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Ecosystem Functions, Services and Biodiversity-I[1]

During the last two decades, there has been considerable discussion in the scientific community about how humans have been managing ecosystems and biodiversity, and some of this has percolated to the general public through different media. However, the understanding and perception of this subject among the public and non-biologists can be a bit vague, and here we try to explain it in relatively simple language for a broader and more general understanding.

There has been much discussion and writing about ecosystem functions, as it relates to biodiversity conservation. In this, the first part of our Brief, we attempt to summarize known facts about ecosystem functions, services, and biodiversity. In the next part, we deal with the role of biodiversity in maintaining ecosystem functions and on issues related to why and what needs to be done to manage biodiversity conservation in support of ecosystem services.

Ecosystem Functions

We are aware that all living organisms, including we ourselves, are surrounded by air, water, soil, climate, etc., which are essential for survival of all living things. Ecology can be viewed as the relationship between living organisms and their surroundings, the plants, animals, people and environment and the interactions between these. The natural conditions where plants and animals live is called as the habitat, and it is important for us to keep this habitat healthy for our own health and continued survival. A good understanding of these relationships and of the interactions that constitute the ecosystem (the dynamics of plants, animals and micro-organisms and their non-living environment interacting together as a functional unit) is essential for the continued well-being of humans on planet earth, who are an integral part of the ecosystems.

Ecosystem Services

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Nature provides ecosystem services without human intervention. Yet, we benefit a lot from these, which are most often provided completely free of cost too! Humans enjoy the natural functions of the ecosystem. A few examples of ecosystem services are the following:

- Leaf, fruit, and seeds, etc., produced by photosynthetic processes as food
- Oxygen provided by removing carbon dioxide in the air, via growing plants and trees
- Provision of timber by trees for house construction, etc.
- Provision of clean water and fish for human consumption
- Beneficial insects, such as pollinators, honey bees, parasites, etc., and
- Healthy soils for food production

In general, ecosystem services provide life support services necessary for the survival of humans, animals, and other living organisms. At the same time, human activities impact significantly on ecosystem services and, in some instances, may cause their abuse. For instance, the natural processes of seed distribution are interrupted due to over-exploitation and harvesting of too many trees or too many fruits, compromising the life sustaining function of oxygen supply and carbon sequestration. Hence, understanding the nature of ecosystem services and how these are sustained helps all of us to be alert and to play a part in in protecting the ecosystems.

What are Ecosystem Functions?

Ecosystem functions refer to the structural components of an ecosystem (e.g., vegetation, water, soil, atmosphere and biota) and how they interact with each other in different combinations, within ecosystems and across ecosystems. Sometimes, ecosystem functions are called ecological processes. Nineteen ecosystem functions have been described in the literature and these can be classified into four groups, as shown below.

- *Provisioning Functions*: These relate to provision of natural resources required for life support that include raw materials, water supply, shade and shelter, nutrients and medicines, and genetic resources.

- *Regulating functions*: These relate to maintenance of essential ecological processes and life support systems, such as regulating oxygen levels in the air, provision of water for life to flourish, pollination to promote seed production, soil retention, nutrient regulation, waste decomposition, biological control, etc.

- *Supporting functions*: These relate to providing habitat (living spaces) for plant and animal species at local and regional scales; for example, soil formation and nutrient cycling.

- *Cultural Functions*: These relate to providing life fulfilment opportunities and logical development, such as landscape opportunities, cultural heritage, and recreation and tourism.

Ecosystem functions are not distinct and discrete. They interact with each other and are sometimes synergistic – their interaction enhances overall function/service. Each ecosystem function can contribute to more than one ecosystem service, and it takes more than one ecosystem function to provide any of the ecosystem services. To understand the concept of ecosystem services, it needs to be put in a context where a "system" can be described at different levels. For example, a cell in our body is one level, an organ is another, while a person as a whole is yet another level. Organisms build up ecosystems that in turn create a biosphere, consisting of a variety of ecosystems that interact with each other and exchange services, like our body does to function effectively. At each level, processes tend to act in a coordinated and collaborative fashion to create a working system at that level.

Ecosystem functions can also occur at a range of scales-- temporal (e.g., minutes, years, decades) and geographical (e.g., patch scale – patches of uniform conditions, within a catchment, an air shed - geographic boundary for air quality standards- globally. Currently our understating is that the rate and scale at which ecosystem functions operate depends on the components of the ecosystem involved in the interaction (e.g., birds and animals, atmosphere, and water), as well as topography and the spatial arrangement of ecosystems in the landscape. Ecosystems, therefore, do not function independently, and often rely on interactions with other ecosystems or their components to function efficiently. The rate and scale at which ecosystem functions operate must be considered when assessing the potential to provide ecosystem services into the future.

Biodiversity

Biodiversity or biological diversity is the variety of plant and animal life (including microorganisms) in a habitat (or in the world). It is based on a hierarchy/rank of variation of plants and animals in the given location, and is a 'live' component of the ecosystem. In simple language, it refers to the amount of diversity within and between species and ecosystems in each location at a time. Thus, it is the sum of all the variability among living organisms from all sources including those on earth, air and water. Generally tropical regions (for example, India) are rich in biological diversity and temperate regions, deserts etc., are less so.

It estimated that there are up to about 100 million species on the earth, of which humans know only about 1.5 million species; however, these figures tend to vary significantly from author to author. Nevertheless, all these estimates confirm one fact that there are many species of living beings about

which we know very little (see Table 1). Several species are known to be threatened, or already extinct, due to various natural and human–induced causes. Hence, conservation of biological diversity and resources is essential for a healthy society and continuation of humanity.

Table 1. Estimated number of species on earth.

Species	Earth			Ocean		
	Catalogued	Predicted	±SE	Catalogued	Predicted	±SE
Eukaryotes						
Animalia	953,434	7,770,000	958,000	171,082	2,150,000	145,000
Chromista	13,033	27,500	30,500	4,859	7,400	9,640
Fungi	43,271	611,000	297,000	1,097	5,320	11,100
Plantae	215,644	298,000	8,200	8,600	16,600	9,130
Protozoa	8,118	36,400	6,690	8,118	36,400	6,690
Total	1,233,500	8,740,000	1,300,000	193,756	2,210,000	182,000
Prokaryotes						
Archaea	502	455	160	1	1	0
Bacteria	10,358	9,680	3,470	652	1,320	436
Total	10,860	10,100	3,630	653	1,320	436
Grand Total	**1,244,360**	**8,750,000**	**1,300,000**	**194,409**	**2,210,000**	**182,000**

Predictions for prokaryotes represent a lower bound because they do not consider undescribed higher taxa. For protozoa, the ocean database was substantially more complete than the database for the entire Earth so we only used the former to estimate the total number of species in this taxon. All predictions were rounded to three significant digits.

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Importance of Conservation of Biodiversity

It is generally agreed that the value of biodiversity goes far beyond anything we can describe using economic valuation indices. The material benefits it offers humankind are also tremendous in terms of its functions in maintaining equilibrium in any given ecosystem, in addition to providing food, fibre, medicines, and other day-to-day needs of humans. Thus, the conservation and optimal use of the available biodiversity becomes imperative.

All living creatures need other creatures for their continued existence and are thus interdependent. In part 2 and 3 of this brief, it will become clear that biodiversity is the foundation of our existence on earth, as it provides us with many benefits. In addition to its utilitarian values, it is also important to conserve biodiversity to satisfy our own curiosity and aesthetic appreciation. Biodiversity is the life support system of not only humans but also of other living beings - for air to breathe, food to eat, and water to drink. Wetlands, along with their flora and fauna, filter pollutants from water; trees and plants reduce global warming by absorbing carbon; and bacteria and fungi break down organic material and fertilize the soil. Over the years, an enormous amount of experimental evidence has been collected to show that native species richness is linked to the health of ecosystems, as is the quality of life for humans.

Nevertheless, despite its value and importance, biodiversity is being lost at an alarming rate due to such factors as population growth, deforestation and habitat loss, overexploitation, invasive species, pollution, and climate change. Agricultural biodiversity - the biodiversity present as varieties, breeds, populations and species in crops, livestock, fish and all the other species of relevance to agriculture - is also being lost at significant rates and is further threatened due to land degradation, climate change, increased incidence of pests and diseases, the use of improved varieties and technologies that promotes monoculture and leads to the loss of traditional knowledge. Agricultural biodiversity provides the basis for the provision of regulating and supporting ecosystem services in production systems, as well as ensuring that we can all have a sufficient and varied diet (Provisioning services). Agricultural biodiversity also provides those cultural services that we associate with our own food customs and cultural heritage.

Given these continued threats, it is important that we should all be concerned about conservation of this fundamental natural resource.

Concluding Remarks

We have tried here to provide the definitions of ecosystem functions, services, and biodiversity. We have briefly described the functions and services with some examples, so that the reader can better understand these important issues that concern all of us. We have also tried to explain what biodiversity entails, and described briefly the importance of conserving and using it in the present and in the future, to ensure the well-being of the human race in a sustainable manner. The main conclusion that emerges is that we all must be aware of the significance of ecosystem functions and the importance of biodiversity, so that we can then contribute to its conservation.

In part 2, we will try to explore the role of biodiversity in maintaining the ecosystem, ensuring that it functions well, and the conservation of biodiversity in general and plant genetic resources in particular.

Selected Reading

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