The giant panda (*Ailuropoda melanoleuca*)is one of the oldest and most well-known global icons of biodiversity. It has been classified as Endangered on the International Union for Conservation of Nature (IUCN) Red List for over two decades and has served as the symbol of the World Wildlife Fund (WWF) since the program’s inception in 1961 (WWF, 2009 referenced by Ran *et al.* 2009). Despite ongoing conservation efforts, giant panda populations continue to be threatened; these animals face a variety of challenges such as mismanagement of reserves, poaching, susceptibility to predation, high mortality of juveniles, overlapping generations, and bamboo shortages (Ran *et al.* 2009; Zhu *et al.* 2010). The most hostile problem these pandas face is habitat loss and fragmentation, which is primarily caused by anthropogenic expansion and infrastructure development. Conflicts between economic growth and protection of habitat of pandas further complicate the issue of conservation. The general consensus in the field suggests that protecting high-altitude conifer forests in China, the preferred habitat of the giant panda, is the most effective method of conservation. Recent developments focus on improving the process of reintroduction of captive giant pandas into the wild as a secondary conservation measure. There is still a lot of progress to be made in conservation research and implementation.

Many studies suggest that the primary factor inhibiting giant panda populations is human expansion and consequent habitat loss and fragmentation. Zhu covers the history of human expansion in China over the past 300 years, and explains the impact on giant panda populations (2010). During the Qing Dynasty (1661-1911), people migrated to the mountains as a result of agricultural developments and major policy changes, which led to deforestation and exploitation of mountain resources. Ran, Zhang, and Zhu all address the issue of habitat fragmentation due to roads, highways, dams, and tourism and believe that habitat fragmentation is the most potent threat (Ran *et al.* 2009; Zhang *et al.* 2007; Zhu *et al.* 2010). Zhu affirms that the drastic decline in pandas is concomitant with a sharp increase in the human population in China; increases in Chinese city populations (as high as 41-fold) are correlated with decreases in panda habitats by nearly 31-fold over the same period (2010). Thus, we see that human expansion leads to habitat loss, which directly affects panda populations.

Many studies also acknowledge secondary factors that are contributing to the endangered status of the giant pandas. One factor is the narrow range of pandas due to their restricted habitat and specific dietary preferences. Qi, Zhang, and Ran address the dependency of pandas on the availability of bamboo. Giant pandas are solitary animals that feed exclusively on nutrient-poor bamboo in high altitude forests in western China and must consume between twenty six and eighty four pounds of bamboo daily (Qi *et al.* 2011). Consequently, pandas are sensitive to fluctuations in bamboo availability; according to Ran, a bamboo die-off in the 1970s and 1980s led to the deaths of more than two hundred pandas in the Minshan and Qionglai Mountains (2009). Recent habitat degradation occurred in the Wenchuan earthquake in May 2009. According to Ran, this earthquake damaged more than 1,200 km² of giant panda habitat (about 5.2% of the total known panda habitat). Further, giant pandas have long generation times (the time it takes for a cub to reach breeding age) between four and eight years and low reproductive rates (Zhu *et al.* 2010). Zhu suggests that the slow breeding rate of giant pandas inhibits recovery from incidents such as illegal hunting, natural disaster, and other anthropogenic causes of death (2010). All of these factors are compounded by fragmentation of the panda’s habitat due to anthropogenic expansion.

Since 1963, reserves have been established to protect the giant panda (Ran *et al.* 2009). Numerous reserves have been established recently, with over 40 decreed after 1990 and over 26 in the past ten years (He2007; Yan 2007 referenced by Ran 2009). Natural reserves serve to protect the habitat and bamboo of pandas, and also are patrolled to prevent poaching or logging. Other reserves, such as those in zoos, serve primarily to breed pandas and conduct research on mating, disease, and behavior. The goal of captivity breeding is to eventually introduce the pandas to the wild. However, reserves have many drawbacks. Many reserves do not fulfill their conservation mandate due to lack of sufficient funding, poor infrastructure, and incapacity for monitoring and protection (Ran *et al.* 2009). Further, only 71% of panda habitat and 23.7% of potential habitats are protected by panda reserves and significant portions of habitat are currently exposed to human activities (State Forestry Administration 2006 referenced by Ran 2009). Pandas bred in captivity have low genetic diversity compared to wild pandas and reintroduction to natural habitats has failed in many cases (Ran *et al.* 2009). The captive panda Xiangxiang was trained for two years before it was reintroduced to Wolong National Nature Reserve in 2006, but its dead body was found less than a year after reintroduction (Di 2007 referenced by Ran 2009). Pandas have high risk of mortality when first reintroduced due to inexperience, and may fall prey to wild dogs and leopards (Du *et al.* 2012). Thus, we see that reserves have many weaknesses and are not currently providing effective protection for giant pandas.

Recent developments in the field focus on improving reintroduction strategies. Du conducted a study that suggests pandas are born with innate predator recognition and recommends developing anti-predator behavior before pandas are released into the wild from captivity (2012). Based on new findings on the importance of old-growth forests (those that have been around for over 120 years) to panda mothers to rear their young, Swaisgood believes that conservation and reintroduction efforts should focus on these specific areas (2010). Similarly, Qi suggests that differences in male and male preferred habitat should be considered in reintroduction; females have more restrictive preferences than males of high altitude conifer and mixed forests with >10 to ≤ 20⁰ slopes (2011). Other solutions include establishing a corridor between panda populations to increase genetic diversity, reducing the number of people who come into the mountains (which may lead to further economic-conservation conflict due to tourism), developing the local economy to prevent exploitation of the forests, and relocating wild pandas to reserves (Zhang *et al.* 2007; Zhu *et al.* 2010). However, many of these proposals have yet to be implemented.

Giant pandas face a variety of challenges such as habitat loss, low reproductive rates, and bamboo shortages. One of the biggest obstacles in panda conservation is the conflict between human expansion and protecting the pandas. Ran and Zhu both address the conflict between farmers and conservation efforts for pandas. Bamboo shoots are a major source of income for local farmers, which have led to conflicts between conservation and development in these forest areas. Cultivation of other crops such as maize, potato, and sweet potato encroaches upon panda habitat today (Ho 1959 referenced by Zhu *et al.* 2010). Roads, highways, and other infrastructures necessary for human development in these areas lead to harmful fragmentation of habitat. Further, Swaisgood calls for an updated estimate of population size, which is crucial for future research. The outdated figure on panda population size limits the application of growth models. A new survey will determine the efficacy of recent conservation strategies and dictate future efforts. A protection policy for forest conservation against further anthropogenic expansion should be enforced, and corridors between fragmented habitats should be created to promote genetic diversity in giant pandas (Zhang *et al.* 2007). One method of increasing the carrying capacity is to restore damaged habitat; logging should cease and humans should emigrate out of these areas (Zhou 1997). These conservation efforts may conflict with human expansion, but the giant panda—the global icon of biodiversity—must be protected.

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