

## Marine bordered eco systems

### Introduction

The intertidal zone is the place where terrestrial and the marine habitat meet whereas estuary is a place where freshwater and salt water meet. It is a transition zone between the two aquatic ecosystems. Estuaries have been remaining close in association with humans, because many of the major cities of the world are established on estuaries. In contrast to other ecotomes or transitional areas, estuaries have few permanent species.

### Types of Estuaries

There are many definitions of an estuary, because several geomorphological features of coastlines, such as lagoons, sloughs, fjords, and other shallow embayments are often considered estuaries. A simple definition is that an estuary is a partially enclosed coastal embayment where freshwater and seawater meet and mix. This definition implies the free communication of the sea with the freshwater source, at least during a part of the year. This definition excludes permanently isolated coastal water impoundments, as well as such isolated brackish or saline bodies of water of the Caspian Sea, Azov Sea, and Great Salt Lake.

Based on the geomorphology of an estuary, the geological history of the area, and the prevailing climatic conditions, there may be different estuarine types, each displaying somewhat different physical and chemical conditions. These may be grouped into a few basic types. Perhaps the most common type of estuary is the coastal plain estuary. Coastal plain estuaries were formed at the end of the last ice age when the rising sea level invaded low-lying coastal river valleys. Estuaries such as the Chesapeake Bay and the mouths of the Delaware and Hudson rivers in the United States and the Cornwall and Devon estuaries in Great Britain, are examples of this type. Similar to this is the tectonic estuary. In this class of estuary, the sea reinvades the land due to subsidence of the land, not as a result of a rising sea level. A good example is San Francisco Bay. A third type of estuary is the semi-enclosed bay or lagoon. Here sand bars build up parallel to the coastline and partially cut off the waters behind them from the sea. This creates a shallow lagoon behind the sandbars, which collects the freshwater discharge from the land. The water in such lagoons varies in salinity, depending on the climatic conditions, whether or not any major river flows into the lagoon, and the extent to which the bars restrict sea water access. Such estuaries are common in North Carolina and along the Texas and Florida coasts in northwestern Europe (the Netherlands), and part of Australia. A final category of estuary is the fjord. These are valleys that have been deepened by glacial action and are then invaded by the sea. They are characterized by a shallow sill at the mouth that greatly restricts water interchange between the deeper waters of the fjord and the sea. Often, these deeper waters are stagnant because of lack of circulation. Fjords are abundant on the coasts of Norway, Chile, Scotland, Alaska, New Zealand and British Columbia.

Estuaries may be classified in yet another way the salinity gradients are formed. In most estuaries, there is a gradient in salinity from whole seawater (33 – 37 ppt (psu) at the mouth to freshwater at the upper reaches. Freshwater is less dense than seawater and where the two meet, the freshwater will float on the seawater. Mixing occurs when the two come in contact, but the extent of the mixing varies with many other environmental factors, including basin shape, tide, river flow, and rainfall. In estuaries where there is substantial freshwater outflow and reduced evaporation (typical temperate zone estuaries), the fresh water moves out over the top of the Salt Water, mixing with it near the surface and reducing the salinity, leaving the deeper waters more saline. In such a situation, a cross section of the estuary shows isohalines (lines of equal salinity), which extend upstream at bottom. At any given point on the estuary, a vertical column of water has highest salinity at or near the bottom and lowest at or near the surface. This is a positive estuary (or) salt wedge estuary. These estuaries are also called river dominated (or) stratified. Such estuaries form a continuum –from those with little mixing and very prominent salt wedges, through those with partial mixing and lesser wedges, to homogenous, marine-dominated, and mesohaline estuaries where either complete mixing or having an evaporation rate equal to the freshwater inflow gives similar salinities from surface to bottom at any point. Where one estuary fits in this continuous depends not only on the amount of mixing of the water masses, but also on the region, the geometry of the estuarine basin, and the river flow. The tidal region and river flow may be further altered seasonally. In general, positive estuaries are common, while mesohaline estuaries are rare. Galveston Bay, Texas, and Alligator Harbour, Florida, are examples of mesohaline estuaries. In desert climates, where the amount of freshwater input to the estuary is small and the rate of evaporation is high, a negative (or) evaporite estuary results. In a negative estuary, the incoming salt water enters at the surface and is somewhat diluted by mixing with the small amount of freshwater. The high evaporation rate, however, causes this surface water to become hypersaline. Hypersaline water is denser than seawater, sinks to the bottom and moves out of the estuary as a bottom current. A salinity profile of such an estuary is the reverse of the positive estuary, with highest values at the bottom and lowest at the top. A final category is the seasonal (or) intermittent estuary. These estuaries are formed in areas where there is a marked wet and dry season (Mediterranean climate). In the rainy season, they have freshwater input and are open to the ocean. In the dry season, they have no freshwater input, may become dry or stagnant, and are often cut off from the ocean by seasonal sandbars. Salinity in these estuaries varies not spatially but temporally.

### Physical characteristics of Estuaries

The physico chemical regime of estuaries is one with large variations in many parameters, which often create a stressful environment for organisms. It is probably due to such stresses that the number of large species living in an estuarine area is small in comparison to other marine habitats.

### The Biota of Estuaries

There are three types of fauna in estuaries: marine, freshwater, and brackishwater or estuarine. The marine fauna is the largest group in terms of numbers of species and includes three subgroups. The stenohaline marine animals are marine forms that either are unable, or barely able, to tolerate broad range of salinity changes. These organisms are usually restricted to the mouth of estuaries where salinity is generally 25 ppt or above. These animals are often the same species found in the open sea. The second subgroup is the euryhaline marine animals capable of tolerating varying amounts of salinity reduction below 30 ppt. Such species are capable of penetrating varying distance up the estuary. Most tolerate salinities down to 15 – 18 ppt (psu), with a few hardy species tolerating levels down to 5 ppt.

The brackishwater or true estuarine species are found in the middle reaches of the estuary in salinities between 5 and 18 ppt but are not found in freshwater or in full sea water. Examples of these animals include the polychaeta *Nereis diversicolor*, oysters (*Crassostrea*, *Ostrea*) clams (*Scrobicularia plana*, *Macoma balthica*) small gastropods (*Hydrobia*), crabs (*Callinectes*) and shrimps (*Palaemonetes*). Some of these estuarine genera may be limited in seaward direction not by physiological tolerances but by biological interactions, such as competition and predation.

The third component is derived from freshwater. These animals are able to tolerate salinities much above 5 psu (ppt) and are restricted to the upper reaches of the estuary.

There is also a transitional component. This includes those organisms such as migratory fishes, that pass through the estuary on their way to breeding grounds either in freshwater or salt water. Common examples are the salmon (*Salmo*, *Oncorhynchus*) and the eels (*Anguilla*). Also included here are forms that spend only part of their lives in estuary. Usually it is the juvenile stage; and the adults are found at sea. Good examples of this latter group are the various shrimps of the family *Panaeidae* (*Penaeus setiferus*, *P. aztecus*, *P. duorarum*). The young occur in estuaries. The transitional form also includes species that enter the estuary only to feed and includes many birds and fishes.

The number of species of organisms inhabiting estuarine systems is significantly lower than the numbers inhabiting nearby marine or freshwater habitats. This is probably because freshwater organisms cannot tolerate the increased salinities and marine organisms cannot tolerate the decreased salinities of the estuary.

The true estuarine organisms are derived primarily from marine stocks and not freshwater. This is similar to the situation in the other transitional zone, the intertidal, which is also populated mainly with marine organisms, not terrestrial forms. In contrast to the intertidal, however, the number of true estuarine species is very small, and the middle reaches of estuaries are depauperate. If marine animals can tolerate a greater reduction in salinity than the freshwater ones can endure salinity increases, and because the true estuarine organisms are primarily derived from marine stocks, most of the estuary is inhabited by marine animals.

Why are there so few estuarine species? The most common explanation is that the fluctuating environmental conditions, mainly salinity, are of such magnitude that only a few species have been able to evolve the necessary physiological specializations to exist there. Another explanation is that estuaries have not existed long enough in geological time to permit a complete estuarine fauna to develop. A final reason may be that estuarine areas have little topographic diversity, being mainly broad expanses of mud. There are fewer niches and, therefore, fewer species. It is not possible at this point of time to say if one, all or none of the above are responsible for the presence of few estuarine species and apparently eurihalinity is a trait not easily acquired.