

China Council for International Cooperation on Environment and Development (CCICED)

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1 *Importance of China's biodiversity*

Definition: Biodiversity is taken to include the entire genetic content and all ecological functions processes and structures of the fauna and flora of China.

Overview: China's biodiversity is the third richest in the world, and richer than any other Asian or temperate country. This wealth of species and populations is explained by very large size, extreme climatic and geographic variation, long continental stability and the most extensive subtropical zone in the world. Major ecosystems include 1) forests, that range from temperate to tropical (10%), 2) extensive high altitude grasslands and alpine systems (60%), 3) extensive steppe grasslands and deserts (15%), 4) important rivers, lakes and wetland systems, 5) rich marine and coastal areas and 6) agricultural land (11% of total area).

However, China has the world's largest human population, including both some of the world's most densely populated and intensively cultivated areas and also some of the most desolate and unpopulated regions of the planet. The dependence of the human population on direct and indirect benefits and services derived from biodiversity is enormous. The reason China has been able to sustain this high population is directly related to its reliance on its biological resources over 1500 years of ecosystem management. A first attempt to list and evaluate the major benefits are given below.

It is the conclusion of the Biodiversity Working Group that the full range and importance of these benefits and services are not currently appreciated by policy-makers and planners in the national and provincial governments, nor by technical planners in sectoral ministries and certainly not by the general public. As a result (1) major policy errors are being made—totally inadequate attention is being paid to protection of biodiversity and thereby the benefits derived from it; (2) inadequate investment is being made in research and manpower development; (3) inappropriate decisions are being made with regard to land-use; (4) inappropriate technology is being applied in areas of forest restoration and range management; (5) inadequate measures are being taken to control over-use and depletion of natural resources, pollution controls, wasteful use practices, and (6) inadequate compensation charges are levied on the damagers of natural ecosystems.

This report lists the main benefits being derived from various ecosystems in China, the main threats and problems jeopardizing the sustained flow of such benefits and specific recommendations for containing these threats. The two over-riding recommendation, however, remains the same as this group made to the council two years ago, namely that China is not

taking the destruction of its biodiversity seriously enough and that public awareness is the most important need to raise the levels of attention and investment.

1.1 Benefit and services derived from biodiversity

The working group has tried to clarify exactly what these various short and long-term benefit deriving from biodiversity are. The two tables below indicate firstly what kinds of benefit are derived from each major ecosystem type and secondly what these benefits might be worth in economic terms to the Chinese and global economies. The evaluations are of necessity crude and are given wide estimate ranges. Many of these values will grow as the standard of living grows. Others are only a small fraction of their ultimate potential.

Table 1 Matrix of benefits derived from biodiversity in 5 major ecosystems of China

Benefits/services	Forest systems	Grassland system	Wetland system	Marine systems	Agriculture
Carbon sequestration	* *	*			
Watershed protection	* *	*			
Hydrology recycling	* *	*			
Pollution cleansing	* *	*	*	* *	
Flood control	* *	*			
Climate regulation	* *	*			
Nutrient cycling	* *	* *			*
Research/education	*	*	*	*	* *
Tourism/recreation	* *	*	* *	* *	
Timber production	* *				
Firewood/fuel	* *	*			
Game/fish	*	*	* *	* *	*
Medicines	*	* *			* *
Other non-timber	* *	*	*	*	
Genetic resources	* *	* *	* *	*	*
Cultural/scientific	*	*	*	*	*

* * = highly important * = secondary importance

Table 2 Evaluation (estimated in US\$ billions per year) of biodiversity benefits and services in China

	(\$ billions/a)
Carbon sequestration of forest	140~200
Soil and water conservation of forest	20~48
Recreation and Tourism	20~30
Contribution to agriculture production	6~8
Direct harvest of foods from nature	5~7
Firewood supply	5~12
Medicinal plants/animals	5~20
Timber and construction wood	8~15
Rattan/bamboo	4~6
Wildlife heritage and keystone effect	4~7
Fisheries	15~20
Contribution to animal husbandry	4~6
Carbon sequestration by rangelands	7~17
Environmental cleaning services	14~25
Total	\$ 255~410 Billion

Notes: Explaining the logic and calculation of these values are given in annex 1 of this report

Tables 1 and 2 illustrate the enormous economic benefit of biodiversity to China. Three points are worth highlighting. (1) The value of environmental services of natural vegetation are much higher than the actual harvested resource values. (2) Wildlife's chief value is in its keystone role of maintaining floral communities in balance. (3) The value of forest is usually many times greater than the value of its timber.

A proportion of the agricultural and animal husbandry production in China must be credited as a major biodiversity service since all the germplasm used is derived from biodiversity, all improvements, new domestications and technological improvements to agricultural crops and stocks will depend on the continued preservation of China's biodiversity. This is like the payment of copyright or insurance in other branches of the economy.

The world has wider benefits deriving from China's biodiversity in the form of germplasm of rice, wheat, barley, kiwifruit, tea and domestic animals. Equally, China benefits from many externally derived sources of biodiversity such as potatoes, maize, sugar, rubber, oilpalm, eucalyptus etc.

It is quite clear that unless actively protected all forests and natural landscapes would be destroyed through overuse in the next few decades. The cost of protecting the natural systems that provide such benefits is easily justified. However, at present there is an unwillingness to pay these costs perhaps because of an underappreciation of these services. The various ecological systems of the country face different threats and these need a variety of solutions. The following section lists these problems and the groups specific recommendations for remedial actions.

1.2 Forests ecosystems

Forests cover 10% of China's land surface. At present they are managed almost entirely on the basis of timber production. However, with appropriate ecosystem management they provide a much wider and more valuable range of economic and social benefits. The Biodiversity Working Group (BWG) has identified major threats to the productivity of forest systems and lists remedial actions necessary to solve these problems. Many of these actions are already being tackled and have already been identified in such reviews as the China Biodiversity Conservation Action Plan (1994). We add some more detailed recommendations of the most important of these.

1.2.1 Threats

(1)Over-harvest of timber; (2)Illegal and uncontrolled cutting (including firewood); (3) Improper species reforestation (too often monocultures of eucalyptus or conifers are planted instead of mixed broadleaf species); (4) Agricultural encroachment (including replacement of native forests by industrial plantations); (5) Forest fire; (6) Poaching of wildlife; (7)Overgrazing; (8)Fragmentation of landscapes (leading to community simplification); (9)Introduction of exotic species (threatening original species); (10)Uncontrolled tourism; (11)Pollution and acid rain; (12)Climate change; (13)Disease and insect pest problems (increased as a result of species simplification (1), (3), (4), (8)); (14)Road construction (rendering forests vulnerable to illicit extraction); (15)Misplaced protection investment (mostly in buildings); (16)Abuse of forests by staff of the management agencies, e. g., litter, illegal resource extraction.

1.2.2 Remedial actions needed

(1)Sustainable ecosystem management of all natural forests; (2)Banning timber production from primary forests; (3)Restoration and rehabilitation of secondary forests or bare lands, avoiding pure plantations (conifers and eucalyptus); (4)Stop development of rubber (econom-

ically and ecologically a loss); (5) Manage productive forests sustainably; (6) Develop complex agroforestry around forests as a buffer; (7) Apply integrated forest management; (8) Establish biodiversity regions in areas of high biodiversity value; (9) More effective management of protected areas, including paying more attention to protection of keystone species; (10) Prepare long-term economic plan for forests including all economic benefits derived from them.

1.2.3 Recommendations

Protect primary and secondary forests. Ban logging in the few remaining primary forests and strengthen protection to secondary forests. Extend biodiversity beyond protected area boundaries by developing "biodiversity regions". Many protected areas were transformed from tree farms; adjacent areas are still logged and there is encroachment into the protected areas. This should be stopped. The secondary forest outside protected areas must also have some protection, because of the valuable service that they provide to protect the watershed. Further layers of buffering can be provided by developing agroforestry systems adjacent to forests, where villages exist, to meet the needs of local people while protecting the environment.

Restore and rehabilitate secondary forests or bare land. For example, sequential closing of mountain slopes to accelerate the natural regeneration of sparse woodlands and shrublands is an effective and economic method for restoration of forest in low and middle elevation of mountains. Limestone forests are a high priority.

Avoid pure plantations (Conifers, Rubber, Poplar and Eucalyptus), to minimize disease and improve diversity. Show preference for native species in reforestation. Closing forests on a rotational basis and allowing dense secondary recolonization is generally the fastest and cheapest way to re-establish forest. These forests have much denser biomass and ground cover than plantations.

Improve management of protected areas with investment in guarding activities not in wasteful buildings and added middle levels of bureaucracy. A merit system should be established that rewards forest managers for proper management activities.

Reduce China's long-term dependence on timber by investing in development of alternate construction materials and alternate furnishing materials and fuels.

1.3 Grassland ecosystems

China's grasslands and alpine systems cover about two thirds of the entire country including the very extensive Xizang-Qinghai plateau and northern steppes. Their primary productivity creates food for grazing mammals (domestic and native). But the natural small burrowing mammals (pikas/zokors)—are just as important in recycling of nutrients, aeration of soil, increased plant species richness which in turn increases ecosystem stability; reduces erosion; hydrological stability. These areas have important potential for ecotourism. Zokor bones can be used as a substitute for tiger bones and therefore have the added benefit of reducing exploitation of another endangered species. There are other aesthetic, scientific, ethical (religious) values dependent on the maintenance of these ecosystems.

1.3.1 Threats

(1) Encroaching agriculture, leading to unsustainable agriculture, increased wind erosion and top soil loss, and difficulty in reverting the land to natural conditions; (2) Elimination of large herbivores due to overhunting and poaching and to putative competition with cattle; (3) Overstocking of rangeland which leads to unsustainable loss of grasslands, increased erosion potential and invasion of poisonous plants; (4) Poisoning of small burrowing mammals intend-

ed to reduce competition with domestic stocks in fact results in reduced benefits, direct loss of non-target species and loss of keystone species needed to maintain the productivity of grasslands.

1.3.2 Remedial actions needed

(1) Restore sustainable livestock management by reducing stock ratios on high altitude grasslands and steppes (as used historically by pastoralists); (2) Stop poisoning small mammals. This policy does not benefit domestic stocks and is leading to degradation of vast areas; (3) Stop encroaching agriculture. Apparent short-term successes in developing agriculture in many areas are completely unsustainable in the long-term and already resulting in massive loss of fertility; (4) Controlled game and other animals (e.g. zokors) harvest on a sustainable basis; (5) Establish protected areas in localities accessible for eco-tourism. Restock (restoration ecology) these protected areas with native ungulates and small carnivores as a "draw" for eco-tourism. Use this as a demonstration project—with returns to local pastoralists to pay for reduction stocking rates of livestock.

1.3.3 Recommendations

Immediately halt all further rodent control programmes. These have been tried disastrously in other countries and found to be totally counter-productive and very destructive.

Set up committees between local government and traditional pastoralists to determine sustainable stocking programmes. Economists trained only in financial matters may see the vast open spaces and imagine they can multiply stocking levels many times but they do so with serious consequences. These policy-makers may be unaware of the great advances made by Chinese biologists in ecosystem management. Appropriate grazing strategies can benefit the richness of biodiversity in steeper ecosystems, and can control insect pest damage.

1.4 Freshwater ecosystems

Lakes and rivers are of great importance to humans in China. In good health and with regulated hydrology they provide living places, modes of cheap transport, water, irrigation systems and fish, and are enjoyed for recreation and tourism. Unregulated they are dangerous, destroy agriculture and property, silt up expensive hydropower and irrigation developments, etc. The health and regulation of these systems depends on proper watershed and ecosystem management.

1.4.1 Threats

(1) The construction of water conservation projects (dams, dikes, and lake segmentation); (2) Reclamation of land for farming; (3) Natural catastrophes; (4) Excessive exploitation of fish resources including destructive methods such as poisons, explosives and small new mesh; (5) Pollution, including eutrophication of lakes; (6) Introduction of exotic fish species; (7) Forest and vegetation damage in the upper reaches of the rivers; (8) Secondary extinction of species following destruction of water vegetation; (9) Choking from exotic weeds such as water hyacinth (south only).

1.4.2 Remedial actions needed

(1) Proper watershed management and protection including protecting catchment forests and halting the reclamation of farm land from the lakes and rivers in response to shrinking and fragmentation of lake ecosystems due to subsidence of mud from flowing water of the rivers and due to conversion of land use to agriculture through the construction of dikes; (2) Re-link the lakes that were isolated from the Yangtze River, in order to reestablish connections between riverine spawning areas and other fish habitat. This will also assist in main-

taining stability of the ecosystem; (3) Establish freshwater fish preserves; (4) Improve the regulation of fisheries to control over-exploitation and use of inappropriate fishing methods; (5) Develop aquaculture; (6) Protect the water grass, to prevent related problems of reduced size of fish, decline in lake ecosystem stability, and disappearance of many periphyton and mollusc; (7) Eliminate direct discharge of waste water (industry, domestic, agricultural) into the lakes and rivers.

1.5 The marine environment

China has a very large marine area that has been important for fisheries, coral reefs and other products (shells, turtles, seaweeds etc). The coastline and marine areas also have enormous recreational and tourist potential. Coastal ecosystems such as corals and mangroves serve an important function in protecting the coastline from sea erosion and preservation of highly productive fishing areas and prawn spawning areas. However, it is clear that marine fisheries are crashing in Chinese seas and pollution is causing loss of corals and other communities.

1.5.1 Threats

(1) Overharvesting of fish; (2) Oil pollution; (3) Riverbourne pollution and sedimentation; (4) Unchecked coastal development; (5) Destructive fishing methods (poisons, explosives, destructive nets); (6) Lack of marine protected areas (especially in fish breeding areas); (7) Coral breaking; (8) Uncontrolled sale of marine souvenirs.

1.5.2 Remedial actions needed

(1) Set up a marine conservation department; (2) Draw up a marine conservation strategy; (3) Establish a system of marine protected areas; (4) Improve capacity for enforcing fishery regulations; (5) Ban destructive fishing methods; (6) Monitor the marine environment; (7) Ban coral mining; (8) Institute integrated planning of coastal developments; (9) Clean up river pollution which is killing marine areas.

The Working Group has not yet conducted any specific studies on the marine ecosystem so have not yet formulated any specific recommendations to the Council.

1.6 Agricultural systems

A total of 11% of the land area of China is used for agriculture. This area feeds over one billion people. On these lands are maintained the most valuable items of biodiversity harnessed from nature. Protecting the full range of domesticated varieties is important for the future of agricultural development and technological improvement. There is a dangerous tendency to abandon "inferior" varieties in favour of new more productive strains. However, many local varieties contain important genes and adaptations to specific local conditions or resistance to disease which are of enormous value for future crop improvement work.

1.6.1 Threats

(1) Overuse of pesticides; (2) Reduction of varieties maintained in production; (3) Loss of indigenous knowledge; (4) Over-emphasis on monocultures.

1.6.2 Remedial actions needed

(1) Set up stations to maintain less economic varieties as genepool reservoirs; (2) Maintain genetic seedbanks; (3) Devote more attention to document indigenous knowledge; (4) Develop more natural and more complex gro-forestry and intercropping systems; (5) Control Pollution which affects agricultural areas.

1.6.3 Recommendations

Pay more attention to indigenous knowledge which is very valuable to biodiversity man-

agement. There are many minority nationalities in China, each with its own traditional knowledge of plants, agriculture and forests which is quite valuable to biodiversity management and sustainable development. In recent years, international funding agencies and scientists have paid special attention to the study and application of indigenous knowledge on biodiversity, but the government and foundations of China still pay little attention to this issue.

2 *Other technical issues relevant to biodiversity conservation*

2.1 Biodiversity information management

Ecological systems are extremely complex. In order to make informed decisions about the management of ecosystems, watersheds, and landscapes, one needs biodiversity databases built on reliable and accurate data of species distributions, geographical information, and regulatory controls. This is done by building databases of information on geography, species, vegetation, management, etc. and using these data to predict outcomes of management proposals or climatic change. The establishment and maintenance of biodiversity databases is critical to make informed, economically viable decisions.

Biodiversity databases are important because they are: The basis of knowledge, attitudes and decisions; Important for estimates on socio-economic values, threats, and strategies; Basis for biodiversity prospecting (discovering of new medicines); Good environmental health indicators; Good predictors of climatic change; The basis for ecosystem management; The sole record of China's rich natural heritage.

2.1.1 Recommendations

- Maintenance and preservation of biodiversity collections

Over the last decade, much progress has been made in development of biodiversity databases. However, in most cases, little or no attention has been paid to the source of the original data for the information management—the specimens in zoological and botanical collections. The taxonomies used are inconsistent, there is little or no funding for the preservation and maintenance of the collections, and many collections are deteriorating rapidly. These collections need to be reviewed, in many cases brought up to professional standards, and supplied with adequate funding to keep the only record of China's rich natural heritage and biological wealth.

We propose: A. A review of natural history collections and an evaluation of their condition so that informed decisions can be made as to where to focus improvement efforts; B. Adoption of standards for taxonomies used in the collections so that the information will be compatible with database systems; C. Complete verification and upgrade of collections. Start with a demonstration project with the collections in Beijing.

- Increased emphasis on systematics and taxonomy

A lack of trained systematists and taxonomists in China is a major constraint in China's ability to monitor its biodiversity and limiting its capacity to absorb international systems and cooperation in biodiversity management. Incentives must be found to make these areas more attractive to young scientists.

We recommend: A. Seeking international support in training of systematists; B. Increases in basic funding for systematic research; C. Expansion of college level coursework and education in taxonomy and systematics.

- Expansion of biological inventories and monitoring programs

Because of the lack of adequate numbers of trained systematists and taxonomists, the basic data collected from inventories is often inadequate, out of date, and in some cases improperly collected. This will promote poor management decisions, discourage international sources of help, and in some cases lead to the detriment of the very species one is trying to protect.

We recommend: A. A training program on basic biological inventory and monitoring methods; B. Review of methodology now used; C. Networking of monitoring programs.

2.2 *Ex-situ* conservation needs

The working group is concerned that Chinese authorities are placing too much emphasis on *ex-situ* methods of conserving wildlife. There have been a few successes such as rescue of doomed populations of crested ibis, Yangtze alligator and reintroduction of captive bred Pere David's deer. But there have been expensive failures such as the breeding programme for giant pandas and Yangtze River dolphin (baiji). *Ex-situ* conservation is very expensive, often not successful and globally very few successful reintroductions have been achieved. Most plans to construct new breeding centres for rare pheasants, deer, primates and carnivores in China appear to be motivated by commercial rather than conservation motives. Most zoo examples of *ex-situ* conservation in China are mainly for exhibition and commercial hopes and are completely negative for conservation. The standards of most Chinese zoos are so poor that these constitute a national embarrassment and a constant source of international protests.

By far the best and cheapest way to save species *en masse* is by *in-situ* conservation of their entire ecosystem. *Ex-situ* conservation should be seen only as an insurance to maintain a captive genepool in the event a species becomes extinct in the wild. The primary function of zoos should be for public awareness and education. At present, there is little or no emphasis on this in China's zoos. Some zoos have reduced their education work because it does not add revenue. Cruel display of animals solely for public amusement gives out the totally wrong public awareness message and should be halted.

Ex-situ conservation of plants is more feasible. Plants need less space and are cheaper to maintain than animals. Reintroduction to the wild is much easier. Standards of botanical gardens in China are much higher than of zoos. About 120 botanical Gardens (arboreta) have been set up in China, currently cultivating about 18 000 species of China's flora accounting for 65% of the total species listed in the first batch of protected plants. This is a significant contribution to the *ex-situ* conservation of plant diversity in China.

2.2.1 Recommendations

- Programs are needed to set up some new botanical gardens as well as emphatically support the botanical gardens which have better foundations in order to achieve the goal of *ex-situ* conservation on rare and endangered plants as proposed in the "China Biodiversity Conservation Action Plan". A coordinating authority should be set up to supervise this programme on the basis of a national botanical gardens strategy.

- The China Zoo Association is urged to draw up a national strategy for zoos in China on the basis of the global zoo strategy of IUCN. Emphasis should be placed on improving standards of care to reach self sustained captive populations. Primary objectives of the strategy should be public education and awareness, not *ex-situ* conservation. Standards should be defined. Those zoos unable to meet the standards should be closed down and refused further permits to acquire new animals. Zoos should be free to raise gate prices to pay for the improvements needed.

- *Ex-situ* conservation strategies for endangered species should only be developed in the context of overall species survival plans for the species in the wild.

2.3 Wildlife trade issues

While China has been famous for its trade in wildlife for food and medicine for thousands of years, the time has come when these revered traditions are no longer sustainable by nature. There is no longer enough biodiversity remaining in China—and perhaps the world—for all of China's 1.2 billion people to enjoy the *unmitigated* use of plants and animals as food, medicine and other consumer products in a *sustainable* manner. If wildlife trade in China is not more strictly controlled soon, it will be the cause of major losses of what biodiversity remains in China and perhaps extinctions of entire species.

In order to ensure that wildlife trade in China is sustainable and does not destroy the biodiversity of China or her neighbours, the following measures *must* be taken urgently:

- A biological inventory of China's wild animals and plant populations. Without inventories conducted by strict scientific standards, sustainable use levels cannot be accurately determined.

- A review of the entire Chinese pharmacopoeia to establish which wild plants and animals are essential to public health in China and which are being used in high volumes with serious impact on the wild population. This review should be used to predict which wild animals and plants are in need of immediate conservation attention and regulation to avoid endangerment due to high volumes of trade for medicinal purposes and promote sustainability.

- A review of government-held trade statistics to document rates of consumption of any and all wildlife products used in commercial trade. Until now, with a couple of exceptions, these statistics either have not been made available or have not been examined.

- Strict regulation for the marking and selling of wildlife products from farming or captive breeding operations to ensure that wild-collected animal and plant products are not "laundered" as captive bred.

- An accurate and detailed analysis of wildlife farming and propagation as a conservation tool. Does wildlife farming really take pressure off of wild populations or does it simply stimulate demand and open opportunities to launder wild-collected specimens?

- More undercover investigations by government authorities to stop black marketing of protected species. These investigations should be investigated with the same methods used for interdiction of narcotics trade.

- Training of border officials for identification and interdiction of wildlife in trade. A number of foreign organizations and agencies are keen to assist with training workshops and identification materials. This should be conducted at the local or provincial level, rather than from the central government down, because regional needs are both immediate and, in some cases, quite different from those of other regions.

- More stringent inspection procedures at all border points, especially those known as entry or exit points for wildlife, such as the borders with Hong Kong, Mongolia, Russia and Vietnam.

- Government trade quotas for non-protected species to ensure sustainability of commercial trade, especially of those identified as key species for medicine, food and other popular commercial uses.

- Financial and political incentives for research and production of acceptable substitutions for wildlife derivatives, especially traditional Chinese medicine.

- A government campaign to inform traditional medicine specialists and consumers of their role in saving China's and the world's biodiversity. This would entail a positive message to tell them their help is essential to the effort to save some of their country's most valuable assets for reasons of not just beauty, but economic stability and to make China a responsible citizen of the world. In other words, what they buy does make a difference to China and to the world.

- Host a wildlife trade symposium with neighbouring countries to develop better trade controls. A total wildlife trade ban is recommended between China and Vietnam. The customs authority should cooperate more closely with forestry authorities to control wildlife trade.

- Establish regulations to avoid invasion of exotic species. Regulations are needed to regulate the confiscation of illegally traded species and releasing them into nature to prevent the release of unwanted exotic species and to regulate the breeding of exotic species to avoid their escape to the wild.

2.4 Public awareness

Attitudes towards nature are currently focused on selfish utilization over the short term only. Members of the public, nature reserve staff, local governments and state policy-makers are not yet convinced of the long-term values of biodiversity. Public awareness will lead to stronger support for the establishment of policies and respect for the policies once established.

2.4.1 Remedial actions needed

(1) Persuade state to change school curricula; (2) Provide data, information, etc. to improve understandings and attitudes; (3) Promote reflection on China's long past for an improved long view of the future in all work on biodiversity values and recommendations; (4) 'Expect The Best'—of China, its state council, its government staff and the people; (5) Ask for the assignment of P. A. tasks to selected groups, agencies, persons. e. g.—field guides to birds, mammals, etc.; —poster for specific audiences; —media releases; —regular briefings of policy-makers; (6) Translate existing wildlife films, books, etc. into Chinese; (7) Use Chinese zoos and Botanical Gardens to better educational effect. *

3 Major conclusions of the Biodiversity Working Group

3.1 It is clear that the real scale of values and benefits derived from biodiversity to the Chinese economy and society are unrecognized and under-appreciated by both the general public and government. The threats to those benefits are also not fully appreciated. This lack of understanding is leading to major policy errors that will cost the nation billions of dollars in the future. This is not merely a question of preferring short-term benefits to long-term benefits. The benefits from biodiversity are being gained on the short-term on an enormous scale (crudely estimated at between 200~450 billion US\$ per year).

3.2 A serious policy error consists of viewing forest as primarily for timber production and therefore planning reforestation (in a massive and expensive manner) in terms of future timber yields instead of the more valuable restoration of ecological function (which can be achieved cheaper and faster). Indirect benefits to agriculture are more important than timber

* Note: There are about 120 botanical gardens (aboretas) and about 170 Zoos established in China which receive about 120 000 000 visitors per year. These must be primary candidates for development of public education on biodiversity and its sustainable development. The botanical gardens and Zoos in China, however, mostly lack facilities for education. In order to improve educational conditions the governmental agencies should give special funds for public education programs

(we can find alternate materials for construction and furniture but we cannot find alternates to food). Provincial greening and reforestation programmes should be supervised by a committee with representation from all concerned bureaus not determined solely by Bureau of Forestry.

3.3 A second major policy error is the mistaken belief that productivity of grassland systems can be increased by simply boosting livestock levels and by conversion to agriculture. These systems are fragile and have a limited sustainable production. They can be pushed over their natural capacity only for short periods after which they degrade fast and take centuries to rebuild their original soil fertility. China should learn from the errors made in Central Asia, India and parts of Africa where overgrazing has already led to massive desertification. Thousands of years of Chinese pastoralism by local people have determined "safe" production levels for these lands. As with forests, the greatest values of these lands are their ecological services not their harvested resources. Only minor improvements can be achieved sustainably.

3.4 Other policy errors concern the lack of consideration to damage to wetland, freshwater and marine systems by land developments and industry.

3.5 Such policy errors are caused by lack of awareness and will continue to be made as long as the true values of biodiversity services remains unappreciated. The solution to the problem is a massive national awareness campaign through the formal education system, mass media, local interest groups and non-government organizations and special courses for government officials.

3.6 Underappreciation of the benefits derived from biodiversity and the serious levels of threat faced by biodiversity continue to result in totally inadequate investment in biodiversity protection. Major increases in national budgets for development of nature reserves are largely wasted as a result of a poor understanding of protection needs. Large sums of money have been spent on unnecessary buildings often far from the reserves and manned by unnecessary management staff. Almost no funds have been invested in improving the effectiveness of the guardforce. The training given to reserve managers is also deficient.

3.7 China faces a growing problem in the lack of new taxonomists. This discipline is clearly not seen as attractive to young scientists but it is crucial to China's ability to monitor and regulate biodiversity in the future. Some way to create more incentive for entering this discipline must be found. Too much emphasis is placed on developing fancy and expensive GIS and database systems and not enough emphasis on actual data collection, quality and maintenance of collections.

3.8 China could improve its performance in international arenas of biodiversity conservation by being more active and participatory in programmes. More technical expertise rather than foreign relations skills should be included in representative teams. In return China could get far more out of these programmes through a fuller participation. Many funding opportunities are being lost through a stand-back approach.

Annexe 1. Notes on Evaluation of Biodiversity Benefits and Values

Carbon sequestration values for tropical forest estimated by international environmental economists range from \$ 1600~3600 hm^2/a . As China spans from northern tropics through subtropical to temperate systems we have used a lower range of estimates \$ 1400~2000/ $\text{hm}^2/\text{a} \times 100$ million hm^2 . These benefits are global and not confined to China. Funding mechanisms are being created whereby China may be able to claim compensation for not cutting its remaining forest. Values for carbon sequestration of non-timber habitats is based on relative biomass. The vast expanses of scrub and grass are scored at only 1.5% that of forest.

International estimates for soil and water conservation values of forest vary from \$ 75~475 hm^2/a . We have taken the higher range of these limits \$ 200~475 because in the case of China the downstream valleys are so highly cultivated and inhabited. We feel these are still probably underestimates and would recommend specific site studies to achieve more realistic estimates. This is probably the most immediately felt and appreciated service of forests in China.

Recreation and tourism includes a futures value for development potential but is mostly costed as a recreation benefit to the domestic Chinese population of \$ 20~30 head/a. The figure should include about 15% of all tourism earnings and this figure will rise year by year.

Contributions to agriculture and animal husbandry are based on the insurance value of having the germ-plasm with which to maintain and advance these productive sectors. A rate of 2% has been applied on total estimated production (including materials grown and eaten without ever entering the economy) in line with insurance premiums paid for machinery, constructions etc.

Direct harvest of food from nature is based on a per capita estimate of 5~7 \$/a. This is probably an under-estimate but there are no available statistics or studies.

Firewood supply is based on the estimate that 25% of domestic fuel need in the country are met by firewood at a mean consumption of 0.25 cu. m. person/a and a cost of \$ 30/c. m.

Medicinal plants and animals are based on an estimate that 50% of all medicines and tonics are made from such materials and that a conservative average expenditure on medicines per year is \$ 10~40/person/a. This will certainly rise as the economy grows. In US this would be several hundred dollars per year.

Timber and construction wood is based on an expected yield of 1 cubic metres of timber $\text{hm}^2/\text{a} \times 100$ million hm^2 at \$ 80~150/cu. m. Much rural timber is extracted direct from forests and never enters the economy.

Heavy use is made of China's bamboos and rattans. China holds a large portion of the global export market of \$ 7 billion/a but most use is made domestically. A nominal guesstimate of \$ 4~6 /person/a is used.

The Chinese people benefit from the heritage value of their wildlife, pride in their unique and rare species but also indirectly from the keystone services that wildlife perform in maintaining ecosystems, seed dispersal, pollination, soil aeration, decomposition etc. A nominal value of \$ 4~7 /person/a is applied equivalent to 2 cinema tickets. As one contributant a total of 120 million visitors to zoos paid an average \$ 1 to see captive biodiversity. The population enjoys biodiversity through television, art, visits to parks and forests, scenery etc.

Fisheries in China provide more than half of the country's protein. Even where this is based on artificial ponds, dependence on wild stocks is high. A nominal estimate of \$ 15~20 person/a is used.

Environmental cleaning services include the alternate costs that would be required to clean up our living environment if much of our pollution discharged into the air and waters were not broken down through biological activities and absorbed by vegetation. An estimate of \$ 14~20 person/a is considered very conservative but is limited by willingness to pay.

Annexe 2. Revised Terms of Reference for the Biodiversity Working Group of CCICED

Create a fertile forum for exchange of ideas and approaches whereby China has access to wider experience beyond her borders and where managers can network with scientists and technicians to solve issues of policy,

strategy and action in the field of biodiversity conservation.

Provide a mechanism whereby priority needs identified by scientists and technicians can be brought to the attention of relevant leaders and decision-makers through a multisectoral forum.

Provide an independent view of China's biodiversity and advise the government on areas of concern or sectoral failure.

Provide advice and assistance as needed in China's international participation in International Biodiversity Conventions and programs to ensure that China gets maximal benefit from these mechanisms and also presents the most favourable international image of its considerable biodiversity achievements.

Initiate studies to demonstrate the contribution of biodiversity conservation to regional economic development in selected ecosystems in China and identify both factors that threaten such systems and appropriate remedies to ensure the sustainability of such benefits.

Annexe 3. Technical Reports Produced by BWG in Past Year

1 Review of zoological gardens in China	Wang Zongyi
2 The status and strategy for <i>ex-situ</i> conservation of plant diversity in Chinese botanical gardens	Xu Zaifu
3 Studies of wildlife trade between China and Vietnam	Li Dianmo
4 Biodiversity problems in lake ecosystems	Xie Ping , Chen Yiyu
5 The status of the endangered freshwater fishes in China and the analysis of endangered causes	He Shunping , Chen Yiyu
6 On the restoration and rehabilitation of degraded ecosystems in tropics and subtropics of China	Wang Xiangpu
7 On the forest restoration in Northern China	Chen Lingzhi
8 Report on studies of wildlife trade in South China	Michael Lau