

## Habitat Selection and Conservation Suggestions for the Yangtze Giant Softshell Turtle (*Rafetus swinhoei*) in the Upper Red River, China

WANG JIAN<sup>1,2,3</sup>, SHI HAI-TAO<sup>2</sup>, WEN CHENG<sup>4,5</sup>,  
AND HAN LIAN-XIAN<sup>4,6</sup>

<sup>1</sup>Chengdu Institute of Biology, Chinese Academy of Sciences,  
Chengdu 610041, China [cuora.jian@gmail.com];

<sup>2</sup>College of Life Science, Hainan Normal University, Haikou  
571158, China [haitao-shi@263.net];

<sup>3</sup>University of Chinese Academy of Sciences,  
Beijing 100049, China;

<sup>4</sup>Honghe University, Mengzi, Yunnan 661100, China;

<sup>5</sup>School of Life Science, Peking University, Beijing 100871, China  
[ailaowolf@gmail.com];

<sup>6</sup>College of Life Science, Southwest Forestry University, Kunming  
650224, China [lianxian.han@gmail.com]

**ABSTRACT.** – Exhaustive interview surveys were carried out on the upper Red River (Honghe) and nearby river systems of southwest China to characterize the distribution of *Rafetus swinhoei*, one of the rarest turtles in the world. The results show that the species once ranged strictly in the Red River system, apart from the lower Yangtze, and still existed in recent years, although it was on the brink of extinction due to overharvesting and habitat degradation. Further conservation efforts require monitoring of the hunting and trade of turtles in this region, public education, delaying the building of dams, setting up new protected areas, and international cooperation.

*Rafetus swinhoei* (Gray 1873), commonly known as the Yangtze giant softshell turtle, Red River giant softshell turtle, or Swinhoe's softshell turtle, is one of the largest freshwater turtles in the world. It is listed as one of "The world's 25+ most endangered tortoises and freshwater turtles" by the Turtle Conservation Coalition (2011). There are only 4 live individuals of the species known to exist now: a pair in Suzhou Zoo of China, a huge male that lives in the Hoan Kiem Lake of downtown Hanoi, Vietnam, and another male that lives in Dong Mo Lake, west of Hanoi, Vietnam (Turtle Conservation Coalition 2011).

Early surveys (Tao and Wang 2004) in the developed Yangtze basin did not find any evidence of the giant softshell turtle remaining in the wild. An individual living in Shanghai Zoo identified as *R. swinhoei*, which came from Gejiu Zoo of Yunnan in 1971, suggests the last wild *R. swinhoei* survived in the Red River (Honghe) of southwest China (Wang and Shi 2011). Other than studies that concern taxonomy (Farkas and Webb 2003) and captive breeding (Ma et al. 2007), we know very little

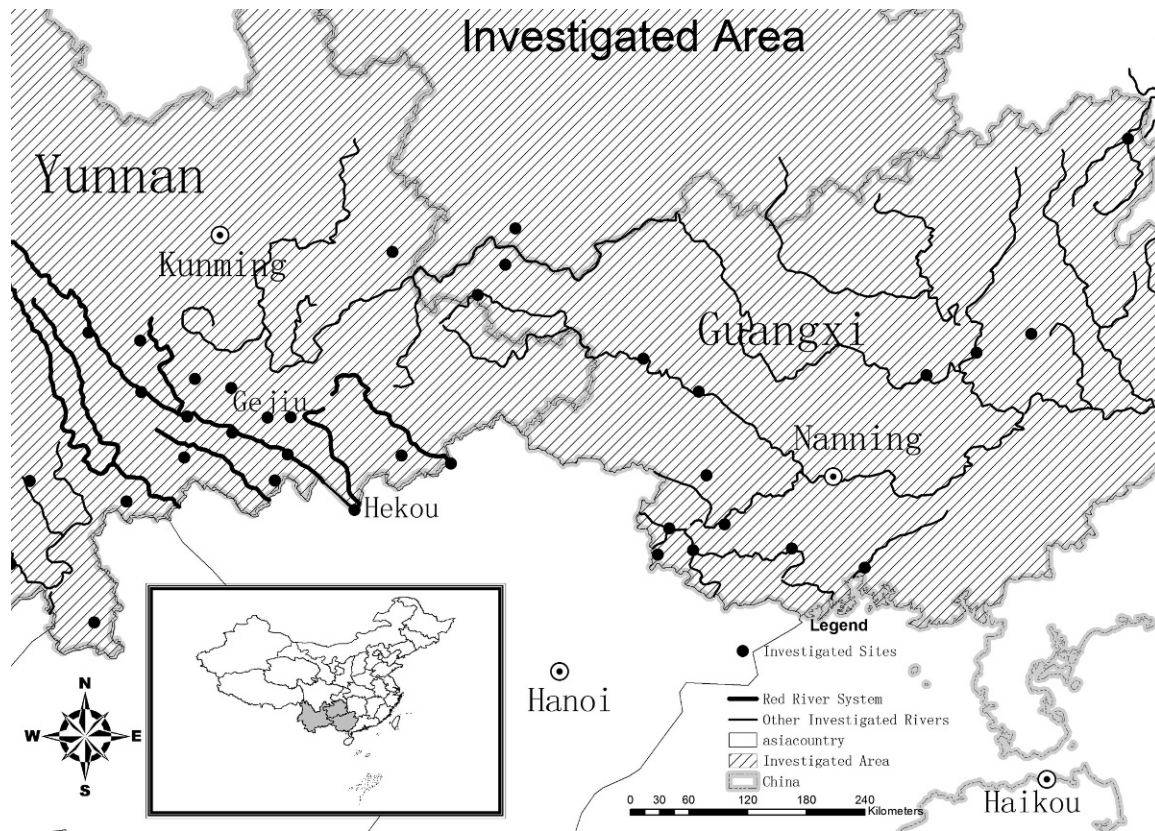


Figure 1. Investigated area in southwest China.

about the field status and biology of *R. swinhoei*. To pursue conservation and management of this species, exhaustive surveys for the last wild *Rafetus* in southwest China were conducted from 2007 to 2010.

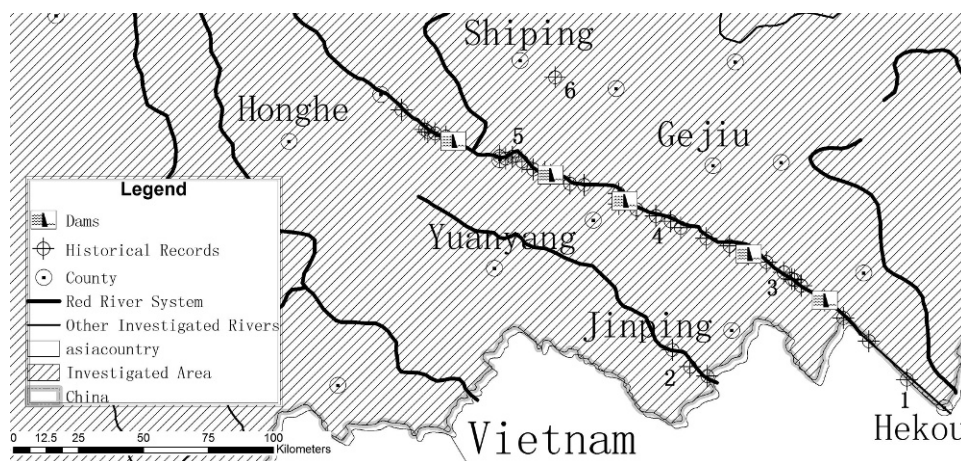
## METHODS

*Survey of Distribution and Status.* — We visited 38 counties in 3 provinces (Yunnan, Guangxi, and Guizhou) that cover the mainstems, largest tributaries, and floodplain lakes of the Mekong, Red, Pearl, Qinjiang, and Xiangjiang rivers (the last being the southernmost tributary of the Yangtze River) from 2007 to 2010 (Fig. 1). We interviewed fishery, wildlife, and nature reserve management authorities, experienced fishermen, and turtle farmers, and also investigated the use of food, traditional Chinese medicine, and pet markets in every county if possible. One hundred questionnaires were also handed out to the college students from southeast Yunnan and northern Vietnam at Honghe University. Field investigations focused mainly on the villagers living along the Red River and its tributaries, from Xinping County at the middle reaches to Hekou County on the China–Vietnam border, 350 km southeast of Xinping. Eighty-two communities from county towns to villages were visited, whereas approximately 960 individuals were questioned in semistructured interviews. To eliminate the

stress and worry of interviewees, local officials were invited to serve as middlemen and interpreters in most cases. We also visited knowledgeable people from local zoos, schools, institutes, and departments of government to gain information regarding the distribution of *R. swinhoei*.

During the interview, the interviewee was first asked to freely give a brief description of the variety of native turtles and their local names, features, and capture methods. Then, the interviewer classified and listed the contents from each interviewee's description and asked the subject to confirm the items one by one to find out whether there was any duplication or conflict, so as to evaluate the reliability of the information. Afterward, the interviewer showed pictures of different turtles (including some species absent from the area, e.g., *Amyda cartilaginea*) to the interviewee and asked him to identify them, so as to further verify the reliability of his responses. Each clearly credible interviewee was then asked to give detailed accounts of any capture records of giant turtles (more than 10 kg). Finally, the interviewee was asked to show live turtles, turtle skeletons, and fishing equipment, if he had any.

*Habitat Selection.* — Locations where *Rafetus* had been caught or observed in the past 20 yrs were recorded by using a global positioning system and chosen as occupied plots for habitat selection. The same number of random locations was chosen as contrasting plots. Habitat was studied on the macro level, with 6 geo-



**Figure 2.** Sites (⊕) along the upper Red River where *Rafetus swinhoei* was recorded, with dams and indicated sites: 1, Basa; 2, Mengla; 3, Manhao; 4, Lengdun; 5, Honghe; 6, Yilong Lake.

morphological parameters collected in the usage and contrasting plots: bend (BD), confluence (CF), sandbar (SB), central bar (CB), width of river (WR), and distance from nearest man-made structure. The BD, CF, SB, and CB parameters were ranked as 0 (absent) and 1 (presence). WR was ranked as 1, 0–70 m; 2, 70–140 m; and 3, > 140 m; and distance from nearest man-made structure was ranked as 1, 0–500 m; 2, 500–1000 m; and 3, > 1000 m. Chi-square tests were performed to compare these parameters between occupied and random sites. Logistic regression analysis was used to determine the principal macrohabitat components associated with the presence of *R. swinhoei*. All analyses were performed by using SPSS.

## RESULTS

*Distribution and Status.* — Results of interviews from the general survey have drawn the outline of distribution of *R. swinhoei* in southwest China, although no specimens have been seen recently in markets or turtle farms. Very few traders and restaurant keepers living along the Red River admitted to having sold or seen this species before. Responses from college students at Honghe University showed that nearly all of the younger generation had never heard about the giant turtle in their hometown along the Red River. Interviews with local villagers living along Red River and its tributaries revealed more information about this turtle.

There are 4 sympatric species of softshell turtles living in southern China and northern Vietnam. The Swinhoe's turtle has been extensively confused with other turtles, in particular, large softshells of the genus *Pelochelys*. The Chinese softshell turtle (*Pelodiscus sinensis*) is rather small, with a carapace length of only 20–25 cm. *Palea steindachneri* is larger (up to 43 cm), and the adults have extensive patches of wattles at the bases of their necks (Shi et al. 2008). Young *R. swinhoei* are virtually unknown,

apart from the dated specimen in European museums (the type specimen from Taihu Lake, Gray 1873, and a slightly larger specimen from Hanoi, Farkas 1992). No juvenile *Rafetus* specimen has been obtained from upper Red River populations, and the local people cannot identify softshell hatchlings and subadults to species.

Most of the local people living along the upper Red River belong to the Dai/Thai ethnic group. All of the descriptions from them point to the common varieties. No *P. cantorii* or any species of hardshell turtles exist in the upper stream in places occupied by the Dai people, except the border river in Hekou County. Softshells from the Red River can be classified into 2 categories by Dai people: *fa* or *ba fa* (*luan yu* in Chinese, meaning “round fish”), which are of smaller size, and *dao* (*wu gui*, which means black hardshell turtle in Chinese as well as in Thai and Lao), which is a softshell turtle that grows to a gigantic size. Combined with the description of its morphology and materiel evidence remaining, *dao* is not a hardshell turtle, but *Rafetus*! Although some old Cantonese speakers living in Hekou called *P. cantorii sha bie* (sandy softshell), just as along the Pearl River in Guangxi and Guangdong provinces, they also named the endemic *R. swinhoei hua tou mei* (spotted head turtle), which perfectly demonstrated its characteristics. We can be sure that all of the *dao*, *wu gui*, and *hua tou mei* mentioned by local people living along the upper Red River must refer to *R. swinhoei*.

*Pearl, Qinjiang, Xiangjiang, and Upper Mekong Rivers.* — Our survey in these areas did not find any information that relates to *R. swinhoei*, but there are verified locations in the tributaries of the Pearl River and upper Mekong where *P. cantorii* remained until recently.

*Yilong Lake.* — Yilong Lake lies on the Yunnan Plateau east of the Red River Valley at an altitude of 1415 m. Hydrologically and historically, it is part of the Pearl River, although, in 1971 a man-made tunnel was drilled through the watershed that transferred its water into the Red River. Later, in 1981, the lake dried up and a giant softshell turtle that weighed approximately 88 kg

**Table 1.** Specimen records of *Rafetus swinhoei* from the upper Red River.

Preserved location <sup>a</sup>	Capture location	Yr	Carapace length (mm)	Carapace width (mm)	Weight (kg)	Notes
Shanghai Zoo	Lengdun, Gejiu	1971	~ 1500	Unknown	~ 115.0	Died in 2006
CMNH	Gejiu	1978	500	470	Unknown	Died in 1978
SMNH	Gejiu	1970s	800	660	70.0	Cited: Zhang et al. 1998
SMNH	Gejiu	1970s	Unknown	Unknown	Unknown	Cited: Zhang et al. 1998
Beijing Zoo	Unknown	1987	~ 500	Unknown	Unknown	Died in 2005
Qingmuli, Yuanjiang	Longdong, Yuanjiang	1988	446	398	~ 40.0	Private
Honghe County	Ma'anzi, Honghe	~ 1988	~ 500	~ 400	~ 38.0	Private

<sup>a</sup> CMNH = Chongqing Museum of Natural History; SMNH = Shanghai Museum of Natural History.

was caught in the bottom of the lake and sent to the county-operated fishing farm, where it died a few days later. Our interview with the head of the farm revealed that there was a metal ring around a hind leg of the turtle, which implies that it may have been released by someone. There were no other turtles similar in appearance found when the lake dried up, which further suggests that the turtle was introduced to Yilong Lake.

*Upper Red River.* — The Red River (*Honghe* or *Yuanjiang* in Chinese, *Song Hong* or *Hong Ha* in Vietnamese) originates from the Ailao Mountains in central Yunnan and flows through the deep gorge in southeast Yunnan and settles on the fertile floodplain of north Vietnam. Many tributaries emanate from the Yunnan

Plateau and flow out of the boundary independently, joining the main river in the Vietnamese floodplain.

*Rafetus swinhoei* was reported only below Bahong Village of Yuanjiang County in the mainstem Red River, 265.9 km from Hekou on the China–Vietnam border. Some distributaries, including the Nanxi, Tengtiao, and Panlong rivers, may have maintained *R. swinhoei* 15 yrs ago. We found no evidence of *R. swinhoei* in the upper Lixian River (Black River, *Song Da*) within the Chinese border (Fig. 2).

Softshell turtles used to be abundant according to the local villagers. Indigenous people said they could sometimes see giant turtles basking on the sand bank near their village before the 1960s but were afraid to catch them. We met a retired fisherman at Datun Fishing Farm who joined the professional fishing fleet from 1959 to 1961 located at Manhao town beside the Red River and organized by the Commercial Bureau of Gejiu City. He said that they adopted effective rolling hooks to catch giant catfish and turtles for consumption during the famine. According to official documents, until the fishing corps was dismissed in 1961, more than 500 big softshells were captured from the 100-km river reach between Manhao town and Hekou County. These turtles weighed 25 kg on average, ranging from 2.5 to 75 kg. Undoubtedly, many of them were *Rafetus*.

After the fishing fleet was disbanded, the rolling-hook skills were widely spread to local communities for commercial consumption. The Baohua Park Zoo located at Gejiu received more than 30 *Rafetus* in the 1970s and early 1980s, only three of which were kept alive and then exchanged with other zoos, including the Shanghai Zoo. We found another specimen in the Chongqing Museum of Natural History, which was donated by Chongqing Zoo and which had received this turtle by exchange with Baohua Park Zoo. The third *Rafetus*, which was donated to the Beijing Zoo in 1988 by former chairman of P. R. China Yang Shang-Kun, was said to be from Yunnan. In addition, there are 2 other *R. swinhoei* specimens misidentified as *Pelochelys bibroni* in the Shanghai Museum of Natural History (Table 1).

Interviews in communities along the Red River revealed 2 more skeletons kept by local people, one of them preserved in a small hamlet called Qingmuli in Yuanjiang County (Fig. 3) and the other preserved by a



**Figure 3.** Skeleton of a *Rafetus swinhoei* preserved by a local fisherman at Yuanjiang. Photo by Wang Jian.



**Figure 4.** A *Rafetus swinhoi* saved and released in Yuanyang in 1998. Photo by Chen Gang.

traditional Chinese doctor living in the county town of Honghe. Half of the latter skeleton had been cut up for medicine. After a long period of capture for food, the giant softshell turtle became so rare that, by the 1990s, even rolling-hook fishing was no longer productive. However, new electroshock fishing techniques that focus on small fish, including juvenile and hatchling turtles, were quickly adopted. Two series of photos were found and identified in the fishery department of Honghe Hani and Yi Autonomous Prefecture. One of them showed a female turtle reportedly that weighed 24 kg that had been saved from a restaurant by the forestry and fishery department of Yuanyang County, then identified as *P. bibroni* and released back into the Red River (Fig. 4).

Another turtle was caught in Honghe County around the same time, but the officials of Honghe did not tell us where (Fig. 5). The spotted heads visible in the 2 photos (Shi et al. 2008) suggest they were both *R. swinhoi*.

*Habitat Selection.* — Approximately 33 locations where *R. swinhoi* had been captured or witnessed within the past 20 yrs and that could be confirmed by at least 2 people were suggested to us by local villagers, with 7 reports from 2005 or later. We compared habitat variables for these 33 locations and 33 random contrasting plots. There were significant differences between inhabited and random plots in CF and SB (Table 2), and they were the most important habitat factors for predicting *R. swinhoi* presence (Table 3).



**Figure 5.** A *Rafetus swinhoi* photographed in Honghe in 1998. Photo by Honghe Forestry Bureau. The label “83 Shi Jin” means 41.5 kg.

**Table 2.**  $\chi^2$  tests of the 6 habitat parameters between inhabited and random plots.

Parameters	Status	Inhabited plots ( $n = 33$ )	Random plots ( $n = 33$ )	$\chi^2$ test $p^a$
Bend	Present	5	1	0.197
	Absent	28	32	
Confluence	Present	18	6	0.004*
	Absent	15	27	
Sandbars	Present	32	18	0.000*
	Absent	1	15	
Central bar	Present	3	2	1.000
	Absent	30	31	
Width of river	0–70 m	11	9	0.751
	70–140 m	18	21	
	> 140 m	4	3	
Distance from man-made structure	0–500 m	10	13	0.253
	500–1000 m	12	6	
	> 1000 m	11	14	

<sup>a</sup> \*  $p < 0.01$ .

## DISCUSSION

*Distribution and Status.* — Our study confirms the distribution of *R. swinhoei* in the mainstem upper Red River, Yunnan Province. Compared with some smaller tributaries such as Nanxi and Tengtiao River, no signs of *R. swinhoei* had been found in the upper Lixian (Black River), the largest branch of the Red River, although there are specimen records from Hoa Binh of Vietnam (Pritchard 2005). Its absence may be attributed to the rocky bottom and lack of sand banks in the upper river within the Chinese boundary. When considering that the populations from the Yangtze and Red rivers are conspecific (Farkas and Webb 2003), although there is a big gap between them, we suggest further research in this area (Wang and Shi 2011).

Although several occurrences of *R. swinhoei* were claimed by credible local villagers until recently, we have not spotted any individuals ourselves, owing to the long distances, limited time and personnel, limited water visibility, and high human disturbance. It is likely that the density of *R. swinhoei* is extraordinarily low and that the turtle is on the brink of extinction.

*Habitat Evaluation.* — The analysis of habitat characteristics indicates that *R. swinhoei* prefers rivers with sandbars, in particular, where a tributary flows into the main river. Sandbars are important for softshell turtles to bask and lay their eggs (Kitimasak et al. 2005)

**Table 3.** Logistic regression analysis of the 6 habitat parameters.

Parameters <sup>a</sup>	$\beta$	SE	Wald $\chi^2$	$p^b$
BD	2.006	1.598	1.576	0.209
CF	1.116	0.671	2.765	0.096
SB	3.140	1.186	7.014	0.008*
CB	1.026	1.146	0.802	0.371
WR	0.144	0.531	0.074	0.786
DM	0.202	0.383	0.278	0.598
Constant	−3.551	1.348	6.937	0.008

<sup>a</sup> BD = bend; CF = confluence; SB = sandbar; WR = width of river; DM = distance from nearest man-made structure.

<sup>b</sup> \*  $p < 0.01$ .

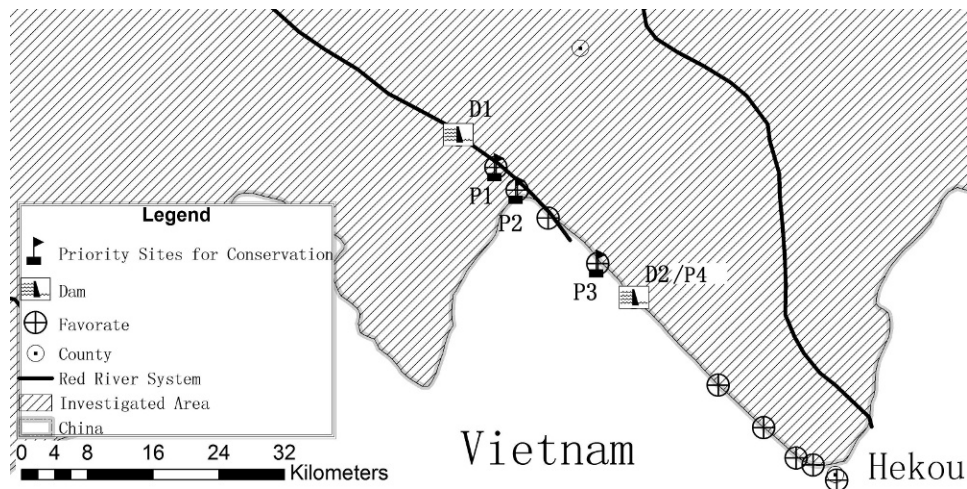
and the confluence may create deeper water and abundant food, and also additional sandbars. This habitat selection is also shown by *P. cantorii* (Wu and Wang 1987) but differs in *R. euphraticus*, which prefers shallow water in Turkey and Iran (Taskavak and Atatur 1998a; Ghaffari et al. 2008). We suppose that the difference may be owing to the smaller size of *R. euphraticus*, which has a carapace length of less than 68 cm (Taskavak and Atatur 1998b).

In addition to overharvesting, another major threat to *R. swinhoei* is habitat degradation. Villagers claimed to have seen 2 *R. swinhoei* basking near Zhala Village of Jianshui County in 2003 and 3 near Yuni Village in 2003. However, nobody has seen a giant softshell turtle again since 2006, the year in which the sandbars were flooded by the reservoir formed by the Nansha Hydropower Plant.

Dams reduce water flow while dividing the species' population into smaller segments, which make it more difficult for the last survivors to mate with each other. If survivors can manage to live in the deep water of reservoirs, then they will still find it difficult to find any suitable place for nesting in a river that consists of a series of end-to-head lakes with limited sandbars for basking, similar to the situation of *R. euphraticus* in Turkey (Gramentz 1991; Taskavak and Atatur 1998a) and *Chitra* spp. in Thailand (Kitimasak et al. 2005). Besides the profound impacts of the dams to downstream areas, such as anomalous flood and lower water temperatures (Gramentz 1994; Kitimasak et al. 2005), the remnant population in northern Vietnam would also be greatly affected.

Nansha Dam is only 1 of 12 planned dams on the mainstem Red River. Within the historical distribution range of *R. swinhoei*, 5 more dams are under construction, in Luodie, Daheigong, Nansha, Madushan, and Xinjie. After all these hydropower plants are completed, approximately 29 historical record locations (88% of the total), 197 km of river (74% of the total), and 27 km<sup>2</sup> of habitat (73% of the total) may be flooded, as evaluated when using Google Earth Pro.

Any habitat with both sandbars and confluence may be considered favorable habitat for *R. swinhoei*. There are



**Figure 6.** Favored habitats, proposed dams, and prior protected sites: ⊕, Favorable sites; D1, Xinjie Dam; D2/P4, Dawan; P1, Kafang; P2, Wuguitan; P3, Nanping.

9 favorable habitats below the Xinjie Dam that may not be flooded directly, including Kafang, Wuguitan, Longbo confluence, Nanping, Dawan, Tropical Crop Institute, Dongping, Beishan, and Nanxi confluence. Among them, the Longbo confluence is highly disturbed by mining, and both Tropical Crop Institute and Dongping are heavily cultivated for bananas on the sandbars. The Nanxi confluence lies between the downtown of Hekou and Lao Cai and Beishan will be the new town of Hekou. This leaves 4 sites, Kafang, Wuguitan, Nanping, and Dawan, which have the highest priority to be protected (Fig. 6). If the proposed Dawan Dam is built, however, all of the remaining suitable habitat for *R. swinhoei* will be lost in China.

*Further Conservation.* — The upper Red River is the last hope for wild Swinhoe's turtles to survive in China. Several primary research projects that involved local communities and authorities have been achieved in this area. After our visit, some officials and villagers gave us new clues of suspected softshell turtles, although all of them have now been clarified as *P. sinensis*.

Future work to find live specimens of *R. swinhoei* must be continued. We recommend that fishery and wildlife departments monitor turtle hunting and trade, and promote education to increase public awareness. The proposed Dawan Dam on the border river must be delayed and new protected areas should be set up on the 4 identified sites with the highest priority. If any live specimens can be found, then they should be temporarily kept in captivity. Stakeholders, including authorities, experts, and local communities should be gathered to discuss any such case. If the health condition of the turtle is good and there is suitable habitat and community support, then we suggest releasing the turtle where it was caught or in identified favored sites with a satellite or radio transmitter, tracking, and studying it. If it is not safe to release the turtle back into the wild, then it may be taken into captivity to try to mate it with other captives.

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