INTRODUCTION

Biodiversity constitutes the most important working component of a natural ecosystem. It helps maintain ecological processes, creates soils, recycles nutrients, has a moderating effect on the climate, degrades waste, controls diseases and above all, provides an index of health of an ecosystem. Providing food, medicines and a wide range of useful products, it is the natural wealth that exists on land, in freshwater and in the marine environment. Plant diversity alone offers more than just food security and healthcare for the one-quarter of humanity who live their lives at or near subsistence levels; it provides them with a roof over their heads and fuel to cook, and, on average, meets 90 per cent of their material needs (Tuxill 1999).

BIODIVERSITY: STATUS AND TRENDS

The three bio-geographic realms of the Asian and Pacific Region are of immense significance to the world, and include all of the major ecosystems to be found, including mountains, forests, grasslands, desert, wetlands, and seas. The rich biodiversity of the region, however, has been under serious threat from a variety of human induced factors, which can be measured by a reduction in the natural habitat, loss of species and depletion of genetic diversity. Indicators of this change, however, are not easy to define, since only a limited number of species have been identified and catalogued to date (Box 3.1); nevertheless, the impact is serious.

A. Habitat Diversity: Patterns and Trends

The area of natural habitat in the Asian and Pacific Region is rapidly shrinking. The major ecosystems in the Indo-Malayan realm are estimated to have lost almost 70 per cent of their original vegetation, with habitat losses being most acute in the Indian subcontinent and the Peoples Republic of China. Thailand, the island of Java in Indonesia, and the central islands of the Philippines have also experienced an extensive reduction in natural habitat. Habitat losses have been comparatively less severe in the South Pacific, with the exception of some of the small island ecosystems and coral systems, which have been lost or degraded.

1. Terrestrial Habitat

(a) Forests

The forests of Asia and the Pacific are the habitat of countless numbers of plants, mammals, birds and insects and are home to between 50 to

Box 3.1 Biodiversity of Papua New Guinea

The island nation of Papua New Guinea is approximately the size of California and contains some of the largest and most important remaining blocks of tropical forest wilderness. It also claims some of the least disturbed coral reef systems left on Earth. Papua New Guinea has an extremely diverse culture – an estimated 875 distinct languages are still spoken there. The combination of its rich biodiversity and cultural heritage makes Papua New Guinea a high conservation priority.

The Lakekamu Basin is one of the largest remaining pristine lowland rain forests in Papua New Guinea, covering an area approximately 975 square miles in the Gulf Province. Virtually uninhabited, the Basin has until now been spared from human destruction, offering excellent opportunities for conservation. In October and November of 1996, Conservation International sent an expedition to this area of Papua New Guinea, under its Rapid Assessment Programme (RAP). Over a four-week period, the RAP team, comprising world-renowned experts and host country scientists, surveyed the Lakekamu Basin to create a first-cut assessment of the biological resources in this poorly known area. A research station was also established in the region, which will serve as a base for further research and field training of in-country scientists.

The expedition discovered nearly 44 new species of frogs, fish, ants, bees, wasps, reptiles, and dragonflies. Species new to science included 22 species of ants, bees and wasps, 11 species of frogs, 7 species of reptiles, 3 species of fish and 1-3 new species of dragonflies and damselflies. More importantly, over 250 species of ants were found in a one square-kilometre area, making the Basin a record-setting site for the greatest animal diversity outside South America. The expedition's data, together with previous work in the Basin, will provide essential data for guiding Papua New Guinea's development. The working paper of the expedition makes recommendations for conservation measures in the Basin that incorporate the economic interests of the local landowners. Like most of Papua New Guinea, indigenous people own much, if not all of the land in the basin. It is clear from the large number of new species discovered during just one month's work of the expedition that there is an urgent need for more biological inventories and taxonomic studies in this area. Ironically, however, while the expedition continued to identify the species collected in the Basin, forests were already being logged without collecting biological information that is critical to ensuring that conservation efforts precede logging and development. Undoubtedly, with some of the largest and biologically richest tracts of tropical forest remaining on the planet, Papua New Guinea and other mega diversity countries of the region are today at a critical juncture in their history, as pressure mounts on the developing nations to exploit their natural treasures.

Source: Conservation International 1998a

90 per cent of the world's terrestrial species (WRI 1999b). However, they have been under serious human assault during this century, from activities such as agricultural development, construction and urban development, with an average annual loss of over 4 million ha per year during the latter part of the century (see Chapter 2). According to FAO (1998), the rate of deforestation dropped slightly during its last survey period, 1990-1995, and was offset to some extent by the enhanced plantation of trees and wood lots.

However, from an ecological point of view, the state of forests is not simply a matter of their extent; more important are their health, genetic diversity, and age profile. In addition, much of the remaining natural forest has been reduced to a patchwork of small-forested areas. This process of fragmentation leaves very little natural or frontier forest of a size and extent which can support species such as the large mammals; the tiger being a prime example.

(b) Grasslands

Grasslands constitute about 24 per cent of land cover in Asia and about 19 per cent in the South Pacific. The natural Asiatic steppe originally extended from Manchuria westwards to Europe, as far as the land which now forms the countries of Bulgaria and Hungary, occupying the broad zone between the taiga (coniferous boreal forest) in the north, and the deserts or mountains to the south. The continental climate of this vast area, with its hot, dry summers and very cold winters, is inimical to the growth of trees, and the area has not supported forest since a more favourable climate prevailed in one of the earlier interglacial period. This belt holds the grasslands of both Northeast and Central Asia. The grasslands of the South Pacific are primarily concentrated in Australia.

A high proportion of the natural Asiatic steppe has now been lost, particularly in Central Asia, where extensive tracts of land in countries such as Kazakhstan and Uzbekistan were turned over to irrigation during the Soviet Era. The grasslands habitats in Northeast Asia have also been disturbed by extensive agricultural, industrial and transport development, and in South Asia, a widespread cycle of vegetation clearance, fire, overgrazing, erosion and abandonment has taken place for many centuries, leaving countries like India with apparently no surviving primary grasslands at all (although there is continuing dispute over the origin of hill grasslands in the southwest). The overall effect is a prevalence of vegetation which is relatively poorly endowed with perennial herbaceous plants, has low floristic diversity, and which in general supports a poor representation of mammals and other wildlife.

Although much of the grassland habitats of Australia in the South Pacific have also been subject to traditional patterns of burning and clearance for many hundreds of years by the Aboriginal people, this has generally been carried out in a rotational system, with the burns being carefully timed in relation to season and weather. This has kept vast areas of the Australian hinterland in a broadly open condition, and has increased productivity for grazing animals. However, during the last one hundred years or so, as more of Australia has become settled, the traditional burning patterns have been disrupted. Many areas are burned annually, allowing few of the native plants and animals to survive, and creating an environment in which introduced European plants are increasingly dominating pastures. Conversely, large areas of land which were previously grazed by the Aboriginals are now burnt much less frequently, with two important consequences: firstly, species of grassland and other open habitat decline because the vegetation becomes too thick, woody and tall; and secondly, when fires do happen, they burn at a higher temperature and are more destructive (WCMC 1992).

2. Marine Habitat

The marine environment in Asia and the Pacific is extremely rich in biodiversity; its mangroves, coral reefs and sea grass beds are some of the most productive and diverse ecosystems in the world. In general, the coastal waters of the region support far more life than the open ocean or the deep sea because they contain the most abundant food sources. Approximately 20 per cent of marine plant production occurs in the 10 per cent area of the sea that occupies continental shelves, an area which extends on average to about 70 km from the shore. Here, microscopic phytoplankton and bottom dwelling plants thrive on the nutrients delivered from the land by rivers.

Coral reefs are regarded as the marine equivalent of the tropical rainforests, as they provide a wide variety of habitats to a large number of species. Unfortunately, these ecosystems are being degraded throughout Asia and the Pacific by the consequences of a wide range of human activities, including pollution from sewage, agricultural runoff and industrial waste; disturbance and pollution from aquaculture; sedimentation as a result of inland soil erosion; dynamite fishing and commercial collection of coral; and mineral prospecting and ocean mining (see Chapter 5).

3. Freshwater Habitat

Freshwater habitats are home to a wide variety of fauna and flora, including fish, amphibians, invertebrates, plants and microorganisms. However, compared to terrestrial and marine habitats,

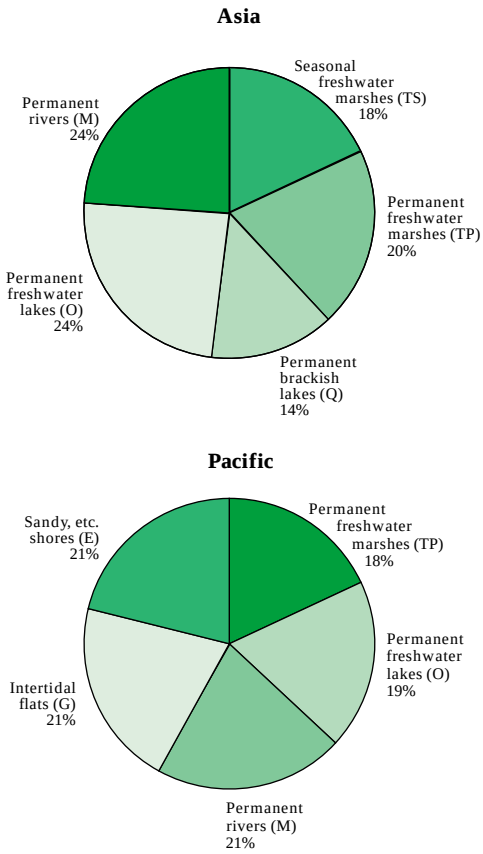
freshwater systems offer fewer chances for biodiversity to adjust to environmental change, since they are relatively discontinuous and offer less opportunity for species to disperse when conditions become unfavourable. Consequently, freshwater biodiversity is extremely sensitive to environmental disturbance. Being highly localized, however, lakes, rivers or streams can often harbour unique, locally evolved forms of life. In particular, some of the ancient lakes can have extremely high levels of endemism and spectacular species diversity; for example it is said that 90 per cent of the species in Lake Baikal in the Russian Federation are unique to the lake.

Freshwater habitats in Asia and the Pacific have been significantly reduced and degraded over the last century by a combination of factors, relating to water use, pollution and physical disturbance. These include abstraction for both irrigation, which has occurred on a vast scale in many countries of South and Central Asia, and water supply, which has risen in combination with rising population and growing industrial demand. In addition to over abstraction, natural freshwater ecosystems have also been degraded by a range of activities (see Chapter 4), such as the construction of dams and reservoirs, the drainage of wetlands, and the biological, chemical and thermal pollution of water bodies by industry (WRI 1999a). A classic example of the impact on biodiversity from the degradation of freshwater habitats relates to the Aral Sea in Central Asia, where receding water levels in the latter half of this century have reduced the number of nesting bird species in the delta of the Amudarya River from 319 to 168, and the number of mammal species from 70 to 30 (Mainguet and Letolle 1998).

4. Wetlands

Wetlands are ubiquitous to Asia and the Pacific, and provide an important and unique habitat for the region's biodiversity. They extend from the low-lying Pacific islands to the mountain lakes with fringing marshes which are abundant in the Himalayas. They exist in the mangrove forests of India and Bangladesh, and also in the extensive floodplain systems of the Ganges and Brahmaputra rivers. It is estimated that there are some 120 million ha of wetlands of international importance in the region (Scott and Poole, 1989), over 80 per cent of which occurs in just seven countries: Indonesia, China, India, Papua New Guinea, Bangladesh, Myanmar and Viet Nam. Although wetland types are extremely diverse, of the 40 types of wetlands of international importance identified by the Ramsar Convention on Wetlands, the three most commonly recorded in the Asian and Pacific countries are permanent rivers, permanent freshwater lakes, and permanent freshwater marshes (Figure 3.1).

Figure 3.1 Wetland Types in Asia and the Pacific



Remark: These wetland types are defined under Ramsar Pacific represents Micronesia, Samoa, New Caledonia, Vanuatu / New-Hebrides, French Polynesia, Tahiti, Australia, New Zealand, Pacific Islands, Guam, Saipan, Papua New Guinea, Fiji, Solomon Islands

Source: Frazier 1999

Over the centuries, vast wetland habitats in the region have been lost due to a variety of human induced and natural causes (Table 3.1). The most serious cause of wetland loss has been conversion (and usually drainage) for alternative uses, such as agricultural or urban development (Frazier 1999; Moser et al 1996). Other degrading influences include inundation from impoundment schemes, changes in water quality through pollution, unsustainable extraction of wetland products, the introduction of new (exotic) species, and, in recent years, fire (Box 3.2). The apparent extent of wetland loss throughout the region is significant. For example, no trace remains of the natural floodplain wetlands of the Red River Delta in Viet Nam, which originally covered almost two million hectares. Likewise, there is virtually no trace left of the one million hectares of natural floodplain vegetation that once covered the

Table 3.1 Agents of Wetland Change

ITEM	Wetland Type						
	Estuaries*	Open Coasts	Flood-plains	Freshwater Marshes	Lakes	Peatlands**	Swamp Forest
Human actions: direct							
Drainage for agriculture and forestry; mosquito control	●	●	●	●	•	●	●
Dredging and stream channelization for navigation; flood protection	●	❍	❍	•	❍	❍	❍
Filing for solid waste disposal; roads; commercial, residential and industrial developments	●	●	●	●	•	❍	❍
Conversion for aquaculture / Mari culture	●	❍	❍	❍	❍	❍	❍
Construction of dikes, dams and levees; seawalls for flood control, water supply, irrigation and storm protection	●	•	•	•	•	❍	❍
Discharges of pesticides, herbicides and nutrients from domestic sewage; agricultural runoff; sediments	●	●	●	●	●	❍	❍
Mining of wetland soils for peat, coal, gravel, phosphate and other minerals	•	•	•	❍	●	●	●
Groundwater abstraction	❍	❍	•	●	•	❍	❍
Human actions: indirect							
Sediment diversion by dams, deep channels and other structures	●	●	●	●	❍	❍	❍
Hydrological alterations by canals, roads, and other structures	●	●	●	●	●	❍	❍
Subsidence due to extraction of groundwater, oil, gas and other minerals	❍	❍	•	●	❍	❍	❍
Natural causes							
Subsidence	•	•	❍	❍	•	•	•
Sea-level rise	●	●	❍	❍	❍	❍	●
Drought	●	●	●	●	•	•	•
Hurricanes and other storms	●	●	●	●	•	•	•
Erosion	●	●	•	❍	❍	•	❍
Biotic effects	❍	❍	●	●	●	❍	❍

Source: UNEP and Wetland International 1997

● common and important; • present; ❍ absent or exceptional

* without mangroves

** including peat swamp forest

Sylhet Basin in Bangladesh, or the six million hectares of floodplain wetlands in the lowlands of central Myanmar. Recent studies (Moser et al 1996) have tried to quantify the loss of certain types of wetland. Figures produced demonstrate the significance of the loss of mangrove systems in certain countries, such as Singapore (97 per cent loss), Philippines (78 per cent loss) and Thailand (22 per cent loss), and also the loss of peatlands in countries such as Thailand (82 per cent loss), Malaysia (42 per cent loss), Indonesia (18 per cent loss) and China (13 per cent loss).

In the South Pacific, little published quantitative information exists for the extent of wetland loss in the small island developing states, despite a recent survey in the subregion. Cromarty (1996) estimates a loss of 90 per cent of the original wetland area in New Zealand. For Australia, the recently published national wetland directory estimates losses of 27 per cent for Victoria (freshwater and marine), 89 per cent for the south eastern part of South Australia and the Swan Plain Coast of South Australia. The most detailed study is for Victoria, which shows losses of freshwater marshes exceeding

Box 3.2 Wetlands on Fire

Peat swamp forests are waterlogged forests growing on a layer of dead leaves and plant material, up to 20 metres thick. The continued survival of these wetlands depends on a naturally high water level, which prevents the soil from drying out to expose combustible peat matter. Peat swamp forests provide a variety of goods and services, both directly and indirectly, in the form of forestry and fisheries products, energy, flood mitigation, water supply and groundwater recharge.

The countries of Southeast Asia, in particular Malaysia and Indonesia, have more than 20 million ha or 60 per cent of the global resource of tropical peatlands. Fires have become a major threat to these peatlands. Initial estimates indicate that the fires have spread to forests covering 800 000 ha of peatlands. Fires in these peatlands are unique in that they create many times more smoke per hectare than other forest types, and they are almost impossible to extinguish without restoring the naturally high water levels in these swamps. The fires go deep underground and can burn uncontrolled and unseen in the peat deposits for several months.

In the past 10 years, there has been an increasing incidence of major fires in the peat swamp forests of the Southeast Asian region. In East Kalimantan, Indonesia, one fire which started in September 1982 lasted for 10 months and effected more than 35 000 ha. This fire followed an almost unprecedented period of drought in the region associated with "El Nino", the same climatic event which is being blamed for the severity of the 1998 forest fire in Indonesia.

The contribution of tropical peatlands to the global carbon cycle is higher than those of most of the temperate zones as 15 per cent of the global peatland carbon may reside in tropical peatlands. These prolonged peat fires are releasing a massive amount of carbon dioxide and particulate matter which has very serious implication for global warming and long-term climate disruption. It is therefore extremely important to safeguard the peat swamps from forest fires through national and cooperative action.

Source: Standing Committee of the Ramsar Convention 1997

70 per cent, although there have been some gains through the creation of some artificial wetlands (such as reed-bed wastewater treatment systems).

B. Species Diversity: Patterns and Trends

Of the seventeen-megadiversity nations in the world, which collectively claim more than two-thirds of the Earth's biological resources, seven – Australia, People's Republic of China, India, Indonesia, Malaysia, Philippines and Papua New Guinea – are in Asia and the Pacific (CI 1998b). These countries are also home to a significant number of threatened endemic species, in relation to which a number of biodiversity "hot spots" have been identified in the region (Figure 3.2). These include the Indian Ocean Islands, Indo-Burma, the Philippines, Eastern Himalayas, southwestern Australia, Polynesia and Micronesia Island Complex, New Caledonia, Western Ghats and Sri Lanka, and New Zealand.

1. Terrestrial Diversity

(a) Plant Diversity

Asia and the Pacific has a wealth of over 165 000 vascular plant species. Forests in the tropical part of the region account for a major share of these species, although the Hindu Kush Himalayan belt also has as many as 25 000 plant species, comprising 10 per cent of the world's flora (Shengji 1998).

Amongst subregions, Southeast Asia has the highest plant diversity (Figure 3.3), primarily because of its tropical forests. Amongst nations, Indonesia has the single highest plant diversity in the region (Table 3.2), estimated at 37 000, and is also in the top five countries worldwide. The country is also first in the world in terms of palm diversity, with 477 species (of which 47 per cent are endemic), and one of its provinces, Irian Jaya, is home to the very rare "birds-of-paradise" plant, which is only found elsewhere in the Moluccas and Australia (CI 1998c). Australia has far and away the highest rate of endemism in the region, at 92 per cent (Table 3.2), although high rates of endemism are also reported for the Hindu Kush Himalayan area (Shengji 1998), where for instance, of the 9 000 plant species found in the Eastern Himalayas, 3 500 species are endemic to the region.

Figure 3.2 Biodiversity "Hot Spots" in Asia and the Pacific

Source: Conservation International 1998g

Table 3.2 Higher Plant Diversity and Endemism in Megadiversity Countries of Asia and the Pacific

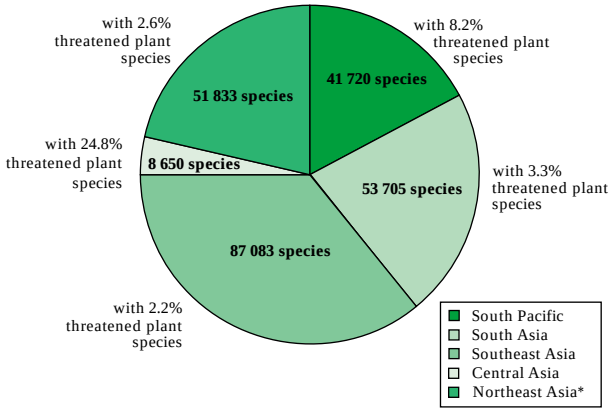
Country	Total higher plant diversity	Number of endemic species	Ranks by Endemism	Rate of Endemism (%)	Endemics as % of global diversity of higher plants
Indonesia	37 000	14 800 - 18 500	1	39 - 49	5.9 - 7.4
PR China	27 100 - 30 000	10 000	4	33	4.0
Papua New Guinea	15 000 - 21 000	10 500 - 16 000	2	50 - 76	4.2 - 6.4
India	17 000 +	7 025 - 7 875	5	41 - 46	2.8 - 3.2
Australia	15 638	14 458	3	92	5.8
Malaysia	15 000	6 500 - 8 000	6	43 - 53	2.6 - 3.2
The Philippines	8 000 - 12 000	3 800 - 6 000	7	48 - 50	1.5 - 2.4

Source: Conservation International 1998b

Likewise, the Indian Himalayas contain more than 50 per cent of India's endemic flora.

It is not known how many species of plants in Asia and the Pacific have already become extinct as a consequence of human activities, however, according to the IUCN (1998) Red List, more than 10 000 existing plant species in the region are threatened. Amongst subregions, Southeast Asia has the largest proportion of threatened plants (Figure 3.3). Amongst countries of the region, Turkey has the highest percentage of threatened plant species estimated at 21 per cent, closely followed by French Polynesia, at approximately 20 per cent. In terms of actual numbers of threatened species, Australia and Turkey have the highest estimates, at 2 245 and 1 876, respectively. More than 1 200 species of vascular plants in India, 707 in Japan, and about 500 each in Malaysia and New Caledonia are also threatened.

Figure 3.3 Total Number of Plant Species in Asia and the Pacific by Subregion and the Percentage of Threatened Plant Species



Source: WCMC 1997

* excluding the Russian Federation

(b) Animal Diversity

The mega diversity countries identified earlier also possess a large proportion of the animal diversity of Asia and the Pacific, a large number of which are endemic species (Table 3.3). Vertebrates provide a good indicator of species diversity, since they generally occupy the top rungs in food chains, i.e. habitats healthy enough to maintain a full complement of native vertebrates will have a good chance of retaining the invertebrates, plants, fungi, and other small or more obscure organisms to be found there. Conversely, ecological degradation can often be read most clearly in native vertebrate population trends (Baille and Groombridge 1996). As with plant diversity, terrestrial vertebrates are most abundant in the tropical forests of the region (WRI 1999d).

(i) Birds

Birds were the first animals that IUCN comprehensively surveyed, in 1992, followed by full re-assessments in 1994 and 1996. They are recognized as good indicators of biodiversity because their distribution is well known and they are sensitive to environmental change. Amongst the countries of the region, Indonesia has both the largest number of bird species (Table 3.3), equating to about 17 per cent of the world's total, and also one of the highest rates of endemism in the region (only Australia and the Philippines are higher). Endemic bird areas that are of highest priority for conservation in the region are located in the Lesser Sundas in Indonesia, Eastern Himalayas, and Luzon (especially Mindoro) in the Philippines.

Close to 1 100 of the region's bird species are threatened, of which 40 per cent are in the Southeast Asian subregion (Figure 3.4), and 104 are in Indonesia alone (Table 3.4). The most threatened major groups include rails and cranes (both specialized wading birds), parrots, terrestrial game birds (pheasants, partridges, grouse and gitans), and pelagic seabirds (albatrosses, petrels and shearwaters). About one quarter of the species in each of these groups is currently threatened. Only 9 per cent of songbirds

Table 3.3 Terrestrial Animal Species Diversity and Endemism in Megadiversity Countries of Asia and the Pacific

Country	Mammals			Birds			Reptiles			Amphibians			Total number of non-fish vertebrate species		
	No. of Species	No. of Endemism	% of Endemism	No. of Species	No. of Endemism	% of Endemism	No. of Species	No. of Endemism	% of Endemism	No. of Species	No. of Endemism	% of Endemism	No. of Species	No. of Endemism	% of Endemism
Indonesia	515	201	39.0	1 531	397	25.9	511	150	29.4	270	100	37.0	2 827	848	30.0
Australia	282	210	74.5	751	355	47.3	755	616+	81.6+	196	169	86.2	1 984	1 350	68.0
PR China	499	77	15.4	1 244	99	8.0	387	133	34.4	274	175	63.9	2 404	484	20.1
Philippines	201	116	57.7	556	183	32.9	193	131	67.9	63	44	69.8	1 013	474	46.8
India	350	44	12.6	1 258	52	4.1	408	187	45.8	206	110	53.4	2 222	393	17.7
Papua New Guinea	242	57	23.6	762	85	11.2	305	79	25.9	200	134	67.0	1 509	355	23.5
Malaysia	286	27	9.4	738	11	1.5	268	68	25.4	158	57	36.1	1 450	163	11.2

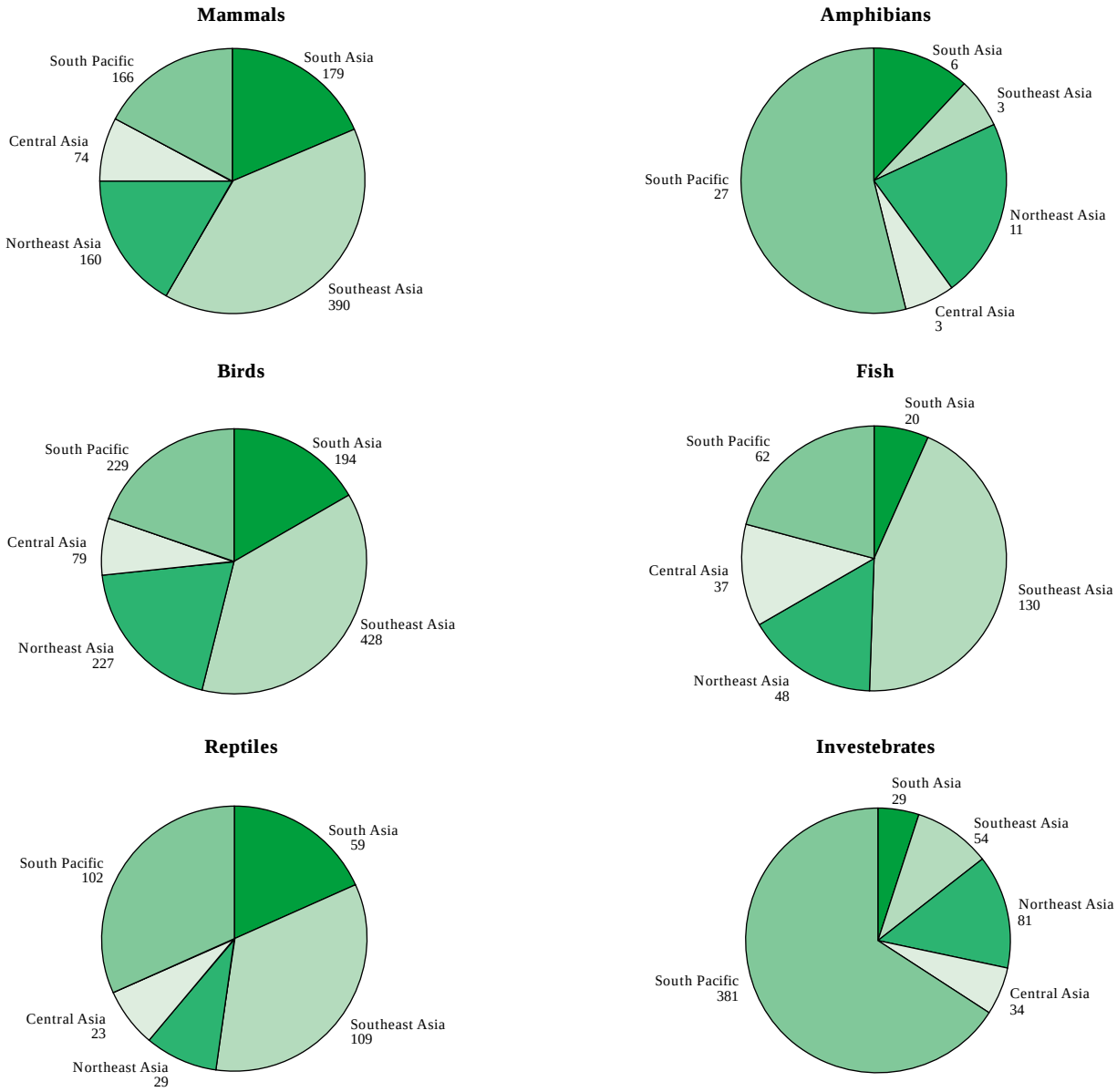
Source: Conservation International 1998b

Table 3.4 Top Five Countries in Asia and the Pacific by Each Group of Threatened Species and Percentage of the Regional Total

Rank	Mammals			Birds			Reptiles			Amphibians			Fish			Invertebrates		
	Country	No. of Species	% total	Country	No. of Species	% total	Country	No. of Species	% total	Country	No. of Species	% total	Country	No. of Species	% total	Country	No. of Species	% total
1	Indonesia	128	13.2	Indonesia	104	9.6	Australia	37	11.5	Australia	25	50	Indonesia	60	20.2	Australia	281	48.5
2	India PR China	75 75	7.7	PR China	90	8.3	Myanmar	20	6.2	Japan	10	20	Australia	37	12.5	Japan	45	7.8
3	Australia	58	6.0	Philippines	86	8.0	Indonesia	19	5.9	India	3	6	PR China	28	9.4	Indonesia French Polynesia	29 29	5.0
4	Papua New Guinea	57	5.9	India	73	6.8	India Thailand	16 16	5.0	Turkey Islamic Rep. of Iran Philippines	2 2 2	4	Philippines	26	8.8	Russian Federation	26	4.5
5	Philippines	49	5.1	Viet Nam	47	4.4	PR China	15	4.7	PR China Viet Nam New Zealand Fiji	1 1 1 1	2	Turkey	18	6.1	India	22	3.8

Source: WCMC 1997

Figure 3.4 Number of Threatened Animal Species in Asia and the Pacific by Subregion



Source: WCMC 1997

are threatened, but they still contribute the single largest group of threatened species because they are far and away the most species-rich (Baille and Groombridge 1996). Other threatened bird species of the region include the crested ibis, a wading bird that has been eliminated from its former range in Japan, the Korean peninsula, and the Russian Federation, and is now down to one small population in the remote Qinling mountains of China, the Philippine monkey-eating eagle and the blue-winged Racquet-tail parrot.

The relatively high numbers of threatened species in the island environments are in part a reflection of the fact that island birds tend naturally to have smaller ranges and numbers, making them more susceptible to habitat disturbance. In the Philippines a number of bird species are believed to have disappeared due to habitat loss as a result of deforestation from the islands of Cebu, Negros, Panay and Mindoro. In Indonesia, the endemic bird habitats of the islands of Sumbu, Banggai and Sula are also under pressure. Another threat to bird species in the region, and in particular to the small island states of the Pacific, is due to predators and competition from introduced domestic animals.

(ii) Mammals

Asia and the Pacific has the largest number of mammal species in the world. Amongst the countries of the region, Indonesia has the largest number of

mammal species (Table 3.3), and also one of the highest rates of endemism in the region (only Australia and the Philippines are higher). Almost 1 000 of the region's mammal species are currently threatened, of which 40 per cent are in Southeast Asia (Figure 3.4, and 128 are in Indonesia alone (Table 3.4). Moreover, Indonesia is also home to the orang-utan, whose populations decreased to such low levels in the early 1990s, when more than half were reportedly lost, that they were listed by the Convention on International Trade in Endangered Species of Fauna and Flora (CITES) as the most endangered species in the world (Conservation International 1998b). Current estimates suggest that less than 30 000 may still be surviving in Borneo (Van Schaik 1999), however, this figure could even be lower since these estimates were made before fires devastated millions of hectares of forests in Borneo in the late 1990s.

Other threatened species include the tiger, the largest of all cats that once ranged from Turkey to Bali and the Russian Far East. Wild tigers now barely total 3 000 to 5 000 individuals, many in small, isolated populations that are under severe threat (Tuxill and Bright 1998). Species such as Caspian tiger (*Panthera tigris virgata*) and Near Eastern leopard (*Panthera pardus ciscaucasica*) have already disappeared this century from Uzbekistan (Sievers 1999). The tiger is also regarded as extinct in the Republic of Korea, where the Siberian leopard, the fox wolf and sika are also no longer observed (National Biodiversity Report of Korea 1998). Other endangered species in the Republic of Korea include the musk deer, otter and Eurasian flying squirrel. Another critically endangered specie in the region is the Bulmer's fruit bat, found only in Papua New Guinea (Conservation International 1998b).

(iii) Amphibians

Asia and the Pacific is home to a large number of amphibian species. Amongst the countries of the region, People's Republic of China (closely followed by Indonesia) has the largest number of amphibian species (Table 3.3), and also the highest number of endemic species in the region. The Philippines, although comparatively low in amphibian species has high rate of endemism. The three introduced amphibian species are *Bufo marinus*, a marine toad introduced in the 1930s to control beetle infestation of sugarcane; *Rana catesbeiana*, a bullfrog introduced in the 1970s for breeding and export as food; and *Rana rugulosa*, introduced in the 1990s for breeding and export as food (PAWB-DENR 1998).

Of the 50 species of amphibian which are currently threatened in Asia and the Pacific, over 50 per cent are in South Pacific (Figure 3.4), and almost all of these (25) are in Australia alone (Table 3.4). There are also a high number of threatened amphibian species in Japan, which accounts for some 20 per cent of the overall total for the region.

(iv) Reptiles

Asia and the Pacific is home to a large number of reptile species. Amongst the countries of the region, Australia has the largest number of reptile species (Table 3.3), and also has by far the highest rate of endemism in the region (over 80 per cent).

Over 300 of the region's mammal species are currently threatened, of which over 65 per cent are in the Southeast Asian and South Pacific subregions (Figure 3.4); Australia, Myanmar and Indonesia having the highest individual totals (Table 3.4). Among reptiles, the status of turtles, crocodilians, and tuataras (an ancient lineage of two lizard-like species living on scattered islands off New Zealand) has been comprehensively surveyed (Tuxill and Bright 1998), but most snakes and lizards remain unassessed (Cogger 1992). Studies aside, however, a glaring case of reptile extinction is the sea turtle whose population has declined by more than 50 per cent worldwide, largely as a result of the over-exploitation of their eggs (Abas 1999). In some localities of Southeast Asia, such as Khram Island in Thailand, only 50 green turtles and 10 hawksbills are now found compared to 158 and 45, respectively, in the 1950s. In Malaysia, the leatherback turtle has been identified as the most endangered turtle specie, with a 99 per cent drop in its numbers since man began hunting it several hundred years ago. Barely 10 leatherbacks were sighted between 1993 and 1999, compared to 2 000 in the 1950s, and only 400 green turtles were spotted in Sarawak over the same period, compared to 4 500 in 1930s. Less than 100 green turtles can now be found in Ogasawara, Japan, as a result of an estimated harvesting of 1 800 adult green turtles each year.

Although less well known than their seagoing relatives, tortoise and river turtle species also are exploited intensively in certain areas of the region, to the point where populations have been greatly depleted (Tuxill and Bright 1998). In addition, certain species of crocodilians suffer from overhunting and also from pollution of their environment (such as the Indian gharial and the Chinese alligator), but this is one of the few taxonomic groups of animals whose overall fate has actually improved over the past two decades. Since 1971, seven alligator and crocodile species have been taken off IUCN's *Red Data* list, including Australia's huge estuarine crocodile.

(v) Invertebrates

Substantial uncertainty exists over the relative abundance of invertebrate species in the tropical forests of Asia and the Pacific (WRI 1999d), although they probably represent the richest group of biodiversity in the region. Until recently, the relative diversity of arthropods in the tropics, as compared to the temperate zone, was expected to be similar to that of better known groups, such as vascular plants or birds. However, the relatively recent discovery of a tremendous richness of invertebrate species in the canopy of tropical forest of Sulawesi, Indonesia, suggests that the richness of arthropods in the tropics is much greater. It has been estimated that as many as 30 million arthropod species-up to 96 per cent of the world's total for all species – may exist in tropical forests alone.

Almost 600 of the region's known invertebrate species are currently threatened, of which the vast proportion (almost 70 per cent) are in the South Pacific (Figure 3.4). Australia alone contains almost 50 per cent of the subregion's threatened species (Table 3.4).

2. Marine Diversity

Marine ecosystems harbour a myriad of life forms. The deep sea floor may contain about a million undiscovered species, and out of the 1.7 million species catalogued to date, around 0.25 million belong to the marine environment (WRI 1999f). However, the state of knowledge on marine species distribution and "hot spots" is currently poor because only about 7 per cent of the oceans have been sampled (WRI 1999e). Entirely new communities of organisms-hydrothermal vent communities – were found less than two decades ago in the marine ecosystems, and more than 200 new families or sub-families, 50 new genera, and 100 new species from these vents have already been identified. The highest overall diversity takes place in the tropical Indo-Western Pacific, a region that includes waters off the coasts of Asia, northern Australia, and the Pacific Islands. Within this region, some of the highest levels of marine species richness are found off the coasts of the Philippines, Indonesia, and Papua New Guinea. It is possible that, as a result of its marine diversity, Indonesia rivals Brazil for the title of the most biodiverse country on Earth.

Endemism in marine communities appears to be proportionately more dominant in areas surrounding isolated islands and thermal vents (WRI 1999e). Broad distributions of marine species seemingly indicate that they are less vulnerable to extinction than their terrestrial kin. However, not all marine species may be as wide-ranging as is currently believed. For example, a recent effort to map the distribution of coral reef fish revealed that, of the 950 species whose ranges were mapped (about 23 per cent of the total), one-third were limited to areas of less than 2 220 km^2. Although coral reefs share numerous attributes with tropical forests, their level of local species endemism is much lower (WRI 1999g). Within the Indo-Pacific, for example, the vast majority of coral species are found throughout the region. Because coral reef species disperse readily, locally endemic species occur only on isolated oceanic islands.

About 40 per cent of the world's mapped reefs are found in the Pacific (WRI 1999l), including the most extensive coral reef system in the world, the Great Barrier Reef of Australia, and many small islands in the South Pacific with extensive coral formations, such as Fiji, Guam, New Caledonia, Tonga, the French territories of the Pacific Islands and Tuvalu. Coral reefs and associated species diversity, however, is greatest in Southeast Asia, which has a cluster of coral hotspots within the Indo-West Pacific region (WRI 1999g). Containing one-quarter of the world's mapped reefs (WRI 1999i), this subregion support more than 16 per cent of the world's estimated 19 000 species of freshwater and marine fish (WRI 1999g). Indonesia and the Philippines account for a major portion of these reefs, each are containing at least 2 500 species of fish (WRI 1999i). Waters surrounding Polynesia and portions of Indian Ocean also contain areas with high levels of reef fish diversity.

Amongst marine fish, the coral reef variety makes up one-quarter of all known species (WRI 1999e). Some 4 000 species of fish and 800 species of reef-building coral have been described to date, but the total number of species associated with reefs is estimated to be more than one million (WRI 1999j). Levels of coral reef species diversity vary within the marine ecosystems depending on location. The most species-rich reefs are found in a swath extending through Southeast Asia to the Great Barrier Reef, off northeastern Australia. More than 700 species of corals alone are found in this area. The Great Barrier Reef, the world's largest system of coral reefs (covering 349 000 km^2) supports approximately 400 species of coral, 1 500 fishes, over 4 000 species of molluscs and populations of Indo-Pacific invertebrates, birds, turtles, dugong, whales, and dolphins (WRI 1999h). In addition, 252 species of bird's nest and breed on coral cays, five species of turtles live on the reef, and several species of whales and dolphins are associated with the habitat (WRI 1999j).

Like their terrestrial counterpart, marine species have also been subject to pressures. About 68 per cent of all threatened marine species suffer from

over-exploitation (WCMC 1998). By 1994, 90 marine mammal species were listed as threatened or endangered (WRI 1999a). More than a quarter of the world's reefs are at high risk from human disturbance (WRI 1999j). In Asia and the Pacific, coral reefs are most threatened in the Southeast Asian subregion (see Chapter 5).

3. Freshwater Diversity

The overall number of species in freshwater is low compared with marine and terrestrial groups. However, species richness in relation to habitat extent is extremely high, since the area occupied by freshwater is so much lower than land or sea. As a consequence, the importance of protecting freshwater habitats is correspondingly high.

Although most freshwater plant species are relatively cosmopolitan, the tropical regions of Asia appear to be one of the most rich in freshwater plant species which are restricted to a single continent, country or area (WCMC 1998). Sri Lanka, India, Myanmar and Indonesia hold localized species such as the Podostemaceae and a large number of narrowly endemic species in some cases, with several forms restricted to different stretches of a single river.

Animal species are considerably more diverse and numerous in inland waters than plants (WCMC 1998). More than half of all freshwater vertebrate species are fish, and more than 8 500 species (40 per cent) of the 25 000 known fish species exist in freshwater. Unfortunately, their distribution and systematic are inadequately known (WCMC 1998). Among the countries of Asia and the Pacific, IUCN has listed the highest number of freshwater species in Australia (which is also ranked third in the world), followed by Papua New Guinea and Turkey (Table 3.5). Scientists believe that Thailand may have as many as 1 000 species of freshwater fish but only some 475 have actually been recorded (WRI 1999a). Apart from fish, other important groups of inland water species in the region include crustacea, molluscs and insects.

Table 3.5 Total Numbers of Threatened Freshwater Fishes in Selected Countries of Asia and the Pacific

Country	Total species	Threatened species	Percentage of threatened species
Australia	216	27	13
Papua New Guinea	195	12	6
Turkey	174	18	11
Japan	150	7	4
Sri Lanka	90	8	9

Source: WCMC 1998

Accurate data required to evaluate the extinction of aquatic species are generally not available, although some 81 fish species are recorded as having become extinct during the past century, and a further 11 are extinct in the wild, but remain as captive populations (WCMC 1998). A recent survey in Malaysia found fewer than half of the 266 fish species previously known to exist in the country (WRI 1999a). Similarly, in Singapore, 18 out of 53 species of freshwater fish collected in 1934 could not be located some 30 years later, despite an exhaustive search. In the freshwater and marine ecosystems, over-fishing has also resulted in shifts in fish size, abundance and species composition. For example, some 20 species of edible fish were thriving in the Aral Sea during the 1940s, but in the early 1990s, only five species remained (Mainguet and Letolle 1998). At present, only one is thought to survive.

C. Genetic Diversity: Patterns and Trends

The term "genetic resources" describes a category of biodiversity encompassing the diversity of genes in crop seeds, genetic materials such as germplasms or naturally occurring chemicals found in plant and animal species (Putterman 1999). The contribution of genetic resources to the global economy ranges from the use of genes in modern agriculture to enzymes used in industrial manufacturing, and from organic molecules used to design new pharmaceutical drugs to extracts of medicinal plants that are used to prepare herbal products.

Genetic resources yielding potentially valuable chemicals, enzymes or genes come from terrestrial and marine microbes, plants, insects, venomous animals and other marine organisms. Tropical rainforests recognized for their high biological diversity, are the major source of genetic wealth, but dryland ecosystems including dry forests, savannah, deserts and marine ecosystems such as coral reefs are also know to yield high levels of bioactive compounds (Putterman 1999). The wealth of genetic material which are available for medicine is amply demonstrated by World Health Organization statistics, which estimate that 3.5 billion people in developing countries (most of which are in Asia and the Pacific) rely on plant-based medicine for their primary health care (Tuxill 1999). Ayurvedic and other traditional healers in South Asia use at least 1 800 different plant species in treatments and are regularly consulted by millions of people. In People's Republic of China, where medicinal plant use goes back at least four millennia, healers employ more than 5 000 plant species (Baille and Groombridge 1996). Likewise, varied traditional communities in

Indonesia possess great knowledge on the use of biodiversity as a source of food and medicine etc. and Indonesian communities in their daily life use some 6 000 plants, 1 000 animals and 100 microbe species.

In addition to naturally occurring genetic resources, over the millennia, farmers have developed a wealth of distinctive genetic varieties within crops by selecting and replanting seeds and cuttings from uniquely favourable individual plants (Tuxill 1999), thus creating a series of folk varieties, or *landraces*. Many of these were perhaps ones that matured slightly sooner than others, were unusually resistant to pests, or possessed a distinctive colour or taste. Subsistence farmers have always been conscious of such varietal diversity, because it helped them cope with variability in their environment. India alone, for instance, probably had at least 30 000 rice landraces earlier this century (Swanson et al 1994).

These domesticated landraces have been in substantial decline in recent years. In most developing countries of the region, losses were minimal until the 1960s, when the Green Revolution introduced high yielding varieties of wheat, rice, corn, and other major crops (Tuxill 1999). Developed to boost food self-sufficiency in famine-prone countries, the Green Revolution varieties were widely distributed, often accompanied by government subsidies, and thereby displaced landraces from many prime farmland areas (NRC 1993). There is now a growing concern that these crops may have lost their genetic variability to such an extent that they may not be resistant to any future environmental pressures from, for example, global climate change (SOEAP 1995), or from attack by pesticide – resistant pests and diseases (Box 3.3).

An example of increasing genetic uniformity is provided by rice, the most important crop in the region. In India, it is estimated that by 2005, 75 per cent of rice production will come from less than ten varieties (Ryan 1992), as opposed to the thousands of varieties grown in 1950s. Similarly, in Indonesia, 1 500 local varieties of rice disappeared between 1975 and 1990, and nearly three quarters of the rice planted today descends from a single maternal plant (WRI/UNEP/IUCN 1990).

A reduction of genetic diversity is also becoming evident in animals, as new breeds selected for high output. A clear example is that of the domestic chicken, where, to improve production output, many traditional breeds have been abandoned in commercial terms in favour of US imports such as the white leghorn for egg production, and the Rhode Island Red for meat production.

D. Biotechnology, Biosafety and Bioprospecting: Prospects and Trends

The scale of manipulation of genetic diversity in recent years has been unprecedented. In particular, manipulation of pollens, seeds and other propagules through biotechnology and/or genetic engineering has contributed to changes in the patterns of occurrence of some genes. It has even resulted in transfer of genetic material from one species to another. This has brought revolutionary changes in agriculture, medicine and other fields. However, it

Box 3.3 Risk to Food Security as a Result of Monoculture and Biodiversity Loss

In the mid-1970s, a mysterious disease started devastating rice crops in Indonesia. The Green Revolution had encouraged the introduction of new, high-yielding but genetically uniform varieties of rice, highly vulnerable to attack by pathogens. Within a couple of years the virus was threatening more than a million ha, putting hundreds of millions of people throughout Southeast Asia at risk.

The International Rice Research Institute (IRRI) rapidly screened all 6 273 varieties in its collections for resistance to the virus. Only one possessed it – a low yielding, spindly species, collected from the wild in Southern India but thought to have no commercial value. The resulting new variety, IR36, is now planted as yet another genetic monoculture over millions of Asian hectares – vulnerable to the next pathogen whose natural selection may outpace the plant breeders.

Will there still be an uncultivated wild variety of rice possessing the genes needed to save people from starving when the next pathogen strikes? Or will it already be extinct? If climate change radically alters the patterns of agriculture throughout the world, as inevitably it will, where will the genetic material come from to produce the new crop varieties on which human survival will depend? Gene banks, like the IRRIs, may provide a partial answer, but the greatest gene bank of all is nature, and this is being destroyed at an increasing rate. The myriad of genes, species and ecosystems that collectively make up what we call Nature – may have taken four billion years to evolve, but it seems destined to be largely destroyed in just four human generations. Rates of species extinction are estimated to be 50-100 times the natural background rate and this could increase to 1 000 to 10 000 times with the forest loss projected for the nest 25 years. Unless direct action is taken now to protect biodiversity, the humanity will lose forever the opportunity of reaping its full potential benefits.

Source: Watson, T.R. et al, eds. 1996

has also brought new challenges for the protection and conservation of biodiversity in the region.

1. Agricultural Biotechnology

(a) Environmental and Health Related Risks

The most important outcome of agricultural biotechnology to date is the production of genetically engineered plant seeds, more commonly known as genetically modified (GM) seeds. Genetic engineers claim that the new seeds are to all intents and purposes the same as the original ones, except that they have been improved to produce a higher crop yield, for example through increased resistance to pests, and enhanced response to particular fertilizers. Critics of the new technology, however, assert that there are too many risks associated with genetic engineering, particularly in relation to environmental and human health. More specifically, they are concerned about biosafety of genetically engineered organisms (such as plants and micro-organisms), that is, their safe transfer, handling, use and disposal in the environment.

In terms of environmental risks, the consequences of releasing genetically engineered seeds into the environment have not been adequately assessed. Wind blown pollen from the modified seeds may, for example, fertilize related plants outside the growth area, and if it contains a gene for herbicide resistance, a new strain of "superweeds" could result. Similarly, it is difficult to predict with any certainty what effects the modified plants may have on other organisms. For example, genetic engineers have developed new strains of many plants that contain a gene from a bacterium *Bacillus thuringiensis* (Bt), which makes them resistant to insect pests. However, there is some evidence that the crops may have an impact not just on the pests, but also on beneficial insects such as bees, lacewing, and ladybirds and the birds that eat them.

In terms of health risks, it has been found that certain transgenic crop varieties (e.g. Bt-maize) contain a marker gene that codes for antibiotic resistance in the bacteria *Erwinia coli*. There is a risk that if animals or humans consume such products, for example in the form of cattle feed or starch, some antibiotics would be rendered useless. Another concern is that when crops such as rice or rape-seed with high Vitamin A concentrations are planted, there will be no way to distinguish them from normal crops, with the contingent risk of liver damage if too much Vitamin A is unwittingly consumed. Laboratory tests have also shown that certain genetically engineered materials are also associated with reproductive problems in rabbits.

In some countries, such as England and France, major supermarket chains have already banned genetically engineered products from their shelves, and in some Asian and Pacific Region countries, including Japan and Hong Kong, China, supermarkets have begun to introduce GM – free products to test consumers reaction (see Chapter 13). Reaction amongst some other countries is the biodiversity rich Asian and Pacific region, has also been hostile, for example, students from the Republic of Korea have blockaded government funded biotechnology greenhouses, and in India, farmers have made strong protests to the government. However, the reaction has been varied amongst different stakeholder groups throughout the region (Box 3.4).

(b) Intellectual Property Rights and Dependency

Intellectual property rights (IPR) is another area of major concern to some of the less industrialized countries of Asia and the Pacific which are rich in biodiversity; the worry being that they will be forced to accept or adopt some form of IPR, even before a full and frank international debate has taken place about the suitability of such systems to protect resources that are collectively owned. Moreover, if foreign researchers and transnational corporations can patent indigenous plants (e.g. varieties of rice) without adequately compensating the communities who provided them, there are fears that farmers will end up paying surcharges on products formed from their own knowledge and experience (Box 3.5). In response, some experts believe that IPR should also be applied in favour of the farming communities, to patent and protect their own varieties in order to retain any benefits, which are derived from them. However, this in turn gives rise to the problem of benefit sharing, how to define "community" and, in the case of plant breeding, whether it is possible to determine the provenance of a plant that is the product of generations of farmers' inputs.

Probably the most important and challenging risk to biodiversity rich countries of the region in relation to genetic engineering is the balance of power over food supply, which is fast becoming concentrated in the hands of a few major companies who dominate the world's seed market, such as Monsanto, Novartis, Calgene, Du Pont and AstraZenica. "Control of the plant gene" has aroused particular concern in this respect; a genetic technique which enables seed companies to ensure that farmers are not able to raise second generation (F2) populations from first generation (F1) seeds using mechanisms such as embryo abortion in the first generation seeds. Currently, 80 per cent of crops in the biodiversity rich world are grown each year from saved seed. The cost of buying expensive new seeds every year will clearly place a significant economic burden on many small farmers.

Box 3.4 Public Acceptance of Transgenic Crops in Asia and the Pacific: A Case of Transgenic Rice in the Philippines

With the advent of genetic engineering, *Bacillus thuringiensis* (Bt), a common natural resource potentially used as biopesticides, have been inserted directly in to several crop and have become widely commercialized. To understand the issue of public acceptance of this genetically engineered crop, a survey was conducted by the *Department of Agricultural Economics* at the *Swiss Federal Institute of Technology* (ETH) in cooperation with the *University of the Philippines Los Baños* (UPLB). The study aimed to examine the perception of risk and benefits of transgenic rice among the main political actors in the Philippines indicated that there were three major groups of perception with corresponding political weight in the debate:

The *first group* dominated by NGOs, some large NGO networks, people's organizations (POs) and other public interest groups opposed biotechnology and did not see any potential for genetic engineering in agriculture. They anticipated that this technology had high risks and low benefits. In the survey, respondents perceived this group to have a major influence on public opinion since they seemed to be the most active in protest activities and other campaigns and were very effective in gathering and disseminating information. However, this group was not considered very important with regard to direct political decision-making processes in the Philippines, since they were not members of any legislative body.

The *second group* included the majority of government officials and politicians with considerable influence on political decision-making processes and, to a certain extent, on public opinion. They had an important role in issuing directives and granting financial support. Respondents in this group had high expectations of the potential of genetic engineering for solving the problems confronting the Philippine rice economy. There was a contradiction in their expectation. On the one hand, they agreed that genetic engineering could only address agronomic problems, yet many of them also expected the technology to solve structural problems. Further, this group had a rather ambivalent attitude towards risks and benefits of genetic engineering. Half of them perceived the benefits while the other half perceived the risks. This may be explained by their perception that biotechnology was a tool that enabled plant breeders to solve those problems that could not be addressed through conventional technology. At the same time, this group doubted the sustainability of biotechnology since according to them insects would eventually develop resistance to Bt rice.

The *third group* consisted of scientists of private companies, and national and international research centres. While scientists from the University of the Philippines were to be found in all three perception groups, in general the third group's view of the potential of genetic engineering in agriculture was more modest, although their attitude was definitely positive. Although they did not expect biotechnology to solve structural problems yet, they certainly saw the potential of genetic engineering for solving agronomic problems, including those caused by natural calamities. This group which received financial support from both national and international donors, was central in the debate on genetic engineering and genetically engineered rice and according to the survey respondents, represented the most important suppliers of information. Their influence on political decisions was felt to be relatively high, whereas their influence on public opinion was considered to be low. This group did not have direct access to the public; instead, those who had better access to the public, such as the NGOs and the mass media, gathered information from this group.

A majority of the surveyed population indicated that labelling of transgenic food products and allowing farmers free choice of seeds was important for gaining public confidence. While real consumer behaviour could not be anticipated by the study, the survey indicated that consumer organizations had only a marginal stake in the debate and that health risks among the respondents were not perceived as very serious. Therefore, it is not anticipated that the average urban consumer in the Philippines would reject transgenic rice for fear of serious health risks. This can be considered as a major difference to opposition in industrialized countries.

Given the NGOs' lack of direct influence in the political decision-making process, their opposition to genetic engineering will most likely not lead to restrictive legislation against genetic engineering in agriculture. This is probably because modern biotechnology is considered the 'flagship' of the government's 'Vision Philippines 2000' for national economic growth. However, it might have consequences on the future strategies in development cooperation in the Philippines since doubts about this technology, or lack of confidence in the responsible institutions, could lead to an increased polarization in the debate and may hinder future cooperation among all the actors.

Source: Aerni, P. et al 1999

2. Bio-prospecting

Biodiversity prospectors search for genetic and biochemical resources that have a commercial value, particularly to the pharmaceutical, biotechnological, and agricultural industries. Biodiversity prospecting is not new – plant collectors from industrialized countries have ventured southward in search of valuable genetic material for agricultural plant breeding for many years – however, recent advances in molecular biology, and the increasing availability of sophisticated diagnostic tools for screening, have made it an increasingly cost-effective operation for pharmaceutical corporations and others to perform. As a result, the market for buying and selling exotic biological specimens is expanding rapidly (it is conservatively estimated that the market for

Box 3.5 Patenting of Genetic Materials and Plight of Developing Countries in Asia and the Pacific

In September 1997, the US company Ricetec, Inc., was granted a patent on Basmati rice. The patent is for a variety achieved by the crossing of Indian Basmati with semi-dwarf varieties, and it covers Basmati grown anywhere in the Western hemisphere. Ricetec can also put its brand on any breeding crosses involving 22 farmer-bred Basmati varieties from Pakistan and, on any blending of Pakistani or Indian Basmati strains with the company's other proprietary seeds. Ricetec also claims the right to use the Basmati name. The Indian government has challenged Ricetec's claim, arguing that the patent jeopardizes India's annual Basmati export market of around US$277 million, and threatens the livelihood of thousands of Punjabi farmers.

The company is also marketing another proprietary rice called Jasmati, which is derived from a variety called Della, developed in the US. BIOTHAI (the Thai Network on Community Rights and Biodiversity) is concerned that by giving this variety a name that implies a cross between Jasmine rice and Basmati rice, the company is threatening the livelihoods of five million poor farmers in the northeast of Thailand too.

A similar case is W.G. Grace and Co.'s series of patents on extracts from the neem tree, whose seeds and bark have been used for centuries in India and Pakistan for natural pesticides. Grace has estimated that the global market for the pesticide could reach US$50 million a year by 2000, and while there are no hard statistics on the impact on Indian farmers to date, Vandana Shiva says that farmers in the south of India, where neem is harvested, are already losing out because the processing and exporting of the seeds and oil is no longer available to them.

Another example is the case of two Mississippi doctors who were granted a patent in 1995, for the traditional use of turmeric as a healing powder. India's Council of Scientific and Industrial Research (CSIR) petitioned the US Patent and Trademark Office (PTO) on the grounds that the 'discovery' was not original, but had been chronicled in traditional Indian texts. In August 1997, the PTO rejected the patent holders' claims. "What is being patented is not one invention of one individual or corporation, but the collective creativity and inventiveness of millions of people over millennia, a creativity...that is necessary for meeting the needs of our people in the future."

Among developing countries of Asia and the Pacific, India is particularly vocal on farmers' rights and in order to cope with such patenting problems the Agriculture Ministry has drafted new legislation, which allows farmers to use, and exchange traditional varieties. In contrast to International Convention for the Protection of New Varieties of Plants (UPOV), the legislation will recognize the farmer as breeder first and foremost, before foreign commercial or research interests. India also commissioned a US$20 million national genebank in 1997, the third largest in the world, and the government is in the process of drafting legislation, in accordance with the CBD, which will regulate the export of germplasm and prohibit open access to the Indian genebank by American seed companies, access that was allowed under a 1988 agreement with the US. A National Biodiversity Authority (NBA) will be set up to enforce the law.

Source: Spinney, L. 1998

natural product research specimens within the pharmaceutical industry alone is US$30-60 million per annum). The renaissance of bio-prospecting is also fuelled, in part, by the realization that species, their genetic material, and the ecosystems of which they are a part are rapidly disappearing from the face of the earth. In the mid-1980s, pharmaceutical industry analysts warned that each medicinal plant lost in the tropical rainforests could lose drug firms possible sales of more than US$200 million.

Valuable chemical compounds derived from plants, animals and micro-organisms are generally more easily identified and of greatest commercial value when collected with the assistance of, or in combination with, the knowledge of indigenous peoples. For example, scientists have found that 86 per cent of the plants used by Samoan healers displayed significant biological activity when tested in the laboratory. However, the contribution of indigenous peoples has rarely been acknowledged or rewarded in the past, and no matter how convincing the rhetoric today, conservation and equity are likely to remain secondary issues for the various corporations involved in the practice of bio-prospecting. Moreover, once indigenous peoples share information or genetic material, mechanisms such as monopoly patents can mean that they effectively lose control over those resources forever, regardless of whether or not they are compensated.

CAUSES AND CONSEQUENCES OF BIODIVERSITY LOSS

A. Causes of Biodiversity Loss

The Global Biodiversity Strategy (WRI/IUCN/UNEP 1992) identifies six fundamental causes of biodiversity loss (UNEP 1995):

- unsustainably high rates of natural resource consumption and human population growth;

- steadily narrowing spectrum of traded products from agriculture and forestry, and introduction of exotic species associated with agriculture, forestry and fisheries (including bio-engineered species);
- economic systems and policies that fail to value the environment and its resources;
- inequity in ownership and access to natural resources, including the benefits from use and conservation of biodiversity;
- inadequate knowledge and inefficient use of information;
- legal and institutional systems that fail to protect against unsustainable exploitation.

The above are a mixture of both direct and indirect (or underlying) causes, and are discussed in more detail in the following sections.

1. Direct Causes of Biodiversity Loss

(a) Habitat Loss and Degradation

Habitat loss and degradation is by far the leading cause of biodiversity loss in the region. In some cases, habitat alteration is intensive and large-scale, for example, when native forest is converted to plantation, or when a large dam inundates an area. In other instances, habitats are gradually eroded over time, as when a native forest or grassland is fragmented by expanding agricultural practice and/or population pressures (Baille and Groombridge 1996). In either case, plant species are lost and many animal species are forced from their natural habitats.

It is estimated that at least three quarters of all threatened bird species are in danger because of the pressures on their natural habitats, and that habitat loss is also the principal factor for the decline of at least three-quarters of all mammal species. In areas where forest degradation and conversion have been most intense, such as South and Southeast Asia, a significant proportion of the endemic primate species face extinction (Baille and Groombridge, 1996). Species of reptiles and amphibians are also declining for similar reasons; habitat loss accounts for the decline of 68 per cent of all threatened reptile species and 58 per cent of threatened amphibian species (Baille and Groombridge 1996).

Although degradation of terrestrial habitats such as forests may gain the most attention, both marine and freshwater habitats are also under serious pressure from human activities such as urbanization and agricultural expansion (Tuxill and Bright 1998). For example, river engineering works such as the construction of dams and/or levees have the effect of either inundating or drying up wetlands and backwaters which are important fish spawning grounds, and changing flow regimes to downstream lakes and estuaries, thereby altering their ecologies. A substantial proportion of marine ecosystems are also at risk, primarily due to the direct activities associated with coastal development, including dredging, filling, breakwater construction, mining and drilling, but also from secondary effects such as pollution and increased marine traffic (WRI 1999m).

The impacts of habitat pollution on biodiversity can be instantaneous or cumulative. For instance, oil wastes can asphyxiate and/or poison a wide range of marine life – from algae to seabirds – whereas other contaminants, such as radioactive wastes, pesticides, and other toxic chemicals, can take a while to build up and cause harm within individual organisms, especially within species high on the food chain. In addition, the impact of pollution can be secondary, for example, certain species of algae will capitalize on high nutrient conditions introduced by some forms of pollution, undergoing massive population explosions (known as blooms) which can in turn introduce toxins which are harmful to marine life such as fish and shellfish, or to consumers of those produce (WRI 1999m), or which can lower water clarity and oxygen content to the extent that marine life is depleted. Coral bleaching is another frequent outcome of pollution-induced stress (WRI 1999p).

(b) Over-exploitation of Biological Resources

Throughout South and East Asia, a major factor in the excessive exploitation of wildlife has been over-hunting in response to the unsustainable demands of both national and international trade (see next section) in goods such as animal parts for traditional medicine or curios. Species which have been particularly affected include the tiger, which has been hunted almost to extinction in South Asia (Matthiesen 1997), and the seahorse, which is harvested in numbers approaching 20 million per year – a rate which is unlikely to be sustainable because of their low reproductive rate, complex social behaviour (they are monogamous, with males rearing the young) and low mobility. Already, it is thought that some 36-seahorse species are threatened by this growing, unregulated harvest (Vincent 1996). Tortoise and river turtle species also are exploited intensively in certain areas of the region; in Southeast Asia they have long been an important source of meat and eggs, but there is also now a burgeoning international trade for their use in traditional medicine, in countries such as People's Republic of China. At least five turtle species involved in this trade are now candidates for the most stringent listing available under the Convention on International Trade in Endangered

Species of Wild Flora and Fauna (CITES) (Baden-Daintree 1996).

Uncontrolled harvesting of fish is playing a major role in jeopardizing freshwater and marine ecosystems and their native biota (WRI 1999a, g), resulting in a situation whereby about 68 per cent of all threatened marine fish species in the region suffer from over-exploitation. A prime example is the sturgeon in Central Asia, where poaching is now so widespread that the few remaining stocks of this fish are nearly gone (Amstilavskii 1991; Birstein 1993; Baille and Groombridge 1996). Aside from overfishing of commercial stocks, poor management practices are also to blame for the decline in marine resources, which include blast fishing, fishing with cyanide and other poisonous chemicals, *muro-ami* netting (pounding reefs with weighted bags to scare fish out of crevices) and coral harvesting (WRI 1999m, n).

2. Underlying Causes of Biodiversity Loss

(a) International Trade

As discussed above, the growing international demand for traditional medicines, rare foods, curios and aquarium specimens etc. is leading to increasing over-exploitation of certain species within the region. The pressures on some individual species are illustrated by the value of their markets, for example, the market price for the body parts of a single tiger can be as much as US$5 million, and top-quality dried seahorses can sell for as much as US$1 200 per kilogram in parts of People's Republic of China. In addition, according to a recent report by TRAFFIC, a group that monitors the international wildlife trade, the annual Northeast Asian trade in tortoises and river turtles involves some 300 000 kilograms of live animals, with a value of at least US$1 million.

Traditional herbal therapies are also growing rapidly in popularity amongst industrialized countries of the world. The FAO estimates that between 4 000 and 6 000 species of medicinal plants are traded internationally, with People's Republic of China accounting for about 30 per cent of all such exports. In the early 1990s, the booming US retail market for herbal medicines reached nearly US$1.5 billion, and the current European market is thought to be even larger (Iqbal 1995; Shelton et al 1997).

The Asian rattan palm is another species of plant that has been in decline in recent years due to high international demand to supply an international furniture making industry worth US$3.5 to 6.5 billion annually. Rattan stocks are being depleted at an unsustainable rate throughout tropical Asia due to a combination of the loss of native rainforest and over-harvesting. As a result, in the past few years some Asian furniture makers have even begun importing rattan supplies from Nigeria and other central African countries (Network for Bamboo and Rattan 1997; Sunderland 1998).

(b) Population Growth and Poverty

Continued population growth and urbanization is exerting a constant and degrading pressure on biodiversity throughout the region, primarily due to encroachment into natural habitats and their conversion for human settlement, or for the expansion of agricultural production to meet increased demand. In addition, the intensification of agriculture production is also encouraging the use of hybrid seeds and agricultural chemicals, thereby further degrading natural habitats and biodiversity.

Poverty is another significant underlying factor in regard to the loss of biodiversity in the region. The poor are frequently forced to occupy and/or subsist on marginal lands, and thereby often encroach upon fragile ecosystems, such as wetlands in Bangladesh, hill forests in India and Nepal and mangroves in Thailand. Urgent, but pragmatic, responses are therefore needed to address this problem, for example focusing on developing alternative livelihood strategies for those who currently rely on protected natural habitats for their living (Box 3.6). It is worth mentioning, however, that it is by no means clear whether poverty, with its pressure to survive, or affluence, with its pressure to consume, ultimately leads to greater degradation of resources and the environment.

(c) Bioinvasion

Bioinvasions are the processes by which new (or "exotic") species are introduced into a habitat. They are rated second only to habitat loss as the major cause of biodiversity loss in the region, where they are deeply enmeshed in basic economic processes such as trade and travel. Such processes have created hundreds of exotic "pathways" for invasion (Bright 1996), for example, container shipments of used tires from Japan are believed to be responsible for the arrival of Asian tiger mosquito in New Zealand and Australia, and the ballast water of foreign ships was thought to contain the poisonous plankton which burst into the dinoflagellate "red tides" which devastated Australian fisheries in the 1980s (Hallegraeff and Bolch 1991; Carlton 1992b). Other examples include the introduction of the domestic cat to New Zealand, which is thought to have been the main factor in the loss of many bird populations in that country, and the invasion of "exotic" rats, particularly the black and the brown rat, which have also taken a similar toll on many island birds across the region. Another spectacular example involves the brown tree snake, which

Box 3.6 Conserving Biodiversity Through Eco-development

Using a strategy known as eco-development, India's Forestry Research Education and Extension Project (FREEP) is enlisting local communities in the effort to preserve precious biodiversity, and to move away from a more traditional, and confrontational, approach to safeguarding areas. The strategy involves developing alternative resources and sources of income for the many thousands of poor people who depend on protected natural habitat for their livelihood.

FREEP is conducting pilot eco-development programmes in two protected areas in the states of Tamil Nadu and Himachal Pradesh. The Kalakad-Mundanthurai Tiger Reserve (KMTR) in the southern state of Tamil Nadu is one of these areas; located in the southern part of the Western Ghats, the reserve contains a unique and varied array of flora ranging from thorn and dry teak to tropical evergreens, and it supports a rich variety of birds and mammals, including tigers, leopards, and elephants. The last tiger refuge in Tamil Nadu, the KMTR is one of 23 sites covered under the Indian government's Project Tiger, a programme receiving international assistance to enhance tiger habitat. The reserve consists of a core area of 536 square kilometres with large sections of undisturbed forest. It is bounded on the west, northwest, and south by protected forests. To the east is a belt about 5 kilometres wide (324 square kilometres in area) containing 145 villages, the inhabitants of which, depend heavily on KMTR resources for fuel, timber, and fodder. About 25 000 families, totaling almost 100 000 persons, live in these villages owning about 130 000 cattle and buffaloes, many of which routinely graze in the reserve.

The project was initiated in 1995, with the formation of a technical team, and training of staff in eco-development techniques. It also involved seven locally operating non-governmental organizations (NGOs), to implement its operational plan. A village's support was usually obtained through a visit by an eco-development team, comprising forestry department staff, NGO personnel, and a village representative, which met with villagers to discuss the need for biodiversity conservation and to help them identify what actions they might take to reduce their village's pressure on the reserve.

A village forest committee (VFC) was then formed with six members (at least three of whom were to be women), who pledged to collaborate to reduce their village's pressure on the forest. The VFC worked with a smaller group from the eco-development team to produce an eco-development microplan for the reserve. Under this plan, the village inhabitants were to agree to take measurable steps toward conservation in return for eco-development investments. For example, a village population could agree that it would reduce the number of headloads of fuelwood removed from the reserve by an agreed percentage in return for investments in fuel-saving devices or fuelwood plantations. A capital of Rs 250 000 (approximately US$7 100) per group of 200 families was usually set, and villagers had to agree to contribute at least 25 per cent toward the cost of microplan investments. To ensure transparency, funds could be released from the VFC account only with the approval of a two-thirds majority of the villagers participating in the microplan.

Over 100 villages are now participating in the project. These villages have only recently begun making investments, but the results are already significant. Communities and individual farmers have planted fuelwood and fodder plantations. Some villagers have installed cow dung-based gas plants for home fuel needs and are using fuel-saving pressure cookers and more efficient wood-burning stoves (smokeless *chulas*). VFCs have also made loans for a wide array of alternative income-generating activities such as dairy and poultry farming, tailoring, coconut leaf weaving, and setting up tea and dry goods shops. Because the people who encroach on reserves are typically the poorest in the community, the VFC loan programme is targeted at them. Many are receiving loans for the first time, but VFCs report practically 100 per cent repayment, reflecting borrowers' genuine sense of responsibility to their communities.

It has been reported that because of the project, forest encroachment has decreased dramatically. One woman from Mudaliarpatti village, along the reserve boundary, reports, "Now that I've a milk cow through a VFC loan, I no longer have to travel long distances to the forest in the hot sun to find wood to sell. I can stay home, take care of my cow, and earn income". More importantly, the project has transformed the relationship between villages and the state forestry department. Former adversaries have become collaborators in conserving biodiversity. Communities have become "social fences" reporting encroachments to forestry authorities. Some VFCs have even levied fines against members discovered entering the reserve. Thus the eco-development programme at the KMTR is rapidly coming to be seen as a model for conserving biodiversity through local participation.

Source: World Bank 1999

invaded Guam from Papua New Guinea around 1950 and has driven nine of the island's 18 native birds into extinction, along with several lizards and probably three species of bats (Savidge 1987; Fritts and Rodda 1995).

Although mammals have in general been less susceptible than birds to invasive species, a significant exception has been the unique marsupial and rodent fauna of Australia (Tuxill and Bright 1998). The introduction of non-native rabbits, foxes, cats, rats, and other animals in this country has combined with changing land-use patterns during the past two centuries to give Australia the world's highest rate of mammalian extinction. In total, 19 species of mammal have become extinct since European settlement in the Eighteenth Century, and at least

one quarter of the remaining native mammalian fauna remains threatened.

As yet there are few data to analyse their impact, but the rapidly increasing use of genetically engineered micro-organisms, and their establishment (either directly or indirectly) within natural habitats, could increase the potential risks to existing natural biota (see section below). This could occur, for example, through engineered genetic traits which are harmful to non-target species upon which other native biota depend, through a mixing (and subsequent loss) of genetic stocks, or through their general competitive superiority and subsequent intrusiveness.

In agriculture, species which are considered favourable in some areas can become serious "biological polluters" in other some areas (Bright 1996). For example, the spice cardamom is a problem in lowland moist forests of Sri Lanka and southern India (Heywood 1989), whilst black pepper has invaded forest edges in Malaysia (Whitmore 1989). In addition, *Chromolaena odorata*, the shrub valued by small farmers in Indonesia as a fallow crop, has become a serious pest for many major tropical crops, such as rubber, oil palm, and coconut, and arguably the single most invasive plant in tropical nature reserves (Usher 1989; Baxter 1995).

B. Consequences of Biodiversity Loss

1. Impacts on the Ecosystems

One major consequence of biodiversity loss is the alteration and decline in species compositions, which may then trigger local and global extinctions (WRI 1999m). Evidence also suggests that removal of key herbivore and predator species may ultimately produce large-scale ecosystem changes. For instance, removal of triggerfish has been linked with explosions in burrowing urchin populations (their prey), which subsequently accelerate reef erosion through feeding activities (WRI 1999n). Moreover, the loss of a region's top predators or dominant herbivores is particularly damaging because it can trigger a cascade of disruptions in the ecological relationships among species that maintain an ecosystem's diversity and function. Large mammals tend to exert inordinate influence within their ecological communities by consuming and dispersing seeds, creating unique micro-habitats, and regulating populations of prey species. Similarly, decades of excessive whaling reduced the number of whales that die natural deaths in the open oceans. This may have adversely affected unique deep-sea communities of worms and other invertebrates that decompose the remains of dead whales after they have sunk to the ocean floor (Butman et al 1995). Loss of biodiversity through bioinvasion of exotics also has a serious repercussion as it could result in loss or alteration of genetic purity or genetic uniformity. Exotics can pose a kind of internal threat to natives as they may cause the mixing of genetic stocks. An exotic closely related to a native may interbreed with it, releasing its genes into the native gene pool (Bright 1996; WRI 1999m). Such genetic invasions can undermine the distinctiveness or stability of a native population by swamping it in foreign genes. Among plant species, many crops interbreed with wild relatives, and it is possible that these "exotic genes" could escape into wild plant populations – or that the crops themselves could escape. The appearance of herbicide tolerant or disease-resistant wild plants could obviously lead to major ecological- and agricultural-impacts (Rissler and Mellon 1995).

Mixing of genetic stocks could also occur in freshwater and marine species. In marine ecosystems, biodiversity loss has two important genetic consequences. Firstly, it affects the genetic variability within a species. Species exhibiting broad genetic diversity (the range of genetic variability found within different organisms in a population and between populations of a single species) are more likely to adapt to changing conditions than species with narrow genetic diversity. Population declines, by reducing genetic diversity, also reduce the ability of a species to adapt to changing conditions. Secondly, these losses can have cascading, unanticipated effects on other species within an ecosystem (WRI 1999a).

2. Impacts on Humankind

With the continued loss of terrestrial, freshwater and marine biodiversity in the region, fish, grains and other food and medicinal products which are derived from these ecosystems are also under increasing pressure. In most cases, these food and medicinal products are integral to the lives of poor and indigenous communities, and so it is they who are being forced to find alternative livelihoods, and who in many cases are suffering as a result. Moreover, although people who are more integrated into regional and national economies tend to use fewer natural resources, they still may depend on plant and animal diversity to generate cash income, for example in India, nearly six million people make a living by harvesting non-timber forest products, a trade that accounts for nearly half the revenues earned by Indian state forests.

Loss of biodiversity is also frequently associated with a decline in the quality of diet and/or intake of food for the poor, which can exacerbate the incidence of malnutrition and sickness, especially amongst children. Moreover, humanity derives many of its medicines and industrial products from the region's wealth of biodiversity, and as plant and

animal species with medicinal properties are lost, primary healthcare for millions of people across the region, and in particular the poor, is at risk (Campbell and Schlarbaum 1994). In response, professional ethno botanists surveying medicinal plants used by different cultures are racing against time to document traditional knowledge before it vanishes with its last elderly practitioners (Gubler 1993).

POLICIES AND PROGRAMMES FOR BIODIVERSITY CONSERVATION

A. Implementation of International Conventions

International agreements have undoubtedly made a significant contribution towards to the preservation of biodiversity across the region. The most important of these is the Convention on Biological Diversity, which was signed by the majority of nations attending the Earth Summit in 1992. These, and others, are discussed below.

1. Convention on Biological Diversity (CBD)

The Convention on Biological Diversity (CBD) calls for increased international cooperation in the fight to conserve biodiversity across the globe, and provides a framework for individual countries to develop national strategies and programmes to this effect. The convention encompasses all ecosystems, species and genetic resources, and addresses both traditional conservation efforts and the sustainable exploitation of resources for commercial and economic benefit (including the relatively new field of bio-technology). Given its comprehensive scope, the CBD has led to action at both the national and international level.

(a) National Action

Recognizing that the most effective action will generally take place at the national level, the CBD requires governments to develop and implement national strategies and programmes to conserve biodiversity, which would include efforts to: monitor biodiversity levels (thus ensuring that action is based on sound scientific knowledge); integrate biodiversity concerns into national decision-making; adopt economic and social measures that encourage conservation and sustainable natural resources use; and support efforts by local populations to adopt more sustainable practices. In response, as of March 1999, some 36 countries of the region had ratified the Convention (see Chapter 21, Table 21.5) and a total of 21 countries have now prepared, or are close to preparing, national strategies and action plans. Table 3.6a and b lists these countries, and broadly outlines the main components of their plans and strategies.

(b) International Action

At the international level, the CBD's main objective is to ensure that all benefits arising from the use of genetic resources are both fair and equitable. To achieve this, it seeks to promote cooperation to strengthen human resources and institutional capabilities worldwide, particularly in developing countries, through joint programmes for research and technology development, as well as exchange of information and expertise between participating countries. It also seeks to identify and provide funding to developing countries to achieve these aims, primarily by a financing mechanism currently being operated under GEF.

In order to promote international cooperation, the third Conference of the Parties (COP) of the CBD in November 1996, launched a major programme called the "Biotrade Initiative" (Box 3.7). The initiative consists of three complementary components:

- a country programme under which opportunities and constraints for the development of a sustainable bio-resource industry will be assessed in countries, and 'bio-partnership' will be facilitated.
- market research and policy analysis to include issues such as Intellectual Property Right (IPR), technology transfer, and benefit sharing mechanisms; and
- dissemination and exchange of country programmes' experiences through the establishment of Internet and communication services (Table 3.7).

The Biotrade country programme represents the most comprehensive part of the initiative. It analyses opportunities and constraints for the development of a sustainable bio-resource industry. To capture opportunities and solve identified problems, the country programmes develop proactive strategies, focusing on bio-business development, bio-partnerships, sustainable use, conservation, and benefit sharing incentives. The other two components are designed to systematically compile and analyse market data and policy issues. Information thus gathered will be disseminated through a web site, publications and briefings, which it is hoped will form the basis for a more transparent understanding of market dynamics and trends, market barriers, trade and investment flows, property right regimes, and bio-business development, as well as conservation,

Table 3.6a National Strategies for Conservation and Sustainable Use of Biodiversity in Asia and the Pacific

Strategy	National Strategy and Action Plan	Policy/ Legislation	Trust Fund	Conservation Programmes/ Plans	Human Resource Development	Community Participation	Public Education and Awareness	Incentive Measures	Protected Area System	Conservation and Access to Genetic Resources	Institutional Capacity Building and Skill Enhancement	Research	Survey and Monitoring	Land Use Planning	Database Establishment and Exchange of Information	Economic Valuation of Biodiversity Resources
Australia	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓			✓
Bhutan	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
PR China	✓	✓		✓	✓		✓		✓	✓	✓	✓	✓			✓
Fiji	1/	1/	✓	✓					✓							✓
Indonesia	✓	✓		✓	✓	✓	✓	✓	✓		✓					✓
Japan	✓	✓		✓	✓	✓	✓		✓	✓		✓	✓			✓
Rep. of Korea	✓	✓		✓	✓	✓	✓	2/	✓	✓	✓	✓	✓	✓		✓
Malaysia	✓	✓		✓	✓		✓		✓	✓	✓	✓	✓			✓
Maldives	✓	✓		✓					✓							✓
Marshall Islands	✓			✓		✓	✓						✓			✓
Mongolia	✓	✓	✓	✓	✓		✓		✓		✓		✓			✓
Nepal	✓	✓	✓	✓	✓	✓	✓		✓		✓					
New Zealand	1/	✓		✓	✓		✓		✓	✓	✓	✓	✓			
Philippines	✓	✓		✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	
Russian Federation	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓		✓	✓
Singapore	✓	✓	✓	✓	✓		✓		✓	✓	✓		✓			
Sri Lanka	✓	✓		✓		✓	✓		✓		✓	✓			✓	✓
Thailand	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	
Turkey	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Uzbekistan	✓			✓		✓	✓		✓							
Viet Nam	✓	✓		✓			✓		✓	✓		✓	✓		✓	

1/ In the process of formulating their national strategy

2/ Currently insufficient

Table 3.6b National Strategies for Conservation and Sustainable Use of Biodiversity in Asia and the Pacific

Strategy	Comments
Australia	• Incorporates measures for integrating conservation and sustainable use of biodiversity into sectoral strategies plans and programmes (Commonwealth of Australia 1998). • In-situ conservation is an important component of the Strategy. • Also established and maintained a wide range of measures and facilities for ex-situ conservation, through Commonwealth, States and Territory agencies as well as tertiary institutions and scientific organizations.
Bhutan	• Action Plan highlights alternative actions that can be taken to realize benefits from Bhutan's rich biodiversity (Government of Bhutan 1997). • Includes establishment and management of protected area system as well as development of management strategies for the buffer and enclave zones around and in protected areas. • Envisages both in-situ and ex-situ conservation of wild and domestic biodiversity resources. • Strategy includes supporting measures such as scientific research, surveys and monitoring, database establishment, land use planning, economic valuation of biodiversity resources, integrating of biodiversity in related sectorsû strategy and planning, etc.
PR China	• Action Plan has identified priority projects according to the urgency of conservation and their feasibility. • Country Study elaborates the strategic goal for national capacity building, human resources strengthening, conservation facility construction, development of science and technology, promotion of education and awareness, information management and international cooperation. • Other State Council departments have incorporated conservation concerns into their own departmental action plans.
Fiji	• Strategy and Action Plan is the cornerstone of the Sustainable Development Bill, which embodies together environmental protection and resource management as well as biodiversity conservation and national parks management (Department of Environment, Ministry of Local Government, Housing and Environment 1997). • Government has declared several areas as national parks, nature and forest reserves, and conservation and protected areas. • Present system is weak due to overlapping jurisdictions between the Departments of Environment, Fisheries and Forestry and the National Trust for Fiji.
Indonesia	• National Strategy provides guidance to all stakeholders, especially those involved in the management of biodiversity (Government of Indonesia 1997). • Action Plan sets out an action strategy for in-situ conservation in terrestrial parks and protected areas as well as outside the protected area network (i.e. in production forests, wetlands, agricultural areas, and coastal and marine environment) and also provides for ex-situ conservation. • Important component of the Strategy is prioritization of approaches which fulfil basic human needs and generate income for the poor.
Japan	• National Strategy describes the major legislation, and provides guidelines / administrative framework for conservation. • Major components of Strategy are purpose and objectives, basic directions for each sector, guidelines for cooperation between agencies, and its in-built monitoring and review process.
Rep. of Korea	• National Strategy identifies priority concerns, such as biodiversity survey, in-situ and ex-situ conservation, control of threatening activities, ecosystem rehabilitation, and follow-up monitoring (Government of Korea 1998). • Also covers measures for sustainable use of biodiversity resources in agriculture, fisheries, forestry, tourism and recreation, and genetic resources. • Advocates upgrading of capacity for biodiversity management through improved systems, incentives, strengthening education and research, raising awareness, exchange of information and technology
Malaysia	• National Policy developed to address biological diversity issues across various sectors of the economy (Ministry of Science, Technology and the Environment 1998). • 15 Strategies developed covering areas such as: improving scientific knowledge base; enhancing sustainable utilization of biodiversity; integrating conservation programmes into sectoral planning; enhancing staff skills, capabilities and competence; and, promoting institutional and public awareness.

Table 3.6b *(continued)*

Strategy	Comments
Maldives	• Environmental Protection and Preservation Act, a basis for a conservation strategy, is in place and marine protected areas and protected species have been declared (Ministry of Planning, Human Resources and the Environment 1997). • Two different governmental bodies deal with the issues of biodiversity: the Ministry of Environment and the Ministry of Fisheries and Agriculture. • Future conservation activities are planned in the 2nd National Environment Action Plan which includes development of a National Strategy, formulation of an Action Plan, drafting of First Report to the CDP, establishment of protected areas, conservation of coral reefs, and strengthening biodiversity awareness.
Marshall Islands	• In process of formulating, through participatory and analytical processes, a Strategy / Action Plan (Government of Marshall Islands 1997). • Focuses on assessment of the status and trends in biodiversity, and the collection and provision of a local information resource on biodiversity.
Mongolia	• Action Plan provides for the sustainable use of biological resources and their natural restoration (Ministry for Nature and the Environment / UNDP-GEF 1998). • Plan gives emphasis on institutional capacity building, policy development and planning, renewal and strengthening of legislation, survey, improved management of protected areas network, public education and awareness. • Large-scale investments to protect biological resources are also in place through the Mongolian Science and Technology Fund, Environmental Protection Fund, Endangered Species Fund and the Mongolian Environmental Trust Fund.
Nepal	• Conservation underpinned through establishment of protected areas in representative ecological zones, as well as adoption of policy and legal measures which focus on benefit sharing, and empowerment of the local communities (e.g. through community and leasehold forestry). • Environmental trust fund has been established • Preparing Action Plan, which will address cross-sectoral issues, refine priorities and develop investment proposal for implementing effective conservation programmes.
New Zealand	• National strategy not yet complete, but country has a range of institutional and legal arrangements in place to address biodiversity management issues (Government of New Zealand 1997).
Philippines	• Followed CBD guidelines in preparing national policies on bioprospecting, biosafety, biotechnology, marine conservation, indigenous knowledge, as well as their integration into sectoral plans and decision making (Protected Areas and Wildlife Bureau-Department of Natural Resources and Environment 1998). • Strategy / Action Plan formulated as blueprint for biodiversity conservation agenda.
Russian Federation	• GEF Biodiversity Conservation Programme launched in 1996 includes preparation of Strategy / Action Plan (State Committee of Russian Federation for Environmental Protection 1997). • Rapid expansion of the federal system of protected areas, creation of regional networks of protected areas and expansion of the network of organizations involved in ex-situ conservation of rare animal and plant species. • Enhanced role of Russian and international non-governmental ecological organizations in the conservation of biodiversity.
Singapore	• Green Plan describes the broad policy direction towards attaining a model green city (The National Parks Board and the Report Drafting Committee 1997). • Broad goals, objectives and approaches for biodiversity conservation have already been formulated, and several action programmes are also being implemented.
Sri Lanka	• Action Plan prepared through a participatory approach involving a large body of stakeholders, including state agencies, over 100 non-governmental organizations, local communities etc. (Government of Sri Lanka 1997). • Broad objectives include capacity building, developing programmes to enhance public awareness and encourage public participation in conservation. • One notable step taken by the government to fulfil its obligations to the CBD is the establishment of the National Experts Group on Biodiversity to advise / steer government policy on the subject.

Table 3.6b *(continued)*

Strategy	Comments
Thailand	• Strategy prepared through participatory approach (The Office of the Environmental Policy and Planning 1997). • Actions prioritized for: building institutional capacity; enhancing protected areas management; conserving species, population and ecosystems; monitoring and controlling activities which threaten biodiversity; and, promoting cooperation between international and national agencies / institutions.
Turkey	• Strategy / Action Plan outlines current status of biodiversity, with specific actions / recommendations (Government of Turkey 1997). • Strategy provides framework for action at all levels, and recognizes need for international cooperation.
Uzbekistan	• Strategy emphasizes three objectives: the conservation of biodiversity, the sustainable use of its components, and the fair and equitable sharing of benefits (Government of Uzbekistan 1997). • Includes plan for reorganization and expansion of protected areas system, enhancement of public awareness, education and participation in conservation. • Plan elaborates specific actions, and identifies responsible agencies and organizations, and timetable for implementation.
Viet Nam	• Action Plan for Viet Nam is being implemented through various activities with the objectives of conservation of terrestrial, marine and wetlands biodiversity as well as genetic resources. • Since the 1994 Law on Environment Protection, efforts towards public education and awareness building for biodiversity conservation have been intensified. • Several laws and statutes have been adopted to control over-exploitation of biological resources and the illegal trade in endangered species of wild fauna and flora.

sustainable use and benefit sharing. Guidance about the Biotrade Initiative is generally provided by an national advisory panel, which will bring together representatives of the private sector, local and indigenous communities, NGO's, academic institutes, governments and intergovernmental organizations.

Another major initiative under CBD is the ongoing negotiations concerning Biosafety protocol. These negotiations reflect the growing concerns about the potential risks posed by living modified organisms produced by modern biotechnology. Many countries with modern biotechnology industries do have domestic legislation, however, there are no binding international agreements addressing situations where living modified organisms cross national borders. The negotiations, therefore, focus on transboundary movements, and include consideration of informed agreement procedures that will enable governments to control imports and refuse those that are unwanted. Accidental releases of organisms are also being addressed in the protocol. A major concern is that many developing countries lack the technical, financial and institutional capacity to address biosafety. They need greater capacity for assessing and managing risks, establishing adequate information systems, and developing expert human resources in biotechnology.

Initiatives are also being promoted at subregional level in South Asia, Southeast Asia and South Pacific to assist countries in fulfilling the objectives of CBD as well as help conserve biodiversity. For example, with the assistance of European Union, ASEAN has established the ASEAN Regional Centre for Biodiversity Conservation (ARCBC) which serves as the main focal point for networking and institutional linkage among ASEAN Member Countries (AMCs) and between ASEAN and European Union (EU) partner organizations, to enhance the capacity of ASEAN in promoting biodiversity conservation (see Chapter 17). The EU provides the means for networking, applied research, training and technical assistance, whilst ASEAN provides office space, facilities and support personnel. The Department of Environment and Natural Resources (DENR) in the Philippines is the project's executing agency.

2. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

CITES, which regulates the import and export of endangered species of wild flora and fauna, has become a very effective instrument for countering the loss of biodiversity caused by international trade, although there is still work to be done in Asia and the Pacific to improve its implementation and enforcement. The treaty operates through the issuance and control of export and import permits for species that can withstand current rates of exploitation, but prohibits trade in those facing extinction (CITES 1999a).

Box 3.7 The Biotrade Initiative: A New Integrated Approach to Biodiversity Conservation

The BIOTRADE initiative was launched at the third Conference of the Parties (COP3) of the *Convention on Biological Diversity (CBD)*, Buenos Aires, November 1996, to stimulate investment and trade in biological resources as a means of furthering the three objectives of the CBD, i.e. to promote: (1) conservation of biodiversity; (2) the sustainable use of its components; and (3) a fair and equitable sharing of benefits arising out of the utilization of biological resources. The initiative's objectives will be pursued by enhancing the capability of developing countries for sustainable use of biodiversity to produce new value-added products and services for both international and domestic markets.

The initiative envisages to promote the profitable use of biodiversity by enhancing collaboration among different actors that are very often perceived a potential rivals, both in industrialized and developing countries, these include: the private sector, including both multinational corporations and local companies; governments; universities; financial institutions; and local and indigenous communities. If successfully implemented, cooperation could take place both at the local community and national levels. The core activity areas of the initiative cover Bioprospecting, harvest of non-timber forest products (NTFPs) and promotion of eco-tourism.

The Biotrade Initiative stresses a so-called 'rights and benefits' approach, arguing that both should be addressed at the same time. It advocates that merely concentrating on fighting for rights, and waiting for the proper definition of all rights of local and indigenous communities would mean the loss of many years in the struggle for biodiversity conservation. In the same line, the initiative pursues a 'protect and promote' strategy, encouraging instruments and mechanisms that could protect and promote intellectual property, traditional knowledge, and biodiversity, for national or local producers as well as local and Indigenous communities. As part of the Biotrade country programmes, the Spanish patent office provides technical assistance for developing countries in these legal issues. However, it remains to be seen if this assistance will be of use for issues that go beyond the drafting of patent legislation.

Though the Biotrade Initiative is still a new endeavour, it now constitutes a global network for the use of biological diversity to support social and economic improvements in developing countries. A number of projects are linking biodiversity conservation with remuneration for its sustainable use. However, the implementation of the initiative will be judged according to its ability to build entrepreneurial and institutional capacities to take advantage of the abundant genetic resources in the South; target multiple and profitable sectors and to handle the issues of access to genetic resources and traditional knowledge and the equitable sharing of benefits.

Sources: CBD Secretariat 1999 and Rojas, M. 1999

Table 3.7 Component of Biotrade Initiatives

Market Research & Policy Analysis	Biotrade Country Programmes	Web Services & Communication
• Market Research • Economic Analysis • Technology Transfer • Property Right Regimes • Benefit Sharing • Conservation • Incentives • Bio-industry Development	• Training & Capacity Building • Country Assessment • Identification & Development of Market opportunities • Biopartnerships	• Research Up-dates • Country Experiences • Discussion Forums • Country Level Websites

Source: Biotrade 1998

As of March 1999, 25 countries from Asia and the Pacific had ratified the Convention (see Chapter 21, Table 21.6). Under this agreement, each member country is responsible for the implementation of CITES within its own jurisdiction, including the appointment of at least one Management Authority, and one Scientific Authority. Several countries have already taken moves to effectively implement the treaty. For example: in India, the Ministry of Environment and Forest established the National Coordination Committee (NCC) in 1995 which has been promoting effective inter-departmental coordination for the control of illegal trade in wildlife and related products (CITES 1999c); in Hong Kong, China, the Agriculture and Fisheries Department (AFD) launched a public awareness campaign about trade in endangered species (CITES 1999d); and in Thailand, the Thai Management Authority, in cooperation with the CITES Secretariat, has developed an Orchid Identification Guide to combat the problem of trade in rare orchid specimens (CITES 1999e).

3. Convention on Wetlands

The Ramsar Convention is aimed at the protection and conservation of internationally significant wetlands (Ramsar Convention Bureau 1999). Signatories are required to adopt the Ramsar Convention Strategic Plan 1997-2002, and to thereafter work with Wetlands International, at both the national and regional level, to implement the Convention. The main challenge for Ramsar signatories is to maintain the ecological character of their listed sites and all their wetlands through conservation and wise use (Frazier 1999). As of March 1999, 18 countries in the region had ratified the Convention (see Chapter 21, Table 21.7).

At the national level, collaboration is achieved through a combination of: development of national wetland strategies and policies (which have already been developed for Indonesia, Malaysia and Russian Federation); training programmes; wetland surveys; public education and awareness building; and demonstration management of selected wetland sites (Moser 1999). At the regional level, collaboration is achieved through the implementation of multi-country projects and regional wetland inventories.

In 1996, an international non-binding framework, the Asia-Pacific Migratory Waterbird Conservation Strategy: 1996-2000, was endorsed by contracting parties to the Ramsar convention to promote the conservation of migratory waterbirds and their wetland habitat in the Asian and Pacific Region. One of the Strategy's priorities is the establishment of networks of sites of internationally important wetland habitats for three groups of waterbird species: shorebirds (sandpipers, plovers and related species); cranes; and anatidae (ducks, geese and swans). There is already an East Asian Australasian Shorebird Reserve Network, launched in 1996, under which an Action Plan for the Conservation of Migratory Shorebirds in Asia and the Pacific 1998-2000 guides the work until the end of 2000 (Watkins 1999). A Shorebird Working Group of Experts from Australia, People's Republic of China, Japan, the Philippines and the Russian Federation coordinates the Action Plan. In the South Pacific, a number of tangible achievements in the implementation of the Convention have been noted. Potential Ramsar sites have been documented in Solomon Islands and Vanuatu, and a second Ramsar site has been designated for Papua New Guinea. An inventory of freshwater fish has also been conducted, revealing that far greater species richness is present on certain islands than was thought only 10 years ago.

4. Convention on the Conservation of Migratory Species of Wild Animals (CMS)

The Convention on the Conservation of Migratory Species of Wild Animals (also known as the Bonn Convention) aims to conserve terrestrial, marine and avian migratory species throughout their route or range. It is one of a small number of inter-governmental treaties concerned with the conservation of migratory wildlife and their habitats on a global scale. Seven countries from Asia and the Pacific (Australia, India, Mongolia, Pakistan, Philippines, Sri Lanka and Uzbekistan) are parties to the convention, all of whom work together to conserve migratory species and their habitat by providing strict protection for the endangered migratory species (see Box 3.8); by concluding multilateral agreements for the conservation and management of migratory species; and, by undertaking cooperative research activities (CMS 1999a).

Amongst the multilateral agreements formed under CMS, the African-Eurasian Migratory Waterbird Agreement (AEWA) is the largest. Worldwide, it covers 172 species of birds that are ecologically dependent on wetlands for at least part of their annual cycle, including many species of pelicans, storks, flamingos, swans, geese, ducks and waders (CMS 1999b). Other important agreements under CMS that concerns parts of the Asia are the Memorandum of Understanding Concerning Conservation Measures for the Slender-billed Curlew (CMS 1999c), and the Memorandum of Understanding Concerning Conservation Measures for the Siberian Crane (CMS 1999d).

B. Conservation of Ecosystems, Species and Genes

1. Protected Areas System

At present, about 2.4 million square kilometres of the region's surface area is officially designated as protected, or about five per cent of the total area. In all, there are over 4 000 protected areas in the region, more than two-thirds of which are in Northeast and Southeast Asia (Figure 3.5); the majority of these are in Indonesia and People's Republic of China (Figure 3.6). In terms of areal extent, People's Republic of China (in particular, Hong Kong, China) and the eastern regions of the Russian Federation (e.g. Lake Baikal) contain almost half of the officially designated protected area in the region (Figures 3.7 and 3.8). As a rule of thumb, it has been recommended that country's should aim to designate at least 10 per cent of their territory as protected

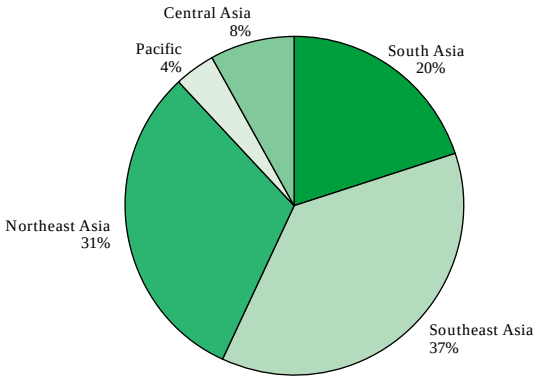
Box 3.8 Conservation of Migratory Species in Mongolia

Eastern Mongolia is home to vast herds of migratory Mongolian gazelles that were once widespread in Mongolia and neighbouring areas of Russian Federation and People's Republic of China, but are now limited largely to the Eastern Steppes of Mongolia due to habitat destruction and hunting in People's Republic of China and Russian Federation, and disruption of migration routes. There are estimated to be over two million gazelles, but migrating species always pose a formidable conservation challenge as they cannot be confined to protected areas and they readily cross international borders. The Mongolian gazelle has suffered a massive reduction in range and population size over the last few decades, and its continued survival is threatened if present trends continue.

In order to assist Mongolia with conservation of this globally important ecosystem supporting migratory species, the Global Environment Facility have provided funds through the United Nations Development Programme to implement a conservation project. Executed by the Ministry for Nature and the Environment and the United Nations Office of Project Services, the project, referred to as the Eastern Steppe Biodiversity Project, started in 1998 and is expected to run for 7 years. The project's vision is, in effect, of the whole Eastern Steppes being managed for economic development without depleting natural resources or adversely affecting ecological processes. It sees vast herds of Mongolian gazelle continuing to roam over the grasslands, and it sees their survival safeguarded by a well enforced system of protected areas and legislation, by economic incentives for sustainable harvests or tourism operations, and by effective land-use planning to reconcile the needs of economic development and infrastructure with the needs of the gazelles to follow their migration routes. It sees an integrated approach to rangeland management leading to the coexistence of traditional herding practices and wildlife, and it sees many local residents finding alternative livelihoods and small business opportunities. Most importantly it sees the participation of all stakeholders – the herders and other local citizens and government officials – as the key to successful management of the grasslands.

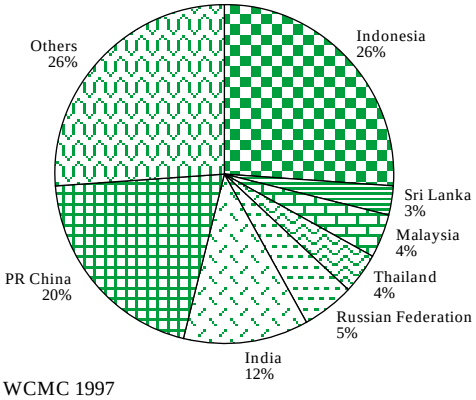
Source: UNDP 1999

Figure 3.5 Percentage Share in Number of Protected Areas by Subregions in Asia and the Pacific



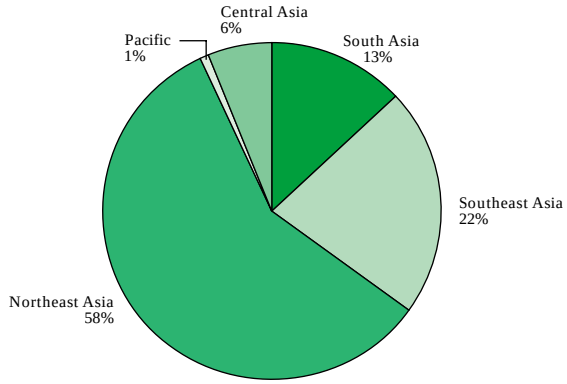
Source: WCMC 1997

Figure 3.6 Percentage Share in Number of Protected Areas by Countries in Asia and the Pacific



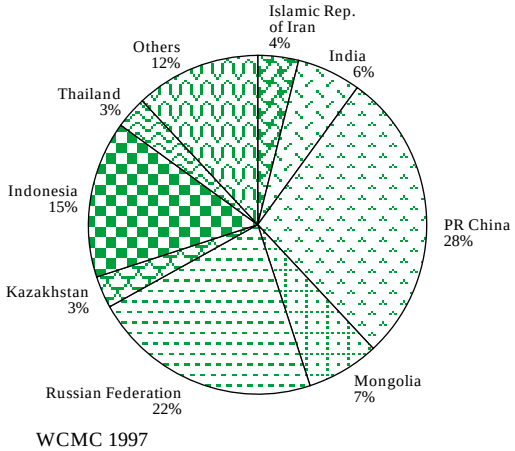
Source: WCMC 1997

Figure 3.7 Percentage Share in Areal Extent of Protected Areas by Subregion



Source: WCMC 1997

Figure 3.8 Percentage Share in Areal Extent of Protected Areas by Countries in Asia and the Pacific



Source: WCMC 1997

(McNeely and Miller 1984; ADB and IUCN 1995). Few countries of the region have been able to reach this benchmark (Figure 3.8). However, it should be emphasized that percentage share of protected areas is only a very crude statistic of the effectiveness of ecosystem coverage in any one country, and one which does not reflect the relative diversity of the areas protected.

No doubt considerable achievements have been made in the region through designation and management of protected areas. However, there are some serious shortcomings with current efforts. For example, protected areas do not always target sites of high biological diversity (Tuxill 1999). Moreover, many protected areas, which are officially decreed as such on paper, are simply not protected in practice, due to reasons such as under-funding and/or understaffing of natural resource agencies. The lack of commitment by governments to implement protected area legislation is another shortcoming (Tuxill and Bright 1998), as a result of which, officially designated reserves are often subjected to agricultural development, mining, extensive poaching, and other forms of degradation. An example is the Narayan Sarovar Sanctuary in India, which is home to a rich assembly of wildlife, including wolves, desert cats, and the largest known population of Indian gazelle. In 1995, this reserve system was turned over to mining companies eager to harvest the coal, bauxite, and limestone deposits found in the area. Problems also arise when strictly defined borders conflict with the cultural and economic interests of local communities. An example is the current conflict between the Government of the Philippines and inhabitants in and around Mt. Kitanglad National Park, a biodiversity rich area in the southern part of the country. The Government's plans for the area have been strongly opposed by mountain farmers, who object to being forced to switch from traditional monocropping practices (e.g. potatoes) into agro-forestry, which is perceived as less profitable.

(a) Botanical Gardens and Zoological Parks

Botanical gardens and zoological parks play an important role in both *in situ* and *ex situ* conservation of biological diversity. Since botanical gardens and zoological parks store myriads of plant and animal accessions, these represent a vast conservation resource of stored and managed biodiversity. In addition, botanical gardens have also played a crucial role in the development, designation, care and management of conservation areas through activities such as: habitat restoration; wild plant population research, recovery or management; individual species recovery programmes; development and maintenance of databanks; identification and development of economically important species in commercial horticulture, forestry and agriculture and bioprospecting, etc.

Five countries-Australia, People's Republic of China, India, Japan and the Russian Federation-house the majority of botanical gardens in the region. A recent initiative to link botanical gardens within a coordinated global network is the founding of Botanic Gardens Conservation International (BGCI), whereby member-countries are working towards the implementation of a worldwide Botanic Gardens Conservation Strategy and Action Plan for plant conservation (BGCI no date), providing technical guidance, data and supporting for botanical gardens, and helping create or strengthen national and regional networks of gardens in many countries, including Australia, People's Republic of China, India and Indonesia.

(b) Gene Banks

The conventional solution to the conservation of plant germplasm has been the establishment of genebanks, which serve as storehouses for germplasm collections, including seed banks, field genebanks, and tissue collections in culture (Jackson 1999). In Asia and the Pacific, they are commonly integrated with botanical gardens and have been an important source of material for plant breeding programmes and other research activities, thereby forming a basic element in biodiversity conservation programmes in the region (Tripp and van der Heide 1996).

Maintaining botanical gardens and gene banks, however, is costly, time-consuming and labour-intensive (Tuxill 1999). For example, the current estimated total annual cost of maintaining samples in gene banks is US$50 per accession. Many countries in the region do not have the facilities and are hard-pressed for operating funds; therefore, they cannot maintain samples of a number of species under optimal physical conditions.

C. Bioregional Management

Policymakers and environmental managers in several countries of the region have begun to adopt an integrated, "total ecosystem" strategy for regulating activities which adversely affect biodiversity (WRI 1999). Such an approach, whether on land or at sea, can be used to balance conservation needs with the economic and social demands of the people living within or close to the habitats which are being protected. Integrated coastal zone management programmes provide a good example of the concept of bioregional management.

By far the largest application of bioregional management within the region is the Regional Seas Programme initiated by UNEP, an action-oriented

strategy focusing on the mitigation or elimination of both the causes and consequences of environmental degradation (UNEP 1999b). It has a comprehensive, integrated, and results-oriented approach towards combating environmental problems through rational management and development of marine and coastal areas. Each subregion is required to formulate their own action plans (see Chapter 5) to promote the parallel development of intra-regional legal agreements.

Another significant example of bioregional management is the International Coral Reef Initiative (ICRI), created to protect coral reefs and the associated ecosystems such as sea grass beds and mangroves. ICRI currently involves Australia, Japan, and the Philippines (UNEP 1999c) and seeks to implement those components of Agenda 21 which call on states to take a special care of marine ecosystems exhibiting high levels of biodiversity and productivity.

Establishment of transboundary-protected areas is also taking place in many parts of the region in order to promote bioregional management. For example, the Mekong River Commission has been tasked to coordinate activities related to the use and development of water and associated resources of the Lower Mekong Basin (United Nations 1995), and the concept of transboundary conservation within the Hindu-Kush Himalayan area is being facilitated by international organizations such as ICIMOD and WWF (Shengji 1998). Another good example of a transboundary reserve is the Turtle Islands group, a well-defined rookery of green turtles shared by nine islands, of which six are within Philippine territory (United Nations 1995). Within this group, the Philippines, Malaysia and Indonesia are all cooperating with one another in conducting scientific and sociological studies to promote turtle conservation. For example, the Philippine-Sabah Turtle Islands and Berau, Indonesia support the only major green sea turtle breeding populations in the world. These countries also collaborate in tagging and monitoring activities, hatcheries operations, and monitoring of traffic of turtle eggs between islands. Finally, in the Brunei Darussalam / Indonesia / Malaysia / Philippines East Asian Growth Area (BIMP-EAGA) subregion, the Working Group on Environmental Management are also implementing various projects with the involvement of the private sector (UNEP 1999a).

Several inter-governmental regional agreements such as the SACEP in South Asia, ASEAN in Southeast Asia and SPREP in the South Pacific also deal with aspects of biodiversity conservation. For example, SACEP's Strategy and Programme includes regional cooperation in wildlife conservation and genetic resources and conservation of corals, mangroves, deltas, and coastal areas (see also Chapter 16). In addition, ASEAN established a regional framework for the promotion of conservation and sustainable use of heritage areas and endangered species (see Chapter 17). In the South Pacific biodiversity-related projects are included (Chapter 18) under the South Pacific Biodiversity Conservation Programme (SPBCP).

CONCLUSION

Asia and the Pacific is extremely rich in biodiversity, and possesses an immense variety of ecological habitats and climatic conditions. Seven out of seventeen mega diversity countries of the world are located in the region, which not only have a wealth of biodiversity, but are also noted for their high rates of species endemism. The region's biodiversity, however, has been under serious threat as a result of habitat loss, over-exploitation of resources, and the introduction of exotic species. A range of economic and social pressures on the environment exacerbates these problems.

According to the IUCN (1998) Red List, more than 10 000 higher plant species and over 3 000 vertebrate animal species in Asia and the Pacific are threatened. As natural habitats rapidly shrink, over a thousand birds, about a thousand mammals, and several hundred reptiles and fish species are at risk. Genetic diversity is also diminishing, particularly in relation to domesticated crops and livestock. In the short-term, this means that existing genetic resources are less able to adapt to conditions of stress, for example, in relation to pathogens or pests, drought or temperature extreme. In the long-term, it means the loss of well-adapted genetic varieties.

In an effort to preserve biodiversity in the region, policies and programmes have been promoted at the national level, and coordination of these programmes has been promoted at the regional and international level. Many countries in the region have prepared national strategies and action plans in response to international conventions such as the Convention on Biological Diversity. These strategies and plans emphasize actions in areas such as: the enhancement of institutional capacity; improved management systems for *in situ* and *ex situ* conservation; sustainable utilization of biodiversity by mainstreaming within other sectoral strategies; enhancing public awareness; research, surveys, and monitoring; partnerships with stakeholders, including increasing community participation in the management of biodiversity; and the promotion of national and international cooperation. All these components, if properly implemented, could have significant bearing on the region's biodiversity.

However, inadequate human and financial resources, particularly in the developing countries of the region, are hampering implementation of these strategies and action plans.

Protected area systems in the region are still limited in extent, as they constitute only five per cent of the total area, against an IUCN guideline of 10 per cent. Moreover, many important habitats are either un-represented or under-represented in the present system of protected areas. The coverage of wetlands and marine ecosystems, for example, is still extremely limited. Clearly, there remains considerable scope for expanding the network further, through conservation and restoration of natural areas or traditionally maintained land and/or seascapes. Another deficiency includes a preponderance of small and fragmented areas, which jeopardizes their integrity and long-term viability.

In terms of genetic resources, the concept of intellectual property rights and the lack of a clear, multilateral system for these rights distract stakeholders in countries of the region from the task of conservation of these resources. Governments in Asia and the Pacific should support (and legislate for) the right of subsistence farmers to save and adopt the seeds they plant, which is arguably the most important mechanism for sustaining agro-biodiversity. It is important to build institutional capacity in this regard, and to promote measures such as bioprospecting that could contribute both to conservation of biodiversity and enhancement of resources for conservation. Research, training and information to help expand the capacity for conservation of genes, species and ecosystems also remains vital.

Biotechnology and genetic engineering also appear to have significant potential for generating income amongst the region's poor, however, these are new fields, and much remains to be found out about the potential environmental and health risks from the interaction of genetically engineered or modified organisms with natural ecosystems, and strong regulatory and legal frameworks need to be introduced to protect against these impacts.

Finally, there is a need to provide appropriate incentives to individuals, institutions and industries that depend directly on biodiversity for their well-being; to invest in strategies that will help conserve ecosystems whilst promoting and sustaining developing country economies. There is a simultaneous need to involve these various stakeholders in policy and decision-making through multi-stakeholder programmes, environmental steering committees, public consultations and public awareness programmes.