

# Threats to Vertebrate Species in China and the United States

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*We analyzed the threats to imperiled vertebrate species in China and compared our results with those from a similar study conducted in the United States. Overexploitation is the most pervasive threat to Chinese vertebrates, contributing to the endangerment of 78% of imperiled species, followed by habitat destruction (70%), pollution (20%), alien species (3%), and disease (< 1%). Harvest for food and use in traditional Chinese medicines are the two main forms of overexploitation, while logging is the most pervasive form of habitat destruction. Threats to vertebrate species are strikingly different in the United States, where habitat destruction affects 92% of imperiled vertebrate species, followed by alien species (47%), pollution (46%), overexploitation (27%), and disease (11%). The greater frequency of overexploitation in China stems from China's larger, poorer, and more rural population, along with widespread trade in wildlife products. The apparent lower frequency of alien species in China may reflect neglect of this issue by Chinese scientists.*

*Keywords: vertebrate species, endangered species, overexploitation, habitat destruction, alien species*

**I**n the wake of an expanding human population and greater consumption of natural resources, biodiversity is undergoing a dramatic decline. By some estimates, recent extinction rates of species are 100 to 1000 times greater than the historic rate measured over geological time (Pimm et al. 1995). Not surprisingly, therefore, a growing number of species are considered endangered or vulnerable to extinction (Williams et al. 1989, IUCN 2004).

To slow the rate of species loss, it is essential to have a clear idea of what the actual threats to species are, and how those threats vary geographically or by taxon. Somewhat surprisingly, there have been relatively few quantitative studies of threats to species. Notable exceptions include global assessments for particular groups of organisms (BirdLife International 2000 [birds], Mace and Balmford 2000 [mammals]), a handful of national-level assessments (Flather et al. 1998, Wilcove et al. 1998), and studies directed at imperiled species within particular ecosystems (Richter et al. 1997 [freshwater ecosystems]).

Within the United States, two studies have concluded that direct habitat destruction by humans is the most frequent cause of species endangerment, followed by the spread of non-native (alien) species (Flather et al. 1998, Wilcove et al. 1998). Pollution, overexploitation, and disease lag well behind these two factors in terms of the absolute number of species they threaten. However, even within the United States, the nature of the threats to species varies among regions (Richter et al. 1997, Flather et al. 1998) and between islands and the mainland (Wilcove et al. 1998).

To the best of our knowledge, few such analyses have been done for the flora and fauna in developing countries, even though such countries harbor a disproportionately large share of the world's biodiversity (McNeely et al. 1990, WCMC 1992). In this article, we analyze the threats to imperiled vertebrate species in China and compare the results with those of a similar study from the United States (Wilcove et al. 1998). China and the United States are approximately the same size (the two countries differ in total land area by only about 2%); both countries are located in the Northern Hemisphere; and both span a wide range of climatic zones, from cold temperate regions to the tropics. Hence, a comparison of these two nations contributes to better understanding of global similarities and differences in threats to biodiversity.

China's importance in terms of biodiversity is indisputable. Among nations, it ranks second in terms of the total number of mammal species, eighth in birds, sixth in amphibians, and third in higher plants (WCMC 1992). In recent decades, the combination of an expanding human population and rapid economic development has led to greater consumption of China's natural resources, resulting in severe pressure on

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its flora and fauna. Given that China's vertebrate species are much better known than its other animals and plants, we made them the focus of this study. Today, China may have more imperiled vertebrate species than any other nation (WCMC 1992). Approximately 15% of China's vertebrate species are considered to be in danger of extinction (Le and Chen 1998, Wang 1998, Zhao 1998, Zheng and Wang 1998). These vertebrate species account for over 95% of the species officially afforded protection by the government (China Forestry Ministry 1989).

### Cataloguing the threats

Information on the threats to each imperiled species and subspecies of vertebrate was obtained from the *China Red Data Book of Endangered Animals* (Le and Chen 1998, Wang 1998, Zhao 1998, Zheng and Wang 1998) and from interviews with specialists on particular species. The *Red Data Book* was compiled by more than 40 experts and is based on approximately 1100 publications on threatened vertebrate species in China. The book identifies 535 vertebrate species and subspecies as extinct in the wild, endangered, threatened, or rare in China, including almost all of the species on the State Key Protected Animal List. Using these same sources, we also gathered data on the causes of extinction for all vertebrate species classified as extinct in China.

From the *Red Data Book*, we extracted the recognized cause of endangerment (or extinction) of each species or subspecies. We excluded any potential or hypothetical threats listed in the *Red Data Book*. We did not try to distinguish between ongoing and historical threats, because such information is often lacking, and the distinction itself is problematic in the case of habitat destruction. Descriptions in the *Red Data Book* of the threats to seven species were unusually vague (e.g., "economic development"); we contacted experts on those species for more information. In total, we were able to obtain information on threats to 437 (82%) of the 535 imperiled or extinct species and subspecies (table 1).

Following Wilcove and colleagues (1998), we tabulated the number of species threatened by five broad categories of threats: habitat destruction, overexploitation, pollution, the spread of alien species, and disease. We used the resulting database to determine the frequency of these threat categories for imperiled and extinct species in each vertebrate class. We further subdivided each primary threat factor into finer categories, and determined the frequency of each of these causes of endangerment. Wherever possible, we gave precedence to ultimate rather than proximate causes. For example, if soil erosion due to logging activities was determined to be a threat factor to an imperiled fish, we listed logging rather than soil erosion as the cause in our analysis.

Five important assumptions are attached to these data. First, although the *Red Data Book* and other sources used in this study represent an impressive compilation of information on threats to species, we do not know the extent to which they may be biased for or against particular threats. In other words, some of the many contributors to the *Red Data Book* may have focused on particular threats to the exclusion of others. The same is true for the data underlying Wilcove and colleagues' (1998) analysis of threats to US vertebrates. Thus, our comparisons are based on the assumption that all threats had equal probabilities of being detected and recorded for each species and country. Second, in most cases there is little actual experimental evidence connecting a particular threat to a particular species. The determination that a given human activity is now or has been a threat to a species is typically the result of someone's professional judgment, rather than the result of a formal experiment. We assume that documented threats are accurate, and that any biases in the data are consistent across all vertebrate classes and between the two countries. Third, because the faunas of both countries are essentially allopatric, we assume that the threats to biodiversity in each nation are independent, notwithstanding obvious linkages through international commerce. Fourth, although individual species in each country may be listed under multiple threats (a reflection of the reality that many species are threatened by more than one factor), we considered the data independent because any species theoretically could fall into any of the individual categories or combination of categories. (It is possible, however, that imperiled species with broader ranges encounter more threats and therefore contribute disproportionately to our data.) Fifth, we assumed no interaction between threats, although in reality there probably are (e.g., between habitat destruction and the spread of alien species).

We used Spearman's rank correlation to examine the relationship between the ranking of primary threat categories for extinct species and the ranking for imperiled (but not extinct) species in China, and the relationship between the rankings of primary threats in China and those in the United States. We tested for differences in frequency of each primary threat for each vertebrate class in China versus the United States using the chi-squared contingency test. All analysis ( $p = 0.05$  significance level, two-tailed test) was done with SPSS 7.0 (SPSS Inc. 1997).

**Table 1. Taxonomic breakdown of Chinese species used in the study.**

Group	Number of imperiled or extinct species	Number of species with data on threats	Percentage of species with data on threats
Vertebrate species	535 (21)	437 (15)	82 (71)
Mammals	133 (5)	123 (5)	92 (100)
Birds	183 (2)	127 (0)	69 (0)
Reptiles	96 (9)	74 (6)	77 (67)
Amphibians	31 (2)	25 (1)	81 (50)
Freshwater fishes	92 (3)	88 (3)	96 (100)

Note: Data for extinct species are in parentheses.

Source: Le and Chen 1998, Wang 1998, Zhao 1998, Zheng and Wang 1998.

## Ranking the threats

Table 2 presents a summary of the percentages of vertebrate species in China imperiled by habitat destruction, overexploitation, pollution, alien species, and disease. Overexploitation is the most pervasive threat to Chinese vertebrates, contributing to the endangerment of 78% of the listed species, followed by habitat destruction (70%). In comparison, pollution affected 20% of species, and alien species and disease are comparatively minor causes of endangerment.

Focusing on vertebrate classes, one sees that overexploitation is the most pervasive threat to reptiles and fishes, followed by habitat destruction in both cases. Habitat destruction is the most pervasive threat for mammals, birds, and amphibians, followed by overexploitation. Alien species appear to be a minor threat to China's imperiled vertebrates.

Table 3 provides a finer-scale breakdown of threats to species. The primary reasons for overexploitation are to obtain food (affecting 55% of vertebrate species imperiled by overexploitation), medicines (18%), and raw materials (14%). This pattern holds within each vertebrate class, with harvest for food being the first-ranked threat within the category of overexploitation for all classes, and harvest for medicines or raw materials being the second-ranked for all classes except freshwater fishes. Individually and collectively, these three factors vastly exceed all other forms of overexploitation in terms of their frequency.

For Chinese vertebrate species as a whole, and for four of the five vertebrate classes in particular, logging is the most frequently cited cause of habitat destruction. Reptiles are an exception, however; habitat loss due to agriculture is a slightly more frequent threat. Two classes (mammals and birds) have agriculture as the second most common form of habitat destruction. For amphibians, the second most common form of habitat destruction is the construction of dams and reservoirs, while for fishes, it is water use for irrigation, and for other domestic and industrial purposes.

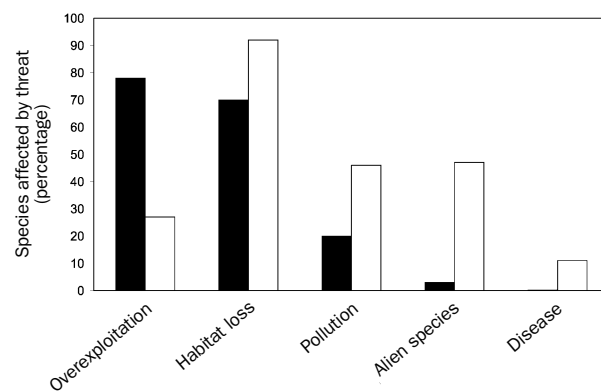
Of the 535 Chinese vertebrates in our database, 21 are classified as extinct or extinct in the wild. Two of these species (Père David's deer [*Elaphurus davidianus*] and the false gharial [*Tomistoma schlegelii*]) disappeared from the wild in China approximately 1000 years ago. The other 19 have vanished within the past century. The ranking of major threat categories for extinct species is correlated with ranking for imperiled (but not extinct) species ( $r = 0.900$ ,  $p = 0.037$ ,  $n = 5$ ), suggesting that the causes of extinction are similar to the causes of

endangerment. Because Wilcove and colleagues (1998) did not include extinct species in their study, we cannot do a comparable analysis for the United States.

## Comparing China and the United States

The pattern of threats to vertebrate species in China differs strikingly from that in the United States (figure 1; see also table 2 in Wilcove et al. 1998). Differences in the frequencies of each of the five primary threat categories for vertebrate species in China versus the United States were significant ( $\chi^2 = 376.27$ , degree of freedom [df] = 4,  $p < 0.001$ ). Also, the rankings of the five broad threat categories within each vertebrate class in China showed no significant correlations with comparable rankings for each class in the United States (e.g.,  $r = 0.300$ ,  $p = 0.624$ ,  $n = 5$  for vertebrate species;  $r = 0.433$ ,  $p = 0.467$ ,  $n = 5$  for mammals). In general, the frequency of overexploitation as a threat to vertebrate species is much higher in China than in the United States (e.g.,  $\chi^2 = 38.037$ , df = 1,  $p < 0.001$  for birds), while the frequency of alien species is much lower (e.g.,  $\chi^2 = 77.20$ , df = 1,  $p < 0.001$  for vertebrate species). This distinction between the two countries holds across essentially all vertebrate classes, and is especially pronounced in the case of birds, reptiles, amphibians, and fishes.

Judging from available data, water development would appear to be a less common threat to aquatic species in China than it is in the United States. Water use for irrigation and for other domestic and industrial purposes is the second most



**Figure 1.** Percentages of imperiled vertebrate species threatened by various causes in China (dark bars) versus the United States (light bars). China data are from this study; US data are from Wilcove and colleagues (1998).

**Table 2.** Percentage of species in China imperiled by five major threats.

Threat	Vertebrate species (n = 437)	Mammals (n = 123)	Birds (n = 127)	Reptiles (n = 74)	Amphibians (n = 25)	Freshwater fishes (n = 88)
Habitat destruction	70	87	70	32	72	70
Overexploitation	78	85	63	96	64	80
Pollution	20	11	24	10	24	42
Alien species	3	0	0	0	4	14
Disease	0	2	0	0	0	0

Note: Categories are nonexclusive, and therefore percentages do not total 100.

**Table 3. Finer-scale analysis of threats to vertebrate species in China, expressed as percentages of vertebrate species harmed by particular causes.**

Threat	Vertebrate species (n = 437)	Mammals (n = 123)	Birds (n = 127)	Reptiles (n = 74)	Amphibians (n = 25)	Freshwater fishes (n = 88)
<b>Habitat destruction</b>						
Logging	33.2	48.8	43.3	9.5	24.0	19.3
Agriculture	12.6	18.7	11.8	10.8	8.0	8.0
Dams and reservoirs	6.9	1.6	2.4	1.4	12.0	13.6
Overgrazing	6.2	14.6	5.5	0.0	8.0	0.0
Food shortage	4.3	5.7	6.3	2.7	0.0	2.3
Tree plantations	4.1	8.1	6.3	0.0	0.0	0.0
Water use	3.9	1.6	0.0	0.0	0.0	17.5
Tourism	2.7	3.3	0.8	4.1	16.0	0.0
Mining	2.5	6.5	0.8	1.4	4.0	0.0
Roads and building construction	2.3	4.1	2.4	0.0	8.0	0.0
Harvesting reeds for paper making	1.6	0.8	4.7	0.0	0.0	0.0
Desertification	1.1	0.0	3.9	0.0	0.0	0.0
Collecting medical herbs	0.9	0.0	3.1	0.0	0.0	0.0
Fires	0.9	3.3	0.0	0.0	0.0	0.0
Climate change	0.7	0.0	0.0	2.7	0.0	1.1
Oil-field development	0.5	1.6	0.0	0.0	0.0	0.0
Use of plants for fuel	0.5	0.0	0.8	1.4	0.0	0.0
Border protection	0.2	0.8	0.0	0.0	0.0	0.0
Bamboo flowering	0.2	0.8	0.0	0.0	0.0	0.0
<b>Overexploitation</b>						
Food	55.4	44.7	53.5	78.4	40.0	58.0
Medicines	18.3	27.6	2.4	51.4	20.0	0.0
Raw materials	14.2	32.5	3.1	24.3	0.0	0.0
Export	3.9	3.3	0.0	17.6	0.0	0.0
Fishing with explosives	3.4	0.0	0.8	0.0	4.0	14.8
Fishing with electricity	3.4	0.0	0.8	0.0	0.0	15.9
Fishing with poison	3.0	0.0	2.4	0.0	4.0	10.2
Zoos/public display	3.2	1.6	0.8	13.5	4.0	0.0
Pests	2.1	4.1	0.0	4.1	0.0	1.1
Incidental harvest	1.9	1.6	0.8	0.0	0.0	5.7
Pets	1.1	0.8	3.1	0.0	0.0	0.0
Specimen collecting	0.9	0.0	0.8	1.4	0.0	2.3
Adornments	0.5	0.0	1.6	0.0	0.0	0.0
Smuggling abroad	0.2	0.0	0.8	0.0	0.0	0.0
<b>Pollution</b>						
Industrial and domestic sewage	12.8	2.4	12.6	2.7	36.0	29.5
Pesticides	3.9	3.3	3.1	4.1	20.0	1.1
Accumulated toxins	3.4	4.9	5.5	2.7	0.0	0.0
Chemical fertilizer	0.7	0.0	0.0	2.7	4.0	0.0
Oil pollution	0.2	0.0	0.8	0.0	0.0	0.0
Air pollution from factories	0.2	0.0	0.0	1.4	0.0	0.0
<b>Alien species</b>						
	3.0	0.0	0.0	0.0	4.0	13.6
<b>Disease</b>						
	0.5	1.6	0.0	0.0	0.0	0.0

Note: Categories are nonexclusive, and therefore percentages do not total 100.

frequent form of habitat destruction for Chinese fish, while the construction of dams and reservoirs is the third most frequent. Yet the percentages of imperiled fish in China that are harmed by these activities (18% and 14%, respectively) are much lower than comparable values in the United States, where water development in general is a factor in the decline of 91% of imperiled fish. Dams and reservoirs in particular constitute a threat to 64% of imperiled fish in the United States, a far higher percentage than the comparable figure from China (14%;  $\chi^2 = 100.849$ ,  $df = 1$ ,  $p < 0.001$ ).

Logging emerged as the most pervasive form of habitat destruction for China's imperiled vertebrate species, affecting a third of the species in our database. In contrast, logging was identified as a threat to only 16% of imperiled vertebrate species in the United States. Agriculture was listed as a threat to only 13% of China's imperiled vertebrate species, far less than the 40% in the United States. These differences between the two countries are significant ( $\chi^2 = 13.071$ ,  $df = 1$ ,  $p < 0.001$  for logging;  $\chi^2 = 64.456$ ,  $df = 1$ ,  $p < 0.001$  for agriculture).

### Why do the threats differ?

The most striking differences that emerge from this study relate to two types of threats: overexploitation and alien species. Overexploitation appears to be a far more pervasive threat to vertebrate species in China than it is in the United States, whereas alien species appear to be harming a far smaller percentage of China's imperiled vertebrates than is the case in the United States.

We believe the heightened frequency of overexploitation in China may be due to two factors. First, China has a much larger, poorer, and more rural population than the United States. As of 1999, 239 million people in China were living below the international poverty line (World Bank 2001)—a number equal to nearly 85% of the entire population in the United States. Most of these poor people live in rural mountain areas, where they depend on hunting for a part of income and animal protein (Li and Li 1995, Ran et al. 2001). Thus, China's vertebrate species are under tremendous hunting pressure, far more so than is the case in the United States. Second, China has a long tradition of using animals and plants for medicines (traditional Chinese medicine, or TCM) and other purposes, resulting in a flourishing trade in wildlife products (Ling 1995). It has been estimated that over 1500 animal species are used in TCM. A wide variety of vertebrate species are used in commercial trade in China's cities, especially in South China (Li et al. 1996, Lau et al. 1997, Li and Li 1997, 1998).

The lower frequency of alien species in China compared with the United States is harder to explain. It may reflect some important ecological differences between the two countries, or it may simply be an artifact of neglect: Chinese ecologists have not focused on alien species as a threat to biodiversity until relatively recently (Xie et al. 2001). Some recent studies suggest that the alien species do indeed pose a threat to native vertebrate species in China (Xie et al. 2001, Li and Xie 2002). China has a long history of trade with other countries, including the "Silk Road" that linked the imperial court with the Roman Empire, so it should not be surprising that many plants and animals have been transported to new locales. One study estimated that more than 600 species of nonnative plants and animals have become established within natural ecosystems in China (Li and Xie 2002); approximately 40 of the alien animals are classified as harmful to the environment. Yet in the United States, a much younger country, the documented number of alien species appears to be much higher. Pimentel and colleagues (2000) estimated that 10,000 alien plants and animals have escaped into natural ecosystems in the United States, of which approximately 10% cause major environmental damage.

Differences between the two countries in the prevalence of various forms of habitat destruction are best viewed in a historical context. In China, over 37 million hectares (ha) of land had been brought under cultivation as early as the West Han dynasty in AD 2 (Liang 1980). By the late 17th century (early Qing dynasty), the amount of arable land totaled nearly 54 million ha, approximately half the current acreage

(103 million ha in 1998, roughly equal to 13% of the land area). Within the United States, American Indians cleared land for thousands of years to grow crops, but the major agricultural conversions did not begin until the arrival of European settlers, 300 to 400 years ago. Arable lands presently constitute about 20% of the land area of the United States (Klein 2001).

Forests present a somewhat different picture. The most dramatic changes in forest composition in China have occurred over just the past half-century, largely because of human population growth and improved logging technology. During this period, timber harvests in China have increased 18-fold, while the acreage of natural forest has declined by 30% (China Forestry Ministry 1986, 1999, Zhang et al. 1999; see also Smil 1984, 1993). Although total forest cover in China has actually increased during this period (China Forestry Ministry 1986, 1999), most of that increase can be attributed to the spread of plantation-style forests, which do not provide suitable habitat for most of China's vertebrates. In the United States, in contrast, the greatest losses in natural forests occurred during the latter half of the 19th century and the beginning of the 20th, with subsequent regeneration across much of the nation (Wilcove 1999). The Pacific Northwest region of the United States is an exception; logging of most of that region's old-growth forests has occurred over the past half-century.

China's much longer history of intensive agriculture may explain why a lower percentage of its imperiled vertebrates are threatened by this activity than is the case in the United States (13% versus 40%). Species acutely sensitive to agriculture would have vanished long ago. In contrast, the recent, explosive growth of China's timber industry may explain why the percentage of the country's imperiled vertebrates thought to be threatened by logging is higher than that in the United States.

We are hard pressed to explain the lower incidence of water development as a threat to fish in China compared with the United States. It may be the case that such activities have not been as harmful to fish in China as they have in the United States, but the difference may also reflect inattention to this issue by Chinese scientists and conservationists. China is rapidly developing its water resources for agricultural, industrial, and urban usage. China has more large dams than the United States (UNEP 2000a). Over 99% of these dams have been built within the past half-century. Approximately 370 large dams, including 60 dams over 60 meters tall, are currently under construction. It is difficult to imagine that all of this activity does not pose a significant threat to many of China's aquatic vertebrates.

A comparison of patterns of extinction between China and the United States proves to be surprisingly difficult. As noted earlier, 21 species and subspecies of vertebrates are classified as extinct or extinct in the wild in China. All but two vanished within the past 100 years. Stein and colleagues (2000) identify 40 vertebrate species that once occurred in the United States but are now extinct throughout their ranges. Of these

40 species, 15 (38%) vanished in the 19th century and 25 (62%) vanished in the 20th century. This would suggest a pattern of earlier extinction events in the United States compared to China. However, 95% of the extinct vertebrate species in the United States are either birds or fishes, and the two groups differ markedly in the timing of their disappearances. Nearly 60% of the extinct birds vanished during the 19th century, compared with only 12% of the fishes. We are aware of no authoritative list of extinct vertebrate subspecies in the United States or of vertebrates that are extinct in the United States but still occur in other countries.

### Will history repeat itself?

During the last quarter of the 19th century and the first quarter of the 20th, overexploitation was undoubtedly the biggest threat to vertebrate species in the United States (Wilcove 1999). That era witnessed the extermination of the passenger pigeon (*Ectopistes migratorius*) and Carolina parakeet (*Conuropsis carolinensis*), and the near-extermination of the American bison (*Bison bison*), northern elephant seal (*Mirounga angustirostris*), sea otter (*Enhydra lutris*), and Eskimo curlew (*Numenius borealis*). A rapacious commercial market in waterfowl and shorebirds threatened populations of many other species as well. The imposition of laws and treaties regulating the harvest of vertebrate species essentially eliminated overexploitation as a threat to most US vertebrate species (although marine fish stocks continue to be overharvested). A subsequent era of industrialization placed habitat destruction at the top of the list of threats.

One is tempted to ask, therefore, whether China is following a similar trajectory, and whether its species threat profile will ultimately converge on something approximating the contemporary threat profile for wildlife in the United States. We certainly believe that habitat destruction will gain ascendancy as a threat to Chinese wildlife as the nation's population grows in number and affluence. Indeed, evidence points to growing losses of habitat for wildlife as grasslands are overgrazed by livestock and as natural areas are destroyed by urbanization, water and hydropower development, and illegal logging (China Waterpower Ministry 1992, 2001, China Environmental Protection Ministry 1992, 2001, 2002, UNEP 2000b). Nor would we be surprised to see alien species emerge as a more widespread threat in China, in the wake of both additional research and additional commerce. But we also believe that overexploitation of China's vertebrate species will not disappear anytime soon, given the nation's large, poor, rural population and its tradition of using plants and animals for medicine and commercial trade. In fact, an increasingly affluent, increasingly urban population in China is creating a growing demand for wildlife products (Li et al. 1996, Lau et al. 1997, Li and Li 1998, Robinson and Bennett 2002). Absent stronger and well-enforced laws to protect wildlife, the problem of overexploitation seems certain to grow in China.

China, in short, faces a daunting set of conservation challenges. The threats to its biodiversity differ significantly from threats to biodiversity in the United States, demonstrating once

again that conservation policies must be tailored to the individual nation, region, or community.

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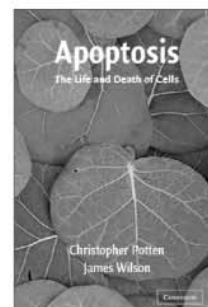
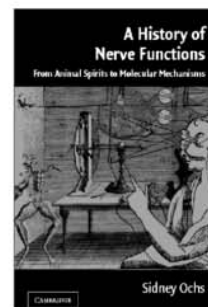
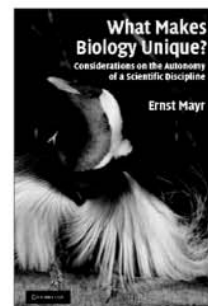
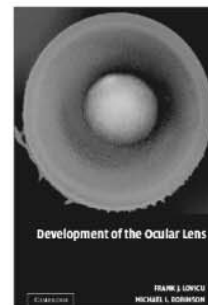
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