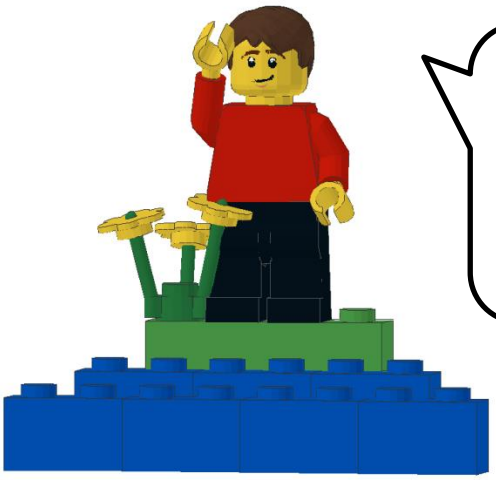
Love your saltmarsh



Help! Our town is about to be swamped by the waves! Can you help me to protect our town and still leave us some chocolate coins to spare?

An activity about the benefits we get from nature and making choices about coastal management.

Scotland version.

By Cai John Tomos Ladd and the Biodiversity and Ecosystem Service Sustainability (BESS) research programme.

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1. Introduction

This activity illustrates how saltmarshes and mudflats reduce wave heights. 'Love your saltmarsh' can also be used to initiate discussion about how we manage our coasts. When there is no saltmarsh and mudflat in front of a LEGO® town, participants discover that they spend more of their chocolate coins to build and maintain a higher sea wall.

'Love your saltmarsh' was designed for one to three researchers to deliver at events such as science festivals, where a few participants take part at a time. The activity was made with 7-11 year olds in mind, but it can be adapted for different age groups. The activity can also be used in schools and field studies centres as part of a longer activity or field trip about coastal ecosystems and management.

BESS researchers can request some of the materials for loan from the Directorate. The BESS Directorate would appreciate being informed each time this activity is run in any context until April 2017.

Kate Wade

5+ mins

5-7 years

7-11 years

11-14 years

14-7 years

This activity is called 'love your saltmarsh', but you may want to use a different title for your event.

2. Learning outcomes

Key learning outcomes from the activity:

- Salt marshes and mudflats reduce the height of waves arriving at the shoreline (all ages) and so reduce coastal erosion & flooding (some 5-7s, 7-11s, 11-14s, 14-17s)
- 'Soft' coastal defences are often a less expensive way of managing coastal erosion and flooding than building and maintaining 'hard' coastal defences. (some 7-11s, 11-14s, 14-17s)
- As a society, we need to make decisions about where and how we spend public money on coastal defences and what we want our coast to look like. (some 7-11s, 11-14s, 14-17s)

Piran White

Additional learning outcomes through discussion:

- Storms and coastal flooding around the UK are likely to increase, at least in part due to climate change caused by human activities.
- Salt marshes are muddy seashores with particular species of plants that can tolerate the salty conditions and being submerged in sea water.
- Salt marshes are important habitats for fish and birds. The upper parts of salt marshes can be grazed by farm animals.
- UK saltmarshes are recognised internationally as being rare and very important for wildlife such as migrating birds.
- People enjoy visiting the coast to have fun and there is growing evidence that spending time in nature is linked to good physical and mental health.
- Many people live at the coast, or their livelihoods depend on activities at the coast, such as farming, fishing and tourism.
- Many saltmarshes around the UK have been destroyed by being drained and reclaimed for agriculture or housing, or through erosion.
- 'Hard' coastal engineering includes building sea walls to prevent erosion and reduce the amount of flooding. 'Soft' coastal engineering includes maintaining or encouraging the development of salt marshes and beaches.
- Managed realignment is a 'soft' coastal engineering technique that involves removing hard coastal defences and allowing previously reclaimed land to flood. This slowly creates new areas of saltmarsh and mudflat, but compensation needs to be paid to the land owners.

Tips for different age groups with reference to the Curriculum for Excellence. (England & Wales and Northern Ireland versions are also available)

Note that within a group of the same age you are likely to encounter a wide range of abilities and needs. Teachers will vary their teaching styles and materials to enable all students to understand the main content.

5 – 7 year olds

For this age group it is important to make a clear link between the lego and a saltmarsh/mudflat. You could show photos and briefly talk about some animals and plants that live in this habitat. Ask them what they know already and if they have seen big waves at the coast or heard about flooding. Ask them to predict what will happen to the village each time something changes. Encourage them to count out the lego and coins and work out how many coins they will have left if they build the walls to different heights. With more time you could turn the activity into an experiment by asking them to plan how to test if the wall and the saltmarsh will prevent the waves from flooding the town.

7 – 11 year olds

Students around this age learn about interactions and energy flow between plants and animals in ecosystems, food chains and webs. Experiences and outcomes in social studies include being able to:

- describe the physical processes of a natural disaster and discuss its impact on people and the landscape.
- consider the advantages and disadvantages of a proposed land use development and discuss the impact this may have on the community.
- explain how the needs of a group in my local community are supported.

Use photos to relate the LEGO® to the saltmarsh/mudflat and ask them about visiting a coastal town. You may be able to make this activity locally relevant or relate it to a news item. You could encourage 7 - 11 year olds to think and work scientifically by asking them to make predictions and encouraging them to think about fair tests. For example, have they kept the waves the same height with and without the saltmarsh present?

11 - 14 year olds

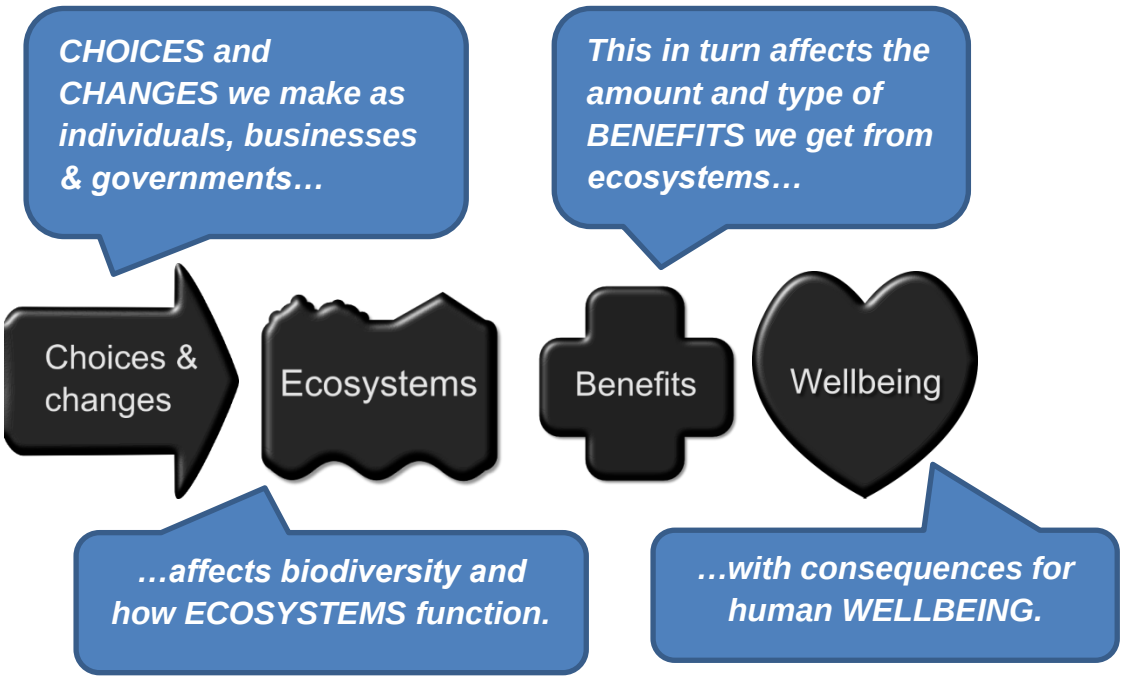
You can use this activity to help students explain some of the processes which contribute to climate change and discuss the possible impact of atmospheric change on the survival of living things. Encourage students to identify the possible consequences of increased coastal flooding and suggest ways to manage impacts.

If they engage with this activity, encourage 11 - 14 year olds to think and work scientifically: What do they know already about waves, flooding and different types of coastal defence? What do you predict? How could this activity be made into a better experiment? What are the sources of error? What further questions come up from this activity? Do you think models like this are useful? How could you investigate whether saltmarshes reduce wave heights and coastal flooding in the real world? What variables could they keep the same and what would they change? What would they measure? This activity is likely to be rejected as too 'childish' by some in this age group, so be ready with questions about their own experience, discussion points, ethical debate or perhaps alternative materials.

14 - 17 year olds

This activity will need to be presented from a different angle or within a different context for most 14 - 17 year olds to engage and benefit. For example, with more lego this could be adapted into a team based coastal engineering competition to identify and build the best solution given multiple conflicting needs. You could provide further information about coastal management to encourage students to critically analyse the issues and use relevant information to develop an informed argument.

Talking about ecosystem services for 11 years +



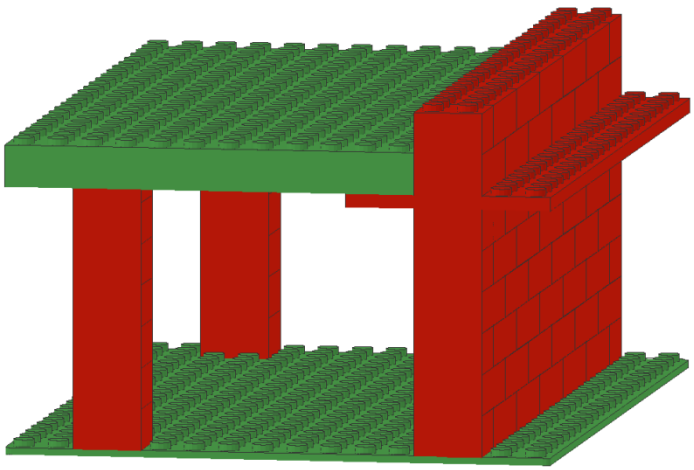
3. Materials and preparation:

Materials

** BESS researchers can ask for the starred materials to be posted to them. Please pay for return postage or postage to the next researcher and for any major* LEGO® *loss!*

- A see-through plastic box/tank of at least 50 cm length x 30 cm width x 30 cm depth.

- A large green LEGO® 'canister plate' as the top of the town base (LEGO® element no 30072).
- At least 50 2 x 4 LEGO® bricks (element no 3001) to build up your sea wall across the front of your village to at least 6 bricks high.*
- At least 50 2 x 2 bricks (element no 3003) for parts of the sea wall and in pillars to support the town base and saltmarsh/mudflat.*
- Two plate bricks to adjust the rear pillars of the town base (element no 3022).*
- 'Plate' bricks with which to attach the saltmarsh to the town wall (e.g. 2 x each elements 3026 and 3029).*
- LEGO® people*, houses and other decorations for your town or fields.



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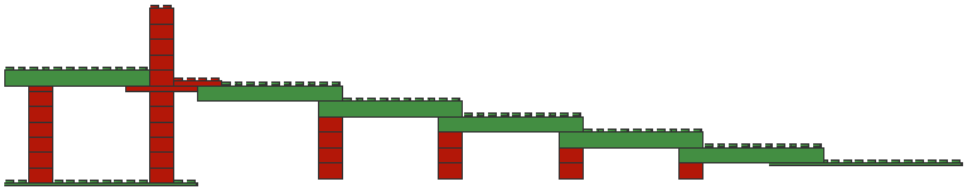
Try to get as long a box as possible.

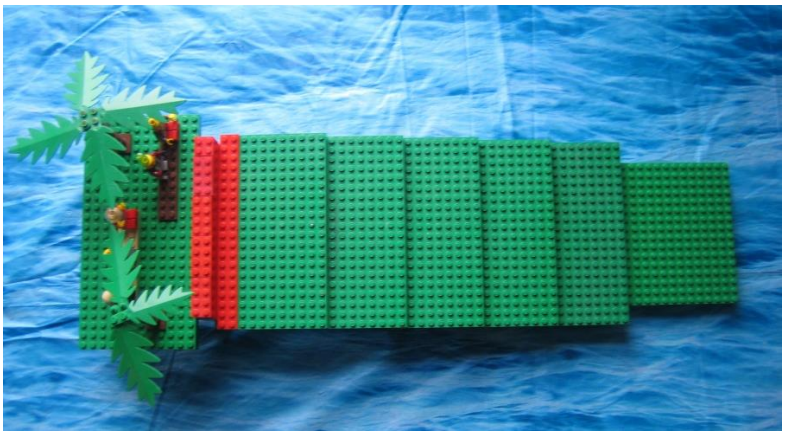
The best height for your town and length of your saltmarsh will vary depending on the length of your box.

For LEGO® inspiration see brickipedia or brickset.com !

The first saltmarsh segment can also be placed directly on top of the plate bricks jutting out from the town wall, but this is harder to remove quickly.

- 5 - 7 'Canister plates' (e.g. 10 x 20 element no 30072) for the saltmarsh/mudflat.*
- 1 building plates (e.g. element no 3334) for the last section of the mudflat/saltmarsh.*





- A large LEGO® building plate or other plastic paddle with which to create the waves.*
- Pebbles or other weights to place on your town building plate base (essential).

Tom Holmes

- Chocolate ‘gold coins’, or other tokens for money.
- Chocolate/cake/coffee for yourself and your helpers (essential!).
- Table (optional).
- Waves design plastic table cover (optional).*
- A small white board* and white board pens (optional).
- Sufficient litres of water to reach at least a third of the way up your saltmarsh/mudflat, plus some spare.
- Plastic aprons for helpers and participants (optional).
- Paper towels and cloths to mop up any water spillage.
- Warning cones in case of water spills (optional).

Hilary Ford

For BESS researchers:

- BESS and/or CBESS banner.
- BESS and/or CBESS information.

Assess risk for eating at the event and for potential allergies (milk, nuts).

It helps (in several ways) to let accompanying adults know before the event that chocolate will be handed out!

Be prepared for things and people to get wet; particularly at high energy events where children are excited!

It is important to spend time getting this right before your event! It may help to first read the full activity description in the following section.

Setting the water height, wall height and coin number.

Place your town at one end of your tank/box and attach the saltmarsh/mudflat. The height of your town and length of saltmarsh/mudflat will depend on the length of your tank/box. Add water to reach about a third of the way up your saltmarsh/mudflat. You need enough space at one end of the box to create waves that will wash up onto your upper saltmarsh and towards your town.

Use the paddle at the far end of the tank to create waves. Adjust the water level, village height, saltmarsh length and angle so that:

- When the saltmarsh/mudflat is present, but no sea wall, large waves should occasionally hit the town.
- When both the saltmarsh/mudflat and sea wall are present it should be very unusual for waves to hit the town.
- With a sea wall but no saltmarsh/mudflat it should be obvious that lots more waves are hitting the town and/or that the sea wall would need a lot of maintenance!

Find out how many rows of bricks on the wall are needed to protect the village from all but the most extreme waves with and without the saltmarsh/mudflat present. Set an appropriate coin number to give participants so they can build a wall and have money over. However, when the saltmarsh/mudflat is removed they should need to spend all their coins or ask for more to build a sea wall that is tall and long enough to protect the village.

Risk assessment pointers

You will need to complete your own or contribute to a wider event risk assessment, but these are a few pointers:

- How will you reduce trip and slip hazards? How will you prevent spills and mop them up quickly if they do occur?
- Could you or your helpers be injured by lifting; particularly if using a lot of water and moving tables? How will you prevent this?
- Are there hazards from water and electrical equipment being in the same area?
- How will you keep fire exits clear and prevent ‘bottlenecks’ of people within the venue or within your activity area?
- Will you be handing out food in an environment where there may be chemicals, soil etc from other activities? Can participants be supervised sufficiently so that they do not eat it until later and after handwashing?!

- Is any of your food a common allergen?
- Do you have any small parts or food that could be a choking hazard if young children are likely to attend?
- Will any adult helping with your activity be left alone to supervise a child or vulnerable adult? If yes, Disclosure Barring Service screening will be needed for this adult for their role.

Accessibility

Consider some possible needs of your participants and adaptations, for example:

- Can your tank be easily seen and accessed by someone using a wheelchair or quickly adapted if necessary?
- Have you thought about how you might describe the activity to better include someone with a visual impairment?
- How will you include someone in the activity and decision making if they are not able to manipulate the lego pieces?

Photographs

Please check and follow your institution's or event's policy regarding photography and filming of children, young people and vulnerable adults. You should also check your institution's guidelines on the Data Protection Act. The Directorate has some good practice guidance for BESS researchers on considering the the context in which photographs are taken and seeking appropriate verbal or written consent. The BESS Directorate follows University of York advice, so will not publish photographs of children on the internet without written consent from a parent or guardian and will not share photographs of children between institutions.

When taking photographs of children it is best practice to ask for active informed consent from the parent. This includes letting them know exactly where and how the photograph will be used and how to contact you or the institution(s) who will use it.

If you publish photographs of children with consent, do not include the child's name.

Tom Holmes

Twitter

The nercbess handle is @nercbess and the BESS early career network handle is @nrgbess. Good hashtags to use include #loveyoursaltmarsh, #nercbess, #cbess, #biodiversity and #ecosystemservices. People on twitter who designed, developed and tested this activity are @cailadd @LyLuBach & @l_j_harrison.

4. Running the activity:

Try to tailor your introduction to the tempo of the event and age of participants – some children will want to get straight in and do something!

You could play the BBC shipping forecast or another forecast predicting a storm.

If you have a good level of attention you could ask your participants to imagine how your different LEGO® characters have been affected by the flooding.

Your participants have an extra incentive if they are allowed to take spare chocolate coins from that year away to eat later!

A. **Introduce participants to your town** - perhaps locate your town somewhere local to your participants or ask them if they've been on holiday somewhere similar. Point out a few of your lego characters; perhaps an arable and/or pastoral farmer, an ice-cream business woman, a family with young children, an elderly couple etc. Point out the saltmarsh and mudflat. You could briefly explain what saltmarshes and mudflats are and what you might see, hear and smell if you visited them. Photographs and video might be helpful.

B. **Demonstrate how to produce some waves** (that don't flood the town). Ask if anyone would like to have a go at making some really realistic waves; can you do better than me? You will probably find that participants produce some really big waves that flood the town! If they don't, then ask your participants to produce some bigger waves.

C. **Explain that the town citizens are really fed-up with flooding that has got worse recently**. If you haven't already, point out how one or two of your LEGO® characters might be affected by the flooding in different ways. Explain that the town citizens know from scientists that the number and severity of coastal storms is likely to increase in the future and that sea level is rising. The citizens have decided to build a wall to protect their town from the waves.

D. Give participants the number of coins decided on at set-up and explain that this is money from the citizen's taxes and that they've asked them to be in charge of coming up with a solution. **Explain that building and then maintaining the wall costs one coin for each lego brick row of wall each year.**

E. Invite one of your participants to **make waves** again. The other participants spend coins to **build a wall** until the village is protected from all but the very strongest waves.

F. Explain that the citizens are very happy with your participant's work and they can spend the coins they have left for that year on something else. Ask your participants to name something the citizens might like to do for their local area with the spare money or perhaps they could reduce taxes next year?

G. **Take the salt marsh/mudflat away.** You might want to decide between three possible scenarios to explain why.

1) The saltmarsh and mudflat has been drained to build a port or houses. Note: it might seem more understandable to move the town to the position of the built-on saltmarsh, but changing the position of your village could change the size of your waves.

2) Sea level rise, dredging, erosion from the wash of passing boats and/or the effect of a large sea wall have changed the water flow and stopped sediment being deposited that is needed to maintain the salt marsh and mudflat. In this case you will need to explain why saltmarshes and mudflats are still helpful in preventing erosion and flooding!

3) You could compare two villages in two tanks or one very large tank with and without a saltmarsh and mudflat. This is perhaps more accurate as most saltmarsh was drained historically, but might be less interesting and immediately obvious to participants.

H. Invite participants to make waves that are just the same as before. Ask: "What do you notice?" Flooding should be more severe and happening more often this year without the saltmarsh and mudflat in front of the wall.

You are likely to be asked about flooding further inland, particularly by adult participants.

I. Give participants their yearly coins again minus the number of rows of sea wall they have (maintenance). **Ask your participants what they are going to do about the flooding this year.**

1) If participants decide to spend their remaining coins on building the wall higher, they will discover there are no or fewer coins left this year to spend on something else (or eat!). They might need to ask their citizens for more money to make the wall high enough, stronger and keep it in good repair!

2) If participants say 'bring back the saltmarsh' you could discuss options for how this might be done, how long it might take and how many coins it might cost.

3) If participants say 'go and live somewhere else' you could ask them how they might feel about this.

You could ask: who should pay for coastal defence? Who gains and who loses from your decision? What do they think about the other options?

If you have time you could check learning by asking questions and continue the discussion about coastal management. You could talk about your own research and further resources.

An alternative approach is to start without the saltmarsh/mudflat and then add it, showing how the wall does not need to be as high or maintained as often. This option could be used to show that managed realignment can help to recreate saltmarsh on previously reclaimed land and you could give some chocolate coins back to participants. This option could potentially be misleading because you will need to explain that land that was previously behind the sea wall has to be given up. Taking bricks away from the wall is also not as easy part-way through the activity.

Extension ideas for more time and older age groups:

Add extra LEGO® to include farmland in addition to the village, perhaps creating a landscape. You could have saltmarsh/mudflat in some areas and not in others. Participants discover that they do not have sufficient coins to build a wall to protect all of the land area. Participants could take on the roles of different LEGO® characters and then have a debate about some different strategies for meeting different people's needs.

What trade-offs might need to be made? Discuss 'hard' and 'soft' coastal defence options. Explain that some farmland will have to be lost in order to restore the saltmarsh, although this will help to protect land behind and also benefit wildlife. How much should the farmer be compensated? Where should a wall be built and maintained? Where should there be just saltmarsh? Where should there be a wall and saltmarsh? Be sure to flag up different people's viewpoints and discuss the scientific evidence. For a longer or follow-on activity you could include audio clips and written examples from the media about coastal flooding.

Well done! Please let the BESS Directorate know how your activity went and any comments you might have for improving the activity and/or instructions: laura.harrison@york.ac.uk

Acknowledgements

This activity was designed by Cai Tomos Ladd (Bangor University), the instructions were written by Dr Laura Harrison (University of York) and it was piloted and further developed by Dr Hilary Ford (Bangor University), Lydia Bach (Queen's University, Belfast), Dr Martin Skov (Bangor University), Siân de Bell (University of York) & Tom Holmes (University of York).

Many are members of the early career researcher network NRG BESS.

5. Further resources

The BBC shipping forecast for sound effects:

http://www.bbc.co.uk/weather/coast_and_sea/shipping_forecast

Paper makers: bringing science to life through art *(project led by Lydia Bach & Kate Foster):* http://the-paper-makers.blogspot.co.uk/

Nature writing: Traver, Tim (2008) *Sippewissett: or, life on a salt marsh.* Chelsea Green publishing
http://books.google.co.uk/books/about/Sippewissett.html?id=a5NomMQTytYC

Poetry (be aware of copyright):

http://www.fizzyfunnyfuzzy.com/showpoem.php?poemID=48

http://www.literarynorfolk.co.uk/Poems/morston_marshes.htm

http://www.poemhunter.com/poem/the-salt-marshes/

http://www.poemhunter.com/poem/at-the-salt-march/

http://www.poemhunter.com/poem/love-in-the-salt-marsh/

BESS coastal researcher profiles and saltmarsh/mudflat photographs

The profile text and photographs may be copied for and used at outreach events by BESS and NRG BESS researchers and by educational organisations for their own teaching purposes. Electronic versions of the photographs are available from laura.harrison@york.ac.uk. Please credit the photographer on each photograph. Please contact BESS before using the profiles or photographs in any published materials. A full set of early career researcher profiles is also available.

Cai John Tomos Ladd

Cai is a PhD student at Bangor University

Saltmarshes help us in clever ways – they stop coastal flooding, lock away carbon, and even clean our oceans! Sadly, saltmarshes get damaged by erosion, which is likely to get worse with climate change (causing more storms and increasing sea level). It is important for us to know how saltmarshes might change in the future and how easily they can recover from damage. I'm trying to answer this question: why do some saltmarshes recover from erosion, while others are permanently lost - even when they look the same?

I've been using old photographs and 3D models to see how different saltmarshes have been expanding or contracting over time. I'm then trying to find out what causes these changes; is it the plants or the environment that explains differences between saltmarshes? Some of my previous work makes me think that plants are important - having more types of plants on the saltmarsh makes it more likely to resist against and recover from erosion. I'm investigating whether this is because more plants mean more roots, and more roots means more help to bind and trap soil particles together. Larger chunks of eroded soil means more space for new growth and hence recovery of the marsh.

My work so far has taken me to the dark vaults of map archives, to the virtual world of a supercomputer, and to one of the prettiest estuaries in the whole world - Glaslyn!

A skill that is important for me as a scientist is being adventurous. By adventurous, I mean adventurous in the way we look at the world. Thinking in this way has led me to spot new problems, and the need to find novel ways to solve them. By adventuring, I've met with amazing scientists, seen beautiful landscapes, and learned about techniques I'd have thought were too complicated for me.

I was inspired to become a scientist because of the beauty in this Earth. It's just so amazing, who wouldn't want to find out how all the pieces fit together!

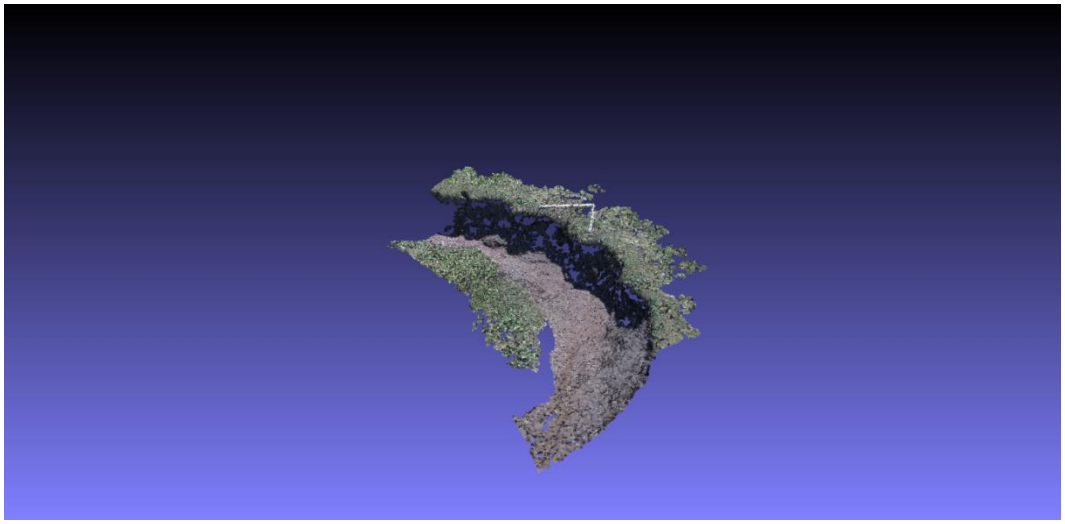
At school I studied Biology, Chemistry, Maths and Physics. I then came to University to study Marine Biology. I then did a masters in Saltmarsh Ecology, which let me to where I am today. I've not only stayed at School - during the summers, I worked in an aquarium in Berlin, visited Virginia to learn about the ecology there, and worked as a Warden on Llanddwyn Island nature reserve in Anglesey.

In my free time I like to listen to and mix dance music, play guitar and walk the craggy slopes of Snowdonia. I'm currently working on a project to build my own remote control helicopter.

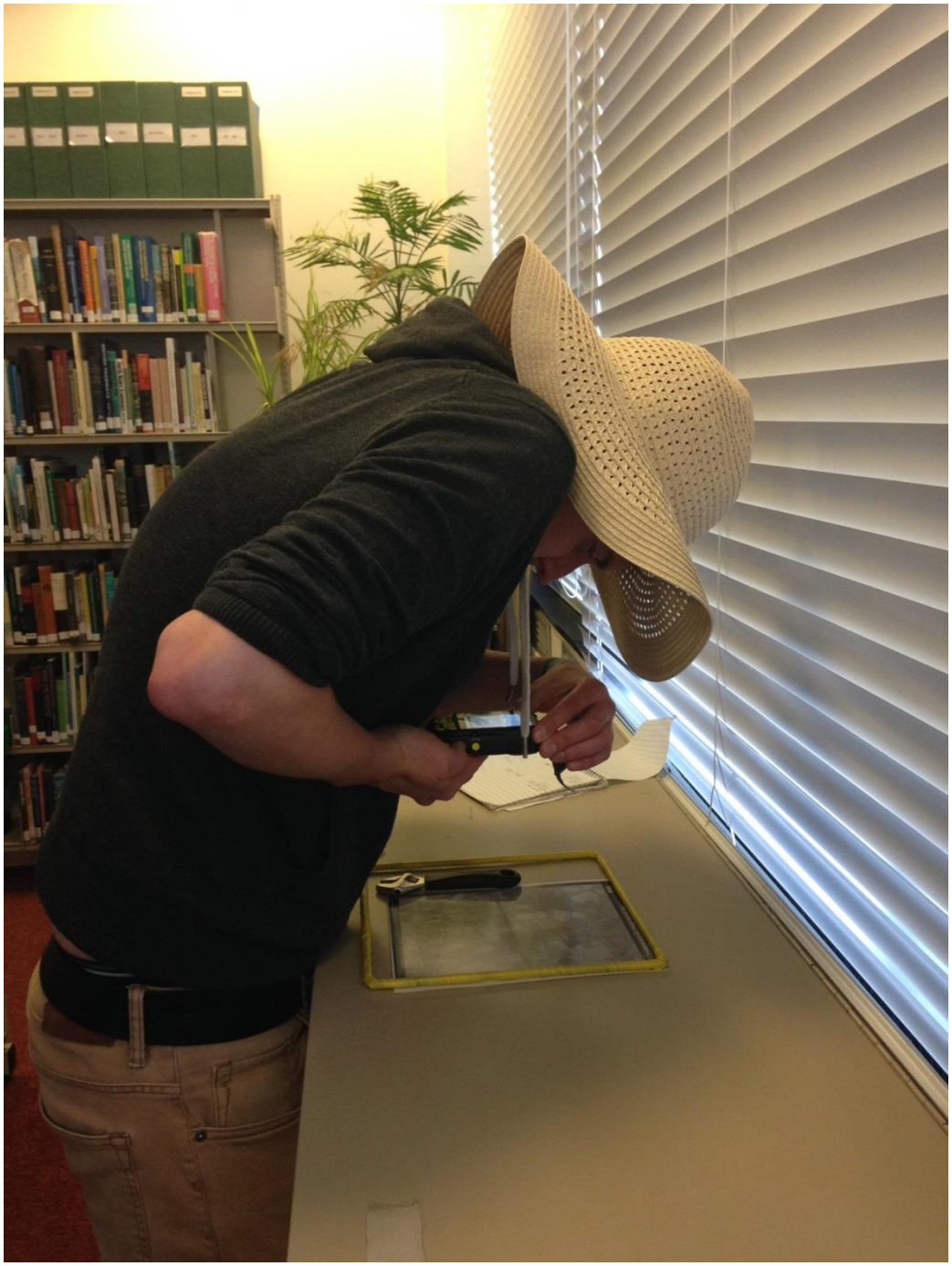
Cai's pictures:

Credit: Cai Ladd. Photographing the marsh – at the top of that pole is a digital camera. It takes photos every 6 seconds and back at home, I can stitch the pictures together to create 3D models. The cubes are there as a reference, so I can see exactly how the marsh has changed over time, by how much.

Credit: Cai Ladd. Glaslyn estuary – marsh edge eroding, with lots of slump blocks being formed in the process – could these help plants to recolonise, and recover the marsh?



Credit: Cai Ladd. Making a "point-cloud" – A little like Lego, this programme builds a 3D model of my saltmarsh (a creek here), so I can see exactly where erosion happens, and by how much.



Credit: Cai Ladd. Taking pictures of pictures! – Working in the archives, we couldn't afford to scan the old aerial images, so had to photograph them instead. Though I look rather silly, the hat is to block out glare from the light and the yellow frame and wrench were the only weights I could get hold of to keep the picture flat! Science is all about compromise and adjustment!

Dr Hilary Ford

Hilary is a CBESS funded Post-Doctoral Researcher at Bangor University. Her Bangor University webpage can be found here: http://www.bangor.ac.uk/oceansciences/staff/php/staffdetails1.php?person=10269

I'm interested in how the biodiversity of living things underpins the benefits we get from coastal habitats such as salt marshes e.g. flood protection, habitat for birds and carbon storage. I collect information on vegetation, soil, invertebrates (spiders and beetles) and greenhouse gases from different UK salt marshes. To do this you have to be good at digging, hammering in soil cores, getting muddy, avoiding cattle and working in the rain / wind / sleet whilst remaining enthusiastic and handing out spare clothing and chocolate bars to any-one who has agreed to help you!

As well as field work I get to do a lot of lab and office work, analysing and presenting my results and writing up scientific reports. To do this work I have to be good at Biology and Geography and it really helps to be enthusiastic enough to learn statistics even if pure Maths isn't your strong point. I also have to be very organised and enjoy working as a member of a team.

I enjoy helping Masters and PhD students with their research projects and teaching junior school children about flood protection!

Lydia Bach

Lydia is a CBESS PhD student at Queen's University, Belfast.

Coastal ecosystems are under a lot of pressure and I want to know how we can protect them into the future. We need to understand how ecosystems function so that we can predict how human impacts like climate change will affect them.

I'm finding out what animal eats what in coastal ecosystems. I have visited Morecambe Bay and the Essex Coast and am now working in Carlingford Lough, which I am visiting several times during the year to collect and identify invertebrates from the mud. I look at the stomach contents of fish and crabs to find out what they have been eating. I also use isotope analysis where you can use chemical signatures to indicate what animals have been eating over a long time. This helps me to decide where each species is in a food chain (e.g. herbivore, intermediate predator, top predator). Reading papers where other scientists describe what they have found out about coastal animals is also very important.

Putting together all of this information results in a food web showing how all the animals in an ecosystem are connected with each other through what they eat. I'm particularly interested in finding out how food webs change from place to place and at different times of the year.

Stephen Watson

Stephen is a BESS funded PhD student at the Plymouth Marine Laboratory.

I study coastal ecosystems and the benefits we get from them, such as recreation, food, flood prevention and nutrient cycling. We know that climate change will affect these ecosystems and might also change these benefits.

I'm gathering information about fish, invertebrates and the environment in two UK estuaries. I'm using this information in computer simulations to predict how biodiversity and benefits we get from coastal ecosystems will change. I'm also looking at how these changes are likely to affect local people and the economy.

Tom Holmes

Tom is a BESS funded PhD student at the University of York.

I'm finding out how storms affect coastal ecosystems and the benefits that we get from them. Coastal ecosystems like saltmarshes are important for wildlife and help to protect us from flooding. They can also help to reduce climate change because they lock away carbon instead of it being in the atmosphere as carbon dioxide.

I collect tubes of soil, called soil cores, from saltmarshes at the Humber Estuary and Morecambe Bay (see picture). Soil cores allow you to look back in time and find clues about what the environment was like then, with the deepest part of the soil core being the oldest. By measuring the size of grains from different depths in my soil cores I can see when there were big coastal storms over the last 100 years. This is because the storms washed sand onto the saltmarsh. I also analyse the chemicals in the soil and look at the pollen grains to see if and how the saltmarshes changed following each storm.

This work helps me to understand how well and how quickly saltmarshes recover if they are damaged by storms. This is important because climate change is likely to make coastal storms worse and happen more often. I am also interviewing people who live and work at the coast to find out what they think about how the coastal environment is changing and how storms affect them.

Piran White