Chapter 3
Biodiversity in Crisis and Our Daily Lives
—Life on the Earth That Runs on to the Future—

Section 1 Accelerating Loss of Biodiversity

According to the United Nations Millennium Ecosystem Assessment, the present rate of extinction of living organisms has reached 100 to 1,000 times higher than the rate of extinction in the past, and most indicators that show the status of ecosystem services (benefits people can obtain from ecosystems) are exhibiting a deteriorating trend. This section addresses the impact of biodiversity loss on our daily lives (decreases in products from agriculture, forestry and fisheries industries) and economic loss from declining ecosystem services, and then underscores the need to halt biodiversity loss and enhance biodiversity.

Column What Is Biodiversity?

"Biodiversity," to put it plainly, is the state of "many living organisms existing by adapting to a variety of environments on the earth, from the abyssal ocean to uplands." This phrase contains the following three aspects. The existence of diverse types of ecosystems, such as forests, rivers, wetland, tidal flats, coral reefs and oceans, is described as "ecosystem biodiversity," while the existence of diverse kinds of living organisms in these ecosystems is called "species diversity" and the existence of various genetic variations in the same species, such as differences in body size, pattern or resistance to disease is termed "genetic diversity."

Let us explore these three aspects more deeply.

Ecosystem diversity means that there exist a variety of environments due to a variety of circulations on the earth. For example, there is the circulation of water in which precipitation that seeps into the ground evaporates through plants and forms clouds to cause rain. In the circulation of material, organic material that goes through consumers by the food chain ultimately returns to inorganic material by decomposers and producers again turn inorganic material into organic material. In the atmospheric circulation, carbon dioxide emitted in association with activities of living organisms on the earth, including human activities, is absorbed by forests that produce oxygen. These diverse circulations, for example, help form small units of specific ponds and forests, which combine to form larger units of basins, and several basins consist of units of archipelagoes and continents, which together constitute the earth, thus establishing various ecosystems on the earth in seamless manners. There exists no identical ecosystem on the earth. This is ecosystem diversity.

Species diversity indicates that there exists about 30 million species of various living organisms, including unknown ones, after living organisms have evolved to adapt to various environments on the earth. When kinds of living organisms are diverse, interactions between them are also diverse. There emerge a variety of direct and indirect interactions, from eating, being eaten, parasitizing other living organisms and providing habitats to competing for resources and decomposing dead living organisms. Looking at relationships of eating and being eaten, for example, while there is a manner of utilization in which some species feed on anything that is fit to eat, there is also the relationship based on strong mutual links where a certain insect eats only leaves of a certain plant. The diversity of species is thus based on the existence of various physical environments created by ecosystems, natural selection of species caused by a variety of interactions such relationships between living organisms and physical environments and relationships between living organisms, and genetic differences caused by evolution.

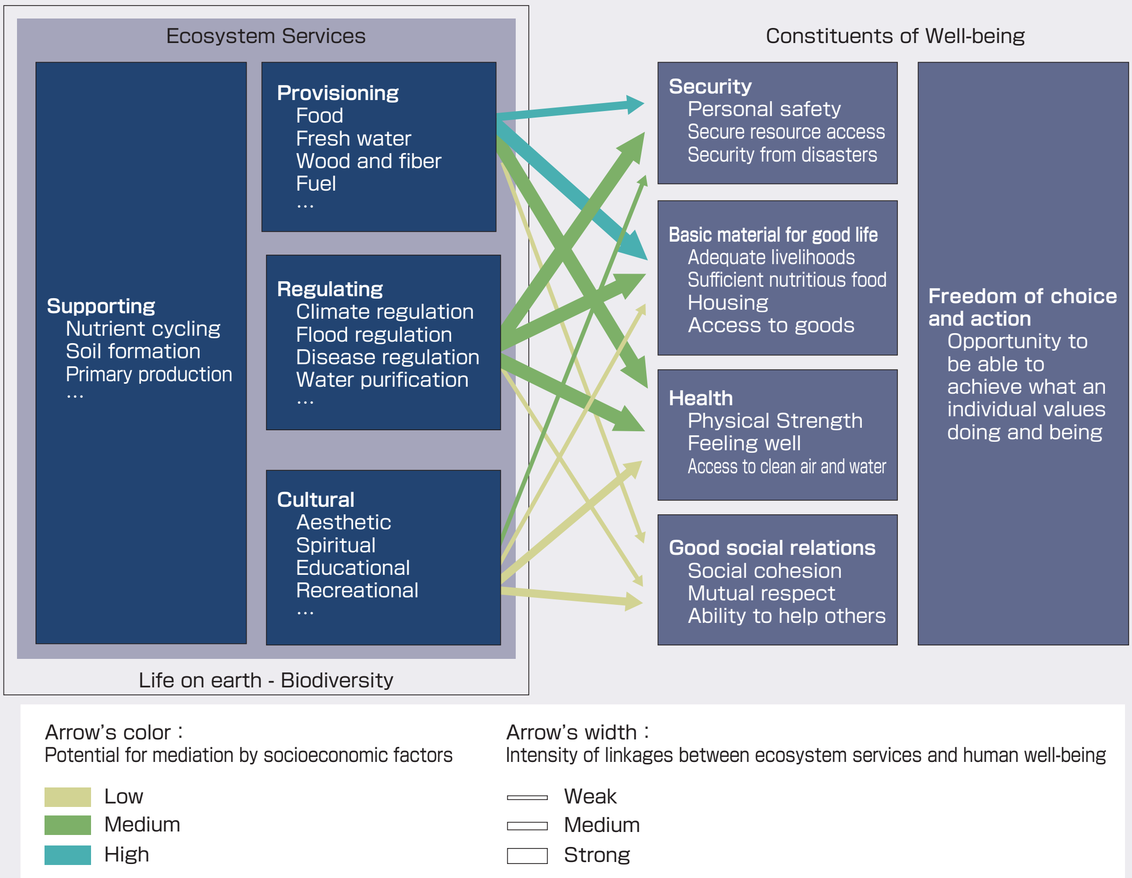
The significance of genetic diversity needs to be considered by keeping in mind that living organisms are the beings that try to survive, by maintaining life as individual organisms or by leaving next generations through procreation. A variety of living organisms we are currently seeing have been created through a long process of evolution. When there are genetic differences among individual living organisms and those differences influence their survival and procreation, which is exactly where evolution starts. Properties that make the survival easier, if only little, are carried forward to next generations. What properties make the survival easier depend on environments surrounding living organisms. Different properties evolve under different environments. In other words, genetic diversity (difference) that exists between living organisms (individuals) is the source of evolution. Biodiversity we have now can be described as the direct result of genetic diversity.

Then, what benefits are we, humans, getting from biodiversity? We find a variety of benefits of the diversity of ecosystems in that forests generate oxygen through photosynthesis and develop water sources, that rivers bring bountiful soil, that tidal flats purity contaminated water and that coral reefs provide many fish species with places of spawning, growth and feeding, bringing the richness of fish and shellfish. Humans have evolved and built civilization under these environments. Humans benefitted from species diversity as they found ones they could utilize from among various living organisms and created methods to produce grains, vegetables, livestock and other foods in large quantities that made it easier to secure food. Furthermore, genetic diversity, which supports the "existence of biodiversity" as a whole, must be recognized as indispensible for all living organisms on the earth, including humans.

Let us look at the benefits we humans are receiving from ecosystems in more specific terms. Ecosystems have inherent mechanisms to reproduce animals and plants, and humans obtain food, water, lumber, fuels and other things necessary for subsistence thanks to these mechanisms. Ecosystems also have the regulating function to stabilize the habitat environments for living organisms, such as easing of climate change and flooding, water purification, and control of diseases and destructive insects. Moreover, ecological elements are deeply related to our mentality and cultures. Examples include our sense of awe for nature, appreciation of sceneries as recreation, observation of animals and plants, and use of natural things as objects of paintings and haiku. These various benefits of ecosystems humans are receiving are called "ecosystem services" as a whole.

Where do we see the degradation of biodiversity and ecosystem services it underpins? In the first place, most of what we eat and drink comes from living organisms such as plants and animals, with the only exceptions of water and salt. We may directly make use of living organisms in nature or we may clear off living organisms in nature to grow grains and raise livestock useful for humans. Not a few living organisms have lost their habitats because of environmental contamination by humans. In tandem with the population growth and changing lifestyles, their burdens on the environment have kept increasing and grown too heavy. For example, the area of forests on the earth has been halved by human activities from the level prior to the spread of the impact of human

Linkages between Ecosystem Services and Human Well-being



Source: Millennium Ecosystem Assessment

activities, and the ratio of fish stocks being excessively utilized has kept growing. Thus, it is evident that human activities are burdening nature. This is clear from the results of analysis of changes in ecosystem services made in the third edition of the Global Biodiversity Outlook, published by the Secretariat of the Convention on Biological Diversity. Global trends concerning food show that while ecosystem services for grains, livestock and aquaculture are increasing, ecosystem services for fish catches and wild foods are decreasing (Figure 1-5-2). What we should not forget is that biodiversity and ecosystem services it underpins have been formed by a long history of evolution over approximately four billion years and they are not something humans can produce like manufactured products made at industrial plants, and thus cannot be restored to the original state easily once they are lost.

What can we do in order to maintain biodiversity and ecosystem services in good conditions and carry them over to future generations? Human activities are very significant in that they affect the environment, and we need to respond as society as a whole that depends on ecosystem services. For example, in manufacturing and construction industries dependent on biological resources, we need to switch processes of selection, processing and disposal of raw materials to sustainable ones that pay heed to biodiversity and manage ecosystem services as common assets of mankind through adequate payments for ecosystem services by various entities, including citizens. We should also do proactively what we can as individuals. People in the past lived with due heed to whether they could harvest crops or catch fish in the coming year. In the modern age when most people are not engaged in production activities, we rarely find ourselves in such scenes of directly paying heed to such things. However, we still must be able to feel that we are living with life bestowed upon us each day, set great store by and not waste food, and even in urban areas, notice the verdure and autumnal leaves of street trees, dandelions and the blossoming of cherry trees, and seasonal changes in the chirping of birds and insects. It is important to have these senses in everyday life and act on the basis of consciousness about “mottainai” wastefulness and a sense of gratitude for the blessing of life. We should be able to live nicely on the earth if we, as society as a whole and as individuals, pay due heed to biodiversity and proceed with efforts to maintain ecosystem services.

1 Fast-disappearing biodiversity on the earth

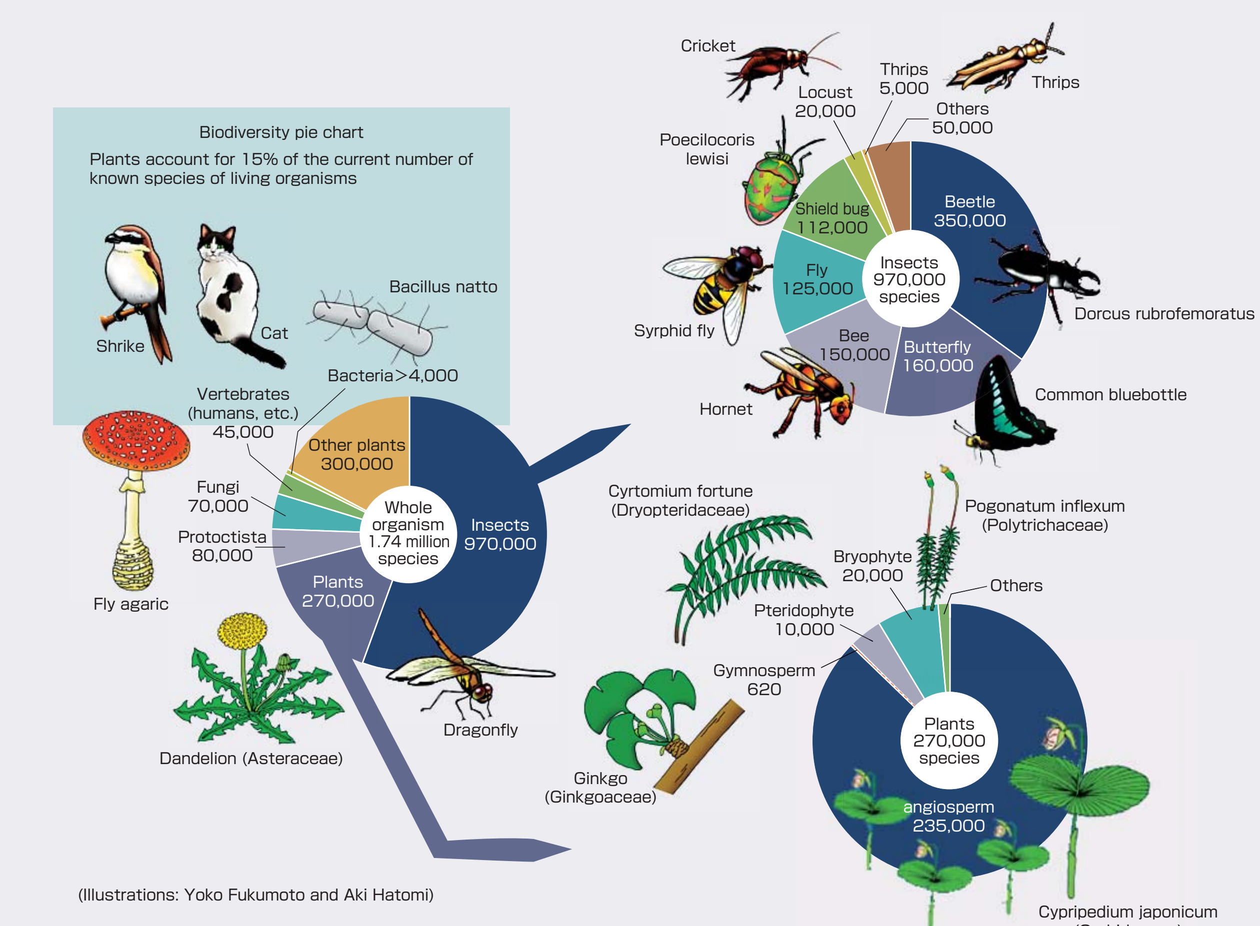
“Species” is the most fundamental unit in understanding biodiversity. Living organisms on the earth have adapted to a variety of environments in the history of evolution over approximately four billion years. As a result of this evolution, there are now multitudes of living organisms, estimated to amount to 30 million species, including unknown ones. Of them, the number of species we know of is about 1.75 million, only a fraction of the total (Figure 3-1-1). Since the birth of life, ecosystems on the earth that surround us are established on the basis of the long history of activities by living organisms on the earth. It is easy to imagine that it would require mind-boggling long years to restore ecosystems once they are lost. We know that biodiversity is essential for our subsistence given that oxygen that is essential for the subsistence of living organisms is generated by plants, agricultural products such as grains, vegetables and fruits are refined versions of wild plants and produced only because of the existence of biodiversity, and genetic biodiversity that can adapt to various environmental changes is necessary for species of living organisms to survive by avoiding extinctions caused by climate change or the spread of diseases.

Mass extinctions of living organisms are believed to have occurred five times on the earth in the past. These extinctions of species under natural conditions took several ten thousands to several hundred thousands of years to happen, averaging about 0.001 species a year. The problem is that current extinctions of living organisms being caused by human activities at an incommensurable speed compared with those in the past. Since 1975, about 40,000 species are said to be becoming extinct each year. Humans are indeed capable of extinguishing other living organisms before we know it (Figure 3-1-2).

According to the Red List of the International Union for Conservation of Nature (IUCN) announced in November 2009, out of a total of 47,662 species assessed, 17,285 species are listed as threatened, an increase of 363 species over the 2009 list (Figure 3-1-3). The biggest driver pushing these species towards extinction is the destruction of habitats, but the main drivers are varied, including hunting and picking, invasion by invasive alien species, and contamination of water and soil. IUCN found that of species assessed, 21% (5,490 species) of mammals, 30% (6,285 species) of amphibians, 12% (9,998 species) of birds, 28% (1,677 species) of reptiles, 32% (4,443 species) of fish, 70% (12,151 species) of plants and 35% (7,615 species) of invertebrates are at risk of extinction. This means that we are rapidly losing useful assets in the form of unknown genes of living organisms.

Overexploitation and poaching of living organisms have an impact on biodiversity, and we have the Washington Convention (the official name: the Convention on International Trade in Endangered Species of Wild Fauna and Flora) as an international agreement concerning trade in rare plants and animals. The Washington Convention is designed to protect certain

Figure3-1-1 The Number and Ratio of Known Species of Animals and Plants



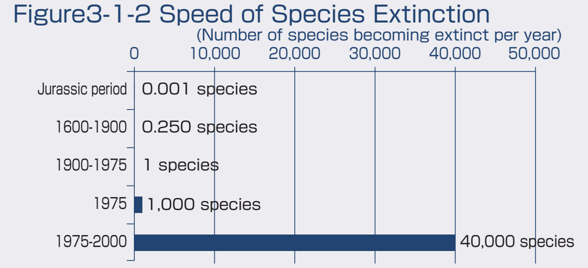
Source: Website of Tsukuba Botanical Garden, National Museum of Nature and Science

species of wild fauna and flora against overexploitation through international trade. The convention took effect in 1975, and Japan acceded to it in 1980. The number of parties to the convention increased from 18 in 1975 to 175 in February 2010 (Figure 3-1-4).

Degradation of biodiversity has become actually observable at various locations around the world. While nine subspecies of wild tigers are known, including Bengal tiger and Amur tiger, three subspecies have already become extinct (Photo 3-1-1). According to an investigation by the World Wide Fund for Nature (WWF), the population of tigers is estimated to have dwindled from 100,000 to about 3,400 to 5,100 in a period of 100 years to the 21st century. Main reasons behind the decline include poaching for beautiful furs and materials for Chinese medicine and habitat loss due to development of agricultural land.

In Japan, remarkable examples of biodiversity degradation include the decrease in coral cover degree in Okinawa, the changing dynamics of benthic fish and shellfish in Tokyo Bay, and the decrease in alpine plants due to feeding damage from deer in Oze. Coral reefs are exposed to a variety of stresses, including rising sea temperatures, a sharp increase in acanthasters, and the inflow of red soil and nutrient salt. An analysis of field surveys and aerial photos show that areas with high coral cover of 50% or over decreased to just about 18% in 2003 compared with the 1980 level (Figure 3-1-5).

Figure3-1-2 Speed of Species Extinction

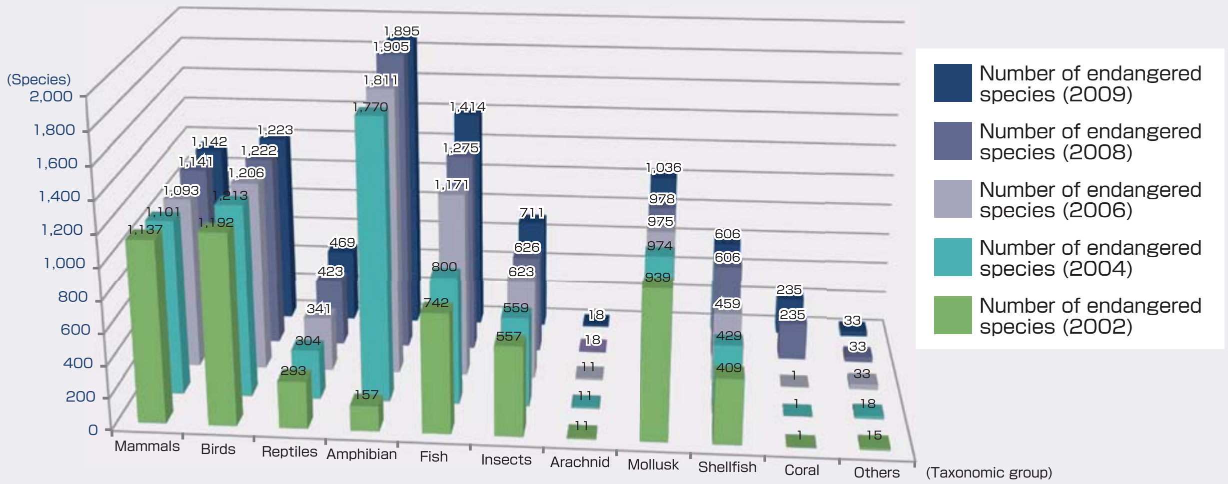


Source: Prepared by Ministry of the Environment based on Norman Myers, "The Sinking Ark: A New Look at the Problem of Disappearing Species" (1981)

In Tokyo Bay, the long-term monitoring of 20 fixed points in the inner bay area has been going on with the same method for over 30 years (from 1977 to present), resulting in the accumulation of valuable knowledge from a global viewpoint. The survey covers the population, weight and the number of species of benthic fish and shellfish communities as a whole in coastal sea areas heavily susceptible to human activities. The survey results show that both the population and weight tended to increase from the 1970s through the latter half of the 1980s due to water quality improvement in Tokyo Bay, the population and weight decreased sharply from the late 1980s to the 1990s. In the 2000s, while the population stayed at a low level, only the weight of fish species increased, with commonly observed species like squillas, marbled flounders and pennant coralfish declining and large-size fish species growing, bringing about changes in biota (Figure 3-1-6). Causes of these developments are unknown, but some changes in the propagation environment, such as the emergence of hypoxic water masses and the shrinkage of shallow sea areas, have been assumed, and resources are unlikely to recover unless these problems are solved.

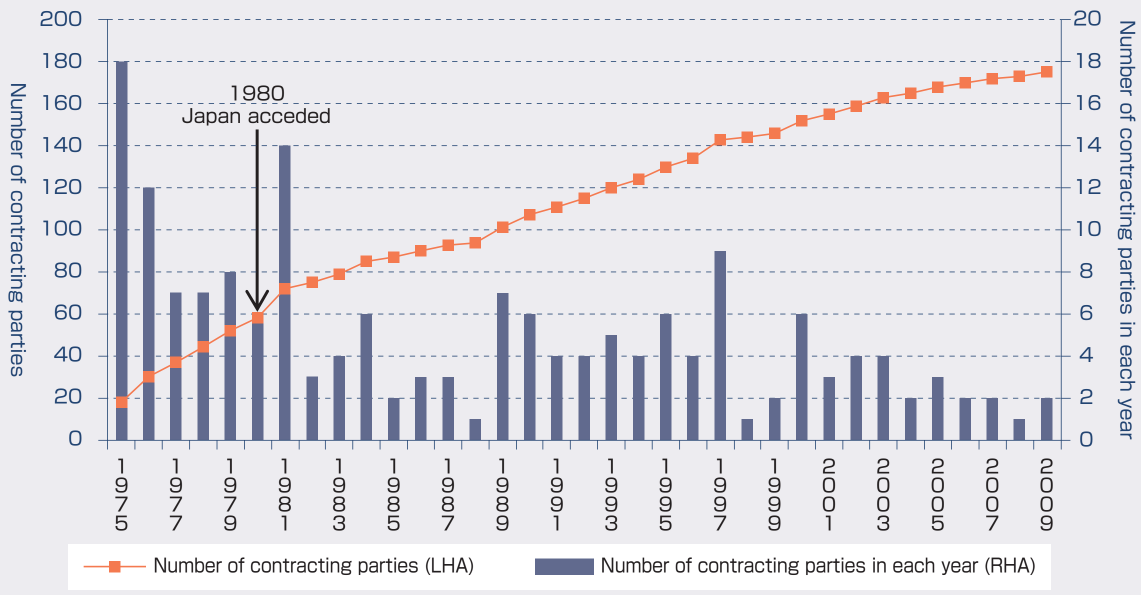
In Oze National Park that came into being in 2007, since the inhabitation of Sika deer was confirmed in the mid-1990s, vegetation in wetlands has been disrupted by feeding damage. The population survey estimates that 305 Sika deer will have been living in the park in 2020, 3.4 times the population 10 years ago, which may give an irreparable impact on the ecosystem that has never been influenced by Sika deer before. Aside from the possibility that the ecosystem in the national park that has been established over a long period of history may be destroyed, it is also feared likely that the landscape and the cultural value as the object of academic investigations might be damaged or the deteriorating landscape could lead to a decline in the number of visitors to the national park to cause an economic loss to the local community.

Figure3-1-3 Number of Threatened Animal Species in the World by Taxonomic Group



Source: Prepared by Ministry of the Environment based on the Red List of the International Union for Conservation of Nature (IUCN)

Figure3-1-4 Changes in the Number of Contracting Parties to the Washington Convention

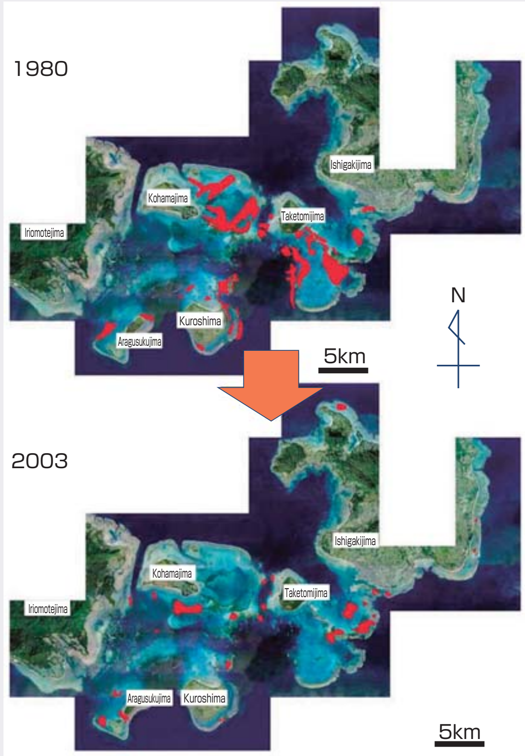


Source: Prepared by Ministry of the Environment based on the website of the Secretariat of the Washington Convention

Photo3-1-1 Bengal Tiger

Source: Hollingsworth, John and Karen/U.S. Fish and Wildlife Service (FWS)

Figure3-1-5 Changes in Coral Cover Degree in Sekisei Lagoon



Source: Ministry of the Environment

2　Linkages between biodiversity loss and our daily life

The U.N. Millennium Ecosystem Assessment carried out between 2001 and 2005 points out that large and irreversible change in biodiversity due to human activities has occurred in the past 50 years. It also points out that the degradation of ecosystem services would grow significantly worse during the first half of the 21st century and the risk of accelerating and irreversible changes could grow, concluding that coupled with the exacerbation of poverty, these problems, unless addressed, will substantially diminish the benefits that future generations obtain from ecosystems.

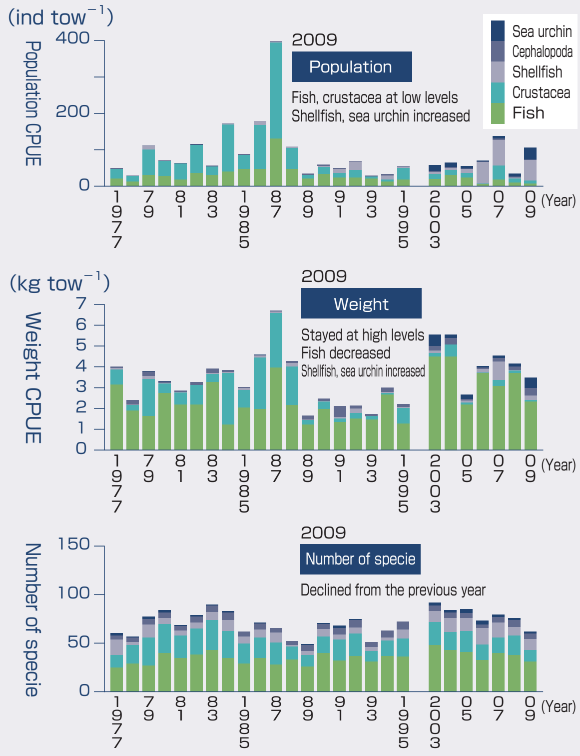
The main drivers for the degradation of biodiversity include the decrease in forests and overexploitation of biological resources and the burden on biodiversity from either of them is known to be continuing or even growing. The area of forests in the world stood at 4,077.28 million hectares in 1990, but decreased by 8.90 million hectares (0.22%) per year in 1990-2000 and by 7.30 million hectares (0.18%) per year in 2000-2005. While the rate of decrease slowed, the decrease was the net change after deducting the increase from forest planting, vegetation restoration and natural expansion of forests. The continuation of the loss of forest area amounting to as large as about 7.30 million hectares per year presents a major problem (Figures 3-1-7 3-1-8). It is apparent that the decrease in forest area is showing no sign of halting particularly in Africa and Latin America.

On the other hand, global demand for timber is projected to grow at an annual rate of just over 1% in coming years (Figure 3-1-9). While any sharp tightening of timber supply and demand is seen unlikely in the long term in view of the expanding area of highly productive planted forests, it is necessary to continue with efforts for sustainable forest management.

Fisheries production, meanwhile, increased over six times in the 50 years between 1950 and 2000, a rate of increase far greater than the population growth of about 2.4 times during the same period, with the rising proportion of overexploitation (Figures 3-1-10, 3-1-11).

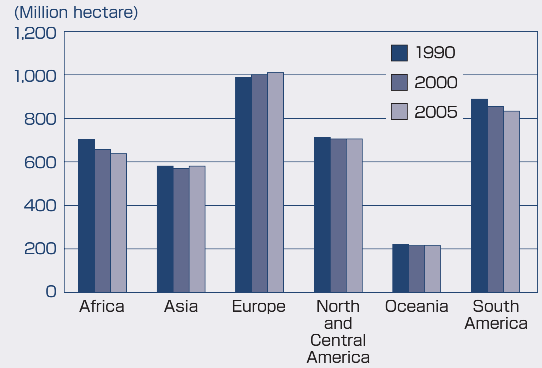
As fish and shellfish resources necessary in the future are estimated to keep growing, unless the exploitation of these resources is held within the scope of resource recovery, our everyday life will likely be affected sooner or later (Table 3-1-1). The Western and Central Pacific Fisheries Commission (WCPFC) in December 2009 decided not to increase the number of vessels and days of operation for fishing bluefin tuna in the Western and Central Pacific from the 2002-2004 level, beginning in 2010. In November 2009, a decision was also taken to reduce caches of bluefin tuna in the Atlantic Ocean. These decisions mark the start of medium- and long-term efforts to conserve resources.

Figure3-1-6 Secular Change in Fish Catches (Population and Weight) and Number of Fish Species in Tokyo Bay



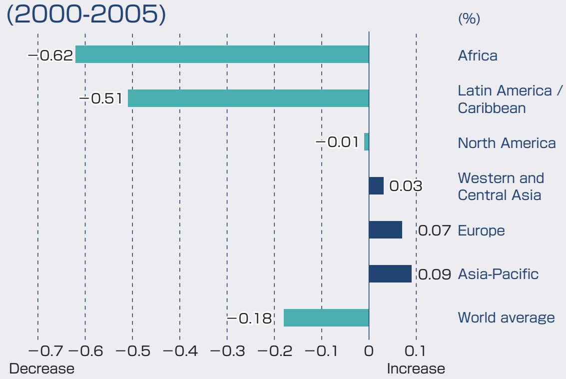
Source: Laboratory of Fisheries Biology, Department of Aquatic Bioscience, Graduate School of Agricultural and Life Sciences, University of Tokyo; National Institute for Environmental Studies

Figure3-1-7 Trends in forest area by region 1990-2005



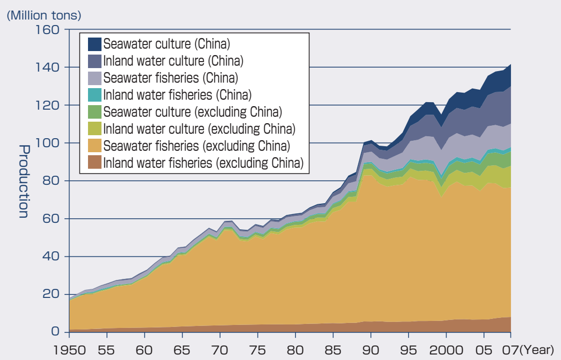
Source: Prepared by Ministry of the Environment based on FAO, "Global Forest Resources Assessment 2005"

Figure3-1-8 Net Annual Change in Forest Area (2000-2005)



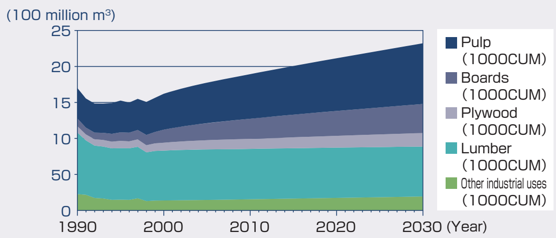
Source: Prepared by Ministry of the Environment based on FAO, "Global Forest Resources Assessment 2005"

Figure3-1-10 Changes in Global Fisheries Production



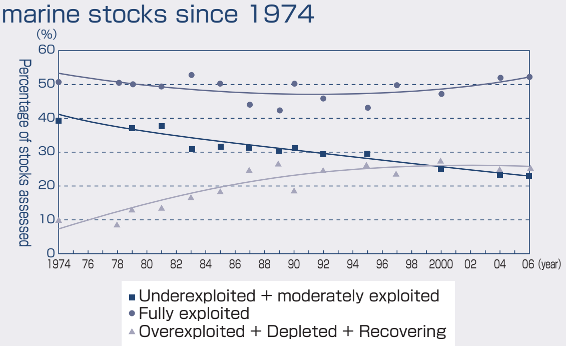
Note: Excludes marine plants, marine mammals and miscellaneous fishery products
Source: Prepared by Ministry of the Environment based on FAOSTAT database

Figure3-1-9 Actual and Projected Industrial Roundwood Demand (World Total) by Use



Note 1: Estimates based on actual demand for 1961-1999
2: Model-based calculated figures for 2000 onward
Source: Forestry and Forest Products Research Institute, Selection of Study Results in FY 2006 (2007)

Figure3-1-11 Global trends in the state of world marine stocks since 1974



Source: FAO, "The State of World Fisheries and Aquaculture 2006"

Table3-1-1 Projected Future Demand for Fishery Products

	Per-capita fish and shellfish consumption for food per year	World total demand A	World total production B	Demand - production A - B
1999/2001	16.1kg	133 million tons	129 million tons	- 4 million tons
2015	19.1kg	183 million tons	172 million tons	- 11 million tons

Note: World total demand and world total production include nonfood fish and shellfish.
Source: Materials provided by the Fisheries Agency

3 Economic losses from the degradation of ecosystem services

Efforts have been made to capture the economic value of ecosystem services in order to objectively capture the impact of biodiversity loss on our livelihood. There are various types of ecosystem services. It is difficult to make an economic valuation of some of them because of the characteristics of their services. Table 3-1-2 shows some examples of the estimation of the economic value of ecosystem services made to the extent that they can be converted into monetary value.

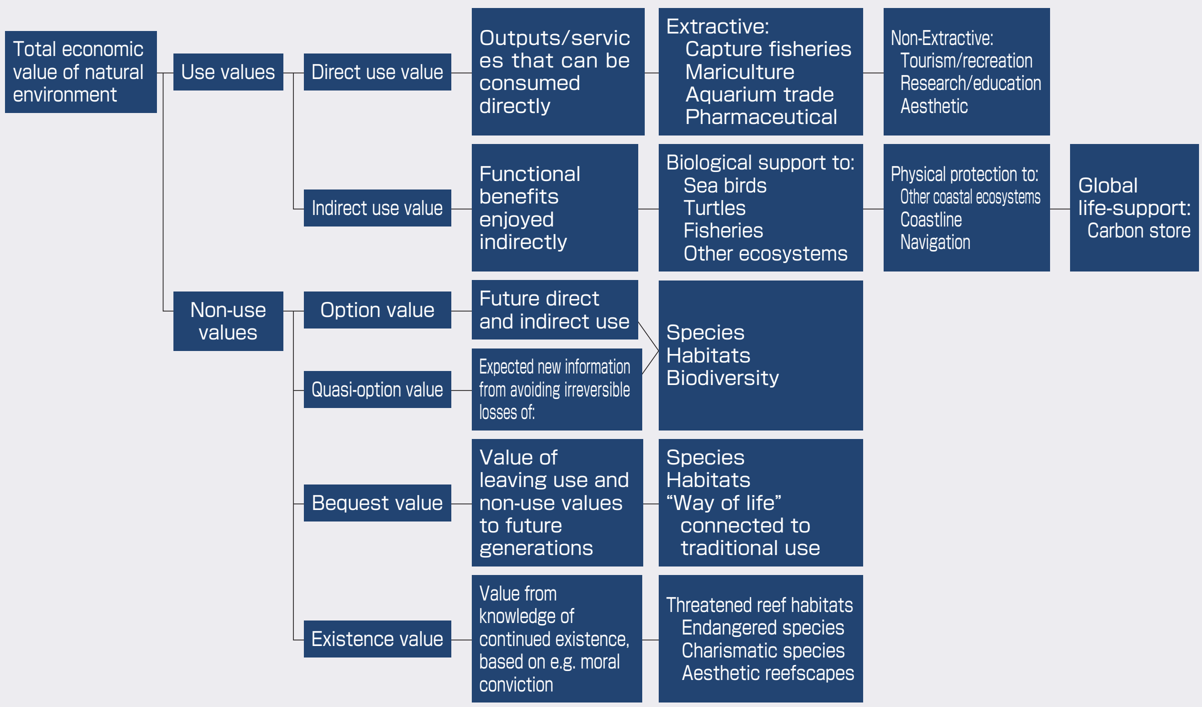
While active efforts are under way to capture the economic value of natural environment, there is no single identical natural environment subject to the economic valuation of ecosystem services. Since it is very difficult to evaluate ecosystem services by the use of a single yardstick, like pricing of carbon dioxide emissions in global warming countermeasures, full heed needs to be given to this in considering the economic valuation of ecosystem services.

One conceivable way of evaluating the economic value of natural environment is, given the diverse values of natural environment, to divide the economic value into use value and non-use value and subdivide them further into smaller categories. One example is the classification shown in Figure 3-1-12. But the evaluation needs to be

Table3-1-2 Examples of Monetary Value Assessed for Ecosystem Services

Item	Monetary value of ecosystem services	Estimator
Global ecosystem services	About $33 trillion per year	Dr. Robert Costanza, University of Maryland, U.S., 1997, Nature (U.K. science magazine)
Function of pollinating insects	About ¥24 trillion per year	French National Institute for Agricultural Research (INRA), 2008, Ecological Economics (U.S. science magazine)
Rain forests	An annual average of about ¥540,000 per ha, about ¥982 trillion globally	International Union for the Conservation of Nature and Natural Resources (IUCN), 2009
Degradation of forest ecosystem	An economic loss amounting to about ¥220-500 trillion expected by 2050	The Economics of Ecosystems and Biodiversity (TEEB), An Interim Report, 2008
Mangrove forest	Protection and planting of mangroves in Vietnam cost $1.1 million, but save annual expenditures on dike maintenance of $7.3 million	The Economics of Ecosystems and Biodiversity (TEEB), D1 (For Policy Makers), 2009
Conservation of global protected areas	Costs about $45 billion annually, but the functions of nature (absorption of carbon dioxide, preservation of drinking water, flood prevention, etc.) are worth $5 trillion per year	The Economics of Ecosystems and Biodiversity (TEEB), D1 (For Policy Makers), 2009

Figure3-1-2 Total Economic Value of Natural Environment and Attributes of Economic Values to Coral Reefs



Source: Barton (1994)

made by keeping in mind that respective subdivided values contain the following two valuation axes:

(i) Natural science-based valuation: Investigate and show the state of nature and to what problems nature is exposed.

(ii) Social science-based valuation: Show the significance to humans and what values are offered to humans.

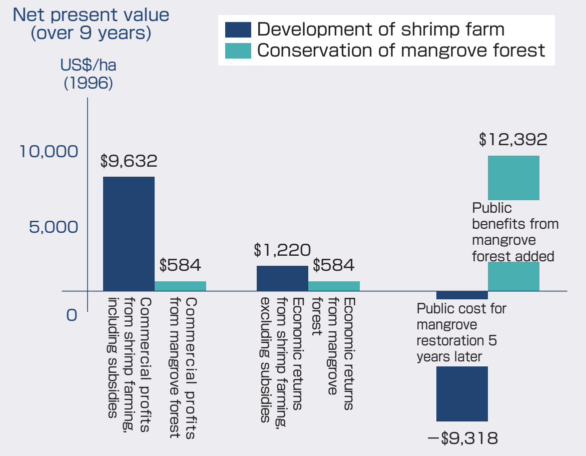
As methods to evaluate the value of natural environment by substituting it with things that already have market values, there are the output evaluation method, prevention expenditure method, damage cost method and alternative method, etc. However, the evaluation cannot be made unless there are substitutable market goods. The value that cannot be converted into monetary value has to be evaluated qualitatively. For example, as the landscape and the function of preserving ecosystems do not have substitutable market goods, they cannot be evaluated using the above-mentioned methods.

According to "The Economics of Ecosystems and Biodiversity (TEEB), D1 (For Policy Makers)" , in a local development project, as commercial profits are often given priority and ecosystem services are underestimated, the act of development tends to be judged commercially feasible. When government subsidies are excluded and post-development restoration costs are taken into account, however, ecosystem services turn out to be larger than expected benefits from not undertaking the development project exceed benefits from development. For example, in a project to develop a shrimp farm by cutting down mangroves, the project most likely is assessed only from the aspect of economic gains to be obtained by a developer. When the economic effects of the shrimp farm and benefits from mangroves are compared, the former is judged considerably larger (the left-hand graphs in Figure 3-1-13). However, the shrimp farm development project is funded by government subsidies, and when this support factor is excluded, the economic effects of the development is reduced to about one-eighth (the middle graphs in Figure 3-1-13). Further, in addition to the profits to be gained by the developer, when the benefits of the development and mangrove conservation are compared, including public costs necessary to restore the functions of mangrove forests on the site of the shrimp farm five years later and public benefits from preserving mangrove forests, the benefits of conservation prove to be larger than the benefits of development (the right-hand graphs of Figure 3-1-13).

Meanwhile, efforts to economically evaluate ecosystem services are under way in Japan as well. For example, around Kabukurinuma (wetlands designated under the Ramsar Convention, in Osaki, Miyagi Prefecture), known as one of the largest destinations of anatine birds in Japan, the economic value of ecosystem services (maintaining the number of anatine birds coming to the wetlands at the current 70,000) protected by environmentally-sound farming around the wetlands has been analyzed. The analysis was made using the conjoint method, under which a survey is carried out by presenting multiple environment conservation measures to potential respondents and asking them to rank their desirability to evaluate the economic value. A nationwide questionnaire survey for a six-day period via the Internet drew a total of 3,257 responses (the response rate at 21.6%). The survey results put the willingness to pay at an average ¥1,007 per household per year, which is estimated to total ¥53.2 billion when extended to the total number of households of 52.88 million in Japan (as of March 2009) (based on "Policy Research on Environmental Economics," Associate Professor Managi and Professor Kuriyama).

As seen above, by translating the economic value of ecosystem services into monetary value, it becomes possible to compare the economic value of development and the economic value maintained through conservation as well as the costs involved in both.

Figure3-1-13 Relationship between Benefits from Shrimp Farm Development and Public Benefits of Mangrove Forest



Source: The Economics of Ecosystems and Biodiversity

Column　World of Mutualism between Corals and Crabs

A variety of living organisms, including crabs, shrimps, univalve shells and small fish, use the space between coral branches as their habitats. Based on research on the relationship between Pocillopora damicornis and Trapezia cymodoce, we introduce the mutualism (the relationship of harmonious coexistence that brings mutual benefits) between them in this column.

Trapezia cymodoce feeds on mucus made by corals. This is the advantage of living with corals. Corals, on the other hand, are protected by Trapezia cymodoce from acanthasters, their natural enemy. Scenes of Trapezia cymodoce beating off acanthasters that approached to eat corals by cutting off their ambulacral feet and grabbing and cutting their needles are observed. All of more than 10 types of Trapezia cymodoce confirmed to live in coral reefs in Okinawa behave like this.

On the other hand, what remains less well understood is cases where congeneric multiple species of Trapezia cymodoce live in the same coral colony, which is contrary to the principle that "species with the similar mode of life do not live in the same habitat." One tentative theory under study is: "The coexistence relationship between corals and Trapezia cymodoce is related to the existence of acanthasters. When acanthasters are around, many species of Trapezia cymodoce gather to protect corals. If acanthasters are not around, Trapezia cymodoce do not have to exert efforts to beat off acanthasters, so species of Trapezia cymodoce start fighting among them and only strong species survive. Then, individuals in the surviving species start fighting and a pair of a large-size male and female occupy the coral colony."

If the above phenomenon is unraveled, clues to the protection of corals from acanthasters may be obtained. Besides this example, there are a lot of unknowns about the mechanism of ecosystems. Destroying biodiversity that brings immeasurable benefits to us without elucidating these unknowns would be a great loss to all living organisms on the earth, including humans.

Multiple species of Trapezia cymodoce confirmed to live in the same coral colony

Photo: Professor Makoto Tsuchiya, Faculty of Science, University of the Ryukyus

Section 2　Biodiversity and Global Warming

According to the IPCC Fourth Assessment Report, the risk of species extinction is projected to increase with increase in global average temperature. Droughts and wildfire associated with climate change are also threatening food production and ecosystems, while the degradation on biodiversity such as decreasing forest area is accelerating global warming. Therefore, it is necessary to implement measures to conserve biodiversity and measures against global warming by linking them.

1　Impact of global warming on biodiversity

The IPCC Fourth Assessment Report states that annual average Arctic sea ice extent has shrunk by 2.7 [2.1 to 3.3] % per decade, with larger decreases in summer of 7.4 [5.0 to 9.8] % per decade (Numbers in square brackets indicate a 90% uncertainty interval around a best estimate). The U.S. Fish and Wildlife Service (FWS) estimates that sea ice changes as projected, two-thirds of the global population of polar bears will be lost by around the mid-21st century. The IPCC Fourth Assessment Report states that increases in sea surface temperature of about 1 to 3℃ are projected to result in more frequent coral bleaching events and