

A Survey of Reeves' Turtle (*Mauremys reevesii*) in Qichun County, Hubei Province, China

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ABSTRACT. – Reeves' turtle (*Mauremys reevesii*) originated in China and was once one of the most widely distributed and abundant hard-shelled turtles in China; however, overharvesting has led to a sharp decline in its wild populations. A survey of Reeves' turtle was conducted from July 2021 to March 2022 in Qichun County, Hubei Province, China. A total of 74 individuals were caught in 26 ponds (1078 trap-days), indicating a catch effort population density of 0.07 individuals/trap-day. The 840 similar ponds in the field-surveyed towns indicate a population number of 2391 individuals and density of 4 individuals/km². Our preliminary results suggest that Reeves' turtle populations face serious threats from human hunting activities, habitat destruction, and artificial release and urgently require an aggressive conservation program to ensure their survival.

KEY WORDS. – Reeves' turtle; *Mauremys reevesii*; conservation; overexploitation

Reeves' turtle (*Mauremys reevesii*) is an aquatic species of medium size, widely distributed in central and eastern continental China (Zhao and Adler 1993). It is one of the most widely distributed and abundant turtle species in China (Sowerby 1925; Pope 1935); its Chinese name “Wugui” is used by most Chinese people to refer to all species of hard-shelled turtles. However, Reeves' turtle, similar to most turtle species, faces the risk of extinction due to the demands arising from the pet, food, and traditional Chinese medicine markets (van Dijk et al. 2000; Rhodin et al. 2018). It was a common species in food markets in China in the 1970s and early 1980s; however, it gradually disappeared from Chinese markets at the end of the last century (Lau and Shi 2000). Overharvesting has led to a sharp decline in wild populations and Reeves' turtle has disappeared from at least half of its original distributional areas due to targeted capture (Lovich et al. 2011). It is listed as Endangered by the International Union for Conservation of Nature (International Union for Conservation of Nature 2022) and is listed as Wildlife Under Second-Class Protection under China's special state protection (National Forestry and Grassland Administration of the People's Republic of China [NFGA] and Ministry of Agriculture and Rural Affairs of the People's Republic of China [MARA] 2021).

There is little data available on wild populations of Reeves' turtle in China. Takenaka and Hasegawa (2001) captured 1123 individuals on Ishima Island (1.9 km²), Japan, and estimated the total number to be 1179. Noda and Kamata (2004) carried out a survey in Ishikawa Prefecture, Japan, capturing a total of 61 individuals. According to the survey results of Song et al. (2014) in national parks and nearby areas in South Korea, a total of 29 individuals were captured. However, Reeves' turtles in these areas are assumed to have been introduced and are

not indigenous (Lovich et al. 2011). Unfortunately, there is a lack of ecological data on the wild populations of this endangered species in China, where it shows the largest natural distribution and population. Chen and Lue (2010) captured 20 individuals in Kinmen Island, Taiwan; however, no survey of Reeves' turtles in wild populations has been conducted on the Chinese mainland.

Over the past decade, our turtle research team has conducted a number of pilot surveys of wild Reeves' turtles without finding a wild population; thus, we speculate that populations of this species in mainland China are endangered. A population survey of the Reeves' turtle is necessary to highlight the urgency of its conservation in China.

It was not until 2021 that we found a wild population of this species, located in Qichun County, Hubei Province. Qichun County is the hometown of Shizhen Li, a prominent traditional Chinese medicine expert who was born 500 yrs ago during the Ming Dynasty. His well-known medical scripture, *Compendium of Materia Medica*, included turtles as medicinal materials that were recorded as “modern nourishing party often use, usually with turtle shell” for extensive, long-standing use of the Reeves' turtle (Xiao and Wang 2012). However, it is not clear about the population status under the high utilization pressure in Qichun County. Therefore, our survey results can illuminate the wild population status of the Reeves' turtle and provide a preliminary point of reference for the conservation of this species in China.

METHODS

Interview Surveys. — An initial interview survey concerning Reeves' turtle was conducted from July 2021 to May 2022 in Qichun County (lat 29°59'–30°40'N, long

115°12'–115°56'E). We sampled 7 towns, accounting for 50% of the townships in Qichun County. A total of 109 people were interviewed, including 24 fish farmers, 2 turtle farmers, 1 turtle trader, 65 villagers, 7 collection station owners, and 10 hunters. This species is a protected animal in China and as a result, the interviewees were sensitive to inquiry. This necessitated 2 or 3 simple, targeted, oral questions for different groups as follows:

Villagers were asked the following questions: 1) Have you seen any Reeves' turtles? 2) If yes, when did you last see any? 3) Is there any difference in the number of turtles now compared to that of the past? Fish farmers: 1) Did you harvest any Reeves' turtles in fish ponds while fishing? 2) If yes, when did you last harvest any? Collection station owners: 1) Did you collect wild turtles? 2) If yes, how many turtles might you receive annually? Pet traders: 1) How many turtles are handled each year? 2) How many of these individuals are from the wild? Turtle farmers: 1) Did you buy any wild individuals for breeding purposes? 2) If yes, when did you last buy any?

Field Surveys. — Field surveys were conducted from July to October 2021. Long rectangular nylon cages were arranged (length 300 cm, cross-section 30 × 20 cm) in each pond to capture turtles. The fish and shrimp that came into the cage became natural bait for the turtles. We determined the sex and measured the weight and carapace length of captured turtles. At the end of the study, all turtle cages were removed to prevent harm to local wildlife.

The population density of Reeves' turtle was expressed as the relative population density (RPD; catch per unit effort) and minimum population density (MPD; total count) on the basis of data from 2021 using the following formulas:

$$\text{RPD} = n/\text{trap-day} \quad [1]$$

$$\text{MPD} = N/a \quad [2]$$

$$N = n \times p_1/p_2 \quad [3]$$

where n is the number of turtles caught, N is the estimated number of turtles in the surveyed towns, p_1 is the number of ponds surveyed, p_2 is the number of ponds within the surveyed towns that are similar to the ponds we surveyed, and a is the area of the surveyed towns.

Females with mean carapace lengths > 110 mm were regarded as adults, based on the minimum carapace length (110.2 mm) seen in captured individuals that laid eggs (R.B., unpubl. data, 2021). Males with mean carapace lengths > 87 mm were regarded as adults, based on the minimum carapace length (87.4 mm) seen in captured individuals that participated in mating (R.B., unpubl. data, 2021).

RESULTS

Interview Surveys. — The survey results showed that 96% (23/24) of fish farmers had caught turtles in their

ponds; among these farmers, 96% (22/23) had not caught turtles for more than 10 yrs, with only 1 farmer catching a single turtle in December 2021, indicating that turtle populations had dropped significantly. The turtle farmers admitted that they bought wild Reeves' turtles from the market every year but were reluctant to state actual numbers. The turtle (pet) trader who was surveyed cryptically indicated that they handled at least 100 turtles per year and only wild individuals, which are more expensive and easier to sell. Of the 92% (60/65) of villagers who said they had seen turtles basking, 93% (56/60) of them had not seen turtles for more than 10 yrs and only 7% (4/60) had seen turtles during the past 5 yrs (2017–2021). It should be noted that the villagers who had not seen turtles were young (no more than 35 yrs old) and performed little agricultural activity, which may explain why they had not seen a turtle. All of the collection station owners (7/7) indicated that they buy wild turtles and receive more than 100 wild Reeves' turtles per year. Furthermore, almost every village had a similar collection station. Lastly, 60% (6/10) of hunters reported catching between 50 and 100 Reeves' turtles per year and 40% (4/10) reported catching more than 100 individuals; however, they were reluctant to disclose exact numbers. Additionally, they reported that the number of individuals caught was dwindling each year. During our investigation, we found that 2 hunters had more than 50 turtles caught from the wild in their homes; therefore, we conclude that the annual number of turtles caught by hunters is very large.

Field Surveys. — A total of 74 individuals were caught in 26 ponds (1078 trap-days) that were distributed at altitudes between 69 and 150 m above sea level, indicating an RPD of 0.07 individuals/trap-day. Of the 3 towns (618 km²) we surveyed, about 840 ponds were similar to those we surveyed. So we estimated the number of individuals in the 3 towns to be 2391, indicating an MPD of 4 individuals/km². The overall sex ratio was 1:2.4 (22:52; Fig. 1), which was significantly female-biased ($\chi^2 = 12.16$, $p < 0.001$). The sex ratio of mature individuals was 1:2.1 (14:30; Fig. 1), which was significantly female-biased ($\chi^2 = 5.52$, $p = 0.016$). The ratio of adults to juveniles was 1.5:1 (44:30; Fig. 1).

The average body mass of turtles was 236.83 ± 200.90 g (range, 34.8–1015.1 g; Fig. 2) and the average carapace length was 107.63 ± 29.17 mm (range, 58.74–197.46 mm; Fig. 3). The average body weight of mature males was 144.91 ± 41.67 g (97.8–235.7 g) and their average carapace length was 98.42 ± 9.84 g (87.4–119.28 g). The average body weight of mature females was 409.95 ± 213.91 g (197.6–1015.1 g; Fig. 2) and their average carapace length was 135.47 ± 22.11 mm (110.2–197.46 mm; Fig. 3).

Reeves' turtles were captured close to human settlements. In total, 107 nylon cages were found in ponds and streams where turtles were captured and often drowned.

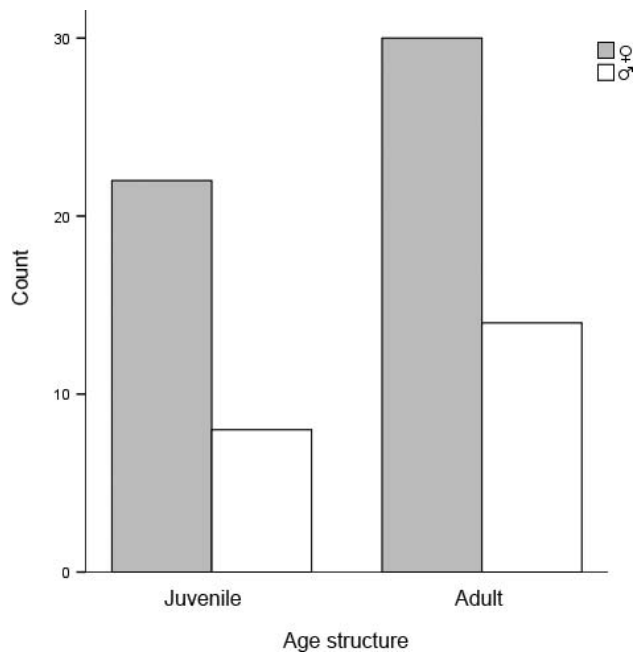


Figure 1. The age structure of Reeves' turtles captured during field surveys in Qichun County, Hubei Province, China.

DISCUSSION

Population Density and Population Structure. — The survey investigated the distribution of wild populations of Reeves' turtle in various villages and towns. Although past surveys have proved that the turtle is widely distributed in Hubei Province (Dai et al. 2011), there is a lack of specific field studies and our results prove that at least it is widespread in Qichun County. We captured 74 individuals in 26 ponds, and estimated the number of individuals in 840 similar ponds in the 3 towns surveyed to be 2391, with

a density of 4 individuals/km². To be clear, in order to calculate the density in this area, we assumed that the other 840 similar ponds had the same density, but from our observations this should be higher than the actual density because we specifically selected the highest density area for our study. This population density is much lower than that on Ishima Island, Japan, where 1179 individuals were estimated in 1.9 km² (621 individuals/km²). In addition, Noda and Kamata (2004) captured 61 individuals from Ishikawa Prefecture, Japan; Song et al. (2014) captured 29 individuals from national parks and nearby areas in South Korea. However, it is not clear how much area they surveyed, so comparisons cannot be made. The wild turtle population in our survey area still has some density, but it is one of the highest population densities in China. Moreover, our aim is to capture individuals for ecological research, so the survey was conducted under the guidance of experienced local hunters in an area with a high density of Reeves' turtles, which resulted in a slightly higher density than the actual density, reflecting the endangered status of the Reeves' turtle in China.

There was a significant female bias in mature individuals (14:30), which may have an impact on the long-term sustainability of the population. The results of a survey conducted by Takenaka and Hasegawa (2001) on Ishima Island indicated a male-biased sex ratio (833:214, approximately 4:1), suggesting increased female mortality during overwintering. Similarly, there is a male-biased sex ratio on Kinmen Island (Chen and Lue 2010), which may make it difficult to maintain the population over the long term. By contrast, a survey in South Korea indicated a uniform sex ratio (12:17; Song et al. 2014), and an investigation of Reeves' turtles in Ishikawa Prefecture conducted by Noda and Kamata (2004) also showed a

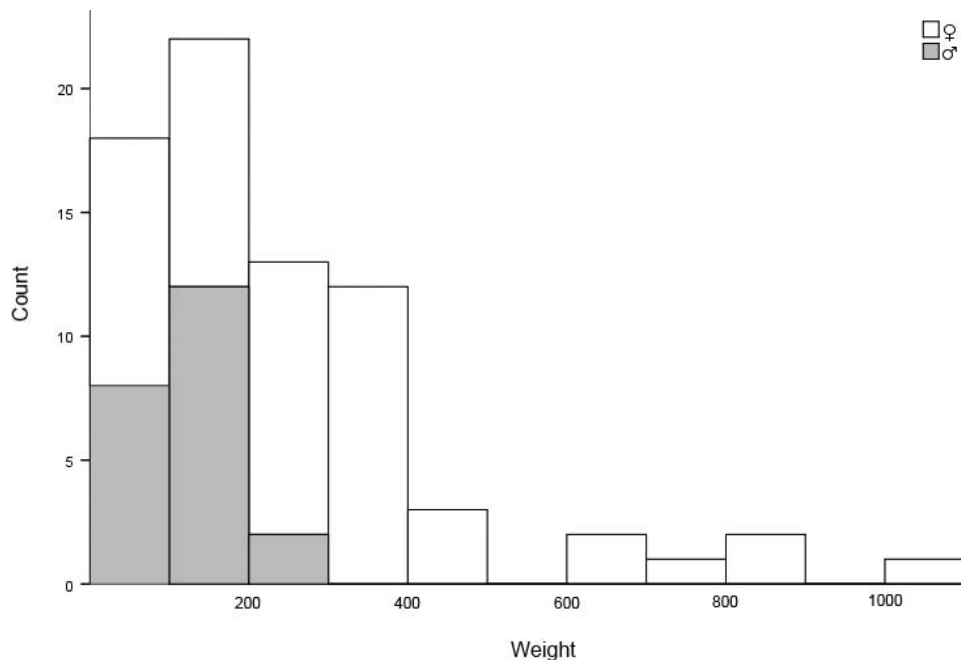


Figure 2. The body mass of Reeves' turtles captured during field surveys in Qichun County, Hubei Province, China.

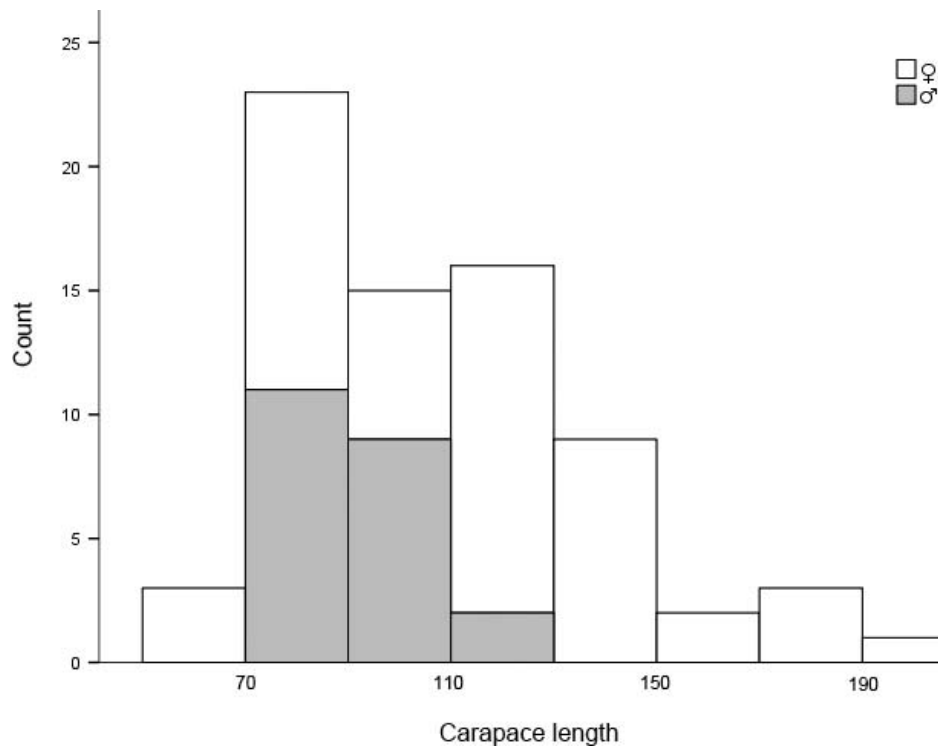


Figure 3. The carapace length of Reeves' turtles captured during field surveys in Qichun County, Hubei Province, China.

uniform sex ratio (27:26), which is beneficial for maintaining the population stability of this species.

The maximum carapace length (male: 119.28 mm; female: 197.46 mm) and body mass (male: 235.7 g; female: 1015.1 g) observed in our survey were smaller than those of the Japanese (Yabe 1994; Noda and Kamata 2004) and South Korean populations. Yabe (1994) reported on a population in Gifu Prefecture, Japan, where the maximum carapace lengths of adult males and females were 185.3 and 237.0 mm, respectively. In addition, maximum body weights of 500–600 g and 1600–1700 g in adult males and females, respectively, were observed in a population in Ishikawa Prefecture (Noda and Kamata 2004). Our findings support the assessment of Pritchard (1994), which is that Japanese Reeves' turtles may attain greater carapace lengths than those of Chinese populations. However, Ernst and Barbour (1989) documented an individual female Reeves' turtle in Sichuan Province, China, with a carapace length of 236 mm, which is almost identical to the maximum length in the Japanese population. Thus, further investigation may be required to support the assessment by Pritchard (1994). Nevertheless, the maximum carapace lengths and body masses of the South Korean (male: 154.8 mm, 506 g; female: 202.9 mm, 1100 g; Song et al. 2014) and Japanese populations are larger than those of the population in the present study. This could be due to excessive hunting pressure in our survey area. In past surveys, painted turtle (*Chrysemys picta*) and red-eared sliders (*Trachemys scripta elegans*) were found to have smaller individuals in areas with high

hunting pressure (Close and Seigel 1997; Gamble and Simons 2004).

Threats. — The results of both the interview and field surveys indicate that the Reeves' turtle population is overexploited, with wild Reeves' turtles being caught by hunters in large numbers and being diverted to food, traditional Chinese medicine, and pet markets through collection stations and pet traders. This conclusion is in line with the evaluation made by Lovich et al. (2011). Reeves' turtle, colloquially known as one of the “Qichun four treasures,” is widely used in traditional Chinese medicine and diets (Xiao and Wang 2012). In addition, local farmers catch wild crayfish, eel, and loach in nylon cages, which results in bycatch of Reeves' turtles, which are then sold to local purchase stations. The breeder who was surveyed revealed that some of the individuals he stocked came from the wild, confirming the previous study that showed that the wild individuals were acquired by turtle farmers for supplementary breeding needs (Shi et al. 2007). This species seemed to be minimally affected by pollution from traditional farming and individuals can still be found in turbid ponds and even ponds with unpleasant odors.

Wild Reeves' turtles also experience habitat destruction caused by land development and various changes in inland waters. They are distributed in ponds close to human settlements, which have been developed for farming fish, crayfish, and lotus roots. This proximity results in them being easy to be found and captured when basking or moving. Some people place nylon cages in ponds to target turtles after they see turtles basking. This

practice is a continuing threat to the Reeves' turtle population, as interview surveys confirm that large numbers of turtles are captured annually and fewer adults are available each year. Of course, such habitats would not necessarily elevate the mortality of Reeves' turtles if they were not captured, but capture is the biggest threat they face. However, unlike individuals in the Japanese population, which has been reduced by river changes due to flood control (Usuda et al. 2012), the Reeves' turtles in this study have not been caught in rivers by local hunters for a long time. This is because the turtles do not show a preference for river habitats and are mainly found in ponds; therefore, they are unlikely to be affected by river changes.

Another serious problem is that a large number of turtles are released artificially in the wild. These individuals, whose origin is unknown, mate with the native turtles and produce offspring, which is a prominent problem of genetic contamination of the species (Shi et al. 2007). The apparent wide distributional range of this turtle in China is considered to be partially attributable to artificial translocations (Lovich et al. 2011), from their initial distribution in the Yangtze River and Minjiang River basin (Pope 1935) to their later spread throughout most areas of China except the western and northern regions (Zhao and Adler 1993). Released individuals are not targeted by turtle hunters because they have no trade value and, more importantly, Buddhist beliefs discourage hunters from capturing turtles that have been released for prayer. Another released species is the red-eared slider (*T. s. elegans*), which is regarded as a dangerous invasive species (Invasive Species Specialist Group, Species Survival Commission 2001). The red-eared slider often occupies a dominant position in the food chain resulting in a significant decline in the populations of native turtles (Vilà et al. 2008; Polo-Cavia et al. 2008, 2009). Although we did not capture any in the field survey, the results of the interview survey showed that almost all ponds and rivers have large numbers of this species and they can also be seen basking and floating on the surfaces of ponds.

More seriously for the Reeves' turtle, the local regulatory authorities are evidently not capable of regulating the capture of the species and many wild individuals can be found in the fishing acquisition stations in towns and counties. Although this species is listed as wildlife under second-class protection as per China's special state protection (NFGA and MARA 2021), local regulators apparently do not realize the urgency of protecting it (Bu et al. 2021).

Conclusions. — This is the first study on the wild population of Reeves' turtle in China, providing data for future studies of this species. The results are indicative of the distribution and wild population of Reeves' turtle in various villages and towns and the population is relatively healthy. However, the ongoing negative effects on populations caused by illegal harvesting and habitat destruction have resulted in the rapid decline of Reeves'

turtle populations in recent years and may affect the long-term viability of these populations. This species urgently requires enhanced conservation measures to reduce the threats to them to ensure their survival. In the future, more large-scale specialized population density surveys are necessary to understand the overall population status of this species in China, where it is naturally distributed.

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