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Learning Resource

Sustainable Shipping

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Sustainable Shipping

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Around 80% of world trade is transported by ships, but how often do you think about the environmental impact of shipping? In this resource we will think about the impact shipping has on us and our planet and come up with some ideas for creating more sustainable shipping.

In this activity you and your students will:

- Research the impact of shipping on us and our planet.
- Design and build a model of a ship for the future.
- Test their ship on water!

Objectives

To find out about the impact of our most common form of trade transport, and think of ways to make it more sustainable.

What do I need to make it work?

For this activity, you'll need:

- Card, PVA glue, sticks or paper straws, anything you can find to make your ship designs.
- A large tray of water or a paddling pool.

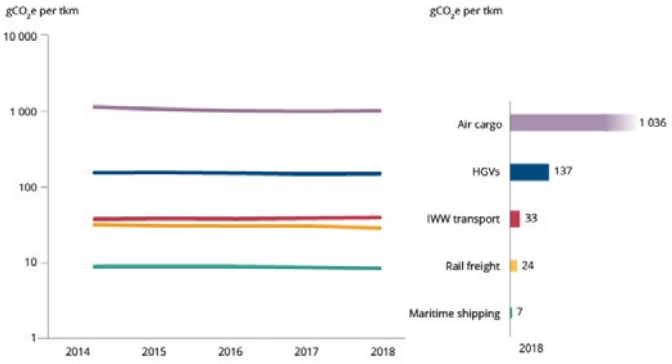
What things will my students create?

- A concept and model of a sustainable cargo ship.

Investigate shipping

What do you know about the world's most common form of trade transport?

Today, most maritime shipping (transporting cargo across seas and oceans) is powered by the fossil fuel 'bunker fuel', or more properly 'heavy fuel oil'. Nonetheless, shipping is considered one of the least environmentally damaging forms of transportation. A study of cargo transported to and around European countries shows that maritime shipping emits very little greenhouse gas per tonne of cargo compared to other forms of transport, especially planes and trucks.



Average greenhouse gas emissions by motorised mode of freight transport, EU-27, 2014-2018. A logarithmic scale is used in the diagram on the left, the diagram on the right shows the grams of CO_2 produced by transporting 1 tonne of cargo one kilometer (HGV = truck, IWW = inland waterway) – Adapted from https://www.eea.europa.eu/publications/rail-and-waterborne-transport

However, even though the amount of CO_2 released per tonne of freight is low, because of the vast amount of shipping undertaken to transport all commodities we require in our lives, maritime shipping still makes a big impact on the environment – around 80% of global goods travel by sea, accounting for around 3% of total global CO_2 emissions.

What do you know about ships?

In your group discuss what you already know about shipping. These questions might help you get started:

- What do ships carry? (Food, furniture. electronics, toys, everything!)

Mini-project

Each student should choose a room in their home (their bedroom for example) and do a survey. For every item in the room that that states its origin (e.g. a 'made in...' label), where did it come from? Collate the class results and plot them on a map. What percentage of those goods likely travelled by sea to get to you?

- Do you know the names of any parts of a ship? And a container ship in particular? There are diagrams from simple to complex here for you to compare your knowledge with: bit.ly/3K1FNFa
- How much can some ships carry? You might be surprised! Here is a BBC article about the size of ships and how much they can carry: bbc.in/32PTTZO
- How are ships powered? What makes them move?

Take it further

It's not just the greenhouse gas emissions of ships that can be problematic for the environment. What other news stories about ships and the environment can you find? Here is an example of a ship spilling oil over a UNESCO heritage site: cnn.it/3zLK0rN

Want to know more?

- Here is a fun 6 minute podcast about container ships your group could listen to: bit.ly/3t2phyR
- Encyclopædia Britannica has a very helpful article on ships if you want to send your group off for more reading and research: bit.ly/3G5dDGV, or check out this article on Kiddle: bit.ly/3F2CSIH

What are sustainable ships?

The shipping industry has been trying to figure out how they can make shipping a carbon zero industry by powering ships with renewable energy and they have been working on some pretty cool stuff!

What is renewable energy?

Renewable energy is energy generated from natural resources which are replenished on a human timescale, so unlike fossil fuels they will always be available. Most sources of renewable energy do not involve burning so do not create carbon dioxide and other greenhouse gases.

Can your students name some sources of renewable energy? How many can they come up with? Can they name a renewable energy that ***does*** create greenhouse gases? Or a non-renewable energy source that does not?[1]

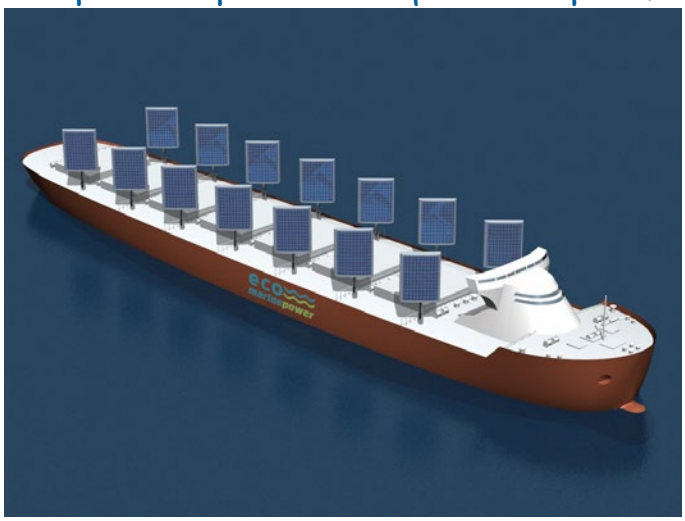
Wind powered ships

The E-Ship 1 is a Flettner ship: four large rotorsails that rise from its deck are rotated via a mechanical linkage to the ship's propellers. – Alan Jamieson from Aberdeen, Scotland, CC BY 2.0 <https://creativecommons.org/licenses/by/2.0>, via Wikimedia Commons

Wind powered ships aren't a new thing. It's how ships used to work before we invented engines. But to get the right thrust for a massive container ship with a sail does present a challenge! Sails don't have to look like they did in the 1700s either – the Magnus effect uses rotating masts to create thrust. There's a great explainer on YouTube, here: bit.ly/3HUMNBS

Here are some other current and conceptual wind powered ships: bit.ly/3n6M1d7

Solar powered ships (with a bit of wind to help out!)



The Aquarius Eco Ship – Image: Eco Marine Power

Energy from the sun can be converted into electricity to power a motor to propel the ship through the water – which is great if it's sunny all the time. That's why this Japanese company has designed a ship that uses its solar panels as sails to capture some wind power too! – bit.ly/3F5Yp3p

Hydrogen ships

You might have heard of hydrogen powered cars as an alternative to electric battery powered ones (bit.ly/3K2Ypoc) … well, you can power cargo ships with hydrogen as well. Here is one design that could be used up and down the River Seine in Paris soon: bit.ly/3t6tuBr

Hydrogen can be used to directly power an engine, but is more commonly used to power something called a ***fuel cell***, which converts the hydrogen into electricity (bit.ly/3r9xGh5). Both burning hydrogen in an engine, or using it in a fuel cell creates clean water as a byproduct, so hydrogen vehicles do not create harmful emissions ***at point of use***.

However, creating hydrogen in the first place requires a lot of electricity. So, for a hydrogen powered ship to be truly environmentally friendly the hydrogen needs to be created using an emissions free electricity source.

What do you think?

What do you think would work best? What are the pros and cons of each method of powering a large ship? Can you think of any other ways to make a container ship more environmentally friendly?

Note that as container ships are really huge, it can be difficult to power them solely by emission-free means, but anything which can reduce the amount of fossil fuels used is a step forward.

1 Here's what we came up with: clean sources of renewable energy include sunlight, wind, rain, tides, waves, falling water (hydroelectricity) and geothermal heat. Biomass (burning e.g. wood) is a renewable energy source that creates greenhouse gases and nuclear power is a non-renewable energy source that does not.

Design and make your own container ship

Now that we've thought a bit about shipping and ships, it's time to design and make your own!

Get drawing

Start by sketching your container ship design ideas. Remember to think about:

- How it will be powered or propelled through the water.
- What materials will you use to make it? And how can you make it waterproof?
- Where the cargo will go.
- How can you make it both stable in the water, but also glide through the water efficiently?

Making your ship

With all your ideas on paper, decide which is the best one to try and make. Then plan out how you will construct the model.

Here are some basic cardboard ship tutorials:

- Ship with curved ends – bit.ly/339iSXC
- Flat bottomed ship – bit.ly/3JNgsyJ

Tip! – If you want to keep your models simple, then stick with wind power as this won't require any motors or electrics.

Advanced Tip – If you want to try something with a motor, here is an example of a basic solar powered boat set up: bit.ly/337G8Fs

Test your model

Once you have made your ship we need to test it to see if it can:

- Float
- Move forward by your chosen propulsion system (wind, windup elastic band, solar)
- Carry any cargo

It's probably best to test your ships in a large tray of water in the classroom, or paddling pool. That way you can avoid littering your school or local pond with broken boats! Wind boats can be tested using a small portable fan, and solar boats using a powerful torch if your local conditions aren't sunny enough or your test 'sea' is inside.

CAUTION! Electricity and water do not mix! Any torches, fans etc. should only be used by a responsible adult and kept as far from the water as possible.

For cargo, you could try seeing how many pieces of fruit each ship can carry, and if it makes it to the other side, the team get to eat the cargo!

Hold a competition

With older students, why not make this a competition? You could award prizes for:

- The ship which can transport the heaviest load across your 'sea' without sinking or coming to a halt.
- The ship which travels fastest under the standard conditions.

More advanced students might also be interested in developing a remotely steerable, renewable energy powered ship. You could even use a small computer like a Raspberry Pi (www.raspberrypi.com) to create a ship which travels around a predetermined course.

Want to help improve this activity?

This activity is a living document! Help us by editing this activity to make it as good as possible, just use this short link (just type it into your web browser's address bar): bit.ly/34ow3EB – full instructions are provided. Any edits that can make this resource easier to use in the classroom are very welcome, so please follow the link and make your contribution!

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Show us your ships!

As always we would love to see the results of your creativity! Please log into the Roots & Shoots website and post a mission update. Let us know how you got on by providing us with a project write-up including pictures and videos.

Why not enter the Jane Goodall's Roots & Shoots Awards?

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Keep up to date with Jane Goodall's Roots & Shoots UK

You can find us on Facebook at **fb.com/RootsnShoots.org.uk**, on Twitter (@JaneGoodallUK, direct link: **goo.gl/xTQnVm**) and on Instagram (@janegoodalluk, direct link: **bit.ly/jgi-insta**). Or why not sign up for our weekly email newsletter full of inspiring stories from our Roots & Shoots members in the UK at **rootsnshoots.org.uk/sign-me-up**.

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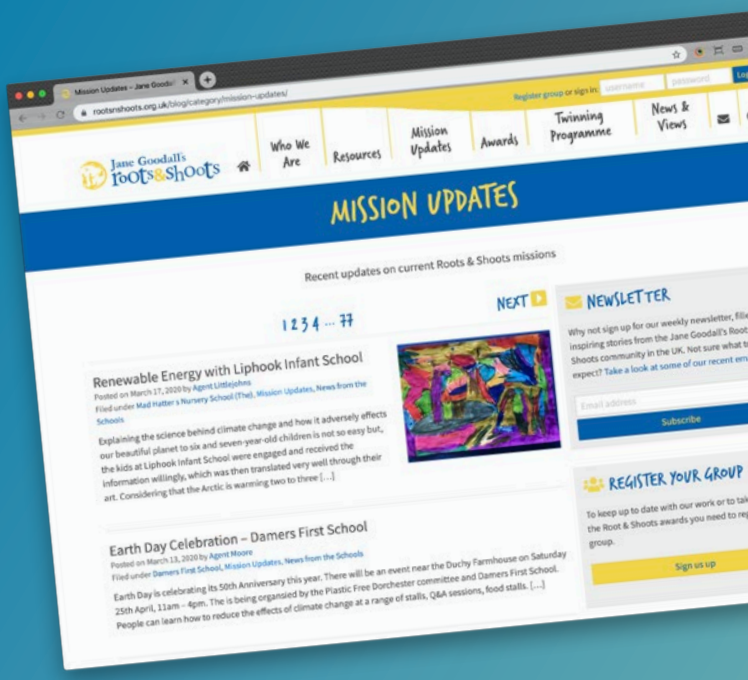

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Aquaculture

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Aquaculture

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Farming on land (agriculture) is familiar to everyone, but not all young people will have heard of its water-based equivalent, aquaculture. Just like agriculture, the environmental impact of aquaculture varies depending on which species are being farmed and the methods used.

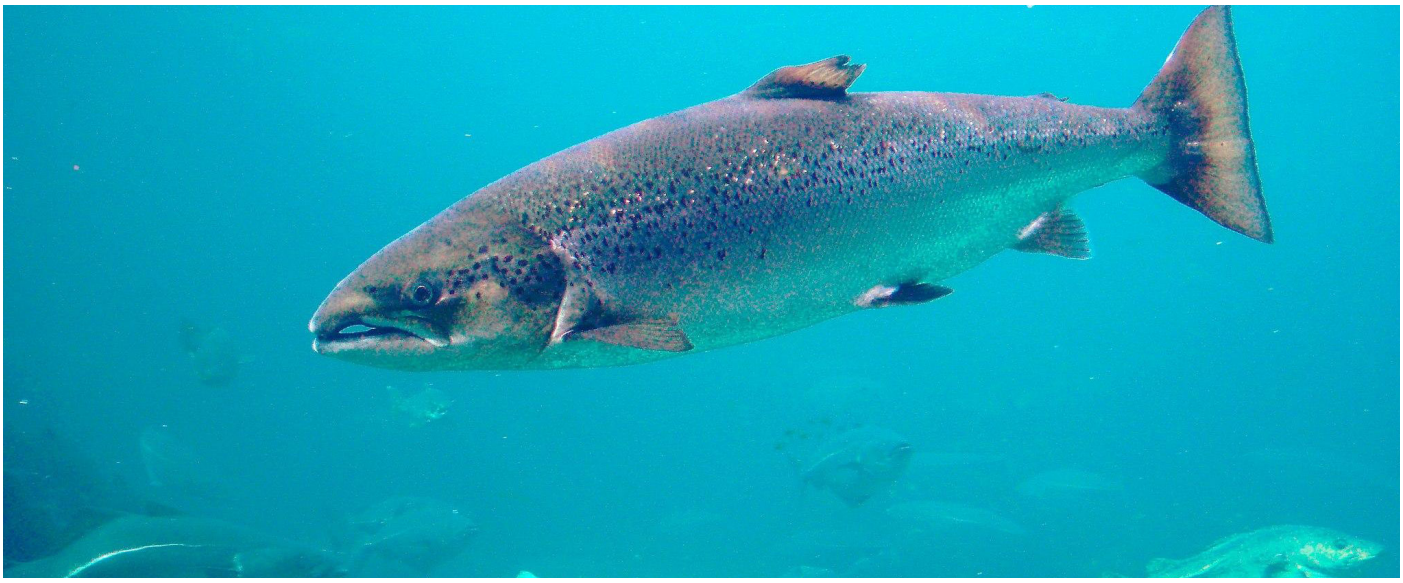
objectives

In this resource we will compare and contrast the environmental impact of salmonid (salmon and trout) farming to the farming of bivalve molluscs such as oysters and mussels and brainstorm ways that *you* can make a difference.

You do not need any specialist materials for this activity, although a whiteboard/blackboard/flipchart would be helpful.

Salmonid farming

Salmonid farming is one of the most commercially important forms of aquaculture in the world, worth over US$10 billion globally per year.



Atlantic salmon, Salmo salar, taken through glass, in Atlanterhavsparken, Ålesund, Norway Hans-Petter Fjeld, CC BY-SA 2.5, via Wikimedia Commons

What is a salmonid?

Salmonids are fish in the family ***Salmonidae*** which includes Atlantic salmon and brown trout. They are carnivorous and in the wild they feed on small crustaceans, insects and other fish. Salmonids are born and spend their early life in freshwater lakes and rivers. Many species then migrate to the ocean where they spend most of their time, coming back into freshwater to breed.

Norway and Chile are the biggest producers of farmed salmonids in the world. Some salmonids like brown trout (***Salmo trutta***) are farmed for sport fishing, but the majority are farmed for food. The most commonly farmed salmonid is the Atlantic salmon (***Salmo salar***).

Salmonid farming is complex because of the dual freshwater/saltwater lifecycle they lead. Eggs are hatched in freshwater tanks where the young salmon (called smolts) live for 12 to 18 months before being transferred to cages or pens in the sea near the coast. In traditional farming methods, these pens allow water from the surrounding sea to freely move in and out.

There are lots of problems associated with traditional salmonid farming methods (see a summary on Wikipedia, here: bit.ly/3frHqBu) but for this resource we are going to focus on two particular issues: environmental pollution and the impact on food chains.

Brainstorm exercise: raising an animal

- Ask the students to raise their hands if they have ever had a pet. Ask them to keep them raised if it was a pet that was kept in a contained environment such as a cage or a tank. Did anyone ever keep fish?
- Ask the students to shout out the tasks one has to carry out to care for a pet that lives in a cage or tank and make a list on the whiteboard.
- Ask a student who has/had a pet (preferably a fish) to estimate how much food it required, and how much waste it produced.

Fish farms in Scotland alone are estimated to have raised 56.6 ***million*** Atlantic salmon in 2021[1]. Can you even imagine how much food they ate and how much waste they produced!

Environmental pollution

Traditional salmonid farming in open sea pens pollutes the environment in two ways. Various chemicals used to e.g. combat fish lice can spill over into the environment. More importantly, the vast amounts of fish poo created (along with leftover food particles) is also leaked into the environment. If the local water currents are not enough to dissipate it, all this leads to local buildups of nutrient-rich organic matter which can cause **eutrophication**. For an in-depth study of this we recommend this article from the Journal of Environmental Management for older students: bit.ly/3ShuXyN

What is eutrophication?

Green algal bloom forming a thick surface layer in Lake Dora, Florida. Photo Credit: Nara Souza | Florida Fish and Wildlife Commision via Flickr https://www.flickr.com/photos/48722974@N07/5120227735

Eutrophication refers to when a body of water, such as a lake or part of an ocean, becomes overly filled with nutrients such as nitrogen and phosphorus. These high levels of nutrients can cause massive blooms of algae. When these blooms die the vast amount of rotting material they deposit depletes the oxygen in the water causing more plants and animals to die, lowering the oxygen even further. In extreme cases this can lead to the development of practically life-free areas called **dead zones**, or contribute to coral bleaching.

https://youtu.be/92TFJTtuq6k

Impact on food chains

Around 20% of the world's annual wild fish catch is used to make fishmeal and fish oil, of which about 70% then goes to fish farms to feed the carnivorous salmonids. This wild fish catch may lead to overfishing, particularly in the Global South[2]. This is harmful on the environmental scale (impacting food chains and reducing biodiversity) and on the human economic scale (affecting the livelihood of fishers in the Global South who may have no other viable source of income).

Lessening the impact of salmonid farming

Brainstorm exercise

Can your students brainstorm how (in general terms) to lessen the impact of salmonid farming? Here are some prompts to help them, and you can find some more information below.

- Many of the pollution problems are caused by the free exchange of water between the pens and the surrounding sea water.
- A large part of the salmonids' diet is made up of oils from wild fish catch. A relevant web search term to help is 'vegan cod liver oil'.

Some salmonid farms are using modern methods and feed to improve their environmental performance. For example:

- Using oils from algae as a source of Omega 3 for their farmed fish, to replace fish oil from wild fish.
- Moving away from using open pens to closed systems like raceways or re-circulation systems. Read more on SeaChoice.org here: bit.ly/3dMuq94

1 https://www.gov.scot/publications/scottish-fish-farm-production-survey-2019/pages/4/

2 The concept of Global North and Global South (or North–South divide in a global context) is used to describe a grouping of countries along socio-economic and political characteristics. The Global South is a term often used to identify regions within Latin America, Asia, Africa, and Oceania. https://en.wikipedia.org/wiki/Global_North_and_Global_South

Bivalve mollusc farming

The amount of farming of bivalve molluscs is small compared to salmonid farming and radically different in terms of environmental impact.

Picking oysters by hand at low tide, Willapa Bay, Washington, October 1969. Bob Williams, Public domain, via Wikimedia Commons

What is a bivalve mollusc?

Bivalve molluscs are a type of shellfish that have a hard shell consisting of two parts held together by a hinge. Bivalves come in all sorts of shapes and sizes and can be found attached to rocks and stones in lakes, rivers and oceans the world over. You might be most familiar with oysters and mussels.

The most commonly farmed bivalve molluscs are oysters and mussels. Oysters are farmed all over the globe. China is the biggest producer, followed by Korea, Japan, USA and France (see bit.ly/3r7nqql). Mussels are also farmed worldwide, although in lesser quantities. Again, China is the biggest producer with Chile and Spain also being important. As well as being a source of food, oysters are also farmed for their pearls (used in jewellery) and for their shells which are coated in nacre (also known as 'mother of pearl') and often used as buttons.

Bivalves tend to be farmed in shallow, tidal water near to the coast or in tidal estuaries (meaning harvesting can be carried out relatively easily at low tides). Often, farms are sited on existing mollusc beds. The farming environment usually closely mimics natural conditions and does not require additional food to be added to the water.

Bivalves: nature's water filters

Oysters and mussels are both active ***filter feeders***, meaning that they feed themselves by sucking in water from their surroundings, straining out microscopic algae and nutrients and then releasing the water. The oyster's faeces and anything it accidentally filters that it can't digest (like sand) are packed up together along with sticky mucus inside its shell and then occasionally expelled.

This process makes bivalves natural water filters – not only are algae and nutrients directly removed from the water for food, the undigested matter (and faeces) is packed into heavier pellets which fall out of suspension when expelled from the shell. In optimal conditions a single oyster can clean as much as 5 litres of water per hour, actively helping to fight against eutrophication!

Using bivalves to measure water quality

Bivalves are great at filtering excess algae and nutrients out of water, but only up to a point. If the water quality drops too far then the bivalves start to get stressed, which they show by closing their shells. This means that you can use the length of time that a bivalve shuts its shells while underwater to get a rough estimate of water quality.

The company Spyvalve is trying to use this method to measure changes in water quality in real time – check out what they are doing at spyvalve.com

What can we do?

Brainstorm exercise

Can your students brainstorm how individuals can help lessen the environmental impact of aquaculture? Here are some prompts to help them, and you can find some more of our ideas below.

- Think about what ***actions can you take personally***?
- Recognise that what works for them may not work for everyone else as they have different constraints on their lives. Putting yourself in someone else's shoes, ***what actions could they take***?
- People will not change if they don't know there is a problem. ***How can you inform people?***
- Industries will not change without pressure. ***How can you legally create that pressure?***

Some ideas we came up with are:

- **Personal change of eating habits from any piscivores!** For example:
  - Reduce amount of farmed salmon eaten. Switch to eating more vegan alternatives, committed piscivores can consider switching to farmed bivalves!
  - **Research farmed salmon providers that use cleaner farming techniques** and switch to those (note that this is likely to be more expensive, so need to stress ***where possible and affordable***). ASC labels are a starting point (bit.ly/3Cg5ujD) although they come with their own problems, see for example this article on SeaChoice.org: bit.ly/3LNVQYu
- **Create a set of resources to inform other people** (e.g. other students at school) about what you have learnt and present practical ways that they can make a difference. E.g.
  - Posters for your school wall
  - Gather and share recipes that people could use as an alternative to existing fish dishes – here are some suggestions to get you started: bit.ly/3BTwqUR
- **Write to an aquaculture company** in your country to ask them about the methods they use and how they are minimising their environmental impact.

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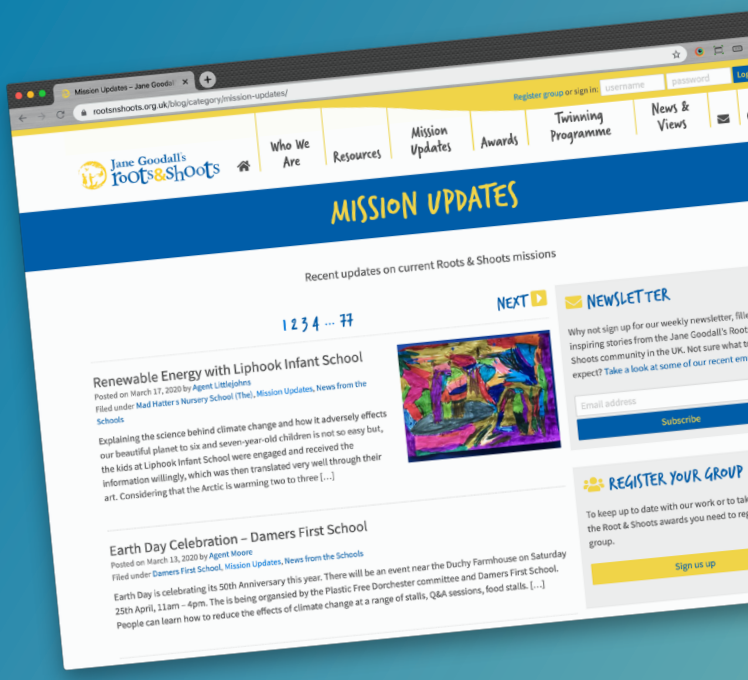

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Commercial fishing

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It is estimated that 260 million people worldwide are supported by marine fishing. This resource examines the fishing industry and suggests choices that consumers can take to help steer it into more sustainable practices

In this activity you and your students will:

- Learn about the jobs supported by the fishing industry across the world.
- Learn about some of the problems associated with commercial fishing and how it can be made more sustainable.
- Learn about the concept of consumer pressure.
- Carry out a survey of the fish available at a local supermarket and write to them to ask about their sourcing policies.

Fishing – a global industry

Marine fishing is a truly global industry, directly or indirectly supporting around 260 million people, 22 million of which are small-scale fishers[1]. That's a lot of people, so what are they all doing?

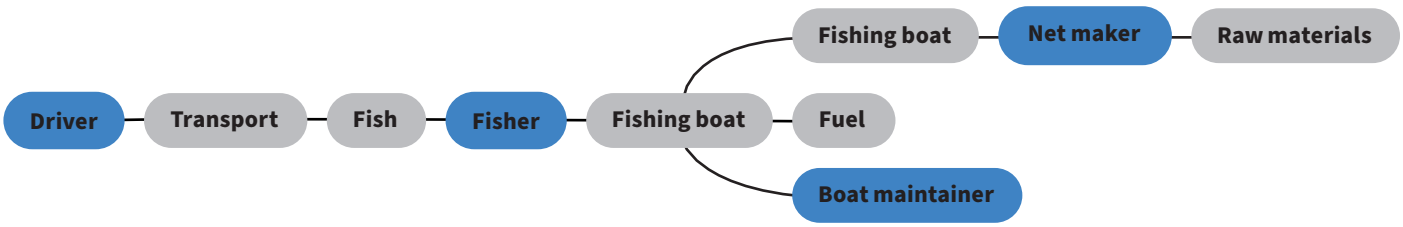
"Trawl Net Fish Sampling" by NOAA Great Lakes Environmental Research Laboratory is licensed under CC BY-SA 2.0. Via Openverse.

A fishing jobs mind map

A great way to visualise the sheer number and variety of jobs that are reliant on fishing is to make a mind map[2]. This can either be done on the class white/blackboard or online using a tool such as MindMup (mindmup.com).

There are a lot of ways you can organise your mind map. One method would be to make bubbles of two colours, one for 'items' and one for 'jobs'. Starting with the job of fisher in the centre, add bubbles for the equipment they use and the fish they catch. From those bubbles add in the jobs that are required to produce the equipment/process the catch/etc. and work out from there. We've made a small start in the example below with 'items' in grey and 'jobs' in blue, but you should try and cover the whole range of activities from producer to consumer.

When making your mind map, don't forget that wild-caught fish are used in all sorts of ways, not just delivered directly to the consumer. Some fish is eaten fresh, some is processed for human consumption in cans or frozen. Other fish are processed for their oil, or (as you can learn about in our aquaculture resource) are used to feed captive fish in fish farms.



1 Contribution of marine fisheries to worldwide employment - Teh - 2013 bit.ly/3Ci8kV5

2 Unsure what a mind map is? This article should help: bit.ly/3y0IfYq

Environmental problems of fishing

Commercial fishing today causes a number of environmental problems. These include:

- **Overfishing and bycatch**: taking too much of a particular fish species out of the water can cause them to become extinct in a particular area. This can occur in two ways. ***Overfishing*** refers to taking too much of the target fish, an example being cod in the North Sea (you can find an in-depth article on this here: bit.ly/3V0qxhB). ***Bycatch*** refers to accidentally taking creatures other than the target fish – some sources estimate that as much as 25% of the world's catch is bycatch!
- **Plastic waste and pollution**: many of the nets, lines and other equipment used by fishers are made of non-biodegradable plastic. This equipment is frequently lost or abandoned at sea, contributing to the vast amount of plastic in our oceans (the UN estimated over 17 million metric tons of plastic waste entered the oceans in 2021 alone bit.ly/3Sug4cA. You can read more on Sea Shepherd here: bit.ly/3resMjt). The fuel used by fishing vessels is also often polluting for both oceans and the atmosphere.
- **Habitat destruction**: some fishing methods also contribute to habitat destruction. For example, ***bottom trawling*** involves dragging a weighted net over the seafloor which is extremely damaging. Living Oceans has a good overview of different fishing methods which you can read here bit.ly/3y44vAC.

Moving towards more sustainable fishing

What can be done to help steer industries like fishing into more sustainable practices?

Image by Anirnoy, CC BY-SA 4.0 <https://creativecommons.org/licenses/by-sa/4.0>, via Wikimedia Commons

More sustainable fishing techniques

To make fishing more sustainable the industry needs to address each of the problem areas we looked at in the last section. Taking inspiration from more traditional fishing methods still used on a small scale around the world there are a number of things that can be done:

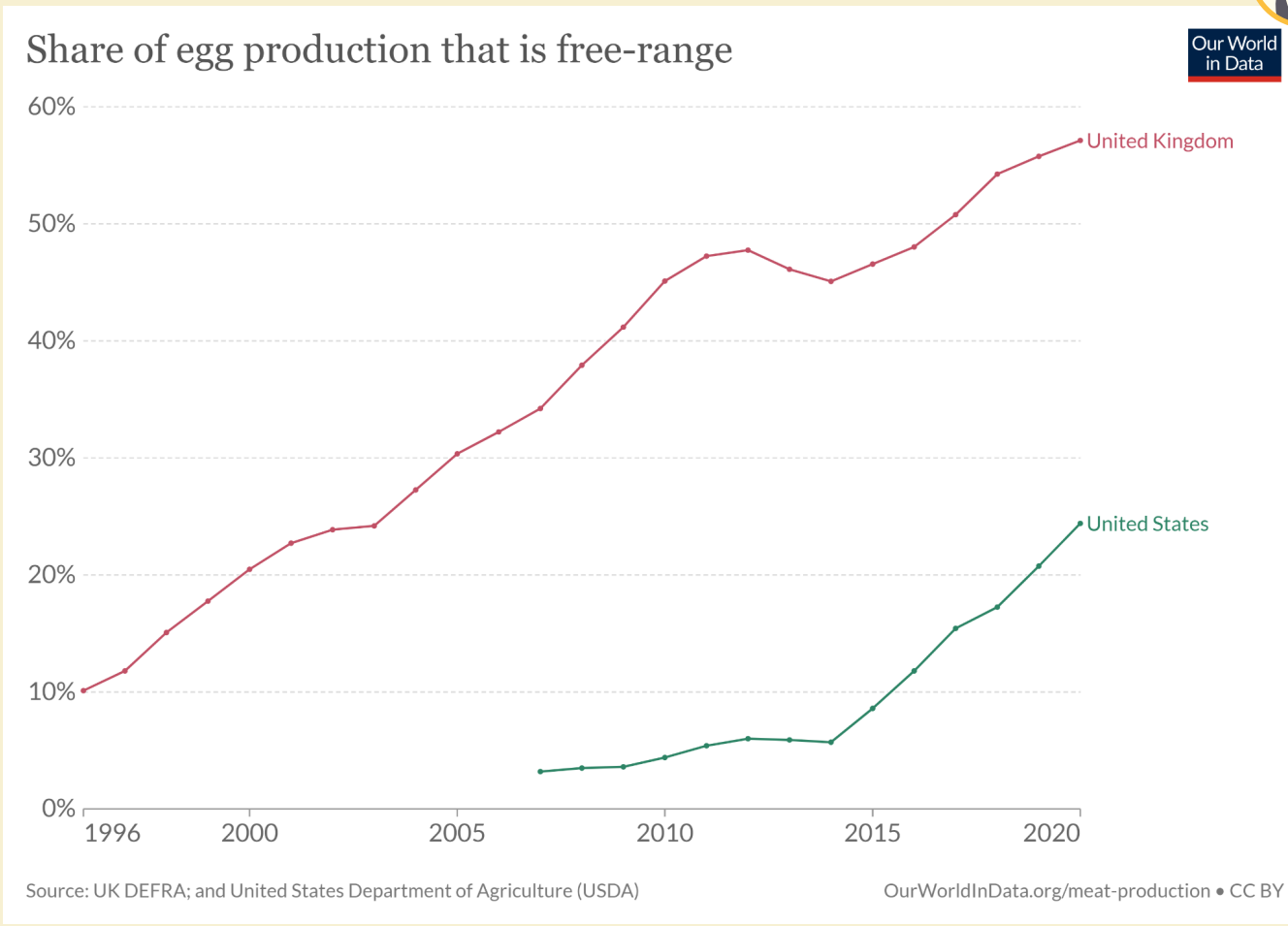
- **More targeted methods**: Fishing methods such as hook & line, spear fishing and cast nets reduce bycatch and avoid the habitat damage that is seen in methods like bottom trawling. They also result in less plastic being added to the oceans.
- **Seasonal fishing**: choosing which fish to catch according to the season, thus allowing populations to recover on a regular basis can greatly reduce the problems of overfishing. Read more about this approach and more targeted fishing methods in this excellent article on National Geographic: bit.ly/3SlWlvf
- **Enforced quotas**: strictly regulating the amount of particular species which can be brought ashore and sold also plays an important role in fighting overfishing. Such quotas are difficult to negotiate and hard to enforce but there are some success stories, such as Europe's Common Fisheries Policy (https://bit.ly/3SozZJO)
- **Biodegradable equipment**: currently there are relatively few non-plastic options for much of the equipment required for fishing. However, a research project at the University of Portsmouth in the UK is looking to change that, aiming to produce a commercially viable biodegradable fishing net by 2023 (see bit.ly/3Rjdwwh)

Fish farming can also provide some advantages over commercial fishing, but it comes with its own set of problems, as you can read about in our aquaculture resource.

What can we do as consumers?

You might be forgiven for thinking that there is nothing we can do to influence the fishing industry, but that's not the case. ***Consumer pressure*** is real and it moves industries!

Case study: free-range eggs



The percentage of eggs that are produced from free-range hens has massively increased in both the UK and the US in recent years, though the US still lags behind. This is almost entirely due to consumers demanding higher welfare standards. This kind of pressure has two effects: it influences government legislation (the worst battery-hen cages were banned in Europe in 2012 and in California in 2015) and it changes the behaviour of supermarkets and food producers. In the UK, consumer pressure has led to many supermarket chains having a 100% free-range sourcing policy for their own brand products. This change in buying habits by the supermarkets then led to increasing free-range egg production to meet demand.

Read more about this story on Hannah Ritchie's blog at bit.ly/3fpwVhU

Take action

Now you know the background it's time to take action

Inform yourself

In order to apply consumer pressure you need to be able to make informed choices. Here are two resources to help you (more can be found on the internet).

- The MSC label. The Marine Stewardship Council is a non-profit organisation which aims to set standards for sustainable fishing. Look for the blue MSC label on fish products when buying. You can also find further information about certain species on their website at msc.org

Public domain, via Wikimedia Commons

- Good Fish Guide. The Marine Conservation Society hosts a fantastic 'Good Fish Guide' on their website at mcsuk.org/goodfishguide which goes into detail on a large number of fish species. This is especially useful for species where the sustainability varies depending on catch location and catch method. It also covers farmed fish.

Find out what's available near you and apply pressure

Survey the fish products at your local supermarket. What types of fish are there? Is there enough information available to you to tell how it was caught? Any MSC labels on display?

If you have a number of different supermarket chains in your area then survey as many as possible and compare your findings. Which company stocks the most sustainable products?

Write to the head office of the supermarket(s) you surveyed with your findings and ask what their policies are when it comes to stocking and labelling sustainable fish products. Do they plan to improve this in the future?

Take personal action

Now you know what to look for and where best to shop, any fish-eating students can encourage their families to switch to more sustainable fish eating. Why not also try to replace at least some fish meals with vegetarian or vegan alternatives – here are some suggestions to get you started: bit.ly/3BTwqUR

Spread the word

Share your findings with the rest of the school in a poster, or why not write an article for the school newspaper or website?

Want to help improve this activity?

This activity is a living document! Help us by editing this activity to make it as good as possible, just use this short link (just type it into your web browser's address bar): bit.ly/3MdtRlf – full instructions are provided. Any edits that can make this resource easier to use in the classroom are very welcome, so please follow the link and make your contribution!

How did you get on?

As always we would love to see the results of your creativity! Please log into the Roots & Shoots website and post a mission update. Let us know how you got on by providing us with a project write-up including pictures and videos.

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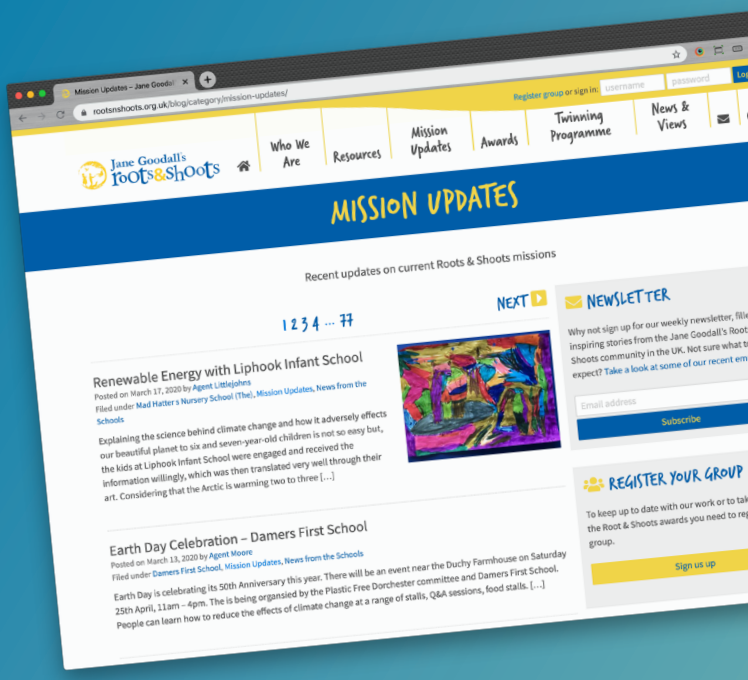
See **www.rootsnshoots.org.uk/awards** for details about the awards and information on how to upload your 'mission update' story and win!



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Learning Resource

Our oceans, our pollution

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Our oceans, our pollution

SCAN ME

Get the links

All links in this activity can be found on our website. Scan the QR code or use this short link: **bit.ly/38eYqrp**

The oceans and seas of the world are truly amazing and beautiful places full of life … and our pollution! Every year, about 8 million tons of plastic waste escapes into the oceans having a huge impact on the wildlife and their habitats. Use this resource to discover the types of waste floating around the ocean and how you can help, no matter where you live!

Trash in the oceans in Maldives. "Thilafushi Kuni Gondu - God's dirty little secret" by Hani Amir is licensed under CC BY-NC-ND 2.0.

In this activity you and your students will:

- Learn about what types of waste end up in our oceans and how it gets there.
- Create a map of where that waste is piling up.
- Learn about actions people are taking to clean up the oceans.
- Get involved by taking action, for example by running a local beach or waterway clean, or taking part in a citizen science project.

Objectives

To learn about how our waste is filling up our oceans and how we can address it

What do I need to make it work?

For this activity, you'll need:

- Internet access
- A printer
- Optional: A selection of cleaned waste items such as used PET bottles, old newspapers, cans, etc.

What things will my students create?

- A base map of world oceans with a layer showing where waste is accumulating

Types of waste

Let's take a bit of time to figure out what kinds of waste end up in the ocean. This will help later when we work out how to reduce it!

Sorting the waste

Ask your group to list as many items as they can think of that they might normally throw out or recycle at home and write each one on a piece of paper. You could also find images or bring in clean items of waste to use if you wish.

Now sort those items into the following categories – you might want to adjust these categories slightly to reflect the sorting systems used in your local area.

- In the bin
- Composted
- Recycled
- Reused

Now think about some questions:

- What happens to the items in each pile? Where do they end up?
- What about when we are not at home, what do people do with their waste then?
- Can you sort the "In the bin" pile in order of how long each item takes to decompose? Here's some information on how long some items take: bit.ly/3z0cnnU
- Which kinds of waste are worse for our oceans and why?

How does waste end up in the ocean?

Have a think in your group about how the waste we create might end up in the sea.

- WWF have a short article with some pointers: bit.ly/3PLPpae
- This plastic tracker is also quite helpful: bit.ly/3PGZghn

Microplastics

Microplastics are plastic pieces that measure less than five millimetres.

Some microplastics have been made small intentionally, for example industrial abrasives used in sandblasting and microbeads in facial scrubs. Others have formed by breaking away from larger plastics such as single use plastic carrier bags which have fragmented over time.

Find out more on the UK Natural History Museum website: bit.ly/3lEokrA

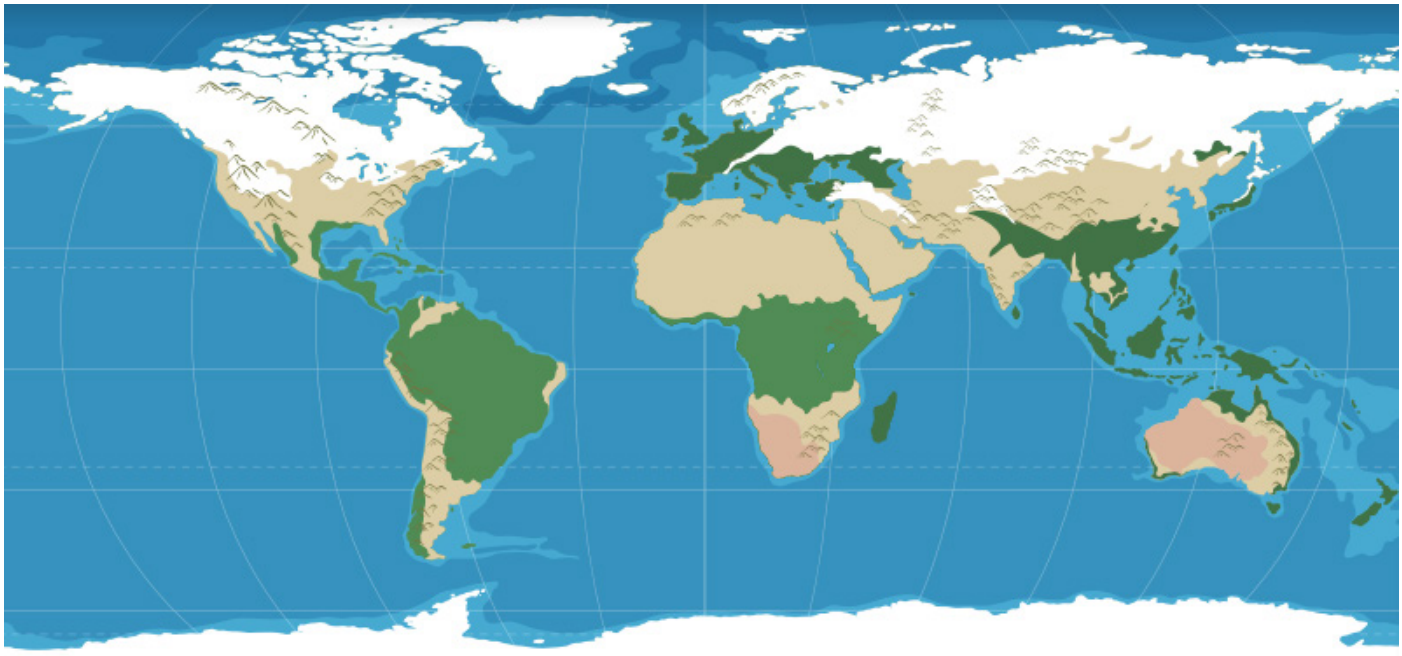
Image: The results of picking up plastic fragments (microplastics) along 22 metres (75ft) of Oregon Coast at Cape Perpetua during a Eugene Natural History Society Beach Clean Up. "Microplastics IIb - Beach Clean up - 25g plastics / 22m That's 638KG along the Oregon Coast" by Wolfram Burner is licensed under CC BY-NC 2.0.

Make an ocean waste map

Now we've thought about what kinds of waste is out there, let's see if we can find where in the world it is building up!

Prepare a basemap

First, you'll need to print out a map of the world. We can then use this as a base map to add different layers to, in this and other activities.



We've prepared a low-ink colour map for you to download and print: bit.ly/rs-globe-map

Locate the waste

Once waste flows down our rivers or is dropped on a beach, where does it end up? Encourage your group to research where larger patches (known as 'garbage patches') and other problem areas can be found around the globe.

Here are some helpful resources:

- What and where are 'garbage patches': bit.ly/3Gh2pQF
- Ocean plastic map: bit.ly/3lJdPDb – shows where large patches are developing and also other sightings of waste on beaches and in coastal areas.
- NASA are also tracking the flow of waste around the oceans: go.nasa.gov/3z0ooKc

Ocean currents

If you want to learn more about the ocean currents that determine where waste accumulates in our oceans, then be sure to try our 'Warm seas, cold seas, ocean currents' resource.

Map the waste

Using the information that your group has found, mark the garbage patches and other likely places for waste accumulation you've identified on your map. You can either draw directly on the map, or if you are planning on carrying out a number of ocean activities then you might prefer to overlay a clear sheet of acetate on your basemap and draw directly on that instead.

Is anyone clearing it up?

Let's take a brief look at some of the clean up operations already going on

Waste2Wear:

bit.ly/3wLxjNU – Cleaning up the oceans, giving people jobs and recycling waste into clothing.

Trashion

It's amazing what you can make out of discarded materials. The process of turning unwanted materials into clothing is called 'trashion' and anyone can give it a try. Check out what some of our Roots & Shoots schools in the UK have been doing on the website here: bit.ly/3wQfNYL – there is even an activity sheet to get you started running your own trashion show!

The Ocean Cleanup:

https://theoceancleanup.com/oceans/ – Their method is to slowly drag a large U-shaped boom with a waste collection net in the middle between two ships. Once they have filled the 'retention zone' they empty it out and sort it for recycling.

Plastic eating bacteria:

https://bit.ly/3guw1xR – Scientists in Manchester, UK have made a biotechnological breakthrough which may help humans to call on engineered bacteria cells to reduce our plastic waste.

Can you find any other projects that are helping clean up our oceans? Why not try to plot them as another layer on your map of the world?

What can you do to help clean up the oceans?

There's a lot of waste out there and as we've discovered, some people are already doing their bit to try to tackle the problem – but we all need to take part to fix it properly!

Get your group to come up with some ideas of what you could do to compost, reduce, reuse and recycle more waste, either before it's gone anywhere from your home or by finding it out in the wild.

Here are some ideas to consider:

- You could try our "Rubbish charts" resource (bit.ly/rubbish-charts) and get litter picking and rubbish surveying – why not do a litter pick and survey at a local river or beach?
- Join a beach clean: bit.ly/3PBdAYN. Don't forget that waste also travels to the oceans and seas from far inland, so if you are nowhere near a beach then perhaps there is a small, local waterway or river that could benefit from your attention (CAUTION: ensure that proper safety protocols are followed at all times on a litter pick, both in terms of equipment used, provision of adequate supervision and selecting locations away from e.g. deep or fast-flowing water or areas that may be dangerous due to tidal conditions).
- Maybe there are more items we could recycle than we think – how about a campaign to raise awareness of what can be recycled in your local area? For example, did you know that Coop supermarkets in the UK now collect soft plastics: coop.uk/3wNGsV4? What other recycling can you find out about – Check out www.recyclenow.com

Want to help improve this activity?

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Show us your ships!

As always we would love to see the results of your creativity! Please log into the Roots & Shoots website and post a mission update. Let us know how you got on by providing us with a project write-up including pictures and videos.

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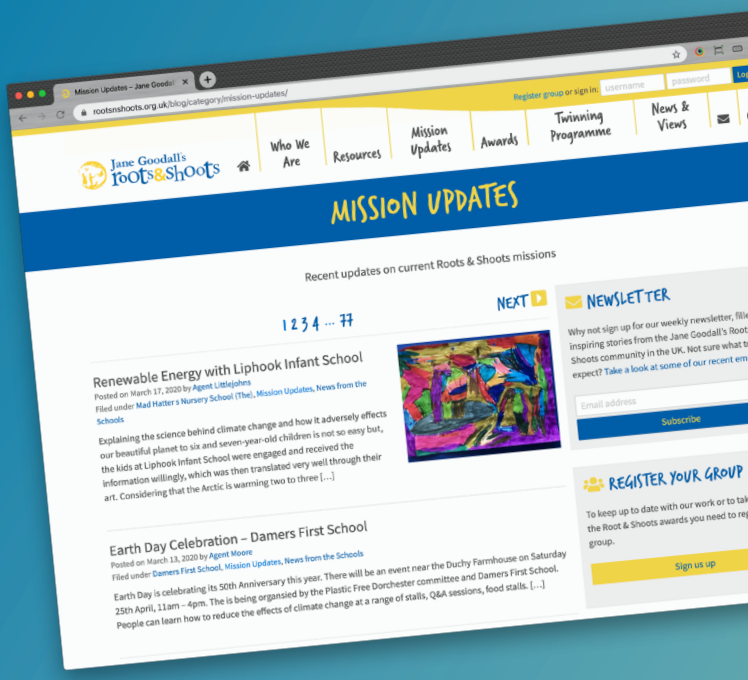

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Tell us how you got on

When your project is finished we'd love to see what you did! If you already have an account you can upload a story with images to the Jane Goodall's Roots & Shoots UAE website (find us at uae.rootsandshoots.community) to show off pictures and videos of your ships to a wider audience. If your school or youth group does not already have an account then just fill in the form on the website and we can set you up.

Keep up to date with Jane Goodall's Roots & Shoots UAE

As well as the website you can also find us on Facebook at **facebook.com/RootsnShoots.ae** or on Twitter as **@JaneGoodallUAE**

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Learning Resource

Ocean life

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Ocean life

SCAN ME

Get the links

All links in this activity can be found on our website. Scan the QR code or use this short link: **bit.ly/39KL46G**

What kind of plants and animals live in our ocean? Why is the life we see in a warm sea like the Indian Ocean different from what we see in a cold sea like the North Atlantic?

In this activity you and your students will:

- Look at the environment of the northern North Atlantic and northern Indian Ocean.
- Look at some typical animals of each ocean.
- Look at the differences and similarities between these fauna and relate them to the environmental differences.
- *Optional*: Take it further by exploring the effects of climate change on life in our oceans.

What do I need to make it work?

For this activity, you'll need:

- Access to the internet
- Material to make a wall chart

What things will my students create?

- A wall chart/map showing typical fauna and conditions in the two studied locations.

Warm seas, cold seas, ocean currents

This resource looks at the different types of life that live in different areas of the ocean, particularly the difference between warm and cold seas. If you want to know more about *why* some seas are warm and others are cold then be sure to also try our 'Warm seas, cold seas, ocean currents' resource.

Photo by Felix Rottmann: https://www.pexels.com/photo/tail-of-a-whale-above-water-10305569/

Want to help improve this activity?

This activity is a living document! Help us by editing this activity to make it as good as possible, just use this short link (just type it into your web browser's address bar): bit.ly/3O93L37 – full instructions are provided. Any edits that can make this resource easier to use in the classroom are very welcome, so please follow the link and make your contribution!

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The northern North Atlantic

The North Atlantic is the area of the Atlantic Ocean that lies north of around 8°N. We are going to look at the more northerly part, from around 35°N.

Split your students up into 2 groups to do some research. The first group will investigate the environment of the northern North Atlantic, the second group will investigate the animals.

Environment

Here are some questions for the environment group to tackle:

- Average sea temperature. This is most easily researched by looking at the available data for a series of places, for example Porto in Portugal (towards the south of the area), Donegal in Ireland (in the East of the Atlantic), St Anthony in Canada (a similar latitude to Donegal, in the West) and Hammerfest in the north of Norway.
- Average visibility. It's difficult to find accurate information about this, but a fun way to get a feeling for ocean visibility is to look through some scuba diving videos on YouTube for various locations. Look for dives out in the ocean where possible. Some possible search terms are 'scuba greenland', 'wreck dive norway', 'scuba west coast ireland', and 'scuba lisbon'.
- Average number of stormy days per year. This can be compiled from this resource from Colorado State University: bit.ly/3zLzJxY
- Deepest part and average depth.
- Number of islands. Rather than aiming for a number here, students can take a look at a service such as Google Maps and rate whether there are very few, few, many or very many islands. Make sure you zoom in!

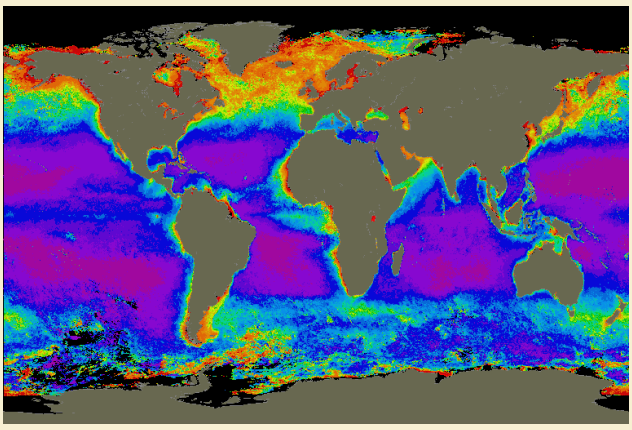
Animals

Here are some questions for the animals group:

- How much phytoplankton is there? Is there very little, little, quite a lot or lots?
- What are some of the most common types of fish?
- How many different species of fish are there? Are there very few, few, many or very many?
- Do the fish tend to be colourful or fairly dull?
- The three fish questions can be tackled in a variety of ways, but one quick method is to look at the Wikipedia category page for 'Fish of the North Atlantic' (bit.ly/3y1jA64).
- What marine mammals can you find in this region?
- What sort and quantity of corals can you find in the region? Are they solitary corals, or are they reef-building corals?

Phytoplankton

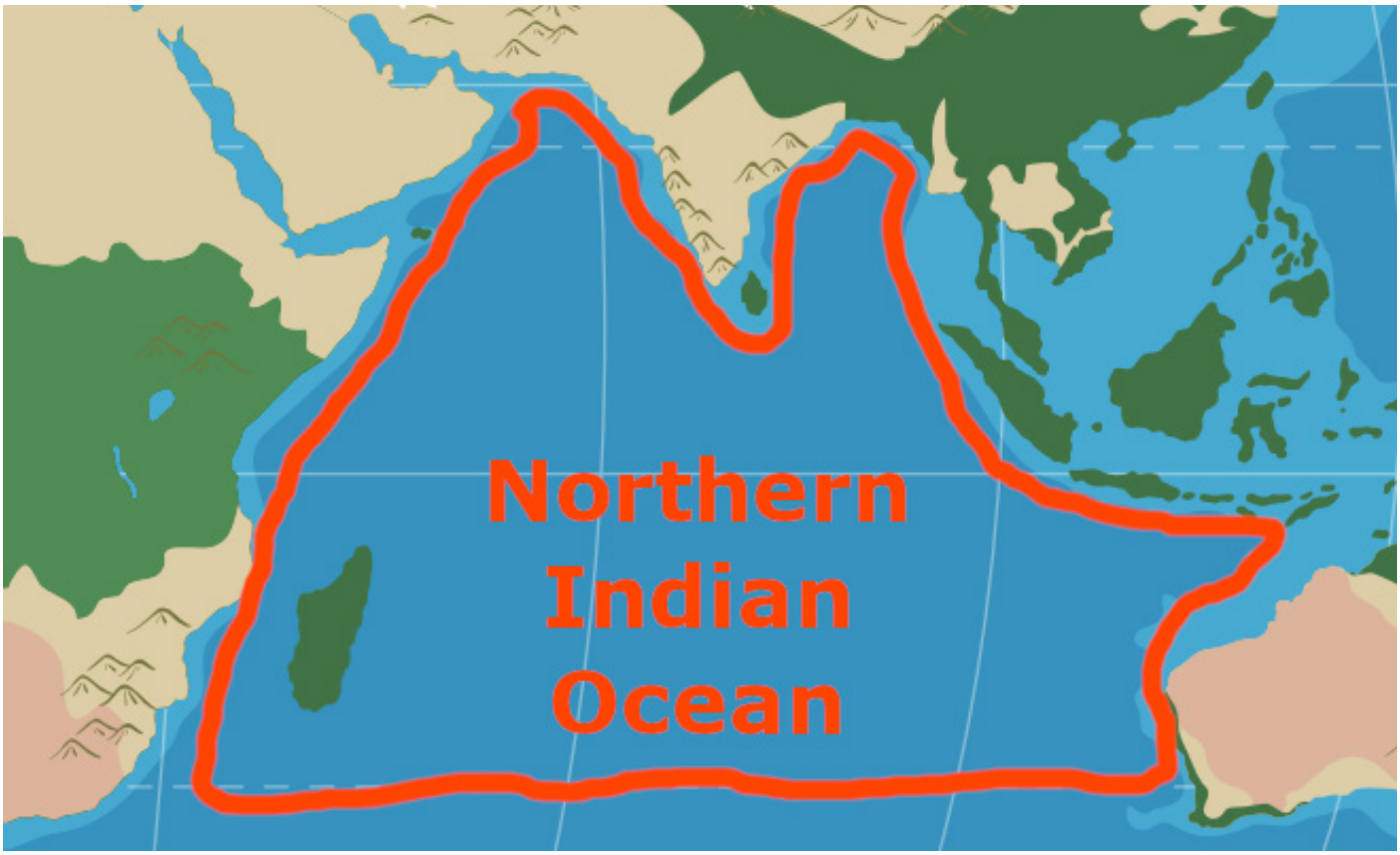
Phytoplankton are single-celled organisms that photosynthesise like very small plants. They are also a very important foodstuff for many animals, so the more phytoplankton there are the more animal life that can be supported. Find out more about them and where they live here: bit.ly/3PRD2t6 and if you want to know more about why they are distributed as they are then check out our 'cold seas, warm seas, ocean currents' resource.



Red and orange indicate high concentrations of phytoplankton. Concentrations decrease as you go down the colour spectrum. Image from NASA's SeaWiFS mission. Downloaded from bit.ly/3PRD2t6

The northern Indian Ocean

The northern Indian Ocean is the area of the Indian Ocean that lies roughly between the Tropic of Capricorn (around 23.5°S) and the Tropic of Cancer (around 23.5°N).



Swap over your two student groups so that the group that studied the environment for the North Atlantic are studying animals for the Indian Ocean. Now, try and answer the same questions as before.

Environment

Here are some Indian Ocean specific hints for the environment group:

- Average sea temperature. Check Mombasa in Ethiopia (in the centre west of the area), Padang in Indonesia (centre east), Gwādar in Pakistan (north), Saint-Paul in Réunion (southwest) and Carnarvon in Australia (southeast).
- Average visibility. Some possible YouTube search terms are 'dive coral bay australia', 'dive pulau weh', 'dive oman' and 'dive durban'.
- Average number of stormy days per year. Use this resource from Colorado State University: bit.ly/3zNfnEq

Animals

Here are some Indian Ocean specific hints for the animals group:

- The Wikipedia category page for 'Fish of the Indian Ocean' is bit.ly/3b4ZuyX

Photo by Jeremy Bishop: https://www.pexels.com/photo/photo-of-sea-turtle-2765872/

Compare and contrast

What are the key similarities and differences between the two oceans?

Depending on time available and the age of the students, you might want to ask the groups to present their findings to one another (they could include some images plus a short section of a representative dive video) or you could summarise for them. Key findings should include:

- The Indian Ocean is much warmer than the North Atlantic.
- The eastern side of the North Atlantic is warmer than the equivalent latitudes in the west, whereas the Indian Ocean is more uniform.
- In general, underwater visibility is higher in the Indian Ocean than in the North Atlantic.
- The North Atlantic is considerably stormier than the north Indian Ocean.
- The North Atlantic is deeper than the Indian Ocean.
- Although it's still very sparse, there are more islands in the Indian Ocean than in the North Atlantic.
- Although the phytoplankton map suggests there is more life in total in the North Atlantic, it is home to relatively few different species of fish, and they tend to be dull in colour compared to what we see in the Indian Ocean.
- The North Atlantic contains relatively few corals and they are almost all solitary, as opposed to the Indian Ocean where you can find a large number of reef-building corals.

Can your students connect some of their environmental findings to their animal findings?

Why are the Indian Ocean fish so colourful?

There are a lot of things that affect the colour and patterns on fish (there is a great article here in Dive Training magazine: bit.ly/3QAzZ8O), but a major underlying factor is the availability of light. The lower visibility in the North Atlantic (itself caused by more storms and more phytoplankton) caused fish eyes to evolve to favour particular wavelengths of light – the fishes' colours and patterns then adapted too, into what looks to us surface dwellers as being less colourful.

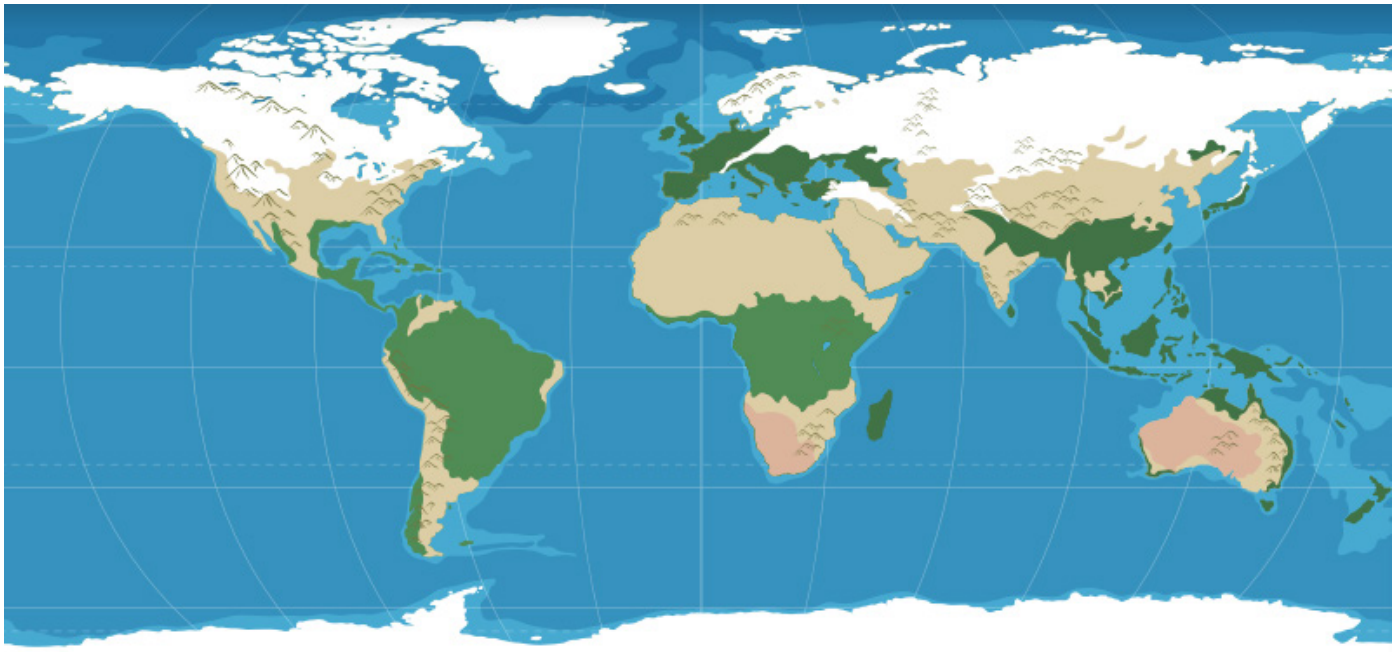
Make a wall display

Now we've done the research, let's display it!

Prepare a basemap

First, you'll need to print out a map of the world. We can then use this as a base map to add different layers to, in this and other activities.

We've prepared a low-ink colour map for you to download and print: bit.ly/rs-globe-map or you could make a map of your own.



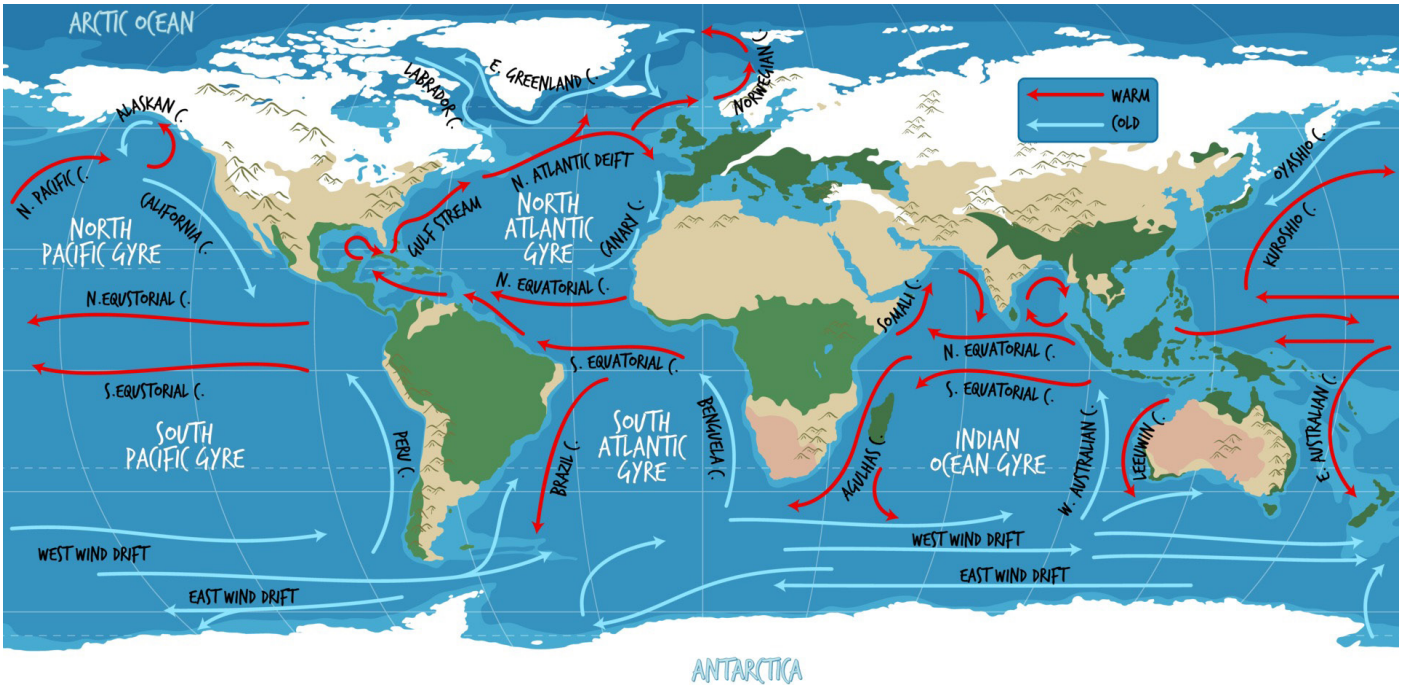
Add your findings

Decorate your map with your findings. You could include print-outs of some of the common fish types, marked points to show average temperatures, locations of large coral reefs, anything!

Taking it further

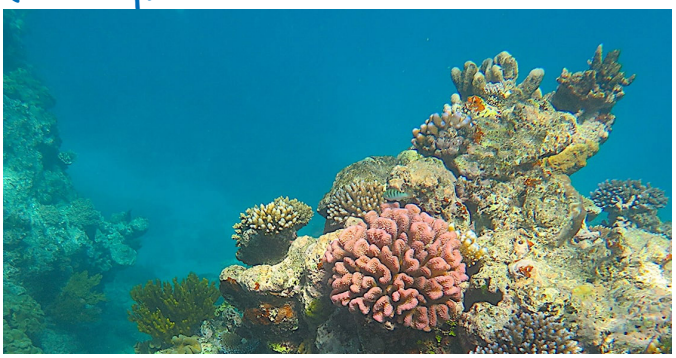
With your basic research in place there are lots of directions to take to expand this activity. Here are some suggestions:

Warm seas, cold seas, ocean currents



If you want to know more about why some seas are warm, others are cold and how this affects the distribution of life then be sure to also try our 'Warm seas, cold seas, ocean currents' resource.

Coral reefs



Diverse coral community at Norman Reef in the northern Great Barrier Reef, Australia by Rebecca Jackson, CC BY-SA 4.0 <https://creativecommons.org/licenses/by-sa/4.0>, via Wikimedia Commons

In terms of fauna, one of the big differences between the North Atlantic and the Indian Ocean is the prevalence of reef-building corals. Some things to research:

- Is a coral a plant, an animal, or something different?
- What temperature of water is optimum for reef-building corals?
- How deep/shallow does the water need to be for a coral reef to form? Why?
- Can you relate what you have learnt about corals to the observations you have made in this activity?

Climate change

Bleached branching coral (Acropora sp.) at Heron Island, Great Barrier Reef. Author: J. Roff. By Acropora at English Wikipedia, CC BY-SA 3.0 <https://creativecommons.org/licenses/by-sa/3.0>, via Wikimedia Commons

The effect of man-made climate change on our oceans is heart-breaking and ever increasing. Some particular effects you might want to explore more include:

- Coral bleaching: what causes it and what effect does it have on the reef community? There are a series of resources published by NOAA in the US which can help explain this: bit.ly/3QuNvei
- Range shift: as temperatures change in the ocean, the range of various species change, which can have dramatic effects on other species which rely on their presence. This Scientific American article is a good starting point: bit.ly/3xI7Xj5

Want to do your bit to tackle climate change?

Every little helps when we work together! There are lots of things that you and your students can do to help cut your energy use by reducing, reusing and recycling. You can find some great resources to get you started on the Roots & Shoots UK website at bit.ly/3zPxIAY

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Learning Resource

Warm seas, cold seas, ocean currents

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Warm seas, cold seas, ocean currents

SCAN ME

Get the links

All links in this activity can be found on our website. Scan the QR code or use this short link: **bit.ly/3N7cim2**

What makes one sea warm and another sea cold? What makes water flow from one part of the world to another? And how does this affect where we find life in the oceans of the world?

In this activity you and your students will:

- Carry out some simple experiments that explain the basics of ocean currents.
- Carry out some experiments that show the conditions plant life needs to thrive and how this relates to water temperature.
- Learn about the impact this has on the diversity and location of marine life.
- Create maps showing the major ocean currents and life 'hotspots'.

objectives

To understand why water flows around the world and the effect this has on marine life.

What do I need to make it work?

There are a number of experiments in this activity.
You can choose to carry out all of them, a selected few or none at all depending on the amount of time and resources you have available – we've filmed or picked videos for each experiment to fill in for the ones you don't carry out yourself.

What things will my students create?

- Maps of ocean currents and ocean life.

Ocean life

This resource touches on where you find life in our oceans, but if you want to learn more about the particular plants and animals that thrive in warm and cold seas, then be sure to also try our 'Ocean life' resource.

Convection cells

Why are some parts of the Earth warmer than others? What effect does this have on the oceans?

Experiment 1: torch and ball

Watch this experiment (30 seconds): youtu.be/578cejRWHrQ

To carry out this experiment yourself, you will need:

- A small torch that can be focused on something fairly close
- A medium or large size ball, e.g. a child's football

Have one student hold the torch and another the ball. Turn on the torch and point it at the ball. Find a distance between torch and ball such that when the torch is focused on a spot on the ball's 'equator', the light only covers a small area. From the same distance, change the aim of the torch so that it is pointing at a higher 'latitude' on the ball. Note that the light now covers a much bigger area.

What does the experiment tell us?

Areas near the Earth's equator receive more of the sun's energy than areas near the poles.

The energy received from the sun is spread out over a much smaller area near the equator than it is nearer the poles. Areas on the Earth's surface like the equator that receive more energy per square metre get heated to a higher temperature than areas like the poles.

Experiment 2: temperature and salt

Watch this experiment (1 minute): youtu.be/ZXo6i6ts5EE

To carry out this experiment yourself, you will need:

- A clear glass vessel such as a beaker from the school science lab filled with water at room temperature
- A smaller container of hot water
- A smaller container of room-temperature salt water (the more salt the better)
- Red and blue food colouring
- A pipette

Add a small amount of red food colouring to the hot water and mix well. Add the blue food colouring to the salt water. Gently add a few drops of the hot water to the large beaker – it should float around at the top. Now add a few drops of the salt water – it should sink to the bottom of the beaker so that you have three distinct layers.

What does the experiment tell us?

Warm water is less dense than cold water, and saltier water is more dense than fresher water.

You can see from this experiment that we might expect the water near the surface of the ocean to be warmer and less salty than water near the bottom.

Experiment 3: convection cells

Watch this experiment (3 minutes): youtu.be/0mUU69ParFM

To carry out this experiment yourself, you will need:

- A small-medium sized clear plastic tank, like a fish tank, half filled with room temperature water. You should be able to safely balance the tank on two mugs
- 3 identical mugs, two filled with ice-cold water and one filled with hot water
- 2 coasters
- Red and blue food colouring (paste or gel is best).

Place the two mugs of cold water onto the coasters, and balance the tank on top of them (space them widely). Carefully place a blob of red colouring at the bottom of the tank, in the centre (you may need a pipette for this). Now place two blobs of blue colouring either side of the central blob (leave a reasonable gap between them).

Slide the mug of hot water under the centre of the tank, beneath the red blob. As the water in the tank is heated by the mug, you will be able to watch convection cells develop as the water rises near the middle, travels along the top to the edges of the tank, cools, and returns to the centre along the bottom.

What does the experiment tell us?

The density differences in the water caused by differential heating drive currents.

In experiment 1 we saw that the Earth receives much more heat energy from the sun at the equator – this is equivalent to the mug of hot water under the centre of the tank. The mugs of cold water at the edges represent the Earth's poles. Experiment 2 showed us that warm water is less dense than cold water. This experiment shows us that these two effects combined cause currents in the 'ocean' represented by the water in the tank.

Coriolis effect

The results of our experiments show that we might expect ocean water to be heated near the equator, travel outwards from there towards the poles along the surface where it cools and sinks, being pulled back towards the equator nearer the bottom of the ocean. And that indeed is what happens, but there is something else going on as well: the coriolis effect.

The coriolis effect is the name given to the way things which are travelling in a straight line appear to have a curved path when viewed from a rotating frame of reference such as the surface of the Earth.

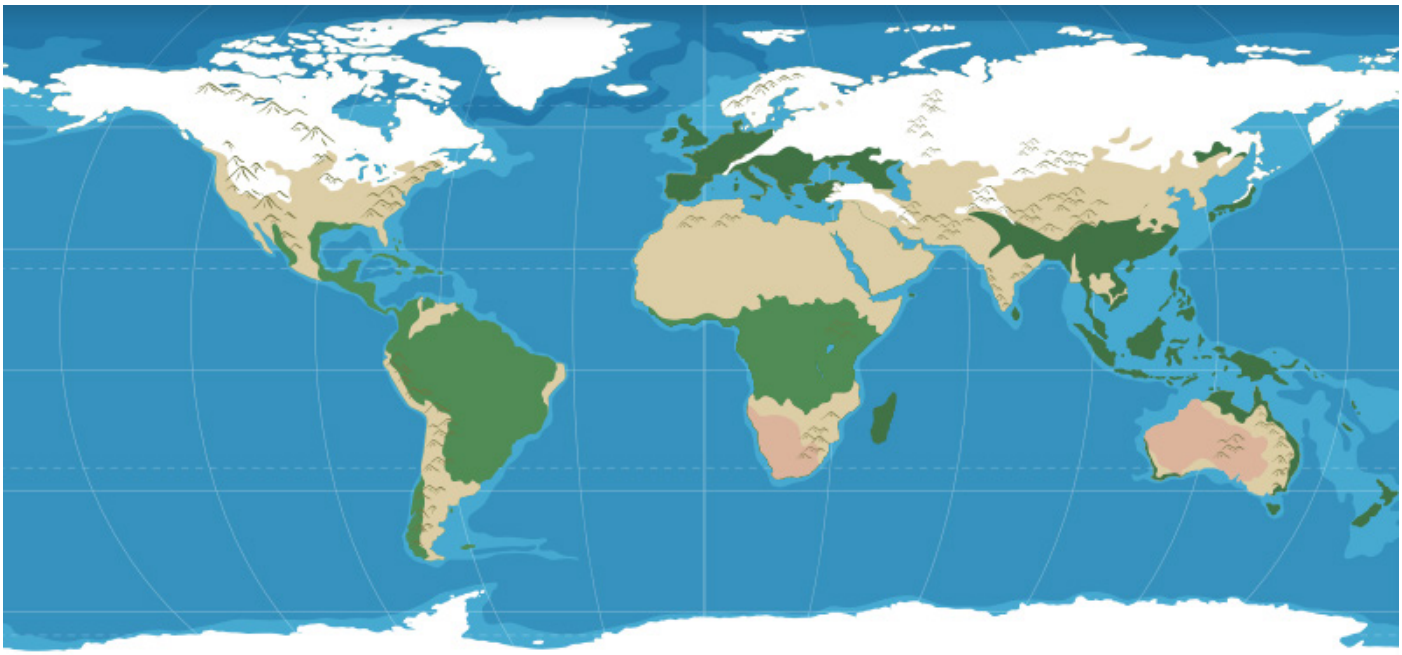
With care, it is possible to demonstrate the coriolis effect using a ball and a merry-go-round, but you may prefer to just watch the video for this one: youtu.be/mPsLanVS1Q8.

Mapping the main ocean currents

We now have everything we need to predict how we might expect the main ocean currents to travel around the Earth's oceans.

Older students: Ask them to try and draw what they think the main ocean currents might look like on a base map,using what they have learnt about convection cells and the coriolis effect, then compare to the map shown later.

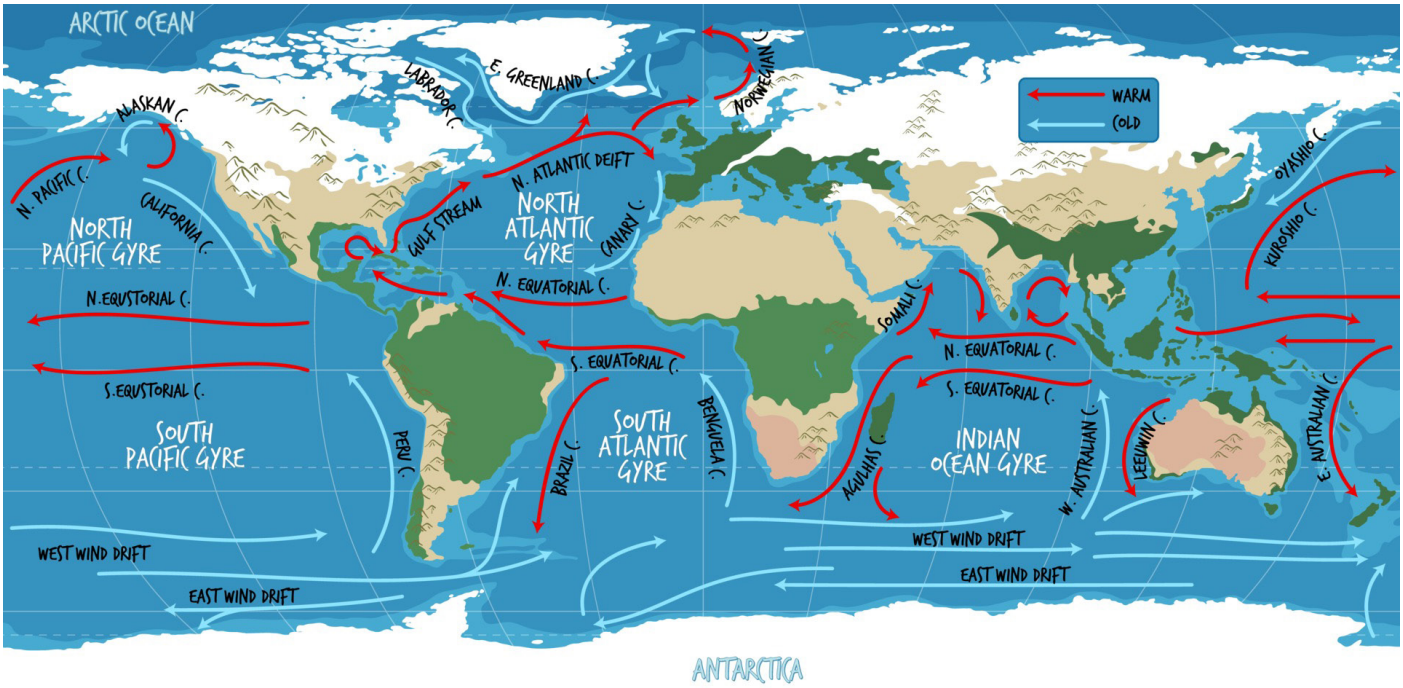
We recommend using a basemap like this one:



We've prepared a low-ink colour map for you to download and print: bit.ly/rs-globe-map

Younger students: Show them the ocean currents map below and relate what they can see back to convection currents and the coriolis effect. The differential heating/convection cell experiment helps explain the flow of warm water from the equator towards the poles, and the coriolis effect accounts for the circular patterns:

Download your own copy of the ocean currents map from Vecteezy: bit.ly/3x1nprD



Growing plants

Ocean currents can help us predict where we see the most life in our oceans, but we also need to know a few more things.

Experiment 4: what do plants need to grow?

Watch this experiment (5 minutes and 40 seconds): youtu.be/Nffg3GlSuXg

To carry out this experiment yourself, you will need:

- Some dried beans, such as pinto beans
- 6 glass jars, two of which need well-sealed lids (jars for preserving food work well)
- Some cotton wool balls
- Some soil
- Water

Fill four of the jars about halfway to the top with loosely-packed soil. Fill the remaining two jars to the same height with cotton wool. Add a few beans to each jar, placing them gently between the soil/cotton and the glass wall so that you can see them. They should be about a couple of centimetres below the surface of the soil/cotton. Add water to each of the jars so that the soil/cotton is damp but not soaking wet. Seal two of the jars containing soil tightly with the lids.

Place one set of three jars (cotton, soil with no lid, soil with lid) somewhere fairly sunny, and the other set in a cupboard where it is dark. Leave them for a week, checking that the soil/cotton wool in the open jars is damp every day and adding water if required (try not to open the sealed jars unless you can see that the soil is getting very dry).

After a week, compare how well the beans have grown in each of the six jars. What can this tell us about which of the sun, nutrients (soil) and air are needed for healthy plant growth?

What does the experiment tell us?

As well as water, plants need access to sunlight, nutrients and air to grow well.

The beans in the open, soil jar that was kept in the sunlight should have produced the healthiest, most vigorous growth.

Experiment 5: air

We learned from experiment 4 that plants need water, sunlight, nutrients and air to grow. As we are looking at life in the oceans, access to water is not a problem.

Sunlight in the oceans

The sun can penetrate approximately the top 200m of the ocean, known as the sunlit, or photic zone. Below that we find the twilight zone then the midnight zone. Learn more: youtu.be/uKhpx6lAH1k

Sunlight, too, is plentiful in the upper part of the oceans. Nutrients in the ocean are mostly derived from organic matter on land making its way into the sea, so you tend to find the most nutrients in the parts of the ocean which are nearest the land. So what about air?

Watch this experiment (2 minutes): youtu.be/wQanYgXZtQg

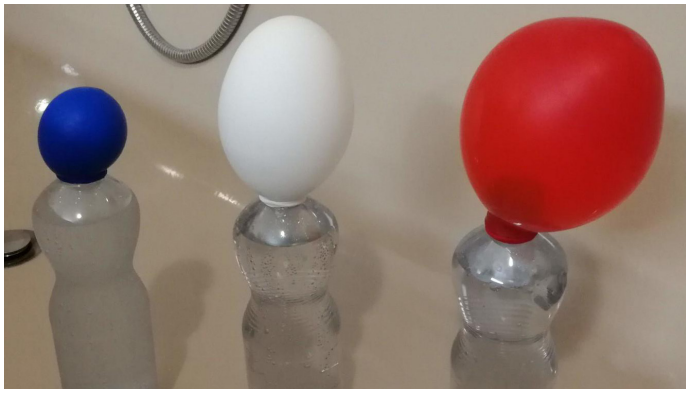
To carry out this experiment yourself, you will need:

- 3 small PET bottles of carbonated (fizzy) water with screw lids
- Some uninflated balloons (you need one per bottle, plus some spare)
- A large container of very hot (but not boiling) water, such as a large saucepan
- Access to a fridge or freezer
- Somewhere to open the bottles where it does not matter if they spill

Carefully stretch a balloon over the top of each closed water bottle. Work the neck of each balloon down so that the lid of the bottle is completely within the bulb. Place one bottle in the fridge for a few hours (or in the freezer for around 30 minutes, be careful not to let it freeze). 30 minutes before you are ready to take the cold bottle out of the fridge/freezer, submerge a second bottle in the container of hot water and leave it for 30 minutes. Keep the third bottle at room temperature, out of direct sunlight.

You should now have one bottle containing fizzy water at around 10°C, one with water at around 20°C and one with water at around 40°C. Place the bottles somewhere where it does not matter if they spill and carefully unscrew the lid of each bottle, keeping it within the balloon.

As the gas within the bottle escapes, it will fill the balloons. Note how the cold bottle releases relatively little gas, and the hot bottle releases much more.



Here's our attempt! The cold bottle is on the left with the blue balloon, the room temperature bottle is in the centre and the hot bottle is on the right with the red balloon.

What does the experiment tell us?

Different temperatures of water are able to hold different amounts of dissolved gas.

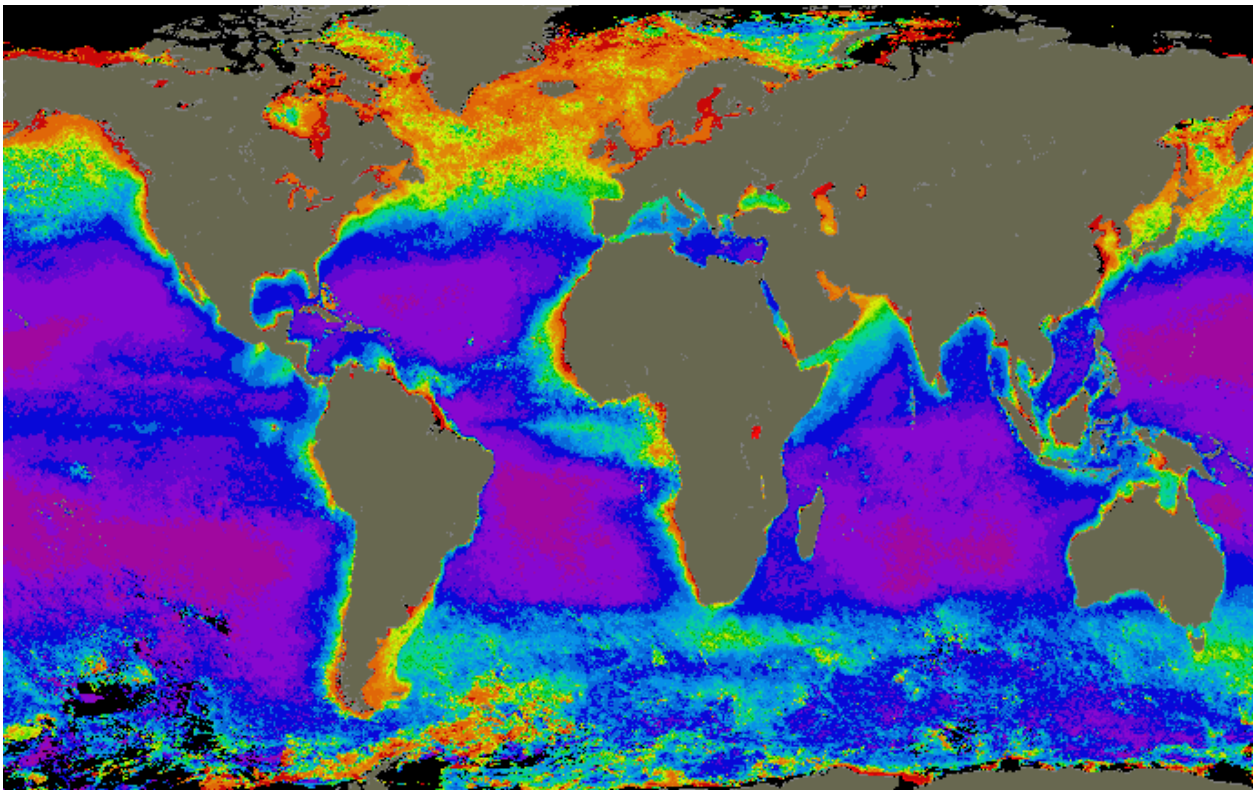
Assuming that each bottle started off containing the same amount of dissolved gases, the experiment shows that hot water can contain less dissolved gas than cold water (as more gas is expelled into the balloon from the hot water bottle).

Mapping ocean life

We now have everything we need to predict where we might find the most plant life in the oceans. And since animals need something to eat, this is also a great predictor of where we find the most animals too.

Older students: Ask them to try and draw what they think the most life can be found in the oceans, then compare to the map shown later. We can assume that everywhere on the ocean surface has a good supply of sunlight and water, so think about where in the oceans you can find the most nutrients, and the most dissolved gases.

Younger students: Show them the map below and relate what they can see back to the ocean currents map, the arrangement of the continents and hence where we find the most nutrients and the most dissolved gases.



Red and orange indicate high concentrations of phytoplankton. Concentrations decrease as you go down the colour spectrum. Image from NASA's SeaWiFS mission. Downloaded from bit.ly/3PRD2t6

The map above shows the global distribution of photosynthetic algae called phytoplankton. Red and orange show the highest concentrations, decreasing through the colour spectrum. You can see that the most phytoplankton is found in high latitudes where the water is cold (hence containing more dissolved gas) and near land (which provides nutrients). There is also an increase in concentration around the equator – thinking back to our ocean currents pattern and the convection cell experiment, this is where relatively cold, gas rich water which sank at the poles is moving up from near the bottom of the ocean towards the surface.

Biodiversity

This resource has focused on working out where in the oceans we can see the most life. So if the most life is in the colder oceans, why do we always think of tropical oceans as being teeming with life? There are a couple of reasons:

Firstly, because there are fewer nutrients to be found in tropical seas, life tends to concentrate in the areas where they can be found. So, the productive areas of a tropical ocean tend to be ***very*** productive, with lots of life crammed into a relatively small space. In the colder oceans things tend to be more spread out.

Second, although the overall number of plants and animals is greater in colder seas, the ***diversity*** of life is greater in tropical seas. Seeing lots of variety can trick us into thinking that the overall number of animals we see is higher than it actually is.

Taking it further

Although the ocean model we built using these experiments is very simple, it does a good job of explaining the basics of ocean currents and how they affect the distribution of life. In reality the picture is more complex – in particular, circulation of air in the atmosphere helps drive the surface flow of water in the oceans, and the density changes that help drive the deep circulation are influenced by salt content as well as temperature differences. A good starting point for gaining a full understanding is chapter 9 of the freely available book "Introduction to Oceanography" by Paul Webb, which can be found online at https://rwu.pressbooks.pub/webboceanography/

Want to help improve this activity?

This activity is a living document! Help us by editing this activity to make it as good as possible, just use this short link (just type it into your web browser's address bar): bit.ly/3ssHBQl – full instructions are provided. Any edits that can make this resource easier to use in the classroom are very welcome, so please follow the link and make your contribution!

Jane Goodall Institute

Learning Resource

A Tale of Two Ports

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A Tale of Two Ports

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Get the links

All links in this activity can be found on our website. Scan the QR code or use this short link: **bit.ly/3nA8505**

London Gateway in Essex is the newest and most advanced container port in the UK. Jebel Ali in Dubai is home to the biggest and busiest port in the Middle East. Separated by thousands of kilometres, what do they share in common and what sets them apart?

In this activity you and your students will:

- Learn about the founding, development and present day operations of the ports of London Gateway and Jebel Ali.
- Compare and contrast the two ports.
- Speculate what the future holds for each port.

Objectives

Learn how regional and global pressures shape how cities and nearby communities develop.

What do I need to make it work?

For this activity, you'll need:

- Flipchart/poster paper.
- Pens.
- Post-it notes in various colours.
- Access to the internet for further research.

What things will my students create?

- A wall display comparing the ports of London Gateway and Jebel Ali.

Introducing the ports

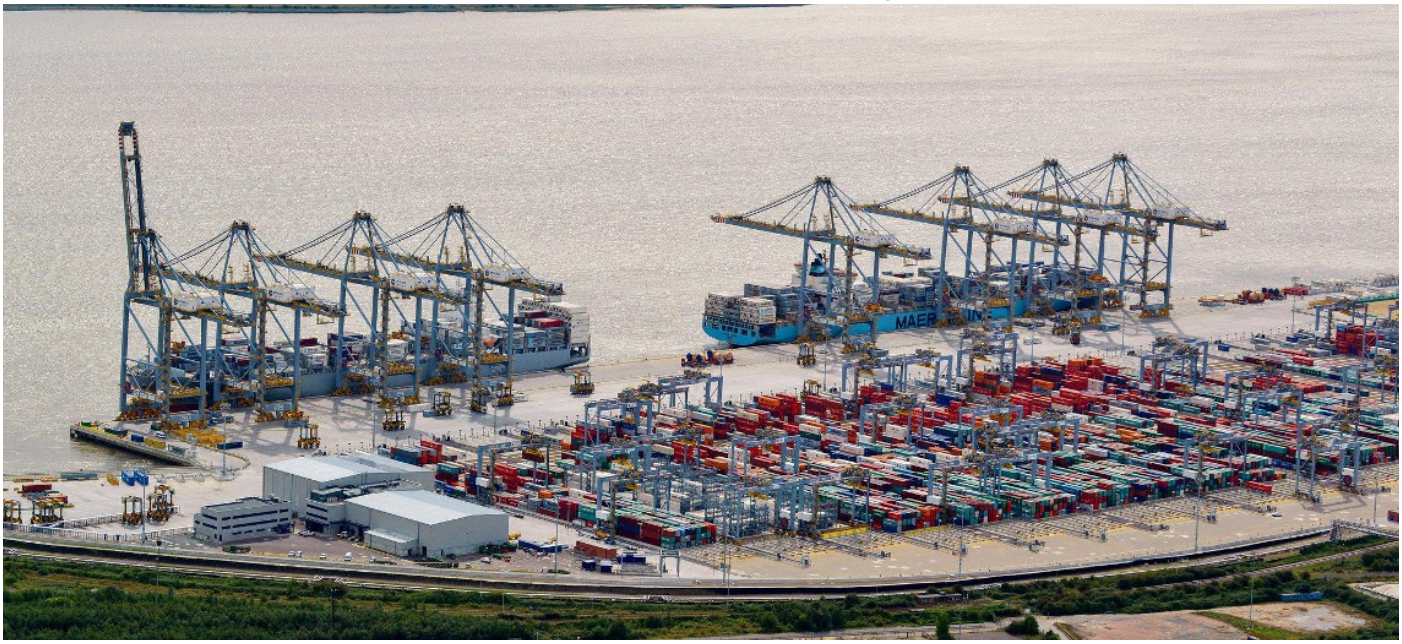
London Gateway in the UK and Jebel Ali in Dubai, UAE are both home to important cargo ports. In this section you will learn about the founding, development and operations of both ports

Below you will find a potted history of each of the two ports, along with some suggested links where you can start researching more. There are various ways that this can be presented to the students, but one possibility is as follows:

- Split your students into two groups. Assign London Gateway to one group and Jebel Ali to the other.
- Give a copy of the corresponding potted history to each group. We've put them on separate pages in this resource so they are easy to print out separately, and you can find separate PDF downloads of each one on our links page at bit.ly/3nA8505 if you prefer to distribute them electronically.
- Each group should read through their potted history – we've also provided a few questions at the end of each one to help check understanding. Older students are encouraged to research further independently, with the links provided as starting points.
- Each group can then prepare a short presentation on their port to the other group, perhaps including a short Q&A session at the end.

Photo by Eilis Garvey on Unsplash

London Gateway



Maersk ships in at London Gateway by Nick Strugnell, via Flickr. CC BY 2.0 licence <https://creativecommons.org/licenses/by/2.0/>. bit.ly/36pMDVC

When and why was it founded?

Built on the tidal River Thames, archaeological finds show that the UK's capital city of London has been a port since before written records began. The earliest evidence of sustained port activity from the Roman era shows that ships unloaded right by the location of the present day London Bridge. Since then, port activity has gradually moved further downstream to both accommodate larger ships (which require deeper water) and to allow the city itself to expand.

The area now known as Docklands in East London was the centre of activity in the 19th century, when London is believed to have been the busiest port in the world. The move downstream did not stop there though, and by the 1990s most of the Docklands ports closed and activity was centred around oil and gas terminals in Kent and Essex and the new container port at Tilbury, Essex.

In the 21st century things have changed again. After lying dormant for around 10 years, the site of the Shell Haven oil terminal on the north bank of the Thames in Thurrock, Essex has now been redeveloped and expanded to become the London Gateway container port and logistics park.

How has it developed?

Construction on London Gateway started in February 2010 and the first parts of the port opened for business in 2013. Although mainly built on an existing brownfield[1] site, construction of the site posed an unexpected environmental challenge as the site had been partially reclaimed by wildlife, including over 600 adder snakes, 300 water voles and about 5,000 great crested newts! These were all relocated to a newly expanded nearby nature reserve over the course of 4 years.

Since opening, the port has steadily expanded from processing 300,000 TEU[2] in 2014 to 1.8million TEU in 2021.

The port today

London Gateway (which is operated by the company DP World) is already the most technologically advanced and fastest growing container port in the UK and also offers the biggest on-site warehousing and logistics facilities in Europe. These on-site facilities combined with the presence of a rail terminal and road connections allow the port to serve the vast consumer needs of London and the South-East of England in a more eco-friendly way than before, as on-road transport by relatively small vehicles can be drastically reduced.

The port currently has 3 berths spread along 1.25km of quayside, and has space to expand with demand. It also boasts the tallest quay cranes in the world, at a massive 138m tall!

Questions

1. Where in London has the first evidence of a port been found by archaeologists?
2. What was the site of London Gateway used for before being developed into a container port?
3. Which rare species had to be relocated as part of the construction?
4. When did London Gateway first open?
5. How many TEU did the port handle in 2021?

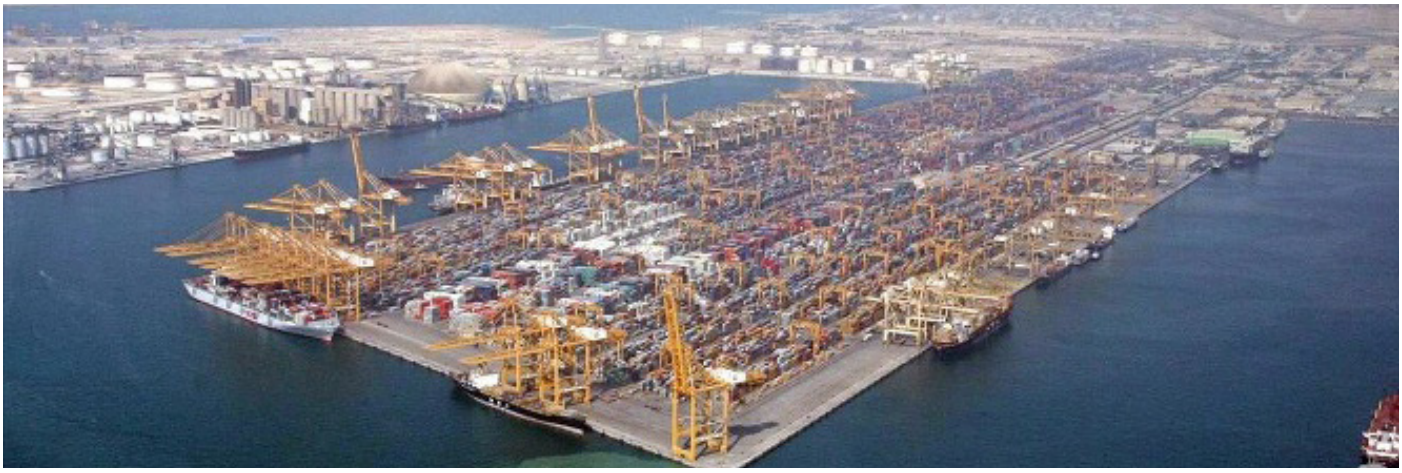
Learn more

- Want to learn more about the London Gateway? Here are some links to start you off:
- Wikipedia article on the Port of London and the move downstream: bit.ly/3u41U6S
- Wikipedia article on London Gateway: bit.ly/36kxiWt
- London Gateway's official website: bit.ly/37sGQza
- Evening Standard article on the wildlife relocation: bit.ly/3KIqMI2
- For older students: Archaeological report on the London Gateway site: bit.ly/3CP7Lkh

1 A brownfield site is one that has previously been developed but is no longer in use. This is opposed to 'greenfield' which is a term for completely undeveloped land.

2 A TEU is the equivalent volume to a standard 20ft (6.1m) shipping container.

The Port of Jebel Ali



Imre Solt, CC BY-SA 3.0 <http://creativecommons.org/licenses/by-sa/3.0/>, via Wikimedia Commons. bit.ly/3r7fTbB

When and why was it founded?

In the 1960s, the city of Dubai became very important in the global trade of gold. The gold was not mined in Dubai itself, rather, the port of Dubai was acting as an *entrepôt* – a place where goods can be shipped to, stored, traded and then exported elsewhere. A key feature of an *entrepôt* is that the goods do not formally enter the country, so no import duty is paid (another term for *entrepôt* is 'duty-free port').

The darker side of gold

Back in the 60s much of the gold that traded through Dubai was bound for the Indian market. However, the import of gold to India was illegal, so the Dubai-based traders instead delivered the gold to boats just outside India's territorial waters. As with any high price item, questionable practises remain in the gold trade, particularly the processing and sale of gold which has been illegally mined in Africa, the profits of which often fuel conflict. Read more about the problem here: bit.ly/34feSVW and what the industry is doing to tackle it here: bit.ly/3rXJALx

In the mid-60s, oil was discovered in the waters off Dubai. Sheikh Rashid bin Saeed Al Maktoum invested much of the revenue from the oil into construction, including building Port Rashid in Dubai city. At this point the use of Dubai as an *entrepôt* for all manner of goods really took off and trade boomed. To cope with the ever increasing amount of cargo ships using Dubai, the dedicated deep water cargo port of Jebel Ali (Arabic: ميناء جبل علي) was built 35km southwest of the city of Dubai in the late 1970s, opening in 1979.

How has it developed?

Starting out with two terminals, the port of Jebel Ali has continually expanded since it was first built. Initially very remote from Dubai city due to poor transport links, a separate village was needed to house workers. The first two terminals have been continually upgraded and expanded and transport links to Dubai city have eliminated the need for most workers to live on site. Consequently the purpose of Jebel Ali village has developed, becoming primarily a large business zone ('Jafza') housing a number of offices, warehouses and showrooms.

A 3rd terminal was added to the port in 2014 and is one of the largest semi-automated terminals in the world.

The port today

Today, Jebel Ali port is operated by the company DP World. In 2020, Jebel Ali was the 11th busiest port in the world, handling 13.5 million TEU[3]. The port has 28 berths and 102 cranes (19 automated) and can handle ships exceeding 18,000 TEU. The amount of storage space available at Jebel Ali is staggering – over 134,000m^2 (that's about 25 football fields).

Construction is underway on yet another terminal (T4) which will take the port capacity to 22.4 million TEU, plus a train line to further improve transport links. Luxury housing and leisure facilities are also starting to be built in Jebel Ali village.

Questions

- Which commodity fuelled the growth of Dubai as a port?
- What does the word *entrepôt* mean?
- When did the port of Jebel Ali open?
- How far away is Jebel Ali from the city of Dubai?
- How big a ship can Jebel Ali port service?
- How many football fields worth of storage space are there at Jebel Ali?

Learn more

Want to learn more about the port of Jebel Ali? Here are some links to start you off:

- Wikipedia's page on the history of Dubai: bit.ly/3HbrPyC
- DP World's page on Jebel Ali port: bit.ly/3IHWVyn
- Wikipedia's page on Jebel Ali port: bit.ly/35vS84S
- The Jebel Ali Free Zone (Jafza): jafza.ae
- 40 years of Jebel Ali port (from Gulf News): bit.ly/3o5ZB0T
- The top 50 container ports (from the World Shipping Council): bit.ly/3Gfrmuk

3 A TEU is the equivalent volume to a standard 20ft (6.1m) shipping container.

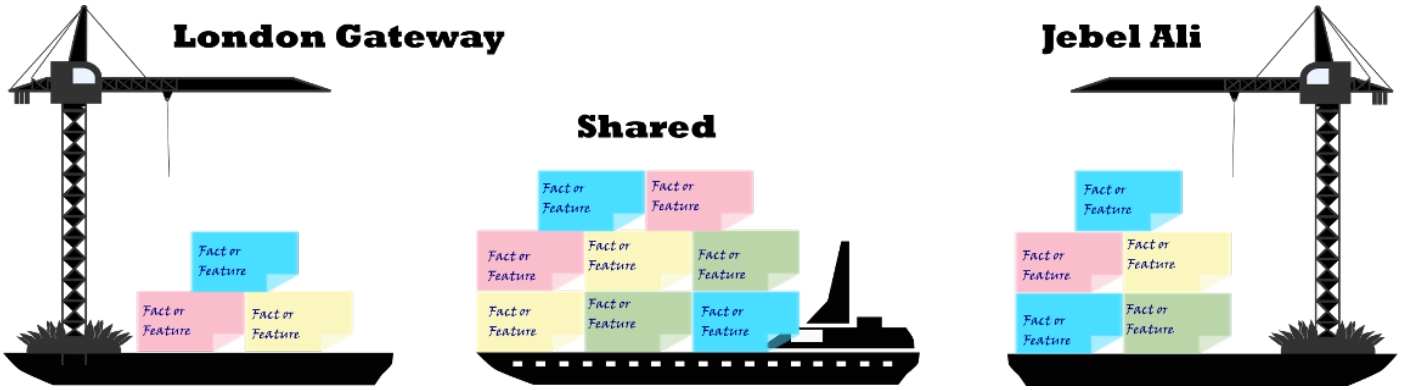
Compare and contrast

Let's get creative to display the similarities and differences between the two ports.

Venn diagrams

Your students are most likely to be familiar with using Venn diagrams to express the similarities and differences between two sets. If not, then this blog post provides a good explanation with some simple examples: bit.ly/3KJXUQt

The Venn Dockyard



Artwork adapted from 'Crane illustration' bit.ly/3ADI1aG by Erdinc Ciftci (WMDE), CC BY-SA 4.0 <https://creativecommons.org/licenses/by-sa/4.0>, via Wikimedia Commons, 'SVG boat' bit.ly/3r815JM by Mouh2jijel, CC BY-SA 3.0 <https://creativecommons.org/licenses/by-sa/3.0>, via Wikimedia Commons and 'Sticky notes' bit.ly/3HhMyBe by Amitchell125, Public domain, via Wikimedia Commons.

Rather than use a classic Venn diagram with two overlapping circles, we suggest something themed a little more appropriately to the content of this activity: introducing the Venn Dockyard!

Each dockside in the 'Venn Dockyard' is used to represent facts or features that only apply to either London Gateway or Jebel Ali. The container ship passing through the central passage is used to represent facts or features that are common to both ports.

Building your dockyard

We suggest building your dockyard as a wall display. You can either draw your own dockyard using marker pens, or you can download and print out the artwork below and stick it onto a backdrop. If possible, each file should be printed at A3 size.

- Right-facing dock: bit.ly/3AEdBUF
- Left-facing dock: bit.ly/34i1jVH
- Container ship: bit.ly/32Em3Xm

Past, present and future

To avoid your Venn Dockyard getting overcrowded, we might want to create 3 separate dockyards. One to represent the ports at the time of their founding, one to represent the ports today and one to represent how the group thinks the ports will develop in the future.

Filling your dockyard

Ask your students to write short facts or features about the port they studied on individual sticky notes. Then, as a group, decide how they should be distributed onto your Venn Dockyards.

How does your dockyard fill up? Are the two ports somewhat similar or very different? How do you think that will change over time?

Want to help improve this activity?

This activity is a living document! Help us by editing this activity to make it as good as possible, just use this short link (just type it into your web browser's address bar): bit.ly/3nA7xHz – full instructions are provided. Any edits that can make this resource easier to use in the classroom are very welcome, so please follow the link and make your contribution!

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JGI & DP World

Jane Goodall Institute

DP WORLD

The Jane Goodall Institute has partnered with DP World to support the growth of the Roots & Shoots programme. DP World are a leading provider of worldwide smart end-to-end supply chain logistics with a presence in 55 countries, enabling the flow of trade across the globe. This exciting partnership supports the creation of resources on the wider marine ecosystem as well as supporting the expansion of Roots & Shoots groups around the world. **Find out more: bit.ly/jgi-dpw**

Show us your ships!

As always we would love to see the results of your creativity! Please log into the Roots & Shoots website and post a mission update. Let us know how you got on by providing us with a project write-up including pictures and videos.

Why not enter the Jane Goodall's Roots & Shoots Awards?

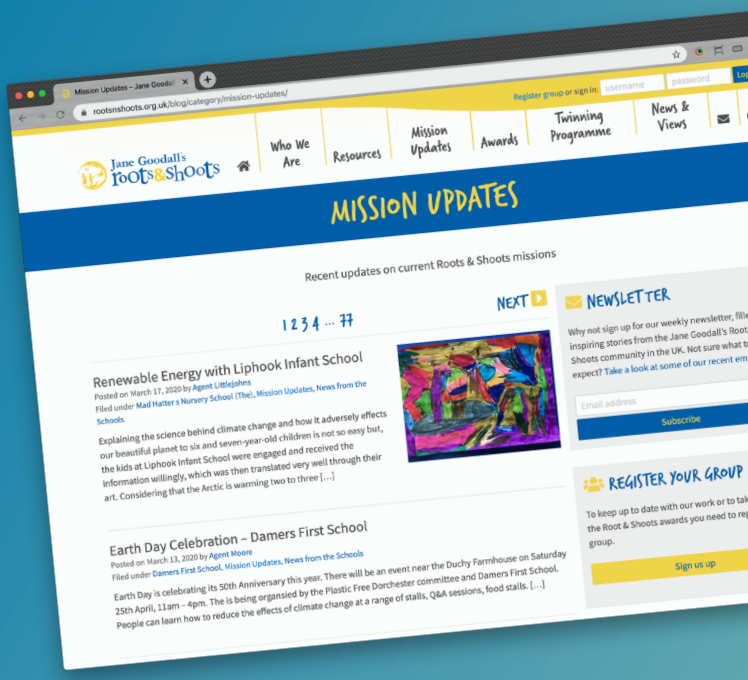
This resource was provided by Roots & Shoots UK, a not for profit charity run by the Jane Goodall Institute (UK). One of the aims of Roots & Shoots is to inspire young people to care for people, animals and the environment, and one of the ways that we like to do this is by running annual awards.

Every school that uploads a story about their activities to the Roots & Shoots website **www.rootsnshoots.org.uk** automatically wins a bronze award certificate to display at school, and the best stories win the chance for you and your children to meet Dr Jane Goodall herself along with a host of other prizes.

Keep up to date with Jane Goodall's Roots & Shoots UK

You can find us on Facebook at **fb.com/RootsnShoots.org.uk**, on Twitter (@JaneGoodallUK, direct link: **goo.gl/xTQnVm**) and on Instagram (@janegoodalluk, direct link: **bit.ly/jgi-insta**). Or why not sign up for our weekly email newsletter full of inspiring stories from our Roots & Shoots members in the UK at **rootsnshoots.org.uk/sign-me-up**.

See **www.rootsnshoots.org.uk/awards** for details about the awards and information on how to upload your 'mission update' story and win!



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