Water

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Natural resource management

» There are four major types of habitats in the biosphere-

> Freshwater,

> Marine,

> Estuarine, and

> Terrestrial.

Habitat Ecology

Freshwater Ecology

- It is mainly the study of relationship between organisms and the freshwater environment.
- Study of
  - Physical,
  - Chemical.
  - Geological, and
  - Biological
- Limnology: The study of all aspects of freshwaters is termed as Limnology.

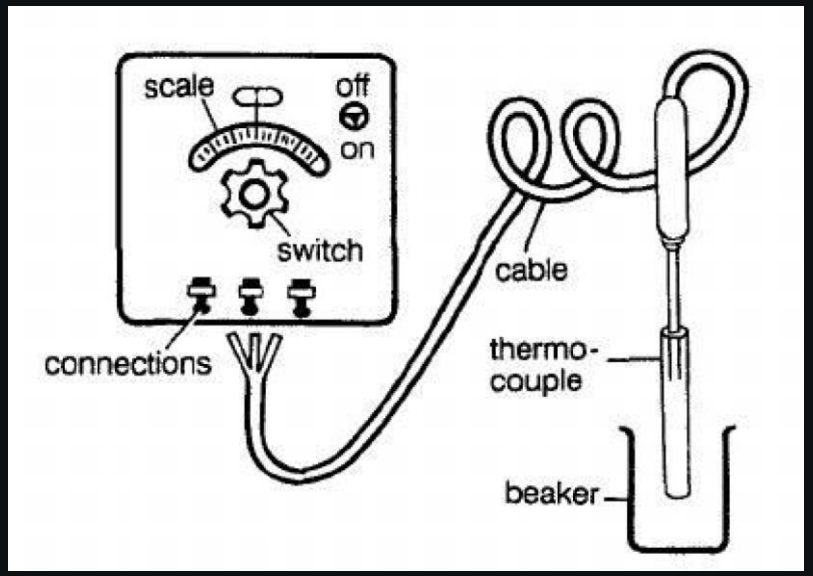
Terminologies

- Freshwater habitats occupy a relatively small portion of earth's surface as compared to marine and terrestrial habitats.
- But freshwater habitats are of much importance to mankind.
- Such habitats are of two general types:
  - Standing-water or (***lentic***): Such as
    - Pond,
    - Lake
    - Swamps,
    - Bog etc., and
  - Running-water or (lotic). Such as
    - River,
    - Stream,
    - spring etc.

Habitat conditions

- Temperature in freshwater habitats does not show much range of variations.
- Due to several unique thermal properties of water.
- Less variations in temperature is a major limiting factor in distribution of organisms.
- Aquatic organisms generally have narrow tolerances i.e. are ***stenothermal***.
- Temperature of water is measured with the instrument, ***thermistor***.

Diagram showing a thermistor



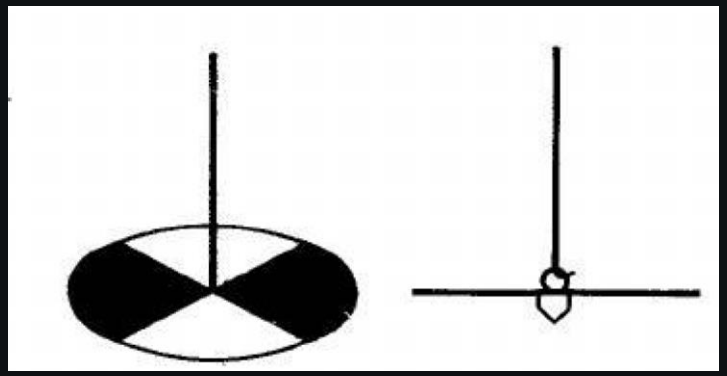
Temperature

- It depends upon:
  - The kind and amount of suspended materials, chiefly as silt
    - Clay particles and
    - Living organisms etc.
- Turbidity affects
  - The penetration of light (transparency), and
  - It is important limiting factor in the distribution of organisms.

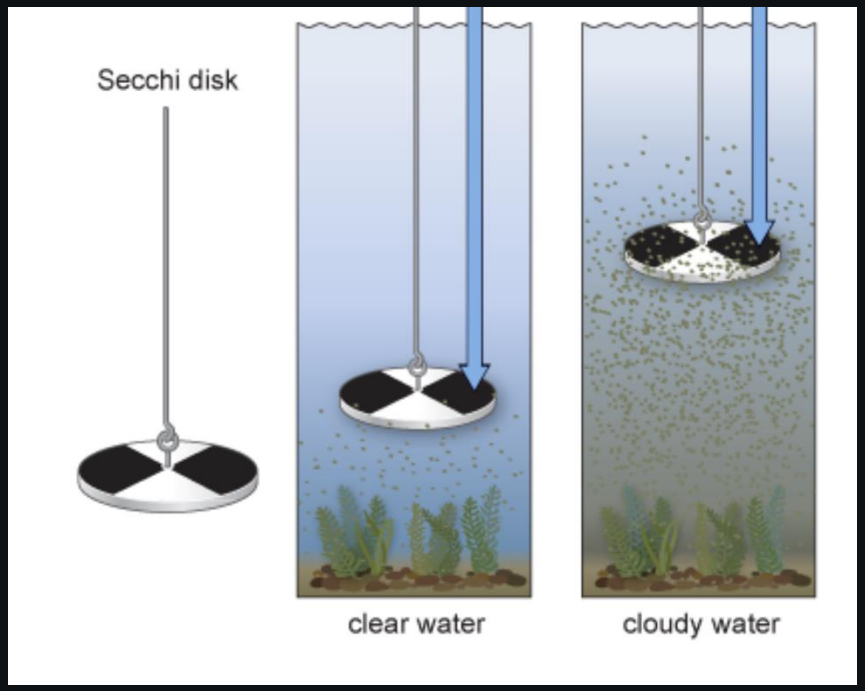
Turbidity

Transparency

- It is directly related to turbidity of water.
- It is generally measured with a very simple instrument called a ***Secchi disk*** (introduced by A. Secchi, 1865).



Secchi disc-front and lateral views.



- It has direct very important effect on the organisms' distribution.
- It affects the distribution of
  - Vital gases,
  - Salts, and
  - small organisms.
- It is often limiting factor in such habitats.
- Their concentrations are measured in terms of
  - D.O.- dissolved oxygen, and
  - B.O.D.-biological oxygen demand etc.
- Concentration of biogenic salts, (as nitrates, phosphates etc.), appear to be limiting factor to some extent in the distribution of organisms in such habitats.
- Due to higher concentration of salts in their body fluid, protozoans with contractile vacuoles, and fish with their kidneys are efficient for osmoregulation, thus avoiding the swelling up and bursting of their bodies.

Current action of water

- These are generally classified in the following manner:
  - On the basis of their major niches based on their position in the energy or food chain,
    - They are autotrophs (producers),
    - Phagotrophs (macro-consumers), and
    - Saprotrophs (decomposers or microconsumers).
  - On the basis of their life-forms or life habit,
    - Benthos (bottom),
    - Periphyton (attached to other plant),
    - Planktons (floating),
    - Nekton (swimming), and
    - Neuston (resting or swimming on surface).

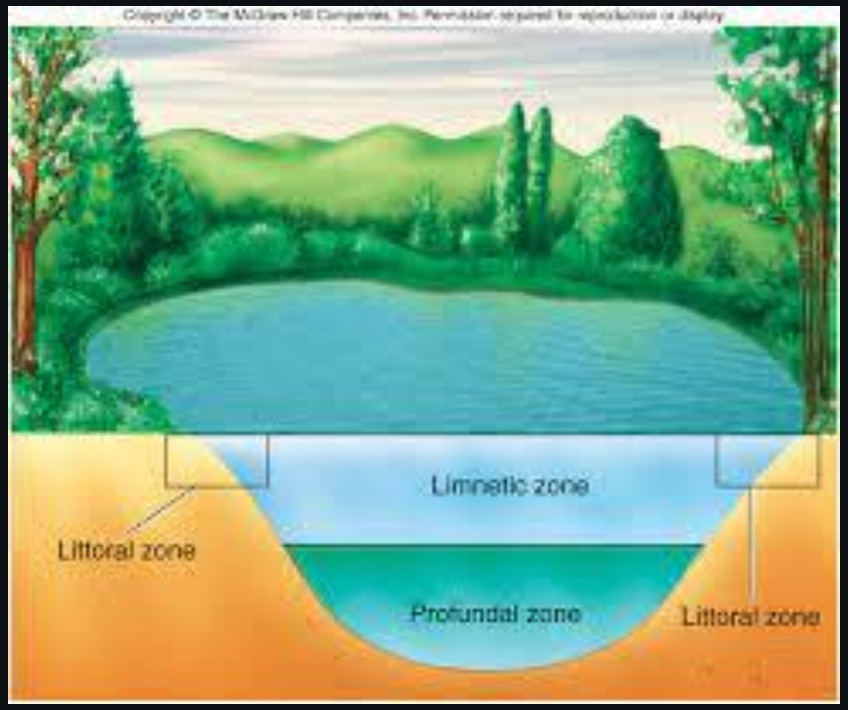
Ecological classification of organisms

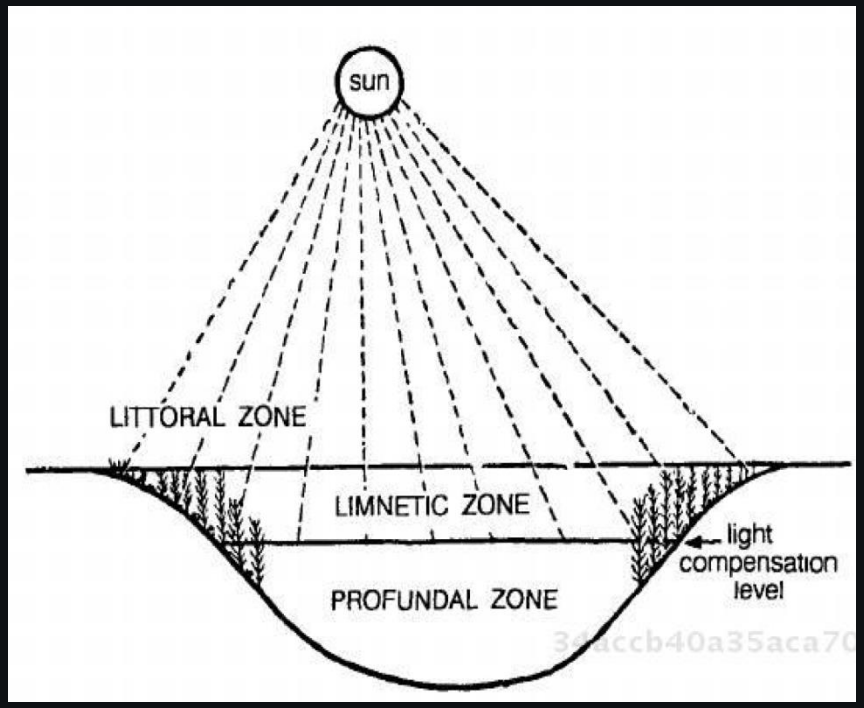
» Three generally distinguished zones are,

(i) **Littoral zone**. which is shallow-water region,

(ii) **Limnetic zone**, an open-water zone to the depth where effective light can penetrate,

(iii) **Profundal zone** (often absent in ponds), the bottom and deep water area, beyond the depth of effective light penetration.



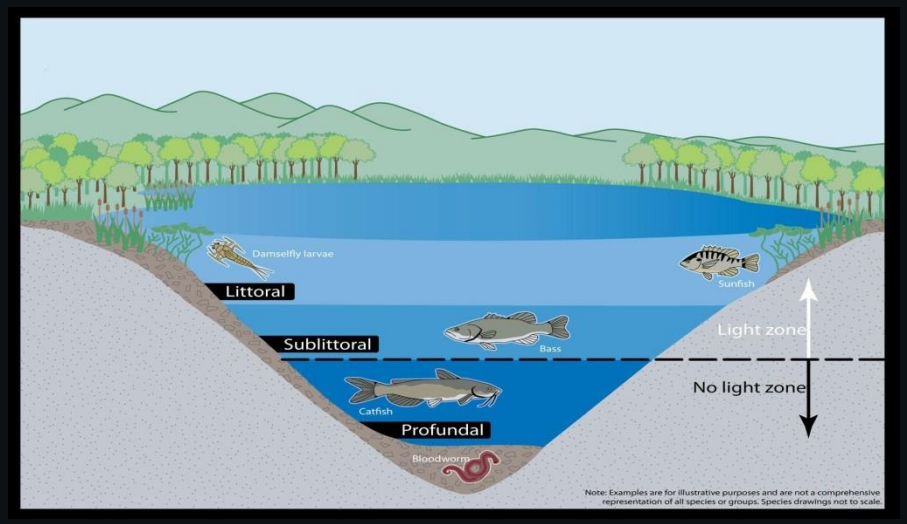


Pond or Lake

- In freshwaters the common components of flora and fauna are:
  - Algae,
  - Bacteria,
  - Fungi.
  - Aquatic phanerogams,
  - Crustaceans,
  - Aquatic insects,
  - Molluscs, and
  - Fish.
- The species composition in the above said three zones differ from each other.
- The species found in ***lentic*** (ponds, lakes etc.) and ***lotic*** waters (streams etc.) are also somewhat different.

The communities

- Lentic communities are aquatic communities that occur in still waters where the current does not have one flow of direction such as ponds, lakes, and wetlands.
- Each lentic community is divided into
  - The littoral zone,
  - Sublittoral zone or limnetic zone and
  - Profundal zone.



Lentic communities:

- In littoral zone, the producers, are
  (i) Rooted or benthic plants, mainly seed plants and
  (ii) Floating green plants, the phytoplanktons, which are mainly the algae.

- From shallow to deeper waters in ponds and lakes, we generally find
  - *Zone of emergent species*, i.e. rooted hydrophytes with their assimilatory organs projecting above the water level *e.g. Typha, Scirpus, Sagittaria, Eleocharis* etc.
  - *Zone of rooted plants with floating leaves*, such as species of *Nymphaea*. *Nelumbo* etc.
  - *Zone of submergent vegetation*, consisting of rooted plants that remain completely or largely submerged in water *e.g. Potamogeton, Ruppia, Ceratophyllum. Hydrilla, Vallisneria, Nitel!a, Chara, Elodea* etc.
  - The phytoplanktons in the littoral zone are several species of algae that keep on floating in this as well as in limnetic zone.
  - Some algae found in littoral zone are attached to or associated with the rooted plants.
  - These algae are diatoms, green algae, including unicellular forms as desmid, filamentous (attached or floating) as species of *Spirogyra, Zygnema, Oedogonium, Cladophora, Chara* etc., and, various colonial forms as *Volvox, Hydrodictyon* etc; blue green algae, which are unicellular or colonial.

Littoral zone : Producers

- Consumers are animals in which vertical rather than horizontal zonation.
- Some of the common animals of this zone are pond snails, damsel fly nymphs, rotifers, flatworms, hydra. some insect larvae etc.
- Those resting or moving on the bottom or beneath silt or plant debris, are sprawling *Odonata* nymphs, crayfish, isopods and certain mayfly nymphs.
- More deep into the bottom mud are burrowing *Odonata* and *Ephemeroptera*, clams, annelids, snails, and chironomids and other *Diptera* larvae.
- The nekton (swimming) organisms in litoral zone are adult and larvae diving beetles and various adult *Hempitera*.
- Various *Diptera* larvae and pupae remain suspended in water.
- Amphibians. such as frogs, turtles and water snakes are exclusively found in the littoral zone.
- Pond fish keep on moving freely between the littoral and the limnetic zone, but most species spend a large part of their time in the littoral zone.
- The zooplankton of the littoral zone is rather characteristic and differs from that of the limnetic zone in preponderance of heavier, less buoyant crustacea which often cling to plants or rest on the bottom.
- Important components of zooplanktons are large, weak-swimming species of water fleas, some cyclopoidea and all of the *Harpacticoidea*, some rotifers and many ostracods.
- The neuston organisms of littoral zone are three surface insects (whirlgig beetles of the family Gyrinidac; large water striders, family Gerridae; and the smaller, broad-shouldered water striders, family Veliidae); numerous protozoa, though not conspicuous, and other microorganisms associated with surface film.

Littoral zone: Consumers

- The producers are mainly phyto-planktonic algae, which are diatoms, green algae and blue-green algae.
- In limnetic zone, some other producers are algae-like green flagellates chiefly the dinoflagellates, Euglenidae and Volvocidae.
- In temperate lakes phytoplanktonic populations show marked seasonal variations, sometimes forming conspicuous blooms or pulses.

In limnetic zone: the producers

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- The consumers of, the zooplanktons represent a few species but their number is large.
- Copepods, cladocerans, and rotifers are chiefly present, the species of which are entirely different from these of the littoral zone.
- Common forms are *Diaptomus*, *Cyclops*, *Diapharwsoma*, *Sida* and *Bosmina*. Swimming (nekton) animals in this w ne are exclusively the fish, as the gizzard shads, that feed on planktons.

Limnetic zone: Consumers

- The organisms mainly depend for their food on the littoral and limnetic zones, since there is no penetration of effective light to this zone.
- In return, this zone provides 'rejuvenated‘ nutrients, that are carried by currents and swimming animals to other zones.
- Major life-forms are bacteria and fungi, abundant in the water-mud interphase; bloodworms or haemoglobin containing chironomid larvae and annelids; small clams of the family Sphaeriidae; and 'phantom larvae' that are planktonic.
- These all are adapted to withstand periods of low oxygen concentrations.

Profundal Zone

- Being larger in size than ponds, show important ecological differences.
- In lakes the limnetic and profundal zones are relatively large, as compared to the littoral zone, whereas in ponds generally reverse is true.
- Thus, in lakes, the limnetic zone is the chief 'producing region' whereas in ponds such a region is the littoral zone, and the communities of this zone are of primary interest.
- In lakes, the phytoplankton and the nature of the bottom. and its living organisms are of first interest.
- Moreover, in ponds, there is limited stratification of temperature and oxygen whereas lakes particularly of temperate zone, which are not very shallow, show stratification at certain seasons.

The lakes

Differences between Lentic and Lotic communities

- The following are the chief ecological differences between lentic and lotic freshwater habitats:
  - Water current is much more of a major controlling and limiting factor in streams: Velocity of current varies greatly in different parts of the same stream.
  - Current makes for a big difference between stream and pond life, and governs differences in various parts of a given stream.
  - Land-water interchange is relatively more extensive in streams, resulting in a more 'open‘ ecosystem and a 'heterotrophic' type of community metabolism.
  - Streams form an open ecosystem that is inter-digitated with terrestrial and lentic systems.
  - Oxygen tension is generally more uniform in streams and there is little or no thermal or chemical stratification.
  - In ponds and lakes (lentic), the prominent zonation is horizontal, in streams, it is longitudinal.

- Lotic communities are systems of moving water such as creeks, streams, and rivers.
- The water in a lotic community must flow in one direction from source to mouth.

Lotic Communities

- The chief producers that remain permanently attached to a firm substrate are attached green algae such as *Cladophora*, encrusting diatoms and aquatic mosses of the genus *Fontinalis*.
- The consumers show certain such features as permanent attachment to a firm substrate, presence of hooks and suckers, sticky undersurfaces, streamlined bodies, flattened bodies, positive rheotaxis (rheo=current; taxis = arrangement) and positive thigmotaxis (thigmo = touch, contact).
- Thus a variety of animals are found, which are freshwater sponges and caddis-f1y larvae, larvae of *Stimulium* and *Blepharocera*, snails and flatworms, fish, and stonefly and mayfly nymphs.
- Longitudinal zonation of fish in stream becomes very much apparent, which is influenced mainly by gradients of temperature, current velocity and pH of the medium.

Producers and consumers

- Marine ecology emphasizes the totality or pattern of relationships between organisms and the sea environment.
- The study of the sea in all of its aspects i.e. physical, chemical, geological and biological is termed **oceanography**.

Marine Ecology

- The sea is big, covering about 70% of earth's surface.
- The sea is deep and continuous, not separated as are land and fresh water.
- All the oceans are connected.
- Temperature, salinity and depth are the chief barriers to free movement of marine organisms.
- The sea is in continuous circulation due to wind stress set up by air temperature differences between poles and equator.
- Sea is dominated by waves of many kinds and tides produced by the pull of moon and sun.
- The sea is salty, with an average salinity of 35 parts of salt (weight basis) per 1000 parts of water, or that is usually written as 3.5% i.e. parts per 1000 (cf. salinity of fresh water that is less than 0.5%).
- The chief salts are
  - chlorides,
  - sulphates,
  - bicarbonates,
  - carbonates and
  - bromides of sodium, magnesium, calcium and potassium, of which sodium chloride is present in maximum amount.
- Dissolved nutrients are in a low concentration, that is an important limiting factor in determining size of marine populations.

Environmental conditions

- Seas also exhibit a distinct zonation.
- Generally, there is a continental shelf extending for a distance offshore, beyond which the bottom drops off steeply as the continental slope then levels off somewhat (the continental rise) before dropping down to a deeper, but more level, plain.
  - The shallow-water zone on the continental shelf is the neritic (near shore) zone.
  - The zone between high and low tides (also called the littoral zone) is known as the intertidal zone.
  - The region of the open sea beyond the continental shelf is called oceanic region, which comprises the region of the continental slope and rise - the bathyal zone; area of the ocean 'deeps' - abyssal region; and light compensation zone separating an upper thin euphotic zone from a vastly thicker aphotic zone.
- Within these primary zones (based chiefly on physical factors), there may occur distinct secondary zones, horizontal as well as vertical, in such waters.
- Thus communities in each of the primary zones, excepting the euphotic, have two distinct vertical components, the benthic (bottom), and the pelagjc (open sea).

Zonation in the sea

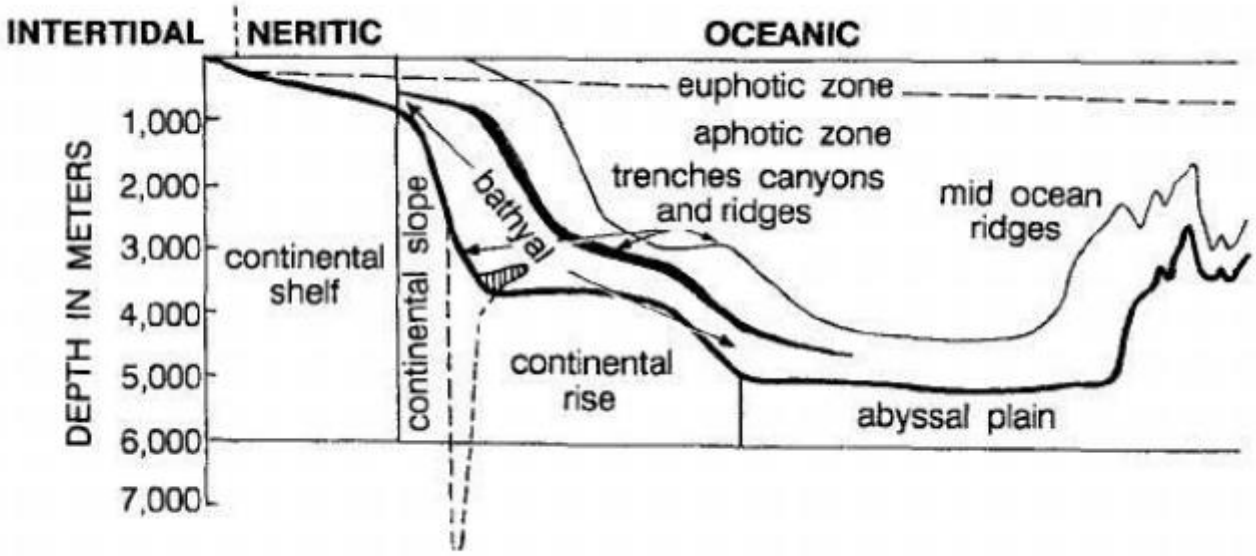

Fig. 11.2. Diagrammatic sketch showing horizontal and vertical zonation in the sea.

- The producers in the continental shelf region are chiefly the phytoplank-tonic diatoms and dinoflagellates.
- Near seashore large multicellular attached algae or seaweeds are also important that form extensive forests or kelp beds below the tide mark.
- Green algae. brown algae, and red algae are important producers, of which the latter two are more common.
- These algae show a depth distribution roughly in the order named (with red algae deepest).
- Neritic phyto-plankton at least in temperate regions, undergoes a seasonal density cycle similar to that in eutrophic lakes.

The communities- producers ›

- Zooplanktons:
  - These are of various types.
  - Those which remain for their entire life cycle as planktons are called haloplankton, as copepods, larger crustaceans (krill), euphausids, protozoans, 'wing-footed' molluscs, tiny jellyfish, ctenophores, pelagic tunicates (salps), and free-floating polychaete wonns etc.
  - Some of the zooplanktons are called meroplanktons, as most of the benthos, and much of the nekton (fish) in larval stages join the plankton assemblage for varying periods.
- Benthos:
  - These are in large numbers and are sessile or relatively inactive animals in the inshore region.
  - They are distinct in supratidal, intertidal and subtidal zones.
  - These include a variety of crabs, amphipods, tiger, beetles and other insects, periwinkles, isopods, ghost shrimps, barnacles, oysters, mussels, dollars, clams, shells, corals, sea anemone etc.
- Nekton and neuston:
  - These are swimming animals which include fish, turtles, such mammals as whales, seals, etc., and the marine birds. Moreover, some other animals that feed on planktons are also found, which include herring, menhaden, sardine etc.
- Bacteria:
  - These are present in less amount being mainly as sediments.
  - Fungi and yeasts are not very important in such habitat. In the oceanic region, communities are chiefly of pelagic and benthic type.

The communities- consumers ❯

- An estuary is a semi-enclosed coastal body of water which has a free connection with the open sea
- It is strongly affected by tidal action, and within which sea water is mixed with fresh water from land drainage.
- Examples: river mouths, coastal bays, tidal marshes, and water bodies behind barrier beaches.
- Estuaries may be considered as transitional zones or ecotones between the freshwater and marine habitats.
- Estuaries are variously classified on the basis of their geomorphology, water circulation and stratification and systems energetics.
- Based on geomorphology, estuaries are

(i) drowned river valleys,
(ii) ford-type estuaries,
(iii) bar-built estuaries,
(iv) estuaries produced by tectonic processes,
(v) river delta estuaries etc.

Estuarine Ecology

- On the basis of water circulation and stratification, estuaries are classified as

  (i) highly stratified or salt-wedge estuaries,

  (ii) partially mixed or moderately stratified estuaries,

  (iii) completely mixed or vertically homogeneous estuaries, and

  (iv) hyper-saline estuaries.

- Based on the ecosystem energetics, as done by Odum et al., (1969), estuaries are classified as

  (i) physically stressed systems of wide latitudinal range,

  (ii) natural arctic ecosystems with ice stress,

  (iii) natural temperate coastal ecosystems with seasonal programming,

  (iv) natural tropical coastal ecosystems of high diversity,· and

  (v) emerging new systems associated with man.

- Communities of estuaries are a mixture of endemic species and those which come in from sea.

- Here rate of primary production exceeds the rate of community respirations.
- The producers are reefs, banks, seaweed or sea grass beds, algal mats and salt marshes.
- This system exports energy and nutrients to deeper waters of the estuary and adjacent coastal shelf.
- Estuaries are equivalent to tropical rain forest and coral reefs as natural productive ecosystems.
- Indeed estuaries are more productive than either the sea on one side or the freshwater drainage on the other.
- Estuaries are said to be the nutrient traps.
- Being rich in diverse types of producers these remain 'programmed' for virtually year around photosynthesis and derive benefit from tidal action in creating a subsidized fluctuating water level ecosystem.
- They have all the three types of producers, the macrophytes (sea-weeds, sea grass and
- marsh grasses), bentbic microphytes and phytoplanktons.
- The important macrophytes are *Spartina*, *Zostera* and *Thdlassia*.
- Benthic algae grow on macrophytes and sessile animals as well as on rocks, sand and mud.
- Moreover, estuaries possess distinct blooms such as red tides of large blooms of red pigmented dinoflagel-lates, such as species of *Gonyaulax* and *Gymnodinium*.

Shallow water production zones

- These are present in the deeper channels, sounds and lagoons in which respiration exceeds production and in which particulate and dissolved organic matter from the production zone is used.
- Here nutrients are regenerated, recycled, stored and vitamins and growth regulators are manufactured.
- The consumers are often versatile in their feeding habits.
- They are more or less similar to those present in marine environment though well developed in estuaries.

Sedimentary subsystems

- They move freely between the two above said fixed subsystems.
- They keep on producing, converting and transporting nutrients and energy while responding to diurnal, tidal and seasonal periodicities.
- Generally, holo-plankton comprises relatively few species, while the mero-planktons tend to be more diverse, reflecting the variety of benthic habitats.

Plankton and nekton

Major Threats to Aquatic Biodiversity

Human Activities Are Destroying and Degrading Aquatic Habitats

- Habitat loss and degradation: Some 90% of fish living in the ocean spawn in coral reefs , mangrove forests, coastal wetlands, or rivers and these areas are under intense pressure from human activities. Scientists reported in 2006 that these coastal habitats are disappearing at rates 2–10 times higher than the rate of tropical forest loss.
- Loss and degradation of many sea bottom habitats by dredging operations and trawler fishing boats. Trawlers drag huge nets weighted downwith heavy chains and steel plates like giant submerged bulldozers over ocean bottoms to harvest a few species of bottom fish and shellfish (Figure 11-3). Trawling nets reduce coral reef habitats to rubble and kill a variety of creatures on the bottom by crushing them, burying them in sediment, and exposing them to predators.
- Habitat disruption is also a problem in freshwater aquatic zones: Dams and excessive water withdrawal from rivers and lakes (mostly for agriculture) destroy aquatic habitats and water flows and disrupt freshwater biodiversity. As a result of these and other human activities, 51% of freshwater fish species—more than any other major type of species—are threatened with premature extinction.

Invasive Species Are Degrading Aquatic Biodiversity:

- The deliberate or accidental introduction of hundreds of harmful invasive species—the into coastal waters, wetlands, and lakes throughout the world. These bio-invaders can displace or cause the extinction of native species and disrupt ecosystem services. For example, since the late 1980s, Lake Victoria (Core Case Study) has been invaded by the water hyacinth (Figure 11-4). This rapidly growing plant has carpeted large areas of the lake, blocked sunlight, deprived fish and plankton of oxygen, and reduced aquatic plant diversity.
- According to a 2008 study by The Nature Conservancy, 84% of the world's coastal waters are being colonized by invasive species. Bioinvaders are blamed for about two-thirds of fish extinctions in the United States between 1900 and 2000.
- Consumers also introduce invasive species. For example, the Asian swamp eel has invaded the waterways of south Florida (USA), probably from the dumping of a home aquarium. This rapidly reproducing eel eats almost anything—including many prized fish.

Population Growth and Pollution Can Reduce Aquatic Biodiversity

- The U.N. Environment Programme (UNEP) projects that, by 2020, 80% of the world's people will be living along or near the coasts, mostly in gigantic coastal cities. This coastal population will add to the already intense pressure on the world's coastal zones, primarily by destroying more aquatic habitat and increasing pollution. Humans have doubled the flow of nitrogen, mostly from nitrate fertilizers, into the oceans.
- These inputs of nitrogen (and similar inputs of phosphorus) result in eutrophication of marine and freshwater systems, which can lead to algal blooms, fish die-offs, and degradation of ecosystem services.
- Toxic pollutants from industrial and urban areas can kill some forms of aquatic life by poisoning them and each year, plastic items dumped from ships and left as litter on beaches kill up to 1 million seabirds and 100,000 mammals and sea turtles. Such pollutants and debris threaten the lives of millions of marine mammals and countless fish that ingest, become entangled in, or are poisoned by them. These forms of pollution lead to an overall reduction in aquatic bio diversity and degradation of ecosystem services.

Climate Change Is a Growing Threat

- Climate change threatens aquatic biodiversity and ecosystem services partly by causing sea levels to rise. During the past 100 years, average sea levels have risen by 10–20 centimeters (4–8 inches), and scientists estimate they will rise another 18–59 centimeters (0.6–1.9 feet) and perhaps as high as 1–1.6 meters (3.2–5.2 feet) between 2050 and 2100 mostly, because of projected global warming. This would destroy more coral reefs, swamp some low-lying islands, drown many highly productive coastal wetlands, and put much of the U.S. state of Louisiana's coast, including New Orleans, under water.
- The human demand for seafood is outgrowing the sustainable yield of most ocean fisheries.

Overfishing and Extinction:

- Thousands of years, humans living in some coastal areas have overharvested fishes, shellfish, seals, turtles, whales, and other marine mammals (Concept 11-1). But today's industrialized fishing fleets can overfish much more of the oceans and deplete marine life at a much faster rate.

- We can help to sustain marine biodiversity
  - By using laws and
  - Economic incentives to protect species, setting aside marine reserves to protect ecosystems, and
  - Using community-based integrated coastal management.
- Laws and Treaties Have Protected Some Endangered and Threatened Marine Species: Protecting marine biodiversity is difficul: It hast several reasons.
  - First, the human ecological footprint and fishprint are expanding so rapidly into aquatic areas that it is difficult to monitor the impacts.
  - Second, much of the damage to the oceans and other bodies of water is not visible to most people.
  - Third, many people incorrectly view the seas as an inexhaustible resourcethat can absorb an almost infinite amount of waste and pollution and still produce all the seafood we want.
  - Finally, most of the world's ocean area lies outside the legal jurisdiction of any country.
  - Thus, it is an open-access resource, subject to overexploitation.

How Can We Protect and Sustain Marine Biodiversity\?

- The regulatory approach.
  - National and international laws and treaties help to protect marine species: It include
    - The 1975 Convention on International Trade in Endangered Species (CITES),
    - The 1979 Global Treaty on Migratory Species, the U.S.
    - Marine Mammal Protection Act of 1972.
    - The U.S. Endangered Species Act of 1973,
    - The U.S. Whale Conservation and Protection Act of 1976, and
    - The 1995 International Convention on Biological Diversity.
- Economic Incentives Can Be Used to Sustain Aquatic Biodiversity
  - According to a 2004 World Wildlife Fund study, sea turtles are worth more to local communities alive than dead.
  - The report estimates that sea turtle tourism brings in almost three times more money than does the sale of turtle products such as meat, leather, and eggs.
  - The problem is that individuals seeking to make a quick gain take the turtles before their surrounding communities can realize the longer-term economic benefits by protecting them.
  - Educating citizens about this issue could inspire communities to protect the turtles

Ways to protect and sustain marine biodiversity

- Marine Sanctuaries Protect Ecosystems and Species:
  - By international law, a country's offshore fishing zone extends to 370 kilometers (200 statute miles) from its shores.
  - Foreign fishing vessels can take certain quotas of fish within such zones, called exclusive economic zones, but only with a government's permission.
  - Ocean areas beyond the legal jurisdiction of any country are known as the high seas, and laws and treaties pertaining to them are difficult to monitor and enforce.
  - Through the Law of the Sea Treaty, the world's coastal nations have jurisdiction over 36% of the ocean surface and 90% of the world's fish stocks. Instead of using this law to protect their fishing grounds, many governments have promoted overfishing, subsidized new fishing fleets, and failed to establish and enforce stricter regulation of fish catches in their coastal waters.
  - Some countries are attempting to protect marine biodiversity and sustain fisheries by establishing marine sanctuaries.
    - Since 1986, the IUCN has helped to establish a global system of marine protected areas (MPAs)— areas of ocean partially protected from human activities.
    - There are more than 4,000 MPAs worldwide, 200 of them in U.S. waters. Despite their name, most MPAs are only partially protected.
    - Nearly all allow dredging, trawler fishing, and other ecologically harmful resource extraction activities.

- Many scientists and policymakers call for adopting an entirely new approach to managing and sustaining marine biodiversity and the important ecological and economic services provided by the seas.
- The primary objective of this ecosystem approach is to protect and sustain whole marine ecosystems for current and future generations instead of focusing primarily on protecting individual species.
- The cornerstone of this ecological approach is to establish a global network of fully protected marines reserves, some of which already exist.
- These areas are put off-limits to destructive human activities in order to enable their ecosystems to recover and flourish.
- This global network would include large reserves on the high seas, especially near highly productive nutrient upwelling areas, and a mixture of smaller reserves in coastal zones that are adjacent to well-managed, sustainable commercial fishing areas.
- This would encourage local fishers and coastal communities to support them and participate in determining their locations.
- Some reserves could be made temporary or moveable to protect migrating species such as turtles.
- Governments could use satellite technologies to update fishing fleets about the locations of designated reserves.

Establishing a Global Network of Marine Reserves: An Ecosystem Approach to Marine Sustainability

- Such reserves would be closed to extractive activities such as commercial fishing, dredging, and mining, as well as to waste disposal.
- Most reserves in the proposed global network would permit less harmful activities such as recreational boating, shipping, and in some cases, certain levels of small-scale, nondestructive fishing.
- However, most reserves would contain core zones where no human activity is allowed.
- Outside the reserves, commercial fisheries would be managed more sustainably by use of an ecosystem approach instead of the current approach, which focuses on individual species without considering their roles in the marine ecosystems where they live.

- Marine reserves work and they work fast.
- Scientific studies show that within fully protected marine reserves, fish populations double, fish size grows by almost a third, reproduction triples, and species diversity increases by almost one-fourth.
- Furthermore, this improvement occurs within 2–4 years after strict protection begins, and it lasts for decades.
- Research also shows that reserves benefit nearby fisheries, because fish move into and out of the reserves, and currents carry fish larvae produced inside reserves to adjacent fishing grounds, thereby bolstering the populations there.

- There is hope for significant progress in sustaining marine biodiversity, but it will require that we change our ways—and soon.
- For example, IUCN and The Nature Conservancy scientists reported in 2006 that the world's coral reefs and mangrove forests could survive currently projected global warming if we relieve other stressors such as overfishing and pollution.
- Some coral species may be able to adapt to warmer temperatures, they may not have enough time to do this unless we act now to slow down the projected rate of global warming.
- Increasing ocean acidity could have a major impact on corals and other marine organisms that build shells and skeletal structures out of calcium carbonate, which can dissolve at certain acidity levels. Increasing ocean acidity is likely to have serious impacts on the biodiversity and functioning of coral reefs.
- A 2005 report by the United Kingdom's Royal Society concluded that there was no way to reverse the widespread chemical and biological affects of increasing ocean acidification except by sharply reducing human inputs of CO_2 into the atmosphere, without delay.
- To deal with these problems, communities must closely monitor and regulate fishing and coastal land development and prevent pollution from land-based activities. More important, each of us can make careful choices in purchasing only sustainably harvested seafood.
- Coastal residents must also think carefully about the chemicals they put on their lawns, and the kinds of waste they generate and where it ends up.
- And individuals can reduce their carbon footprints to slow climate change and its numerous harmful effects on marine and other ecosystems.

Protecting Marine Biodiversity Requires Commitments from Individuals and Communities

Thank You