China Nature Watch 2016

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Contents

Wu Lang Mountain, Yunnan/ He Bin

『Forest Watch』

Forest matters not only to human beings. It also provides living necessities for other species on the planet. Forest change may impact not only the human world but also numerous lives hidden under the leafy canopy. Likewise, the forest ecosystem has functions that, more or less, affect the ways in which matter circulates, energy flows, and information spreads around the globe.

Understanding how forest changes in China will help us keep abreast of the overall status and trend of forestation nationwide and assess the effectiveness of forest conservation in the country.

Key facts:

1.Forest status and change in China (2000–2014)

- The total forest area within the territories of China was 1,780,472 km^2 in 2000 (tree cover exceeded 20%);
- There was 9,370 km^2 of forest gain between 2000 and 2014;
- There was 66,063 km^2 of forest loss between 2000 and 2014.

2.Forest status and change by province (2000–2014)

- Notable forest changes mostly occurred in southern China:
- Top five provinces with the greatest forest gain were Guangxi, Guangdong, Fujian, Jiangxi, and Yunnan;
- Top five provinces with the greatest forest loss were Guangxi, Guangdong, Fujian, Yunnan, and Jiangxi;

3.Forest change by national nature reserve (2000–2014)

- This report incorporates data collected from the 21 newly founded national nature reserves in 2014.
- As of 2014, 428 national nature reserves had been founded covering approximately 1,040,000 km^2 of land and accounting for 64% of the total protected area in China.
- The forest area in these 428 national nature reserves was 89,865 km^2 accounting for 5.05% of the country's total forest area in 2000.
- Within the nature reserves between 2000 and 2014, the area of forest gain was 69.5 km^2 and of forest loss 1,356 km^2; the greatest loss, 348.8 km^2, occurred in 2006. The rate of net forest loss within the nature reserves was 1.51%, lower than the national rate of 3.71%. This difference implied that 1,978 km^2 less forest was destroyed;
- Top ten nature reserves with the greatest forest loss (Nanweng River, Huzhong, Raohe Northeastern Black Bee, Zhuona River, Xishuangbanna, Wolong, Baishuihe, Yarlung Tsangpo Great Valley, Youhao, and Dazhanhe Wetlands) had a total forest loss of 764.6 km^2, accounting for 56.4% of the total forest loss in all the nature reserves over the same period of time;
- The national nature reserves had a total forest loss of 19.67 km^2 in 2014, which was below the annual means (96.9 km^2) from 2000 to 2014.
- Field investigations found that forest losses in some of the nature reserves, such as Nanweng River, Zhuona River, and Honghuaerji, were caused by fire; and that forest loss in Yunnan Xishuangbanna Nature Reserve was the result of rubber and banana plantation. (The nature reserve lacks administrative power due to historical reasons concerning its boundaries). These two types of loss accounted for 37% of the total area of forest loss in the nature reserves between 2000 and 2014.

4.Global Forest Watch data accuracy assessment

- Global Forest Watch (GFW) and GlobeLand30 highly overlapped in terms of spatial forest interpretation;
- A pixels-based accuracy assessment was performed using Google Earth's high-res remote-sensing imagery from which canopies were visually identifiable. The results show that at a threshold set to be 20% tree cover, the overall accuracy of forest/non-forest interpretation with GFW's tree cover data reached 87.5%;
- Forest changes were verified in situ in four of ten nature reserves with the greatest forest loss: Xishuangbanna, Nanweng River, Zhuona River, and Huzhong. Field observations were also made in some other nature reserves, including Yingge Range and Datian of Hainan, Honghuaerji Scots Pine Forest of Inner Mongolia, and Hanma along the Greater Khingan Range. Both in situ and Google Earth visual verifications fully acknowledged extensive areas of forest loss as identified by GFW. Ground inspection also found that GFW's lost years remained consistent with the reality.

Nan Weng He Nature Reserve burned area/ Zhang Di

Da Tian/ Zhang Di

1.Foreword

Forest cover change affects the delivery of important ecosystem services, including biodiversity richness, climate regulation, carbon storage, and water supplies (Foley et al., 2005). Forest conservation has become a topic drawing a great deal of attention from governments and the general public and has received massive inputs of public resources. An understanding of China's forest changes not only serves as a basis for evaluating the trend of change in biodiversity and taking effective protective actions accordingly but also as an issue of public policy and general public interest.

Unfortunately, no data concerning forest distribution and change has been made publicly accessible in China. Of the country's available forest data, some were produced by national forest resources inventory carried out regularly by the State Forestry Administration; the others came from several domestic research institutions whose surveys and maps were based on 30m resolution satellite imagery with regard to nationwide land use/coverage. For instance, several research institutions under the Chinese Academy of Sciences (CAS) jointly completed four land use datasets in 1995, 2000, 2005, and 2010 respectively (Liu J.Y. et al., 2003, 2009). In addition, ChinaCover 2000 and 2010 produced 30m resolution datasets based on Landsat TM/ETM and HJ-1 satellite data in combination with field survey results (Wu B.F. et al., 2014). GlobeLand30 also produced global 30m resolution datasets based on Landsat TM/ETM and HJ-1 satellite data in two benchmark years, 2000 and 2010 (Chen J. et al., 2014). At present, however, only GlobeLand30 provides data downloading service for 2010 time phase.

In 2013, Hansen et al. released the 30m resolution global tree cover datasets of 2000-2012 based on Landsat data, assessed forest losses and gains during the same timeframe, and provided a spatial dataset on the trend of annual forest loss. Before that, there had been a lack of high-res global forest data with spatial and temporal properties; previous efforts were either sample-based or insufficient in terms of spatial resolution. This global analysis is characterized by i) being spatially explicit; ii) quantifying gross forest loss and gain; iii) providing annual loss data and quantifying trends in forest loss; and iv) being derived through an internally consistent approach that was exempt from the vagaries of different definitions, methodologies, and data inputs (Hansen et al., 2013). More significantly, these data can be retrieved from Global Forest Watch's website (http://data.globalforestwatch.org) for free use and are being updated.

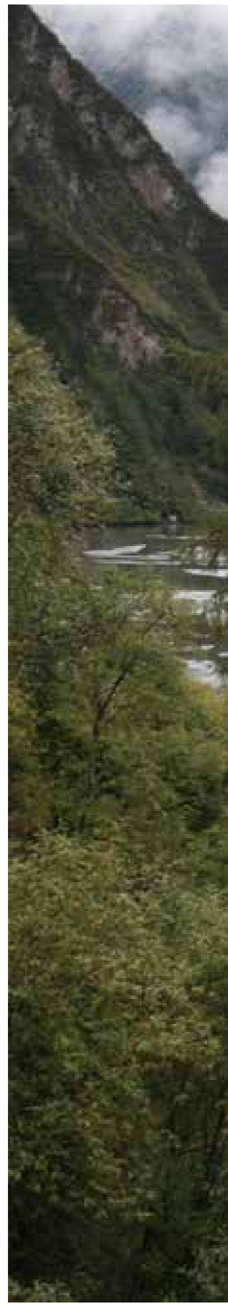
GFW datasets are accessible to the general public to make large-scale, real-time forest status assessment possible. Such data allow us to assess China's forest status and conservation from the perspectives of a third party, and it is our first time being able to do so.

2.Methodology

We downloaded updated datasets ver. 1.2 from GFW's website and incorporated it into our forest change data. These datasets were interpreted on the basis of LandSat TM/ETM satellite imagery. The horizontal resolution was 30m, including datasets for tree cover of 2000, forest losses of 2000-2014, forest gains of 2000-2014, and lost years. Forest loss was defined as stand replacement or the complete tree cover removal in a pixel cell. Forest gain was defined as the inverse of loss or a non-forest to forest change (Hansen et al, 2013). Tree cover was defined as the canopy density of all vegetation higher than 5m and is expressed at 0-100% on each pixel grid. About the datasets, the authors explained that percent tree cover, forest loss and forest gain were incomparable, i.e., “net” loss cannot be estimated simply by subtracting tree cover loss from tree cover gain, nor can forest cover extent after 2000 be derived by subtracting the forest cover of 2000 from annual forest loss. Furthermore, tree cover by definition is not forest but rather the biophysical existence of trees. It can be a part of natural or planted forest. Therefore, forest loss may be attributed to various causes, including deforestation, fire, and sustainable forestry production. Similarly, tree cover gain may also include an increment of natural or planted forest. (Global Forest Watch, 2015) China's forest resources inventory defined closed forest land as forest covered land with 0.20 or greater canopy density, including trees, mangroves and bamboos, and open forest land as land covered by trees with 0.10-0.19 canopy density. According to GFW's tree cover data, areas with a cover rate greater than 20% were similar to closed forest land as defined in China.

The administrative boundary map employed in our spatial statistics was a 1:250,000 digital map the National Geomatics Center produced using topographic map layers on the same scale from the National Administration of Surveying, Mapping, and Geoinformation (hereinafter called “1:250,000 digital map”). It was overlaid with GFW data using ArcGIS 10.1 to analyze and consolidate nationwide forest change data by province and then to make comparison with the national forest resources inventory, ChinaCover, GlobeLand30, and global forest assessment datasets provided by the United Nations Food and Agriculture Organization (FAO). Computation with the 1:250,000 digital map caused a 3.2% deviation from the national statistical yearbook in terms of national land area; the deviations of administrative areas of the provinces ranged between -3.5% and 7.5%. For comparability with data issued by the state, corrections were made on the basis of the provinces' administrative area data recorded in statistical yearbooks.

We employed three methods in our GFW data accuracy assessment: i) by assessing the forest spatial overlapping ratios generated from two data sources: GFW and GlobeLand30; ii) by using high-res Google Earth imagery, i.e., visual verification; and iii) by conducting field surveys to verify the years and causes of change locations.



Ba Wang Hai/ Zou Tao

3.Results

3.1.Forest status and change in China (2000–2014)

- The total forest area within the territories of China was 1,780,472 km^2 in 2000 (tree cover exceeded 20%);
- There was 9,370 km^2 of forest gain between 2000 and 2014;
- There was 66,063 km^2 of forest loss between 2000 and 2014.

Table 1 shows how the pixels of various tree cover levels of 2000 changed between 2000 and 2014. This report estimates that the total forest area within the territories of China was 1,780,472 km^2 in 2000, as defined by pixels with 20% or more tree cover. The gross gain area was 21,276 km^2. Specifically, 11,906 km^2 was gain area in the regions where tree cover was less than 20%, i.e., regions defined as non-forest. New forest gain with tree cover greater than 20% was 9,370 km^2. Specifically, the total area which might have undergone a reverse shift, namely "forest – no forest – forest again," was 5,323 km^2. The remaining 4,048 km^2 was forest gain of closed forest land and therefore became illogical. It should be counted as an error instead.

Gross forest loss was 71,493 km^2. Specifically, the area with tree cover greater than 20%, i.e., regions defined as forest, was 66,063 km^2, of which 53,685 km^2 loss (81.3%) occurred in areas with dense tree cover (>60%). The loss area of non-forest regions was 5,430km^2. Specifically, the total area which might have undergone a reverse shift, namely "forest – no forest – forest again," was estimated 611 km^2. The remaining 4,819 km^2 was forest loss of non-forest regions and therefore became illogical. It should be counted as an error instead.

Compared to the data released in China Nature Watch 2014, the forest gain estimates remain constant; the forest loss increased from 61,622 km^2 to 66,063 km^2; and the number showing reverse shifts rose from 5,480 km^2 to 5,934 km^2.


An Sai Canyon/ Zhang Chenghao

Table 1 *Forest change at various tree cover levels in 2000-2014 (Unit: km^2)

	Tree cover	Area in 2000	Gain	Loss	Reverse shifts	Error**
Non-forest	0%	7514170	10477	3983	525	3459
	1%-10%	117308	615	491	34	457
	11%-20%	132098	813	956	52	903
	Subtotal	7763576	11906	5430	611	4819
Forest	21%-30%	125214	564	936	42	522
	31%-40%	109584	607	1228	57	550
	41%-50%	204849	1080	3899	167	914
	51%-60%	303083	1186	6315	329	858
	61%-70%	245611	944	8414	444	500
	71%-80%	296325	1428	12900	939	489
	81%-90%	351104	2536	24518	2322	214
	91%-99%	114292	1025	7376	1023	2
	100%	30410	0	478	0	0
	Subtotal	1780472	9370	66063	5323	4048
Subtotal		9544047	21276	71493	5934	8867

*There are four types of change for every spatial pixel: (1) no change; (2) gain; (3) loss; and (4) reverse shifts, which may correspond to (i) no forest – forest – no forest again (e.g., failed afforestation) or (ii) forest – no forest – forest again (e.g., natural forest clearing and then commercial forest planting).

** This table shows two types of illogical errors. A. Positive – error: Land plots with original forest cover greater than zero appeared to have forest gain (with exception of reverse shifts); B. Negative – no error: Areas with zero original cover appeared to have forest loss (with exception of reverse shifts).

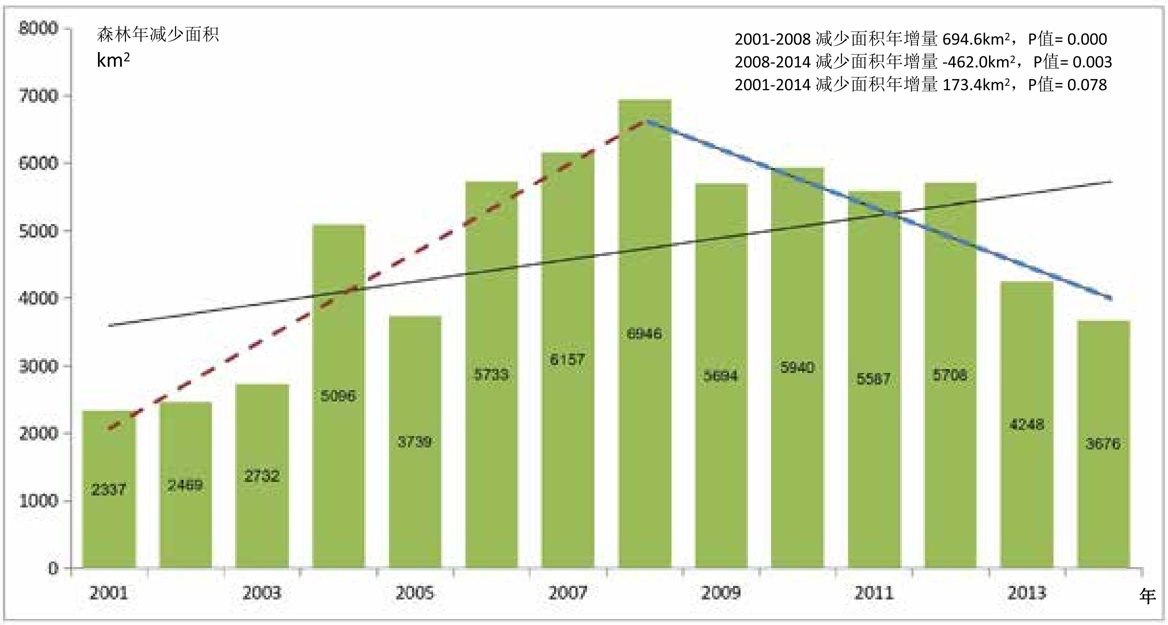


Fig.1 Annual distribution of forest loss areas in China 2000-2014

We used the updated data to analyze the trend of forest loss of each year. China had a total of 66,063 km^2 forest loss in 2000-2014, an annual decrease of 4,719 km^2 in 14 years. The least loss, 2,337 km^2, occurred in 2001; the greatest loss, 6,946 km^2, occurred in 2008.

The annual forest area loss between 2000 and 2014 shows an upward trend. The linear-regression analysis of annual area loss over the years shows a slope, i.e., the increment of annual area loss, at 173.4 km^2, and the significance of regression coefficient was tested as $P = 0.078$. A turning point appeared in 2008. Before that year, the increment of annual area loss was 694.6 km^2, $P = 0.000$, indicating a notable upward trend. After 2008, the increment of annual area loss dropped to -462.0 km^2, $P = 0.003$, showing a notable downward trend. This means that forest loss kept slowing down after 2008, though there was still a forest loss of 3,676 km^2 in 2014.

3.2.Forest status and change by province (2000–2014)

- Notable forest changes mostly occurred in southern China:
- Top five provinces with the greatest forest gain were Guangxi, Guangdong, Fujian, Jiangxi, and Yunnan;
- Top five provinces with the greatest forest loss were Guangxi, Guangdong, Fujian, Yunnan, and Jiangxi;

Consistent with the national trend, each province had greater forest loss than forest gain. Notable forest changes mostly occurred in southern China: Top five provinces with the greatest forest gain were Guangxi, Guangdong, Fujian, Jiangxi, and Yunnan; top five provinces with the greatest forest loss were Guangxi, Guangdong, Fujian, Yunnan, and Jiangxi (Table 2).

This result is primarily consistent with China Nature Watch 2014, except that Yunnan rose from the fifth place to the fourth place, followed by Jangxi, as one of the five provinces with the greatest forest loss.

Table 2. Forest change in regions with tree cover >20% in 2000-2014(Unit: km2)

Province	Gain	Loss	Reverse shift	Province	Gain	Loss	Reverse shift
Beijing	0	7	0	Hubei	38	741	7
Tianjin	0	5	0	Hunan	406	4619	172
Hebei	2	273	0	Guangdong	2553	11113	1670
Shanxi	1	364	0	Guangxi	2826	14381	1821
Inner Mongolia	30	2877	2	Hainan	225	1744	100
Liaoning	9	753	2	Chongqing	26	154	1
Jilin	19	607	1	Sichuan	91	1439	5
Heilongjiang	265	5340	10	Guizhou	189	1966	25
Shanghai	0	0	0	Yunnan	549	6107	237
Jiangsu	3	54	1	Tibet	197	1042	127
Zhejiang	163	2016	64	Shaanxi	15	210	0
Anhui	171	1416	63	Gansu	1	112	0
Fujian	1859	8099	1301	Qinghai	0	7	0
Jiangxi	844	5488	432	Ningxia	0	1	0
Shandong	1	32	0	Xinjiang	2	103	0
Henan	16	208	3	Taiwan	25	277	10

Causes of these changes are subject to further investigation.

3.3.Forest conservation effectiveness in nature reserves

- This report incorporates data collected from the 21 newly founded national nature reserves in 2014.
- Analyzed were 428 national nature reserves covering approximately 1,040,000 km^2 of land and accounting for 64% of the total protected area in China;
- The forest area in these 428 national nature reserves was 89,865 km^2 accounting for 5.05% of the country's total forest area in 2000.
- Within the nature reserves between 2000 and 2014, the area of forest gain was 69.5 km^2 and of forest loss 1,356 km^2; the greatest loss, 348.8 km^2, occurred in 2006. The rate of net forest loss within the nature reserves was 1.51%, lower than the national rate of 3.71%. This difference implied that 1,978 km^2 less forest was destroyed;
- Top ten nature reserves with the greatest forest loss (Nanweng River, Huzhong, Raohe Northeastern Black Bee, Zhuona River, Xishuangbanna, Wolong, Baishuihe, Yarlung Tsangpo Great Valley, Youhao, and Dazhanhe Wetlands) had a total forest loss of 764.6 km^2, accounting for 56.4% of the total forest loss in all the nature reserves over the same period of time;
- The national nature reserves had a total forest loss of 19.67 km^2 in 2014, which was below the annual means (96.9 km^2) from 2000 to 2014.
- Field investigations found that forest losses in some of the nature reserves, such as Nanweng River, Zhuona River, and Honghuaerji, were caused by fire; and that forest loss in Yunnan Xishuangbanna Nature Reserve was the result of rubber and banana plantation. (The nature reserve lacks administrative power due to historical reasons concerning its boundaries). These two types of loss accounted for 37% of the total area of forest loss in the nature reserves between 2000 and 2014.

Burned area of Mongolian pine in Honghuaaerji/ Zhang Di.UAV

By the end of 2014, there were 428 national nature reserves founded in China covering approximately 1,040,000 km^2 of the national land and accounting for 64% of the total protected area in China. At a tree cover rate greater than 20%, the total nature reserve forest area was estimated 89,865 km^2 accounting for 5.05% of the gross forest area, a ratio lower than that of the total national nature reserve area over the national land area. Valid boundary data could only be found of less than half of the nature reserves. The area of 1,032 nature reserves with boundaries was approximately 1,300,000 km^2 covering about 6.8% of forest, which is lower than their coverage of the national land (14.95%). This number exceeded 10% in most other countries/regions. The coverage rate of the world's protected area system over terrestrial ecosystems was 12.7% (FAO, Forest Resources Assessment 2010).

Within the 428 nature reserves between 2000 and 2014, the area of forest gain was 69.5 km^2 and of forest loss 1,356 km^2; the greatest loss, 348.8 km^2, occurred in 2006. The annual mean loss was 96.9 km^2. The rate of net forest loss within the nature reserves was 1.51%, lower than the national rate of 3.71%. This difference, which is equivalent to 1,978 km^2 less forest being destroyed, indicates that the nature reserves were effective in forest conservation. But the results of the forest change assessment show that a net forest loss of nearly 1,300 km^2 occurred in the national nature reserves, indicating considerable room for improvement in forest conservation.

Specifically, ten national nature reserves including Nanweng River, Huzhong, and Raohe Northeastern Black Bee had the greatest net forest loss, as shown in Table 3.11. These ten nature reserves had a total forest loss of 764.6 km^2, accounting for 56.4% of the total forest loss in all the nature reserves assessed; these were the same top ten reported in China Nature Watch 2014, though ranked differently.

Burned area/ Zhang Di

Table 3. Top ten national nature reserves with the greatest forest loss in 2000-2014 (Unit: km^2)

Nature reserve	Forest area	Gain	Loss	Reverse shift	Year of the greatest loss	Year of upgrade to the national level
Nanweng River	1877.8	0.3	370.5	0.0	2006	2003
Huzhong	1935.7	0.2	73.9	0.0	2001	1988
Raohe Northeastern Black Bee	5174.4	0.5	69.1	0.0	2011	1997
Zhuona River	1139.3	0.1	60.0	0.0	2008	2012
Xishuangbanna	2311.0	5.1	49.5	3.0	2003	1986
Wolong	1064.9	0.1	36.7	0.0	2008	1975
Baishuihe	207.3	0.1	29.2	0.0	2008	2002
Yarlung Tsangpo Great Valley	4197.0	1.8	28.1	0.5	2001	1986
Youhao	466.1	0.6	25.4	0.0	2009	2012
Dazhanhe Wetlands	1430.9	1.2	22.2	0.0	2004	2009
Grand total	19804.4	10.0	764.6	3.5		

The nature reserves had a total of 19.67 km^2 forest loss in 2014, much lower than the annual means of 96.9 km^2 between 2000 and 2014. Table 4 shows top ten nature reserves with forest loss in 2014 and their loss areas.

Table 4. Top ten national nature reserves (NR) with the greatest forest loss in 2014 (Unit: km^2)

Place	Nature reserve	Loss
1	Xishuangbanna	2.45
2	Anhui Chinese Alligators	1.05
3	Nanweng River	0.80
4	Huboliao	0.55
5	Yarlung Tsangpo Great Valley	0.53
6	Danxia Mountains	0.53
7	Lin'an Qingliang Mountain	0.52
8	Taohongling Sika Deer	0.52
9	Wuyan Range	0.50
10	Huanlian Mountains	0.48

Field investigations found the following explanations for nature reserve forest losses: (1) forest losses in some of the nature reserves, such as Nanweng River, Zhuona River, and Honghuaerji, were caused by fire; and (2) the forest loss in Yunnan Xishuangbanna Nature Reserve was attributed to the fact that collectively owned forest in the experimental zone was converted mostly to rubber plantation and partially to banana cultivation as a result of great limitations the nature reserve administration has in its power to control the use of collectively owned forest due to historical reasons concerning its boundaries. These two types of loss accounted for 37% of the total area of forest loss in the nature reserves between 2000 and 2014, as shown in Table 5.

Table 5 Causes of patch loss, verified in situ

Cause	Province					Patch ratio (%)
	Inner Mongolia	Heilongjiang	Yunnan	Hainan	Subtotal	
Fire	17	11			28	45.9%
Commercial forest plantation			20	9	29	47.5%
Urbanization				3	3	4.9%
Habitat management				1	1	1.7%
Grand total	17	11	20	13	61	100%

3.4.Global Forest Watch data accuracy assessment

- Global Forest Watch (GFW) and GlobeLand30 highly overlapped in terms of spatial forest interpretation;
- A pixels-based accuracy assessment was performed using Google Earth's high-res remote-sensing imagery from which canopies were visually identifiable. The results show that at a threshold set to be 20% tree cover, the overall accuracy of forest/non-forest interpretation with GFW's tree cover data reached 87.5%;
- Forest changes were verified in situ in four of ten nature reserves with the greatest forest loss: Xishuangbanna, Nanweng River, Zhuona River, and Huzhong. Field observations were also made in some other nature reserves, including Yingge Range and Datian of Hainan, Honghuaerji Scots Pine Forest of Inner Mongolia, and Hanma along the Greater Khingan Range. Both in situ and Google Earth visual verifications fully acknowledged extensive areas of forest loss as identified by GFW. Ground inspection also found that GFW's lost years remained consistent with the reality.

Forest ground truthing/ Zhang Di

3.4.1.The assessment of forest spatial overlapping ratios generated from two data sources: GFW and GlobeLand30

Global Forest Watch and GlobeLand30 both have 30m resolution datasets, and these were the only data publicly available at this level of resolution with spatial properties covering the whole of China. GlobeLand30 2010 assessed the accuracy of 154,070 sampling points at nine levels set up for the corresponding data interpretation results, though it did not provide any explicit explanation about its definition of forest. The overall accuracy was 83.51%. Specifically, the producer accuracy in the category of forest, namely the ratio of accurately interpreted checkpoints (52,538) over checkpoints that were actual forest (60,320), was 87.1%; the user accuracy in the category of forest, namely the ratio of accurately interpreted forest checkpoints (52,538) over checkpoints interpreted as the category of forest (59,034), was 89.0%. Grassland and farmland were most often misinterpreted as forest checkpoints, at 5.3% and 3.9% respectively. (National Geomatics Center of China, 2014) We assessed the reliability of GFW data with reference to GlobeLand30-2010. GlobeLand30 data interpretations show 2,128,468 km^2 of forest area in China; according to the expected producer and user accuracies in the category of forest, the actual forest area was estimated 2,174,834 km^2. This number was 7.1% higher than the maximum area estimates with GFW data of 2000, namely 2,029,878 km^2 with tree cover greater than zero.

Global Forest Watch and GlobeLand30 highly overlapped in terms of spatial forest interpretation, at a rate of 78.97% when tree cover was greater than zero, at 83.94% when tree cover exceeded 20%, and at 92.93% when tree cover was more than 75%. A small part of GFW interpreted forest fell into the category of other land use interpreted by GlobeLand30, its highest proportions being farmland and grassland, which was consistent with GlobeLand30 accuracy assessment results. By testing, we found that 21% of GFW's pixels of loss before 2010 were in a non-forest state in the context of GlobeLand30-2010. This rate should be 78% if GFW and GlobeLand30-2010 are independent of each other and have no spatial relationship. The variance shown in the chi-squared test was remarkable (P=0.000), indicating a significant spatial relationship between GlobeLand30-2010 and GFW in terms of forest state. We hold that GFW and GlobeLand30 2010 are comparable in terms of forest interpretation and that GFW data are reliable as a basis of reference to forest status and change in China.

Forest ground truthing/ Zhang Di

3.4.2.Visual assessment using high-res Google Earth imagery

In verifying forest change patches using Google Earth's high-res remote-sensing imagery from which canopies were visually identifiable, patch boundaries of 312 nature reserves with forest loss >25 ha were overlaid with the imagery to determine the forest status of various time phases on the same patch as well as the changes and the years in which they occurred. This visual inspection via Google Earth fully acknowledged extensive areas of forest loss as identified by GFW.

A pixels-based accuracy assessment was performed using Google Earth's high-res remote-sensing imagery from which canopies were visually identifiable. The results (Table 6) show that at a threshold set to be 20% tree cover, the overall accuracy of forest/non-forest interpretation with GFW's tree cover data reached 87.5%;

Table 6 The confusion matrix of GFW accuracy assessment, obtained by visually identifying random points on Google Earth

GFW tree cover category		Classification of visual identifications with Google Earth (%)							User accuracy
		Forest	Non-forest					Subtotal	
			Farmland	Cities/ towns	Bare land	Water bodies	Other		
Forest	75%-100%	2061	18	8	20	1	6	6546	95.08%
	50%-74%	2578	32	13	47	2	7		
	20%-49%	1585	72	21	53	7	5		
Non-forest	0-19%	1115	1819	805	956	172	71	4938	77.42%
Subtotal		7339	4145					11484	Overall accuracy 87.49%
Producer accuracy		84.81%	92.23%						

3.4.3.In situ verification of the years and causes of forest change locations

Forest changes were verified in situ in four of ten nature reserves with the greatest forest loss: Xishuangbanna, Nanweng River, Zhuona River, and Huzhong. Field observations were also made in some other nature reserves, including Yingge Range and Datian of Hainan, Honghuaerji Scots Pine Forest of Inner Mongolia, and Hanma along the Greater Khingan Range. The field inspection fully verified the extensive plots of forest loss as identified by GFW. Ground inspection also found that GFW's lost years remained consistent with the reality. As shown in Table 7, by way of both field investigations and interviews in the communities/ nature reserves concerned, we identified all 51 forest loss patches as the change indicated by GFW interpretations, namely full consistency (100%) between reality and data. The actual lost years were verified through interviews: 39 patches were consistent (76.4%); 12 patches were uncertain (23.5%).

Table 7. Patches verified by field inspection

GFW category	Consistent		Inconsistent		Uncertain		# of patches
	#	%	#	%	#	%	
Lost location	51	100	0	0	0	0	51
Lost year	39	76.4	0	0	12	23.5	51

Of ten patches verified by interviews, all (100%) were consistent in terms of loss locations; three (30%) were consistent in terms of lost years; and seven showed inconsistency between the interviews and GFW interpretations in terms of lost years.

Burned area/ Zhang Di

Rhacophorus maximus, Motuo, Tibet/ Wang Fang

『 Species Watch 』

IUCN Red list of threatened species published by the International

Union for Conservation of Nature (IUCN) shows that a quarter of mammals, about 1,200 bird species and 30,000 plants are facing the threaten of extinction. Since six hundred million years ago, we have experienced 5 times of mass extinction. Are we in the 6th mass extinction? Or is it 3 species disappeared within each hour? We cannot verify, however, we are quite affirmative that species extinction caused by human disturbance is unusual during the entire human history, maintaining species diversity is also significant to human survival.

According to statistical material from the state Environmental

Protection Administration, during past 20 century, 6 species of

large mammal have been extincted: Equus przewalskii (Extincted

in wild since 1947), Saiga tatarica (Extincted since 1920), Panthera

tigris lecoqui (Extincted since 1916), Rhinoceros unicornis (Extincted since 1920), Rhinoceros sondaicus (Extincted since 1922), and Dicerorhinus sumatrensis (Extincted since 1916).

In this part, we discusses the methods of evaluating the most concern endangered animals protection situation for better understanding the conservation works and researches on endangered animals in China.

Species Watch: Status Assessment

Motacilla alba，Gongbujiangda, Tibet/ Wang Fang

1.Foreword

China is one of the world's most biodiverse countries. Since the turn of the century, the Chinese government has steadily increased its input in species conservation. Meanwhile, there has been growing public awareness and action in this area. Currently, however, we lack an effective means to evaluate the effect of these inputs. How an endangered species is being protected, whether its number is increasing, or whether its habitat is improving - these are the questions the public is most interested in asking with regard to species conservation but can hardly find an answer.

The categorization of species endangerment serves as an important basis for determining species conservation priority zones and formulating conservation policies for endangered species and is widely seen as a key step in biodiversity conservation at various levels, including the Convention on Biological Diversity (CBD), international NGOs, and states (Cheng K.W. and Zang R.G, 2004). The IUCN Red List Categories and Criteria Version 3.1 was released in 2001 and has received worldwide recognition and application. Many countries, including China, have compiled their own red lists in reference to its quantitative assessment system and expert consultation method. But this system is intended as a means to assess species endangerment status; it may not be fitted to gauge conservation effectiveness (Jiang Z.G. and Fan E.Y., 2004).

Equus kiang, Suojia, Qinghai/ Wang Fang

The 1988 amendment of the U.S. Endangered Species Act (ESA) stipulates that species recovery plans must include specific effectiveness assessment indicators. More than a decade later, the academic community evaluated the role of these indicators in terms of the effectiveness of the conservation plans and found a positive correlation between the assessment indicators and the recovery of endangered species populations (Boersma et al., 2001; Clark et al., 2002; Gerber & Hatch, 2002; Bottrill et al., 2011). Apart from the U.S., Canada, Australia, and New Zealand have also carried out quantitative assessments of endangered species conservation effectiveness (Cullena et al., 2005; Taylor et al., 2005). China has yet to develop a specific legal-binding species conservation practice or a standard to assess conservation effectiveness. This is a major setback to increasing social inputs into species conservation.

This is why we tried to formulate a conservation effectiveness assessment system based on the best data currently available, and thereby to start a rapid assessment process for conservation effectiveness among the most concerned endangered species (MCES) in China. In addition, we also conducted a comprehensive review of publications concerning research on endangered species (Sutherland & Woodroof, 2009; Sutherland et al., 2014) in order to provide necessary information for such assessment and to achieve an understanding of the overall trend in the development of China's research on endangered species. This assessment will cover more species with regular updates of China Nature Watch from 2014.

2.Methodology

2.1.The listing of species assessed

The List of National Key Protected Wild Animals and the List of National Key Protected Wild Plants (hereinafter called "the Lists") include approximately 530 species (this number is subject to change with continuing revisions to the categories in which some species are listed by genus). Specifically, 168 are of Class I and 361 of Class II. Among the more scientific and systematic assessments which have already been conducted, 10,211 species were covered by China Red List and 6,207 species by IUCN Red List (both included infraspecies). In this assessment, we included species above Vulnerable (VU) on the IUCN Red List hoping to reach out more species that are seriously threatened. We verified the categorization of only 362 species when we started our assessment in early 2014, coinciding with the once-in-every-five-years updating of the IUCN database; 262 of the species then assessed overlapped with the Lists. Additionally, from the Peking University Center for Nature and Society, we also garnered accumulated data about 117 species which were not included in the Lists. Altogether 746 species were initially chosen for assessment.

Falco cherrug, Kalamaili, Xingjiang/ Yan Xuefeng

In the course of literature retrieval, we noticed that research papers and accumulated data were insufficient to assess most of the species selected. An important purpose of this assessment was to formulate an effective set of assessment criteria, but it would make no sense if huge information gaps prevented us from learning about the species so as to decide if the criteria would indeed be effective. Eventually, we narrowed down our list to include only species that were rather fully documented in terms of research and distribution data. The Lists, the only valid legal references to endangered wildlife conservation in China, cover species that remain the focus of most conservation and research efforts, particularly Class I National Protected Species. Furthermore, bird populations and distributions are most fully documented, indicating that bird species receive more attention from researchers, conservationists, and bird watchers. The critically endangered (CR) and the endangered (EN) species among them are naturally accorded higher conservation value. The species mentioned earlier represent the highest level of China's conservation and research efforts for endangered species. We define them as the most concerned endangered species (MCES); there are 174 of them.

In 2015, we moved on to include the entire Lists and IUCN Red List species above VU (8/15/2015 update) – a total of 1,085 species – for this assessment.

2.2.The formulation of assessment criteria

Based on the most reliable data currently available and partly in reference to the Ecological Society of America (ESA) assessment criteria for species recovery plans, we set up the following four indicators for assessing the conservation status of the species stated earlier.

- Population dynamics: quantitative, based on literature and accumulated monitoring data and consultations. For undocumented

Protobothrops jerdonii, Qingchuan, Sichuan/ Wang Fang

species, reference was made to IUCN Red List descriptions.

- Suitable habitat change: quantitative, based on remote-sensing data and distribution data simulation. For details, see 2.4.
- Information completeness: qualitative, literature based, reflecting how much biological information was collected about the species. Scores were given as to the availability of documents in six areas of research: taxonomy, species monitoring, habitat change, behavioral study, reproduction systems, and genetic biodiversity.
- Nature reserve over modelled distribution area coverage: quantitative, based on distribution data modelling. For details, see the works of the same year by Wen et al.

2.3.Literature retrieval and data abstraction

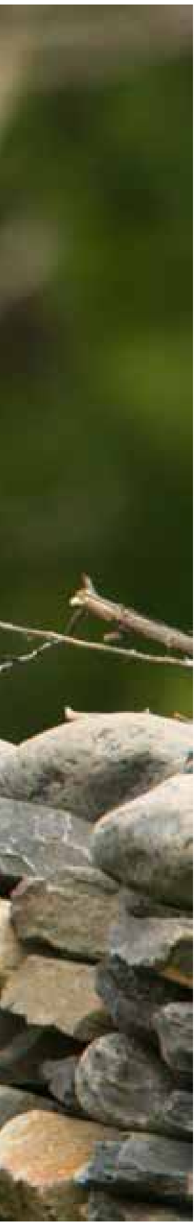
Among the above-mentioned four indicators, population dynamics, information completeness, and some distribution data may be obtained from published research papers. Besides, the increasing number of studies also reflects attention being drawn to endangered species. Therefore, by the following rules, we worked with volunteers from all over the country to retrieve data about 1085 species on our list.

- The sources of literature: Retrieve English literature with Google Scholar using Latin names of the species as keywords. For Chinese

Macaca mulatta, Gongbujiangda, Tibet/ Wang Fang

Table 1. Conservation effectiveness assessment criteria

Indicator	1	0	-1
Population dynamics	Steady increase	Little change	Decrease or no signs of recovery
Suitable habitat change	Over 1% pixels improved	1% pixels improved or unclear	Over 1% pixels deteriorated
Information completeness	Behavior, reproduction or genetic biodiversity documented	Populations and habitats documented	Only taxonomical studies available
Nature reserve over modelled distribution area coverage:	>15%	5-15%, or unclear	<5%



literature, use their Chinese names as keywords instead and search them in Cqvip.com/CNKI.net. Download full texts. The publication time range should be 2000-2014. Screen sources for relevance and discard any discussions held for pure academic or agricultural purposes irrelevant to conservation.

- Data abstraction:
- Populations: Abstract information about population dynamics from the studies retrieved.
- Study sites: Abstract information about the site of each study and make it precise to the county level. If possible, abstract the coordinates. Such information actually reflect distribution and can be used for habitat modelling.
- Research classification: As required for this assessment, we unraveled IUCN's endangered species status assessment system by grouping the most discussed research topics into three categories of "status," "threat," and "action."

Our review showed that over 90% of the abstraction results sent back from the volunteers was accurate. This is the evidence that our data abstraction approach was simple and clear enough and would not present any difficulties even for non-majors.

2.4.Habitat change

The vegetation index may reflect how organisms-carrying vegetation changes over time (Liu & Gong, 2012; Lii et al., 2015). We analyzed the trend of vegetation changes in China during 2000-2013 using the enhanced vegetation index (EYI) derived from Terra/MODIS imagery (part of MOD13Q1 dataset) publicly released by the National Aeronautics and Space Administration (NASA). The first step was to find the average of EVI data in 8 time phases during summer when vegetation was at its best, i.e., from May 25 (24 in a leap year) to September 29 (28 in a leap year). Next, we performed linear regression using 14 data (2000-2013) for every pixel and verified the slope and significance of the regression equation. The result would show that the vegetation status either remarkably worsened or improved depending on whether the slope turned negative with a great significance or otherwise. An insignificant slope would mean that the vegetation index had no remarkable change (Yu et al., 2011).

Then we combined five land cover datasets, dividing land cover in China into seven categories: forest, grassland, wetland, desert and bare land, glacier, farmland, and urban land. By overlaying them with the results of our vegetation index trend analysis, we obtained variations for every category of land cover and calculated area percentage (number of pixels) therein. These five land cover datasets are:

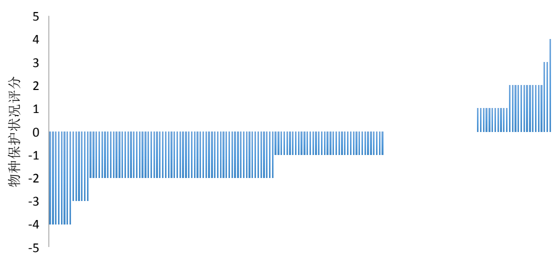
- China subset based on SPOT4 satellite remote sensing data developed by GLC2000.
- China subset in global land cover data based on AVH-RR (Advanced Very High Resolution Radiometer) remote sensing data supported by IGBP-DIS (International Geosphere-Biosphere Program: Data and Information System)
- China subset in MODIS (Moderate Resolution Imaging Spectroradiometer) global land cover data
- China subset in global land cover data based on AVHRR data and NDVI (Normalized Difference Vegetation Index) data generated by University of Maryland
- Nationwide 1 km resolution land use data product obtained through consolidation and vector-to-raster conversion on the basis of China (2000) 1:100000 land cover data organized by the Chinese Academy of Sciences (CAS)

Finally, we laid distribution predictions over with vegetation index variation layers of various land cover categories for consolation of changes as one of the assessment criteria for habitat change. Each species was rated in consideration of its habitat characteristics and dependency upon vegetation in that specific habitat. For example. increased vegetation in forest should be considered as a positive sign for species living in forest; otherwise is true for species whose habitat is desert or bare land.

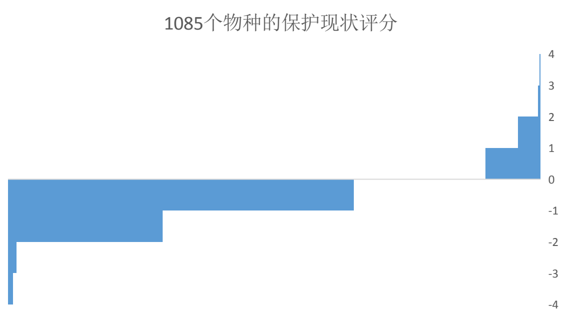
3.Results

3.1.The overall rating of species conservation status

Of the 174 species assessed in 2014, only 26 experienced an overall improvement in their conservation status, 32 maintained status quo, and 116 had worse conditions.

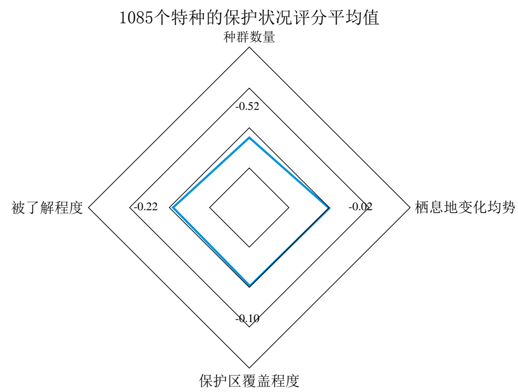


When our assessment expanded to include 1,085 species, only 102 experienced an overall improvement in their conservation status, 245 maintained status quo, and 738 had worse conditions. See the appendix for all the species assessed in this report.



The conservation status ratings of the 1085 species

The arithmetic mean value of these ratings gives an overall indication of their conservation status. All the figures are negative, indicating that despite the massive input of conservation resources, the conservation status for these endangered species is still worsening.



Of the species best conserved as listed in Table 2 , the populations of *Davidia involucrata, Cervus nippon, Cycas revoluta, Equus kiang, Kingdonia uniflora, Macaca cyclopis,* and *Naemorhedus swinhoei* (the last two species are distributed in Taiwan) were steadily increasing; *Ailuropoda melanoleuca, Budorcas taxicolor, Bos grunniens,* and *Rhinopithecus roxellana* received higher scores because data about these species and their habitats. A very limited number of species benefited from conservation practice: *Ailuropoda melanoleuca, Budorcas taxicolor, Rhinopithecus roxellana,* and *Nipponia nippon,* and a few other species distributed on the Tibetan Plateau, such as *Pantholops hodgsonii* and *Equus kiang.* Of these species, *Rhinopithecus roxellana* and *Budorcas taxicolor* benefited from conservation efforts for *Ailuropoda melanoleuca* as they inhabit the same geographical region.

Budorcas taxicolor，Qingchuan, Sichuan/ Wang Fang

Table 2 Species in the best conservation status (scoring 2 or higher)

Chinese name	*Latin name*	Population dynamics	Habitat change	Nature reserve coverage	Basic info	Grand total
西藏野驴	*Equus kiang*	1	1	1	1	4
金雕	*Aquila chrysaetos*	1	1	0	1	3
珙桐	*Davidia involucrata*	1	1	0	1	3
黑鹳	*Ciconia nigra*	1	0	0	1	2
胡兀鹫	*Gypaetus barbatus*	1	1	1	-1	2
东北红豆杉	*Taxus cuspidata*	1	0	0	1	2
台湾猴	*Macaca cyclopis*	1	0	0	1	2
台湾鬣羚	*Capricornis crispus*	1	0	0	1	2
伯乐树	*Bretschneidera sinensis*	0	1	0	1	2
独叶草	*Kingdonia uniflora*	1	0	0	1	2
斑尾榛鸡	*Tetrastes sewerzowi*	0	0	1	1	2
梅花鹿	*Cervus nippon*	1	0	0	1	2
藏羚	*Pantholops hodgsonii*	-1	1	1	1	2
大熊猫	*Ailuropoda melanoleuca*	-1	1	1	1	2
苏铁	*Cycas revoluta*	1	0	0	1	2
红花绿绒蒿	*Meconopsis punicea*	1	0	0	1	2
羽叶点地梅	*Pomatosace filicula*	1	0	0	1	2
鹅喉羚	*Gazella subgutturosa*	1	0	0	1	2
白豆杉	*Pseudotaxus chienii*	1	0	0	1	2
黑颈乌龟	*Mauremys nigricans*	1	0	0	1	2
长薄鳅	*Leptobotia elongata*	1	0	0	1	2
仙八色鸫	*Pitta nympha*	1	0	0	1	2
天山桦	*Betula tianschanica*	0	0	1	1	2
黄嘴白鹭	*Egretta eulophotes*	1	0	0	1	2
仿刺参	*Apostichopus japonicus*	1	0	0	1	2
莽山烙铁头蛇	*Protobothrops mangshanensis*	1	0	0	1	2
川陕哲罗鲑	*Hucho bleekeri*	1	0	0	1	2
乌雕	*Clanga clanga*	1	0	0	1	2
梅花参	*Thelenota ananas*	1	0	0	1	2
卷口鱼	*Ptychidio jordani*	0	0	1	1	2
凹耳蛙	*Odorrana tormota*	1	0	0	1	2
秦岭冷杉	*Abies chensiensis*	1	0	0	1	2
台湾油杉	*Keteleeria davidiana var. formosana*	1	0	0	1	2
海南油杉	*Keteleeria hainanensis*	1	0	0	1	2
太白红杉	*Larix chinensis*	1	0	0	1	2
四川红杉	*Larix mastersiana*	0	0	1	1	2
油麦吊云杉	*Picea brachytyla var. complanata*	1	0	0	1	2
白枕鹤	*Grus vipio*	1	0	0	1	2
长脚秧鸡	*Crex crex*	1	0	0	1	2
姬田鸡	*Porzana parva*	1	0	0	1	2
棕背田鸡	*Porzana bicolor*	1	0	0	1	2
铜翅水雉	*Metopidius indicus*	1	0	0	1	2
小勺鹬	*Numenius borealis*	0	0	1	1	2

Among species with the worst conservation status, *Equus przewalskii* is now extinct in wilderness; *Lipotes vexillifer* and *Psephurus gladius* most probably have gone extinct. Among species scoring below -3, *Manglietiastrum sinicum, Nyssa yunnanensis* and *Pinus squamata* have extremely small populations while others have a very low level of information completeness.

3.2.The rating of species conservation status by individual indicator

3.2.1.Population dynamics

In terms of population sizes, 584 out of the 1085 species assessed were on the decline, accounting for 53.8%; 407 remained stable, 37.51%; and 94 were on the rise, 8.7%. Species with the greatest population growth included *Davidia involucrata, Cycas revoluta*, and *Equus kiang*; most of them were low-risk or least-concerned species with a great population size. Among species with the greatest population decline, *Equus przewalskii, Lipotes vexillifer* and *Psephurus gladius* have gone extinct in wilderness; *Pinus squamata*, *Abies beshanzuensis* and others with extremely small populations still exhibit a trend of shrinking. The number of declining species was actually underestimated due to the fact that species with unclear population dynamics also scored zero.

3.2.2.Suitable habitat change

Among the 1085 species assessed, 311 (28.7%) had suitable habitat loss by more than 1%; 43 (4.0%) had habitat change within ± 1%; and 36 (3.3%) had habitat gain by more than 1%. Furthermore, 695 species scored zero because their distribution data was insufficient for modelling.

3.2.3.Nature reserve over modelled distribution area coverage

Among the 1085 species assessed, 161 (14.8%) had less than 5% of modelled distribution areas covered by nature reserves; 161 (13.7%) had a rate of 5-15%; and 66 species (6.1%) had over 15%. Furthermore, 695 species scored zero because their distribution data was insufficient for modelling.

3.2.4.Information completeness

Among the 1085 species assessed, 425 (39.2%) had incomplete basic information; 437 (40.3%) only had information about distribution and population; and 223 (20.6%) were studied in terms of habitat status, genetic diversity, behavior, or reproductive biology, in addition to basic

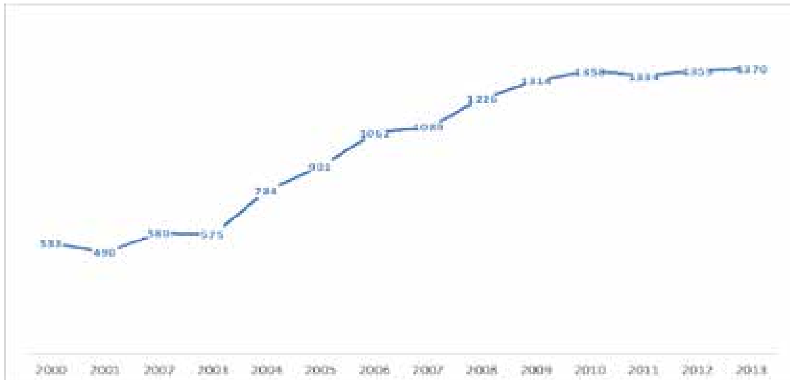
Table 3 Species in the worst conservation status (scoring below -3)

Chinese name	*Latin name*	Population dynamics	Habitat change	Nature reserve coverage	Basic info	Grand total
云豹	*Neofelis nebulosa*	-1	-1	0	-1	-3
鼋	*Pelochelys bibroni*	-1	-1	-1	0	-3
华盖木	*Manglietiastrum sinicum*	-1	-1	0	-1	-3
灰腹角雉	*Tragopan blythii*	-1	-1	-1	0	-3
云南蓝果树	*Nyssa yunnanensis*	-1	-1	-1	0	-3
儒艮	*Dugong dugon*	-1	-1	-1	0	-3
芒苞草	*Acanthochlamys bracteata*	-1	-1	0	-1	-3
勺嘴鹬	*Calidris pygmaea*	-1	-1	0	-1	-3
白鱀豚	*Lipotes vexillifer*	-1	-1	-1	-1	-4
白鲟	*Psephurus gladius*	-1	-1	-1	-1	-4
野马	*Equus przewalskii*	-1	-1	-1	-1	-4
豹	*Panthera pardus*	-1	-1	-1	-1	-4
巧家五针松	*Pinus squamata*	-1	-1	-1	-1	-4
四川苏铁	*Cycas szechuanensis*	-1	-1	-1	-1	-4
中华水韭	*Isoetes sinensis*	-1	-1	-1	-1	-4

information. Those at a relatively high level of information completeness were all flagship species or species of high economic value.

3.3.Literature review

To provide information needed for species conservation status assessment, we performed literature retrieval on a broad scale for the 1085 species stated herein. A total of 14,788 research papers were obtained: 12,754 were written in Chinese and 2,034 in English. Generally, the majority were Chinese papers accounting for 87.06% of the retrieval. Of the 1085 species assessed, 556 (51.24%) were specifically studied. Averagely, 26.59 papers were retrieved for each species.

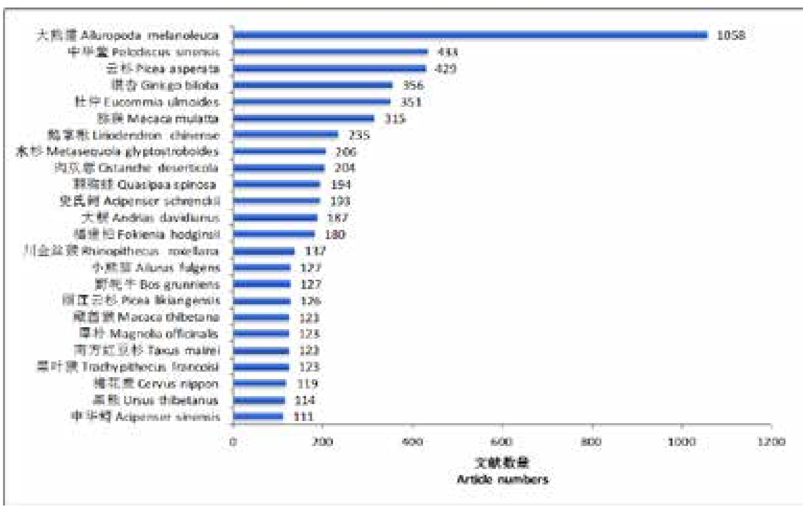


The number of species studied and the number of papers published both appeared to be rising year on year, from 96 species and 328 papers in 2000 to 212 species and 822 papers in 2013, as shown in Figure 1. This growth was remarkable from 2003 to 2009 and then slowed down or even fell back.

3.4.The distribution of studies among species

Our review of the literature showed a very uneven distribution of research papers among species. The greater part of the studies we retrieved focused on flagship species and other species of high economic value. Most other species received little research interest. Of the 1085 species assessed, only 556 were found being specifically studied and 529 (48.8%) were not.

Of the 14,788 papers retrieved, 1058 specifically discussed the flagship species Ailuropoda melanoleuca. Most of these studies were done in farms and labs; only about 20% (222) were field studies.



Apart from Ailuropoda melanoleuca, some species under its umbrella effect, and a few widely distributed, least concern species, all other species covered by more than 100 papers was one of high economic value. Specifically, next to the most studied species was Pelodiscus sinensis (VU).

Species Watch: Distribution

1.Foreword

It's been two years since China Nature Watch 2014 was released. It included the assessment of 96 species the International Union for Conservation of Nature (IUCN) rated as critically endangered (CR) and endangered (EN) as well as wildlife the Chinese government listed in the first class of protection in China. Back in 2000, Myers et al. classified the Indo-Burma region, the Himalayan area, and the Mountains of Southwest China as the world's biodiversity hotspots that involve China. Also based on biodiversity factors, Brooks et al. added the Tianshan Mountains of Xinjiang to the trio in 2006. Such classification remains consistent with the mapping of global biodiversity hotspots in the Critical Ecosystem Partnership Fund (CEPF) database. The Nature Conservancy (TNC) database for conservation priorities selected 65 plots in China. Unfortunately, most of them overlapped with the core areas of China's national nature reserves, hence providing weak references for conservation planning.

By following the major reporting methods and assessment procedures of China Nature Watch 2014, this report expanded the scope of species assessment and examined the distribution and nature reserve coverage of 715 threatened/conserved vertebrate species (62 were mammals, 316 birds, 141 reptiles, 196 amphibians, and 86 were plants). We computed their distribution data at two different angles: biodiversity and priority. The results showed that for terrestrial vertebrates, areas along the Yangtze River (particularly along the middle and lower Yangtze), areas around the Bohai and Yellow Seas, and the Taiwan Island also are China's biodiversity hotspots and conservation priorities, in addition to the four internationally recognized hotspots mentioned earlier. For floras, we generated results similar to the previous findings from several international and Chinese teams. Though a great number of priorities in the mountain areas of southern China were identified, we failed to fully outline the hotspots for the conservation of higher plants due to data limitations. Compared to our previous findings, this report employed a fuller body of data and involved a new method for prioritization. These new adjustments allowed us to provide more detailed information about priority biodiversity conservation zones around the Yellow and Bohai Seas, along the middle and lower reaches of the Yangtze River, in the northern part of Xinjiang and in the tropical areas of southern China.

Land value, however, varies greatly across China's vast territory. China is also one of the world's most biodiverse countries. But there are few official indicators available for us to measure weights as they should be added to the calculations of priorities at different levels of species conservation or to the extremely wide range of distribution radii among the great number of endemic species. We tried to solve this problem this year. Our work will be further optimized with data updates and methodological advancements.

Cervus albirostris，Angsai, Qinghai/ Pu Wajie

2.Data

2.1.Species catalog

The groups of wildlife selected in this report are birds, amphibians, reptiles, and tracheophytes. Our species catalog for assessment was screened by the following criteria: 1) National class I and class II protected animals on the List of National Key Protected Wild Animals; 2) CR, EN, and VU animals on IUCN Red List (http://www.iucnredlist.org/); 3) CR, EN, and VU animals on the Redlist of Chinese Biodiversity (RCB): Vertebrates; and 4) tracheophytes on the List of National Key Protected Wild Plants.

2.2.Distribution

We screened and selected distribution data from the following sources: 1) historical data from mammal sampling sites, collected by CAS Institute of Zoology (Beijing) and other research institutions; 2) distribution points identified with RAP and monitoring efforts Peking University Center for Nature and Society has made in various parts of the country, such as Sichuan, Tibet, Qinghai, and the Argun watershed in the northeast with the support of CI, the Ministry of Science and Technology, and other sponsors; 3) public science databases: 46,073 bird watching entries between January 1, 2000 and May 31, 2016, retrieved from Bird Talker (http://www.birdtalker.net/) and Bird Report (http://www.birdreport.cn/index); 4) peer-reviewed published papers: 1,951 papers published between January 1, 2000 and May 31, 2016, retrieved from CNKI (http://www.cnki.net/) and Google Scholar (https://scholar.google.com/) using the Chinese/Latin names of the species to be assessed; 5) books: relevant distribution data of 2000-2016 from works such as A Checklist on the Classification and Distribution of the Birds of China (2ed edition), the Avifauna of Taiwan, the Colored Atlas of Chinese Amphibians and Their Distributions, and the Atlas of Reptiles of China; and 6) floral specimen data and monitoring records shared by protocol between Shanghai Chenshan Botanical Garden and Shan Shui Conservation Center.

These distribution data were translated into 13,045 sets of coordinates for mammals, 13,181 for birds, 875 for reptiles, and 2,279 sets for tracheophytes, using Google Maps (http://www.google.cn/maps).

2.3. Environment variables

We selected 27 environment variables for further distribution modelling. Specifically, 19 of them are climate variables from the database WorldClim 1.4 (www.worldclim.org/); three are Shuttle Radar Topography Mission (SRTM) variables predicting

The number of species selected in each group is listed in Table 1.

Table 1 The number of species selected for China Nature Watch 2016, by category

Category/# of species	National class I	National class II	IUCN CR	IUCN EN	IUCN VU	RCB CR	RCB EN	RCB VU	Grand total
Birds	43	196	11	26	61	13	51	75	314
Mammals	53	37	12	38	39	61	55	69	206
Amphibians	0	7	8	41	55	13	46	117	196
Reptiles	6	11	13	20	17	35	37	65	141
Tracheophytes	11	76							87

30

elevation, gradient and aspect; and three are geographical variables from CAS Institute of Geographical Sciences and Natural Resources (personal communications) representing distance to road/railway and soil types. The distance to water variable was generated by calculating with "buffer" in ArcMap after we extracted "water body" from the category of land use. The type of land cover was identified in the Landcover30 database (http://landcover.usgs.gov/glc/) and, using interpolation, was converted into 1 km data. All the variables were converted in ArcGIS's digital elevation model (DEM) format. For details, see Table 2.

Table 2 Environment variables for modeling

SN	Variable	Source
Bio1	Annual Mean Temperature	WorldClim
Bio2	Mean Diurnal Range(Mean of Monthly (Max Temp - Min Temp))	
Bio3	Isothermality	
Bio4	Temperature Seasonality	
Bio5	Max Temperature of Warmest Month	
Bio6	Min Temperature of Coldest Month	
Bio7	Temperature Annual Range	
Bio8	Mean Temperature of Wettest Quarter	
Bio9	Mean Temperature of Driest Quarter	
Bio10	Mean Temperature of Warmest Quarter	
Bio11	Mean Temperature of Coldest Quarter	
Bio12	Annual Precipitation	
Bio13	Precipitation of Wettest Month	
Bio14	Precipitation of Driest Month	
Bio15	Precipitation of Seasonality(Coefficient of Variation)	
Bio16	Precipitation of Wettest Quarter	
Bio17	Precipitation of Driest Quarter	
Bio18	Precipitation of Warmest Month	
Bio19	Precipitation of Coldest Month	
E20	Elevation	Shuttle Radar Topography Mission
E21	Slope	
E22	Aspect	
E23	Distance to Water	Institute of Geography and Resource Research, Chinese Academy of Sciences
E24	Soil Type	
E25	Distance to Road	
E26	Distance to Railway	
E27	Land Use Type	National Geomatics Centre of China

3.Methodology

3.1.Distribution mapping

For species with five or more distribution points, we used the MaxEnt model (MaxEnt 3.3.3k) to map species distributions. For each species, Bootstrap Replicate in the MaxEnt model were used to simulate five times independently; 80% of the distribution point data was used for training and the other 20% for testing. The output values of the five sub-models thus generated in each pixel were averaged. The resulting average predictive raster was regarded as the prediction of species distribution status. Three thresholds the model provided in correspondence to the equal training sensitivity and specificity (ETSS), the maximum training sensitivity plus specificity (MTSS), and the balanced training omission, predicted area and threshold value (BTOPT) were used to convert the predication into three Presence/Absence images. The fact that these binomial images constituted the smallest map covering all the distribution points determined the validity of the thresholds identified. The AUC value was used to assess the accuracy of the predication with the model.

Considering that mammals had more legacy data and insufficient updates than the other groups of wildlife, we applied an overlaying strategy using expert knowledge and recent land cover information to correct the map.

A species distribution layout was obtained by overlaying the binomial distribution images of each species in ArcGis.

3.2.Habitat mapping

For each species, we selected a corresponding type of land cover as identified by Landcover 30. Then we generated a habitat map by using the ExtractByMask command in ArcGis to cut out the binomial distribution images of the species.

Land cover types were selected by the following rules: 1) to identify a habitat type for mammals, refer to A Guide to the Mammals of China; 2) for birds, refer to the Avifauna of China and A Field Guide to the Birds of China; 3) for amphibians, select "water" and "forest"; and 4) for reptiles, refer to the Fauna of China.

A species habitat layout was obtained by overlaying the habitat map of each species in ArcGis.

3.3.Species distribution hotspot mapping

For the habitat distribution layout of each group of species, the pixels with the top 5% species richness were identified as a distribution hotpot. This process was achieved by using the "regroup" command in ArcGis.

3.4.Spatial conservation prioritization

For each group of the species selected, we used the Zonation model for spatial conservation prioritization. A map of priorities was obtained for each group by performing an Zonation analysis of the averaged raster of the five sub-models produced by the MaxEnt model for each species in a particular group.

Zonation is an algorithm for spatial conservation prioritization, assuming that the top 2% is within the top 5%, which is within the top 10%. This algorithm is specified as follows:

1) Start with the entire study area and set the level r=1;

2) Calculate marginal loss in each pixel, i.e., the loss of conservation value left in a zone after the removal of the pixel;

3) Remove the pixel with the minimum marginal

loss, set the level r=r+1, and repeat step 2 until there is no pixel left to remove.

This report employed two methods to calculate conservation value: Core-area Zonation (CAZ) and Additive Benefit Function (ABF).

CAZ emphasizes "habitat suitability," meaning that a pixel has high conservation value as long as it is a perfect habitat for any given species. The following is the CAZ equation for pixel i:

$$\delta_i = \max_j \frac{q_{ij}\omega_j}{c_i}$$

where q_{ij} is the result of the MaxEnt model for species j in pixel i, ω_j is the weight added to species j, and c_i is the cost of conservation for pixel i.

ABF emphasizes "species richness," referring to an overlay of conservation values of all species in this pixel. The following is the ABF equation for pixel i:

$$\delta_i = \frac{1}{c_i}\sum_j \omega_j[V_j(q_j) - V_j(q_j - i\mathrm{h}]$$

where $V_j(q_j)$ is the MaxEnt model result value of all the remaining pixels and $V_j(q_j - i\mathrm{h}$ is the MaxEnt model result value of all the remaining pixels after the removal of pixel i.

When the prioritization layout was generated, the top 2%, 5%, 10%, 25%, 50% and 80% were used as thresholds to classify the prioritization.

3.5.The analysis of national nature reserve gaps

We produced presence/absence binomial distribution images and a habitat map for each species, distribution and habitat layouts, and distribution hotspot coverage rates. We compared these rates with global indicators (Aichi Targets). This process allowed us to perform a GAP analysis of the coverage of national nature reserves over the distribution areas of threatened birds, reptiles, amphibians, and tracheophytes in China.

Vulpes vulpes, Yushu, Qinghai/ Wang Fang

4.Results

4.1.MaxEnt modelling accuracy assessment

We used the AUC values produced by MaxEnt to assess the accuracy of the modelling. The AUC values for each group of the species were distributed as follows:

1）Birds: The AUC values of 179 modelled bird distribution maps averaged 0.956, the lowest value being 0.761 *(Aquila heliaca)* and the highest value being 1 *(Haliaeetus leucogaster)*; 12 of the species in this group were below 0.9, 105 were above 0.95, and 63 varied in between.

2）Reptiles: The AUC values of 56 modelled reptile distribution maps averaged 0.945, the lowest value being 0.756 *(Mauremys reevesii)* and the highest value being 0.999 *(Leiolepis reevesii and Cuora galbinifrons)*; 10 of the species in this group were below 0.9, 34 were above 0.95, and 12 varied in between.

3）Amphibians: The AUC values of 83 modelled amphibian distribution maps averaged 0.973, the lowest value being 0.872 *(Rana tigrina)* and the highest value being 0.999 *(Amolops chapaensis, Hynobius arisanensis, Limnonectes fragilis, Paa medogensissp, Pelophryne scalptus, Ranodon sibiricus, Rhacophorus arvalis, and Rhacophoms aurantiventris)*; 2 of the species in this group were below 0.9, 72 were above 0.95, and 9 varied in between.

4）Tracheophytes: The AUC values of 86 modelled tracheophyte distribution maps averaged 0.941, the lowest value being 0.791 *(Parakmeria omeiensis Cheng)* and the highest value being 0.999 *(Chamaecyparis formosensis and Helminthostachys zeylanica (Linn.))*.

The AUC values of 404 species averaged 0.954, the lowest value being 0.761 (*Aquila heliaca*) and the highest value being 1 (*Haliaeetus leucogaster*); 39 of the species were below 0.9, 254 were above 0.95, and 104 varied in between. Generally, the species distributions had a high modelling accuracy; 62.9% of the species assessed had an AUC value higher than 0.95.

For mammals, we modelled distribution maps for 50 species excluding 20 species known as extinct in China (e.g., *Bubalus arnee*) or species with very few reliable distribution data since this century (e.g., *Helarctos malayanus*). These were corrected for using expert knowledge and therefore were not incorporated into the AUC values of the models.

4.2.Kriging species richness maps by group

Finally, distribution maps and habitat map layers were produced for 454 out of the 801 species assessed (50 were mammals, 179 birds, 56 reptiles, 83 amphibians, and 86 tracheophytes). By overlaying with these distribution maps by biological and conservation category, we managed to generate kriging maps of species distributions and habitats as shown in Figs. 1-5.

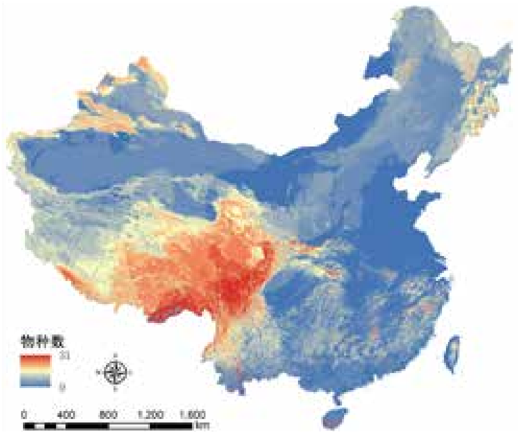


Fig. 1 Distribution of threatened/national protected mammals

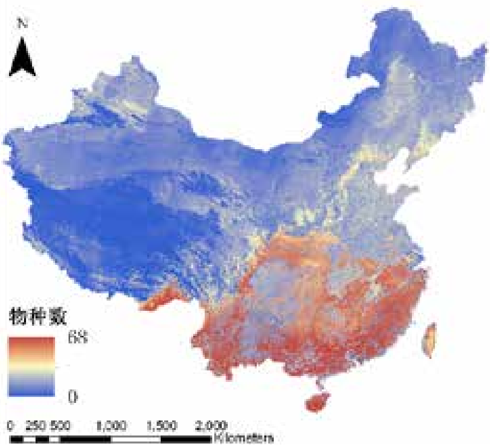


Fig. 2 Distribution of threatened/national protected birds

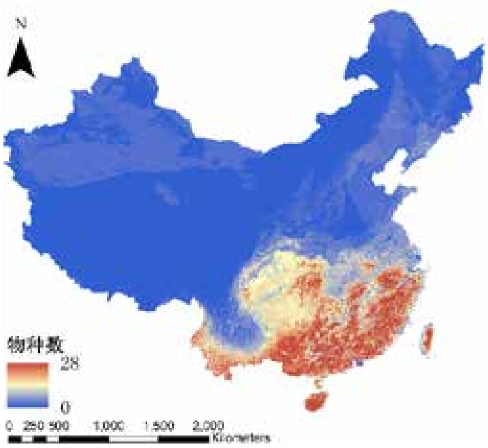


Fig. 3 Distribution of threatened/national protected reptiles

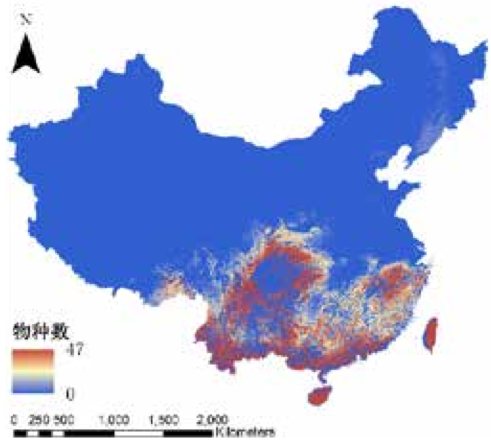


Fig. 4 Distribution of threatened/national protected amphibians

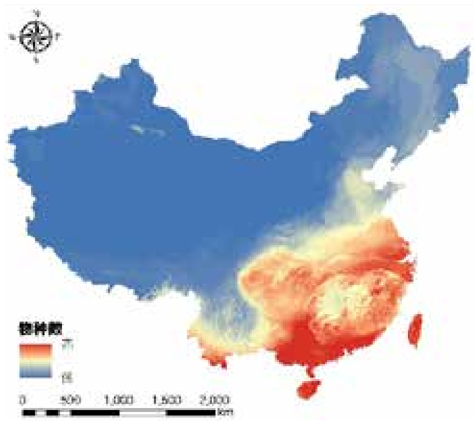


Fig. 5 Distribution of threatened/national protected tracheophytes

Fig. 1 shows that the distribution hotspots of 50 threatened mammalian species in China are mostly areas least disturbed by humans, including areas from the Hengduan Mountains to the neighboring Qinghai-Tibet Plateau and the surrounding areas (such as the Qinba Mountain areas), the Greater and Lesser Khingan Mountains, the Pamirs, the Tianshan Mountains, the Altai Mountains, and some mountain areas in central Yunnan and central, eastern and southern China. Currently areas with no or little human habitation in western China, such as the Qinghai-Tibet Plateau and the Hengduan Mountains, have a high concentration of nature reserves, particularly national nature reserves.

Extensive native habitats can be found only in the greater part of eastern China, including the farthest north of the northeast, the southeast, the west part of the north, northeastern Jiangxi, western Zhejiang, and western Fujian. These habitats also are the only distribution areas for large mammals in the east part of the country. Marine mammals were not covered by this assessment.

Fig. 2 shows that the 179 threatened bird species assessed are highly distributed in the Bohai Rim area, along the middle and lower Yangtze, the Mountains of Southwest China, southern Tibet, and Hainan. Compositionally, a higher distribution of migrating raptors and water birds is in the north, central, and the east, whereas resident forest birds constitute biodiversity hotspots in the south and the southwest. Habitats in this group mostly are the plains along the west coast of the Bohai Sea, the wetlands along the middle and lower Yangtze, the forests in southern Tibet, the Qinling-Daba Mountain areas, the Hengduan-Gaoligong Mountains, the hilly land in the southeast, and the mountain areas in the south of the Five Ranges. This pattern is primarily attributed to the large portion of forest birds of the 179 bird species assessed (almost twice as many as the water birds).

From this distribution diversity layout, one can see that the coverage of national nature reserves is still deficient in southern Tibet, Bohai Rim areas, and areas along the north and east coasts, the last two of which are coincidentally the centers of human habitation and economic development, posing even greater threat to wildlife. It's worth noting that water bird habitat hotspots include the Sanjiang plain wetlands, the Bohai Rim mudflats, the Yellow Sea mudflats, the north plains and the wetlands and lakes along the Grand Canal, wetlands along the middle reaches of the Yellow River (the Weihe vale and the Sanmenxia), wetlands and great lakes along the middle and lower reaches of the Yangtze River (lakes in Hubei, the Dongting lake system, the Poyang lake system, the Taihu lake system, and the Yangtze Delta wetlands) and the Sichuan Basin. Specifically, the Sichuan Basin and areas along the middle and lower Yangtze are considered important for overwintering, the habitats in the north and the east for stopping-over, and the Sanjiang Plain in the northeast for breeding. Altogether, these three groups of habitats embody high ecological value as the Chinese part of the migration route that runs from east Asia to Australasia.

Fig. 3 shows a general distribution pattern for 56 reptilian species as modelled (also the distribution pattern of threatened reptiles on the Redlist of Chinese Biodiversity). Most of the reptilian species threatened in China are located on a stretch of mountain areas at medium and high altitudes to the south of the Qinling-Huaihe. *Lacertilia, Ophidia, Testudines*, and *Crocadylia* (only *Alligator sinensis*) are part of the species composition in the Qinling-Daba-Shennongjia mountain areas, southern Yunnan, the Dabie-Mangshan-Xuefeng mountain areas at medium altitude, hilly land in the southeast from the Wuyi to the Nanling, the alpine gorges of the Yunnan-Guizhou Plateau, and Hainan Island. The greater part of the species composition in the northeast and the northwest is *Ophidia* (*Eryx miliaris, Elaphe taeniura, Coluber spinalis*, etc.). Very few updated data is available of *Testudines* in China. All the freshwater members are being threatened. This situation also reflects the urgency to protect the freshwater ecosystem in the country.

Fig. 4 shows the distribution of 83 amphibian species as modelled under this report. Most of them are distributed across a stretch of land in the south of the Qinling Mountains to the Huaihe River: 1) Areas around the Sichuan Basin, such as forestlands and river valleys along the Qinling, Daba, Minshan, Liangshan, and the Shennongjia; 2) areas in the east, such as forestlands and river valleys in the Wuyi, Huangshan, and the Mangshan along the lower Yangtze; 3) areas in the south, mountain creeks in the south of the Nanling, the Pearl River watershed; and 4) areas in the southwest, such as the middle section of the Gaoligong Mountain, the Red River valley, the Dawei Mountain, river valleys in Xishuangbanna, the Yaoshan Mountain and the Shiwan Dashan region of Guangxi, rivers flowing through Karst

Caves in southern Guizhou. Additionally, Hainan and Taiwan Islands are also key habitats for amphibians. A few species are distributed in the north, including *Hynobius leechii* and *Glandirana emeljanovi*.

Fig. 5 shows the distribution of 86 protected tracheophyte species as modelled under this report. Most of the protected tracheophytes of China are distributed in areas to the south of the Jinsha and Yangtze Rivers, including the Qinling-Daba mountain system, the Shennongjia region, southern Yunnan, the lower Yangtze, southern China, and Hainan. Specifically, southern Yunnan and Hainan are key distribution areas for tropical plants in China, whereas most of the species endemic to China are in the south and the areas along the middle and lower reaches of the Yangtze River.

4.3.Distribution hotspots by group

For the habitat distribution layout of each group of the species assessed, the pixels with the top 5% species richness were identified as a distribution hotpot. The following are Kriging maps thus generated for the groups of the species assessed.

Fig. 6 Distribution hotspots for threatened/ national protected mammals

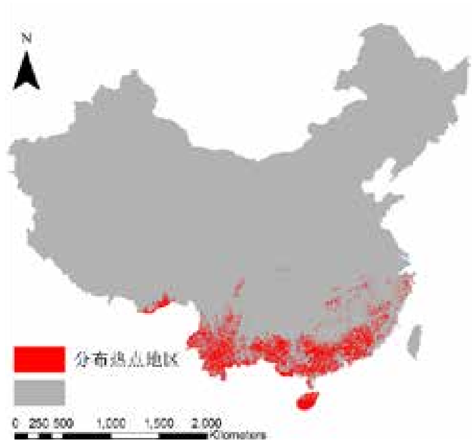


Fig. 7 Distribution hotspots for threatened/ national protected birds

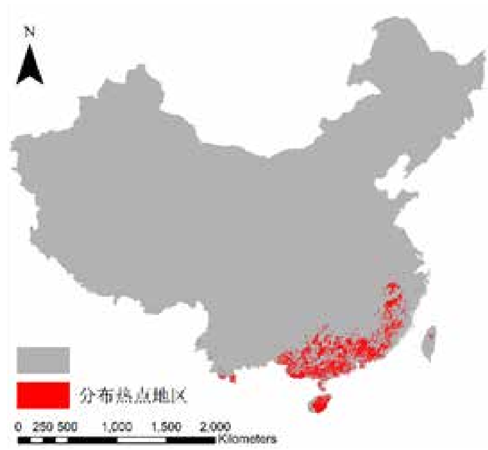


Fig. 8 Distribution hotspots for threatened/ national protected reptiles

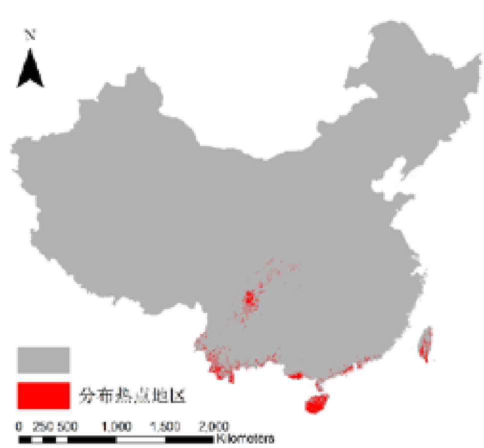


Fig. 9 Distribution hotspots for threatened/ national protected amphibians

Fig. 10 Distribution hotspots for threatened tracheophytes

Fig. 6 shows distribution hotspots modelled for all 50 mammalian species assessed hereunder, most of which are in the Hengduan Mountains and the surrounding areas, southeastern Tibet, central Yunnan, the mountain areas of southern Yunnan, mountain areas in the south of northeastern China, the Wuyi Mountains, and the Nanling.

Fig. 7 shows distribution hotspots modelled for all 179 bird species assessed hereunder, most of which are in the areas to the south of the Yangtze River (southern Tibet, Yunnan and Guizhou, the Nanling, and the Wuyi). For the reason that more forest birds were selected in this assessment than water birds, this map does not reflect coastal hotspots around the Bohai and Yellow Seas, which have recently received great attention from around the world.

Fig. 8 shows distribution hotspots modelled for all the reptilian species assessed hereunder, including areas in the south of Guangdong and Guangxi, eastern Hainan, the Wuyi, the Nanling, Xishuangbanna, and the Karst regions of Guangxi and Guizhou. This map also highlights areas around the Wuyi Mountains, where Cuora, Clemmys gutatta, and Ophidia constitute the major part of the local species composition and therefore hold high conservation value.

Fig. 9 shows distribution hotspots modelled for all the amphibian species assessed hereunder, including the southeast part of the Hengduan Mountains, the Qinba mountain areas, southern Yunnan, southern Guizhou, southern Guangxi, the Pearl River Delta, and the greater part of Hainan Island.

Fig. 10 shows distribution hotspots modelled for all 86 tracheophyte species assessed hereunder, most of which are in the south: 1) the southwest part of Hunan; 2) the south and east parts of Guangxi; 3) eastern Guangdong and southern Fujian; and 4) the Leizhou Peninsula and eastern Hainan. For the reason that the species assessed only constitute a very small portion of threatened tracheophytes, this map does not reflect all the hotspots as it should, particularly not the south and southeast parts of Yunnan and the Daba Mountain.

4.4.A preliminary analysis of conservation prioritization results

We used the Zonation model for spatial conservation prioritization and performed an analysis using CAZ and ABF algorithms. The following are preliminary results within the bird group without considering weights added at different levels of threats.

Fig. 11 shows priorities identified with the Zonation model for threatened birds: 1) In the CAZ algorithm that emphasizes habitat suitability, priority zones for birds in China include the Tianshan-Altai Mountains, the Helan-Alxa region, the Greater Khingan Range, areas between the Changbai Mountains and the Yalu Estuary, the Taihang-Yanshan Mountains in the north part of northern China, the Qinling-Daba-Hengduan Mountains, southern Tibet, areas around Mt. Everest, the Gaoligong Mountain-southwestern Yunnan, the Huangshan-Wuyi Mountains, the Pearl River Delta, southern Hainan and Taiwan;

2) in the ABF algorithm that emphasizes species richness, priority zones for birds in China include the Tianshan-Altai Mountains, northern China, southern Tibet, southwestern Yunnan, the south of the Five Ridges, Hainan, and the middle and lower reaches of the Yangtze River.

Whether or not the Qinling-Daba-Hengduan Mountains, the northeast part of China, and the lower Yangtze were included is the major difference between the results of these two algorithms. This is because the ABF prefers areas with greater species richness (see "species distribution and habitation patterns"). We will refine these results in consideration of other parameters, such as land prices and human population density.

4.5.The coverage of national nature reserves over distribution areas

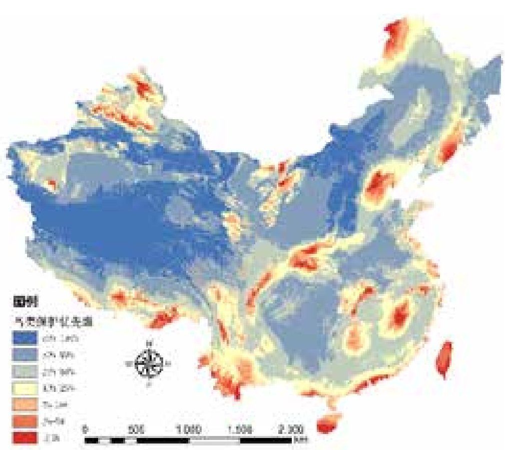
We calculated the coverage rate of national nature reserves over the habitat of each species. For birds, the calculations also included presence/absence binomial distributions on account of their scope of activity and characteristics (the species of Taiwan were not included due to the lack of local nature reserve data). For vascular plants, only binomial distribution areas were included because of the lack of knowledge about their habitat types. The results are summarized as follows (see the appendix for details).

1) Mammals

Coverage over habitats: The average rate is 15.4%; the lowest rate is 4.3% (*Capra ibex*); the highest rate is 81.9% (*Bos mutus*); 12 of the species (*Pseudois nayaur, Uropsilus andersoni, Panthera uncia, Ailuropoda melanoleuca, Ursus arctos, Felis manul, Felis lynx, Cervus albirostris, Procapra picticaudata, Trachypithecus francoisi, Cuon alpinus, Bos mutus*) have coverage exceeding 17% (*Aichi Targets*); and 6 of the species (*Capra ibex, Parascaptor leucura, Selenarctos thibetanus, Felis chaus, Prionailurus bengalensis, Muntiacus reevesi*) have coverage lower than 5%.

2) Birds

Coverage over binomial distribution areas: The average rate is 5.7%; the lowest rate is 2.2% (*Mergus squamatus*); the highest rate is 19.6% (*Grus nigricollis*); 2 of the species (*Grus nigricollis, Gypaetus barbatus*) have coverage exceeding 17% (*Aichi Targets*); and 96 of the



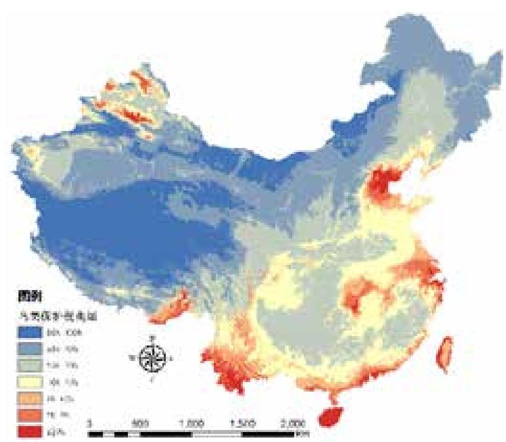


Fig. 11 Priorities for 179 bird species, identified with CAZ (left) and ABF (right)

species have coverage lower than 5%.

Coverage over habitats: The average rate is 6.2%; the lowest rate is 0.7% (*Emberiza sulphurata*); the highest rate is 34.2% (*Falco naumanni*); 9 of the species have coverage exceeding 17%; and 97 of the species have coverage lower than 5%.

3) Reptiles

Coverage over habitats: The average rate is 3.9%; the lowest rate is 0.1% (*Gehyra mutilata*); the highest rate is 41.7% (*Thermophis baileyi*); 1 of the species (*Thermophis baileyi*) have coverage exceeding 17%; and 47 of the species have coverage lower than 5%.

4) Amphibians

Coverage over habitats: The average rate is 5.4%; the lowest rate is 0.2% (*Hynobius yiwuensis*); the highest rate is 20.2% (*Ranodon sibiricus*); 1 of the species (*Ranodon sibiricus*) have coverage exceeding 17%; and 38 of the species have coverage lower than 5%.

5) Tracheophytes

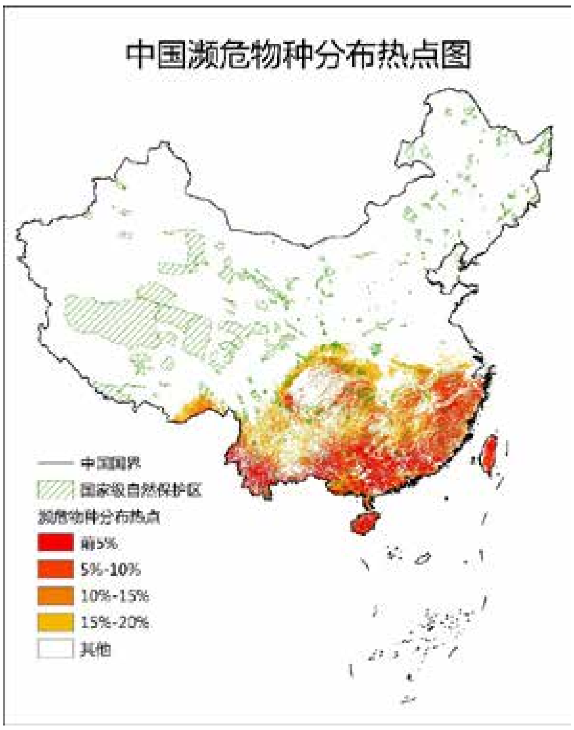
Coverage over binomial distribution areas: The average rate is 3.2%; the lowest rate is 0.03% (*Glycine tomentella*); the highest rate is 14.1% (*Meconopsis punicea*); none of the species have coverage exceeding 17%; and 70 of the species have coverage lower than 5%.

All the species included have an average coverage rate of 4.6% over distribution areas and 5.6% over habitats.

Generally, the coverage of national nature reserves over distribution areas and habitats still remains deficient: 67.1% (in terms of distribution) and 45.1% (in terms of habitation) of the species have a coverage below 5%. *Hynobius yiwuensis* has the lowest coverage rates of 0.1% (over distribution areas) and 0.2% (over habitats). Worse, this species has small distribution areas and highly fragmented habitats in Zhejiang, where human populations are dense.

In some species with extremely small populations, especially some *tracheophyte* species, all known wild individuals are distributed in only a handful of nature reserves. A high coverage rate in this context doesn't necessarily mean that these species are well protected.

For endangered plants, the coverage rate of national nature reserves (as of 2014) over distribution hotspots is 1.9%; for endangered mammals, 16.2%; for endangered amphibians, 6.2%; for endangered reptiles, 3.1%; for endangered birds, 2.1%; and for all these groups, 3.2%.



4.6.Conclusion

This assessment covered 801 species, including terrestrial mammals, birds, reptiles, amphibians. and tracheophytes. While performing a continuous direct overlay of species distribution modelling outputs to generate distribution patterns and hotspots for various groups of the species selected hereunder, we tried to perform spatial conservation prioritization for these groups in a more sophisticated manner using Zonation, particularly in border areas for which no such data had been made available.

However, we are aware that the sources from which data can be updated are very limited for other groups of species apart from birds, a group of species indicative for biodiversity assessment. Both citizen science groups and research institutions need greater support in this area of work.


藏羚羊 / 严学峰摄于西藏双湖

『 Protected Areas Watch 』

With a unique geographical ecology, China also has a very vulnerable condition of biodiversity. Due to factors of habitat destruction, habitat fragmentation, environmental pollution and illegal trade of wildlife, problems of biodiversity declining and ecosystem degradation still remain serious. Within the 34 biodiversity hotspot areas globally, three of them are related to China: the Southwestern Mountainous Area, the Indo-Burma Hotspot Area and the Central Asia Mountainous Area, which are unique and rich in biodiversity, but are also facing severe challenges. Under the situation of the rapid fragmentation and ecological degradation in these areas, it is urgent and imperative to conduct scientific research and effective actions for conservation.

1.Introduction

China has a unique geographic ecology. But its ecosystems are all very fragile. Damaged or fragmented habitation, pollution, and wildlife trafficking are some of the reasons why biodiversity is diminishing and ecosystems are deteriorating at an alarming speed in China. Three of the world's 34 biodiversity hotspots involve the Chinese territory: the Mountains of Southwest China, the Indo-Burma hotspot, and the Mountains of Central Asia. These areas are highly biodiverse and pose great challenges for conservation. Accelerated fragmentation and ecological degradation make it imperative to conduct conservation research and effective environmental practices in these hotspots.

Cervus albirostris, Sanjiangyuan Area/ Infrared camera, ShanShui

Protected areas represent a type of land targeted by conservation and are an essential means to preserve biodiversity and ecosystems. The International Union for Conservation of Nature (IUCN) defines protected areas as "a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values."

The IUCN has established six categories of protected areas according to their management objectives: Strict Nature Reserve, Wilderness Area, National Park, Natural Monument or Feature, Habitat/Species Management Area, Protected Landscape/Seascape, and Protected Area with sustainable use of natural resources.

Protected areas may also be classified into four categories by governance: governance by government, shared governance, private governance (by individual owner; by non-profit organisations; by for-profit organsations), and governance by indigenous peoples and local communities (Dudley, 2015). Though dominant in China's conservation scene, governance by government nevertheless calls for other social inputs from various sources, such as for-profit organizations, individuals, NGOs, communities, and the general public, as it has failed to cover all the biodiversity hotspot areas in the country.

China has developed a wealthy body of studies and discussions on topics such as layouts, coverage over biodiversity hotspots, management effectiveness, and existing problems with regard to protected areas, particularly the terrestrial protected areas system. This section provides an outline of governance by government in China with a focus on describing its marine protected areas, to which less attention has been paid.

Compared to governance by government, the other types of governance are more flexible and helpful for local communities to get involved in conservation actions. Protected areas under such governance will play an increasingly important role in biodiversity conservation in China given the fact that the country has a dense human population, a great overlap between human habitats and biodiverse areas, and a long course of the social system interacting with the ecosystems. So far, a great number of protected areas have been established across China subject to various types of governance, other than that by government, that fits the locals' needs for both conservation and community development. The authors of this section hope that the cases of successful conservation with communities, governments, NGOs, and for-profit organizations presented herein will provide references for making China's protected areas system more effective on a broader scope of application in the country.

Governance type	Governing body
Governance by government	Government
Shared governance	Stakeholders
Private governance	Non-profit/for-profit organizations or individuals
Governance by indigenous peoples and local communities	indigenous peoples, local communities

2.Protected areas under governance by government

In 1956 China began to establish nature reserves as a way to protect forest and wildlife resources. Now China has developed a complex protected area system under governance by government. Apart from nature reserves, this system also includes tourist attractions, world heritage sites, wetland parks, forest parks, geological parks, and aquatic germplasm resources preserves. These protected areas are managed by different competent authorities with slightly different conservation objectives, but nevertheless they all provide support for conservation efforts in China.

As of 2015, China had built 2,740 nature reserves totaling 1,470,000 km^2. Specifically, 1,420,000 km^2 is terrestrial accounting for 14.8% of the national land. Of these nature reserves, 446 are accredited as national-level, totaling 970,000 km^2 and accounting for 10% of the national territory; 2,294 are on the local level, 500,000 km^2. Over 90% of China's terrestrial ecosystems have typical nature reserves established for them; 89% of the national key protected wildlife and most of the important natural monuments are protected within nature reserves. A totality of nature reserves at various levels employ 45,000 full-time managers, 13,000 of whom have technical skills (Chen, 2016) Forestry and environmental protection agencies are responsible for their management.

Tourist and world heritage sites are managed by the Ministry of Housing and Urban-Rural Development (MHURD). As of July 2016, China had 15 world heritage sites (including four natural and cultural sites) covering 3,774,636 ha. (0.39%) of the national territory if buffer zones are not included and 5,224,490 ha. (0.54%) if buffer zones are included. By the end of 2015, China had established 962 popular tourist sites, 225 of which are national level and 737 are provincial level. These popular tourist attractions account for 2.02% of the national territory (MHURD, 2016).

The responsibility for the establishment and management of forest and wetland parks lies with the State Forestry Administration. By the end of 2014, China had established 3,101 forest parks at national, provincial, and county/municipal levels, including forest tourist sites at the national level. The planned coverage of these protected areas totaled 17,787,000 ha. accounting for 1.85% of the national territory. There are 791 forest parks and one forest tourist site at the national level covering 12,261,000 km^2 (Zhao & Chen, 2016). The wetland park refers to a specific area set aside to protect the wetland ecosystem and properly utilize wetland resources and completed with facilities for wetland-related activities such as conservation, restoration, advocacy, education, research, monitoring, and eco-tourism. The State Forestry Administration is responsible for the proper establishment, guidance, supervision and management of national wetland parks. For local wetland parks, the responsibility for guidance and supervision lies with forestry departments above the county level in where such parks are located.

By the end of 2016, China had established 836 national wetland parks, more than 600 wetland preserves, and 49 designated wetlands of international importance. Altogether they cover 4,050,000 ha. of land. Also established is a conservation network of wetlands along the Yangtze River, the Yellow River, and coastal areas, with more than 300 members.

Aquatic germplasm resources preserves are mudflats of certain sizes and necessary lands set aside to protect and utilize aquatic germplasm resources and their habitats in major regions that support various activities of the protected organisms, such as spawning, feeding, overwintering, and migrating. They are the type of protected areas established and managed by the Ministry of Agriculture. By the end of 2014, China had established 464 national aquatic germplasm resources preserves, totaling more than 100,000 km^2.

Authority	Type of terrestrial protected area in China	#	Area (‘000 ha)	% of the national territory
Forestry, environmental protection, marine, etc.	Nature Reserves at all levels	2740		14. 8%
	National Nature Reserves	428		10. 0%
County forestry admins	Community-based protected areas	49109	10,604.8	1. 10%
Forestry	Wetlands of international importance	49	4,050	0. 42%
Forestry	Forest parks at all levels	3101	17,787	1. 85%
	National forest parks	792	12,261	1. 28%
Forestry	Wetland parks at all levels	836		
	National wetland parks	429		0. 24%
MHURD	World Natural and Cultural Heritages	15	5,224.49	0. 54%
MHURD	Popular tourist sites at all levels	962	19,392	2. 02%
	Popular tourist sites at the national level	244	No data	
Agriculture	Aquatic germplasm resources preserves at all levels	No data	No data	
	Aquatic germplasm resources preserves at the national level	464	10,000	1. 04%
Marine	National Special Marine Reserves	24		
Marine	National Marine Parks	42		

In sum, the Chinese protected area system ensures significant spaces for biodiversity conservation while maintaining wildlife habitats and ecosystem services. It lies at the core of conservation in the country (Chen, 2016). The weaknesses of governance by government have been extensively studied and clearly recognized by scholars and politicians.

Most of China's nature reserves are located in alpine areas or arid regions with little human activity. Areas with low elevation, good hydrothermal conditions, high vegetation productivity, and strong human impacts are not sufficiently covered (Zhao et al., 2013). Specifically, West China has a great number of national nature reserves and larger, fewer protected areas than East China, where most provincial and municipal level nature reserves are located (Cao, Peng, & Liu, 2015). Therefore, the management of the protected areas of West China became challenging and costly, whereas protected areas in the east are usually too small to effectively satisfy conservation objectives. Further, most are forest and wetland preserves. There is a small number of conserved areas for grassland and marine resources. Wildlife coverage is deficient (Wang et al., 2008). The established national nature reserves have failed to provide extensive coverage over key wildlife habitats and biodiversity hotspots. This is particularly notable in the east and south parts of China (Jiang, 2005; Chen et al., 2009; Wen et al., 2015).

Management problems such as "delayed establishment, negligence, or lameness" persist. Many protected areas are "as thin as paper." Compared with other countries, China has an overall weak management of nature reserves, particularly those established more recently at low jurisdictional levels (Quan et al., 2009). As per applicable regulations, expenditure on management should be covered by a local government above the county level and, in the case of national nature reserves, should be properly subsidized by the central government. But most nature reserve management facilities are poorly financed; some even don't have full time management staff (Chen, 2016). Some nature reserves lack financial inputs for payrolls, infrastructures, and equipment. It is therefore difficult for them to effectively serve the purpose of conservation (Wang et al., 2008).

Chinese legislations on protected areas are lagged and unmethodical. Protected areas in China are highly diverse and are managed by multiple different authorities, which all have different management objectives. Some protected areas even have multiple identities. This greatly reduces effectiveness.

Human disturbances also pose great threats to conservation outcomes in some protected areas. Causes of such interference include the following: 1) Surrounding communities have traditions and livelihoods that rely on natural resources within the nature reserve (Lu et al., 2011); 2) budget constraints push the management to opt for various development activities that affect conservation outcomes (Wang et al., 2008); and 3) local officials lay more stress on economic growth than conservation and sometimes give in to development activities such as mining, tourism, and road construction that often extend to the protected area (Ma, 2016).

Generally, the co-management of protected areas in China is inadequate; conservation efforts are not well connected to local communities; capacities for research, nature education, and other facets of conservation need to be enhanced (Quan et al., 2009; Liu et al., 2011). In addition, the establishment of protected areas is subject to bottom-up application procedures which can easily lead to an inconsistent layout in the course of planning and design (Wang, 2008).

According to the Strategic Plan for Biodiversity 2011-2020 and the Aichi Targets, a decision adopted by the Conference of the Parties to the Convention on Biological Diversity (CBD) at its tenth meeting, "Target 11: By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascapes." Now in China, protected areas under governance by government have surpassed the Aichi Target for coverage over the national territory. But, as discussed earlier, the way they are distributed is still unable to precisely cover important wildlife habitats and biodiversity hotspots. Management effectiveness also needs to be increased.

To address these issues, efforts have been made to facilitate a transition to the national parks system in China. In January 2015, the National Development and Reform Commission (NDRC) and 13 other associated agencies jointly endorsed a Pilot Program for the Establishment of National Parks, which explicitly declares that one way to address "spatial overlaps, stark conflict between conservation and development, and low efficiency as a result of mingled management objectives across authorities" is to create a unified, organized, effective management system and an extendible conservation governance mechanism through efforts to "focus on conservation, unify management, delineate ownerships of resources, innovate new operations, and promote community development." This program is being carried out across the country. Various proponents of its top-level design – the nature, objectives, and the management mechanism of national parks – have yet to be clarified and, therefore, are being extensively discussed. Different provinces also seek different ways to establish this system. What exactly can be achieved with this new measure is subject to further investigation.

2.1.Special focus: The marine protected area system

China governs approximately 3,000,000 km^2 of sea areas and 18,000 kilometers of continental shorelines. More than 6,900 of its islands have an area exceeding 500 km^2. The species, ecotypes, and community structures of marine life in China appear to be highly diverse. The reinforcement of marine conservation is an important measure to preserve biodiversity and prevent ecological degradation in the sea. Unfortunately, by the time China began to build its marine reserves,

Nature Watch Festival, Ang Sai Canyon/ Zhang Chenghao

Qilincai Nature Reserve，Hainan/ Shi Xiangying

it was quite late and was in the middle of an industrial boom, giving rise to stark potential conflict between the tapping of natural resources and biodiversity conservation. In the context of global marine conservation, it is imperative to review and outline issues China needs to address, such as the national policy framework for marine conservation, the planning, establishment, and management of marine reserves, and current biodiversity conservation status.

So far China has established 33 national marine reserves (Hong Kong, Macao, and Taiwan not included) and 66 national special marine reserves (national marine parks included). In addition to over 200 marine reserves at provincial and municipal levels, the conserved marine area totals 140,977.58 km^2, accounting for about 4.6% of the sea area governed by the country.

To further understand China's current marine conservation status and prevalent problems, we selected three typical national marine reserves for interviews and investigations: 1) Binzhou Shell Dike Island and Wetland National Nature Reserve, established to protect marine and coastal ecosystems; 2) Huidong Sea Turtle National Nature Reserve, established to protect marine life; and 3) Shandong's Dongying National Special Marine Reserve for Yellow River Estuary Ecology. For these subjects, we collected information about their basic parameters (location, authority, staff, etc.), conservation target changes, scientific conservation efforts (patrol, monitoring, etc.), financial and policy support, and their impacts on surrounding communities and areas. We also carried out in-depth interviews about existing problems and typical events that have happened since their establishment. Our findings for the most part reflected the major problems with China's marine reserves as discussed earlier.

3.The other types of governance

Given China's huge population size, “wilderness” in its truest sense, namely a space with very little human activity, is a rare sight even in the west. Maintaining a balanced relationship between man and nature has been fundamental and challenging in biodiversity conservation, a mission which seems particularly noteworthy in China. Therefore, it is impossible to effectively preserve more key areas just by expanding the scope of governance by government (Jiang, 2005). This is particularly true for eastern and southern China, where dense human habitats greatly overlap with wildlife hotspots. But it does not mean that conservation and human activity cannot co-exist at all in these areas. A patch of headwater forest between farms, a few ponds near this village, a plot of under-story grassland for summer grazing behind that village...these small parcels of land very close to human habitation can become important habitats for a considerable number of species, even endangered species, while offering good resources and living spaces for wildlife. These areas are where the other types of governance can be practiced than by government. They can be effectively protected through flexible, varied, site-specific means. Further, these areas may also hold legacies of human-nature interaction, local traditional cultures, and local knowledge about the sustainable use of natural resources, which the local community needs to stay alive and thrive. The establishment of such protected areas may also help maintain and shape a positive relationship between the human community and nature.

In the course of conservation, the other types of governance may be provided with multifaceted management objectives, including maintaining important wildlife habitats, preserving important ecosystem services, and ensuring the community's sustainable use of natural resources. Communities, local governments, private organizations, for-profit corporations, and individuals may take part in actual conservation efforts in various ways. This management mechanism may look entirely different when applied to a different area. In this section, we tried to show this variability by presenting several success stories in detail. Before that, we first provided simple definitions for some concepts discussed herein.

3.1.Community–based protected areas

The community--based protected area, an officially recognized type of protected area in China, usually refers to a small natural area an administrative agency set aside for conservation, or a protected area outside the main part of a nature reserve, usually without core, buffer, and outer buffer zones (Cui & Wang, 2000). Community-based protected areas are usually drawn up for specific species or landscapes. The first community-based protected area was established in Wuyuan, Jiangxi. It was in 1992 when Yutan Village Protected Area came into existence as three Chinese scientists, Li Qingkui, Hou Guangjiong, and Zhu Zuxiang, suggested, thinking that a mini form of nature reserves should be established in densely populated, commercially buoyant, and ecologically deteriorating areas with easy access to transportation. For this establishment, the Yutan Village Committee applied with the government of Wuyuan County, Jiangxi and, after approval, became the body of management. The land involved would still remain collectively owned. Community-based protected areas are small and flexible. They are mostly self-financed and government-subsidized. Because it fitted local needs for conservation, this measure was soon scaled up in Wuyuan County. In 1995, the former Ministry of Forestry recognized it as a "Wuyuan paradigm" and initiated extension all across China. (Li, 2014)

By the end of 2004, a total of 49,109 community-based protected areas had been established in China covering 10,604,800 ha. (1.1%) of the national territory. Most of them are in Anhui, Zhejiang, Jiangxi, Fujian, Hubei, Hunan, Guangdong, Hainan, and Guizhou. Guangdong has the greatest number: 38,800 (Li, 2014).

3.2.Sacred natural sites

As defined by the IUCN, sacred natural sites are "areas of land or water having special spiritual significance to peoples and communities." Sacred natural sites are gaining more attention because they harbor important biodiversity features around the world, serving as a link between culture and nature (IUCN, 2008). These areas scatter widely across China and have different names in various places or among different peoples. For example, they are known as "holy mountains and sacred lakes" among Tibetans, "mizhi woods" among the Yi, "nong" among the Dai, and "feng shui woods" among the Han. They also carry a faith many ethnic peoples have developed in reverence of nature (Zhou, 2002; Ai, 2003). Sacred natural sites have cultural significance, hence giving rise to various kinds of natural taboos. For instance, one is not permitted to hunt animals, excavate the earth, or pick herbal plants in a holy mountain. Nor can one yell or litter around a sacred lake. Logging and hunting are prohibited in nong and feng shui woods.

These taboos are the reasons why sacred natural sites are less disturbed by humans and thus have become important habitats for wildlife. They provide good habitation particularly in areas that have a lot of human activity. Studies found a higher forest coverage in Tibetan holy mountains than in surrounding areas (Li et al., 2015). Compared to surrounding forest areas, sacred woodlands have a botanical composition closer to that of virgin forest (Hu et al., 2011). That includes older tree age, higher cover, greater diameters at breast height (DBH), and more endemic species (Anderson et al., 2005). Such sacred natural sites provide good habitats for birds and mammals. Bird and mammalian species in these areas are remarkably more diverse than in surrounding areas (Bhagwat et al., 2005, Shen et al., 2012).

Sacred Mountain and Lake，Nianbaoyuze, Qinghai

On the other hand, not all human activities are off-limits in most of the sacred natural sites. Logging, for instance, is prohibited in a sacred forest, but one is allowed to pick fungi and dead tree branches under the scrutiny of their entire community. In areas around sacred natural sites, local cultures usually have been developed in such a way that nurtures various aspects of environment mindfulness: natural resources should be used moderately; one should cherish Mother Nature; humans and all other living things are equal. Worships to sacred natural sites also constitute a solid, less-likely-to-change component of tradition. For many local communities, rituals and festivals developed on its basis remain to this day an integral part of their own cultures.

3.3.Private governance and governance by indigenous peoples and local communities

Governance by indigenous peoples and local communities includes aboriginal areas and territories established and managed by indigenous peoples and protected areas established and managed by local communities. It is characterized as having the following properties: 1) indigenous peoples and local communities care very much about ecosystems, often because these ecosystems are associated with their sacred spiritual values, traditional customs, or livelihoods; 2) these indigenous peoples and local communities hold primary rights to decision-making and governance, have institutions, and can execute official or non-official regulations concerned; and 3) decisions and efforts made by an indigenous people or local community can contribute to the conservation of natural and cultural values. Private governance usually refers to protected areas controlled and managed by individuals, cooperatives, NGOs, or for-profit corporations. But the fact that all land in China is either state-owned or collectively owned is a precondition of management through land lease or trust, usually with close collaboration with the local community. Land trust governance, or private governance, refers to the type of protected area for which the applicant, be it an individual, NGO, or corporation is required to submit the application to the competent government authority for approval.

3.4.Success stories

The following stories represent the concepts we discussed earlier. Those notions may seem lifeless and inanimate, but they actually reflect the roles and relationships of communities, governments, NGOs, for-profit organizations, and individuals involved in establishing and managing protected areas under the other types of governance than by government. They also tell us how to balance and coordinate different objectives, such as the conservation of species and ecosystem services, the continuity of traditional culture, community development, and corporate/personal profit-making. Whether it is called a "sacred natural site" or "community-based protected area" or is defined within the scope of "governance by indigenous peoples and local communities," we have the same ultimate goal: To better preserve biodiversity.

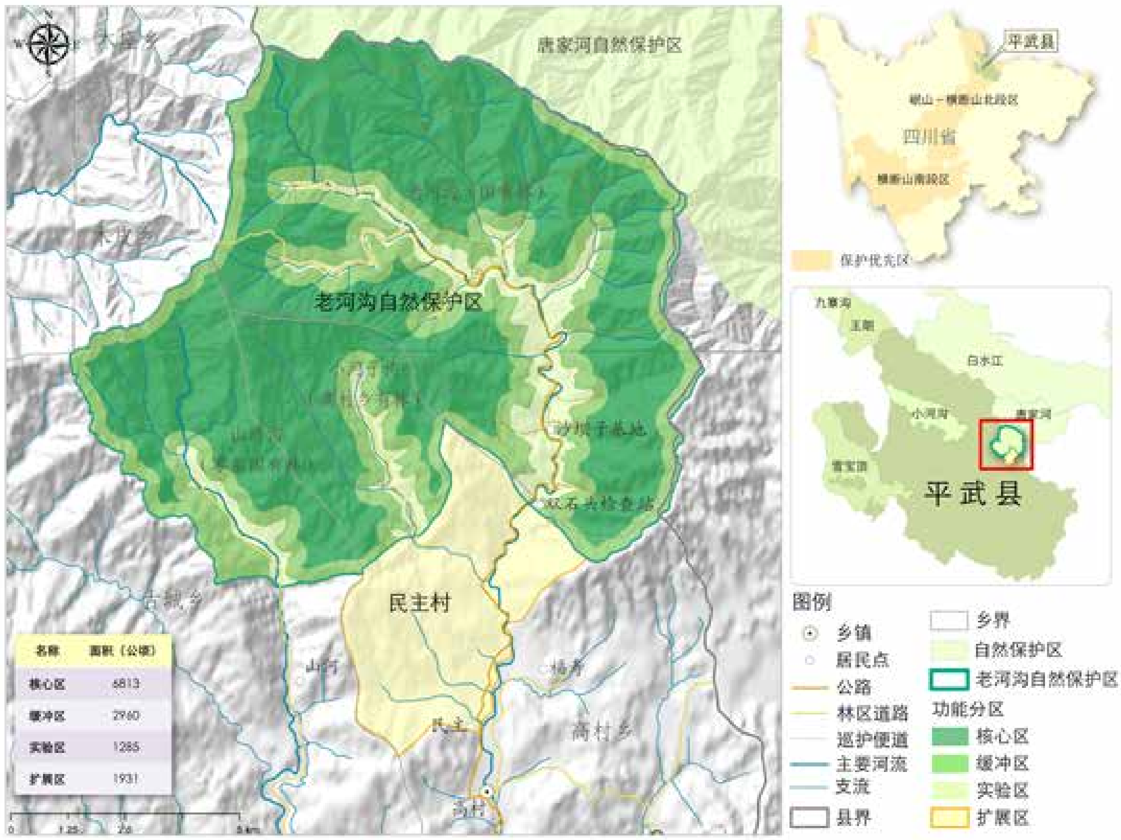
3.4.1.Laohegou: China's First Land Trust Protected Area

Author: Jin Tong/TNC

Background

Early in 2010, just as China was pushing through its collective forest tenure reform, the Nature Conservancy (TNC) seized a social financing opportunity in the country and proposed the establishment of protected areas under the American land trust mechanism. After one year of policy research and in situ investigations, the first land trust protected area was founded in Laohegou of Pingwu County, Sichuan, in 2011.

Pingwu County is located in the priority biodiversity zone in the north section of the Minshan-Hengduan Mountains, 42% of the county area being inhabited by one sixth of China's giant panda populations, hence the nickname "the World's First County for Giant Pandas." But the local nature reserve only covers 30% of giant panda habitats in Pingwu. The greater part of the giant panda population and habitat scatters in state-owned forests and woodlands collectively owned by towns, villages, and communes, lacking effective governance. Based on scientifically designed gap analyses and in situ surveys,



老河沟保护区地图

Laohegou was finally selected under the land trust program considering its conservation value, forest tenure, and other social/economic parameters.

The 110 km^2 Laohegou Land Trust Protected Area is located in the east of Pingwu County, adjoining Tangjiahe National Nature Reserve and Gansu's Baishuijiang National Nature Reserve. It consists of the former Laohegou State-owned Forest Farm, the Shanhegou State-owned Sporadic Woods, and the collectively owned forestland of Gaocun Township, including a key migrating route for the North Minshan giant panda population. It is home to other rare species as well, such as golden snub-nosed monkeys, takin, Chinese yews, and dove trees.

Management mechanisms

In September 2011, during site selection, TNC joined with 22 well-known corporations and individuals to file with the Development of Civil Affairs of Sichuan for the establishment of Sichuan West Conservation Foundation (now called the Paradise International Foundation, PIF for short). The Sichuan Forestry Administration acts as the competent authority for its operation. As China's first non-governmental, non-public foundation committed to biodiversity conservation, the PIF seeks private financial inputs and channel them into efforts to establish protected areas and explore new systems and mechanisms for environmental causes it supports. As its consultant, TNC provides assistance at multiple levels, including management and technical support.

In January 2012, the PIF officially signed a cooperation agreement with the Pingwu government to pilot the land trust program, under which the PIF would be responsible for financing and the latter for policy guidance. In November 2012, the Pingwu government transferred the

50-year exclusive management rights of the Laohegou State-owned Forest Farm and the Shanhegou State-owned Sporadic Woods to the PIF under an entrustment agreement. In addition, the PIF obtained a 46-year management right to Gaocun's collectively owned forest by paid forestland circulation procedures. The entrustment agreement and the forestland circulation contract both specified that the PIF must not change the use of the lands, alter their public interest attributes, or reassign them to non-forest developments.

In its September 2013 written approval, the Pingwu county announced the plan to establish "Laohegou County-level Protected Area" in an area of 110 km^2 managed by the PIF, with the Pingwu Forestry Administration serving as its competent authority and the PIF being held accountable for its management and financial input. In January 2014, TNC assisted the PIF in filing with the Pingwu Civil Affairs Bureau to set up Pingwu County Laohegou Conservation Center (LCC) as a private non-profit entity responsible for routine conservation and management in this protected area. The LCC is designed with a headcount of 35 staffers, and their employment is the PIF's responsibility.

Conservation actions

Early in the preparation stage, TNC began to identify conservation targets and major threats and design proper objectives and actions using the internationally proved Conservation Action Planning method. Through broad participatory discussions, literature reviews, and expert consultations, seven species and ecosystems were chosen as key conservation targets: 1) the giant panda and its habitat; 2) mountains and creeks; 3) takin and dwarf musk deer representing forest ungulates; 4) the Asian golden cat representing mid-to-large sized carnivores; 5) low-altitude evergreen and broad-leaved deciduous forests; 6) alpine shrubs and meadows; and 7) the golden snub-nosed monkey. Human activities like poaching, trapping, and fishing by electricity/poison were identified as the biggest threats. Their primary causes could be attributed to the lack of proper measures for legal protection and conservation management in Laohegou and to the neighboring communities' needs for economic growth and unsustainable use of natural resources. It was also found during the planning that a lack of biodiversity baseline data greatly hindered the conservation objectives and actions identification process. Based on these findings, major conservation actions were initially identified as follows:

- Set up a conservation management team and conduct resources management;
- Conduct baseline surveys and establish an ecological monitoring system;
- Get the community involved in conservation and support eco-friendly industries.

1)Set up a conservation management team and conduct resources management

For its 35 job vacancies, the Laohegou Conservation Center hired 22 former forestry farm workers and made them a local conservation team. Four departments were set up in charge of resources conservation, research and monitoring, community development, and general administration. Accountability, job design, and the performance assessment system in each department were closely examined and established. A micro-management scheme was highlighted. Various procedures for finances, personnel affairs, logistics, performances, and fixed assets were enhanced. A protected area regulations manual and work guidelines for each department were prepared and continually adjusted/optimized in the course of implementation.

To address the worst human disturbances, such as illegal entry, poaching, and electrofishing, the first step was to set up surveillance posts and security check points at the entrances for stringent inspection and registration. A 40 km long patrol trail was built covering almost the entire area, along with a three-level patrol system (general, highlighted, and special). These measures put an end to most of the illegal human activities that had happened within the area.

2)Conduct baseline surveys and establish an ecological monitoring system

International and domestic research institutions, including Peking University (PKU) and the Chinese Academy of Sciences (CAS), were engaged in conducting biodiversity baseline surveys in Laohegou for three years from 2011 to 2014, covering plants, insects, fish, amphibians, reptiles, birds, and mammals. These surveys found 975 species of tracheophytes, 220 species of butterflies, 5 species of fish, 15 species of amphibians, 18 species of reptiles, 188 species of birds, and 24 species of mammals in Laohegou. Specifically, seven animal species and one plant species are first-class national protected, and more than 20 species are second-class protected. Additionally, two plant species and six insect species were newly discovered and named during the process. Each of the species thus documented was carefully observed in the field as evidenced by the site of discovery, photography, or a specimen. The baseline surveys provided a basis on which an ecological monitoring system was established within the nature reserve comprising specific routine procedures and indicators in seven modules: meteorology, phenology, vegetation, aquatics and fish, amphibians and reptiles, birds, and middle to large sized mammals. As needed in 2005, Laohegou adjusted its focuses to the global application of camera traps, the monitoring of the mountains and creeks ecosystem, and the tracking of wild golden snub-nosed monkey populations. These monitoring efforts provided quantitative references for future conservation effectiveness assessment.

3)Get the community involved in conservation and support eco-friendly industries

To relieve conflict between conservation and the economic development of surrounding communities, Laohegou's master plan initially incorporated a radius of 19 km^2 around Minzhu Village, a community outside the nature reserve, as an "extension zone." It was an integrated measure for experimenting new sustainability mechanisms with a new identity: an eco-friendly village innovating on private governance. After going through the early stages of preliminary work, Laohegou moved on toward a clearer goal: To build alliance between the nature reserve and the local community in favor of conservation. A village council was founded to provide a stable, effective form of autonomy whereby villager councilors can sit down with nature reserve staff members and make decisions together. The local community had support in developing eco-friendly products such as free-range chicken, preserved meat, and soy beans. Sales-on-demand access to high-end consumers was provided to generate more income. The Village Activity Center was renovated and an education fund was established as part of the efforts designed to improve public services in the community.

Financial sustainability

Compared to government-funded nature reserves, financial stability remains a major challenge for private protected areas. The basic operation of Laohegou cost about three million yuan on an annual basis. Early each year the LCC would prepare an annual work plan and submit it to the PIF for approval and disbursement. In the meantime, Laohegou also kept exploring possibilities for self-sufficiency. At the end of 2015, the PIF founded Pingwu Paradise Apiculture Co., Ltd and declared in its bylaws that no profits can be used as dividends or reinvestment and that all the remaining profits after defraying the company's operating cost must be returned to the PIF as grants for conservation. This company specializes in making honey wine from good honey and water produced in Laohegou and selling it to high-end markets. The very first year was lucrative enough to cover the operating cost of Laohegou, making financial independence possible.

Conservation outcomes

Laohegou Protected Area shows what land trusts can do: By involving private funds and NGOs, the state and collective ownerships of 110 km^2 forestlands were transformed into a parcel of county-level conserved land with clear boundaries, well-defined land management rights, and a legally assured conservation status. Before all this happened, the only funding source made available for this area was 500,000 yuan of the "Natural Forest Conservation Budget (NFCB)"; each worker was paid as little as 960 yuan a month and his job was only to walk around guarding against fire and stealth as required by the NFCB. Then the PIF launched its land trust program. In three years more than 20 million yuan was pumped into efforts such as infrastructure construction and maintenance, baseline surveying and monitoring, general planning, and IT. After it was established, the protected area would receive about three million yuan a year for maintenance, including salaries, routine operations, and various conservation management activities. This level of input is even comparable to that in neighboring national nature reserves. In the course of implementation, the LCC engaged 22 former forest farm workers in its local operation and management team, defined their jobs and duties, provided training in various skills, and built an effective performance control system. Now a team of more than 30 people is stationed year-round in Laohegou, carrying out non-stop management, regular patrol, wildlife investigation and management, and all other required tasks. Salary has doubled.

Under such management, human disturbances like poaching, fishing by electricity/poison, and understory harvesting almost disappeared. Camera traps caught giant pandas multiple times and proved the existence of Sichuan's largest wild Asian golden cat population on a mountain ridge between Laohegou and Tangjiahe. According to the 4th National Giant Panda Population Census, there are 13 wild giant pandas living within the boundaries of Laohegou Protected Area. Continuing aquatic species monitoring shows that Schizothorax intermedius intermedius populations in the creeks of Laohegou keep recovering. Ungulates such as dwarf musk deer, tufted deer, and takin also show up more often at the roadside or near staff dormitories.

Communities around the protected area have benefited from the land trust program as well. The first year had 7 households engaged in customized agriculture; the second year, 49; and the third year, 76. The sales of community customized produce rose from 90,000 yuan to over 800,000 yuan, indicating an remarkable increase of rural household income within the local community. By the end of 2015, the education fund established in Laohegou had benefited more than 20 juveniles and their families.

The land trust practice in Laohegou has attracted wide attention. High-ranking officials from the State Forestry Administration, the Sichuan Forestry Administration, and other provincial-level forestry agencies and nature reserves paid multiple visits to Laohegou. They all gave a big thumbs-up to what has been done. Time with Laohegou has proved that the new land trust mechanism can be successfully applied and will become an essential part of the protected areas system in China.

3.4.2.Qunan Community-based Protected Area for White-headed Langurs in Fusui County, Chongzuo City, Guangxi

Author: Zhang Yingyi/BRC

Qunan is located southeast of the Jiuchong Mountains in the Bapen area of Chongzuo White-headed Langur National Nature Reserve, covering 412.5 ha. of land as part of Kunlun Village of Shanwei Town, Fusui County. In this area live 15 troops of white-headed langurs (Trachypithecus poliocephalus) according to the latest January 2017 survey. Apart from this national first-class protected species endemic to Guangxi, Qunan abounds with other forms of wildlife. Its forest ecosystem in Karst rock mountains is also well-preserved.

Qunan is a Zhuang village with a population of 450 (110 households). The major sources of income are sugar canes, watermelons, corn, and peanuts. Over the past few years they have been trying to grow citrus fruits as the sugar cane market remains sluggish. Few villagers would leave home for work because the cultivatable land supply is sufficient per capita. Most of the young adults have chosen to farm for a living in the village. Qunan also harbors a profusion of traditional Zhuang customs, including three small and lubricant patches of feng shui woods that have been passed down generations. Even one with the shortest history, a planted forest, can be traced back to the pre-liberation times. The villagers believe that these old trees are the treasure of their village and, therefore, cannot be tampered with, or bad luck will befall. Such karma stories circulate around the village even to this day. Qunan also keeps many traditional festivals alive. For every Spring Festival or the Third of the Third Lunar Month, for instance, the villagers would worship at the Dragon Temple and the Earth God Temple praying for a good and safe year to come. With the eleventh lunar month comes the Harvest Festival,

A drone's view of Qunan after a shower

where families and friends get together for a nice feast.

Qunan has been a major concern for its closest neighbor, Chongzuo White-headed Langur National Nature Reserve (hereinafter called "the Nature Reserve"). Support from the latter includes building garbage pits and hiring forest rangers. From July to August 2014, the Nature Reserve's administration and the Bapen Management Station under it joined with the BRC on multiple visits to Qunan to examine its social, cultural, economic, and ecological factors. After discussions with the village committee, forest rangers, and village congress members, we suggested Qunan apply with the Fusui County Forestry Administration to establish a community-based area in accordance with the Guangxi Regulations on the Establishment of Community-based Protected Areas for Forest and Wildlife. The Nature Reserve also initiated close contact with the Fusui County Forestry Administration. The latter offered great support for this call to action. From September to November, the core leadership of the Qunan Village Committee sought ideas and suggestions from more than a dozen members of the Party-Masses Council before going on to carry out a door-to-door interview with the villagers and see what they had to say. More than one hundred village congress members attended a planetary meeting on November 9 to decide if they'd like to turn their village into a community-based protected area. Everyone voted for it. On December 3, the Fusui County Forestry Administration released Fulin Zi (2014) No. 27 document announcing the establishment of four community-based protected areas: Qunan White-headed Langur Protected Area, Zhonghua Black-headed Langur Protected Area, Longdeng Black-headed Langur Protected Area, and Sairen Black-headed Protected Area. The boundaries of each protected area were also delineated. As its name suggests, Qunan Protected Area targets white-headed langurs and the Karst ecosystem. The members of its management include the head of the village, two deputy directors of the villagers' group, and the secretary of the Kunlun Village Committee. Qunan held a launch ceremony and an evening live show on December 26, officially announcing the establishment of its community-based protected area. The invitation list for this event included not only the Qunan residents but also officials from the Kunlun Village Committee, the BRC, the Nature Reserve, the county forestry administration, the town government, and all other agencies endorsing the proposal. The management set up billboards at two main road intersections and made the evening show an annual event where environmental concepts can be presented with fun.

In April 2015, the management laid down four village rules regarding human activities and other problems that disturb white-headed langurs and their habitat in the protected area: 1) No unauthorized entrance into the protected area is allowed; 2) Hunting, shooting birds, or stealing natural resources is strictly forbidden; 3) do not arbitrarily make fire at the foot of the mountains; 4) if you find any of these activities, report it to the patrol team. The management is responsible for preparing annual management plans to identify actions to be taken each year. Considering that young people are more eager to play roles in public affairs and that Quyuan has a young population, the management also organized a volunteer patrol team of 17 young man. The head of this team directly reports to the management. Further, the village committee boosted the morale of the patrol team members by holding them accountable for public security of the entire village as needed.

Qunan's young volunteer patrol team ©Liu Siyang

All members of the patrol team are volunteering on group patrols. They have taken 18 group patrols since 2016 and stopped 13 infractions. Currently there are 12 people on the team as adjusted to the actual patrol needs. In January 2017, the patrol team reviewed their work of the previous year and prepared a work plan for the next year. They also discusse with the management as to what kind of support they can get, including finances, logistics, and skills training. All these have increased the team's sense of responsibility, professional pride, and confidence.

Since the protected area was founded, the entire village has been engaged in its operation and management. Cases of someone from outside the village entering the protected area unauthorized or violations against the village rules, once found, would be promptly reported to patrol team members.

The Nature Reserve, the county and town governments, and external organizations like the BRC all have extended great support for the establishment of the protected area and the sustainable development of Qunan. In June 2015, for instance, the Nature Reserve helped Qunan obtain some poverty-alleviating funds from the county government, clean its ponds, pipe sewage away from them, and build green walkways along the banks. Pond dredging and other environmental renovations have greatly improved the village's landscapes. White-headed langurs often come down to these ponds for water. So cleaning it also helps preserve the species. In December 2016, a live show stage was built in Qunan, financed by the town government and the forestry administration. The government will also help Qunan carry out anti-drought well drilling and drinking water projects for better water supplies.

The BRC set out to help Qunan with its nature education facilities. Early in January 2015, only a month after the protected area proposal was passed, Qunan welcomed its first winter camp. Sixteen families from megacities like Beijing and Shanghai gathered here for an amazing journey to discover white-headed langurs. Every summer and winter thereafter, the BRC will guide children and their families from metropolises to experience nature in Qunan so that they can know more about white-headed langurs and relationships between

A panoramic view of today's Qunan: two ponds have been revived with government support; a new Wind-Rain Bridge was built to offer a cool getaway for villagers. © Zhao Xingfeng conservation and development. By the end of 2016, Qunan had hosted seven “Journeys with White-headed Langurs in Qunan, Guangxi” for nearly 200 people (more than 50 families) from all over China. This kind of activity generated more than 120,000 yuan, most of which went to local households offering boarding services. A small portion of the income was retained for the routine management of public affairs in the village.

Core management members are discussing how to assign visitors to boarding households. © Feng Ruzhen

These nature education activities have remarkably boosted the villagers' passion about the conservation of white-headed langurs as well as the self-governance capacity of the village as a whole. A lot has been done to facilitate the process. More than a dozen households, for example, offered to renovate spare rooms at their own costs in order to provide boarding spaces for visitors. For self-regulation, a full set of rules was internally passed covering a range of requirements for nature education, including reception standards, costs, and shifts of boarding providers. Security fell upon the shoulders of the patrol team members. Some women folks put together a dancing group, made their contributions to the nature education events, and ran cooking contests and other games of the sort. Young folks built a Green Grass Society to get themselves involved in each nature education session. They also work on book donations and, when off on school breaks, carry out environmental activities in the village, such as cleaning public areas. By the end of 2016, Qunan had acquired basic nature education apparatus. A number of organizations, including Operation Earth, Wanxiang Nature Education, and Xiaolu Studio, have conducted field studies and nature education activities in Qunan.

Other organizations, including the Nature Reserve, the county forestry administration, and the BRC, have always supported Qunan to improve its management and patrol skills since the protected area was established. With their assistance, Qunan's management group grabbed a variety of training and field study opportunities in 2015, including the July trip to see eco-agriculture and community autonomy in Nandan, the October visit to Longzhou to learn how its eco-agricultural mechanisms and specialized farm cooperatives operated, and the November community leadership training.

Further in June 2016, Qunan sent a delegation to Taiwan to study community building and specific approaches to practice eco-tourism in national parks. With hands-on experience of more than two years, the management of Qunan has become more proficient. Liaison, patrol management, financial control, nature education and all other different duties have been more clearly and properly defined.

The management also runs specific training schemes for the patrol team. Topics for the first training session in January 2016 included patrol duties, the connection between patrol and conservation, and the relationship between conservation and community development. Three months later in March, the management had a meeting with the patrol team to set up their code of conduct and work plan. On April 27, 2016, the management issued patrol licenses. They also carried out patrol equipment training (monoculars and binoculars, cameras) and an intensive patrol. In June, the patrol team was taught to identify the avifauna of Qunan. At the end of the year, they had uniforms for the first time and learned about the basic ecology of white-headed langurs and population survey techniques to ensure future success in conducting regular white-headed langur population monitoring.

Apart from these supports, multiple baseline surveys have been conducted in Qunan and have greatly facilitated the establishment process, routine management, and nature education. Specifically, the first baseline survey of Qunan's social, economic, cultural, and ecological facts was jointly conducted by the BRC and Qunan on November 14-18, 2014. Basic information thus collected included location, ecological status, ethnicity, population and culture, economic development, infrastructure, and community service system and its problems. We also took a quick look at local bird and insect species and produced a simple baseline survey report. On December 1, we carried out another survey (KAP survey) to find out how much Qunan villagers know about the conservation of white-headed langurs, how they feel about it, and what they do for it. A KAP report was thus produced. On the 9th, we collected personal accounts of Qunan from 1940 to 2009 and stories about the Earth God Temple and the Shennong Temple by interviewing community leaders from four families in the village: Zhang, Teng, Wu, and Lin. Thereafter, various activities were conducted to find more about Qunan, including its wildlife and social, economic, and cultural factors.

In April 2016, a co-management committee was set up to strengthen Qunan's liaison with external organizations, particularly the BRC and the Nature Reserve, and create more channels to outside resources. This committee includes not only village committee members but also representatives from the women's dancing group, the children's Green Grass Society, and the patrol team. They hold quarterly meetings to discuss matters about cooperation and communications with the outside world, including field studies and applications for carrying out nature education activities in Qunan.

Pan Qing, the BRC's PM for Conservation, helps the community hold a co-management meeting. © Liu Siyang

As is clearly seen, the establishment process and later developments of Qunan White-headed Langur Community-based Protected Area have led to improvements in economy, childhood education, public culture, and connections to outside support as Qunan pressed home its geological and cultural advantages. These measures also benefited various group of interest within the community. Unsurprisingly, everyone became eager to help conserve and stand guard for white-headed langurs on a daily basis. Qunan was also able to continually improve its management thanks to great support organizations from outside the village, particularly the Nature Reserve and the BRC, extended in terms of institution/capacity building and financing. Today, some households are leading the way to eco-agriculture. They have started trying to grow eco-friendly fruits and reach out for marketing channels, such as the Protected Area Friendly Products System and the Nanning Organic Farming. Qunan will go further down the path toward green development if it can have a successful transition to eco-agriculture. Its community-based conservation mechanism will also be enhanced and will last longer.

3.4.3.Sichuan-Guanba Watershed Community-based Protected Area: Conservation Based on Green Marketing

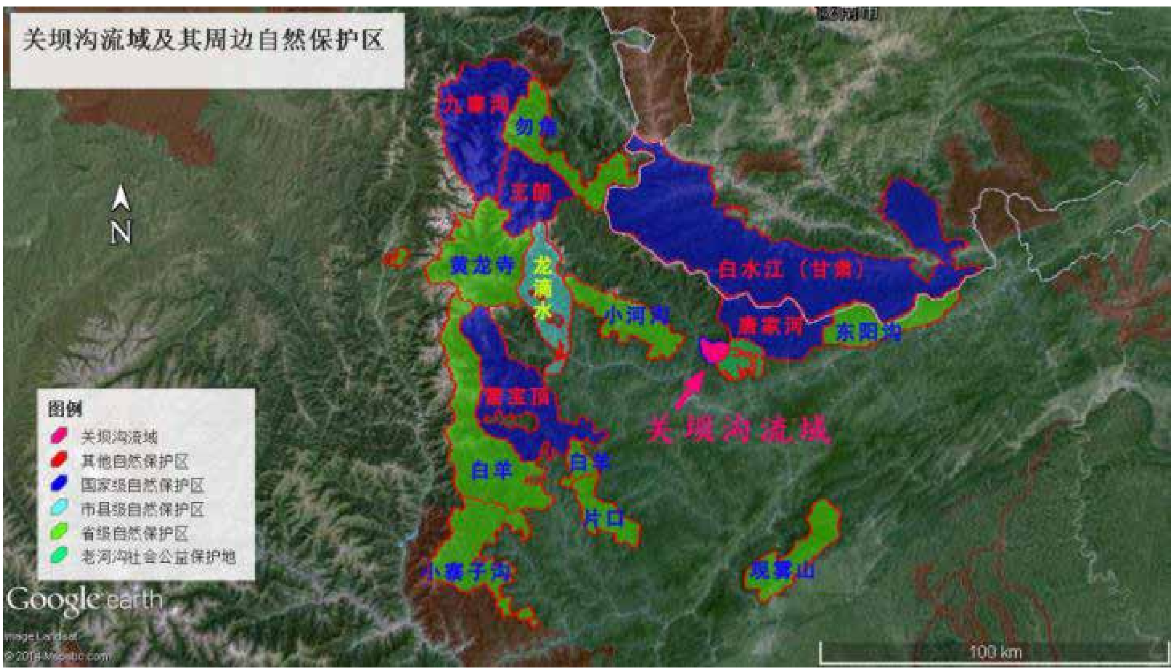
Case study author: Feng Jie, ShanShui Conservation Center

Background

Pingwu, hailed as "the World's First County for Giant Pandas," is located in the northwest of Sichuan Basin. at the east edge of its transition to the Tibetan Plateau along the Upper Fujiang, a secondary tributary to the middle to upper reaches of the Yangtze River. With 74.14% forest cover, it serves as a key ecological polestar and water conservation area for the city of Mianyang. "Eco-development" is one of three development strategies put forth by the environmentally minded Pingwu CPC committee and government.

Guanba, a village 18 km away from the county, has a population of 389 (121 households) in four Villagers' Groups. Under the Mupi Township, this village serves an important ecological niche neighboring Tangjiahe National Nature Reserve in the east, Laohegou Land Trust Protected Area in the southeast, Yujiashan County-level Nature Reserve in the south, and Xiaohegou Provincial Nature Reserve in the west. The 4th National Giant Panda Population Census shows an intermediate population density of 0.06-0.2 individuals/km^2 within the human activity area of Guanba. Four to seven individuals are estimated in the ravines. Abundant natural resources and ecological assets provide Guanba with a strong basis for economic and social development. They also have great value for conservation

Though lavishly endowed by nature, Guanba is one of Pingwu's economically deprived villages. Currently 69 people (23 households, or 17.7% of the population) live in poverty. Specifically, 34 of them (49.35%) fell into poverty because they lost the ability to work; 20 lack new skills; and



A panoramic view of today's Qunan: two ponds have been revived with government support; a new Wind-Rain Bridge was built to offer a cool getaway for villagers. © Zhao Xingfeng

6 are juniors lacking manpower. Furthermore, Guanba is a good example in Pingwu to show how complicated forestland ownerships can be. Local behaviors like poaching, logging, and picking herbal plants are common and, to some extent, affect giant panda habitats and the local environment.

How to balance economic development and conservation is a prominent challenge for Guanba. On the one hand, a local economy can't be developed at the expense of the environment. On the other, local income generation and poverty alleviation goals must be met. What can be done to solve this dilemma? Here is Guanba's answer to this question: build a new conservation management mechanism under which both economic development and conservation can be sustained, government and private efforts coordinated, eco-friendly village governance models established, and natural resources managed and restored in a sustainable way.

Conservation objectives

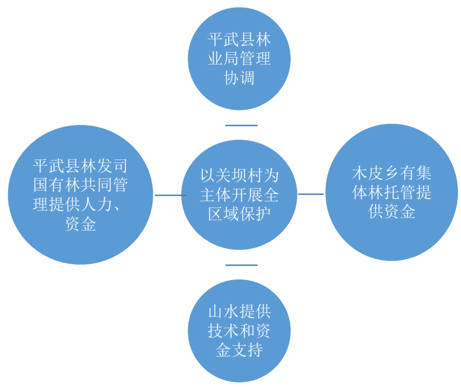
1.Conservation objectives and values

The 4th National Giant Panda Population Census shows an intermediate population density of 0.06-0.2 individuals/km^2 within the human activity area of Guanba. Four to seven individuals are estimated in the ravines. Abundant natural resources and ecological assets provide Guanba with a strong basis for economic and social development. They also have great value for conservation.

Guanba supplies drinking water to more than 600 people, including the residents of the farms and towns of Mupi. The village also has more than 400 hectares of woodland as part of headwater forest along the upper Yangtze River and habitats for giant pandas and other animals

Conservation actions

Efforts have been made to unify the sporadic management of forest resources in the Guanba Watershed, uniformly exercise the rights of management, conservation, and of use for certain business operations, without changing the forestland ownerships. The Guanba Watershed Conservation Center was registered with the local public affairs bureau as an executive agency of Guanba Community-based Conservation Area. The local forestry administration holds responsibility for coordination. The township government provides and authorizes the use of 20,000 yuan/year for forest management in Guanba, whereas a business entity called Pingwu Forestry Development (PFD) provides 30,000 yuan/year as a co-manager. Both have regulatory and supervisory power as Owners. The power to enforce laws within Guanba is exercisable by the correspondingly authorized township government agencies and officials with the power of jurisdiction. Specific matters concerning this procedure are coordinated and carried through by the township government. In addition, business support to Guanba Community-based Protected Area is no less than 30,000 yuan per annum in the form of returns from in situ cooperatives (10%) and for-profit private organizations (5%).



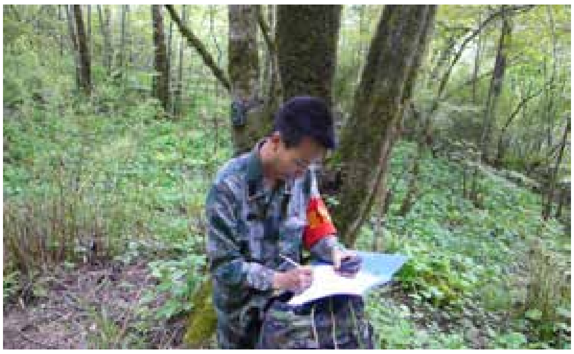
Conservation actions: Empower villagers to take a leading role in conservation

Community members are both the beneficiary of economic growth and the leading actor in conservation. Local people are bound by blessings and curses to their land. Conservation cannot be practiced at the expense of their livelihoods. On the one hand, conservation planning needs to consider economic parameters; on the other, community development needs to acknowledge the sustainable use of natural resources. Guanba took the following course of action in the pilot stage:

(1) Build a 15-people patrol team (13 villagers and 2 PFD employees) to monitor state, township, and collectively owned forests and headwaters within a radius of 20 km^2 in the Guanba Ravines, at a frequency of no less than 12 patrols a year; assign one villager to the job of water resources management; set up a km grid of 25 infrared cameras in the ravines to monitor wildlife and discourage illegal activities, such as poaching, picking herbal plants, and electrifying/poisoning fish; establish an incentive mechanism to mobilize the entire village against these behaviors.


The villagers' patrol team

(2) Release the native cold-water fish species *Euchiloglanis spp*. and *Schizothorax prenanti* for three times and plant 44,689 m^2 of native trees on barren hills as efforts to restore the aquatic ecosystem and the giant panda habitats;


Filling out monitoring sheets


Native cold-water fish fry


Cold-water fish population is growing!

(3) Develop a village-level cooperative economy: establish beekeeping and purple-skinned walnut plantation cooperatives, develop original branding & manufacturing (OBM) strategies, encourage understory plantation of herbs used in traditional Chinese medicine, expand group economy, support poverty-stricken households, and return some profits to village for conservation and medical

Guanba Beekeeping Cooperative


Guanba Beefarm

（4）Provide environmental education: build Asiatic bee show houses and protected area exhibition halls, make stone paintings that show giant pandas and golden snub-nosed monkeys, reconstruct hydraulic stone mills, and establish a Guanba Wetland Culture Plaza (underway);

（5）As an effort to ensure financial stability, the PFD and Mupi Township annually allot 50,000 yuan to the Guanba Watershed Conservation Center for its authorized management of state-owned and collectively owned forests while carrying through the Natural Forest Conservation Program Phase II.


Procapra picticaudata，Zhiduo, Qinghai/ Wang Fang

Get support from the outside world

Under the guidance of the Pingwu CPC committee and government and with support from Pingwu's "Water Fund," Shan Shui (an environmental NGO registered with Beijing's civil affairs bureau in 2007) set out to work in Guanba. Its mission involves not only efforts to introduce environmental concepts and techniques but also tasks to help the local villagers pursue village-level cooperative practices and assist the community in exploring sustainable development.

This organization, for the most part, plays a role in extending support for 1) environmental ideas, methods, and techniques; 2) income generation projects, particularly for young people who return to start a business in their hometown; and 3) the establishment of community-based eco-marketing mechanisms and access to eco-markets.

Find internal driving forces for both development and conservation

One of the challenges we all face as China builds an "ecological civilization" is how to boost up the economy and conservation at the same time. The key point actually is to find driving forces that balance the two. These impetuses must come from within to last long. Two indigenous mechanisms can serve the purpose: new specialized farmer cooperatives and diversified eco-compensations. The former points to actual stakeholders of development, whereas the latter creates a virtuous cycle while answering to the question, what can be done for development. So far Guanba has established beekeeping and purple-skinned walnut plantation cooperatives under a "company+cooperative+farmer" mechanism to fuel the growth of the village-level collective economy. The local community prefers this way to build their cooperatives-based economy. The government provides financial support for households to generate more than 1/3 of energy on a daily basis using the State Grid and solar panels instead of firewood. This measure alone can reduce firewood logging by 55,000 m3 a year. With the government's guidance and NGOs' support, Guanba takes the initiatives to integrate policy, private, and market resources and innovate new mechanisms for community-based protected area governance. The first step is to secure the patrol payroll with an allocation of the Natural Forest Conservation Program (NFCP) Phase II funds for collectively owned non-profit forest management in the newly established protected area. In the meantime, launch the "market to community initiative," a measure designed to finance conservation practices with a portion of profits returned from the sales of eco-products to the community. Thanks to this transition from external to internal financing, Guanba now has its patrol budget guaranteed in at least 10 years to come.

Conservation outcomes

1.Ecological benefits

The September 2016 field survey in Guanba found a remarkable increase of the populations of the giant panda and other animals as compared to the 4th National Giant Panda Population Census 2012. The number of points of interference decreased from 12 to 2. Camera traps caught more than 20 animal species, including the giant panda, the golden snub-nosed monkey, takin, and the Temminck's tragopan. Fish and amphibian populations in the ravines increased from near extinction to a point where one can easily catch some *Euchiloglanis spp*. or *Schizothorax prenanti* from a pond or spot amphibians anywhere in the area. The goat population decreased from 500 to 100. Water conservation outcomes were recognized by the county's water authority, including the establishment of a first-class water conserved area. Further, 44,689 m^2 of the giant panda habitat has been restored.

2.Economic benefits

Eight bee farms have been set up in the ravines. About 600 colonies of Asiatic honey bees are kept there producing approximately 5,000 kilos of honey. The villagers have shared 100,000 yuan of the profits, and additional 40,000 yuan has been returned as support for conservation and medical insurance. Each bee keeper makes 3,000 to 4,000 yuan more as income. The largest bee keeping household can earn as much as 45,000 yuan annually from honey sales. As conservatively estimated, the Euchiloglanis spp. and Schizothorax prenanti released as fry are worth more than 200,000 yuan. Over 100 households have chosen to grow Chinese herbs, such as Rhizoma paridis, each in a 60-130 m^2 plot of land, as well as 1,000 fruit trees. With 600,000 yuan financial support from the forestry administration, Pingwu's purple-skinned walnut nursery has been built in Guanba as part of the collective economy and also as one major future source of income. Ecological improvements, along with the establishment of a community-based protected area, provide a good basis for nature education in Guanba, bringing 200 visitors a year for exchange and study – and also a source of income for the villagers.

3.Social benefits

Local environmental awareness is notably higher than was found by the 2012 baseline survey. Group action appears stronger. Meetings on a case-by-case bases and transparent finances lead to more sound and people-oriented decisions. The idea of building a protected area has also lured some young villagers back to their hometown, injecting fresh blood into the management pool. Some poverty-stricken households have joined the cooperatives, share their profits, and get involved in conservation. Poverty is being alleviated and there are lower chances of slumping back into poverty.

4.Social impacts

Guanba Community-based Protected Area has attracted wide attention from towns along the ravines. They are interested in following the practice. Further, Guanba's ecological approach to poverty alleviation has been selected as a case study under the Key Project of Targeted Poverty Alleviation in Sichuan; the Deputy Secretary of the county CPC committee introduced it to a broader audience of county-level executive leaderships through the Party School of the Central Committee of the CPC. His introduction included key factors about this protected area. Experts from China Executive Leadership Academy (Pudong), Mianyang Teachers' College, and the Sichuan Academy of Social Sciences all have conducted field studies in Guanba to learn its experience, which has been included in the List of Key Reform Experience Extensions in Sichuan. Guanba also has received an extensive media coverage, including the English version of China Newsweek, Sichuan Daily, the Bund, Man and the Biosphere, the State and Sichuan Forestry Administrations' websites, and two promo videos.

3.4.4.Yunnan: Nangun River Community-based Protected Area for Asian Elephants, Nanlang Village (Protected Area Friendly System)

Author: Gong Ziling/Protected Area Friendly System (PAFS)

Nanlang Village is located near Nangun River Nature Reserve in Lincang City, Yunnan. It's one of the three Asian elephant habitats in China. The Asian elephant (Elephas maximus) is in the genus Elephas in the family Elephantidae under the order Proboscidea and is the only largest mammal on land still existing in Asia. It's rated as one of China's national first-class protected animal species and is categorized as Endangered (EN) by the International Union for Conservation of Nature (IUCN).

Fig. 1 The Asian elephant distribution

Asian elephants in China are distributed in three parts of Yunnan: Xishuangbanna National Nature Reserve (sub-zones: Mengyang, Mengla, Shangyong) and the surrounding areas; Nangun River Nature Reserve in Lincang City; and Puer City (Simao District and the counties of Lancang and Jiangcheng). There are less than 250 of them.

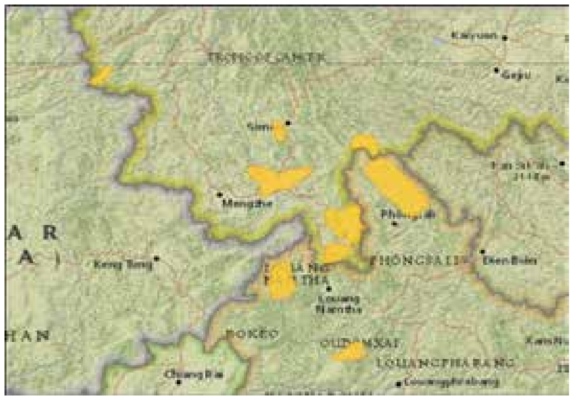


Fig. 2 The distribution of Asian elephants in China

Of these three areas, the Cangyuan area of Nangun River Nature Reserve has a population of about 20 Asian elephants. They have been isolated for nearly 20 years and urgently need intervention. The Cangyuan population is too geographically distanced from other populations in China to have any cross-habitat exchange. Nor can they travel west due to the long loss of forest at Sino-Burmese borders. The Nangun River area has truly become a lone isle for this animal. On the other hand, this population has a high genetic contribution rate because they are most gene-specific and are in an evolutionarily distinct branch. Therefore, they should be given special attention.

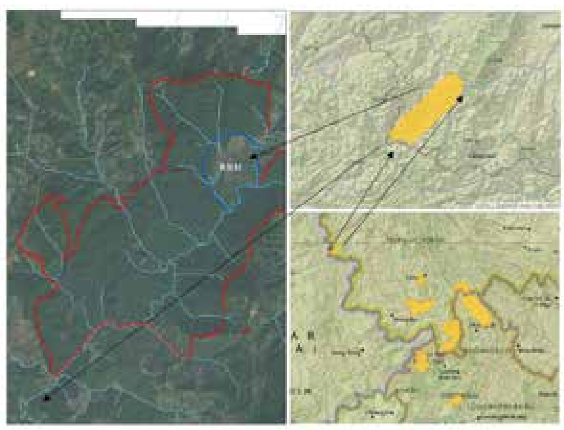


Fig. 3 Map of the Nangun River area

Protected Area Friendly System (PAFS) is a for-profit organization initiated in 2013 by Xie Yan of the CAS Institute of Zoology and then founded in 2014 with a commitment to making conservation sustainable through eco-marketing, a measure to support local conservation groups' long-term work with eco-friendly, conservation-minded communities. Supported by the Critical Ecosystem Partnership Fund (CEPF) in 2015, PAFS set out to work in Nanlang Village, an experimental zone of Nangun River National Nature Reserve, hoping to promote nature friendly lifestyles as a way to unearth traditional knowledge about co-existence with nature, to engage the local community in Asian elephant conservation, and to explore sustainable mechanisms that synchronize development with conservation.

Around Nangun River Nature Reserve are a number of Wa villages. Conflict with Asian elephants can easily occur when the animal would go there and chomp on crops in the season. Two important issues with Asian elephant conservation in this area are habitat restoration and human-elephant conflict alleviation. For the first issue, major problems are sprawling rubber plantations and agricultural pollution; and for the latter, contention over land and food. At the bottom of all is the fact that humans and elephants both rely on the same natural resources for survival, so much so that the latter hurt the economic interests of local villagers.

PAFS's volunteer Daisy had this snapshot on May 24, 2016 when she followed the elephant’s trumpet upon learning that from villagers near the PAFS project site in the Nangun River area.

Conventionally, elephants and the human community are considered two poles apart and external intervention would often put the latter in an inferior position. This inferiority, to some extent, would turn the community against conservation. Conflict between conservation and development seems unresolvable. What can be done to get the community benefited from elephant conservation? Change the community's negative attitude toward the animal. Make them aware that their “true way to get rich” is the ecosystem represented by Asian elephants. Fuel indigenous conservation forces. These are what PAFS is trying to do.

Specifically, our work has two facets. The first is to cultivate premium farm produce a healthy ecosystem can provide, such as conventional crops represented by “Elephant Rice”, a variant of fragrant rice. The second is to develop aesthetic values of a healthy ecosystem offering eco-tourist attractions that center in on elephants. Guidance is needed for the community to sustainably tap into economic values the ecosystem provides. They need incentives to shift to nature-friendly livelihoods.

PAFS envisages a conservation-development cycle in which one benefits the other for the greater good of the community. To achieve this goal, PAFS completed a land-use survey of Nanlang Village in 2015 and took a close look at the pressure of each livelihood component on natural resources used. This analysis provided a basis for habitat restoration.

Fig. 4 The land-use survey of Nanlang

The land-use survey shows that it is more appropriate to work on the west side of the area. One reason is that multiple water systems developed from the secondary tributary are in this area. Improving land use there can effectively reduce water pollutions for Asian elephants living upstream and recover their habitat. Furthermore, a DEM analysis found that this area has quite a few potential observation points that could be used for eco-tourist route planning and design later. They are instrumental for the development and structuring of diverse industries.

Based on these findings, PAFS launched an Elephant Rice Experimental Farm Program in 2016, hoping to reduce agricultural pollution, clean water supplies, and improve habitat conditions. Further, the cultivation of this rare variant of traditional fragrant rice will lead to an increase of farming output value and, therefore, will incentivize the community to practice conservation as they become aware of the ecosystem's true value. In Phase I, the project implementation team plans to replace hybrid rice with a traditional fragrant rice variant on 30,015 m^2 of land in the north of the west side of the area. This rice variant is popularly known as "Little Mouse Fragrant" in Chinese and is endemic to the area. An old granny would tell you that this was the kind of rice she remembered exuding an aroma you could smell miles away. It is also highly adaptable to the local ecosystem because of its endemicity. Its strong immunity to pests and diseases almost spares the need to use pesticides. These traits ensure the produce's quality and make supervision less difficult. This attempt has created the first piece of the conservation-development cycle.

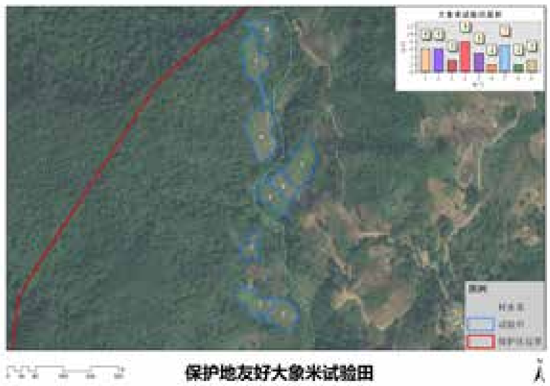


Fig. 5 Map of the experimental farm

If crop improvement is an implicit way to restore habitats, further action will be needed to motivate engagement in green practices by making local villagers more directly see benefits from elephant conservation. One possible approach is by building a tourism-based framework that leverages the inherent aesthetic values in wildlife – elephants in this case. Our DEM analysis shows that this village has many observation points

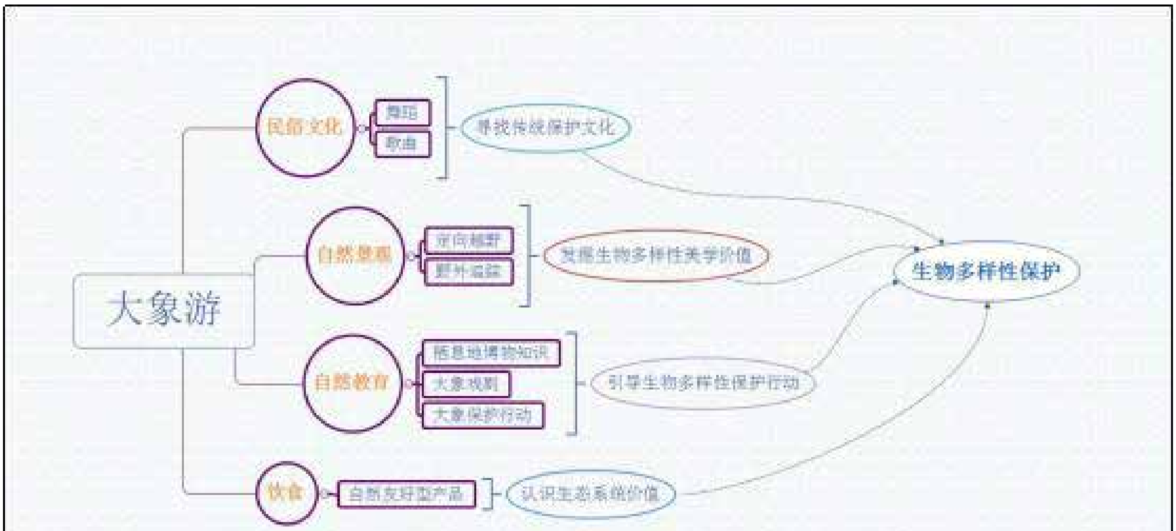


Fig. 6 Eco-tourism design

where tourists can have sightings of the animal in a safe and enjoyable way. The community will get real financial benefits from elephant conservation practice when they are entrusted to operate and maintain observation decks built in these spots. Making elephants an integral part of the community's livelihood shapes a local awareness that the animal is a kind of natural capital. Will an enthusiastic conservationist ever be hard to find if one day the elephants-dominated landscape has become a part of the community's fundamental interests?

The following are positive outcomes achieved one year into the project implementation:

- 1.Conserved 30,015 m^2 of connecting waterhead plots of land and eliminated the use of chemical fertilizers and pesticides within a small area to effectively protect waterheads for Asian elephants living upstream.
- 2.Benefited nine households (30% of the households living at the west side of the area).
- 3.An estimated output of 11,250 kilos of rice (4,322 kilos after sun-drying and filtering). Specifically, 3,297 kilos a-re first-grade and 1,025 are second-grade.
- 4.Local households' incomes have been increased by over 50% on average and over 120% at the highest, with additional 8,800 yuan awarded as incentives for community coordination and 2,297 yuan worth of textbooks for training.
- 5.Elephant Rice has an excellent taste and extraordinary quality. Its fine milling rate ranges between 57% (min) and 65% (max).

A harvest of Elephant Rice

The cultivation of Elephant Rice in Nanlang Village is a fine example of collaboration between private corporations and communities. It also shows a possibility of reducing wildlife threats through sustainable agricultural practices. Such eco-friendly livelihoods are a necessary measure for both development and sustainable conservation in communities around nature reserves and areas where wildlife is distributed.

3.4.5.Qinghai: Yunta Community-based Protected Area – A Showcase of Natural Resources Co-management

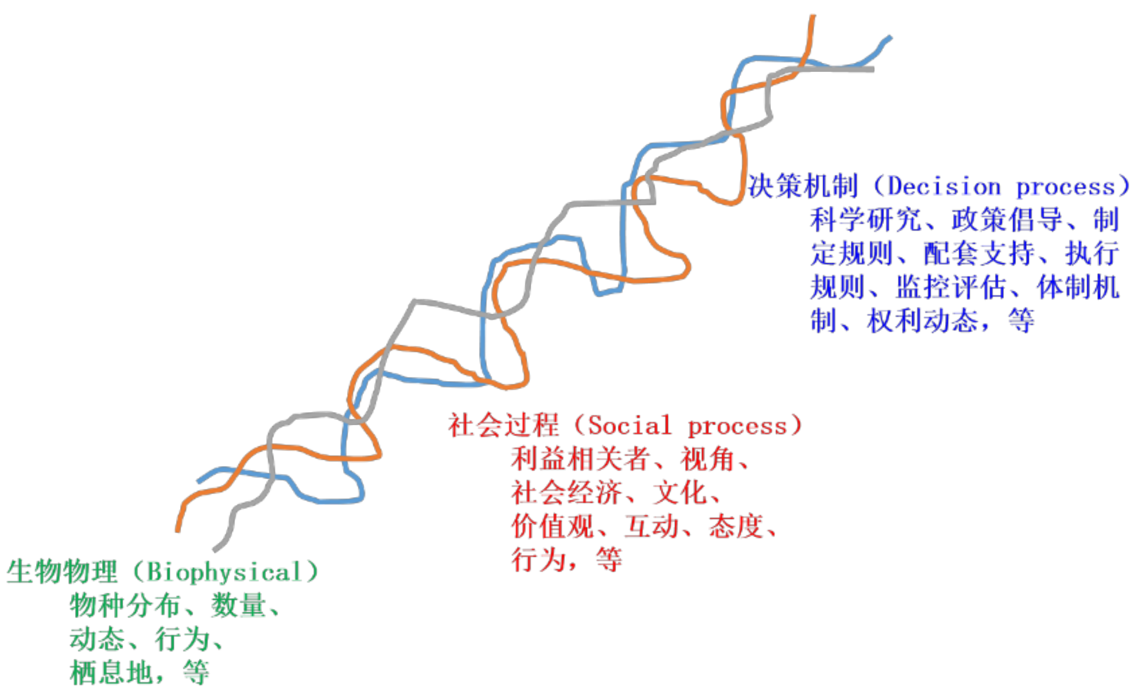
Case study author: Zhao Xiang, ShanShui Conservation Center

Background

Since 2011, Shan Shui Conservation Center has been implementing conservation practices in Yunta Village of Haxiu Township. A protected area inhabited by 612 indigenous people, Yunta expects work to be done toward a two-pronged goal: proper natural resources management and ecosystem conservation.

All problems with conservation are multi-faceted. It is with this complexity that behaviors shaped by individual or group decisions can impact on the society and nature. To address problems with wildlife conservation, therefore, we need to find out what's happening biophysically, such as changes in the distribution, number, dynamics, behavior, and the habitat of a particular species. This kind of information can help us understand how a target species (e.g., the snow leopard) currently live. But it's not enough. We also need to know social interactions that may have something to do the target species, relationships that involve interests, perspectives, values, traditional cultures, behaviors, and the like among different social groups. This kind of knowledge can help us figure out threats to the target species. In addition, we also need to understand local policy-making mechanisms for conservation, such as collective management, institutional problems, and the dynamics of rights and interests behind all this. It is only in such mechanisms that a real change can happen. Here is our mind map:

To reach the two-pronged goal as discussed earlier (natural resources management includes cordyceps, forest, and water), Yunta needs to be considered as a whole for its clear geographical and social boundaries. In determining who were to take a leading role in conservation, we tried to start with the community's old management structure to smooth out their participation as



a whole in three areas: “institutional design, binding commitment, and effective supervision.”

Specifically, we tried to focus on institution building and policy advocacy apart from studies, surveys, and particular conservation efforts. We also made an attempt to draw on our experience with the community-based protected area of Sanjiangyuan. Eventually, we decided to take on three facets of work in Yunta: biophysics (conservation efforts), social interactions (institution building), and policy-making processes (policy advocacy). Over the past five years, we have achieved some progress and experience in the tasks as described earlier.

Yunta Village is an 360 km^2 area of land located near the Tongtian River, under the administration of Haxiu Township of Yushu City in Yushu Tibetan Autonomous Prefecture, with a population of 612 (152 households). Pasturage is the only livelihood in this village. Recently, the cordyceps business generates about 70% of its income.

Conservation objectives

Our project in Yunta has three objectives:

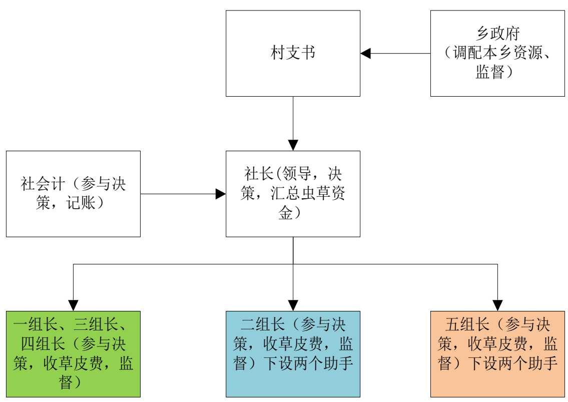
- Promote conservation for the snow leopard community and biodiversity;
- Build a long-standing natural resources management system;
- Practice a community-based natural resources management and conservation mechanism;

While making these changes happen, we also hope to make some progress with the Sanjiangyuan conservation model.

Background natural resources: types, uses, and management methods/problems

Cordyceps: Despite its 1984 policy to sublease cattle and grassland to households, Yunta still considers cordyceps similar to what Elinor Ostrom coined “common-pool resource” because of its rising market value. In other words, cordyceps, as a natural resource, is not covered by Yunta's sublease policy but rather is subject to “community ownership.” Community members have unlimited access to this resource while imposing a “turf fee” to restrict access by outsiders.

When in season, the third commune of Yunta has 12 people aboard a cordyceps management team under the village/commune autonomous governance system: the village secretary, the head and the accountant of the commune, the directors of five production groups thereunder, and four assistants. The first three job titles belong to the autonomous governance system, whereas the rest carry within themselves geographical, historical, and cultural legacies. Under the people's communes system in the 1950s, Livestock Production Groups became the smallest unit of production as needed in open nomadic areas and for the benefit of the community's collective work, similar to “Otor,” a basic production unit in pastoral areas like Inner Mongolia. Directors of such groups are elected from within. They are mainly responsible for coordinating and organizing production activities, such as transferring cattle across pastures and assigning work schedules to group members. Though the communal system has long gone, these groups left so huge an impact among pastoral populations that they still play an important role in pastoral areas. At that time the third commune of Yunta set up five Livestock Production Groups. This is why we say the deployment of five group directors in Yunta's cordyceps management team followed a historical path.



For cordyceps management, Yunta set up the following rules: 1) All villagers of Yunta may harvest cordyceps free of charge, but all the members of the first two communes only have access to a specific area on a limited number of in-season days as decided by the third commune, according to traditional costumes and the village's unofficial code of conduct; 2) A "turf fee" determined by the township government (1,500 yuan/person in 2012 and 1,700 yuan/person in 2013) is imposed upon harvesters from other villages of Haxiu as a measure to take in-season resource control and relieve tension within the village; 3) People from outside the town need to pay for access to cordyceps in any of the three ravines, Larong, Golorong, and Lalai, and such charges are determined by the commune and collected by the five group directors and four assistants (from 4,800 yuan, 6,300 yuan, and 6,400 yuan in 2012 to 7,000, 8,000, and 11,000 in 2013); 4) Anyone who has paid for the access must also do five days of community service in the commune, such as road and bridge construction; 5) No one is permitted to start harvesting cordyceps prior to the Twentieth Day of May without authorization; 6) Households should keep an eye on grassland around where they live and will be awarded half the fine if they have found, and dutifully reported, any unauthorized cordyceps harvest.

The allocation of these levies is also indicative of community behavior. They are first used to cover the 12 management team members' salaries and public fund reservations. The remainder will be shared among the members of Commune Three by the following ratios: 20% of the portion is first and foremost distributed among villagers holding grassland certificates under the 1984 sublease; and then the remaining 80% goes evenly to all members of the commune. In this way, considerations can be taken of the old grassland tenure system, particularly the lives of senior sublease holders who lost the ability to work, while younger households are also included to reduce income gaps.

Despite these sound management procedures, there is some disagreement as to whether access should be further restricted and over management issues that arise when people from outside the town come to harvest cordyceps here. (Some members think that tightening conservation measures will reduce the number of harvesters and therefore lower their income.)

Water resources

Surveys show that waste is a major threat to the quality of Yunta's main water supply, the Golorong River. This problem will become worse as the commodity economy casts deeper impacts. Long transportation distance and scattered human habitation typical of the pastoral areas of Sanjiangyuan prevent Yushu Prefecture from establishing a plastics recycling chain. There are only two landfills in Jiegu Town and most waste is either burned in the open air or buried, resulting in great pollution.

Forestland resources:

Yunta maintains a moderate tap into forest resources. But once every year nearly 2,000 people gather here for a month to harvest cordyceps. Their logging for firewood poses a great threat to local forestland resources. Surveys show that one year of trees thus cut is comparable to the logging of 120-150 century-old Chinese junipers (*Juniperus chinensis*).

Snow leopard monitoring and conservation: population sizes, distributions, food stocks, threats

Blue sheep monitoring: In December 2012, Yunta's trained 12-strong team began their monthly quest to keep count of blue sheep at 49 monitoring points. More than three years have passed. Studies show that the density of blue sheep has gone up to 13 individuals/100 km^2. This is considered fairly good for this species, the most important food source for snow leopards.

Snow leopard monitoring: Since April 2013, Yunta has trained 14 villagers and set up 16 infrared cameras by a 5X5 km grid. Their monitoring revealed that areas along the Tongtian River are most biodiverse with a remarkably high density of alpine musk deer. Poaching this animal is a direct threat to snow leopards.

Targeted conservation measures

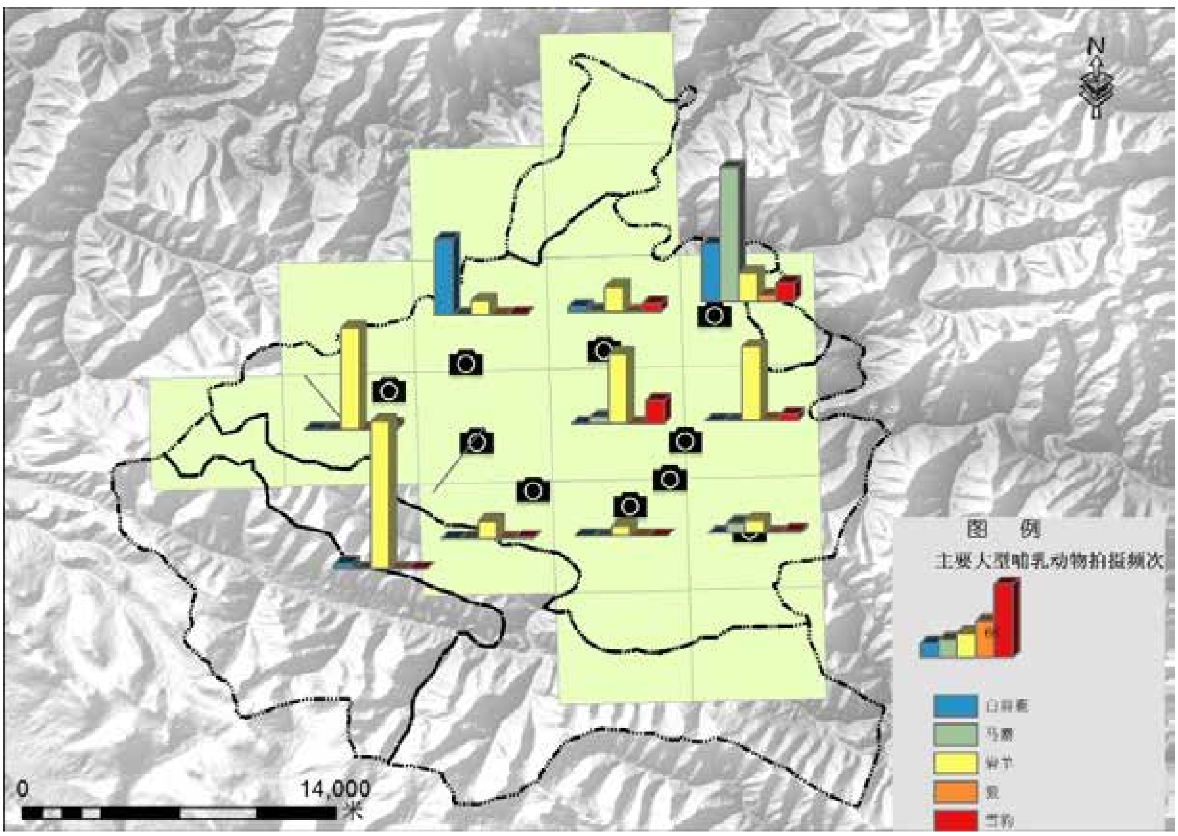
Anti-poaching patrol: A 22-strong patrol team licensed by the Yushu Prefecture Committee of Politics and Law carries out their mission on a monthly basis and takes 4-7 patrols a month when the Tongtian River freezes up. They cleared more than 200 wire nooses in 2014 and 100 in 2015. One year later no such trap was found.

Cordyceps management: Hold regular meetings. Organize assemblies. Cover the cost of institutional reform. Lower the number of harvesters. Impose turf fees. Raise conservation standards. Make eco-commitment cards.

Waste treatment: Hold the community assembly discussing waste treatment issues. Build four classified garbage chambers. Raise awareness and provide training for garbage sorting practices. Four types of garbage are identified in Yunta: kitchen wastes, plastic bottles, worn and torn clothes, and plastic bags. According to the village's waste treatment plans, kitchen wastes are buried in situ; plastic bags are incinerated in situ; plastic bottles and old clothes are taken to the garbage chambers and then transported out to Jiegu. Plastic bottles are recycled through trash dealers and old clothes buried at the prefecture's landfill sites. A part of the transportation cost is set off by selling plastic bottles and the remainder is covered by household contributions (about 60 yuan/household/year). Seven supervisors selected by the Village Resource Center check how well each household sorts out its garbage and keep the surrounding areas clean. These regular checks provide a basis for rating. Once every six months such assessment produces a ranking within the community for the purpose of experience sharing and motivation.

Firewood substitution: Hold the community assembly discussing how to step up the “coal for forest” effort, in which coal is transported from the capital of Yushu Prefecture to Yunta and

Wildlife distribution in Yunta



then sold to cordyceps harvesters while putting a ban on firewood logging. 1,500 kilos of coal was consumed in 2015 and 1,750 kilos in 2016.

Institution-building and policy advocacy

1) Capacity-building and training: We held no less than four group training sessions in 2012-2016 and made it possible for village management committee members to visit Chengdu (twice), Beijing (3 times), and Yunnan (once).

2) Management framework: Based on the existing cordyceps management, we built a Yunta Village Resource Center under the existing community management framework to improve the management and conservation systems at the village level.

3) Policy proposals: Our experience of conservation in Yunta has been encapsulated in policy proposals to higher authorities, such as the CPPCC of Qinghai, the Qinghai Forestry Administration, and the Yushu Prefecture government.

Conservation outcomes

Nature conservation: The size of the snow leopard population has risen from nine in 2013 to twelve in 2015; population growth curves for blue sheep, white-lipped deer, and alpine musk deer have also gone notably upward; first-time records have been made of the activities of leopards, wild boars, and Sambar deer. Livelihood resources: An interview-based assessment shows that 94% of the local residents are happy with the existing mechanism for cordyceps management. Water sources management: The community has set up a garbage sorting mechanism and pays to get wastes transported to the prefecture's landfills once a month. Forestland resources management: no more trees are being cut to make fire with during the cordyceps harvesting season; as much as 1,750 kilos of coal is being used instead, equivalent to 120-150 century-old Chinese junipers saved every year. Institution building: The community has built various management systems for cordyceps management, community-based monitoring, and the Village Resource Center operation, as a basis for long-term governance. Policy: Yunta's conservation mechanism and outcomes have been recognized by government agencies. The village has been showcased in the Qinghai Forestry Administration's reports Advice on Taking Further Conservation Measures for Snow Leopards in Sanjiangyuan and Thoughts on Snow Leopard Monitoring and Conservation in Qinghai, the provincial CPPCC's proposal Innovating New Conservation Mechanisms Based on Local Farmers/Herders, and the Qinghai government report Village Resource Centers: Support to Innovating New Community-based Conservation Mechanisms. The Yunta paradigm has been recognized by the Zadoi County government and is being extended to the townships of Zaqing and Namsee. At the prefectural level, it provides references for the layout of General Demo Areas for Community Development in Yushu

3.4.6.Yunnan: Bamei Community-based Protected Area for Black Snub-nosed Monkeys – A Case of Self-development in Partnership with NGOs

Case study author: Li Xiaolong, ShanShui Conservation Center

Background

The black snub-nosed monkey (Rhinopithecus bieti), a rare primate species native to China, enjoys the flagship status at biodiversity hotspots of the Hengduan Mountains in northwestern Yunnan. There are only about 3,000 of them left in the world, and most are distributed in the Yunling Mountains between the Lancang River and the Jinsha River. Specifically, the Baima Snow Mountain, the Laojun Mountain, and the Yunlong Tianchi Lake of Yunnan, as well as the Hongla Snow Mountain of Tibet, provide key habitats for the species.

To protect this animal, the Chinese government has established several nature reserves at national and provincial levels, including the Mangkang of Tibet and the Baima Snow Mountain, the Yunling, and the Yunlong Tianchi of Yunnan. But the current system is not all-inclusive. Some populations do not live in government-designated protected areas. Rather, they find shelter in collectively owned forests around human communities. This heightens the pressure of the conservation of the species. The Bamei is one such population. Currently there are 15 populations of the black snub-nosed monkey around the world. The Bamei is of great importance because they communicate with the Baima of Yunnan and the Hongla of Tibet.

A troop of black snub-nosed monkeys in forest (courtesy of Yunnan Baima Snow Mountain National Nature Reserve)

Bamei Village is located farthest north of the junction between Yunnan and Tibet within the Lancang watershed, under the administration of Fushan Township of Deqin County, Diqing Prefecture, Yunnan. The greater part of the local population are the Naxi and Tibetan peoples, with a cultural mix of Naxi Dongba and Tibetan Buddhism. This village is comprised of 13 Villagers' Groups. For over 1,300 villagers, understory harvests (e.g.: cordyceps and matsutake), sideline businesses, industrial practices, and subsidies granted for policy considerations are major sources of income.

According to Sinan Gyaltsen, head of Badui Villagers' Group, there was a troop of 500-600 black snub-nosed monkeys in nearby forest a few decades ago. They remained unknown to the outside world because the village was hardly accessible. At that time a massacre broke out among them. Many older people in Gyaltsen's family joined the loot for both medical and culinary purposes. The massive killings of these monkeys reduced their population to just 30 or so. Then, upon learning their existence in Bamei, Baima National Nature Reserve started to carry out conservation with external organizations.

Since 2008, Shan Shui Conservation Center, the Nature Conservancy (TNC), the Critical Ecosystem Partnership Fund (CEPF), and Partnerships for Community Development (PCD) have joined with local organizations, including the Kawagarbo Society, to advance the authorization process. In March 2014, Bamei Community-based Protected Area was officially established with authorization by the Deqing County Forestry Administration. This success was initially driven by the collaboration between global NGOs and the local nature reserve.

Conservation objectives

Bamei Community-based Protected Area covers 66 km^2 of land. Specifically, the forest area is about 50 km^2, most of which is state and collectively owned; the grassland and farmland are about 15 km^2 and 1 km^2 respectively. Dwarf musk deer, blue sheep, Tibetan snowcocks, and

Map of Bamei Community-based Protected Area for Black Snub-nosed Monkeys

Conservation actions

After the protected area was established, a Bamei Villagers' Assembly passed the village's code of conduct, the protected area management procedures, and regulations on maintaining the sustainability of grassland, matsutake, and cordyceps, all needed for the community to maintain sound production and conservation. It was on this basis that Badui and Kangmuding Villagers' Groups founded the Tajiu Wildlife Conservation Association. The president and two vice-presidents of this organization were elected by the villagers. The first position is held by Sinan Gyaltsen, head of Badui Villagers' Group, and the latter by Arong, head of Kangmuding Villagers' Group, and Rinsina Tsrin, director of the Project Management Office, Baima Snow Mountain National Nature Reserve Administration. Its establishment marked the first step the Bamei community took to practice conservation in a self-directed way.

The Bamei population of black snub-nosed monkeys faces many threats, including human-inflected ones. Chief among them is hunting. While harvesting in the community's collectively owned forest, the Badui villagers often find many wire nooses, but never see a hunter. A few years back, three black snub-nosed monkeys were found trapped. There were also times when dwarf musk deer and goral got trapped. So did some domestic animals. In addition, firewood consumption, wood construction, understory harvesting, grazing, garbage, and many other human disturbances also threaten the existence and survival of this population. Natural factors count, too, such as climate change and disastrous natural events, though further assessed evidence is needed in this regard.

To address these threats, the Tajiu Wildlife Conservation Association responds by organizing community members to take patrol on a regular basis. Jinam Tseri, a Tibetan young man in his mid-twenties, is one of the backbones of this 24-strong patrol team. According to him, steel traps and nooses could also hurt matsutake harvesters because villagers and the monkeys live in the same forest. His team has one man from each of 25 households in Badui and Kangdingmu (one of the households is incapable). Assigned to three different zones, they break into three groups and patrol the mountain for one or two days once a month, clearing nooses along the way.

The Bamei villagers on patrol (photo by Li Xiaolong/Shan Shui)

In addition to the patrol schedule, technical staff of the Baima Snow Mountain National Nature Reserve Administration, Deqing Division, offer guidance for local villagers to carry out population surveys and monitoring. The monitoring process has led to not only a huge collection of visual data on the monkeys in their natural habitats but also the discoveries of other species, including the wolf, black bear, dwarf musk deer, serow, and animals in the pheasant family, Phasianidae.

Camp shacks built for the patrol team with grants from Shan Shui Conservation Center serve to be more than a boost to the locals' morale and confidence in conservation. They can be used to prevent forest fire and logging.

In addition, the Tajiu Wildlife Conservation Association has done a lot in other areas of work, including clearing plastics in the wilderness and raising the community's awareness. Specifically, the villagers planted about 26,680m^2 of trees within the protected area in less than two years.

These conservation efforts have attracted great attention and support from outside the village and from local government agencies as well. Specifically, Bamei's mission to save black snub-nosed monkeys has been granted an cumulative sum of 280,000 yuan from Shan Shui Conservation Center and PCD since it was established in 2014, 80,000 yuan from the Foshan Township government in the same year, and 20,000 yuan from the Baima Snow Mountain National Nature Reserve Administration, Deqing Division, in 2014 and 2015.

With these and other supports, Bamei has made some progress in conservation. But difficulties still abound. Up till now, the community's patrol equipment has been insufficient. A great deal of apparatus are either borrowed or granted by the nature reserve. Shan Shui Conservation Center managed to procure, among other appliances, camouflage coats, walkie-talkies, binoculars, and hand-held GPS devices for the patrol team with 10,559.66 yuan raised under a 2015 crowdfunding project on Tencent's donation website.

Apart from this problem, the patrol team also has a budget so limited that it may affect the sustainability of their efforts. Further, the association lacks professionalism and needs further capacity building.

To sum up, Bamei is in an important ecological position and, therefore, has high conservation value. Now the community of Bamei is highly mobilized to practice conservation, though the protected area was established with a collaborative effort by the nature reserve and NGOs, not with indigenous forces. In consideration of current difficulties, further support is needed from the local government and external organizations.

3.5.Conclusion

For China to meet its biodiversity conservation goals and needs with different targets in different contexts, protected areas under governance by government and the other types of governance may complement one another. Whatever category they are in, the relationship between humans and the environment, particularly between the local community and conservation, remains a major issue to address. The various cases presented herein indicate that it is feasible and effective to assign the community a leading role and mobilize them to engage in conservation. Promoting self-reliance, active participation in decision-making, and group action is of paramount importance for sustainable conservation, long-term co-development, and mainstream policy making. Considering a variety of targets and local conditions, it is possible to foster diversity and flexibility for community mobilization, participatory organization, local government roles, support from NGOs, resources needed for conservation, the delineation and allocation of powers, obligations, and interests, and so much more. We hope that this presentation and analysis can provide references for efforts to strengthen community co-management under governance by government and establish the other types of governance

Mustela altaica, Angsai, Qinghai/ Li Yuqiu

Bibliography

Forest Watch

Foley JA, DeFries R, Asner GP, Barford C, Bonan G, Carpenter SR, Chapin FS, Coe MT, Daily GC, Gibbs HK, Helkowski JH, Holloway T, Howard EA, Kucharik CJ, Monfreda C, Patz JA, Prentice IC, Ramankutty N, Snyder PK (2005) Global Consequences of Land Use, Science, Vol. 309 no. 5734 pp. 570-574

Liu JY（刘纪远）, Zhang ZX（张增祥）, Zhuang DF（庄大方）,Wang YM（王一谋）,Zhou WC（周万村）,Zhang SW（张树文）,Li RD（李仁东）,Jiang N（江南）,Wu SX（吴世新）（2003） A study on the spatial-temporal dynamics changes of land-use and driving forces analyses of China in the 1990s. Geographical Research（地理研究）, 22(1): 1–12. (in Chinese with English abstract)

Liu JY（刘纪远）, Zhang ZX（张增祥）,Xu XL（徐新良）, Kuang WH（匡文慧）, Zhou WC（周万村）, Zhang SW（张树文）,Li RD（李仁东）,Yan CZ(颜长珍), Jiang N(江南）,（于东升）（2009）Spatial patterns and driving forces of land use change in China in the early 21st century. Acta Geographica Sinica（地理学报）, 64(12): 1411– 1420. (in Chinese with English abstract)

Wu BF（吴炳方）, Yuan QZ（苑全治）, Yan CZ（颜长珍）, Wang ZM（王宗明）,Yu XF（于信芳）,Li AN（李爱农）,Ma RH（马荣华）,Huang JL(黄进良), Chen JS(陈劲松), Chang C（常存）,Liu CL（刘成林）,Zhang L（张磊）,Li XS（李晓松）,Zeng Y（曾源）,Bao AM（包安明）（2014）, Land cover changes of China from 2000 to 2010. Quaternary Sciences（第四纪研究）04:723-731. (in Chinese with English abstract)

CHEN J（陈军）, CHEN J（陈晋）, LIAO AP（廖安平）, Cao X（曹鑫）,Chen LJ（陈利军）, Chen XH（陈学泓）,Peng S（彭舒）,Han G（韩刚）,Zhang HW（张宏伟）,He CY（何超英）, Wu H（武昊）,Lu M（陆苗）（2014） Concepts and key Techniques for 30m Global Land Cover Mapping. Acta Geodaetica et Cartographica Sinica,（测绘学报）, 43(6):551-557.(in Chinese with English abstract)

Hansen MC, Potapov PV, Moore R, Hancher M, Turubanova SA, Tyukavina A, Thau D, Stehman SV, Goetz SJ, Loveland TR, Kommareddy A, Egorov A, Chini L, Justice CO, Townshend JRG (2013) High-Resolution Global Maps of 21st-Century Forest Cover Change. Science 342: 850–53.

Globe Forest Watch, (2015), Country Profiles: China. http://www.globalforestwatch.org/country/CHN (获取日期：2015.4)

National Geomatics Center of China. (2014) 30-meter global land cover dataset(GlobeLand30) Product Description. http://www.globallandcover.com/GLC30Download/index.aspx (获取日期：2015. 2)

National Bureau of Statistics of China（国家统计局）,（2005） China Statistical Yearbook 2005. http://www.stats.gov.cn/tjsj/ndsj/2005/indexch.htm （获取日期：2014.12)

National Bureau of Statistics of China（国家统计局）,（2014） China Statistical Yearbook 2014. http://www.stats.gov.cn/

tjsj/ndsj/2014/indexch.htm（获取日期：2014.12)

Liu JY（刘纪远）, Kuang WH（匡文慧）, Zhang ZX（张增祥）, Xu XL（徐新良）, Qin YW（秦元伟）, Ning J（宁佳）, Zhou WC（周万村）, Zhang SW（张树文）, Li RD（李仁东）, Yan CZ（颜长珍）, Wu SX（吴世新）, Shi XZ（史学正）, Jiang N（江南）, Yu DS（于东升）,Pan XZ（潘贤章）, Chi WF（迟文峰）（2014）Spatiotemporal characteristics, patterns, and causes of land-use changes in China since the late 1980s. Journal of Geographical Sciences（地理学报）01:3-14. (in Chinese and in English)

Food and Agriculture Organization of United Nations (联合国粮农组织, FAO). Forest Resource Assessment 2010. http://www.fao.org/docrep/014/i1757c/i1757c.pdf (获取日期：2014.12)

Species Watch: Status Assessment

Boersma PD, Kareiva P, Fagan WF, Clark JA, Hoekstra JM (2001) How good are endangered species recovery plans? Bioscience, 51, 643-649.

Bottrill MC, Walsh JC, Watson JEM, Josepha LN, Ortega-Arguetab A, Possinghama HP (2011) Does recovery planning improve the status of threatened species? Biological Conservation, 144, 1595-1601.

Cheng KW(成克武), Zang RG(臧润国) (2004) Advances in species endangerment assessment. Biodiversity(生物多样性), 12, 534-540. (in Chinese with English abstract)

Cullena R, Morana E, Hughey KFD (2005) Measuring the success and cost effectiveness of New Zealand multiple-species projects to the conservation of threatened species. Ecological Economics, 53: 311-323.

Gerber LR, Hatch LT (2002) Are we recovering? An evaluation of recovery criteria under the U.S. Endangered Species Act. Ecological Applications, 12, 669-673.

Jiang ZG(蒋志刚), Fan EY(樊恩源)(2003) Exploring the endangered species criteria: rethinking the IUCN Red List criteria. Biodiversity(生物多样性), 11, 383-392. (in Chinese with English abstract)

Liu S, Gong P (2012) Change of surface cover greenness in China between 2000 and 2010. Chinese Science Bulletin, 57: 2835 2845,

Lü YH, Zhang LW, Feng XM, Zeng Y, Fu

BJ, Yao XL, Li JR and Wu BF (2015) Recent ecological transitions in China: greening, browning, and influential factors. Scientific reports, 5, 8732;

Sutherland WJ, Clout M, Côté IM, Daszak P, Depledge MH, Fellman L, Fleishman E, Garthwaite R, Gibbons DW, De Lurio J, Impey AJ, Lickorish F, Lindenmayer D, Madgwick J, Margerison C, Maynard T, Peck LS, Pretty J, Prior S, Redford KH, Scharlemann JPW, Spalding M, Watkinson AR (2014) A horizon scan of global conservation issues for 2014. Trends in Ecology & Evolution, 29, 15-22.

Sutherland WJ, Woodroof HJ (2009) The need for environmental horizon scanning. Trends in Ecology & Evolution, 24, 523-527.

Taylor MFJ, Suckling KF, Rachlinski JJ (2005) The effectiveness of the endangered species act: A Quantitative Analysis. Bioscience, 55, 360-367.

Anderson, R.P., Dudík, M., Ferrier, S., Guisan, A.J., Hijmans, R., Huettmann, F., Loiselle, B., 2006. Novel methods improve prediction of species' distributions from occurrence data. Ecography 29, 129–151.

Brooks, T. M., Mittermeier, R. A., da Fonseca, G. A., Gerlach, J., Hoffmann, M., Lamoreux, J. F., ... & Rodrigues, A. S. (2006). Global biodiversity conservation priorities. science, 313(5783), 58-61.

Chandler, M., See, L., Copas, K., Bonde, A.M., López, B.C., Danielsen, F., Rosemartin, A., 2016. Contribution of citizen science towards international biodiversity monitoring. In: Biological Conservationhttp://dx.doi.org/10.1016/j.biocon.2016.09.004.

Chen, G., Townsend Peterson, A., 2002. Prioritization of Areas in China for the Conservation of Endangered Birds Using Modelled Geographical Distributions. 12. Bird Conservation International pp. 197–209.

Groves, C. R., Jensen, D. B., Valutis, L. L., Redford, K. H., Shaffer, M. L., Scott, J. M., ... & Anderson, M. G. (2002). Planning for Biodiversity Conservation: Putting Conservation Science into Practice: A seven-step framework for developing regional plans to conserve biological diversity, based upon principles of conservation biology and ecology, is being used extensively by the nature conservancy to identify priority areas for conservation. BioScience, 52(6), 499-512.

Hu, R., Wen, C., Gu, Y., Wang, H., Gu, L., Shi, X., Zhong, J., Wei, M., He, F., Lu, Z.. 2017. A Bird's View of New Conservation Hotspots in China. Biological Conservation, 211: 47-55. doi: 10.1016/j.biocon.2017.03.033.

IUCN, 2012. IUCN Red List Categories and Criteria: Version 3.1, second ed. IUCN; Gland, Switzerland and Cambridge, UK.

Jiang, Z.G., Jiang, J.P., Wang, Y.Z., Zhang, E., Zhang, Y.Y., Ping, X.G., 2016. Red List of China's vertebrates. Biodivers. Sci. 24, 500–551 (in Chinese with English abstract).

Jiménez-Valverde, A., Lobo, J.M., 2007. Threshold criteria for conversion of probability of species presence to either–or presence–absence. Acta Oecol. 31, 361–369.

Lobo, J.M., Jiménez-Valverde, A., Real, R., 2008. AUC: a misleading measure of the performance of predictive distribution models. Glob. Ecol. Biogeogr. 17, 145–151.

Ministry of Forestry in the People's Repubic of China and Ministry of Agriculture of the People's Republic of China, 1988. The Checklist of National Protected Animal of China. (in Chinese).

Myers, N., Mittermeier, R. A., Mittermeier, C. G., Da Fonseca, G. A., & Kent, J. (2000). Biodiversity hotspots for conservation priorities. Nature, 403(6772), 853-858.

Phillips, S.J., Anderson, R.P., Schapire, R.E., 2006. Maximum entropy modeling of species geographic distributions. Ecol. Model. 190, 231–259.

Rodrigues, A.S.L., Akçakaya, H.R., Andelman, S.J., Bakarr, M.I., Boitani, L., Brooks, T.M., Chanson, J.S., Fishpool, L.D.C., da Fonseca, G.A.B., Gaston, K.J., Hoffmann, M., Marquet, P.A., Pilgrim, J.A., Pressey, R.L., Schipper, J., Sechrest, W., Stuart, S.N., Underhill, L.G., Waller, R.W., Watts, M.E.J., Yan, X., 2004. Global gap analysis: priority regions for expanding the global protected-area network. Bioscience 54, 1092–1100.

United States Geological Survey, 1996. Global 30 Arc-second Elevation (GTOPO30). https://lta.cr.usgs.gov/GTOPO30 (Downloaded on May 2014).

Zhao, M., Alström, P., Hu, R., Zhao, C., Hao, Y., Lei, F., Qu, Y., 2017. Phylogenetic relationships, song and distribution of the endangered Rufous-headed Robin Larvivora ruficeps. Ibis 159, 203–216.

艾怀森 , 周鸿 . 云南高黎贡山神山森林及其在自然保护中的作用 [J]. 生态学杂志 ,2003,02:92-96.

陈吉宁 . 关于自然保护区管理和建设工作情况的报告 . 第十二届全国人大常委会第 21 次会议 , 2016

陈雅涵 , 唐志尧 , 方精云 . 中国自然保护区分布现状及合理布局的探讨 [J]. 生物多样性 ,2009,(06):664-674.

崔国发 , 王献溥 . 世界自然保护区发展现状和面临的任务 [J]. 北京林业大学学报 ,2000,(04):123-125.

达德里 . IUCN 自然保护地管理分类应用指南 [M]. 中国林业出版社 , 2016.

蒋志刚 . 论中国自然保护区的面积上限 [J]. 生态学报 ,2005,(05):1205-1212.

李晟之 . 社区保护地保护与新农村建设 [J]. 西南民族大学学报 (人文社科版),2009,(02):40-44.

刘文敬 , 白洁 , 马静 , 宋维明 , 徐基良 , 李忠 . 中国自然保护区管理能力现状调查与分析 [J]. 北京林业大学学报 ,2011,(S2):49-53.

卢爱刚 , 王圣杰 . 中国自然保护区发展状况分析 [J]. 干旱区资源与环境 ,2010,(11):7-11.

马克平 . 当前我国自然保护区管理中存在的问题与对策思考 [J]. 生物多样性 ,2016,(03):249-251.

权佳 , 欧阳志云 , 徐卫华 , 苗鸿 . 中国自然保护区管理有效性的现状评价与对策 [J]. 应用生态学报 ,2009,(07):1739-1746.

王智 , 蒋明康 , 秦卫华 , 贺昭和 , 徐网谷 . 我国自然保护区的问题分析与对策 [J]. 生态经济 ,2008,(06):144-146.

闻丞 , 顾垒 , 王昊 , 吕植 , 胡若成 , 钟嘉 . 基于最受关注濒危物种分布的国家级自然保护区空缺分析 [J]. 生物多样性 ,2015,(05):591-600.

赵广华 , 田瑜 , 唐志尧 , 李俊生 , 曾辉 . 中国国家级陆地自然保护区分布及其与人类活动和自然环境的关系 [J]. 生物多样性 ,2013,(06):658-665.

赵敏燕 , 陈鑫峰 . 中国森林公园的发展与管理 [J]. 林业科学 ,2016,(01):118-127.

周鸿 , 赵德光 , 吕汇慧 . 神山森林文化传统的生态伦理学意义 [J]. 生态学杂志 ,2002,04:60-64.

朱华 , 许再富 , 王洪 , 李保贵 . 西双版纳傣族“龙山”片断热带雨林植物多样性的变化研究 [J]. 广西植物 ,1997,03:22+24+27-29+23+26.

Bhagwat, S. A., C. G. Kushalappa, P. H. Williams, and N. D. Brown. 2005. Landscape approach to biodiversity conservation of sacred groves in the Western Ghats of India. Conservation Biology 19:1853-1862

Cao M, Peng L, Liu S. Analysis of the Network of Protected Areas in China Based on a Geographic Perspective: Current Status, Issues and Integration[J]. Sustainability, 2015, 7(11):15617-15631.

Salick, J., A. Amend, D. Anderson, K. Hoffmeister, B. Gunn, and Z. D. Fang. 2007. Tibetan sacred sites conserve old growth trees and cover in the eastern Himalayas. Biodiversity and Conservation 16:693-706.

Shen, X. L., S. Li, N. M. Chen, S. Z. Li, W. J. McShea, and Z. Lu. 2012a. Does science replace traditions? Correlates between traditional Tibetan culture and local bird diversity in Southwest China. Biological Conservation 145:160-170.

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About Nature Watch

chinanaturewatch.org

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The website of China Nature Watch incorporates a biodiversity database covering all the existing biodiversity components and ecosystems in the country, particularly endemic and endangered species, as well as information on protected areas and conservation agencies nationwide. It's also poised for researchers, conservationists, and nature lovers to record their findings and share them with one another.

Launched by Shan Shui Conservation Center and PKU Center for Nature and Society in 2014, the Nature Watch program aims to examine local biodiversity data and assess conservation outcomes, apart from tasks to build the biodiversity databases and interpret these data for policy-making. It also helps promote public participation in observing and preserving nature.

With HSBC Bank's support, we started to carry out Nature Watch species surveys in 2015. Since then, a great number of endangered species have been closely studied, including animals, birds, and plants, in collaboration with PKU Center for Nature and Society, CFCA, China Birdwatching Association, Wilderness Xinjiang, and Chinese Field Herbarium. We have provided various outlets for public participation, including nature lovers' training and the Nature Watch Festival, in an effort to increase the impact of the network of nature lovers.

Co–initiators

WeChat ID: SSbaohu; Web: http://www.shanshui.org

Founded in 2007, Shan Shui Conservation Center is a Chinese NGO dedicated to conservation practices. Together with our partners – communities, academics institutions, governments, companies and media – we support local initiatives to keep Mother Nature safe. We focus on the most biodiverse areas: Sanjiangyuan, the Mountains of Southwest China, and the Lancang–Mekong River Basin.

Founded in July 2008, Peking University Center for Nature and Society (CNS) has always been committed to promoting policy research, experience sharing, and leadership training for conservation and sustainable development in China and creating sustainability paradigms for the world. It is a well–equipped research facility where specialists and scholars from all over the world – those with great visions and experiences in conservation, sociology, management, and other fields – are engaged to build proposals and designs on both scientific and practical bases for the government, for–profit organizations, and citizens as they make decisions in the context of biodiversity, climate change, energy, and sustainable development.

WeChat ID: zhuquehui2014; Web: http://www.birdreport.cn

We, China Birdwatching Association, try our best to serve our members from all over China. We aim to build a future where Chinese bird watching groups can get more powerful and influential through joint efforts they take, their conservation goals being realized. Come with us to experience the joy of watching birds in their natural environments and plough ahead toward our goal of protecting avian lives and their ecosystems.

WeChat ID: Felidchina

We are an NGO dedicated to the research and conservation of wild cats in China, recently with a focus on North–Chinese leopards (Panthera pardus japonensis) and the ecosystem they represent in the Taihang Mountains. The world of Felidae is where we started to preserve what little is left of the country's wilderness.

WeChat ID: xj28133792; Web: http://www.wildxj.com

Wilderness Xinjiang Fund (Wilderness Xinjiang for short), an NGO under the Youth Development Foundation of Xinjiang Uyghur Autonomous Region, works to promote environmental awareness. It is a group of nature lovers who care about environmental causes, determined to keep the wilderness for future generations. They also try to help people get closer to the great outdoors, achieve more for themselves, and make Xinjiang a better place.

Founded in 2013, Wilderness Open School has become a hub of nature experience and conservation activities in the real world, as guided by online natural science classes and local offline stations it aims to provide across China. This organization works hard to unearth and revive the long lost spirit of natural science, make it accessible, infuse it into the minds of those who can be taught to become natural scientists, and build a team of nature lovers and guardians with hot passion and cool rationality.

Web: http://www.cfh.ac.cn

Chinese Field Herbarium (CFH) is a biodiversity data outlet the CAS Institute of Botany and Shanghai Chenshan Botanical Garden built together with a commitment to promote efficient technical systems for field studies, particularly GIS, GPS, and digital multi-media technology, enabling an online environment for data collection/management as well as species assessment/inventory under the Nature Watch program. It is where professionals and volunteers can work together on extensive biodiversity baseline surveys. “Turn Earth into a living herbarium” is its mission.

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