

# Assessment of the effectiveness of nature reserve management in China

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**Abstract** Assessing the management effectiveness of nature reserves is an effective way to promote management quality and achieve management targets. Using a questionnaire developed by the World Bank (WB) and the World Wide Fund for Nature (WWF) as a tool for tracking management effectiveness, we carried out a survey in 535 nature reserves in China to assess the management status quo in 2005. The results indicated that the indices related to management regulation, infrastructure and equipment, monitoring and evaluation, budget and community involvement produced relatively lower scores, while the indices related to management of protection targets and resources, setup of management agency and reserve boundary had better performances. The independent variables of reserve class, time since establishment, distribution region, economic condition and staff number exhibited strong correlations with the effective management of nature reserves. Pearson correlation coefficients were used to measure the association between the 3 assessment indices representing management effectiveness and other 28 assessment indices. Among these 28 assessment indices, the indices of personnel management, resource management, monitoring and evaluation, and management plan had more effects on the management effectiveness of nature reserves than other indices. When the most pressing management issues and influence factors have been identified, countermeasures can be implemented to improve the management of nature reserves.

**Keywords** Nature reserves · Management effectiveness · Tracking tool · China

## Introduction

The number of protected areas in China has risen dramatically over the past 10 years. According to the “Report on the State of the Environment in China in 2008” (State

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Environmental Protection Administration of China 2009), China had established 2,538 nature reserves with a total area of 1,489,430 km<sup>2</sup> by the time of the report. Protected areas are the cornerstones of most national strategies to conserve biodiversity (Howard et al. 2000). To date, these nature reserves cover 85% of the terrestrial ecosystem types, 85% of the wild-animal species groups, more than 300 endangered wild-animal species, and major distribution regions for more than 130 valuable tree species in China (Ouyang et al. 2002). Although this trend of increasing conservation is welcome, there has been some debate as to its effectiveness, and concern has arisen that China may be establishing “paper parks” rather than achieving sustainable conservation outcomes (Liu et al. 2003). There is increasing evidence of serious breakdowns in many protected-area systems (Stolton and Dudley 1999; Hockings et al. 2004a; Dudley et al. 2004; Fischer 2008). As a result, many individual protected areas are currently being degraded and destroyed (Liu et al. 2001; Hockings 2003; Dudley et al. 2004). Protected areas can deliver environmental, social and economic benefits only if they are effectively managed (Hockings 2000). Better management of protected areas requires an assessment of their management effectiveness.

The need to improve management strategies and the conservation effectiveness of nature reserves is urgent due to this situation. And management effectiveness assessment has been recognized as an important mechanism for both reporting on and improving protected area management (Hockings et al. 2009), which is defined as the assessment of how well protected areas are being managed—primarily the extent to which the current management is protecting values and achieving goals and objectives (Hockings et al. 2006). Management-effectiveness assessment is an important part of systematic conservation planning and has become a key step in linking program implementation with planning and budgeting (Margules and Pressey 2000; Hockings et al. 2004a). The assessment results can enable more systematic and transparent linkages between management objectives and management actions, identify gaps that can consequently be rectified, and provide information for decision makers and interest groups (Day et al. 2002; Hockings et al. 2004a).

Based on the WCPA framework for assessing the management effectiveness of protected areas and protected-area systems (Hockings 2000; Hockings et al. 2002), detailed assessment indices have been established and applied to assessment practices in various countries and organizations throughout the world (Courrau 1999; Ervin 2003a; Hockings et al. 2004b; Xu and Melick 2007). In 2005, using a questionnaire developed by the World Bank (WB) and the World Wide Fund for Nature (WWF) as a management-effectiveness tracking tool (Stolton et al. 2003), we carried out a survey in 634 nature reserves, including the most important nature reserves in China, and 535 of these surveys were effectively completed.

The objectives of this study are to identify the problems facing China’s nature reserves and the primary influence factors for each reserve. In addition, some recommendations for improving the management effectiveness of nature reserves in China are presented.

## Methods

### Assessment methods

Based on the framework of the WB/WWF management-effectiveness tracking tool (Stolton et al. 2003), our questionnaire was designed to assess the actual management situation of nature reserves in China. While designing the questionnaire, we consulted reserve-management researchers, nature-reserve staff members, and national, provincial

and county administrative authorities to obtain opinions from as many different perspectives as possible. The questionnaire had two main sections: a basic information sheet and a scorecard for reserve-management capacity and effectiveness (hereinafter referred to as the scorecard). The basic information sheet recorded information about the site such as the reserve class, location, date of establishment, size, management authority, number of staff members, protection targets and threats. This information provides systematic knowledge about the relationships between the infrastructure, capacity and management effectiveness in each nature reserve. The scorecard involved 31 indices and 7 additional items that were classified into 4 assessment aspects: management base, management mechanism, management activity and management effectiveness (Supplementary Table 1). The assessment was made by assigning a simple score ranging from 0 (poor) to 3 (excellent). A series of four alternative answers was provided for each question to help assessors choose the appropriate score. In addition, supplementary questions elaborated on key themes in the previous questions and provided additional information and points (0 or 1). The current system assumes that all the questions covered issues of equal weight. The total scores on the scorecards ranged from 0 to 100.

### Study area

This survey involved 31 municipalities and provinces, excluding Hong Kong, Macao and Taiwan. We delivered one questionnaire to each nature reserve. Of 634 questionnaires that were delivered, all 634 were returned; 535 were effective based on the provision of complete information sheets and scorecards (Fig. 1). And these nature reserves were divided into seven regions, three reserve classes and five reserve types (Tables 1, 2, 3). These 535 nature reserves represented approximately a quarter of all of China's nature reserves in 2005.

### Data collection and analysis

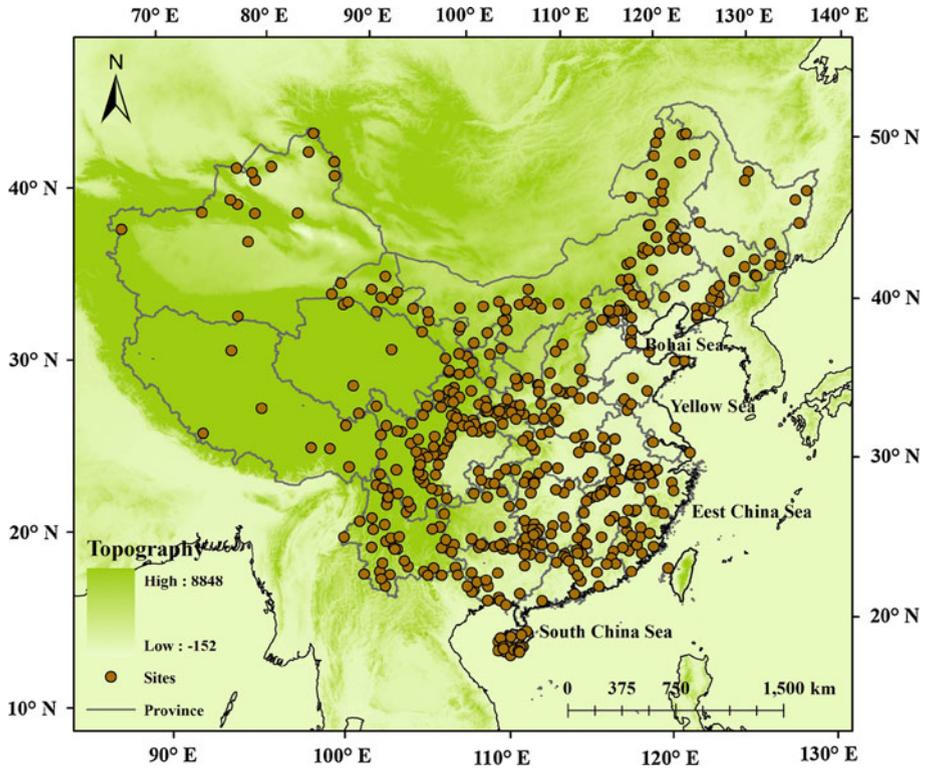
The assessors were mainly the managers of the nature reserves. Data and evaluation for basic information sheets and scorecards were collected. A database was built using Microsoft Access to store the information. Scores for each assessment index and for the overall management effectiveness were obtained from the scorecards. Using Origin 7.5 and SPSS 11.5 as analytical tools (Pearson correlation coefficients, one way ANOVA and multiple comparisons), we further analyzed the survey data to assess the status and characteristics of management effectiveness in China's nature reserves.

## Results

### Problems facing nature reserves

The mean results for each index varied markedly across the set of surveys (Supplementary Table 2). The nature reserves surveyed showed identifiable patterns of strengths and weaknesses. In general, issues related to management regulation, infrastructure and equipment, monitoring and evaluation, budget, and community involvement were less effective.

The survey results show that, among the 535 nature reserves: only 22.80% of them has management regulations for the reserve approved by local provincial government; only



**Fig. 1** Distribution of nature reserves surveyed

**Table 1** Regional locations of nature reserves surveyed

Region	Number	Provinces included
Northeast	31	Heilongjiang, Jilin and Liaoning
Northern China	80	Beijing, Tianjin, Hebei, Shanxi and Inner Mongolia
Eastern China	56	Shanghai, Shandong, Anhui, Jiangsu, Zhejiang and Fujian
Central China	72	Hunan, Hubei, Henan and Jiangxi
Southern China	86	Guangdong, Guangxi and Hainan
Northwest	92	Xinjiang, Gansu, Qinghai, Shanxi and Ningxia
Southwest	118	Chongqing, Sichuan, Yunnan, Guizhou and Tibet

**Table 2** Classes of nature reserves surveyed

Reserve class	Number
National	160
Provincial (municipal)	361
Country/district	14

**Table 3** Reserve types of nature reserves surveyed

Reserve type	Number
Forest ecosystem	336
Wild fauna	91
Inland wetlands	72
Wild flora	21
Desert and grassland ecosystem	14

9.72% of them can meet the requirement for protection within their infrastructure and protection station; and only 2.62% of them can meet the equipment requirements for protection and this equipment could be maintained well and play its function fully.

The percentage of nature reserves surveyed that have budget for reserve staff's salary from government and enough fund for staff's salary and other benefits is 11.4%; only 2.06% of them have enough financial support for reserve daily management activities from government; only 5.98% of them use most of their budgets which are enough for all targets for protection (>70%).

The results show that, only 9.72% of nature reserves surveyed make good use of a systematic monitoring for major protection targets and biological resources; 10.84% of them have set up a monitoring and evaluation system which is well implemented and used in adaptive management.

Local communities could directly participate in making decisions relating to management and influence the decisions in only 5.98% of the nature reserves surveyed; a co-management committee or a counterpart agency exists in only 7.29% of them, launching periodic co-management activities with certain effects.

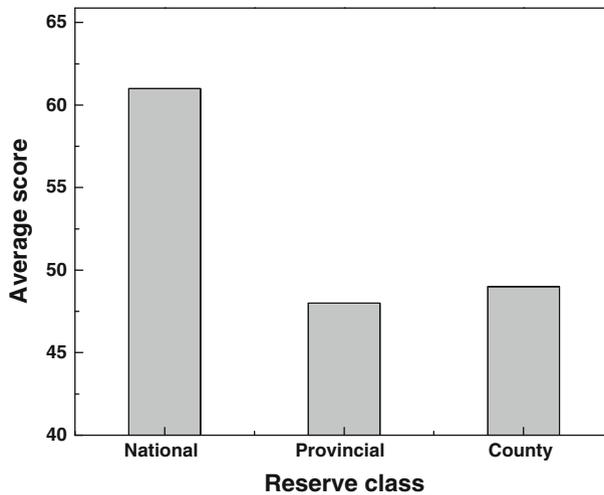
### Primary influencing factors

#### *Reserve class*

The total scores for management effectiveness were analyzed according to the reserve classes (Fig. 2). In a one-way ANOVA, the scores for overall management effectiveness exhibited highly significant differences among reserve classes ( $P < .01$ ). A multiple-comparisons test revealed that the scores for national-class reserves were substantially higher than those for the other two classes ( $P < .01$ ), but there was no significant difference in scores between provincial and county reserves ( $P > .05$ ) (Table 4). National-class nature reserves in China receive more political support and more stable financial allocation from the government, which provides a more positive environment and adequate funding for reserve construction and capacity building (Liu et al. 2008).

#### *Time since establishment*

The total scores for management effectiveness were analyzed according to the time since establishment. The scores of nature reserves established in the same year were averaged. The total scores for management effectiveness exhibited a strong positive correlation with the time since establishment (Fig. 3,  $r = .64$ ,  $P < .01$ ). Older nature reserves tended to have higher scores, suggesting that given more time and effort, reserve management can improve. Moreover, most of the older nature reserves surveyed belonged to the national



**Fig. 2** Average scores for the overall management effectiveness of different reserve classes

**Table 4** Multiple comparisons of reserves in different classes

Dependent variable	I group	J group	Mean difference (I–J)	Std. error	Significance	95% Confidence interval		
						Lower bound	Upper bound	
Total score	LSD	National	Provincial	12.810*	1.331	.000	10.194	15.425
		County	11.760*	3.889	.003	4.120	19.401	
		Provincial	County	–1.049	3.798	.782	–8.510	6.411

\* The mean difference is significant at the .05 level

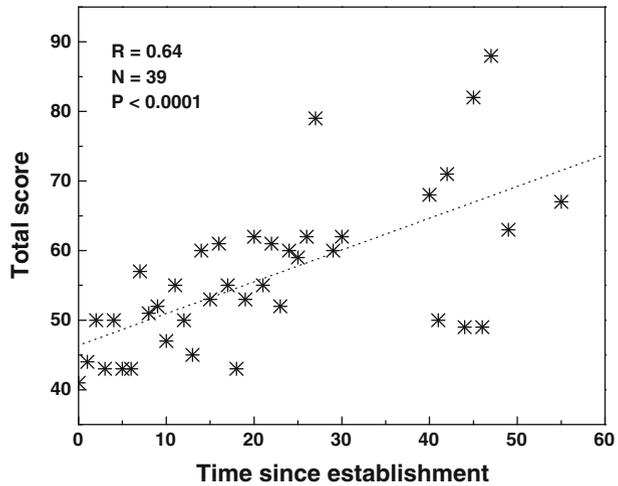
class and may thus have received more political and budgetary support from the government, as discussed above.

However, there are many exceptions to this rule. For instance, Yunnan Chaotianma Nature Reserve, established in 1956, received an overall score of only 48, while Inner Mongolia Huanggangliang Nature Reserve, established in 2004, received a score of 72. Similar discrepancies occurred in many other reserves. These many exceptions suggest that particular strengths and weakness may be endemic to some nature reserves and that unless targeted management actions are taken, time alone will not improve the management or condition of these reserves. If nature reserves are failing to address major management problems, state their management objectives precisely and implement management plans and activities to achieve those goals, they may even become less effective as time goes by.

#### *Distribution region*

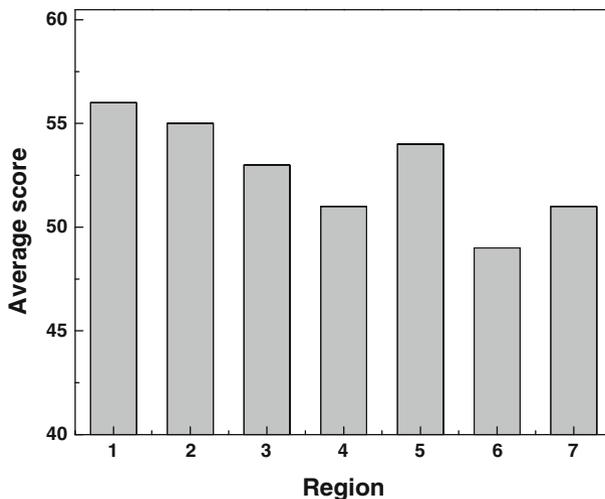
The total scores for management effectiveness were analyzed according to the distribution regions. Reserves in the Northwest received the lowest scores; while reserves in the

**Fig. 3** Correlation between total scores for management effectiveness and time since establishment



Northeast received the highest scores (Fig. 4). A one-way ANOVA showed that the scores for overall management effectiveness differed significantly among regions ( $P < .01$ ).

Because China encompasses a vast area, different regions vary considerably in natural environments, cultural backgrounds, and economic conditions. Generally, nature reserves that are located in regions with more favorable natural environments and economic conditions can be expected to have better natural-resource conditions and funding support for their development. Meanwhile, people in these regions may have greater knowledge about the values and functions of nature reserves, which would also have a positive effect on the implementation of reserve-management policies and activities.



**Fig. 4** Average scores for the overall management effectiveness of different regions. *Note:* 1 Northeast, 2 northern China, 3 eastern China, 4 southern China, 5 central China, 6 northwest, 7 southwest

### Economic condition

To some extent, the gross domestic product (GDP) represents the economic conditions of the districts where nature reserves are located. Supplementary Table 3 shows the GDP of 31 municipalities and provinces in 2005, according to the 2006 statistical yearbook of China (National Bureau of Statistics of China 2007). The scores of nature reserves in the same municipality or province were averaged. Data for the single reserve surveyed in Shanghai were removed because this sample size was too small to obtain statistical significance. Total scores for management effectiveness exhibited a strong positive correlation with GDP (Fig. 5,  $r = .39$ ,  $P < .05$ ).

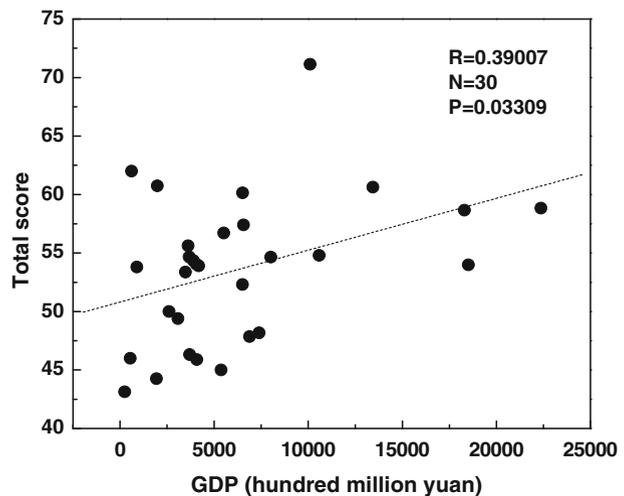
Financial allocation from the local government is the primary budgetary resource for reserve construction and management (Ouyang et al. 2006). Continuous funding is necessary to guarantee the normal operation of reserves. As a result, there is a strong relationship between the management effectiveness of nature reserves and local economic development.

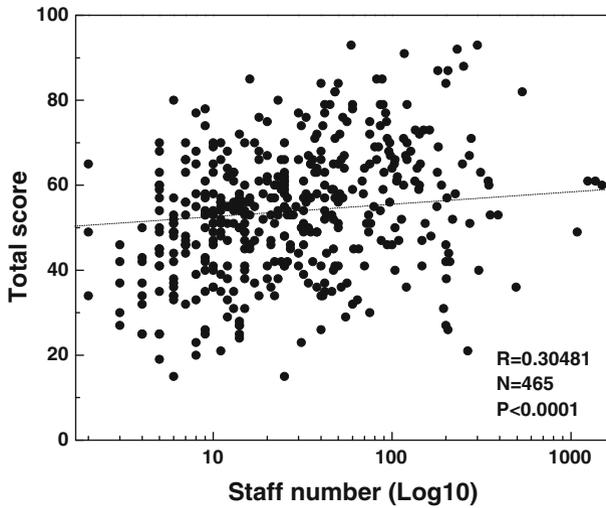
### Staffing

Among 535 effective questionnaires, 438 provided valid data on staff number. The staffing issue was explored by examining the relationship between the number of staff members and the overall management effectiveness. The results indicate that staff numbers are strongly correlated with overall management effectiveness ( $r = .30$ ,  $P < .01$ ) (Fig. 6). Total scores are basically proportional to staff numbers, clearly demonstrating the importance of adequate staffing.

Adequacy of training is inconsistent across the surveyed reserves, with many reserves with low staffing levels also reporting that their staffs face serious shortfalls in training and capacity building. Adequate and well-trained staff members can perform their management duties more effectively and are a basic condition for the efficient management of nature reserves (Dudley et al. 2004, 2007; Lacerda 2004).

**Fig. 5** Correlation between total scores for management effectiveness and GDP





**Fig. 6** Correlation between total scores for management effectiveness and staff numbers

*Assessment index*

Pearson correlation coefficients were used to measure the association between the 3 assessment indices representing management effectiveness and other 28 assessment indices. Personnel management has the strongest correlation with management effectiveness (Table 5). Besides, resource management, monitoring and evaluation, and management plan are very important for achieving the effective management.

As seen by the every single assessment index, condition assessment reporting the management status of protection targets has the strongest correlation with resource management that evaluates the requirements for active management of critical ecosystems, species and habitats. It indicates that the key protection targets would be the focus on reporting the management status of protection targets in nature reserves. Whether the reserve has the rights of forest and land for whole reserve has the largest effects on control of accessing or using of the reserve in accordance with designated objectives. And excellent personnel management makes the staffs work with more passions, which plays an active role in improving the relationships between reserves and communities.

**Table 5** Correlation coefficients of the indices influencing reserve management effectiveness

	Condition assessment	Access assessment	Coordinative development between the reserve and community	Management effectiveness
Personnel management	.333**	.338**	.351**	.466**
Resource management	.418**	.304**	.298**	.462**
Monitoring and evaluation	.333**	.291**	.287**	.414**
Management plan	.366**	.256**	.283**	.410**
Land/forest authorities	.172**	.359**	.126**	.302**

\*\* Correlation is significant at the .01 level (2-tailed); \* correlation is significant at the .05 level (2-tailed)

## Recommendations

These survey results allow us to formulate some general observations. Among the assessment indices, issues related to management regulation, infrastructure and equipment, monitoring and evaluation, budget and community involvement received the lowest scores. These issues are the weak links in nature-reserve management. Considering the influencing factors analyzed, nature reserves in higher reserve classes, those that were established earlier, those that are located in areas with better economic conditions and those that have adequate staffing are likely to be more effective than those that lack these conditions. And the assessment indices of personnel management, resource management, monitoring and evaluation, and management plan had more effects on the management effectiveness.

From the above generalizations, we make the following recommendations in five areas:

(1) Laws and regulations: The “Law on the Management of Nature Reserves in China”, enacted in 1994, is the basis for the management of nature reserves. Many other laws and regulations have been issued, such as the “Forestry Legislation Law in China”, “Law of The People’s Republic of China on Water and Soil Conservation”, “Law of the People’s Republic of China on the Protection of Wildlife”, etc. These laws and regulations, together with administrative regulations from different levels of government departments, constitute legal systems for the establishment and management of nature reserves. However, some problems have appeared during the practical implementation of these laws and regulations. For instance, laws or regulations from different departments may contradict each other, and many laws or regulations cannot be easily implemented due to the absence of specific operative regulations. Therefore, it is urgently necessary to make these laws and regulations consistent and operational. It is also very important for the management of each nature reserve to improve its ability to implement the relevant laws and regulations. Because the aim of a nature reserve is to protect biodiversity within the reserve, the power to implement laws and regulations should be entrusted to the reserve managers.

(2) Capacity building: To meet the requirement of protecting biodiversity, all necessary departments should be established within the nature reserve and should be adequately staffed, including administration, protection, scientific research and education, resource utilization, community affairs and policy stations. Basic equipment or facilities such as work stations and patrol roads should be available in all nature reserves. New techniques and equipment, such as 3S techniques (Geographic Information System (GIS), Remote Sensing (RS), and the Global Positioning System (GPS)), should be widely used in the management of nature reserves. Civil-service systems can be implemented in nature reserves. Staff should be enrolled according to the national rules of civil service and should be paid according to the rules. This would be an effective solution to the inadequacy and instability of staffing. Furthermore, regular training should be organized to improve staff members’ professional abilities so that they can work more efficiently to improve the management of the reserve (Tshering 2003; Tyrlyshkin et al. 2003; Nemekhjargal and Belokurov 2005). All of these measures for capacity building would facilitate the improvement of resource management in the nature reserves.

(3) Management of local communities: Reserves will survive only if the surrounding community’s legitimate concerns are respected and addressed (Liu et al. 2003; Nautiyal and Kaechele 2007). To achieve the conservation goals of nature reserves, the relationships between nature-reserve administration and local communities should be harmonized.

First, ecological-compensation mechanisms should be established at the national level. These mechanisms may include subsidized loans for poverty alleviation or protection funds (Miao et al. 2006). Secondly, community affairs departments should be established in all

nature reserves to facilitate economic development in the surrounding communities, to address the specific requirements of those communities, and to smooth the relationship between development and protection. Community co-management must be applied in the process of reserve management. Many studies have indicated that management plans and management activities have been carried out successfully in many reserves because of the participation of local communities (Borrie et al. 1998; Hayes 2006; Schwartzman et al. 2000). Thirdly, improvement of living standards in surrounding communities is an important component of the resolution of conflicts between reserves and their surrounding communities (Jim and Xu 2002; Zhang et al. 2006), and also an important criterion for nature-reserve management. Many approaches can be found to facilitate community economic development. For example, providing positions for local citizens in the management of the reserve or in the development of tourism would also reduce the cost of monitoring and protection (Ouyang et al. 2002; Hayes 2006). Other examples include improving the productivity of local communities by bringing in talent and capital and by helping local citizens to improve their sense of ecological education and investment in environmental protection.

(4) Funding: Underfunding of protected areas appears to be a systemic problem in many countries (Ervin 2003b). Funding shortages and inefficient management of funds directly influence the management effectiveness of nature reserves (Ouyang et al. 2006).

First, investment from the government should be strengthened, and different strategies of budgetary support should be implemented in different types of reserves, such as developing reserve industries, seeking public and international funding, and promoting international project co-operations (Tyrlyshkin et al. 2003; Yang 1999; Zhu 2001). Second, a fair mechanism of distributing those funds is urgently needed to ensure that beneficial units receive sufficient support to help restore ecosystems or maintain biodiversity. In addition, budgetary management must be strengthened to make sure that the budget is effectively used for the protection of ecosystems. The budgetary mechanisms of the government should guide the application of funds to promoting staff quality and training, as well as to controlling investments in infrastructure. The budget of a nature reserve should not be used for tourism or economic development disguised as equipment investment.

(5) Planning, monitoring and evaluation: The biodiversity conservation outcomes are most likely to be related to the adequacy of dedicated resources and of monitoring programs, the explicit identification of clear objectives with associated performance indicators, and the considered application of management prescriptions (Parr et al. 2009). Master plans and management plans with predefined conservation goals should be developed and implemented in all nature reserves in China. The ultimate success of any natural system will depend on science-based management plans (Margules and Pressey 2000). Because tourists might cause substantial negative environmental effects (Jiang et al. 2006; Zhu 2004), control or management of tourism is needed before these negative effects take place. Therefore, reasonable management plans should be established as soon as possible to achieve the goal of ecotourism (Lv 1998; Yu 2005).

The monitoring programs should be developed closely related to the objectives of management plans (Alexander and Rowell 1999). A detailed system of indices for long-term monitoring and evaluation which could provide species-level data or other quantitative data needed for assessment should be established and applied (Stem et al. 2005; Struhsaker et al. 2005; Vellak et al. 2009). The results of continuous monitoring and regular evaluation could be used to inform the prioritization of activities and funding for all nature reserves, and modify management plans and policies (Hockings 1998; Danielsen

et al. 2000). Monitoring and evaluation can help planners and managers to assess the extent to which their plans have been implemented and resources have been conserved (Day et al. 2002; Pullin and Knight 2005). Moreover, this evaluation process can provide important scientific evidence to help government and civil society track the effectiveness of nature reserves, which should be integral activities within reserve management (Danielsen et al. 2000; Dudley et al. 2004; Hockings 2003).

## Conclusion

The Chinese government has often been more concerned with the numbers and total area of reserves than with their effectiveness (Xu and Melick 2007). As a result, many problems have emerged such as obscure laws and regulations, lack of funding for management, inadequate participation of local communities, and inadequacy of planning and monitoring. All of these shortages are reflected in our assessment results, which basically represent the current status of the management effectiveness of nature reserves in China. The inadequate level of management effectiveness represents a warning and a challenge for governments and nature-reserve managers to improve their effectiveness.

Nature reserves have been established due to the high degree of biodiversity, the existence of species richness and the uniqueness of ecosystems. Therefore, the most important consideration in nature-reserve management is to protect these values more effectively. Rather than creating new nature reserves, we argue that China would be better advised to embark on the arduous process of improving the management effectiveness of nature reserves. Assessment of management effectiveness is an effective monitoring tool for measuring and reporting the progress of management and should be applied every 2 years (Stolton et al. 2007). To be truly effective, the results of these assessments must be carefully balanced and integrated with real-world considerations that ultimately decide whether a conservation strategy will succeed or fail (Caro et al. 2009).

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