University of St Andrews

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Laidlaw Scholarship Programme

Supervisor: Professor William Austin

Public Engagement with Blue Carbon Research

Promoting nature-based solutions to climate change

This report outlines a 6-week summer research project on public engagement with blue carbon research. The aim of this work was to first gain a general understanding of blue carbon research and management within Scotland, as well as of public knowledge of this topic. After that, tools for increasing public engagement with this subject matter were developed. The target audience of these educational materials were youth aged 8-12, as youth engagement resonates with Article 6 of the Paris Agreement, and is a recognizably important approach in the fight against climate change (UNFCCC, 2015).

Through my work, I believe that I have shown the need to increase public understanding of blue carbon knowledge, as well as the potential to do so through a multitude of interactive educational materials.

Word count: 3,000

Acknowledgements:

I would like to extend my gratitude to the Laidlaw Foundation, Lord Laidlaw, and the team at the University of St Andrews, for providing me with the funding and support for this project.

I would also like to thank my project supervisor, Professor Austin, for the time and effort that he has dedicated to helping me. From start to finish, his passion and knowledge of this subject matter has inspired me, and through working with him I have gotten to learn and experience numerous things that I will continue to pursue beyond this report.

My thanks are also extended to Kirsty Ross and Krisztina Toth at the University of St Andrews, as well as the Falkirk Community Trust Team, for their inputs and collaboration.

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Background information and establishment of research concept:

Blue carbon & saltmarshes –

To understand the term blue carbon, the process of carbon sequestration must first be understood. Essentially, as plants perform photosynthesis they remove carbon dioxide from the air, breaking it down into organic carbon and oxygen (NOA, n.d.). The oxygen is then released back into the air, while the organic carbon is stored within the living plant material. As a plant dies and decomposes, the carbon stored within its cells is released back into the air as carbon dioxide gas, completing the carbon cycle (NOA, n.d.). Blue carbon is a term used to describe all the organic carbon that is captured and stored in this way within marine and coastal ecosystems (Shafiee, 2021).

Although it is often terrestrial or 'green' carbon stores that are first thought of by the public when considering carbon sequestration; in reality, blue carbon stores play an essential role in the global carbon cycle (NOA, n.d.). In fact, according to a 2021 Scottish Parliament Briefing, blue carbon represents Scotland's largest carbon store at 9800 Mt CO_2-eq, in comparison to peatlands, terrestrial forests and non-peatland soils (5945, 2050, and 1550 Mt CO_2-eq) (Shafiee, 2021). Within Scotland, saltmarshes represent an abundant biological blue carbon habitat, with over 48,226 hectares along the Scottish, Welsh, and English coastline, and were the habitats of central focus to this research project (MCCIP, 2018).

Saltmarshes are low-lying coastal areas that experience periodic flooding by seawater (MCCIP, 2018). They are home to unique salt-tolerant plant species, and act as sanctuaries for fish and birds. They provide numerous ecosystem services, of which carbon storage potential is of most interest to this work (MCCIP, 2018). Saltmarsh plants are efficient at sequestering carbon directly from the air through photosynthesis, storing it within their cells as the above-ground carbon store. Organic carbon also flows into saltmarshes within sediment from oceans and rivers (MCCIP, 2018). When saltmarsh plants die, they are buried in the sediment and begin to decompose, release carbon dioxide in the process. However, due to the waterlogged and highly saline soil of saltmarshes, the rate of decomposition of this decaying plant material is very low (NOA, n.d.). Therefore, most carbon is driven down into the soil and can remain there for millennia, with very low carbon dioxide emissions. This is the long-term carbon storage value of saltmarshes.

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NbS & climate change –

Due to their wide distribution and carbon storage efficiency, saltmarshes represent a nature-based solution to climate change (NbS) (Shafiee, 2021). In the case of saltmarshes, this occurs through the long-term removal of carbon dioxide from the atmosphere, limiting the extent of human-induced global warming. The NbS approach is increasingly supported by Scottish government and research advisors, most recently seen in the approach to COP26 (Austin et al., 2020).

Although saltmarshes hold this immense carbon storage potential, and in fact research points towards them being more effective, area for area, at carbon sequestration and storage than terrestrial forests, they are currently not recognized for this service within legislation (Hance, 2009). For example, some Scottish blue carbon habitats are protected under policies such as Special Areas of Conservation. However, these policies do not recognize the need to protect and restore saltmarshes on the basis of their role in fighting climate change (Shafiee, 2021). Blue carbon is also currently not included within national greenhouse gas storage inventories, and the overall level of political and research engagement with terrestrial carbon stores is more developed than that with blue carbon (Shafiee, 2021).

It is important to recognize saltmarshes for their potential to fight climate change, due to the urgency of the climate crisis, as well as to generate more support for the protection and restoration of these habitats. Saltmarshes have historically been threatened by the expansion of human developments, such as agriculture, and more recently are also experiencing degradation due to consequences of climate change, such as rising sea levels (MCCIP, 2018). With current projections of climate change, it is estimated that 20-90% of tidal wetland environments, such as saltmarshes, may be lost by the end of the century (Popkin, 2021). The result of saltmarsh degradation is not only the devastating loss of a natural carbon sequestration tool, but also the release of the huge carbons stocks built up within saltmarsh soils, adding to the issue of global warming (Macreadie, Hughes and Kimbro, 2013).

To summarize; saltmarshes represent an important NbS to climate change. However, they are not currently widely recognized for this potential, and are currently threatened by human activities and climate change. It is therefore important to increase knowledge of, and generate support for, the protection and restoration of saltmarshes and the blue carbon they hold.

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Public engagement with research –

Currently, there is little public engagement with blue carbon research within Scotland, and it can be concluded that general knowledge of its potential and importance is lacking. This is seen through the fact that the term 'blue carbon' is not widely utilized, and as previously mentioned, it is mostly terrestrial forests that come to mind when non-specialists are asked to consider carbon sequestration.

Public engagement with climate change research represents an opportunity to increase support for the protection and restoration of saltmarshes, as a NbS to climate change. It is widely recognized that public education and the communication of scientific concepts behind conservation policies, such as marine protected areas, is essential for the success of these initiatives (Ostermann-Miyashita, Pernat and König, 2021). Khatibi et al (2021) identifies that communities need to understand how climate change will influence their lives for climate-change legislation to succeed. It is with education that a sense of caring and a call to action can be generated in the public, which will in turn influence policymaking from the bottom-up. These concepts can be applied to improve the state of blue carbon initiatives within Scotland, fitting with the countries approach of public engagement with the upcoming COP26 conference. The question that I set out to explore thus became:

In what ways can public knowledge of, and engagement with, blue carbon research (specifically on the importance of saltmarshes in the fight against climate change) be increased?

The target audience for addressing this question was chosen to be youth aged 8-12. This decision was based the importance of youth education to the global climate change movement, as it is them who will become the 'leaders of tomorrow' and follow through on current climate change initiatives. Along with this, the importance of scientific experience and experimental work for this age group within the formal education system fit well with the research basis of blue carbon (Woodley, 2009).

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Methods of public engagement:

Upon guidance from Kirsty Ross, working on public outreach at the University of St Andrews, a Logic Model was completed prior to the design of any educational material. This model is a tool utilized within public outreach initiatives, which allows to map out the key aims of a project, along with its relevant context, assumptions, interrelations, and timeline (Public Health England, 2018).

Logic model components –

Aim:

To increase youth understanding of saltmarshes and their importance for climate change, to increase interest in associated blue carbon research.

Situation:

Public understanding of and engagement with climate change research is important for generating support for governmental policies. Saltmarshes represent a NbS to climate change within Scotland. Currently, public engagement with this subject is low and methods to educate and involve groups of the public, such as youth, are needed.

Inputs:

- Time: Myself, Professor Austin, and others involved in consultation and collaboration
- Funding: Laidlaw Foundation

Assumptions:

- Youth want to learn about this topic and do not already know about it
- Increasing public engagement will result in more support for blue carbon management and research
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External factors:

Creating engagement solely virtually due to the pandemic. This is especially challenging for engagement with fieldwork.

Audience:

- Youth (mainly aged 8-12)
- Parents and guardians participating alongside youth

Desired learning outcomes:

- Short-term:
  - Spark curiosity about saltmarshes
  - Increase understanding of their important functions and their threats
- Medium-term:
  - Encourage further learning & generate greater public awareness about blue carbon
- Long-term:
  - Develop support and encouragement for initiatives to sustainably manage saltmarshes
  - Establish a long-term interest in nature and science within youth

With these general components of a logic model established, the methods of public engagement and a timeline to follow throughout the project were developed.

<u>Methods of public engagement, indicators & timeline –</u>

C-side infographics:

I collaborated with Krisztina Toth to develop informational infographics about blue carbon, to support the C-side research group's contribution to the Royal Society Summer Science Exhibit (RSSSE 2021) event. These infographics were made available on the RSSSE section of the C- side website (C Side, n.d.) and through them participants were able to gain a visual understanding of basic saltmarsh functions and research.

As the Royal Society is a reputable organization of scientific learning, this event provided an excellent opportunity to share knowledge of blue carbon with youths who are already interested in scientific concepts. The timeline for completion of this work was 2 weeks (31st May – 11th June).

Saltmarsh experiments:

I created worksheets and demonstration videos of two science experiments involving saltmarshes. The aim of this was to create easily accessible science education materials, to be viewed by youth when convenient. This approach was developed based on the knowledge that hands-on scientific learning is often the most engaging for a young audience (Woodley, 2009).

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Falkirk Science Festival workshop:
I developed a 90-minute virtual workshop for the Falkirk Science Festival, to be viewed by families with children. The workshop covered: 1) What blue carbon is, 2) Saltmarshes as solutions to climate change, 3) Threats to saltmarshes and 4) Ways to protect and manage them. The workshop was recorded and made available to view on the 27thth of July.

Skinflats blue carbon walking trail:
I took part in a collaboration with the Falkirk Community Council to develop a blue-carbon themed audio-guide for a local walking trail passing by saltmarsh habitats. The aim of this work was to combine public engagement with spending time in nature, providing a change from the otherwise only online material available.

Insights from literature–
Guidance from literature on public engagement was kept in mind throughout the development of the public engagement tools. For example, the importance of translating complex concepts into simple structures was a regularly reappearing guideline (Corner, Shaw, and Clare, 2018; van der Linden, Maibach and Leiserowitz, 2015). Along with this, it was often stated that generating engagement with climate change can be difficult due to the long timescales and statistical basis of the research, which can result in an 'out of sight, out of mind' response (Corner, Shaw, and Clare, 2018; van der Linden, Maibach and Leiserowitz, 2015). To combat these challenges, the approaches to public engagement were designed to be simple, interactive, personal, and to highlight the enormous potential for positive actions in this area.

Output of approaches to public engagement:

C-side infographics:
Figures 1-4 feature the final output of the infographics designed for RSSSE 2021. My main role in this collaboration was designing the teabag (Figure 4), providing scientific inputs for the contents of the infographics, as well as creating the scripts for short audio recordings created to provide more information for each infographic.

It is believed that through this tool, complex concepts of carbon sequestration and saltmarsh degradation were communicated in an accessible and engaging manner. The indicator of success for this work was the agreement of the C-side team to feature it on their website and utilize them for the RSSSE 2021 event.

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Figure 1: Saltmarshes as NbS to climate change

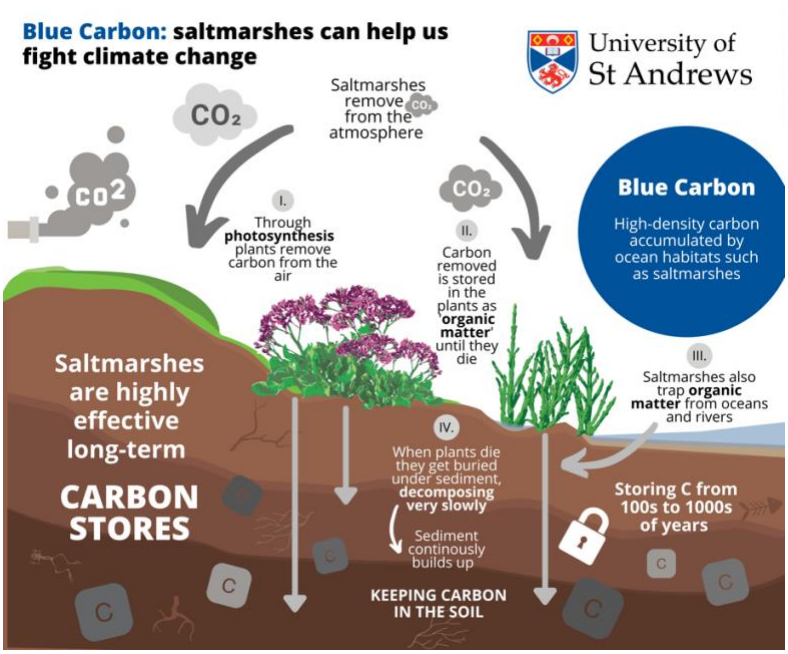


Figure 2: Saltmarshes vs. terrestrial forests, carbon sequestration

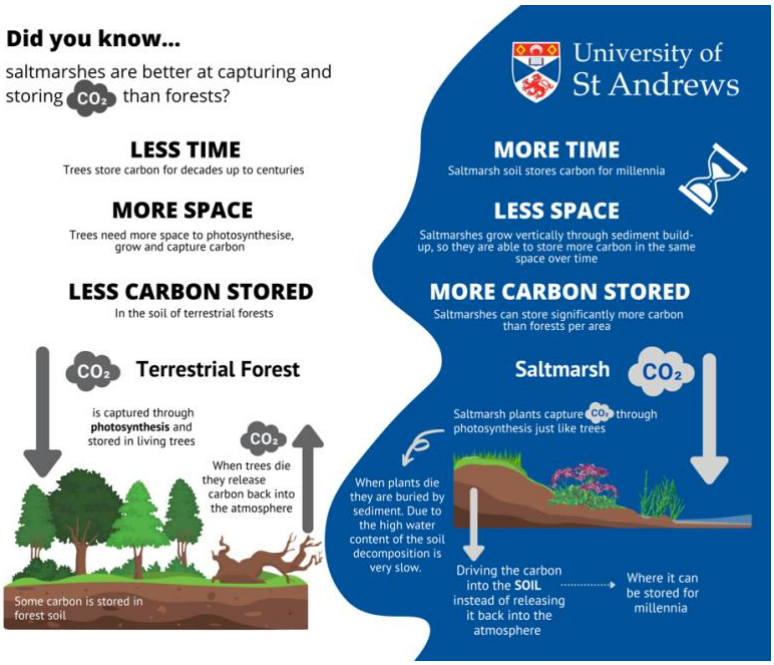


Figure 3: Threats to saltmarshes

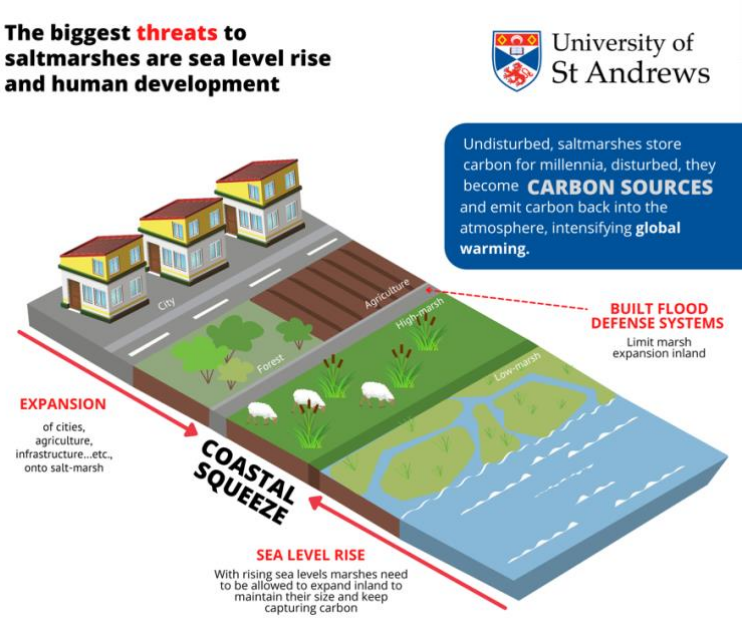
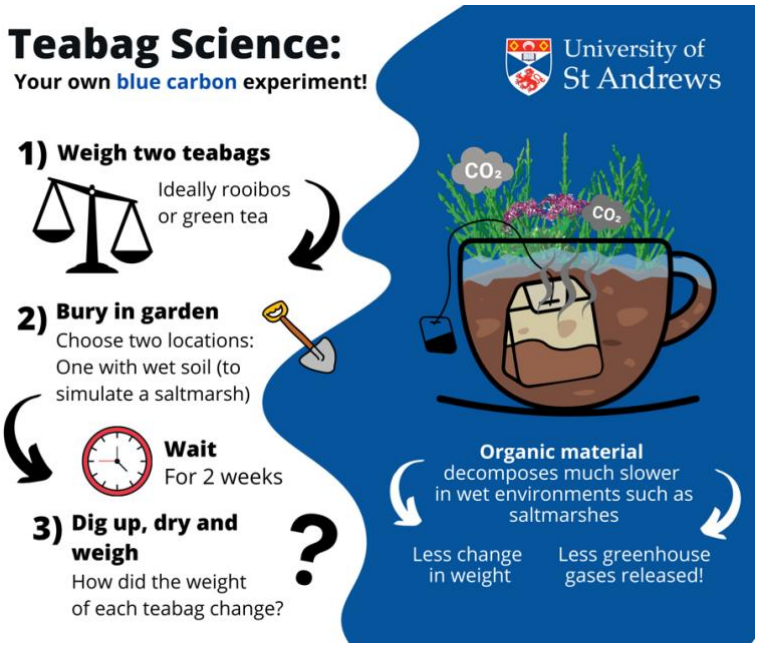


Figure 4: Teabag science experiment



Saltmarsh experiments:

I designed two 'at-home' science experiments the first of which was an adaptation of the Teabag Challenge, coming from the international teatime4science citizen science approach, through which teabags are buried in different soils and their weight change is used as a proxy to measure rates of decomposition (Marley, Smeaton, and Austin, 2019; Teatime 4 Science, n.d.). I adapted this approach to make it more accessible, mainly by switching the type of tea required, as well as providing an option to participate without access to a garden. The second experiment was designed to teach youth about the threats that saltmarshes face, by simulating the impacts of human developments and rising sea levels on 'mini saltmarshes' that can be built in baking trays. Refer to Figure 5 for a visual of this.

Through these experiments, youth can learn about blue carbon through a hands-on approach, resulting in an engaging and unique learning experience. The videos and worksheets have the potential to be utilized in future youth education opportunities. Completion of the experiments and worksheets would indicate the success of this approach to public engagement. However, due to the confines of this project, the materials were not released to families. These indicators are however in place if the materials are used beyond the scope of this project.

Figure 5: Coastal squeeze experiment demonstration

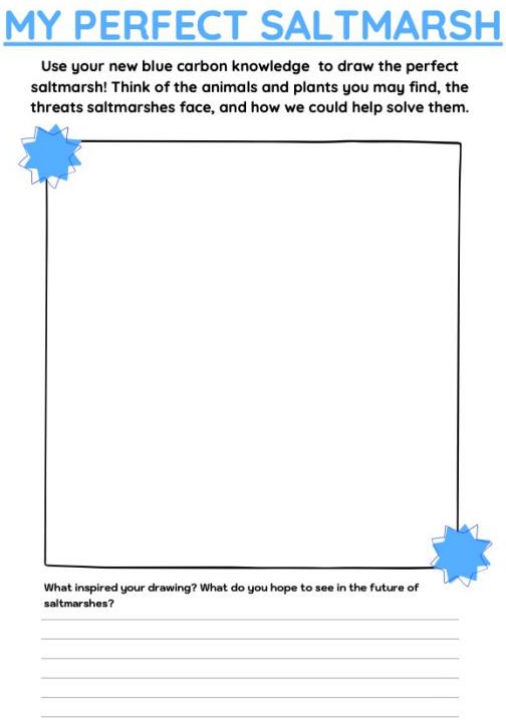
Falkirk Science Festival workshop:

The output for the Falkirk Science Festival was a recording of the workshop, to be then made available as an online tool for families to complete. The material of the workshop includes videos of fieldwork, an interview with a researcher, various activities as shown in Figures 6-7, as well as the two saltmarsh experiments. Due to insights on effective public engagement, this workshop was designed to be interactive. However, the limitation of interaction within the confines of virtual learning must be acknowledged.

The indicator of success for this work was the opinion of the member from the Falkirk Science Festival team who viewed it. In the long term, success will be indicated by the feedback form completed by families who view the workshop.

Figure 6: Word search activity from workshop

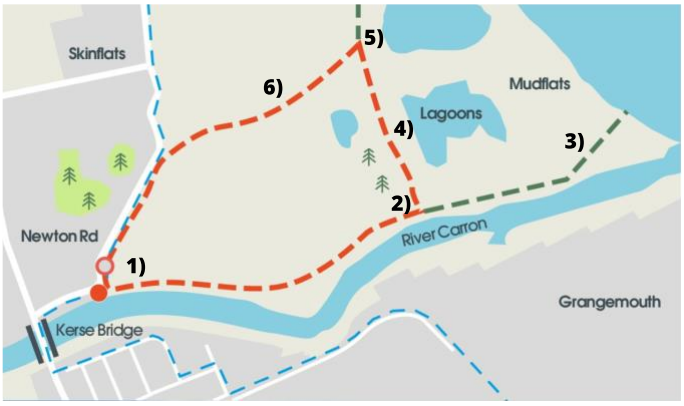
Figure 7: Drawing activity from workshop



Skinflats blue carbon walking trail:

The initial outline and map of where the recordings about blue carbon could be placed along the proposed walking trail were developed, refer to figure 9 for a visual of this. However, unfortunately, this tool was not finalized during the duration of this project, and the further success of this project depends on the availability of the various collaborating parties. If continued, it is believed that this product has the potential to become an effective method of public engagement, due to its unique and interactive nature.

Figure 9: Map of proposed walking route, with markings for audio recordings



Successes, limitations, and future work:

Upon completion of work, the success of developing public engagement with blue carbon research can be assessed. Firstly, a strength of this work is in the variety of materials that were created, as this variety of educational material increases scope for engagement with youth of various learning preferences. Another strength of this material is its longevity. Due to the online basis of this work, it will be available for use well into the future. For example, the RSSSE 2021 infographics have remained on the C-side website beyond the event.

A key limitation of this project is the lack of proper analysis of the success of the methods of public engagement. In no scenario was the material trailed on a test-group of youth, and their interaction with it used to evaluate its success. Although this limits the confidence in the effectiveness of the material developed, the feedback received from public engagement professionals, and researchers with experience in citizen science, throughout this project provides some confidence in the quality of the material.

Another limitation of this project was the lack of time to complete the blue carbon walking route. Although limiting the scope of the project, the experience provided insight into the challenges of collaboration between multiple parties operating on different timelines, which is a reality of collaborative research.

In terms of the continuation of this work, steps are in place to continue developing the blue carbon walking route, creating a lasting collaboration between the Falkirk Community Council and the University of St Andrews. Along with this, communication with a local educator has revealed potential to utilize some of the developed materials in local schools.

It is my hope that increasing public understanding of this topic will result in increased support and pressure for government policies to protect these important habitats, increasing opportunities for nature in the fight against climate change.

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