AN ASSESSMENT OF TURTLE COMMUNITIES IN BACH MA NATIONAL PARK, VIETNAM

Van T. Pham[1,2], Olivier Le Duc[1,3], Benjamin Leprince[1], Cedric Bordes[1,3], Charlotte Ducotterd[1,4], Vinh Q. Luu[5], Le T. An[6], Manh H. Nguyen[6], Van O. Lo[6], Van N. Ha[2], Quang B. Tran[7], Luca Luiselli[8,9,10]

[1]*Turtle Sanctuary Conservation Center, France*
e-mail: t.pham@turtle-sanctuary.org, o.leduc@turtle-sanctuary.org, c.bordes@turtle-sanctuary.org, b.leprince@turtle-sanctuary.org
[2]*Save Vietnam's Wildlife, Vietnam*
e-mail: ngoan@svw.vn
[3]*Associated Wildlife and Environmental Conservation Community, France*
[4]*Centre Emys, Protection et Récupération des Tortues, Switzerland*
e-mail: c.ducotterd@turtle-sanctuary.org
[5]*Vietnam National University of Forestry, Vietnam*
e-mail: qvinhfuv@yahoo.com.au
[6]*Center for Nature Conservation and Development, Vietnam*
e-mail: ha.nguyen@ccd.org.vn, oanh.lo@ccd.org.vn, mrlethanhan@gmail.com
[7]*Vietnam Administration of Forestry, Vietnam*
e-mail: baofuv@yahoo.com
[8]*Institute for Development, Ecology, Conservation and Cooperation, Italy*
[9]*Rivers State University of Science and Technology, Nigeria*
[10]*Université de Lomé, Togo*
e-mail: l.luiselli@ideccngo.org

Received: 18.11.2022. Revised: 02.03.2023. Accepted: 03.03.2023.

Most of the extraordinary biodiversity richness of South-East Asian countries is concentrated in the national parks and other Protected Areas, with species-rich turtle communities surviving mostly in these reserves where their natural habitats are better preserved. However, very few studies have documented the turtle species richness of the various Protected Areas in Vietnam, which is not only one of the hotspots of chelonian diversity in the world but also one of the countries where their exploitation is the highest. Here, the diversity of turtles is studied in the Bach Ma National Park in central Vietnam, mainly characterised by forested hills and mountains, with ponds and streams of various shapes and structures. The study was carried out by conducting (i) semi-structured interviews of hunters recruited through a snow-ball procedure in local villages, (ii) inspection of turtle individuals in their hands, (iii) field surveys along random transects inspecting the various microhabitats used by these reptiles. We observed a total of 15 species, out of which 14 (93.3%) are threatened, based on IUCN Red List. A natural hybrid of *Cuora bourreti* × *C. mouhotii obsti* (*Cuora «serrata»*) was observed. Three species (*Cuora bourreti, Manouria impressa*, *Platysternon megacephalum*) were the most frequently encountered species according to our interviewees. We conclude that, in order to enhance the conservation status of the turtle communities at the local level, it would be important (i) to increase the number of rangers patrolling the study area in the rainy season (from April to September) and (ii) to list the hunter's names in the villages surrounding the Bach Ma National Park and to convince them to sign an agreement with the local authorities to avoid hunting turtles within the Protected Area.

Key words: Chelonia, conservation, diversity, mountain forest, Protected Area, South-East Asia

Introduction

In South-East Asia in general, and in Vietnam in particular, most of the territory is agricultural or heavily altered, and national parks represent the last sanctuaries where a rich biodiversity is still observed (e.g. Polet & Ling, 2004; Yen et al., 2005; Le, 2007; Viollaz et al., 2022). However, most of the Vietnamese Protected Areas are still under pressure by poachers and wildlife traffickers, especially in the northern regions of the country (Cao Ngoc & Wyatt, 2013).

Chelonians are the most endangered group of vertebrates in the world, especially in tropical and subtropical regions (e.g. Stanford et al., 2018). Several causes of turtle decline include their overexploitation for pet trade or food (Van Dijk et al., 2000; Rhodin et al., 2018), traditional medicine, and habitat destruction (by massive deforestation) (e.g. Hendrie, 2000; Pham

et al., 2018a,b, 2019; Stanford et al., 2018), among others. Southeast Asia is one of the highest hotspots of chelonian diversity on Earth (Rhodin et al., 2017), 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 (Stanford et al., 2018). In this regard, the studies on the chelonian diversity and abundance in the Vietnamese national parks and other Protected Areas would be essential for conservation reasons and for planning future management actions at the national scale. However, the state of knowledge on the ecology and distribution of Vietnamese turtle species is still not satisfactory (Ducotterd et al., 2023), up to the point that there is no published study on the abundance of the various species in the Vietnamese Protected Areas (Pham et al., 2020, but see also Le, 2007). This is essentially true for those species, such as *Cuora bourreti* (Obst & Reimann, 1994), which remnant populations appear to survive essentially in Protected Areas.

Bach Ma National Park is one of the largest Vietnamese Protected Areas where species-rich turtle communities, including *Cuora bourreti*, can survive. This Protected Area is particularly interesting for turtle conservation because of its size, types of natural habitats and geographic position. However, its turtle fauna has never been studied so far. Therefore, our aim in this study is to report an analysis of the turtle communities found in Bach Ma National Park assessed by face-to-face interviews with local hunters and field surveys along random transects. We also aim to provide some conservation considerations and suggestions for the future management of the study area in order to enhance the survival of the various turtle species at the local scale.

Material and Methods

Study area

This study was carried out in Bach Ma National Park, Thua Thien Hue province, central Vietnam (geographic co-ordinates (WGS 84) of 16.22789° N, 107.85526° E). This Protected Area has 374.87 km^2 in size (Lan et al., 2002) (Fig. 1), and lies in the central Annamite mountains. The main forest types found within the Bach Ma National Park are lowland evergreen forest below 900 m a.s.l., and montane evergreen forest above this altitude (Gilmour & Nguyen, 1999). The climate is characterised by a tropical monsoon that dominates montane rainforests (at 400–1400 m a.s.l.) and cloud forests from 1450 m a.s.l. to the summit (at 1712 m a.s.l.), with no dry season and only one rainy season from April to September.

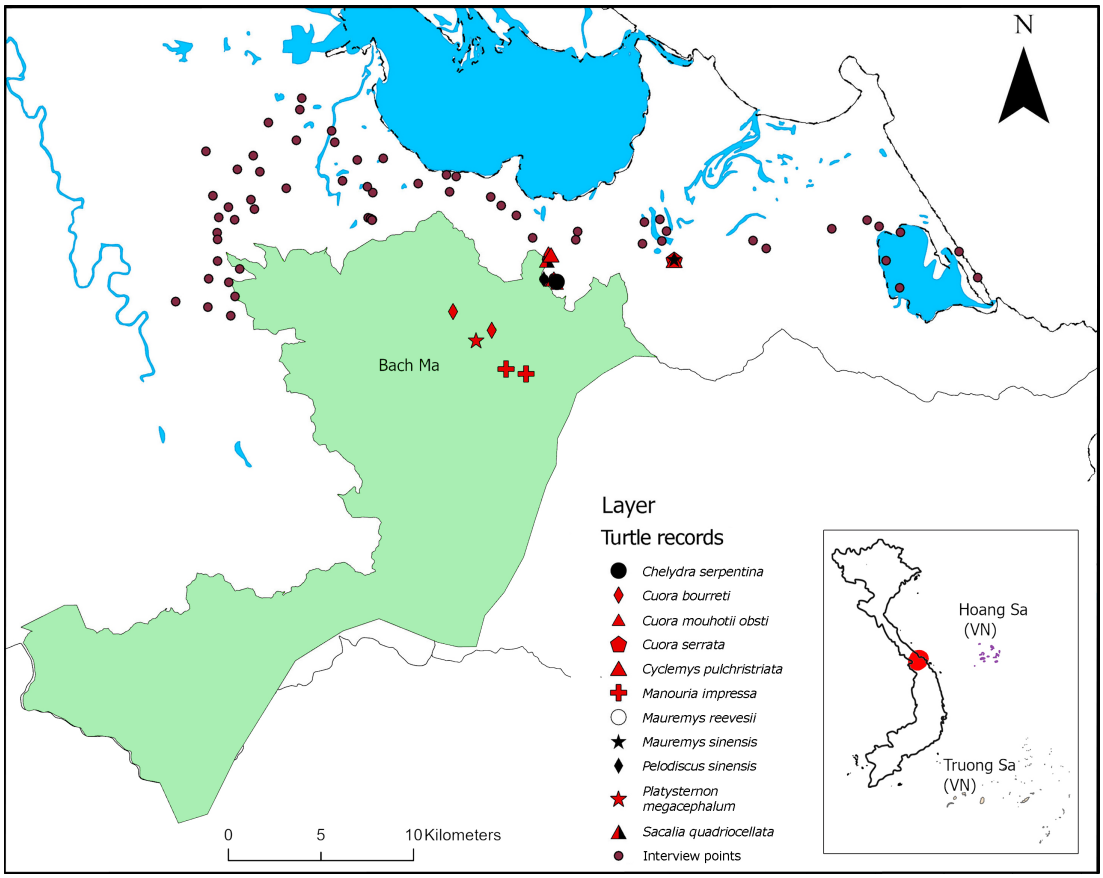

Fig. 1. Geographical location of sampling sites in Bach Ma National Park, and its relative position within Vietnam, showing both interview sites and where turtles were observed. Accurate locations of the collected specimens are in Electronic Supplement 1.

The average temperature at 554 m a.s.l. was 21.60°C (standard deviation: ± 4.5°C) and minimum and maximum values were 9.41°C and 32.60°C, respectively. The humidity was in average at 94.9% (standard deviation: ± 8.1%), with minimum and maximum values at 53% and 100%, respectively. The average temperature at 1373 m a.s.l. was slightly lower (18.20 ± 4.10°C), and minimum and maximum values were 4.60°C and 35.40°C. respectively. The average humidity was 96.3% (standard deviation: ± 6.8%), with a minimum and maximum humidity being 39.81% to 100%, respectively.

Protocol

Interview survey

Face-to-face semi-structured interviews were conducted 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 (Fig. 1). All these interview sites were situated in the buffer zone of Bach Ma National Park, with the farthest interview location being 20 km outside boundaries of the Protected Area. The field team consisted of two persons conducting the interviews, in Vietnamese language, and recruiting persons with snow-ball procedure. All interviews were conducted separately. The interviewees were all males and all over 30 years old and were previously hunters or even providers of turtles to traders. The interviewees were previously informed of the scope of this study, and their identity was kept anonymous. Each interview lasted on average 40 min., but sometimes it was prolonged up to 2 h, if the person appeared particularly well aware of the status of turtles in his area. All interviews followed the rules of the British Sociological Association. The list of questions addressed during our interviews was as follows: (a) Can you list how many turtles you have seen in this region? Please give their local names; (b) Please describe each species by the following questions: (b1) is this species hard shelled or soft shelled? (b2) What is the shape of the shell? (b3) Does the turtle have serration? (b4) What is the approximate size of the turtle? Does the turtle show a hinge on the plastron? (b5) What are the colours of carapace, plastron, and head (be as much specific as possible)? (b6) Is the turtle long or short tailed? Can the turtle withdraw inside the shell? (c) Where did you normally find the various turtle species? (c1) How much time do you need to spend in the field before you may find the turtle in the wild? (c2) Do the various turtles live on land or in water (streams or rivers, ponds)? (d) What do you do if you catch a turtle? (d1) If you sell it, how much do you ask for it? We also recorded all turtle individuals that were in the hands of the hunters, and recorded their carapace length, width, and weight.

Field survey

The field survey was carried out by random walking throughout the forest with applying a time-constrained searching effort (Akani et al., 1999a,b). Field surveys were conducted in June and July 2020, at an altitudinal range of 500–1200 m a.s.l. On each field day, the team consisted of six to eight persons including three main researchers and five local assistants (see Electronic Supplement 1). The research was carried out every day from 07:00 h to 17:00 h (Hanoi time). When in the field, the team followed random transects (1.0 km to 4.5 km long depending on the quality of the surveyed habitat) and searched carefully on the ground for the presence of turtles. The searching time was stopped on every instance in which the researchers were not conducting any active searching, e.g. when measuring an encountered turtle. All the individual turtles that were found during the field surveys or caught by local hunters, were examined and identified to the species level (Rhodin et al., 2017), and their positions were recorded with a GPS. For each individual, we recorded carapace length, carapace width, carapace height and weight. Length measurements were taken by a 30 cm calliper with the accuracy at 0.1 cm, while the turtle weight was measured by using a 5-kg scale, with an accuracy of 1 g. After taking their measurements, all the captured turtles were released unharmed back to the same spots we found them (Pham et al., 2018a). To increase the chance to find the aquatic turtle species, we used ten aquatic funnel traps, round shaped and with a size being 60 cm long × 40-cm diameter. The traps were baited with chicken intestine pieces and were set in apparently appropriate habitats along the streams (Pham et al., 2022).

Results

Interview survey

Overall, 88 interviews reported reliable information on the turtle species at the study area. A total of 15 species were described by hunters (Table 1). Three species (*Cuora bourreti*, *Manouria impressa* (Günther, 1882), and *Platysternon megacephalum* Gray, 1831) were the most frequently cited species by interviewees, with over 50% of the persons

reporting their presence and accurately describing their characteristics (Table 1). Two species (*Cuora cyclornata* Blanck, Mccord & Minh Le, 2006, and *Pelochelys cantorii* Gray, 1864) were mentioned as being present in the area by less than 5% of the interviewees (Table 1). Interviewees reported that these two species were found in the study area up to 20–40 years ago, but no longer existed in the region. Seventeen independent interviewees (19.3% of the total sample) mentioned the presence of *Mauremys annamensis* (Siebenrock, 1903) (Table 1), but only one of them insisted that he can still encounter this species in the wild. This interviewed hunter reported to still be actively poaching *M. annamensis* as the species price was extremely high in 2015–2018. According to this hunter, *M. annamensis* is still present in the swamps situated in-between Thua Thien Hue and Da Nang. *Mauremys annamensis* was by far the most economically valuable species for the hunters. The price given for each turtle species is the one reported by the interviewees at survey time (2020), except for the price of *Mauremys annamensis*, *M. mutica* (Cantor, 1842), and *M. sinensis* (Gray, 1834), that was relative to 3–4 years ago (Table 1).

Field survey

Nine of the species described by hunters were directly observed during our surveys (Table 1). The morphometric details of each observed individual are given in Electronic Supplement 1. Interestingly, we observed one natural hybrid of *Cuora bourreti* × *C. mouhotii obsti* in the village (Fig. S1). This individual was caught from Bach Ma National Park forest. These hybrids were once named *Cuora serrata* Iverson & McCord, 1992, which is an invalid species name now (Iverson & McCord, 1992; Simison et al., 2005). During the time-constrained field surveys, four species were recorded, namely *Cuora bourreti*, *Manouria impressa*, *Pelodiscus sinensis* (Wiegmann, 1835), and *Platysternon megacephalum* (found in an aquatic trap; Fig. S3). On 14.04.2019, one *M. impressa* couple was observed while mating (Fig. 2A,B) and swimming across a forest stream (Fig. 2C,D). Two alien species were also observed, namely *Mauremys reevesii* (Gray, 1831), and *Chelydra serpentina* (Linnaeus, 1758) (Fig. S2).

Discussion

Our survey demonstrated that the area of Bach Ma National Park and surrounding territories are still rich in terms of turtle diversity, given that nine species were directly observed, and six additional species were indirectly recorded in the interviews, although with three species currently extinct or nearly extinct (*Cuora cyclornata*, *Mauremys annamensis*, *Pelochelys cantorii*). Thus, the total number of species (n = 15) represents a conspicuous portion of the turtle fauna of the Indo-Burma region (n = 50 species) (Mittermeier et al., 2015). When we compare these results with the scarce available information concerning the turtle communities in other Vietnamese national parks, the Bach Ma National Park emerged as having a remarkably higher species richness. Indeed, Pham et al. (2018a) documented 12 turtle species to occur in Tay Yen Tu Nature Reserve (Northern Vietnam), while Bac Huong Hoa Nature Reserve had recorded so far five species (Luan et al., 2016), and only 11 species were recorded in Phuoc Binh National Park (Thang et al., 2022). Eleven turtle species were also found in the Xuan Lien Nature Reserve in northern-central Vietnam (Pham et al., 2022). It is impossible at the current level of knowledge to understand why the turtle fauna in Bach Ma National Park is richer in terms of number of species than other Protected Areas. These differences might be due to chance and/or methodological artefacts, but it cannot be excluded that they depend on the particular geographic position of Bach Ma National Park. In fact, Bach Ma National Park is located on a mountain ridge in central Vietnam where the country tapers to a narrow belt. Reaching from the mountains of Laos eastward to the coast, this high ridge cuts across Vietnam's coastal plain, dividing the northern and southern flora and fauna and marking the separation between two climatic zones. Thus, the topography and climate would support a great richness of species as a point of contact between the two climatic zones at Bach Ma National Park (Sterling & Hurley, 2008). The habitats within the Bach Ma National Park are generally in a good state of conservation, and this fact is certainly important to explain how rich the specific diversity of tortoises still is. However, since the various species exhibit various habitat preferences, it is important to properly manage and conserve all the mosaic of habitats present, both terrestrial and freshwater. For instance, whereas *Cuora bourreti* is a forest generalist, *Platysternon megacephalum* inhabits forest streams with waterfalls above 600 m a.s.l., and *Manouria impressa* is found only in bamboo mix forests above 800 m a.s.l. (our unpublished observations).

Table 1. Summary of the turtle species recorded during the present study in Bach Ma National Park, Vietnam. Recorded individuals include both the species encountered in the field and those described as present by the interviewees

Species	Number of recorded individuals	Record type	Price range (US$)/kg	% described	IUCN Red List (2022)
		Platysternidae			
Platysternon megacephalum	1	*	86–173	56.8%	CR
		Geoemydidae			
Cuora bourreti	3	**	30–39	64.8%	CR
Cuora serata	1	**	–	–	–
Cuora mouhotii	1	**	21–34	9.1%	EN
Cuora cyclornata	–	–	–	3.4%	CR
Cyclemys pulchristriata	5	**	8	22.7%	EN
Mauremys annamensis	0	–	3043–4347	19.3%	CR
Mauremys mutica	0	–	260–304	15.9%	CR
Mauremys sinensis	2	**	86	34.1%	CR
Sacalia quadriocellata	1	**	95	39.8%	CR
		Testudinidae			
Manouria impressa	5	*,**	8–21	60.2%	EN
		Trionychidae			
Palea steindachneri	0	–	26–30	25.0%	CR
Pelodiscus sinensis	1	*	26–30	30.7%	VU
Pelochelys cantorii	0	–	–	2.3%	CR
		Alien species			
Chelydra serpentina	1	**	–	–	LC
Mauremys reevesii	2	**	–	–	EN

Note: Currency: 1$ = 23 000VNĐ; % described – percentage of the interviewees who correctly and reliably described a given species out of the total number of interviews (n = 88); * – recorded in the wild, ** – observed in the village.

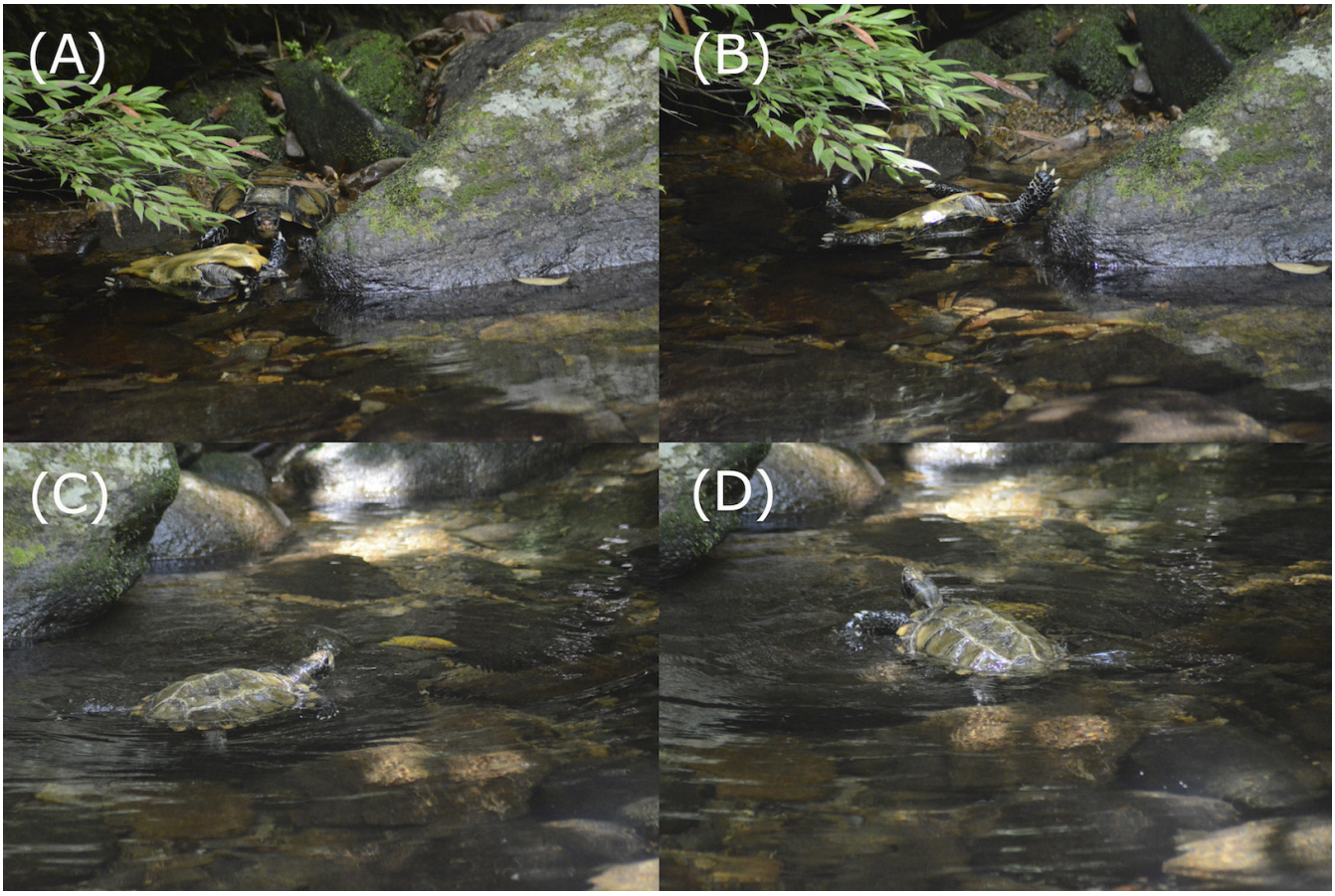

Fig. 2. Photographic evidence of the threatened *Manouria impressa* observed mating in Bach Ma National Park, Vietnam (Author: Truong Cam).

Interestingly, we observed the occurrence of a *Cuora bourretii* × *C. mouhotii obstii* natural hybrid («*Cuora serrata*») that is generally rare in the wild. In reptiles, natural hybrids normally tend to occupy intermediate habitats between those of parental species, as has been observed for example in European vipers (e.g. Martínez-Freiría et al., 2010; Mebert et al., 2015). However, since we observed a single hybrid individual, we cannot conclude whether the same pattern does occur also in «*Cuora serrata*».

Despite the Bach Ma National Park still contains a remarkable diversity of species, our surveys

also demonstrated that turtles are still being traded regularly in its surroundings. The turtle individuals that were traded around the Bach Ma National Park were certainly illegally caught inside it. These poaching activities are normally conducted with hunting dogs, since the boundaries of the Bach Ma National Park are particularly porous and easy to access for hunters. Moreover, turtle individuals can also be randomly encountered (and collected) by local people entering the protected forest to collect honey from bees (from April to September) and other non-timber forest products. Based on what hunters reported in interviews, the turtle demand is still high, which indicate these reptiles represent a good source of additional income for the hunters. In fact, the average turtle prize is substantially higher if compared to the mean local income (5 US$/day/person in average) (Duc, 2018). In this regard, *M. annamensis* certainly represents the main poaching target for the hunters, given its very high market value.

Another of the most valued species for the international pet trade is *Cuora bourreti*, which is illegally traded both within Vietnam and is exported to China (Pham et al., 2018b, 2019). During our interviews, there were several hunters that reported catching *C. bourreti* quite often during the rainy season (April – October) in order to sell them to traders from Loc Tri district and Phu Loc district. Although, officially, the traders buy just frogs and some common snakes, however they still illegally buy the available turtles and even other wildlife species (e.g. wild pigs, civets). Thus, the main threat to *C. bourreti* in the study area is the exploitation for the pet trade (Pham et al., 2018b, 2019). According to the interviewees, *C. bourreti* lives in hilly areas in various forest types, from dense bamboo forests to evergreen forests. This information is also consistent with our field data and shows that this species is likely a habitat-generalist within the forested patches in Vietnam. Interviewees reported that sometimes they found *C. bourreti* individuals nearby streams, but apparently these turtles rarely enter into the streams, and that this species feeds upon earthworms, insects, and some kinds of forest tree fruits (e.g. *Lansium domesticum* Corrêa, *Allospondias lakonensis* (Pierre) Stapf).

Interestingly, two alien species were recorded during our study. One of these two species, the North American *Chelydra serpentina*, has already been observed in other areas of northern Vietnam (Ducotterd et al., 2023). This species can represent a threat to the sympatric freshwater native species, and detailed field studies on the co-existence between this species and native ones are urgently needed.

Although most of Bach Ma National Park's turtles are listed in the Vietnam National Protection Law (Decree 84/2021/NĐ-CP and Decree 64/2019/NĐ-CP), these species are still heavily traded within the country due to the weak law enforcement. At the local level, we suggest increasing the number of rangers patrolling the study area in the rainy season (from April to September) in order to discourage hunters from poaching turtles. It would also be necessary to list the hunters' names in the villages surrounding the Bach Ma National Park and to convince them to sign an agreement with the local authorities to avoid hunting turtles within the Protected Area. It would also be important to make a list of traders that should be closely monitored by the relevant authorities. This information is not difficult to get as the local people know exactly who are doing the illegal trade (our unpublished data). Although these recommendations have never been applied so far in Vietnam, it is important that they would be applied not only in Bach Ma National Park but also in other Protected Areas in the country, as the same threats turtles are facing in the study area also occur more widely in Vietnam.

Conclusions

Our study clearly documented that the study area is particularly noteworthy, among all the various Protected Areas of Vietnam, because of its high chelonian diversity. However, on the basis of the interviews we have done, it is evident that a conspicuous part of this rich biodiversity has been lost, since two species would have become extinct while one would be very rare today (*Mauremys annamensis*). It is necessary that further studies should investigate in detail the local abundance and habitat use of various species in order to develop careful management plans. In fact, so far, no study has ever focused on the behavioural ecology and population dynamics of any turtle species in the study area, thus making any planning of the conservation activities in their support very tentative. We believe that a careful collaboration between scientists (able to better document the ecological characteristics of the species), managers of the Protected Area and rangers is essential for the protection of the Bach Ma National Park's turtles, and that in any case an active collaboration of the hunters must also be sought. In particular,

it would be interesting to try to create an ecotourism circuit focusing on turtles within the Bach Ma National Park, using former hunters as guides, and thus converting their ecological knowledge of the turtle species in favour of their conservation.

Acknowledgements

We are indebted with two anonymous referees for the helpful comments on the submitted draft. The research was funded by Rufford Foundation (grant ID: 29699-1) and Turtle Sanctuary Conservation Centre (Paris, France). We are also indebted Dr. Nguyen Manh Ha from the Centre for Nature Conservation and Development and Bach Ma National Park for providing necessary permissions for the survey. We would like to thank Mr. Nguyen Vu Linh (director of the Bach Ma National Park), Vo Tuong Thu, Nguyen Vu Lam (rangers of the Bach Ma National Park), and several local people in supporting the logistic for the survey in Bach Ma National Park.

Supporting Information

Data on turtle records made during the study measurements of individuals (Electronic Supplement 1. Summary of turtle records made during the interview and field survey and their measurements in Bach Ma National Park, Vietnam), and photographs of some turtles (Electronic Supplement 2. Some turtle individuals observed in surveyed villages around and within the Bach Ma National Park, Vietnam) may be found in the **Supporting Information**.

References

Akani G.C., Barieenee I.F., Capizzi D., Luiselli L. 1999a. Snake communities of moist rainforest and derived savanna sites of Nigeria: Biodiversity patterns and conservation priorities. *Biodiversity and Conservation* 8(5): 629–642. DOI: 10.1023/A:1008849702810

Akani G.C., Luiselli L., Politano E. 1999b. Ecological and conservation considerations on the reptile fauna of the eastern Niger Delta (Nigeria). *Herpetozoa* 11(3/4): 141–153.

Cao Ngoc A., Wyatt T. 2013. A green criminological exploration of illegal wildlife trade in Vietnam. *Asian Journal of Criminology* 8(2): 129–142. DOI: 10.1007/s11417-012-9154-y

Duc Q. 2018. Phu Loc strives to increase per capita income to 52 million VND/year. *Báo Thừa Thiên Huế Online*. Available from https://baothuathienhue.vn/phu-loc-phan-dau-nang-thu-nhap-dau-nguoi-len-52-trieu-dong-nam-a65324.html [In Vietnamese]

Ducotterd C., Le Duc O., Pham V.T., Leprince B., Bordes C., Nghiêm T.L., Thu P.H., Le A.T., Tran B.Q., Luu V.Q., Luiselli L. 2023. Previously Unrecorded Invasive Species and the Unsatisfying Knowledge of Turtle Communities in Northern Vietnam. *Conservation* 3(1): 1–13. DOI: 10.3390/conservation3010001

Gilmour D.A., Nguyen V.S. 1999. *Buffer zone management in Vietnam*. Hanoi : IUCN Vietnam. 86 p.

Hendrie D.B. 2000. Status and conservation of tortoises and freshwater turtles in Vietnam. In P.P. Van Dijk, B.L. Stuart, A.G.J. Rhodin (Eds.): *Asian Turtle Trade: Proceedings of a Workshop on Conservation and Trade of Freshwater Turtles and Tortoises in Asia. Chelonian Research Monographs*. Vol. 2. Lunenburg: Chelonian Research Foundation. P. 63–73.

IUCN. 2022. *The IUCN Red List of Threatened Species. Version 2022-2*. Available from https://www.iucnredlist.org.

Iverson J.B., McCord W.P. 1992. A new subspecies of *Cuora galbinifrons* (Testudines: Batagurinae) from Hainan island, China. *Proceedings – Biological Society of Washington* 105(3): 433–439.

Lan L., Ziegler S., Grever T. 2002. Utilization of forest products and environmental services in Bach Ma National Park, Vietnam. Hanoi: German Development Service. 10 p.

Le M. 2007. Conservation of turtles in Vietnam: a survey of Cat Tien National Park. *Oryx* 41(4): 544–547. DOI: 10.1017/S0030605307012148

Luan T.N., Ha V.H., Thang T.N., McCormack T.E., Sang N.N. 2016. A collection of amphibians and reptiles from Bac Huong Hoa nature reserve, Quang Tri province, Vietnam. In: *Proceedings of the 3rd National Scientific Workshop «Amphibians and Reptiles in Vietnam»*. Hanoi, Vietnam. P. 92–110.

Martínez-Freiría F., Lizana M., do Amaral J.P., Brito J.C. 2010. Spatial and temporal segregation allows coexistence in a hybrid zone among two Mediterranean vipers (*Vipera aspis* and *V. latastei*). *Amphibia-Reptilia* 31: 195–212. DOI: 10.1163/156853810791069001

Mebert K., Jagar T., Grželj R., Cafuta V., Luiselli L., Ostanek E., Golay P., Dubey S., Golay J., Ursenbacher S. 2015. The dynamics of coexistence: habitat sharing versus segregation patterns among three sympatric montane vipers. *Biological Journal of the Linnean Society* 116(2): 364–376. DOI: 10.1111/bij.12582

Mittermeier R.A., van Dijk P.P., Rhodin A.G., Nash S.D. 2015. Turtle hotspots: An analysis of the occurrence of tortoises and freshwater turtles in biodiversity hotspots, high-biodiversity wilderness areas, and turtle priority areas. *Chelonian Conservation and Biology* 14(1): 2–10. DOI: 10.2744/ccab-14-01-2-10.1

Pham V.T., Vu T., Dawson J.E., Bui T., Leprince B. 2018a. Natural history observations on the Endangered turtle *Geoemyda spengleri* in Tay Yen Tu Nature Reserve (Vietnam), with notes on other sympatric species. *Herpetological Bulletin* 146: 1–7.

Pham V.T., Luu Q.V., Vu T.T., Leprince B., Tran K.L., Luiselli L. 2018b. Longitudinal monitoring of turtle trade through Facebook in Vietnam. *Herpetological Journal* 29(1): 24–27. DOI: 10.33256/hj29.1.4856

Pham V.T., Leprince B., Xuan H.L., Thu Q.N., Le Duc O., Bordes C., Tien M.V., Luiselli L. 2019. Observations of threatened Asian box turtles (*Cuora* spp.) on trade in Vietnam. *Herpetological Journal* 29: 173–178. DOI: 10.33256/hj29.3.173178

Pham V.T., Le Duc O., Leprince B., Bordes C., Zuklin T., Ducotterd C., Luu Q.V., Lo V.O., Nguyen T.T.A., Fa J.E., Luiselli L. 2020. Unexpected high forest turtle diversity in hill forests in northern Vietnam. *Biodiversity and Conservation* 29(14): DOI: 10.1007/s10531-020-02061-y

Pham V.T., Luong T.K.L., Lo V.O., Bui T., Le T.A., Pham A.T., Nguyen M.T., Nguyen M.H. 2022. Notes on turtle composition and conservation recommendations at Xuan Lien nature reserve Thanh Hoa province. *Journal of Science and Technology of Forestry* 5: 119–124. DOI: 10.55250/jo.vnuf.2022.5.119-124

Polet G., Ling S. 2004. Protecting mammal diversity: opportunities and constraints for pragmatic conservation management in Cat Tien National Park, Vietnam. *Oryx* 38(2): 186–196. DOI: 10.1017/S003060530400033X

Rhodin A.G.J., Iverson J.B., Bour R., Fritz U., Georges A., Shaffer H.B., van Dijk P.P. (Turtle Taxonomy Working Group). 2017. Turtles of the World. Annotated Checklist and Atlas of Taxonomy, Synonymy, Distribution, and Conservation Status (8th ed.). In: A.G.J. Rhodin, J.B. Iverson, P.P. van Dijk, R.A. Saumure, K.A. Buhlmann, P.C.H. Pritchard, R.A. Mittermeier (Eds.): *Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Chelonian Research Monographs*. Vol. 7. P. 1–292. DOI: 10.3854/crm.7.checklist.atlas.v8.2017

Rhodin A.G.J., Stanford C.B., van Dijk P.P., Eisemberg C., Luiselli L., Mittermeier R.A., Hudson R., Horne B.D., Goode E.V., Kuchling G., Walde A., Baard E.H.W., Berry K.H., Bertolero A., Blanck T.E.G., Bour R., Buhlmann K.A., Cayot L.J., Collett S., Currylow A., Das I., Diagne T., Ennen J.R., Forero-Medina G., Frankel M.G., Fritz U., García G., Gibbons J.W., Gibbons P.M., Gong S. et al. 2018. Global Conservation Status of Turtles and Tortoises (Order Testudines). *Chelonian Conservation and Biology* 17(2): 135–161. DOI: 10.2744/CCB-1348.1

Simison W.B., Wang J., Gong S., Fu B., Shi H., Parham J. 2005. A report on the hybridization between two species of threatened Asian box turtles (Testudines: *Cuora*) in the wild on Hainan Island (China) with comments on the origin of 'serrata'-like turtles. *Amphibia-Reptilia* 26(3): 377–381. DOI: 10.1163/156853805774408487

Stanford C.B., Rhodin A.G.J., van Dijk P.P., Horne B.D., Blanck T., Goode E.V., Hudson R., Mittermeier R.A., Currylow A., Eisemberg C., Frankel M., Georges A., Gibbons P.M., Juvik J.O., Kuchling G., Luiselli L., Shi H., Singh S., Walde A. 2018. Turtles in Trouble: *The World's 25+ Most Endangered Tortoises and Freshwater Turtles – 2018*. Ojai, USA: IUCN SSC Tortoise and Freshwater Turtle Specialist Group, Turtle Conservancy, Turtle Survival Alliance, Turtle Conservation Fund, Chelonian Research Foundation, Conservation International, Wildlife Conservation Society, Global Wildlife Conservation. 79 p.

Sterling E.J., Hurley M.M. 2008. *Vietnam: A natural history*. New Haven, USA: Yale University Press. 448 p.

Thang N.T., Dung T.T.T., Ha H.V., McCormack T.E.M., Luan N.T. 2022. Species composition of tortoises and freshwater turtles in Ninh Thuan province, Southern Vietnam. *Journal of Forestry Science and Technology* 14: 46–54. DOI: 10.55250/jo.vnuf.2022.14.046-054

van Dijk P.P., Stuart B.L., Rhodin A.G. 2000. *Asian turtle trade: proceedings of a workshop on conservation and trade of freshwater turtles and tortoises in Asia*. Lunebourg, USA: Chelonian Research Foundation. 164 p.

Viollaz J., Rizzolo J.B., Long B., Trung C.T., Kempinski J., Rawson B.M., Reynald D., Quang H.X., Hien N.N., Dung C.T., Huyen H.T., Dung N.T.T., Gore M.L. 2022. Potential for informal guardianship in community-based wildlife crime prevention: Insights from Vietnam. *Nature Conservation* 48: 123–147. DOI: 10.3897/natureconservation.48.81635

Yen P., Ziegler S., Huettmann F., Onyeahialam A.I. 2005. Change detection of forest and habitat resources from 1973 to 2001 in Bach Ma National Park, Vietnam, using remote sensing imagery. *International Forestry Review* 7(1): 1–8. DOI: 10.1505/ifor.7.1.1.64163

ОЦЕНКА СООБЩЕСТВ ЧЕРЕПАХ В НАЦИОНАЛЬНОМ ПАРКЕ БАХ МА, ВЬЕТНАМ

В. Т. Фам[1,2], О. Ле Дюк[1,3], Б. Лепринс[1], С. Бордес[1,3], Ш. Дюкоттерд[1,4], В. К. Луу[5], Л. Т. Ан[6], М. Х. Нгуйен[6], В. О. Ло[6], В. Н. Ха[2], К. Б. Тран[7], Л. Льюизелли[8,9,10]

[1]*Центр сохранения заказника черепах, Франция*
e-mail: t.pham@turtle-sanctuary.org, o.leduc@turtle-sanctuary.org, c.bordes@turtle-sanctuary.org, b.leprince@turtle-sanctuary.org
[2]*Сохранение дикой природы Вьетнама, Вьетнам*
e-mail: ngoan@svw.vn
[3]*Ассоциированное сообщество дикой природы и охраны окружающей среды, Франция*
[4]*Центр «Эмыс», защита и восстановление черепах, Швейцария*
e-mail: c.ducotterd@turtle-sanctuary.org
[5]*Национальный университет лесного хозяйства Вьетнама, Вьетнам*
e-mail: qvinhfuv@yahoo.com.au
[6]*Центр охраны и развития природы, Вьетнам*
e-mail: ha.nguyen@ccd.org.vn, oanh.lo@ccd.org.vn, mrlethanhan@gmail.com
[7]*Управление лесного хозяйства Вьетнама, Вьетнам*
e-mail: baofuv@yahoo.com
[8]*Институт развития, экологии, охраны природы и сотрудничества, Италия*
[9]*Государственный университет науки и технологий штата Риверс, Нигерия*
[10]*Университет Ломе, Того*
e-mail: l.luiselli@ideccngo.org

Большая часть исключительно богатого биоразнообразия стран Юго-Восточной Азии сосредоточена в национальных парках и на других особо охраняемых природных территориях (ООПТ), а сообщества черепах с высоким видовым богатством в основном сохраняются преимущественно на этих ООПТ, где их естественные местообитания лучше сохранены. Тем не менее, очень немногие исследования несут информацию о видовом богатстве сообществ черепах на различных ООПТ Вьетнама, который является не только одной из горячих точек разнообразия черепах в мире, но и одной из стран, где их добыча является самой высокой. Целью данной работы было изучение разнообразия черепах в национальном парке Бах Ма (Центральный Вьетнам), в основном, характеризующемся лесистыми холмами и горами с прудами и ручьями различной формы и структуры. В рамках исследования были проведены (1) полуструктурированные опросы охотников, выбранных методом снежного кома в местных деревнях, (2) осмотры особей черепах, находящихся в их руках, и (3) полевых исследований на случайно выбранных трансектах с осмотром различных мест обитания, используемые этими рептилиями. В общей сложности нами обнаружено 15 видов, 14 из которых (93.3%) находятся под угрозой исчезновения согласно международному Красному списку МСОП. Был отмечен природный гибрид видов *Cuora bourreti* × *C. mouhotii obsti* (*C. «serrata»*). На основании опрошенных респондентов, наиболее часто встречались три вида (*Cuora bourreti*, *Manouria impressa*, *Platysternon megacephalum*). Мы пришли к выводу, что для улучшения природоохранного статуса сообществ черепах на местном уровне было бы важно (1) увеличить количество рейнджеров, патрулирующих территорию исследования в сезон дождей (с апреля по сентябрь) и (2) учесть имена охотников в деревнях, окружающих национальный парк Бах Ма, убедив их подписать соглашение с местными властями, чтобы избежать охоты на черепах на данной ООПТ.

Ключевые слова: горный лес, особо охраняемая природная территория, разнообразие, сохранение, черепахи, Юго-Восточная Азия