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Salt Marsh Ecosystems

Introduction – what is salt marsh?

A marsh is a damp area with vegetation; salt marsh is vegetation associated with the shallow saline waters near the coast. A salt marsh may be defined more precisely as the vegetation that occurs on muddy shores between approximately mean high water neap and extreme high water spring tides. A **halosere** is a series of communities displaying a successional sequence where the plants are adapted to salt water.

The development of salt marsh: preconditions

A number of conditions are needed for salt marsh to develop (Figure 1).

Figure 1: Early stages in the development of salt marsh

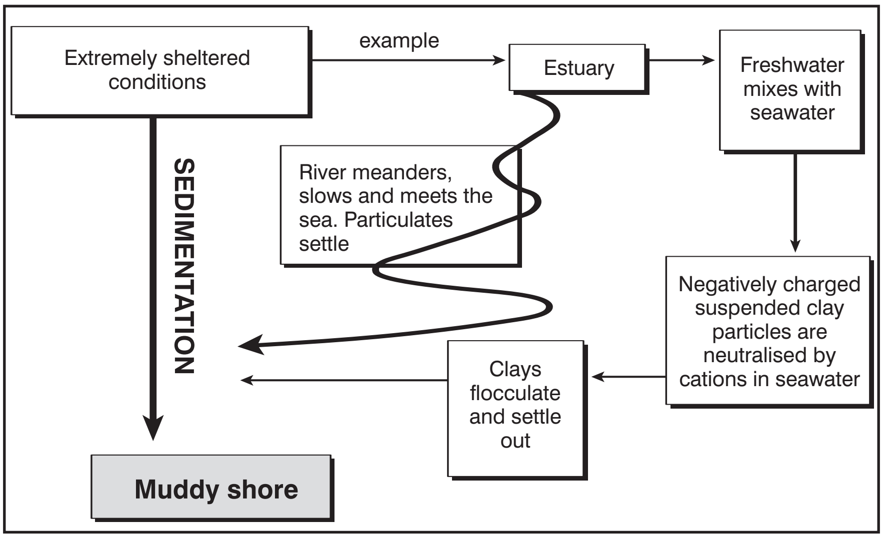
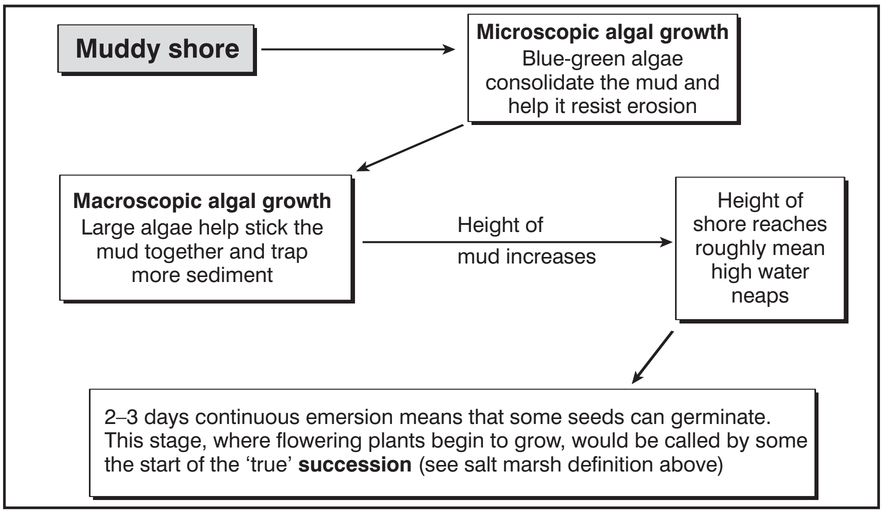


Figure 2: Ongoing development of salt marsh



- **A sea shore with very little wave action**. Fine particulate material like muds, silts and clays cannot fall out of suspension (sedimentation) and build up (accretion) in anything other than calm conditions. Clay particles are very small, they are also negatively charged and mutually repellent, hence they stay in suspension in the river water. In an estuary, river water mixes with seawater and the charges on the clay particles may be neutralised. The clay particles are no longer repellent and may stick together (flocculate) and settle out (sedimentation). This will help the build up of a muddy shore in an estuary. Various algae can also help mud particles to aggregate.
- **Shelter from exposure (wave action)**. Such places are found on the sides of estuaries (where rivers meet the sea and meander, producing shores that are very well protected from the open coast) or on coasts protected by shingle or sand bars or spits or in large bays with narrow entrances.
- **A source of mud**. This can be from the sea or rivers or both.

The height of the mud increases as time goes by and consequently it experiences longer periods of emersion (being out of the water). Eventually, the height of the muddy shore reaches a point that equates roughly to the height of an average high water neap tide. This is a critical point in the development of a salt marsh, because at this height there are several times in the year when the shore is emersed for two or three days continuously.

If a flowering plant seed is to grow, it needs sufficient undisturbed time to germinate and get a grip in the ground. A few days of emersion is just enough time for some seeds to germinate and attach (Figure 2).

Continuing development – flowering plants

The first flowering plants that begin to grow are **pioneer species** like *Salicornia sp* (glasswort) or *Spartina spp* (cord grass). Migration must have occurred for anything at all to be present on the site. If plant seeds are sufficiently undisturbed (i.e. if the mud has built up high enough) they will germinate and grow successfully. Small pioneer plants will begin to colonise the surface of the mud. A **halosere** will have entered the first stage proper of **primary succession** which can be called **colonisation**.

The presence of a fledgling community on the site will affect the physical conditions. The roots of pioneer plants will help consolidate the mud that has already built up by binding it together. Their upper parts will help trap more sediment. (It has been estimated that *Spartina* can add 8–10cm of mud a year to a salt marsh.) Primary producers will provide a source of food and places of refuge for animals. When individuals die their roots will remain in the mud helping to hold it together.

Some parts of them will be resistant to decomposition and they will add humus to the mud.

There will be lots of bare ground available because not many species can survive the marginal conditions found at this early stage of community development. As time passes and the processes outlined above contribute to raising the height of the mud the community enters the next stage of succession.

Establishment

With species like *Spartina* growing and trapping sediment the mud height increases. Consequently the muddy shore spends more time emersed (out of the water). Conditions become suitable for more species and they migrate to the area and begin to grow. Examples of species that may appear at this time are *Puccinellia maritima* (salt marsh grass) and *Aster tripolium* (sea aster). All species (including the pioneers) start to do better. They will grow bigger and they will exist in greater abundance. The vegetation is becoming "closed", forming a continuous carpet over the ground and there is much less bare ground available. The community has entered the next stage of succession – establishment.

There will be a general increase in number of species at this stage. Seeds of flowering plants from the area will be dispersed by water currents all over the marsh. Many of them will fail to germinate should they find themselves at a site at this early stage of community development. Some of them will germinate and be found as seedlings at the establishment stage but will not survive to maturity.

As time passes the height of the mud increases. There are more species taking up more space and there will be less bare ground; the community enters the next stage of development.

Competition

Plants need water, light, carbon dioxide, oxygen, nutrients and space to grow. If many other species (or many of one particular species) want these things in the same place and at the same time and there isn't enough of any or all of these requirements to go round there is **competition**.

In general terms we can think of this stage in the succession as a competition between new plants that grow quickly and die young (opportunistic species) competing with those that may take longer to grow but are stronger and will eventually dominate (equilibrium species).

Opportunistic species put most of their energy into fast growth rapid maturation and production of vast numbers of offspring. These offspring are spread far and wide. The offspring do not have much in the way of food reserves. They depend entirely on finding by chance a suitable habitat. Most of them will die or be eaten but because of their vast numbers some will survive and within a short time produce offspring of their own. This approach can be very successful (think of a dandelion for instance).

Equilibrium species invest more of their energy in long lasting structures. It may be years before they reach maturity and produce offspring of their own. They will not make so many offspring and they may not be so widely dispersed. Each one however will have protection (say a tough coat or unpleasant chemicals) and be provided with a food reserve to ensure a good start in life. This strategy can also work very well (think of an oak tree).

Pioneers tend towards the opportunistic end of the scale and equilibrium species tend towards the long term approach. During the competition stage of succession our pioneer species will tend to be out-competed and replaced by equilibrium species.

It's not always easy to see this in the field but species like *Spartina* and *Salicornia* are often replaced by species like *Halimione portulacoides* (sea purslane) and *Armeria maritima* (thrift or sea pink).

The number of species continues to increase as abiotic factors become more favourable. Competitive exclusion would suggest that where different species are in strong competition one will prevail at the expense of the other.

Stabilisation

The various species continue to compete until there is an assemblage of dominant, successful species. These will not be competing strongly with one another. They all occupy different niches.

At this stage it is to be expected that fewer changes will occur. The height of the ground has increased to such an extent that it gets immersed much less frequently. The rate of height increase of the shore is reduced. Few if any new species will be added to the community at this stage which may be called stabilisation.

Some species which might be expected in this stabilising assemblage are *Cochlearia officinalis* (scurvy grass), *Limonium humile* (sea lavender) and *Glaux maritima*. The community is now changing much more slowly and gradually will develop into the final stage of succession.

Climax

We are now entering the final stage of community development on a salt marsh. This is called the **climax** stage.

The height of the shore is now such that it is only immersed on exceptional tides maybe once or twice a year. The type of vegetation that comes at the end of the succession depends on several things.

At the back and drier side of a salt marsh there are species like *Juncus maritimus* (rush) and *Schoenoplectus tabernaemontani* (sedge) in the damper bits and *Festuca rubra* (red fescue grass) in the drier bits. Whether this is the climax community depends on what is meant by 'climax community'. If there is a freshwater influence at the back of a marsh the salt marsh will probably develop into freshwater marsh and that will develop into scrub and finally forest (this has occurred at some East Anglian sites). On the other hand where there is no freshwater influence the upper salt marsh community appears to be very stable with time, so it might be regarded as a climax. The famous botanist Sir Arthur Tansley (who coined the term *ecosystem*) regarded such vegetation as a regional climatic climax. The less well known botanist V.J. Chapman (who was very knowledgeable about salt marshes) called it a sere climax.

If the climax is different because of human intervention (for example because of a dyke or because of grazing or trampling) then it is known as a **plagio-climax community**.

This is the ecological background to salt marsh. From a geographer's point of view, salt marsh areas are part of a bigger picture. They are areas which have significance from a number of human points of view and are also fragile environments which are facing a number of pressures. These can helpfully be examined by looking at a specific area.

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The coastline of Essex is an example of a submerged lowland coast. It has been sinking slowly since the end of the Ice Age due to isostatic readjustment relating to the loss of weight of ice on the British Isles. There has also been eustatic change, notably recent rises in sea level believed to be associated with global warming. It is a relatively flat coast and combined with rising sea levels the land is quickly flooded, giving rise to long, broad and shallow estuaries with extensive areas of fringing salt marsh, mudflats and offshore sand banks (Figure 3). The area also includes grazing marsh and small areas of shingle shore. It represents a major complex of soft sedimentary habitats in the predominantly flat alluvial landscape.

Essex is situated on the south eastern coast of England. The Essex coast and estuaries covers the coastal area from Hamford Water in the north to Benfleet in the south, including Southend Marshes, the Colne and Blackwater Estuaries, River Crouch Marshes and Old Hall Marshes, Dengie, and Foulness, all of which are designated as Sites of Special Scientific Interest (SSSI) and some as National Nature Reserves (NNR) under UK statutory conservation legislation.

The coastal areas of Essex are low-lying with large areas of land in agricultural use. Much of this area is protected from inundation from the sea by earth, sea walls and concrete embankments. To seaward of the seawall there are large areas of salt marsh which flood on high tides and provide a form of protection from wave attack. Saltmarshes and mud and sand flats are the dominant inter-tidal habitats. The maximum depth is 40m which is not reached until well offshore. Within the estuaries there may be deeper channels.

There are a number of important functions to the coastal zone; these both now and in the past put pressures on the salt marsh environment.

Agriculture and forestry: Essex has well over the national average of high quality and versatile agricultural land. This plus the flat nature of the land allows for large amounts of arable crops to be grown. Forestry is also important in the area.

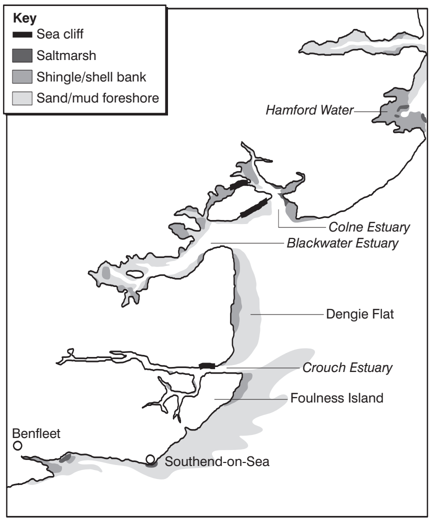
Fisheries and aquaculture: fisheries is one of the key economic activities on the coast. West Mersea on the River Blackwater hosts the largest inshore fishing fleet of almost the entire English south and east coasts.

Tourism and recreation: the Essex coast is a traditional tourist area based on caravan holiday parks, campsites and golf courses. Annually the total number of visitors is nearly 2 million.

Ships and ports: the Essex estuaries are amongst the premier leisure boating areas in northern Europe, with about 11,000 boats moored in the area. At Brightlingsea there is also a small commercial and leisure port and in Colchester there is another general cargo harbour.

Industry, transport and energy: most of Essex is well connected by road to the rest of the country and rail especially to the Greater London area. Harwich International Port serves ferry connections to various destinations on the European continent. There are small and light

Figure 3: Salt marsh and other environments on the Essex coast



Source: http://herakles.fzi.de/Eurosion/incoming/Essex%20estuaries1.pdf

industrial enterprises scattered around the Essex coast, like light engineering works and a boat-building/repair yard at Brightlingsea and some light engineering on the Blackwater Estuary. A number of oil refineries are located at Canvey Island.

Nature conservation: almost the entire Essex coast is designated as a protected area under national or international laws. It is an area of international importance for migrating birds.

Figure 4: Management options on the Essex coast

POLICY OPTIONS	OUTLINE
POLICY 1	Hold the line by maintaining or changing the standard of protection. This policy should cover those situations where works or operations are undertaken in front of the existing defences, to improve or maintain the standard of protection provided by the existing defence line. This policy has been adopted at Sales Point, Marsh House, Deal Hall and Hamford Water. At locations like Deal Hall and Hamford Water, barges filled with sand/mud and brushwood groynes have been used as well as beach replenishment.
POLICY 2	Move seaward by constructing new defences seaward of the original defences.
POLICY 3	Managed realignment by identifying a new line of defence and constructing new defences landward of the original defences. Some experimental sites of this option were Blackwater Estuary, Orplands, Tollesbury and Abbots Hall.
POLICY 4	Limited intervention by working with natural processes to reduce risks while allowing natural coastal change. This policy was adopted at Cudmore Grove.
POLICY 5	Do nothing i.e. no investment in coastal defence assets or operations.

Management of the coastal environment

Rising sea levels pose a serious threat to low lying areas like the Essex coast. The coast is being eroded and salt marsh lost through coastal squeeze (areas of salt marsh or mudflat that become trapped between the seawall and the rising sea levels).

Figure 4 shows that there are a number of possible management options, some of which have already been used. Strategies will involve a combination of both soft and hard measures.

Strategies in part depend on the population density and the value placed on the land and developments along the coast. The population density in Essex County is approximately 427 inhabitants per square kilometre. The population density of the rural hinterland adjacent to the coast (based on estimates from the late 1990s and excluding the settlements of Clacton-on-Sea, Colchester and Southend-on-Sea) is 123 people per sq km.

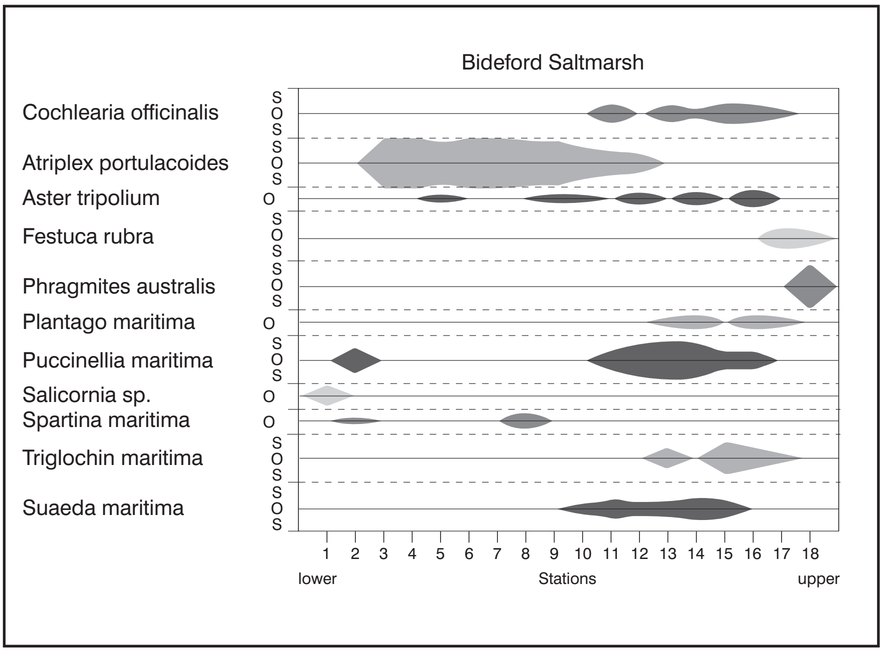
It is clear from the analysis of the situation in Essex that a rising sea level imposes severe restrictions on the capacity of the 'Hold the line' option to be sustainable in the medium to long-term. Recent flooding events in the UK (and in the rest of Europe) suggest that whatever is spent on capital and maintenance of coastal protection features, extreme events will always overcome the defences. Hence it seems likely that the policy of managed realignment will provide some respite from current trends in coastal erosion and it may need to be extended both along the coast and inland.

The loss of habitat, changing perceptions of the implications of sea level rise and cost of maintaining hard defences have all contributed to the move away from 'protect at all costs' to a policy of 'realignment' which accepts that some land will be lost to the sea. This combined with the use of 'softer' engineering options such as beach recharge, represent a much more flexible approach to coastal protection.

Acknowledgements

The author particularly wishes to acknowledge material provided by

Figure 5: Kite diagram showing distribution of plant species on lower section of salt marsh



Source: www.hallsannery.co.uk

Julian Cremona (Head of Centre) at Dale Fort Field Centre, Pembokeshire. This material was obtained from the following website: http://www.theseashore.org.uk/.

Useful sources of information

http://www.english-heritage.org.uk/upload/pdf/CoastalDefenceEH.pdf

http://news.bbc.co.uk/1/hi/england/essex/3401011.stm

http://www.english-nature.org.uk/livingwiththesea/champs/pdf/CHaMPs/Suffolk%20Final%20CHaMP%20rev1.pdf

Focus Questions

1. Figure 5 is a kite diagram showing the plant succession in the lower section of a salt marsh.
a) Which species is dominant in the lower part of the salt marsh?
b) Identify the two main species at station 14.

2. Outline the physical conditions that encourage the development of salt marsh.

3. Describe and explain in your own words each stage leading to a climax community in an area of salt marsh.

4. Evaluate the different options that are available to manage salt marsh coastal environments like those in Essex. In your answer make reference to hard and soft engineering approaches and to the policy options referred to in Figure 4. There is an opportunity here to carry out some research using relevant websites on the internet.