

PRIMARY PRODUCTIVITY IN MARINE ENVIRONMENT

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Primary or basic productivity of an ecosystem or community is defined as the rate at which radiant energy is stored by photosynthetic activity of producer organisms - mostly algae and plants. There are various kinds of organisms responsible for primary production in the marine environments. These include diatoms, dinoflagellates, coccolithophores, seaweeds, seagrasses and symbiotic producers such as corals. About 95% of primary production is contributed by phytoplankton (Steemann-Nielsen, 1975). Various factors such as amount of light, concentration of nutrients, movement of water masses, grazing etc. influence the primary production.

Methods of measuring primary production

Several methods can be used for measurements of primary production. It can be measured by the amount of oxygen released during photosynthesis. O_2 is usually measured by the Winkler titration which has a sensitivity of 0.15 to 0.02 $mgO_2 l^{-1}$ (Hall and Moll, 1975). Because of rather low sensitivity this method cannot be used for primary production measurements in seas and oceans.

The most widely used method for primary production is the radiocarbon method introduced by Steemann-Nielsen (1952). This technique involves the addition of radioactive sodium bicarbonate to a sample of seawater and measure the amount C taken up after a certain incubation time. After appropriate corrections the amount of organic carbon production is estimated.

Primary Production in Different Environments:

The most important biotic component contributing to the primary production in the coastal zones are

1. macroalgae
2. marine angiosperms
3. phytoplankton
4. benthic diatoms

Rockweeds and kelps constitute major components of macroalgae (Fucus sp. Laminaria and Macrocystis). Eel grass, salt marsh cord grass and turtle grass are some important marine angiosperms. Phytoplankton and benthic diatom productions are high at least in coastal and shallow regions (Ivan Valiela, 1984, Woodwell et al. 1973). The table gives an account of the range of net annual primary production of the major marine macrophyte systems.

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Location and species	Production $gC m^{-2} yr^{-1}$
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Canada, Atlantic, <u>Laminaria</u>	900-1900
Indian Ocean, <u>Macrocystis</u>	1100-2000
Carribean, <u>Thalassia</u>	600-900
Indian Ocean, <u>Thalassia</u>	500-1500
California, <u>Macrocystis</u>	400-800
Puerto Rico, Mangroves	300-500
Florida, Mangroves	250-450
N. America, Atlantic, <u>Spartina</u>	120-900
Denmark, Washington State, <u>Zostrea</u>	60-350
Alaska, <u>Zostrea</u>	50-1500
Coastal zone, plankton	50-600
Coastal zone, benthic diatoms	30-200

The total production of coastal zone including that of estuary and that from macrophytes and angiosperms etc. has been estimated to be 1.44×10^9 tons carbon per year (Woodwell et al 1973).

Oceans

Since Steemann-Nielsen (1952) introduced the radiocarbon technique for measurement of primary production extensive work has been carried out throughout the world. Because of large differences in the techniques and approaches comparisons between different estimates become difficult at least as far as the earlier data is concerned. Ryther (1969) classified the oceans into three categories such as open ocean, coastal zone and upwelling areas and using values of 50, 100 and $300 \text{gCm}^{-2} \text{yr}^{-1}$, computed global production as 20×10^9 tons C per year. On the other hand Kolebentz-Miske et al (1970) estimated annual primary production as 23×10^9 tons C. They distinguished five production groups (100; 100-150; 150-250; 250-500; and) $500 \text{mg C m}^{-2} \text{day}^{-1}$. They have made a map of oceanic primary production. These values were later revised by Bruevich and Ivanenkov (1971) on the assumption that higher values have to be considered for oligotrophic waters of the oceans, transition zones and high productivity regions. The revised value became 44×10^9 tons C. Platt and Subba Rao (1975) considered oceanic environments into shelf regions, upwelling areas, coastal waters and open ocean. Data for each of the oceans was compiled by the authors to arrive at a value of 31×10^9 tons carbon per year. However, there are certain shortcomings in all the above estimates. They are due to 1) the loss of radiocarbon due to the storage of filters in a desiccator (only in earlier measurements and 2) non-consideration of extracellular excretion of photosynthetic product especially in oligotrophic waters. According to De Voys, (1979). These two errors necessitate an upward revision of the global production by 40% approximately.

Coral Reefs

The reef building corals lie between 30°N and 30°S latitudes. They occur only in the western regions of the oceans. Coral reefs and atolls are found mainly in the Caribbean and Indo-Pacific regions (Stoddard, 1969). There are three types of coral reefs viz., atolls, barrier reef and the fringe reef. Coral reefs show a high primary production of approximately $1500-800 \text{g C m}^{-2} \text{yr}^{-1}$ while that of the surrounding water range from $20-40 \text{g C m}^{-2} \text{yr}^{-1}$. The

total ocean area where coral reef occurs is 190 million km² of which about 0.059% of the area is covered with coral surface. The total gross and net production of coral reefs is 0.47×10^9 and 0.30×10^9 tons carbon per year.

When the average values of production of various oceanic systems are considered it is found that the production per unit area of estuaries, algal beds and coral reefs are about four times that of the shelf or upwelling region and more than one order of magnitude greater than that of the open ocean. Because open ocean constitutes more than 90% of the total area of the ocean its contribution to total marine production comes to about 60%.

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