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Essay

Integrating and updating wildlife conservation in China

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China has about 11% of the world's total wildlife species, so strengthening China's wildlife conservation is of great significance to global biodiversity. Despite some successful cases and conservation efforts, 21.4% of China's vertebrate species are threatened by human activities. The booming wildlife trade in China has posed serious threat to wildlife in China and throughout the world, while leading to a high risk of transmission of infectious zoonotic diseases. China's wildlife conservation has faced a series of challenges, two of which are an impractical, separated management of wildlife and outdated protected species lists. Although the Wildlife Protection Law of China was revised in 2016, the issues of separated management remain, and the protected species lists are still not adequately revised. These issues have led to inefficient and overlapping management, waste of administrative resources, and serious obstacles to wildlife protection. In this article, we analyze the negative effects of current separated management of wildlife species and outdated protected species lists, and provide some suggestions for amendment of the laws and reform of wildlife management system.

China harbors an exceptional abundance of species, such as over 7,300 vertebrate species (about 11% of the world's total) and a considerable proportion of endemic biodiversity [1]. Because of its high species richness, strengthening China's biodiversity conservation is of great global significance. Despite some successful cases (*e.g.* Giant Panda [2] or Crested Ibis [3]) and increasing conservation responses in some habitats [4], 21.4% of China's vertebrate species are threatened [5] primarily by overexploitation and habitat destruction [6] — a figure higher than the world average (about 20% [7]). Poaching and illegal wildlife trade in China pose serious threats to native wildlife and throughout the world [8–10]. A large number of animals or their products are smuggled into China, such as pangolins [11], turtles [10,12], and ivory [13]. The illegal trade and wildlife consumption not only threaten endangered species, but also increase the risk of transmitting serious infectious diseases, such as SARS in 2003 [14] and COVID-19 in 2019 [15,16]. Given the scale of China's wildlife trade, the protection and management of native and exotic species in China is urgent and imperative.

The first Wildlife Protection Law of China (WPLC) and the 'national key-protected species list' (PSL I) were introduced in 1989. According to the WPLC, terrestrial and aquatic species are managed by the forestry and fisheries departments, respectively. To complicate matters, several other departments are involved in managing wildlife trade. For the next three decades, the issues of separated management and an outdated protected species list were exposed [17,18]. Updating the PSL I will require close cooperation between forestry and fisheries departments, but unfortunately overlapping management by separate agencies has led to administrative conflicts that have postponed this important work. Although the WPLC was revised in 2016, these issues still remain, which has led to inefficient and overlapping management, waste of administrative resources and serious obstacles to wildlife protection.

In recent years, the Chinese government has been committed to biodiversity conservation [1]. Some scholars have called for updating the protected species lists [19]. In particular, major outbreaks of infectious diseases caused by wild animals have delivered severe warnings. Because of the outbreak of COVID-19 in China, on February 24, 2020, China's top legislature comprehensively prohibited the consumption of terrestrial wildlife to protect public health [20]. This decision requires that the State Council and its relevant departments, along with provincial administrative departments, improve law enforcement, clarify the responsibility of law enforcement and adjust relevant species lists and supporting regulations. It's clearly time to revise the WPLC again, in order to integrate wildlife management and update the protected species lists to provide strong legal support for wildlife protection.

Administrative conflicts hinder wildlife management

In the light of China's management system of protected areas, all nature reserves are under the jurisdiction of the forestry department (National Forestry and Grassland Administration). However, the forestry department has no right to manage aquatic animals in nature reserves. The fisheries department (Ministry of Agriculture and Rural Affairs) is tasked with this responsibility, but it is difficult for the fisheries department to enter nature reserves to carry out protection measures for aquatic animals. Three exemplary cases are the Green Sea Turtle (*Chelonia mydas*, Huidong Gangkou Sea Turtle National Nature Reserve), the Giant Salamander (*Andrias davidianus*, Zhangjiajie Giant Salamander National Nature Reserve) and the Yangtze Finless Porpoise (*Neophocaena asiaeorientalis*, Tongling Freshwater Dolphin National Nature Reserve). In each case, the forestry department is in charge of the land of the nature reserve, but has no right to manage these target species. The fact that aquatic animals and their habitats are managed separately by two departments has resulted in inefficient management, hindrance of wildlife conservation and ineffective enforcement of laws [8].

According to Chinese law, a management fee must be paid to the administrative department if someone wants to harvest or import wild animals for captive breeding or other use. Power over wildlife management can bring monetary benefit to departments. Therefore, competition for species

Figure 1. Two of China's critically endangered turtle species.
Left: Juvenile Big-headed Turtle (*Platysternon megacephalum*). Right: Yellow-margined Box Turtle (*Cuora flavomarginata*) Photos: Shiping Gong.

management rights between forestry and fisheries departments has been a long-standing issue. For example, with some amphibians and amphibious reptiles (*e.g.*, frogs, freshwater turtles, and non-native crocodiles [21]), instead of clarifying responsibilities, both the forestry and fisheries departments declare that they have the right to manage these animals, and can give official permission to harvest for captive breeding. The responsibility for law enforcement and supervision is not clear due to the simultaneous management of two departments, which inevitably leads to the two departments shirking responsibility. Regarding the supervision over wildlife farms, the two departments usually replace supervision with giving permission, which can easily promote illegal wildlife trading. For example, illegally collected wildlife is often laundered using official licenses for trade or captive breeding [22]. The management of wildlife trade involves multiple departments (*e.g.*, forestry department, fisheries department, market supervision departments, and customs). The lack of collaboration among these departments leads to lax enforcement, which makes illegal wildlife trade exist for a long time (*e.g.*, illegal turtle trade; see Supplemental information).

Outdated lists of protected species impede wildlife conservation

Lists of protected species are the basis for law enforcement. There are two national protected species lists. One is the PSL I and the other is the "list of terrestrial wildlife under state protection, which are beneficial or of important economic or scientific value" (PSL II) issued in 2000. The first WPLC did not stipulate the modification period of protected species lists. Although the revised WPLC stipulates that PSL I should be adjusted every five years, there is no time limit for the modification period of PSL II. PSL I has not been updated for over 30 years, except for an upgrade of all musk deer species (*Moschus* spp.). Similarly, the PSL II has not been updated in the 20 years since it was implemented.

Whether and how a species is listed on the protected species lists and its protection grade is directly correlated to the intensity of law enforcement and the degree of public concern. In the past 30 years, great changes have taken place in taxonomy and assessment of the conservation status of threatened species [5,23]. In addition, some species, such as bats, with a high risk of transmitting diseases, such as COVID-19 [15], are still not listed on protected species lists. Hence, the ability to manage them is severely limited. Any delay in the application of new scientific knowledge to policy restricts species protection and management [24]. Therefore, the outdated protected species lists no longer meet the needs of wildlife protection. Below, we summarize five negative aspects of outdated species lists.

Taxonomic adjustment confounds species identification

In recent decades, species taxonomy has developed rapidly in large part from the use of molecular data, resulting in changes in nomenclature of animals included on protected species lists, which affects protection and management objectives [25]. Some changes are a simple name change based on new phylogenetic information such as the Chinese Strip-necked Turtle '*Ocadia sinensis*' changing to *Mauremys sinensis* [26] or the Mangshan Pit Viper '*Zhaoermia mangshanensis*' changing to *Protobothrops mangshanensis* [27]. Nomenclatural changes also occur when a polymorprhic species is divided into multiple species. For example, the Indo-Chinese Box Turtle '*Cuora galbinifrons*' was divided into three species, *Cuora galbinifrons*, *Cuora picturata* and *Cuora bourreti* [28].

The change of scientific names and common Chinese names of some species results in inconsistency between the taxonomic species list and protected species list. This inconsistency causes difficulties and confusion for law enforcement officers in species identification based on species names, and may lead to some protected species no longer being protected because their new names are not on the protected species lists [29]. Even illustrated checklist guides, aimed at helping law enforcement [30], are of limited use if the identified taxa are not on protected species lists. In addition, some species previously believed to

be rare and endangered were later shown to be human-produced hybrids (*e.g.*, *Mauremys iversoni*, *Sacalia pseudocellata* [31]), but continue to be on PSL II, resulting in wasted law enforcement resources.

Some newly discovered species are threatened, but not protected

In recent decades, with increased field surveys and use of molecular methods, many new species have been discovered. For example, Zhao and Adler (1993) recorded 388 Chinese reptile species in the book "Herpetology of China [32]." Approximately 20 years later, 462 Chinese reptile species were recorded [23]. During this time period, on average 3.7 new species were added per year. Among these species, some are endemic and endangered [33], such as the Sichuan Hot-spring Keel-back (*Thermophis zhaoermii*), the Yingde Leopard Gecko (*Goniurosaurus yingdeensis*). Yet, these species are not protected by law because they are not included on protected species lists.

Many species with high risk of transmitting diseases are not on protected species lists

Bats and rodents have a high risk of transmitting infectious diseases [14,15,34]. There are over 150 bat species [35] and over 210 rodent species in China [33]. Bats and rodents have important ecological and economic value. Although most of them are not endangered, as highly traded, high-zoonosis-risk species, including them in the protected species allows for their management. However, all bats and about 80% of rodent species are not on protected species lists. As a result, these species are not protected or managed under any law.

CITES-listed non-native species are out of national protected species lists

China is a signatory to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and it implements regulations for CITES-listed species at the point of import/export. Once a specimen has passed through customs, it will be protected and managed by the relevant department's regulations. In 1993, the forestry department issued Announcement No. 48, which approved all terrestrial species listed on CITES Appendix I and II as grade I and II national key-protected species. In 2018, the fisheries department issued Announcement No. 69, which approved most of the aquatic species listed on CITES Appendix I and II as grade I and II national key-protected species. In principle, according to these announcements, the management measures for CITES-listed non-native species approved as national key-protected species are the same as native national key-protected species. However, these announcements issued by forestry and fisheries departments belong to department regulations and are not regulations at the national level. CITES-listed non-native species are not really listed in the national key-protected species list. In actual management, forestry and fisheries departments implement their own rules. However, for some CITES-listed non-native reptile species with management disputes (*e.g.*, crocodile species), forestry and fisheries departments each assigned a protection grade, sometimes different grades for the same species, which causes management confusion [36].

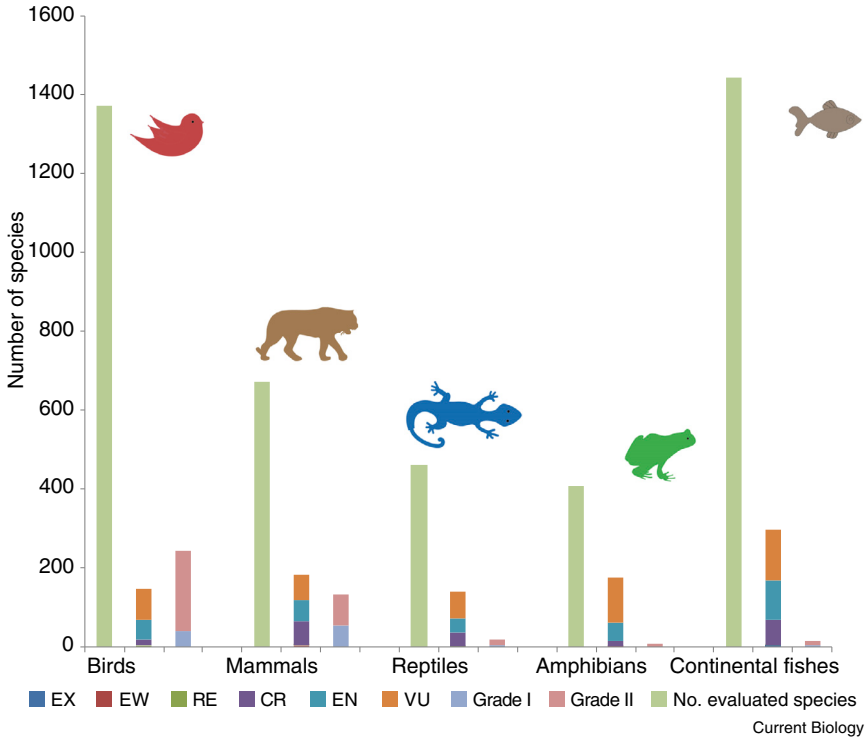

Figure 2. Number of threatened species among China's vertebrates.
The order (from high to low) of threatened degree of five vertebrate groups is amphibians (43.38%), mammals (31.78%), reptiles (30.15%), continental fishes (20.72%), birds (10.86%). However, the order (from high to low) of percentage of protected species in five vertebrate groups is mammals (19.91%), birds (17.71%), reptiles (3.69%), amphibians (1.72%), continental fishes (0.97%). Except for birds, the percentage of threatened species in the other four groups is much higher than that of protected species, especially for amphibians, reptiles and continental fishes, which means that a large number of threatened species are out of the national key-protected species list of China.

Species protection grade does not match endangered status

Over time, the threatened status of many species has changed and some species once considered common have become endangered or critically endangered [33], but remain on PSL II, such as Big-headed Turtle (*Platysternon megacephalum*) and Yellow-margined Box Turtle (*Cuora flavomarginata*; Figure 1). Such species should have been up-listed to PSL I over a decade ago to improve protection. Outdated protected species lists result in a mismatch between a species' status

and protection level (Figure 2), which puts many threatened species at risk and contributes to their extinction. For example, one of the world's most endangered turtles, Swinhoe's Softshell Turtle (*Rafetus swinhoei*) was known from fewer than ten individuals in 2006. Despite this fact, *R. swinhoei* was not a key-protected species, and now there is only a single, living individual known in China [37].

Recommendations for integrating management and updating protected species lists

On the issue of separated management of wildlife and outdated protected species lists, we give the following four recommendations:

First, it is of utmost importance to clarify the responsibilities of wildlife management and to integrate the management rights of aquatic and terrestrial wildlife and their habitats into one department. This avoids administrative conflicts in jurisdiction over wildlife among different government departments and the separation of management rights of aquatic species and its habitat. In the field of wildlife management, there are some successful examples in the world. For example, in the United States, the U.S. Fish and Wildlife Service (FWS), as the sole federal agency, is responsible for the conservation and management of listed species of endangered fish and wildlife, and their habitats [38]. China can refer to the model of the United States and set up a special wildlife management department responsible for the protection and management of wildlife and its habitats.

Second, in terms of wildlife trade management, for efficient joint enforcement, it is necessary to establish an effective mechanism to coordinate relevant law enforcement departments, such as customs, market supervision and public security departments.

Third, it is necessary to create a unified National Protected Species List (NPSL) that includes all native species and CITES-listed non-native species that need protection or management. A unified NPSL helps avoid confusion caused by multiple protected species lists and conflicts between different departmental regulations. All protected species can be divided into three grades according to their protection needs. Highly threatened species could be assigned to grade I or II, whereas common and non-threatened species, such as bats, that need protection or management can be assigned to grade III.

Fourth, it is very important to ensure the NPSL can be frequently updated to keep up with advances or changes in taxonomy and threatened status of wildlife. CITES's methods in addressing the changes in taxonomy and nomenclature of species are a good model to follow [25]. For example, CITES designated taxonomic standard references that list the valid name as well as synonyms. Wildlife management departments need to set up a special scientific committee to be responsible for updating the NPSL every 2–3 years. But in case of urgent protection needs, the NPSL should be updated as needed.

Wildlife conservation is a difficult problem to solve due to its dynamic nature. However, an important first step is to have legislation and enforcement aligned and match the changing conservation landscape. We hope that these recommendations help improve wildlife conservation in China and other parts of the world.

SUPPLEMENTAL INFORMATION

Supplemental Information includes one figure and one table and can be found with this article online at https://doi.org/10.1016/j.cub.2020.06.080.

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Quick guide

Kelp forests

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What is a kelp forest? Kelp forests are among the most productive and biodiverse ecosystems in the world. They are vast habitats creating both canopy and understory, similar to forests on land, but they are comprised of seaweeds ('macroalgae') rather than trees.

Kelp forests are created by large stands of seaweed species within the orders Laminariales ('true kelps') and Fucales (forest-forming 'fucoids'). There are at least 135 different species of true kelps and more than 550 species of fucoids. Giant kelp (*Macrocystis pyrifera*; Figure 1A) is the largest of all seaweeds — it can grow rapidly (up to 30 cm/day), reach lengths of over 50 m and persist for more than 25 years, creating forests that stretch from the seafloor to the water surface. On the other side of the spectrum, fucoid species from the genus *Cystoseira* make miniature forests in the Mediterranean (Figure 1B), where adult individuals are typically <30 cm in length, but where individuals can persist for over 50 years.

Where are kelp forests found? Kelp forests dominate rocky reefs in temperate latitudes and are also found in subtropical and polar regions, lining approximately 25% of the world's coasts. Kelp forests generally exist between depths of 0 and 50 m and are often strongly seasonal. Most kelp forests prefer cool (<16°C) waters that are high in nutrients. Many species are restricted to higher latitudes or places where upwelling regularly delivers deeper, cooler, more nutrient-rich waters to the surface.

Why are kelp forests special? Kelp forests underpin coastal food webs and biodiversity, contribute to global biogeochemical cycles, absorb nutrients and contaminants from waterways and can reduce coastal erosion by dampening wave action.

Kelp and kelp-associated animals have been used for food and materials by indigenous peoples around the world for thousands of years. The 'kelp highway hypothesis' postulates that kelp forests played a key role in facilitating the migration of humans from Asia to the Americas during the late Pleistocene. Kelp habitats continue to support coastal communities and industries today, through aquaculture, fishing, tourism and harvesting.

Kelp ecosystems provide habitats for thousands of marine fish, mammals and invertebrates, including many culturally and economically valuable species (e.g., abalone and lobster). Kelp continue to contribute to marine food webs, even after they become detached from the sea floor. Their decomposing tissues become part of the detrital food web and are directly consumed by an entirely new suite of fish and invertebrate species and microorganisms.

Are kelp forests in trouble? Yes. Between 40 and 60% of the world's kelp forests have declined in the last 50 years. The main drivers of this decline are climate change, pollution, coastal development and kelp harvesting. Overfishing can also lead to kelp forest declines because the removal of top predators leads to increased density of herbivores that overgraze kelp. A famous example of this 'trophic cascade' effect comes from Alaska, where a decline of sea otters due to overfishing in the 20th century led to a population explosion of their favoured food, herbivorous sea urchins, which rapidly overgrazed Giant Kelp forests in the region. In some parts of Alaska, conservation measures to protect sea otters have led to a decline of urchins and subsequent recovery of kelp forests. Despite extensive declines in many regions, some kelp forests have remained remarkably stable in some parts of the world, such as South America, and have expanded in other areas, such as the Arctic.

How are kelp forests impacted by climate change? Ocean warming, heatwaves and changes to ocean circulation can directly impact kelp, leading to physiological stress,