



Research article

Bats and belief: A sequential qualitative study in Thailand

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ABSTRACT

Bats are wildlife and distribute globally. In Thailand, there are hundreds of bat species in different locations within four regions. However, few motivations and influences for having contact with bats have been documented. This sequential qualitative study was conducted in ten provinces representing the four regions of Thailand from September 2016 to June 2017. The study was designed to obtain information on villagers' attitudes, perceptions, beliefs and cultural contexts in relation to bats. Focus group discussions (FGDs) were conducted with 305 respondents. Of these respondents, 142 (46.6%) reported coming into contact with bats through various activities, such as hunting, eating, cooking, collecting bat guano, cleaning bat feces, and finding carcasses in houses and communities. Villagers called bats by different names in different regions. They reported having been in contact with bats in different ways based on occupations, bat species, bat habitats, attitudes, perceptions, beliefs toward bats, and cultural contexts. Villagers in the northern and northeastern regions reported having regularly eaten bats. In contrast, the respondents in the central region did not eat bats due to local norms, religious beliefs, and regulations. By ethnicity, the Blu and Thai Dum groups reported coming into contact with and eating bats more often than the Thais. Our results provide evidence-based information on the human-bat interface in different regions in Thailand. The results of this qualitative study could be useful for strategic planning of proper education and interventions for bat conservation, bat contact behavior, and risk of bat-borne diseases among villagers in the future.

1. Introduction

Bats are important mammals that people around the world encounter in various ways, including through hunting (Openshaw et al., 2017), consumption for food (Kamins et al., 2015; Mickleburgh, 2009), use as medicine (Nilsson, 1986; Openshaw et al., 2017), use as natural insect or pest control (Srilopan et al., 2018; Sritongchuay et al., 2019; Wanger et al., 2014; Weier et al., 2019; Williams-Guillén et al., 2008), use for sacred and traditional practices (Wilson, 1987; Yang, 2009), and use of guano as fertilizer (Leelapaibul et al., 2005). People have various beliefs and cultural practices regarding bats. For example, the global mortality of bats might be due to either biotic or abiotic factors (O'Shea et al., 2016).

Bats in Western cultures have long been symbols of contempt and persecution (Todd, 2016) and have often been portrayed in popular media as rampant vectors of disease, blood vampires, ingredients in witches' brews, and, at times, been associated with the dark sides of some religious practices (Kunz et al., 2011; Oliver and Lewis, 2008). In Asia, bats represent death or devils (Frembgen, 2006; Valeri, 2000).

In Thailand, the wrinkle-lipped free-tailed bat (*Chaerephon plicatus*) is the most abundant species and feeds on insects. Insectivorous bats are more widespread than fruit bats. Additionally, the insectivorous bats in Thailand are favored for guano production (Leelapaibul et al., 2005). The public has reported coming into contact with bats in different ways (Robertson et al., 2011; Suwannarong and Schuler, 2016). However,

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studies on people's attitudes, beliefs, and perceptions toward bats are limited. This sequential qualitative study was conducted among villagers who lived in areas where several species of fruit bats and insectivorous bats were found in four regions of Thailand. Focus group discussions (FGDs) were employed to gather comprehensive information from the villagers who reported having been exposed and having not been exposed to bats in four regions of Thailand, which have diverse cultural contexts. Our study aimed to provide verification of and corrections to our previous quantitative study on the human-bat interface in Thailand and to obtain information on the possible factors that might be influenced by bat contact among villagers. Moreover, the findings will assist in designing strategies for community approaches to bat species conservation and the provision of appropriate information that might be related to health-related risks from bats.

2. Materials and methods

2.1. Study design and study period

This sequential qualitative study was implemented from September 2016 to June 2017 following an analytical cross-sectional quantitative study on the "human-bat interface in Thailand" in ten provinces of Thailand. Focus group discussions (FGDs) were performed to gather information from respondents on the following topics: 1) profiles of the respondents and contact characteristics; 2) local bat names, species, characteristics, and habitats; 3) bat contact behavior characteristics; 4) advantages of bats; 5) disadvantages of bats; 6) attitudes and perceptions toward bats; 7) beliefs and cultural contexts related to bats; and 8) preventive measures toward bat contact.

The purpose of the FGDs was to seek verification and corrections regarding our understanding of the quantitative study findings, to gather information on the attitudes, perceptions, beliefs, cultural contexts, contact behavior characteristics, perceptions of the advantages and disadvantages of bats, preventive measures for coming into contact with bats to reduce the risk for bat-borne diseases and to provide recommendations for communication strategies on community approaches for bat species conservation and health risk behaviors.

2.2. Study respondents, recruitment procedures, and procedures

The population of interest was villagers who had lived in the study areas for at least six months before the research. The respondents were pre-recruited based on the following criteria: 1) individuals between the ages of 20 and 75 years old, 2) lived in the study areas at least six months before the data collection study, 3) willingness to participate in the study, and 4) ability to communicate properly (e.g., no mental disorders or drunkenness displayed during the FGD). In this study, all respondents reported that they had been living in the area for more than a year during the fieldwork.

The respondents were categorized into two groups: 1) those who reported histories of contact with bats [contact or exposed group] and 2) those who reported no contact with bats within the past six months [noncontact or nonexposed group]. Different genders were analyzed separately for each FGD to reduce the dominant and cultural issues in each site.

2.3. Study settings

The selected provinces for the study were located in the following regions: the central (Ang Thong, Ayutthaya, Lopburi, and Saraburi), northern (Chiang Mai and Chiang Rai), northeastern (Khon Kaen and Ubon Ratchathani), and southern regions (Krabi and Surat Thani). The sites were selected based on the presence of bat roosting places in the regions. Figure 1 shows a map of the selected provinces in Thailand described below:

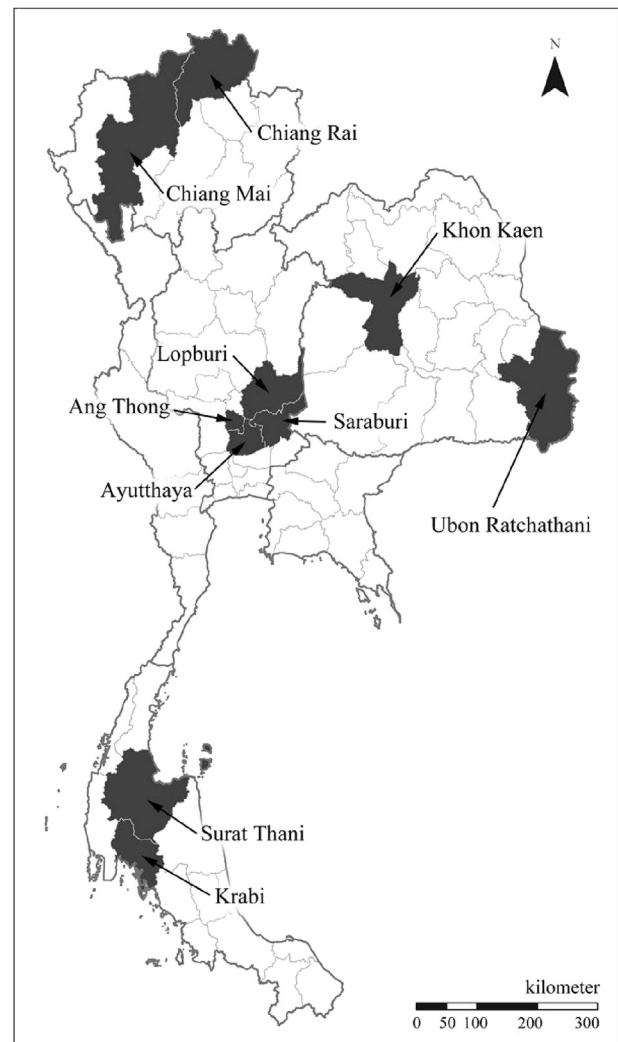


Figure 1. A map of the study sites in Thailand.

2.3.1. Northern region

Chiang Mai Province is located 685 km north of Bangkok and connected to Myanmar borders with the Daen Lao Range as a natural borderline. It was surrounded by Daen Lao Range, Thanon Thong Chai Range, and Khun Tan Range. The majority of the area is covered by rain forest. The study site is a large cave with Buddha's sacred monument inside the main cavern. Local and international tourists come to visit the cave and can reach the cave via a concrete stairway built outside of the cave. Along the cavern floor, there is a concrete path that leads to the end of the caverns. This study revealed that the number of bats had been reduced due to people's hunting and consumption.

Chiang Rai Province is located in the northern province of Thailand bordered by Laos to the east, bordered by Myanmar to the north and adjacent to Chiang Mai to the west. The eastern part of Chiang Rai is a flat river plain while the northern and western parts are hilly. The study site is the cave located in the temple area. The main cave entrance is located above ground level and can be accessed via the concrete stairway. The monks' residences are in front of the main cave entrance. The main cave floor is concrete. There is also another large cave near the main cave. Tourists and pilgrims are allowed to enter both the main cave and other caves to pay respect to Buddha sculptures.

2.3.2. Central region

Ang Thong Province is located 92 km north of Bangkok. Ang Thong is situated on a low river plain created by Chao Phraya and Noi River. The

study site is in a rural sub-district where a temple serves as bats' roosting place. Trees are densely growing around the temple. During the day, bats hang upside down on the trees and leave at night to look for food. Tourists come and visit the temple to observe the bats. The Lyle's flying fox (*Pteropus lylei*) is the most common bat species that abound in the area.

Ayutthaya Province is located 68 km north of Bangkok, and adjacent to Ang Thong province. It occupies a flat river in Chao Phraya river valley. The areas are rice paddies and fruit farms. The study site nestles a Buddhist monastery that is covered by a green canopy and frequented by bats as their roosting place. Approximately ten thousand of Lyle's flying fox (*Pteropus lylei*) live in this area. However, the number of bats has been reduced if compared during the last decade due to the expansion of the well-known temple. Considered as a historical site of Buddhism practice, tourists and pilgrims frequently visit this place not only to pray to Buddha but also to appreciate nature, including the bats. The bats roost on trees during the day and leave during at night.

Lopburi Province is located 93 km central of Bangkok. Lopburi mainly consists of alluvial plains with some hills and mountains that cover the province. The selected study site has a cave in Lopburi, surrounded by mountains where a temple has been built and taken care of by Buddhist monks. The cave is divided into various chambers; the temple uses some of the chambers as the praying hall. About a million bats roost in the cave. Tourists and pilgrims can access cave chambers via the temple entrance. Some of the cave openings can be accessed only by a wooden ladder. These openings are for bats guano mining. Around 6:00 in the afternoon every day, tourists gather to observe the bats flying out of the cave. The bats' species that can be found in this site are, for example, *Chaerephon plicatus*, *Rousettus amplexicaudatus* (Williams et al., 1976).

Saraburi Province is located 97 km northeast of Bangkok. Its neighboring provinces include Ang Thong, Lopburi, and Ayutthaya. Saraburi is situated on the east side of the Chao Phraya river. High plains and plateaus cover the eastern area of the province, and the western area is a mostly low flat plain. The study site is a Buddhist temple surrounded by large trees. The community of this study area initiated this temple as a tourist spot for observing the bats. This study found that the temple and nearby communities are also bat's roosting sites. All of the bats live in this temple are Lyle's flying fox (*Pteropus lylei*). They roost on the tree during the day and leave the roosting site between 18:00–05:00 h.

2.3.3. Northeastern region

Khon Kaen Province is located 450 km northeast of Bangkok. The study site is a cave in a national park. Local authorities consider this cave as a tourist spot for viewing bats around late afternoon (17.00–19.30 h). The cave, located 50 m above the ground on a small mountain, is a habitat of over a million bats. Every evening (about 18:00 h), bats leave the cave in line over 10-km long. Tourists can enter the main chamber of the cave, but they cannot go into the bats' roosting site beyond the main chamber. *Chaerephon plicatus* is the main bat species found in the cave. This species is an insectivorous bat favored for guano production (Boonkerd et al., 2001).

Ubon Ratchathani Province is located in the Korat basin on Korat Plateau, lies 496 km northeast of Bangkok. It is covered mostly by rice fields and forests and has a relatively flat landscape with some hilly area. The study site located near the Mekong River is a cave known only to local people. Inside the cave, there is a small stream that is a tributary to the Mekong River. This cave is famous as a fishing and bat hunting ground among locals. People reported bat exposure during fishing. The field researchers could not clearly identify the main species of bats in the cave, but based on the interview with the residents, both insectivorous and fruit bats can be found in this cave.

2.3.4. Southern region

Krabi Province is located 650 km south of Bangkok on Strait of Malacca and borders the Andaman Sea to the west. The southern part of

Krabi covered mountains by such as Khao Phanom Bencha mountain. Several species of bats have been reported during the current study data collection, including flying foxes and insectivorous bats. The bats are around numerous fruit farms, e.g., rambutans and durians. Mostly flying foxes have been found in September to December each year during the fruit-harvesting period.

Surat Thani province is located 527 km south of Bangkok. The center of Surat Thani is coastal plain, while the west is the Phuket mountain range covered by forest. The study site is nearby a conserved forest with the largest limestone cave in Thailand. However, bats are not only found in the forest, but also around fruit plantations. Bat guano was previously mined in this cave, but the mining activity already stopped due to law enforcement in the area. Tourists explore the cave by walking along the 1250 m-length concrete trail. The cave is divided into various chambers along the trail.

2.4. Data collection procedures and data analysis

The field researchers (facilitators and note takers) were trained by the principal investigator (PI) and co-PI to conduct the FGDs among the respondents. The trained facilitators and note takers could speak the local languages of the study sites. At least one note taker accompanied each facilitator to record audio and observations during the FGDs. The note takers were trained to describe body language, the presence of other individuals during the interview, and the details of the environment in which the discussions were carried out.

Upon completion, the FGD audio recordings were transcribed and translated from local languages into Central Thai transcripts. Keywords that were thematically coded by using the NVivo10 qualitative analysis software and triangulation analysis based on the objectives of the study were applied.

2.5. Ethical considerations

Written informed consent, including consent to record audio of the interviews and discussions, was obtained before conducting the FGDs. The study was reviewed and approved by the Research Ethics Review Committee for Research Involving Human Research Participants, Health Sciences Group, Chulalongkorn University, and the Chiang Rai Provincial Health Office gave approval for data collection in humans (Ref No. 034/59 and 26/2559, respectively). Local authorities and health officers agreed to and cooperated during the study implementations.

3. Results

3.1. Profiles of the respondents and contact characteristics

A total of 305 respondents participated in the study. The average age of the respondents was 49.0 years old. They most common group was agricultural-related workers (134; 43.9%), followed by temporary/seasonal employees, e.g. construction workers (75; 24.6%), government employees (47; 15.4%), bat guano miners or collectors (28; 9.2%), and housewives (21; 6.9%). One hundred twenty-four respondents (40.7%) were from the central region, while 50 (16.4%), 69 (22.6%), and 62 (20.3%) were from the northern, northeastern, and southern regions of Thailand, respectively (Table 1).

3.1.1. Bat contact behavior characteristics

Of the 305 respondents, 142 (46.6%) reported coming into contact with bats through various activities, such as hunting bats, eating bats, collecting bat guano, cleaning bat feces, and finding bat carcasses in houses and communities. In the northern region, the bat hunters were males, while the bat carcass sellers were females. In the central region, bat guano miners; alcohol drinkers; hunters; children/juveniles and adults; monks; tourists; and people who lived near temples reported coming into close contact with bats (Table 2).

Table 1. Numbers of respondents in the focus group discussions (FGDs).

Provinces	Regions	Bat contact group		Bat noncontact group	
		Males	Females	Males	Females
Chiang Mai	Northern	8	0*	7	6
Chiang Rai	Northern	7	5	9	8
Ayutthaya	Central	6	9	7	12
Ang Thong	Central	11	9	9	11
Lopburi	Central	7	8	6	7
Saraburi	Central	5	5	6	6
Khon Kaen	Northeastern	9	7	7	6
Ubon Ratchathani	Northeastern	10	10	10	10
Krabi	Southern	9	8	10	15
Surat Thani	Southern	3	6	5	6
Total		75	67	76	87
Grand total		305			

* No female group in the noncontact group in Chiang Mai province.

Table 2. Description of the respondents and bat contact characteristics.

Regions	Bat contact characteristics
North	Bat consumers, hunters (males only), kids, monks, bat carcass sellers (females only)
Central	Bat guano miners, male alcohol drinkers, hunters and consumers (only people from the northeastern region of Thailand, a Vietnamese construction worker), kids/youth, monks, tourists, people who live near temples
Northeast	Bat consumers (older than 8 years old), forest rangers, hunters (males only) adolescents, monks, the Blu ethnic group, bat cooks (housewives)
South	Bat guano miners, bat consumers, hunters (males only), orchard, plants, and fruits owners/workers, the Thai Dum ethnic group, bat cooks (housewives)

“Mostly the monks have regular contact with the bats because they have to collect and burn the bat carcasses” (male noncontact group in the central region)

Children were also reported to play with bats in the central region.

“Kids have a high chance of coming into contact with bats because they play near trees.” (male contact group in the central region)

In the northeastern region, bat consumers, persons aged older than 8 years, adolescents, monks, people of the Blu ethnicity in Ubon Ratchathani province, housewives who cooked bats or encountered bats, and forest rangers were reported to have contact with bats. The respondents mentioned that the officers controlled illegal bat meat and guano usage, especially in Khon Kaen province.

“The forest rangers take care of the bats, trees and bat guano” (male contact and noncontact groups in the northeastern region)

In the southern region, bat hunters were reported as males and housewives. Bat guano miners and people of the Thai Dum or Thai Song Dum ethnicities in Surat Thani province) were also reported having close contact with bats, similarly to people of the Blu ethnicity. Orchard and fruit farm owners/workers had contact with bats by catching bats for consumption and preventing the bats from destroying crops, plants, and fruits (e.g., rambutans, and durians), especially during the crop season between September and December.

“Orchard workers have contact with bats during the crop season.” (male noncontact group in the southern region)

3.1.2. Locations with bat encounters

Respondents reported encountering bats in different locations. Houses were considered unacceptable places for bats to live. Temples in the central region were considered acceptable living areas for bats. Trees or forests were acceptable living locations for bats in almost all regions except the northern region. In addition, mountains and abandoned

houses were acceptable places among the respondents from the north-eastern and southern regions.

“We do not live in temples, so it is acceptable for bats to live in temples (Laugh)” (female contact group in the central region)

“It would be a big issue if bats lived in our house.” (female contact group in the central region)

3.2. Bat local names, species, characteristics, and habitats of the bats

3.2.1. Bat local names

The northern villagers considered bats to be insects that have been living in caves and were called by the local names of *Meng Tham* or *I-kea*, which translate to *insects in caves* or *insects that have ears like rabbits*. The people in the northeastern region were likely to call the bats by the same name as the northern region, referring as *I-kea*. In Ubon Ratchathani province, people referred to bats as *Meng Kham Pue*, while in the southern and central regions called them *Kang Kao*, which is typical of the Thai language.

3.2.2. Bat species, characteristics, and habitats of the bats

The northern respondents reported finding several types of bats, such as flying foxes, which are as large as chickens. Small-sized bats were also found, which were reddish and had faces resembling those of the dogs that live in the caves around the communities. Some of them reported that they found bats with large and long ears, like those of rabbits. Surprisingly, some respondents also mentioned that they found flying foxes in areas in the Chiang Mai and Chiang Rai provinces (Table 3).

In the central region, several types of bats were found in caves (e.g., small bats). Some bat species (flying foxes) lived around trees in the communities and temples. They mentioned that bats had faces like those of dogs or monkeys; some bats had long faces with large ears. Flying foxes were described as quite large, as large as chickens, and weighed approximately 0.5–1.0 kg.

Table 3. Bat local names, species, characteristics, and habitats of bats in each region.

Regions	Local names	Bat species/types	Characteristics	Bat habitats
North	Kang Kao	Flying foxes	As big as chickens	Trees, caves, houses, temples, rice fields, orchards, and abandoned houses
	Meng Tham (insects living in caves)	Dog-faced Bats	Big, brownish; abdomens are gray or brown	
		Fai Bats	Small with reddish body	
		Kang Bats	As big as chickens	
		Giant-faced Bats	Big with a face that resembles Thai giant	
Central	Kang Kao	Flying foxes	As big as chickens, with erect ears, V-shape mouth Dog-like face	Trees, caves, houses, temples, and bamboo brushes
		Dog-faced Bats	Small	
		Rat-faced Bats	Small, dark brown, resemble rats	
		Giant-faced Bats	Larger than dog-faced bats	
Northeast	Kang Kao	Flying foxes	Big	Trees, caves, mountains, and temples
	I-kea	Dog-faced Bats	Small	
	Meng Kham Pue	Big Bats	Black fur	
		Messy-faced Bats	Cleft nose	
South	Kang Kao	Flying foxes	Big, long black fur	Trees, caves, houses, temples, mountains, and abandoned houses
		Dog-faced Bats	Black fur, no neck fur	
		Small baby rat Bats	Little, rat-like face	

In the northeastern region, four types of bats were reported, which included flying foxes or large bats and dog-faced bats that were reported to have black fur. Several bat habitats were reported, including trees, caves, mountains, and temples.

In the southern region, three types of bats were reported, including flying foxes, which were large and had long black fur, dog-faced bats that had black fur and no neck fur, and small bats that had a rat-like face. The bat habitats reported by the respondents included trees, caves, houses, temples, mountains, and abandoned houses.

3.3. Advantages of bats

Bats serve as food, mosquito or pest control, and bat guano serves as fertilizer. The bats spread crop seeds around plantation areas. Specific information is provided in the following:

3.3.1. Bats as food

Respondents from all regions reported eating bats; however, the cooking methods varied between the regions, e.g. stir-fry in the northern region.

“Make the bat into a spicy stir-fried with curry, deep-fried with garlic and eat it with Jim Jaeow sauce” (male contact groups in the northern and northeastern regions)

“Stir fry until the bats turn dry, then pour some rice whiskey in, simultaneously heat it, and let it burn in the pan.” (female contact group in the northern region)

Interestingly, most of the local villagers in the central provinces reported that they did not eat bats. However, those who did consume bats were likely those who migrated from the northeastern region and construction workers.

“Construction workers who came from the northeastern part of Thailand shot bats and cooked them” (male contact group in the central region)

In Ubon Ratchathani province, rural people of the Blu ethnicity consumed bats for food. Nevertheless, local Thais are also eating bats as food.

“In the past, only the Blu people ate bats, but currently not only the Blu people but local Thai people also eat bats” (female contact group in the northeastern region)

3.3.2. Bats guano collection and use as fertilizer

Bat guano was collected and sold as fertilizer in several provinces in the central (Lopburi) and northern (Chiang Mai and Chiang Rai) regions of Thailand. In Lopburi and Chiang Rai provinces, Buddhist temples managed the bat guano mining activities and hired local villagers to collect and pack the guano for sale. The respondents in all regions, except those in the northeastern region, reported using bat guano for their crops. The reason they did not report the use of guano in Khon Kaen is that the province has strictly enforced the law toward bats and guano usage, while there is less guano in caves of Ubon Ratchathani province.

“I can make 25 Baht by collecting 1 gallon of bat guano.” (male contact group in the central region)

3.3.3. Bats for mosquito or pest control

Bats were reported to help reduce the mosquito or pest populations in the northern and northeastern regions.

“They (bats) will come to eat mosquito or Maeng Hin (insect or pest).” (female noncontact group in the northern region)

“I think the advantage of bats is that they eat mosquitos.” (male noncontact group in the northeastern region)

3.3.4. Bats as medicines

Bats were used as medicines, either through eating bat meat or drinking bat blood, in all regions. In the northern and southern regions, carcasses of flying foxes were sold to produce medicines believed to cure asthma. A respondent in Ang Thong province reported that a person boiled a bat in water and drank the water to improve his sexual drive and power. Male respondents in the central and northern regions mentioned that the blood of bats has high protein content, provides more sexual power, and promotes longevity. Moreover, a male respondent from the central region reported that bats were used as medicine to relieve muscle pain. A male respondent in Surat Thani preserved flying fox carcasses for sale and delivered them to another southern province to produce asthma medicine.

“Bats are also used as medicine to relieve muscle pain.” (male noncontract group in the central region)

3.3.5. Tourist attractions

Bats were also reported as a tourist attraction, which helps to create jobs and income in the provinces of the northern and central regions and Khon Kaen province in the northeastern region.

“I think that if bat habitat could be made into a tourist attraction, it can create income for people in this area. It is an opportunity” (male contact group in the central region)

3.3.6. Bat trades

Selling bat guano was reported in all regions except in the northeastern region and was especially common in the northern region (Chiang Rai), the central region (Lopburi), and the southern region (Surat Thani).

Selling or trading of bat carcasses was also reported in the northern and southern regions. The traders were local hunters or neighbors in the communities.

“Mostly, the husbands catch the bats, and the wives sell the bats.” (male noncontact group in the northern region)

The price of the bats is currently costly due to limited numbers of bats at the sites.

“Bats are rare now, so they are expensive. Raw bats cost 15–20, and cooked bats are expensive...” (female contact group in the northern region)

3.4. Disadvantages of bats

Bats were reported to destroy people's belongings, crops, plants, and fruits, and are sources of pathogens, diseases, and mites. Bats also annoyed people.

3.4.1. Destruction of belongings, crops, and fruits

Respondents in all regions reported that bats had damaged their belongings, crops, plants, and fruits during the harvesting season.

“Bats bite our belongings.” (male contact group in the central region)
“I do not want bats to live in those orchards.” (female contact group in the southern region)

3.4.2. Illness related to bats

The respondents reported knowing about diseases or pathogens related to bats in all regions. The central respondents provided specific diseases that were related to bats, such as influenza, rabies, allergies, and asthma. The respondents in the southern region reported diseases from

bats or symptoms that included rabies, brain-related diseases, mites, bad odor, and asthma.

“Bats cause Leptospirosis or something like that.” (male and female, contact and noncontact group in the central, northern, and southern regions)

“Bats cause rabies. Theirs guano stinks. They also have mites.” (male contact group in the central region)

“I am scared of them (bats). I am concerned that bats may bring pathogens with them.” (female noncontact group in the northern region)

“I have heard that northeastern people who eat flying fox Larb. (Thai spicy minced meat dish prepared with bats) was infected with rabies and something related to the brain.” (male noncontact group in the central region)

The bats and mites inside the caves were also reported to cause itchy skin and skin rashes among the respondents who collected and packed bat guano in the central and northern regions. Moreover, the respondents reported that eating bats would cause eczema.

3.4.3. Annoyance from bats

Most respondents reported that bats were annoying and had a bad odor. For example, in the northern region, bats urinated or defecated onto people's bodies and clothes. A respondent in the central region mentioned that bat urine could ruin car color (Table 4).

“When we sleep, the bats on the ceiling urinate on me.” (male noncontact group in the northern region)

The respondents from the southern region also reported that they had protected plants and fruits from bats by shooting or trapping bats by using nets around the fields. They caught bats to eat, sell, or preserve for sale as medicinal asthma products in other provinces in the southern region.

“Around the house and orchard areas...we use nets to catch the bats if they are too small. (male noncontact group in the southern region)

3.5. Attitudes and perceptions toward bats

In the northern region, the respondents reported bats as beautiful, harmless, and non-problematic creatures. They did not want to eliminate bats. They expressed no negative feelings or concern toward bats. Interestingly, the bats were also considered delicious delicacies. In contrast, some respondents held a negative attitude toward bats. They

Table 4. Advantages and disadvantages of bats.

Regions	Advantages	Disadvantages
North	Bat guano could be sold or used as fertilizer. Bats could be eaten. Bats helped to reduce the mosquito population. Bats were used as medicine. Bats were sold for consumption.	Bats carried dirt. Bats were sources of pathogens, diseases, and mites.
Central	Bat guano could be sold and used as fertilizer. Bats could be eaten. Bats could attract tourists to visit the area that helped to create jobs and income. Bats were as medicines.	Bats were sources of pathogens, diseases, and mites. Bats had a bad odor. Bats carried dirt. Bats damaged belongings.
Northeast	Bats could be eaten. Bats helped to reduce the mosquito population.	Bats were annoying. Bats were sources of pathogens and diseases. Bats caused damages to crops, plants, and fruits. Bat and their guano have an unpleasant smell.
South	Bat guano could be sold or used as fertilizer. Bats could be eaten. Bats helped to reduce the mosquito population. Bats were seed propagators and bioindicators. Bats were as medicines.	Bats were carriers of dirt. Bats were sources of pathogens and diseases. Bats had a bad odor. Bats damaged crops, plants, and fruits.

viewed bats as disgusting, unappetizing, dirty, or malodorous animals. They were scared of getting any diseases from bats.

“Bats are beautiful when they fly out of the cave in tandem.” (male contact group in the northern region)

“I have no concerns about bats. It is normal. It is the bats' nature.” (male noncontact group in northern region)

In the central region, the respondents claimed that bats were common creatures. They felt lucky that there were bats in their villages. They mentioned that bats should be allowed to live. They had no fear of bats and enjoyed watching bats. They pitied bats because bat habitats have been reduced. Bats were related to beliefs, such as the symbol of death or bad omen, or people who ate bats would be cursed. One could contract diseases from bats. Bats were malodorous or annoying animals.

“I only respect, love, and like bats. When I see them, it is okay.” (female contact group in the central group)

“I feel nothing toward bats because they live by themselves normally. They are different from pigeons that defecate onto our house. For bats, sometimes, I pity them because of the decrease in the number of trees.” (male noncontact group in the central group)

In the northeastern region, the respondents had a neutral feeling toward bats. When cooked, bats were delicious. Some respondents viewed bats as national treasures for tourist attractions. However, bats were also described as disgusting, dirty, annoying, and capable of carrying diseases.

“Bats are national treasures.” (male noncontact group in the northeastern region)

“I am scared of bats because since I was a child, I watched TV cartoons that featured bats as mysterious and scary animals.” (male contact group in the northeastern region)

In the southern region, bats were delicious if cooked and were attractive creatures. The people in the region expressed no positive or negative feelings toward bats. However, they also claimed that bats were malodorous, unappetizing, creepy, scary or harmful, and capable of carrying diseases. They did not want to live near bats.

“It is their (bats) nature. We are humans that eat chickens, pigs, and other foods. Similarly, bats eat fruit naturally. It is their nature.” (male contact group in the southern region)

3.6. Beliefs and cultural contexts related to bats

Respondents from the northern and northeastern regions did not report any of their beliefs related to bats; in contrast, people in the central region believed that bats were holy and sacred animals, meaning that they had to respect and could not kill/eat bats (Table 5).

“Bats are holy animals belonged to a Buddhist priest.” (male and female, contact and noncontact groups in the central region)

Table 5. Beliefs and cultural contexts related to bats.

Regions	Beliefs
North	None.
Central	Bat-eater or people who harm bats will be cursed/have bad luck. Bats waking up in daytime signals the death of a person. Bats are holy animal bats belong to a Buddhist priest. Bats in a house are a bad omen. Bats flying around the main temple signals the death of a person.
Northeast	None.
South	Believing that eating bats will lead to eczema.

“Bats are sacred animals...they are revered a the father's (Buddhist monk) animal.” (male and female contact and noncontact groups in the central region)

Respondents in both bat-contact and noncontact groups in the central region mentioned that bat consumption could cause one to be cursed.

“Bat-eaters or people who harm bats will be cursed or have bad luck” (male contact group in the central region)

“Bats that wake up during the daytime signal the death of a person” (male and female, contact and noncontact groups in the central region)

“Bats flying around the main temple signal the death of a person.” (male and female, contact and noncontact groups in the central region)

“A bat in the house is a bad omen.” (female contact group in the central region)

“Eating bats is not good for you. It will lead to misfortune” (male contact group in the central region)

3.7. Preventive measures toward bat contact activities

The respondents in northeastern and southern regions reported no preventive measures when having contact with bats. The respondents from the northern and central regions reported various measures, including blocking any openings that bats could enter, using nets, and using personal protective equipment. In the northern region, they reported using a spotlight to chase bats away. In contrast, the respondents reported using fire, using insecticide, and hanging colored water bottles to chase bats away in the central region.

4. Discussion and conclusion

This study provided comprehensive qualitative information on the human-bat interfaces in different regions of Thailand. The respondents had been in contact with bats through various activities, including hunting, cooking, eating, collecting bat guano, cleaning bat feces, and finding carcasses in their houses and communities. These findings differed based on occupations, bat species, bat living locations, attitudes, perceptions, beliefs, and cultural contexts. Children, adolescents, bat hunters, housewives who cooked bats, forest visitors, and forestry officers were reported to come into contact with bats more often than other groups of villagers. Trees, forests, temples, and houses were reported as both acceptable and unacceptable living locations for bats.

In this study, respondents were able to identify several types of bats, such as *Cynopterus brachyotis*, which is found in the Chiang Mai and Chiang Rai provinces in the northern region; *Pteropus lylei*, which is found in the Ang Thong, Ayutthaya, and Saraburi provinces; and *Chaerephon plicatus* and *Rousettus amplexicaudatus*, which are found in Lopburi province in the central region. People in the northern region consumed bats as food more often than those in other regions, while people in the central region did not eat or hurt or kill bats due to their local beliefs, religions, norms, and regulations. In contrast, a previous study conducted on bat consumption in four provinces, including central and lower northern Thailand (Ratchaburi, Sakaeo, Nakhon Sawan, and Phitsanulok), revealed that the villagers consumed bat meat and blood (Suwannarong and Schuler, 2016). In these four provinces, villagers did not have any religious taboo-related or strict local regulations on bat consumption. Similarly, a previous study revealed that laws and regulations (fines) alone were unlikely to induce a change in bat consumption (Kamins et al., 2015).

According to this qualitative study, the Blu and Thai Dum ethnic groups came into contact with and consumed bats more often compared to people in the Thais. Bats were cooked depending on regional contexts; for example, bats were cooked with chili and fish sauce in the northern

region and fried with chili in the southern region. Bats and bat carcasses were collected from caves, farms, and forests by local hunters and sold in the community. In contrast, in previous studies in Thailand and rural West Africa, bats were sold in restaurants (Anti et al., 2015; Suwannarong and Schuler, 2016).

Bats were reportedly used as medicines to improve sexual drive and power. In this study, flying fox carcasses were preserved and sold in the southern provinces, especially to treat asthma. Similarly, in some Indian cultures, people consume fresh bat meat with the belief that it would cure asthma, trouble breathing, and blindness (Sinha and Sinha, 2001). Lopburi province in the central region and Chiang Rai province in the northern region had bat guano mining businesses, especially those managed by temples, which was similar to a previous report in Ratchaburi province (Suwannarong and Schuler, 2016). Interestingly, the two provinces of the northeastern region did not report any bat guano mining. A possible explanation could be that some provinces had strict law enforcement of bat guano production. This study showed that bats were also used for mosquito and pest control. A previous study revealed that bats could prevent food loss and could protect food by controlling pests (Wanger et al., 2014).

Bats could also increase community income through tourist attractions, guano mining, and carcass selling in the community. In contrast, bats also created disadvantages, such as destroying crops, plants, and fruits. Positive and negative attitudes toward bats were reported according to people's religions, beliefs, and local contexts. For example, bats were considered holy and sacred animals in some areas, where people believed that bats must not be slaughtered and eaten. In addition, respondents in the Lopburi and Ang Thong provinces believed that people who harmed bats would be cursed or may encounter bad luck. This agreed with the previous studies that it was taboo to harm, kill, or eat bats (Valeri, 2000; Wilson, 1987).

According to the respondent's perception, bats are able to carry diseases, pathogens, and mites. The respondents mentioned being aware of some diseases, such as rabies, influenza, asthma, skin itchiness and rashes. Our results agreed with a previous study that guano miners knew that rabies could be transmitted through contact with bats (Robertson et al., 2011). Interestingly, some of the respondents reported incorrect information on bat disease transmission to humans, such as leptospirosis and avian influenza. Preventive measures for coming into contact with bats were reported among people in the northern and central regions, whereas those from the northeastern and southern regions reported fewer preventive measures. Lack of knowledge on bat contact and implications for health should be addressed to reduce possible infection with bat-borne diseases.

A limitation of this study is that qualitative approaches do not allow statistical comparison among study locations. However, our results provide important contributions to the social dimensions of bat knowledge across different regions of Thailand and can be used as a reference for bat conservation purposes. In conclusion, our results can be used in the following ways; a) to identify the risk of bat contact behaviors in different locations to predict possible bat-borne diseases among the villagers, b) to provide evidence on the attitudes, local beliefs, cultural contexts, norms, and regulations that influence bat contact behaviors in specific provinces and regions, c) to assist strategic planning for proper education and intervention on bat conservation, bat contact behavior, and risk of bat-borne diseases among villagers, and d) to employ law enforcement activities to improve conservation activities and to reduce bat-human interface. Future investigations could focus on quantitative and qualitative approaches to bat contact behavior among specific ethnic groups in Thailand.

Declarations

Author contribution statement

Kanokwan Suwannarong: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Karnsunaphat Balhthip: Performed the experiments; Analyzed and interpreted the data.

Phitsanuruk Kanthawee, Santisith Khiewkhern: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

Kangsadal Suwannarong, Thanomsin Ponlap, Nisachon Bupha: Performed the experiments.

Cecilia Lantikan: Analyzed and interpreted the data; Wrote the paper.

Alongkorn Amonsin: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Competing interest statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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