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ECONOMIC VALUE ON BIODIVERSITY

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The diversity of life forms, popularly known as **biological diversity** or **biodiversity** is the greatest wonder of this planet, and it is so numerous that we have yet to identify most of them. Biodiversity is out there in nature, everywhere we look, an enormous assemblage species, diverse in form and function, with beauty and usefulness beyond our wildest imagination. But first we have to identify these plants and animals and describe them before we can hope to understand what each of them means in our own survival. There are indigenous peoples in some parts of the world who have an appreciation for biological diversity that puts our famous conservation theorists to shame.

Biological diversity must be treated more seriously as a global resource, to be measured, preserved, and then used for our benefits. Three circumstances give this matter an unprecedented urgency.

1. First, exploding human populations are degrading the environment at an accelerating rate, especially in tropical countries.
2. Second, science is discovering new uses for biological diversity in ways that can relieve both human suffering and environmental destruction.
3. Third, much of the diversity is being irreversibly lost through extinction caused by the destruction of natural habitats, again especially in the tropics.

Overall, we have engaged ourselves in a race. We must hurry to acquire the knowledge on which a wise policy has to be developed for conservation and development biodiversity in near future.

HUMAN DEPENDENCE ON BIOLOGICAL DIVERSITY

In the 1980s, the question seems to be, "What has biological diversity done for us?" The good news is that the answer to that question is, "Plenty, and more than we realize." Our lives are full of examples of the logic of preserving the plants and animals that we depend upon as a species.

Deep Ecology

The basic tenet of deep ecology is ethical, that all living things have a right to exist—that human beings have no right to bring other creatures to extinction or to play God by deciding which species serve us and should therefore be allowed to live. Deep

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ecology rejects the anthropocentric view that humankind lies at the center of all that is worthwhile and that other creatures are valuable only as long as they serve us. Deep ecology says, instead, that all living things have an inherent value—animals, plants, bacteria, viruses—and that animals are no more important than plants and that mammals are no more valuable than insects. Deep ecology is similar to many eastern religions, like Buddhism, which hold that all living things are sacred. When human activities drive one of our fellow species to extinction, it is a betrayal of our obligation to protect all life on the only planet we have.

In the developing world, as well as in our overdeveloped world, we are obligated to present economic, utilitarian arguments to preserve the biological diversity that ultimately benefits us all. Deep ecology makes interesting conversation over the seminar table, but it won't work in front of the poor people of Third World, where elephant herds consume and destroy acres of ripe paddy fields, where flocks of parakeets feed on maize, where foxes or hyenas stole pet chickens.

Ethical considerations about biological diversity may become an important reason for species conservation in some day. But at present, if we want to save our planet's biological diversity, we have to speak about utility, economics of biodiversity, and its role in well-being of individual human beings.

Consumptive use value

The direct utilization of timber, food, fuel wood, fodder by local communities. The biodiversity held in the ecosystem provide forest dwellers with all their daily needs, food, building material, fodder, medicines and a variety of other products. They know the qualities and different uses of wood from different species of trees, and collect a large number of local fruits, roots and plant material that they use as food, construction material or medicines. Fisher folk are highly dependent on fish and know where and how to catch fish and other edible aquatic animals and plants.

Productive use value

The biotechnologist uses bio-rich areas to 'prospect' and search for potential genetic properties in plants or animals that can be used to develop better varieties of crops that are used in farming and plantation programs or to develop better livestock. To the pharmacist, biological diversity is the raw material from which new drugs can be identified from plant or animal products. To industrialists, biodiversity is a rich store-house from which to develop new profitable products. For the agricultural scientist the biodiversity in the wild crop plants are the sources for developing better and productive crops. Genetic diversity enables scientists and farmers to develop better crops and domestic animals through careful breeding. Originally this was done by selecting or pollinating crops artificially to get a more productive or disease resistant strain. Today this is increasingly being done by genetic engineering, selecting genes from one plant and introducing them into another. New crop varieties (cultivars) are being developed using the genetic material found in wild relatives of crop plants through biotechnology. Even today, species of plants and animals are being constantly discovered in the wild. Thus these wild species are the building blocks for the betterment of human life and their loss is a great economic loss to mankind.

Among the known species, only a tiny fraction has been investigated for their value in terms of food, or their medicinal or industrial potential. Preservation of biodiversity has now become essential for industrial growth and economic development. A variety of industries such as pharmaceuticals are highly dependent on identifying compounds of great economic value from the wide variety of wild species of plants located in undisturbed natural forests. This is called biological prospecting.

Social value

While traditional societies which had a small population and required less resources had preserved their biodiversity as a life supporting resource, modern man has rapidly depleted it even to the extent of leading to the irrecoverable loss due to extinction of several species. Thus apart from the local use or sale of products of biodiversity there is the social aspect in which more and more resources are used by affluent societies. The biodiversity has to a great extent been preserved by traditional societies that valued it as a resource and appreciated that its depletion would be a great loss to their society. The consumptive and productive value of biodiversity is closely linked to social concerns in traditional communities. So-called 'ecosystem people' value biodiversity as a part of their livelihood as well as through cultural and religious sentiments. A great variety of crops have been cultivated in traditional agricultural systems and this permitted a wide range of produce to be grown and marketed throughout the year and acted as an insurance against the failure of one crop. In recent years farmers have begun to receive economic incentives to grow cash crops for national or international markets, rather than to supply local needs. This has resulted in local food shortages, unemployment (cash crops are usually mechanized), landlessness and increased vulnerability to drought and floods.

Aesthetic value

Knowledge and an appreciation of the presence of biodiversity for its own sake is another reason to preserve it. Quite apart from killing wildlife for food, it is important as a tourist attraction. Biodiversity is a beautiful and wonderful aspect of nature. Sit in a forest and listen to the birds. Watch a spider weaves its complex web or a weaver bird builds its palace-like nest. Observe a fish feeding. It is magnificent and fascinating.

Option value

Keeping future possibilities open for their use is called option value. It is impossible to predict which of existing species or traditional varieties of crops and domestic animals will be of great use in the future. To continue to improve cultivation and domestic livestock, we need to return to wild relatives of crop plants and animals. Thus the preservation of biodiversity must also include traditionally used strains already in existence in crops and domestic animals.

One of the important factors in providing biodiversity with the benefit of the doubt that it deserves to educate ourselves and our governments' policy makers about our dependence, as human beings, on biological diversity. That education tends to emphasize the utilitarian value of species protection. One of the results is that there is a growing, pragmatic ethic among scientists and conservationists. It is an ethic that centers on the realization that our ability to preserve biological diversity depends on our ability to demonstrate the benefits that diversity brings to human beings. On one level, these benefits take the form of immediate economic income through activities like wildlife harvesting, tourism, and maintaining agricultural production. On another level, they focus on unfulfilled potential—new crops, new medicines, new industrial products. Taken together, the benefits of biological diversity provide short-term income to individual people and improve the long-term well-being of our species as a whole.

These two levels of benefits work together in the sense that if we hope to see the long-term benefits of biological diversity, we have to focus first - or least simultaneously - on the immediate, short-term benefits to individual people. Few of the wild gene pools – the raw materials for future medicines, food, and fuels – are likely to survive intact in places where people have to struggle simply to provide their basic, daily needs.

One of our long-term goals as a species is to enjoy the uncounted benefits that our planet's biological diversity can eventually bring us. But in the short term, at a minimum for the next few decades, our basic strategy must concentrate on ensuring that people here and on the frontiers of the developing world receive material incentives that will allow them to prosper by protecting biological diversity rather than by destroying it. When that is done, we can return to the ethical and aesthetic arguments of deep ecology.

Many of the initial international wildlife conservation efforts focused on attractive species of endangered mammals—the so-called charismatic megafauna. Although a number of these programs have proven to be extremely successful, the modus operandi was clearly not entirely applicable to the conservation of all organisms: “Save the Grasses” is just not as stunning slogan as “Save the Tiger”. We cannot save the pandas, however, unless we save the bamboos on which they feed. Furthermore, human existence is much more dependent on the plant kingdom than on animals. Plants are indeed the roots of life.

THE AMOUNT OF BIOLOGICAL DIVERSITY

Many recently published sources indicate that about 1.8 million living species of all kinds of organisms have been described Approximately 750,000 are insects, 41,000 are vertebrates, and 250,000 are plants (vascular plants and bryophytes). The remainder consists of a complex array of invertebrates, fungi, algae, and microorganisms. Most systematists agree that this picture is still very incomplete except in a few well-studied groups such as the vertebrates and flowering plants. If insects, the most species-rich of all major groups, are included, the absolute number is likely to exceed 5 million. We do not know the true number of species on Earth, even to the nearest order of magnitude. A well forwarded guess, based on the described fauna and flora and many discussions with entomologists and other specialists, is that the absolute number falls somewhere between 5 and 30 million.

HOW FAST IS DIVERSITY DECLINING?

When a forest is reduced from, say, 100 square kilometers to 10 square kilometers by clearing, some immediate extinction is likely. However, the new equilibrium will not be reached all at once. Some species will hang on for a while in dangerously reduced populations. Elementary mathematical models of the process predict that the number of species in the 10-square-kilometer plot will decline at a steadily decelerating rate, i.e., they will decay exponentially to the lower level.

Studies by researchers led to the estimation of the decay constants for the bird faunas on naturally occurring islands. These inlands were previously been connected to South America, New Guinea, and the main islands of Indonesia. It is found that the smaller the island, the higher the estimated decay constant and hence extinction rate. The actual number known to have vanished as a probable result of insularization is 12% of the 108 breeding species originally present. Several other studies of recently created islands of both tropical and temperate-zone woodland have produced similar results, which can be crudely summarized as the extinction rate is highest in the smaller patches.

What do these first measurements tell us about the rate at which diversity is being reduced? No precise estimate can be made for three reasons. First, the number of species of organisms is not known, even to the nearest order of magnitude. Second, because even in a simple island-biogeographic system, diversity reduction depends on the size of the island fragments and their distance from each other—factors that vary enormously from one country to the next. Third, the ranges of even the known species have not been worked out in most cases, so that we cannot say which ones will be eliminated when the tropical forests are partially cleared.

However, scenarios of reduction can be constructed to give at least first approximations if certain courses of action are followed. Let us suppose, for example, that half the species in tropical forests are very localized in distribution, so that the rate at which species are being eliminated immediately is approximately this fraction multiplied by the rate-percentage of the forests being destroyed. Let us conservatively estimate that 5 million species of organisms are confined to the tropical rain forests, a figure well justified by the recent upward adjustment of insect diversity alone. The annual rate of reduction would then be 0.5×5× 106×0.007 species, or 17,500 species per year. Given 10 million species in the fauna and flora of all the habitats of the world, the loss is roughly one out of every thousand species per year. How does this compare with extinction rates prior to human intervention? The estimates of extinction rates in Paleozoic and Mesozoic marine faunas cited ranged according to taxonomic group (e.g., echinoderms versus cephalopods) from one out of every million to one out of every 10 million per year. Let us assume that on the order of 10 million species existed then, in view of the evidence that diversity has not fluctuated through most of the Phanerozoic time by a factor of more than three. It follows that both the per-species rate and absolute loss in number of species due to the current destruction of rain forests would be about 1,000 to 10,000 times that before human intervention.

WHY BIOLOGICAL DIVERSITY IS IN TROUBLE?

Discussions of the crisis of biodiversity often focus on the overexploitation by human beings. Thus black rhinos are disappearing from Africa, because their horns are in demand for the manufacture of ceremonial daggers for Middle Eastern puberty rites; elephants are threatened by the great economic value of ivory; spotted cats are at risk because their hides are in demand by furriers; and whales are rare because, among other things, they can be converted into pet food.

Concern about such direct endangerment is valid and has been politically important, because public sympathy on some selective species seems more easily aroused. The time has come, however, to focus public attention on a number of more obscure and unpleasant truths, such as the following:

• The primary cause of the decay of biological diversity is not direct human exploitation, but the habitat destruction that inevitably results from the expansion of human populations and human activities.

• Many of the less cuddly, less spectacular organisms that *Homo sapiens* is wiping out are more important to the human future than are most of the publicized endangered species. People need plants and insects more we need than tiger and rhino; we care least for them.

• The most important anthropocentric reason for preserving biological diversity is the role that microorganisms, plants, and animals play in providing free ecosystem services, without which society in its present form could not persist. We are not aware of the fact.

• The loss of genetically distinct populations within species is as important a problem as the loss of entire species. We have very limited knowledge about the distinct populations ithin species.

• Once a species is reduced to a remnant, its ability to benefit humanity ordinarily declines greatly, and its total extinction in the relatively near future becomes much more likely. By the time an organism is recognized as endangered, it is often too late to save it.

• Arresting the loss of diversity will be extremely difficult. The traditional "just set aside a preserve" approach is almost certain to be inadequate because of factors such as runaway human population growth, acid rains, and climate change induced by human beings. A quasi-religious transformation leading to the appreciation of diversity for its own sake, apart from the obvious direct benefits to humanity, may be required to save other organisms and ourselves.

THE VALUATION OF BIODIVERSITY – ECONOMISTS' VIEW

Analysis of the value of preserving biodiversity requires the attention of many disciplines. As resource economists, it is one of our direct obligations to measure, explain, and predict how individuals and institutions manage natural resource systems, value biological diversity, and make decisions affecting its preservation. Environmental economists are interested in markets not because they want to use market prices to multiply something but because they are interested in measuring the preferences of individuals and ascertaining their trade-offs between environmental resources and money or conventional market commodities

Both direct and indirect techniques for eliciting or inferring the preferences of individuals have been greatly refined in recent years. An attempt to summarize them is given in following texts –

Economic valuation offers a way to compare the diverse benefits and costs associated with ecosystems and biodiversity by attempting to measure them and expressing them in a common denominator—typically a monetary unit.

Total economic value

Economists typically classify ecosystem goods and services according to how they are used. The main framework used is the Total Economic Value (TEV) approach. The breakdown and terminology vary slightly from analyst to analyst, but generally include (i) direct use value; (ii) indirect use value; (iii) option value; and (iv) non-use value. The first three are generally referred to together as 'use value'.

Direct use values refer to ecosystem goods and services that are used directly by human beings. They include the value of *consumptive uses* such as harvesting of food products, timber for fuel or construction, and medicinal products and hunting of animals for consumption; and the value of *non-consumptive uses* such as the enjoyment of recreational and cultural activities that do not require harvesting of products. Direct use values are most often enjoyed by people visiting or residing in the ecosystem itself.

Indirect use values are derived from ecosystem services that provide benefits outside the ecosystem itself. Examples include natural water filtration which often benefits people far downstream, the storm protection function of mangrove forests which benefits costal properties and infrastructure, and carbon sequestration which benefits the entire global community by abating climate change.

Option values are derived from preserving the option to use in the future ecosystem goods and services that may not be used at present, either by oneself (*option value*) or by others/heirs (*bequest value*). Provisioning, regulating, and cultural services may all form part of option value to the extent that they are not used now but may be used in the future.

Non-use values refer to the enjoyment people may experience simply by knowing that a resource exists even if they never expect to use that resource directly themselves. This kind of value is usually known as *existence value* (or, sometimes, *passive use value*). In general, direct use values are the easiest to value, since they usually involve observable quantities of products whose prices can usually also be observed in the market-place. Recreation is also relatively easy to value as the number of visits is directly observable. Assessing the benefit received by visitors is more difficult, but a large literature has developed to tackle this problem, mainly using surveys of tourists' actual travel costs or of their stated Willing-To-Pay (WTP) to visit particular sites.

Measuring indirect use value is often considerably more difficult than measuring direct use values. For one thing, the 'quantities' of the service being provided—such as the amount of carbon stored in biomass or in the soil—are often hard to measure. While their contribution of ecosystem services to the production of marketed goods and services may be significant, it is often difficult to distinguish it from that of other, marketed inputs to production. Moreover, many of these services often do not enter markets at all, so that their 'price' is also difficult to establish. The aesthetic benefits provided by a landscape, for example, are non-rival in consumption, meaning that they can be enjoyed by many people without necessarily detracting from the enjoyment of others.

Non-use value is the most difficult type of value to estimate, since in most cases it is not, by definition, reflected in people's behavior and is thus almost wholly unobservable (there are some exceptions, such as voluntary contributions that many people make to 'good causes', even when they expect little or no advantage to themselves). Surveys are used to estimate non-use or existence values, such as consumers' stated WTP for the conservation of endangered species or remote ecosystems which they themselves do not use or experience directly.

COMMODITY, AMENITY, MORALITY AND OPTION VALUE

A species has *commodity value* if it can be made into a product that can be bought or sold in the marketplace. In this category, alligators have potential value in the manufacture of shoes, but they may also have indirect commodity value if it turns out that vinyl shoes stamped in an alligator pattern sell for more than plain vinyl shoes. Indirect value of this sort is especially important in the pharmaceutical industry, since many of our most valuable medicines are synthetic copies of biologically produced chemicals.

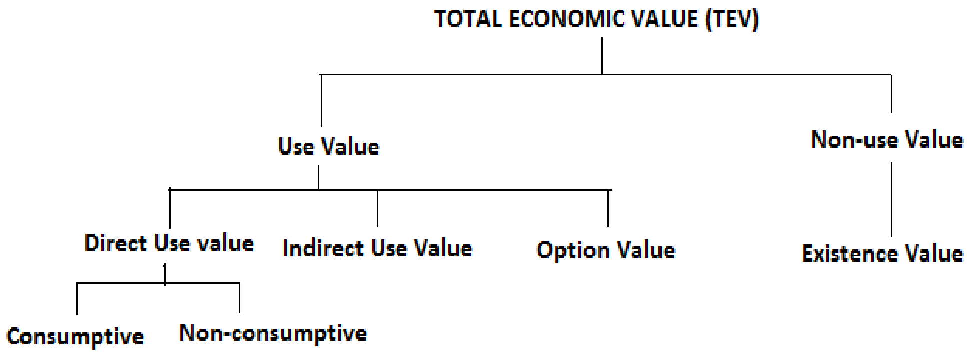
A species has *amenity value* if its existence improves our lives in some nonmaterial way. For example, we enjoy walks in the forest more when we experience a sight of a peacock or a hummingbird. Hiking, fishing, hunting, bird-watching, and other pursuits have a huge market value as recreation, and wild species contribute, as amenities, to these activities. Bald eagles, for example, have not only inspired the production of millions of dollars worth of tourism, but they also generate aesthetic excitement through a whole area that is blessed with a nesting pair of them.

Finally, species have *moral value*. Here, we begin to encounter controversy. Some philosophers would say that species have moral value on their own. They are, according to this view, valuable in themselves, and their value is not dependent on any uses to which we put them (Regan, 1981; Taylor, 1986). We will not be able to settle this issue. Suffice it to say that species have moral value even if that moral value depends on us. Many of us believe that observing other species helped us to live a better life Thus species have value as a moral resource to humans, as a chance for humans to form, re-form, and improve their own value systems.

At present, however, we do not have sufficient knowledge to calculate the value of most species. Consequently, in addition to the known values that economists note with respect to some small number of species, they also calculate an ***option value*** for species of unknown worth, i.e., the value we should place on the possibility that a future discovery will make useful a species that we currently think useless.

If we make a species extinct now, such discoveries are lost forever. Option value can be defined as the present benefit of holding open the possibility that some species we might eradicate today may prove valuable in the future. To estimate the option value people are asked how much they are willing to pay to retain the option of saving the species, given the possibility that new knowledge indicating its value may be discovered in the future.

One important aspect of option value is that it applies equally to commodity, amenity, and morality. As time passes, we gain knowledge in all of these areas, and new knowledge may lead to new commodity uses for a species or to a new level of aesthetic appreciation, or our moral values may change and some species will, in the future, prove to have moral value that we cannot now recognize.



WHY PUT A VALUE ON BIODIVERSITY?

Three to four decades ago, the topic would not have been thought worth discussing, because few scientists and researchers believed that biological diversity was – or could be – endangered in its totality. Three or four decades before that, a discussion of the value of biological diversity would probably have been a ridiculous idea. In the early part of this century, that value would have been taken for granted; the diversity of life was considered an integral part of life, so valuing diversity would have been thought a terrible waste of time.

In the last part of the twentieth century, we have seminars, papers, and entire books devoted to the subject of the value of biological diversity. It has become a kind of academic cottage industry, with dozens of us sitting at home at our word processors churning out economic, philosophical, and scientific reasons for or against keeping diversity.

There are probably many explanations of why we are compelled to place a value on diversity. One, for example, is that our ability to destroy diversity appears to oblige us to evaluate what we are destroying. A more straight forward explanation is that technological development, consumerism, the increasing size of governmental, industrial, and agricultural enterprises, and the growth of human populations – are responsible for most of the loss of biological diversity. Our lives and futures are dominated by the economic manifestations of these often hidden processes, and survival itself is viewed as a matter of economics, so it is hardly surprising that even we have begun to justify our efforts on behalf of diversity in economic terms.

It does not occur to us that by assigning value to diversity we merely legitimize the process that is wiping it out. But it is certain that if we determine value where value ought to be evident, we will be left with nothing but our greed. Two concrete examples that question this evaluating process come immediately. The first is by Clark - an applied mathematician at the University of British Columbia. His paper is about the economics of killing blue whales. The question was whether it was economically advisable to halt the killing of this species by Japanese whale industry in order to give blue whales time to recover to the point where they could become a sustained economic resource. Clark demonstrated that in fact it was economically preferable to kill every blue whale left in the oceans as fast as possible and reinvest the profits in growth industries rather than to wait for the species to recover to the point where it could sustain an annual catch. He was not recommending – just pointing out a danger of relying heavily on economic justifications for conservation in that case.

Another example concerns the pharmaceutical industry. It is often said, and to some extent still is, that the myriad plants and animals of the world's remaining tropical moist forests may well contain a great many chemical compounds of potential benefit to human health – everything from safe contraceptives to cures for cancer. We think this is true, and the pharmaceutical companies think it is true also, but the point is that this has become irrelevant. Pharmaceutical researchers now believe, rightly or wrongly, that they can get new drugs faster and cheaper by computer modeling of the molecular structures they find promising on theoretical grounds, followed by organic synthesis in the laboratory using a host of new technologies, including genetic engineering. There is no need, they claim, to waste time and money slogging around in the jungle. In a few short years, this so-called value of the tropical rain forest will become old computer printout.

But value is an intrinsic part of diversity; it does not depend on the properties of a given species. There are two practical problems with assigning value to biological diversity. The first is a problem for economists: it is not possible to figure out the true economic value of any piece of biological diversity, so we think about the value of diversity in aggregate. We do not have enough data about any gene, species, or ecosystem to calculate its ecological and economic. Even in relatively closed systems (or in systems that they pretend are closed), economists are poor at describing what is happening and terrible at making even short-term predictions based on available data. How then should ecologists and economists, dealing with huge, open systems, decide on the net present or future worth of any part of diversity?

Moreover, how do we deal with values of organisms whose very existence escapes our notice? Before we fully appreciated the vital role that mycorrhizal symbiosis plays in the lives of many economical plants, what kind of value would we have assigned to the tiny, threadlike fungi in the soil that makes those relationships possible? Given these realities of life on this infinitely complex planet, it is no wonder that contemporary efforts to assign value to a species or ecosystem appear inadequate.

The second practical problem with assigning value to biological diversity is one for conservationists. Few conservationists accept that many species, perhaps most, do not seem to have any conventional value at all, even hidden value. True, we cannot be sure which particular species fall into this category, but it is hard to deny that there must be a great many of them. And unfortunately, the species whose members are the fewest in number, the rarest, the most narrowly distributed – in short, the ones most likely to become extinct – are obviously the ones least likely to be missed by the biosphere. If the Bengal tiger disappears forever from the Sunderbans, it will be a tragedy: but we won’t expect the delta to perish, the mangroves to wither, or even the Sunderbans tourist industry to suffer – they won't.

Again we come to the relevant question - why we need to value biodiversity. Economics is about choice and every decision is preceded by a weighing of values among different alternatives. Life support functions of biodiversity underpin a wide variety of ecosystem services that are essential for economic performance and human well-being. Current markets, however, only shed information about the value of a small amount of biodiversity and components that are priced and incorporated in transactions as commodities or services. This poses structural limitations on the ability of markets to provide comprehensive pictures of the values of biodiversity involved in decision processes. Moreover, an information failure arises from the difficulty of quantifying most biodiversity in terms that are comparable with services from human-made assets. From this perspective, the logic behind valuation of biodiversity is to unravel the complexities of socio-ecological relationships, make explicit how human decisions would affect biodiversity values, and to express these value changes in units (e.g., monetary) that allow for their incorporation in public decision-making processes.

In summary, there are at least five reasons for conducting valuation studies on biodiversity -

- ✓ For some biodiversity goods and services, it is essential to understand and appreciate its alternatives and alternative uses.
- ✓ Uncertainty involving demand and supply of natural resources, especially in the future.
- ✓ To resolve the tradeoff between industrial and urban development and biodiversity conservation.
- ✓ Government may like to use the valuation as against the restricted, administered or operating market prices for designing biodiversity/ecosystem conservation programs.
- ✓ In order to arrive at natural resource accounting, valuation is a must.

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