Geo Factsheet

Number 124

Salt Marshes

Cinderellas or Ugly Ducklings in the Coastal Environment?

Introduction

Salt marshes are both complex and fragile. They are also some of the most threatened environments on the planet as they occupy coastal locations that are attractive for industrial, commercial and recreational use. These uses create pressures for development and contribute to pollution and other damage to the marshes. The marshes are also vulnerable to environmental change. This includes global climate change which is leading to rising sea levels.

In the past they have not always attracted much sympathy as candidates for protection. They lack the spectacular scenic attractions of cliffs and fjords or the sunbathing opportunities of sandy beaches. Although of interest to seekers after wilderness and bird lovers they have often been ignored. This neglect has been compounded by a lack of understanding. Whilst the basic mechanisms of formation are well-known, the complexity of their interactions with other coastal and human processes is not well documented. For example, we do not know for certain why many areas of marsh vegetation suffer periodic die-back. And yet these features have critical roles in supporting wildlife, determining coastal and river processes, protecting land from coastal erosion and providing increasingly rare areas of wilderness in a congested country. Study of them is well worthwhile.

The Formation of Salt Marshes

Salt marshes, as seen in *Fig. 1*, occupy a mid level between the mudflats that edge the permanently submerged marine zone and the terrestrial (land-based) habitats that lie above the high water mark. Like sand dunes they result from the interaction of **geomorphological** and **ecological** processes. The key to their formation is a **low energy** tidal environment, that is one where the sea's erosional ability is limited. This allows plant colonisation and sediment accumulation. The plant community then undergoes a series of changes known as a **succession**. These combine to create a feature that can eventually emerge above sea level and become permanent. Their development, however, is susceptible to changes in a number of factors *(Fig. 2)*.

Fig. 2 Factors Affecting Salt Marsh Development

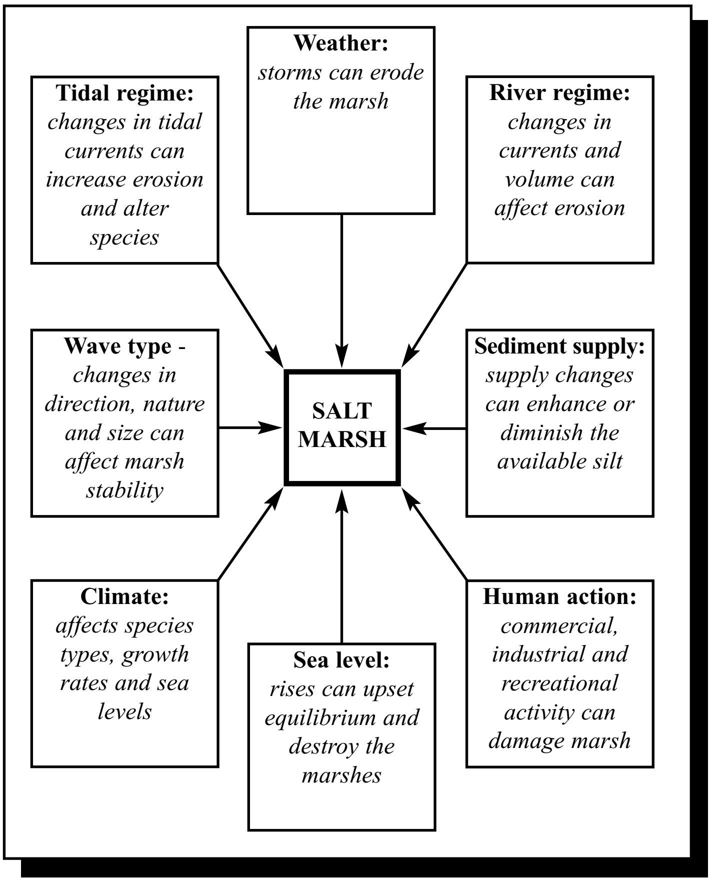
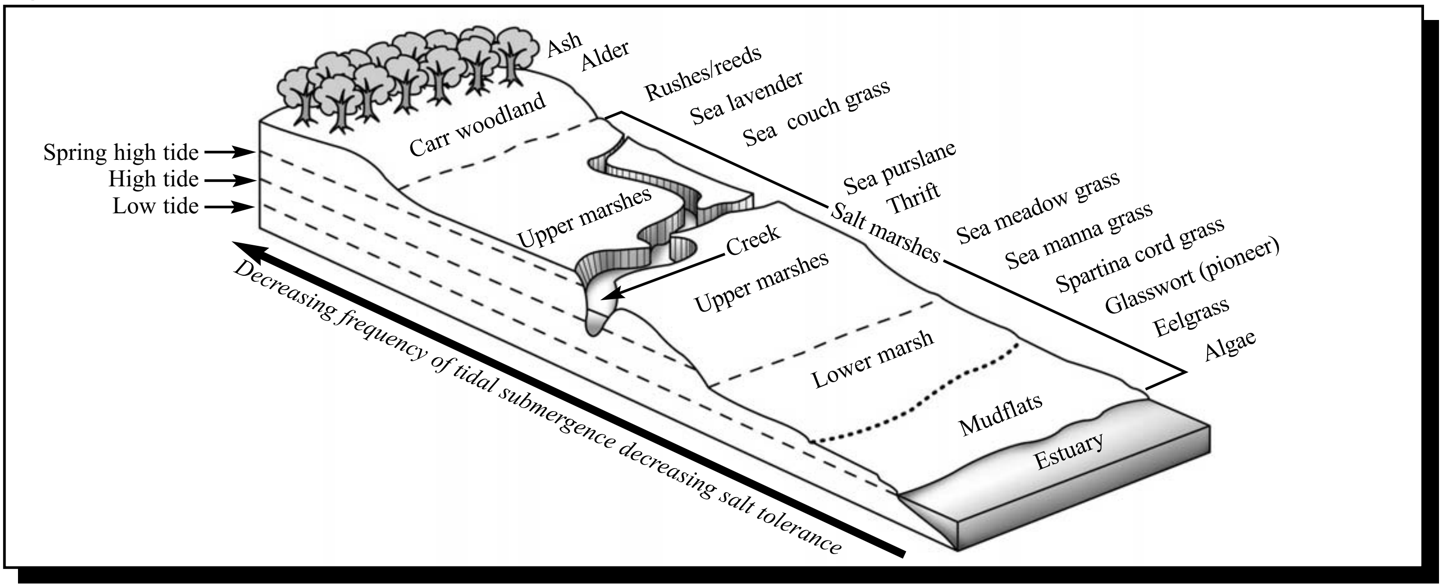


Fig. 1 Location and zonation in salt marshes



During their lifetime salt marshes have to adapt to changes in these factors. They try to maintain a balance between them so they are said to be in a state of **dynamic equilibrium**.

The initial low energy environment can result from many causes. The most common are:
- *the protection from the open sea provided in the inner reaches of estuaries and rias.*
- *the protection offered by spits, bars or other coastal landforms.*

The latter is common. Indeed the formation of spits and salt marshes is often linked, as can be seen in places such as Hurst Castle Spit in the Western Solent. Once a low energy environment is established a number of processes take place to form a halosere or saltmarsh succession *(see Table 1)*. A succession is a vegetation sequence developed over time.

Table 1 The formation of a saltmarsh succession.

- *As the tidal currents are slowed they begin to deposit material. This is fine-grained at first. It may be encouraged by the growth of eelgrass in submerged areas.*
- *Eel grass helps slow the currents further.*
- *Gradually uneven mud flats develop that are exposed at low tide.*
- *These mud flats can then become colonised by pioneer plant species.*
- *These plants are tolerant of salt and the periodic soaking of the sea caused by the tides. They are known as* ***halophytes****. They include species such as* ***glasswort*** *and* ***sea blite****. They are small and are annuals, new ones developing from seed each year.*
- *They gradually develop close vegetation over the mud. This allows colonisation by further types of plants such as sea aster, marsh grass and sea lavender. These form a dense mat of vegetation up to 15 centimetres high.*
- *This vegetation creates friction to slow the tidal currents even further. This causes yet more sediment to be deposited.*
- *Additionally, the vegetation itself traps particles. These accumulate eventually on the mud.*
- *The plants also produce leaves and stalks that die and help build up the sediment level. This vegetation waste or detritus can be up to 15 tonnes of dry matter per year.*
- *These processes combine to increase the level of the mud flats by between 1mm and 30mm per year. They also provide a food supply for other species, such as small invertebrates, to exploit.*
- *As the mud levels rise, complex creek systems evolve that channel the flowing and ebbing tides. These become deeper as the land rises.*
- *Eventually the land rises above sea level as new species such as rushes and reeds become established. These species are perennials, as are the trees such as alder and ash that appear.*
- *By this time the salt marsh succession is complete. This* ***halosere*** *or* ***succession*** *also shows* ***species zonation****, as can be seen in Fig. 1. Zonation can be defined as a distinct spatial distribution.*
- *By this stage the upper levels of marsh are rarely covered by the sea. Only high spring tides and storms allow them to become inundated.*

SUCCESSION

Exam Hint: Students frequently confuse zonation with succession in both salt marsh and sand dunes. Read through the text to check you know the difference.

Salt marshes thus become attractive to farming and are often reclaimed. Many of the marshes around southern and eastern England have been reclaimed and are being defended by sea walls. Today they are relict features and no longer being actively formed. Traditionally they have been used for cattle or sheep to graze but some have been drained and "improved" and support arable crops.

Because of rising sea levels, some reclaimed salt marshes are under threat and as the land is comparatively low value, they have now been declared as areas for managed natural retreat. These coastal management strategies will allow the marine erosion to breach sea defences to recreate the salt marshes, so acting as a natural buffer against further erosion.

Although the succession described has taken place over hundreds of years, in the nineteenth century a new element appeared, particularly in southern England. Cordgrass or *Spartina maritima* existed in England prior to 1800 but increasing trade led to the accidental importation of similar species from abroad. These interbred with the native forms to create a new variety called *Spartina Anglica*. This is an astonishing plant, perfectly adapted to survive in the hostile conditions of tidal environments. It has:
- *glands to secrete salt and minimise dehydration;*
- *deeply recessed pores to reduce water loss;*
- *2 root systems - a fine mat of surface roots to bind the mud and long, thick and deep roots with airways that can secure it in up to 2 metres of sloppy mud.*

It thus has a remarkable ability to thrive on mudflats. It grows so quickly that it can trap 4,000 tonnes of silt/hectare/year. Not surprisingly a ready export market has been found for it. It has been used for reclamation purposes in countries as far apart as China and France.

Since the 1950s *Spartina* has been in decline, possibly due to oil pollution. Other likely causes are environmental change or changes in the plant's biological make-up. This is a cause for concern as Spartina acts as a catalyst in speeding up the rate of saltmarsh formation.

Whether characterised by Spartina or not, salt marshes provide the basis for a rich ecosystem. They have high levels of primary productivity, i.e. the ability to produce nutrients to support large invertebrate communities in the marshes themselves and in the adjacent mudflats and marine channels. In the Solent (Hampshire) mudflats between 20 and 80,000 Laver Spire snails can be found in every square metre of mud. These creatures are up to 60 millimetres long and provide food for the higher trophic levels or predators, such as birds. In the UK as a whole, mudflats and salt marshes provide overwintering for up to two million waders and one million wildfowl. In the Solent alone over one hundred thousand birds can be found in January. These include oystercatchers, plovers, terns, curlews, godwits, dunlin, Brent geese, teal and widgeons.

Threats to the Salt Marshes

Sadly, these outstanding and increasingly rare environments are under severe threat. The complexity of the biotic and abiotic factors that are involved in salt marsh formation *(see Fig. 5 on page 4)* means that there is a wide range of threats that can upset their stability.

Direct human action

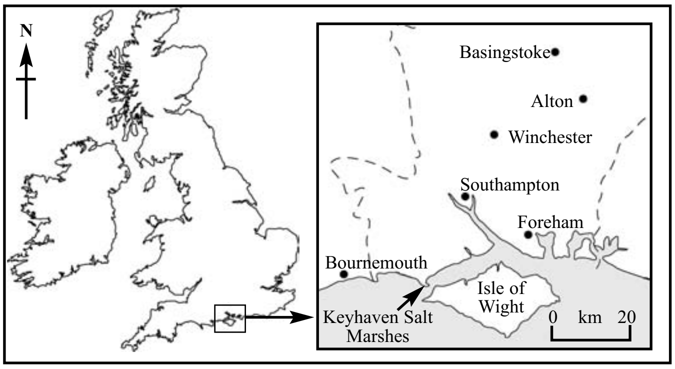
- Industrial pollution may harm many marsh species. One author has suggested that oil pollution in the Solent has contributed to the decline of *Spartina*.
- Agricultural pollution has led to **eutrophication** and the disruption of the marine and marsh ecosystems.
- Dredging removes sediment - this may reduce mudflat accumulation. It also affects tidal and other currents that may have an impact on scour and erosion.
- Commercial and recreational shipping and water sports activities, such as jet-skiing, cause "wash". This can erode marshes already vulnerable to vegetation "dieback".
- Grazing can cause trampling of species and alterations to species diversity by selective eating.
- Reclamation itself makes remaining tidal areas narrower. This means there is less space in which energy can dissipate. This can create increased erosion.
- Finally, there is much pressure for development in these coastal areas. Developments include marina and recreational facilities, *e.g. in southern Brittany,* and port construction*, such as that proposed at Dibden Bay in Southampton Water.*

Case Study – Keyhaven Marshes

Keyhaven Marshes lie in the Western Solent in southern Hampshire. Their development was linked to the formation and subsequent migration of Hurst Castle Spit. This striking feature forms the eastern end of Christchurch Bay. The spit lies ultimately on the submerged terrace of a small river but it has been fashioned and maintained by a supply of shingle from the west, carried to the spit by an easterly longshore drift. The spit extends some 4 kilometres across the Solent and provides a sheltered environment in which the mud flats and marshes have formed (see Fig. 4).

There are relict features (former salt marshes) to the landward side of the current marshes which were reclaimed. The current marshes owe much to the vitality of Spartina anglica since the nineteenth-century. This has enabled these marshes to grow some two metres higher than might otherwise have been the case. As the spit has receded across the marshes it has created an artificially high crest to the spit. For a long time this masked the loss of shingle supplied by longshore drift. This was caused partly by groynes and other engineering works to the west. This misled many into thinking that the spit was healthier than it actually was. In fact the recession of the spit over the marshes has had two effects. Firstly, the marsh has subsided under the weight of the shingle. This has reduced the height of the spit. Secondly, the marsh has become exposed on the seaward side of the spit. This has led to its rapid erosion. This combined with other factors - reduced shingle supply and increased storm events - has led to breaches in the spit itself. If these had not been dealt with by the authorities the spit might have become isolated and marshes overwhelmed by marine attack from the southwest. This is the direction from which the dominant waves originate and they might have eroded much of the marshland.

Fig. 3 The Location of Keyhaven Marshes



In addition to this, the Spartina marshes themselves have been in decline since the 1950s. The exact cause is unknown. The resultant die-back has exposed slumping platforms of bare mud. These are very vulnerable to marine erosion. If this erosion was to happen, the effects could be dramatic. The marshes protect an extended section of coastline. This would become exposed to wave attack and to flooding. Releases of mud could affect the stability of the spit, clog navigation channels and destroy the marsh ecology. As well as reducing the primary productivity of the area it would have a knock-on effect on the invertebrates and eventually the bird life of the western Solent. It is not surprising, therefore, that the area is protected under a number of designations. These include its status as a Site of Special Scientific Interest (SSSI) and as a wetlands RAMSAR site covered under European law.

The shoreline management plan (SMP) published in 1998 evaluated the options for protecting the marshes. It noted that their survival was dependent also on the survival of Hurst Castle Spit. In other words, the two features are not totally independent - a holistic or integrated approach to their protection was therefore required. Work had in fact already been undertaken to protect the spit. This involved the creation of 550 metres of rock armour to protect the Western end where it joins the beach at Milford. At the beginning of the spit proper, an armoured breakwater was built. Above all, the spit was nourished with 300,000 cubic metres of shingle, dredged from the offshore Shingle Banks. This created a crest some 12 metres wide and varying in height between 5 and 7 metres. Finally, a 100-metre rock revetment was built at the eastern end of the spit to protect its tip or distal end.

It was believed that in the short term at least, stabilisation and maintenance of the spit would provide essential protection for the salt marshes. In addition, existing defences on the landward side of the marshes - mainly low embankment and sea walls - would be maintained. However, the SMP also noted that much more information was needed about the Solent salt marshes. It recommended that a working party be established to develop a saltmarsh strategy. This would investigate in detail the potential impact of reclamation and sea level rise, along with the effects of dredging, pollution, grazing and recreation. It proposed detailed assessment of how marshes develop and their long-term sustainability, in particular their susceptibility to die-back. A two years study was recommended, paid for by European funds.

Exam Hint: A sketch map can illustrate many key features of salt marsh formation. Practise drawing a map and then using information, as written below, to annotate your map.

Fig. 4 Map of Hurst Castle Spit and Keyhaven Marshes

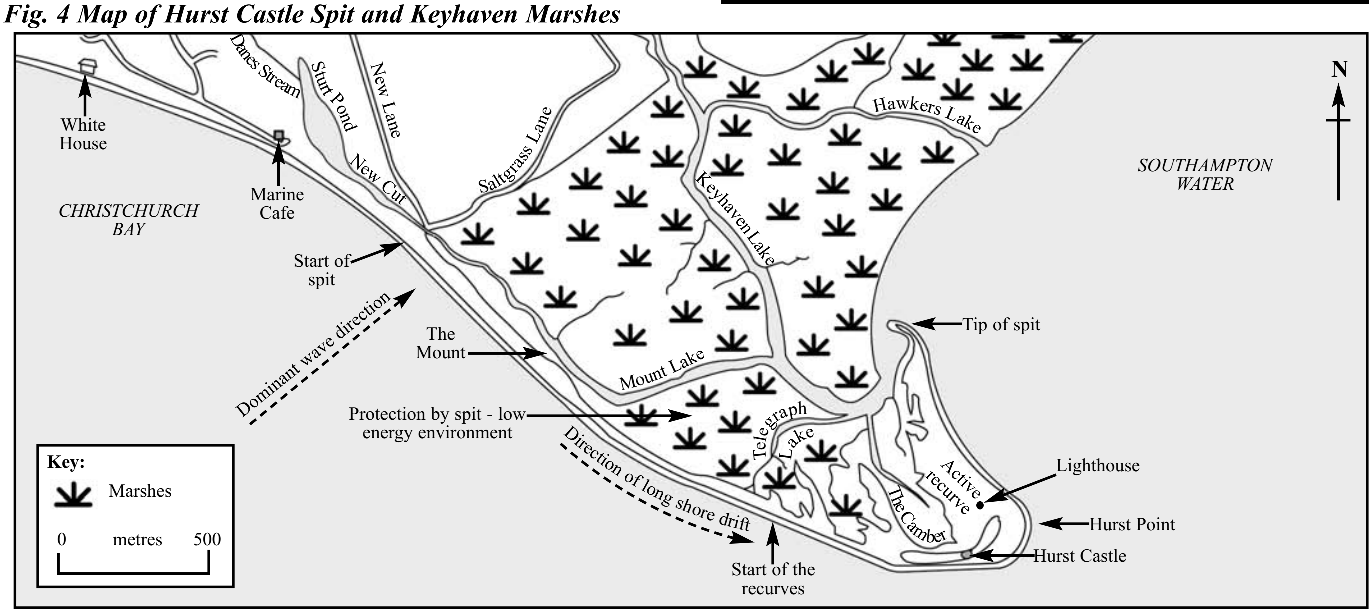
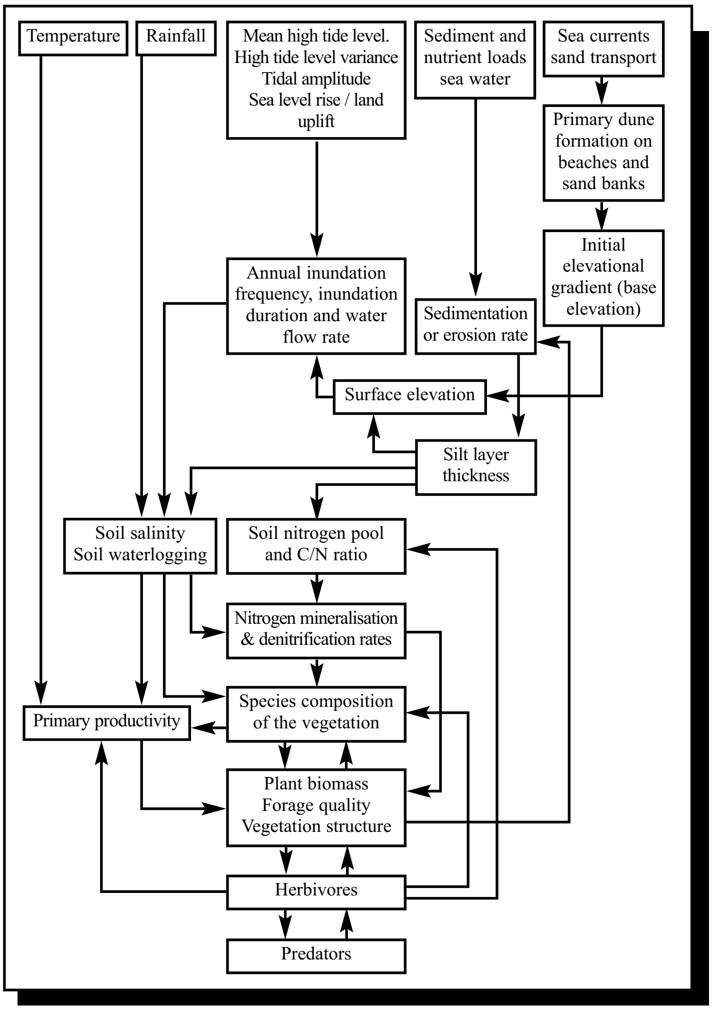


Fig. 5 The relationship between the abiotic and biotic components of a salt marsh ecosystem.



Exam Hint: Draw a trophic level diagram to show the energy flow and structure of a salt marsh, using Fig. 5 and the previous text to help you. Learn it as it is easy to draw in an exam.

Natural threats

- Sea levels may rise too quickly for the marshes to adjust. Increased incidence of storms leads to increased flooding.
- Storms create greater wave energy and more potential erosion and may lead to a loss of sediment supply.
- Changing temperatures and rainfall patterns may affect the tolerance of the marsh species - this has been suggested as one reason for the decline in *Spartina*. *Note: climate change may be considered to be indirect human action because of the release of increased greenhouse gases.*

The loss of salt marshes for whatever reason is likely to have serious consequences. Modifications to river hydraulics and coastal wave patterns are likely to lead to increased marine energy in other parts of the coastal system. These may be natural features such as unprotected coast or sea walls and other sea defences. These may become vulnerable to breaching and inundation. There will also be a loss of habitat and biodiversity. This may affect spawning grounds and the fisheries and shell-fisheries that depend on them. There will also be a loss of amenity and recreational opportunities such as bird watching or experiencing a wilderness environment.

Exam Hint: Most questions on coastal ecosystems would expect you to summarise the threats with examples (see practice question) so knowledge of a case study, such as the one on page 3, is vital.

Conclusion

- Salt marshes have not been a fashionable topic in geography, as they are perceived as less "sexy" than the rapidly crumbling cliffs of Barton or Holderness *(the Ugly Duckling)*.
- Their low relief and absence of spectacular features has seen them largely neglected by students.
- Their neglect is not deserved as they are increasingly rare ecosystems that are under severe threat. The loss of these habitats may well be more serious than the loss of habitats on crumbling cliffs.
- So valuable are these erosions that current coastal management plans to not only conserve existing sites but actually to create new salt marshes from reclaimed areas by the process of managed natural retreat *(Cinderella)*.

Further activities

1. With the aid of a map of the UK, summarise the factors which have led to the distribution of salt marshes at the coast.
2. Draw an annotated diagram to explain how a halosere develops.
3. Research the role of managed natural retreat as a coastal management strategy and summarises the arguments for and against managed natural retreat.
4. Examine the threats facing salt marshes in the UK, both directly and indirectly. Do you consider these threats to be more related to natural or human causes? (use the website provided)
5. Research an alternative case study of a salt marsh area and compare its value as an ecosystem and the threats facing it with the case study of Key Haven marshes.

Exam Questions

1. Examine the importance of salt marshes as an ecosystem. *10 marks*
2. Assess the direct and indirect threats to the survival of saltmarshes. Use examples to support your answer. *10 marks*

Answers

1. The value of an ecosystem can be assessed by the goods and services it provides. Include details of primary productivity and food chain, importance as a conservation area for flora and fauna, role as a 'buffer' against coastal erosion (use geomorphological and ecological as your two key headings).
2. Assess means weigh up. Be careful to distinguish between direct (e.g. dredging pollution building, reclamation and indirect e.g. climate change or knock-ons from coastal defences leading to erosion of a spit protecting marshes. Think carefully where to include 'die back' of Spartina. An assessment might also look at the role of protection strategies which mitigate the threats.

Further Study

Accounts of marsh succession can be found in *"Managing Ecosystems"* by Adrian Kidd, Hodder
RSPB book *"Ecosystems and Human Activity"*. Collins
Accounts of Christchurch Bay and Hurst Castle Spit can be found in *"Managing the Wessex Coast"* in *Geography Review*, January 1997.
Details of the options for protecting Keyhaven can be found in the *Shoreline Management Plan for the Western Solent*, 1998.
Information on threats to wetlands can be found at *http://www.rspb.org*
Information on Shoreline Management Plans can be found at:
http://www.environmentagency.gov.uk

Acknowledgements
This Factsheet was researched and written by Robert Case who teaches at Farnham Sixth Form College and King Alfred's College, Winchester. He is a senior examiner and author of several books (including "Coastal Management", "Brittany" and "Japan").
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