



Detailed Final Report

Research and conservation the Critically Endangered turtle (*Cuora bourreti*) and its sympatric species in Bach Ma National Park, Vietnam



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September 2021

Suggest citation: Pham. V. T (2021). Research and conservation the Critically Endangered turtle (*Cuora bourreti*) and its sympatric species in Bach Ma National Park, Vietnam. Technical report to Rufford Foundation.

Top photo: a *Cuora bourreti* observed in village in Phu Loc town, Phu Loc district, Thua Thien Hue

Right hand photo: A wild observed *Manouria impressa* found on top of Bach Ma at about 1300m

Middle photo: a wild *Platysternon megacephalum* found on a stream at more than 700m

Left photo: a village observed *Sacalia quadriocellata* in Phu Loc town, Phu Loc district, Thua Thien Hue

1. Introduction

Chelonians are now the most threatened group of vertebrate animals on the planet (Rhodin et al., 2018; Stanford et al., 2018). There are many causes of the decline of turtles, including the overexploitation of turtles for pet trade or food, traditional medicine, habitat destruction (by massive deforestation) (Cheung & Dudgeon, 2006; Hendrie, 2000; Pham et al., 2018; Pham Van et al., 2019; Rhodin et al., 2018; van Dijk et al., 2000). Southeast Asia is one of the highest hotspot of chelonian diversity on Earth, with 125 species considered as endangered or critically endangered (Mittermeier et al., 2015). Vietnam is in an especially fragile condition with many turtle species being critically endangered (Turtle Taxonomy Working Group et al., 2017). However, there is basically no study about abundance of the various species in the whole region, and our research team has recently started to assess the turtle populations with a standardized methodology for the first time in Vietnam in 2018 and 2019 (Pham et al., 2020). *Cuora bourreti* is a Critically Endangered species with a restricted distribution in central Vietnam and Laos (Pham Van et al., 2019; Stuart et al., 2011). Remnant populations of this species survive essentially in protected areas. Bach Ma National Park is one of the largest protected areas where this species does survive. This project aims at providing population size and conservation ecology, threats of the species and also of the other sympatric turtle species. Therefore, the proposed work will improve the conservation outlook for this species by greatly increasing our knowledge of the species' occurrence, biology, and threats. At the local level, our project will serve to enhance the awareness of local populations toward the conservation of the species, and also to help the National Park management to take corrected decisions for increasing the wild population sizes of an otherwise neglected threatened species.

2. Material and methods

2.1 Study sites

Bach Ma National Park, Hue province, central of Vietnam (geographic coordinates (WGS 84) of 15°59' to 16°16'N and 107°37' to 107°54'E) established in 1986, which situated in the central Annamite mountains with the size of 37,487ha (Lan et al., 2002; Ngo & Ngo, 2013) (Figure 4). The national park lies on a high mountain ridge that runs west-east from the Laotian border to the East Sea at the Hai Van pass (Sourcebook, 2004). The main forest types found within the national park are lowland evergreen forest below 900 m, and montane evergreen forest above this elevation (Gilmour & Nguyễn, 1999). The climate is characterized by a tropical monsoon that dominates a montane rainforest (at 400 to 1,400 m in elevation) and cloud forests from 1,450 m in elevation to the summit (at 1,712 m in elevation), subtropical climates, no dry season, only one rainy season from April-September (Nguyen et al., 2004, p.). This ridge interrupts the coastal plain of Vietnam, and, therefore, forms a biogeographical boundary between the faunas and floras of northern and southern Vietnam (Sourcebook, 2004). Thus, the Bach Ma area has long been known for its highly diversity of flora and fauna with 2373 species and 1715 species respectively (see: http://www.bachmapark.com.vn/gioi-thieu/tai-nguyen-rung_108.html). Within fauna diversity, there are several endangered species have been found in the park such as: *Pygathrix nemaeus*, *Arctictis binturong*, *Megamuntiacus*

vuquangensis, *Lophura edwardsi* and so on. To date, on the website of the park has listed wrong name of the turtle distribution as *Cuora galbinifrons* instead of *Cuora bourreti* (Fritz et al., 2002).

2.2 Methods

Literature has been searching through google scholar, web of knowledge and other data bases. In addition, eventual local grey literature reports even if in Vietnamese, will be scrutinized in order to collect all available data on the species.

2.2.1 Interview survey

The interview survey conducted by the team in early June 2020 in Loc Tri, Phu Loc, Loc Tien, Lang Co, Loc Dien, Loc Hoa, Loc An communes, Phu Loc district, Thua Thien Hue province (Figure 3). There were 88 respondents from local people surround Bach Ma NP have been interviewed. The survey has been using the semi structure interview with basic questions:

- a) Can you list how many turtles you have seen/known in this region? Give local name
- b) Can you describe each species by following questions: is this species was hard shell or softshell? What I the shape of the shell? Does the turtle have serration? How big of the turtle? Does turtle have hinge on plastron? What color of the carapace, plastron, head (be specific)? Long tail or short tail? Can turtle withdraw inside shell?
- c) Where did you normally find the turtle? How high that normally you found the turtle in wild? What do turtle live (on land or water (streams or river, ponds)
- d) What do you do if you catch a turtle? if sell how much?

If any turtle encountered at the household, the information will be recorded by photograph, measurement the maximum carapace length, width, and weight.

2.2.2 Field survey

The field survey carried out by randomly walking throughout the forest by applying a time-constrained searching effort (Akani, Barieenee, et al., 1999; Akani, Luiselli, et al., 1999) from late June and July 2020. In each field day, the team will consist of six to eight persons including three main researchers and five local assistants (See appendix 1). The research carried out on every day from hr 0700 to hr 1700 (Hanoi time). When in the field, the team follow random transects (1 to 4.5 km long depending on the quality of the surveyed habitat) and will search carefully on the ground for the presence of turtles. The searching time will be stopped on every instance in which the researchers will not be conduct any active searching, e.g., when measuring an encountered turtle. All the individual turtles that will be found during the field surveys or caught by local hunters, will be examined and identified to the species level. For each individual, we will record carapace length, carapace width, carapace height and weight. Length measurements will be taken by a 30cm caliper with the accuracy at 0.1 cm, while turtle weight will be

measured by using a 5kg scale, with an accuracy of 1g. To increase the chance to find the aquatic turtle, we use 10 aquatic traps to set along the streams.

2.2.3 Collecting the temperature and humidity at sites

According to the survey found, there were two hobo loggers and two pendent data loggers have been set in the field at two locations. The first location was at 554m a.b.s.l coordinate N16.22789° E107.85526° and second locations was 1373m a.b.s.l coordinate N16.19396° E107.86404°. The loggers were set to record humidity and temperature in each 1 hour.

3. Results

The literature on turtle in Vietnam is very poor. Many turtles survey has been conducted. However, very few of them has been published in peer-review journals. I have search for several publications on turtle online (e.g.: <https://scholar.google.com/>), most of publications are on turtle trades (e.g. (Hendrie, 2000; Le Dien Duc & Broad, 1995; Le et al., 2004; Pham et al., 2018; Pham Van et al., 2019; Tran et al., 2016). While very few of them were published on nature history of turtle in the wild, especially *C. bourreti* was very rare. Very few papers, gray literature has been mentioned the *C. bourreti*. Such as Fritz et al., (2002) has mentioned the integration between two sister species *C. galbinifrons* and *C. bourreti* in Phong Nha Ke Bang NP, Quang Binh province. It is also showed the northernmost locality of the *C. bourreti*. While Pham et al (2018; 2019) has mentioned *C. bourreti* was the most traded turtle among its sister species (*C. galbinifrons* and *C. picturata*). Stuart et al., (2011) recorded the *C. bourreti* the first time for Laos herpetology fauna. Besides, the *C. bourreti* is mystery species in its range

3.1 Interview survey

There were 88 interviews have been conducted. The result shows on the table 1 below

Table 1: Summary turtle recorded, and the species has been described by interviewees. The price of turtle is current at survey time 2020 except the price of *M. annamensis* and *M. mutica*, *M. sinensis* were 3-4 years ago with currency 1\$=23000VNĐ. % described = interviewee describe species/total interview (n=88).

| No. | Latin name | Local name | # Of turtle recorded | Record type | Price range (US\$/kg) | % Described | IUCN red list 2021 |
|-----|----------------------------------|------------|----------------------|-------------|-----------------------|-------------|--------------------|
| | Platysternidae | | | | | | |
| 1 | <i>Platysternon megacephalum</i> | Ác Mó | 1 | * | 86-173 | 56.8% | CR |
| | Geoemydidae | | | | | | |

| | | | | | | | |
|----|--------------------------------|------------------------------|---|------|---------------|-------|----|
| 2 | <i>Cuora bourreti</i> | Rùa hộp, rùa nắp | 3 | ** | 30-39 | 64.8% | CR |
| | <i>Cuora serata</i> | Rùa nắp | 1 | ** | | | |
| 3 | <i>Cuora mouhotii</i> | Rùa mây | 1 | ** | 21-34 | 9.1% | EN |
| 4 | <i>Cuora cyclornata</i> | Rùa vàng | | | | 3.4% | CR |
| 5 | <i>Cyclemys pulchristriata</i> | rùa nước, rùa cánh sen | 5 | ** | 8 | 22.7% | EN |
| 6 | <i>Mauremys annamensis</i> | rùa đẹp, rùa trâm | 0 | | 3043- 4347 | 19.3% | CR |
| 7 | <i>Mauremys mutica</i> | rùa đẹp | 0 | | 260- 304 | 15.9% | CR |
| 8 | <i>Mauremys sinensis</i> | rùa nước | 2 | ** | 86 | 34.1% | CR |
| 9 | <i>Sacalia quadriocellata</i> | Rùa hôi | 1 | ** | 95 | 39.8% | CR |
| | Testudinidae | | | | | | |
| 10 | <i>Manouria impressa</i> | Rùa Mây, rùa xe tăng | 5 | *,** | 8-21 | 60.2% | EN |
| | Trionychidae | | | | | | |
| 11 | <i>Palea steindachneri</i> | Ba ba gai (hôn gai) | 0 | | 26-30 | 25.0% | CR |
| 12 | <i>Pelodiscus sinensis</i> | Ba trăn (hôn trăn) | 1 | * | 26-30 | 30.7% | VU |
| 13 | <i>Pelochelys cantorii</i> | Rạnh, Ba đỉnh | 0 | | | 2.3% | CR |
| | Invasive | | | | | | |
| 14 | <i>Chelydra serpentina</i> | | 1 | ** | | | LC |
| 15 | <i>Mauremys reevesii</i> | | 2 | ** | | | EN |

*) wild recorded

***) village observed

According to the interview survey, there were 15 species has been described/observed. Among them, 9 species were strongly confirmed presence at Bach Ma NP with villages and field specimen observed. While one natural hybrid species *C. serata* (*C. bourreti* x *C. mouhotii* *obsti*) is also observed in village with confirmation from owner that the turtle was wild caught in Bach Ma NP Forest. The rest species with low description rate is also need

more survey to confirm. Some species has been mentioned by local respondents that was 20-40 years ago that no longer exist in the region such as *Cuora cyclornata*, *Pelochelys cantorii*. Some people mentioned *Mauremys annamensis* still can capture in the wild in swamps in between Thua Thien Hue – Da Nang when the species get very high price 3-4 years ago. This information slightly different with the finding from Le et al. (2004) claim that the Da Nang is Northernmost of the species. The *Cuora bourreti* and *Manouria impressa*, and *Platysternon megacephalum* are the most frequent described by local people as they are often targeted to hunt/catch by chance (Figure 2 &3). According to the local people who kept turtle at home, *C. bourreti* is claimed to catch in the Km 8 on the way to top of Bach Ma Mountain. At the area the elevation is from 500a.b.s.l. Most of specimen have been observed in villages that people mainly want to keep them as pet (some was for food e.g., *Cyclemys pulchristriata*) as they got low cost to sell and easy to survive (e.g., *Cyclemys pulchristriata*). Two non-native species were also observed at local bought from pet shop online are *Mauremys reevesii* and *Chelydra serpentina* (Appendix 2). The non-native species is commonly as pet in Vietnam as new fashion in the young (see Pham et al., 2018).

According to the survey, the turtle still being traded often in surrounding the Bach Ma NP. Hunters still can easy access the NP to hunt turtle with hunting dogs. However, many turtle also can be collected by chance when local people go to forest to collect honeybee from April-September and collect non-timber forest products. As turtle price for a turtle found is much higher compare to local income (average 5 US\$/day/person) (Duc Quang, 2018)

There were several hunters claims to catch *C. bourreti* quite often in rainy season from April-October. They will later sell to traders in Loc Tri district or communes in Phu Loc district. The traders in theory just buy frogs and some common snakes. However, they still illegally buy turtle and wildlife (wild pig, civets...). Some hunters claim that one of the biggest traders in the Loc Tri has been arrested one time with much wildlife at her house. But then she has paid some "under table" money and she was fine at that time. She is now still buying and selling wildlife, but she is very wary for who asking information regarding her business. Thus, the threats to *C. bourreti* is mostly hunting for trade toward national pet market and to China market to supply the international pet trade (Pham et al., 2018; Pham Van et al., 2019)

According to the interviewees, the *C. bourreti* is known to live in hilly forest in different forest type of dense bamboo forest to evergreen forest. People claim that the species diet is worms, insect and some kind of forest fruit trees (e.g., *Lansium domesticum*, *Spondias lakonensis*). Sometimes found them in near stream but did not see it enter the stream.

Although most of turtle are listed in Vietnam national protection law (Decree 06/2019/NĐ-CP and 64/2019/NĐ-CP). However, the due to weak law enforcement that make the turtle are still in trouble. A strong management should be implemented in order to stop

wildlife trade and hunting. A sad story happened that 6 hunters were arrested with many endangered primate and other mammal hunted in Bach Ma NP (Do, 2021) recently is an alarm bell that the park should be stricter in wildlife protection in the park. Stop hunters enter the park easily is main task that Bach Ma should implement

3.2 Field survey

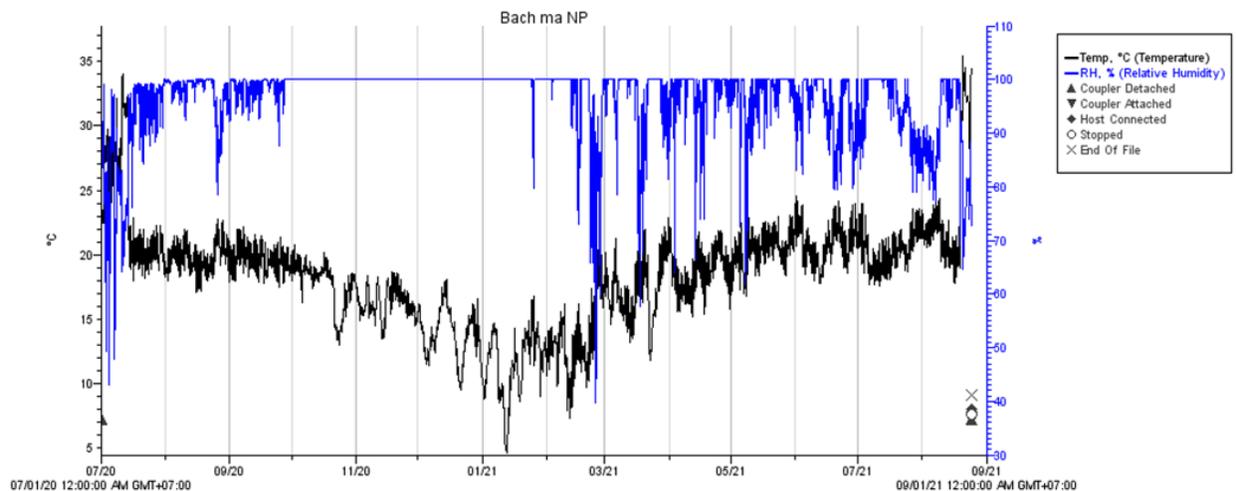
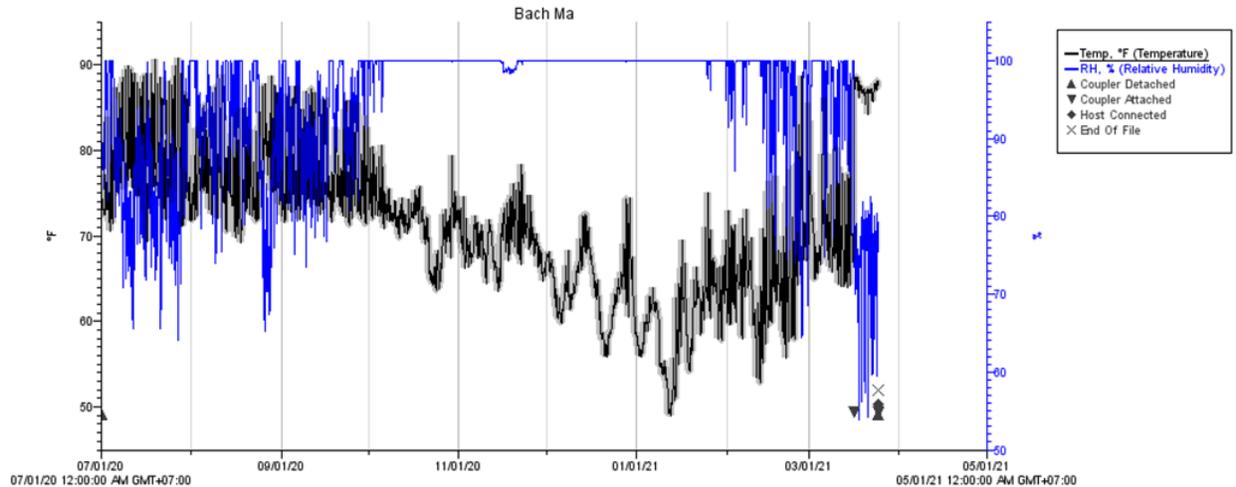
The field survey has conducted in the forest range from 500-1200 elevation. There were only three individuals of three species have been found. The research team has found 01 *Manouria impressa*, 01 *Pelodiscus sinensis* by human searching effort while 01 *Platysternon megacephalum* have been recorded by aquatic trap. All three turtle after measurement have been released unharmed back to same spot, we have found them. The *P. sinensis* has found in the stream near village at low elevation 37m a.s.l while both *M. impressa* and *P. megacephalum* found in high elevation at 783 m and 1383m respectively (see table 2). Besides, the field team did not find any *C. bourreti* (possibly no luck) in the wild. However, as the rangers of the park known that there was the turtle expert come to study on turtle, they later on sent the photos of two individuals wild observed when the do monitoring in the forest. The GPS have been estimated on Google Earth, then we could not use it for analysis of the species ecology. There were also 04 others *M. impressa* has been observed in the wild by rangers at top of Bach Ma Mountain. Interestingly, a couple of *M. impressa* are mating and swimming across forest stream. The guy has been photographed that behavior.

Besides, during the survey, we also photographed other wildlife we have seen in the forest (see appendix 3&4).

The principal investigator is drafting a paper regarding the result of the survey. The paper will get more comprehensive insight the result of the survey in order to save the endangered *C. bourreti* and its sympatric species.

3.3 Temperature and humidity at sites

The temperature has been recorder for one year from 1 July 2020 to 20 August 2021. The average temperature at 554m was 21.6° C (Standard deviation $\pm 4.5^{\circ}\text{C}$) and minimum and maximum were 9.41 and 32.6° C respectively. And the humidity average was 94.9% (Standard deviation $\pm 8.1\%$) and the minimum and the maximum at 53% and 100% respectively. While the average temperature at 1373 m a.b.s.l was slightly lower at 18.2° C (Standard deviation $\pm 4.1^{\circ}\text{C}$) and the minimum and maximum were 4.6° C to 35.4° C. The humidity at this site is also higher than the 554m location. Average humidity was 96.3% ($\pm 6.8\%$). Minimum and maximum humidity at this location was 39.81% to 100% respectively (Figure 1). The data will be available from this report that will support the ex-situ conservation to provide right condition for *Manouria impressa* and *C. bourreti*



3.4 Recommendations and conservation actions

Recommendations for further steps in conserve the turtle fauna at Bach Ma NP and central of Vietnam.

- 2 staff of science department of the Bach Ma NP have been trained the research methodology and technique to search for the turtle in the wild and interview survey method. They also have been trained to used GPS, aquatic trap, temperature, humidity devices. Besides, together with local people who join the Bach Ma's Conservation Community team get attention on protecting turtle (as they do not care before). They are also aware that turtle is fully protection in national law (decree 06/2019/NĐ-CP, 64/2019/NĐ-CP). Thus, any turtle keeping at local house is illegal
- On 20 August 2020, the recommendation the release locations to director of the Bach Ma NP. Later on, the Bach Ma NP has released 50 individuals of *C. bourretii* and 35 individuals of *Platysternon megacephalum* transferred from Turtle Conservation Center, Cuc Phuong National Park. The recommendations

information is based on knowledge that the principal investigator obtained from the turtle survey in June and July 2020

- Base on the many turtles still being illegally keep as pet at home and turtle trade still happened in the region, the suggestion of establish a rescue center in order to rescue, captive breeding the endangered herpetology (focus on *C. bourretti*) have been made. Through the discussions between Turtle Sanctuary Conservation Center and Bach Ma NP, there were an agreement that the rescue center should be built to support conservation turtle and some other herpetology. The Park has agreed to provide more than 3ha to start raising fund for the rescue center. After that, due to Covid, the processing of building the rescue center has been delay. During that time, the principal investigator has written the article on important of the herpetology rescue center in Bach Ma NP that published in Elaphe a German's magazine.
- The further survey should be implemented in order to find viable population of the *C. galbinifrons* to monitor them strictly
- Strengthen law enforcement in order to stop wildlife hunting and trading in the park.
- Increasing the rangers patrolling in the rainy season from April- September in order to reduce people go to forest to hunt the turtle while collect the NTFPs and honeybee harvesting.
- List the hunters name in villages surrounding the NP and convince them sign an agreement that do not hunt wildlife from the Bach Ma NP anymore. As well as the park should have list of traders that can closely monitoring. That information is not difficult to get as local people know exactly who are doing the illegal thing.



Figure 2: Photos of turtle villages observation. Top left photo are two individuals of *Cyclanotus pulcherrimus*, top right is an individual of *C. seratus*. Below left is a *Sacalia quadriocellata* and right is a *Cuora mouhoti*.



Figure 3: A *Platysternon megacephalum* found in stream by aquatic trap (top left) and a *Manouria impressa* found in top Bach Ma mountain by human effort (top right). A *Pelodiscus sinensis* found by chance in a stream in village (below left) and a *Cuora bourreti* found by local ranger in the wild

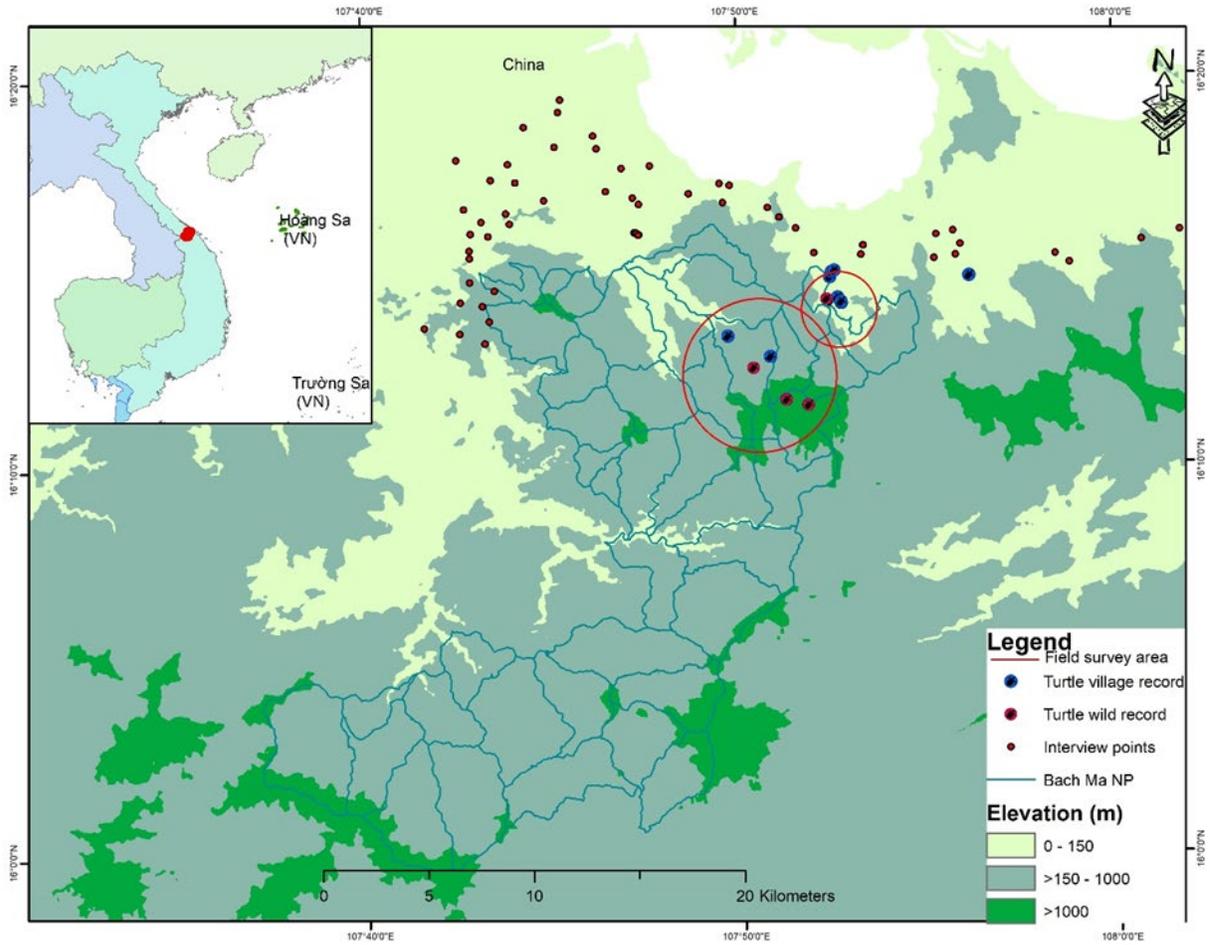


Figure 4: Map of the interview survey and field survey area with the turtle record at Bach Ma NP and villages observed

Table 2: Summary turtle record during the interview and field survey and their measurement

| Species name | Specimen type | Record type | N | E | Alt | Specimen age | Carapace length (mm) | Carapace width (mm) | Shell Height (mm) | Weight (g) | Gender |
|----------------------------------|---------------|------------------|----------|----------|------|--------------|----------------------|---------------------|-------------------|------------|--------|
| <i>Sacalia quadriocellata</i> | Alive | Village observed | 16.24737 | 107.8739 | 8 | Adult | 122 | 81 | 39 | 252 | M |
| <i>Cuora serata</i> | Alive | Village observed | 16.24744 | 107.9357 | 10 | Adult | 166 | 126 | 75 | 710 | M |
| <i>Cuora bourreti</i> | Alive | Village observed | 16.24954 | 107.8747 | 20 | Adult | 150 | 110 | 80 | 820 | F |
| <i>Cuora mouhotii obsti</i> | Alive | Village observed | 16.23623 | 107.8789 | 24 | Subadult | 139 | 103 | 53 | 399 | F |
| <i>Platysternon megacephalum</i> | Alive | Wild observed | 16.20875 | 107.8397 | 783 | Adult | 155 | 113 | 75 | 778 | M |
| <i>Manouria impressa</i> | Alive | Wild observed | 16.19263 | 107.8639 | 1339 | Adult | 267 | 223 | 98 | 3214 | M |
| <i>Cyclemys pulchristriata</i> | Alive | Village observed | 16.23854 | 107.8773 | 19 | Juvenile | 120 | 100 | 40 | 295 | F |
| <i>Cyclemys pulchristriata</i> | Alive | Village observed | 16.23854 | 107.8773 | 19 | Adult | | | | | |
| <i>Cyclemys pulchristriata</i> | Alive | Village observed | 16.2501 | 107.876 | 21 | Adult | 175 | 127 | 76 | 1104 | |
| <i>Cyclemys pulchristriata</i> | Alive | Village observed | 16.24744 | 107.9357 | 10 | Adult | | | | | |
| <i>Cyclemys pulchristriata</i> | Shell | Village observed | 16.2501 | 107.8759 | 21 | Adult | | | | | |
| <i>Mauremys sinensis</i> | Alive | Village observed | 16.24744 | 107.9357 | 10 | Adult | | | | | |
| <i>Pelodiscus sinensis</i> | Alive | Wild observed | 16.23798 | 107.8725 | 37 | Juvenile | 97 | 75 | 24 | 138 | M |
| <i>Manouria impressa</i> | Alive | Photos (rangers) | 16.19496 | 107.8542 | 1267 | Adult | | | | | |
| <i>Manouria impressa</i> | Alive | Photos (rangers) | 16.19496 | 107.8542 | 1267 | Adult | | | | | |
| <i>Manouria impressa</i> | Alive | Photos (rangers) | 16.19496 | 107.8542 | 1267 | Adult | | | | | M |

| | | | | | | | | | | | |
|----------------------------|-------|------------------|----------|----------|------|-------|--|--|--|--|---|
| <i>Manouria impressa</i> | Alive | Photos (rangers) | 16.19496 | 107.8542 | 1267 | Adult | | | | | F |
| <i>Cuora bourreti</i> | Alive | Photos (rangers) | 16.21351 | 107.8472 | - | Adult | | | | | |
| <i>Cuora bourreti</i> | Alive | Photos (rangers) | 16.22247 | 107.8284 | - | Adult | | | | | |
| <i>Chelydra serpentina</i> | Alive | Village observed | 16.23669 | 107.8788 | 34 | Adult | | | | | |
| <i>Mauremys reevesii</i> | Alive | Village observed | 16.23669 | 107.8788 | 34 | Adult | | | | | |

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Appendix



Appendix 1: Photos of project's activities. Field survey and interview survey. It also contains the habitat where *Manouria impressa* and *Platysternon megacephalum* were found.



Appendix 2: Photos of two invasive species *Mauremys reevesii* and *Chelydra serpentina* being kept as pet at local house in Phu Loc town, Phu Loc district, Thua Thien Hue.

Other finding of herpetology, fish and primate in Bach Ma



Appendix 3: Some other fauna species found during the field survey.



Appendix 4: Some reptile, frogs and the beauty of the red shank douc langur *Pygathrix nemaeus* found during the survey.