AS Geography 1.3 Coastal Environments *Student Notes*

How and why plant succession develops from a pioneer community in a sand dune ecosystem (psammosere).

You need to understand the concept of succession and you should be able to describe and explain the succession in a sand dune system. You should be able to use transects to describe the spatial dimension of the succession but you must also appreciate that it is the temporal dimension that is the focus of the idea of succession.

Braunton Burrows is a 970ha dune system. It is an SSSI and an international Biosphere Reserve. Occasional MOD training has disturbed the dunes, but the effects of trampling by visitors are confined to a few more accessible areas close to car parks.

The formation of sand dunes here depends on number of factors:

- An abundant supply of sand, often from beaches with a wide exposure of sand at high tide. In the case of Braunton Burrows, Saunton Sands is the source. This has probable been provided to the Taw and Torridge rivers although some may have been combed up the shore with the onset of the Flandrian transgression.
- Onshore winds with sufficient frequency and strength.
- Impeded longshore transport of sand (Saunton Sands is essentially a swash aligned beach with little longshore drift).
- Low topography on the landward side of the dunes.
- A climate that can support the vegetation necessary to build the dunes.

The sand is moved from the beach in the wind by **saltation** and may accumulate around seaweed, driftwood and other flotsam at the top of the beach. This accumulation of sand is then colonised by "**pioneer species**" that stabilise the sand and help to encourage further deposition. This occurs as the plant stems create a zone about 1cm deep with no wind. (This contrasts with open sand when the zone of no wind is about 1mm: insufficient to prevent the sand grains from being moved).

Succession is the sequential development of change within a plant community as it progresses towards a **climax**. The climax (or climatic climax) is reached when the plant community stabilises when it reaches a state of **dynamic equilibrium** with its climate. Individual plant species are adapted to particular **environmental niches**. Succession occurs because as environmental conditions change, favouring different plant species at different times. As a result, populations of well-adapted species replace earlier ones, which as now less well equipped to compete in the altered conditions.

The **pioneer species** that colonise the embryo dune, such as **sea couch**, and **sea twitch** are specialist plants adapted to windy, saline (salty) conditions. Nutrients are obtained from decaying seaweed. Occasionally the plants will need to withstand flooding from high tides, and spray from storm waves. Sea couch can extract fresh water from salt water and has long rhizomes for roots that anchor it in the shifting sand.

Under favourable conditions the dune will start to accumulate at rates up to 50-60cm a year around the pioneer plants which grow through the sand to keep pace with it. This change in height reduces the seawater content of the dune and leads to an increase in organic content. Soon **early colonisers** like **marram grass** will start to appear. This is better adapted to the increasing drought conditions of the growing dune and it can withstand the extremes of wind and sand inundation. Like sea couch it can grow quickly through the accumulating sand but it is also adapted to drought by having its stomata in grooves of the underside of its leaves. When water is in short supply it can curl its leaves, trapping the stomata inside these grooves, reducing water loss. The leaves are shiny and they also act like weather vanes and streamline themselves with the wind direction. This also reduces water loss. Marram also has long roots that penetrate deep into the dune to reach water at depth.

The process of accumulation continues until a large foredune is formed up to 5m high. In some dune systems, the foredune is the largest, but at Braunton Burrows, the second and third dune ridges are larger. These seaward dunes often lack organic matter, giving them name **yellow dunes**.

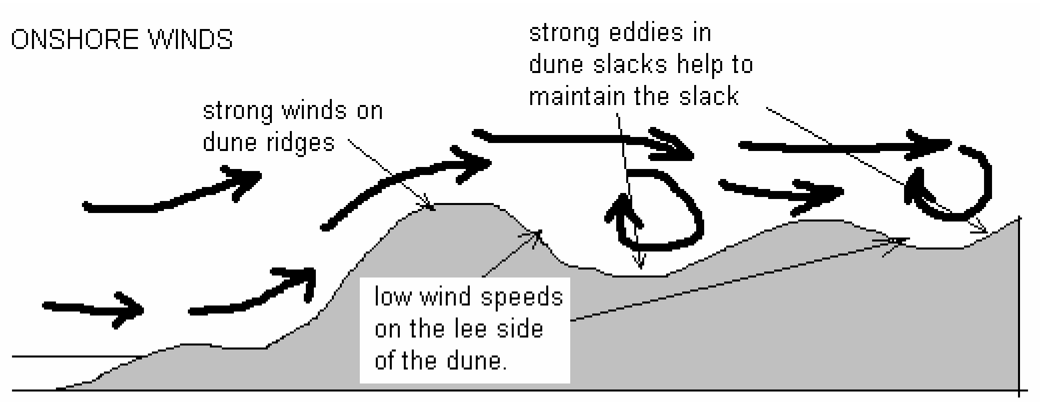
As the dunes age, further dunes form on their seaward side. This distances the aging dunes from the sea and their supply of sand. Without regular sand supplies, a surface soil starts to develop from decaying organic matter, changing the conditions once more. The soil now has a greater capacity to hold moisture and a higher nutrient level. New species appear that are better adapted to these new conditions than the marram grass. These include fescue grasses, rest-harrow, bird's-foot trefoil and screw moss. The dunes turn from yellow to become **grey dunes** with the increased organic matter in the soil.

At a further stage the succession reaches a dune pasture stage, which has the richest diversity in plant species. Succession may be halted by introduced animals such as grazing rabbits, which maintain a **plagioclimax** by preventing shrubs from growing. At Braunton Burrows, the warden has tried to maintain this plagioclimax as it contains rare orchids.

The reduction in rabbit population as a result of a viral epidemic, has allowed the succession to continue. Scrub vegetation (hawthorn, bramble and sea buckthorn) and aggressive grasses like Yorkshire Fog have grown, despite attempts to use other grazing animals such as sheep and cattle. Some mowing takes place in important areas to maintain the dune pasture

At the very landward side of the dunes, **sallow carr** vegetation has grown. This is immature woodland dominated by willow, although there are saplings of the climatic climax species, oak.

Between the dune ridges are lower areas called **dune slacks**. These are maintained by the pattern of wind across the dune system.

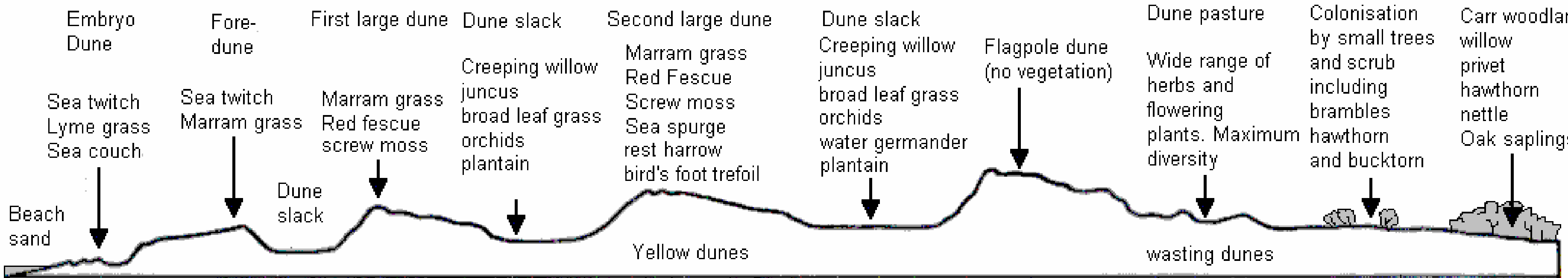


Onshore winds are high over the dune ridges but turbulence creates strong **eddies** within the dune slacks, preventing the accumulation of sand. It is only on the **lee slope** of dunes that the wind is light enough for sand accumulation. The height of the dunes is also restricted by the strength of the wind.

The process of succession can also be seen in the dune slacks, although the species are usually completely different to those on the dune ridges. These are adapted to higher moisture levels, lower temperature extremes and higher nutrient levels. Species such as creeping willow, reeds and rushes dominate

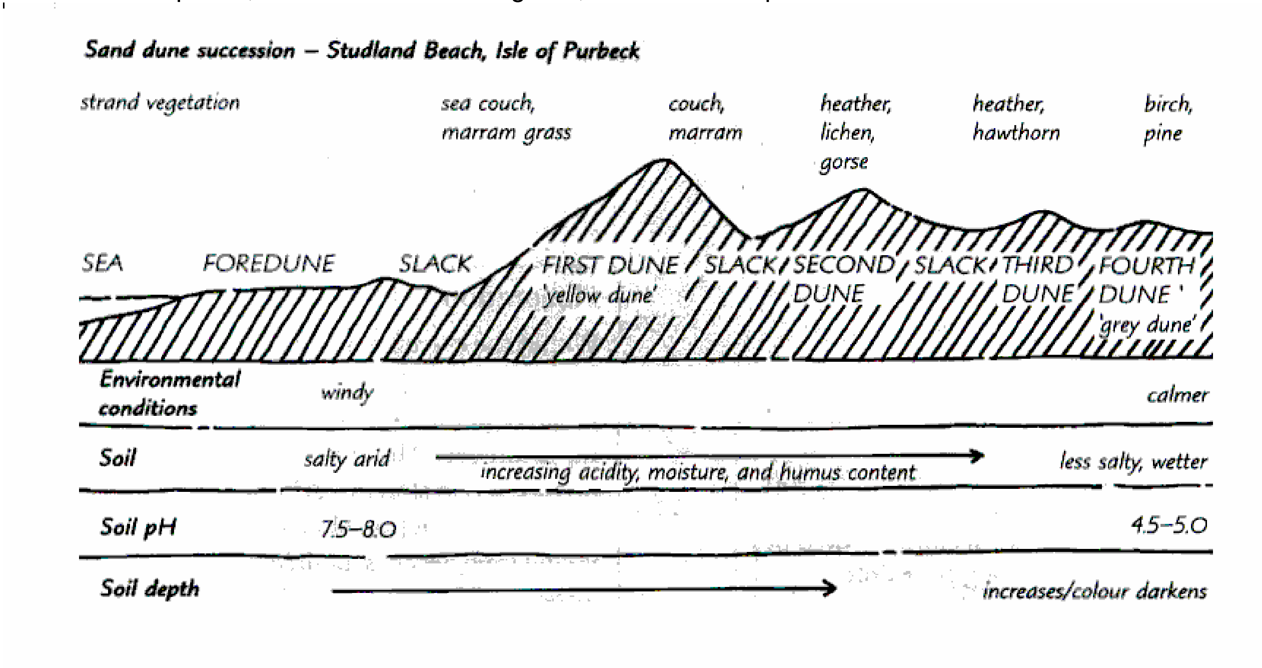
The diagram on the next page shows a cross section through the dunes at Braunton Burrows. The width of the section is about 1.3 km from the coast, due east to the Sandy Lane car park in the middle of the dune system.

The "flagpole dune" takes its name from the pole that is used to fly a warning flag if the MOD is using the site for military training. Visitors are drawn to this focal point and the dune has become heavily trampled, removing the vegetation and activating the migration of the dune inland. The bare sand is now an "attraction" in its own right. The dune height is gradually falling creating a **deflation hollow**. The warden has given up trying to re-colonise the dune with plants. Instead his management strategy is to sacrifice the site and using it to draw people away from other, less trampled sites. (A type of "honey-pot" strategy).



	DUNE RIDGES	DUNE SLACK		
Environmental Conditions: Exposed to strong wind Some inundation at high spring tides Saline Highly calcarious due to shell sand (pH 9) Warm to high temperature in summer sun Dry, mobile sand. Limited organic matter	Environmental Conditions: Little moisture, mainly obtained from rainwater Still highly calcarious (pH 8.5) Warm to high temperatures in summer months Exposed to strong winds, but reduced at the base of plants allowing sand deposition and accumulation Dry mobile sand, building over plants Slight increase in organic matter Low nutrient levels	Environmental Conditions Moist because near to water table and higher organic content in soil. Occasionally flooded after heavy rain. Less alkaline (pH 7.0) Cooler soils due to high moisture content. Strong winds Relatively high in nutrients compared with dune ridges.	Environmental Conditions: Higher levels of organic matter help to improve both the moisture holding capacity of the soil and the nutrient content. Still nutrient defficient. Soil less acid (pH 7.0) More sheltered from strong winds Much less mobile sand In the past, heavy grazing prssures from rabbits. now replaced by sheep, cattle or mowing.	Environmental Conditions: High level of organic matter High water table Neurtral to acid soils (pH 7.0 to 6.0) Humid Little wind
Pioneer and early coloniser species adapted to extreme environmental conditions	**Early colonisers adapted to drought, low nutrient levels, strong winds and shifting sands.**	**Early to late colonisers with a much greater species diversity than dunes. Plants able to withstand occasional flooding. Reeds and rushes grow in the wetest locations.**	**Diverse dune pature with late colonisers including shrubs and small trees.**	**Late colonisers and some climax community plants**
Sand hoppers, flies Shore birds such as ringed plovers	Snails feeding on grasses, spiders feeding in flies. Some thrush species(such as stonechat) feeding on snails.	Wider range of insects including poplar leaf beetles. Lizards feeding on insects and snails.	Rabbits are main herbivores. Broad range of birds including thrushes and warblers	Braod range of woodland species of insects and birds

The sand dune system at Studland Beach on the Isle of Purbeck in Dorset is similar to that at Braunton although there is one major difference. Unlike Braunton, there are few shell fragments in the sand so it is much less alkaline (more acidic). On the grey dunes, the species that dominate are heathland plants, such as heather and gorse, with birch and pine on the landward side of the dunes.



How and why sand dune systems are modified by human activity.

You should appreciate that human modifications can be short term or long term and both deliberate and unintentional.

Modification by human activity on sand dunes:

- **Short term deliberate**. In the 1940's, US forces, training for the Normandy landings, used Braunton Burrows. The dune system was extensively damaged but has largely recovered since, although this explains why the dunes are more "disorganised" than other dune systems.

- **Long term deliberate**. The northern end of Braunton Burrows is used as a golf course. Introduced grasses have replaced natural species. The use of sheep, cattle and mowing and even localised controlled burning, to maintain dune pasture is another long-term strategy

- **Long term unintentional**. Access points, particularly the car park, hotel and camp site to the north of the system have led to a large amount of trampling, despite attempts to fence off parts of the dunes. Marram grass has been destroyed and holiday chalets could be threatened with flooding in storm conditions if the dune erosion continues. At a car park at the southern end of the system, a boardwalk and fencing have been introduced in an attempt to manage visitors.

- Trampling can also lead to **blowouts**. The removal of vegetation, particularly from the foredune can lead to sand migrating rapidly inland, lowering the dune height to virtually nothing. With narrow sand dune systems this can remove a protective barrier, which leaves the land behind the dune vulnerable to flooding during winter storms.

- **Short term unintentional.** A fashion for 4-wheel drive vehicles has led to people driving their vehicles across the dunes, damaging the thin vegetation. Reducing road access to the dunes using gates can stop this.