Ecosystem

DEFINITION

A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.

Convention on Biological Diversity 1992[1]

KEY POINTS

- Ecosystems are the smallest unit of a living system which is functionally independent. They have four main elements – biotic, abiotic, interactions of energy flows, and a physical space in which to operate.
- Ecosystem services are now seen as an integral part of ecosystems, in recognition of the benefits to man provided by the natural world.
- The protection of ecosystems is at the core of the Convention on Biological Diversity which promotes the protection, rehabilitation and restoration of ecosystems as part of in-situ conservation.
- There is not yet an agreed international list of ecosystem types although there is a move within the conservation community to produce a list of 'threatened ecosystems'.

INTRODUCTION

An ecosystem (ecological system) is a way of describing the complex communities which make up the natural world. The idea of ecosystems has evolved to include the concept of ecosystem services which recognises the benefits provided by the natural world to man.

HISTORY

Although the concept of the connectivity between organisms and their environment has been well understood throughout history, the term ecosystem was first articulated by British biologist A.G. Tansley in 1935. It has now become mainstream terminology in biological discussions on the natural world.

UNDERLYING BIOLOGY

Ecosystems have four essential elements:

1. a biotic complex (living components of the system);
2. an abiotic environment (non-living e.g. temperature and rock);
3. the interactions within and between these two elements through energy flows; and
4. a physical space in which to operate [2].

An example of an interaction (energy flow) is the consumption of grass by a zebra[3]. An external input into almost all ecosystems is sunlight converted into energy (carbohydrates) through the process of photosynthesis. This organic energy is used by living organisms and is the basis of food-webs. Until the 1970s it was thought that all living organisms were dependent on sunlight as the source of energy [4]. However, hydrothermal vents surrounded by life were discovered in the deep ocean, far beyond the depth of penetration of sunlight (hydrothermal vents are formed by volcanic activity on the sea floor). These vent communities derive their energy from chemical compounds, in a process called chemosynthesis, largely independent from solar energy [5] (chemosynthesis is the equivalent to photosynthesis, but organisms produce energy from chemicals in the absence of sunlight).

CLASSIFICATION AND SCALE

An ecosystem is the smallest unit of a living system which is functionally independent. There is no fixed size of an ecosystem. It can exist at any scale and could, for example, be a complex collection of organisms within the gut of a termite, a grain of soil, a forest or an entire ocean [6]. Some even consider the earth to be a single ecosystem [6]. The fluidity in the concept of what constitutes an ecosystem has caused considerable scientific debate in theoretical ecology. It is argued that, until it is possible to classify an ecosystem as a precise definable unit, it will not be possible to accurately study the resilience or fragility of these systems [7].

Led by IUCN, a process now exists to develop a methodology to assess the state of ecosystems and to produce a list of “threatened ecosystems” [2, 8] which is currently being tested in country-level studies. This complements the ongoing work to assess the state of species which, at the global scale, is presented through the IUCN Red List of Species [9]. The aim of a list of threatened ecosystems is to focus conservation action on a higher structural level than the species level, in order to benefit several species at the same time. This process is challenged by the lack of an agreed method for classifying ecosystems and the lack of an agreed global list of ecosystem types to classify.

HUMAN DEPENDENCE

Humans are dependent on ecosystems because they provide the requirements for life such as food, fuel and water. Ecosystems also have embedded processes which function to support us; for example, by cycling nutrients and forming soil. The Millennium Ecosystem Assessment (MA), published in 2005, highlighted the essential ‘services’ which ecosystems provide and categorised them into four main groups: supporting, provisioning, regulating and cultural. These services underpin our existence. The MA provided a more utilitarian approach to assessing the value of ecosystems to humans, focusing on how reliant we are on a functioning environment. This perspective highlights that the loss of species and habitats directly affects human wellbeing in addition to moral, ethical or intrinsic loss [10]. More recently, an initiative called The Economics of Ecosystems and Biodiversity (TEEB) has been published, which focuses on drawing attention to the economic benefits of biodiversity. Its objective is to highlight the growing cost of biodiversity loss and ecosystem degradation, underpinned by an evidence base linking economics and ecology.

MULTILATERAL ENVIRONMENTAL AGREEMENTS

The protection of ecosystems is at the core of the Convention on Biological Diversity (CBD) which promotes the protection, rehabilitation and restoration of ecosystems as part of in-situ conservation [1]. Biodiversity underpins the functioning of ecosystems and is central to the rational for the Strategic Plan for Biodiversity 2011-2020 [11]. Globally, one of the largest threats to biodiversity is habitat destruction which is essentially destroying the biotic element of ecosystems and changing the patterns of energy flow within them. Habitat loss and fragmentation have been identified as primary causes of species range decline, numerical abundance decline, and extinction [12].

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A wetland ecosystem in Dartmoor National Park, UK. Andy Fox Photography/Shutterstock.com

Category:

Key terms: In depth

Internationally recognised definitions

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