number of nests from 2013 to 2016 (Table 3). Throughout the study, we have collected a total of 2,542 *B. affinis* eggs from a total of 205 nests for incubation from 2012 to 2016. Of these, a total of 1,723 hatchlings have been produced, head started and subsequently reintroduced into the Kemaman River. Without the participation of the local community, this project would not have been possible because the fieldwork required at least one researcher to spend the night on the riverbank throughout the *B. affinis* nesting season.

Head starting and reintroductions

Survivorship of head started *B. affinis* hatchlings in captivity ranged from 96.7−100 % among cohorts. Nine hatchlings of the 2012 cohort escaped (Table 4). Ten from the 2012 cohort, eight from the 2014 cohort and six from the 2016 cohort died of unknown causes.

Body mass, SCL and SCW of *B. affinis* increased over time while in captivity. Head started *B. affinis* averaged 53.8g (SD = ±7.5) and 6.7cm (SD = ±0.3) SCL at hatching (N = 554) and 305.0g (SD = ±84.2) and 12.7cm (SD = ±1.2) SCL at the time of release (N = 737). This translates to a 467% increase in weight and 90% increase in SCL. The largest head started hatchling produced to date (#1236, 591g, 15.8cm SCL at release) was from the 2013 cohort.

Between 2012 and 2016, we reintroduced a total of 1,690 *B. affinis* hatchlings into the Kemaman River. Two hundred hatchlings that were less than four weeks old were reintroduced in 2012 in conjunction with "World Turtle Day" that was celebrated worldwide on 23 May. Subsequently, all head started juveniles were reintroduced at the end of the year. While we did not perform a health screen on all the head started juveniles prior to reintroductions, we did not observe any individuals exhibiting clinical signs of disease. Reintroductions typically took place in September, prior to the arrival of the annual Northeast monsoon that influences the east coast states in peninsular Malaysia, including Terengganu.

The annual reintroduction events were public events, with the aim of increasing public awareness on the status

Table 4. Number of head started *Batagur affinis* hatchlings, survivorship, mean increase in body mass (BM), straight carapace length (SCL) and straight carapace width (SCW) during head starting from 2012 to 2016 in the Kemaman River, Terengganu, Malaysia. Some data from 2012 are missing.

	2012	2013	2014	2015	2016
No. of hatchlings head started	711	274	245	257	236
No. of hatchlings released	692	274	237	257	230
Survivorship (%)	97.3	100	96.7	100	97.5
Escaped/ Died	19	0	8	0	6
Head starting duration (weeks)	–	20	18	18	21
Mean increase in BM per week (g/week)	–	15.88	15.78	11.13	11.90
Mean increase in SCL per week (cm/week)	–	0.34	0.35	0.29	0.30
Mean increase in SCW per week (cm/week)	–	0.26	0.27	0.22	0.23

of *B. affinis* as well as the research and conservation projects carried out in the village. Every year, between 150 and 250 participants attended the release events, and these were school students, members of the public, donors who symbolically adopted terrapins, and the local communities. We put up mini exhibitions during the reintroduction events that aimed to educate the public on turtle diversity in Malaysia, our conservation efforts, and how the public could help save our terrapins.

One of the innovative fundraising programs that we initiated was the symbolic adoption program. Members of the public could help support our conservation activities by symbolically adopting a *B. affinis* at MYR 30 each. This amount was raised to MYR 35 in 2016. Every year, we invited all sponsors to participate in our reintroduction events and to release their adopted terrapins. The number of *B. affinis* symbolically adopted each year translated into a substantial amount of funds (Table 5). These funds were channeled back into the conservation project, which in turn, sustained the project.

All previous *B. affinis* reintroduction events had been reported in numerous national and international newspapers and magazines, such as the local Utusan Malaysia, Berita Harian, Sinar Harian, The Star, the New Straits Times, a few Chinese-medium newspapers, the Malaysia, Australia and New Zealand Association (MANZA) magazine, Turtle Survival Alliance magazine, etc. (Chen & Chan 2014; Anonymous 2015; Yaacob 2015; Husin 2016; Yusof 2016). The annual reintroductions have also been mentioned in various social media sites such as websites, Facebook, Instagram, and Twitter.

Table 5. Number of symbolic adoptions received and funds raised from 2012 to 2016 as part of the fund raising activity in the Kemaman River, Terengganu, Malaysia. Each symbolic adoption cost MYR 30 each, and this was raised to MYR 35 each in 2016. Results are also provided in US Dollars, based on an average conversion rate of US$ 1 to MYR 3.25 from 2012 to 2014, and US$ 1 to MYR 4.40 from 2015 to 2016

	2012	2013	2014	2015	2016
No. of terrapins symbolically adopted	48	367	334	121	580
Amount raised (MYR)	1,440	11,010	10,020	3,630	20,300
Amount raised (US$) (approximate)	443	3,388	3,083	825	4,614

The project also appeared in a 30-minute segment in a local TV program (https://www.youtube.com/watch?v=ouW6BuPbh14), as well as news clips in a few Astro (cable TV) stations (https://www.youtube.com/watch?v=Z3oulRfptXI). In 2015, the project was chosen as one of the three winners of a 'Good Story Pitch' by the Our Better World Foundation based in Singapore, and a team of videographers documented our *B. affinis* project in an 8-minute documentary (Our Better World 2015).

DISCUSSION

Community based conservation

The overarching goal of this study sought to provide the first account of the active participation of a local community in a *B. affinis* research and conservation project in the Kemaman River, Malaysia.

This study has shown that for conservation projects to be sustainable, the local communities must be involved and they must be trained to be stewards of their natural resources (Horwich & Lyon 2007). While participation does not predict behavioral and ecological outcomes (Waylen et al. 2010), this strategy was also proposed in the *B. affinis* review by Moll et al. (2015) in lieu of immediate solutions to poaching, habitat loss and sand mining that directly caused the decline of the wild populations. In fact, Horwich & Lyon (2007) documented numerous successful conservation projects that involved the participation of local communities.

One of the most important outcomes of this *B. affinis* conservation project was the formation of a group of "Terrapin Guardians" who prided themselves much with the work that they were involved with. Surprisingly, these "Terrapin Guardians," who were not very highly

educated, were able to follow instructions and perform scientific tasks in the absence of a researcher. This supports the assumption that the local community can be trained to be responsible over their own natural resources. Moreover, Waylen et al. (2010) also found that greater community participation is associated with intervention success. There are several possible explanations for this. Firstly, these local villagers had been poachers of *B. affinis* eggs for decades, and they could be more knowledgeable about the terrapins than any new researcher or conservationist; however, they may not be familiar with the science behind the conservation actions. Secondly, they felt empowered by being involved in a conservation project that helped to conserve a Critically Endangered species (Horwich & Lyon 2007).

The participation of the local community also brought about increased infrastructure to the village, such as improved roads, and a new hatchery for the conservation project; and civic pride among local villagers (Badrulhisyam B. Jusoh pers. comm. May 2015). This has led to more collaboration between the Village Development and Security Committee and project proponents in organizing community events such as "World Turtle Day" celebrations and reintroduction events. Additionally, this project has also garnered increased media attention to the local village, to the extent that the Village Committee has now adopted the *B. affinis* conservation project and has begun making plans to expand the conservation project. In May 2016, the Village Committee built a new hatchery for the project. Finally, the Village Committee also offered the project a utility room adjacent to the Community Hall, which we could turn into a Mini Terrapin Museum.

This project represents a vital partnership between the author and the Village Committee, local villagers, school students, and numerous volunteers, who share the same goal of conserving *B. affinis*, and we recognize that all involved must be a part of the solution (Bird et al. 2003). Presentations to government agencies and the public, as well as published newspaper and magazine articles have garnered support for the conservation project, ensuring the project's long-term viability (see also Buhlmann et al. 2015). The above outcomes demonstrated that while the participation of the local community is not a simple prescription for guaranteed success (Adams & Hulme 2001), they suggest that community participation promotes conservation success (Campbell & Vainio-Mattila 2003). Despite these promising findings, further work is required to ensure the sustainability of the *B. affinis* conservation project. The analysis of ethnoecological knowledge and local management practices gives precise information on how local practices interact with the population ecology of the species considered (Ghimire et al. 2004). This is important because ultimately, for any conservation project to be successful and sustainable, it has to be internally driven and motivated, and the local communities are the best people to assume the responsibilities of taking charge of their own natural resources (Horwich & Lyon 2007). This case study could serve as a reference for future *B. affinis* conservation projects that involve the local communities in Malaysia.

Population size of *B. affinis* in Malaysia

This was the first study that attempted to systematically quantify the wild, female population of *Batagur affinis* through a mark-recapture study in the Kemaman River. By microchipping the nesting females, and recapturing them in subsequent years, we found that there are at least 186 wild, female *B. affinis* in the Kemaman River. Comparatively, there were approximately 30 females in the Setiu River; between 33 and 100 females in the Terengganu River, the longest river in the state; between 10 and 30 females in the Dungun River; and between 8 and 25 females in the Perak River, the most studied population. These estimates were, however, calculated from the number of wild-laid eggs or nests collected for incubation and by taking into consideration that *B. affinis* would deposit between one and three nest holes during each nesting event (see Loch 1950; Khan 1964; Moll 1978, 1980, 1985; Chan & Chen 2011), rather than a direct count of females captured. Despite the inconsistencies in the reporting units used, these reports revealed a drastic decline of wild *B. affinis* populations throughout its range (Kalyar et al. 2007; Moll et al. 2015). For example, Platt et al. (2008) reported that according to local villagers, small numbers of *B. affinis* (then called *B. baska*) were present in Tonle Sap in Cambodia during the early 1900s, but they were now locally extirpated. Hence, the findings from this study confirms the assumption that the Kemaman River harbors one of the largest *B. affinis* populations in Malaysia and throughout its global range (Platt et al. 2006).

Very little was found in the literature on the size and age of sexual maturity for female *B. affinis*. In the first record of the natural history of *B. affinis*, Moll (1980) suggested that females appeared to mature at around 45cm. Additionally, using the von Bertalanffy Growth Model, it was estimated that *B. affinis* took approximately 22 years to reach first maturity at 51cm

(Eng Heng Chan et al. unpub.). The results from this study concur with both previous studies as the smallest post-nesting female *B. affinis* measured in the Kemaman River was 47.5cm SCL.

The present results are significant as they suggest that the Kemaman River harbors one of the largest populations of *B. affinis* in the country, and possibly throughout its range. This is important for conservation because knowledge of the status of this population provides the basis for more behavioral and ecological studies on *B. affinis*, and future conservation efforts. Further research should be undertaken to investigate the population size and demography of *B. affinis* in all the river systems in Malaysia.

Egg protection program

Prior to the initiation of this *B. affinis* egg protection program, local villagers collected all wild-laid *B. affinis* eggs for consumption. The eggs were considered a local delicacy and if sold in the market, could fetch a high price of approximately RM 5 each (US$ 1.60 in 2012). Hence, one of the initial objectives of this project was to document the *B. affinis* egg protection effort in the Kemaman River. One of the principal results of this study was that more than 2,542 *B. affinis* eggs were collected for incubation from 2012 to 2016 and this is interesting because it shows the willingness of the local community to give up consuming *B. affinis* eggs and instead incubate them for conservation purposes.

A few previous studies have documented *B. affinis* egg protection programs in various river systems in Malaysia (see Chan & Chen 2011) but this study provides the first report of such a program in the Kemaman River. We found a 70% drop in the number of nests and eggs collected from 2012 to 2013 (Table 3). There are several possible explanations for this. Firstly, it could be due to the major floods that occurred in December 2012, which was recognized as one of the worst floods in the area in recent years (Anon. 2012). In fact, 90% of the population of the village was evacuated to higher grounds (Mat Zaik b. Mohd. Yusof pers. comm. January 2013). The abnormal rise in the flood waters may have facilitated the movements of *B. affinis* from the Kemaman River over land and into unknown areas. Secondly, it could be a result of the removal of a fallen concrete bridge in the river, approximately 1.7km upstream from the *B. affinis* nesting bank. This fallen bridge had, in the past, constrained the upriver movements when female *B. affinis* migrate moderate to long distances upstream from feeding areas in the estuaries to the sand banks used for nesting (Moll 1980; Moll et al. 2015). Discussions with the "Terrapin Guardians" revealed that the fallen concrete bridge and concrete debris used to block the entire width of the river (approximately 60m), and because female *B. affinis* could not move upstream to nest on other potential nesting banks, they returned to our nesting bank throughout the nesting season (Mohd. Zulkifli b. Mohd. Noor pers. comm. May 2013). The concrete debris were removed by the authorities in 2012, and as such, in the subsequent nesting seasons, the terrapins were free to move along and nest in the other nesting banks further upriver.

Despite the drastic decrease in the number of nests and eggs, we recorded a consistent hatching success that ranged from 62.7–76.6% from 2012–2016. A possible explanation for the gradually increasing hatching success could be improved incubation techniques. In 2016, however, the hatching success dropped to 66.1% due to serious ant infestation at the hatchery. In fact, all nests undergoing incubation had to be relocated into individual buckets for the remaining incubation duration.

Nevertheless, the egg protection program has produced 1,723 *B. affinis* hatchlings in five years, which would not have been possible without intervention. Comparatively, only 1,477 *B. affinis* hatchlings have been produced from the Setiu River from 2004 to 2014 (Eng Heng Chan & Pelf Nyok Chen unpub.). This finding, while preliminary, again suggests that the Kemaman River possibly harbors the largest wild population of *B. affinis* in Malaysia. Despite these promising results, the egg protection program should be intensified, possibly to adjacent nesting banks, to increase recruitment into the Kemaman River.

Head starting and reintroductions

One of the primary objectives of this study was to head start *B. affinis* hatchlings in captivity until they outgrew the period of greatest vulnerability to predators, and then release them into the river in order to increase their survival in the wild (Heppell et al. 1996).

In this study, *B. affinis* eggs were collected and incubated in captivity, and the resulting hatchlings were released after a period of husbandry, that ranged from 18–21 weeks. My results showed that at the end of the head starting duration, *B. affinis* hatchlings showed a 467% increase in BM and 90% increase in SCL. The mean increase in BM recorded in this study (range 11.13–15.88 g/week) was consistent with that recorded by Chen (2008). The commercially available tilapia pellets that we used provided a nutritious diet and all hatchlings fed on it readily. In addition to tilapia pellets, various vegetables were introduced to the head started hatchlings to help

provide a more balanced diet (Chen 2008). None of the head started hatchlings exhibited "pyramiding" or any visible clinical diseases before they were released.

Unlike most head starting programs where animals were raised between 9 and 12 months (Heppell et al. 1996; Herlands et al. 2004; Chen 2008; Buhlmann et al. 2015), *B. affinis* hatchlings in this study were only head started for four to five months before they were reintroduced. In spite of the relatively short head start duration, *B. affinis* hatchlings were raised to a size where they would only be predated upon by apex predators in the wild. These hatchlings could not be head started any longer due to the annual northeast monsoon that affects the entire village and project site from October/November to January/February. In fact, the project site was so badly flooded in December 2012 that the entire village was at least 2.5 m under water (Anon. 2012).

Conservation efforts that emphasized ex situ techniques such as hatcheries, head starting and captive breeding require decades to ascertain whether these strategies are effective (Moll et al. 2015). Conservationists have argued that unless the underlying causes of population decline such as poaching of large adults, habitat loss, etc. are addressed, head starting and releasing large numbers of juvenile terrapins into the environment is unlikely to reverse the downward population trends (Moll & Moll 2004; Burke 2015; Moll et al. 2015).

While this study does not offer a conclusive answer to the question of whether head starting is an effective conservation tool, it does allow conservationists to reintroduce larger individuals into the river, which in turn increases their chances of survival (Pritchard 1981). It would be fruitful to pursue further research which focuses on recapturing the head started *B. affinis* in order to determine their post-release adaptability, growth and survival. However, in the setting of a community-based conservation, we demonstrated that local villagers could be trained to manage head starting programs provided they are given sufficient training.

Survivorship during captivity ranged from 96.7−100 % among cohorts. However, there were no published reports on this or a closely related species that could be used as a basis for comparison. The mortality in this project did not result from accidents or negligence (Table 4). As annual survivorship in juvenile turtles appears to increase with age due to a reduced risk of predation of larger individuals (Frazer 1992), recovery programs such as head starting attempt to ameliorate low survivorship during early life history stages by raising hatchlings in captivity and releasing them only after they reach a larger size (Haskell et al. 1996). Despite the on-going debate on the efficacy of head starting as a conservation tool, I believe that it remains an important recruitment strategy in the absence of immediate solutions to causes of population declines.

Approximately 1,690 *B. affinis* hatchlings have been reintroduced into the Kemaman River from 2012–2016. Contrary to common practices where individuals were repatriated or relocated to a site where populations have been extirpated (Seigel & Dodd 2000), these hatchlings were released into the same locality where their eggs were laid. However, the efficiency of the head starting and reintroduction programs will not become apparent until the survivors breed as adults over 22 years later (Horwich & Lyon 2007; Eng Heng Chan et al. unpub.). Similar reintroduction programs that were successful were previously reported (Bell & Parsons 2002; Herlands et al. 2004; Buhlmann et al. 2015).

Our annual reintroductions involved mostly the local communities and included activities that spread conservation awareness as well as raised funds. The reintroduction events were heavily publicized and school children and members of the public were encouraged to participate. We also demonstrated to the local community the numerous benefits of conserving *B. affinis*. An example of another such program was reported by Wood & Herlands (1997) and Herlands et al. (2004) for Diamondback Terrapins in New Jersey, USA. These reintroductions provide an important avenue for promoting conservation, raising public awareness, educating the public (Stuart 1991; Lindburg 1992; Rahbek 1993; Wiese et al. 1996) and raising funds (Snyder et al. 1996; Wiese et al. 1996). Our symbolic Terrapin Adoption Program provided the public a platform to support our *B. affinis* conservation project by making a small donation, and funds generated were sufficient to ensure the sustainability of the project. Considering numerous conservation projects were terminated due to the lack of funds, the ability to sustain a long-term conservation project is extremely important to ensure the survival of a critically endangered species.

Wildlife reintroduction is a common conservation strategy (Anthony et al. 2015), in which individuals are moved from one locality to another (Seigel & Dodd 2000). Researchers have reintroduced numerous marine and freshwater turtles into the wild, either as a result of captive breeding, rehabilitation of diseased individuals and/or in an attempt in population recovery (Williams 1993; Wood & Wood 1993; Haskell et al. 1996). Common indicators of successful reintroductions includes positive survival and reproduction rates, establishment of viable

wild and captive populations, increased population sizes, developed protocols, etc. Non-biological indicators include increased public and local stakeholder awareness and establishment of legal protection for the wildlife (Ewen et al. 2014). The only way to carry out a real evaluation of the reintroduction project is by long-term monitoring (Bertolero & Oro 2009).

Given the long maturation period for most chelonians, including *B. affinis*, Dodd & Seigel (1991) recommended that reintroduced turtles be monitored for at last 20 years. To determine the success of our head starting and reintroductions, further work is required to monitor the adaptation, survival, growth and movements of the post-release individuals. Without monitoring and an evaluation of the reintroduction programs, it is impossible to assess whether this is a successful strategy for the conservation of *B. affinis*. Additionally, future research should focus on the assessment and protection of the critical habitats in the river and address the underlying causes of population decline such habitat loss, the use of indiscriminate fishing gear, and the continued tradition of consuming *B. affinis* eggs among the older generation of local villagers.

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Malay abstract: Ia adalah jelas bahawa penglibatan masyarakat setempat memainkan peranan yang penting dalam kejayaan sesuatu projek pemuliharaan. Walaupun Jabatan Perlindungan Hidupan Liar dan Taman Negara telah memulakan projek pemuliharaan *Batagur affinis* yang pertama di Malaysia sejak tahun 1967, dan melibatkan program pengeraman telur, pemeliharaan anak tuntung dalam kurungan dan program pelepasan semula anak tuntung ke dalam sungai, pihak Jabatan tidak melibatkan masyarakat setempat dalam projek-projek tersebut. Ini merupakan projek pertama yang melibatkan penduduk setempat dalam projek penyelidikan dan pemuliharaan *B. affinis* di Sungai Kemaman, Terengganu, Malaysia. Lanjutan daripada penglibatan penduduk setempat, Jawatankuasa Kemajuan dan Keselamatan Kampung juga telah terlibat dalam projek pemuliharaan ini. Dari 2012 hingga 2016, kami telah menangkap dan memproses sebanyak 102 ekor tuntung betina. Kaedah tangkap-tanda-lepas-dan-tangkap-semula Schnabel menganggarkan sekurang-kurangnya 186 ekor tuntung sungai betina yang liar di dalam sungai. Kami telah mengumpul sebanyak 2,542 butir telur *B. affinis* dari 205 sarang untuk pengeraman, dan menghasilkan sebanyak 1,723 ekor anak tuntung (purata kadar penetasan 67.8%). Kemandirian anak-anak *B. affinis* semasa dalam pemeliharaan di dalam kurungan direkodkan antara 96.7–100% antara kohort. Anak-anak tuntung mencatatkan peningkatan berat badan sebanyak 467% dan peningkatan panjang karapas sebanyak 90%. Kami telah melepaskan sebanyak 1,690 ekor *B. affinis* juvenil ke dalam sungai. Kami juga telah memulakan program anak angkat secara simbolik untuk menjana kewangan dan memastikan kemampanan projek pemuliharaan ini. Kajian ini membuktikan bahawa masyarakat setempat mampu menguruskan sumber-sumber mereka sendiri, sekiranya diberi latihan yang mencukupi dalam teknik-teknik pemuliharaan.

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