Marine Ecology Systems

Lesson Aim

To introduce students to the basic concepts of ecology and discuss the first basic groups of marine animal life.

ECOLOGY

Ecology is the scientific study of the diversity of life, and the ways in which living organisms interact with each other and their environment. In some ways, ecology is a relatively new science, but it is an important one. People are also members of ecological systems who interact with other living organisms and their physical and natural environments (otherwise known as ecosystems). We therefore play an important role in the overall health of ecosystems, and our impact can be either positive or negative, depending on our actions. Ecology is primarily a branch of biology that looks at the *relationships* that exist between organisms and their environment.

The Ecosystem

An ecosystem is made up of abiotic (non-living, physical) components (soil, water, air and their components), and biotic constituents (living parts known as producers, consumers and decomposers). These can be summarised as follows:

1. Abiotic Components: The physical features plus the basic inorganic compounds of the environment.

2. Biotic Components: The living organisms

a) *Autotrophic components/Producers* Producers are organisms (such as plants, algae and some bacteria) that are able to create their own food by using the energy that is made available from the sun – a process best known as photosynthesis. This occurs when unusable light energy from the sun, is converted into chemical energy in the form of carbohydrates such as glucose. It is these sugars which the plants use as a source of growth. Oxygen is also produced as a waste product of this reaction, making photosynthesis arguably one of the most important biochemical pathways that occur in life. There are only three factors that plants need to create sugars and oxygen; carbon dioxide (CO_2) is the gas that is drawn through the leaves of the plant, water is taken up through the roots of the plant, and sunlight is the energy required to drive the chemical reaction. Producers are otherwise referred to as autotrophs. The other organisms (i.e. animals) depend on the producers for their source of energy.

b) Heterotrophic components/Consumers Organisms which cannot manufacture the food they utilize.

They rearrange and ultimately decompose the compounds manufactured by autotrophs by ingesting other organisms or particles of organic matter.

- Primary Consumers Feed on plants (herbivores cattle, insects, small mammals, birds. etc.)
- Secondary Consumers Primary carnivores feeding mainly on herbivores (e.g. frogs, lizards, small mammals, some birds. etc.).
- Tertiary Consumers Secondary or top carnivores feeding mainly on other carnivores (e.g. Snakes, predatory birds).

3. Decomposers: The heterotrophs (mainly bacteria and fungi) which break down complex compounds of dead animals or plants absorb some of the products and then release simple inorganic substances which are then made useable once more by the autotrophs. This creates the food web or trophic levels that exist within an ecosystem. From this, you begin to see that there are a lot of interrelationships occurring in any ecosystem.

The Web of Life

The interrelationships between the various aspects of the environment can be represented simply as follows:

- CLIMATE Plants modify climate
- PRODUCERS Animals eat plants
- CONSUMERS Animal waste to soil
- SOIL Soil eroded by animals and climate
- DECOMPOSERS Decomposing animals and plants go into the soil.

Decomposed plant and animal material feeds new plants which in turn feed animals eating the plants.

These interrelationships can be represented by a *web of life* chart (as shown in Figure 1). This *food web* consists of two or more food chains interconnected together. A food web represents the interconnected feeding relationships in an ecosystem. These relationships can be complex; some organisms may feed on more than one trophic level, or changes may occur depending on a species' life history stages or the availability of food. Food webs are more complex and show more relationships between the living parts of the ecosystem than a simple food chain does.

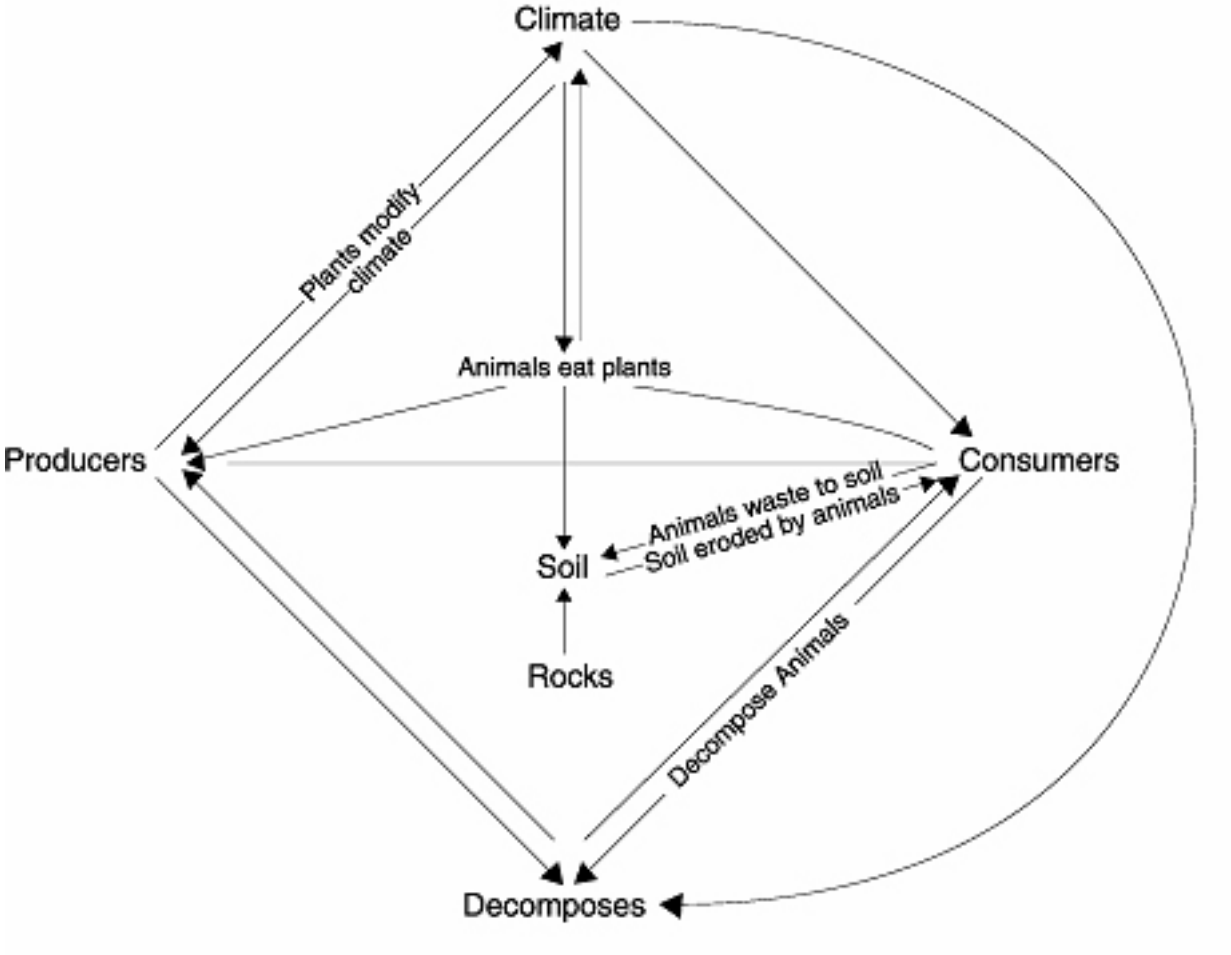

Figure 1: Web of Life – The arrows drawn indicate the interrelationship that exists between each of the constituents of an ecosystem

A *food chain* shows how each living thing gets its food. Some animals eat plants and some animals eat other animals. For example, a simple food chain links the trees & shrubs, the giraffes (that eat trees & shrubs), and the lions (that eat the giraffes). Each link in this chain is food for the next link. A food chain always starts with plant life and ends with an animal. Food chains are always cyclic, that is, no matter where on the food chain an organism lies it will eventually be recycled and become valuable to other elements within the food chain.

Ecological Concepts

Knowing the basic components of an ecosystem leads to learning of the basic ecological concepts. Different authors might list concepts in different ways, however the following are basic, universally accepted and essential to any ecosystem:

1. The sun is the source of all energy

All energy in any organism originally came from the sun. For example, a producer converts sunlight and Co_2 to sugars during photosynthesis. The primary consumer ingests this, the secondary consumer then ingests the primary consumer and so on. Other energies in the environment also originate from the sun (eg. wind, tides, water cycle, light etc).

2. Everything is connected to everything else

All living things interact with other things (both living and not living) in their environment. The climate affects the living things in an area. The plants influence the insect population and the insect population determines the fish population who eat the insects, and so on.

3. Everything must fit in to how and where it lives

'Adaptation' is the key word of this concept. Unless a species adapts to a niche, it will have a limited potential to survive. A principle related to this concept is Darwin's Theory of Evolution. One aspect of this theory is concerned with the preservation of beneficial mutations that occur in an organism's genetic makeup, in response to changing conditions. This process is known as Natural Selection and explains how some organisms in a species have inherited certain variations that give them an advantage over others for survival. Over time, those individuals that are genetically inferior are gradually eliminated.

4. All ecosystems are dynamic

An ecosystem is dynamic; in a constant state of change. In death or degradation there is no waste. Matter is continually recycled among biotic or abiotic components. Rocks are worn down into soil, or changed, moved and leached by the forces of the environment. Soil is then used as a substrate and source of nutrients by plants for their growth and survival.

5. Ecosystem Dynamics

For every action there is an equal and opposite reaction. For every event there is a consequence. There is a delicate balance of nature between producers and consumers which allows both to exist. If this interrelationship becomes and remains unbalanced, one and/or both members of the interrelationship will die. The introduction of new elements into the ecosystem, whether they are biotic or abiotic, will have an effect on the way that the system functions. The depth to which this adversely affects its inhabitants depends on two factors; the *toxicity* of the introduced element, and the *resiliency* of the system to recover from these effects.

MARINE ECOSYSTEMS

A marine ecosystem is based on the same principles that apply to any ecosystem. Water quality is as important as air quality as this is the abiotic component by which most marine organisms (apart from marine mammals) obtain oxygen. In some respects a marine environment is more fragile because of this very factor. However, large marine systems have the ability to dilute impurities such as toxic chemicals or suspended solids. The smaller the marine system (i.e. tidal pools or estuaries), the more susceptible it is to disturbance.

Marine ecosystems are often complex and dynamic environments in which many organisms are involved in many intricate and often totally unobvious relationships. It is due to this complex web and fragility that marine ecosystems can be subject to sudden and dramatic consequences as a result of changing environmental conditions. A prime example of this is the collapse of certain fishing industries due to a lack of efficient control over the fishing quota and practices. Overfishing of a certain species can be expected to produce this result, however there are instances of seemingly totally unrelated species being affected by the exploitation of another species.

Fishing communities who are reliant on the productivity of these environments can also be adversely affected by the depletion of stocks. The economies of countries such as Peru and Newfoundland have been reliant on the income generated from their coastal fisheries. Overexploitation of these systems in response to the growing demand for fish stocks, places huge pressures on the sustainability of these systems to endure such demands.

Another example (and putting coral reefs at very high risk of being destroyed in the 21st Century) is the consistent rise of global warming and its known effects on coral bleaching. Over the past one hundred years, the temperature of sea water in many tropical areas has been rising. Rising water temperatures block the photosynthetic reaction that converts carbon dioxide into sugar (a process carried out by the zooxanthellae – the microscopic algae that reside within the corals). The result is a build-up of products that poison the zooxanthellae. To save itself, the coral expels the zooxanthellae and some of its own tissue, leaving the coral a bleached white. The bleached coral can recover, but only if cooler water temperatures return and the algae are able to grow again. This is an incredibly slow process however,

Assignment 1

Question 1

Write a report based on set task number 1 (up to 2 pages).

Question 2

Based on set task 2:

- Discuss the relationship between ocean currents and weather patterns.
- Give a brief account of the El Nino phenomena and what effects it has on weather patterns.

Submit 200-300 words for each.

Question 3

Using a range of references such as encyclopaedias, text books, journals, etc., briefly define the following terminology:

- Thermocline
- Gulf stream
- Continental shelf
- Nutrient cycle
- Plankton
- Red tide

Question 4

Write a one page report based on the ecological significance of seagrasses and algae to other marine life.

Question 5

Explain how shore dwelling vegetation impacts on the life of marine animals (up to one page).

Question 6

Draw up a diagram of a marine food chain. Give a brief description of each step as set out in your diagram.

Congratulations on finishing this section.

Now start the next section on the next page