



# Sand dune vegetation sampling

## Time needed for activity

**Sand dune succession survey - Half day to full day depending on size of group and number of samples taken.**

**Each of the individual pre and post-visit activities could be completed within an hour.**

## Location

**Outdoors - Some activities can be covered before and after a visit, but the survey activities need to be carried out on a sand dune system.**

## Context

The aim of this activity is to give learners the opportunity to complete an onsite investigation into plant succession on a sand dune system and to prove or disprove a hypothesis. Suggested pre and post-visit activities are provided to maximise the learning opportunities a field visit to a dune system provides.

Natural Resources Wales' purpose is to pursue sustainable management of natural resources in all its work. This means looking after air, land, water, wildlife, plants, and soil to improve Wales' well-being, and provide a better future for everyone.

## Curriculum for Wales

### Humanities

- **What matters** - Enquiry, exploration and investigation inspire curiosity about the world, its past, present, and future.
- **What matters** - Our natural world is diverse and dynamic, influenced by processes and human actions.

### Mathematics and Numeracy

- **What matters** - The number system is used to represent and compare relationships between numbers and quantities.

### Science and Technology

- **What matters** - The world around us is full of living things which depend on each other for survival.

## Objectives

- Learners will be able to learn fieldwork skills and will be able to critically analyse the advantages and disadvantages of different sampling strategies.
- Learners will be able to identify and recognise sand dune plants and form a hypothesis as to whether certain plant species prefer specific habitats across a dune system.
- Learners will be able to gain a practical understanding of ecological succession.
- Learners will be able to gather and evaluate data and come to conclusions based on the data they have gathered.
- Learners will be able to use appropriate computer programs to display and manipulate their data.
- Learners will be able to critically evaluate their fieldwork and come to conclusions as to whether the strengths/weaknesses of their investigation affected their data.



## Equipment and resources

### Pre-visit activities require:

- 1 m<sup>2</sup> quadrat or a hula hoop per group
- Measuring tape – ideally 30 metres plus
- **Information note – Soil types**
- Soil pH testing kit (optional)

### Sand dune visit activities require:

- 2 bamboo sticks per group, 1m ideally, or measuring poles
- Measuring tape per group – 30 metres plus ideally
- A clipboard per learner
- Pen or pencil for each learner
- Copy of the **Worksheet - Sand dune vegetation sampling** per learner
- 1 m<sup>2</sup> quadrat or a hula hoop per group
- Sand dune plant identification keys or apps

**Publications Archives – Field Studies Council ([field-studies-council.org](http://field-studies-council.org))**

**Dynamic Dunescapes – Apps on Google Play**

- Calculators
- **Information note – Soil types**
- Soil pH testing kit

### Pre and post-visit activities require:

- Access to computer programs such as Microsoft Excel, Word and PowerPoint or Google Sheets, Docs or Slides (optional) or graph paper.

---

## What to do

### Background information

To ensure your learners get the best out of a visit to a sand dune system, ensure they have a good understanding of dune formation and the different zones within a dune system before they visit. The following resources should help:

- **Information note – Sand dunes**
- **Information note – Soil types**
- **Resource cards – Sand dune development**
- **Activity plan – Sand dune super species**
- **Advice and guidance for visits**

### 1. Risk Assessment

Sand dunes are often protected habitats and are potentially hazardous environments. To ensure you and your learners have a safe and enjoyable visit, get in touch with us before your visit **Natural Resources Wales/Plan an event, activity or project on our land** to an NRW sand dune to see if you need permission for your planned activities. We've got a short and simple form for you to complete and in our reply, we'll tell you about any restrictions currently in place, help with maps and offer guidance.

It is vital that you complete a Risk Assessment with your students before you go

- Discuss with your learners the contents of your risk assessment, ensuring they are aware of any hazards and the strategies in place to minimise the risks. Things to mention include:
  - Being aware of the incoming tide - consult tide timetables for high tide times.
  - Advise your learners on how to handle and carry their surveying equipment responsibly.



- Vegetation – be aware of prickly/stinging plants and ones that may cause an allergy.
- Animals – grazing animals need to be avoided and there needs to be minimal noise around them when in the vicinity. If grazing animals come close then you should quietly and calmly walk away to a place of safety. Wild animals should generally stay away from you but ensure that they are not touched or disturbed, especially if they are rearing young. Many invertebrates can sting or cause irritation if touched so also be careful to avoid them. Ticks and adders can be found on sand dunes. Ensure your learners know what these look like, what they can do and what they need to do if bitten.
- Slip, trip hazards and mobile sand – advise your learners to take care and watch where they are putting their feet e.g. rabbit burrows can be hidden by vegetation. Dunes are often steep and unstable so they should ensure that they are careful and also don't just run/walk anywhere on the dunes.
- Advise your learners to be aware of the possibility of unexploded military ordnance. With areas of the Welsh coastline being used for target practice and training during the Second World War, unexploded military ordnance can be washed ashore after winter storms or become exposed at the surface of the dunes having laid buried for years. Ordnance (bullets, mortars, bombs, grenades etc.) can come in different shapes and sizes and are not always easy to identify if they are rusty or heavily corroded. If learners spot anything that looks suspicious or out of the ordinary on the dunes, beach or in the sea, advise them not to touch or move it and to seek and inform you as group leader immediately. Move your learners away from the area and ring the site manager or emergency services.
- Weather conditions – sand dunes are very exposed places so ensure all your learners are dressed appropriately. Ensure if it is a sunny day that learners have sun cream.
- Other users – remind your learners that the sand dunes are used by a range of people for recreational activities such as nudists.
- If your learners are going to be working in small groups, make sure they are aware where they should congregate at the end of the session and at what time you expect them back. Mobile phone signal may not be perfect in dune areas so ensure learners know what to do and where to find you in an emergency.

## 2. Practice sampling

Explain to your learners that their task when visiting the dune system will be to identify, count and record the number of different plant species on site. Ask them to consider and discuss how they would go about this?

It is not realistic or time-effective to count every single individual organism in a habitat, so a sample is taken. Sampling is a way of getting a quantitative measurement which is an estimate of the actual number of organisms present. It involves finding the average number of organisms of a species in a location and then multiplying this by the total size of the area being studied. The more samples that are taken the more reliable the average data produced will be, as any errors or anomalies will have less of a bearing on the overall results.

A **transect** is a line across a habitat or part of a habitat and can be as simple as a length of string or rope placed in a line on the ground. To record species along a transect you will need to use quadrats, for example, a quadrat could be placed at regular distances every five metres to record species. The number of observed organisms of each species along a transect is recorded at regular intervals.

A **quadrat** is used to sample plants and slow-moving animals. It marks off an exact area so that species in that area can be identified and counted. When using a quadrat, it can be placed randomly and multiple samples recorded, so that a representative and valid sample is taken, or placed systematically along a transect or grid. It depends on the recording method you have chosen to use as to which method you use. Practice sampling at your settings' grounds or local park by establishing a transect and using quadrats or hula hoops to count different plants.



However, if you are recording point-based data e.g. soil pH, vegetation height, water depth or topography along a transect, then you would make your recording at the assigned point along the transect and learners would not need to use a quadrat.

Explain to your learners that they will need to decide on their sampling strategy as a group. Can your learners think of any advantages or disadvantages of different sampling strategies?

There are a range of sampling methods that can be used.

Sampling method	Advantages	Disadvantages
<p>A <b>systematic sampling</b> method is where a sample is taken at a regular agreed interval.</p>	<p>In the case of a sand dune system, if you know the dunes cover a distance of 1km from the strandline to the hind dunes, it would be appropriate to select sampling locations at 100 metre intervals travelling from the shoreline to the mature/hind dunes. This would ensure the depth of the dune system is covered and is likely to provide data representing the gradual change in vegetation as you walk into the dune system.</p>	<p>It is more biased. Not all locations along a dune system have an equal chance of being selected. It may lead to over or under representation of a particular vegetation species.</p>
<p>A <b>random sampling</b> method means that the sample locations are randomly chosen.</p> <p>Quadrats could be thrown at random within the location being sampled. A spreadsheet can be used to generate random numbers. For example, if a dune system covers 1,000 metres, in depth from strandline to hind dunes, random numbers between the values of 0 and 1000 could be generated. This can be done on an Excel spreadsheet with the formula =RANDBETWEEN(0,1000). The sites randomly generated along the 1000 metres would be sampled.</p>	<p>Choosing a location because it has loads of vegetation or it has minimal vegetation for example will show bias.</p>	<p>Using random selection might not provide an appropriate range of sites to investigate as certain sections of the dune system may be overrepresented and significant sections of the dune system might not be included. Overall, the data collected might not be representative of changing habitat conditions.</p>

**Useful resources to share with learners**

Sampling - Field investigations - OCR Gateway - GCSE Biology (Single Science) Revision - OCR Gateway - BBC Bitesize

DIY Ecology Experiment for Beginners - YouTube - which includes how to make a quadrat



### 3. Investigate soil types

The best way to tell what type of soil is present in any given location is by touching it and rolling it in your hands. Give your learners the opportunity to use our **Information note – Soil types** to investigate what soil type you have at your setting before they repeat this activity on the dunes.

#### Task 1 – Hypothesis (complete before the visit)

The main question for your learners to consider during the course of their investigations will be ‘How and why do plant species vary across a dune system? Ask your learners for their initial thoughts and ask them to note their hypothesis on their **Worksheet – Sand dune vegetation sampling**.

Examples of hypothesis:

- There is less vegetation at the start of the dune system near the strandline than towards the mature dunes.
- Marram grass is the predominant plant species on the embryo dunes.
- There is more ground cover at the start of the dune system at embryo dunes than at the rear.
- The range and quantity of species increases as you move along a transect to the rear of the dunes.

In theory, there should be a greater variety of plant species on the oldest dunes. As the plants grow, die, and decompose, the organic matter accumulates, creating soil and enabling a greater variety of plants to thrive.

At the end of this activity plan there is a table to assist teachers and learners with information regarding what can be found at each stage of the dune.

On arrival at the sand dune system you plan to survey with your learners, introduce them to the site and provide them with any suitable background information. Ensure that you revisit the risk assessment with your learners on arrival.

#### Task 2 – Sand dune survey

1. Explain to your learners that they will be working in small groups (3-4) and that they will need to work through the **Worksheet – Sand dune vegetation sampling**. Advise your learners that at each quadrat site, they should swap roles within the group so that everyone has a turn at recording, measuring, observing, and identifying.
2. Along with noting down some key information about their survey site, learners will need to decide as a group what their sampling strategy will be. Encourage your learners to consider if their sampling strategy will provide a suitable range of data to test their hypothesis? With time constraints, will their sampling strategy be easy to implement during the time they have on site? They should note their reasoning for choosing their sampling strategy on their worksheet.
3. Learners work through the worksheet. It is unlikely that learners and possibly teachers too will be able to identify every plant to species level. It may be easier to identify whether you find a grass, lichen, moss, rush, orchid or daisy, for example. This is the genus or family level. There are apps or guides that are useful to have with you for this activity such as: **Seek by iNaturalist · iNaturalist** or purchase a **Sand dunes guide – Field Studies Council (field-studies-council.org)** to help identify species. If learners have a phone with a camera they could also take photographs and identify them together at a later date.

The list of species has been left blank and there are a number of options for you:

- i) Ask your learners to decide as a group beforehand which species they think will be predominant and add these to the table, however this will introduce some bias to the fieldwork.
  - ii) Leave it blank and ask your learners to add in the species as they are found (there is enough space for 9).
4. Teachers may want to provide a species tick list/photo guide of the more common species likely to be found in each dune habitat type and ask the learners to put a percentage cover against each of those they find in their quadrat. Again, this will add in some bias. It's a good opportunity to discuss bias in fieldwork.



Learners will need to provide the following information for each sample location:

- Quadrat number, ascending order from the strandline.
- Grid reference or what3words location for each sample location – your learners could plot their data on a map.
- Classification of the dune habitat they are surveying. Is it a mobile dune, fixed dune, embryo, or dune slack etc?
- % bare sand – what % bare sand can be seen? This reading will give an indication of how mobile the dune is.
- % vegetation ground cover per species – learners should note the percentage of the quadrat area that is covered by one species (e.g. Marram grass).
- Plant biodiversity score – learners should record the number of different plant species recorded within each transect. Even if they can't all be named it would be useful to get learners to count them.
- Distance from the strandline in metres – what conclusions can your learners make about the % ground cover and plant richness as the distance from the strandline increases?
- Is soil present? If so, what type? Learners should use our **Information note – Soil types** to ascertain what type of soil is present at each sample site.
- Soil pH if soil present? – this is a number that describes how acid or alkaline a soil is. A pH of 7.0 is considered neutral. An acid soil has a pH value below 7.0, and above 7.0 the soil is alkaline. As a rule, soil pH becomes more acidic the further dunes roll back from the sea. Soil pH DIY kits are widely available at garden centres. Relatively cheap and easy to use, these kits provide a good indication of soil pH.
- Notes – any other observations that your learners may consider important at each sample location should be noted.

Once your learners have completed their survey, they should complete these tasks on the **Worksheet - Sand dune vegetation sampling**

- Calculate the average % of vegetation cover of each species by dune habitat.
- Learners give an estimate of the % of bare sand dune by dune habitat. Bare sand for some organisms is essential.
- Calculate the richness of plant biodiversity score according to the dune habitat type. If a list of species has been predetermined on the recording form it will not be a true representation of actual species richness. Bias has already been introduced.

### Forming conclusions

The worksheet asks learners to discuss and consider:

- Were there any anomalies in their findings? Were there any species that seemed out of place or were there more, or less, than expected?
- Which dune habitat had the greatest plant biodiversity? What implications does this have for the animal communities present?
- Did their results confirm their hypothesis?
- Considering all of their results what conclusions can they make about the dune ecosystem from the information and data they have gathered?

### Evaluation

Learners are asked to consider and explain:

- What worked well?
- What didn't work well?
- Have the strengths/weaknesses of their investigation affected their data or influenced their conclusions? Were there any anomalies in their data?
- Is the data they have gathered accurate and reliable? Was bias introduced in any way? If so, what, and how?
- What would they do differently next time?



## Suggested key questions

- How and why do plant species vary across a dune system? What do the results show?
- What conclusions can be made about the dune ecosystem from the information and data you have gathered?
- Was the right sampling strategy chosen? Justify your answer.
- How effective is the vegetation on site at stabilising the sand?
- What would happen if there were no decomposers in the food chain?

## Adapting for different needs/abilities

### More support

- Tell your learners which sampling strategy to use.
- Ask your learners to complete less samples so they have longer to complete each quadrat.
- Arrange groups into mixed ability differentiated groups so that there is peer support available.
- Help your learners identify some of the plants on site and make observations.
- Provide a species tick list/photo guide of the more common species likely to be found in each dune habitat type and ask the learners to put a percentage cover against each of those they find in their quadrat rather than the table in task 3.

### More Challenge

- Ask your learners how they could enhance their sampling activity to test a theory?
- Ask them to take quadrat readings more frequently – every 5 metres for example.
- Other variables you could ask your learners to measure, not included on the worksheet:
  - wind speed
  - temperature
  - soil depth
  - soil moisture content

## Follow up activity/extension

After your visit to the sand dune system, here are some activities your learners could undertake to display the data they have collected.

- Ask learners to write a report, create a display or presentation to share their findings.
- Combine the results of each group. Create a summary table.
- Draw a line graph to show the percentage cover of e.g. Couch grass, Marram grass and Creeping willow across the three sand dune habitats.
- Draw a bar chart to show the numbers of different plant species across the three sand dune habitats.
- The results of learners soil sampling could be shown on a histogram or radial graph.
- Create a line graph to demonstrate number of species against distance from the strandline.
- Using Google Maps or DataMapWales calculate the total area of the sand dune system. Calculate the area of the mobile dunes, fixed dunes, and dune slacks.
- Plot your data results on a map.
- Plot your results on a sand dune profile diagram.
- What percentage area of the dunes were mobile and what percentage were fixed?
- If you know the total area of mobile dunes within the sand dune system, using your calculated total average % of vegetation cover, estimate the % of vegetation cover across the entire area of mobile dunes.



### Additional Information



Zone		Key features	Photographs
Beach		<ul style="list-style-type: none"> <li>Bare sand – no vegetation</li> </ul>	
Mobile dune	Vegetated strandline	<ul style="list-style-type: none"> <li>Generally, above the high tide line</li> <li>Mostly bare sand</li> <li>Sand mounding up around plants</li> <li>Typical species include Sea rocket (<i>Cakile maritima</i>), Sea sandwort (<i>Honckenya peploides</i>), Prickly saltwort (<i>Salsola kali</i>) and Orache species (<i>Atriplex ssp.</i>).</li> </ul>	
	Embryo dune	<ul style="list-style-type: none"> <li>Above the high tide line</li> <li>Little mounds of bare sand (&lt;1m in height) colonised by grasses.</li> <li>Typical species include Sand couch grass (<i>Elymus repens</i>) and Lyme grass (<i>Leymus arenarius</i>).</li> </ul>	






Zone		Key features	Photographs
Beach	Shifting dune	<ul style="list-style-type: none"> <li>• Usually the first dune ridge from the beach.</li> <li>• Can be very tall when looking from the beach.</li> <li>• Lots of bare sand and Marram grass.</li> <li>• Typical species include the Marram grass (<i>Ammophila arenaria</i>) and Lyme grass (<i>Leymus arenarius</i>) and herbs such as Spurge species (<i>Euphorbia paralias</i> and <i>E. portlandica</i>), and Sea holly (<i>Eryngium maritimum</i>).</li> </ul>	
Fixed dune	Semi-fixed dune	<ul style="list-style-type: none"> <li>• Less bare sand than the frontal shifting dunes.</li> <li>• Marram grass still dominant but other species more common.</li> <li>• Mosses can form patchy ground cover.</li> <li>• Typical species include Marram grass (<i>Ammophila arenaria</i>), Red fescue (<i>Festuca rubra</i>), Restharrow (<i>Ononis repens</i>), Sand sedge (<i>Carex arenaria</i>), Birds foot trefoil (<i>Lotus corniculatus</i> and mosses.</li> </ul>	
	Fixed dune	<ul style="list-style-type: none"> <li>• Oldest and most fixed dune habitat.</li> <li>• Vegetation looks like a grassland with little to no bare sand except where rabbits or livestock have disturbed the surface.</li> <li>• Scrub and trees should be rare.</li> <li>• Typical species include Red fescue (<i>Festuca rubra</i>), Lady's bedstraw (<i>Galium verum</i>), Ribwort plantain (<i>Plantago lanceolata</i>), Bird's-foot trefoil (<i>Lotus corniculatus</i>) and violets including Dune pansy (<i>Viola tricolor subsp. curtisii</i>). There may still be some Marram grass (<i>Ammophila arenaria</i>) and/or Sand sedge (<i>Carex arenaria</i>).</li> </ul>	



Zone	Key features	Photographs
Dune slack	<ul style="list-style-type: none"> <li>• A flat-bottomed, low-lying hollow between dune ridges, which are often damp or wet (except during the driest summer months).</li> <li>• Flooding in winter is common.</li> <li>• Mosses and liverworts can be a dominant component.</li> <li>• Typical species include; Creeping willow (<i>Salix repens</i>) Common sedge (<i>Carex nigra</i>), Silverweed (<i>Potentilla anserina</i>), Marsh pennywort (<i>Hydrocotyle vulgaris</i>), Yorkshire fog (<i>Holcus lanatus</i>), Red fescue (<i>Festuca rubra</i>), Creeping bent (<i>Agrostis stolonifera</i>), Glaucous sedge (<i>Carex flacca</i>), Creeping buttercup (<i>Ranunculus repens</i>) and Pointed spear-moss (<i>Calliergonella cuspidata</i>).</li> </ul>	
Dune heath	<ul style="list-style-type: none"> <li>• Tends to be found in the oldest parts of the dune system where soil has become acidic and much drier.</li> <li>• Found in mosaics with other dune habitat types.</li> <li>• Resembles a lowland dry heath in character.</li> <li>• The vegetation can often be dominated by lichens, which form a continuous grey carpet over the ground.</li> <li>• Typical species include Heather (<i>Calluna vulgaris</i>), Sand sedge (<i>Carex arenaria</i>), Bell heather (<i>Erica cinerea</i>), Sheep's-fescue (<i>Festuca ovina</i>) and Common bent (<i>Agrostis capillaris</i>) and Sand sedge (<i>Carex arenaria</i>).</li> </ul>	



Zone	Key features	Photographs
<p>Dune scrub and Native dune woodland</p>	<ul style="list-style-type: none"> <li>• Often occupies the back of the dune system, where soils are most developed, and the least sand movement occurs.</li> <li>• Little to no bare sand.</li> <li>• Dominated by woody perennial species which can resemble small woodland copses.</li> <li>• Typical species include Willow species (<i>Salix</i> sp.), Birch species (<i>Betula</i> sp.), Hawthorn (<i>Crataegus monogyna</i>), Blackthorn (<i>Prunus spinosa</i>), Alder (<i>Alnus glutinosa</i>) and Elder (<i>Sambucus nigra</i>).</li> <li>• Sea-buckthorn (<i>Hippophae rhamnoides</i>) is non-native to Wales and is considered a serious threat to sand dunes. Extensive stands of Sea-buckthorn can often develop to form a dense, impenetrable cover at the expense of other herbaceous sand dune species.</li> </ul>	

### Looking for more learning resources, information and data?

Please contact: [education@naturalresourceswales.gov.uk](mailto:education@naturalresourceswales.gov.uk) or go to <https://naturalresources.wales/learning>

Alternative format; large print or another language, please contact: [enquiries@naturalresourceswales.gov.uk](mailto:enquiries@naturalresourceswales.gov.uk)  
**0300 065 3000**

