

Conserving plant species with extremely small populations (PSESP) in China

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Abstract Over the past decades, biodiversity conservation in China has achieved a number of successes. However, due to inadequate conservation policies, poor implementation and lack of financial support, wild plant species that are extremely small in population size and therefore seriously threatened have not had the attention they require. But the new concept of plant species with extremely small populations (PSESP), first promulgated in Yunnan Province, is becoming more widely accepted in China. Several national and regional-level conservation strategies and actions for conserving China's PSESP are being implemented over the next 5 years. With this new policy framework leading the way, plant conservation in China is set to make important new advances.

Keywords Conservation actions · Conservation guidelines · Chinese plant conservation · PSESP in China

Introduction

China is one of the worlds' mega-biodiversity countries and over the past decades both in situ and ex-situ conservation actions have achieved some success. The first national-level nature reserve was created in 1956 and by the end of 2009, 2,541 terrestrial nature reserves with a total area of 147,000,000 ha accounting for 14.7 % of China's territory, had

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been established (Ministry of Environmental Protection (MEP) 2010). Plant protection has also been strengthened. Over 20,000 higher plant species (around 60 % of China's total) have been conserved at some 160 botanical gardens and arboreta and a National Germplasm Bank of Wild Species has been established in Yunnan at the Kunming Institute of Botany, Chinese Academy of Sciences. In 1999, the State Council of China promulgated a list of National Key Protected Wild Plants (First Group) containing 302 species in 194 genera and 92 families; these plant species are legally managed and protected by the central government. To further evaluate the conservation status of China's plant species, Wang and Xie (2004) published the *China Species Red List (Vol.1)* patterned after the IUCN Red List and outlining basic conservation status. Furthermore, in response to the Global Strategy for Plant Conservation published by Botanic Gardens Conservation International in cooperation with the Convention on Biological Diversity and the United Nations Environment Programme, China's Strategy for Plant Conservation was published (CSPC Editorial Committee 2008), declaring the nation's commitment to plant conservation and establishing targets to reduce the loss of plant diversity (Li and Pritchard 2009). Implementation of this plan is a cooperative effort between the Chinese Academy of Sciences, State Forestry Administration and the Ministry of Environmental Protection. The strategy proposes 16 targets that can be used as a framework for Chinese plant conservation. For example, the goal of Target 7 is to protect some 90 % of China's national key protected plants through in situ efforts. Target 8 aims to reintroduce 10 % of China's threatened plant species to their natural habitats and establish monitoring programs to track management success.

However, these conservation achievements are not sufficient to protect China's high level of plant species diversity (Jiang and Ma 2009). The country's rapid economic growth, overexploitation of natural resources and resulting habitat degradation, pollution problems and stresses associated with global climate change are seriously challenging plant conservation in the new millennium. At the same time, management issues (e.g. lack of conservation awareness from governmental officials and local people, an imperfect legal system) and inadequate basic research on endangered species also create barriers to success. Conserving the most threatened wild species in China is thus more urgently needed than ever before (Lopez-Pujol et al. 2006).

Several additional factors hinder the progress of plant conservation action in China. One of the most important is that there is no clear concept of which wild species should receive protection priority. In fact, determining the conservation status of plant species is one of the outstanding problems that has limited Global Strategy for Plant Conservation progress (Jackson and Kennedy 2009). And even though it is the most widely used and all-encompassing system for global and national plant conservation, the IUCN Red List approach is also imperfect as the probabilistic assessment of the likelihood that a species in a particular threat category will go extinct within some stated time frame cannot be used as a robust prediction about the fate of a particular species for which conservation actions could be implemented (Lamoreux et al. 2003; de Grammont and Cuarón 2006; Rodrigues et al. 2006; Miller et al. 2007; Mace et al. 2008; Harris et al. 2012). In China, although categories for threatened wild species have been established based on IUCN classifications and despite strong recommendations from academic experts, little attention to these standards has been forthcoming from authorities (for comparison with US efforts, see Harris et al. 2012). Thus, only plant species listed as National Key Protected Wild Plants (first group) have been subject to conservation actions; little has been undertaken to conserve species listed on the *China Species Red List (Vol. 1)* (Wang and Xie 2004).

New Chinese policy focus: plant species with extremely small populations (PSESP)

To address this problem for the most threatened plant species in China, a new conservation action concept focused on PSESP was recently proposed (Ren et al. 2012). This new policy focuses on populations of plant species that are extremely small in number with much lower than minimum viable populations for long-term survival in the wild. The PSESP concept refers to species with low numbers due to serious human disturbance in recent times; it excludes naturally rare species (e.g. *Tupistra pingbianensis*, Qiao et al. 2010). Small remaining populations, restricted habitat, serious human disturbance and extremely high risk of extinction are key characteristics of PSESP.

Specifically, the PSESP concept is based on recognition of species with: (1) unique topography and habitat; (2) extremely limited distribution range; (3) enormous pressure due to habitat destruction; and (4) habitat in plant diversity hotspot areas with poor economic development. In addition to the expertise of scientists and officials, the importance of cultural understanding about plant conservation was also incorporated within this concept by attempting to consider traditional Chinese values toward nature and the acceptability of plant conservation to local peoples (Grumbine and Xu 2011). In China, few conservation actions can be performed without the approval of local residents who may be reluctant to accept IUCN-type guidelines.

Some of the key characteristics of PSESP are consistent with the IUCN criteria. For example, if species meet quantitative thresholds of any of the following criteria, they will be added to the IUCN Red List: (1) declining population size, (2) small geographic range, (3) small population size plus declining numbers, (4) very small population size, and (5) quantitative analysis of extinction probability (Harris et al. 2012). The PSESP concept includes (2) and (4) above. Economic perspectives are also taken into account. Nevertheless, many countries (including China) produce local or regional imperiled species lists that are inconsistent with the IUCN Red List. For example, Wilcove and Master (2005) estimated that approximately 90 % of US imperiled species (including animals, fungi, and plants) are not included on the federal list. In the detailed comparison by Harris et al. (2012) between imperiled species listed on the IUCN Red List and the US Endangered Species Act, they found 40.3 % of IUCN-listed US birds and more than 80 % of lesser-known taxa that were not also listed by the act.

Due to its tremendous plant species diversity (Yang et al. 2004), Yunnan province was the place where China's PSESP was initiated when in 2005 *A Proposal for Conserving the PSESP in Yunnan Province of China* was submitted to the State Forestry Administration through the Yunnan Forestry Department. Specific implementation measures for PSESP conservation were consolidated in 2009 when a *Planning Outline of Rescuing and Conserving Yunnan's PSESP (2010–2020)* was approved by the provincial government. On the basis of this work, an "*Emergency Action Plan for Rescuing and Conserving Yunnan's PSESP (2010–2015)*" was issued in which conservation actions and funding for 20 PSESP were specifically addressed (see basic information and IUCN evaluation for the 20 PSESP in Table 1). These plant conservation plans passed central government evaluation indicating the level of acceptance of the concept throughout China's bureaucratic system.

National-level conservation guidelines for PSESP

Actions in Yunnan led to the March 2012 national-level *Implementation Plan of Rescuing and Conserving China's PSESP (2010–2015)*. The *Implementation Plan* is a milestone for

Table 1 Key demographic attributes and IUCN evaluation of 20 ESPPS for conservation priorities in Yunnan, China

Species	IUCN evaluation	Numbers (I,II,III,IV) ^a	Populations (i,ii,iii,iv) ^b	Occurred within the protected area
<i>Acer yangbiense</i>	CR	I	i	No
<i>Annamocarya sinensis</i>	CR	II	iv	Yes
<i>Aquilaria sinensis</i>	CR	IV	ii	Yes
<i>Camellia fascicularis</i>	CR	–	iii	No
<i>Coptis quinquesecta</i>	CR	IV	i	Yes
<i>Cycas Diannanensis</i>	CR	III	iii	Yes
<i>Cycas hongheensis</i>	CR	III	i	No
<i>Cyclobalanopsis sichourensis</i>	CR	I	i	No
<i>Diploknema yunnanensis</i>	EN	I	i	Yes
<i>Keteleeria xerophila</i>	CR	–	i	No
<i>Malaria oleifora</i>	CR	IV	ii	No
<i>Manglietia ventii</i>	CR	II	iii	Yes
<i>Manglietiastrum sinicum</i>	CR	I	iii	Yes
<i>Mastixia euonymoides</i>	EN	I	ii	Yes
<i>Myristica yunnanensis</i>	EN	IV	iii	Yes
<i>Nyssa yunnanensis</i>	CR	II	ii	No
<i>Paraisometrum mileense</i>	CR	III	i	No
<i>Pinus squamata</i>	CR	II	i	Yes
<i>Pinus wangii</i>	CR	II	iii	Yes
<i>Poncitrus polyandra</i>	CR	I	i	No

^a I, 0–10; II, 11–100; III, 101–1000; IV, $\geq 1,000$ individuals

^b i, single population; ii, 2 populations; iii, 3–4 populations; iv, 5–9 populations

PSESP management. The plan specifies 120 PSESP and assigns their conservation priority. Since it is impossible to conserve all PSESP due to inadequate financial support and lack of detailed information of species biology, the first 120 PSESP were selected based on their status as national key protected wild plants; their total numbers of individuals estimated at less than 5,000; their restriction to only one or two known localities; their recognition as national or provincial key protected endemic species; and their great potential for economic or scientific value. In addition, basic information on distribution for the 120 PSESP has already been documented so that specific conservation actions can be proposed (Ren et al. 2012).

Conservation action in China is aided due to the fact that the central government controls all sovereign lands. Therefore, it is not difficult to re-zone some areas for a different use, e.g. as nature reserves or conservation sites for protecting PSESP. But for effective PSESP management implementation, there must be cooperation between government departments (especially national or provincial nature reserve management bureaus), scientists and local people. For scientists, cooperative research on PSESP is urgently needed, especially with regard to population genetics, reproductive biology, population and community ecology. Local communities are usually willing to support conservation when they understand what is required and when they receive reasonable compensation for their land when it is appropriated for conservation activities. In addition,

scientific education and government-sponsored publicity for conserving PSESP are also important, especially to support local peoples' awareness.

Conservation of PSESP also requires financial support. From 2010 to 2015, for management of the first 120 PSESP, it is expected that costs will be more than one billion RMB. Monies will be allocated as follows: 54 % for in situ conservation; 33 % for ex-situ conservation; 7 % for conservation training; 4 % for germplasm conservation; and 2 % for reintroduction experiments. Funding will be raised from central, provincial and local governments.

Conservation for the first 120 PSESP will be multi-faceted. Actions will include collection of PSESP for the National Germplasm Bank of Wild Species at the Kunming Institute of Botany, Chinese Academy of Sciences. In situ conservation will be carried out as soon as possible to ensure that PSESP will not disappear. Breeding and propagating technology will be developed to increase individual numbers. Seedling production methods will employ hand cross pollination so that genetic diversity can be maintained. Reintroduction of propagated plants into the wild will be a key strategy. Public education for conservation awareness, especially for local people, will be conducted for all these implementation steps.

By the end of 2015, five goals for PSESP conservation are expected to be reached. Individual numbers for all 120 PSESP will be listed and a monitoring and protection management information system will be established. The natural habitat of the PSESP will be effectively conserved. Germplasm resources of the 120 PSESP will be collected and conserved. Individual numbers will be increased due to propagation. Reintroduction actions will be implemented for at least 15 PSESP.

Current conservation actions for PSESP in Yunnan

With support from State Forestry Administration of China and the Yunnan Forestry Department, along with several NGOs (Fauna & Flora International, Botanic Gardens Conservation International and the Green Development Foundation), several PSESP reviews have already been conducted. For example, *Acer yangbiense*, a species with only five individuals recorded so far, has been subject to genetic survey work and hand-pollination for increased fruiting (Sun and Yin 2009; Zhao 2011). This has resulted in 1,606 saplings being propagated and conserved at the Kunming Botanical Garden, Chinese Academy of Sciences (Zhao 2011). Reintroduction of this maple to its native habitat will be carried out soon. Other current PSESP studies are focused on the ex-situ conservation biology and reintroduction/restoration of *Quercus sichouensis* (Xia et al. 2008), *Manglietiastrum sinicum* (Sun et al. 2005, 2007a, b; Zheng and Sun 2009), *Michelia coriacea* (Zhao and Sun 2009; Zhao et al. 2009, 2012), *Trigonobalanus doichangensis* (Sun et al. 2006, 2007a, b; Chen et al. 2007; Zheng and Sun 2008; Zheng et al. 2009; Chen and Sun 2010), and *Rhododendron protistum* var. *giganteum* (Ma et al. 2012). In addition, the first experimental field demonstration base for general in situ PSESP reintroductions has been established in southeast Yunnan. Moreover, in Yunnan, any new development project must take PSESP into consideration during the environmental review process. This regulation may soon be adopted by other provinces in China.

Further policy and publication activities will help promote and encourage further acceptance of PSESP across China. In 2013, a textbook on *PSESP and Conservation in Yunnan* will be published. The central government is in the midst of finalizing plans for a National Key Laboratory for PSESP Conservation that will be located at the Kunming

Institute of Botany. Yet, given that it is impossible to create in situ reserves for all PSESP using the existing Chinese protected area system, five selected plants in Yunnan (*Q. sichourensis*, *Diploknema yunnanensis*, *M. sinicum*, *Nyssa yunnanensis* and *Paraisometrum mileense*) are being used to establish a novel category of small-scale plant-specific protected areas. In Asia, it should be noted that such small protected areas aiming to conserve certain plant species have already been implemented in Malaysian Borneo where a “Rafflesia Conservation Area” of 356 ha under the Sabah Forestry Department in 1984 has been designated in an area that is increasingly under shifting agriculture pressure (Payne 1986). There is also a “Rafflesia Sanctuary” within the former Mamut Copper Mine lease in Ranau District (jointly managed by Sabah Parks and the lease holder) (Nais 2001). These two sites specifically protect extremely small populations of *Rafflesia keithii* Meijer.

Over the next 5 years, PSESP efforts will likely improve plant conservation in Yunnan and will soon be scaled up to the national-level across China. For example, in 2012, a nation-wide biological resources inventory incorporating PSESP review standards was conducted. From a slow start only 13 years ago, plant conservation in China is now set to enter a new era where policies on paper are better matched by implementation actions on the ground.

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