Aquatic ecosystems

2- Marine ecosystems

Marine ecosystems cover 70 per cent of the earth's surface and have an average depth of 3.750 m (the greatest known depth being 10,750 meters in the Marianas Trench).
Marine ecosystem as you know is one of the largest reservoirs of water, living things and essential nutrients needed by both the marine and land organisms. The total biomass in the marine ecosystems far exceeds that of all fresh water ecosystems put together.

Salient Features of Marine Ecosystems
Marine ecosystems are of great ecological significance and have certain salient features

Physico-chemical factors

1) **Salinity** : The sea is salty and its salinity is fairly constant, averaging about 3.5% usually written as 35 ppt (parts per thousand). Sodium chloride is the main salt while the rest are calcium, potassium and magnesium salts.

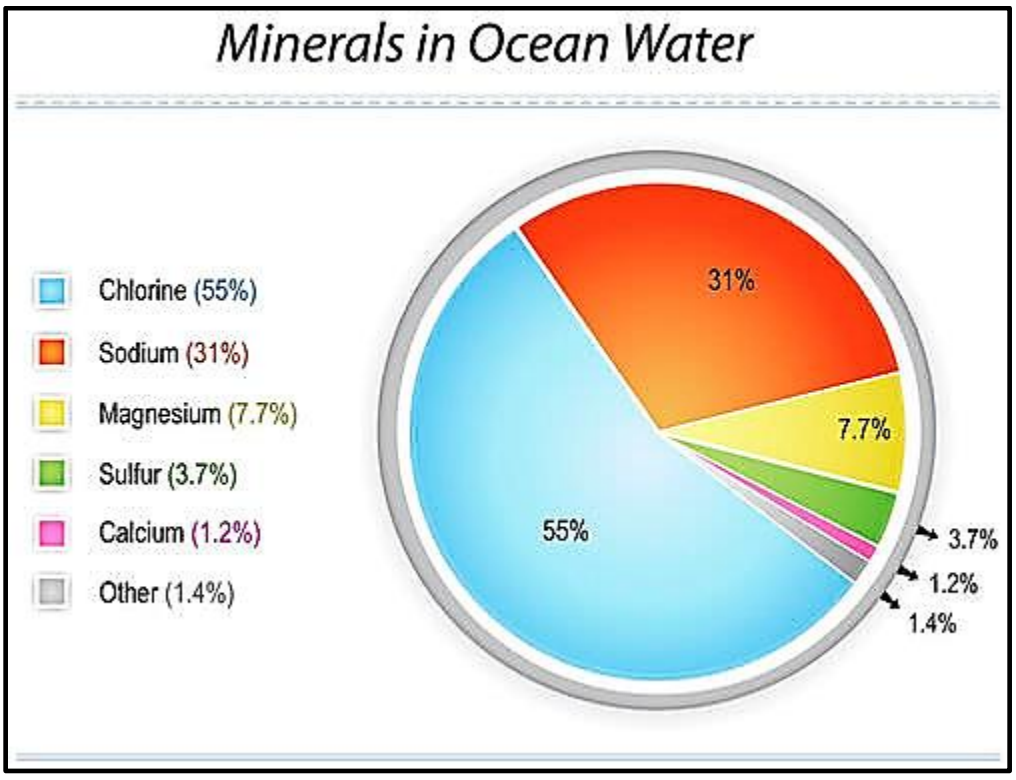


Table 1 : Chemistry of the Sea Water (g/Kg -ppt)

Positive ions (cations)	ppt	%	Negative ions (anions)	ppt	%
Na^{+}	10.497	30.59	Cl^{-}	18.971	55.29
K^{+}	0.379	1.10	Br^{-}	0.065	0.19
Ca^{++}	0.400	1.16	SO_4^{-}	2.639	7.69
Mg^{++}	1.278	3.72	CO_3^{-}	0.071	0.21
			HCO_3^{-}	0.140	0.41
			F^{-}	0.001	0.000

2) Light: is a limiting factor in the ocean as it contributes significantly to organic production and distribution of marine life. The ocean is divisible as shown in on the basis of the light penetration into two vertical zones:

i)The lighted photic or euphotic zone extending from the sea surface up to a depth of 200 meters, where sufficient light reaches to support photosynthesis. This photic zone, also called the epipelagic one, is characterized by sharp gradients or light, temperature and salinity. The amount of light reaching the lower level of this zone rarely exceeds 0.0001% of what is received at the surface. Below this is the

ii) aphotic or lightless zone which distinguishable into three further sub-zones
(a) ***mesopelagic zone*** which extends from 200 meters to 1000 meters. This zone is in semi-darkness as very little light penetrates it. Here temperature gradient is more even and gradual, without much seasonal variation. Further this zone contains a minimum of oxygen and a maximum of nitrates and phosphates.
(b) ***bathypelagic zone*** which extends from 1,000 meters to 2,000 meters and where darkness is virtually complete, for humans though some fishes and crustacean do respond to dim light.
(c) ***abyssopelagic zone*** where permanent darkness prevails and where temperature is uniform at 3°C and hydrostatic pressure is enormous.

3) Temperature: like salinity remains almost constant in the oceans in contrast to the land or terrestrial ecosystems ranging from about **2°C** in the polar seas to **32°C** or more in the tropics. The annual variation in any part of the sea is usually not more than **6°C**.

4) Concentration of Nutrients: The marine environment is low in concentrations of dissolved nutrients, which since they occur in very little amount are measured in parts per billions (**ppb**) in contrast to salts, such as sodium chloride which is measured in parts per thousand (**ppt**). This low quantity of nutrients acts as a major limiting factor in determining the size of marine populations.

5) Dissolved Gases: The marine environment serves as a gigantic reservoir of dissolved oxygen and carbon dioxide, which respectively help regulate the composition of the air we breathe and the temperature of the atmosphere.

6) Alkalinity: The sea is alkaline, as the electrical dissociation force of cations exceeds that of anions. Further it is buffered and has a pH of 8.2 normally, and so resists changes in pH.

7) Pressure: Water pressure increases with depth which varies in the ocean from 1 atmosphere at the surface to 1000 atmosphere at the greatest depth. Pressure changes in the sea are several times greater than those on land and so have a distinct effect on the distribution of life. Since organisms are limited to surface waters, where pressure is not so great, others are adapted to life at greater depths.

8) Continuity: The sea is a continuous body of water. All the oceans : Pacific,. Indian, Arctic and Antarctic are connected together. However, temperature, salinity and depth seem to act as barrier to free movement of marine organisms.

9) Depth: The sea is very deep varying in different regions. Generally life extends to all depths but is confined more to the continental shelf and islands.

10) Currents : The sea is in continuous circulation by means of currents. These may be either, wind driven surface currents of deeper currents, resulting from variations in temperature and salinity.

11) Waves and tides :The sea is dominated by several kinds of waves and tides, which are produced by the pull of moon and sun.

12) Circulation of nutrients in the coastal zone : Circulation of nutrients from the sea bottom to the upper surface, occurs in the coastal regions by two processes
(i) upwellings -where the winds cause the surface waters to be blown offshore, which are replaced then by the cold nutrients rich waters from the deep.
(ii) outwellings - where the sea is enriched by nutrient rich estuarine waters entering it.

Zones of the Marine Ecosystems

The marine habitat is distinguishable into two different horizontal zones benthic zone and pelagic zone.

(1) Benthic Zone : Which forms the basin or floor of the ocean, regardless of depth. The benthic zone is divisible into sub zones horizontally.

The shape of the benthic zone is roughly the form of an inverted hat. The upper most portion is called the**, (i) supra littoral zone**, comprising the beach down to the edge of the ocean. Then the **(ii) littoral zone** which represents the area between the upper and lower tide levels and is, therefore, also known as intertidal zone. Littoral zone is the shore of the ocean. Next to this is the

(iii) sublittoral or continental shelf which extends from the littoral zone to the beginning of the continental slope. The continental shelf is the underwater extension of the continent and extends to a depth of 125 to 200 meters. After the continental shelf, a rapid descent (slope,drop) occurs and this is called the **(iv) continental slope**. The continental slope after some distance forming the **(v) continental rise** which may be geologically active. This region has canyons and trenches which are subject to underwater eruptions and avalanches. The region of the continental slope and rise together comprise the bathyal zone. **The bathyal zone** which is 200 meters deep descends rapidly to a depth of 3,000 or 4,000 m. From this the bottom drops for further several thousand meters and levels, off around 6,000 m to form the broad flat **(vi) abyssal plains** where temperature is never above 4°C.

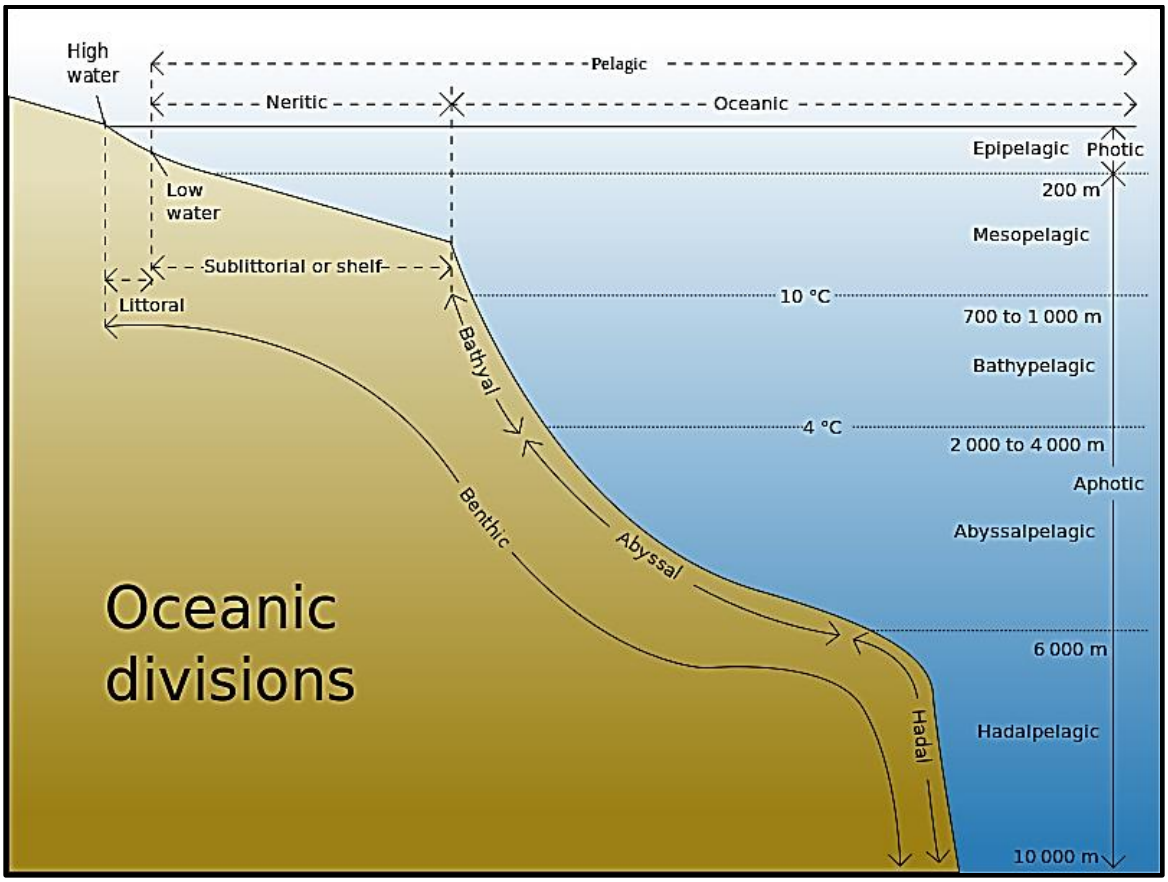
(2) Pelagic Zone: Which represents the free water zone, filling the basin. The waters contained in the sea basin, constitute the pelagic zone which is divided into:

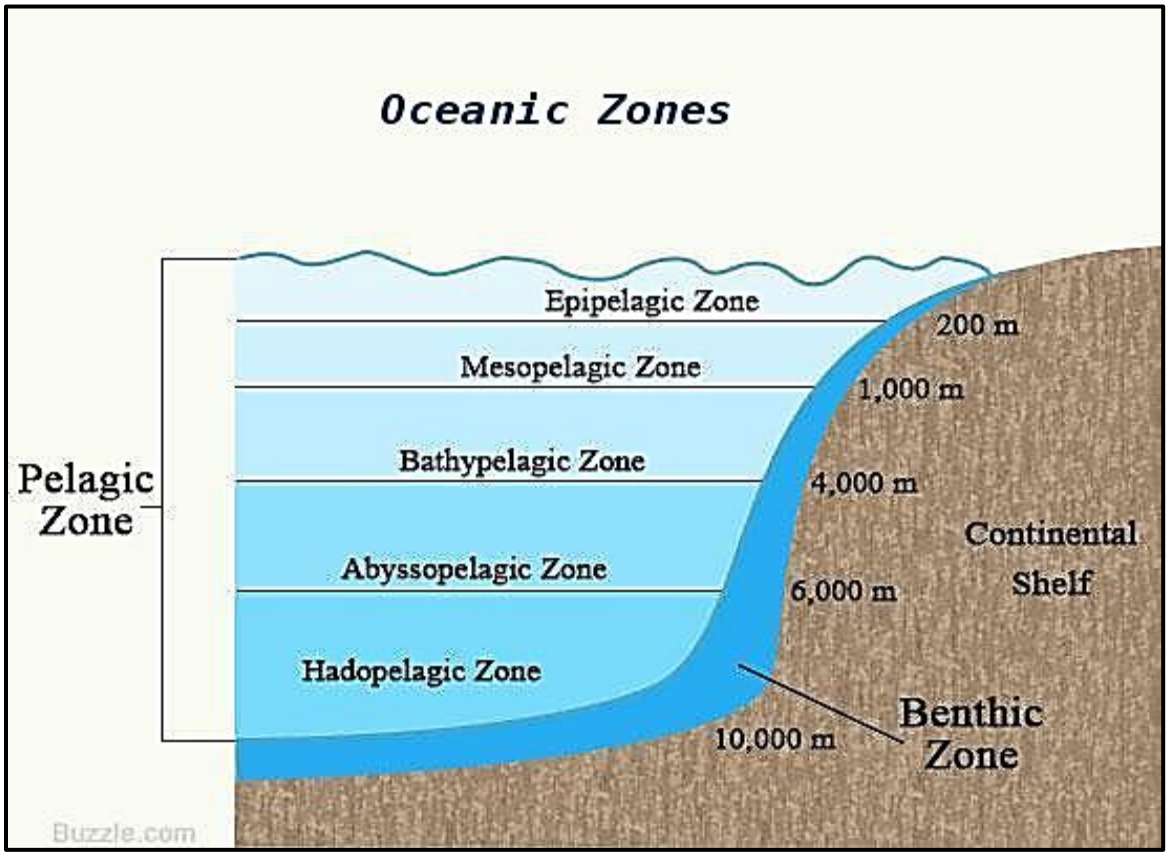
(i) **the neritic zone** situated above the sublittoral zone or the continental shelf starting from the edge of the littoral sea and extending up to the edge of the continental shelf, to a depth of 200 m. Beyond this is the

(ii) **deep, open sea** of the oceanic zone which is divided on the basis of light penetration as discussed in earlier sections the physico-chemical property of light of the oceans.

The upper illuminated zone of the open ocean is also called **epipelagic zone**. So the euphotic pelagic ocean is named a epipelagic one. The aphotic pelagic province has been divided into the following three horizontal (vertical) zones :

mesopelagic, bathypelagic and the abyssopelagic zone. There is no light in the bathyplagic and abyssopelagic zones. The mesopelagic zone is comparatively less dark but light is not sufficient to carry out photosynthesis.


High water
Pelagic
Neritic
Oceanic
Epipelagic
Photic
Low water
200 m
Mesopelagic
Sublittorial or shelf
10 °C
Littoral
700 to 1 000 m
Bathypelagic
Bathyal
4 °C
2 000 to 4 000 m
Aphotic
Benthic
Abyssal
Abyssalpelagic
Oceanic divisions
6 000 m
Hadal
Hadalpelagic
10 000 m


Oceanic Zones
Epipelagic Zone
200 m
Mesopelagic Zone
1,000 m
Pelagic Zone
Bathypelagic Zone
4,000 m
Continental Shelf
Abyssopelagic Zone
6,000 m
Hadopelagic Zone
Benthic Zone
10,000 m
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Biota of Oceans

Life in the sea is not particularly abundant, though the diversity of organisms is very high. Almost every major group of animals and every major group of algae occur-somewhere in the oceans, with the exception of vascular plants and insects. These two have a few marine representatives though they are abundant in estuaries. On the basis of depth-wise differences in life forms, the expanse of marine ecosystems has been divided into littoral, neritic, pelagic and benthic zones. Let us now read about biota of each one of these.

1. **Biota of Littoral Zone** : This zone is the shore region of the marine ecosystems and is subject to strength of waves and tides, fluctuation of water level and variability of temperature, light, salinity and moisture. In common language supra littoral zone is termed as a **beach**. Considerable light penetrates the bottom of this zone which is exposed and submerged twice a day except for tide pools. Thus, animals living here exist in a difficult environment and so must be either resistant to periodic drying or able to burrow to water level. This zone is thus also called intertidal zone. This intertidal zone or the littoral zone is a region of high productivity with a simple community, many of whose members may be exceedingly abundant.

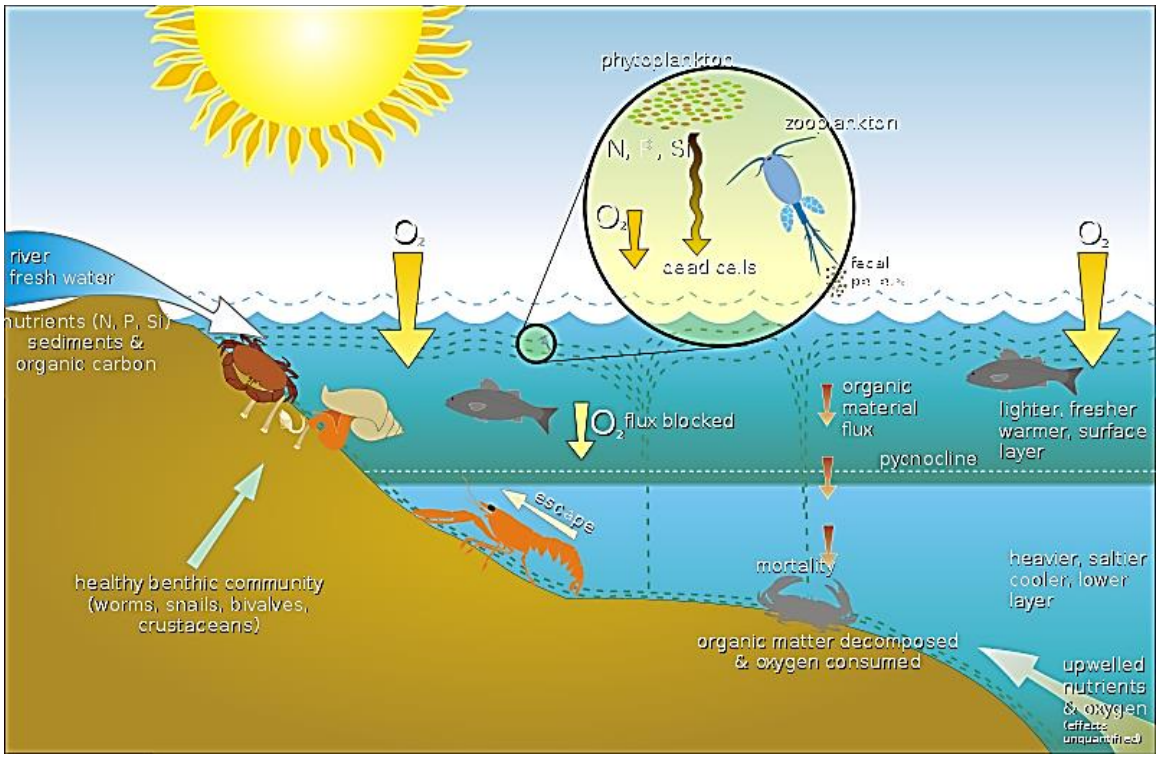
   There is no typical littoral zone, there are two types of beaches; a rocky intertidal Beach is different from a sandy beach or a mud flats. However, all have certain things in common. The wave action is stronger here than anywhere else in the sea. The turbidity is high and the substrate erodes rapidly. There are few species of plants. Those that occur are attached securely to the substrate and may be present in large numbers. The energy requirements of the animal community here depends on the large amount of detritus washed in by the waves. Common animals found here are snails, clams, barnacles, crustaceans, annelids sea anemones and sea urchine. The animals here exhibit zonation with respect to tides. Animals more resistant to desiccation usually occurring at higher levels than those that are less resistant.

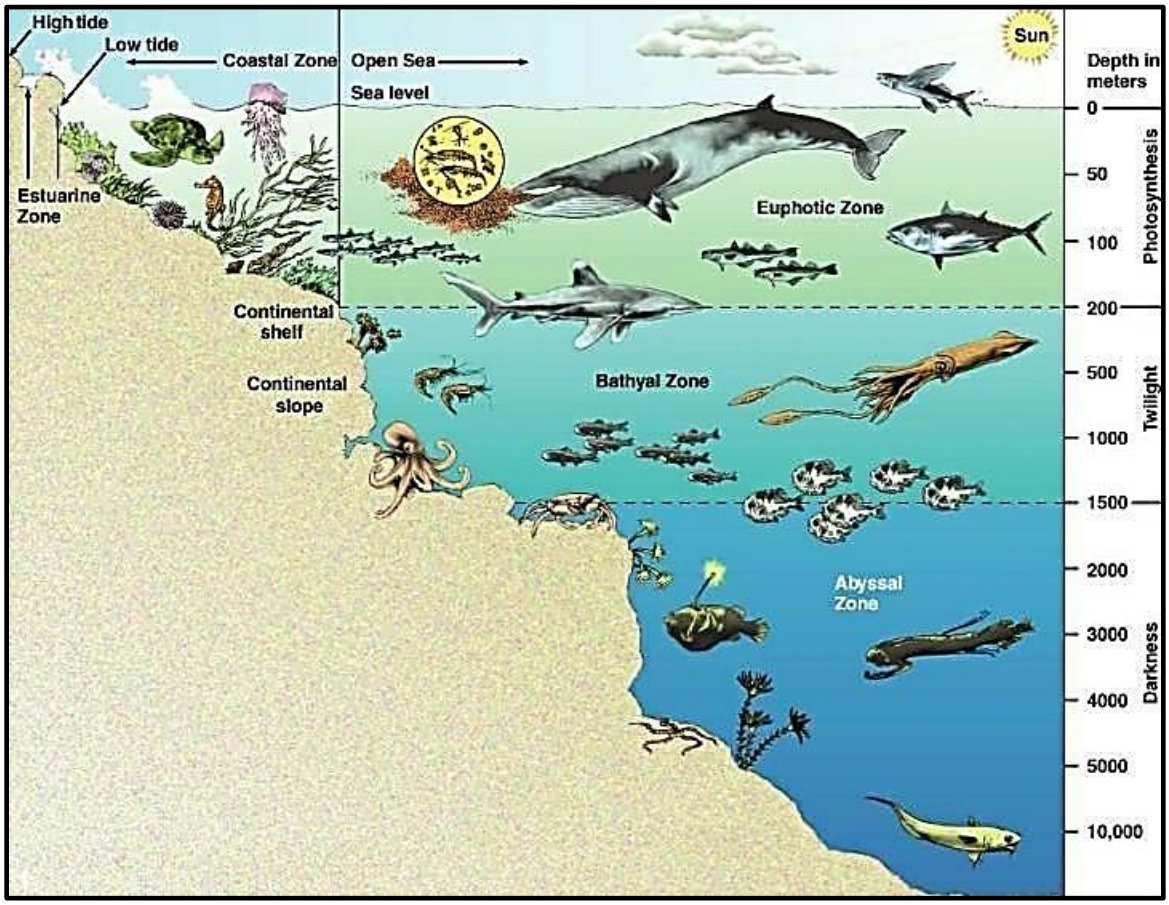
2. **Biota of the Neritic Oceanic Zone** : This zone constitutes 75% of the total oceanic area and is relatively rich in species and high in productivity owing to factors such as penetration of light to considerable depths and high concentrations of nutrients.

   Communities in this region are both richer and more diverse compared to those of the open ocean. No other region has such a variety of life not even the tropical rain forests. The most productive phytoplanktons are the dinoflagellates and diatoms, though red, brown and green algae attached to the bottom in the shallow regions. The zooplanktons are usually similar to those of the pelagic zone.

Nekton in the ocean over neritic zone or the continental shelf are diverse and commonly known such as whales, seals, sea-otters, sea snakes and large squids. Fishes are numerous and include several shark species, sardine, salmon and tuna.
The benthic part of the neritic zone is called the sublittoral zone which has a wide variety of animals among which are clams, shrimps, snails, lobsters, crabs, sea cucumber, starfish, sponges, annelids and foraminifera. These animals exhibit more diversity than those of the deeper waters, since the physical factors here are more variable. The bottom may be rocky, sandy or muddy and the temperature difference in the sublittoral zone of this region is greater as compared to the deeper ecosystems. The difference in the physical environment is reflected in the benthic community occurring here.

3**. Biota of Pelagic Zone:** Pelagic region constitutes 90% of the total ocean surface and is less rich in species and numbers of organisms than the two regions discussed before. The species of this zone are characteristic. The environment due to the continuity of the sea waters is uniform and stable for the organisms occurring here.
The most abundant pelagic phytoplanktons are still the dinoflageilates and diatoms which are the chief photosynthetic feeders, other are carnivores. Detritus feeders such as sea lillies rise above the sea floor while clams and tubeworms remain burrowed in mud. Sea cucumbers and sea urchins crawl on the floor eating detritus and bacteria and serve as food for the carnivorous brittle stars and crabs.


phytoplankton
zooplankton
N, P, Si
O_2
dead cells
fecal pellets
river
fresh water
nutrients (N, P, Si)
sediments &
organic carbon
O_2 flux blocked
organic
material
flux
lighter, fresher
warmer, surface
layer
pycnocline
escape
mortality
heavier, saltier
cooler, lower
layer
healthy benthic community
(worms, snails, bivalves,
crustaceans)
organic matter decomposed
& oxygen consumed
upwelled
nutrients
& oxygen
(effects
unquantified)


High tide
Low tide
Coastal Zone
Open Sea
Sea level
Sun
Depth in
meters
Estuarine
Zone
Euphotic Zone
Continental
shelf
Continental
slope
Bathyal Zone
Abyssal
Zone
0
50
100
200
500
1000
1500
2000
3000
4000
5000
10,000
Photosynthesis
Twilight
Darkness

*__Coral reef zone__: This area is considered one of the most productive and highly diverse areas of marine life, and the animals that make up coral reefs prefer shallow water, sunlight, the intensity of light in tropical regions is high and the day is long, while the intensity of light in the regions near the poles decreases and the day is shorter therefore, in tropical regions, many coral reefs are formed while their growth is slow at the poles and coral reefs are few.

They preferred temperature to build these reefs between 22-28 ° C., and there are other types that have the ability to build Coral reefs differ from the regular types as they are a solid barrier located almost in the deep and dark waters of the edge of the continental shelf, and the organisms forming these types are active in the construction process at a temperature ranging between 4-15 ° C and at a depth ranging between 60-180 meters, A third of the coral reefs prefer lower temperatures between 2-6 ° C.

Nutrients such as nitrates and phosphates play an important role in the diet of the animals building the coral reefs. These substances are present in small quantities throughout the year. In turn, it is considered one of the important sources of food for the animals building the coral reefs.

The animals building coral reefs have the ability to live in waters whose salinity is between 30-40, and these waters are saturated with calcium carbonate salts necessary to build the coral reef structure.