Teacher's Pack

STEM BOX

Blue Carbon in Falkirk

Digital Version Here

Falkirk Science Festival 2021

The Helix

Falkirk Council

Falkirk Community Trust

aye for ideas
Science for Scotland

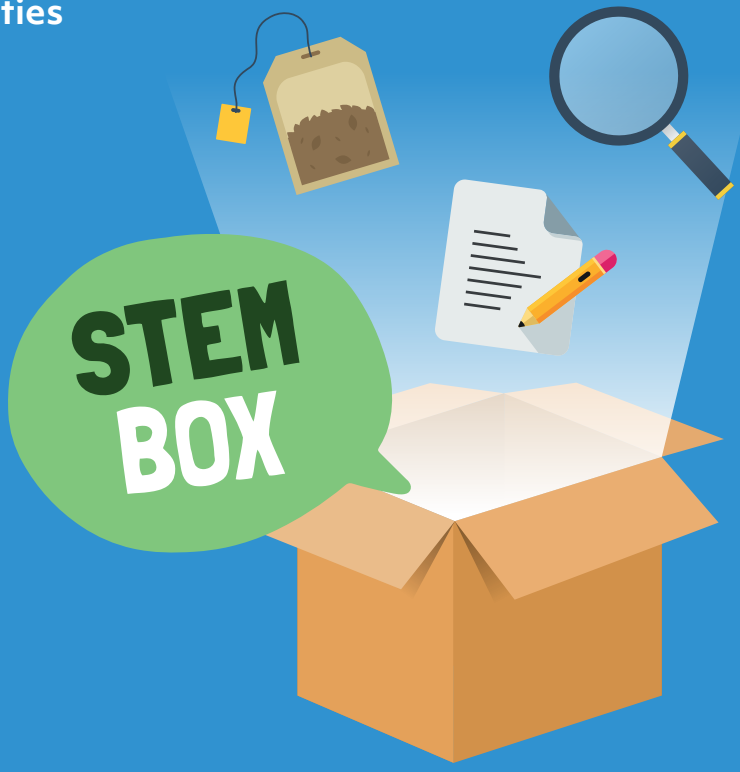
University of St Andrews

Great Place

HERITAGE FUND

Scottish Government
Riaghaltas na h-Alba
gov.scot

Contents Page:



Introduction

How To Use This Box
(including lesson objectives, curriculum links and suggested lesson timing guide)

Welcome to the Blue Carbon in Falkirk STEM Activity Box

Inside this Teacher's Guide you will find all the information you need to deliver a jam-packed STEM lesson with a hands-on activity, local heritage links and future career inspiration for your pupils **aged 8 to 14!**

This document also doubles up as a class presentation: by following this QR code/LINK (below) you can access the digital version and display the information, videos and images on your interactive whiteboard or laptop.

You can use the resources in any order or way that is helpful to your classroom.

However, in order to get the most from your STEM box, we suggest the following structure. **(see next page)**

Digital Version Here

Suggested Timeline

0–10 mins

Read through the Blue Carbon Introduction, use our class friendly digital version on the board, watch the accompanying videos and look at where Blue Carbon exists in Falkirk

10–15 mins

Discuss: What choices do we make daily to protect the planet and stop climate change? What is Blue Carbon? Have you ever seen a salt marsh 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?

15–20 mins

STEM Story challenge and Tea Bag experiment set up

20–45 mins

Pupils carry out experiment and make notes on the Research Findings Worksheet.

Teachers: prepare a location to store plant pots for up to 2 weeks.

45–50 mins

Discuss: How will our research findings impact others? Who in the working world uses this information and how? How did this information influence the natural landscape in Falkirk? What kinds of jobs are key to making changes to protect Blue Carbon?

50–60 mins

Plenary: What main points have we learned today about Blue Carbon? When we check on our experiment in two weeks, what do we think will happen to the weight of the teabags in each different plant pot? How can we record our findings and demonstrate any changes?

Two Weeks - 3 months

Note experiment findings, discuss, report back to the class and prepare to take part in the Press Conference Challenge extension exercise!

5 mins

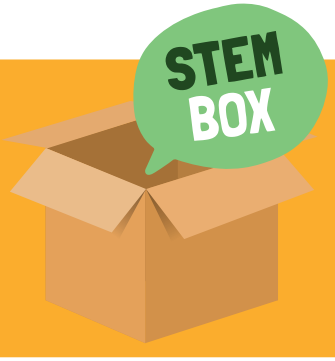
Use the Evaluation links provided and let us know what you think of this STEM box

Warning: The STEM Box is a Science Experiment Kit

Not suitable for children under 8 years

For use under adult supervision

Please carefully read the instructions



STEM Heritage in a Local Context

Welcome to teabag science! It's not just the secret formula to a relaxing break time!

This STEM Box, Teacher's Guide and associated activities will take you through the steps to learn more about Blue Carbon, it's important links to Falkirk and how to perform a simple experiment through which you can explore decomposition in different soil environments and learn about the value of saltmarshes in the fight against climate change.

Lesson Objectives

- To explore Blue Carbon in Falkirk and discuss personal experiences of combating climate change
- To introduce the idea that Blue Carbon is more efficient than forests at limiting the release of greenhouse gases. That we can impact the environment positively by understanding the threats to Blue Carbon
- To conduct an experiment, work collaboratively, investigate changes in plant matter and record findings effectively
- To have an awareness of what job opportunities exist within Blue Carbon and of local opportunities to find out more
- To understand and articulate scientific data in a compelling way

Curriculum for Excellence

Sciences

Through carrying out practical activities and investigations, I can show how plants have benefited society.
SCN 2-02b

I can explain some of the processes which contribute to climate change and discuss the possible impact of atmospheric change on the survival of living things.
SCN 3-05b

I have contributed to discussions of current scientific news items to help develop my awareness of science.
SCN 1-20a

I can report and comment on current scientific news items to develop my knowledge and understanding of topical science.
SCN 2-20b

Technologies

Having analysed how lifestyle can impact on the environment and Earth's resources, I can make suggestions about how to live in a more sustainable way.
TCH 2-02a

During practical activities and design challenges, I can estimate and measure using appropriate instruments and units.
TCH 1-13a / TCH 2-13a

Social Studies

I can consider ways of looking after my school or community and can encourage others to care for their environment.
SOC 1-08a

I can discuss the environmental impact of human activity and suggest ways in which we can live in a more environmentally-responsible way.
SOC 2-08a

I can consider the advantages and disadvantages of a proposed land use development and discuss the impact this may have on the community.
SOC 2-08b

Having explored the landscape of my local area, I can describe the various ways in which land has been used.
SOC 1-13a

I can explain how the physical environment influences the ways in which people use land by comparing my local area with a contrasting area.
SOC 2-13a

English

To help me develop an informed view, I can distinguish fact from opinion, and I am learning to recognise when my sources try to influence me and how useful these are.

LIT 2-08a

When listening and talking with others for different purposes, I can: share information, experiences and opinions, explain processes and ideas, identify issues raised and summarise main points or findings, clarify points by asking questions or by asking others to say more.

LIT 2-09a

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. Countries around the globe are being asked to come forward with ambitious 2030 emissions reductions targets that align with reaching 'net zero' by the middle of the century.

Plants remove carbon dioxide from the air through photosynthesis and store it in their cells as carbon, thereby decreasing the effect of global warming. When they die, they often become buried in the sediment into which they fall, slowly making their way down through the soil. Over time, microbes in the soil break down this plant material. This is called decomposition, and it is associated with the release of greenhouse gases, such as carbon dioxide, into the air. Greenhouse gases accumulating in the air are causing global warming, heating the surface of the earth and resulting in issues such as sea level rise.

In order to limit the extent of global warming, we must limit the release of greenhouse gases into the air. Contrary to popular belief, coastal ecosystems have been more efficient in this process than forests and store more carbon than the world's forests combined.

Critical Storage

Ocean + Coastal Habitats

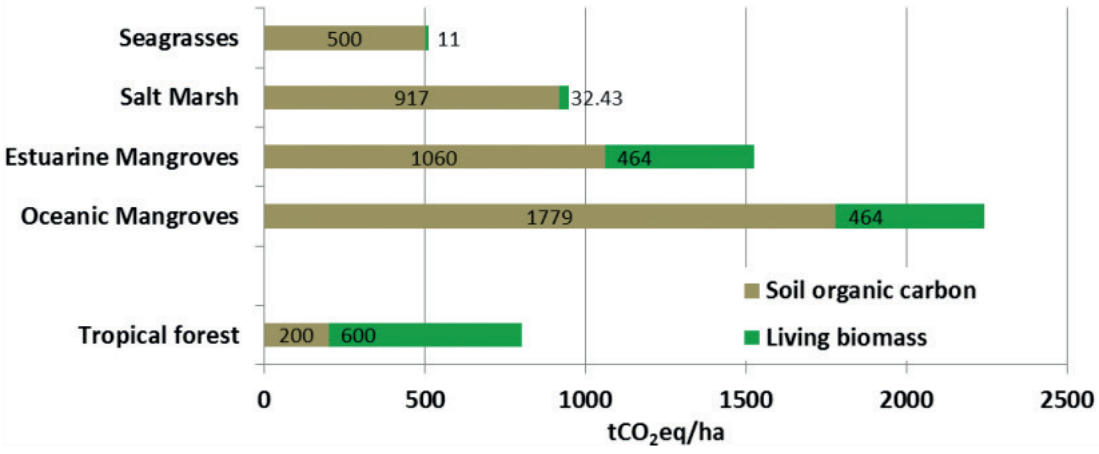
83% Global Carbon

2% Coverage

50% Sediment Carbon

83% of the global carbon cycle is circulated through the ocean. Coastal habitats cover less than 2% of the total ocean area, but account for approximately half of the total carbon sequestered in ocean sediments.

Source ICUN.ORG



Saltmarshes:

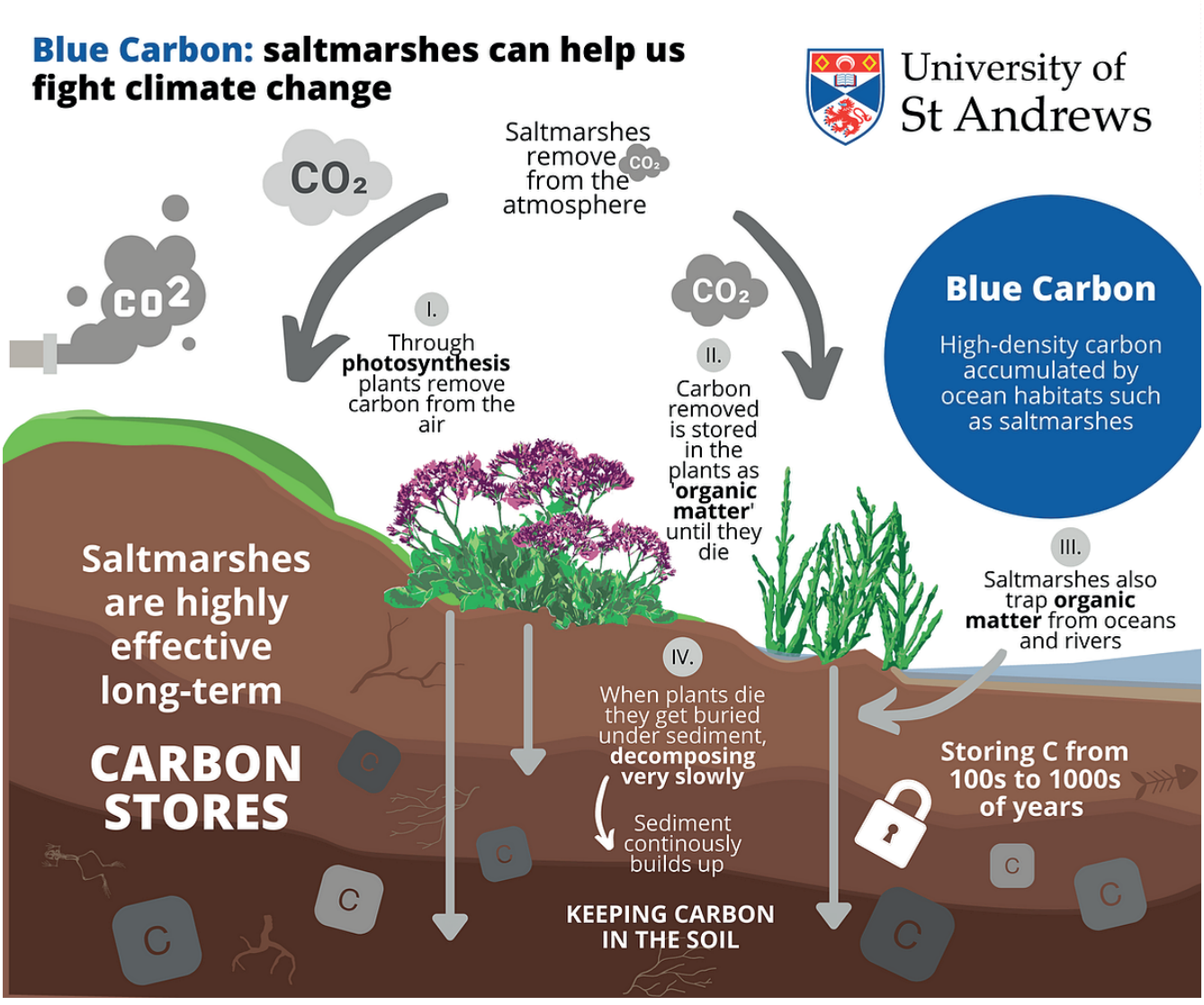
Saltmarsh soil is flooded with seawater daily, meaning it is saturated with water (waterlogged). As a consequence, microbial activity in the soil of saltmarshes is low. This, along with other properties of seawater, results in **very slow rates of decomposition in saltmarshes.** Due to this, they make effective long-term carbon stores, **preventing the release of greenhouse gases** from decomposing plant material for up to millennia.

Pupils and indeed scientists, can study the decomposition of plant material with the use of teabags! The tea acts as the plant material, which can be placed in different soil environments to decompose. We can use the weight change of a teabag to understand the amount of greenhouse gases released during its decomposition. 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 this STEM Box experiment, we'll use this information to compare decomposition between a saltmarsh and regular soil environment.

Blue Carbon Introduction Video

https://vimeo.com/636076877



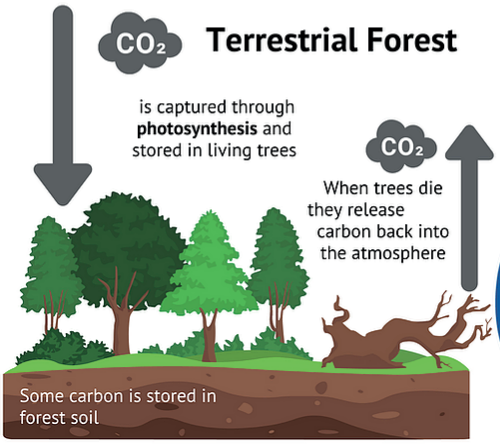
Did you know...

saltmarshes are better at capturing and storing 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

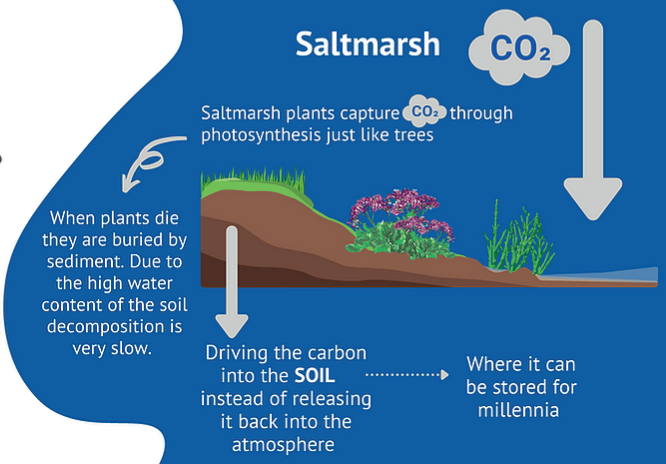
LESS CARBON STORED
In the soil of terrestrial forests



MORE TIME
Saltmarsh soil stores carbon for millennia

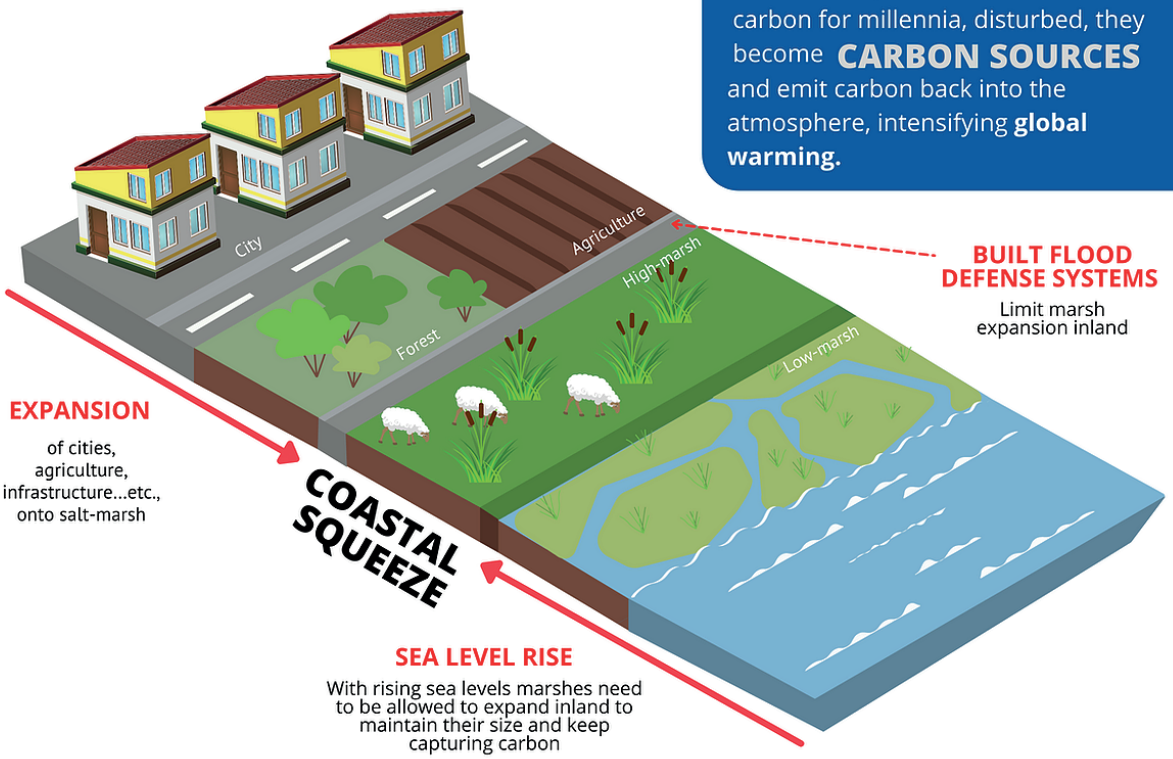
LESS SPACE
Saltmarshes grow vertically through sediment build-up, so they are able to store more carbon in the same space over time

MORE CARBON STORED
Saltmarshes can store significantly more carbon than forests per area

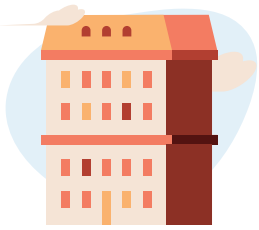


The biggest threats to saltmarshes are sea level rise and human development

Undisturbed, saltmarshes store carbon for millennia, disturbed, they become **CARBON SOURCES** and emit carbon back into the atmosphere, intensifying **global warming.**



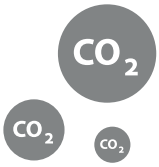
The Problem



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 saltmashes!

Protect

Existing saltmashes 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

In the lab

Blue Carbon in Practice: Professor William Austin:
https://vimeo.com/635377136

RESIST Project introduction to Saltmarshes
https://www.youtube.com/watch?v=P9m7vAdqsWc


1


2


3


4


5


6


7

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 has been home to sources of Blue Carbon for many years. The Skinflats are key to providing unique habitats, important for their role in housing a variety of wildlife species. However, what is lesser known, is their remarkable potential to act as tools in the fight against climate change.

High levels of carbon dioxide are one of the main causes of global warming and the Scottish Government has an aim to reach 'net-zero': an ambition to end the emission of greenhouse gasses which contribute to the process of global warming. The habitats you will see at the Skinflats are very effective at removing carbon dioxide from the air, storing it within their soils for millennia, thereby helping decrease the levels of carbon dioxide in the environment and reducing global warming. We hope that by learning through this STEM box, and taking adventures outdoors, you will understand the power of our local environment, and the importance of safeguarding it into the future.

1. The Design of the Helix

Before the 43-million-pound Helix project transformed the 350 hectares, the 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.

At the design stage the landscape architects kept the best areas of woodland, concentrating on areas where native trees were prevalent and introduced mixed species hedging and new specimen avenue trees. Whilst some areas have cut grass for picnics and play, other areas are left uncut for wildlife to flourish without too much public intervention.

To bolster biodiversity in the park, the Helix team recently introduced frog ponds to allow amphibians to transect between wetlands, introduced new meadow areas for pollinators and have started planting an uninterrupted green highway throughout the site.

2. The Skinflats

Whilst crop fields and infrastructure developments are immediately evident, not far from there lies an expanse of lagoons and marshland. 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.

3. The importance of the saltmarshes

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.

4. Birds of the Inner Forth

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.

5. Saltmarsh Habitat Management

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 inundated 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 anthropogenic behaviours and the encroachment of manmade habitats.

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.

6. The Lagoon

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 liters 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.

Original Text Written by Marcelina Lekawska

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

Tidal pool at Skinflats RSPB Nature Reserve (c) David Palmer.

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

Available on the App Store

GET IT ON Google Play

STEM Story Challenge

NEWSFLASH: STALL THE WALL!

Local Millionaire Kelsey Sheldon, has been spotted this week campaigning to build a huge sea wall in order to protect their 6-story mansion near the Inner Forth, threatening centuries of natural and cultural heritage as well as putting wildlife at risk!

A team of specialist researchers at _____ school have been recruited by a top environmental organisation to conduct a ground-breaking experiment, demonstrating the intrinsic value of the surrounding habitats and precious Blue Carbon, the building works seek to destroy.

With their laboratories maliciously locked from the inside by intruders, the brave team have been left with just teabags, soil and basic amenities to prove Sheldon wrong, and confront the planning permission councillors at an upcoming press conference held by the building company. Can tea bags save the world before it boils over?! The life of the Inner Forth is in their hands!

STEM Activity Instructions

Teabag Science Experiment: Instruction Sheet

Tea bag experiment instruction video: https://vimeo.com/636071628

Welcome to teabag science! This worksheet will take you through the steps to perform a simple experiment through which you can explore decomposition in different soil environments and learn about the value of saltmarshes.

Let's use this information to compare decomposition between a saltmarsh and regular soil environment and complete **STAGE ONE AND STAGE TWO:**

STAGE ONE:

Gather your materials and work in pairs:

Materials

Teabags (ideally rooibos or green tea)

Weighing scale (experiment can be adapted if do not have one)

Shovel or pot

Garden or two pots of soil

Straws or wooden coffee stirring sticks

Paper, pencil and marker

Envelope

Ruler

Time (2 weeks – 3 months wait)

PLEASE NOTE: Biodegradable plant pots may fall apart easily when watered and are best kept in the ground, however if you wish to keep the experiment indoors, you could use recycled items or cups with a depth of 8cm.

STAGE TWO:

Instructions:

1. **Prepare two teabags**. Choose one to be the 'dry soil' and one to be the 'wet soil' sample. **Make sure to keep track of which is which.**
2. Weigh the teabags. Note down their weight on your **Research Findings Worksheet.**

3. Find two spots in the school grounds with **different types of soil** or use your plant pots in class. Ideally, find one spot with regular soil, for example near a flower patch. This will be the 'dry soil' spot. For the second spot, try to find an area with very wet soil, for example near a puddle. If you do not have a spot like this, you can get creative and make one with the use of water. This will be the 'wet soil' spot.

Dry Soil Location

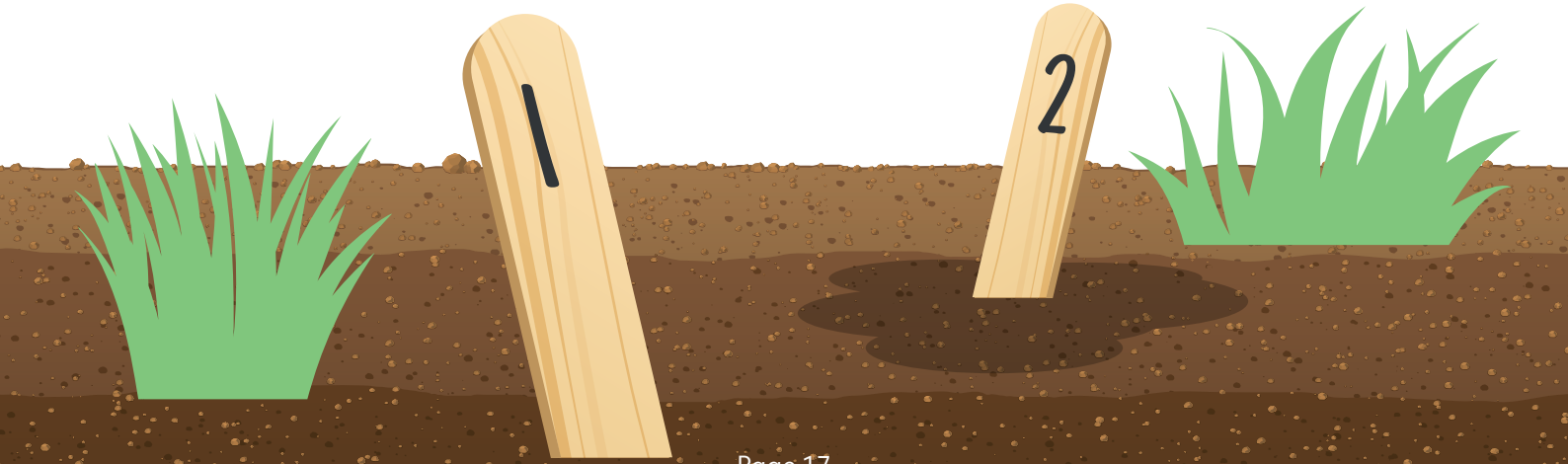
Wet Soil Location

4. **If you do not have a school garden which is appropriate, fill two pots with soil.** To create the 'wet soil' environment, add water to **one** of the pots.

5. At each spot, **dig a hole with a depth of around 8cm.** Place a teabag in each hole and fill it back up. Use a straw or wooden stick to mark the sight of burial. Write down where each pot or tea bag location is on your Research Findings Worksheet.

Mark your dry soil tea bag location

Mark your wet soil tea bag location



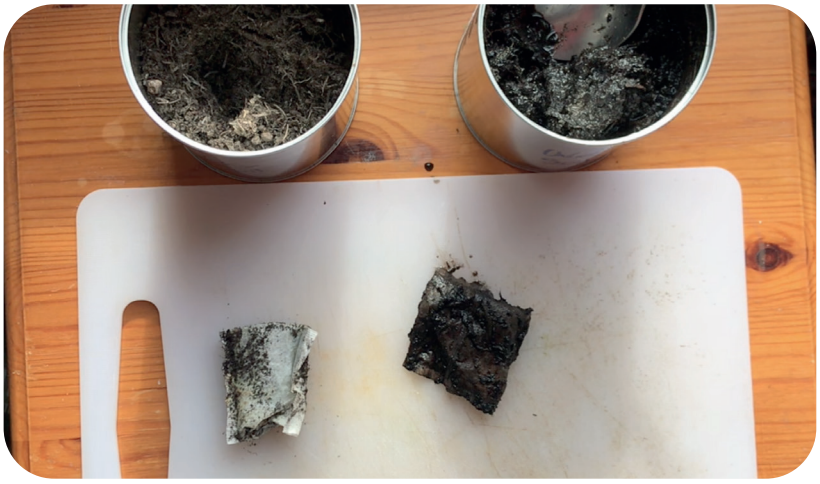
STAGE THREE:

After TWO weeks to 3 months:

For best results

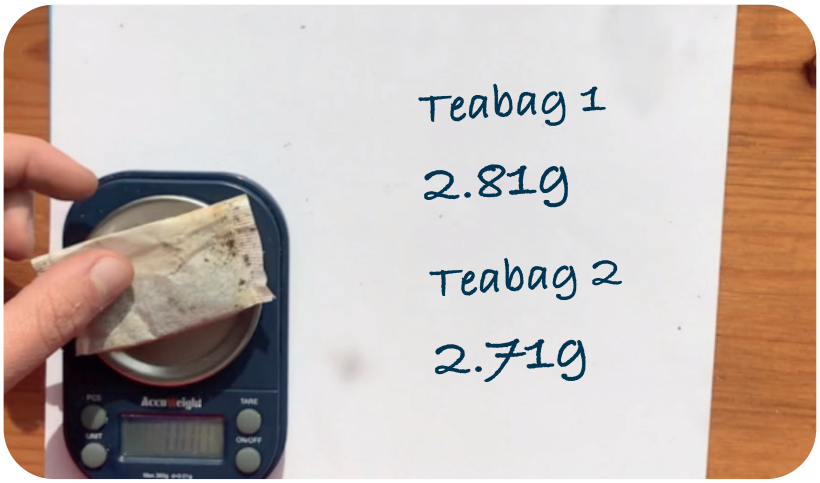
For the best results teabags should remain buried for **2 weeks to 3 months.** However, if this is too long of a wait for you, it is okay to continue with the experiment after leaving the teabags in the soil for 2 weeks.

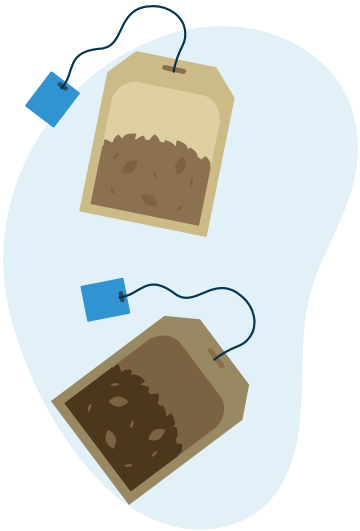
6. Dig up the teabags, remove any excess soil gently and leave them to dry for at least 24 hours. They must be completely dry to continue the experiment.



***If you could not weigh your teabags, skip steps 6 and 7 then continue with step 8. ***

7. When teabags are completely dry, re-weigh them.



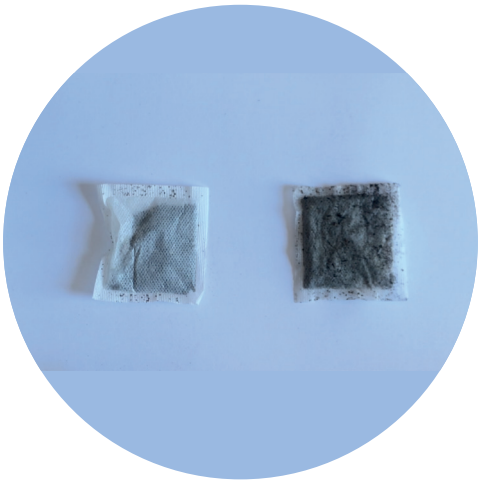


8. Compare the weight of the teabags after the burial period to their weight before the experiment. **Note down the change in weight of each teabag.**

9. **If teabags could not be weighed**, take an unused teabag from your pack and compare it to the ones which were buried in the different soil environments.

What about their appearance is different?

Open them up and see if the amount of tea inside has changed



10. Complete your Research Findings Worksheet and questions

Extension Activity

Try putting extra tea bags and plant pots into environments like: a fridge, by an open window, in shade OR/AND keep the bags in three different saturations of soil (completely wet, completely dry, switch between wet and dry every few days)

Extension Activity

Try the Press Conference Challenge and report your findings to the class!

Blue Carbon: Research Findings Worksheet

STAGE ONE: CONDUCTING YOUR EXPERIMENT

1. Note the weight and appearance of each tea bag.

Dry Soil Tea Bag:

Wet Soil Tea Bag:

2. Where have you chosen to bury your tea bags? How have you labeled your tea bags?

STAGE TWO: AFTER 2 WEEKS TO 3 MONTHS

3. How did your teabags changed after the experiment? (Weight and appearance)

4. Which one of your teabags lost more weight?

5. Why do you think this happened?

6. Saltmarshes Can Store Carbon For a Long Time Because

- A They are very large
- B Decomposition in their soil is fast
- C Decomposition in their soil is slow
- D They have a lot of plants

5. During plant decomposition, what is released from the soil?

- A Air
- B Greenhouse gases
- C Water
- D Carbon

7. By storing carbon, saltmarshes help us fight climate change.

- A True
- B Face

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?

Marcelina

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/

Blue Carbon: Press Conference Challenge:

Use your knowledge about the Saltmarshes in Falkirk, threats to the Blue Carbon and possible solutions to create a presentation showing how the Salt Marshes (Scotland's Blue Carbon) might be preserved for future generations, including your own.

Part A

Blue Carbon Press Conference Challenge – In groups make a poster, short film, speech or write an article for a school blog/ newspaper presenting your experiment and research findings, prompting the community to protect Falkirk's very own Blue Carbon.

What threats does our Blue Carbon face? What can we do to help?

Part B

Present each group's findings at the Class Press Conference (3-5 mins each) – which stories were more compelling? Why? What parts of the presentation inspired us to take action the most? Where do we see these environmental calls to action today in our media, online, advertising and news?

Part C

Consider the presentations from the perspectives of our Blue Carbon career path mentors and STEM Story Challenge characters, what points would they make in response to the presentations, or for and against the proposals?

Make notes in your groups below each heading, then make your presentation piece based on these:

Love

What do you love about the Saltmarshes?

Care

What threat to the Saltmarshes would you like to tackle?

Act

What actions can be taken (and by whom) to help preserve the Saltmarshes for future generations?

Coastal Squeeze Simulation

Welcome to this at-home or in-class saltmarsh simulation! This worksheet will take you through the steps to perform a simple experiment through which you can build your own saltmarsh, learn about some of the threats saltmarshes are currently facing, as well as how we can protect them.

Background information –

Saltmarshes are grassy coastal ecosystems that are regularly flooded by seawater. They provide many services, including acting as natural buffers from large waves, providing habitat for fish and birds, and long-term carbon storage in their water-saturated soils. This last service is very important. You may initially think that it is only forests that remove carbon dioxide from the air, but in reality, saltmarshes can be more efficient at this process area-for-area. Unfortunately, saltmarshes face several pressures and much of the historic extent of saltmarsh area in the UK has been lost.

One pressure that saltmarshes face comes from the rising sea levels associated with global warming. As sea levels rise, saltmarshes are eroded. Luckily, research points towards the possibility for saltmarshes to expand inland, growing and keeping pace with rising sea levels. However, the other significant pressure that saltmarshes face, human development, can prevent this positive natural process from occurring. Pressure from human developments comes in two forms. Firstly, there is the conversion of saltmarsh land into towns, fields for livestock, etc. Secondly, there are coastal defense structures built behind saltmarshes, such as sea walls. Due to the presence of these human developments, saltmarshes are unable to migrate inland as sea levels rise. This is coastal squeeze. Saltmarshes are squeezed into smaller and smaller areas by human developments and rising sea levels.

Now, let's explore this issue with the use of a few simple household items.

Materials –

- Baking tray
- Sand or dirt
- Paper
- Colouring pencils
- Water
- Blue food colouring
- Kitchen herbs (such as chives and thyme)
- Empty plastic bottle
- Tape
- Scissors
- Straws or wooden coffee stirring sticks

Instructions

1. Use the paper and colouring pencils to create a drawing of a human development that you think could be found behind a saltmarsh. For example, this could be a town or a farm.
2. Build your saltmarsh by filling half of the baking tray with sand/dirt.
3. Use the herbs to create plants in the saltmarsh. Place them throughout the sand/dirt until you are happy with how your saltmarsh looks. Feel free to consult a picture of a real-life saltmarsh for inspiration!
4. Use tape to attach the sticks/straws to the back of your drawing, and position it so that it is upright behind the saltmarsh. This represents the human developments that are often found behind saltmarshes.
5. Pour water with blue food colouring into the side of your baking tray without the saltmarsh. Make sure the water level comes up to about half the height of the baking tray. This represents the current sea level.
6. Move your plastic water bottle back and forth through the water, creating waves.

   This represents the waves hitting a saltmarsh under current sea levels. Notice how some of the sand/dirt is washed away with each wave, but the overall structure remains stable.
7. Pour more water with blue food colouring into your baking tray. This represents the rising sea levels associated with global warming.

   Once again, use your plastic bottle to create waves
8. Notice how now the waves wash over the saltmarsh, destroying many of the plants and the structure of the saltmarsh nearest to the water. This represents how rising sea levels are threatening saltmarshes from the seawards side.

Simulation Summary

By following these steps, you have demonstrated coastal squeeze. Rising sea levels decreased your saltmarsh area from the seawards side. The saltmarsh should have been able to expand up the coast due to the new sediment brought in by waves. However, the human development represented by your drawing prevented this migration.

Questions

1. Saltmarshes are diverse habitats supporting many plants and other species.

- A True
- B False

2. What are saltmarshes threatened by?

- A Rising sea levels
- B Human developments
- C Birds
- D Both a and b

3. What is coastal squeeze?

- A When there are too many people at the beach
- B When saltmarsh area is lost due to rising sea levels and human developments
- C When saltmarsh area changes throughout the day due to the tides
- D When saltmarshes expand out onto human developments

4. How did your saltmarsh change after the sea level rose?

5. Do you have any ideas for how we can protect saltmarshes from these threats?

Answers to Coastal Squeeze Questions

1. True. Saltmarshes are home to many plants, fish and birds.

2. The correct answer is d. Both human developments on the landwards side and rising sea levels on the seawards side threaten saltmarshes.

3. The correct answer is b. This is the process we explored throughout this simulation. Saltmarshes are squeezed into smaller and smaller areas by the pressures they face from both their seawards and landwards facing sides.

4. You may have noticed that your waves travelled further onto the saltmarsh than they did when the sea level was lower. They may even have hit the edge of the baking tray, or your drawing. Along with this, some of the saltmarsh plants, and the sand/dirt nearest to the water, may have been washed away by the waves.

5. We can protect saltmarsh areas from the expansion of human developments such as towns and agriculture. We can restore marshes which have been previously damaged. We can even create new marshes in certain coastal areas with the correct conditions!

Local STEM Heritage Quiz

1) **Fill in the gaps: "The Skinflats is designated as a _____ _____ area meaning that the location and species within it are protected under law."**
2) **What is the process of 'Carbon Sequestration'?**
3) **Through which process do saltmarsh plants remove carbon from the atmosphere?**
4) **How many hectares does The Helix span?**
5) **Carbon can remain trapped in saltmarsh sediment for up to as much as:**
   a) 2 years b) 40 years c) 1000 years
6) **Name 3 bird species found in the Inner Forth**
7) **Saltmarsh is the name of the vegetation found within the tidal zone of:**
   a) a lake b) a pond c) an estuary
8) **Name the technique used to create new areas of salt marshes found at RSPB Skinflats reserve**
9) **Which body of water found at The Helix holds around 15 times more than an Olympic swimming pool?**
10) **Complete this sentence: High levels of _____ _____ are one of the main causes of global warming.**

Answers can be found in 'Teachers Notes and Answers' on Page 30

Teachers Notes and Answers

Thank you for choosing to use this STEM Box resource in your classroom, in preparation for the big day, we wanted to include a few helpful pointers to ensure the activities go as planned:

1. To enable a smooth introduction to this topic of Blue Carbon for everyone, we have used the teacher's pack to include more detailed notes on each area that you can read at your own pace and an abridged, class friendly version of the worksheets and Blue Carbon Introduction with extra context for your digital board or laptop.
2. Within the experiment section, if you do not have school grounds or a garden please check in advance, if there's a suitable space within the school to keep up to 15-20 small soil filled plant pots for up to two weeks.
3. Biodegradable plant pots may fall apart easily when watered and are best kept in the ground, however if you wish to keep the experiment indoors, you could use recycled items or cups with a depth of 8cm.
4. The experiment is an activity that can also be achieved at home if additional space is required
5. We invite you to make use of the biodegradable plant pots in your school garden if they would be of benefit to new plants
6. We have designed this resource as shared between pairs in a 30-person class, it can also be easily adapted to suit groups or individuals.
7. Each pair has their own Research Findings Worksheet with the Teabag experiment instructions available to share on a digital board or shared in print between small groups.
8. If you need additional copies, please feel free to photocopy the resources in this STEM Box
9. COVID 19: The STEM box is designed in such a way as to encourage learning in a way that works socially distanced or within small groups/pairs where pupils can use their own tools independently and share where appropriate. Wiping down of any shared item is encouraged, mainly the soil shovel or any weighting scales.
10. This experiment may not be suitable for those who have: a fear of dirt and germs (Mysophobia)

Taking Care of your STEM Box

- Please keep your STEM Box in a cool, dry location
- Take care of any teabags that may have ripped in handling
- The box is made from 75% recycled material, 100% recyclable & degradable
- The worksheet wallets included are 100% recyclable
- The packaging can be used more than once. We encourage reuse where appropriate by keeping your printed teachers guide handy, and placing all unused materials or worksheets back In the box for another class.
- If you received biodegradable plant pots, these are made with paper pulp. If these pots are not easily separated, please remove them by directly throwing these pots to the ground vigorously or knocking the upper position of outer wall.
- If you received soil with your box, keep the bag sealed after use in a cool, dry area of your school, such as a garage or basement where it will be out of direct sunlight and fluctuations in moisture. If you plan to use it for the garden, do not store the bag outdoors where day and night-time extremes can affect the soil.

Soil Use Guidelines:

Description: Compost. This mixture does not contain ingredients classified as hazardous substances. Do not ingest and avoid soil contact with eyes. Dispose of the bag when empty. Wear gloves when handling the product over long periods of time: Gloves can be used if preferred. However, use of the shovel or pot and short experiment duration should limit this contact. Wash hands and observe good hygiene practice after handling the soil.

Shovels: Please use shovels for their intended purpose. Keep away from eyes and sensitive areas. Wash any remaining soil off when experiment is complete.

When the use of the experiment kit list is complete. Please dispose of any remaining soil in an appropriate compost bin or consult your venue grounds team for alternative uses. Recycle any remaining self-made soil pots and re-use what you can by keeping it in the STEM box for the next class.

For a more detailed risk assessment on the contents of this box please visit the QR code link on the front of this Teacher's Pack.

Warning

The STEM Box is a Science Experiment Kit

Not suitable for children under 8 years

For use under adult supervision

Some parts may cause skin or eye irritation

Some parts may be Flammable

May Contain Small Parts

Recyclable

Handle with Care

Store in a cool, dry place

For Educational Purposes Only

Further learning materials:

Global teatime science experiment (http://www.teatime4science.org/)

Teatime4schools project in Austria: https://www.teatime4schools.at/en/

C-Side project (https://www.c-side.org/)

The Blue Carbon Initiative (https://www.thebluecarboninitiative.org/)

IUCN – (https://www.iucn.org/resources/issues-briefs/blue-carbon)

Blue Forest Solutions – (https://www.blueforestsolutions.org/)

Teabag science report in the lab:
The Tea Bag Index: a novel approach to collect uniform decomposition data across ecosystems: https://doi.org/10.1111/2041-210X.12097

Videos about blue carbon –

(https://www.youtube.com/watch?v=KujRa-BDRaI)

(https://www.youtube.com/watch?v=4fNW8spFS_o)

Teacher's Answers to the Tea Bag Experiment:

1. **The weight of both teabags should have decreased.** The teabags lost weight due to decomposition by microbes found in soil. If you waited 3 months, this change will have been larger than the change after waiting only 2 weeks.

2. The teabag in the 'wet soil' environment **should have had less change in weight** than the one in the 'dry soil' environment.

3. This is because there are **less microbes living in wet soil**, and therefore the rate of decomposition there is slower than in a regular soil environment.

4. **The correct answer is c.** Saltmarshes are periodically flooded with saltwater, and the wet and salty characteristics of the soil result in a slow rate of plant decomposition. Due to slow decomposition, carbon remains in the soil long-term and is not released into the air as greenhouse gases.

5. **The correct answer is b**. Greenhouse gases are the substances which are released from the soil during plant decomposition. They have many sources, and limiting their emissions is very important in fighting the issue of global warming.

6. **True.** Keeping carbon in the soil prevents its release into the air as greenhouse gases, which contribute to climate change through heating the air.

Teacher answers to Local STEM Heritage Quiz:

1) Fill in the gaps: "The Skinflats is designated as a **Special Protected** area meaning that the location and species within it are protected under law."

2) What is the process of 'Carbon Sequestration'?
A: The process by which which saltmarsh habitats remove carbon dioxide from the atmosphere and store it in their soils.

3) Through which process do saltmarsh plants remove carbon from the atmosphere?
A) Photosynthesis

4) How many hectares does The Helix span?
A) 350

5) Carbon can remain trapped in saltmarsh sediment for up to as much as:
C) 1000 years

6) Name 3 bird species found in the Inner Forth
A) Shelducks, Teals and Curlews

7) Saltmarsh is the name of the vegetation found within the tidal zone of:
C) an estuary

8) Name the technique used to create new areas of salt marshes found at RSPB Skinflats reserve
A) Managed Realignment

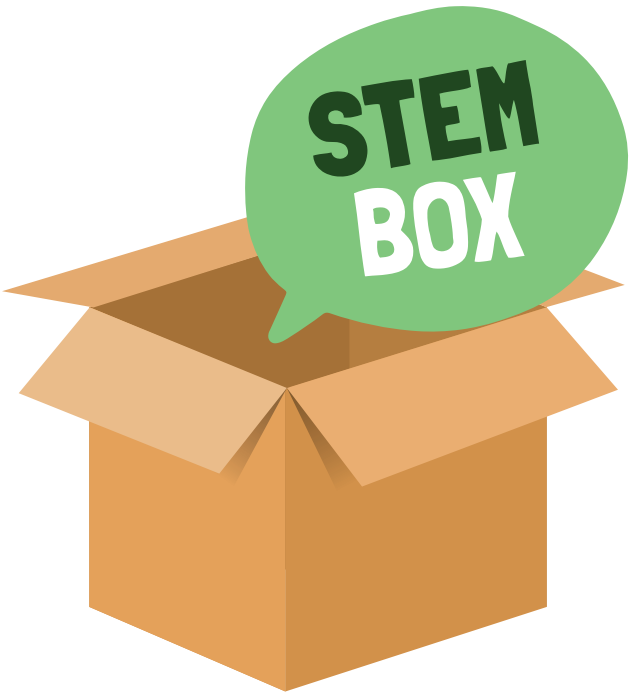
9) Which body of water found at The Helix holds around 15 times more than an Olympic swimming pool?
A) The Lagoon

10) Complete this sentence: High levels of **Carbon Dioxide** are one of the main causes of global warming.

Certificate of Completion

This certificate is awarded to

for the completion of the Blue Carbon in Falkirk STEM Box Experiment



Blue Carbon in Falkirk

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Thank you for using this STEM box, please take a few minutes to fill in our brief evaluation form:

For Teachers:

https://forms.office.com/r/sEwPDgNRk8

For Pupils:

https://forms.office.com/r/RRDDTiKzXM

Teacher Evaluation

Pupil Evaluation

Falkirk Science Festival 2021 · The Helix · Falkirk Council · Falkirk Community Trust · aye for ideas Science for Scotland · University of St Andrews · Great Place · Heritage Fund · Scottish Government Riaghaltas na h-Alba gov.scot