

Cw 1: plant, water and soil testing report

Introduction

This report investigates how factors such as water, plants and soil influence the biodiversity on a site and assesses constraints to biodiversity due to human influences. It proposes a methodology to formulate a testing plan on how to examine these factors and then discusses improvements to the site. This study is unable to encompass the laboratory skills needed to establish scientific results so instead, it's based on visual examinations and basic tests to examine the site. The UN convention of biological diversity, 1992 defines biodiversity as “the variability among living organisms from all sources including terrestrial, marine, and other aquatic ecosystems and ecological complexes of which they are a part: this includes diversity within species, between species, and of ecosystems” (Anderson et al, 1992)

Image 1



Background of the site

The site I have chosen is located in the SA1 area of Swansea bay. It is a stretch of vegetated sand dunes between Swansea's West pier to the Tower of the Ecliptic Observatory. The approximate location of the site is illustrated in image 1 where you can see it labelled by the blue circle. It is located to the West of Swansea bay, to the left of the River Tawe. The approximate area is illustrated in more detail in image 2, the total area is 32575.8 m². Before visiting the site, it's important to establish a baseline of what is there, what isn't there and what used to be there.

From completing background research into the area, Swansea west pier underwent repair in 2018 after significant deterioration prior due to storm damage. The lack of structure there caused deterioration to the dunes, resulting in sand being blown onto the path creating challenges with removing and disposing of it. The structure is there to prevent coastal erosion and protect the sand dunes (Kajastie, 2022) as dunes have the purpose of stabilising sand and contributing to the biodiversity of the natural local environment. (YLab, nd) Sand dunes are an important ecosystem service as they provide benefits to humans in terms of natural coastal defences. In this area specifically, they help to protect the homes behind it located on Trawler Road. Some challenges that have been raised by the council are the introduction of non-native species such as 'Italian alder' and 'Japanese rose' which threaten the natural biodiversity causing ecological damage to the native dune habitat. (Swansea bay news, 2020) This is because non-native species can cause new diseases which can alter and damage native species and

Image 2



they also create competition for obtaining essential resources such as water, nutrients and sunlight. This affects ecosystem services.

According to the international union for conservation of nature (2021), non-native species reduce habitat resilience which is why “invasive species are one of the biggest causes of biodiversity loss and species extinction”. This demonstrates why this issue has been highlighted on this site and why action has been put in place to remove invasive species to reduce spreading and stop them from establishing further.

As well as non-native species found, the typical species here are dune grass, dune willow and amphibian species such as lizards and slow worms.

Another problem that has been raised is damage that occurred from the construction of the west pier. The area next to the wall, used to store equipment and machinery, has left behind damage and debris. Image 3 shows a comparative before and after shot of this area demonstrating the effect that human influence has had.

There is also an issue with litter across the site with lots of plastic bottles, wrappers and glass being scattered throughout the dunes which is a big cause of microplastic contamination in soils.

Image 3



Aerial image of site **before** construction by Richard Youle

Image of site **after** construction by Nia Kajaste

Examining plant diversity

There are two types of sampling you can use using quadrats; systematic and random sampling. Random sampling involves using a random generator to choose the coordinates of the location to place the quadrat and identify, count and record what you have inside and repeat this multiple times. This allows you to gain a holistic view of what biodiversity you have there without any bias. Systematic sampling involves placing your quadrat at regular intervals and recording what you have in each one.

Other pieces of equipment that can be used include pitfall traps which are small containers that are buried in the ground and catch insects that fall into the trap or sweeping nets which are large nets which catch flying insects by sweeping the net. This method is useful in long grass such as that found in dunes.

A simple statistical test that can be used to establish biodiversity is Simpson's diversity index.

$$D = 1 - \frac{\sum n(n-1)}{N(N-1)}$$

The formula calculates the species diversity in a given area using the equation shown with the variables being:

- n = number of individuals of each species
- N = total number of individuals of all species
- D = diversity index

A high score (close to 1) indicates high diversity. (Locke et al, 2016).

You can use field guides to help determine the identity of species. You can look at the shape and arrangement and edges of leaves, and the venation which can be used to gain analysis of a plant. Guides allow you to determine the health of plants by looking at discolouration and deficiencies for example a nitrate deficiency causes leaves to turn pale green or yellow due to the reduction of chlorophyll.

For inspection at my site, I used an app called 'LeafSnap' to help me determine the classification of the plants I identified. On the app, you use the built-in camera to take a clear shot of the plant you are looking at and it will identify the plant. I randomly selected plants and identified them using the app and recorded them in the table below.

Plant name	Image	Function and biodiversity value
Maram grass (Ammophila Arenaria)		Plays a vital role in stabilising the dunes by binding the sand down. It has many adaptations to allow it to survive in a coastal environment. (The wildlife trust)
Restharrow (Ononis repens)		Their pink flowers and sweet scent attract bees High medicinal value in treating kidneys (the wildlife trust)

Sea spurge (euphorbia paralias)		Alter dune communities due to dense infestations as seed disposal rapidly spreads them.
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However, these results can be scrutinised as I only visited the site on one occasion so they are not representative of the changing habitat conditions through the seasons. The results could be different had I visited at different times on multiple occasions. Additionally, the app may not give accurate identification of the plant so to increase the validity of the results you should cross-check the identity of the plant using a field guide.

Examining soil quality

When testing a site for biodiversity, soil can be used to indicate biodiversity. It's important to look at physical, biological and chemical health as good maintenance of these factors allows for the greatest soil potential.

Physical health

To examine soil composition and texture you need to determine the percentages of sand, silt and clay in the soil. The soil texture triangle is the most widely used identification tool developed by Whitney.M, (1911) under the USDA. The triangle is split into 12 different texture classes which are determined by soil fraction percentages. The texture of soil directly influences the growth of plants as it has an impact on drainage, water storage, pH, organic matter content and rooting depth (Aarthi, 2020) A well-structured soil will allow water to move freely through the soil structure and roots to grow easily as problems such as compaction and poaching make it harder for plants to access minerals in the soil and root which increases the risk of soil erosion.

A way of determining the soil percentages yourself is by digging a column of soil and filling a jar $\frac{1}{3}$ of the way with it and filling the rest of the jar with water and a small amount of dish detergent. Shake it vigorously and allow 24 hours for it to settle into each layer. The heavier coarse sand will separate out first at the bottom, then the darker silt sediments and then the superfine clay particles on the top. (Jeffers, 2022). To calculate the percentage use this equation by measuring each layer:

$$\frac{\text{soil depth of layer (mm)}}{\text{total soil depth}} \times 100$$

You can also determine soil fraction percentages in more detail by using a process called laser diffraction.

Chemical health

The chemical health of soils is also important to understand. According to *(the USDA Natural Resources Conservation Service January 1998)* a pH of 6-7 is the most favourable to plant growth. At this level, most nutrients are available as they are most soluble in this range. A pH too high may cause problems with deficiencies of nutrients and a pH too low can result in poor plant growth. This highlights the importance of knowing your soil properties as it allows you to maximise the productivity of the site.

A way of testing soil pH at home would be to dig a small sample of soil at least 4-6 inches deep. Remove the stones and sticks then add some water to create a mud-like consistency. Split this into two containers and add vinegar to one to test for alkalinity and baking soda to the other to test for acidity. If positive the sample will fizz. You can also buy at-home pH testing sticks in which you add water to a sample of soil and drain it through filter paper and compare the test strip to the chart provided.

Another factor to look at would be Micronutrients and macronutrients which would need to be examined in a laboratory using a method called broad spectrum analysis which can identify deficiencies in the soil.

Biological health

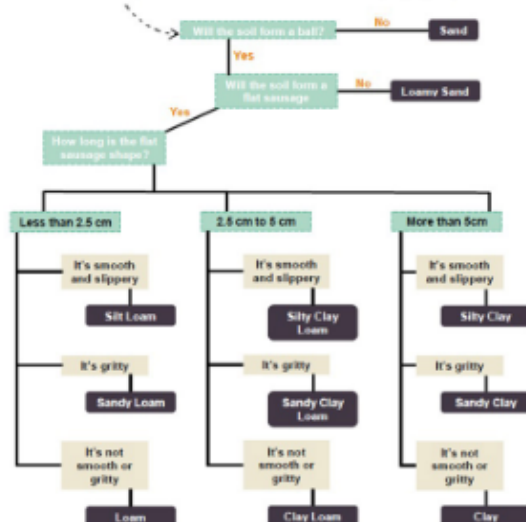
According to (FHD 2019) healthy soil contains a high species richness level which has a large quantity and variety of organisms that interact to provide a variety of ecosystem services. A study by Griffiths et al (2019), concluded that in a 20cm x 20cm square of healthy arable soil there would be 5-10 earthworms so this could be a good indicator of soil biodiversity and health. Earthworms are important because they aerate soils and allow water to penetrate. However, this method of analysis has some limitations; you could argue that the sample size is too small and this method needs to be completed in multiple random spots across the site to be able to conclude more objective, inclusive results.

On the site, I looked at the soil type by touching it and rolling it in my hand and I used the flow diagram in image 4 to help determine my result. The soil had a high percentage of sand so would be classed as sand. From a more detailed inspection, the grain size of this particular sand is small, according to Aarthi (2020), the range of soil particle diameter for sand is 2.00- 0.075 mm. Sand dune soils are known for having a high lime content and are poor in organic matter and plant nutrients so vegetation is adapted to this. (Ranswell, 1986) Many plants are growing on the sand, meaning its a stable structure however through the dunes you can see where footpaths have been created by people as

Image 4

Soil Texture Test Instructions

Take a golf ball sized amount of soil.
Knead this, whilst adding a small amount of water until the soil feels like putty/play dough.



there is little plant growth in these sections which could be due to soil compaction.

Examining water quality

Another aspect of testing a site is looking at the water quality. Test strips can identify the concentration of a specific chemical in a water sample by dipping it into the water and comparing the colour on the strip to a colour chart. Another way is by using colorimetry which involves adding a chemical reagent to a water sample. The colorimeter determines the concentration of a specific component based on its absorbance of a specific wavelength of light which is detected by a 'photocell' inside the device. (Choudhury, 2014) colorimeters can screen for minerals found in water such as chlorine, fluorine, ammonia, nitrates etc and also determine the pH of water.

The seawater in Swansea bay is analysed frequently by natural resources wales (2021) and the most recent results highlight these key points: the water quality is rating as 'good' in 2021 and results indicate 'acceptable water quality'.

Suggestions for improvements

It is challenging to suggest improvements for this site on specific components, without having data from lab tests on the properties of the soil, water and plants.

Trampling has been highlighted as an issue in terms of vegetation loss. An improvement for this would be to create localized fencing enclosures on the dunes. Routes through dunes should be paved with wooden boards or netting to avoid trampling with the purpose of fencing to be explained on notice boards. An alternative way is to rotate heavily worn routes with alternative rested ones. (Ranswell, 1986) Another suggestion to improve the site would be to reduce the amount of litter found by providing more bins on the coastal path behind the beach and more education and signs about the impacts of litter. Also, continued efforts are needed to maintain the removal of non-native species.

Conclusion

This report established that the site shows many signs of biodiversity with a wealth of plant diversity, well-structured soil and 'good water quality'. It's important to look at a range of indicators to establish a thorough examination of biodiversity and health. It is important to maintain biodiversity as healthy ecosystems help to maintain the earth's processes.

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Image 1
digimaps, OS-Roam (Edina.ac.uk) (accessed 24.11.2022)

Image 2
digimaps, OS-Roam (Edina.ac.uk) (accessed 24.11.2022)

Image 3 left: Richard Youle. Right: Nia Kajaste

Image 4 RHS, 2022, soil texture test as a flow diagram, available at <https://schoolgardening.rhs.org.uk/Resources/Info-Sheet/Soil-texture-test-as-flow-diagram>