

**Investigating the occurrence of the Yangtze Giant Softshell
Turtle (*Rafetus swinhoei*) in Madushan Reservoir
of Yunnan Province, China**



Steven G. Platt, Fenglian Li, and Bin Liu

Report to:

**Wildlife Conservation Society-China Program, Room 2-1101,
Tower 2, Ronghua Shijia, No. 29, Beijing 100101,
Peoples Republic of China**

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Executive summary

The Yangtze Giant Softshell Turtle (*Rafetus swinhoei*) is considered the most critically endangered chelonian in the world. With the recent death of a turtle inhabiting Hoan Kiem Lake in Hanoi, Vietnam, the known global population of *R. swinhoei* has declined to three individuals. Surveys conducted 2013-15 suggested that at least one adult *R. swinhoei* survives in Madushan Reservoir, an impounded section of the Red River below Honghe in Yunnan Province, China. Attempts to capture and incorporate this turtle into a captive-breeding program have as yet proved unsuccessful.

In collaboration with the Kunming Institute of Zoology (KIZ), we investigated the current status of *Rafetus swinhoei* in the Madushan Reservoir during May-June 2016. We assessed the status of *R. swinhoei* based on local reports and attempted to confirm these with a follow-up field survey and photographic evidence. We also recorded traditional ecological knowledge about *R. swinhoei* gleaned during interviews of persons with first-hand experience of this species in the wild. We provide recommendations for future conservation actions based on our findings.

We employed a variety of methods to accomplish the objectives of this investigation. First, we relied heavily on informant reports collected by a local fisher-farmer with long-standing family ties to local communities. Second, we conducted semi-directed, open-ended interviews of area residents with first-hand experience of *R. swinhoei* in the wild. Third, we conducted pedestrian reconnaissance patrols and maintained surveillance of bait stations in an attempt to observe and photograph softshell turtles. Search effort was quantified as person-hours per day (e.g., 1 person searching for one hour = 1 person-hour of search effort). Trapping was prohibited under the conditions of our research permit issued by provincial conservation authorities.

Informant reports span a period from dam construction (early 2000s) to 2015. Alarming, there have as yet been no reports of large softshell turtles from Madushan Reservoir during 2016. Sightings of large softshell turtles are clustered around Man Gong Village, Fish Camp Cove, and Turtle Cove. Most reports are of swimming and basking turtles observed by fishermen. Oval depressions attributed by informants to softshell turtles are thought instead to be constructed by fish. Informants also reported the illegal harvest of a large softshell turtle "three or four years ago".

We made three observations of turtles at Madushan Reservoir during 412.2 person-hours of search effort over a period of 20 days (mean \pm 1SD = 20.6 ± 6.2 person-hours/day). Our observations occurred in Turtle and Fish Camp Coves; efforts to locate turtles in other areas proved unsuccessful. Two of the turtles we observed were unequivocally Trionychids (*Apalone ferox* and *Pelodiscus sinensis*). The third observation (a dark form moving below the surface) may have been a large fish. A Red-eared Slider found entangled in discarded monofilament netting highlights the danger of this material to any *R. swinhoei* that might survive in the reservoir.

Very few people we interviewed had first-hand experience with *R. swinhoei* in the wild. Deep whirlpools in the Red River were the preferred habitat of large *R. swinhoei*.

Turtles were harvested by riverside communities for subsistence until quite recently (circa 2005). Villagers in Man Gong captured turtles by suspending long lines affixed with multiple unbaited hooks (spaced about 30 cm apart) in deep water on the periphery of whirlpools. Capture was affected when hooks snagged the legs and head-neck of passing turtles. Villagers reportedly observed mating in May-June and clutch deposition occurred in July on high sandbanks. Eggs were harvested for domestic consumption.

The lack of any recent (2016) observations of large softshell turtles in Madushan Reservoir is disturbing and raises the possibility that the one or more *R. swinhoei* presumed to inhabit the reservoir as late as 2015 (Kuchling and Lu, 2015) has since succumbed to unknown causes. Nonetheless, in the absence of unequivocal evidence (e.g., carcass), we consider it prudent to continue searching for the turtle(s). To this end, we recommend that Bai Xiuhua continue mining her network for information on turtles. Should a credible report be received of a large softshell turtle no effort should be spared to bring this animal into captivity for use in the captive-breeding program. In anticipation of future trapping efforts, we recommend pre-positioning the needed equipment (e.g., large nets and traps) at KIZ in Kunming or another location in close proximity to Madushan Reservoir. Furthermore, trapping permits should be in-hand and renewed as needed to avoid unnecessary delays in the event trapping becomes a reality. Project personnel should also be prepared to deploy to Kunming on short notice and immediately initiate trapping operations. While recognizing the dangers inherent in capturing wild animals, the consequences of doing nothing (likely extinction of *R. swinhoei*) far outweigh the risks involved in capturing the remaining wild turtle(s). As it stands, any wild *Rafetus swinhoei* remaining in Madushan Reservoir are already "demographically dead" as opportunities for continued reproduction are non-existent.

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Introduction

With the recent demise of Lonesome George, the sole surviving Pinta Giant Tortoise (*Chelonoidis abingdonii*), the Yangtze Giant Softshell Turtle (*Rafetus swinhoei*) became the most critically endangered chelonian in the world (Rhodin et al., 2011; Kuchling et al., 2012). *Rafetus swinhoei* historically occurred in the lower Yangtze River of China and the Red River system in Yunnan Province, China and northern Vietnam, but a combination of chronic over-harvesting, wetland destruction, and widespread water pollution has pushed the species to the brink of extinction. Until recently, the confirmed global population of *Rafetus swinhoei* consisted of four individuals (Rhodin et al., 2011; Kuchling et al., 2012): a pair housed in the Suzhou Zoo, China, and two adults in Vietnam (Hoan Kiem Lake and Dong Mo Reservoir). The confirmed global population declined to three individuals after the death of the turtle inhabiting Hoan Kiem Lake in Hanoi during January 2016.

On the basis of extensive interview surveys (2007-2010) conducted along the Red River and tributaries in Yunnan Province, China, Wang et al. (2013) concluded *R. swinhoei* faced imminent extinction as the result of over-harvesting for food and traditional medicine, and habitat degradation, particularly dam construction. Wang et al. (2013) recommended capturing any *R. swinhoei* remaining in the wild and incorporating these animals into a captive-breeding program. Follow-up surveys suggested at least one adult *R. swinhoei* was present in Madushan Reservoir, an impounded section of the Red River below Honghe (Kuchling and Lu, 2015). Unsuccessful attempts to capture this animal using cathedral traps (Kuchling, 2003) were made in 2013-15 (Kuchling and Lu, 2015).

Ex-situ conservation efforts for *R. swinhoei* have to date proved unsuccessful. After decades of living in separate facilities, the two captive *R. swinhoei* in China were brought together at the Suzhou Zoo in 2008, and the female deposited large clutches (60-100 eggs) of nonviable eggs in subsequent years. Initially, these results were attributed to years of inadequate nutrition and the advanced age (80 to > 120 years) of the pair (Rhodin et al., 2011). However, an examination of the male in 2015 found extensive scarring of the penis resulting from injuries sustained during an aggressive encounter with a conspecific that also damaged the posterior margin of the carapace. Although the male continues to produce viable sperm, for mechanical reasons he appears unable to successfully inseminate the female. Semen collection and artificial insemination was attempted in 2015 and again in 2016. While the initial effort proved unsuccessful, the outcome of the most recent attempt remains unknown at the time of this writing.

In collaboration with the Kunming Institute of Zoology (KIZ), we investigated the current status of *Rafetus swinhoei* in the Madushan Reservoir during May-June 2016. We assessed the status of *R. swinhoei* based on local reports and attempted to confirm these with a follow-up field survey and photographic evidence. We also recorded traditional ecological knowledge about *R. swinhoei* gleaned during interviews of persons

with first-hand experience of this species in the wild. We make recommendations for future conservation actions based on our findings.

Madushan Reservoir

Madushan Reservoir is an impounded section of the Red River below Honghe in Yuanyang County, Yunnan Province, China (Figure 1). The Madushan Hydropower Dam, completed in 2007, is one of 12 dams constructed, under construction, or planned on the mainstream of the Red River in China (Wang et al., 2013). Madushan Reservoir extends approximately 47 km upstream from the dam (depending on water levels), and is 0.3-0.8 km wide and up to 30 m deep. Water is stored in the reservoir through the dry season (October-May), released at the end of the dry season, and replenished during the following wet season (June-September). Steep rocky banks supporting little if any riparian vegetation are exposed when water levels drop in the reservoir. Sandbanks are absent in the main body of the reservoir, but present at the mouth of at least two tributary creeks. The watershed surrounding the reservoir is characterized by steep hills covered in shrubs, second-growth scrub forest, and agricultural fields. Many extremely steep slopes are under cultivation, resulting in high levels of soil erosion and sediment deposition in the reservoir. The Red River upstream from Madushan Reservoir is heavily impacted by sand and gravel mining.

Madushan Reservoir supports numerous floating fish farms and a small commercial fishing industry. The latter group relies on monofilament gill nets to harvest fish and discarded or abandoned netting can be found throughout the reservoir, festooning emergent snags and draped over shoreline rocks. Madushan Reservoir is also popular with recreational anglers who harvest fish with hook-and-line from the shore. Batteries of floating fish camps that provide accommodation to recreational fishers are clustered around access points to the reservoir. Raw sewerage from communities scattered around the reservoir, combined with organic inputs from floating fish farms and fertilizer run-off from agricultural lands appear to be creating eutrophic conditions in much of the lower impoundment.

Methods

We employed a variety of methods to accomplish the objectives of this investigation. First, we relied heavily on a network of informants established by Professor Rao Dingqi and Dr. Gerald Kuchling during earlier surveys. This informant network is loosely coordinated by Mrs. Bai Xiuhua, a fisher-farmer with long-standing family ties to area communities. Mrs. Bai is employed by KIZ to continually query local residents and collect reports of turtle observations. Mrs. Bai is in regular contact with fishermen as part of her fishing business and her interest in turtles is well-known throughout the area.

Second, we conducted semi-directed, open-ended interviews (Gilchrist et al. 2005; Martin 1995) of knowledgeable individuals in several communities around Madushan Reservoir. In accordance with the format of a semi-directed interview, we asked



Figure 1: Madushan Dam (above) and reservoir (below).

informants a series of questions that included standard questions prepared in advance and others that arose during the course of conversation. We guided the discussion, but the direction and scope of each interview was allowed to follow the participants' train of thought (Huntington 1998). Our questions focused on the past occurrence of softshell turtles, recent sightings of particularly large individuals, natural history observations, techniques of exploitation, and potential threats.

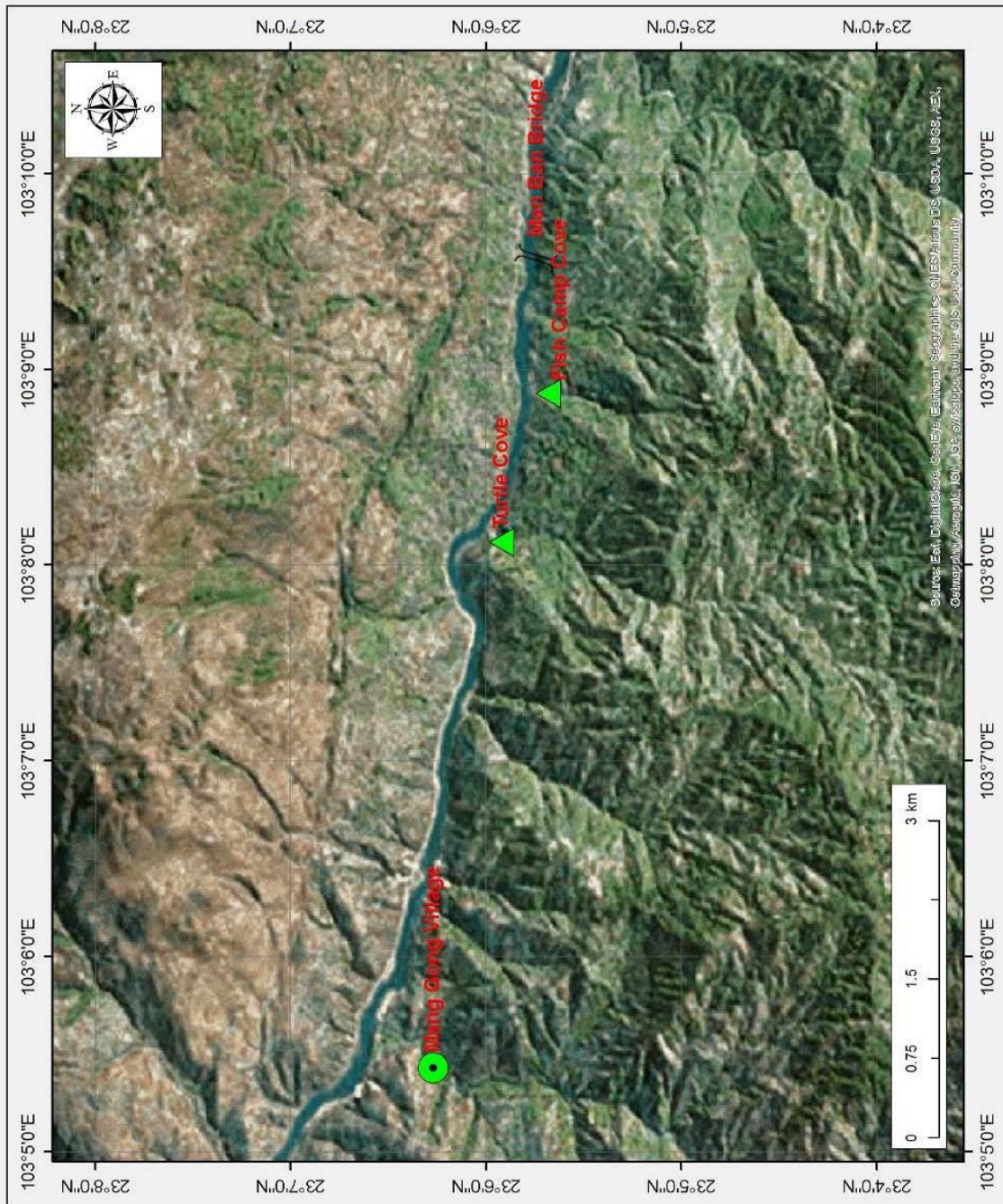
We also conducted pedestrian reconnaissance patrols and maintained surveillance of bait stations in an attempt to observe and photograph softshell turtles. Our efforts focused on an area of the reservoir where sightings of large softshell turtles (presumably *Rafetus swinhoei*) have occurred in the past. Pedestrian reconnaissance patrols were conducted along a gravel road on the western shore of the reservoir between Ban Man Bridge and Man Gong Village (see cover photograph). During these patrols, we moved slowly and used binoculars to scan the surface of the reservoir and likely basking sites along the shoreline. We generally walked from Man Ban Bridge to Man Gong Village (or beyond) and then returned along the same route (Map 1). We established bait stations in Fish Camp Cove and Turtle Cove. Each bait station consisted of one or two fish suspended from a line at the water's surface (Figure 2). Fish used as bait (*Tilapia* and *Hemicultr*) were obtained from the roadside market in Long Dun; baits were changed daily or on alternate days. One or more observers posted nearby in nearby Observation Posts (OP) maintained surveillance of each bait station throughout the day. Baits remained deployed overnight and were examined the following day for evidence of turtle feeding activity. Search effort was quantified as person-hours per day (e.g., 1 person searching for one hour = 1 person-hour of search effort). Trapping was prohibited under the conditions of our research permit issued by provincial conservation authorities. A detailed trip itinerary and gazetteer are presented in Appendices 1 and 2, respectively.

Results

Local informants

We accompanied Mrs. Bai on a boat trip around Madushan Reservoir on 17 May 2016 and examined locations where softshell turtles have reportedly been observed in the past (2007-2015). The geographic location of each sighting was determined with a Garmin GPS76 and observations are summarized in Table 1. Informant reports proved difficult to interpret for several reasons. First, five species of softshell turtle occur or once occurred in Madushan Reservoir (Kuchling et al., 2013; Rao Dingqi, pers. comm.) and reliably distinguishing these species is difficult, even for experienced biologists (Magnusson, 1983). Large body size appears to be the only characteristic that can be used to assign specific reports to *R. swinhoei*, although reliably estimating the size of large reptiles is often problematic (Platt and Rainwater, 2015). Furthermore, critical elements, such as date and time, are lacking for many accounts.

These reports span a period from dam construction (early 2000s) to 2015. Notably and alarmingly, there have as yet been no reports of large softshell turtles from Madushan



Map 1: Red River downriver from Honghe in Yunnan Province, China. This area is now inundated by the Madushan Reservoir. Bait stations were established in Fish Camp Cove and Turtle Cove. Pedestrian search area extended from Man Ban Bridge to Man Gong Village and beyond.



Figure 2: Fenglian Li (WCS China Program) standing beside a bait station in Fish Camp Cove (above). Stations were established in Fish Camp Cove and Turtle Cove and baited with fresh fish obtained at a local market (below).

Table 1: Summary of local observations with accompanying GPS coordinates of large softshell turtles in Madushan Reservoir. Approximate locations were determined with a Garmin GPS76 (WGS84 Datum).

23°06.02'N; 103°08.22'E

- Large softshell turtle observed swimming in mid-channel of reservoir by fishermen during April or May 2015.

23°06.02'N; 103°08.00'E (Fish Camp Cove)

- Mrs. Bai and a relative probing sand in shallow water and flushed a large turtle during the summer of 2014. The turtle immediately moved into deep water, leaving behind a large oval depression (diameter ca. 1.0 m) in the sand.
- Other large depressions found in sand along shoreline. These depressions are assumed to be made by buried turtle seeking to ambush prey in shallow water. Several small (diameter ca. 40 cm) depressions were obvious during our visit (17 May 2016). These depressions were most likely made by fish rather than softshell turtles.
- Two large softshell turtles observed by villagers in 2014. Unclear if the turtles were observed together or on separate occasions.

23°06.23'N; 103°07.68'E

- Fisherman observed a softshell turtle (CL ca. 400 mm) swimming on the surface as it crossed the reservoir. Based on the reported body size, this turtle was probably not *Rafetus swinhoei*.

23°06.02'N; 103°07.18'E

- Fishermen observed a softshell turtle swimming along shoreline in this area; no further details were available.

23°06.45'N; 103°06.36'E

- Large turtle observed by fishermen basking in this area on multiple occasions 2-3 years ago (circa 2013-14). Three small creeks flow into the reservoir at this location and each has mud and gravel bars that seem to offer suitable basking substrates.

23°06.63'N; 103°05.52'E (Man Gong Village)

- Father and son investigating large depressions in shallow water apparently flushed a buried turtle, which created a discernible wave as it swam away while submerged.

23°05.91'N; 103°08.41'E

- Three villagers observed the head of large softshell turtle protruding above the surface shortly after Madushan Dam was completed and the impoundment began to fill (ca. 2008-09). Later identified the turtle as *Rafetus swinhoei* after viewing photographs presented in Kuchling et al. (2013).

23°05.73'N; 103°08.72'E (Turtle Cove)

- Large shallow depressions (up to 1.0 m in diameter) found below bridge were attributed to buried softshell turtles.
- Baited hooks set for fish found straightened; attributed to large softshell turtle.
- Three or four farmers working on hill above reservoir observed a large softshell turtle swimming on surface. Carapace described as "black". Turtle swam out of Turtle Cove and into open water before being lost from view. Sighting occurred 7-8 years ago (circa 2008).
- Informant was electrofishing from a boat with several other individuals. A large softshell turtle surfaced in response to the electric shock; head and neck described as "greenish". Informant contained shocking hoping to drive turtle onto the shore where it might be more easily captured. Turtle submerged instead and was not observed again. Although it is possible the turtle may have been stunned and drowned, no bloated carcass was ever found in the reservoir. This incident occurred circa 2008 or 2009.

Reservoir during 2016. With the exception of sightings near Man Gong Village, local reports of large softshell turtles are clustered around Fish Camp Cove and Turtle Cove (Figure 3), the same area where attempts were made to trap turtles in previous years (Kuchling and Lu, 2015). Most reports are of swimming turtles observed by fishermen, which is not unexpected given the large numbers of recreational fishermen present on the reservoir. There are several reports of a basking turtle observed multiple times at one location during 2013-14.

Local informants attribute oval depressions of varying sizes found in shallow water or exposed substrates to *R. swinhoei*. Based on the abundance of these depressions, several informants claim as many as 10 *R. swinhoei* survive in the reservoir. While some of the large diameter (ca. 100 cm) depressions may have indeed been formed when turtles buried themselves in the substrate to ambush passing prey, the majority are no doubt



Figure 3: Softshell turtles were observed in Fish Camp Cove (above) and Turtle Cove (below) during surveys in May-June 2016. Local informants report sightings of large softshell turtles (presumably *Rafetus swinhoei*) from the same area.

excavated by fish, particularly *Tilapia*. Indeed, on two different occasions we watched as *Tilapia* constructed depressions of the type ascribed to softshell turtles.

Informants also reported the illegal harvest of a large softshell turtle "three or four years ago". The turtle was captured by villagers in the reservoir and weighed about 50 kg. The large reported body size, suggests the turtle was most likely *R. swinhoei*. The turtle was killed and butchered, and the meat sold in local villages from the back of a motorcycle. Additional information concerning this incident was unavailable.

Field observations

We made three observations (Table 2) of turtles at Madushan Reservoir during 412.2 person-hours of search effort over a period of 20 days (mean \pm 1SD = 20.6 \pm 6.2 person-hours/day). Our observations occurred in Turtle and Fish Camp Coves (Figure 3); efforts to locate turtles in other areas proved unsuccessful. Many potential basking sites hosted recreational fishers, which probably deterred turtles from leaving the water. Turtle sightings were in close proximity to our bait stations, although no evidence of turtle feeding activity was ever noted at the bait stations. Because dead fish are abundant in the reservoir, fish baits may hold little attraction for turtles. To maximize attractiveness and increase chances of trapping success, future efforts should include a more diverse array of bait, including fish and chicken carcasses, and organ meat from pigs and goats.

Two of the turtles we observed were unequivocally Trionychids; one was most likely a feral *Apalone ferox* and the other *Pelodiscus sinensis*. The third sighting was made from an elevated OP and consisted of a dark form moving just below the surface. Although likely a turtle, we cannot rule out the possibility that the dark form was actually a large fish. In addition to sightings of softshell turtles, we documented the mortality of a Red-eared Slider (*Trachemys scripta elegans*) that drowned after becoming entangled in discarded monofilament fishing net (Figure 4). Our finding high-lights the danger discarded netting material poses to any *R. swinhoei* that might survive in the reservoir. Finally, we observed two hatchling (CL = 60 mm) *Pelodiscus sinensis* offered for sale at the roadside fish market in Long Dun. According to vendors, these turtles were captured where the Red River empties into Madushan Reservoir.

Traditional ecological knowledge

Very few people we interviewed had first-hand experience with *R. swinhoei* in the wild. Most of the ecological data were obtained from a small group of older residents in Man Gong Village. Prior to construction of Madushan Dam, Man Gong Village was located beside the Red River and many residents fished in the river. Before closing the floodgates, the village moved upslope to its current location.

According to our informants, before the Red River was dammed, deep whirlpools were the preferred habitat of large *R. swinhoei*. Turtles were harvested by riverside

Table 2: Field observations of turtles at Madushan Reservoir (May-June 2016)

Date (time)	Description
9 May (1250 hrs)	<i>Trachemys scripta elegans</i> (female; CL = 150 mm) found floating on surface in Turtle Cove. Turtle drowned after becoming entangled in discarded monofilament fishing net.
18 May (1810 hrs)	Momentary glimpse of large softshell turtle (CL ca. 400 mm) at base of steep bluff in Turtle Cove. Turtle suspended near-vertically in water column with head extended above water. Turtle immediately submerged as observers peered over bluff. The turtle was most likely a feral <i>Apalone ferox</i> , a non-native species which is reportedly established in reservoir (Kuchling et al., 2013).
28 May (1330 hrs)	Small softshell turtle (CL ca. 250-300 mm) observed swimming in shallow water just below the surface in Fish Camp Cove. Turtle surfaced momentarily exposing its head, submerged and then moved off into deeper water, disappearing from view.
31 May (1345 hrs)	Dark, turtle-like form observed swimming just below the surface in Turtle Cove. We cannot rule out the possibility that a fish was responsible for this sighting.

communities for subsistence until quite recently (circa 2005). Soldiers stationed along the Red River in the 1970s killed several large softshell turtles while fishing with hand grenades. These turtles were quite possibly *R. swinhoei*, although *Pelochelys cantorii* also occurs in the Red River and tributaries (Kuchling et al., 2013; Rao Dingqi, pers. comm.). About 50 years ago, informants claimed a turtle weighing about 200 kg and requiring seven people to lift it was captured in the Red River near Man Gong. Villagers in Man Gong also described capturing several large softshell turtles and selling these animals to the now defunct Baohua Zoo in Geiju. Apparently this zoo received more than 30 *R. swinhoei* during the 1970s and 1980s, several of which were exchanged with other zoos. However, the fate of most of these turtles is unknown (Wang et al., 2013). Villagers in Man Gong captured turtles by suspending long lines affixed with multiple unbaited hooks (spaced about 30 cm apart) in deep water on the periphery of whirlpools. Capture was affected when hooks snagged the legs and head-neck of passing turtles.

Villagers reportedly observed *R. swinhoei* mating in May-June and clutch deposition occurred in July. Turtles were said to deposit eggs in sandbanks along the river. Nest sites were located high on the sandbank, well above the water line near the sand-soil interface. Interestingly, the reported nesting phenology is not synchronized with the annual wet-dry season cycle. If clutch deposition did indeed take place in July, it



Figure 4: Non-native Red-eared Slider (*Trachemys scripta elegans*) that drowned in discarded monofilament fishing net (above). Abundant discarded netting (below) poses a serious threat to any surviving *Rafetus swinhoei* in Madushan Reservoir.

occurred well after the onset of the wet season (early June), and as such nests would seem at considerable risk of being lost to flooding. When queried further, our informants maintained that females could accurately predict maximum river levels and nests were positioned above this point. Villagers harvested turtle eggs for local consumption, although some people suffered an allergic reaction after consuming them. Villagers located buried turtle eggs by following tracks and drag marks made by the nesting female and probing likely nesting sites with slender sticks.

Villagers described two "types" of softshell turtles inhabiting the Red River prior to dam construction. The first was described as the largest species weighing > 50 kg with a dark carapace and black head-neck. A smaller species weighing 30-40 kg was also present. The smaller species had an intricate color pattern on the head-neck with a uniformly dark carapace. None of the informants was able to recall differences in snout morphology making it difficult to reliably determine what species were being described. Indeed, these folk taxa might well refer to different size-classes of a single species of softshell turtle.

Conclusions and recommendations

The lack of any recent (2016) observations of large softshell turtles in Madushan Reservoir is disturbing and raises the possibility that the one or more *R. swinhoei* presumed to inhabit the reservoir as late as 2015 (Kuchling and Lu, 2015) has since succumbed to unknown causes. Nonetheless, in the absence of unequivocal evidence (e.g., carcass), we consider it prudent to continue searching for the turtle(s). To this end, we recommend that Bai Xiuhua continue mining her network for information on turtles. Should a credible report be received of a large softshell turtle no effort should be spared to bring this animal into captivity for use in the captive-breeding program. In anticipation of future trapping efforts, we recommend pre-positioning the needed equipment (e.g., large nets and traps) at KIZ in Kunming or another location in close proximity to Madushan Reservoir. Furthermore, trapping permits should be in-hand and renewed as needed to avoid unnecessary delays in the event trapping becomes a reality. Project personnel should also be prepared to deploy to Kunming on short notice and immediately initiate trapping operations. While recognizing the dangers inherent in capturing wild animals, the consequences of doing nothing (likely extinction of *R. swinhoei*) far outweigh the risks involved in capturing the remaining wild turtle(s). As it stands, any wild *Rafetus swinhoei* remaining in Madushan Reservoir are already "demographically dead" as opportunities for continued reproduction are non-existent. Rosenzweig (2003) described such species as "zombies", i.e., populations consisting of one or a few long-lived individuals ("the living dead") that are ultimately doomed to extinction because of continued lack of reproductive success.

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Literature Cited

- Gilchrist, G., M. Mallory, and F. Merkel. 2005. Can local ecological knowledge contribute to wildlife management? Case studies of migratory birds. *Ecology and Society* 10:20–31.
- Huntington, H. P. 1998. Observations on the utility of the semi-directed interview for documenting traditional ecological knowledge. *Arctic* 51:237–242.
- Kuchling, G. 2003. A new underwater trap for catching turtles. *Herpetological Review* 34:126-128.
- Kuchling, G. and S. Lu. 2015. *Rafetus swinhoei* in China – still on the brink despite eight years of captive breeding attempts. *Turtle Survival* 2015:34-35.
- Kuchling, G., D. Rao, and S. Lu. 2012. Rescuing the Giant Yangtze and Red River Softshell Turtle (*Rafetus swinhoei*). *Turtle Survival* 2012:44-45.
- Kuchling, G., D. Rao, and S. Lu. 2013. Softshell turtles of Yunnan (P.R. China) and adjacent areas. Turtle Conservation Fund and Turtle Survival Alliance. 41 pp.
- Magnusson, W.E. 1983. Size estimates of crocodilians. *Journal of Herpetol.* 17:86-88.
- Martin, G. J. 1995. *Ethnobotany: a Methods Manual*. Chapman Hall, London. 268 pp.
- Platt, S.G. and T.R. Rainwater. 2015. A critical evaluation of two historic records of large *Python*. *Herpetological Review* 46:31-33.
- Rhodin, A.G.J., A.D. Walde, B.D. Horne, P.P. van Dijk, T. Blanck, and R. Hudson. 2011. Turtles in trouble: The worlds 25+ most endangered tortoises and freshwater turtles - 2011. IUCN Tortoise and Freshwater Turtle Specialist Group, Turtle Conservation Fund, Turtle Survival Alliance, Turtle Conservancy/Behler Conservation Center, chelonian Research Foundation, Conservation International, Wildlife Conservation Society, and San Diego Zoo Global. 54 pp.
- Rosenzweig, M.L. 2003. *Win-win ecology: How the earth's species can survive in the midst of human enterprise*. Oxford University Press, Oxford, UK.

Wang, J., S. Hai-Tao, W. Cheng, and H. Lian-Xian. 2013. Habitat selection and conservation suggestions for the Yangtze Giant Softshell Turtle (*Rafetus swinhoei*) in the Upper Reach River, China. *Chelonian Conservation and Biology* 12:177-184.

Appendix 1: Annotated trip itinerary and summary of daily activities (5 May – 11 June 2016).

- 5 May Fly from Bangkok, Thailand to Kunming, China, arriving ca. 1900 hrs. Meet Bin Liu (WCS China Program) at airport; consult with personnel from Kunming Institute of Zoology.
- 6 May Kunming: Meet with Professor Rao Dingqi at Kunming Institute of Zoology (1500 to 1730 hr). Briefed on previous field surveys for *Rafetus swinhoei* conducted in Yunnan Province. According to Professor Rao, three independent sightings were made by villagers in April, May, and June of different years. Observations occurred along a 1 km stretch of river. Fishermen also claimed fishing nets had been torn and damaged by large softshell turtles. Gerald Kuchling set two traps in this area; each baited with dog meat. Traps were set for up to 10 days, although these efforts ultimately proved unsuccessful. Professor Rao considers many local informants to be untrustworthy and believes some individuals might be conspiring to capture turtle. In the past, a local woman with excellent rapport with villagers was employed to gather information on recent sightings of large softshell turtles. This woman received an annual salary of about US\$1600 for her services. Professor Rao suggested this woman be employed in the future to collect information.
- 7 May Travel by road from Kunming to Honghe (Yuangying County), arriving at 1630 hr (Distance = 300 km). Road traverses desolate mountains with very little tree cover. Other than planted Eucalyptus, vegetation is low and scrub-like with some pines. Unclear whether this vegetation is due to the effects of climate or long-term over-harvesting of trees and subsequent erosion. One stretch of road passes through a steep-walled gorge; walls covered in lush forest.
- 8 May Honghe: Visit market and search for turtles; single *Pelodiscus sinensis* being sold (0730-0750 hr). After breakfast drive southeast along Red River to Madushan Dam. Pick up a local informant (Mrs. Bai) along the way. Madushan Dam constructed in early 2000s and reservoir filled in 2007. Cross to south bank of Red River and investigate area where many recent sightings of *Rafetus swinhoei* have occurred. Stopped to examine shallow depressions in exposed mudbank purportedly made by submerged turtles (most likely made by large catfish). Continue to Mang Gong Village and interview three remaining families (about 10 people). Village was formerly located along the river, but relocated upslope when reservoir filled. Returned to Honghe about 1800 hrs.

- 9 May Honghe: Visit market and search for turtles (0730-0750 hrs). Drive to fishing camp of Mrs. Bai, rent boat, and conduct waterborne reconnaissance of lakeshore to examine locations of past turtle sightings and search for basking turtles; find dead *Trachemys scripta* in abandoned monofilament fishing net (1055 to 1335 hrs). Reconnoiter south of Man Ban Bridge after lunch (1530 to 1630 hrs).
- 10 May Honghe: Visit market and search for turtles; single *Pelodiscus sinensis* and several frogs observed for sale. Professor Rao departs for Kunming (0930 hrs). Receive message from Kunming Institute of Zoology to immediately stand down and cease fieldwork until further notice (1200 hrs). Took long hike around Honghe to vent frustrations.
- 11 May Honghe: Continue to stand down; no new developments concerning agreement between KIZ and WCS or status of research permits. Spend much of day writing. Bird watching with Bin Liu in later afternoon; walk south of town and follow trail up steep slope above Red River. Vegetation consists of thick scrub composed of shrubs and small trees. Reach open grassy plateau after climbing about 1400 ft. Late hour and aggressive dogs at an isolated farmhouse dictate a return to base of mountain.
- 12 May Honghe: Stand down continues; no developments concerning agreement between WCS and KIZ or status of research permits. Hike to ridgeline looming over Honghe in afternoon. Watch birds and find nest of Pied Bushchat constructed in cavity of steep road embankment. Hills covered in low shrubs with very few trees. Severe erosion in some places.
- 13 May Honghe: Stand down continues; no developments concerning agreement between WCS and KIZ or status of research permits. Frustrating! Work in hotel room for much of day. Heavy downpour in early afternoon with widespread power outages. Hike along tributary of Red River after rain stops.
- 14 May Honghe: Stand down continues; little chance research permits will be issued over the weekend. Compiled and analyzed data, wrote draft of manuscript this morning. After lunch hiked into hills on north side of town and climbed to summit of high ridge. Observed Red Junglefowl (male) and Black-billed Magpie in scrub on upper slopes. Returned to hotel shortly before dusk.
- 15 May Honghe: Stand down continues through the weekend. Worked on manuscript for much of day. In late afternoon accompanied Bin Liu to top of high ridge (ca. 2000 ft) on northwestern edge of town. Observed large flight (>30 birds) of Oriental Hobby over mountain. Examined nest of

Pied Bushchat; two eggs hatched in previous 12 hours. Returned to hotel shortly after dark.

- 16 May Honghe: Stand down continues. Hiked to ridgeline on northwestern edge of town to observe parental care at Pied Bushchat nest; unsuccessful as female would not enter nest while I was present. Walked to top of ridge and observed Oriental Hobby (about 10) and Common Kestrel ($n = 1$). Returned to hotel at dusk.
- 17 May Madushan Reservoir: Conduct boat-borne reconnaissance with Mrs. Bhai of area in reservoir where turtles have been observed in the past (1000 to 1330 hrs). Mrs. Bhai indicated specific areas where past sightings have occurred and provided details of each incident; GPS coordinates were determined at these locations ($n = 8$). Return to Honghe in late afternoon.
- 18 May Madushan Reservoir: Conduct pedestrian reconnaissance along southern shore of reservoir. Began at bridge and walked north along road carefully scanning the reservoir below with binoculars. Initially we planned to walk to Man Gong Village and return. However, owing to late hour we stopped short of our objective after walking 5.07 miles. Back-tracked and returned to Bridge where we rendezvoused with vehicle and driver. Softshell turtle (species undetermined; not *Rafetus swinhoei*) observed briefly along shoreline in Fish Camp Cove (1810 hrs). Several Eurasian Hobby observed catching and consuming insects (possibly Cicada) in flight earlier in afternoon. Search conditions: Intermittent light rain ending in mid-afternoon and clearing; winds calm. Search personnel: Bin Liu, Ma Xiao Hui, and SGP. Search effort: $3 \text{ persons} \times 6.25 \text{ hours} = \mathbf{18.75 \text{ person hours}}$.
- 19 May Madushan Reservoir: Conduct pedestrian reconnaissance along southern shore of reservoir. One person stationed in observation post (OP) above Turtle Cove (1330-1600 hrs). Two people dropped off at Man Gong Village and walked back to Man Ban Bridge (1400-1715 hrs), picking up person stationed at Turtle Cove OP. No evidence of turtles encountered. Fish observed constructing depressions in shallow water by Turtle Cove observation post; similar depressions are attributed to softshell turtles by local villagers. These observations suggest otherwise. Search conditions: Partly cloudy and calm. Search personnel: Bin Liu, Ma Xiao Hui, and SGP. Search effort: $(2 \text{ persons} \times 3.25 \text{ hrs}) + (1 \text{ person} \times 2.5 \text{ hrs}) = \mathbf{9.0 \text{ person hours}}$.
- 20 May Honghe: Bin Liu departs for Kunming (1030 hrs). Madushan Reservoir: Conduct pedestrian reconnaissance along southern shoreline of reservoir. Walk from Turtle Cove, to abandoned quarry, return to Turtle Cove, and then continue to Man Ban Bridge (1315-1830 hrs). Extremely hot (ca.

38°C); little wildlife observed. The numerous weekend anglers fishing along shoreline of reservoir likely deterred any basking by turtles. Search personnel: Ma Xiao Hui and SGP. Search effort: 2 persons \times 5.25 hours = **10.5 person hours**.

- 21 May Honghe: Vehicle unavailable for transport to Madushan Reservoir; rain and high winds present unsuitable survey conditions. Remain in Honghe and work at hotel. Brave weather and climb ridgeline after lunch. Flights of Eurasian Hobby passing overhead on updrafts (at least 30 birds observed) after rain ceased in late afternoon. Inspect nest of Pied Bushchat. Numerous Chinese Francolins calling from scrub-covered slopes. Return to hotel ca. 1830 hrs.
- 22 May Madushan Reservoir: Conduct pedestrian reconnaissance along southern shoreline of reservoir. Walk from Man Ban Bridge for 5.0 miles, return along same route as far as Fish Camp Cove and meet vehicle (1300-1730 hrs). Suboptimal survey conditions: Intermittent light rain throughout afternoon, brisk winds from SE, light chop on reservoir. Additionally, weekend fishers posted in every cove where turtle sightings are most likely. Search personnel: Mrs. Bai, Ma Xiao Hui, and SGP. Search effort: 3 persons \times 4.5 hours = **13.5 person hours**.
- 23 May Madushan Reservoir: Conduct pedestrian and vehicle-borne reconnaissance on southern shoreline of reservoir. Pedestrian group walked from Man Ban Bridge to Rock Quarry and returned to bridge (1200-1630 hrs). Vehicle-borne group drove to Man Gong Village, and then returned, stopping occasionally to scan promising areas (1200-1600 hrs). Suboptimal survey conditions (overcast with intermittent rain and gusty SE winds). Interviewed local fisherman who resides in hillside village above Turtle Cove. This individual claimed that a large softshell turtle weighing about 50 kg was killed 3-4 years ago and the meat sold in area villages. According to the fisherman, at least one large softshell turtle is observed in the reservoir every year, although none have yet been sighted in 2016. Returned to Honghe ca. 1730 hrs and visited fish farm where *Rafetus swinhoei* will be kept if captured. Four ponds of various sizes (each about 2 m deep with mud bottoms) are available for use if the need arises. Search effort: (2 persons \times 4.5 hours) + (3 persons \times 4.0 hours) = **21.0 person hours**.
- 24 May Honghe: Heavy monsoonal rains force cancellation of planned fieldwork at Madushan Reservoir. Professor Rao returns to Kunming. Prepare extension request for Chinese alligator project. Hike to ridge above Honghe and search for birds; little of interest observed owing to inclement conditions.

- 25 May Madushan Reservoir: Established two bait stations in hopes of attracting turtle. Each station consisted of two large Tilapia obtained from the fish market in Honghe this morning. The fish were tied together and suspended on a line at the water's surface. Fish entrails were scattered about the suspended fish. Stations were established at Fish Camp Cove and Turtle Cove and kept under surveillance until 1845 hrs. Pedestrian survey also conducted along shoreline from Turtle Cove to abandoned rock quarry near Man Gong Village and back. Search effort: $(2 \text{ persons} \times 5.25 \text{ hours}) + (1 \text{ person} \times 5.75 \text{ hours}) = \mathbf{16.25 \text{ person hours}}$.
- 26 May Madushan Reservoir: Stopped at roadside fish market in Long Dun to purchase fresh fish for bait. Two small softshell turtles (CL = 60 mm; one alive, the other dead) being offered for sale in market. According to the fishmonger, the turtles were captured locally in the Red River/Madushan Reservoir. Recovered fish from bait stations established yesterday. Fish were intact with no sign of feeding by turtles. Fresh bait (*Sawbelly*; *Hemiculter* sp.) placed at each station and monitored throughout the afternoon and early evening; one person assigned to monitor each station. Pedestrian survey conducted by SGP from Turtle Cove to abandoned rock quarry near Man Gong Village, and back to Man Ban Bridge. Intermittent rain throughout afternoon. Search effort: $3 \text{ persons} \times 6.25 \text{ hours} = \mathbf{18.75 \text{ person hours}}$.
- 27 May Madushan Reservoir: Stopped at roadside fish market in Long Dun and purchased four Carp for turtle bait. Replaced bait at each station; fish carcasses remained intact with no evidence of turtle feeding activity. Two searchers detailed to monitor baits throughout the day while SGP conducted pedestrian reconnaissance from Turtle Cove to abandoned rock quarry near Man Gong Village, and back to Man Ban Bridge. Clear skies and beautiful weather, although extremely hot. Search effort: $3 \text{ persons} \times 6.5 \text{ hours} = \mathbf{19.5 \text{ person hours}}$.
- 28 May Madushan Reservoir: Purchase fish (*Hemiculter* sp.) at Long Dun fish market and establish bait stations at Fish Camp Cove and Turtle Cove. Retrieved the baits left out overnight; fish were intact with no evidence of feeding by turtles. As SGP deployed bait at Fish Camp Cove, the driver (standing on bridge) observed the head of a turtle protruding above the surface in shallow water. SGP scrambled back up the steep bridge embankment and from this vantage point was able to observe a submerged turtle moving in the shallow, turbid water below. The turtle never resurfaced and eventually was lost from sight when it entered deeper water. Both SGP and driver concurred that the carapace length measured between 250 and 300 mm. SGP conducted pedestrian reconnaissance from Turtle Cove to the abandoned quarry near Man Gong Village. After a brief respite from the heat, SGP returned along same route and continued

onwards to Man Ban Bridge. Near-optimal search conditions today: clear skies, little breeze, and a glass-like surface on reservoir. That said, air temperatures were ca. 40C and with little shade along the track, the pedestrian survey was brutal. Little other wildlife was observed today, most likely due to the high ambient temperatures. Search effort: 3 persons × 6.0 hours = **18.0 person hours**.

- 29 May Madushan Reservoir: Purchase *Tilapia* and search for turtles at Long Dun Fish market. Water levels up about 0.5 m in reservoir, submerging both bait stations. Fish recovered, but showed no evidence of feeding by turtles. Bait stations reestablished above rising water levels with some difficulty. SGP conducts pedestrian reconnaissance, beginning at Turtle Cove, continuing to Man Gong Village, and returning to Man Ban Bridge. Foul weather hampers survey; intermittent rain throughout day, at times heavy with SE wind and waves on reservoir. Search effort: 4 persons × 5.75 hours = **23.0 person hours**.
- 30 May Madushan Reservoir: Checked baits deployed yesterday; all were intact with no signs of turtle feeding. Water levels continue to rise; > 1.0 m in past two days. SGP conducts pedestrian survey beginning at Man Ban Bridge, continuing to Man Gong Village, and following the same route back to the bridge. Fishermen pre-empted almost every likely basking site in our search area today. Weather: Intermittent rain throughout the day, ending at dusk. SE winds and light chop on the reservoir. Search effort: 4 persons × 6.0 hours = **24.0 person hours**.
- 31 May Madushan Reservoir: Purchased fish (*Hemicultr* sp.) at Long Dun Fish Market and replaced bait at stations; old bait showed no evidence of turtle feeding. Reservoir levels have stabilized. Submerged turtle observed at Turtle Cove (1330 hrs). Turtle remained just below the surface. CL estimated to be < 30 cm. Based on body size, this turtle was almost certainly not *Rafetus swinhoei*. Turtle Cove under surveillance throughout the afternoon, although turtle never reappeared. SGP conducted pedestrian reconnaissance from Man Ban Bridge to Rock Quarry. Significant rock slide brought about by recent rainfall closed track for much of day forcing an early return. Scattered showers, clearing and hot, followed by overcast skies with light winds from SE. Search effort: 4 persons × 5.5 hours = **22.0 person hours**.
- 1 June Honghe: Stand down for day of rest; purchase supplies and attend to administrative duties. Hike to summit of nearby ridge in mid-afternoon. Find and remove illegal bird nets placed to capture nesting bee-eaters.
- 2 June Madushan Reservoir: Purchased fish (*Hemicultr* sp.) at Long Dun Fish Market and replaced bait at stations (Fish Camp Cove and Turtle Cove).

No evidence of turtles feeding on retrieved baits originally deployed on 31 May 2016. Maintained surveillance at bait stations until 1900 hrs. SGP conducted pedestrian reconnaissance from Man Ban Bridge to Man Gong Village and returned. Near-optimal search conditions in early afternoon, but cloudy with light rain and wind beginning at 1600 hrs and continuing until dusk. Water level in reservoir dropped about 0.75 m since 31 May 2016. Search effort: 4 persons \times 6 hours = **24 person hours**.

3 June Madushan Reservoir: Checked baits deployed yesterday; no signs of turtle feeding. Monitored bait stations at Fish Camp Cove and Turtle Cove. SGP conducts pedestrian reconnaissance from Man Ban Bridge to Man Gong and returned. Suboptimal survey conditions throughout the day. Cloudy to clear in the morning, becoming cloudy with intermittent rainfall throughout the afternoon; brisk wind from NW generating waves on reservoir. Water level in reservoir dropped another 0.5 m in past 24 hours. Search effort: 3 persons \times 6 hours = **18 person hours**.

4 June Madushan Reservoir: Replaced baits at Fish Camp Cove and Turtle Cove with fresh *Tilapia*. No evidence of turtle feeding on bait. SGP conducted pedestrian reconnaissance from Man Ban Bridge to Man Gong Village; returned along same route. Extremely high air temperatures made for an exhausting (and dehydrating) walk. Recovered fresh DOR *Ptyas korros* (TL = 1280 mm) along dirt track. Dissected snake and recovered freshly consumed *Sphenomorphus indicus* (TL = 198 mm) from stomach. Optimal search conditions; clear, hot, and little wind. However, numerous fishermen on lake and most suitable basking sites pre-empted by weekend anglers. Water levels in reservoir continue to fall. Search effort: 4 persons \times 6.25 hours = **25 person hours**.

5 June Madushan Reservoir: Inspected baits deployed at Turtle Cove and Fish Camp Cove yesterday; neither showed any evidence of feeding by turtles. SGP conducted pedestrian reconnaissance from Man Ban Bridge to Man Gong Village and returned along same route. Mrs. Bai reported illegal electrofishing activity in reservoir in past 24 hours. Most electrofishing is said to occur during the late night and early morning. Although illegal, enforcement appears non-existent on reservoir. Water levels in reservoir appear to have stabilized. Search effort: 4 persons \times 6 hours = **24 person hours**.

6 June Madushan Reservoir: Purchase fish (*Hemicultr* sp.) in local fish market and deploy at bait stations in Turtle Cove and Fish Camp Cove. SGP conducted pedestrian reconnaissance from Man Ban Bridge to Eucalyptus Cove along recently opened footpath. Searched additional basking sites not previously accessible. Exhausting and dehydrating walk under blazing sun. Optimal search conditions until late afternoon when wind speed

increased, spawning light chop on reservoir. Search effort: 4 persons \times 6 hours = **24 person hours**.

- 7 June Madushan Reservoir: Deploy three additional fish (Carp) at bait station in Turtle Cove and hire local farmer to monitor station overnight. Meet Dr. Wang Jian (Honghe University) at Man Ban for lunch. At his suggestion we drove south along the Red River to Hekou. Between Mang Hao and Hekou the Red River forms the international boundary between China and Vietnam (approximately 100 km). Because of the sensitive nature of this area, few boats are allowed on the river and little fishing occurs. Dr. Jian suggested this "neutral area" might harbor a small population of *Rafetus swinhoei*. We saw few boats from the road, although there was a surprising amount of sand dredging, especially near Hekou. The status of *Rafetus swinhoei* in this stretch of river warrants further investigation. Returned to Honghe ca. 2100 hrs after a long, hot, and uncomfortable drive.
- 8 June Madushan Reservoir: Replace bait (*Hemicultr* sp.) at stations in Fish Camp and Turtle Coves. No activity reported by watchman at bait stations in Turtle Cove. SGP conducted pedestrian reconnaissance from Man Ban Bridge to Eucalyptus Cove and returned along same route. Encountered Treeshrew along track above Eucalyptus Cove. Search conditions suitable; heavy rains overnight but clear to partly cloudy today with moderate SE winds resulting in some chop on surface of lake. Search effort: 4 persons \times 6 hours = **24 person-hours**.
- 9 June Madushan Reservoir: New bait not deployed at stations; however, both stations monitored throughout the afternoon. SGP conducted pedestrian reconnaissance from Man Ban Bridge to outskirts of Man Gong Village and returned along same route. Extremely hot and humid day with brisk wind from SE. Chinese holiday (Dragon Boat Festival) and large numbers of recreational fishermen were present on reservoir. Search effort: 5 persons \times 4 hours = **20 person-hours**.
- 10 June Madushan Reservoir: Bait stations monitor, but fresh bait not deployed. SGP conducts pedestrian reconnaissance from Man Ban Bridge to Eucalyptus Cove and back. Group monitoring bait station at Turtle Cove observed turtle at 1500 hrs. Sighting described as a dark shadow moving just below the surface for several minutes. Search effort: 6 persons \times 6.5 hours = **39 person-hours**.
- 11 June Travel by road from Honghe to Kunming (0900-1700 hrs).

Appendix 2: Gazetteer: Geographic coordinates (latitude and longitude) and elevation (feet) of localities mentioned in the text. Place names in agreement with local usage; listed alphabetically in gazetteer. Geographic coordinates determined with Garmin GPS 76 (WGS 84 Datum).

Location	Latitude (N)	Longitude (E)	Elevation (feet)
Abandoned Rock Quarry	23°06.68′	103°05.27′	815
Eucalyptus Cove	23°06.81′	103°05.02′	785
Fish Camp Cove	23°05.68′	103°08.88′	750
Hobby Cove	23°05.63′	102°09.21′	830
Honghe	23°13.21′	102°50.16′	800
Kingfisher Cove	23°06.27′	103°06.21′	760
Long Dun	23°10.99′	102°57.28′	900
Madushan Dam	23°02.75′	103°17.20′	650
Man Ban Bridge	23°05.74′	103°09.57′	715
Mang Gong	23°06.27′	103°05.43′	825
Rock Quarry	23°06.25′	103°06.36′	770
Turtle Cove	23°05.92′	103°08.12′	820