Investigating sand dunes

***Left:** Marram pioneer species*

***Above:** Greater complexity of species, together with plant height, develops inland as physical conditions become less hostile for plant survival and growth*

Ecosystems and the processes of plant succession in different ecosystems feature in most AS and A2 geography specifications. Sand dunes offer an ideal coastal environment in which to investigate the complete sequence of plant succession, from pioneer species closest to the beach to climatic climax communities on secondary, older dunes further inland (Figure 1).

This idealised model of succession on sand dunes is known as a **psammosere**. The extent to which this model reflects what is found on the ground depends upon a balance of natural and human influences, which together interrelate to produce a unique landform and ecosystem. The balance of human and physical factors depends upon the location, so each of the sand-dune systems in the UK will differ slightly.

Sand dunes are common in the UK. They form in coastal areas with:

- high onshore prevailing winds,
- a large and ready supply of sand,
- a large tidal range (the difference between high and low tides). This allows sand to be exposed for long periods, and therefore to dry out; it can then be carried onshore by the wind erosion processes of creep, suspension and saltation (Figure 2)

How do dunes form?

There are several theories of sand-dune formation, each of which differs slightly. Some models suggest that moving grains of sand are trapped by any beach obstacle, e.g. driftwood, decaying seaweed or discarded litter, and that sand heaps around it. Wind flow then creates a crescent around the sides, and turbulence that erodes at the face of the dune, creating a steep windward (or stoss) side and a slack, or more gently angled leeward side.

However, this process would probably produce random dunes. In fact sand dunes are rather regular features, which suggests different processes at work. Dune growth is more likely to be part of the process by which plants develop on bare sand — the sequence of events known as a psammosere. **Xerophytic** (drought-resistant) plants are the first to colonise the **foredunes** (the newest dunes, nearest to the sea). Sea lyme and marram grass have the ability to tolerate both sets of conditions. Marram has long tap roots and

- is able to align itself with the prevailing winds
- is able to fold its stem to enclose the leaf stomata and therefore prevent evaporation
- has shiny surfaces by which wind friction and stem damage are reduced

Marram plants form root systems which bind the sand together. As sand accumulates around the grass and builds upwards, so the plant continues to grow upwards, creating more roots which trap more sand, and so on. Marram plants are able to grow up to 8 metres from their initial root systems and their roots can filter fresh water from saline water.

With increased distance from the sea and over time a succession of invading and colonising plants and animals occurs. Marram gives way to increasing varieties of ground plants such as cat's foot, and accumulation of dead organic material from each plant leads to a gradual replacement of sand by decayed organic matter, or humus. This greater organic content allows more complex low, bushy plants such as heather to survive. Each new species is less salt tolerant as conditions change, and sand ridges furthest from the sea contain the oldest and therefore most complex plant communities. This is the vegetation closest to **climatic climax** (the vegetation the climate of the area would permit with no interference by man). In a true climatic succession the vegetation would develop into birch forest about 1 km inland.

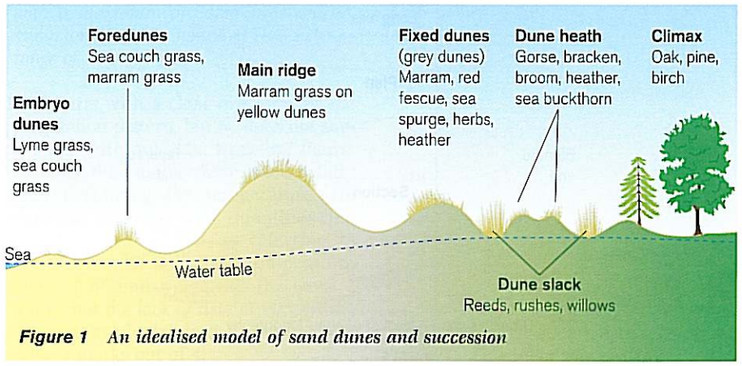

***Figure 1** An idealised model of sand dunes and succession*

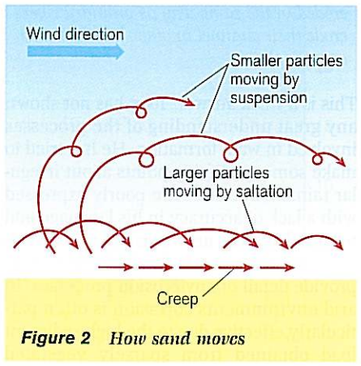

***Figure 2** How sand moves*

Fieldwork in sand-dune areas

There are plenty of opportunities for fieldwork in sand dunes. Physical studies can focus on plant succession, while human studies can investigate the impact of tourism. Here we look at how to carry out physical fieldwork.

Studies of dune plant succession

In order to demonstrate succession on a dune, it is necessary to collect measurements without surveying the entire dune system (see Table 1). A good technique is to use a series of **transects** (sampling lines) that extend from the water's edge inland. You can record plant, soil and dune information at points along the transect. Once the transect is decided, methods of sampling (Inset 1) need to be established.

Before beginning the study, it is common to focus the investigation by formulating a question or a hypothesis. You can then identify the extent to which the area under study correlates with models of succession. Appropriate questions might include:

- 'To what extent has human interference limited natural succession?'
- 'To what extent have soil and vegetation characteristics changed with increased distance from the sea?'

Such questions are easily converted into hypotheses:.

- 'The dunes at location X display evidence of human intervention.'
- 'The dunes at location X display evidence of human intervention.'
- 'Soil and vegetation characteristics become more complex with increased distance from the sea.'

***Table 1** Recording data in the field*

Information required	Collection method
Vegetation height	1-metre ruler, measuring the tallest plants
Vegetation type	Plant identification booklet
Vegetation diversity	Plant identification booklet
Vegetation density	A 1-metre square quadrat to estimate percentage ground cover
Soil colour	A 'smear' of soil from your finger on to white paper, then descriptive words for colour — brown, grey etc.
Soil depth	Trowel and ruler: measure from surface to clean sand
Soil pH	A pH meter to record data direct in the field or a lab pH kit to test samples later in a lab
Soil humus and moisture content	■ Samples of soil placed in plastic bags ■ In the lab, weight of soil sample recorded ■ Sample of soil baked in crucible in a soil oven at low heat to remove moisture ■ Sample reweighed and weight loss calculated as per cent of original weight ■ Soil sample baked in oven at high temperature to burn off organic matter ■ Sample reweighed and new weight loss calculated as per cent of original weight
Slope angle of the dune	Clinometer
Human activity	Notes and photographic evidence of erosion, litter, paths and duckboards

Sampling as described in Table 1 along two or three transects should provide sufficient data to present composite annotated summaries such as that shown in Figure 3. Presenting the data in this way on a diagrammatic representation of a transect allows you to see spatial and biotic trends.

Your conclusions should address and explain:

Site 1	
% Groundcover	0
No. of species	0
Dominant	Sand
Secondary	–
Plant height	–

Site 2	
% Groundcover	15
No. of species	7
Dominant	Marram
Secondary	Stonecrop
Plant height	50 cm

Site 3	
% Groundcover	60
No. of species	2
Dominant	Marram
Secondary	Bog myrtle
Plant height	55 cm

Site 4	
% Groundcover	90
No. of species	4
Dominant	Marram
Secondary	Ivy
Plant height	50/5 cm

Site 5	
% Groundcover	0
No. of species	0
Dominant	Sand
Secondary	–
Plant height	–

Site 6	
% Groundcover	30
No. of species	2
Dominant	Lymegrass
Secondary	Sea lavender
Plant height	50 cm

Site 7	
% Groundcover	50
No. of species	2
Dominant	Marram
Secondary	Ivy
Plant height	50 cm

Site 8	
% Groundcover	70
No. of species	3
Dominant	Marram
Secondary	Ivy
Plant height	50 cm

Site 9	
% Groundcover	100
No. of species	3
Dominant	Marram
Secondary	Ivy/gorse
Plant height	50 cm

Site 10	
% Groundcover	95
No. of species	4
Dominant	Marram
Secondary	Ivy/gorse
Plant height	50 cm

Site 11	
% Groundcover	100
No. of species	6
Dominant	Marram
Secondary	Ivy
Plant height	50 cm

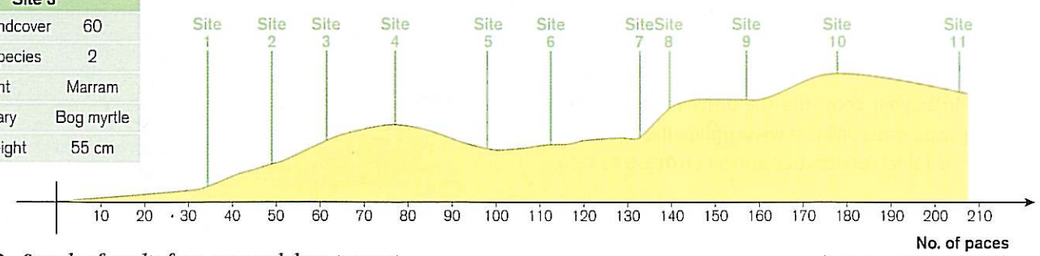

***Figure 3** Sample of results from one sand dune transect*