OCEAN AND CLIMATE CHANGE DIGITAL SCHOOL SCIENCE KIT

People · Ocean · Planet

MARINE ALLIANCE FOR SCIENCE AND TECHNOLOGY FOR SCOTLAND

Recommended age: 11-14 years

This science pack has been created by the Marine Alliance for Science and Technology (MASTS). MASTS is an organisation that enhances the excellence of marine research in Scotland across 17 institutes and 700+ members. With such a large number of scientists working at the forefront of marine science, MASTS recognise the importance of communicating what we learn to the public.

People Ocean Planet

People Ocean Planet (POP) is an initiative within MASTS, helping to drive positive changes across society for the ocean by making best use of our scientific knowledge.

Meet the MASTS Scientists

In this digital science kit you will hear from 4 scientists, each of which have expertise across 4 different areas of marine science - Fisheries, Marine Renewable Energy, Sea Level Rise and Ocean Acidification. Each scientist has also included a science profile to help get to know them better!

Explore the Ocean with your Pupils

After an introductory video on the ocean and climate change, and each of the topics, the students will get to choose which area they want to learn about first. These packs are designed to have a mix of learning new information through videos and information sheets, as well as encouraging students to conduct their own further research. The activities within this pack then encourage and ask the students to choose their own scientific path to pick how they would best navigate the science around climate change.

From choosing where they would place a marine energy park, conducting ocean acidification experiments, learning how to manage fish stocks and drawing, dancing or writing about protecting habitats, this science kit covers a range of curriculum for children aged 11-14. This science kit can be incorporated into a single or multiple lessons and would also be ideal as a science club activity.

Within the teacher kit for this pack, there are also extra questions and answers from scientist to help you answer any additional questions during the activities. As well as example lesson plans, and additional information. By participating in this pack and filling out the short feedback form at the end, you will also be contributing to helping People Ocean Planet group learn and improve how educational resources like this are made in the future. We also have an active social media, which you can share the science you learn with us!

POP

MASTS

BREAKDOWN OF THE SCIENCE KIT

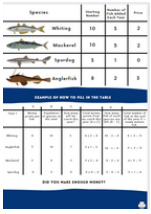
Introduction Video (4.5 mins) - This video is an introduction to the overall topic of oceans and climate change.

Topic Introduction Videos (4.5mins) - Each of the 4 parts of this science kit also come with an introduction to each of the more specific topics.

Meet the Scientists (3 mins): These videos and an introduction to the 4 scientist who created this pack.

Printables - This is a separate document which just includes pages where this logo is seen and a more 'printer-friendly' version on the page sin the pack can be found.

Fisheries and Climate Change Pack
Estimated time to complete = 20 minutes
Preparation Required = Optional cut outs of fish species
Resources/Materials Needed = Paper, Pens, Pencil



Marine Renewable Energy Pack
Estimated time to complete = 20 minutes
Preparation Required = None
Resources/Materials Needed = Paper, Pens, Pencil

Sea Level Rise Pack
Estimated time to complete = 30 - 45 minutes
Preparation Required = Printing of activity sheets and habitat information cards
Resources/Materials Needed = Paper, Pens, Pencil, Colouring pencils

Ocean Acidification Pack
Estimated time to complete = 30 minutes
Preparation Required = Printing of activity sheets
= Optional - Egg experiment
(conducted over 24 hours).
Resources/Materials Needed = Paper, Pens, Pencil
= Optional for Egg experiment
(Jar with lid, Egg, White Vinegar).

Share your Science Sheets - At the end of each pack there are some sheets included which help the children reflect on the decisions they made and how they found the pack. As everyone may choose different science paths we would love for you to share this via social media so we can all learn together (see social media guidance section). **https://www.greatscienceshare.org/share**

Great Science Share for SCHOOLS

How did your pupils find this resource?
MASTS and People Ocean Planet Group have created this resource and feedback to help us monitor the impact and improve on this activity will be key to helping us evaluate this activity. Therefore we ask if you could **please fill in a very short 10 question multiple choice survey after running this activity** (https://standrews.eu.qualtrics.com/jfe/form/SV_0jtNvQesa00pFnU)

#POPSCIKIT
#GSSFS2022
@OceanBehaviours
@mastscot
@GreatSciShare

PROPOSED LESSON PLAN - SCIENCE KIT OVER ONE LESSON (1 HOUR)

0 to 15 minutes - Introduce the activity, play introduction video, each of the 4 topic videos and the meet the scientist video.

15 - 20 minutes - Children split into 4 groups and choose the activity they want to try first.

20 - 50 minutes - Children work through the various activities, if they finish one pack they can start another. It should be possible, depending on the amount of independent research time they are given to complete two of the four sections of the pack in a single lesson.

50 minutes - 1 hour - fill in the feedback sheets, share and discuss what they chose/learnt with peers.

PROPOSED LESSON SCHEDULE - SCIENCE KIT OVER MULTIPLE LESSONS

Each of the Science kits, with independent research time could be conducted over an individual lesson. Giving children the chance to complete each of the 4 activity packs. This is a suggested order to conduct the packs in, but they can be completed in any order.

Lesson 1 - Introduce the activity, play introduction video and sea level rise introduction video.
- Complete the sea level rise pack.
- Homework = complete the task to communicate ways to protect a habitat.

Lesson 2 - Start with presentations of protecting habitat from Sea Level Rise pack.
- Play fisheries introduction video and work through Fisheries Science Pack
- Play Ocean acidification introduction video and start the Egg dissolving experiment for Ocean acidification pack.

Lesson 3 - Work through ocean acidification pack.

Lesson 4 - Play marine renewable energy introduction video.
- Complete the marine renewable introduction pack.
- End with a group discussion and filling in of feedback sheets of how they found the activity, what they learn and want to research in the future.
- (Teacher to fill out survey).

SHARING OVER SOCIAL MEDIA

The Great Science Share for Schools have a fantastic online presences where people can share the exciting science investigations and findings!

We would love for you to join in with this too and share how your students are using this pack!

For ideas and further guidance on what to share please check out the Great Science Share for Schools website.

We would love to see whatever you are willing to share, in whatever creative ways you come up with.

But we have also included some forms that help the students share and reflect on their activities - which can be easily photographed and shared!

Please share with the hashtags:

#POPSCIKIT

AND

#GSSFS2022

You can also tag us on twitter:

@mastsscot
@OceanBehaviours
@GreatSciShare

It is the responsibility of the teacher/adult to ensure all the correct permissions are gained to share any information of photos online and with MASTS/People Ocean Planet. Only adults can share and email about the activities.

By posting to social media you are agreeing that MASTS and People Ocean Planet can use print screens and quotes from the tweets on social media for promotion, a measurement of impact and sharing information about the project with others.

If higher quality images or images/information are emailed to us - we will gain relevant permissions before using them.

RISK ASSESSMENTS

It is the responsibility of the adults/teachers to ensure the activities have been risk assessed and ensure children are supervised during the activity.

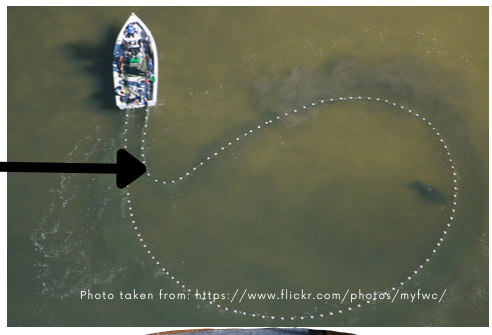
The University of Manchester's Science & Engineering Education Research and Innovation Hub assume no liability with regard to injuries or damage to property that may occur as a result of engaging in the Great Science Share for Schools. This campaign is designed to be carried out by children working with an adult. The adult is fully responsible for ensuring the activities are carried out safely. You can access the CLEAPSS website or SSERC website for up to date health and safety information when planning practical activities for children.

http://primary.cleapss.org.uk/
https://www.sserc.org.uk/

FISHERIES AND CLIMATE CHANGE PACK - ANSWERS AND ADDITIONAL INFORMATION

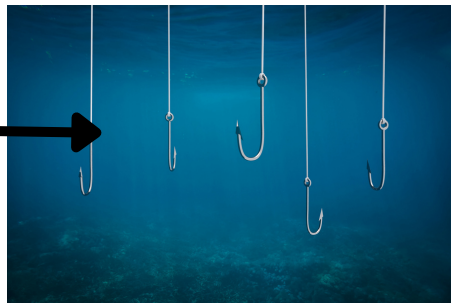
Fish can be caught using traps called creels (often these are used for shellfish like crabs and lobsters).

Some fish are caught be placing nets around them, called Seine-netting.



Some shellfish are caught using gear that is towed by boats, similar to a plough on a farm, and this is called dredging.

Some fish are caught using lines of hooks which are set with bait and then picked up.



Some fish are caught using nets which are towed behind boats, either on their own or in pairs, which is called trawling.

Some shellfish, like scallops, are caught by divers picking them by hand

HOW MANY INDIVIDUALS OF EACH SPECIES OF FISH CAN BE TAKEN FROM THE SEA AND THERE STILL BE MORE INDIVIDUALS AFTER YEAR 6 THAN YEAR 1?

Whiting - 2 each year
Mackerel - 4 each year
Spurdog - 0 each year
Anglerfish - 1 each year
However, you may not take the same number each year so this answer is not exact. Each student may take different numbers.

ADDITIONAL QUESTIONS

How do you age a fish?
We can tell a fishes age by a little ear bone fish have, called an otolith. Otoliths have age lines, much like a tree, which we can count and tell us how old the fish was.

How old can fish live?
Fish can live to many different ages depending on what species they are. One of the longest living species in the world are Greenland sharks which can live as long as 400 years! This means there might be some Greenland sharks still swimming around that were alive in the 1600s!

How many species of fish are there in the UK?
It's difficult to know exactly how many species of fish we have in the UK because of how many different habitats there are but it is over 300. There are even some species that many people don't know about. Some cute (small-spotted catshark), some colourful (cuckoo wrasse) and some very strange (ocean sunfish, John Dory).

How many fishing boats are there in the UK?
There were 5911 registered fishing vessels in the UK in 2019. The majority of these boats are small, day boats under 10 metres in length.

Does the UK have a boat for surveying fish?
Yes, the UK has some boats which are used by scientists to survey fish. Two of these boats are known as the MRV Scotia which is based in Scotland, and the RV Cefas Endeavour, which is based in England.

Where is the biggest fishing port in the UK?
Peterhead, in Scotland, North of Aberdeen is the biggest UK port for landing fish.

What is the most caught species of fish in the UK?
In the UK, Mackerel is the most caught species by value in the UK.

OCEAN ACIDIFICATION CHANGE PACK - ANSWERS AND ADDITIONAL INFORMATION

PH SCALE:
1 – STOMACH ACID
2 – LEMON JUICE
3 – VINEGAR
4 – TOMATO
5 – BLACK COFFEE
6 – MILK
7 – PURE WATER
8 – SEA WATER
9 – BAKING SODA
10
11 – AMMONIA SOLUTION
12 – SOAP
13 – BLEACH
14 – DRAIN CLEANER

EMISSIONS:
39% - COAL COMBUSTION
31% - OIL COMBUSTION
19% - NATURAL GAS COMBUSTION
3% - OTHER INDUSTRY AND FUEL USE
4% - NON-ENERGY USE OF FUELS
4% - CEMENT PRODUCTION

ADDITIONAL QUESTIONS

What would happen if the ocean got too acidic?
The simple answer is that calcifying organisms' shells will dissolve faster than they are able to repair them, this will cause them to become more vulnerable to other environmental stressors and to predation. A loss of these animals will ripple up the food chain and affect other animals. The more complex answer is that we don't fully know if and how animals will adapt to increasing acidification. There are possibilities that some animals will be able to cope with the new conditions. When some animals can cope and others can't cope there could be a shift in the types of animals we see in different environments, and changes to many food webs.

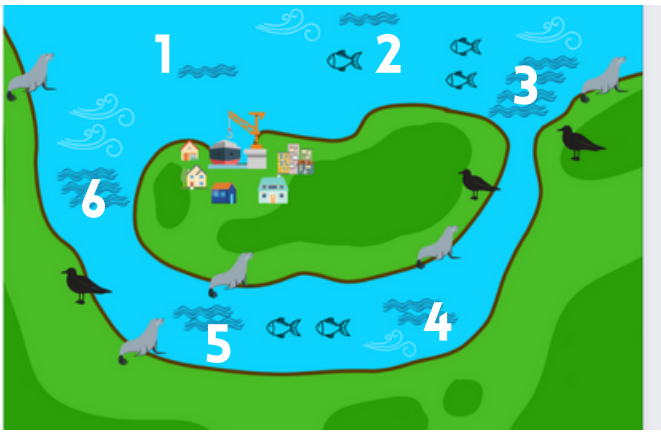
Can Whales be affected by ocean acidification?
Whales are marine mammals, and as such will not be affected the same way as either the other animals we have spoken about. Unlike calcifying animals, they do not have shells or skeletons that are in contact with the acidic water. They also do not balance their chemistry with the surrounding water in the way fish do.
They could still be affected however by changes in their food source brought about by increased acidification.

What would happen if the ocean got much less acidic?
Increasing the alkalinity of the oceans is a proposed solution to help reduce the affects of ocean acidification we have already seen by reducing the amount of carbon dioxide in the oceans. There is very little known about what would happen If the alkalinity was to increase too much (higher pH), and this is an area that needs more research if increasing alkalinity is to be used to reduce acidification.

MARINE RENEWABLE ENERGY PACK - ANSWERS AND ADDITIONAL INFORMATION

The **RENEWABLE ENERGY SOURCE** causes the blades of the **DEVICE** to move/rotate. From this movement we can capture energy using a **GENERATOR** with the **TURBINE**. The energy is transported by **CABLES** back to land where is can be stored, transported and used in places like our homes.

PLACEMENT OF THE MARINE ENERGY PARK



There are no right or wrong answers, but there are things to consider for each locations which are discussed in these points.

1) This is close to Port Town and away from any sites known to be important sites for animals. But there is low current speed and wind in this area.

2) This is close to Port Town and away from any sites known to be important sites for mammals or birds. There is low current speed but is a windy area. It is also an area important for fish.

3) This area has the highest current speed of any area on this map, and is also a windy area. It is also not too far from Port Town. However, this is an important site for lots of fishing grounds, mammals and bird activity, which we do not want to disturb.

4) This area is far away from Port Town, but has somewhat high current speed and is windy. It is not too close to important areas for mammals or seabirds, but may be important for fishing.

5) This area is not windy, but has somewhat high current speed. It is, however, very close to areas important for marine mammals.

6) This area is close to Port Town has high current speed and is the windiest place on this map. Sea birds and mammals do have areas important to them somewhat close to this site, but not as close as other sites. This is also not an important area for fishing.

ADDITIONAL QUESTIONS

How much offshore energy is available in the UK?

It is estimated that offshore renewable energy capacity in Scottish waters total 25% of the tidal, 10% of the wave, and 25% of the offshore wind resources in Europe. So, despite its relatively small size as a country, Scotland has a large proportion of Europe's potential for marine and offshore renewable energy

Can offshore renewable energy devices and structures be beneficial to sea life?

Yes, by providing somewhere for creatures to settle on and grow, devices and structures can increase biodiversity. Structures in the sea may form 'artificial reefs' which tend to attract fish and other commercially-valuable sealife like crabs and lobsters. There may be some benefits of this, but we must remember that these are not natural structures and we must find the right balance between making best use of renewable energy resources and protecting natural environments.

SEA LEVEL RISE PACK
- ANSWERS AND ADDITIONAL INFORMATION

The words in the wordsearch include: CLIFFS, MUDFLATS, ROCKYSHORES, SALTMARSHES, SAND BEACHES, SAND DUNES, SEAGRASS MEADOWS, SHINGLE BEACHES

The two secret words are not habitats, but there is a picture of a SEAHORSE on the page of the wordsearch and the students have been introduced to CLIMATE CHANGE on the first page of their booklets.

Primary production – critical role as food	Plant and rock structure – environment for habitat, refuge and nursery for lots of species	Rock pooling
Pollution filtering	Water-skiing	Sediment stability
Oxygen production	soil formation from soils and rocks deposited into habitats	Wave and current dampening
Seed production and dispersal	Carbon accumulation	Nutrient cycling
Plant material can be used to make baskets	Snorkeling	Plant material being used for fuel

Final activity: This task requires the flash cards. The students will focus on ONE habitat. The students can complete this task independently or as a group. It is an open-ended task where there are no wrong answers as long as the students can understand their habitat a little better from reading the flashcards and are able to decide how they are going to try and make a positive impact on the environment. Some of the ideas that they may choose to help protect their habitat may be things you as a class can do together, other things are wider scale measures required to make an impact. Hopefully this will lead to healthy discussion amongst groups, to pick their favourite approached.

If you have decided to use this pack across your whole class, you may want to use this exercise for the students to all practice their public speaking by asking the students to share their poems, articles and chosen ideas of how to protect their habitat.

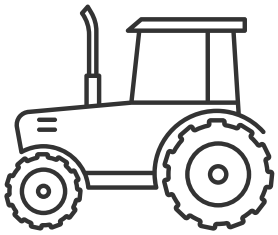
ADDITIONAL QUESTIONS

We don't live in the sea so why does it matter if the sea level rises?
Coastal areas have seen particularly intense change caused by human activity. Population density is also higher in coastal areas than non-coastal areas (Small and Nicholls, 2003). In Europe alone over 70 million people live on the coastline and globally the UN estimates 40% of the world's population live within 1 km of the coast (Martínez et al., 2007; Ondiviela et al., 2014). The combination of population and economic growth has created a strain on the provision of these ecological services. For example overexploitation of fisheries, including physical disturbances due to dredging and trawling, are widespread (Cullen-Unsworth and Unsworth, 2013; McLeod et al., 2011). In 2018, an estimated 179 million tonnes of seafood was extracted from the marine environment for aquaculture production, human consumption as well as non-food uses (FAO, 2020). The average annual rise in seafood consumption is 3.1% (compared with annual world population growth of 1.6% between 1961-2017; FAO, 2020) and there are major concerns about the direct and indirect (such as extraction of feed for aquaculture) impacts this is having.

A further pressure, land-use change has resulted in large losses and degradation of intertidal habitats worldwide (Lovelock and Reef, 2020; Waycott et al., 2009). Saltmarsh loss has been largely attributed to land reclamation for agricultural practices (Almeida et al., 2014; Hobbs and Shennan, 1986). It is unclear how these coastal ecosystems will continue to provide essential services that are critical for climate adaption and resilience, when they are also vulnerable to climate change.

DEFINITIONS

Agriculture activity = Farming activities that have a connection with producing items for commercial purposes (grazing farm animals, planting crops).

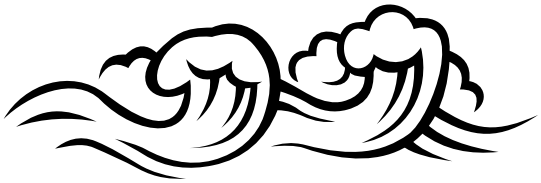


Atmosphere = The gases that surround a planet in layers, these strongly influence the conditions of earth. Without the atmosphere life would not exist on earth.

Carbon footprint = The amount of carbon dioxide released into the air because of a single persons energy needs.

Climate = The weather conditions prevailing in an area in general or over a long period.

Climate change =The long term change in weather patterns. This is influenced by lots of different variables, but carbon dioxide and other green house gases for energy and resource use have been released at at a significant rate into the atmosphere which is changing the earths climate.



Coast/coastal = The part of land connected or near the sea.

Colonise = The process by which a plant or animal settles and becomes established.

DEFINITIONS

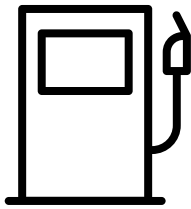
Deforestation = The process of cutting down forests and then changing the use of the area, typically forests are cut down for agricultural activities and urbanisation. This has a very negative impact on ecosystems, the animals and plants within them and the climate.

direct impact = Something immediately leading to or resulting in something else.

Dune = A mound or ridge of sand or other loose sediment formed by wind and waves.

Ecosystem = A system of interacting plants and animals with their physical (non living) environmental materials including water, rocks and soil.

Erosion = The process where typically wind or water wear away sediment, soil or rocks.



Flooding = The temporary inundation of dry land. It typically occurs during storm events.

Fossil fuels = a natural fuel such as coal or gas, formed in the geological past from the remains of living organisms. These fuels take thousands to millions of years to form.

Glacier = A mass of land ice, usually created from the accumulation of snow on mountains.

Global warming = An increase in the average temperature of the earth's atmosphere. This has been caused by human activity and has long-term effects on environmental conditions including sea level rise, flooding, drought and forest fires.

Green house gases = Gases which are in the earth's atmosphere are both natural and manmade. These have increased in the atmosphere since the industrial revolution. The three main greenhouse gases include carbon dioxide, methane, and nitrous oxide.

Habitat = The natural home or environment of an animal or plant.

indirect = Something not directly caused by or resulting from something.

DEFINITIONS

industrial activity = Activities which include all stages of finding materials, creating products and distributing products.

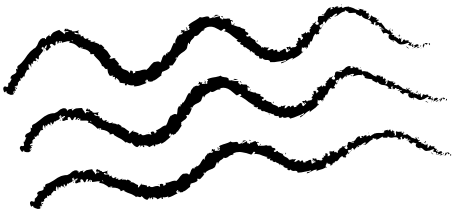
invasive animals and plants = An invasive species is one that, previously not existing in an area, can outcompete species that would normally inhabit that area, becoming dominant and changing the local ecology. They are often introduced by humans (accidentally or deliberately), but may also be forced to move into new areas as they adapt to the conditions of a changing climate.

Restoration = the act of returning a habitat to its former natural condition.

Rewilding = The planned return of an area of land or sea to a more natural state, by restoring habitats or removing human activities that damage habitats.

Risk = The probability of harmful consequences or expected losses (to habitats, animals and plants, properties and livelihood) resulting from interactions between natural and human made hazards.

Sea level rise = The change in the volume of the world's oceans, this occurs due to temperatures increasing and ice melting (including glaciers). This can change due to climate change.



Sea wall = A wall or structure built along a section of coast to prevent the sea causing further erosion to land by wave action.

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SEA LEVEL RISE

MARINE ALLIANCE FOR SCIENCE AND TECHNOLOGY FOR SCOTLAND

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People Ocean Planet (POP) is an initiative within MASTS, helping to drive positive changes across society for the ocean by making best use of our scientific knowledge.

To deliver this information we have worked with experts from MASTS Research forums. There are 12 of these forums in MASTS, creating a network of experts who meet to discuss, direct and support the research in their field. In this section of the pack you will hear from Dani Whitlock the representative of the Biogeochemistry forum.

You can learn more about MASTS, People Ocean Planet and the Biogeochemistry Forum in the QR links to the left.

MASTS

POP

Biogeochemistry Forum

Curriculum Links
Age 11-14

Biology - Relationships in an Ecosystem
Human and Physical Geography - Physical and Human Geography
- Expressive Arts

If this logo is in the bottom right hand of a page, there is a more printer-friendly version of this page available in the 'to print document' on our website.

Great Science Share for SCHOOLS

DR DANI WHITLOCK

PROJECT OFFICER AT FIDRA

ABOUT DANI

HER JOURNEY INTO STEM

At a young age I was definitely not academic and struggled. In my wildest dreams I would have never have imagined I would go on to become a scientist. I had drive, determination and a passion for the environment so I just kept going, questioning the world we live in and trying to use my knowledge to improve the world we live in.

HER JOB

Project Officer at Fidra, an environmental charity working to reduce plastic and chemical pollution in the ocean.

HER HOBBIES

I love being outside, whether that's on a mudflat or up a mountain. I have a very energetic border collie puppy called Ollie and he likes to explore just as much as me. I also love to ski. If I'm not outdoors I'm in my garage doing DIY.

THE QUESTION DANI WANTS TO ANSWER IS...

Have you ever considered how important soil is?
Peatlands are a very special ecosystem that helps capture a lot carbon - but peatlands are threatened for reasons such as, using peat as compost in gardens.

DANI INSPIRES YOU TO THINK ABOUT...

How you can implement positive eco-friendly changes into your family's lives?

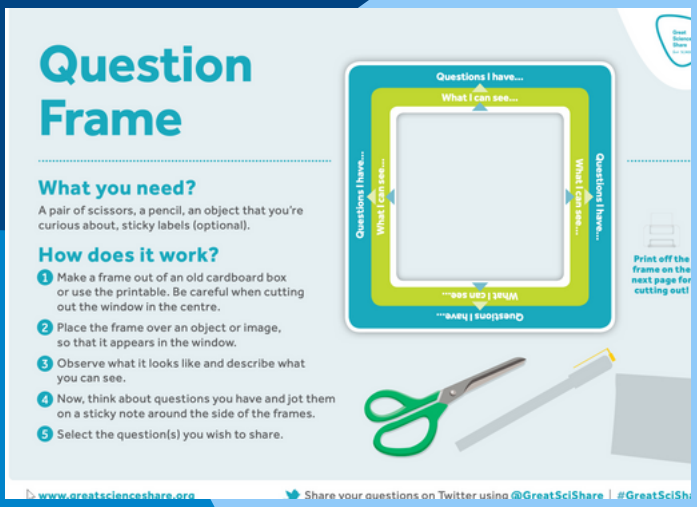
IT'S TIME TO EXPLORE SEA LEVEL RISE WITH DANI - LETS GO!

It is an important part of a scientist's job to ask questions. Asking questions is the first step to learn more about a topic. We can then go and find the answers by reading more information on the topic, or if there are no answers we can do our own experiments and research to find out.

ACTIVITY 1

After listening to Dani's talk, do you have any questions? Write them down in the space below.

TIP: you can use a question frame for your experiment to help you think of questions!



Question Frame

What you need?

A pair of scissors, a pencil, an object that you're curious about, sticky labels (optional).

How does it work?

1. Make a frame out of an old cardboard box or use the printable. Be careful when cutting out the window in the centre.
2. Place the frame over an object or image, so that it appears in the window.
3. Observe what it looks like and describe what you can see.
4. Now, think about questions you have and jot them on a sticky note around the side of the frames.
5. Select the question(s) you wish to share.

Questions I have...
What I can see...
Questions I have...
What I can see...
Questions I have...
What I can see...
Questions I have...

Print off the frame on the next page for cutting out!

www.greatscienceshare.org
Share your questions on Twitter using @GreatSciShare | #GreatSciSh

Download the question frame and other question makers using this QR code!

Space to write your questions:

COASTAL HABITATS

IN THIS NEXT SECTION DANI HAS ANSWERED SOME QUESTIONS ON THIS TOPIC

WHAT?

WHAT IS A HABITAT?

The home or environment of an animal or plant where all the conditions for the survival of that organism are found.

ACTIVITY 2: WORD SEARCH

Can you find all the coastal habitats within this word search? There are EIGHT habitats and TWO secret words!

S	V	F	X	D	V	H	O	I	A	B	B	H	R	F	K	T	J	S	P	M	I	V
A	M	H	O	N	B	O	C	D	L	W	T	H	G	B	Y	M	F	H	M	D	J	S
L	F	G	E	Z	K	J	A	L	N	E	G	I	O	X	O	R	V	I	M	T	T	A
T	H	T	G	I	O	R	W	V	Y	I	B	N	S	W	I	C	V	N	N	P	J	N
M	R	A	W	W	J	N	Z	X	H	E	M	P	M	C	R	G	K	G	E	C	X	D
A	O	X	O	K	E	D	H	T	K	M	W	K	Q	J	K	T	M	L	X	R	P	B
R	C	T	U	Q	Y	W	M	U	D	F	L	A	T	S	M	D	A	E	N	R	X	E
S	K	W	A	C	E	G	N	A	H	C	E	T	A	M	I	L	C	B	Z	R	J	A
H	Y	A	Q	I	H	D	J	D	Q	P	D	B	N	D	R	N	T	E	N	C	B	C
E	S	C	L	I	F	F	S	U	J	I	O	B	F	B	K	O	Q	A	H	D	B	H
S	H	W	I	E	S	R	O	H	A	E	S	R	K	S	N	L	I	C	G	V	R	E
L	O	O	A	S	A	N	D	D	U	N	E	S	Y	D	Q	G	S	H	G	V	H	S
C	R	Z	R	G	L	H	Q	B	D	Y	S	E	C	N	W	I	P	E	A	X	M	X
X	E	D	G	Q	F	A	S	R	J	D	P	Y	O	S	V	N	M	S	C	U	E	B
S	S	Y	R	D	K	T	I	A	Z	E	R	X	G	Y	O	B	X	L	W	I	R	O
L	U	Z	S	E	A	G	R	A	S	S	M	E	A	D	O	W	S	N	L	B	Q	C

The secret words are

.....

and

.....

WHAT?

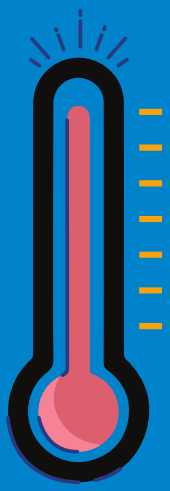
WHAT THREATS DO COASTAL ECOSYSTEMS FACE DUE TO SEA LEVEL RISE ?

Climate change is causing sea level rise, threatening coastal communities, infrastructure and coastal habitats. The coast is a vital component of climate systems. The increased sea temperature can also increase the destructive potential of storms and have impacts on coastal plants and animals.

Climate change is the change in weather patterns which are caused by human activities. Including burning fossil fuels through energy consumption (e.g. travelling) removing forests for urbanisation and farming practices.

HOW?

HOW MUCH HAS THE SEA LEVEL RISEN?



Since 1993, seas around the world have been rising at an average rate of 3.3 millimetres per year.

WHAT?

WHAT AREAS WILL BE MOST AFFECTED BY SEA LEVEL RISE?

Coastal areas have been subject to the most intense change from human activities. Coastal areas are highly populated; in Europe, 70 million people live within 1km of the coast, almost half of the European Union population lives less than 50km from the sea. People live and visit the coast because coastal habitats provide lots of benefits to us and are relied upon for trade.

WHY?

WHY DO WE WANT TO PROTECT COASTAL HABITATS?

All coastal habitats could be affected negatively from sea level rise.

Coastal habitats are really important providing lots of positive benefits to humans and the greater environment.

There are four main categories explaining how we benefit from coastal habitats:

PROVISIONING SERVICES

A provisioning service is a service that can be directly taken from nature. Things that humans can make use of.
- Fisheries
- Building materials

For example, fishfingers are made from fish. Commercially important fish communities may rely on a seagrass meadow to feed and grow.

REGULATING SERVICES

A regulating service is a process that helps maintain conditions favourable for life.

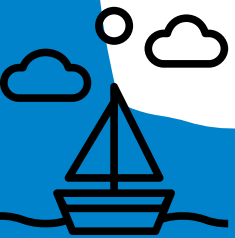
This includes:

-The storage of carbon in sediments
-Coastal habitats act as a barrier to protect coastal communities from erosion caused by storms and waves

CULTURAL SERVICES

A cultural service is a non-material benefit humans gain from nature. These include recreational enjoyment, as well as physical and mental health benefits.

In Europe, the seaside is the most popular holiday destination which is important for people's livelihoods.



SUPPORTING SERVICES

A supporting service is different from all other services, because their impacts are indirect to humans and they allow earth to sustain basic live.

These include nutrient cycling, oxygen production and soil formation.

ACTIVITY 3: NAME THE SERVICE

Identify which service each of the items below belongs to.
Colour all the post-stick notes with the matching colour

PROVISIONING SERVICES = BLUE

REGULATING SERVICES = GREEN

CULTURAL SERVICES = YELLOW

SUPPORTING SERVICES = RED

Plant material can be used to make baskets

Snorkelling

Plant material used for fuel, such as wood

Production of food

Plant and rock structure providing habitat, refuge and nursery for species

Rockpooling

Filtering pollution

Water-skiing

Sediment stability - how likely soil is to be washed away by the sea.

Oxygen production

Soil formation from soils and rocks deposited into habitats

Wave and current dampening

Seed production and dispersal

Carbon accumulation - how much carbon is removed from the atmosphere and stored in a habitat

Nutrient cycling - a process where nutrients used to help organisms grow, can be used again by other organisms

ACTIVITY 4: HELPING TO PROTECT A HABITAT

An important part of protecting a marine habitat is being able to raise awareness of potential issues and sharing the science behind them.

For this task, you are going to pick a habitat to share information about.

We have provided some cards with information on about different habitats. You can use one of these habitats or can pick another one. We encourage you to also go and research more about your chosen habitat - if you want!

We have also provided some of thoughts on how these habitats may be threatened (Activity Sheet 4A), and what actions we can take to protect them (Activity Sheet 4B). But we have left many spaces blank - its up to you to research and fill these in with answers relevant to your habitat.

To Do List

- [ ] Read the habitat cards
- [ ] Pick a habitat to research and share about
- [ ] Research the threats to the habitat from climate change
- [ ] Research the ways to protect the habitat from climate change
- [ ] Share what you have learnt about the habitat

Once you have done your research and its time to share what you have learnt.

This can be in any way! Maybe you want to write a story or poem. Maybe you want to write a song, perform a dance or draw a picture. Could you make a poster or a sign? A book or leaflet? Write a serious speech or put a comic twist on the talk to grab peoples attention. It's up to you!

You may not immediately think these skills relate to being a scientist, but as scientists we have to communicate what we learn and research all the time. We give talks at conferences, present posters of scientific information and sometimes even speak on the news or television. So it's important to practice how we share our science!

SEAGRASS MEADOWS

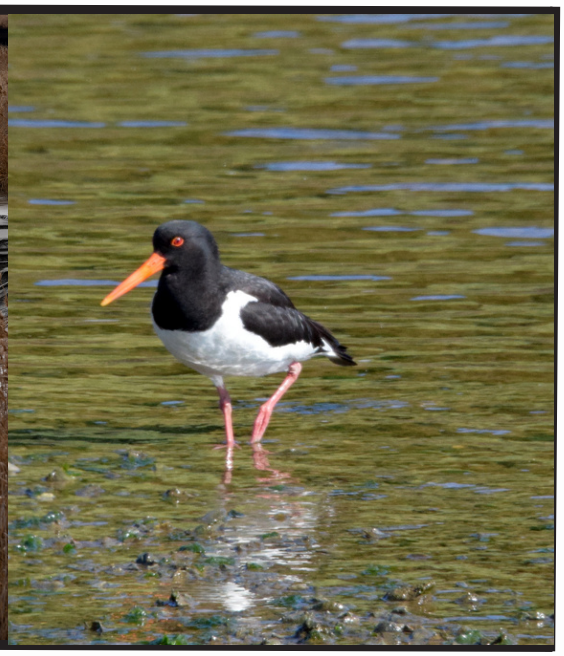
A seagrass meadow looks just like a meadow of grass on land, but the grasses can survive in sea water! Seagrass might sound uninteresting, but it is incredibly important. There are 72 different types of seagrass and they are found on every continent in the world, except he Antarctica.

Seagrasses provide lots of services to humans and the environment.

Including:

- They provide a home and shelter for a diverse community of fishes and other sea life including seahorses, lobsters and crabs.
- They also provide food for sea turtles in some areas of the world.
- One type of seagrass found in the Mediterranean is very good at storing carbon in the sediment it grows in. The type of seagrass is called Posidonia oceanica and unlike any other seagrass it has a woody structure, which makes it look more like a tree than grass living under the sea.

MUDFLATS



Mudflats are also known as tidal flats, and is an area where sediment accumulates due to the river and tides. Even though these habitats are 'muddy' and usually empty of any plant life. Very stable mudflats are often gradually colonised by plants including seagrasses and marsh plants.

Mudflats are important because they help to protect inland areas from erosion by acting as a barrier.

Their empty appearance is deceiving as lots of sea snails and animals live here, such as molluscs. Which makes them a really important habitat for migratory and sea birds who eat these organisms.

In Northwest European countries including Germany and the Netherlands mudflat hiking can be a popular activity!

SALTMARSHES

Saltmarshes, are made up of lots of different plants including grasses and reeds. They are inundated with seawater twice daily in the UK.

One of the main services a saltmarsh provides is supporting sediments to settle by slowing the energy of waves as they approach the shore.

Saltmarshes in the UK are known for being excellent places to see nesting birds in late spring and summer, including geese, sandpipers and herons.

Whilst Japanese culture love to incorporate seaweed into dishes, here in the UK Samphire a type of edible marsh plant that grows naturally. It is not seaweed and looks like a cactus crossed with asparagus, perfect for your fish and chips!

ROCKY SHORE

Rocky shores provide a home for lots of animals and seaweed to live.

This is an extreme environment controlled by intense periods of wave and tidal action. During low tide the animals and plants living here must be able to thrive during drought periods, especially in warmer countries.

Regardless of this, because this habitat is incredibly stable, unlike beaches they contain a very high number of different plants and animals. The erosional features of a rocky shore create pools of mini habitats.

Many animals who live in rocky shores have adaptive features. For example:

- Animals, like limpets (a type of snail), who attach more firmly to the rocks during low tide to retain water.
- Crabs which are mobile, with their body protected by hard shell (exoskeleton), claws to help them scavenge for food during low tide.

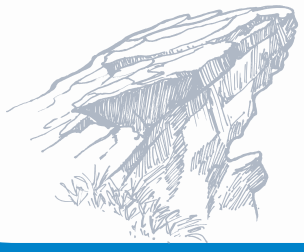
CLIFFS

Sea cliff habitats are often overlooked, but these habitats provide a home for a range of unique plants and animals.

Here in the UK, there are lots of seabirds that use cliff ledges to nest, helping to keep their eggs safe from predators, such as foxes and rats. Many of these seabirds only come to land to breed, spending the rest of their time on the water, so it is important that these habitats are protected.

Gannets, guillemots and puffins are some of the more famous UK birds you can see nesting on cliffs!

Alongside the damage of sea level rise and erosion, sea cliff vegetation is highly susceptible to damage from recreational activities such as rock climbing, where in order to make routes safe they have to remove vegetation. This can lead to long-term vegetation loss and disturbance to nesting birds.



SAND DUNES

Sand dunes are incredibly fragile habitats, formed from wind and water driven sand movement. The dunes are comprised of loose sand that collects and forms ridges and mounds. Often when you visit a sand dune, they have boardwalks across them to protect them from erosion.

They can help maintain a beach where sand is retreating back into the water, reduce coastal flooding and provide shelter from the wind for coastal habitats and populations.

Sand dunes are often sites exposed to the elements, due to the loose nature of the sand they make excellent habitats for insects and bees, butterflies, beetles and dragonflies.

SHINGLE AND SAND BEACHES

A shingle beach is usually made up a mixture of materials including pebbles and rocks and sand. They are usually steeper than sand beaches because of the way waves flow throw and over the different materials that make up the beach. Sandy beaches are mostly made up of sands.

Beaches are incredibly important for tourism and lots of coastal towns and villages rely on them to support the local community.

Beaches that receive seaweed, plants and animal bodies help to support unique insects, crabs, lobsters and seabirds, by providing food and nutrients to the beach.

ACTIVITY 4A: THREATS TO HABITATS

Dani has provided some threats to marine habitats.
Are these relevant to your habitat?
Are there more threats that are important to tell people about?

Coastal Erosion

Habitat Loss

Pollution

Flooding

Increased risk of storms

ACTIVITY 4B: WAYS TO PROTECT TO HABITATS

Dani has provided some ways we can help protect marine habitats and reduce the impact of the things that threaten them.

Are these relevant to your habitat?
Are there more ways we can protect marine habitats that are important to tell people about?

Conservation groups

Rewilding land

Reduce carbon footprint

Reuse and Recycle

People · Ocean · Planet

#POPSCIKIT

MARINE ALLIANCE FOR SCIENCE AND TECHNOLOGY FOR SCOTLAND

THE HABITAT I CHOSE TO LEARN AND SHARE ABOUT WAS...

I CHOSE TO SHARE ABOUT THE HABITAT BY....

I CHOSE THAT HABITAT BECAUSE...

I CHOSE TO SHARE ABOUT THIS HABITAT THIS WAY BECAUSE...

MY FAVOURITE FACT WAS...

#POPSCIKIT

Great Science Share for SCHOOLS

People · Ocean · Planet

MARINE ALLIANCE FOR SCIENCE AND TECHNOLOGY FOR SCOTLAND

I CHOSE TO LEARN ABOUT HOW CLIMATE CHANGE IMPACTS...

I LEARNT THAT...

WHAT I WILL RESEARCH NEXT IS ...

I FEEL INSPIRED TO...

Share with us so we can learn with you!

www.greatscienceshare.org

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FISHERIES AND CLIMATE CHANGE

MARINE ALLIANCE FOR SCIENCE AND TECHNOLOGY FOR SCOTLAND

This science pack has been created by the Marine Alliance for Science and Technology (MASTS). MASTS is an organisation that enhances the excellence of marine research in Scotland across 17 institutes and 700+ members. With such a large number of scientists working at the forefront of marine science, MASTS recognises the importance of communicating what we learn to the public.

People Ocean Planet (POP) is an initiative within MASTS, helping to drive positive changes across society for the ocean by making best use of our scientific knowledge.

To deliver this information we have worked with experts from MASTS Research forums. There are 12 of these forums in MASTS, creating a network of experts who meet to discuss, direct and support the research in their field. In this section of the pack you will hear from Ieuan Jones the representative of the Fisheries Science forum.

You can learn more about MASTS, People Ocean Planet and the Fisheries Science Forum in the QR links to the right.

MASTS

POP

Fisheries Science Forum

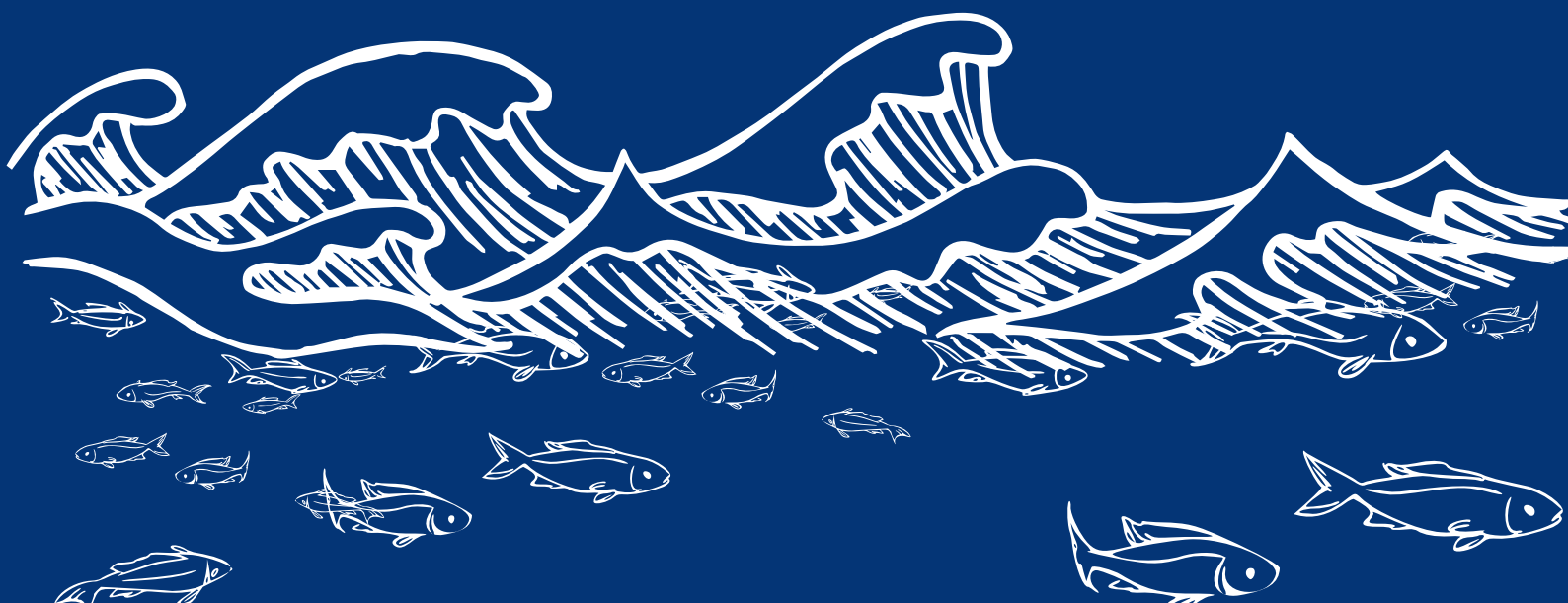
Curriculum Links
Age 11-14

Science - Relationships in an Ecosystem
- Genetics and Evolution
- Earth and Atmosphere

Geography - Human and Physical Geography

Mathematics - Using maths to make decisions

If this logo is in the bottom right hand of a page, there is a more printer-friendly version of this page available in the 'to print document' on our website.



Great Science Share for SCHOOLS

ABOUT IEUAN

HIS JOURNEY INTO STEM

I started with a love for the sea as a kid, growing up learning to surf and playing in the sea. When I was 16 I got the opportunity to volunteer on a leatherback turtle conservation project for a short time in Costa Rica, which really inspired me to pursue marine biology and conservation. Once at university, I became fascinated with fishing, and how we can manage fishing so that it is sustainable. I wanted to learn how we can protect people's livelihoods and food sources while also protecting our oceans. This lead me to study for my PhD.

HIS JOB

I am a PhD researcher looking at how the fish we find around the North Sea (of the East coast of the UK) have changed with increasing sea temperatures and reduced fishing. I'm also interested on ways we can help to avoid catching the fish species that we don't want (known as bycatch). Ieuan is working at the University of Aberdeen.

HIS HOBBIES

Paddleboarding, surfing, seabird watching and photography.

IEUAN JONES

PHD RESEARCHER

UNIVERSITY OF ABERDEEN

THE QUESTION IEUAN WANTS TO ANSWER IS...

How can we make fishing safe for the oceans and protect are seas and fish against the effects of climate change?

IEUAN INSPIRES YOU TO THINK ABOUT...

Many people around the world rely on fishing for their livelihoods and their main source of protein, so it is important that we protect our seas and fish for future generations.

ITS TIME TO EXPLORE OCEAN FISHERIES WITH IEUAN - LETS GO!

HOW ARE FISH INFLUENCED BY CLIMATE CHANGE?

There are many impacts that climate change and ocean warming can have on fish.

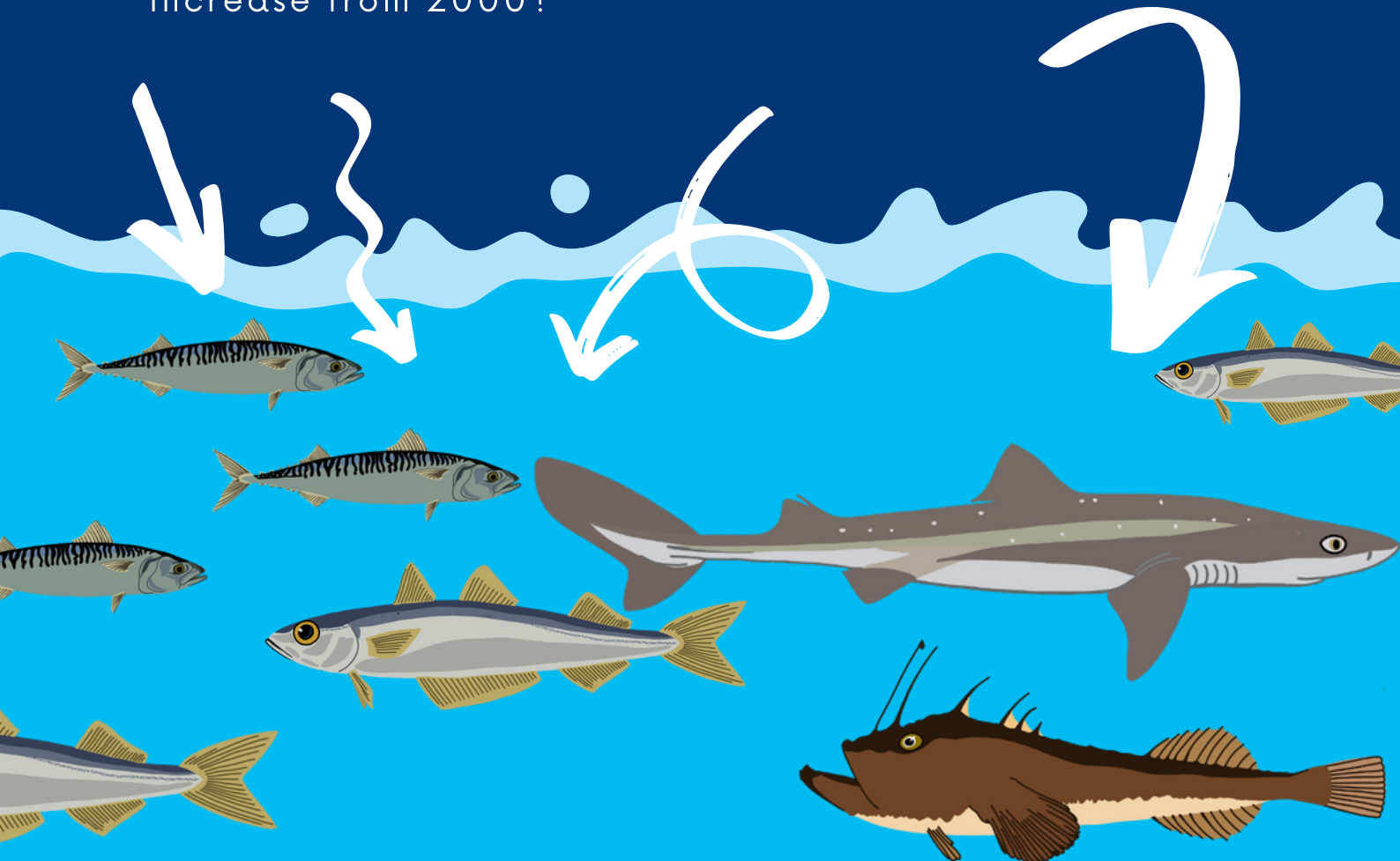
Firstly, fish may move to stay in waters which are the right temperature for them. Scientists call this 'tropicalization', which means that fish normally found in tropical waters (places nearer the equator) are moving into areas that were previously colder.

This can change the ecosystem and foodwebs that we see. Fish grow up to be smaller in areas where temperatures are higher compared with cooler areas. This means that if temperatures continues to increase, we can expect fish to generally get smaller.

Rising sea temperatures are now closely monitored and compared back in time. Here are links to resources which show the increase. Can you notice the particular increase from 2000?

moat.cefas.co.uk

European Environment Agency



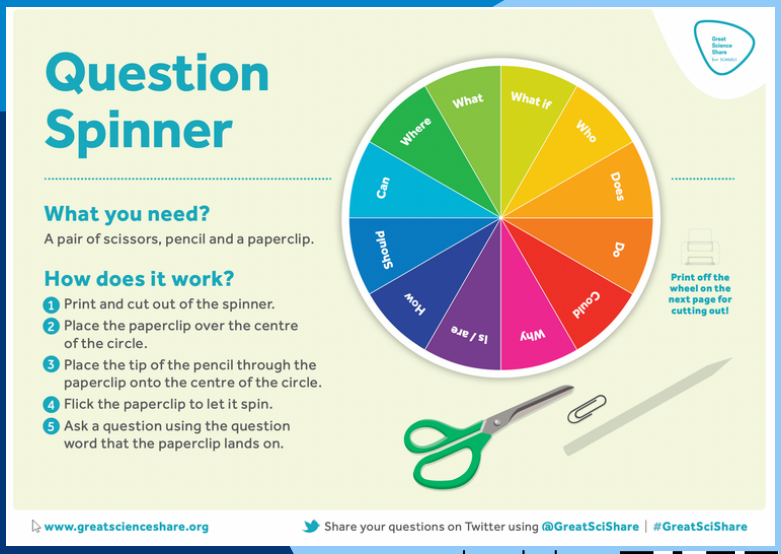
It is an important part of a scientist's job to ask questions. Asking questions is the first step to learn more about a topic. We can then go and find the answers by reading more information on the topic, or if there are no answers we can do our own experiments and research to find out.

ACTIVITY 1

After listening to the introduction video, write a list of questions you have about fisheries and climate change?

Link to introduction video

TIP: you can use a question spinner to help you think of all the different types of questions you could ask!



Download the question spinner and other question makers using this QR code!

Space to write your questions:

Now that we have our questions it is time to find some answers.
Our fisheries scientist Ieuan, has answered some questions below. Read these through carefully as they will help you with an upcoming activity.

WHAT?

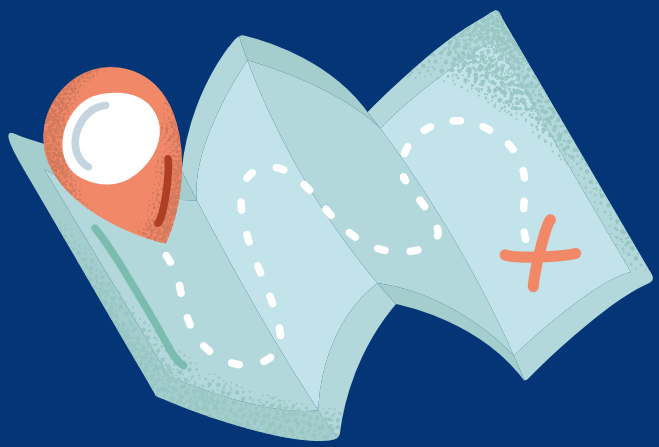
CLIMATE CHANGE IS CAUSING THE TEMPERATURE OF OUR SEAS TO RISE. WHAT DO YOU THINK WILL HAPPEN TO THE FISH WE NORMALLY FIND AROUND THE UK?

The UK is in the Northern Hemisphere. The sea temperature around the UK is colder the further North you are and warmer as you travel South. As sea temperatures rises due to Climate Change, the temperature found in a particular part of the sea changes. Fish, like other animals, are adapted to their environment, so when the sea temperature changes they will move to be in the area which is the temperature they have adapted to survive in. This means they will be found in different locations and move further North as temperatures increase.

WHY?

WHY DO YOU THINK FISH MOVING LOCATION MIGHT BE A PROBLEM FOR FISHERS IN THE UK?

This could be a problem for fishers as it might mean that they have to travel further away to catch fish that we are used to. Fish that we are used to eating in the UK, like cod and haddock, prefer cooler waters and so if these move due to climate change that will cause problems for fishers. They may even leave waters that our fishers are allowed to fish in, or be much less common.



HOW?

HOW DO WE FISH?

There are many methods that fishers use to catch the fish that we eat.

ACTIVITY 2

Match up the descriptions of the fishing methods to the photos below

Fish can be caught using traps called creels (often these are used for shellfish like crabs and lobsters).

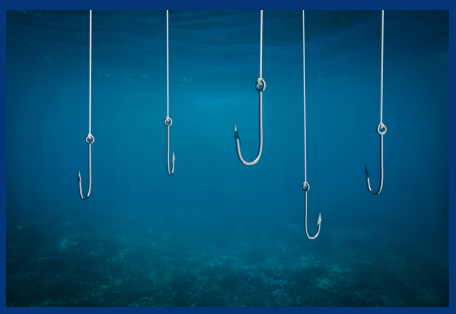
Some shellfish, like scallops, are caught by divers picking them by hand.

Some fish are caught by placing nets around them, called Seine-netting.

Some fish are caught using nets which are towed behind boats, either on their own or in pairs, which is called trawling.

Some shellfish are caught using gear towed by boats, which digs into the seabed to disturb the shellfish hiding in the mud or sand. This is called dredging.

Some fish are caught using lines of hooks which are set with bait and then picked up.



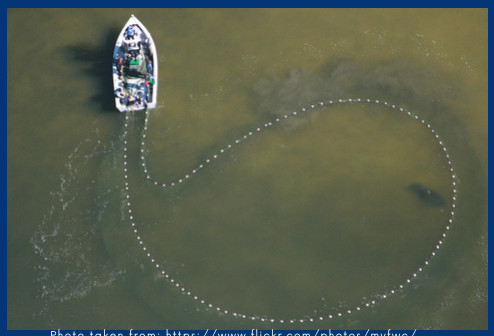
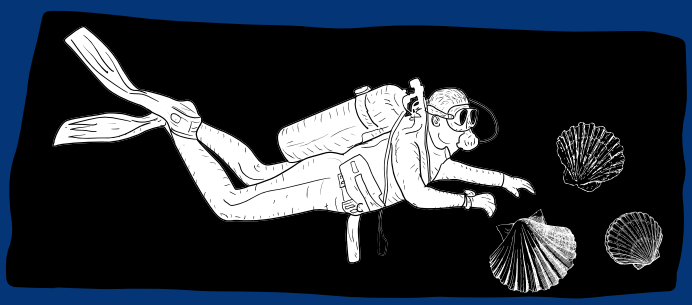
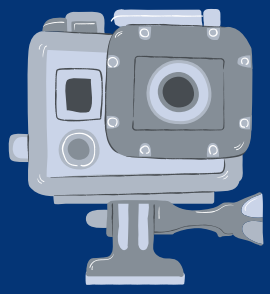


Photo taken from: https://www.flickr.com/photos/myfwc/



DO?

DO SCIENTISTS MONITOR WILD FISH POPULATIONS? HOW?

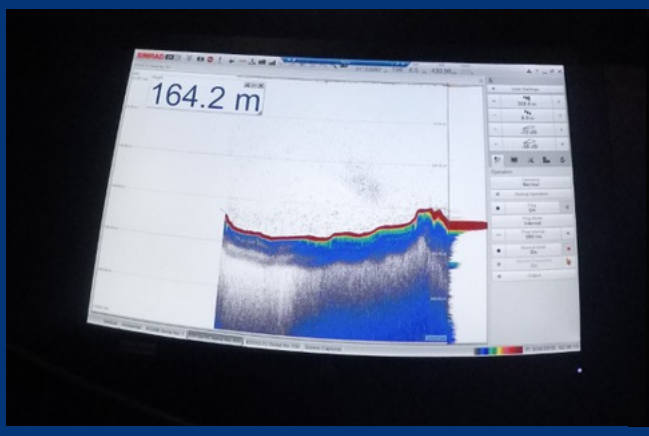


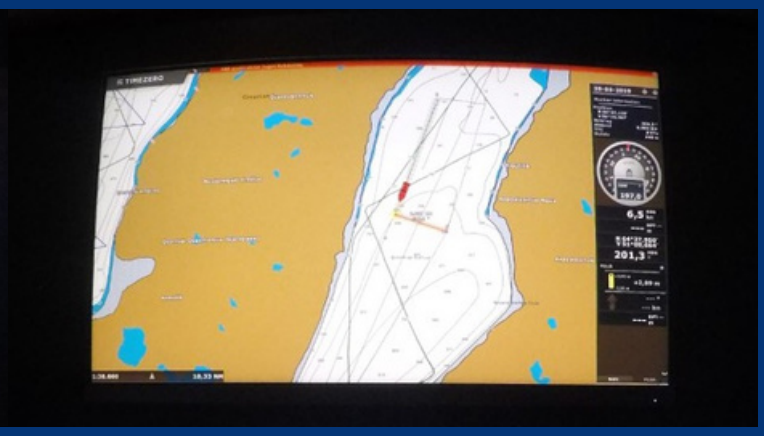
Twice a year scientists go out and catch fish in certain places in the sea so that we can count, measure, weigh and find the age of the different species.

Scientists can also go out with fishers so that they can measure what fishers are catching, and what fish are being caught accidentally.

Scientists can also go to the fish markets to sample the fish being brought in by fishers.

Sometimes scientist can use different methods like underwater cameras, or acoustic surveys where we use soundwaves to measure where fish are and how many there are.





WHAT?

WHAT DOES SUSTAINABLE FISHING MEAN?

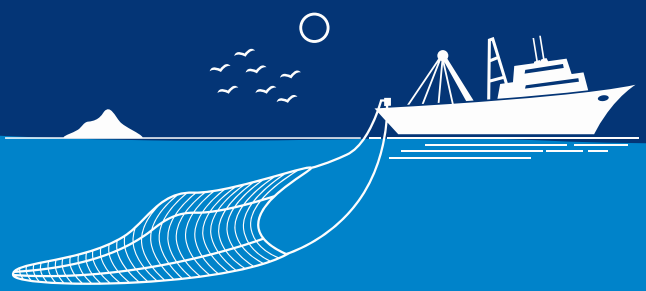
Sustainable, in fishing, means that we aren't catching more fish than are being replaced by young fish growing into adult fish. If we catch more than are being replaced, then we will have less fish next year. If we keep catching more, then eventually there may not be enough fish left for us to catch.

CAN?

CAN SUSTAINABLE FISHING HELP PROTECT FISH FROM CLIMATE CHANGE ?

Sustainable fishing can help protect fish from climate change by making sure that we're not causing extra problems for fish. Making sure that fish numbers are healthy can also give fish more chance to adapt to changes in their environment.

ACTIVITY 3



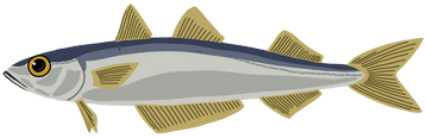
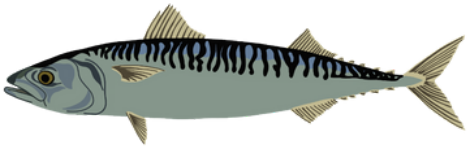
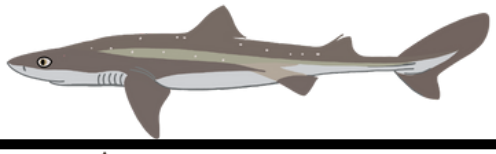
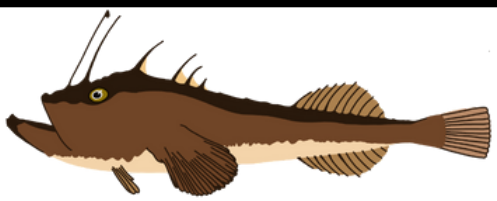
In this activity you are going to get the chance to become UK fishers!

You will be able to fish for 4 different species of fish that can be caught in the UK.
Each has a starting population number, this is the total number of fish of that species you can catch.
Every year, each species will have more fish added as young fish mature.

You can choose how many fish you catch and remove from the sea each year, which will earn you money points. You need to make at least 15 points a year.

It's up to you how much you catch each year, but you may start to notice if you take too many the fish population will go down. If they go down too much and you are left with no individuals of that species they cannot recover their population.

Use your cut outs of the fish to watch your fish population change and plot the number of fish you have on the graph to help you keep track! These can be found on the next pages.

Species	Starting Number	Number of Fish Added Each Year	Price
 Whiting	10	3	2
 Mackerel	10	5	2
 Spurdog	3	1	0
 Anglerfish	8	2	3

EXAMPLE OF HOW TO FILL IN THE TABLE

	A	B	C		D	
Year 1	Money points per fish	Population of species at the start	How many will we catch this year?	Total money points from my catch this year (A x C)	How many fish of each species are left (B - C)	Total number of fish at the end of the year D + newly mature fish
Whiting	4	10	2	4 x 2 = 8	10 - 2 = 8	8 + 3 = 11
Anglerfish	3	10	1	3 x 1 = 3	10 - 1 = 9	9 + 2 = 11
Mackerel	2	8	2	2 x 2 = 4	8 - 2 = 6	6+ 5 = 11
Spurdog	0	3	0	0 x 0 = 0	3 - 0 = 3	3 + 1 = 4

DID YOU MAKE ENOUGH MONEY?

BLANK TABLE

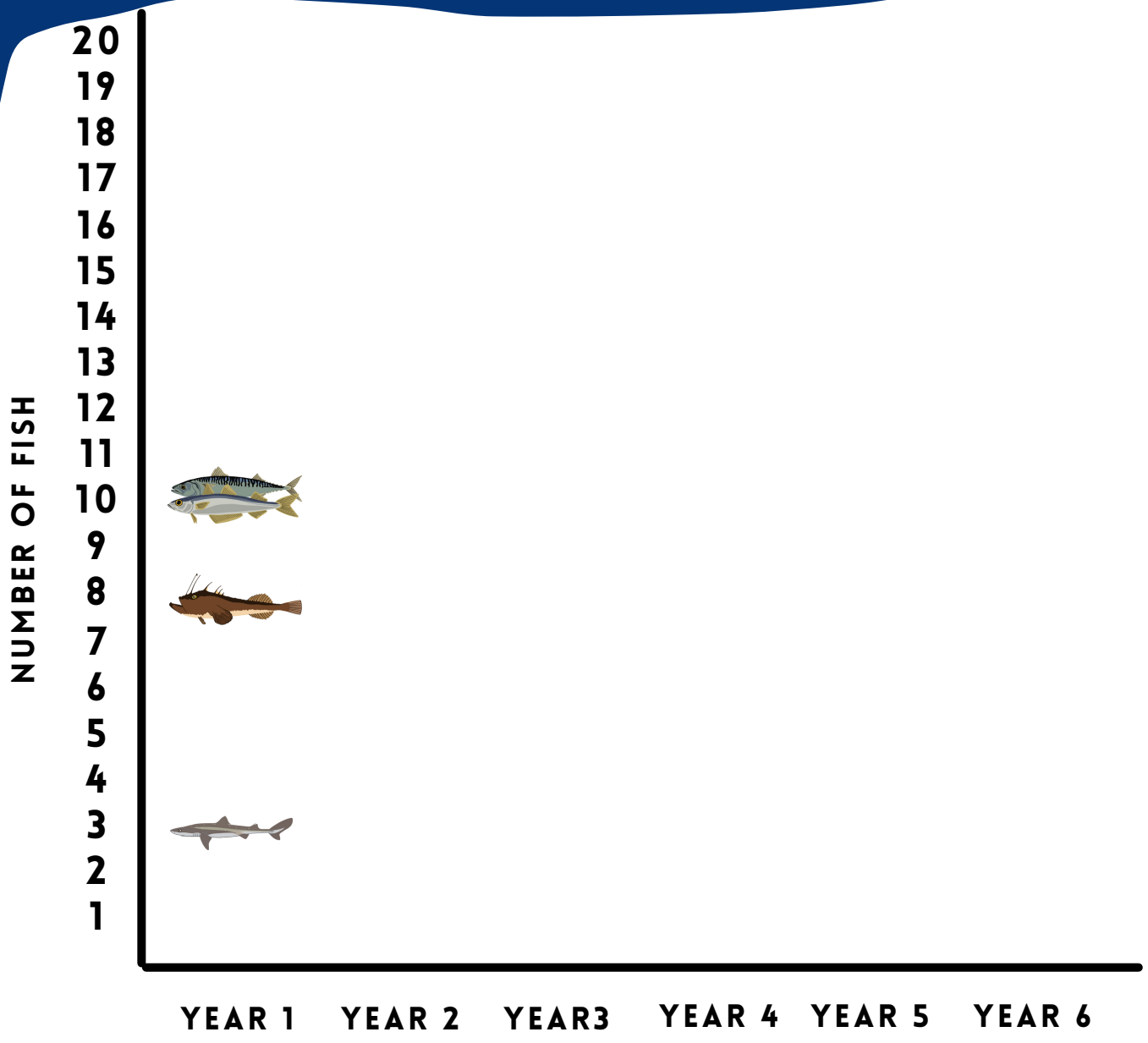
	A	B	C		D	
Year 1	Money points per fish	Population of species at the start	How many will we catch this year?	Total money points from my catch this year (A x C)	How many fish of each species are left (B - C)	Total number of fish at the end of the year D + newly mature fish
Whiting						
Anglerfish						
Mackerel						
Spurdog						

Ieuan would also like you to answer this questions:

HOW MANY INDIVIDUALS OF EACH SPECIES OF FISH CAN BE TAKEN FROM THE SEA AND THERE STILL BE MORE INDIVIDUALS AFTER YEAR 6 THAN YEAR 1?

WHY IS SPURDOG WORTH NO MONEY POINTS? SHOULD EVERY TYPE OF FISH IN THE SEA BE CAUGHT?

USE THIS GRAPH AND/OR THIS FISH CUT OUTS TO KEEP TRACK OF YOUR FISHING AND RECORD THE POPULATION EACH YEAR



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MARINE ALLIANCE FOR SCIENCE AND TECHNOLOGY FOR SCOTLAND

THE SPECIES I CHOSE TO FISH WAS ...

I CHOSE THESE SPECIES BECAUSE...

HOW DIFFICULT DID YOU FIND CHOOSING THE AMOUNT OF FISH TO CATCH?

DID YOU CHOOSE TO FISH SUSTAINABLY?

MY FAVOURITE FACT WAS..

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Great Science Share for SCHOOLS

People · Ocean · Planet

MARINE ALLIANCE FOR SCIENCE AND TECHNOLOGY FOR SCOTLAND

I CHOSE TO LEARN ABOUT HOW CLIMATE CHANGE IMPACTS...

I LEARNT THAT...

WHAT I WILL RESEARCH NEXT IS ...

I FEEL INSPIRED TO...

Share with us so we can learn with you!

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OCEAN ACIDIFICATION

This science pack has been created by the Marine Alliance for Science and Technology (MASTS). MASTS is an organisation that enhances the excellence of marine research in Scotland across 17 institutes and 700+ members. With such a large number of scientists working at the forefront of marine science, MASTS recognises the importance of communicating what we learn to the public.

People Ocean Planet (POP) is an initiative within MASTS, helping to drive positive changes across society for the ocean by making best use of our scientific knowledge.

To deliver this information we have worked with experts from MASTS Research forums. There are 12 of these forums in MASTS, creating a network of experts who meet to discuss, direct and support the research in their field. In this section of the pack you will hear from Matthew Wale the representative of the Marine Stressors forum.

You can learn more about MASTS, People Ocean Planet and the Marine Energy Forum in the QR links to the right.

MASTS

POP

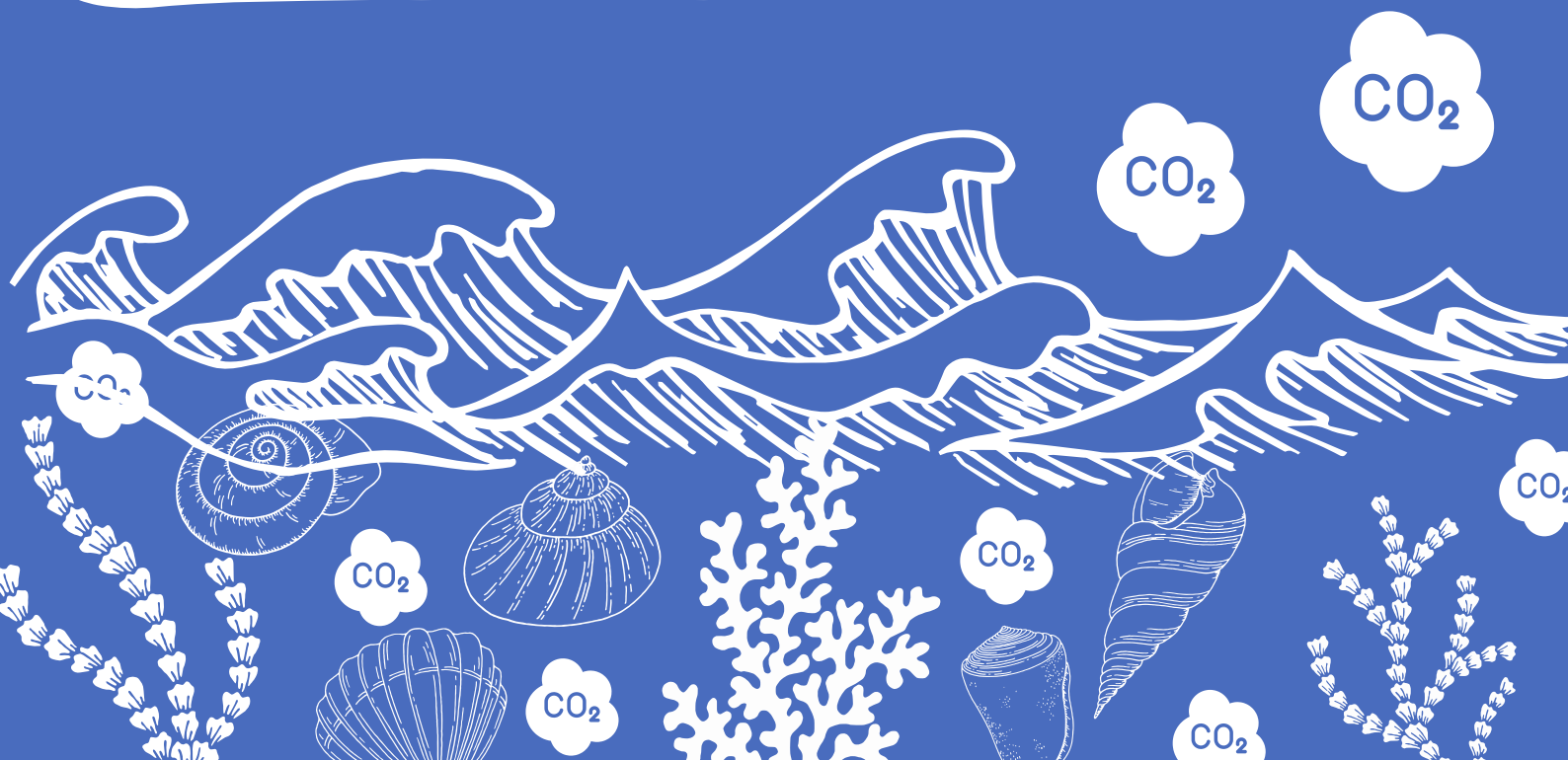
Marine Stressors Forum

Curriculum Links
Age 11-14

Science - Acidity of metals and non-oxides
- The carbon cycle
- Production of carbon dioxide by human activity and the impact on climate
- Relationships in an Ecosystem

Geography - Human and Physical Geography

If this logo is in the bottom right hand of a page, there is a more printer-friendly version of this page available in the 'to print document' on our website.



Great Science Share for SCHOOLS

DR MATTHEW WALE

UNIVERSITY TUTOR

UNIVERSITY OF EDINBURGH

ABOUT MATT

HIS JOURNEY INTO STEM

Matt has been fascinated with the marine world from a very early age, regular seaside holidays rock pooling led him to announce, at the age of 4, that he wanted to be a marine biologist. From then on, he worked towards this goal, finally enrolling at the University of Plymouth to study Marine Biology. During his time at university, he developed a love of marine invertebrates and how they interact with human impacts in the environment. He continued his studies with research degrees from the University of Bristol and Edinburgh Napier University, followed by postdoctoral research at Edinburgh Napier and King Abdullah University of Science and Technology in Saudi Arabia.

HIS JOB

Matt now works as a tutor at Edinburgh Napier University where he helps to teach the next generation of marine scientists. Alongside his teaching commitments, Matt conducts research to understand the ways marine invertebrates interact with their environment and how these interactions are affected by human disturbance. The overarching goal of Matt's research is to use the information he gains by understanding these interactions to begin to reduce human impacts on the marine environment.

HIS HOBBIES

Even when not at work Matt is around water, spending time scuba diving, surfing, and kayaking. He equally enjoys exploring the Scottish wilderness and regularly goes wild camping and hill walking in the highlands and islands of Scotland.

THE QUESTION MATT WANTS TO ANSWER IS...

How do marine invertebrates respond to human made disturbances in their environment?

As human populations have increased large proportions of the marine environment are regularly in contact with human activities. These activities bring with them a number of potential disturbances that can affect the biology of the organisms that experience them. By understanding the ways marine organisms are influenced by human activities we can reduce their impacts and conserve marine biodiversity for future generations.

MATT INSPIRES YOU TO THINK ABOUT...

How the things humans do in the oceans can have unforeseen effects on marine organisms, and that we need to study these effects to limit our impact on the oceans and the organisms that live there.

IT'S TIME TO EXPLORE OCEAN ACIDIFICATION WITH MATT - LET'S GO!

WHAT?

WHAT IS AN ACID?

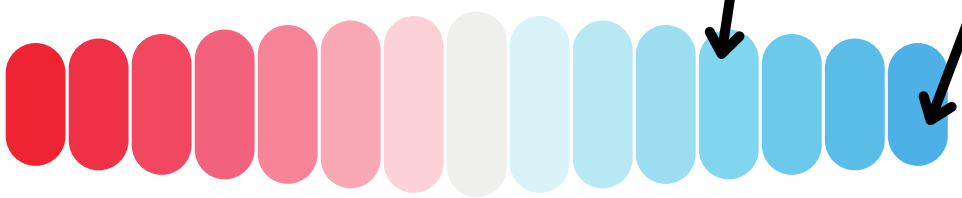
An acid is a substances which can release hydrogen ions H+ when dissolved in water. The acidity is measured on a pH scale, which is an abbreviation of measuring the 'power of hydrogen'.

ACTIVITY 1

Can you match up the pH of these items with the right number on the pH scale. Matt has given you the answers to a few to get you started.

pH scale

Acidic Neutral Alkaline



0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

WHAT?

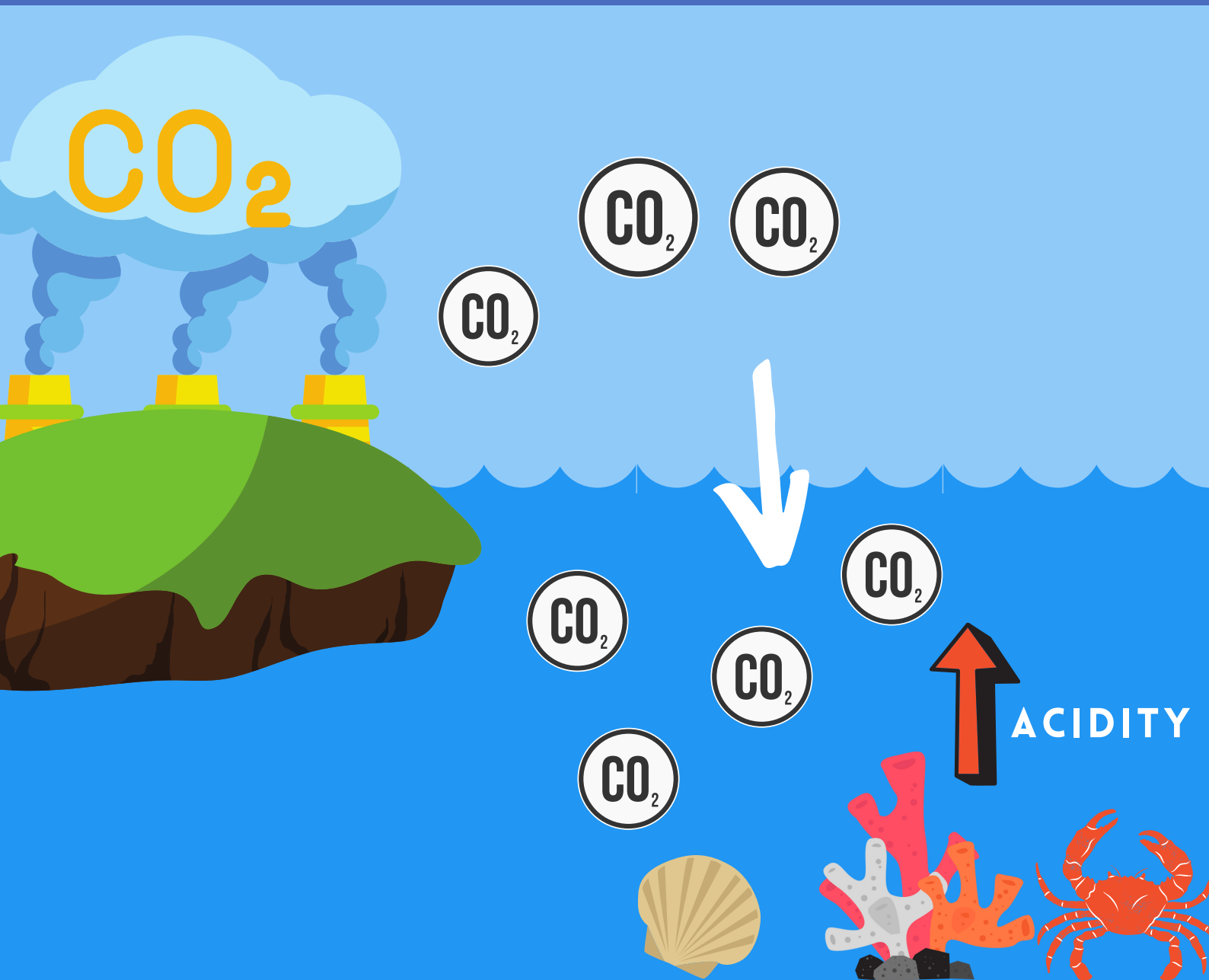
WHAT IS OCEAN ACIDIFICATION?!

Our oceans are a mixture of water and trace amounts of other substances. These other substances can effect the pH of the ocean as different chemicals have a different pH. When we measure the pH of a substance we can find out if it is acidic (low pH) or alkaline (high pH).

Carbon Dioxide (CO_2) is acidic. When we burn fossil fuels CO_2 is released into the atmosphere which dissolves in seawater (just like sugar dissolving into tea).

When you add a lot of acidic CO_2 into seawater, which is normally neutral (middle of the pH scale) it starts to get more acidic.

This is not good news for some sea creatures....



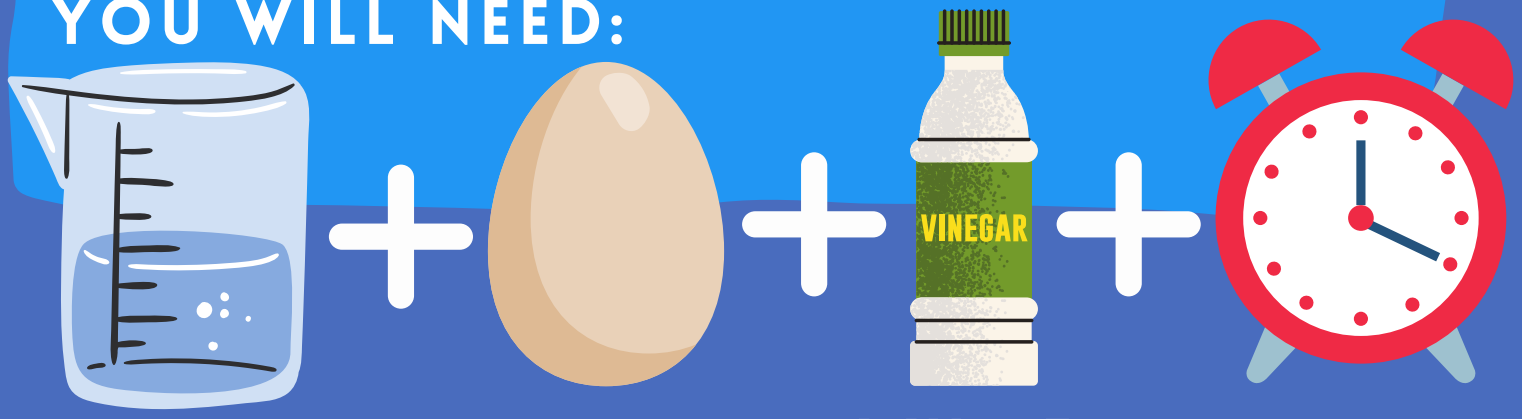
EXPERIMENT - DISSOLVING SHELLS

To see how increasing the acidity of the ocean influences sea creatures with a shell we are going to be doing an experiment alongside Matt our ocean acidification scientist.

Matt will be showing how an acidic solution influences Maerl skeletons. You might not have heard of Maerl but this is a fascinating organism that forms a protected habitat - you will learn more about Maerl later.

Maerl is just one example of lots of marine creatures, both animals and plants, that create shells to protect themselves. These shells are made of a similar material to egg shells - which you will be using in your experiment.

YOU WILL NEED:



JAR + EGG + WHITE VINEGAR + 24 HOURS

1) You will need a jar (with a lid to help stop spills) that is big enough to fit an egg in and some room for extra liquid.

2) Place an egg into the jar

3) Pour white vinegar into the jar so the egg is entirely covered

4) Put the lid onto the jar and leave it at least 24 hours

5) Keep checking back to see if the shell has dissolved.

6) After the experiment be sure to throw away and don't keep longer than a few days.

DID YOU NOTICE BUBBLES?

That is CO_2 being released and is a product of the chemical reaction taking place to break down the shell!

IS?

IS THIS WHAT WOULD HAPPEN IF WE PUT AN EGG IN THE OCEAN?

NO

It is important to understand that this experiment uses a liquid much more acidic than the ocean. Therefore, you see what acidity can do to shell much more quickly and more extremely than is happening in the ocean right now.

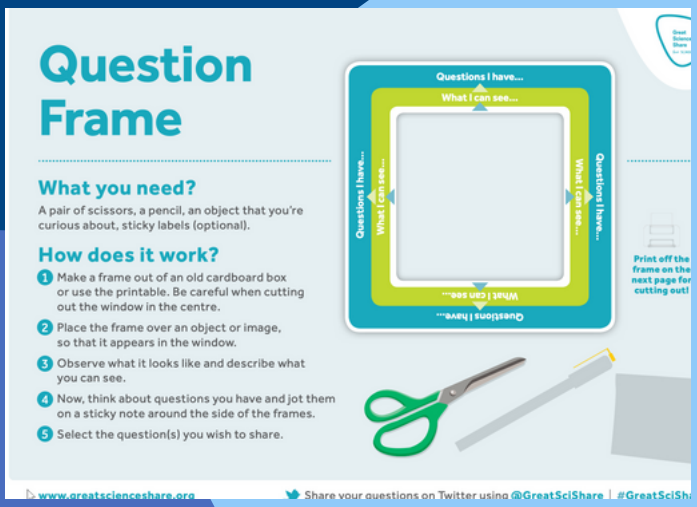
But what you can see is how even on a much slower scale how bad it could be for sea creatures, and how even a small acidicity change can negatively impact sea creatures with shells.

It is an important part of a scientist's job to ask questions. Asking questions is the first step to learn more about a topic. We can then go and find the answers by reading more information on the topic, or if there are no answers we can do our own experiments and research to find out.

ACTIVITY 2

After watching/conducting your own experiment and learning about what ocean acidification is, write down any questions you have about this topic

TIP: you can use a question frame for your experiment to help you think questions as you observe the changes to the shells.



Question Frame

What you need?

A pair of scissors, a pencil, an object that you're curious about, sticky labels (optional).

How does it work?

1. Make a frame out of an old cardboard box or use the printable. Be careful when cutting out the window in the centre.
2. Place the frame over an object or image, so that it appears in the window.
3. Observe what it looks like and describe what you can see.
4. Now, think about questions you have and jot them on a sticky note around the side of the frames.
5. Select the question(s) you wish to share.

Download the question teller and other question makers using this QR code!

Space to write your questions:

Now that we have our questions it is time to find some answers.
Matt has answered some questions below. Read these through carefully as they will help you when you with an upcoming activity.

WHAT?

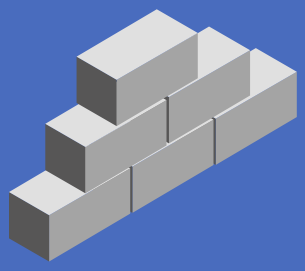
WHAT ARE THE MAIN CAUSES OF CARBON DIOXIDE EMISSIONS?

ACTIVITY 3

Can you match the below causes of CO_2 emssions with the percentage of CO_2 emissions

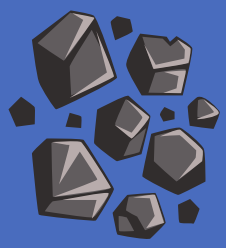
BURNING NATURAL GAS

OTHER INDUSTRY AND FUEL

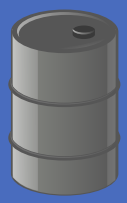


PRODUCTION OF CEMENT FOR CONCRETE

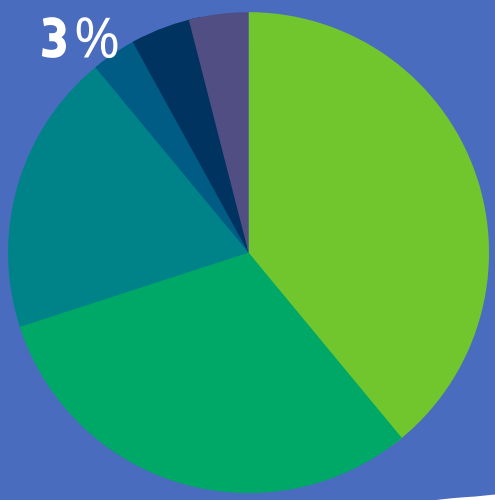
NON-ENERGY FUEL USE E.G. CREATING CHEMICALS



BURNING COAL



BURNING OIL



Trends in Global CO_2 and Total Greenhouse Gas Emissions - 2020 Report. Olivier and Peters (2020)

HOW?

HOW DO WE MEASURE OCEAN ACIDITY?

Geologists can drill into the earth and take soil samples which are known as sediment cores. These cores contain soil and rocks from millions of years ago through to modern times. They can record the amount of carbon trapped within the different layers of the core and work out the pH of the ocean at that time.

Photo from Carolina Marine Lab, University of North Carolina (Flickr)

https://www.flickr.com/photos/uncims/51204279357

Direct measurements of ocean pH have been happening for the last 30 years – another benefit of now knowing about this issue is we can build up big sets of data to help map how quickly these changes are happening.

Seawater has a pH of 7.4 – 8.5 so is considered to be fairly neutral. However, over the past 100-200 years scientists have observed that the oceans are becoming more acidic. Over the last million years, the average surface seawater pH has been quite stable, at between 8.3, during cold periods and 8.2, during warm periods. However, the pH has dropped today to an average of 8.1

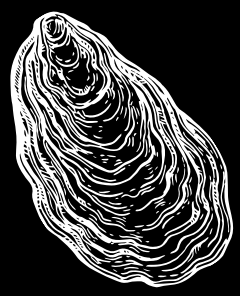
THIS IS THE SAME AS A 30% INCREASE IN ACIDITY!

HOW DOES OCEAN ACIDIFICATION AFFECT DIFFERENT SEALIFE?

CALCIFYING ORGANISMS

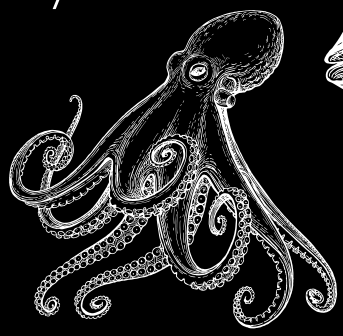
Animals and plants that produce shells or skeletons from calcium carbonate are especially at risk from ocean acidification. Including

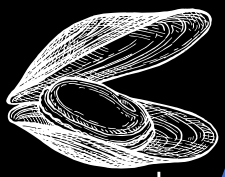
MOLLUSCS


oysters


squid

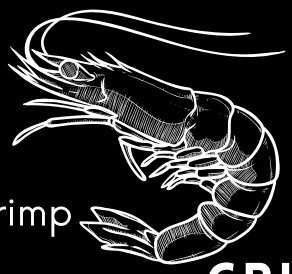

sea snails

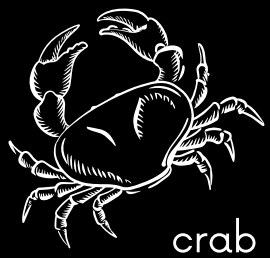

octopus


mussels

PLANKTON

CRUSTACEANS


shrimp


crab


lobster

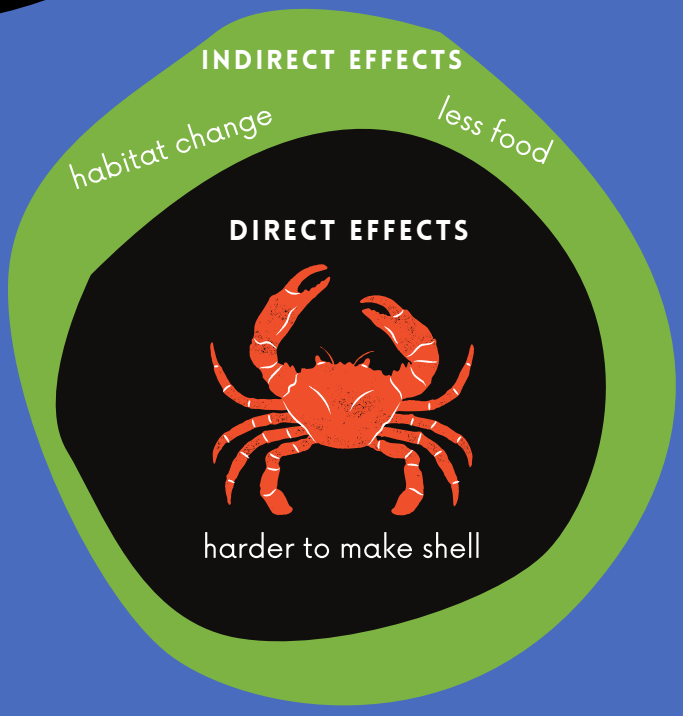
ECHINODERMS


urchin

CORALS

All these species will experience a DIRECT EFFECT to their own body with ocean acidification.
But it is also important to consider INDIRECT EFFECTS too.

How will marine creatures food and habitats be affected?



HOW DOES OCEAN ACIDIFICATION AFFECT DIFFERENT SEALIFE?

ANIMALS THAT FEED ON CALCIFYING ORGANISMS

The animals and seaweeds that are directly affected by ocean acidification often lie at low levels of food webs. Therefore, any animals that feed on them will be indirectly affected as their food source reduces in abundance/number.

ANIMALS THAT LIVE ON REEFS

The shells and skeletons of calcifying organisms are solid surfaces that other plants and animals can live on. When multiple of these organisms are together a reef is formed, providing a home for many other animals and plants. Ocean acidification can erode these reefs reducing the areas where reef living organisms can safely live.

HOW WILL FISH BE AFFECTED?

While fish don't have shells and are not affected in the same way as the other organisms mentioned, they can still feel the effects of acidification. Fish balance their body chemistry to that of the surrounding water, so a drop in water pH will be reflected by the same drop in the pH of the fish's blood. A drop of 0.2-0.3 in blood pH can be fatal for fish.

Some fish, like clown fish, have been observed to less effectively detect predators in more acidic conditions, making them more vulnerable to predation.

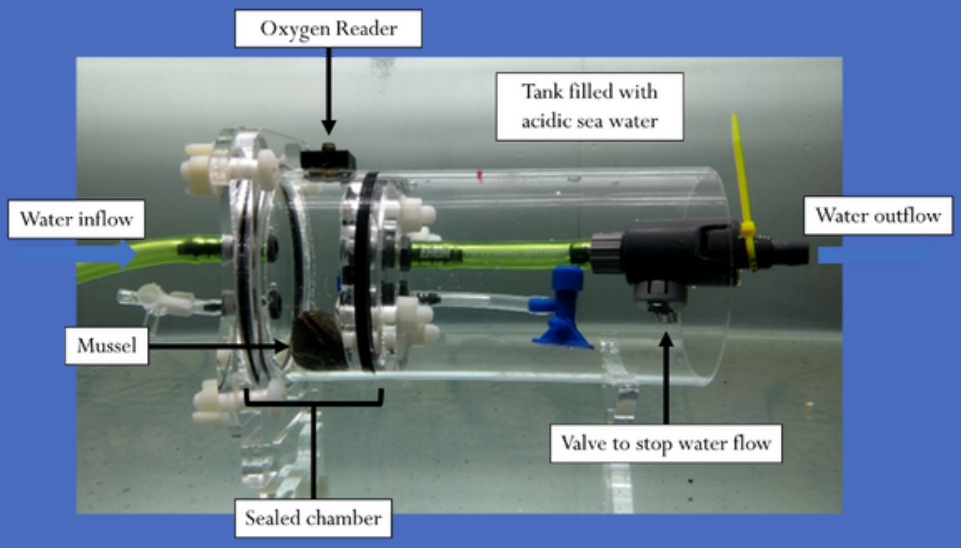
HOW DO SCIENTISTS STUDY HOW SEALIFE IS AFFECTED BY OCEAN ACIDIFICATION?

There are two main ways scientists can study ocean acidification.
1)Laboratory studies
2) Recording species in the wild at sea

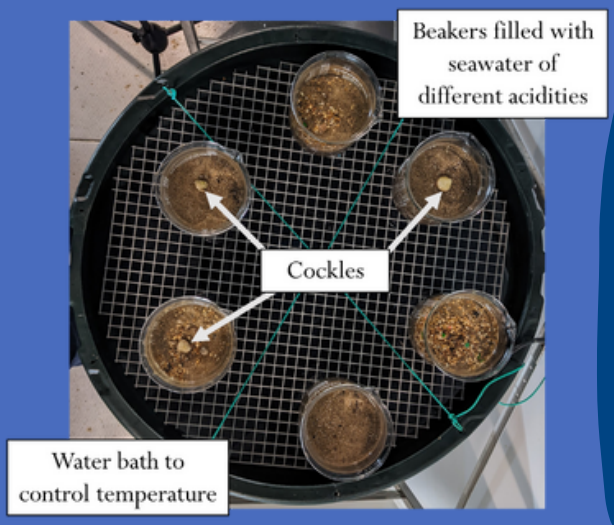
LABORATORY STUDIES

Smaller animals can be brought into the laboratory where the water conditions can be altered to reflect different levels of ocean acidification, either over a long period of change or as a sudden change. The ways the animal responds to these changes can then be recorded.

Laboratory studies also allow scientists to observe the ways that two different animals interact under different levels of acidification



This experiment is testing how a mussel's breathing changes under different environmental conditions!



This experiment films the impact of different acidities on the behaviour cockles burrowing into the sand where they live and feed.

You often find hundreds of cockle shells on beaches.

STUDIES IN THE SEA

You can observe the number of animals in a particular environment over long periods of time and combine these with measurements of the water pH.

TYPE OF SURVEY

Diving Surveys

Divers can go under water and directly look at and record sealife

ROV/Camera Footage

Remote operated vehicles (ROV e.g. underwater drones) can take video footage for scientists to record sealife

Counting Marine Mammals or Birds from a Boat or Cliff

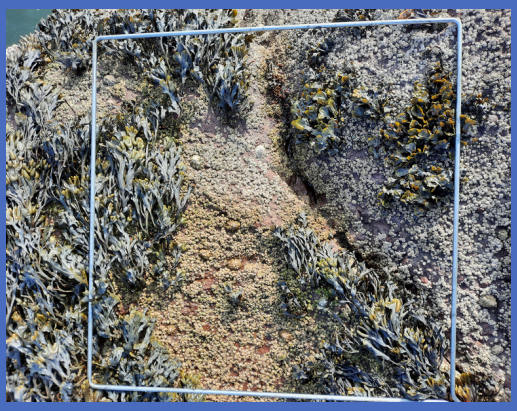
For marine mammals and birds which breathe air we can record these species when they come up for air

HOW TO MEASURE CHANGE?

Measure pH by using a pH meter

It is important to measure the pH to be able to monitor the change

Counts or Percentage cover



We can count how many individuals of a species there are. Or when some species like seaweeds can be difficult to count individually so instead we measure the percentage cover of the space they occupy e.g. 70% of a rock

ACTIVITY - SCIENTIFIC REPORT

Scientists want to know both how animals and seaweeds react to when acidity increases, and also whether these organisms have ways to cope with these changes.

Some species may even surprise us! For instance, scientists have found that some corals are able to control their own chemistry and combat the effects of ocean acidification. They have also found that when certain seaweeds grow close to vulnerable organisms, they can absorb the carbon dioxide from the surrounding water, reducing the acidity.

To do this, scientists conduct experiments and in this activity you write a scientific report on a type of sealife creature of your choice.

1 PICK A SPECIES

You get to choose what type of species you want to research! It can be one of the 8 species below (which already has some information on them) or you can go away and research a different species yourselves!

2 CREATE AN HYPOTHESIS

This is your prediction of the results. Given what you have just learnt about, how do you think this type of species might be impacted by ocean acidification?
Example Hypothesis: An acidic liquid with a pH of 3 will dissolve a shell quicker than pure water.

3 WRITE A METHOD

This is how you will conduct your experiment. Use the information found in this pack to plan it. Will you use a boat to go diving and count sea snails? Or maybe you will run a laboratory study investigating crabs?

It is up to you - there is no right or wrong answer as long as you understand why you want to do it.

4 STATE YOUR RESULTS

Read this pack and use the information to say how the type of sea creature may be directly or indirectly affected. Not sure? You can always do some of your own research too - you might find some even more amazing facts!

5 WRITE WHAT YOU HAVE LEARNT

As well as sharing the results it is important to reflect on what you enjoyed and learnt as a scientist. What was your favourite new fact? How did you feel writing a scientific report?

6 DO SOME EXTRA RESEARCH

Did you find this interesting - want to know more? Great here space to write down any more information you go away and learnt!

CALCIFIED SEAWEED

Description: Some seaweeds have a really neat trick to stop them getting eaten. They have a calcium carbonate skeleton, which means they are partially made out of rock (not tasty).

Fun fact: These are nick-named Coral weeds because corals also have a calcium carbonate skeleton

Food: Algae photosynthesises so gains energy from light from the sun, just like plants!

SEAWEED

Description: The name "seaweed" applies to any algae that grow in the sea except phytoplankton. Many seaweeds attach themselves to solid structures with holdfasts (they can look like plants roots) and can provide a home for many different marine animals.

Fun fact: Seaweeds and phytoplankton produce at least 50% of the earth's oxygen!

Food: Algae photosynthesises so gains energy from light from the sun, just like plants!

SEALS

Description: Seals are marine mammals that live around the coast of mainly cold water environments. In UK waters seals are at the top of the marine food web.

Fun fact: Seals can sleep underwater!

Food: Seals mainly eat fish but will also eat squid, crabs, and lobsters.

SEA SNAILS

Description: Sea snail is the name given to many slow-moving marine molluscs with external shells and a muscley foot to move around on. They come in many different shapes and sizes with a huge variety of shells.

Fun fact: Most sea snails breathe in water, but some species can also breathe in air.

Food: Many sea snails are herbivores, which eat only plants. They lick tiny seaweeds off of rocks with a tongue that is covered in teeth. Others sea snails are active predators feeding on worms, barnacles and even other sea snails.

FLAME SHELLS

Description: Flame shells are small clams with bright orange tentacles. They live hidden on the seafloor in nests which they build from shells and stones they find around themselves.

Fun fact: When many flame shells live together they form a reef that can be home to over 250 different species.

Food: Flame shells filter small food particles from the surrounding water with their tentacles.

FISH

Description: Fish are aquatic vertebrates that swim through water with fins and breathe through gills. They come in many shapes and sizes from tiny gobies to massive sharks.

Fun fact: The UK is home to many fish species including the second largest fish in the world, the basking shark.

Food: Fish eat a wide range of food including seaweed, krill, worms, crabs, and other fish.

Image Taken From:
https://www.flickr.com/photos/tooiake/

MAERL

Description: Mearl are coralline algae (algae that grow hard calcium carbonate skeletons) that look like miniature stag's horns. Individuals grown together in large reefs called beds that sit on the seafloor.

Fun fact: Mearl beds are so important for biodiversity that they are often protected under UK laws.

Food: Algae photosynthesise so gain energy from the light from the sun, just like plants!

CRABS

Description: Crabs are decapod (10 legs) crustaceans with short tails that curl under their body, and (usually) a hard Skeleton on the outside of their bodies. They live all over the world in the oceans, fresh water, and even on land.

Fun fact: Crabs need to shed there entire shell to grow bigger!

Food: Crabs are scavengers and not picky eaters. They eat everything from algae to shrimp and snails, they will also eat the meat of dead fish and mammals that sink to the seabed.

STUDY SPECIES:

SPACE FOR DRAWING/PICTURE OF SPECIES

HYPOTHESIS:

METHOD FOR EXPERIMENT:

RESULT:

WHAT YOU LEARNT:

SPACE FOR EXTRA RESEARCH IDEAS:

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MARINE ALLIANCE FOR SCIENCE AND TECHNOLOGY FOR SCOTLAND

THE SPECIES I CHOSE TO LEARN AND SHARE ABOUT WAS...

I CHOSE THAT SPECIES BECAUSE...

MY FAVOURITE FACT WAS..

WHAT I WANT TO LEARN ABOUT NEXT IS...

#POPSCIKIT

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MARINE ALLIANCE FOR SCIENCE AND TECHNOLOGY FOR SCOTLAND

I CHOSE TO LEARN ABOUT HOW CLIMATE CHANGE IMPACTS...

I LEARNT THAT...

WHAT I WILL RESEARCH NEXT IS ...

I FEEL INSPIRED TO...

Share with us so we can learn with you!

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MARINE RENEWABLE ENERGY

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MASTS

POP

Marine Energy Forum

Curriculum Links
Age 11-14
Science - Motion and Forces
- Energy, Earth and Atmosphere
- Relationships in an Ecosystem
Geography - Human and Physical Geography
- Use of resources

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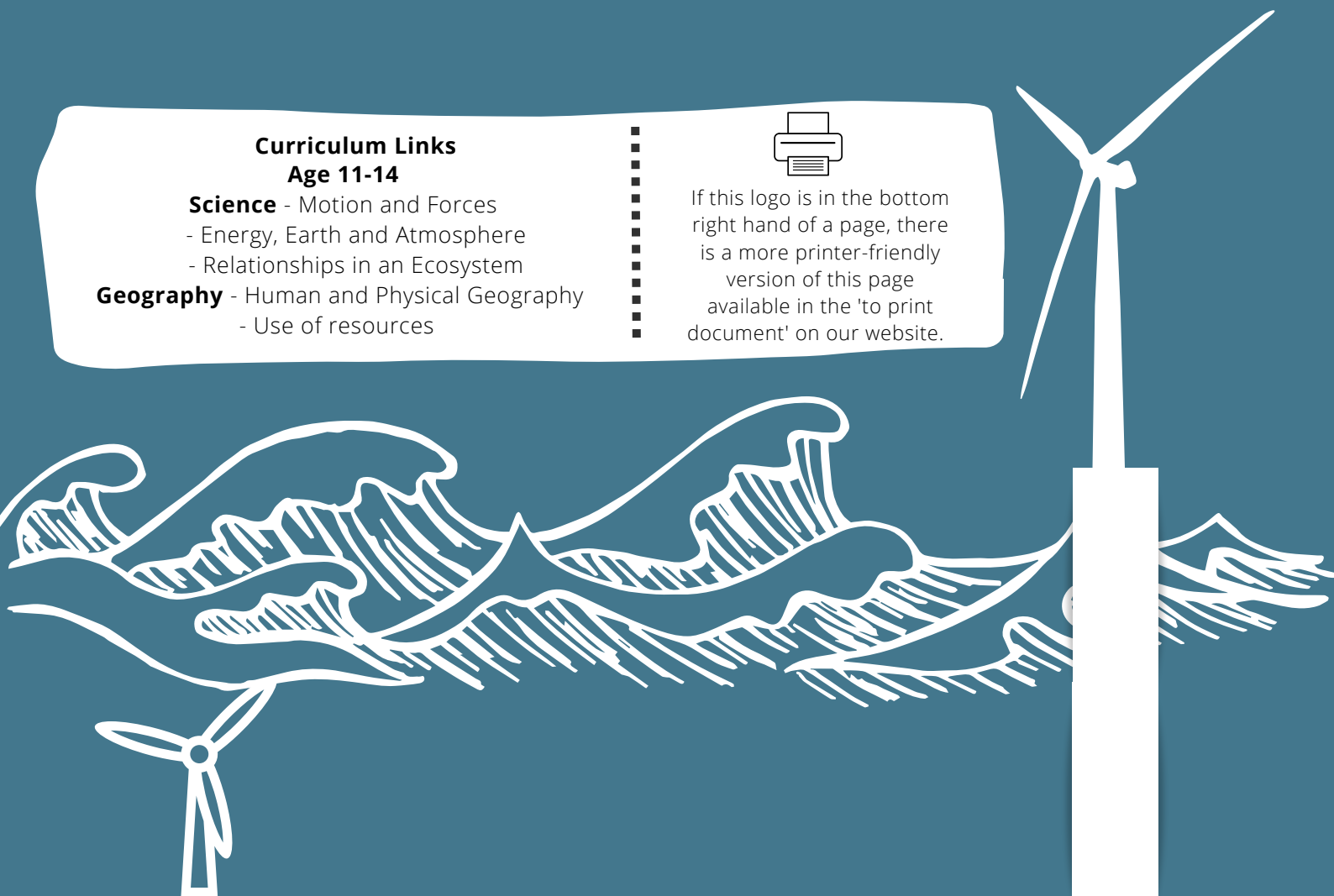

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DR ANDREW WANT

RESEARCH ASSOCIATE

HERIOT WATT UNIVERISTY

ABOUT ANDREW

HIS JOURNEY INTO STEM

Andrew has loved the natural world since his earliest memories. Family holidays to the coast gave him his passion to learn about the fascinating creatures living in the sea. At school, these interests attracted him to the field of biology. These studies continued throughout university. Andrew is now a Doctor of Marine Ecology.

HIS JOB

Andrew is a Research Associate at Heriot Watt University in Scotland, where he is a researcher and works with post-graduate students.

HIS HOBBIES

Andrew likes hiking, snorkeling, volleyball, and playing guitar.

THE QUESTION ANDREW WANTS TO ANSWER IS...

How can we make the transition to generate electricity from renewable marine sources rather than carbon-releasing fossil fuels, while also making sure that sea-life is protected?

ANDREW INSPIRES YOU TO THINK ABOUT...

Problem-solving to tackle climate change and ensure that our sea remain healthy and productive.

IT'S TIME TO EXPLORE MARINE RENEWABLE ENERGY WITH ANDREW- LET'S GO!

It is an important part of a scientist's job to ask questions. Asking questions is the first step to learn more about a topic. We can then go and find the answers by reading more information on the topic, or if there are no answers we can do our own experiments and research to find out.

ACTIVITY 1

After listening to the introduction video write a list of questions you have about marine renewable energy and climate change?

TIP: you can use a question teller to help you think of all the different types of questions you could ask!

Question Teller

What you need?

Scissors.

How does it work?

1. Print and cut out around the outside of the question teller.
2. Fold the paper to create the tell. You could follow the directions at: www.wikihow.com/Fold-a-Fortune-Teller
3. Think about the science you're interested in and use the teller to create questions.
4. Use the teller with someone else to find out what questions they have to!

Download the question teller and other question makers using this QR code!

Space to write your questions:

Now that we have our questions it's time to find some answers.
Our renewable energy scientist Andrew has answered some questions below. Read these through carefully as they will help you with an upcoming activity.

WHAT?

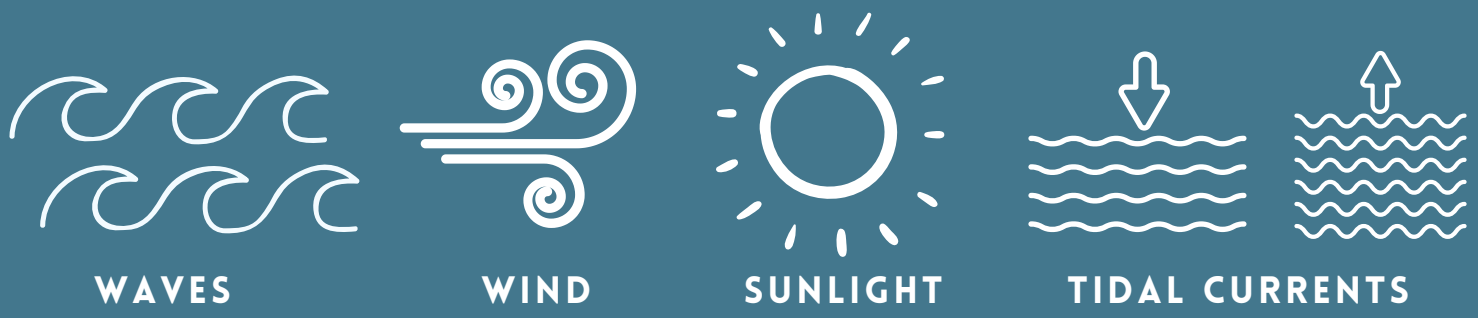
WHAT IS MARINE RENEWABLE ENERGY?

Marine offshore renewable energy means using a device to capture power to produce electricity from sources found out at sea. These may be close to shore in quite shallow waters or far, far out in deep seas.

CAN?

CAN WAVES PRODUCE ENERGY?

At sea, energy can be captured from the waves, but also tides, the wind blowing across the open ocean, and even from sunlight far from land.



HOW DO DEVICES TURN WIND AND TIDAL CURRENTS INTO ELECTRICITY?

Once a device is deployed into the water there are several stages in capturing wind out at sea to power our homes.

Let's do an activity!

On the next page read the terms and definitions and fill in the blanks on the paragraph.

Fun Facts!

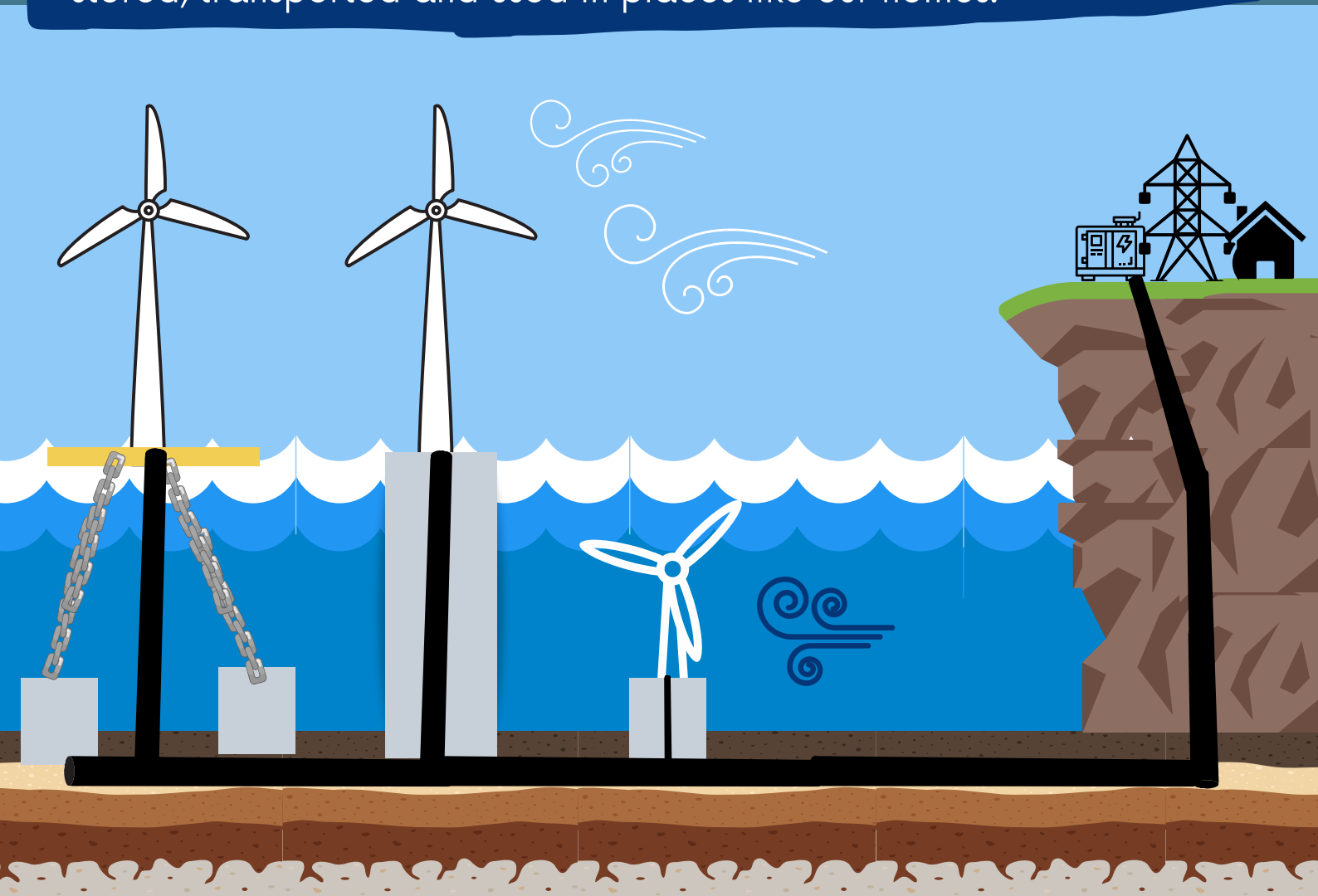
THE WORLD'S FIRST TIDAL POWER STATION OPENED ON THE FRENCH COAST IN 1966... ALMOST 60 YEARS LATER, IT IS STILL PRODUCING ELECTRICITY!

THE WORLD'S LARGEST OFFSHORE WIND TURBINE HAS THREE BLADES, EACH 118 METERS LONG!

ACTIVITY 2 - FILL IN THE BLANKS

DEVICE	Machines that are engineered to be able to capture energy from one specific energy source such as wind, wave, sun.
FOUNDATION	How devices are attached to the seafloor to keep them stable.
GENERATOR	Converts movement (kinetic) energy into electrical energy.
RENEWABLE ENERGY SOURCE	Natural processes with lots energy, such as wind, waves and sun.
CABLES	Often made of metal and enables the transport of electricty from one location to another.
TURBINE	The energy capturing part of a wind device, containing the blades, gears, and generator.

The _____ causes blades of the _____ to move/rotate. From this movement we can capture energy using a _____ within the _____. This energy is transported by _____ back to land where it can be stored, transported and used in places like our homes.



WHY?

WHY ARE PEOPLE SAYING THAT WE SHOULD PRODUCE ELECTRICITY FROM RENEWABLE ENERGY SOURCES?

Most of our electricity is generated by burning fossil fuels. Once these are burned, they cannot be used again, and burning them to produce energy also releases lots of carbon dioxide into the air. However, there are other ways to produce electricity using renewable sources – these do not run out and do not produce carbon dioxide as they help us power our homes.

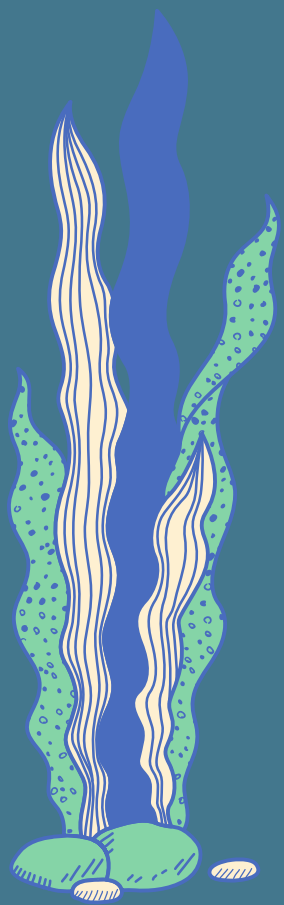
WHERE IS THE BEST PLACE TO PUT A MARINE RENEWABLE ENERGY DEVICE IF YOU WANT TO CAPTURE AS MUCH ENERGY AS POSSIBLE?

Firstly, it depends on what type of device you have:

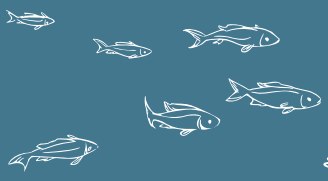
- A floating tidal turbine must be on the surface of the sea, anchored to the seabed, and in a place where there is a strong flow of water driven by the tides.
- A wind turbine might be placed on a tall tower, extending to the seabed, or floating on the surface with moorings to the seabed – either way, they must be placed in a windy area.

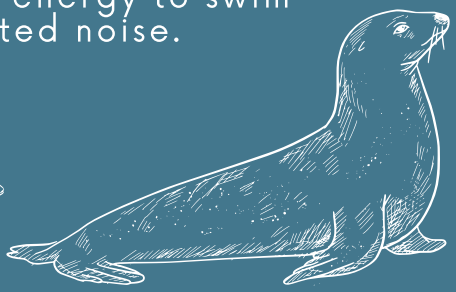
It can sometimes be difficult to choose between places because one area may occasionally have the strongest seas or winds, but another place may be more reliable on more days.

DO WE NEED TO BE CAREFUL ABOUT PUTTING RENEWABLE ENERGY MACHINES IN THE SEA?



Yes, it is important to put devices in places where they will have the least impact on the animals and plants that live in our seas. While it is important to place them where they can capture the most energy, we must be careful to not damage the seabed and avoid areas where important sea life lives. These machines may include turbines that rotate underwater or with the wind above the sea surface. These may make it so animals have to use more energy to swim around and may create unwanted noise.





ACTIVITY 3 - PLACE YOUR MARINE RENEWABLE DEVICE

You get to place your very own tidal or wind turbine to generate marine renewable energy.

The speed that the tide flows can be quite different when comparing one place to another. Tidal currents are usually measured as the number of metres that the water moves in one second. In engineering this is described as metres per second, and shown as m/s. On our map, the more symbols for tidal currents you see the faster the water moves in m/s.

Our map also shows where the main harbour is located at Port Town. Ships from Port Town would be used to place the tidal turbines in the final chosen site, and to access the turbines when they need repairing. In addition, the map indicates cliffs that are home to many important seabirds, fishing grounds where fishers from Port Town, and areas used by colonies of seals to haul out and rest, these are usually near areas where they feed.

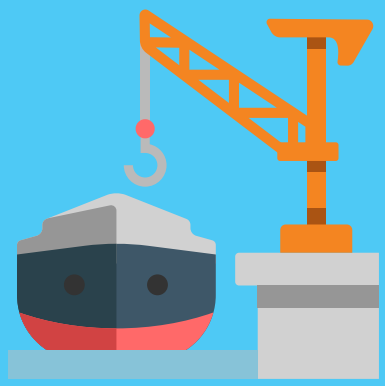
Based on what you know about marine renewable energy and sea life. Is there a best location to place the farm of tidal turbines? Are some places better than others? How do you decide what is the best place? Is the choice easy? There is space to write about your decision below.

MAP KEY

MORE SYMBOLS MEANS A STRONGER WIND OR CURRENTS

WIND

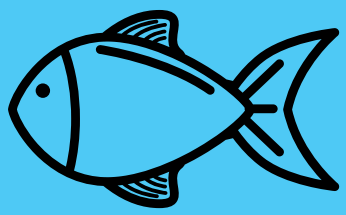
TIDAL CURRENT



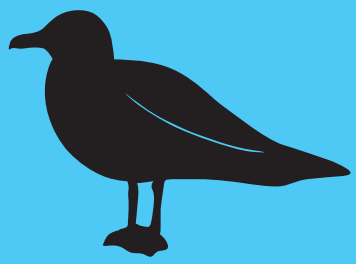
PORT

THESE SYMBOLS MEAN IT IS AN IMPORTANT AREA FOR:

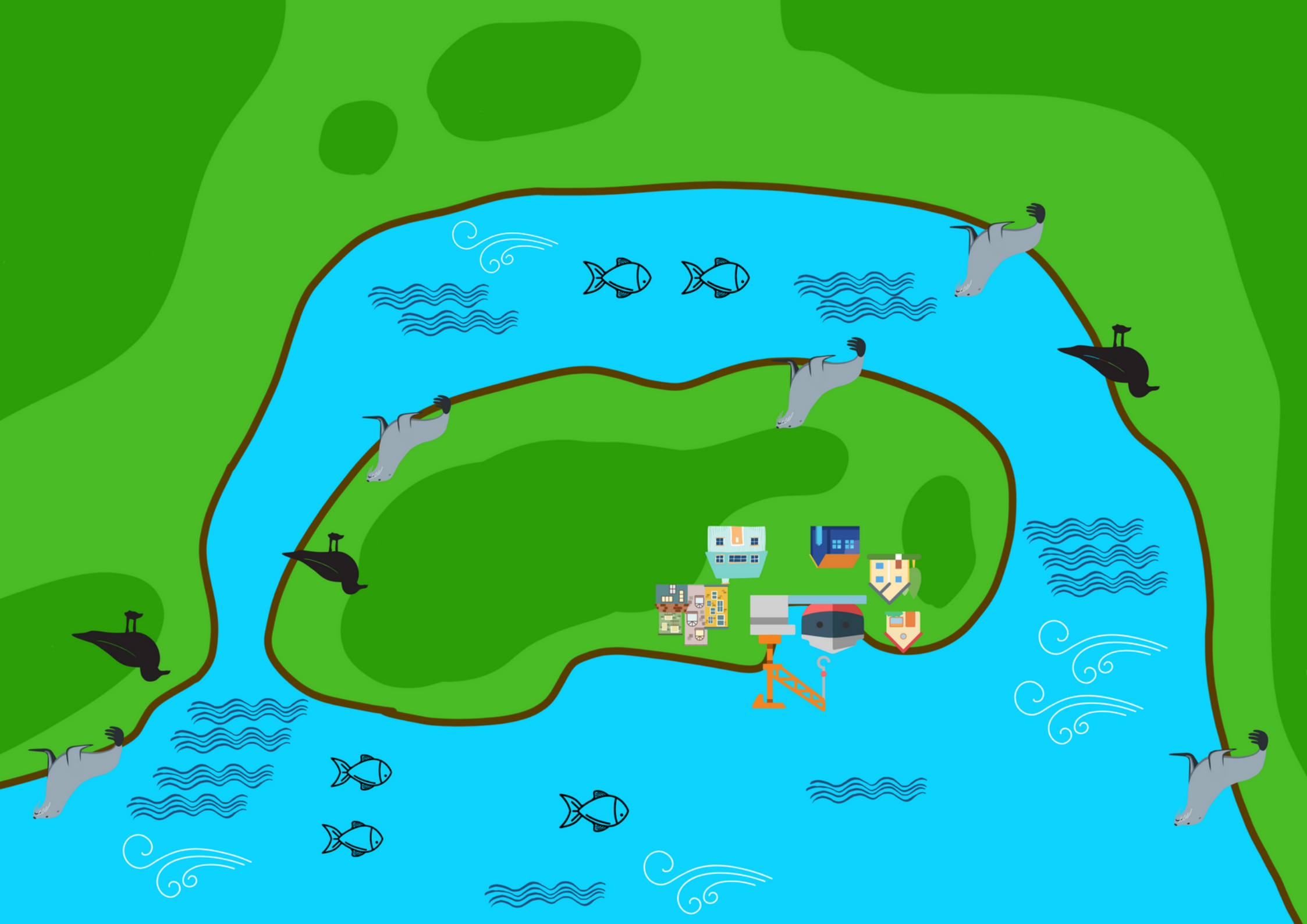
MARINE MAMMAL



FISH

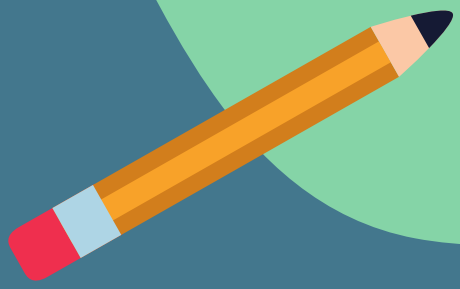


BIRDS



DID YOU CHOOSE A TIDAL TURBINE OR A WIND TURBINE? WHY?

It's important as scientists to understand why we make decisions and keep a record of this - we do this regularly in laboratory notebooks and field journals, and more formally in scientific papers.



WHERE DID YOU PLACE YOUR DEVICE? WHY?

HOW DID YOU DECIDE WHAT WAS THE BEST PLACE? WHAT DID YOU CONSIDER? WAS IT EASY?

#POPSCIKIT

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