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Establish a special conservation zone for the captive giant panda

Yi-ping Chen[a,b], Aaron M. Ellison[c] and Yong-long Lu[d]

aSKLLQG, Institute of Earth Environment, Chinese Academy of Sciences, Xi'an, China; bCollege of Geography and Environment science, Northwest Normal University, Lanzhou, China; cHarvard University, Harvard Forest, Petersham, MA, USA; dResearch Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing, China

ABSTRACT

The giant panda (*Ailuropoda melanoleuca*) is recognized worldwide as an icon for wildlife conservation. Since the introduction in 1992 of reliable methods for artificial insemination, the population of captive pandas has grown to approximately 350 individuals in 2013. However, captive panda populations are harmed by environmental pollution, diseases transmitted from domestic animals, and other anthropologenic activities. Although the Chinese government has proposed the creation of a Giant Panda National Park, there are at least three reasons that suggest that it is premature to reintroduce captive pandas into this proposed national park. First, habitat fragmentation remains the greatest threat to survival of giant pandas; second, most captive pandas are hybrids of the Sichuan and Qinling subspecies and release of hybrids may lead to further introgression between the two subspecies; and third, captive pandas may be competitively inferior to wild pandas in the region, and may not survive fights for food or mates. As an alternative, we suggest establishing a special conservation zone in the Shennongjia National Nature Reserve for wild training of captive pandas prior to their reintroduction into the National Park.

Status of the captive giant panda conservation

The giant panda (*Ailuropoda melanoleuca*) is recognized worldwide as an icon for wildlife conservation. According to the State Forestry Administration (SFA) of China, the number of wild pandas had increased to 1864 individuals by 2015 because of habitat protection and the establishment of successful captive breeding centers (Chen and Ellison 2017; Liu 2015).

Seven *ex situ* centers have been established since 1953, and there have been four major milestones in *ex situ* breeding of pandas in the last 60 years (Xie 2012). The first was the successful rearing of giant pandas in captivity in 1955. In 1964, the first panda was born in captivity (Xie 2012). The first panda conceived through artificial insemination was born in 1978, and the first panda was weaned successfully on artificial formula in 1992 (Xie 2012). The total
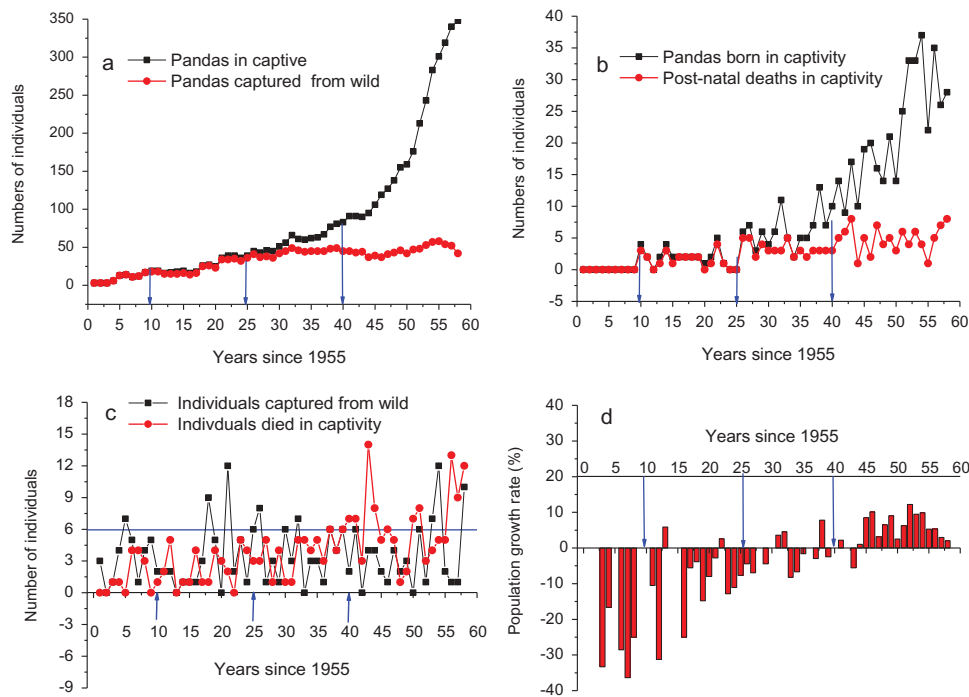
Figure 1. Changes in captive panda populations (1955–2012), based on data in ref. 4. (a) Total number of pandas in captivity (black line) and numbers of captive pandas captured from the wild (red line); (b) Annual number of births (black line) and postnatal deaths (red line) of captive pandas; (c) Number of pandas captured each year (black line) and number of pandas that died in captivity (red line); (d) Annual population increase of all captive panda populations. Arrows indicate years in which the first panda was: successfully reared in captivity (1955); born in captivity (1963); born using artificial insemination (1978); and reared on artificial formula (1992).

number of captive pandas and the number of pandas born in captivity increased gradually from 1955–1978, and then increased more rapidly thereafter, as *ex situ* technology for captive breeding improved (black lines in Figure. 1(a,b)). At the same time, the number of individual pandas captured from the wild and the postnatal mortality rate remained roughly constant (red lines in Figure. 1(a-c)). Finally, population growth rate of captive pandas was negative before 1991, but has been positive since 1992 (Figure 1(d)). In summary, maintenance of the captive population of pandas relied on capture of individuals from the wild before 1978, but with the introduction of reliable methods of artificial insemination, captive populations now increase without additional captures of wild individuals.

Captive panda populations face their own risks

From the introduction in 1992 of reliable methods for artificial insemination until 2013, the population of captive pandas grew to approximately 350 individuals (Xie 2012). However, the maintenance of captive panda populations is not without its own risks. Breeding centers are located near cities and urban diseases transmitted by people and animals can spread rapidly into captive panda populations. For

example, several female individuals of the Qinling subspecies of giant panda housed at the Shaanxi Wild Animal Research Center were infected with canine distemper virus transmitted from domestic dogs, and some reproductive female pandas were killed by this virus (Hvistendahl 2015). Its rapid spread caused international alarm and illustrated how easy it can be to rapidly wipe out many years of *ex situ* conservation achievements.

Wild panda populations now are isolated on six mountains in Gansu, Shaanxi, and Sichuan provinces. These natural environments are fragile and sensitive to external perturbations, and pandas are suffering from the risks of habitat fragmentation and loss resulting from natural disasters, climatic change, and expanding human activity (Chen and Ellison 2017). The Chinese government has proposed the creation of a Giant Panda National Park spanning three provinces and in which the pandas can roam freely (*China Daily*, 12 April 2017; "As of 2017, the Baidu Baike listed on its website http://baike.baidu. com/link") (pink area in Figure 2(a)). The plan for this proposed national park, released in April 2017, would set aside 27,134 km² – more than three times the size of Yellowstone National Park in the USA – within the Min, Qionglai, and Daxiangling Mountains in Sichuan province, part of the Qinling Mountain in Shaanxi Province, and the Baishuijiang section in Gansu Province. Current estimates of
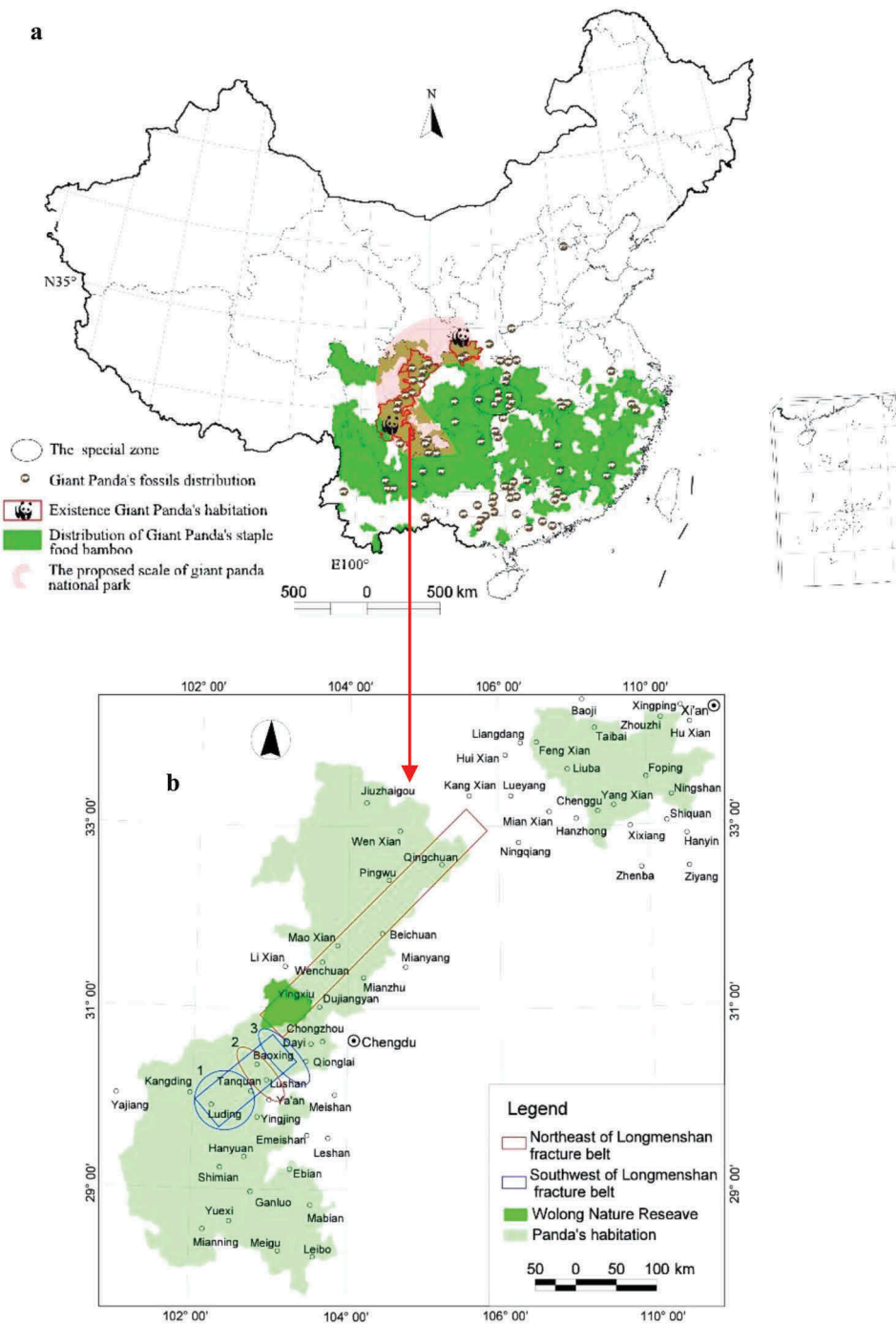
Figure 2. (a) Current (red polygon) and fossil (gray points) distribution of the giant panda; distribution of its staple food (green), bamboo in the genera *Bambusa, Neosinocalamus, Phyllostachys, Chimonobambussa, Oiongzhuea, Drepanostachyum, Fargesia, Yushania, Pleioblastus, Bashania* and *Indocalamus*; the proposed giant panda national park (pink); and our proposed special conservation zone (black oval); (b) Vulnerability of giant pandas to potential earthquakes along the Longmenshan fracture belt. The blue circle is the potential earthquake zone (Chen et al. 2013).

panda subpopulation sizes within the proposed park are: 655 pandas in the 10,013 km² Min section; 549 pandas in the 10,164 km² Qionglai-Daxiangling section; 298 pandas in the 4386 km² Qinling section; and 111 pandas in the 2571 km² Baishuijiang section (*China Daily*, 12 April 2017).

With rapid industrialization, environmental pollution is increasing and following a similar trajectory to that previously seen in developed countries (Seinfeld

2004). Recent studies also have revealed that captive pandas are exposed to high concentrations of toxic chemicals, including PCDDs (polychlorinated didenzo-p-dioxins), PCDFs (polychlorinated dibenzo-furans), PCBs (polychlorinated biphenyls), PBDE (polybrominated diphenyl ethers), and heavy metals (Chen et al. 2016; Chen et al. 2017a; Chen et al. 2017b; Chen et al., forthcoming). A detailed study of the Qinling subspecies demonstrated that exposure to
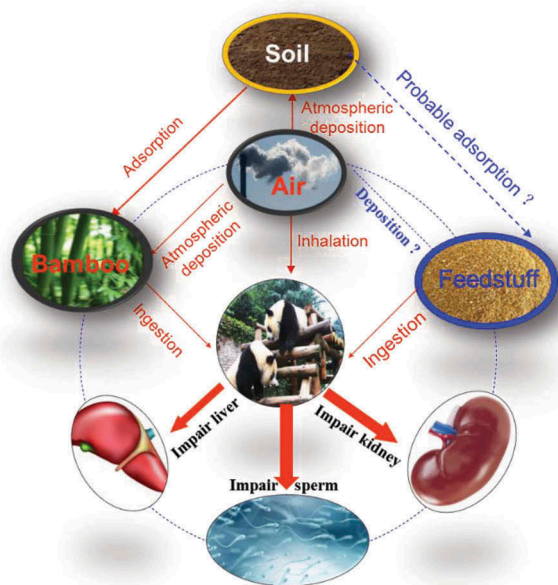
Figure 3. Source of pollutants that affect the health of giant pandas in captivity.

these toxicants was associated with liver, kidney, and reproductive impairment in captive pandas, and that air pollution was the primary source of the elevated pollutants detected in panda blood (Figure 3). These threats to panda health have not been considered in siting the proposed national park, but the threats may affect pandas within the park (Chen et al., *unpublished data*).

Additional issues threaten pandas in the proposed Giant Panda National Park. First, habitat fragmentation is the largest threat to survival of giant pandas; approximately 1860 individuals remain spread across 33 fragmented habitats. Habitat fragmentation also results in high rates of panda mortality when bamboo dies after flowering (Zhao 2007) or after natural disturbances such as fire, infectious disease, extreme weather events, or earthquakes. Moreover, the primary habitat in the proposed national park of the Sichuan subspecies is in a tectonically active zone along the Longmenshan fracture belt. Earthquakes can disturb pandas and compromise panda conservation efforts, and earthquakes occurred along the Longmenshan fracture belt in Wen-chuan in May 2008, Ya-an in April 2013, and Jiuzhaigou in August 2017 (Figure 2(b)). Second, most of the captive pandas are hybrids of the Sichuan and Qinling subspecies. Release of these hybrids into existing habitat in the southwest may lead to further introgression between the two subspecies. Third, captive pandas released into existing habitats in the southwest may be competitively inferior to wild pandas in the region, and may not survive fights for food or mates. Considering all these threats to the long-term survival of the giant panda, we think that new approaches are needed to conserve and protect this conservation icon.

New approaches for captive panda conservation

By analogy with the special economic development zones, we suggest that the panda merits a special conservation zone that crosses administratively geographic boundaries. Special economic zones with development policy preferences have been established to stimulate economic and social development in Shenzhen (Guangdong Province) and Pudong (Shanghai City). Thus, there are precedents in China to establish special zones, which could provide a viable method and policy preferences to conserve giant pandas. We therefore suggest that a special conservation zone outside of the proposed park boundaries should be established for wild training of captive pandas and their subsequent reintroduction into natural habitats.

Note that we are not suggesting immediate reintroduction of captive pandas into existing habitat within the proposed national park. The China Conservation and Research Center for the Giant Panda has reintroduced seven pandas into the wild, but the success of these reintroductions remains uncertain. Successful reintroductions will require unfragmented and unpolluted habitats, and habitat reconstruction also should be undertaken together with mechanisms to increase the economic well-being of people who will be displaced by the creation of new protected areas. New data also have revealed that old-growth forests are associated strongly with panda populations, perhaps because old-growth trees provide large cavities for birth and weaning of panda cubs (Zhang et al. 2011).

For four reasons, the Shennongjia National Nature Reserve provides an ideal location for our proposed special conservation zone with special policies for wild training and reintroduction of pandas would be. First, Shennongjia National Nature Reserve is within the historic range of the panda and within the distributional range of more than 60 species of bamboo that provide their staple food (Geng, Wang, and Wu 1980; Yi and Jiang 2010) (green area in Figure 2(a)). Second, just 100 km national roadway (G209) and about 58 km provincial (S307) currently pass through the Shenlongjia Natural reserve, so habit fragmentation is relatively low. Third, although the nearby Second Motor Corporation is a potential source of hazardous pollutants, its location is downwind of Shenlongjia. Fourth, its core section is ≈3300 km² and has ≈85% vegetation cover, including old-growth forests, which provides high-quality habitat for pandas. A broad set of boundaries for this special conservation zone could include regions to the north of the Yangtze River, south of the Hanjing River, and east of the Daba and Wu Mountains (Figure (2a)).

We are aware that ≈80,000 people currently live within the core section of Shennongjia National

Nature Reserve, and many of these people live in poverty. Concomitant with the establishment of a special conservation area for pandas, the people should be provided with new homes on better agricultural land or in urban centers where job training is more readily available. Such relocation and job training would require an investment of ≈5 billion RMB (US ≈$1 billion).

Finally, we propose the establishment of a national engineering research center for giant panda breeding and reintroduction that would fit into China's system of national engineering research centers. Such a center could benefit from international cooperation with experts in park design, landscape ecology, animal ecology, and panda reproduction.

If our proposed project proves successful, the panda will continue to be an icon for conservation and serve as an example for protection and management of other threatened and endangered species. Moreover, this special conservation zone could be used for reintroduction of captive pandas into the wild, and would be a global resource for scientific research and public education.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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