An Assessment of Anthropogenic Threats to Hoolock Gibbon (*Hoolock leuconedys*) Populations and Potential Conservation Measures in Yingjiang County in West Yunnan, China

Final report

By

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Photo: An adult male hanging on the tree in the collective forest in Xiangbai Village, this photo was taken by staff of Yingjiang County Forestry Bureau.

CONTENTS

SUMMARY

The survey reported the hoolock gibbon population status and the impacts of anthropogenic activities on the species in Yingjiang County, West Yunnan, China. The survey was undertaken from January to December 2015, Dr. Guan Zhenhua and Associate Professor Li Maobiao from Yunnan Academy of Biodiversity, Southwest Forestry University and supported by the Gibbon Conservation Alliance. To assess the anthropogenic threats to hoolock gibbon (*Hoolock leuconedys*) populations and potential conservation measures, we choose 14 relevant communities in two townships to conduct interview and transect survey. There are 18 groups in Yingjiang County, of which 14 groups are distributed in the collective forests outside the existing nature reserve, which are under local community management. Few direct threats to gibbon were found. The main threats are fructus tsaokos expansion leading to forest fragmentation, and the multiple groups may already been genetically isolated. To address this issue we recommend a series of conservation actions that should be implemented in the near future. We suggest to cooperate with the local forestry bureaus to investigate the land/forest tenures of all the gibbon habitat areas as this has great impacts on the conservation project designing and development in Yingjiang County. Meanwhile, scientific research should be conducted on some groups for providing an underlying foundation for hoolock gibbon conservation. Through some type of community-based conservation education program, we recommend habitat-friendly fructus tsaoko cultivation, for instance, leaving or planting more large trees and food sources trees in the fructus tsaoko fields. For the long-term conservation of gibbons, we consider that the initial habitat restoration efforts should be conducted to connect the subpopulations in Lamahe and Xiangbai.

Dr. Guan Zhenhua toke all the photos in the text of this report except for the photo in the title page.

LIST OF CONTACTS AND PEOPLE MET DURING PROJECT ACTIVITIES

Mr. Li Kaizhou: Director of Yingjiang County Environmental Protection Bureau
Mr. Zhao Zengfu: Deputy director of Yingjiang Environmental Protection Bureau
Mr. Zhao Yongquan: Head of the Zhina Township Forestry Station
Mr. Li Peng: Worker in Zhina Township Forestry Station
Mr. Yang Zuwei: Worker in Zhina Township Forestry Station
Mr. Zao Xinglong: Head of Sudian Township Government
A number of local villagers were interviewed during the survey. Their names not listed in detail here.

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Photo: Members of the field survey team. From left: Dr. Guan Zhenhua, Mr. Li Peng, Mr. Yu Chenglong, Mr. Zhao Yongquan, Mr. Yang Zuwei

1. BACKGROUND

Six gibbon species belonging to the three genera (*Hylobates lar*, *Nomascus concolor*, *N. nasutus*, *N. hainanus*, *N. leucogenys*, and *Hoolock leuconedys*, Geissmann, 2007) were reported to distribute in south China. However, recent surveys reported that two species (*H. lar* and *N. leucogenys*) appear to have gone extinct ecologically in China (Fan et al., 2014; Grueter et al., 2009) and all of the remaining species are confronted with some major threats, e.g. small population size, habitat fragmentation and poaching (Fan et al., 2011; Jiang et al., 2006). Eastern hoolock gibbon (*H. leuconedys*) is distributed in a narrow area between the Chindwin River and the Salween River in Myanmar, which is a border region between the People's Republic of China and the Republic of the Union of Myanmar (Das et al., 2006; Groves, 1967, 1972). Globally, the eastern hoolock gibbon is considered as Vulnerable on the IUCN Red List (Brockelman and Geissmann, 2008) and as a Class I protected species in the List of National Key Protected Wild Animal Species (1989, the Ministry of Forestry). It is also listed in Appendix I in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Historically, the eastern hoolock gibbon ever distributed extensively in nine counties in the mountain ranges to the west bank of the Salween River in we Yunnan, including Lushui County, Longyang District of Baoshan City, and Tengchong, Longling, Lianghe, Yingjiang, Longchuan counties, as well as Luxi and Ruili cities. The most recent survey revealed that hoolock gibbon disappeared in most of the above areas, only less than 200 individuals were found in three areas in Yingjiang County, Tengchong County and Longyang district of Baoshan, respectively (Fan et al., 2011). In the 1980s, as the key conservation targets, the hoolock gibbon and their habitats were important justifications for the establishment of Gaoligongshan National Nature Reserve, Tongbiguan Provincial Nature Reserve and Xiaoheishan Provincial Nature Reserve. In 2013, the collaborative efforts of FFI, Gaoligongshan National Nature Reserve and Tongbiguan Nature Reserve Management Bureau, *the Eastern Hoolock Gibbon Conservation Action Plan* was formulated. In July 2013, the first hoolock gibbon monitoring patrol team was mobilized to strengthen the protection and monitoring of the critical areas in Mt. Gaoligong National Nature Reserve which had enhanced the effective protection of the species. However, a large portion of the hoolock gibbon populations are inhabited outside the nature reserves.

In Yingjiang County, local communities still depend on goods and services directly from the natural environment, particularly the forest resources. According to the latest survey, the species populations in Yingjiang County

account for nearly half of its total in China, whereas little information about the populations in Yingjiang County was available since that survey. Because of poor data availability about their distribution, population size and threats, we were unable to assess the status quo of the gibbon populations and the areas that were most important for the species, and what the most important threats were. For the long-term sustainable conservation of gibbons, we need to understand the motivations driving the indigenous and local people to participate in conservation projects and assess the impacts of anthropogenic activities on the species. We are supposed to identify the relationship between the local economic activities and conservation measures to address the threats. Therefore, we propose to conduct this survey in Yingjiang County supported by the Gibbon Conservation Alliance, we hope our report could provide the information and basis required to develop further conservation actions for the better conservation of the species.

2. SURVEY AREA

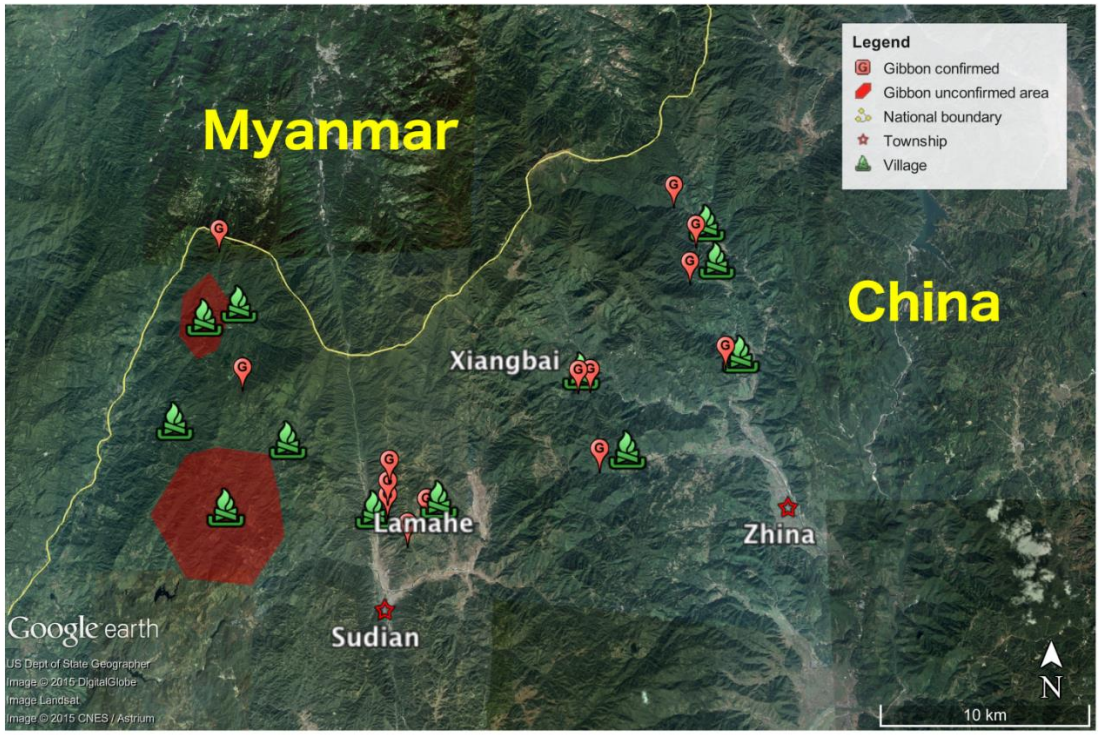

Figure 2.1 A gibbon distribution map on Google Earth. We mapped 14 groups and 11 villages, there are two areas where gibbon populations were not confirmed or the survey result is inconsistent.

Our survey was conducted in Sudian and Zhina townships in Yingjiang County. Both townships border Myanmar and are important border areas for exchange of the people from both sides (Figure 2.1). Minimum altitude in the two townships is 640 m and the highest at 3,404.4 m. The annual average

temperature is 13.3 °C (-4 °C - 30 °C). Sudian Township is a Lisu ethnic township, totaling 7,852 people living in four administrative villages (administering 49 natural villages), over 90% of its populations are Lisu people; other minorities, including Jingpo and Dai, account for only a small portion. Zhina Township has five administrative villages (60 natural villages), totally 14,732 people, 93% of people are the minority which is consisted of Lisu, Dai and Jingpo. The annual average precipitation is 3,553.5 mm in Sudian and 2,586 mm in Zhina. Tongbiguan Nature Reserve, located between 23°54′30″-25°20′24″ N and 97°31′40″-98°06′36″ E, was established in 1986, and it spans 51,650.5 ha and is comprised of six separate areas. All the six areas were distributed in Yingjiang, Longchuan and Ruili counties. Daniangshan area and Tongbiguan area were in Yingjiang County. Tongbiguan Nature Reserve plays an important role for protecting a small hoolock gibbon population distributed in Daniang Mountain area. It is located between 25°10′12″-25°20′24″ N, 97°50′24″-98°06′36″ E, along the southern national border and adjoins several villages, e.g. Lamahe, Xiangbai, Baiyan. This subarea occupies 11,938.4 ha and is one of the six subareas of the Tongbiguan Nature Reserve, and host to a high diversity of plant species and vegetation types/forest ecosystems.

Photo 3.1 Interview with government officials from Sudian Township. From left: Zhao Zengfu; Zao Xinglong; Three staff from Sudian Township government; The last is Zhao Yongquan

3. METHODOLOGY

We collected information from the county forestry bureaus and township government to identify where to conduct the interviews and field survey (Photo 3.1). Meanwhile, we alco checked the survey result from 2009 (Fan et al., 2011). Finally, 13 communities in Sudian and Zhina townships were selected to conduct our surveys.

3.1 Semi-structured interviews

We conducted our interviews in 13 communities, seven in Sudian and six in Zhina (See detailed information in Appendix 2), The field survey was implemented in January and November, 2015. We asked the information specified in our questionnaires (Appendix 1). Accordingly, we asked information about gibbon's historical/recent presence, population sizes, habitat disturbances and poaching threats in the adjacent villages. The interviewees were senior hunters, foresters, forest rangers and villagers as non-timber forest products collectors (Photo 3.2).

Photo 3.2 Interview with local people. 1 and 2: villagers used to be hunters. 3: villager; 4: forest ranger

We also collected information about the local people's economic status and production activities, e.g. non-timber forest products collection, grazing, planting cash crops, installing snares, etc., in the forests. In order to know the status of forest resources use, we asked for the permission to visit their houses and see their ways of cooking and furniture, or household items that might relevant to forest resources. In case of interviewing with people who often sight or know gibbons, we also asked about the gibbon group size, food types/species, calling behavior and so on. During the interviews, the attitude of the local people toward the wild animals and their habitats were of great concern for us. Some relevant information was asked such as the significance of the wild animals and natural forests in their mind and their wish to participate the conservation project.

3.2 Transect survey

Based on the gibbon information collected, we set 12 transects in different habitats in Sudian (five transects in the state and mostly collective forest areas of four communities) and Zhina (seven transects in the state and mostly collective forest areas of five communities) townships. Anthropogenic activities were assessed along the transects. We asked the local forestry rangers to lead us to gibbon habitats, if the rangers did not quite know gibbon habitats, we asked them to lead us to the place he often sight gibbon or where gibbon often called, then we walked around for about one kilometer. Each time we spend one to two hours depending on the complexity of the habitat terrain and the gibbon knowledge habitat of our guides. Along the transects, we measured the disturbances by recording all types of anthropogenic activities, including agriculture, logging, traces of burning and snares (Photo 3.3). Signs of disturbances may also include gunshots heard and encounters with hunters.

Photo 3.3 Different anthropogenic activities in gibbon habitats. Left up: fructus tsaoko plantation; Left down: burning site; Right up: Vegetable field surounded by fence; Right down: logging timber.

3.3 Survey itinerary

Table 3.1 Field survey itinerary

Date in 2015	Activity
January 21	Taking shuttle bus from Kunming City to Yingjiang County
January 22	Interview with Zhao Zengfu, discussions about our project and survey plan, and introduction of our project to Mr. Li Kaizhou. Interview in Sudian Township Government with Zao Xinglong and Lamahe Community
January 23-24	Interview in Xiangdelong, Lishu, Xinwen communities. Check out on the township market
January 25-26	Taking township bus to Yingjiang County, and taking township car to Tongbiguan Township and interview with Wang Liyan
January 27	Taking shuttle bus from Yingjiang County to Kunming City
November 18	Taking plane from Kunming to Yingjiang County, discuss our project plan with Mr. Li Kaizhou and Mr. Zhao Zengfu
November 19-26	Go to Zhina Township, meet Mr. Zhao Yongquan, Li Peng and Yang Zuwei. Interview and transect survey Xiangbai, Baiyan, Zhongshan, Shidong, Xianjiazhai, Zhongling villages. Interview with the staff and forest rangers in township forestry stations
November 27	Taking township car back to Yingjiang County
November 28-30	Go to Sudian Township and conduct interview and transect survey in Lamahe, Waku, Nanpa, Mulonghe, Lishu villages
December 1	Taking truck to Zhina Township, making summary of our survey
December 2	Taking township car back to Yingjiang County, introduce our project result and discuss with Li Kaizhou and Zhao Zengfu
December 3	Taking plane back to Kunming

4. RESULT

4.1 Gibbon Populations

Our survey was conducted in January and November 2015. Through our survey, the locations of 18 groups were preliminarily confirmed, of which, 14 groups were mapped (Figure 2.1, Table 4.1). We heard four groups during this survey, we also sighted one group of gibbon in the collective forest in Lishu Village and followed this group for about half an hour stealthily hiding behind large trees. There were three individuals in the group, including one female. According to the results of the interview result, the largest group of eight individuals was living near Xiangbai Village, and three smallest groups of only two individuals each were distributed in several places. According to the forestry data collected, only two groups of gibbon were distributed in Tongbiguan Nature Reserve (one group near Baiyan and another near Lamahe), and two groups were located in an area on the nature reserve boundary (one group near Zhongshan and another near Xianjiazhai). All the other groups were distributed outside the nature reserve.

Table 4.1 Summary of gibbon locations and population size

Township	Nearest Village	No. of Groups	No. of Individuals
Sudian	Lamahe	5	4 & 3 & 6 & 6 & 3
	Lishu	1	3
	Waku	2	4 & 2
	Jiganzhai	1	unconfirmed
	Laluotang	1	2
	Zijiawaduo	1	unconfirmed
	Xiaokuhe	unconfirmed	
	Dakuhe	unconfirmed	
Zhina	Xiangbai	2	8 & 3
	Baiyan	2	7 & 2-3
	Zhongshan	1	3
	Xianjiazhai	1	2-3
	Zhongling	1	2
Total		18	60-70

4.2 Community livelihoods

A total of 30 villagers and four officials, aging from 24 to 86 in the county forestry bureau and township forestry stations were randomly chosen to conduct the interview. We also asked relevant information if we occasionally encounter people during the survey. All the interviewees were local natives in 13 communities in the two townships. We asked the information specified in our questionnaires (Detail interview result in Appendix 2). The average annual household income was RMB 14,750 *yuan*, ranging from RMB 4,000 to 50,000 *yuan*, n=24. Generally, as most gibbon habitats overlaps with the collective forest areas where forest resources use by the community residents is intensive, a large part of the local people's livelihood had close relationships with the gibbon habitats. Overall, cultivation, logging, infrastructure construction constituted the main threats to hoolock gibbon. Although it is convenient for the local people to buy household consumables from the township markets for most communities, a lot of their furniture were made by local people themselves using bamboo and timbers from the collective forest areas.

Livestock: In all the villages, rearing cows, pigs, goats, chickens and bees is common but not in a large scale. Water buffalos are kept only in the lowland basins, near the central towns, as water is needed for the livestock. Moreover, the cattle population has been decreasing significantly compared to the past years, which is primarily attributable to the expansion of fructus tsaoko plantation. Firstly, it reduced the land available for rearing livestock, and secondly, the livestock may browse the seedlings and seeds of fructus tsaoko, and the local people even have to install fence or barbed wires around the fructus tsaoko field.

Agriculture: In both townships, most of the family income was consisted of growing economic crops, of which fructus tsaoko (*Amomum tsaoko*) occupied a large part, except several communities (Photo 4.1). Sugar cane accounted for a main part in Xianjiazhai Community since a mudslides washed away all the fructus tsaoko in 2004. In Zhongling Village, walnut accounted for the main part, at above 50%. The agricultural practices also depend on rearing livestock, e.g. pigs, apiculture of wild/native bees. Other farm crops include corn, vegetables were grown in all the communities, but mostly for family consumption only and rarely sold in the local markets.

Photo 4.1 Different cultivation practices in habitats. From Left: fruits of fructus tsaoko; Plants of fructus tsaoko. The fructus tsaoko has been the main family income for decades in most the communities.

Forest resources uses/Timber extraction: People cut some tree species for fire wood and construction timber, 10 species are the target species including *Castanopsis calathiformis, C. echidnocarpa, Lithocarpus polystachyus, Schima wallichii, Alnus nepalensis, A. cremastogyne, Alnoides Betula alnoides, Cunninghamia lanceolata, Aleurites moluccana* and *Camellia Camellia-Oilfera Abel.*

Herbs, wild vegetatbles and mushrooms: All the communities had a traditional way to collect mushrooms, some wild vegetables, including potherb (unidentified species), *Dendrobium spp*. (Photo 4.3). In some communities, such as Zhongshan and Baiyan, local villagers also collected bamboo shoots in spring and autumn.

Photo 4.3 non-timber forest products collection species. Left: Dendrobium spp.; Right: unidentified species found on the township market

Hunting: We found that one red fox (*Vulpes vulpes*), one Chinese porcupine (*Hystrix hodgsoni*) and some birds were hunted, five gun shots were heard and two hunters with guns were sighted during the survey. Meanwhile, we also found one macaque's skull (*Macaca mulatta*) and one sambar deer antler (*Rusa*

unicolor), which was hunted 30 years ago according to the owner (Photo 4.4). This traditional hunting culture effectively prevents excessive hunting in the past. During the survey in November, we found intensive hunting activities for birds as it was the peak hunting season for birds. Using snare was another way to hunt in this time of the year, which targets at both large and small mammals, such as wild boars, macaques, deer, mice, civet cats, porcupine and so on. With the availability of more advanced hunting tools, such as guns, the potential threats on the wild animals is growing as the local hunters still continue hunting indiscriminately hunt despite the traditional taboos.

Photo 4.4 Some animals hunted. Left up: a fox corpse (Vulpes vulpes); Right up: a pheasant of unidentified species; Middle Left: Chinese porcupine (Hystrix hodgsoni); Middle Right: a skull of a rhesus monkey (Macaca mulatta); Left down: an antlers of sambar deer (Rusa unicolor); Right down: Two hunters with guns on a motorbike

4.3 Transects

The transect survey was conducted in November and December 2015. In total, 12 transects (seven in Zhina and five in Sudian) were surveyed. We measure the disturbance level by recording all the types of anthropogenic activities, including plantation, logging, trails, fire places and snares set to catch ungulates. Anthropogenic activity varied in places according to the local climate conditions for cultivation. Fructus taoko plantation, non-timber forest products collection, shifting cultivation, firewood, construction timbers were the main anthropogenic types affecting the gibbon habitats. As most of the transects were set up in the collective forests, where anthropogenic activities were intensive, we incorporated the observation results of gibbon habitats and measured the disturbance level. We assign three (3) as the serious disturbance, which means logging, cultivation and hunting were found in the area; two (2) means hunting and serious logging were not found in the area; one (1) means only some cultivation and non-timber forest products collection were found in the area. Based on the results, only the habitats near Xiangbai Village were found with low-level disturbance (Table 4.2).

4.4 Mammal diversity

We assessed the level of relative mammal diversity based on the transect survey and interviews. Overall, we found that mammal diversity was relatively higher in the gibbon habitats than other areas outside the nature reserves areas and varied in different habitats. Five large mammals (e.g. Asiatic black bear (*Selenarctos thibetanus*), Chinese serow (*Capricornis milneedwardsii*), red muntjic (*Muntiacus vaginalis*), wild boar (*Sus scrofa*), sambar deer (*Rusa unicolor*)), five primates (rhesus monkey (*Macaca mulatta*), northern pig-tailed macaque (*M. leonina*), hoolock gibbon (*Hoolock leucogenys*), leaf monkey (*Trachipithecus phayrei*), slow loris (*Nycticebus bengalensis*)), and three mammals (e.g. Chinese porcupine (*Hystrix hodgsoni*), masked palm civet (*Paguma larvata*), hoary bamboo rat (*Rhizomys pruinosus*)) were recorded in the surveyed areas. To measure the mammal diversity, we combined the results from both the interviews and field observations; we classified the mammal diversity into three levels. We defined the highest level as three (3), which means greater than 10 species were recorded in the area; two (2) means 5-9 species; one (1) means ≤ 5 species (Table 4.2). However, we have not conducted multiple transect surveys for particular forest types, we may not be able to correlate the anthropogenic disturbance to the mammal diversity for given habitat types. This should be taken into account in future field surveys and studies in these areas.

Table 4.2 Summary of the transect surveys in the gibbon habitats

Township & Community		ID	Anthropogenic activity	Anthropogenic level	Mammal diversity level
Sudian	Lamahe	1	Fructus taoko plantation, Shifting cultivation	3	3
		2	Fructus taoko plantation Shifting cultivation	3	2
	Lishu	3	Fructus taoko plantation Shifting cultivation hunting	3	1
		4	Fructus taoko plantation Shifting cultivation hunting	3	2
	Mulonghe	5	Fructus taoko plantation Fuel wood, construction timber hunting	3	3
	Waku	--	--	2	3
Zhina	Xiangbai	6	Fructus taoko plantation non-timber forest products collection	1	2
		7	Fructus taoko plantation non-timber forest products collection	1	2
	Baiyan	8	Fructus taoko plantation Fuel wood, construction timber	2	3
		9	Fructus taoko plantation Fuel wood, construction timber	3	2
	Zhongshan	10	Fructus taoko plantation Fuel wood, construction timber	3	2
	Xianjiazhai	11	Fuel wood, construction timber non-timber forest products collection	2	1
	Zhongling	12	Walnut plantation Fuel wood, construction timber	3	1
	Shidong	--	--	--	--

Score grading is used: 1 = Low, 2 = Medium, 3 = High

4.5 Gibbon folklores and stories

In our survey areas, the local people have different cognition and understanding toward the gibbons. The gibbon's presence in the forest brings spirituality to the people whose life is closely connected with the forest and natural resources. Its calling usually brings signals for weather forecast or something ominous. The local Lisu people do not hunt the gibbons as they believe that hunting gibbons will bring them and their family bad luck. Villagers were told at young age that hunting or eating the gibbons would bring misfortunes to the community. When outsiders who failed to share these beliefs hunt or kill the gibbons, these people were seen to have experienced unfortunate events. Such experiences reinforced the local villagers' beliefs. So far, few cases of killing gibbons were heard or documented. One case was told during our interview, Cao Yuhua, a Lisu minority native, who lives in Xinwen Village told us the story: In Xinwen Village, gibbons were found about 200 years ago, the local people have developed their own traditional customs to protect the gibbon. Singing of the gibbons functions as a warning message. If gibbon calling is heard at around 1:00 am, an old man would die soon. If the gibbon calling is heard at around 1:00 pm, one young man would encounter unfortunate happenings. Although ancient ethnic Lisu people had a long hunting tradition, hunting the gibbons was banned a long time ago by their own traditional beliefs. Hunters who hunted gibbons would be severely penalized: the hunter must give a public apology to the community, pay 60 kilograms of pork and two earthen jars of homemade rice wine as the penalty, and offer a dinner for all the people in the community. Another story about gibbon was told in two communities (Xianjiazhai, Mulonghe): The gibbons, locally called "black monkey", are believed to have black hearts. The adult males eating baby gibbons was seen by old people. The local people considered this story as an important reason for why gibbon populations have not increased. Biologically, this is an infanticide phenomenon in some gibbon populations, which is rarely seen.

4.6 Conservation awareness

Historically, Lisu people have had a long hunting tradition. Traditional Lisu hunting culture has some taboos and seasonal characteristics, such as hunting only takes place from November to February, and it is forbidden to hunt pregnant animals and females with cubs. Based on our interviews, all the people knew the "black monkey" (gibbon) and something about their calling behavior. The gibbon is considered as a taboo which is forbidden to hunt (such as in Result 4.5). In some communities (Xinwen, Lishu, Lamahe etc.) in

Sudian Township, the local Lisu ethnic people are glad to tell us that the gibbon groups still live near their villages due to their effort in a long-term period. In the past hundred years, the local Lisu ethnic people have traditional self-protective practices through protecting gibbons from being hunted by their own people and the outsiders who do not share the beliefs. . This information is good for gibbons, however, we also noticed that the local people lack conservation awareness for the other wild animals and their habitats, we witnessed that the other wild animals were being hunted in the survey areas (Photo 4.4). We want to keep the "gibbon taboo" which we admit played an important role on the gibbon conservation. Because of that, we explained and promoted the importance of forests and habitats during the interviews.

To build the conservation awareness, we told the local people that the primary forests provide clean water, clean air and habitats for wild animals, the gibbon depends heavily on the primary forests, and other wild animals also played an important role in maintaining the forests. All of this can benefit local people in a long time in the future. We told them that the forest resources had been over-exploited, and many types of forest degradation were resulted, such as a lot of wild animal disappeared and the non-timber forest products collected area decreasing every year. We also recommended that they should adjust the utilization of forest resources in a sustainable way, such as using firewood-saving stoves, biogas systems and solar power, all of which help to control the forest over-exploitation. Leaving more big trees and planting gibbon food trees in the cultivation field also help ehnhance the habitats and biodiversity for wildlife.

5. ASSESSMENT OF ANTHROPOGENIC THREATS

5.1 Estimated populations in Yingjiang County

Our population estimate comprised of all the hoolock gibbon groups near 13 communities. In total, 18 groups were confirmed and we mapped 14 groups on the map. The large subpopulations (five groups) were found near Lamahe Village in Sudian Township (Figure 2.1, Table 4.1). However, comparing to gibbon survey through the interviews conducted in May 2015, which was 19 groups (Fan, personal communication), we found that the hoolock gibbon groups were still not clear due to some inaccurate information. The information about some gibbon groups was inconsistent in several places, e.g. small communities including Nanpa, Xiaokuhe, Dakuhe, Xinwen and Xiangdelong.

One explanation was that local people may not know very well the gibbon's home range behavior. Since some gibbon groups are distributed at the common boundary of several different communities, when the gibbons call in different places in different months or seasons, the local people who have heard them tend to believe they were separate gibbon groups. One case was found between Shidong and Xianjiazhai villages in Zhina Township. One group of gibbon inhabited on the common boundary area between Shidong and Xianjiazhai villages, the villagers in both communities believed that they were separate gibbon groups depending on gibbon calling. However, one forest ranger confirmed that they actually belong to only gibbon group. Another similar case was in Lishu Village, where one group gibbon always moved near the common boundary area between Lishu and Xiangdelong villages.

Another explanation was that some gibbon groups might split into small subgroups temporarily. Then people tend to believe there were more groups than before when they spotted gibbon in different places. There was a similar case in Xiangbai and Lamahe villages. In the habitat area near Xiangbai, two groups existed, and one group consisted of eight individuals always split into two subgroups and foraged separately. So some villagers tended to believe three groups are living near the community during our interview. However, since several community gibbon conservation projects were implemented in this community and two forest rangers participated in these projects confirmed the presence of two groups based on their follow-up observations.

Moreover, there may be several floating single gibbons. This was also an explanation for error of estimating gibbon populations. These individuals dispersed from some groups after maturation. Due to the lack of suitable areas, they were forced to adapt to the fragmented habitats. As a result, they may float in different forest patches and were witnessed or heard by local people. We inferred this as possible from some incomplete information in Nanpa, Xinwen, and Pawa communities, such as "the gibbons called occasionally and were not always spotted by local people"; "I had heard gibbon calling several times last year, but not any more this year". Nanpa, Pawa villages were near the "gibbon not confirmed areas" (Figure 2.1)

5.2 Habitat fragmentation and degradation

We find that only two groups are distributed in Tongbiguan Nature Reserve, all the other 16 groups are distributed in fragmented patches of forests outside the nature reserve. We believed that shifting cultivation and logging are the primary driving forces for habitat degradation and the former has

been practiced for a long time in Yingjiang. Much of the forests in the low elevation areas has been destructed by shifting cultivation and logging. Consequently, the remaining gibbon populations have therefore been restricted in the areas at relatively high altitudes. Since the 1980s, the state forest law and policies banned natural forest logging to a large extent. Then the promotion of economically important cash crops and construction timber plantation gradually reclaimed the degradation area. As a result, all the gibbon habitats are mostly secondary forests. Most of the habitats are probably suboptimal for gibbons as the dominant vegetation is mountain forest types, which include pines, rhododendrons and bamboo species which do not yield much food sources for the gibbons (Photo 5.1). Secondly, the harsh winter with occasional snowing days in the north Yingjiang County has probably limited food availability for at least part of the year.

Photo 5.1 Gibbon habitats: All the gibbon habitats are secondary forests. The bamboos become dominant species in many habitats.

Habitat loss and fragmentation have been reported as major anthropogenic threats for the eastern hoolock gibbon in all the distributed area (Chetry et al., 2008; Chetry and Chetry, 2010; Fan et al., 2011; Ngwe et al., 2011; Geissmann et al., 2013). Forest dwelling primates may be vulnerable to habitat fragmentation (Arroyo-Rodríguez and Dias, 2009; Arroyo-Rodriquez et al., 2013), habitat fragmentation may degrade habitat quality and food availability. For gibbons, one possible manifestation is the diet change. They may eat some fruits which are not of their favorite, such as Fagaceae spp. During our surveys, we were also concerned about the gibbon food sources and asked the local people who often spotted gibbons during patrolling, two

forestry rangers in two communities (Xiangbai and Zhongshan) could identify more than 20 species of gibbon food, which contained such species as Fagaceae Caanopsis echidnocarpa. This suggests that gibbons had to modify their food choices in response to fragmented habitats with changing floral composition in their home range, though we may not be able to draw a conclusion as such with insufficient observation data. This phenomenon also occurred with the western black-crested gibbon (*Nomascus concolor*) inhabiting in Pinghe in Mt. Ailao (Sun, personal communication) and Jinping Bajiaohe (Ni et al., 2014).

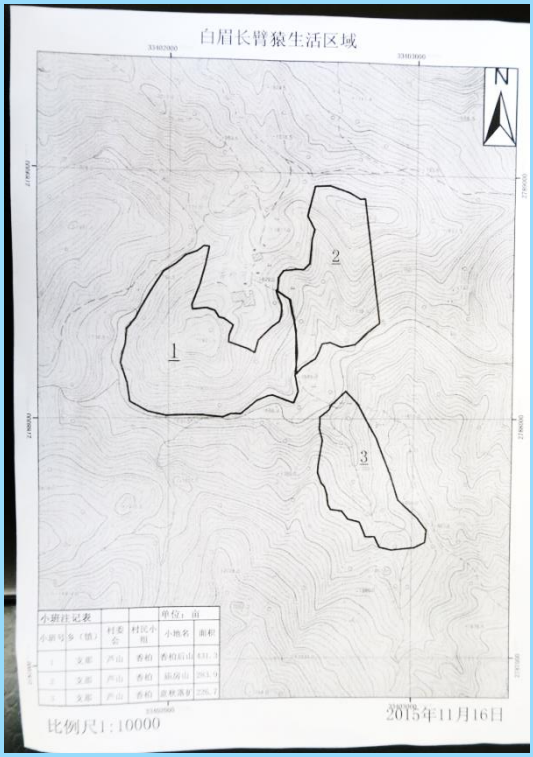

Photo 5.2 A map of the gibbon distribution areas in Xiangbai Village. The solid line in the middle of the photo was the gibbon habitats boundary. The boundary of these areas was drawn along the forest edges. Two (Group 1 and 2 were actually one group on our interviews) groups lived in this area of approximately one square kilometer. We made this photo in Zhina Township Forestry Station.

We found that the large group size reached eight individuals near Xiangbai Village (Photo 5.2), followed by seven near Baiyan Village and six near Lamahe Village. These groups were much larger than the outcome from the latest survey result in 2009 (mean=3.9, Fan et al., 2011) and the survey result (mean = 2.89) in India (Sarma et al., 2015). Compared to the most recent survey in 2009 (Table 2 in Fan et al., 2011). One group size increased from six to eight individuals near Xiangbai Village, one group size increased from five to six near Lamahe Village. This may be a direct result of forest fragmentation. Because of small sizes, limited and non-contiguous forest patches, the gibbons cannot disperse far enough to reach other forest areas after maturation. As a result, with the increasing group sizes, the gibbons were restricted in small fragments of forests, their behavior may change and the inbreeding may occur. We need more genetic evidences to clarify this issue.

5.3 Dependence on natural resources

Our survey results show that local people depend heavily on forest resources. In the two townships, local people still need to cut trees for building houses and firewood (Photo 5.3), even the logging was at a small scale. This is the main reason causing habitat degradation. According to our survey, most gibbons distributed at approximately 2,000 m asl., which was dominated by monsoon evergreen broadleaf forests. The dominant species in these areas were *Castanopsis terox, C. hystrix, C. echidnocarpa, C. fleuryi, Lithocarpus truncates, L. fenestratus, Schima wallichii, S. khasiana* et al. After a long period of logging for local construction and firewood use, only some small disconnected patches of these dominant species still remain with only a few tall trees in the habitats. Ten arborous species suitable for building timber were harvested from the gibbon habitats, including *Castanopsis calathiformis, C. echidnocarpa, Lithocarpus polystachyus, Schima wallichii, Alnus nepalensis, A. cremastogyne, Betula alnoides, Cunninghamia lanceolata, Aleurites moluccana* and *Camellia Camellia-Oilfera Abel*. Three to four of them were dominant species. Since most of the gibbon groups inhabit in the collective forest which are being used by local communities, the gibbon habitats continue to shrink every year. Despite the government departments' effort to promote afforestation of fast growing species, e.g. *Betula alnoides, Alnus cremastogyne, Cunninghamia lanceolata* as alternative house-construction timber sources, local people still have to harvest much of the timber from the natural forest areas before the new plantation forests can supply needed construction timber. Besides, habitat destruction was also driven by a number of other activities, such as farmland expansion, road construction and non-timber forest products harvest (including wild vegetables, bamboo shoots, many medicinal plants and edible mushrooms, et al. Photo 4.3).

We believe that the Lisu ethnic culture helps explain the reasons behind the growing remaining populations: their taboo of not hunting the gibbons and its distribution at higher altitude areas. Ancient ethnic Lisu had a long hunting tradition but the gibbon hunting is exempted from their hunting practices since a long time ago. However, with the social and economic development and upgraded hunting tools, it is becoming more and more difficult to curb excessive poaching, especially for those animal species inhabiting outside the nature reserves (Photo 4.4).

Photo 5.3 Local people harvested trees for construction timber, firewood and some household tools and utensils.

5.4 Fructus Tsaoko plantation

Based on our survey, fructus tsaoko cultivation and management was the main reason for people to go into the gibbon habitats. About 50% of the decreased populations of eastern hoolock gibbons in Nankang and Houqiao Mt. Gaoligong was attributable to fructus tsaoko plantation (Fan et al., 2011). Since the 1970s, fructus tsaoko was introduced as an economically important cash crop to Tongbiguan Township in Yingjiang County, it was then rapidly extended to all over the county, including Sudian and Zhina townships. Now it has become the main income sources for local people in this region. The mean household income in the both township was RMB 14,750 *yuan*, most of which came from the fructus tsaoko planting. The highest income from fructus tsaoko cultivation reached as high as RMB 50,000 *yuan* a year for one household in Nanpa Community in Zhina.

Fructus tsaoko is a perennial shade tolerance herb of the family Zingiberaceae, genus Amomum, and grow in areas between 1,200 m and 2,000m asl. in fertile soils and under forest shading of 50% to 60% (Dai et al., 2004; Qin et al., 2008).

As common practices, people will remove the large trees, shrubs, and weeds to meet plantation requirements. As a result, a lot of food trees growing in the valleys were removed, such as *Saurauia tristyla*. The canopy becomes discontinuous, and the fragmented habitats then became even more fragmented and the corridors for gibbons to migrate from one side of the canyons to the other side were removed. As a forest dwelling species, the gibbons had to consume more energy to move and forage in fragmented forests. Meanwhile, the chance of infants falling from tall trees increased significantly. One case was reported that a 3-year-old gibbon fall from the canopy while migrating (Yuan et al., 2014). Besides, according to a botanic study (Guo et al., 2010), in the perennial fructus tsaoko plantation, the diversity of arbors and shrubs would decrease gradually in aging plantations, and the species composition is homogenized. Only few big trees were maintained as a shading species in the fructus tsaoko fields.

Figure 5.6 Local people improved fructus tsaoko planting conditions through digging canals to irrigate fructus tsaoko.

Until now, fructus tsaoko plantation is still expanding every year. We find that local people improve fructus tsaoko planting conditions through irrigation by digging trench to divert water from a distance (Photo 5.4). Those areas originally not optimal for fructus tsaoko planting is becoming wetter than before. This may speedup the expansion of fructus tsaoko plantation. Fan et al. (2011) suggested that comparative studies focusing on the behaviors of the hoolock gibbon in forests with and without fructus tsaoko needs to be conducted in the future to provide important insights for the conservation of the species. We recommend gibbon conservation efforts in these areas should first start with changing the fructus tsaoko plantation method, such as leaving more shade trees, and planting some gibbon food trees as a supplementary food sources.

6. RECOMMENDATIONS FOR THE GIBBON CONSERVATION

Although the main habitats of the gibbon are outside the nature reserve in Yingjiang County, local people had a traditional way to protect gibbon. Sustainable conservation of the gibbon should involve the local communities to a larger extent. Our project also builds conservation awareness around the communities, all the people are willing to participate in the conservation project, everyone knew the "black monkey" (gibbon) and nature conservation was important and expressed their willingness to participate in the conservation activities. We suggest encouraging local protection by increasing local participation in protected area management, making expansion of other instruments for community resources management that might benefit gibbon habitat protection, including watershed management and community forestry. Based on our result, we found that fructus tsaoko plantation was the most difficult part of the whole conservation process. It is impossible to remove the fructus tsaoko and restore the forest. To address this issue, and for a long-term effective conservation project, we suggest a series of conservation action which should be implemented in the near future.

1. We believe that some gibbon groups may have large areas of home range based on the survey results, we need to cooperate with the local forestry bureaus to investigate the land/forest tenures of all the gibbon habitat areas as this has great impacts on the conservation project designing and development in Yingjiang County. Meanwhile, we need to pay attention to the gibbon population near "the gibbon unconfirmed area" in Figure 2.1, a gibbon patrol monitoring team should be established with professional training, then we have to monitor the gibbon songs simultaneously from several listening points, at least three points for close monitoring (Brockelman and Srikosamatara, 1993).

2. Starting scientific research on some groups, such as those in Xiangbai or Lamahe. This had to be regarded as an underlying foundation for hoolock gibbon conservation. Building a domestic professional scientific community specialized in gibbon conservation is a long-term goal, though considerable investment has already been made by a number of conservation and academic institutions towards this goal.

3. The people also would like to participate in the conservation project about 10 days for RMB 2000-3000 *yuan*, at a lump sum rate of about RMB 200-300 *yuan* per day for reference. This is important information for our

conservation project, especially those targeting at reducing forest resources consumption and cultivating forest resources. A series of alternative livelihoods with reference to this information should be implemented to control fructus tsaoko plantation, at least to stop the expansion. As some firewood saving stoves and solar power projects were extended by government in several communities, we suggest these projects should cover all the villages whose collective forests are habitats for the gibbons. Meanwhile, with a community-based conservation education, we recommend habitat-friendly fructus tsaoko growing, for instance, leaving or planting more large trees and food sources trees in the fructus tsaoko fields to maintain the migratory corridors between the bridge valleys while enriching the overall biodiversity assemblage.

4. The habitat in Xiangbai and Lamahe villages were the most important subpopulations according to the gibbon distribution. These groups, which inhabited in the central areas of the Yingjiang gibbon populations, were an important bridge to connect all the hoolock gibbon groups in Yingjiang. A long-term habitat restoration should be conducted in this area. More specifically, the initial habitat restoration efforts should be conducted to connect the subpopulations in Lamahe and Xiangbai.

REFERENCE

Arroyo-Rodríguez, V., Dias, P.A.D., 2009. Effects of habitat fragmentation and disturbance on howler monkeys: a review. Am. J. Primatol. 72, 1–16.

Arroyo-Rodriquez, V., Cuesta-del Moral, E., Mandujano, S., Chapman, C.A., Reyna-Hurtado, R., Fahrig, L., 2013. Assessing habitat fragmentation effects on primates: the importance of evaluating questions at the correct scale, in: Primates in Fragments. pp. 13–28.

Brockelman, W.Y., Geissmann, T., 2008. *Hoolock leuconedys* (Eastern Hoolock, Eastern Hoolock Gibbon) [WWW Document]. URL http://www.iucnredlist.org/details/39877/0 (accessed 4.24.14).

Brockelman, W.Y., Srikosamatara, S., 1993. Estimation of density of gibbon groups by use of loud songs. Am. J. Primatol. 29, 93–108.

Chetry, D., Chetry, R., Das, A., Loma, C., Panor, J., 2008. New Distribution Records for Hoolock leuconedys in India. Primate Conserv. 125–128.

Chetry, R., Chetry, D., 2010. First Record of Eastern Hoolock Gibbon in Assam, India. Primate Conserv.

Dai, K.J., Tang, L., Zhou, D.M., 2004. Ecological significance of the replacement of natural forest in the conversion of cultivated land to plant *Amomum tsaoko*. Hunan For. Sci. Technol. 31, 64–66.

Das, J., Biswas, J., Bhattacharjee, P.C., Mohnot, S.M., 2006. First distribution records of the eastern hoolock gibbon. Zoos' Print J. 21, 2316–2320.

Fan, P., Fei, H., Luo, A., 2014. Ecological extinction of the Critically Endangered northern white-cheeked gibbon *Nomascus leucogenys* in China. Oryx 48, 52–55.

Fan, P., Xiao, W., Huo, S., Ai, H., Wang, T., Lin, R., 2011. Distribution and conservation status of the Vulnerable eastern hoolock gibbon *Hoolock leuconedys* in China. Oryx 45, 129–134.

Geissmann, T., 2007. Status reassessment of the gibbons: results of the Asian primate red list workshop 2006. Gibbon J. 5–15.

Groves, C.P., 1972. Systematics and phylogeny of gibbons, in: Rumbaugh, D.M. (Ed.), Gibbon and Siamang. Karger, Basel, Switzerland, pp. 1–89.

Groves, C.P., 1967. Geographic variation in the hoolock or white-browed gibbon (*Hylobates hoolock* Harlan 1834). Folia Primatol. (Basel). 7, 276–283.

Grueter, C.C., Jiang, X., Konrad, R., Fan, P., Guan, Z., Geissmann, T., 2009. Are *Hylobates lar* Extirpated from China? Int. J. Primatol. 30, 553–567.

Guo, J.Q., Wang, K.L., Liu, G.F., Wang, Y.H., 2010. Influence of plant diversity by *Amomum tsaoko* (Zingiberaceae) plantation. Guihaia 30, 844–849.

Jiang, X., Luo, Z., Zhao, S., Li, R., Liu, C., 2006. Status and distribution pattern of black crested gibbon (*Nomascus concolor jingdongensis*) in Wuliang Mountains, Yunnan, China: implication for conservation. Primates. 47, 264–271.

Lwin N., Geissmann T., Aung S.S., Aung T.N., Aung Z.M., Hla T.H., Grindley M., Momberg F., 2011. The Myanmar Hoolock Gibbon Conservation Status Review: first results. Gibbon J. 6, 18–21.

Ni, Q.Y., Huang, B., Liang, Z.L., Wang, X.W., Jiang, X.L., 2014. Dietary variability in the Western Black Crested Gibbon (*Nomascus concolor*) inhabiting an isolated and disturbed forest fragment in southern Yunnan, China. Am. J. Primatol. 76, 217–229.

Qin, W.L., Lan, Z.Z., Li, W.C., 2008. Technology of planting and breeding Amomum tsaoko. Pop. Sci. Technol. 107, 131–132.

Sarma, K., Krishna, M., Kumar, A., 2015. Fragmented populations of the vulnerable eastern hoolock gibbon *Hoolock leuconedys* in the lower Dibang Valley district, Arunachal Pradesh, India. Oryx 49, 133–139.

Geissmann T., Grindley M.E., Lwin N., Aung S.S., Aung T.N., Htoo S.B., Momberg F., 2013. The Conservation Status of Hoolock Gibbons in Myanmar. Gibbon Conservation Alliance, Zurich,Switzerland.

Yuan, S., Fei, H., Zhu, S., Cui, L., Ai, H., Fan, P., 2014. Effects of tsaoko (Fructus tsaoko) cultivating on tree diversity and canopy structure in the habitats of eastern hoolock gibbon (*Hoolock leuconedys*). Zool. Res. 35, 231–239.

APPENDIX 1 QUESTIONNAIRE TABLE

Id	Position	Name	Sex	Ethnic group	Age	Education	Other

Information	Answer
Animal Conservation Awareness	
Animals in the forests now	
Animals in the forests historically	
Primate animals information	
Environmental catastrophes	
Hunting	
Relationship between wildlife and living	
Animal conservation awareness	
Other ad-hoc questions	
Economic status	
Family members	
Crop plantations	
Domestic animals	
Economic alternatives	
Migrant workers	
Education	
non-timber forest products collection	
Products collected, e.g. species, price etc., % in total income	
Other ad-hoc questions	

APPENDIX 2 SUMMARY INFORMATION TABLE INTERVIEW

Township	Communities	No. of Families	Pop.	Interviewees	Age	Sex	Ethnic group	Work	Family income	Income source	non-timber forest products
Sudian	Lamahe	51	300	Zao Zhengwang	41	M	Lisu	Forestry Ranger	¥20,000.00	Fructus tsaoko and walnut plantation	potherb
				Zao zhengwen	49	M	Lisu	Villager	¥25,000.00	Fructus tsaoko and walnut plantation	potherb
				Ma Xingchun	32	F	Lisu	Villager	¥27,000.00	Fructus tsaoko and walnut plantation	Potherb Cymbidium spp.
	Lishu	28	120	Yu Shengrong	31	M	Lisu	Forestry Ranger	¥10,000.00	Fructus tsaoko plantation	Potherb Bamboo shoot
				Cao Xinghua	55	M	Lisu	Villager	¥16,000.00	Fructus tsaoko plantation, odd job	Potherb Bamboo shoot
				Yu Xinghe	53	M	Lisu	Villager	¥30,000.00	Fructus tsaoko and walnut plantation, odd job	Potherb Bamboo shoot
				Li Xinggui	51	M	Lisu	Forestry Ranger	¥20,000.00	Fructus tsaoko and walnut plantation	Potherb Bamboo shoot

Township	Communities	No. of Families	Pop.	Interviewees	Age	Sex	Ethnic group	Work	Family income	Income source	non-timber forest products
	Waku	25	120	Ou Wenfu	26	M	Lisu	Villager	¥8,000.00	Fructus tsaoko plantation accounted for 6000, liveock farming	potherb, herbs
	Mulonghe	10	40	Kong Xingda	25	M	Lisu	Forestry Ranger	¥17,000.00	Fructus tsaoko plantation accounted for 50%, liveock farming	potherb, herbs
	Nanpa	15	120	Zao Liqiang	54	M	Lisu	Villager	¥50,000.00	Fructus tsaoko plantation accounted for 90%, liveock farming	potherb, herbs
	Xiangdelong	42	250	Li Shengcheng	47	M	Lisu	Villager	¥10,000.00	Fructus tsaoko plantation	potherb, herbs
				Cao Xingzhou	40	M	Lisu	Villager	¥20,000.00	Fructus tsaoko and walnut plantation	potherb, mushrooms
				Li Xuechun	39	M	Lisu	Villager	¥10,000.00	Fructus tsaoko and walnut plantation	potherb, mushrooms
				Yu Guimei	35	F	Lisu	Villager	¥6,000.00	Fructus tsaoko plantation	potherb, mushrooms
	Xinwenzhai	29	230	Cao Fuxing	24	M	Lisu	Villager	¥10,000.00	Fructus tsaoko and corn plantation	potherb

Township	Communities	No. of Families	Pop.	Interviewees	Age	Sex	Ethnic group	Work	Family income	Income source	non-timber forest products
				Zao Mingzhen	86	F	Lisu	Villager	¥4,000.00	Fructus tsaoko and corn plantation	potherb
				Yu Muda	56	F	Lisu	Villager	¥4,000.00	Fructus tsaoko and corn plantation	potherb
				Cao Baikuai	67	M	Lisu	Villager	¥5,000.00	Fructus tsaoko and corn plantation	potherb
				Ma Youlan	57	F	Lisu	Villager	¥6,000.00	Fructus tsaoko and corn plantation, weaving crafts	potherb
				Cao Jinchun	30	M	Lisu	Villager	¥6,000.00	Fructus tsaoko plantation, odd job	potherb
Zhina	Xiangbai	78	383	Mi Wu	38	M	Lisu	Forestry Ranger	¥10,000.00	Fructus tsaoko plantation accounted for 80%	potherb, herbs
				Yu Zhongfu	45	M	Lisu	Forestry Ranger	-	-	-
	Baiyan	90	40	Cao Shenghua	34	M	Lisu	Forestry Ranger	¥10,000.00	Fructus tsaoko plantation accounted for 80%	Potherb Bamboo shoot
				Yu Zhongxiang	49	M	Lisu	Villager	-	-	Potherb Bamboo shoot

Township	Communities	No. of Families	Pop.	Interviewees	Age	Sex	Ethnic group	Work	Family income	Income source	non-timber forest products
	Zhongshan	37	200	Yu Chenglong	-	M	Lisu	Villager	¥15,000.00	Fructus tsaoko plantation accounted for 80%	-
	Xianjianzhai	34	260	Xian Changke	-	M	Jingpo	Forestry Ranger	¥15,000.00	sugar cane plantation accounted for 50%, non-timber forest products, odd jobs	potherb, herbs, mushrooms
	Shidong	--	--	--	--	--	--	--	--	--	--
	Zhongling	10	50	Pai Qihua	-	M	Jingpo	Forestry Ranger	-	Fructus tsaoko and walnut plantation, mainly from walnut plantation	potherb, herbs, mushrooms
				Dong Yuebeng	46	M	Jingpo	Villager	-	-	-
				Pai Layong	43	M	Jingpo	Villager	-	-	-
				Dong Daohong	65	M	Jingpo	Villager	-	-	-