

# Jockey Club Water Caretakers of Tomorrow Programme The Blues: Can we Save the Ocean? - Unit 8

Organised by



Funded by



香港賽馬會慈善信託基金  
The Hong Kong Jockey Club Charities Trust

同心 同步 同進 RIDING HIGH TOGETHER

## About The Jockey Club Water Caretakers of Tomorrow Programme:






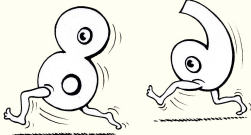
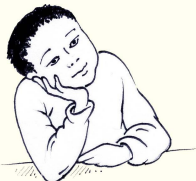
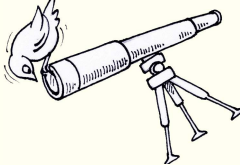
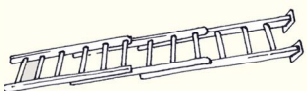
*Jockey Club Water Caretakers of Tomorrow Programme* is organised by Ocean Recovery Alliance, Ltd and funded by The Hong Kong Jockey Club Charities Trust. There are eight units in this program, and each of them is designed with you, a student in Hong Kong, in mind.

### These are the goals for your lessons, to:

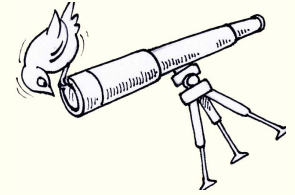
- Understand and appreciate how our water systems function on a local and global scale.
- Understand how watersheds function, and the interconnections of life within and between these watersheds.
- Be able to assess threats, such as pollution and habitat destruction, and learn how to lessen these effects.
- Be empowered to take an active role as caretakers of our water resources by sharing your commitment with your communities.

### Student introduction

- You will need access to the internet.
- In some activities using the camera in your smart phone or tablet will be useful.
- Your teacher will tell you if your work will be done on your computer, printed paper or notebooks.

Start of a new activity.		A new <b>amazing</b> fact.	
Get ready to do an <b>experiment</b> .		<b>Fast forward</b> to make your contribution to improving our world.	
Identify your <b>misconceptions</b> before your move on.		<b>Data</b> will be used to solve problems.	
Identify your <b>prior learning</b> .		These are the <b>goals</b> for this unit.	
An extension activity		A <b>cross-curricular</b> activity	

## Student aims



### At the end of this unit, I will be able to:

- Understand basic ocean ecosystems and organisms.
- Understand the connection between ocean and land.
- Explain how the ocean is being managed and exploited.
- Understand the extent of the effects of plastic pollution in the ocean.
- Draw conclusions about potential future threats to the ocean.
- Implement simple strategies to help reduce our impact on the ocean.

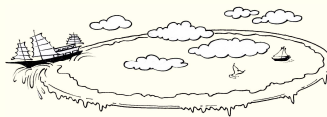
## Glossary

<b>Acidification</b>	In the context of this unit, it refers to chemical changes to the ocean as a result of global warming whereby carbon dioxide reacts with seawater to lower the pH of the oceans.
<b>Ballast water</b>	Large water tanks on ships that increase stability and manoeuvrability.
<b>Bilgewater</b>	Dirty water that accumulates in a ship's hull where the sides meet the bottom of the ship.
<b>Bioaccumulation</b>	The passing on of contaminants starting from the smallest organisms that get consumed by successively larger creatures all the way up the food web.
<b>Calcium carbonate</b>	A white mineral that makes up sea shells and coral skeletons.
<b>Continental Shelf</b>	Underwater landmass that extends from the land.
<b>Coral reef</b>	A collection of different corals forming a large single structure.
<b>Currents/ Tides</b>	The direction and flow of a body of water in the sea or ocean.
<b>Deep Sea Trench</b>	Where the sea bed drops to a depth of many kilometres below the surface.
<b>El Nino/ La Nina</b>	A climatic event in the Pacific known for reversing or changing weather patterns in the region due to warming (El Nino) versus cooling (La Nina).
<b>Fetch</b>	The distance a wave travels in open water.
<b>Heavy metals</b>	Group of metals with a high density, or large atomic mass. They can be hazardous to people and the environment, as a form of pollution.
<b>Hull</b>	The outer shell of a ship.
<b>Microplastics</b>	Plastic that has been broken down into tiny fragments by weathering processes.
<b>Migration</b>	The movement of people and animals from one region of the world to another.

<b>Navigation</b>	The ability to accurately locate and move yourself in relation to the surrounding environment.
<b>Ocean</b>	A large expanse of uninterrupted sea.
<b>PCBs</b>	Polychlorinated biphenyls (PCBs) are toxic compounds manufactured for use as coolants or lubricants in electrical goods. They do not break down or degrade readily, and easily enter the environment by air, water and soil. They are linked with negative health consequences for animals and people when exposed to these compounds.
<b>Pelagic</b>	Relates to the open sea, particularly the upper layers.
<b>pH</b>	A measure of how acidic or how alkaline something is.
<b>Plankton</b>	Microscopic plants and animals in the ocean.
<b>Salinity</b>	Concentration of dissolved salts and minerals in a body of water.
<b>School (of fish)</b>	Referring to a large group of fish, usually of the same species, that swim closely together.
<b>Tanker</b>	Ship that transports large quantities of liquids.
<b>Toxins</b>	Contaminants that are poisonous to people and animals.
<b>Trawling</b>	A method of fishing that drags large nets from a boat.
<b>Typhoon/ Cyclone/ Hurricane</b>	Name given to severe storms, based on where they occur in the world, either in the Pacific/ Indian/ Atlantic ocean.
<b>Waves</b>	Waves are usually caused by wind moving over the water's surface. A wave's size depends on wind speed, wind duration, depth of the water and size of the area over which it moves.



## Prior learning: What's going on?



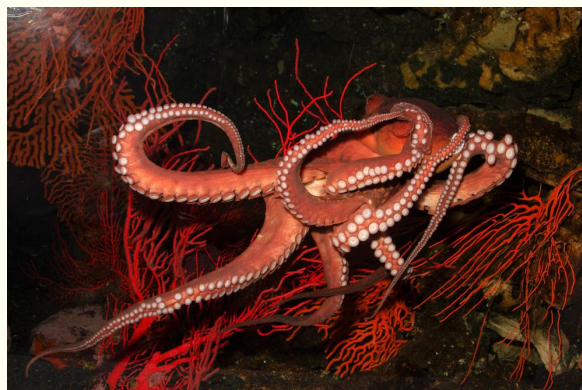
How might the litter in this photo affect the oceans?



Watch this music video for fun. It is an animation of a classic Beatles song:

<https://www.youtube.com/watch?v=IAeSiM4YTFM>

Think about what you know about the ocean. Why are the oceans important to us and to the planet? Jot down some of your ideas below:



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What is your best ocean or seaside experience?

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### Amazing fact

Octopuses are the most intelligent animals of all the invertebrates. They are as smart as most mammals.



# Lesson 1 - Ocean Habitats and Ecosystems



## Activity 1. Big ocean, big impact

The oceans might be big and take up two thirds of the Earth's surface, but humans can have a negative impact on every part of it.

Watch the first two minutes of the Ocean Recovery Alliance video

<https://www.youtube.com/watch?v=4cRkTUQVCNc>

(photo on right is a dead sea turtle floating on top of the ocean)



Describe some effects people can have on the ocean.

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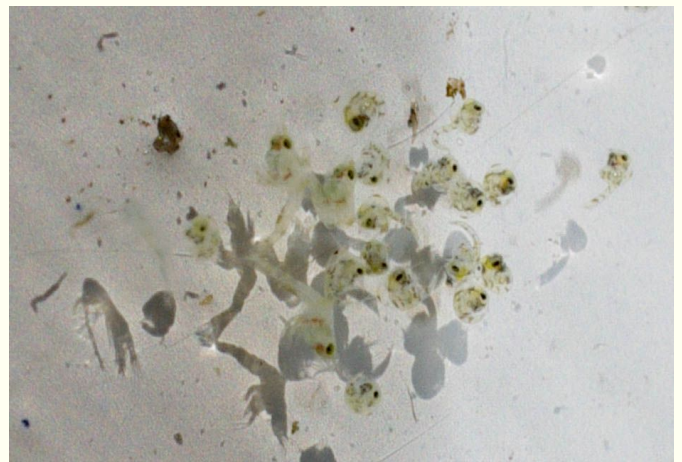
## Activity 2. Life on top of the ocean



The oceans have a great diversity of life. Here are some that can be observed on or near the surface.

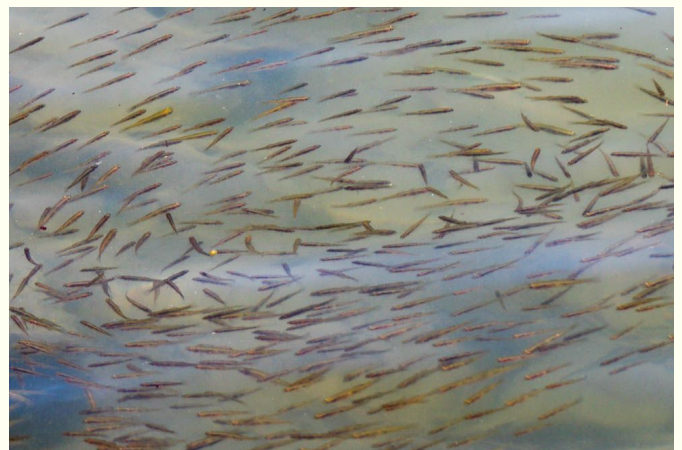
From little things, big things grow. Life in the ocean depends on the smallest microscopic plants and animals. These are the food for larger animals.

Find the definition of plankton.



Some of the ocean life is seen near the surface such as this school of baby fish. Almost everything in the sea is food for something else.

Why do many ocean fish swim in schools?



Jellyfish are often seen near the surface. In this photo there is litter and pollution floating in the water.

Why are plastic bags in the ocean a hazard for turtles?



Many species of marine birds are constantly on the hunt over the vast oceans of the world.

Where do terns rest?

Where do these birds breed?



Whales and turtles need to come to the surface to breathe air.

This whale feeds in the Antarctic during summer. Where do whales give birth?

Where do turtles lay their eggs?



### Activity 3. Life underneath

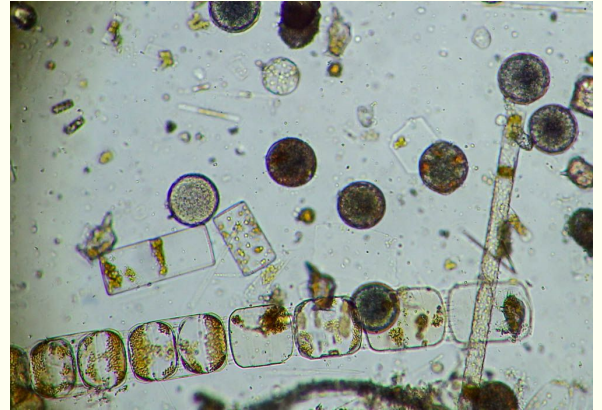
#### Ocean life as a food chain



Life under the water has some advantages including constant temperature and plenty of water. Also, organisms can easily move in all directions.

In the ocean, most of the algae is microscopic. It's called phytoplankton. It must float near the surface where there is light.

What do plants including algae need to grow?



We call the smallest animals in the ocean zooplankton. They eat phytoplankton and smaller zooplankton. Most marine creatures hatch from small eggs. So all their tiny young start life as zooplankton.

How would you catch such small animals to study?



The smallest fish feast on zooplankton or on phytoplankton.

Why do we need large populations of smaller organisms in a food web?



The fish next size up will be eating small fish and other marine creatures you can see with your eyes.

How can this fish tell there is danger?

What could these fish do if there is danger?





Fish are not the only marine predators. This nautilus also stalks the ocean waters.

What is unusual about a nautilus?

How can you tell it's a night hunter?



Barracuda are fast hunters. They often hunt in packs. Lucky for us, we are not on their menu.

What do you notice about the barracuda that enables it to swim so fast?



Sharks may be among the biggest ocean predators, but they also help to keep the sea clean by eating any dead animals before they get rotten.

Why is removing flesh of dead animals in the sea important?



Why isn't the shark or the barracuda going to eat the nautilus?

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### **Pelagic zone**

Pelagic zone is the scientific term used to describe the open sea or ocean that covers the majority of the Earth's surface. The pelagic zone excludes the sea near the coast and the bottom of the sea and ocean. It is all the water in between.

If you are a plant or animal in the pelagic zone, how is life different from land and life close to the coast? For example, is there anywhere to hide? How can you rest?

Plant \_\_\_\_\_

Animal \_\_\_\_\_

## Activity 4. Filtering and fading light



### Amazing facts

Even at the bottom of the deep dark ocean, plastic litter is found. Have a look at this article (<http://www.newsweek.com/theres-even-more-plastic-ocean-floor-its-surface-292715>).

Even in the cleanest water you can't see very far. The first thing you notice is loss of colour. Then the light becomes duller. In these photos we gradually go deeper. At great depth we need artificial light to see anything unless the animals can glow (have luminescence).



Rich colours of the coral can be seen near the surface.



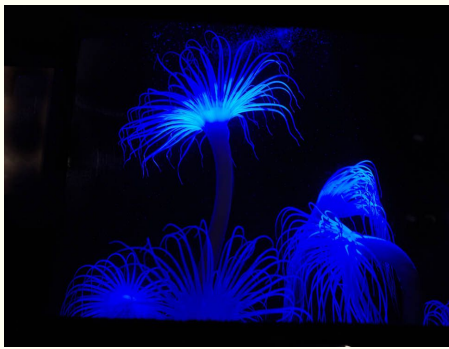
The deeper water has filtered out many of the colours.



As you go even deeper there is much less light.



In the deep sea there is no light at all.



In the deep, some animals feel their way around.



The hagfish used smell to find a dead seal on the sea floor.



Which are the colours are lost between photo one and photo two?

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Which colour remains in the photo top right?

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What does this fading light mean for algae?

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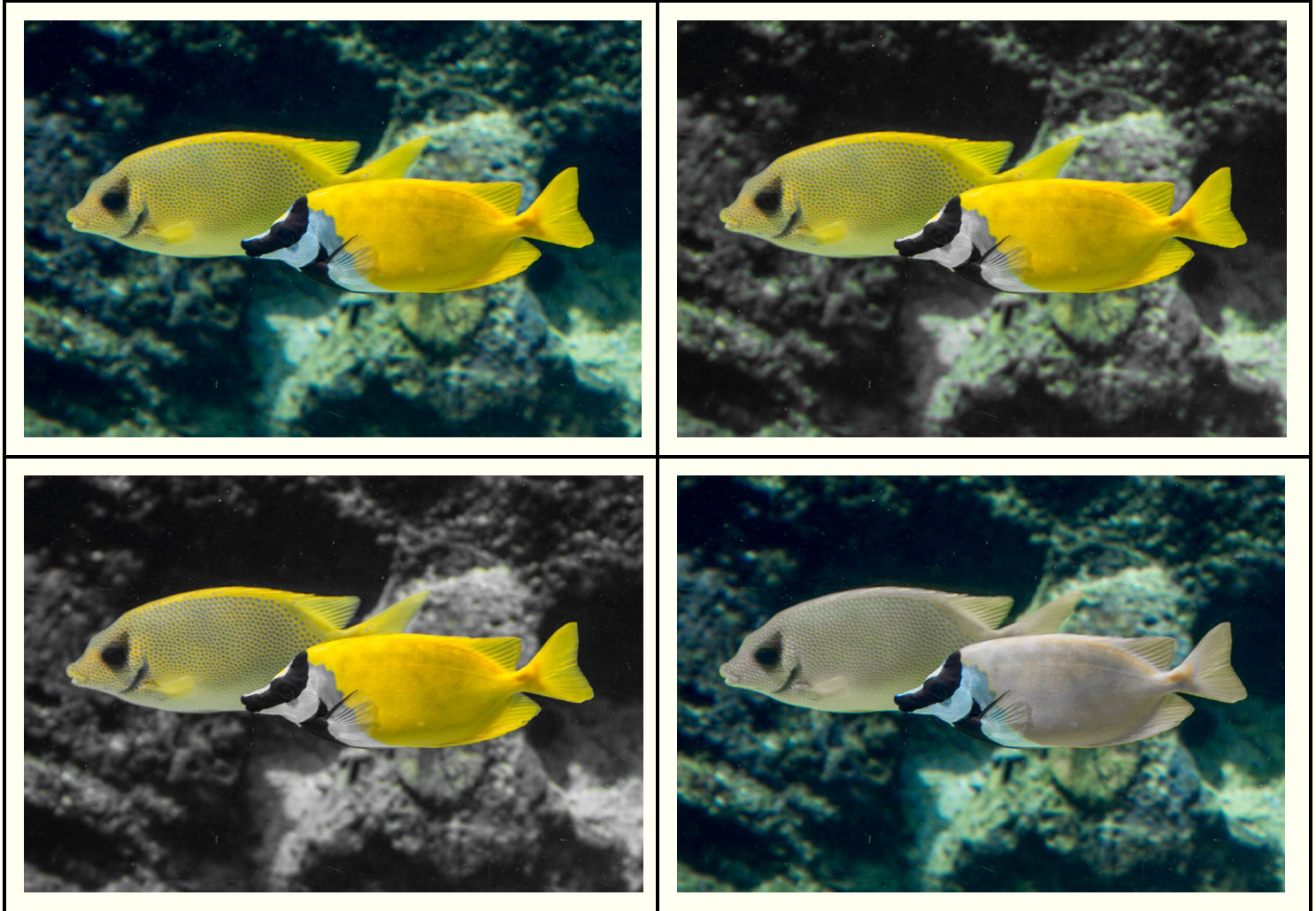
What do pelagic algae do to survive?

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## Filter experiment



As we travel down in the oceans some wavelengths are filtered out more quickly than others. Everything starts to look more blue. The first photo on the top left has not had its colours altered. Look at how the colours of the fish and background have changed when one of the colours has been deleted using a graphic package.



### Material

- Clear plastic packaging
- Permanent markers with different colours or materials of your choice.

### Method

1. Design an experiment to look through filters.
2. Make your own filters.
3. They could be filters to go over eyeglasses.
4. You might be able to obtain different colour cellophane or transparent colour plastic. You could colour clear plastic bags with different colour permanent markers.
5. Describe how the world looks with different colours filtered out.

Which colour filter produces the colour as you go deeper into the sea?

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## Activity 5. Ocean food web



### Amazing facts

Tiny shrimp like krill are the main food for the largest animal that has ever lived - the blue whale.



### Introduction

Food webs help us see how energy flows through an ecosystem. Energy comes from the sun. Plants and some bacteria are able to capture the sun's energy to produce food. These food-producing organisms are then consumed by other organisms. These consumers are usually animals. Some of these animals may just eat other animals. Some bacteria, fungus and animals help in the decomposition of dead organisms. This helps to recycle nutrients and is also part of the food web. In a food web we can draw arrows to show how energy moves from the sun to plants and then through animals.

One of the simplest ocean food chains is phytoplankton, krill and baleen whales. A food web is a more detailed way to see how plants and animals are interconnected. We can show that many animals eat many different foods. It allows for many interconnections and that's why it starts looking a bit like a web.

### Materials

- Printed sheet of ocean life on page 13
- Scissors
- Paste/glue
- Marker
- Sheet of paper to stick animals to

Use Google Images to find examples of ocean food webs. Use the phrase "*ocean food web*". You should see many illustrations of marine food webs.

To construct your food web:

1. Cut out each of the squares.
2. Lay out each square on a large piece of paper to approximate a food web.
3. You might like to place the top carnivores at the top and the plankton towards the bottom
4. Decide where the hagfish will go. It eats dead animals.
5. Glue the squares down.
6. Link the food web together with your marker. Point the arrow in the direction of how energy is passing through the web. For example, if a lion eats an impala, the arrow goes towards



Zooplankton



Zooplankton



Krill



Sea jelly



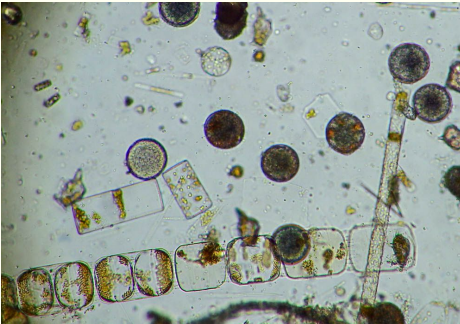
Small fish



Baleen whale



Phytoplankton



Nautilus



Cuttlefish



Orca or killer whale



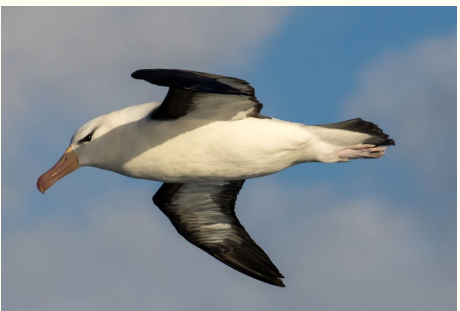
Barracuda



School of large fish



Albatross



Shark



Hagfish



Which part of the web has the fewest links?

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Which part of the web has the largest number of links?

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In waters with low nutrients, there will be a lot less phytoplankton. How might this affect the number of animals and the species of animals?

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What would happen to the web if most of the zooplankton died?

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Where would you find a food web with a polar bear? \_\_\_\_\_

Where would you find a food web with penguins? \_\_\_\_\_

Use the internet to find out where you would find Weddell seals: \_\_\_\_\_





## Lesson 2. Ocean productivity

### Activity 1. It's all about nutrients and sustainable fishing



#### Upwellings

Most of the sea's nutrients on the surface are quickly used up. Only some of these nutrients are constantly replaced. The bottom of the sea is full of nutrients because the dead algae and animals sink to the bottom. Currents run

along the bottom of the ocean. These currents come to the surface when they hit continents and islands. Its along the coastlines where major undercurrents come to the surface that the world's most productive fisheries can be found. Where the currents come to the surface are called upwellings.

[https://oceanservice.noaa.gov/education/tutorial\\_currents/media/supp\\_cur03b.html](https://oceanservice.noaa.gov/education/tutorial_currents/media/supp_cur03b.html)

[http://www.eorc.jaxa.jp/en/earthview/2004/img/tp040405\\_01.jpg](http://www.eorc.jaxa.jp/en/earthview/2004/img/tp040405_01.jpg)

#### Sustainable fishing

It makes sense to only take the number of fish which won't reduce the total population. For some species that is easy but for others it is much more difficult.

This species of squid only live for around a year. They breed very quickly replacing themselves every 12 months. Any changes in population can be easily observed and populations can bounce back quickly.



Tuna is a long-lived species. Some species can live over 40 years. They are much slower to breed. It is more difficult to observe fluctuations in their population. It would take a decade for the population to bounce back.



#### Where do your fish come from?

Watch this video about sustainable fisheries in Hong Kong, made by a Middle School student in Hong Kong:

<https://www.youtube.com/watch?v=r7E61lcQcNc>



## Fishy Issues

The Enviromental Issues of Fish

Take a few photos at the local fish market of the fish on display. Ask the shopkeeper for the names of the fish and write the names down.

Typical fish and other marine life found in the Hong Kong fish market are:

- Tuna
- Squid
- Clams
- Groupers
- Prawns
- Snappers
- Mackerel
- Mullet
- Crabs
- Sea Cucumbers
- Eels
- Sea-Bream
- Herring
- Sole



Name of the seafood you will research: \_\_\_\_\_

Where was the seafood caught? \_\_\_\_\_

How long does the marine animal live? \_\_\_\_\_

Does it have any conservation issues? \_\_\_\_\_

Does it seem easy or difficult to have sustainable fishing of this species? \_\_\_\_\_

Explain what you think needs to be done to make sure the species is fished sustainably:

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## Activity 2. Trawling - what is it?



Very large trawling ships have a much greater impact on fish stocks than small fishing boats or line fishing. Watch this video about trawling and learn about what “bycatch” means:

[www.youtube.com/watch?v=NklxOhr2fal&index=2&list=PLk9ubBtvFgmvxhV1ylnHXwDV-s\\_VB0VN](http://www.youtube.com/watch?v=NklxOhr2fal&index=2&list=PLk9ubBtvFgmvxhV1ylnHXwDV-s_VB0VN)

Then watch this video which shows what bottom trawling looks like:

<https://www.youtube.com/watch?v=IbSQhy0axH0>

To learn more about the costs and benefits of trawling, look at this article about the practice:

<https://marine-conservation.org/what-we-do/program-areas/how-we-fish/destructive-fishing/>

What are the disadvantages of this type of fishing?

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Why do you think trawling was popular in Hong Kong and then banned?

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What could happen if more large trawling ships were built? Consider the size of fish stocks, the rights of small fishing boats and how different countries divide up fish stocks. You may need to do some research about how fishery rights are determined.

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## It's not just about you

Why is fishing very important for small island nations?

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## Ghost nets



Ghost nets is the name given to fishing nets that have been lost at sea or dumped at sea when they have become too damaged to repair. These freely drifting nets will still catch and kill fish along with whales, turtles and sea birds. They will keep killing until they finally wash up on a beach.

These ghost nets have been washed up on the beaches of Horne Island. It is one of a string of Islands between Papua New Guinea and Australia, in an isolated part of the world. Locals have dragged the nets back from the beach. Ghost nets are also washed up around Hong Kong. Floating nets damage ships when they get tangled in the propellers.



Look up ghost nets on the internet.

If you were a “Ghost Net Buster” - what would you do and what would you require fishermen to do in order to prevent fishing nets from roaming the seas?

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### Activity 3. The commons:

The game is called *Tragedy of the Commons*. Your teacher will explain the rules to you.



#### Materials:

Use this Google Presentation link to introduce the activity.

[https://docs.google.com/presentation/d/1CL6fYohqwwabiSkaVbAYuD6lhWxO2dcrdOG3KCKZDz4/edit#slide=id.g76d12a94c\\_0\\_62](https://docs.google.com/presentation/d/1CL6fYohqwwabiSkaVbAYuD6lhWxO2dcrdOG3KCKZDz4/edit#slide=id.g76d12a94c_0_62)

A projector or computer screen to show presentation to the class.

Straws (1 per student),

Paper strips,

M&Ms - about 50

Blue tray

Tissues,

Tally sheet (copy sheet at end of this activity)

In some old farming cultures everyone used the same common land to graze their cattle, sheep goats etc. There was no interest in just one or two people looking after the common land when it was being trashed by overgrazing by everyone else. Often common land became degraded. To improve agriculture, common land was converted to private ownership. Usually it was a bad decision for those using the land as they ended up with nothing. The tragedy of the commons is that when we have common resources that nobody owns, it is likely to be trashed with over-exploitation.



### Activity 4 . Researching our oceans

Many countries have large research ships like this one that belongs to South Africa. These ships transport many scientists who do a wide range of investigations. They include investigating marine life, fisheries, pollution, climate change, effects of currents and weather, chemistry of the seawater, photosynthesis of phytoplankton, general health of the ocean, etc.

Pretend that you were given a grant to research the topic(s) of your choice about Pacific Ocean issues. Write a proposal for what you want to study and why you think it is important to the health of the ocean.

You must include the following general topics in your proposal:

- Ocean habitat/ecology
- Fisheries and/or Transportation
- Pollution
- Reasons for why your research is important for the future health of the ocean

You can also specify the research ship of your choice and explain how it is outfitted for your purposes.



### Activity 5. Biography

A biography is usually the life story of a person. It is factual, but the biography is written about the parts of the person's life that are most interesting and relevant to the story that the writer wants to tell.



Choose one of the animals and write its biography from the time it is born or hatched. You will need to use some imagination, but still keep it factual. Explain where it lives in the sea and how it survives. What does it eat? How does it move? Does it have special senses? What are some of the natural dangers it has to avoid? What are some of the human dangers that can affect its survival? Does it hang out with its own species? If it does, what is the advantage of being in a group? You might like to decide how your animal dies.

- Your biography should be around 600 words.
- You will need to do some research before you can write.
- Jot down some notes as you do your research.
- Decide which location in the sea or ocean your animal lives. You will need to describe the habitat.
- You can use images, sketches or cartoons.

Below are the animals to be researched. The questions above are the most important ones to answer in your biography. There are some more questions below for each animal that might help you gather your information.

#### **Pink dolphin**

How many pink dolphins are left?  
Where are the remaining populations?  
What are some reasons given for their rarity?



## Tuna

How big are tuna? Are there different species of tuna?  
What would it be like for the fish being attacked by a school of tuna?  
How fast are they?  
Is there anything unique about tuna compared to other fish species, which enables them to move so fast?  
Why do you think that some species grow so large?  
Where does most of the tuna fishing occur?  
Is tuna fishing sustainable? Why should we make sure it is sustainable?  
Why is it a popular food?



## Squid

How are squid caught by fishermen?  
What animals like eating squid?  
What are some of the unusual features of squid?  
How do they move fast and slow?  
What's unusual about their eyes?  
When are squid active?  
Why is fishing for squid likely to be more sustainable than other marine animals?



## Marlin

Boats like this are hired by sports fishermen to go out to sea and try to catch marlin.  
What is special about marlin?  
Are there many marlin?  
How quickly can they reproduce?  
Do you think it's fair to catch a marlin if you put it back? Why or why not?



**Baleen whales (a family of whales that includes the humpback, blue and fin whales)**

In the past, why were whales hunted?  
Where do they breed, feed and migrate?  
How do they catch their food?  
How do they give birth to young, feed and protect them?  
What has happened to their numbers since people stopped hunting them?



**Dolphin**

What makes you think dolphins are social?  
What makes you think dolphins are intelligent?  
What do dolphins have that helps them catch fish?  
How can they protect themselves from larger animals like sharks?  
What do you think about dolphins being trained to do tricks in an aquarium?



**Turtle**

Where do turtles lay eggs?  
Why are many of the locations where turtles lay eggs under threat?  
Why is litter in the ocean a problem for turtles?  
Why are ghost nets (nets that have become litter) a danger to turtles?  
Why would someone buy a dead stuffed turtle as a souvenir?  
Is it acceptable for an islander who has lived off the sea to eat turtle?



**Shark**

Why are people scared of sharks?  
Why are sharks important for a balanced food web?  
How many people have been killed by sharks yearly?  
How many sharks get killed by people yearly?  
How is the hunting of sharks for just their fins a bad example of using sea resources?



## Herring

What has happened to the population of herring around the world?

What new methods are being used to catch herring?

How have governments tried to regulate the fishing of herring?



## Sardines

Where are you likely to come across sardines?

How big are sardines?

How many would you see in a school of sardines?

Sardines refers to more than one species. What do the different species have in common?

Why are sardines important food sources for other marine animals and humans?



## Albatross

When is the only time albatrosses go onto land?

Why do albatrosses follow fishing boats?

Why is plastic litter in the sea a problem for albatrosses?

What are some of the unique characteristics of this bird?

What are some of the biggest threats to these birds while feeding at sea and nesting on remote islands?



# Lesson 3. Oceans and Weather - Commotion in the Ocean



The oceans in the past were always a dangerous place for humans to sail, not knowing when the next big storm would strike. Intense winds whip up massive waves along with strong gusts.

Barometers were the first instruments that indicated that storms could be on the way. The barometer measures air pressure.

This barometer is showing very low air pressure. Outside are hurricane force winds.



This ship's wind monitor is recording 77 knots which is about 150km per hour. The maximum gust of wind was 100 knots which is about 200km per hour. When people go outside on the deck they must strap themselves to the boat or hang on tightly.



## Amazing fact

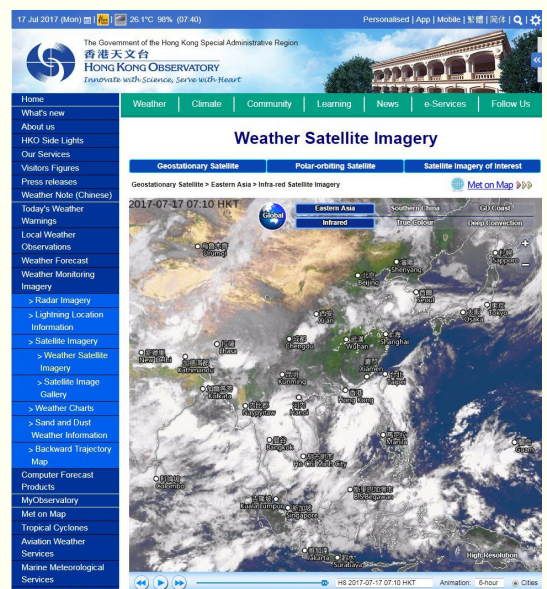
It requires the world's most powerful computers to predict the weather over the next week.



## Activity 1. Weather from satellite and radar

Use these websites to look at radar and satellite information provided by Hong Kong Observatory. Press the play button on the bottom left of the image.

<http://www.hko.gov.hk/wxinfo/intersat/satellite/sate.htm>





Go to the radar page:

[http://www.hko.gov.hk/wxinfo/radars/radar\\_range1.htm](http://www.hko.gov.hk/wxinfo/radars/radar_range1.htm)

What information do satellites provide?

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What information does radar provide?

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### Extension

Find out about the Beaufort scale. What is its history and how is it used today?

### Activity 2. Ocean circulation

Blood circulates around your body. Water circulates around the ocean. The circulation on the surface of the ocean can be different to that on the seafloor. These ocean currents are linked to, and help drive, atmospheric processes as well. This relationship is key in determining weather and climate patterns around the world.



Watch this video: <https://www.youtube.com/watch?v=-aESMZyrQ1Y>

See if you can find Hong Kong in the animation of the ocean currents. (go to approximately 7 min. 20 sec.) What is the direction of the movement of ocean currents around Hong Kong? Are they clockwise or counterclockwise? Describe the patterns.

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How do you think it is possible for litter from your region to end up thousands of kilometers away?

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Scientists have actually learned a lot about ocean currents from tracking the path of containers lost on ships in storms, which end up on beaches. Read these articles to learn more:

...about the organisms and plastic that move around in currents:

<https://www.sciencedaily.com/releases/2016/04/160419130133.htm>

...and the incredible trips of rubber duckies:

<https://www.csmonitor.com/2003/0731/p01s04-woeu.html>

[www.mnn.com/earth-matters/wilderness-resources/stories/what-can-28000-rubber-duckies-lost-at-sea-teach-us-about](http://www.mnn.com/earth-matters/wilderness-resources/stories/what-can-28000-rubber-duckies-lost-at-sea-teach-us-about)

### Activity 3. Rubber Ducky Science



Your teacher will provide you with the worksheets for an activity that explores ocean currents by tracking the rubber duckies you have just read about.

[https://dps.instructure.com/courses/574084/files/41708625/download?download\\_frd=1](https://dps.instructure.com/courses/574084/files/41708625/download?download_frd=1)

#### Amazing facts

The water at the bottom of the deep ocean is always at around 0 to 3 degrees Celsius. To form ice, water must expand. The pressure is so great deep down, that water can't expand and freeze into ice.



### El Nino and La Nina

The phenomena known as El Nino and La Nina refer to a reversal, or change, of normal oceanic and atmospheric currents. They were first observed in South America by the fishing communities. In a normal year during the winter, fish stocks were plentiful off the western coast of South America. But in some years, the fish stocks were very low and catches were very low. They called the years with low fish stocks "El Nino" meaning "little boy" in Spanish.



Scientists had noticed that these fish stock observations were the result of oceanic and atmospheric abnormalities, and these had corresponding effects on the other side of the Pacific. When scientists compared the changes in winds and sea surface temperature, they found that they matched the El Nino and La Nina years. La Nina years are associated with cooling effects in the equatorial Pacific Ocean.

This new information has helped millions of farmers and fishermen predict how much rain they are likely to have. It can also indicate if there will be devastation due to floods or droughts. However, no El Nino or La Nina events are identical.

### Activity 4.

The two short videos below provide you with further explanation about El Nino and La Nina.

[https://www.youtube.com/watch?v=tyPq86yM\\_lc](https://www.youtube.com/watch?v=tyPq86yM_lc)

<http://video.nationalgeographic.com.au/video/news/101-videos/el-nino>

- Choose any country that might be affected by El Nino and La Nina
- Annotate a diagram or make a table that compares the effects of the two events in that country.

## Activity 5. Are the oceans the biggest heat sink?



Natural changes in currents and ocean temperature have always influenced the climate. Now the oceans are also being affected by increases in the Earth's temperature due to greenhouse gases.

### Amazing facts

Most of the 15 cm rise in sea level in the past 100 years has been due to the expansion of water in the oceans. The expansion of water is due to the sea's temperature rise. Melting glaciers and Antarctic ice will contribute more to sea level rise in the future.



### What is a heat sink?

A heat sink is a material that holds heat for a long period of time. Water can store heat for a long time, but air loses heat quickly. When the sun goes down, the air starts to cool and will keep cooling until the sun is back the next day. The sea temperature hardly changes over 24 hours unless the water is very shallow.

### Rising ocean temperatures and sea levels

Read the first three paragraphs of this website. The articles provide a graph of the amount of extra energy the oceans have absorbed since 1965. The units used to measure energy is joules. It takes about 4 joules to heat a gram of water by 1 degree centigrade. Since around 1985 the oceans have absorbed around 15 followed by 22 zeros ( $10^{22}$ ) or 150,000,000,000,000,000,000,000 joules of energy.

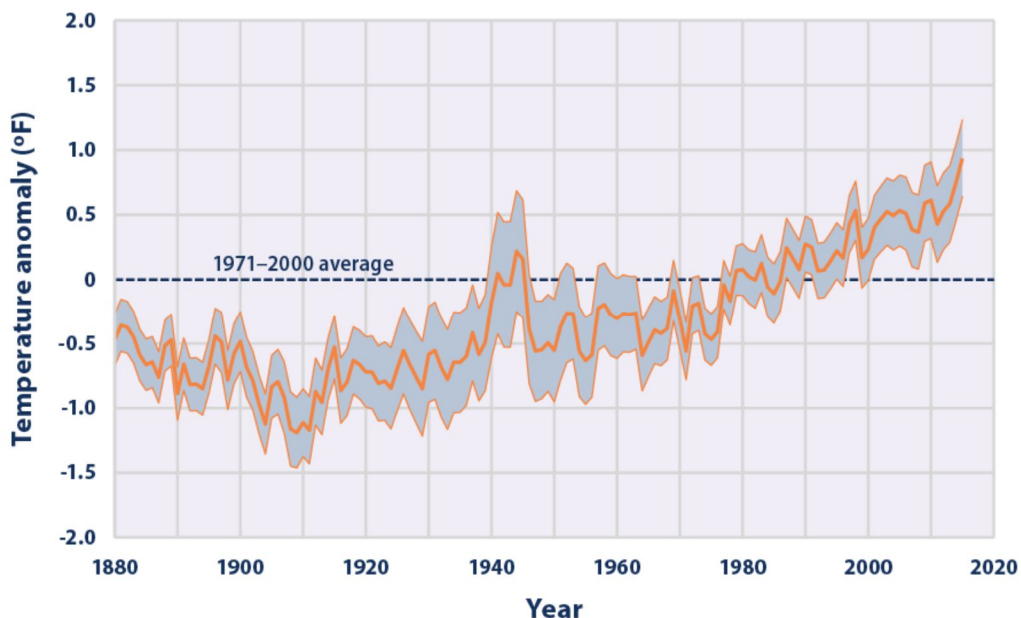
[www.climate.gov/news-features/understanding-climate/climate-change-ocean-heat-content](http://www.climate.gov/news-features/understanding-climate/climate-change-ocean-heat-content)

Why are the oceans getting warmer?

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Source: USA EPA

<https://www.epa.gov/climate-indicators/climate-change-indicators-sea-surface-temperature>

Compare the four graphs showing changes in the ocean's heat, temperature and sea levels on these four webpages.

<https://www.epa.gov/climate-indicators/climate-change-indicators-ocean-heat>

<https://www.epa.gov/climate-indicators/climate-change-indicators-sea-surface-temperature>

<https://www.epa.gov/climate-indicators/climate-change-indicators-sea-level>

[http://www.hko.gov.hk/climate\\_change/obs\\_hk\\_sea\\_level\\_e.htm](http://www.hko.gov.hk/climate_change/obs_hk_sea_level_e.htm)

What is similar in the four graphs?

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Predict what will happen to the ocean over the next 30 years;

Temperature increase \_\_\_\_\_

Sea level rise \_\_\_\_\_

### Activity 6. Ocean heat sink - looking for trouble



The sea level will continue to rise because water expands as it is heated. Also glaciers are melting, adding to the amount of water in the sea.

A small increase in sea level might not be very noticeable until there are bad weather events. It becomes more difficult for flood waters to reach the sea, so more land gets flooded. When waves surge onto the coast during typhoons, the seawater will reach further inland.

### Consequences - sea level rise

These are two references to sea level rise. It seems to be happening, but very slowly.

<http://www.nationalgeographic.com/environment/oceans/critical-issues-sea-temperature-rise/>

[www.scmp.com/news/hong-kong/health-environment/article/1877284/rising-sea-levels-set-displace-45-million-people](http://www.scmp.com/news/hong-kong/health-environment/article/1877284/rising-sea-levels-set-displace-45-million-people)

Look up further online references.

What are the consequences of sea levels rising?

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Explain if you think the predictions about cities being flooded are objective or biased:

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## Consequences - storms, hurricanes, floods etc.

There has been a lot of research into how higher atmospheric and sea temperatures will affect weather. We have also known for a long time that warmer oceans increases atmospheric moisture. Use these links to find out more climate change influences damaging weather events.

<https://scijinks.gov/hurricane-simulation/>

<http://www.nhc.noaa.gov/outreach/games/canelab.htm>

<https://earthobservatory.nasa.gov/Features/ClimateStorms/page2.php>

Explain why warmer oceans increases the amount of water in the atmosphere and can lead to more devastating weather events.

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Source of photo: <http://www.scmp.com/news/hong-kong/health-environment/article/2095537/hong-kong-grinds-halt-amid-rainstorm-leaves-social>

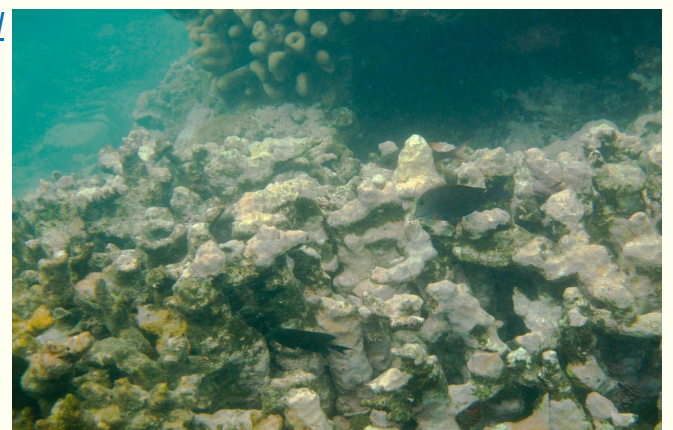
## Consequences - coral bleaching events

Over some summers, coral sea reefs around the world have had large increases in temperature. During these periods, the coral turns white. Often the coral die and it can take up to a decade for the corals to recover, provided there are no new stresses. Learn more from these links.

[https://oceanservice.noaa.gov/facts/coral\\_bleach.html](https://oceanservice.noaa.gov/facts/coral_bleach.html)

More in-depth link:

[www.gbrmpa.gov.au/managing-the-reef/threats-to-the-reef/climate-change/what-does-this-mean-for-species/corals/what-is-coral-bleaching](http://www.gbrmpa.gov.au/managing-the-reef/threats-to-the-reef/climate-change/what-does-this-mean-for-species/corals/what-is-coral-bleaching)



How are increasing sea temperatures currently affecting coral reefs?

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## Lesson 4 - Ocean resources

Nobody owns the oceans. This can make it difficult to control how the oceans are used. There are many international conventions that aim to protect the oceans. Ships crossing between countries must comply with a wide range of safeguards to make sure the ship and its crew are safe and the environment is not polluted. It is more difficult to regulate things like ocean fishing when countries or fishing companies don't want to be regulated. Also, while some fishing grounds are close to a nation's coastline, others are in open ocean, which is technically open to all. This makes fair and reasonable divisions of resources hard to enforce.

### Amazing facts

Herrings keep their mouths open so they can catch small creatures as they swim. Some of their schools can take up four square kilometers of ocean.



### Activity 1. Fishing - when do we say, “no thank you”?

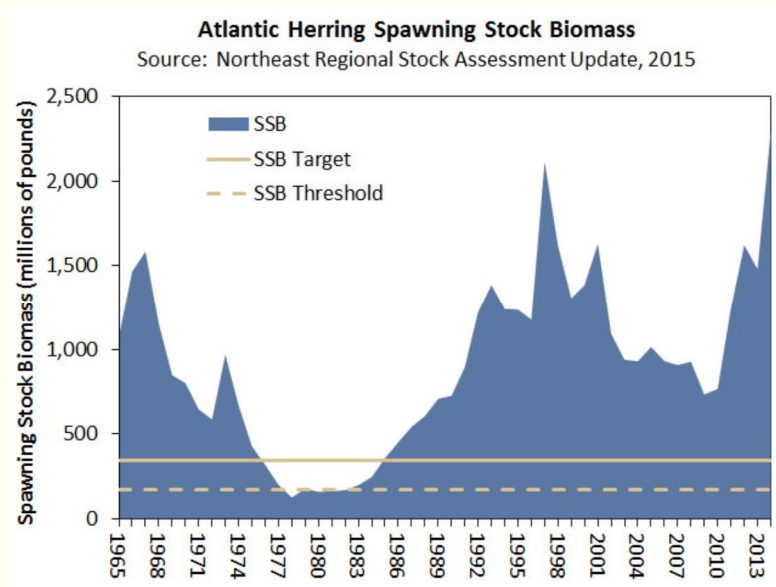
Where did your latest fish dinner come from? In the past that was an easy question to answer as it would have only been caught locally. As powered fishing boats became bigger and their nets larger, more fish can be caught. By using sonar and even helicopters, fishermen know where to drop their nets. Our increased efficiency in fishing has greatly contributed to the decline in certain fish populations. Your last fish dinner could have come from anywhere in the world. It's quite unlikely it was caught just off the coast.



### The story of the Atlantic herring

Herring is a culturally iconic fish for many European countries. They have been catching them for centuries, economies were based on them, and many countries prepare them in unique and flavourful ways.

Herring do not start breeding until they are four or five years old. They can live for 20 years. In the 1970s and 80s it was feared that herring were being fished close to extinction. Countries were forced to almost stop fishing herring to allow the fish populations to recover. By weight, it is one of the most abundant fish in the sea.



Have a look at these sites about herring:

<https://www.edf.org/blog/2013/11/14/fish-fight-climate-change-hits-fisheries-north-east-atlantic>

<http://www.arkive.org/atlantic-herring/clupea-harengus/video-00.html>

<http://www.asmfc.org/uploads/file//58f8d115AtlanticHerring.pdf>

<http://slideplayer.com/slide/9445714/>

Describe the fluctuation (ups and downs) of herring stock.

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What could have happened if fishing continued as usual throughout the 1980s to 90s?

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Use this online powerpoint to find out more about herring. If you lack time, read the last two slides - slide 24 and 25. <http://slideplayer.com/slide/9445714/>

What is special about herring spawning?

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How did the herring population recover?

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How does everyone win when fishing is done sustainably?

<https://www.nationalgeographic.org/encyclopedia/sustainable-fishing/>

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This fish guide shows the herring being fished in one region of the North Atlantic.

<http://www.goodfishguide.org/fish/herring-or-sild-175> How is it helpful to have consumer fish guides like this? What information did you find useful?

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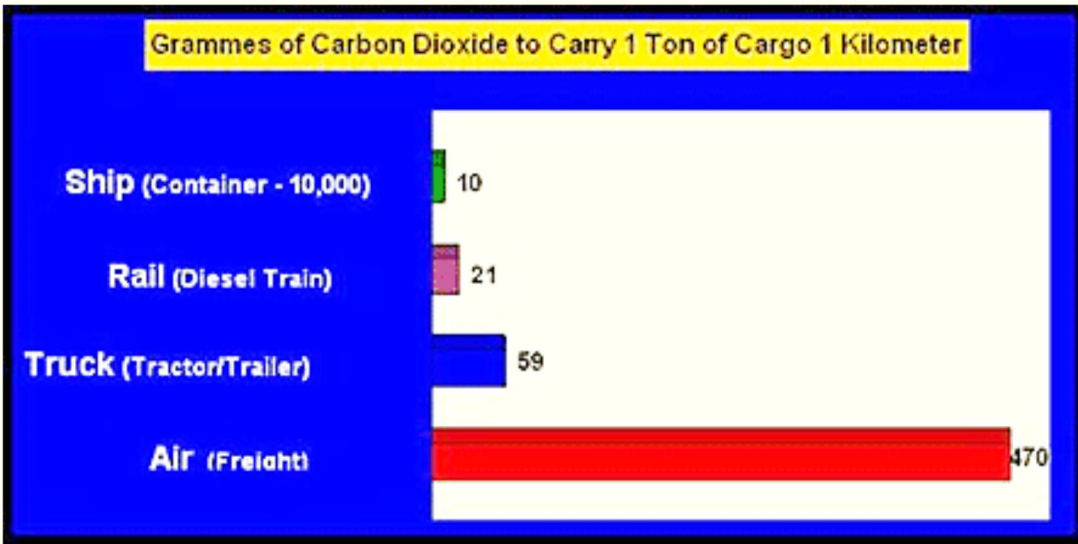
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Have a look at the World Wildlife Federation's seafood guide which outlines fish that are commonly eaten in Hong Kong. You can find this on the following website:

[http://www.wwf.org.hk/en/whatwedo/oceans/supporting\\_sustainable\\_seafood/](http://www.wwf.org.hk/en/whatwedo/oceans/supporting_sustainable_seafood/)

## Activity 2. Accidents at sea



Source: Network for Transport and the Environment

Using the graph above, explain why shipping is more fuel-efficient than other forms of transport.

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What kinds of pollution from ships can affect the oceans?

[www.ausmepa.org.au/ships-and-the-marine-environment/marine-environment-what-if/types-of-pollution/](http://www.ausmepa.org.au/ships-and-the-marine-environment/marine-environment-what-if/types-of-pollution/)

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When accidents happen at sea, the consequences can be severe. Use a search engine to look up shipping accidents. Use the search words "shipping disaster". Pick one shipping disaster and explain why it happened and what the consequences were.

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How might the disaster have affected the environment?

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**What should be done and could be done.**

Ships are required to manage and log all their waste and its disposal. Inspectors can look at the logs. Many of the waste materials must be disposed of when the ship is in port. Some waste materials can be treated and disposed of at sea. It is easy to police big ships, but smaller vessels and private boats can get away when no one's looking.

Larger ships are supposed to have a waste system so that rubbish is safely stored and removed once in port. These bins are securely tied to the metal railing.



On this ship waste is also recycled.



Untreated toilet waste must not be released into the sea. It must be stored onboard in large tanks like the one below.



## Cleaning up

Long boom being placed around a floating oil slick stops it from spreading.



The machine in the water filters out floating oil.



Another type of machine that can remove floating oil.



Spraying chemicals to break oil slicks should only be used as a last resort.



This is a beach vacuum cleaner for removing oil.



Getting ready to use shovels and rakes to remove oil from the sand.

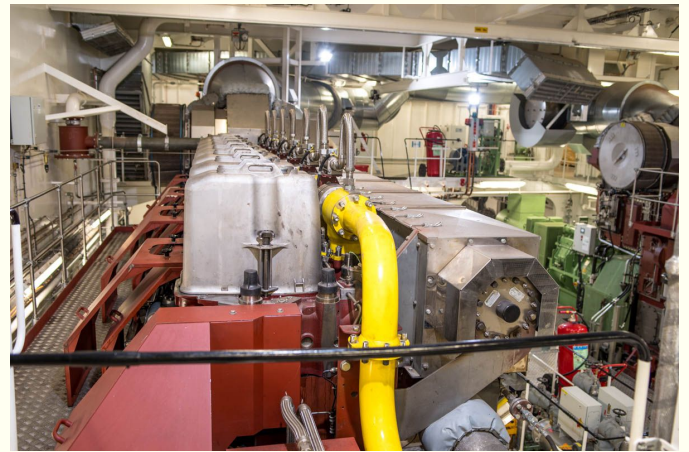


A ship's engines will produce waste water mixed with waste oil. This sinks to the bottom of the engine called the bilge. In this photo the bilge pump, pumps the oil contaminated water into a storage tank. In port this bilge liquid will be pumped into a waiting tanker (truck).

There are heavy penalties for any ship caught releasing bilge water at sea.



This is one of a new type of ship. It can run on both oil and gas (methane). The yellow pipe is for the gas. Gas produces a lot less air pollution.



Palm oil being cleaned up on a Hong Kong harbour.



Students picking up litter along the coast.



This container can be driven and then flown anywhere in Australia to help rescue oil affected wildlife.



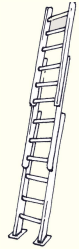
Inside the standard sized container is everything needed to clean and rehabilitate wildlife the animals rescued from oil spills.



## Extension

Visit the Hong Kong Maritime museum at the Central Ferry Piers. To prepare for your visit, identify which topics you would like to explore. They might include:

1. The history of shipping around Hong Kong.
2. How shipping of goods around the world provided the need to establish Hong Kong.
3. The current role of shipping today.
4. How shipping and its cargo is managed.
5. How ports are operated.
6. Water transport around Hong Kong.
7. How Ports and Shipping look after the environment.
8. Training of ship crews
9. Water recreation around Hong Kong



## Activity 3. Oil drilling - big risks when things go wrong

Does Deep Water Horizon mean anything to you?



Where did it occur?

Watch the video from CNN. Read some of the text if you have time.

<http://edition.cnn.com/2015/04/14/us/gulf-oil-spill-unknowns/index.html>

What are some of the impacts of this oil disaster?

How much oil escaped (measured in barrels; 1 barrel = 159 L) \_\_\_\_\_

How much has been spent up until 2015 cleaning up the oil? \_\_\_\_\_

## Lesson 5 - Ocean Pollution

### Just the facts

Litter does not disappear. It lasts a long time..

Aluminium cans: at least 80 years.

Plastic bottles: 450 years.

Fine fishing net: at least 600 years (much longer for heavier nets).

Glass bottles: 1 million years.



### Activity 1. Land based pollution - was it you?

In this photo, stormwater drains release their water on a Hong Kong beach. The plastics and other litter are easy to see. Other pollution such as oil, grease, chemicals, dangerous bacteria, etc. can't be seen. Most of the ocean's pollution comes from the land. It's a good approximation that the amount of litter on the beach is equal to the amount of other harmful pollution in the water.



Marine debris is the term often used for the litter that reaches the sea.

Look at this webpage about marine debris.

<http://nellhamilton.com/10-astonishing-alarming-facts-marine-debris/>

Choose the most shocking fact on the website.

My shocking fact is \_\_\_\_\_

Watch these two videos about plastics in the ocean:

<https://www.youtube.com/watch?v=cwTDvgaqPIM>

<https://www.youtube.com/watch?v=FjT8GG0ETQg&t=1s>

What solutions can you come up with that might help to reduce the impact that plastics are having on the sea?



Why do you think we are so dependent on plastic?

What would you do if you just landed a job to regulate boat owners including fishermen in the Hong Kong Region? You have to write regulations about what boat owners must do with their waste and what they need to carry on their boat to avoid waste being emptied or lost at sea.

Regulation 1. Rubbish \_\_\_\_\_

\_\_\_\_\_

Regulation 2. Toilet waste \_\_\_\_\_

\_\_\_\_\_

Regulation 3. Fishing lines and fishing nets \_\_\_\_\_

\_\_\_\_\_

Regulation 4. Securing items on board of boats \_\_\_\_\_

\_\_\_\_\_

Regulation 5. Oil, petrol and other chemicals \_\_\_\_\_

\_\_\_\_\_



### Amazing facts

According to a study by the World Economic Forum, eight million metric tonnes of plastic waste enter the marine environment each year.



## Activity 2. Microplastics - small but deadly: it's double trouble



### UN deeply concerned!

Look at this website and play the video

[http://www.un.org/apps/news/story.asp?NewsID=56638#.WZTe\\_1UjEuX](http://www.un.org/apps/news/story.asp?NewsID=56638#.WZTe_1UjEuX)

Why is the United Nations deeply concerned about plastics in the ocean?

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### Microplastic has two main sources:

1. Plastic litter in the sea such as plastic bottles, break up into smaller and smaller pieces. Eventually the pieces are microscopic.
2. Every time we wash synthetic clothing, fibres are removed. These miniscule threads can pass through the sewage system and out to sea.

Some makeups and toothpastes use plastic microbeads. Microbeads are defined as plastic beads Typically between 0.5 to 500 micrometres in diameter. They get washed down the drain, pass right through sewage treatment plants and then enter the waterways and the ocean. Once in the water they absorb toxins and are eaten by organisms. They make their way up the food chain and eventually, when we eat fish, we are ingesting large concentrations of these toxins.

These are some examples of the effects of public pressure on companies that were using microplastics in their products:

[www.greenpeace.org/international/en/news/Blogs/makingwaves/microbeads-companies-response/blog/57314/](http://www.greenpeace.org/international/en/news/Blogs/makingwaves/microbeads-companies-response/blog/57314/)

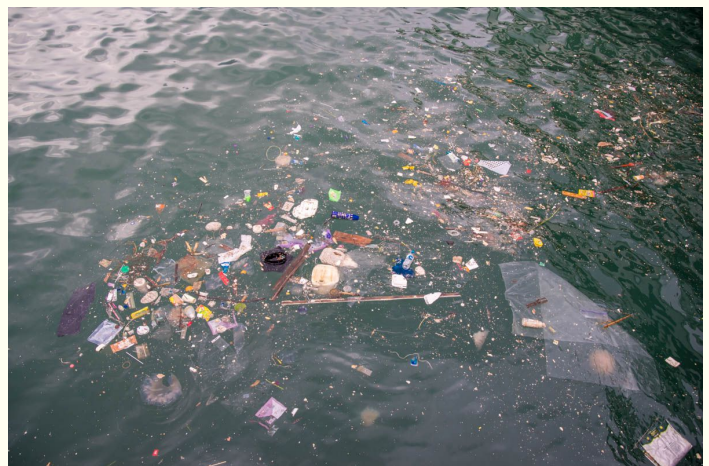
This is a list of products that contain plastic microbeads:

<http://www.beatthemicrobead.org/product-lists/>

### A double sting in the tail

Many of the smallest marine animals filter the water for food. These animals will quickly build up the plastic in their bodies. As these get eaten by larger animals, they will collect all the plastic from the animals they have consumed.

This is what makes the microplastic so dangerous. Many chemicals including pesticides and other toxic substances are absorbed by the plastic. This is a new pathway for toxic chemicals to be build up as it is passed down the food chain.



## News report

In small groups, create a short news report about microplastics.

1. It can be for a newspaper, magazine, online, TV or radio.
2. Use the web link below to source your information.
3. Come up with a gripping heading.
4. Explain the source of microplastics.
5. Explain how it affects the food chain.
6. Make a statement about what can be done.

<http://www.tangaroablue.org/resources/fact-sheets.html?download=61:what-are-microplastics>

## My reusable water bottle

Write three reasons for using your own reusable water bottle.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

What reasons might you have for buying water in a disposable bottle?

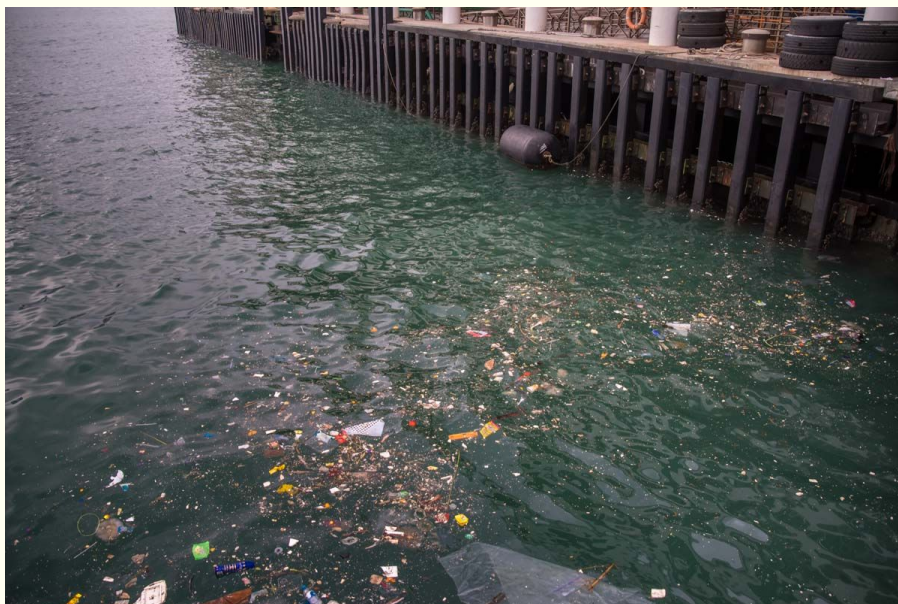
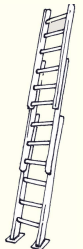
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## Extension:

1. Research a few alternatives to plastic that are being developed or used at this time.
2. Research some experimental cleanup techniques that are being developed to address the problem of plastic waste in the oceans.





### Activity 3. Ship breaking in Bangladesh- deadliest jobs for people and the sea



When ships get to the end of their life, they need to be recycled. It is difficult to break up a ship because ships are designed to be battered by the sea. Before a ship can be broken up it needs to have the polluting materials removed, so it doesn't contaminate the sea. Many parts of the ship hold oil, asbestos, heavy metals and other dangerous chemicals.

Read the National Geographic article and watch as much of the video as you can.

<http://ngm.nationalgeographic.com/2014/05/shipbreakers/gwin-text>

Watch the first 13 minutes of this video if you have time:

<https://www.youtube.com/watch?v=qhlaEEW63Sc>

Use Google Maps. Change the map to Earth. Use the information about places in Bangladesh where ships are broken up to do a search. Then find by scrolling along the coast of Google maps where ships are being broken up.

How many ships did you find?

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The sea around Singapore is some of the busiest shipping lanes in the world. Many of the ships that have no cargo to carry are anchored off the Singapore coast. These are often older ships and may be sold for scrap in the next few years. Use Google Maps to take a look at the sea around Singapore. Take exactly one minute to see how many ships you can find anchored at sea.

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*Ships anchored off the Singapore coast.*

#### Activity 4. Acidification - destroying the ocean's chemistry



It seems like a good thing. The oceans absorb a lot of the extra CO<sub>2</sub> we are producing. If it didn't, we might have increased the world's temperature by as much as 3 degrees. But there is a catch to this good news. As the seas absorb more CO<sub>2</sub>, its chemistry will go from being slightly basic to slightly acidic.

A slightly acidic sea would be much, much weaker than lemon juice, but the impact on the sea would be an ecological catastrophe. Thousands of species of animals and some plants that use calcium in the sea, wouldn't be able to perform the necessary chemical reactions.

- All corals would die because they can't make their coral skeleton
- Half the species of shellfish would die because they can't make their shells
- One of the most abundant microscopic plankton called foraminifera would also disappear because their shells would dissolve.

Draw a cartoon of how coral and shellfish will be affected by ocean acidification.

- It can look realistic.
- It can be more like a newspaper cartoon with the sealife having something to say.
- The cartoon can be before and after.
- It could have chemicals in the water doing chemical reactions.
- It could imagine how weakened shells could make some of the creatures more vulnerable to predators



These websites might help:

<https://theotherco2problem.wordpress.com/what-happens-chemically/>

<http://climateinterpreter.org/content/chemistry-ocean-acidification>

<https://emmachutchinson.com/2015/02/12/ocean-acidification-a-hidden-impact-of-climate-change/>

<https://au.pinterest.com/pin/572097958895744804/>

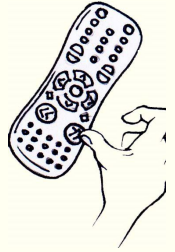
<https://au.pinterest.com/pin/300896818824248784/>

<https://360exposure.wordpress.com/2016/04/14/ocean-acidification/>

<https://au.pinterest.com/pin/192317846562575135/>

## Activity 5. Looking forward

What will you do to help our oceans?



### Purchasing sustainable fish

Find the most appropriate App for Hong Kong to help you choose the most sustainable fish at the market.

### Social media project

Get together with some classmates, friends or family.

- Decide what social media platform you would like to use.
- Get permission from your teachers and parents. Explain to them your procedures for staying safe on the web (includes no link to names and addresses).
- Decide what issues you want to explore.
- Design your campaign.
- Plan how you will keep adding content.
- Link up with like minded groups.
- Provide feedback provided it complies with your web safety procedures.

### Follow an ocean experience of interest

- Decide what kind of scientific research, sea recreation or location you are interested in eg a scientific vessel, Antarctica surfing.
- Identify what digital platform will most likely have what you are interested in.
- Find a link to your area of interest.
- Follow it for at least the next couple of weeks.
- If you can ,communicate with those conducting the research to find out more. Find out what qualifications they have.
- Find out what it is like to do research on the ocean.

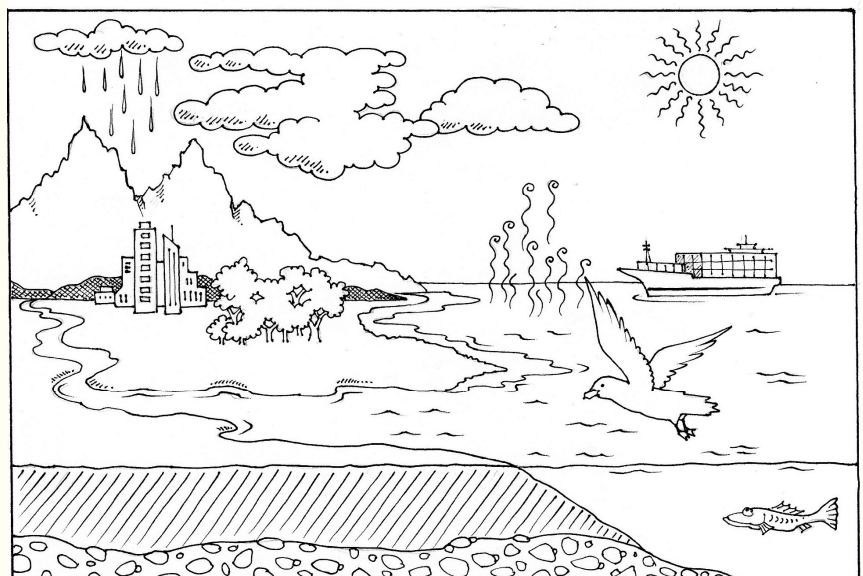
### Music about the seas and oceans

<https://www.youtube.com/watch?v=q3EE83q6tzw>

- Put together a music list of no more than ten tunes that includes the sea and oceans with web links.
- Share your list with friends and family.
- With friends, compose your own music to share.

### Woods Hole Oceanographic institute, Massachusetts

- Explore the institute's website <http://www.whoi.edu/>
- Find out what people are doing and the research that is being conducted.
- Identify and describe the three coolest things you would like to do.



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