
Primary productivity:

In ecology, productivity is the rate at which energy is added to the bodies of organisms in the form of biomass.

Biomass ((total mass (or energy) of all living material (units: g C/m² or kJ/m²).))

There are many types of productivity:

1- Gross primary productivity or GPP: It means the total production of organic matter per unit area and unit time via solar energy including energy consumed in the form of Respiration (R). . Producers such as plants use some of this energy for metabolism/cellular respiration and some for growth (building tissues).

Gross primary productivity (GPP) = rate of conversion of CO₂ to organic carbon per unit area and unit time.

Units: g C m⁻² year⁻¹ , or kJ m⁻² year⁻¹

2- Net primary productivity or NPP: is gross primary productivity minus the rate of energy loss to metabolism and maintenance. In other words, it's the rate at which energy or carbon is stored as biomass by plants. Respiration by Autotrophs (RA) = how much energy or carbon is used for plant metabolism

Net Primary Production (NPP) = GPP - RA = how much energy or carbon is stored as biomass

Net primary productivity varies among ecosystems and depends on many factors. These include solar energy input, temperature and moisture levels, carbon dioxide levels, nutrient availability, and community interactions.

3- Net community productivity (NCP)

It is the rate of storage of organic matter in plant tissues that have not been consumed by organic organisms (Heterotrophic i.e . consumed and decomposed organisms) during the growing season or year.

Net community productivity = Net primary productivity - consumption of organic organisms.

$$NCP = NPP - \text{Heterotrophic consumption}$$

Or In other words

Respiration by heterotrophs (RH) = how much energy or carbon is used for heterotroph metabolism

$$NCP = GPP - RA - RH$$

$$NCP = NPP - RH$$

Net community production (NCP) = how much of GPP produced is not lost in respiration

4-SECONDARY PRODUCTIVITY (SP): Biomass gained by heterotrophic organisms through feeding and absorption. , Not all food eaten is absorbed (assimilated) into an animals body.

Unassimilated food = feces or droppings

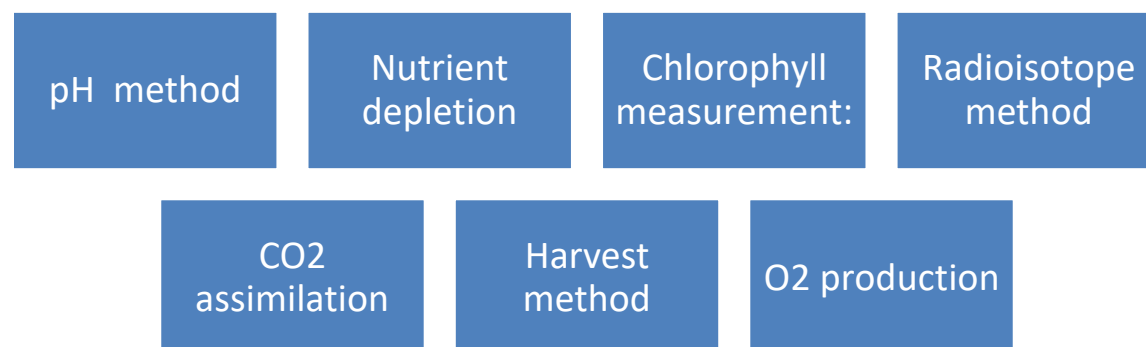
$$\text{Secondary Productivity SP} = \text{food eaten} - \text{fecal loss}$$

Q/ What are the factors that affect secondary productivity ?

- a- the quality of food and the ability to digest it .
- b- the quantity and presence of food .

Q/ How to measure Primary Productivity ?

1. Harvest method : measure biomass and express as biomass per unit area per unit time.
2. CO₂ assimilation : measure CO₂ uptake in photosynthesis and release by respiration.
3. O₂ production (Oxygen light - dark bottle method) : Measure O₂ production and consumption.
 - the dark bottle measures community respiration
 - the light bottle measures net community photosynthesis
4. Radioisotope method : use C¹⁴ tracer in photosynthesis.
5. Chlorophyll measurement: assumes a correlation between amount of chlorophyll and rate of photosynthesis.
6. Nutrient depletion: There is a relationship between the rate of decreasing nutrient concentration in soil for a period of time and the rate of primary productivity.
- 7- pH method : There is a relationship between the dissolution of carbon dioxide in water and the value of pH ((decrease the pH rate during the process of photosynthesis and increase in the process of breathing)) therefore used as a guide to productivity.



Environmental Factors Affecting the Productivity in Ecosystem:

1. Solar radiation and temperature.
2. Moisture, i.e., leaf water potential, soil moisture .
3. Mineral nutrition, i.e., uptake of minerals from the soil, fire effects, salinity, heavy metals and nitrogen metabolism.
4. Biotic activities, i.e., grazing , predators and parasites and diseases of primary producers.
5. Impact of human populations, i.e., pollutions of different sorts, ionizing radiations, such as atomic explosions, etc.
6. In aquatic systems, productivity is generally limited by light, which decreases with increasing water depth. In deep oceans nutrients often become limiting for productivity. Nitrogen is most important nutrient limiting productivity in marine ecosystems.

Primary productivity of the major ecosystems of the world is as follows:

Table 12.1. Geographical area, mean plant biomass and net productivity in major world ecosystems

<i>Major world ecosystems</i>	<i>Geographical area 10⁶ km²</i>	<i>Mean plant biomass (t ha⁻¹)</i>	<i>Mean net primary productivity (t ha⁻¹ year⁻¹)</i>
1. Tropical rain forest	17	440	20
2. Tropical deciduous forest	8	360	15
3. Temperate deciduous forest	7	300	12
4. Temperate coniferous forest	12	200	8
5. Savanna	15	40	9
6. Temperate grassland	9	20	5
7. Desert shrub	18	10	0.7

t = ton = 1000 kg ; ha = 10,000 m²

Biological interrelationships :

These interactions can be negative such as predation or positive interactions such as Mutualism .

Table showing possible biological interactions between different species of organisms ((+ Population growth is increasing , - population growth is decreasing , = population growth not affected)) :

Type of interaction	Simple information	species I	species II
Neutralism التعادلية	Two different species are not affected negatively or positively (When food and shelter are available)	=	=
Commensalism التعايش	When the interaction is beneficial to one and equal to the other (such as birds that build nests between branches)	+	=
Mutualism تبادل المنفعة	is a useful relationship for both organisms ((such as Lichens) Lichens that consist of algae and fungi . Algae produce food for themselves and for fungi, while fungi provide moisture and attachment sites))	+	+
Predation الاقتراس	The first organism is called the predator and the second is called the prey	+	-
Parasitism: التطفل	is a living organism called parasites living inside or on the bodies of other organisms called hosts and get food from them may cause weakness, disease or death of the host , parasitism may be a temporary or permanent	+	-
Competition التنافس	competition in plants is usually on light, water and nutrients, but between animals on water, food and mating	-	-

Q/ What are the types of behavior that make the organism a strong competitor?

- 1- aggressive behavior of one species leads to the escape of the other
- 2- a high rate of reproduction that leads to the occupation of the habitat environmental.
- 3- resistance to diseases.
- 3 - greater success in finding food and mating .
- 4 - greater ability to find cooperative relations and benefit from them .
- 5 - greater success in avoiding Competitive confrontations.

Q/ Give a definition of Amensalism (التضاد) with an example ?

One population is affected (inhibition) while another is not .

Example: In the forest, tall trees prevent light from shrubs and grasses.

(Only plants that can tolerate shade can survive).

Q/ What is antibiosis التضاد الحيوي?

A form of Amensalism in which an organism produces a toxic metabolite against other organisms, for example , Penicillium, which produces an antibiotic named Pencilin that causes the death of many bacteria.