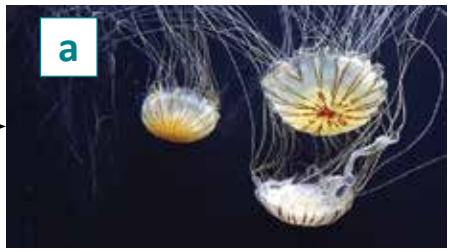
The Rocky Shore Ecosystem

Starter: Plankton match

Match the plankton larvae to their adult life



Jellyfish

Common shore crab

Octopus

Edible sea urchin

Acorn barnacle

The Rocky Shore Ecosystem

- What are the **advantages** of living on the rocky shore?

1.	2.	3.

- What are the **disadvantages** of living on the rocky shore?

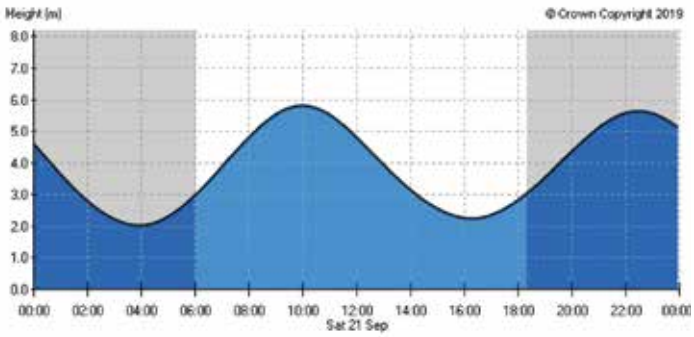
1.	2.	3.

Time for tides

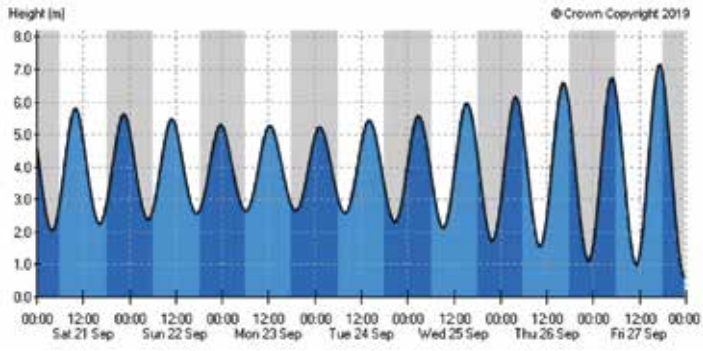
The graphs (right) show how the change in tide height over time. The blue area is the area covered by water during each hour of the day.

1. How much time does an organism living at 3m spend out of the water in a 24 hour period?
2. How much time does an organism living at 5m spend out of the water in a 24 hour period?
3. Describe the changes over the week shown, with regard to tidal range and height.
4. Using what you know about tides, explain why tidal height varies day to day.

Check out the tide simulator at www.schoolsobservatory.org/discover/sims-cals/tidesim



This chart shows the change in tide over 24 hours



This chart shows the change in tide over 1 week

Research Question: How does the distribution and abundance of species change with height on a rocky shore?

- State the **hypothesis**

- Identify the independent, dependent and control variables in this investigation

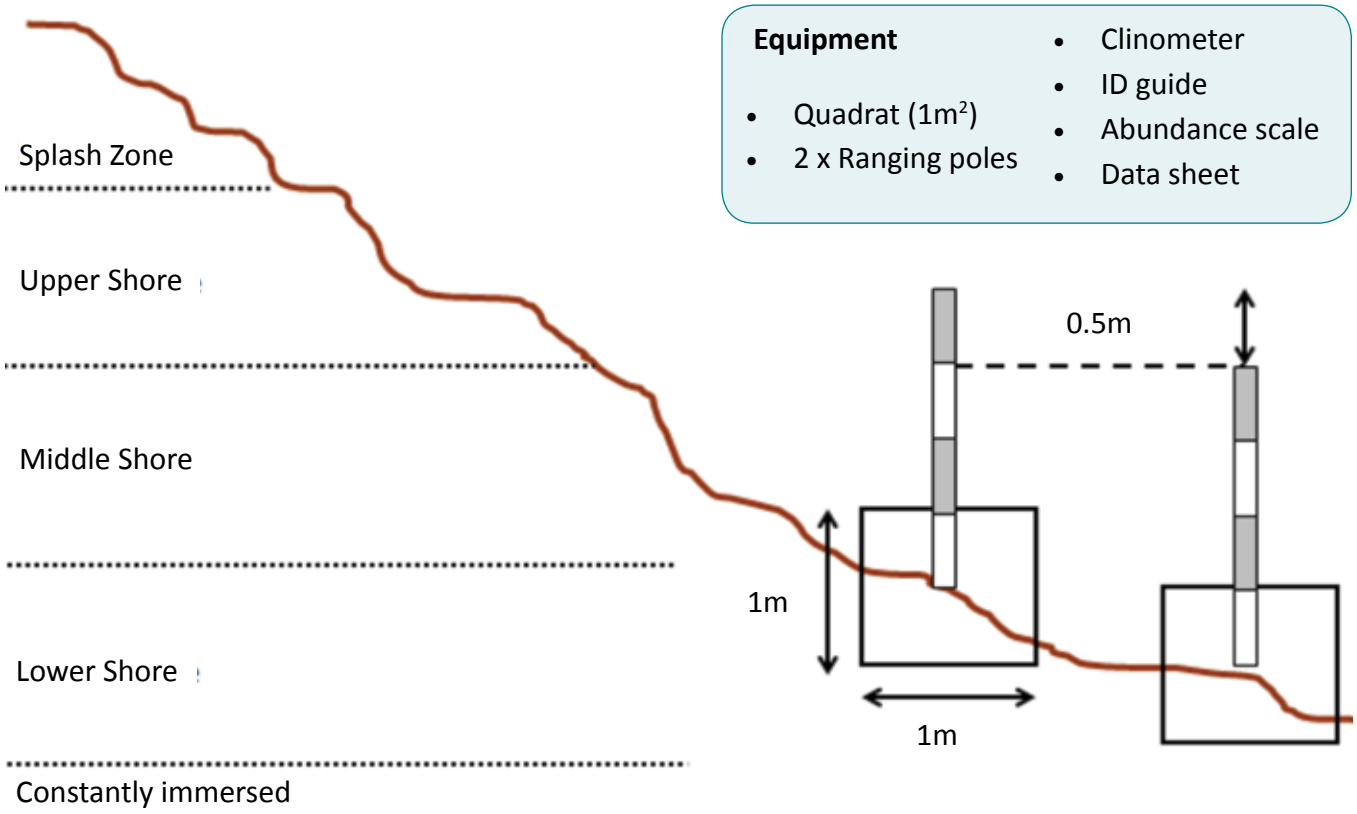
Independent variable	Dependent variable	Control variable

- Our method can be described as **a systematic, vertical, interrupted transect**
  Can you break down this phrase and explain what the different words might refer to?

Systematic	
Vertical	
Interrupted	
Transect	

KS5 Rocky Shore Ecology

PRE-LESSON PREPARATION



Equipment

- Quadrat ($1m^2$)
- 2 x Ranging poles
- Clinometer
- ID guide
- Abundance scale
- Data sheet

Note down any questions you wish to submit which can be answered during the Live Session:

The **Story Map** contains information about the fieldwork location, rocky shore ecology, species information and how we can collect data on the rocky shore. You can find it here: https://bit.ly/fieldworkliveRS

www.tidetimes.org.uk/millport-tide-times to find out when low tide is at Millport on the day of #FieldworkLive. What is the tidal range that day?

Location Fact File
Farland Bight, Isle of Cumbrae

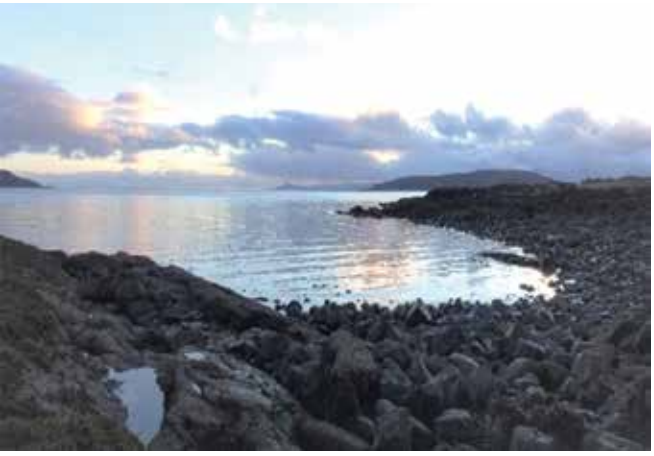


Figure 1. Pottery Bay

Introduction to the Isle of Cumbrae

The Isle of Cumbrae is an island located in the west coast of Scotland, in the Firth of Clyde. The island is relatively small with an area of only 4.5 square miles. Due to its location, geology and other factors, the island has some fascinating natural history. The coastline around the Isle of Cumbrae is very varied but has several great examples of rocky shores. Rocky shore are intertidal areas where the ground is mostly composed of solid bedrock. These areas provide habitat for many marine species and are a great place to learn about marine environments and life.

Location of field site

On the south coast of the Isle of Cumbrae, there is a headland known as Farland Point. On the east side of this peninsula is a small cove known as Farland Bight, with a beach called 'Pottery Bay' (as seen in Figure 1). This document provides geographical, geological and ecological information regarding this field site and will discuss some of the potential impacts that climate change may have on this bay.

Figure 2. Location of Farland Point on the west coast of Scotland

The latitude and longitude of Pottery Bay are:
Lat.: 55°44'46.27" N
Long.: 4°54'42.26" W

History of Pottery Bay

If you were to take a walk around Pottery Bay, you would quickly realise where it gets its name. Throughout the industrial period, there were many ceramic pottery factories around the City of Glasgow and along the Clyde river banks. Across the floor of Pottery Bay, thousands of small and broken ceramics lie scattered. It is unknown whether these items have been deliberately deposited here or deposited by the action of the tides and waves from around the Clyde and the old factories that once were in operation here.

Tidal information

Pottery Bay is an intertidal zone meaning that the tide moves in and out of the bay, exposing the bay for part of the day and covering it for the other part. High-tide and low-tide are both reached two times per day. This leads to changing abiotic conditions throughout the day and so in order to survive, organisms on the rocky shore must be adapted to the changing conditions.

The tidal range of an intertidal zone is the vertical distance between the low-tide mark and the high-tide mark. The tidal range at Pottery Bay is 3-4 meters. Changes in the alignment of the sun and moon during the lunar cycle cause the tidal system to periodically experience abnormally low tides, called 'neap' tides and abnormally high tides called 'spring' tides.

Exposure

The aspect of a beach or bay is the direction in which it faces. The aspect influences the abiotic conditions at the beach such as sediment transportation, erosion and vulnerability to storms. The prevailing wind direction is south-westerly in the West of Scotland, which brings warm and damp oceanic weather conditions.

- Using Figure 2, can you estimate what the **aspect** of Pottery Bay might be?

Figure 3. Sandstone bedrock at Farland Point

Geology of Great Cumbrae

The Great Cumbrae fault runs north and south dividing the island into the west and east section - Farland Point lies on the east of this fault. The entire east section of the island is composed of 600-metre deep continental Devonian Sandstone, or as it is sometimes referred to, Old Age Sandstone. As its name suggests, this rock was deposited across north-west Europe throughout the Devonian age, approximately 416 to 359.2 million years ago.

Sandstone is an example of sedimentary rock, meaning the minerals that make up the rock were once carried as sediment before being deposited – after being deposited, the minerals are buried and solidify into the rocks that we see today. Many of the boulders and sand found on the island is derived from this type of rock as well.

- Why is the rock type and corresponding geological properties important for the ecology of rocky shores?

Climate change and rocky shores

Sea temperature

Climate change is likely to have a big impact on the natural history and physical landscape of Pottery Bay, and the changes seen here are likely to reflect the changes that will be seen on rocky shore areas around the rest of Britain. One change we are likely to witness, is the rise in sea water temperatures. It has been predicted by the year 2080, sea water temperatures around Britain could rise by an average of 2.5°C.

- What are the possible consequences of rising sea temperatures on marine habitats such as rocky shores?

Ocean acidification

Increased carbon emissions and carbon dioxide in the atmosphere are also able to alter the chemistry of marine systems – this is called ocean acidification. Naturally the oceans absorb carbon from the atmosphere, acting as a 'carbon sink', and convert it into oxygen and carbonic acid. However, due to the increased volume of carbon dioxide in the atmosphere, the oceans are absorbing more, and in turn, more carbonic acid is being produced. This can have a negative impact on marine ecosystems as the additional carbonic acid decreases the water's pH. Many marine animals around the world, including some found on Pottery Bay, form their exo-skeletons and shells with a mineral called calcium carbonate ($CaCO_3$) – an alkaline substance. The reduced pH of the water dissolves the calcium carbonate.

- Some of the most important organisms in the ocean build their bodies out of $CaCO_3$; can you think what these are? What would be a consequence of losing these organisms on the marine ecosystem?

Sea-level rise & increasing storms

However, the most-stark change we are likely to witness at our rocky shore areas, is the influence of sea-level rise combined with increases in the frequency and intensity of storm events. All over the world, sea levels are rising due to the melting ice-caps with predictions of over 1m rise before 2100. More frequent storms will bring heavier rain, winds and waves to our coasts.

Figure 4: SEPA predictions of areas that have a high risk of coastal flooding.

Both of these issues will present vast problems to some human coastal communities, however it is important to consider how the cumulative impact of these might affect our coastal habitats.

- How could these two factors shape the future our intertidal habitats?
- Will some organisms fair better than others? What are the potential barriers to their survival?

Species Descriptions
Seaweeds

Channel wrack *Pelvitia canaliculata*

This seaweed species is found far away from the sea in the upper shore. This means they have some incredible adaptations to help prevent them from desiccation or drying out. It has rolled fronds like a gutter to reduce evaporation and thick cell walls. It can even survive losing up to 90% of their total water and rehydrate itself in only 25 minutes.

Spiral wrack *Fucus spiralis*

Spiral wrack is also found relatively high on the shore in either the upper or middle zone, usually lower than channel wrack. It possesses similar adaptations to prevent drying out like twisted fronds and thick cell walls. It is also a hermaphrodite to increases its chances of reproducing successfully and releases gametes from receptacles at the end of its fronds in late summer.

Bladder wrack *Fucus vesiculosus*

This species is commonly found across shores all over the UK and can only survive in the middle to lower shore. This means it doesn't have to adapt to desiccation stresses as much as upper shore species, but it does have to cope with low light levels for when the tide comes in. It has evolved air bladders on its fronds to keep it floating to obtain light for photosynthesis.

Serrated wrack *Fucus serratus*

Serrated wrack can be found closest to the sea in the lower shore. As the name suggests it has jagged edges along the fronds and is also often referred to as 'toothed wrack' or 'saw wrack'. This species can support a number of epiphytes on its fronds with over 90 species having been recorded. As well as chlorophyll it also possesses a pigment called fucoxanthin which widens the range of light it can absorb for photosynthesis.

Species Descriptions
Animals

Shore crab *Carcinus maenas*

Shore crabs are a highly versatile animal and can be found as deep as 60m down in all sorts of marine habitats but are most commonly seen in intertidal rocky shores. They are a true scavenger and will eat almost anything they can get their claws on including molluscs, arthropods, algae and fish.

Common starfish *Asterias rubens*

The common starfish can be found under rocks or in crevices on the lower shore and gradually moves deeper as it grows. They have 5 arms and are normally a pale orange colour with small white spines on their dorsal surface. They specialise on bivalve molluscs for food, using their strong tube feet to prise open the shells to eject their stomach into for external digestion.

Common limpet *Patella vulgata*

A common sight on UK rocky shores is the gastropod mollusc the common limpet. These snails keep themselves anchored to the rock when the tide is out using a strong muscular foot. This helps retain moisture to allow them to breathe and stops them drying out. When they are immersed, they lift themselves off the rock and forage for microalgae before returning to their particular spot on the rock called a home scar.

Dog whelk *Nucella lapillus*

Despite looking fairly plain the dog whelk is a notorious predator on the rocky shore. Like other molluscs they possess an organ called a radula which is adapted for feeding on animals with a hard shell. The dog whelk's radula is so hard that, with a combination of chemicals, it can drill through the shells of barnacles and mussels.

Species Descriptions
Animals (continued)

Beadlet anemone *Actinia equina*

A member of the Cnidarian phylum, these anemones are closely related to jellyfish and coral. Their small tentacles contain cnidocyte cells which each have a small harpoon inside filled with toxins to immobilise prey. When uncovered by the sea this species retracts its tentacles within its column and releases a sticky mucus, covering its body to prevent drying out.

Diamond barnacle *Semibalanus balanoides*

This species of barnacle is commonly found across all UK coasts and often goes unnoticed when out of water. Inside each small calcified dome is a small shrimp-like crustacean which has adapted to a more sessile life. When immersed by the tide the aperture at the top of the dome opens and barnacles extend their feeding nets into the water to filter for particles of plankton.