

Teacher's Pack

**STEM  
BOX**

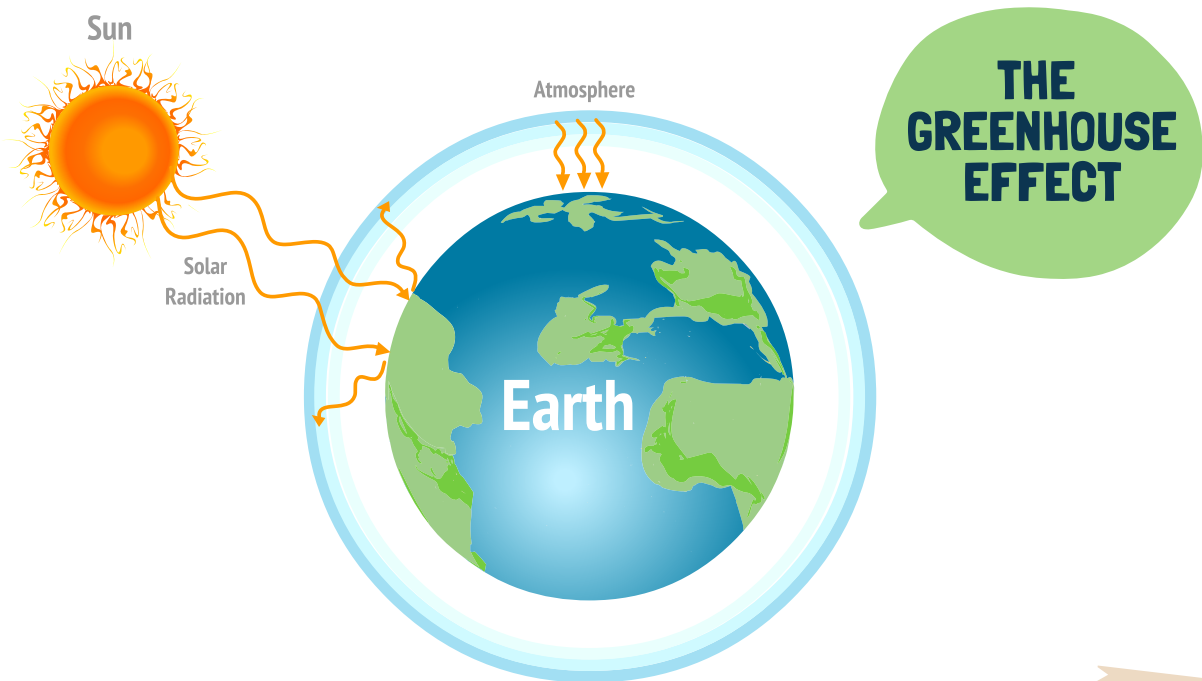
# Blue Carbon in Falkirk



# Blue Carbon Introduction

## Blue Carbon and Climate Change

Our planet is warming due to the release of greenhouse gases, such as carbon dioxide, into the air.



The build-up of greenhouse gases in the atmosphere acts like a blanket or greenhouse around the planet. Heat is trapped inside the Earth's atmosphere. This is the greenhouse effect, and the resulting increase in global temperatures is called global warming, which can result in melting ice caps and rising sea levels.



Researchers report that warming from greenhouse gases can cause sea levels to rise

Credit: Photographer Unknown.  
Image sourced from <https://climate.nasa.gov/>

In order to limit the extent of global warming, we must limit the release of greenhouse gases into the air.

## So, what are we doing about this?

Scotland, along with many other countries around the globe, has committed to reaching 'net zero' emissions by 2045.

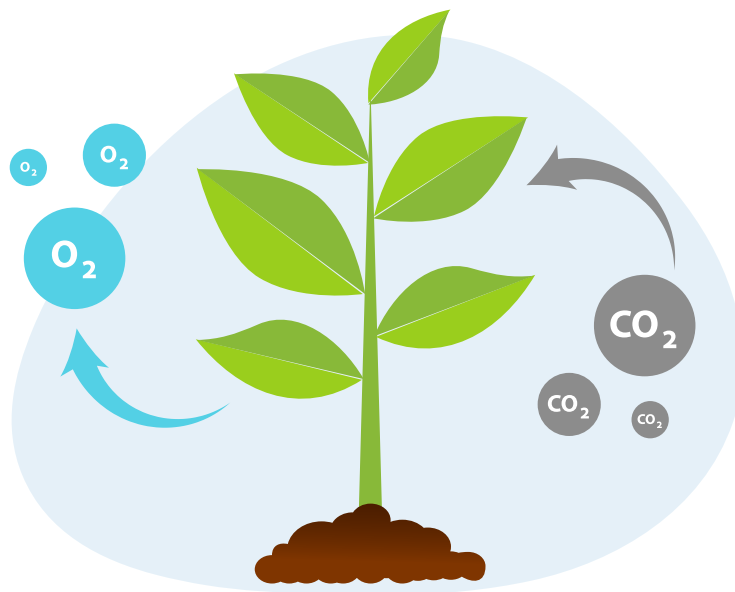
## Discuss: what does "reaching net zero" mean?

Scotland will reach "**net zero**" when the amount of greenhouse gas we add to atmosphere is no more than the amount we manage to take away,

*It's basic maths: e.g.  $+ 2 \text{ greenhouse gases} - 2 \text{ greenhouse gases} = 0 \text{ greenhouse gases!}$*

## So... how can we 'take away' greenhouse gases, such as CO<sub>2</sub>?

Amazingly, plants are able to remove carbon dioxide from the air through photosynthesis and store it in their cells as carbon, thereby decreasing the effect of global warming.



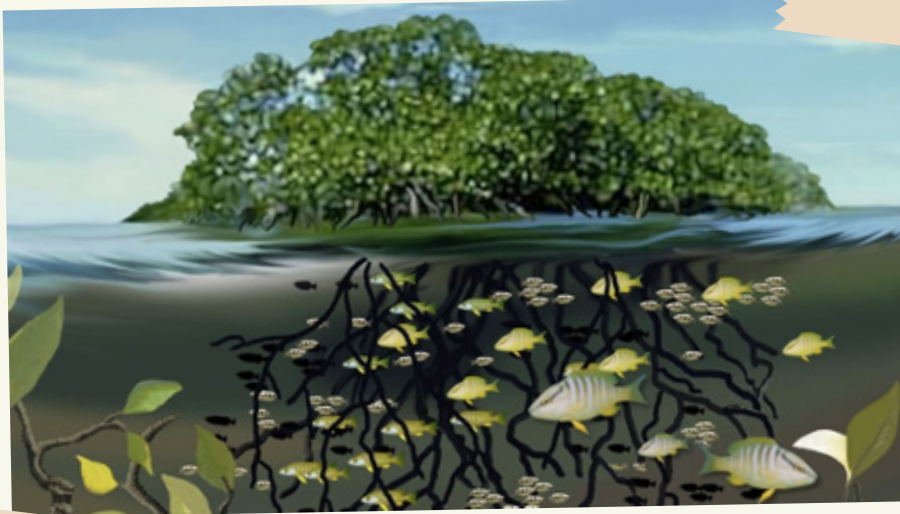
## How on EARTH do they do this?

When plants die, they bury themselves into the sediment beneath where they stood and slowly make their way down through the soil.

Over time, microbes in the soil break down this plant material. This is called decomposition, and this process releases greenhouse gases, such as carbon dioxide, into the air.

**Your first thought might be... let's plant loads of trees, right?  
And that's definitely not a bad idea!**

**BUT, not many people know that coastal ecosystems are actually more efficient at doing this than forests - they store more carbon than the world's forests combined.**



Coastal Ecosystem: Where the land meets the sea

Credit: © 2021 Woods Hole Oceanographic Institution: <https://www.whoi.edu>

**Coastal ecosystems are areas where the land meets the sea, e.g. salt marshes, mangroves, wetlands, estuaries, reefs, bays and more!**



# Critical Storage

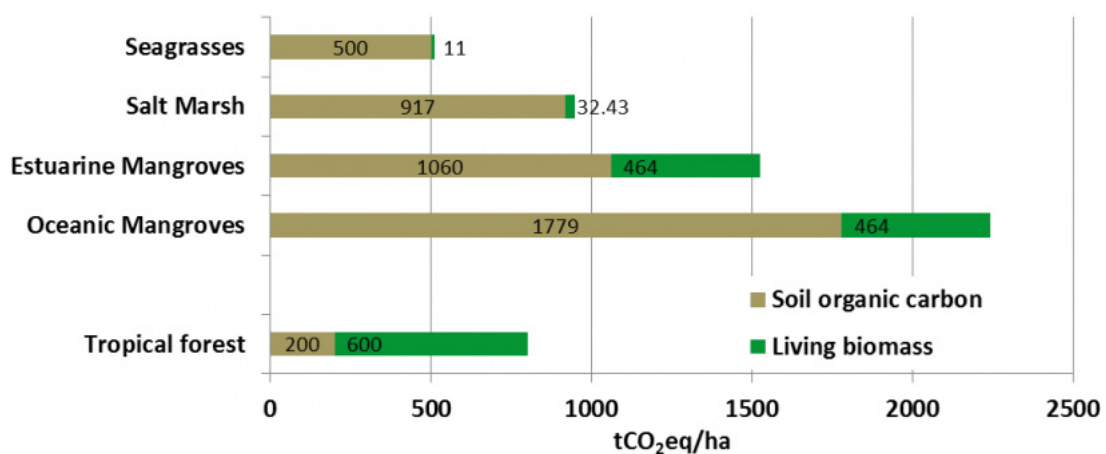
## Ocean + Coastal Habitats

**83%**  
Global Carbon

**2%**  
Coverage

**50%**  
Sediment Carbon

Source: ICUN.ORG



Source: ICUN.ORG

## Discuss

1. What choices do we make daily to protect the planet and stop climate change?
2. What is Blue Carbon?



Let's find out a bit more about one special type of coastal ecosystem that exists right here on our doorstep....

# Saltmarshes



Skinflats Foreshore Ponds with Skinflats in background, 1990s

Credit: Central Regional Council Planning Dept via via Falkirk Archives

<https://collections.falkirk.gov.uk/objects/160418/skinflats-foreshore-ponds-with-skinflats-in-background>

Saltmarsh soil is flooded with seawater daily, meaning it is saturated with water (waterlogged).

As a result, microbial activity in the soil of saltmarshes is low, basically, there's not much going on with all that seawater in the way!

**This means that decomposition in saltmarshes is super-slow....**

Because of this, saltmarshes are brilliant at storing carbon **long-term, as they prevent the release of greenhouse gases** from decomposing plant material for up to millennia (1000 years!)

**Amazing, right?**

# How can I understand this better?



Scientists and now, **YOU** can study the decomposition of plant material with the use of teabags! Here's the clever bit, listen carefully...

- 1 The tea inside the bag acts as the plant material
- 2 The teabag can therefore be placed in different soil environments to decompose.
- 3 After leaving the teabag to decompose (in different types of soil) for a certain amount of time, we can then measure the change in weight of the teabag to understand the amount of greenhouse gases released during its decomposition.
- 4 As the plant material within a teabag decomposes, some of its mass is lost and greenhouse gases are released. Therefore, a decrease in teabag weight signifies a release of greenhouse gases.

In the STEM Box experiment, we'll use this information to compare decomposition between **a saltmarsh and a regular soil environment.**



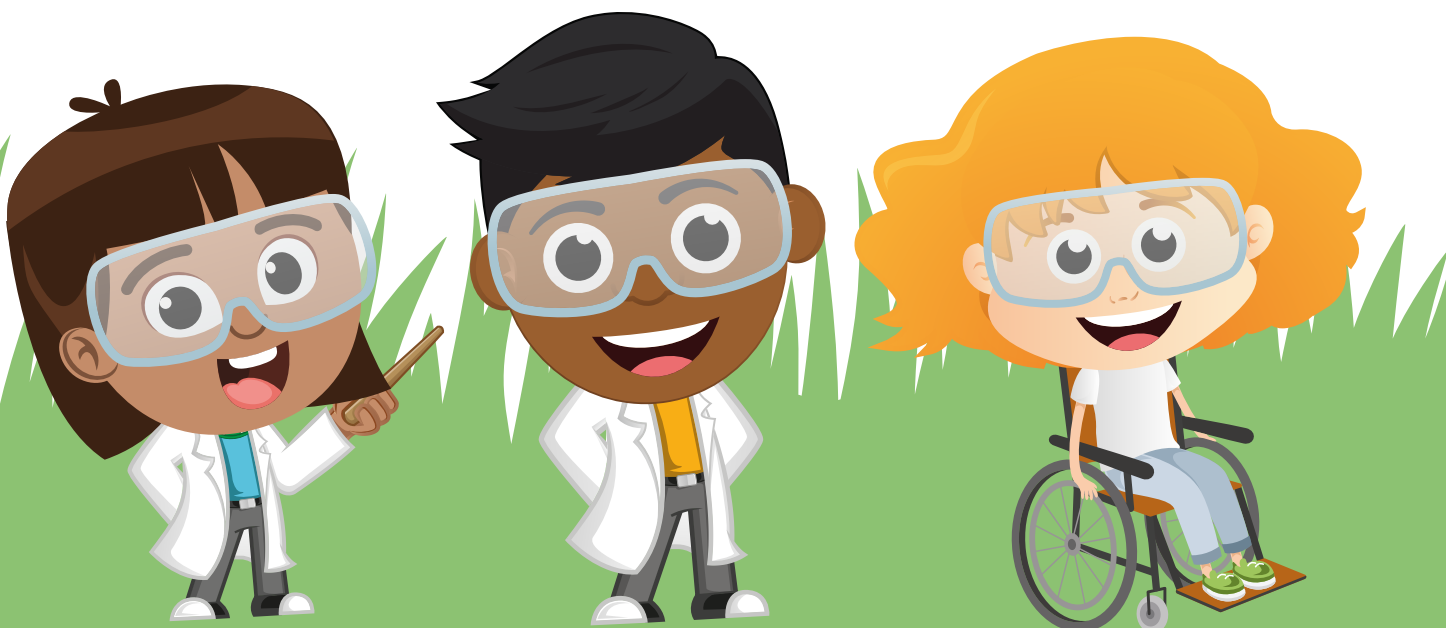
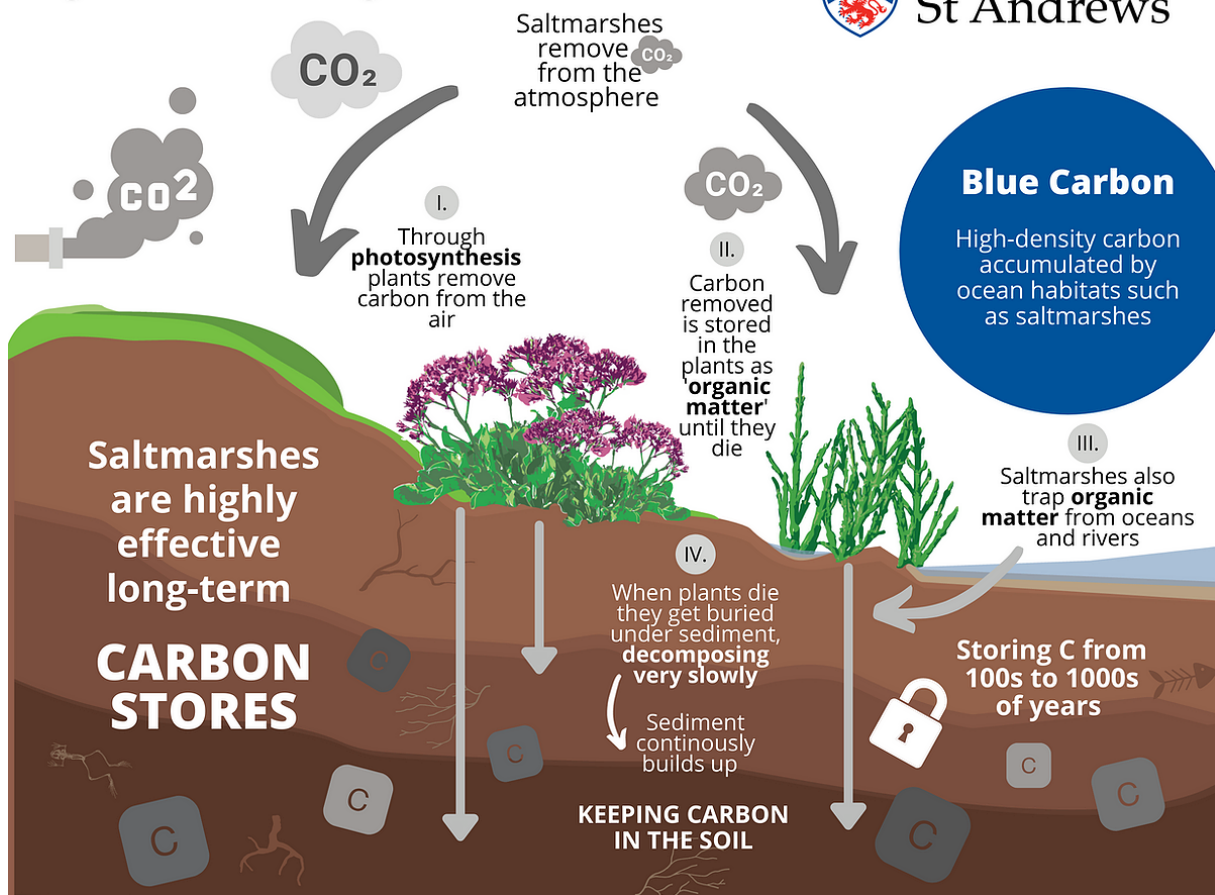
**Blue Carbon Introduction Video**

<https://vimeo.com/636076877>

## Blue Carbon: saltmarshes can help us fight climate change



University of  
St Andrews



## Did you know...

saltmarshes are better at capturing and storing  $\text{CO}_2$  than forests?

### LESS TIME

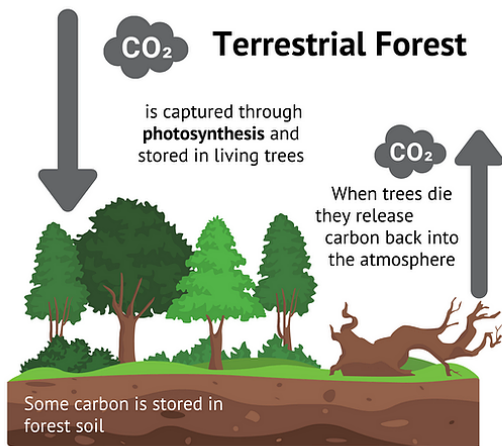
Trees store carbon for decades up to centuries

### MORE SPACE

Trees need more space to photosynthesise, grow and capture carbon

### LESS CARBON STORED

In the soil of terrestrial forests



### MORE TIME

Saltmarsh soil stores carbon for millennia

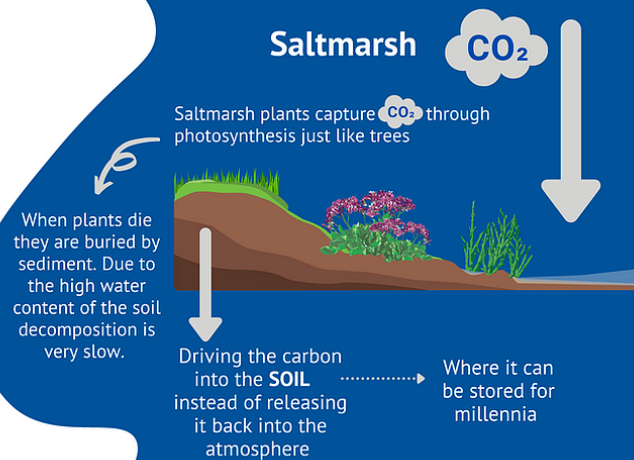


### LESS SPACE

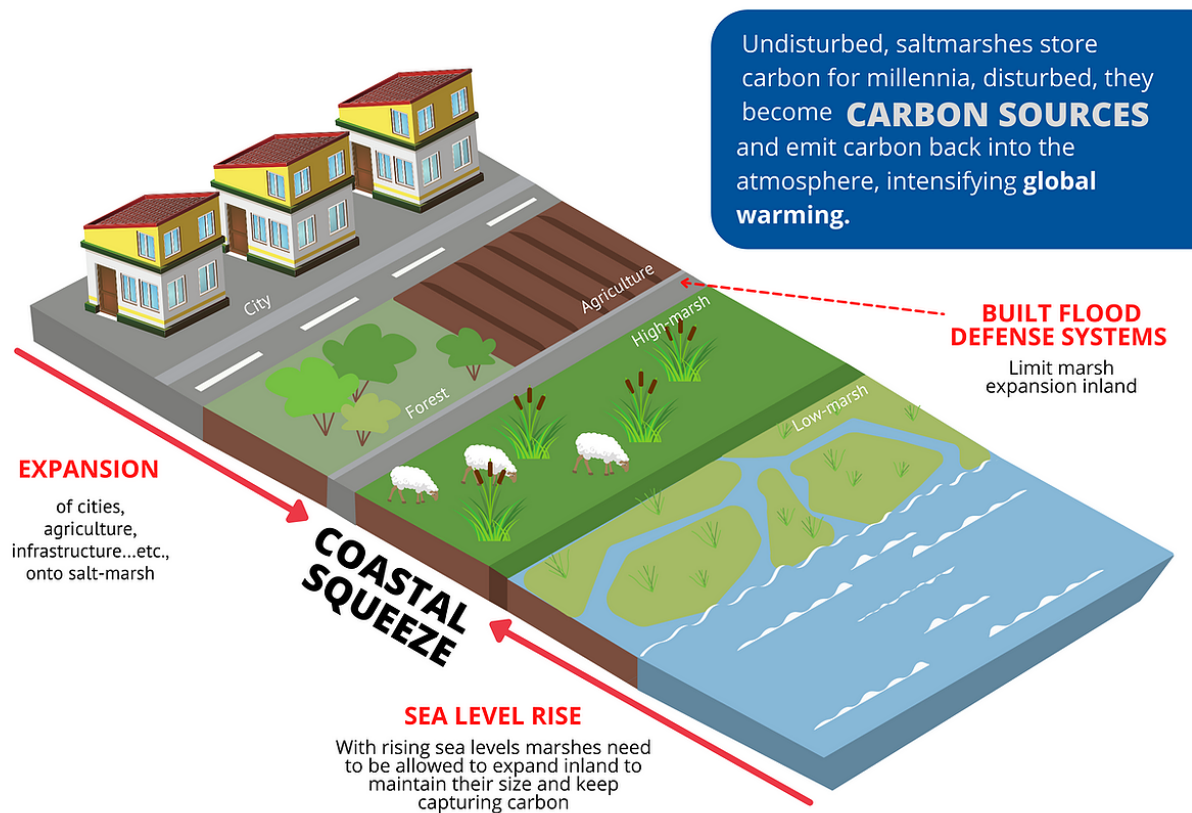
Saltmarshes grow vertically through sediment build-up, so they are able to store more carbon in the same space over time

### MORE CARBON STORED

Saltmarshes can store significantly more carbon than forests per area

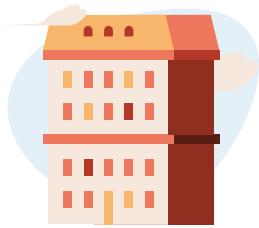


## The biggest **threats** to saltmarshes are sea level rise and human development





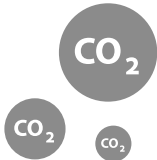
# The Problem



## Saltmarsh areas are being lost

At an alarming rate

Half of UK area lost in last 300 years



## They experience many pressures

Related to human activity



## When disturbed, they release carbon

Adding to global warming

# We can help saltmarshes!



## Protect

Existing saltmarshes from human developments

Leave room to allow them to migrate up the coasts as sea levels rise



## Restore

Degraded saltmarsh habitats



## Create

New saltmarshes!

In spots with the right conditions

# Blue Carbon In Practice

Blue Carbon in Practice: Professor William Austin

<https://vimeo.com/635377136>

RESIST Project introduction to Saltmarshes

<https://www.youtube.com/watch?v=P9m7vAdqsWc>

Tea bag experiment instruction video

<https://vimeo.com/636071628>

**In the lab**



**Total Organic Carbon Stock (TOC %)**  
**How much carbon is stored in the saltmarsh?**  
**Can Compare...**

- Between saltmarshes
- Different depths
- Change over time

## Skinflats – Saltmarsh Restoration

- Creating a Saltmarsh
- Giving land back to nature
- 2009 - beginning
- 2018 - seawall breached



Falkirk is a very special place. While it is well-known for its rich industrial heritage and agriculture, the nature reserve in Skinflats is a great example of the area's natural heritage.



Skinflats Salt marshes

Credit: RSPB - Photographer Unknown

<https://www.rspb.org.uk/our-work/conservation/landscape-scale-conservation/sites/inner-forth/>



# What does 'natural heritage' mean?

Natural heritage sites are natural sites of great conservation value as they provide a crucial habitat for protected species and protect an important ecological process.



Sculpture installation commemorating natural heritage of Skinflats – one of the rarest habitats in the UK  
Credit: Photograph © Fiona Wishart

## Discuss

Have you ever seen a saltmarsh in real life?

Which kinds of wildlife are protected by the Skinflats in Falkirk?

As well as salt marshes, what other kinds of Blue Carbon can we identify around the world?





Click here to see Blue Carbon projects around the world:  
<https://www.blueforestsolutions.org/projects>

## WORD WARM UP

### **Hectare =**

An area of land equal to 10,000 square metres  
or 654 football pitches!)

### **Wetlands =**

Land consisting of marshes or swamps

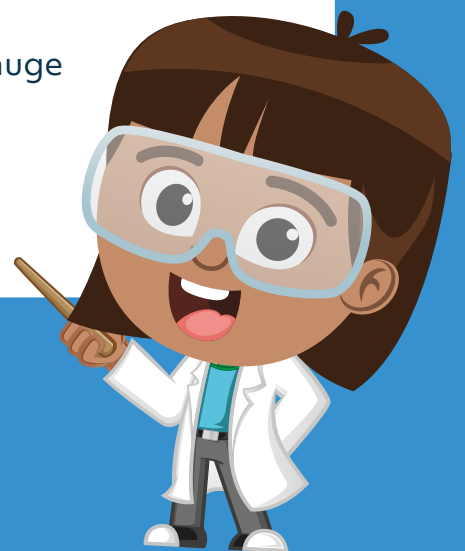
### **Native trees =**

Native UK trees colonised the land when the glaciers  
melted after the last Ice Age and before the UK was  
disconnected from mainland Europe.

### **Pollinators =**

An animal or insect that carries pollen from flower to  
another flower.

The 43-million-pound Helix project transformed a huge  
are within Falkirk - 350 hectares to be precise!



**Before, this vast area mainly consisted of young trees with some overgrown wetlands. Although there was a lot of wildlife, the area was low in species and there were no proper paths for people to use it.**

**What did the landscape architects do to [conserve the natural heritage](#) of the area?**

- Kept the best areas of woodland, concentrating on areas where native trees were prevalent
- Introduced some new and mixed-species of trees and hedges
- Cut some areas of grass for picnics and play
- Left other areas uncut for wildlife to flourish without too much public intervention.

**To [bolster biodiversity in the park](#), the Helix team have recently:**

- Introduced frog ponds to allow amphibians to transect between wetlands
- Introduced new meadow areas for pollinators
- Started planting an uninterrupted green highway throughout the site.







The Helix, Falkirk Source: Visit Falkirk

See here for photos: <https://www.visitfalkirk.com/things-to-do/family-days-out/the-helix/>

# 1. The Skinflats

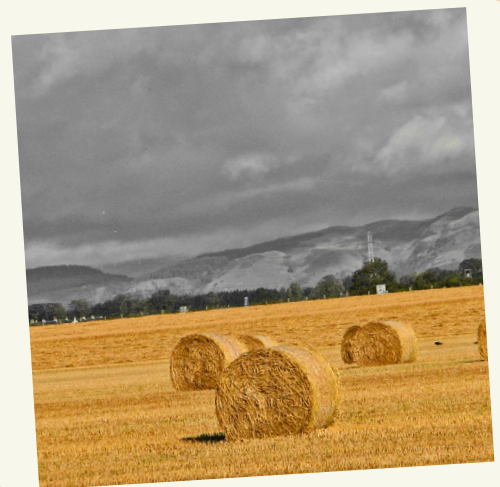
**WORD  
WARM UP**

**Breach =**

Break

**Intertidal Habitat =**

An area which is covered at high tide and uncovered at low tide.



Skinflats: Crop field

Photographer: © Fiona Wishart

**Not far from the crop fields and man-made structures lies an area of lagoons and marshland, both types of coastal ecosystems.**

A breach in the seawall allowing for water from the river Carron to flood the area during periods of high tide, has created both a freshwater and a salty lagoon. These intertidal habitats found in the Inner Forth are wonderful places for wildlife.

Particularly during the winter months, when exposed to low tide, the Forth becomes a home, and a feeding ground, for thousands of birds such as redshanks, knots, dunlins and oystercatchers, making it an internationally important wintering site for birds.

This site is designated as a Special Protected Area, meaning the location and species within it are **protected under law**. This is an important act, as after decades of human development and expansion, unfortunately only a few such habitats remain within the Forth estuary.



Tidal pool at Skinflats RSPB Nature Reserve  
Photographer: © David Palmer.

## 2. The importance of the saltmarshes

(detailed information)

**WORD  
WARM UP**

### **Carbon Sequestration =**

The process of capturing and storing carbon dioxide

### **Photosynthesis =**

The process by which plants use sunlight, water, and carbon dioxide to create oxygen and energy in the form of sugar.

### **Biomass =**

Renewable organic material that comes from plants and animals

### **Sediment =**

Matter that settles to the bottom of a liquid

### **Organic Matter =**

carbon based compounds found in anything that was alive and is now in or on the soil.

Saltmarshes have a unique role in helping us tackle climate change. This is related to the process of carbon sequestration, through which saltmarsh habitats remove carbon dioxide from the atmosphere and store it in their soils.

Through photosynthesis, saltmarsh plants remove carbon out of the atmosphere, storing it in their cells and releasing the oxygen that we need to breathe. This carbon is stored in the plants as **organic matter**, we call this the above-ground, or the living, **biomass**.

Sediments and organic matter also enter saltmarshes from oceans and rivers, flowing across the saltmarsh surface during periods of high tide. **Saltmarsh vegetation** is very good at trapping this material, which is rich in carbon just like the living biomass.

As organic material starts to decay, it becomes buried under the continuously building saltmarsh sediment.

Normally, during the decomposition of plant material, greenhouse gases are released back into the atmosphere. However, due to the high-water content and salinity of saltmarsh soils, the process of decomposition is very slow and only small amounts of greenhouse gases are released.

As sediment continues to build up, the organic material in the saltmarsh soil is buried deeper and deeper.

This belowground carbon store makes saltmarshes effective long-term stores of carbon. Carbon can remain trapped in saltmarsh sediment for 100s to 1000s of years.

The term '**blue carbon**' relates to these high-density carbon stores in marine and coastal habitats. Studying these areas is important and reveals how supporting natural processes can be a strategy to mitigate the effects of climate change.



### 3. Birds of the Inner Forth

**WORD  
WARM UP**

#### **Plummage =**

Bird feathers

#### **Wintering birds =**

Birds that migrate between the Northern and Southern hemispheres to follow the winter seasons

#### **Wading birds =**

Waterbirds, especially those with long legs, that spend a lot of time paddling in water



The Inner Forth holds important populations of wintering wading birds and wildfowl. Some of the most commonly seen birds include shelducks, teals and curlews.

**Shelducks** are large ducks, easily identified by their striking plumage of a white body with chestnut patches, a black belly and a dark green head with a pinkish bill. They are often seen loafing on the mudflats where they dig and dabble for food such as shellfish and insects.

**Teals** are small dabbling ducks; in fact, they are the smallest duck found in the Inner Forth. Males have chestnut-coloured heads with broad green eye-patches, grey flanks and a black edged yellow tail whereas females are mottled brown. The collective noun for a group of teals is a spring, based on the way they take off vertically when startled.

**Curlews** are the largest of all the wading birds found in the Inner Forth. They have brown speckled plumage and are easily recognisable by their long, slender, downturned bills and distinctive 'curlew call'. Unfortunately, curlew numbers have declined by up to 30% over the last 15 years in the UK.





(L) Curlew birds on the Skinflats tidal exchange area, Photographer: © David Palmer.

(R) Shelduck in Flight, Skinflats , Photographer: © David Palmer.

(Bottom) Curlew flock and Grangemouth Oil Tanks Photographer: © David Palmer.



## 4. Saltmarsh Habitat Management

**WORD  
WARM UP**

### **Habitat =**

The natural home or environment of an animal, plant, or other organism.

### **Estuary=**

Where the river meets the sea

### **Coastal Squeeze =**

The loss of natural habitats or a deterioration in their quality caused by man-made structures or human activity

### **Realignment =**

the action of restoring something to a different or former state

Saltmarsh is the name of the vegetation found within the tidal zone of an **estuary** and is categorized by plants which are able to withstand being flooded by salt water daily. They are an important **habitat** for wading birds and a natural flood defence, helping to protect areas inland by acting as 'air bags' for the water when conditions are stormy. In the Inner Forth, nearly 50% of the saltmarsh habitat has been lost over the last 200 years. This is mainly due to invasive non-native species and **coastal squeeze**, caused by man-made structures or human activity.

To ensure no further loss of valuable saltmarsh habitat, we need to protect the existing areas, and try and create new areas by using techniques such **managed realignment**, an example of which can be seen at RSPB Skinflats reserve, adjacent to the Kincardine bridge.



Skinflats Salt marshes Credit: RSPB -

Photographer Unknown <https://www.rspb.org.uk/our-work/conservation/landscape-scale-conservation/sites/inner-forth/>

## 5. The Lagoon

### **Lagoon =**

A stretch of salt water separated from the sea by a low sandbank or coral reef.

### **Siphonic =**

A tube that carries a liquid from a higher level up and over a barrier and then down to a lower level, with the flow maintained by gravity and atmospheric pressure as long as the tube remains filled

**WORD  
WARM UP**

The lagoon at The Helix is man-made with the base being scrapped out of the clay soil, negating the need for a waterproof liner. Its total volume is 33,800 meters cubed, which is around 15 times more than an Olympic swimming pool. It has a maximum depth of 2m.

It's fed from the Forth and Clyde canal at a rate of 5 litres a second from a gravity fed, siphonic system. This means that there is no energy used to produce the flow of water. This is done by 2km of underground pipework starting at the canal at 7m above seal-level, then down to the lagoon before discharging in the turning pool below The Kelpies.

The lagoon is used for watersports, as a beach for visitors and provides a landing area for large waterfowl. Whooper Swans are regular visitors in our winter when they migrate from Iceland.



Helix Plaza man-made Lagoon

Credit: Photographer Unknown ©Falkirk Community Trust





Whooper Swan

Credit: Photographer Unknown ©Falkirk Community Trust

Credit: Based on original text by Marcelina Lekawska

**Extension Activity: Take a look at the Saltmarsh Simulation exercise to observe Coastal Squeeze in action**

## CLASS TRIP INSPIRATION:

Soon this research will be available via the Skinflats Science and Sustainability audio trail. Follow us and invite your class on a 5 mile, low-level walk from the Helix park to the Skinflats Site of Special Scientific Interest, to explore some amazing stories about local wildlife and reflect on the climate emergency, and how we can act to protect the planet with nature-based solutions. This trail was developed as part of the Falkirk Science Festival 2021, with the support of the Helix, St. Andrews University, and RSPB.

**DOWNLOAD THE FALKIRK EXPLORED APP**



# STEM Career Pathways:

Meet one of our key partners in designing and researching the contents of this STEM box: Marcelina Lekawska

## What is your job/position?

"I am a Student at the University of St Andrews studying Biology & Sustainable Development. Through my position on the Laidlaw Scholarship Programme, I have worked on increasing youth engagement and understanding of the concept of blue carbon and the value of saltmarsh habitats."

## Briefly: Your career pathway, including any key qualifications:

"I did the International Baccalaureate programme in secondary school, taking advanced classes in biology and chemistry. From this experience I then chose my university degree pathway (biology and sustainable development)."

## Your current role and responsibilities

"My role is essentially to come up with ways to get people to learn about blue carbon in a fun and engaging manner. To achieve this, I have designed two at-home science experiments which you can discover in this STEM Box! At this point I have also delivered two online workshops to primary schools about blue carbon and saltmarshes, with plans to begin teaching in-person in the upcoming months."

"Communication and good time management are very important in my work for two reasons. 1) I have worked mostly online and therefore, good and consistent communication is a requirement for making sure that I keep up to date with my project supervisor and other project contributors. 2) I do my work part-time alongside studies and other jobs, therefore having a good schedule is essential."

## What is the most exciting and the most challenging aspect of your role?

"The most exciting aspect by far is when I see how excited and passionate young people are about the importance of nature in the fight against climate change."

The most challenging aspect of my role so far has been working online. This can be a bit of an isolating process and it is very important to take breaks and remember that you are supported by your colleagues, even remotely."

## What can somebody in school who is interested in this area start doing now, in order to one day end up in your position?

"Get involved beyond the classroom! As important as studying and achieving good marks is getting involved in climate change activism and community work has been just as important for me as it shows you how to best engage with people on these concepts in everyday life."

## STEM Career Pathways interview:

<https://vimeo.com/636077203>

## What other career pathways can we explore?

Government Policy

Academic

Farmer

Land Owner

Researcher

Site Ranger

Conservation Scientist

Coastal Habitat Creation Specialist

Surveyor and Strategy Planning

Science Communicator

Activist

## Use the Industry links to learn more about the jobs that interest you!

<https://www.solwayfirthpartnership.co.uk/home/what-we-do/>

<https://www.rspb.org.uk>

<https://www.abpmer.co.uk/services/habitat-creation-and-restoration/>

<https://www.innerforthlandscape.co.uk/projects/conserving-restoring/skinflats-saline-lagoons>

<https://www.innerforthlandscape.co.uk/projects/skills-training>

<https://scottishwildlifetrust.org.uk/our-work/our-projects/living-seas/blue-carbon/>

<https://post.parliament.uk/research-briefings/post-pn-0651/>



Marcelina