Table 2.2: Present Status of Established Nature Reserves in China

Category and type	Number	Percentage of total reserves	Area (10,000 hectares)	Percentage of total reserve area
Ecosystem				
Forest	335	47.32%	1108.07	19.77%
Grassland	12	1.69	129.72	2.30
Desert	8	1.13	2948.87	52.59
Inland wetland	16	2.26	101.91	1.82
Marine and seashore	18	2.54	11.68	0.21
Species category				
Wild animal	211	29.80	1246.20	22.23
Wild plant	69	9.75	40.93	0.73
Relic remains or cultural heritage	39	5.51	18.45	0.34
Total	708	100.00	5606.66	100.00

Source: Compiled from statistics provided by relevant ministries (1993).

Table 2.3: Four-Tiered Structure of Nature Reserves and Scenic Spots in China

	Nature reserves		Scenic spots[a]	
Reserve level	Number	Area (10,000 hectares)	Number	Area (10,000 hectares)
State	77	1245	84	390
Province	305	4040	256	307
Municipality	106	92		
County	220	229	137	153
Total	708	5606	477	850

a. "Scenic spots" are often translated "national parks," although national parks in China are different from international ones and are, in fact, selected for scenic value.
Source: Compiled from statistics provided by relevant ministries (1993).

also protect species, a distinction is drawn between species reserves and ecosystem reserves, reflecting the original reason they were established and the regulations and agency authorities involved. However, in all cases in-situ conservation depends on preserving the ecosystems involved. Of the total number of nature reserves classified in this way, two categories and seven types are closely related to biodiversity conservation. The number of established nature reserves in each category, their subtotal area, and their coverage percentage for different ecosystems are summarized in Table 2.2.

Table 2.4: Numbers of Reserves in Management Sectors (1991)

Sector	Numbers	Percentage of total territory
Forestry	420	64.9%
Environmental Protection	107	16.8
Agriculture	29	4.5
Geology and Mining	11	1.7
Oceans	8	1.3
Others	69	10.8
TOTAL	644	100.0

Source: NEPA 1992. Nature Reserves in China. China Environmental Science Press.

Based on the importance of these nature reserves and the level of government authority, China's nature reserves are classified at four levels: State, province (or municipality directly under the central government or autonomous region), municipality (or prefecture), and county (banner). By the end of 1992, the number and total area of established nature reserves at all these different levels is shown in Table 2.3.

Of the 77 State-level nature reserves, 56 are operated by the forestry agencies; 9 by the environmental protection agencies; 7 by the oceanic agencies; 4 by the agriculture agencies; and 1 by the Chinese Academy of Sciences.

Nine of the State-level reserves are included in the Man and Biosphere Programme (MAB). These nine reserves are Changbaishan Reserve in Jilin Province, Wolong Reserve in Sichuan Province, Fanjinshan Reserve in Guizhou Province, Shenglongjia Reserve in Hubei Province, Wuyishan Reserve in Fujiang Province, Bogeda Peak Reserve in Xinjiang Autonomous Region, Dinghushan Reserve in Guangdong Province, Xilingele Reserve in Inner Mongolia, and Yanchen Reserve in Jiangsu Province.

In addition, six State-level nature reserves are listed as wetlands of international importance under the Convention on Wetlands of International Importance, Especially as Waterfowl Habitat (known as the Ramsar Convention). These six reserves are Zalong Reserve in Helongjiang Province, Xianghai Reserve in Jilin Province, East Dongting Lake Reserve in Hunan Province, Poyang Lake Reserve in Jiangxi Province, Bird Island Reserve in Qinghai Province, and Dongzhaigang Reserve in Hainan Province. The forestry departments also established 181 State and local forest parks, of which 105 belong to the State-level (as of September 1992). Of the 84 State-level scenic areas, 5 belong to international nature relics.

The different levels and types of nature reserves have different degrees of protection and management, depending on the laws and regulations and the parent governmental organizations involved. Even within a given type of reserve the actual management will vary greatly depending on a number of factors. The effectiveness of protection provided by a reserve also depends on the size of the reserve and its shape, its location in relation to other reserves, the activities that are carried on within the reserve (such as farming, hunting, fishing and mining) and the activities on the boundaries and adjacent to the reserves.

In-situ Conservation of Ecosystems

The following sections describe the present distribution of reserves on the basis of ecosystem types, indicating the areas of each ecosystem type officially protected by reserves. However, these figures do not necessarily mean that the areas listed are truly protected. As noted below and elsewhere, protection is not complete in many reserves, so formal reserve status does not necessarily protect the ecosystems and species involved. A comprehensive national review of the reserve system is needed to determine the actual protection status of the nation's ecosystems and species (*see* Objective 2, in Chapter 3).

In-situ conservation of forest ecosystems. Establishment of nature reserves for forests began in the 1950s. Altogether 335 forest ecosystem nature reserves had been established by the end

of 1991, accounting for 47.3 percent of all the nature reserves and covering a total area of 11,087,000 hectares. Combined with some nature reserves designed to protect the wildlife in forests (with an area coverage of 3,921,000 hectares), the total area of forest type nature reserves established in China amounts to 15,008,000 hectares, accounting for 26.8 percent of the total area of all nation's nature reserves.

In-situ conservation of grassland ecosystems. China's construction of nature reserves for grassland ecosystems started late and developed slowly. By the end of 1991, 12 nature reserves were established to protect grassland ecosystems, covering 1,297,000 hectares. Combined with the nature reserves established to preserve the wild animals and plants in grasslands, their total area constitutes 1,308,000 hectares, accounting for only 0.75 percent of the total area of all grassland ecosystems in the country.

In-situ conservation of desert ecosystems. Protection for desert ecosystems in China also started late, but has been developing rapidly. Since the 1980s, eight nature reserves have been established, including the Arjinshan, Anxi, and Qiangtang, comprising 29,489,000 hectares and occupying 52.8 percent of the whole reserve area. Combined with the six nature reserves to protect wildlife in deserts (with an area of 4,080,000 hectares), their total area amounts to 33,578,000 hectares, accounting for 60.1 percent of the whole reserve area and 17.5 percent of the total area of all desert ecosystems respectively.

In-situ conservation of inland wetland and freshwater ecosystems. Establishment of the nature reserves to protect inland-type wetland and freshwater ecosystems started in the 1970s. To date some 16 nature reserves have been established, covering an area of 1,019,000 hectares. In addition, 57 nature reserves also have been established on wetlands and freshwater bodies to protect valuable waterfowl, migrant birds, and aquatic wildlife, with an area of 2,126,000 hectares. Combined, the total area of these two types of nature reserves amounts to 3,145,000 hectares, accounting for 7.8 percent of inland and freshwater wetlands in the country.

In-situ conservation of marine and coastal ecosystems. Development of marine and coastal ecosystem nature reserves in the country started in 1970s. To date 19 nature reserves of marine and coastal ecosystem have been established in China, covering an area of 117,000 hectares. There are also 17 nature reserves designed to protect valuable and rare marine animals and marine products, covering a total area of 2,730,000 hectares. The combined total area of all the marine nature reserves of these two types is 2,847,000 hectares, accounting for 0.9 percent of China's seawaters.

In-situ Conservation of Wild Species

Any ecosystem reserve, if it is effective, must conserve the whole spectrum of living species within it. Therefore all reserves should provide for in-situ conservation for wild species. However, for historical, regulatory, administrative and institutional reasons, a number of reserves have been established specifically to conserve wild animals or plants. Establishment of wildlife nature reserves in China began in the 1970s and accelerated in the 1980s. To date, 280 nature reserves altogether have been established to protect wild animals and plants, with a total area of 12,871,000 hectares. Of the 280 nature reserves, 211 reserves are designed to protect wild animals, with an area coverage of 12,462,000 hectares; and 69 reserves are designated to protect wild plants, with an area coverage of 409,000 hectares.

Status and Management of Nature Reserves

Incomplete national network of nature reserves in China. China has a vast territory and complicated natural environment; the number and kind of species of wildlife varies greatly between regions. In order to set up a rational system of nature reserves, a biogeographical zon-

ing plan is required to determine critical areas of biodiversity conservation. Then the reserve construction can be based on this zoning plan. However, there is no such biogeographical zoning plan in China, or overall planning for the reserves. The size and placement of some established nature reserves were not chosen according to a scientific appraisal, and the distribution of reserves nationwide is largely not rational.

At present, the geographical distribution of most established nature reserves are concentrated in the southeastern part of the country, east of a line linking the Greater Xin'an Mountain, Lulian Mountain, Liupan Mountain and Qinghai-Tibet Plateau. This is the area where human pressure and the endangerment to both ecosystems and species is greatest, so the urgency for establishment of reserves also is greatest. The vast arid and semi-arid regions of the northwestern part of the country, and the species and ecosystems needing protection within it, are mostly unprotected, although the more recent reserves in that area tend to be large so that they have a better chance of protecting their ecosystems and wide-ranging wildlife.

Therefore, what is needed to complete the national network is to identify the ecosystems (and if appropriate, particular species) that are not protected adequately under the present system, and to expand the system to include those. Priority in establishing the needed new reserves should be given to those areas which are most immediately threatened.

Construction of the established nature reserves not very rational. Nature reserves have been established according to the priorities of the different regulations and governmental institutions involved, so there is not a balanced coverage of all the different types of natural ecosystems in the country. Although forest reserves are some of the most abundant areas in biodiversity, at the same time that they are built or increased, relevant ministries and agencies should also give more consideration to establishing other types of reserves. Freshwater and marine reserves appear to be particularly poorly represented. Some reserves are small and some very large. What is important is to determine how well the existing ecosystem types (and as appropriate, species) are covered by existing reserves, and, as noted in the previous paragraph, to determine which ecosystem types are not adequately protected and to expand the system to cover them.

Poor legislation for nature reserves and lax enforcement of existing laws. China does not have a systematic state law for nature reserves, nor unified regulations to coordinate departments and to solve issues arising over the establishment and management of nature reserves. More than one-third of the total nature reserves do not have regulations for their management. Many stipulations in relevant laws and regulations are often not enforced, or not strictly enforced, as there are no implementing rules or measures. As a result, illegal hunting and poaching of endangered animal and plant species occurs frequently.

Poorly organized lines of authority for management of nature reserves. There are overlapping and unclear lines of authority for the reserves. In many regions, a lack of coordination between different departments makes resolving issues very difficult.

Conflict between economic development and protection of nature reserves. At present, economic development is progressing very rapidly in China, and capital construction is going on throughout the country. Some engineering projects go on even in the core areas of nature reserves. In other reserves or scenic spots, tourism is promoted to help develop the local economy, and while tourism can assist conservation when it is carried out properly, the prospects for quick profits may lead to abuses of the natural systems and species which the reserves protect. In addition, there are strong economic pressures (on the administration of the reserves or on the individual staff members) to use the land, wildlife or other resources within the re-

serves for short term profit, rather than maintaining them for the long term good of the country. In each of these cases, the biological resources in the reserves are likely to come under serious threat.

Lack of operational budgets and low skill level of management. There is no fixed source of funding for nature reserves, and financial support from the responsible institutions cover only some 50 percent of operating expenses each year. The institutional framework for the reserves is incomplete due to this shortage of funding. Of the 708 reserves, more than one-third do not have management structures.

The professional staff in the reserves is largely unqualified or untrained. Of the 13,033 professional staff in the 708 nature reserves, there are only 2,413 with academic qualifications, or only 18.5 percent. Some nature reserves do not have any professional personnel. There is little ecological monitoring or scientific research going on in many nature reserves, and most nature reserves do not operate at their full effectiveness level.

Lack of incentive system for biodiversity conservation staff. No effective and complete procedures have been formulated for rewarding outstanding performance of biodiversity conservation duties. There is a strong need to develop a system of rewards and incentives for improving performance and for superior achievement. Ways must be found to make biodiversity careers inviting and rewarding, so that the best available personnel will aspire to the profession. At the same time there is a need for administrative or criminal punishments when law violations are perpetrated by staff.

Description and Assessment of Ex-situ Conservation Efforts

In-situ conservation of species and ecosystems is vastly preferable to ex-situ conservation. In in-situ situations the whole spectrum of plants, animals and microorganisms can be preserved whereas generally in ex-situ situations only the single target species may be maintained. Ex-situ measures are primarily suited to emergency rescue of highly endangered species that will otherwise become extinct, and captive collections could have some value for public education.

Ex-situ Conservation of Wild Plants

Ex-situ conservation by botanical gardens. Botanical gardens or arboretums can play a useful role in conserving plant diversity. The number of botanical gardens in China increased rapidly during the 1980s, and now there are about 110. Among these, the comprehensive botanical gardens or medicinal botanical gardens are used mainly for scientific research. Some gardens are used primarily for tree seed collection; others, for ornamental plants or educational and training purposes.

It is estimated that at present about 23,000 wild plant species are cultivated in China's botanical gardens, of which 16,000–18,000 species are native flora. Among them about 300 species are in the "Plant Red Data Book (Volume 1)," or about 80 percent of the rare and endangered plant species listed.

Ex-situ conservation bases and reproduction centers. To help conserve rare and endangered plant species, various ex-situ conservation bases and reproduction centers (known as ecological reservoirs) were established by the relevant departments in the early 1980s. Here, conservation reproduction programs were carried out for forest trees, fruit trees, ornamental plants, medicinal plants, grain crops, vegetables, and some valuable cash crops such as tea and mulberry trees.

Ex-situ Conservation of Wild Animals

Ex-situ conservation by zoos. As of 1991, 41 zoos had been built across the country. If animal exhibition areas in big parks are included, the number would reach 175. These zoos and exhibition areas altogether raise more than 600 species of vertebrate animals, with a total of 100,000.

In the past decades, zoos in the country have carried out extensive research in preservation and reproduction techniques for rare animals;

and have achieved some progress, protecting and in some cases reproducing individuals or small groups of endangered and endemic animal species. The zoos in Beijing, Shanghai, Chengdu, Chongqin, Fuzhou, Xian and Xining succeeded in breeding a few giant pandas (*Ailuropoda melanoleuca*), Manchurian tigers (*Panthera tigris altaica*), South China tigers (*Panthera tigris amyeusis*), snow leopards (*Panthera uncia*), blacknecked cranes (*Grus nigricalis*), redcrowned cranes (*Grus japonensis*), golden monkeys (*Rhinopithecus* spp.), Yangtze alligators (*Alligator sinensis*), *Budorcas taxicolor*, and *Presbytis francoisi*.

Ex-situ conservation bases and reproduction centers. To date, 26 reproduction farms of endangered and endemic animal species have been built for conservation. If those built for commercial purposes such as deer, mink and horse pheasant farms are included, the number is 230. There has been some success in breeding some 10 species of animals, such as *Ailuropoda melanoleuca. Alligator sinensis, Nipponia nippon*, and *Panthera tigris altaica*, that were on the brink of extinction. Altogether, there has been some successful artificial reproduction for more than 60 species of rare and endangered species. However, a captive breeding program cannot be considered really successful until a captive population is functioning and either has reached a size sufficient to prevent genetic loss or is regularly growing with promise of long term viability.

Concurrent with efforts to rescue endangered species, efforts have been made since the early 1980s to bring back some animal species that were indigenous to China but had died out in the past. *Elaphurus davidianus, Equus przewalskii* and *Saiga tatarica* were reintroduced to China. In order to increase the populations of *Elaphurus davidianus*, reproduction centers were set up in Beijing and Dafeng County, Jiangsu Province; *Equus przewalskii* reproduction center was set up in Jiemoseer, Xinjiang autonomous region; and the reproduction center for desert animals was set up in Wuwei County, Gansu Province.

Major Problems in Ex-Situ Conservation of Wild Animals and Plants

Small in number and size. There are relatively few botanical gardens, ex-situ conservation bases and reproduction centers for rare and endangered species, and even fewer are of an adequate size. About 40 percent of the botanical gardens are smaller than 50 hectares, and there are fewer than 1,000 species in about 59 percent of them. The size of the plant populations in the botanical gardens does not meet the requirements for adequate genetic diversity.

Unsuitable management for conservation purposes. Rare wildlife in zoos in China are not yet managed as populations. However, the Chinese Zoo Association is making very important efforts to improve cooperation among zoos and has made a start with Red-crowned and Siberian Cranes and possibly a few other species. At present, many valuable animals are placed in institutions that will not properly manage them, or without mates or facilities that will encourage breeding. Zoos are generally reluctant to put conservation needs or captive population management above narrow institutional goals. At a very simple level, population management is impossible unless individuals are permanently marked and genealogical and other records kept and shared with cooperating institutions. Captive management cannot be effective for conservation purposes unless health management and disease diagnosis programs are functioning. Under the current situation release programs are probably dangerous for wild populations because of disease concerns. At present the first priority should be strengthening cooperation among different zoos and breeding centers, raising standards for care and management, and providing facilities that will benefit the system as a whole, rather than assisting individual centers.

Breeding centers at nature reserves or run by agencies with responsibilities for ecosystem protection have other problems. Some of these centers may be valuable commercial enterprises, but fall short of meeting conservation goals due to ill-defined objectives and lack of integrating

management with management programs for the species and its natural habitats. The rarity of an animal alone is not a sufficient justification for establishing a breeding center. Taking animals into captivity from the wild may have negative effects on small and dwindling populations, and should only be undertaken after careful analysis. Lack of veterinary supervision and poor health management for such collections pose a serious disease threat to wildlife populations living close to the captive animals.

Inadequate funding. The funding for ex-situ conservation of wild animals is inadequate and contributes to the management problems discussed above. Building and maintaining ex-situ conservation facilities is very expensive, and many zoos and reproduction centers cannot support the work. At times the breeding of even protected animals must be limited; for instance, *Alligator sinensis* and *panthera tigris amoyensis* have enforced "family planning." Besides educational use, there is pressure to make commercial use of the species involved in order to provide funding to maintain the programs; therefore zoos and breeding centers are often perceived as existing for commercial purposes rather than for conservation.

The current state of Chinese zoos is that under present stipulations, they cannot raise ticket prices, they are not permitted to buy or sell wild animals, and they are charged high fees for breeding wild animals. Therefore, huge expenditures are needed and revenues are limited, making a shortfall in revenue.

Collection, Assessment and Conservation of Domestic Varieties and Wild Relatives of Crops and Livestock

Collection and conservation of crop varieties and relative species. Before the People's Republic of China was founded, the collection and preservation of crops was not given enough attention. In the late 1950s, the State conducted a nationwide collection of field crops, about 200,000 specimens of some 50 varieties of field crop germplasm were collected. But during the 1960s and 1970s, part of the preserved crop varieties were damaged or lost. Since the 1980s, the work of crop genetic resources have again been given attention; and the number of accessions now total 350,000, one of the largest collections in the world.

In 1987, the Chinese Academy of Agricultural Sciences set up the national germplasm bank for crop genetic resources. By 1992, this national germplasm bank had collected 230,000 accessions. In addition, some provinces and municipalities have set up local mid-term germplasm banks and nurseries.

Collection and preservation of domestic breeds of livestock and poultry. Livestock and poultry are the major source of the meat, eggs and milk consumed by humans. According to preliminary statistics, China has preserved 398 fine breeds of livestock and poultry species. Rapid progress has also been made in gene banks for livestock breeds. Several modern animal cell, sperm, gamete and embryo banks have been completed or are being built.

Assessment of ex-situ conservation of domestic varieties and wild relatives of crops and livestock.

- The work of investigation, collection and preservation for wild species and wild relatives of crops is very inadequate. The number of wild species and genotypes are decreasing rapidly. For example, the wild *glycins max*, wild *Nephelium litchi*, wild *camellia sinensis* and wild *Oryza sativa* are in imminent danger of extinction because of loss of habitat. Here again, in-situ conservation may be more effective and economical than ex-situ efforts.
- The total numbers of collected and preserved varieties of cultivated crops is not adequate. At present, only about 65 percent of the total number of existing varieties of crops is preserved, which is not near enough. Many varieties of

locally cultivated crops and locally bred domestic livestock and poultry have decreased sharply, or disappeared, because of the introduction of high-yielding varieties.

The numbers of germplasm banks and nurseries are inadequate. The existing mid-term germplasm banks and nurseries are capable of preserving only 50 percent of crop genetic resources. Building an estimated 5–17 mid-term germplasm banks and nurseries is required.

Operating funds for the national germplasm bank and local mid-term germplasm banks and nurseries is seriously inadequate: one-third of the germplasm banks are nonfunctional, and the preserved accessions continue to disappear.

Assessment of Scientific Research and Achievement for Biodiversity Conservation

Survey and Inventory of Biological Resources

Survey and investigation of biological resources. Since the 1950s, various ministries and departments, as well as scientific research institutions, have conducted many large-scale comprehensive surveys for biological resources in different regions of the country. Numerous background monographs and scientific reports have been published. At the same time, many of specimens of animals, plants and microorganisms have been collected; more than an estimated 10 million specimens are stored in China.

In the past 10 years, with the development of nature conservation, investigations on nature reserve divisions according to major characteristics have greatly increased. For example, from 1979 to 1983, a survey for nature conservation zoning was organized by the Ministry of Forestry with seven other ministries to study the zoning and assess the work of more than 100 nature reserves. At present, many of the reserves being built or planned, have been surveyed more or less.

The survey and investigation on rare and endangered animal and plants began in China in the early 1980s. In the past 10 years there have been dozens of investigation projects, which are of great significance to making clear the distribution and quantity of such animals and plants and developing protection programs.

One of the urgent present needs is to review the existing information in order to identify what additional information is needed to develop an effective biodiversity conservation program.

Inventory. "Fauna of China," "Flora of China" and "Cryptogamic of China," are the basis for the national inventory of species diversity for China. Altogether a total of 374 volumes are planned. To date, 57 volumes of fauna have been published, about 30.2 percent of planned publications; and 91 volumes of flora have been published, or 70.2 percent of those planned. One volume of cryptogams has been published, or 3.3 percent of total volumes planned. Numerous monographs on biological resources nationwide have been published.

In 1984, the Environmental Protection Committee of the State Council issued the "List of Plants under the State's Key Protection." In 1988, the State Council approved the "List of Wild Animals under the State's Key Protection." In 1991, the Chinese and English editions of the "Red Book on Plants In China" was published. The "Red Data Book on Animals in China" is currently being compiled by the Chinese Academy of Sciences. An inventory is also included in a Biodiversity Research Information Management (BRIM) project that CAS is conducting.

Planning and Enforcement of Biodiversity Conservation

Planning and enforcement of in-situ and ex-situ conservation. In 1956, the Draft Programme on the Establishment of Natural Forest Resources was approved by the First National People's Congress. By 1965, 19 nature reserves covering an area of 650,000 hectares had been set up according to this program.

In 1980, Summary of National Conference on Agricultural Resources Investigation and Agricultural Zoning was approved by the State Coun-

cil. In 1984, the Programme of National Nature Reserve Division had been worked out. The programme proposed 361 reserves in 27 provinces. By 1989, some 570 nature reserves of various categories had been set up, covering an area of 27 million hectares, approximately 3 percent of the nation's territory.

In 1990, entrusted by the State Planning Commission, NEPA organized the drafting of the Eighth Five-Year Plan and Ten-Year Plan of National Nature Reserve and Species Protection. The plan proposed that 1000 nature reserves should be set up by the year 2000, covering 50 million hectares, more than 5 percent of the nation's land. The state-level reserves altogether should reach 120–140, occupying one-fourth to one-third of the total reserve area. This goal has already been met, however, by the establishment of the Qiangtang nature reserve in Tibet, so a revised plan for nature reserves and species protection is in order.

Establishment of monitoring system for biodiversity conservation. To date, there are more than 2,000 environmental monitoring stations in China, under the management of various environmental protection agencies. Some six ecosystem monitoring and research stations have been set up for grassland, desert, tropical rain forests, wetlands and marine ecosystems.

There are also over 30 national ecological stations established by the Chinese Academy of Sciences and its research institutes for studies on different ecosystems, and their evolution changes and trends: 9 stations for forest ecosystems; 6 for grasslands; 15 for agricultural; 2 for wetlands; and 2 for marine.

In the past 20 years, some 480 conservation research and monitoring stations have been set up by the Ministry of Agriculture for environmental protection of different agro-ecosystems and nature conservation.

The State Oceanographic Administration has established 60 monitoring stations, among them 2 are ecosystem stations located in Zhoushan and Xiamen, and 3 are marine resource stations in the Yellow Sea, the East China Sea, and the South China Sea.

Again, a current need is to make a comprehensive assessment of the monitoring efforts to determine how adequate it is for purposes of biodiversity conservation, and to identify the additional monitoring efforts that are needed.

Biodiversity Conservation Technologies and Their Popularization

The institutions dealing with biodiversity conservation have devoted manpower, materials and financial resources to research in biodiversity protection and some progress has been made. For instance, Hangzhou Botanical Garden and South China Botanical Garden are protecting *Carpinus putoensis*, and more than 100 *Magnolia* species. In the breeding of endangered animals, the technology of artificial insemination has been put to wide use. In 1978, for the first time, Beijing Zoo succeeded in breeding a giant panda.

The technique of collection and artificial hatching of wild silkworms, *Antheraea yamamai*, in Heilongjiang Province has obtained good results. The artificial hatching, feeding of the young, and releasing back into the wild have also proven effective for conserving some species, for example, three species of sturgeon in the Yangtze River has benefitted from use of this technique.

Some work has been done in applied technologies of molecular biology. For example, the relationship between mtDNA polymorphism and subspecies differentiation has been studied, based on some 20 types of isozyme of 36 individuals from more than 20 localities, providing valuable information on the differentiation time of these species, their origins and their dispersion patterns.

Technology and Benefits Related to Biodiversity Utilization

The technological benefits of biodiversity primarily come from cross breeding, or possible genetic engineering, to achieve higher production from domestic plants or animals. Most of the effort to date has involved domestic species; however, increasingly there is need to explore wild relatives of domestic species, and other forms of wild plants

and animals, to provide for increasing human needs. Biodiversity technologies have been used extensively in industry, agriculture, forestry, medicine, and environmental protection. The breeding of fine rice varieties with wild relative species is an example of such success, yielding about a 90-million-ton increase in 1975–85. The breeding and popularization of fine varieties of masson pine and eucalyptus, the techniques of rubber tree–tea tree cubic interplanting, fish farming in rice land, and joint afforestation with trees, shrubs and grass are all successful uses of biodiversity techniques.

Major Problems of Research on Biodiversity Conservation

Baseline data on biological resources is inadequate. The number of species and populations of organisms in China is unclear, investigations and research on some species are lacking, and the investigated species still lack in-depth supporting investigations. An integrated inventory of species is lacking. The present status and degree of threat to rare and endangered, protected animals and plants is not well understood. Research on population dynamics and the biological nature of some important species is inadequate. The population of species in large nature reserves has not been studied, and baseline data on biological resources of some nature reserves is still unclear. There are also insufficient ecological monitoring stations, especially for wetland and marine systems.

Lack of research funds, and out-of-date research equipment. There is no fixed source of funding for research in biodiversity conservation. Investment from the State government is very limited, and most administrative departments of biodiversity do not devote basic research funds to biodiversity protection. The established nature reserves not only do not have research funds, but they also lack qualified research staff. Equipment and instruments for biodiversity research generally are old and out-of-date.

Lack of staff and access to data and research opportunities. Many nature reserves do not have qualified research staff and some tend to discourage other scientists from doing research in the reserves by charging fees making research difficult or impossible. Nature reserves should encourage and assist outside researchers to work so long as the results of their research are made available to reserve managers for management purposes. To assist and guide research efforts of technical staff within reserves, partnerships should be developed between nature reserves and research institutes and universities, so that highly qualified outside researchers work closely with reserve staff in the field.

Lack of unified national biogeographic zoning. At present, there is no nationwide biogeographic zoning plan in China, and therefore this important basis for developing a plan for biodiversity conservation is lacking.

Assessment of Institutional Framework Related to Biodiversity Conservation

Central Governmental Institutions and Functions Related to Biodiversity Conservation

Under the direction of the State Council, the State Environmental Protection Commission (SEPC) was established with 38 members from the concerned government organizations. The SEPC has recently designated NEPA as the leading agency to coordinate and monitor the management of biodiversity conservation. The State Planning Commission (SPC), State Science and Technology Commission (SSTC), Ministry of Forestry (MFO), Ministry of Agriculture (MOA), Ministry of Construction (MOC), State Oceanic Administration (SOA), Chinese Academy of Science (CAS), State Education Commission (SEC), Ministry of Public Security (MOPC), State Patent Administration (SPA), State Medical Administration (SMA), State Meteorological Bureau (SMB), and Ministry of Water Resources (MWR) are the participating institutions for biodiversity conservation.

The main functions and responsibilities of the major institutions for biodiversity conservation are as follows:

The function of the SEPC is to examine and approve general principles and policies concerning environmental protection; to guide, organize and coordinate environmental protection efforts at the national level; and to coordinate and resolve difficulties in biodiversity conservation with consultations between relevant institutions. SEPC shares responsibility with NEPA for implementing and supervising the implementation of international conventions.

NEPA assumes the responsibility for the overall management of biodiversity conservation; that is, for formulating laws, regulations and economic and technical policies on nature conservation; for compiling national program and technical specifications for nature reserves; for formulating management regulations and evaluation standards of nature reserves; for supervising conservation of rare and endangered species; for carrying out the day-to-day work of the National Evaluation and Approval Committee of Natural Reserves; and for formulating opinions and approval decisions on the establishment of the state level nature reserves. NEPA also represented the Chinese government in drafting the Biodiversity Convention, and in the later negotiations and revision of the Convention.

The SPC is responsible for national economic and social development planning under the State Council. Its function is to coordinate different ministries and departments, and to work out long-term programs and annual plans for the economic and social development of the country, including the program and plan for biodiversity conservation and supervision of its implementation.

The SSTC is responsible for coordination of science and technology development; for overall management of science and technology; for compilation of national plans for scientific research; for formulation and supervision of implementation of science policies; and for overseeing management of international scientific exchanges and cooperation.

The MFO assumes responsibility for guiding the construction and management of nature reserves of forest, wildlife, and wetland types; for exploitationand conservation of terrestrial wild animal and plant resources; for managing and coordinating the import and export of endangered species under the Convention on International Trade in Endangered Species (CITES) and species under state protection; and for conserving and managing different forest ecosystems.

The MOA is responsible for guiding the protection, research and use of agricultural and grasslands ecosystems, freshwater and marine fisheries, and for biological resources in agriculture; for establishing and managing agricultural nature reserves; for formulating programs, regulations and standards for agricultural biodiversity conservation; and managing import and export of agricultural genetic resources.

The MOC assumes the main responsibility for constructing and maintaining biodiversity conservation facilities in urban areas and scenic spots; and for constructing and managing the urban greenland system, zoological gardens, botanical gardens, and wild animal reproduction bases.

The SOA is responsible for the comprehensive management of the national seawaters; for formulating program for their development and use; for formulating laws and regulations for seawaters management; for setting up seawater boundaries; for protecting the marine environment; for coordinating rational development and utilization of marine resources; for establishing and managing the marine nature reserves; and for organizing the monitoring, tracking and forecast service of the marine environment.

The CAS is a scientific research institution at the national level. In cooperation with the SSTC and relevant departments, it makes long-term scientific research plans for biodiversity conservation. It assumes responsibility for conducting scientific research on biodiversity conservation and ecosystems.

The SEC is the highest comprehensive and coordinating institution in the education domain. It assumes responsibility for formulating education policies, supervising their implementation, compiling long-term and short-term edu-

cation programs and plans, and managing biodiversity conservation education in universities and colleges. It also carries out exchanges and cooperations with foreign organizations.

The MOPC is the public security administration. Its responsibility in biodiversity conservation is to cooperate with departments of environmental protection, forestry, agriculture and other to enhance public security in nature reserves, and to fight criminal activities in damage to and illegal possession of biodiversity resources.

Local Institutions and Their Functions

The corresponding comprehensive management departments, specialized management departments, public security and law enforcement departments, and scientific research and educational departments are set up in the provincial (autonomous region and municipality) government similar to those established at the national level. All these departments assume responsibility for biodiversity conservation under the guidance of the corresponding institution at the national level. Their functions and responsibilities are similar to those at the national level. However, China is very decentralized and while the local institutions receive technical guidance from their national equivalents, they function administratively under their local governments that, in effect, exert the primary control over them.

A major weakness regarding the effectiveness of reserve management is the lack of cooperation among local agencies with authority over resources within or around nature reserves. The reserve management should have some authority to coordinate use of resources within their boundaries. It would be desirable for each reserve to have some sort of coordinating council with the participation of relevant local agencies and the support of local government, so that integrated management of ecosystems is possible. The same issues of local institutions and coordination are very important for biodiversity conservation outside nature reserves.

The local people's governments below the provincial level have established relevant specialized and non-specialized departments to assume responsibilities in biodiversity conservation, depending on the scale and scope of work they have in this domain.

The present institutional framework established by the Chinese Government for biodiversity conservation is shown in the organizational chart in Figure 2.1.

Issues of Coordination, Authority and Responsibility

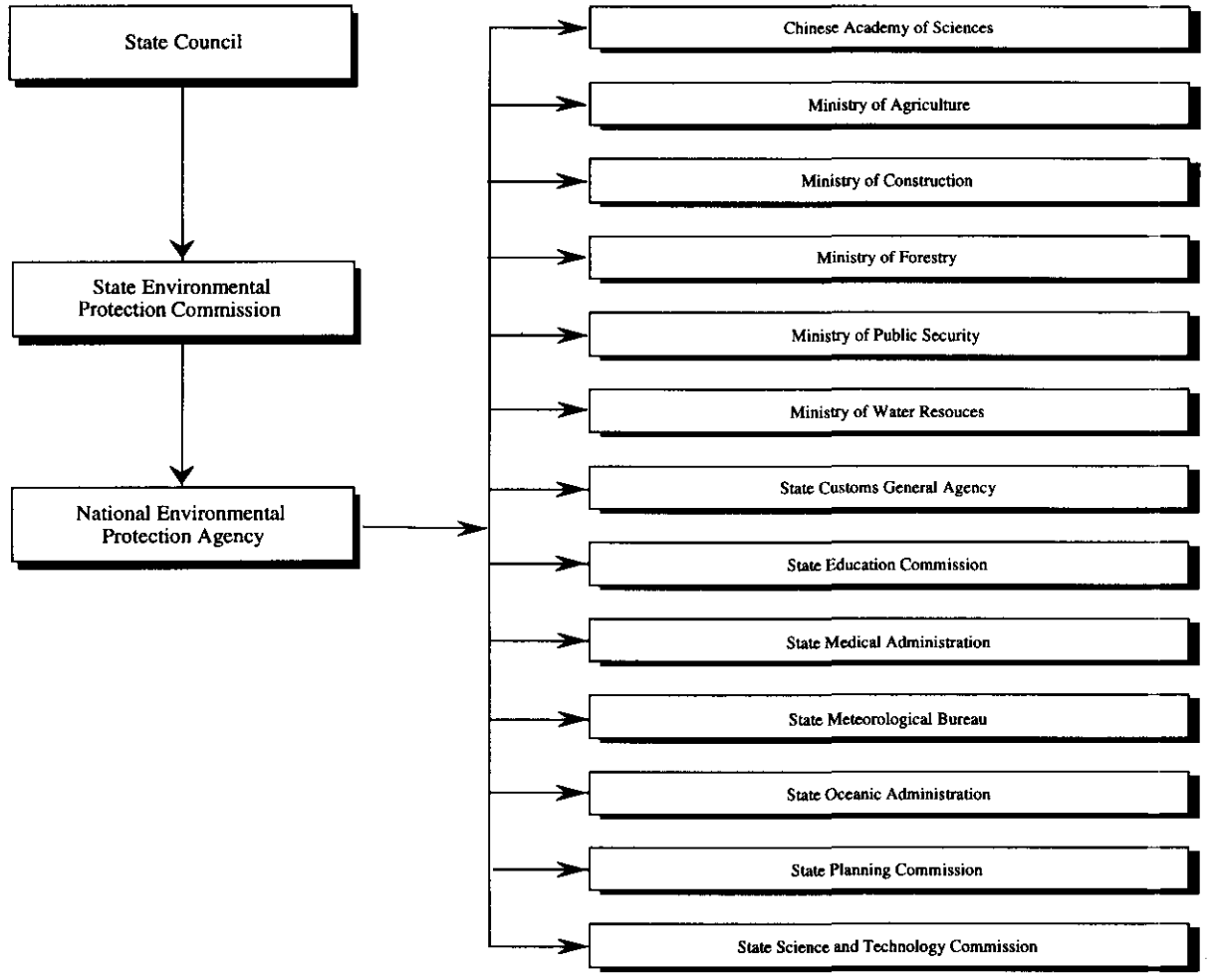
NEPA has been assigned responsibility for oversight, monitoring and coordination of the nation's biodiversity conservation, including the nation's nature reserves and wildlife conservation efforts. Other ministries and agencies responsible for different functions assigned by the State Council, such as MFO, MOA, MOC and SOA, deal mainly with resource conservation within their own domains and specialties. That is, they are responsible for biodiversity conservation through conserving the specific resources and nature reserves falling within their jurisdiction. Still other agencies are directly or indirectly concerned with biodiversity conservation. For instance, the water conservancy agencies are responsible for the rational use and protection of water resources within the specific administration scope. The medical management departments are responsible for the rational use and protection of the precious medicinal materials. CAS, and research institutes under CAS, and different ministries also conduct research for biodiversity conservation.

While the common efforts made by different ministries and agencies have played an important role in biodiversity conservation, the issue of coordination remains a fundamental problem. Given the size and complexity of the country and its governmental structures, achieving effective coordination remains one of the most important and intransigent obstacles to effective biodiversity conservation.

Nongovernmental Organizations and Their Functions

Nongovernmental organizations in biodiversity conservation in China refer mainly to academic

Figure 2.1: Institutional Framework for Biodiversity Conservation in China



or professional bodies, such as the China Ecology Society, China Environment Society, China Forestry Society, China Agronomy Society, China Oceanographic Society, China Botany Society, China Zoology Society, China Wildlife Protection Society, China Gardening Society, China Botanical Garden Society, and China Zoological Park Society.

Nongovernmental bodies in China play a somewhat different role from the more autonomous, activist ones in other countries; and their contribution to biodiversity conservation in China is primarily through research, monitoring and public information. They probably have a substantial potential role in raising public awareness of the importance and threats to China's biodiversity wealth.

Description and Assessment of Biodiversity Conservation Law and Policy

National Policy of Nature Protection

Nature protection has been recognized as an urgent strategic task by the Chinese Government, which has made clear that environmental protection and maintenance of benign cycles of eco-

logical equilibrium is one of the basic policies of China's modern socialist construction.

Under the present conditions in China, one of the most effective measures to protect natural resources and natural environment, to maintain the nature's ecological equilibrium, and to stop the deterioration of the ecological environment is to establish the sustainable use of biological resources. This target must be achieved before the population increases further, so that a number of regions with intact natural environments can conserve their resources. These additional efforts would increase the territorial coverage of nature reserves to the world's average, or better; make their types more diverse; and the regional distribution more rational.

With respect to the establishment of nature reserves, the policy of conservation, development and rational utilization is practiced so that the integration of social, economic and environmental benefits can be achieved. In other words, concurrent with the promotion of economic prosperity, more biological resources and species will be conserved, and the ecological equilibrium shall be maintained.

At present, the Chinese Government is paying close attention to coordinating utilization and conservation of natural resources in the economic structure of the country, placing emphasis on the concept of sustainable development. In line with this concept, equal emphasis is being placed on development and regeneration of natural resources, so that the utilization of renewable natural resources, including biological resources will not exceed their growth rate and so that their sustainable utilization will be possible.

Relevant National Legislation

In the past ten years, China has promulgated a series of laws and regulations, many of which concern biodiversity conservation. The main laws are: Constitution, 1982; Marine Environment Protection Law, 1982; Forestry Law, 1984; Grassland Law, 1985; Fishery Law, 1986; Wild Animal Conservation Law, 1988; Environment Protection Law, 1989; and Criminal Law. Other laws and regulations include: Mineral Resources Law, 1986; Land Law, 1986; Law on Air Pollution Protection and Control, 1987; Water Law, 1988; and Water and Soil Conservation Law, 1991.

The main regulations include: Regulations on Reproduction and Conservation of Aquatic Resources, 1979; Regulations on Salvage Management, 1981; Regulations on Environment Protection in Offshore Oil Exploration and Exploitation, 1983; Temporary Regulations on Scenic Resources, 1985; Regulations on Forest Fire Prevention and Control, 1988; Regulations on Seed Management, 1989; Regulations on Control of Pollution from Ships, 1989; Regulations on Prevention of Pollution Damages to Marine Environment by Coastal Construction Project, 1990; Regulations on Conservation of Terrestrial Wild Animals, 1992; Regulation on Afforestation of Urban Areas, 1992; Regulations on Administrative Penalties for Public Security; and Regulation on Forest and Wild Animal Nature Reserves Management.

In order to conserve local biological resources, the local governments at different levels have also issued regulations and rules of local significance, consistent with State laws and regulations.

Conservation Strategy of the State

After the World Strategy on Natural Resources Conservation was issued in 1980, China set about drafting the China Nature Conservation Strategy. At the end of 1986, the State Environmental Protection Commission approved the strategy report and transmitted it throughout the country as the document of the commission. This report became the first document on nature conservation published by the Government and circulated nationwide.

The strategy illustrated the position and function of natural protection in the modern socialist society, made clear the responsibilities and obligations of the departments concerned with developing and utilizing natural resources,

stated the basic principles for protecting and developing natural resources, and provided a scientific basis for policy-making, planning and legislation of the State and localities.

Major Problems of Biodiversity Conservation Law and Policy

Lack of systematic and complete laws. Legislation for biodiversity conservation and natural resource protection is not systematic and complete. A unified State nature reserve law and wild plant protection law is lacking, as is relevant administrative regulations.

Existing laws not strictly enforced. While many laws and regulations intended to protect biodiversity exist, in practice they are often not enforced or not enforced strictly, or when the violators are apprehended, the court system treats them very leniently. As a result, illegal hunting and collection of endangered animal and plant species is very widespread, and disputes arise continuously between management of nature reserves and local residents, hindering biodiversity conservation efforts.

Description and Assessment of Publicity and Education for Biodiversity Conservation

Publicity and Education

Publicity and education on biodiversity conservation are mainly conducted together with publicity about legal matters, through mass media such as radio, TV, films, newspaper and magazines. Many TV documentaries on nature protection have been completed in recent years. They have featured nature reserves and nature protection and have been well received. The main newspapers on nature protection in China include "China's Environment," "China's Forestry," and "China's Oceans." The main magazines include "The Nature," "Wild Animals," "Rural Ecological Environment," "Agro-Environmental Protection," "Marine Animals," and "Development of Oceans and Seashores." The journal "Chinese Biodiversity," sponsored by CAS, was published in August 1993.

Organizing national compulsory activities through legislation is a means for publicizing biodiversity protection. In 1981, the National Compulsory Tree Planting mandate stipulates that March 12 is a national tree-planting day. This greatly promoted the nationwide campaign of tree planting and forest resource protection. In 1980, the State Council decreed a "Love-the-Birds Week" between April and May of every year. This activity played a positive role in heightening the public's wildlife protection consciousness.

Youngsters are the future of the country; and in the primary and secondary schools, they are taught about wildlife protection in courses like general knowledge and biology. Meanwhile, they can also learn firsthand about biodiversity at summer camps.

Nature reserves are the best places for education and public information on biodiversity conservation. Most of the zoos, botanical gardens, national parks and forest parks use placards, bulletin boards and publicity slogans to spread knowledge to the public. Publicity through exhibitions is another good method being taught; for instance, an "Exhibition on China: Nature Conservation" was recently held in Hong Kong.

In the past 10 years, a great number of academic papers have been published, such as "An Introduction to Natural Conservation" and "Manual of Nature Reserves", and editions from abroad have been translated including "World Conservation Strategy" and "Conserving the World's Biodiversity."

Personnel Training

Lack of adequate numbers of trained personnel is a major impediment to effective biodiversity conservation. In order to raise the professional level of staff engaged in biodiversity scientific research and management, the Chinese Government is seeking to provide training. For long-term training, in many multi-disciplinary, forestry and agriculture universities, the departments and specialties of environmental and natural resources protection are set up to educate all kinds of experts and pro-

fessional staff on environmental protection and conservation of agriculture, forestry, fisheries and wildlife.

For short-term training, NEPA, MFO, MOA, SOA, MOC and CAS have all organized special training classes on resources management and wildlife management and conservation. Since the early 1980s, more than 40 training courses altogether were organized by different ministries and governmental agencies, and more than 2,000 persons were trained.

In addition, a series of public information centers were set up in existing nature reserves by NEPA, MFO and MOA. This kind of public information centers on biodiversity conservation are functioning in the Wuyishan, Wolong, Zhalong, Yancheng and other nature reserves. These centers raise public awareness about the importance of biodiversity conservation and help train some operational staff; the centers have had good results.

Numerous short-term training courses were organized with international funding for project-related studies or programs, such as tropical forest conservation, Giant panda conservation, wetland management, and bird banding. From 1985 to 1992, altogether 14 training courses were organized by the World Wild Fund for Nature (WWF), with 20 to 45 persons trained per training course.

In recent years, the Chinese Government has arranged many cooperative programs with many international organizations and foreign governments and has sent out many professionals for studies and training. These international organizations include the United Nations Environment Programme (UNEP), International Union of Nature and Nature Resources Conservation (IUCN), United Nations Food and Agriculture Organization (FAO), and WWF.

Major Problems of Biodiversity Conservation Publicity and Education

Inadequate publicity and understanding of biodiversity conservation. To date, publicity of biodiversity conservation is still inadequate. Biodiversity conservation is a new technical term for many officials in the governments at all levels and for citizens who are lacking basic knowledge on biodiversity conservation. Therefore there is a need for both formal and informal public education, and for in service training efforts for government personnel, to convey the existence and importance of biodiversity. There should be efforts to popularize scientific information, produce TV programs, films, and suitably illustrated books.

Lack of adequate teaching of biodiversity in schools. At present biodiversity conservation is not an effective part of the curricula at any level in the nation's schools. There is a need to expand the curricula to include biodiversity, to develop teaching manuals and materials, and to provide for specialized training for teachers.

Lack of qualified managerial and technical staff. The existing managerial staffs of the nature reserves are unqualified. Most have not received technical training to meet the needs of managing nature reserves. There is a great need to provide incentives to obtain well-trained staff and to reward them for the effective use of their abilities.

Description and Assessment of International Cooperation in China's Biodiversity Conservation

Multilateral Cooperation and International Conventions

China has attached great importance to international cooperation in biodiversity conservation. China has participated in international conventions and activities, making its contribution to global biodiversity conservation.

In September 1978, China founded the State Committee of Man and Biosphere Programme (MAB) of the People's Republic of China, responsible for the MAB cooperation with UNESCO. The major MAB projects China participates in are: conservation of ecosystems of various forests, grasslands, marshlands and lakes; erosion prevention; and soil desalinization.

In 1980, China officially joined CITES. Since 1989, NEPA has sent experts and delegations to

take part in the drafting, revising and intergovernmental negotiating on the International Convention on Biodiversity. In 1992, China officially signed and approved that Convention. China participated in the drafting of the Marine Law Convention. In 1985, China officially joined the international convention on the dumping of waste and other polluting materials into oceans. In 1992, China signed the Ramsar Convention, cooperating with its members in protecting wetlands and waterfowl habitats.

In 1980 and 1984, the China Environmental Science Society and China Wildlife Protection Society joined IUCN, and actively participated in its various activities. Together with IUCN, WWF and UNEP, the Chinese Government published the "World Conservation Strategy."

Nongovernmental Cooperation

At the same time, China has also conducted some nongovernmental cooperation in biodiversity protection. In 1979, the China Environmental Science Society and WWF signed the Agreement on the Cooperation on Wildlife Resources Protection. The two organizations signed the Protocol on building Centers on Panda Protection, and a center was founded at Wolong, in Sichuan. In 1986 and 1987, two scientific investigations were conducted on South China tigers in the Arjin Mountain Nature Reserve, cosponsored by NEPA and WWF and supported by the Xinjiang Environmental Protection Agency.

In September 1985, Britain's Woburn Abbey presented 22 *Elaphurus davidianus* to China, to return the animals to their homeland. In August 1986, WWF and the London Zoology Society presented China another 39 *Elaphurus davidianus*. Now, the two batches of *Elaphurus davidianus* are respectively feeding and breeding in the Beijing Elaphurus Davidianus Garden and the Dafeng Milu Protected Area in Jiangsu Province.

External cooperation activities have also been completed in some other nature reserves in China. Other NGOs and foundations such as International Crane Foundation, Wildlife Conservation International, Ford Foundation, Rockefeller Foundation and MacArthur Foundation have carried out cooperative and exchange programs with various ministries, governmental agencies and academic organizations in China.

Impediments to Increased Cooperation

Although there are a number of joint multilateral, bilateral, and NGO activities, there could potentially be more. Institutional fragmentation and lack of assessment of priority needs have discouraged outside organizations from forging partnerships with Chinese institutions. This action plan is intended to help encourage and direct potential funding organizations and collaborating institutions to the most urgent activities confronting China today. Better coordination among Chinese agencies would also encourage and expedite increased international cooperation.

Chapter 3
ACTION PROGRAM OF SPECIFIC BIODIVERSITY CONSERVATION MEASURES

Overall Objective of China's Biodiversity Action Plan

As discussed in the preceding chapters, the natural environment and biodiversity resources in China have been severely damaged and are under increasing threats. Therefore, the overall objective of biodiversity conservation in China is to set in place as soon as possible measures for avoiding further damage, and, over the long term, for mitigating or reversing the damage already done.

Basic even to this general objective is the tension between economic development and biodiversity conservation that is found in any country, and more particularly in a developing one. Therefore, a basic consideration underlying this objective is the need to integrate biodiversity conservation into the nation's economic and social development.

Effective biodiversity conservation can achieve this objective in two ways: first, by the total protection of rare and endangered species and ecosystems facing extinction (for example, by banning their use for a period of time); and second, by the rational and sustainable use of those biodiversity resources that exist in sufficient quantities to allow for such exploitation. Because of the urgency of the threat to China's natural resources, the Biodiversity Conservation Action Plan concentrates most of its efforts on the first of these objectives through the following means:

- In-situ conservation in nature reserves, parks, and other protected areas;
- In-situ conservation outside of nature reserves, parks and other protected areas;
- Development of priorities among species for direct protection; and, in combination with analyses of the above proposals, development of options for ex-situ conservation in zoos, botanical gardens, aquaria, gene banks and breeding centers;
- Establishment of a nationwide information and monitoring networks to track the status and trends of China's biodiversity; and
- Integration of conservation issues into the central economic planning of the country as a whole.

In-situ conservation is the core of the program, and is complemented by ex-situ means as indicated above. Nationwide information and monitoring networks will serve to coordinate the efforts of the many organizations necessary for effective biodiversity management of such a vast and geographically varied country (as described in Chapters 1 and 2). All of these efforts should be supported by a comprehensive national policy that takes biodiversity issues into account in overall economic planning. This is particularly important as China moves rapidly toward a market economy.

Specific Objectives and Actions

Objective 1: Improve the basic research of biodiversity in China.

Action 1: Undertake a comprehensive review of the status of biodiversity in China, and its economic value (*see* Annex 3, Project 1). The process of developing this Biodiversity Conservation Action Plan, and particularly the results of the second workshop (November 1992), has produced the most comprehensive data yet on China's biodiversity. Therefore, substantial information on the biodiversity of China already exists, but very significant gaps in the needed information remain. However, to date it has not been possible to assemble the existing data in a

standard format or in a form suitable for further planning and action to assure the conservation of the biodiversity. Action 1 is intended to provide that essential foundation of knowledge organized into a usable form.

Action 2: Establish a biogeographic classification system for China for the purposes of biodiversity conservation. Several biogeographic classification systems have been proposed for China but none have been found acceptable to the participants during the development of the Biodiversity Conservation Action Plan. Because such a classification provides an important foundation for assessing and conserving a nation's biodiversity, a biogeographic classification system should be established for this purpose.

Objective 2: Improve the national network of nature reserves and other protected areas.

Action 1: Undertake a comprehensive review of the coverage and status of the protected areas, in order to define on a country-wide basis the effectiveness of the existing protected areas system (*see* Annex 3, Project 2). An important start on this effort has been made by the MOF/WWF project on protected areas (1992), and additional data has been assembled by other institutions and in the process of developing this action plan. However, there is a need to extend these efforts to the country as a whole and to all aspects of biodiversity, to create a working database as a foundation for further action. Needed detailed information on reserves or other protected areas will be provided by the Action 1 comprehensive review; specifically:

- Their classification according to an accepted biogeographical or ecosystem description and information on the extent to which the existing protected areas protect the full range of ecosystems or biogeographical areas and species of the country;
- Not only their area but the number and area of their similar type already protected in reserves or other protected areas, including data on how many are "large" (roughly, over 1000 kilo-meters of continuous natural habitat) to provide one important indicator of relative conservation importance; and
- A clear description of the health of the protected areas and provision for the actions needed to make degraded ones effective (that is, to restore them ecologically).

The intention is to provide, in this way, as accurate a picture as possible of the current status of protection of China's biodiversity in nature reserves and an assessment of the additional areas and species that need to be added to the existing system, along with priorities, to assure the needed level of conservation. A map showing the distribution of nature reserves in China is provided in Annex 4.

Action 2: Adopt measures to enhance the conservation functions of existing reserves. Although the comprehensive assessment called for in Objective 1, Action 1 and Objective 2, Action 1 will identify more clearly what improvements are needed, general analyses of the needs have been made, as described in Chapter 2. On the basis of these analyses several general recommendations can be made at this time.

Improve the planning and management of nature reserves. Operational planning for all nature reserves should be carried out by specialists or experts; and where appropriate, different functional zones should be set up including the core zone. the buffer zone and the experimental zone. Boundary marks should be installed, and free access should be prohibited. Management plans for each protected area should be developed, implemented, and monitored on a regular basis.

Improve the management agencies, allocating competent personnel to them and assigning clear responsibilities. For many reserves at all levels, competent management agencies do not have clear-cut functions and responsibilities have not been established. In order to improve their management, performance standards should be set and measured periodically, and a system of disci-

plinary action for neglect of duty established. To encourage high morale, a system of awards also should be set, and in general, better working conditions established: better pay, better living conditions, better educational facilities, and allowances for families to live in cities nearby.

Improve personnel training. Professional education and training for the staff of nature reserves should be strengthened and enhanced, so that they understand clearly the significance of biodiversity conservation and how their work supports the overall effort, and so that they are best equipped to understand and undertake the tasks involved. Among other things, instruction should include the animal and plant species under protection, conservation biology and ecology, and relevant laws and regulations. There is a need for both pre-service and in-service training and education (*see* Annex 3, Projects 3 and 4).

Improve scientific surveys serving the purposes of effective biodiversity conservation. In order to improve the surveys, new subjects, new methods, or new ways of coordinating the findings will be needed at times. These issues are described at length in Chapter 4.

Improve relations with local people and find ways for them to make a living without depleting the natural resources. For each of the major ecosystem types, model projects should be developed for integrating conservation with economic activities in the buffer zones or areas immediately adjacent to each reserve. These subprojects should employ different strategies, so that China can develop varied experience in dealing with conservation in the context of the needs of local peoples. These projects could include planning, technical assistance, and limited funding for local communities, to guide development in sustainable directions compatible with the conservation goals of the reserves (*see* Annex 3, Project 5).

Action 3: Establish new nature reserves in regions with urgent need of biodiversity conservation. New nature reserves should be established on the basis of objective criteria adopted by the biodiversity action plan process. The comprehensive reviews called for above are needed as a foundation for the longer term efforts, but much information on priority needs is presently available, especially that produced at the November 1992 Biodiversity Action Plan workshop, and in proposals (for example, in the Panda Plan and the MFO/WWF review of protected areas). The needs are critical, and based on what is presently known about what is urgent (according to the situations described in Chapter 2) and of high priority according to the criteria developed by the biodiversity experts in the November BAP Workshop (*see* Box 3.1), additional reserves should be established. The following is a list of examples:

Nature reserves of forest type. Eight nature reserves of forest type are proposed for consideration.

- Xinglong Nature Reserve in Heilongjiang Province. The proposed reserve is located on the central section of the eastern slope of the Great Xin'an mountain, with primary forests of *Larix gmelini*. Among valuable animals are the *Cervus elaphus, Alces alces*, and *Gulo gulo*. The reserve is one of the headwater areas of the Huma River, a tributary of the Heilongjiang (Amur) River, and has important significance for the conservation of the ecosystems of the Amur.
- Longmenshan Nature Reserve in Sichuan Province. The proposed reserve covers Pingwu, Beichuan and Songpan counties in Sichuan Province, including Sier, Piankou and Baiyang localities. It has the best preserved primary forests, with high mountains and deep canyons, and 3,100 species of wild plants. Among the wildlife are giant panda (*Aliuropoda melanoleuca), Phinopithecus* spp., *Neofelis nebulosa, Panthera uncia, Panthera pardus, Felis temmincki*, and *Ailurus fulgens*. The reserve area is one of the main habitats of the giant panda. Many animals are endemic to Sichuan Province (*see* Annex 3, Project 6).
- Zhucaogou Reserve. The proposed reserve is located in the Dalaoling forest region on the northern slope of Wuling mountain, in

Box 3.1: Criteria for Determining Biodiversity Significance and Conservation Priority of Areas

Until the review called for under Objective 1 is completed, priority areas for conservation can be identified using the criteria described below:

- Areas with high richness of biological diversity (i.e., with high numbers of species and ecosystems);
- Areas that have a high level of endemism (i.e., high numbers of endemic species);
- Areas that are outstandingly representative of the same type elsewhere in the country, or areas that are the best representative of that type;
- Areas that are intact (i.e., relatively unmodified by human actions), and therefore can be used as a baseline for monitoring environmental changes;
- Areas that include particularly valuable or important species (*see* Box 3.2); and
- Areas that are of critical ecological value, for example, as an essential migratory route, an essential breeding area, an essential feeding area, or areas essential to other important ecosystems (e.g., a water catchment for a significant body of water or wetland). These are areas whose loss will have a particularly important impact on surrounding areas or on national biodiversity conservation.

Changyang County, Hubei Province. The reserve has well preserved subtropical, mixed evergreen and deciduous broad-leaved forests, with many relic tree species, such as *Davidia involucrata, Tetracentron sinensis*, and *Davidia involucrata* var. *vilmoriniana*. It has the best preserved and the most concentrated distribution of rare and valuable tree species compared with locations in similar latitudes.

- Hongshuihe Reserve in Guizhou Province. The proposed reserve is located in Xingyi and Ceheng prefectures in southwestern Guizhou Province, and between the Nanpan and Beipan rivers, both third-order tributaries of the Pearl River. Due to warm and humid air masses from the Indian Ocean, it has the South Asian tropical seasonal rain forests. The reserve area is unique in being a seasonal rain forest in such northern latitudes.
- Chunhua Reserve in Jilin Proveince. The proposed reserve is located within the boundaries of Dunhua City, in the Mountain region between the Zhangguangcai Range and the Changbai Mountains. The reserve has typical temperate, mixed coniferous and broad-leaved forests. It is proposed for the primary purpose of conserving *Panthera tigris altaica*.
- Zechagou Reserve in Gansu Province. The proposed reserve is located in Luqu County, Gansu Province, at the northeastern fringe of the Qinghai-Tibet Plateau. Its purpose is to protect high mountain coniferous forests and various Class II State-protected animals such as *Ovis ammon*, and *Pseudois nayaur*.
- Bandong Reserve in Guangdong Province. The proposed reserve is located in the Liannan County, Guangdong Province, in the transition region between the middle subtropical zone and the Southern tropical zone. The reserve was established to protect *Panthera tigris amoyensis, Muntiacus crinifrons, Panthera pardus* and other endangered animal species.

Nature reserves of steppe and desert type. Six nature reserves of these types are proposed for consideration:

- Zhuozishan Reserve in Inner Mongolia. The proposed reserve is located in the western part of Otoke Banner, Inner Mongolia, with a large number of Tertiary relic plants and some geologic characteristics of important significance. The area is subject to frequent human activity and hence is under significant threat.
- Aershan Stony Ground Forest Reserve in Inner Mongolia. The proposed reserve has *Filifoilium sibiricum-Aneurolepidium chinense* steppes and *Larix gmelini* primary forests, with *Cervus elaphus, Alces alces Lepus timidus, Procapra gutturosa* and other rare animal species. Some volcanos and warm springs also occur in the reserve.
- Honghuaerji Reserve in Inner Mongolia. The proposed reserves features meadow steppes and

sandy high plains with *Pinus sylvestris* var. *mongolica* forests.

- Bachu *Populus pruinosa* Reserve in Xinjiang Uighur Autonomous Region. The proposed reserve features a large distribution of *Populus pruinosa*, a valuable relic tree species.
- Wuqia *Ammopiptanthus nonus* Reserve in Xinjiang Uighur Autonomous Region. The proposed reserve features a unique occurrence of the ancient relic plant *Ammonpiptanthus nonus*, with very limited area of distribution.
- Heguigou-Xinmiao Sands Reserve in Inner Mongolia. The proposed reserve contains an isolated *Pinus tabulaeformis* forest, with the largest type of pine tree and with *Glycine soja*.

Nature reserves of freshwater and other wetland types. Seven reserves of the wetland and freshwater category are proposed for consideration.

- Norgai Wetland Reserve in northwest Sichuan Province. The proposed reserve has vast swamps and numerous meanders and is one of the wintering grounds of *Grus nigricollis*.
- Intertidal Flats Reserve in the northwestern section of the Jiaozhou Bay, Shandong Province. The proposed reserve has the longest recorded studies on the marine organisms of intertidal flats in China, with very high richness in species, such as *Balanuoglossus* spp. *Branchiostoma beicheri* var. qingdaoensis, and many other endemic varieties.
- Sihong and Hongzehu Wetland Reserve in Jiangsu Province. The proposed reserve will protect the *Otis tardax* in the Sihong area and the valuable waterfowl in the Hongzehu Lake.
- Intertidal Flat Reserve in Quanzhou Bay, Fujian Province. The proposed reserve is a typical representative of intertidal flats located in estuarian areas of the subtropical zone, with both tropical mangroves and temperate *Spartina* grass species. In the nearby Shenhu Bay there are large sections of ancient sea bottom forests, many valuable marine organisms, and about 100 species of migrating birds. Quanzhou city also is important as a cultural heritage site: it was the beginning of the ancient "Ocean-bound Silk Road" during the Song dynasty.
- Mangrove Forest Reserve on Zhangjiang River estuary, Fujian Province. The proposed reserve serves as the northernmost border for mangrove forests in the Pacific region, with many species of mollusks.
- Mangrove Forest Reserve on Qinzhou Bay, in Guangxi Zhuang Autonomous Region. The proposed reserve is the largest mangrove forest in China. It has been badly damaged by human activities and there is a great need to establish a reserve to enable it to recover.

Nature reserves of marine type. Eight nature reserves of marine type are proposed for consideration:

- Xisha Archipelago and Seawaters Reserve. The proposed reserve is representative of the typical tropical marine ecosystem. It holds well-developed coastal coral reefs, and tropical coral reef forests, such as *Pisonia grandais*. It serves also as the only habitat and breeding ground of *Sulasula rubripes* in the country. It has many valuable marine species, such as *Chelonia mydas*, and *Thelenota ananas*.
- Nan'ao Island and nearby Seawaters Reserve. The proposed reserve stretches along the Tropic of Cancer and represents the typical seawaters of the subtropical region. It holds a complicated spectrum of marine ecosystems, has high richness in biodiversity, and displays many features of subtropical fauna and flora. It serves the northernmost border for tropical marine and coastal organisms, such as corals and mangrove forests.
- Miaodao Archipelago and nearby Seawaters Reserve. The proposed reserve is representative of the marine flora and fauna of temperate zones in China, and provides the passageway for marine organism migrating between the Bohai Sea and the Yellow Sea. It holds a large number of temperate marine species such as *Eubalaena glasialis, Phoca canina, Stichopus japonicus, Haliotis discus hannaio*, and seaweeds. The purpose of establishing this reserve is to pro-

tect the temperate marine ecosystems and marine species.

- Zhoushan Archipelago and Seawaters Reserve, Zhejiang Province. The proposed reserve is located in the estuarian area of the Yangtze River and the Qiantang River, on the transition between the warm-temperate zone and the subtropical zone. Taohua Island and Zhujiajian Island are its core area; and it will put under conservation the different species and ecosystems occurring on the transition between estuarian bays and deep seas.
- Weizhou Island and Seawaters Reserve, Guangxi Zhuang Autonomous Region. The proposed reserve will include the Weizhou and Xiheyang islands, as well as the seawater surrounding these two islands located in the Beibu Bay, Guangxi Zhuang Autonomous Region. It constitutes the southernmost sea area of continental China. Located on the transition from the subtropical zone to the tropical zone, it has inadequately developed coral reefs. The reserve is designed to protect marine ecosystems and relevant natural landscapes. An oceanic park can be established in the proposed reserve.
- Wanshan Archipelago and Seawaters Reserve, Guangdong Province. The proposed reserve is located outside the estuary of the Pearl River and is representative of subtropical estuarian ecosystems. It is designed to protect different marine ecosystems and species of the estuarian areas, including *Macaca mulatta* on the Dangan Island and primary golden bamboo bushes on the Zhuzhou Island.
- Dongshan Island Coral Reef Reserve, Fujian Province. The proposed reserve holds the northernmost distribution of coral reef-builders in the Western Pacific. More than 10 species breed in this area. Coral is collected to produce artifacts or to burn lime, and many species face extinction. Protection is therefore urgent.
- Yongshu Coral Reef Reserve, Nanhai area. The proposed reserve has typical tropical coral reefs, including atolls. Some artificial land pieces have formed on the reefs that can be used for the reserve. More than 100 coral species have been discovered.

Nature reserves for wild relative species of agricultural crops and domestic animals. Seven nature reserves for conserving the wild relative species of agricultural crops and domestic animals are proposed for consideration, in the following areas:

- Yaxian Wild Rice Reserve, Hainan Province
- Jinhong Wild Rice (*Oryza grulata*) Reserve, Yunnan Province
- Kenli Wild Soybean Reserve, Shandong Province
- Monghai Wild Dalitea Tree and Broad-leaved Tea Tree Reserve, Yunnan Province
- Xishuanbanna Wild Flower Reserve, Yunnan Province
- Dongxian Rice Reserve, Jiangxi Province
- Heilongjiang Wild Bean Reserve, Sanjiangyuan, Heilongjiang Province

Objective 3: Conserve wild species that are significant for biodiversity.

Action 1: Review the status of species coverage by protected areas (that is, the effectiveness of nature reserves, including control of hunting and other threats) (see Annex 3, Project 7). A comprehensive and systematic review of the conservation needs of China's species is needed to determine the priorities for action as well as the types of action needed in specific cases.

Action 2: Determine priorities among wild species requiring protection, based on the criteria of biodiversity significance and the degree of threat. Using criteria such as those developed at the BAP Workshops (*see* Box 3.2), a careful assessment can be made to identify priorities among species requiring protection. To guide action in the interim, however, the second workshop on the Biodiversity Conservation Action Plan developed lists of priority species. The full lists are presented in Annexes 1 and 2. From these lists the following priority lists have been developed:

Box 3.2: Criteria for Determining Global Biodiversity Significance and Conservation Priority of Species

Genetic significance	Is the species unique? Is it rare or endemic? Does it have special genetic or scientific importance (e.g., the only species in a family or genus, a relic species or genus)? Is it a typical representative species or a sample of a particular species (individual)? Is it very rare or under severe threat?
Ecological significance	Is the species a "keystone" species (i.e., one on which the health or survival of the ecosystem depends)? Does it have an especially significant impact on the ecosystem in other ways (e.g., as would a top carnivore or elephant)? Is it an especially significant ecological phenomenon, or a component of one (e.g., a complex ecological system or a complex migratory community)? Is it an important indicator species?
Social and economic significance	Is it a source of medicine? Does it have other economic value? Does it have outstanding cultural or historical significance? Does it have important scientific research value? Is it of significance for maintaining conditions necessary for human welfare (e.g., in pollination or pest control)?
Degree of threat and level of vulnerability	These two criteria must be considered together, because a species can be vulnerable but not under immediate threat, while another could be both vulnerable and in imminent danger of extinction. The priority for conservation should be given to the species that are significant (according to the criteria above) and also vulnerable and under threat. In order to determine the degree of threat and vulnerability, the following questions should be asked: How immediate, and therefore urgent, is the threat? Is the population very small? Are its numbers being rapidly depleted? Is the species or population at or close to the minimum size for survival? Is there immediate or imminent demand for it or for its habitat (e.g., because of hunting pressure or demand for land)? Is its continued viability affected by changes in human population level and/or land use? Is it threatened by other external factors such as pollution, diversion of needed water, loss of source of food, desertification, or other major changes in conditions that affect the viability of the species? Is it readily accessible (e.g., to hunting or to other human activities that would threaten it)? Is the protection for it weak or non-existent? Will the threatened loss be irreversible?

Wild animals requiring conservation action. The wild animal species of international significance requiring conservation actions include 62 species of mammals, 43 species of birds, 3 species of amphibians, 6 species of reptiles, 10 species of fish, 2 species of insects, and 4 species of invertebrates (including marine invertebrates).

Wild plants requiring conservation action. The wild plant species of international significance requiring conservation actions are 149 species in number, of which 6 species are of fungi, 17 species are of gymnosperm, and 126 species are of angiosperm.

Action 3: Survey the trade in wildlife. Trade in wild animals and plants in China is a major factor in the depletion of some, possibly many, species, and it appears to be of particular importance in the case of endangered species and those of international importance. As such it is a significant factor affecting biodiversity conservation. Information on the trade and its effect is scanty and difficult to obtain, but this information is needed to implement effectively the biodiversity action plan (*see* Annex 3, Project 8).

Action 4: Review the facilities for the ex-situ maintenance of plants and animals, and their effectiveness for protecting priority species (*see* Annex 3, Project 9). There are many ex-situ facilities for plants and animals in China and a number of additional ones have been proposed. Before new action is taken or new expenditures made on such facilities, it is important to deter-

mine what exists at present and what the role of such facilities, is relative to biodiversity conservation. The review (project 9) should provide that information.

In planning conservation actions, although both in-situ and ex-situ conservation measures will be considered, in-situ will be the primary part of the program, augmented as necessary by ex-situ means. Protecting nature reserves is a far more cost-effective way of conserving biodiversity. Other more cost-effective measures are to improve existing zoos and botanic gardens.

Assess existing ex-situ conservation facilities for wild animals and plants, and marine life.

- Ex-situ conservation facilities for wild animals. Establishing new introduction-propagation facilities should be determined in the context of the analyses of priority species for protection, and the overall assessments of existing reserves and parks (Annex 3, Projects 1 and 2) and of current in-situ and ex-situ programs (Annex 3, Project 9). There must be an evaluation of existing needs and programs before adding new sites. Only this sort of careful planning in selecting the species to be bred and the places to keep them in captivity, will be effective. Captive breeding should be prevented from turning into commercial operations that greatly damage biodiversity by creating markets for animals (or parts of them) in the wild and introducing disease from the workshop; and running the ventures is not cost-effective.
- Ex-situ conservation facilities for wild plants. There are more than 60 botanical gardens and 40 arboretums in the country, along with some 255 plantation gardens and reproduction farms. As described above for animals, the results of the comprehensive review of ex-situ facilities and those of China's biodiversity will provide the basis for determining what further actions should be taken to improve the system of plant ex-situ facilities.
- Ex-situ conservation facilities for marine life. China's marine ecosystems are under particularly severe threat and careful attention should be given to the needs for ex-situ conservation facilities, both for possible conservation of threatened species and for public education and scientific research.

Action 5: Make species conservation plans based on the integration of the analyses of in-situ and ex-situ measures, and on considerations for or constraints to re-establishing in the wild species bred in ex-situ facilities (*see* Annex 3, Projects 10, 11, and 12 for examples of high priority species requiring urgent attention; Annex 3, Project 7 will define other species for which similar treatment is needed). Species of high priority for conservation action, as determined above require comprehensive plans that specify what the conservation needs are and what actions are required.

Action 6: Improve ex-situ management for species conservation (*see* Annex 3, Projects 13 and 14). Standards and facilities for ex-situ management of wild species in China vary greatly. It is recommended that an animal husbandry and health center be established to provide guidance, training and advisory services for improving and maintaining the health and husbandry capabilities of ex-situ facilities in China.

Action 7: Carry out the research needed to support and implement the actions recommended under Objective 3. A variety of types of research are needed to achieve effective species con-servation. General research needs are discussed in Chapter 4.

Objective 4: Conserve genetic resources related to crops and domestic livestock.

Wild relatives of agricultural crops provide the main genetic resources for improving properties of crop varieties. Because of population pressure and eco-

nomic development, however, the habitats of many wild relatives of cultivated crops are being degraded or lost, and many wild species are under severe threat.

Action 1: Conserve genetic resources of crops, grasses and vegetables. First, the in-situ conservation sites of wild rice, soybean, tea, citrus and *Actnidia chinensis* should be set up in their originating areas, so that large enough wild populations can be maintained to avoid gene drift and to ensure the continuity of genetic resources. The following conservation sites are of priority for conserving these genetic resources of crops, grasses and vegetables.

- Western Hubei subtropical high-mountain red clover meadow
- Yanchi sands sheep area, Ningxia Hui Autonomous Region
- Leishan high quality tea area, Guizhou Province
- Nanfeng citrus (mandarin) area, Jiangxi Province
- Dongling Jujube area, Shangdong Province

Action 2: Conserve genetic resources of domestic livestock. China has some 600 varieties of livestock and poultry that have special features of their own. Out of this rich genetic resource less than 20 percent is being used in the current production activities. For example, there some 113 varieties of pig species, of which only some 20 varieties are used and disseminated in production; and there some 73 varieties of oxen and cows, of which only about 10 are used and disseminated in production. This approach has resulted in the decrease of a large number of local good quality species and varieties that now face extinction. There is a need to review the needs for conservation of domestic livestock breeds and to develop actions to conserve those under highest threat (*see* Annex 3, Project 15).

Action 3: Conserve the genetic resources of forest trees.

Objective 5: In-situ conservation outside nature reserves.

Even when a sufficient number of nature reserves are established and are well managed and operated, they will be only a part of the whole biodiversity conservation efforts needed, because they still will be only a fraction of the total land area. Moreover, the distribution area of many animals, plants and ecosystems are not restricted to the areas covered by the existing nature reserves; and many animals, such as gazelles, wild camels and wild donkeys, often feed and breed outside the nature reserves planned for their conservation.

Small reserves also are little more than islands in the production activities and pollution of their surrounding areas. According to a generally accepted guideline of ecology, a natural area covering 10 percent of the surface of a given habitat can support only 50 percent of the previously existing species. In other words, when nature reserves become "islands," many original species will unavoidably be lost. At present, a fragmentation process in many ecosystems and habitats is under way.

Therefore, securing biodiversity conservation cannot be limited to inside nature reserves. It is necessary, in the meantime, to pay close attention to in-situ conservation measure outside the reserves, including the following actions:

Action 1: Integrate biodiversity conservation into national economic planning.

Action 2: Adopt forestry practices that are consistent with the goals of biodiversity conservation (*see* Annex 3, Project 16). These measures include: a ban on logging for the remaining primary natural forests; the introduction of selective cutting instead of clear cutting; minimize fragmenting existing stands of forest by careful planning of the location of cuts; the restoration of forests by natural regeneration; the restoration of the natural species composition or combination

ests by keeping the logging volume at a level lower than the growing capacity; the use of indigenous tree species for reforestation; the planting of mixed species forests to increase product diversity and to enhance the stability of ecosystems; and the provision of substitute energy sources in rural areas to replace firewood for cooking and heating.

Action 3: Introduce and support agro-ecological practices. The proposed measures include: teaching the concepts of agro-ecological farming and encouraging its widespread use; adopting comprehensive integrated pest management practices; reducing the use of chemical pesticides; fostering land conservation measures to avoid water and wind erosion; developing agro-forestry where conditions permit; and establishing management and protection areas around nature reserves.

Action 4: Protect the major habitats outside of nature reserves and prohibit or strictly control conversion of grasslands and wetlands. The natural vegetation growing along the borders of farmland on road shoulders and on river banks, and natural bushes and other plant populations not used by agriculture may provide habitats for many animals species and natural enemies of some pests. The destruction of these areas, therefore, should be avoided. Wetlands are often considered to be wastelands that are useful only if they are "reclaimed" or converted to other uses. However, they provide a number of ecological services including recharge of ground water, flood control and pollution abatement, in addition to their role in maintaining biodiversity, all of which contribute to the economic development and welfare of the Chinese people. Consequently, their reclamation should be strongly discouraged. Grasslands or steppes also play important ecological roles and are essential to maintaining some biodiversity; and they should also be protected wherever possible.

Action 5: Protect coastal areas and the seas. Efforts should be made to protect marine ecosystems against pollution and over-fishing, to protect intertidal flats against pollution and reclamation, and to preserve some sea aquaculture such as prawn artificial breeding from causing local pollution.

Objective 6: Establish a nationwide information and monitoring network for biodiversity conservation.

Decision-making on biodiversity protection should be based on adequate, precise data that can be obtained and made available through monitoring. Therefore, the establishment of a nationwide information and monitoring network, and similar sectoral information and monitoring systems, is a necessary component in the overall biodiversity protection program in China. Information will be provided mainly by monitoring systems, but it can also be obtained from herbaria, specimen rooms and museums of animals and plants, publications and documentation, governmental statistics and reports, results of studies and surveys, and so forth.

All information required for the biodiversity protection program can be classified into two categories:

- Biological information that includes information pertaining to the individuals, populations, communities and ecosystems of all kinds of animals, plants and microorganisms; and in particular information on populations, age structure, sex ratio and change trend of the endangered species (*see* discussion of criteria for selecting priority species for protection in Box 3.2)
- Environmental information that includes information on the natural environment, such as geology, geomorphology, climate, water abundance or shortage, water quality and soil conditions, on the one hand; and on the socio-economic environment, such as land utilization, laws and regulations, investments, trade, publicity, training and others. Special attention should be given to air, water and soil pollution (including air-borne NO_x, SO_x, particulates, CO_2, CO, acid rain, pesticide residue in water and on food, and heavy metals).

The monitoring program in existing nature reserves should be strengthened. Information collection should cover not only the present status of the reserve, but especially the results of a given action. Monitoring should be one of the main tasks of the operational staff, police, guards and patrols at the reserves. All reserves should make periodic reports on the current status of conservation objectives to the superior administrative agencies. The objectives and components of a monitoring system for biodiversity conservation are presented in Box 3.3.

Action 1: Establish uniform information standards and monitoring methodologies. In order to make the large amounts of information coming from different sources comparable and transferable, uniform information standards and monitoring methodologies should be established. Adoption of a geographical information system (GIS) for analysis and handling of information will also help to make accurate assessments. When funds and technical conditions permit, the establishment of remote sensing systems will facilitate the observation and monitoring of changes in land use, outbreaks of plant diseases and parasites, forests fires and other environment problems; and will contribute to the accuracy and speed of monitoring activities.

Action 2: Establish and improve sectoral networks of information and monitoring. MFO has already established the Forestry Resources Monitoring Center (FRMC), which plans a Comprehensive Information Center to handle all data related to forests and wild animals. Agricultural Environment Monitoring Network is now available under MOA, the National Environment Pollution Monitoring Network is available under NEPA and NEPA has a current study on ecological monitoring; the Chinese Ecological Research Network (CERN) and Biodiversity Research and Information Management (BRIM) programs are being undertaken under CAS. These monitoring systems have the most direct application to biodiversity protection efforts in the country. In addition, the computer-based digitized databases in other sectors and ministries are all available for service to biodiversity protection.

There are several other information centers and monitoring networks in the planning stages, including the marine biodiversity information center under SOA, and the information database on agricultural crop genetics under MOA. SOA set up an oceanic ecological monitoring network in 1984. The main problems are in improving the instruments and unifying monitoring methodologies, and developing policy on data sharing and exchanges.

Action 3: Establish a national information and monitoring network to integrate the sectoral networks related to biodiversity conservation. In order to check the information collected by different sectors and to promote collaboration between different governmental departments and research institutions, as well as to increase public awareness and knowledge, an integrated national information and monitoring system should be set up. This is discussed further in Chapter 4.

Objective 7: Coordinate biodiversity conservation and sustainable development.

Biodiversity conservation is an important component of sustainable development. In many regions in China, however, the biological resources are the main source of earning a livelihood for the local people, and if these resources are protected, their income will be severely decreased. How to coordinate biodiversity protection and sustainable use is therefore a problem that needs urgent attention.

Action 1: Establish biodiversity conservation/development regions. Biodiversity management and conservation areas around nature reserves should be established to pioneer projects for sustainable development and conservation, land utilization and industrial production, agricultural

production, and mineral resource exploitation, and should be carried out with the active participation of local governmental agencies and the local people. In establishing these regions, priority should be given to the Xishuanbanna area in Yunnan Province, the Middle South mountain land of Hainan Island, the Taibai mountain area in Shaanxi Province, the South Taihang-zhongtiao mountain area in Shanxi and Henan Provinces, the Changbai mountain area in Jilin Province, the seacoast and seawater area in Pearl River estuary in Guangdong Province, the Xilingele grassland in Inner Mongolia, the Zhuozishan-Helanshan mountain area in Inner Mongolia and Ningxia, the Zhoushan and

Box 3.3: Objectives and Components of a Biodiversity Monitoring System for China

Sound decisions on the conservation of biological diversity are based on detailed and accurate information. For instance, knowledge of land cover conditions and land use changes is an important prerequisite to conservation plans. An effective monitoring system to provide this kind of detailed information about the environment and the results of policies and actions, would have the following features.

Objective 1. Present the results of monitoring in a form readily available and understandable to scientists, managers and the public.

- Use GIS to analyze present biogeographic information and to aid monitoring.
- Publish results of monitoring activities on a timely basis.

Objective 2. Provide information of changes in land classification, use and ecosystem health.

- Prepare and maintain a national biogeographic (ecosystem) database.
- Establish a continuous remote sensing system for observing and monitoring climate and land use changes, plant disease outbreaks, and other environmental problems as technology permits.
- Establish monitoring stations for water flows and quality in critical watersheds.

Objective 3. Provide accurate and timely information on population size and trends, especially of threatened species.

- Include ecological information as part of forest inventories.
- Periodically conduct surveys of threatened species of birds and other animals.
- Determine if indicator species can be used to monitor ecosystem changes.

Objective 4. Provide information on the effects of airborne pollutants on biodiversity.

- Complete air monitoring station network with emphasis on NO_x, SO_x, particulates, CO_2 and CO.
- Establish acid deposition monitoring stations, analyze information and study effects.
- Study the direct effects of airborne toxicants on vegetation and soil organisms.

Objective 5. Monitor implementation of policies and projects.

- Examine national and provincial budgets to determine if resources are being properly allocated to carry out the biodiversity action plan.
- Existing legislation should be reviewed to determine consistency with this plan.
- Inspect and carefully examine ongoing and completed projects to evaluate success.
- Establish regular foot patrols in reserves; train forest guards to monitor conditions in and outside of reserves.

Nanjishan archipelagoes, and the Nan'ao Island sea area.

In such areas the reserves or protected areas should be integrated with the overall land use planning and management. Local people should be brought into the planning and decision-making wherever possible, and ways should be found to bring benefits from the protected areas to the local populations. The use of buffer zones where various kinds of economic activities can be carried out is one important approach, as is seeking ways to develop tourism based on biodiversity (that benefits local people).

Action 2: Set up regional economic demonstration models for coordinating biodiversity conservation and sustainable utilization. Because of limited national funds available for nature reserves, pilot projects should be designed to demonstrate the economic development of the regions around them that could help support the necessary reserve programs for conservation. For this purpose, the three-tiered territorial zonation of reserves should be adopted: the core zone, the buffer zone, and the experimental zone. In the core zone, all species and ecosystems should be strictly protected and remain intact, and the introduction of exotic species into nature reserves should be strictly prohibited. In the buffer zone, such activities as scientific research could be carried out, and limited visits and academic activities allowed. Carefully controlled tourism offers economic benefits in some cases. In the experimental zone, appropriate resource development could be conducted, including resource collection and hunting within specified boundaries and at specified time periods, agricultural and forestry experiments for multi-functional development of resources and comprehensive product processing.

Action 3: Establish demonstration sites of nature reserves. A small number of typical nature reserves should be selected for careful planning and improved management so that model reserves can be demonstrated. The management experience obtained there would be valuable and could be taught to other reserves. Examples are provided by Annex 3, Project 17, which seeks to integrate conservation of internationally important bird populations with hydro development; and Annex 3, Project 18, which seeks to integrate China's largest wetland and its wildlife with agricultural expansion and related development activities.

In order to achieve Objective 7, the following studies are suggested:

- Research in the basic social sciences, including the following three areas: (i) the impact on biodiversity of social and economic development and on the relationship between coordinated development and biodiversity conservation; (ii) the laws, regulations and organizational mechanisms that coordinate the multiple sectors, disciplines, and local people in participatory biodiversity conservation; and (iii) the role of ethics, culture, religion and customs in biodiversity conservation.
- Research on biological engineering techniques for improving and enhancing benefits from biological resources, and on production techniques of their substitutes.