

Aquatic ecosystems

3- Brackish water ecosystems

Brackish water, also sometimes termed brack water, is water occurring in a natural environment having more salinity than freshwater, but not as much as seawater. It may result from mixing seawater (salt water) with fresh water together, as in estuaries, or it may occur in brackish fossil aquifers. Certain human activities can produce brackish water, in particular civil engineering projects such as dikes and the flooding of coastal marshland to produce brackish water pools for freshwater prawn farming. Brackish water is also the primary waste product of the salinity gradient power process. Because brackish water is hostile to the growth of most terrestrial plant species, without appropriate management it is damaging to the environment. Technically, brackish water contains between 0.5 and 30 grams of salt per liter- more often expressed as 0.5 to 30 parts per thousand (‰).

Water type	Salinity (‰)
Freshwater	<0.5
Brackish water	0.5-30
Saline water	30-50
Brine water	>50

Brackish water habitats

1-Estuaries

All the rivers and lakes ultimately drain into the sea. However, many rivers develop a highly specialised zone before joining the proper sea. This zone is called estuary.

An estuary is a transitional zone between rivers and sea representing an ecotone possessing unique ecological features and biotic communities. Estuaries. are the most productive ecosystems of the world.

The best definition comes from a paper by Perillo, 1995, discussing different definitions of estuaries: “An estuary is a semi-enclosed coastal body of water that extends to the effective limit of tidal influence, within which sea water entering from one or more free connections with the open sea, or any other saline coastal body of water, is significantly diluted with fresh water derived from land drainage, and can sustain euryhaline biological species from either part or the whole of their life cycle.

An estuary is where the ocean meets a river in a semi-enclosed area. This causes a mixing of fresh and salt water. An estuary is semi-enclosed part of the coastal ocean containing

brackish water that has free connection with the sea on one side and on the other side it is connected with a river mouth and receives fresh water.

Brackish water condition commonly occurs when fresh water meets seawater. In fact, the most extensive brackish water habitats worldwide are estuaries, where a river meets the sea such as Shatt Al-Arab River meet with Arabian Gulf and Nile River meet with The Mediterranean sea.

Features of Estuaries

The physico-chemical properties of the estuaries have large variation in several parameters and this often creates stressful environment for organisms. This is the one cause that large organisms are less in number in this area than smaller organisms. The most dominant feature of the estuarine environment is the **fluctuation in salinity**. Though salinity gradient exists sometime in an estuary but the pattern of gradient varies seasonally. with the topography, with the tides and with the amount of fresh water.

The estuaries are dominated by muddy **substrates**. which are often very soft. The deposition of particles is also controlled by currents and size of particle. If the strong currents prevail, the substrate will be coarse (sand)' whereas where waters are calm and the currents are weak only fine silt will settle out. These particle in the estuary are of many organic origin derived from both the terrestrial and marine movements. As a result, the accumulated substrate is very rich.

Another important variable is **temperature**. The temperature of estuary keeps on fluctuating, it heats up and cools down more rapidly under prevailing atmospheric conditions. Another reason for this variation is fresh water input. Temperature also varies vertically. The surface waters have the greatest temperature range and the deeper waters the smallest. All the variation i.e. the salinity. the texture of substrate, temperature, organic matter content and available oxygen are controlled by wave action and currents. The wave action in the estuaries is small. As a result there is deposition of fine sediments and development of rooted plants.

Currents in estuaries are caused primarily by tidal action and river flow. Currents are generally confined to channels. but velocities up to several knots can occur. The erosion and deposition in the estuaries are due to currents which is a natural cycle. However, in estuaries deposition exceeds erosion so there is a net accumulation of silt. During dry part of the year. water movement is severely reduced. leading to stagnation, reduced oxygen content, formation of algal blooms and incidence of fish kills.

The water of estuaries is turbid because of the great number of particulates in suspension in the water. The turbidity is minimum near the mouth and increases with distance inland. The major ecological effect of turbidity is a marked decrease in the penetration of light. This, in turn, decreases photosynthesis by phytoplankton and benthic plant, thereby reducing productivity. One of the most important factors in estuary water is oxygen. Since the solubility of oxygen in water decreases with increased temperature and salinity, the precise amount of oxygen in water varies with these parameters. Oxygen is severely depleted in the substrate. The high organic content and high bacterial population of the sediments exert a large oxygen demand on water.

Biota of Estuaries

The estuarine ecosystem is complex and significant. Estuaries are inhabited by animals that are adapted to a changeable environment.

The estuarine community is a mixture of three components : Marine, Fresh water and Brackish water, but overall estuarine diversity is still lower than that of the river or marine community. This is because of huge variation in the estuary's physical environment. Thus, the great productivity of estuaries is built on a narrow base.

The plants of the estuary are of four basic types :

- i) Phytoplankton,
- ii) marginal marsh vegetation,
- iii) mud-flat algae
- iv) epiphytic plants growing on the marginal marsh vegetation.

Because of the turbidity in water, phytoplankton are normally uncommon. The obvious estuarine plants are the marginal and marsh vegetation. These include mangroves and marsh grasses and marsh submerged filamentous colonial green algae. A few animal-feed on them directly but a large proportion is consumed as detritus.

The best known estuarine animals are detritus feeders such as oysters, clams, lobsters and crabs. Several insect larvae, annelid worms and mollusks enter the estuary from fresh water, most near shore marine zooplankton can also be found partway into the estuary along with several types of larger animals. Most important of all this is that estuaries are the nursery ground for a vast number of marine animals ranging from shrimps and crabs to fishes.

This type of ecological succession from a freshwater to marine ecosystem is typical of river estuaries. River estuaries form important staging points during the migration of anadromous and catadromous fish species, such as salmon, shad and eels, Salmon are

anadromous, meaning they live in the sea but ascend rivers to spawn; eels are catadromous, living in rivers and streams, but returning to the sea to breed.

Besides the species that migrate through estuaries, there are many other fish that use them as "nursery grounds" for spawning or as places young fish can feed and grow before moving elsewhere. Herring and plaice are two commercially important species that use the Thames Estuary for this purpose.

Estuaries are also commonly used as fishing grounds, and as places for fish farming or ranching.

Types of estuaries:

There are several ways to divide estuaries, including:

1- **Geomorphology:** On this basis, estuaries are divided into five types:

A- Coastal Plain estuary

B- Bar-built estuary

C- fjord estuary

D- Tectonic estuary

E- Delta estuary

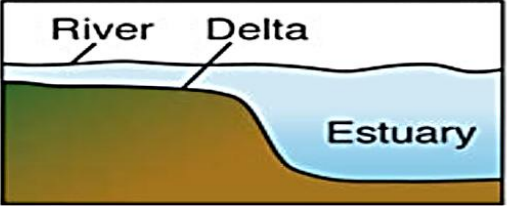
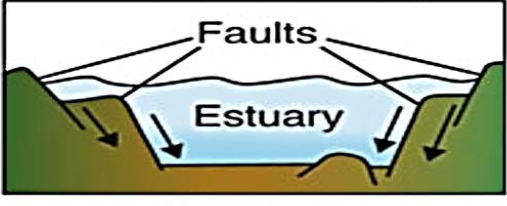
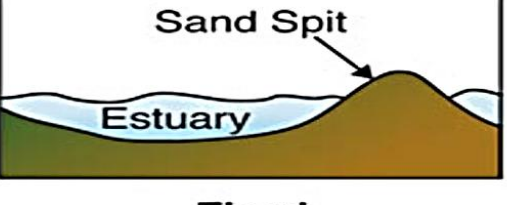
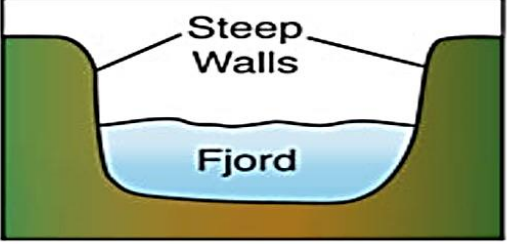

2- **Estuaries Classified by Water Circulation** (Salinity gradient or Stratification)

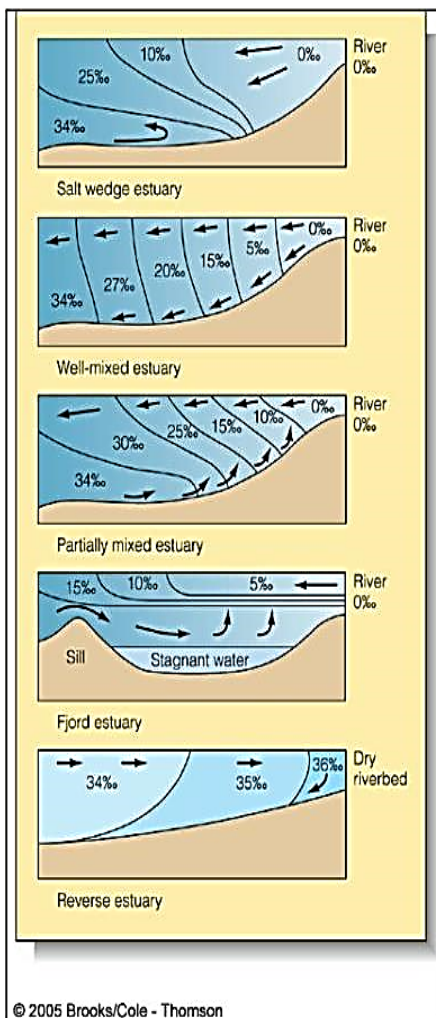
A- Salt Wedge

B- Partially Mixed

C- Well Mixed

D- Fjord-Type

KIND of Estuaries	IMAGE
<p>A coastal plain estuary is one that formed thousands of years ago at the end of the last ice age. During this time, sea levels were lower than they are today so more coastal land was exposed. As the large ice sheets on land began to melt around 10,000 to 18,000 years ago sea levels began to rise and fill in low-lying river valleys to create coastal plain estuaries.</p>	<p>Coastal Plain Estuary</p>  <p>The diagram shows a cross-section of a coastal plain estuary. On the left, a river flows from the land into a wide, flat estuary. The land is brown, and the water is blue. The estuary is labeled 'Estuary' and the river is labeled 'River'. The area where the river meets the estuary is labeled 'Delta'.</p>
<p>Tectonic (fault) estuaries form over time in areas with fault lines. During an earthquake, depressions can occur when land sinks along the fault lines. If the land sinks below sea level and it is near the ocean, the seawater pours into the depression. Over time other faults and depressions allow rivers to do the same and eventually the freshwater and seawater meet to form an estuary.</p>	<p>Tectonic Estuary</p>  <p>The diagram shows a cross-section of a tectonic estuary. It features a central depression labeled 'Estuary' formed by several fault lines, indicated by arrows and the word 'Faults'. The surrounding land is green, and the water in the depression is blue.</p>
<p>Bar built estuaries, also called restricted mouth estuaries, are created when sand bars and barrier islands are formed after ocean currents push sediment toward the shore in areas fed by rivers and streams.</p>	<p>Bar-Built Estuary</p>  <p>The diagram shows a cross-section of a bar-built estuary. A large mound of sediment labeled 'Sand Spit' extends from the land into the water, creating a narrow opening into the 'Estuary'. The land is brown, and the water is blue.</p>
<p>Fjords are the final type of geologic estuary and they are created by glaciers. As these glaciers move toward the ocean they carve long, deep valleys in the coastlines. After the glaciers later retreat, seawater fills in the valleys to meet freshwater coming in from the land to form estuaries.</p>	<p>Fjord</p>  <p>The diagram shows a cross-section of a fjord. It features a deep, U-shaped valley with 'Steep Walls' on either side. The valley is filled with water labeled 'Fjord'. The surrounding land is green.</p>
<p>Deltas are a type of geologic estuary that form at the mouth of a large river where sediment and silt carried by the river are deposited where the river meets the ocean. In these areas the sediment accumulates and overtime wetlands and marshes form as part of an estuary system.</p>	 <p>The diagram shows a top-down view of a delta system. A river labeled 'Delta' branches into multiple channels. Two specific areas are marked with 'A' and 'B'. The land is green, and the water is blue.</p>



SALT WEDGE – high river flow, low tide - nutrients & sediments from river enter estuary

WELL-MIXED – low river flow, moderate tide – tidal turbulence mixes waters together

PARTIALLY-MIXED – low river flow, moderate tide – similar to well-mixed with deeper channel

FJORD – small surface area, high river flow, little tidal mixing

REVERSE – little river inflow, high evaporation

2-Mangroves

Another important brackish water habitat is the mangrove swamp or mangal. Many, though not all, mangrove swamps marginal estuaries and lagoons where the salinity changes with each tide. Among the most specialised residents of mangrove forests are mudskippers, fish that forage for food on land, some of them eat the insects and other small animals living in the trees, Besides fish, numerous other animals use mangroves, including such species as the saltwater crocodile.



3-Brackish marshes

This develop by salt marshes where a significant freshwater influx dilutes the seawater to brackish levels of salinity. This commonly happens upstream from salt marshes by estuaries of coastal rivers or near the mouths of coastal rivers with heavy freshwater discharges in the conditions of low tidal ranges.

4-Brackish seas and lakes

Some seas and lakes are brackish, such as Lake Texoma, the Baltic Sea, Caspian Sea, Hudson Bay and Black Sea.