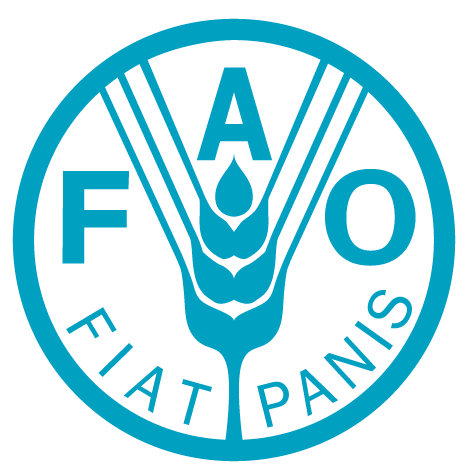
**Oceans Challenge Badge**

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Introduction

Often people do not recognise the essential role that the oceans play in life on Earth. The Oceans Challenge Badge has therefore been developed to help inform, educate and inspire children and young people about the oceans. By completing the badge, they will learn about the importance of the oceans to life on Earth, how people use the oceans and how this use is affecting the oceans and ultimately the world that we live in. The badge has also been designed to encourage children and young people to raise awareness about the oceans and spread the word about just how important the oceans are to all of us.

Covering more than 70% or the Earth’s surface, the oceans are complex and made up of a multitude of different ecosystems and habitats containing a myriad of life. Trying to condense all the necessary information into a Challenge Badge has been a challenge in itself! This booklet therefore contains only flavours of what we know about the oceans, but hopefully it will interest and motivate children and young people to find out more.

This booklet contains information that can be used in a classroom or during guide and scout meetings. Following this introductory material, there is a section for teachers/group leaders that should contain enough information to help them support children and young people in completing the Challenge Badge. It also contains a number of links to relevant websites where further information can be obtained. Teachers/group leaders may find that some children and young people may like to read this for themselves. At the back for this booklet there is a glossary explaining technical terms.

How to use this badge curriculum

**Encourage learning**

Before carrying out the activities included in this booklet, encourage your group/class to learn about the oceans and the life that they contain, how humans use the oceans and how human activities are changing the oceans. You could start by finding out where children/young people in your group last saw the sea, what they did when they last went to the coast and what they liked and disliked about being there. Get them thinking about other people they saw at the coast and how they were using it – did they see any fishing activities? Did they see any boats or ships on the horizon? What else was going on? Explain how some of these activities, while they appear at first sight not to have any impacts on the oceans, can influence the quality of the marine environment and what lives there. Also raise the issue of how what we do on land can influence what goes on in the oceans. Finally, get the group to think about how their actions and choices may be contributing to the change in the oceans and what they can do to make a difference.

If the children/young people in your group are not very familiar with the oceans (and if you have access to the internet), then you might want to see a shortoverview film on the oceans, produced by National Geographic <http://www.youtube.com/watch?v=3GRA7ilM708&feature=fvst> or <http://www.youtube.com/watch?v=ycHt8De_S1w>

Very young children might prefer to watch something like: <http://www.youtube.com/watch?v=FFJuQZhAHr8&feature=bf_prev&list=PL7E32AD6CD90DF1C0>

**Choose activities**

Let the group or individuals choose which activities they would like to do according to their skills, interests and abilities (although for very young children, an adult should help guide them). Many of the activities can be undertaken either individually or in groups, but some are specifically group activities (and in the case of very young children, should be adult led). If only one child/young person is interested in a group activity, it should be possible to modify it so that an individual can complete it. If you have another activity that is relevant or particularly appropriate to your area, you could also include it as an option or an additional activity.

**Allow time and provide support**

Many of the activities included in this booklet can be completed in an evening, but several require children and young people to find out more information or collect materials. Allow them time to carry out each activity and support them in their search for information. Encourage them to be as independent as possible and think creatively about how they carry out each activity.

**Present findings to the group**

Encourage children and young people to present what they have found out from each activity to the rest of their group. Do you notice any changes in their attitudes and behaviour? Get them to discuss their experiences – what have they enjoyed about completing the activity? What have they not? How can they use what they have learnt to make a difference in their everyday lives? How can they encourage others to make similar changes?

**Organise an award ceremony**

For those who have successfully completed the badge curriculum, organise an award ceremony. Invite friends and family, teachers, journalists and community leaders to participate. This could be an opportunity for your group to spread the word about what they have discovered as they completed this badge to the wider community. Award them with certificates and the oceans challenge badge. Challenge badges can be ordered at the WAGGGS online shop: www.wagggs-shop.org

**Share with FAO and WAGGGS**

Send us your stories, photos, drawings, ideas and suggestions: children-youth@fao.org

Age ranges of activities

To help you and your group select the most suitable activities, a coding system is provided to indicate the age group for which the activity is most suitable. Next to each activity you will see a combination of the symbols ➀➁➂.

➀ indicates activities suitable for those aged 5-10,

➁ indicates activities for those aged 11-15, and

➂ refers to activities for those aged 16-20.

This coding system is only indicative and you may find that an activity coded for one age group is suitable for individuals in a different age group. This will vary according to the ability of each individual.

The badge curriculum

The Oceans Challenge Badge is divided into 5 different categories:

* What and where are the oceans?
* Shaping life on the planet
* Weather and climate
* People and the oceans
* Exploration and action

Each category contains ten different activities that have been coded according to different age groups. Most activities are suitable for more than one age group and the majority contain ideas to extend the activity for the older and more able children in the class or group. The learning aim for each activity is stated at the beginning, but each activity also encourages the development of wider skills such as powers of observation, team work, creativity, speaking in public and community involvement.

To earn the badge, children and young people need to **complete two activities from each category** (so ten in total), but if additional activities are of interest to them, encourage them to do extra! Each activity has a tangible output against which children’s and young people’s progress can be gauged. If the suggested outputs are not of interest to the children/young people, encourage them to think of an alternative.

The badge has lots of different kinds of activities from scientific experiments, to model building, art work, creative writing, technical writing, presentations and debates. It is hoped that they will appeal to children and young people from around the world with different levels of access to resources and technologies. Where possible, reference materials have been included (if necessary) and the physical materials needed are limited to everyday household items. The materials needed are listed at the beginning of each activity.

Unfortunately, not all activities can be carried out in all parts of the world. If you aren’t lucky enough to live near the coast, then making trips to the beach may be difficult, but there is a lot you can learn about the oceans without having to leave home. The internet is also a wonderful resource, but not everyone has access to it or it can be very slow if the connection is not good. This guide does point you to numerous internet resources, but the introductory material for teachers/group leaders should provide a good starting point for completing the activities and there are alternatives to the internet, such as reference books, newspapers and magazines, talking to people you know, writing to people to ask for information, and even telephoning them. If you are creative, you can find a way!

Level 1 curriculum for 5-10 year olds

Each activity has a specific learning aim, but in addition to this, children will be expected to learn additional, more general skills including:

* Team work
* Imagination and creativity
* Observation skills
* Cultural and environmental awareness
* Numerical and literacy skills

In addition to learning and skill building, and although many of the issues raised are quite serious, these activities are designed to be fun and bring laughter to the group. Encourage the children to enjoy the process of earning the badge and to have fun while learning about the oceans and the wonderful life that they contain.

|  |  |  |
| --- | --- | --- |
| **Activity category** | **Activity name** | **Learning objective** |
| What and where are the oceans? | Where are the oceans? | *To identify and name the five oceans on the Earth and to learn some key facts about the ocean/sea closest to where you live* |
| What is the difference between seawater and freshwater? | *To understand what makes seawater different to freshwater, understand the meaning of density and how salt and temperature affect the density of water* |
| Evaporation and how to get salt from seawater | *To understand the meaning of evaporation and how evaporation can be used to get salt from seawater* |
| Evaporation and how to get freshwater from seawater | *To further demonstrate evaporation and to illustrate how freshwater can be obtained from seawater* |
| Creating waves | *To understand the role of the wind in creating waves and to think about how people can use waves* |
| Shaping life on the planet | What do you know about life in the oceans? | *To learn the names of different marine creatures* |
| What animal am I? | *To help children with the identification of marine animals and plants* |
| Visit the coast | *To find out what marine creatures live at the coast and learn to be responsible when exploring the natural world* |
| What eats what? | *To understand marine food chains and learn about how different marine animals and plants interact with each other* |
| Modelling the deep seabed | *To explore life on the deep seabed and the different physical features that are found there* |
| Weather and climate | The water cycle | *To understand the water cycle, the meaning of evaporation, condensation, precipitation and collection, and the difference between liquid water and water vapour* |
| Make your own cloud! | *To better understand the concepts of evaporation and condensation and how clouds are formed* |
| And now make some fog… | *To understand how fog forms and the meaning of condensation* |
| Changing oceans | *To introduce climate change and how it is affecting the oceans* |
| The oceans and climate change: rising temperatures | *To understand the causes of sea level rise and the effect of melting sea ice and land ice on sea level and how sea level* |
| Ocean acidification: the other CO2 problem | *To understand the concept of pH, what ocean acidification is and what it means for marine life.* |
| People and oceans | How do people use the marine environment? | *To identify the many ways that people use the oceans and coasts and have an understanding of the many products we use in our everyday lives that come from the oceans* |
| Let’s talk about fish | *To find out about fish that are landed locally, how they were caught and where they have come from* |
| A day in the life of a fisher | *To understand what it might be like to be a fisher* |
| Having fun at the seaside | *To learn about the benefits of exercise and find out about the different recreational activities you can get involved with at your local beach* |
| Boats and seafarers | *To build a model boat that floats and imagine what it would have been like as an explorer to cross the ocean in open boats* |
| The problem with plastic… | *To understand the impact of rubbish in the marine environment and how it affects marine wildlife; to practice sorting, counting and weighing* |
| Exploration and action | Ways to explore your own coast | *To build an underwater scope to look at life under the water surface* |
| Exploring the open ocean | *To learn about early ocean studies, understand about the conditions on board early survey ships* |
| Census of marine life | *To be inspired by marine life* |
| World Oceans Day | *To celebrate the wonders of the oceans, its beauty and importance* |
| Reduce your use of plastic | *To encourage behaviour change and understand the impact of plastic on the marine environment.* |
| Campaign for your local beach or raise awareness of marine environmental problems | *To organise a campaign about an issue that is important to you and how to persuade other people that the issue is also important to them* |
| Take the Seafood Watch Challenge | *To understand how the choices you and your family make about seafood affect the marine environment* |
| Citizen science | *To contribute to a research project by providing data* |

Level 2 curriculum for 11-15 year olds

As for level 1 activities, each activity has a specific learning aim, but in addition to this, children and young people will be expected to learn additional, more general skills including:

* Team work and independent study skills
* Imagination and creativity
* Observation skills
* Cultural and environmental awareness
* Research skills
* Presentation and public speaking skills
* Presenting an argument and debating skills

In addition to learning and skill building, and although many of the issues raised are quite serious, these activities are designed to be fun and bring laughter to the group. Encourage the children to enjoy the process of earning the badge and to have fun while learning about the oceans and the wonderful life that they contain.

|  |  |  |
| --- | --- | --- |
| **Activity category** | **Activity name** | **Learning objective** |
| What and where are the oceans? | Where are the oceans? | *To identify and name the five oceans on the Earth and to learn some key facts about the ocean/sea closest to where you live* |
| Evaporation and how to get salt from seawater | *To understand the meaning of evaporation, how evaporation can be used to get salt from seawater and to learn about salt* |
| Evaporation and how to get freshwater from seawater | *To further demonstrate evaporation and to illustrate how freshwater can be obtained from seawater* |
| Radio broadcast on Tsunamis | *To understand the causes of tsunamis and to experience what it might be like to be a radio journalist or person being interviewed* |
| Tide and time wait for no man | *To understand how the sun and moon affect the tides and the meaning of gravity* |
| Ocean currents: surface and deep water | *To understand how ocean currents are formed and why they are important to the planet* |
| Surface currents: follow the journey of the plastic ducks… | *To better understand the concept of surface currents and why it is important to know where these surface currents flow* |
| Rip currents and staying safe at the beach | *To understand what is a rip current, how to spot one when you are at the beach and what to do if you are swimming and get caught in one* |
| Shaping life on the planet | What do you know about life in the oceans? | *To learn the names of different marine creatures* |
| What animal am I? | *To help children with the identification of marine animals and plants* |
| Visit the coast | *To find out what marine creatures live at the coast and learn to be responsible when exploring the natural world* |
| Study and map the coast | *To understand the physical environments in which marine organisms live and identify the human impacts on these physical environments* |
| Filming the coast | *To produce a short 5 minute documentary film about your local coast describing the habitats, what marine life you will find there and how the marine life is adapted to living there. Learn about how to make a good film and what preparation is needed before filming.* |
| What eats what? | *To understand marine food chains and learn about how different marine animals and plants interact with each other* |
| Modelling the deep seabed | *To explore life on the deep seabed and the different physical features that are found there* |
| Other marine habitats | *To improve research skills and learn about unfamiliar marine habitats* |
| Favourite marine life | *To find out more about your favourite marine life and develop presentation and speaking in public skills* |
| Evolution of life | *To understand the origins of life and when different marine animals and plants appeared on Earth* |
| Weather and climate | The water cycle | *To understand the water cycle, the meaning of evaporation, condensation, precipitation and collection, and the difference between liquid water and water vapour* |
| Hurricanes, cyclones and typhoons | *To understand the impacts of hurricanes/cyclones/typhoons can have on people* |
| The oceans and climate change: rising temperatures | *To understand the causes of sea level rise and the effect of melting sea ice and land ice on sea level and how sea level* |
| Rising sea temperature and marine life impacts | *Using coral reefs as an example, to understand the implications of rising sea temperatures on marine life and to recognise that different species will respond in different ways* |
| Ocean acidification: the other CO2 problem | *To understand the concept of pH, what ocean acidification is and what it means for marine life.* |
| A short guide to the oceans and climate change | *To summarise the many impacts of climate change on the oceans* |
| Get filming – why are the impacts if climate change on the oceans important to me? | *To encourage young people to think about how climate change and its impacts on the ocean may affect them and their communities, and what can be done to reduce its impacts.* |
| People and oceans | How do people use the marine environment? | *To identify the many ways that people use the oceans and coasts and have an understanding of the many products we use in our everyday lives that come from the oceans* |
| A day in the life of a fisher | *To understand what it might be like to be a fisher and what has changed in fishing over the past 50 (or so) years* |
| How do fishers catch fish? | *To understand the different ways that fishers catch fish and the impact of the different fishing methods on the marine environment* |
| Finding out about aquaculture | *To find out about aquaculture, why aquaculture is growing, what species are used in aquaculture, and the environmental impacts of aquaculture* |
| Having fun at the seaside | *To learn about the benefits of exercise and find out about the different recreational activities you can get involved with at your local beach* |
| Marine transport and trade | *To find out about the different ways that the oceans are used for transport and trade* |
| Boats and seafarers | *To build a model boat that floats and imagine what it would have been like as an explorer to cross the ocean in open boats* |
| The problem with plastic… | *To understand the impact of rubbish in the marine environment and how it affects marine wildlife; to practice sorting, counting and weighing* |
| Marine protected areas: are they the answer to better ocean protection? | *To understand who has responsibility for the oceans and the role that marine protected areas can play* |
| Exploration and action | Ways to explore your own coast | *To build an underwater scope to look at life under the water surface and to build a hydrophone to listen to underwater sounds* |
| Exploring the open ocean | *To learn about early ocean studies, understand about the conditions on board early survey ships* |
| Census of marine life | *To be inspired by marine life* |
| Studying the oceans | *To understand how scientists study marine environments* |
| Exploring the Arctic | *To learn about research in the Arctic, what living in the Arctic might be like and how the Arctic is changing* |
| World Oceans Day | *To celebrate the wonders of the oceans, its beauty and importance* |
| Reduce your use of plastic | *To encourage behaviour change and understand the impact of plastic on the marine environment* |
| Campaign for your local beach or raise awareness of marine environmental problems | *To organise a campaign about an issue that is important to you and how to persuade other people that the issue is also important to them* |
| Take the Seafood Watch Challenge | *To understand how the choices you and your family make about seafood affect the marine environment* |
| Citizen science | *To contribute to a research project by providing data* |

Level 3 curriculum for 16-20 year olds

The curriculum below shows how 16-20 year olds can earn the badge. Each activity has a specific learning aim, but in addition to this, young people will be expected to learn additional, more general skills including:

* Team work and independent study skills
* Imagination and creativity
* Observation skills
* Cultural and environmental awareness
* Technical and researching complex issue skills
* Presentation and public speaking skills
* Presenting an argument and debating skills

In addition to learning and skill building, and although many of the issues raised are quite serious, these activities are designed to be fun and bring laughter to the group. Encourage the children to enjoy the process of earning the badge and to have fun while learning about the oceans and the wonderful life that they contain.

|  |  |  |
| --- | --- | --- |
| **Activity category** | **Activity name** | **Learning objective** |
| What and where are the oceans? | Radio broadcast on Tsunamis | *To understand the causes of tsunamis and to experience what it might be like to be a radio journalist or person being interviewed* |
| Tide and time wait for no man | *To understand how the sun and moon affect the tides and the meaning of gravity* |
| Ocean currents: surface and deep water | *To understand how ocean currents are formed and why they are important to the planet* |
| Surface currents: follow the journey of the plastic ducks… | *To better understand the concept of surface currents and why it is important to know where these surface currents flow* |
| Rip currents and staying safe at the beach | *To understand what is a rip current, how to spot one when you are at the beach and what to do if you are swimming and get caught in one* |
| Shaping life on the planet | Study and map the coast | *To understand the physical environments in which marine organisms live and identify the human impacts on these physical environments* |
| Filming the coast | *To produce a short 5 minute documentary film about your local coast describing the habitats, what marine life you will find there and how the marine life is adapted to living there. Learn about how to make a good film and what preparation is needed before filming.* |
| Other marine habitats | *To improve research skills and learn about unfamiliar marine habitats* |
| Favourite marine life | *To find out more about your favourite marine life and develop presentation and speaking in public skills* |
| Evolution of life | *To understand the origins of life and when different marine animals and plants appeared on Earth* |
| Weather and climate | Hurricanes, cyclones and typhoons | *To understand the impacts of hurricanes/cyclones/typhoons can have on people* |
| Rising sea temperature and marine life impacts | *Using coral reefs as an example, to understand the implications of rising sea temperatures on marine life and to recognise that different species will respond in different ways* |
| Ocean acidification: the other CO2 problem | *To understand the concept of pH, what ocean acidification is and what it means for marine life.* |
| A short guide to the oceans and climate change | *To summarise the many impacts of climate change on the oceans* |
| Get filming – why are the impacts if climate change on the oceans important to me? | *To encourage young people to think about how climate change and its impacts on the ocean may affect them and their communities, and what can be done to reduce its impacts.* |
| People and oceans | A day in the life of a fisher | *To understand what it might be like to be a fisher and what has changed in fishing over the past 50 (or so) years* |
| How do fishers catch fish? | *To understand the different ways that fishers catch fish and the impact of the different fishing methods on the marine environment* |
| Finding out about aquaculture | *To find out about aquaculture, why aquaculture is growing, what species are used in aquaculture, the environmental impacts of aquaculture and how aquaculture can be made more environmentally friendly* |
| Having fun at the seaside | *To learn about the benefits of exercise and find out about the different recreational activities you can get involved with at your local beach, start to explore the environmental impacts f marine recreation and tourism* |
| Marine transport and trade | *To find out about the different ways that the oceans are used for transport and trade* |
| Boats and seafarers | *To build a model boat that floats and imagine what it would have been like as an explorer to cross the ocean in open boats* |
| The problem with plastic… | *To understand the impact of rubbish in the marine environment and how it affects marine wildlife* |
| Marine protected areas: are they the answer to better ocean protection? | *To understand who has responsibility for the oceans and the role that marine protected areas can play* |
| Exploration and action | Studying the oceans | *To understand how scientists study marine environments* |
| Exploring the Arctic | *To learn about research in the Arctic, what living in the Arctic might be like and how the Arctic is changing* |
| World Oceans Day | *To celebrate the wonders of the oceans, its beauty and importance* |
| Reduce your use of plastic | *To encourage behaviour change and understand the impact of plastic on the marine environment* |
| Campaign for your local beach or raise awareness of marine environmental problems | *To organise a campaign about an issue that is important to you and how to persuade other people that the issue is also important to them* |
| Take the Seafood Watch Challenge | *To understand how the choices you and your family make about seafood affect the marine environment* |
| Citizen science | *To contribute to a research project by providing data* |

Be safe and sound – looking after you, your friends and the marine environment

Being by, in or on the sea can be a fantastic and exciting experience, but you do need to be extremely careful. The sea can be an unpredictable place and you need to take precautions to make sure everybody stays safe. You also need to make sure that you don’t hurt the marine environment: remember “take only pictures and leave only footprints”.

The Marine Life Information Network for Britain and Ireland has put together a seashore code (<http://www.marlin.ac.uk/pdf/seashorecode.pdf>) containing advice on how to look after yourself and to protect the animals and plants that live there. It says:

* Before you go, tell someone where you are going, when you will be back and make sure you know what the weather and tides will be like. If you can, take a mobile phone.
* Walk carefully over rocks, they may be slippery or unstable or you may kill or damage plants and animals. Cliffs should also be avoided as they may be unstable.
* Do not take living plants or animals home with you. Try to take only photographs. If you do take shells home, make sure they are empty.
* Take your litter home, it can be dangerous to people and wildlife and can ruin the scenery you are there to enjoy.
* Report anything unusual that you find but do not touch anything if you are not sure it is safe.
* Treat all living things with respect and replace any stone or seaweed exactly how you found it.
* When you get home, wash your hands!

A few additional tips should also help to keep you safe:

* Avoid muddy shores as you can easily get stuck in the mud.
* Watch out for waves, especially near rocks, as they can be bigger and more powerful than you think.
* If there are any warning signs on the beach or coast (such as beach closed or no swimming), make sure you follow the advice.
* If you want to swim, don’t go into the water unsupervised and if possible, only swim at beaches where there is a lifeguard on patrol. Make sure you know where other people in your group are.
* Don’t swim immediately after a meal.
* Don’t swim near pipes, outflows, rocks, breakwaters and piers and don’t use them to jump off.
* If you get into trouble in the water, don’t panic; raise one arm up and float until help arrives. If you find you are in a rip current or undertow, float with it; don’t try to swim against it.
* Only use a snorkel if you are a good swimmer and the water is calm.
* Take a first aid kit with you, just in case.

Educational Contents: Introducing the Oceans

What follows is a description aimed at teachers/groups leaders of the basic information needed to support and guide children and young people in the activities described later in this booklet. The information is divided into the 5 sections corresponding to 5 categories of activities. Each section contains useful links to websites that may help children and young people complete the activities.

A, What and where are the oceans?

How many oceans are there and where are they?

More than 70% of the Earth’s surface is covered in water known as the global ocean. This interconnected body of water has traditionally been divided into five smaller oceans (in decreasing size order): the ***Pacific* *Ocean***, the ***Atlantic Ocean***, the ***Indian Ocean***, the ***Southern Ocean*** and the ***Arctic Ocean*** (see figure 1.1). Smaller regions of these oceans, often enclosed by land on more than one side, are known as ***seas*** (e.g. the Caribbean Sea and the Mediterranean Sea), ***straits*** (e.g. the Bering Strait between Alaska and Siberia, and the Strait of Malacca between mainland Malaysia and Sumatra), ***bays*** (e.g. the Bay of Bengal) and ***gulfs*** (e.g. the Gulf of Mexico). There are also a number of ***inland seas***, or salt lakes, that have a number of characteristics similar to the oceans (e.g. the Aral Sea and the Caspian Sea).

What makes the oceans different to freshwater?

The water contained in the oceans is known as ***seawater***. The main difference between seawater and freshwater is the presence of dissolved salts in seawater (mainly sodium and chlorine, but also magnesium, calcium and sulphate). Seawater has a ***salinity*** (saltiness) of about 3.5%, which means every litre of seawater contains about 35g of dissolved salts. In contrast, freshwater only contains about 1g of dissolved salts for every litre. The presence of the dissolved salts in seawater makes seawater ***denser*** (it has a greater mass) than freshwater, and it freezes at a lower temperature (-2oC compared to 0oC). Not all seawater has the same salinity; salinity changes (see figure 1.2) according to the amount of freshwater entering the ocean and the level of ***evaporation*** (the change from liquid water to water vapour, particularly in warmer climates).

Where do the dissolved salts in seawater come from? One theory suggests that as freshwater moves over land in streams and rivers and through land as groundwater, salts get dissolved in it and eventually get transported out to sea. As seawater evaporates (as part of the ***hydrological*** ***cycle***), only the water turns to vapour, leaving behind its dissolved salts, which over time have become concentrated. Scientists now believe that salts also entered the sea from the seabed when the oceans formed and from underwater volcanoes and vents.

What happens if we drink salt water? Humans need some salt in our bodies, but the concentration of salt in seawater is too much for our bodies to deal with. To remove the salt, we need to urinate and the volume we would need to urinate is much greater than the volume of seawater that we drank. In the end we would become thirstier and thirstier and we would die of dehydration! But don’t worry, help is at hand and there are ways that you can remove the salt from seawater... (see activity A4).

To find out more: <http://oceanservice.noaa.gov/facts/whysalty.html>

What happens when freshwater and seawater meet?

Estuaries and deltas are mixing pots where rivers and oceans meet. They are particularly productive environments (i.e. they support a lot of life) because of the flow of nutrients from both rivers and the oceans. All around the world they are important areas for people; they are often heavily populated.

Seawater enters the estuary with the ***tides*** (see below) and becomes diluted by the freshwater flowing from the river. This diluted seawater is known as ***brackish water***. How well the two types of water mix depends on how much of each type of water enters the estuary or delta. Where the Mississippi River meets the sea, there is so much freshwater entering the sea that little mixing occurs and the freshwater floats on top of seawater because it is less dense (it is lighter). The freshwater floats in a layer on top of the seawater that gets thinner and thinner as you move further from land.

What about when it rains? Does rainwater float on top of the ocean? If there is a lot of rain, it will initially float on top of the seawater, or dilute the surface waters, but the presence of waves will eventually mix the rainwater into the ocean.

To find out more: <http://oceanservice.noaa.gov/education/tutorial_estuaries/>

What are waves and how are they created?

Most waves are formed at the surface of the ocean and are the result of the wind blowing over the surface. These waves can travel for thousands of miles over the oceans and can vary in size from a few centimetres to over 30 m! They only break when the waves reach the shallow waters of the coast.

***Tsunamis*** are a different sort of wave resulting from geological change on the seabed (e.g. the movement of the Earth’s plates during an earthquake, volcanic eruptions or because of underwater landslides). These are often very powerful waves that increase dramatically in size as they approach shallow waters. They can have particularly devastating effects once they reach the coast (e.g. the Asian tsunami of 2004).

Waves are important features of the coast and have long been put to use by people for recreational activities such as surfing and body boarding, but also feared by people for their destructive nature. People are beginning to realise, however, the potential of the energy contained in waves and are now developing ways to convert this energy into electricity.

To find out more: <http://www.actionsportsmaui.com/how_ocean_waves_are_made.html>

<http://environment.nationalgeographic.com/environment/natural-disasters/tsunami-profile/>

What are tides?

All around the world, the level of the sea rises and falls as a consequence of the ***tides***. The tides are the result of the gravitational pull of the moon and the sun on the Earth, as well as the result of the turning of the Earth. ***Gravity*** is the level of attraction between two objects – imagine a magnet and how it pulls metal objects towards it, well the gravitational pull of the moon and the sun refers to how they pull the oceans towards them.

Most places around the world see two low and high tides each day (although some only see one of each), although the difference between the low and high tide varies according to the shape of the coast and seabed, the alignment between the sun and the moon and the influence of the deep ocean. When the sun and moon are in a straight line (e.g. when the moon is new or full), the ***tidal range*** (the difference between the highest and lowest tide) tends to be greatest; these tides are called ***spring tides***. When the sun and moon are not in a straight line (e.g. during the first and third quarter of the moon), the tidal range tends to be at its lowest and these tides are called ***neap tides***.

To find out more: <http://www.youtube.com/watch?v=KBTsESF1w-I>

What are ocean currents and how are they formed?

The movement of the oceans caused by the tides also causes what is known as a ***current***. Currents are continuous and directed movements of water found in all water bodies from rivers and lakes to seas and oceans. In the ocean, the tides are only one cause of currents. The wind, which creates waves, also creates currents, affecting the movement of the top 400m of the ocean. In the northern hemisphere, the wind causes a clockwise flow in the surface of the ocean, and in the southern hemisphere, an anti-clockwise flow. Knowing about these ***surface currents*** has been particularly important for people. In the time of sailing ships, it helped sailors cross the oceans. Today yachts-people still depend heavily on knowing about surface currents; it helps ships keep down the fuel costs, reducing the cost of marine transport and commerce. More recently, it has helped with the study of marine debris, such as rubbish. Importantly, wind-driven currents have helped with the dispersal of life around the planet, and they affect our climate.

Differences in the density and temperature of seawater also create currents deep within the ocean. In the Atlantic, wind-driven surface currents send the warmer waters of the tropics towards the Arctic. On this journey, the water begins to cool, becoming denser, and to gradually sink. As more and more cool, dense water arrives in the Arctic, it is forced to flow south, travelling large distances in the depth of the ocean before returning to the surface in the Southern Ocean (although some of it doesn’t rise until it reaches the North Pacific). Figure 1.3 shows the pathway of these ***deep ocean currents***. The journey of seawater around the planet takes several centuries or even millennia, and is important for the distribution of heat around the planet; it therefore plays a very important role in our climate (see activities in section C).

One final type of current that is important to know about is the ***rip current***, especially if you like swimming or taking part in water sports at the coast. Rip currents are narrow and fast moving belts of water that travel away from the coast and have caused many swimmers and recreational users to get into distress at the coast. They often occur at low points on the beach (e.g. at a break in a sand bank) and are more likely when the waves are high and frequent. It can be difficult to detect rip currents, but signs to look out for include a line of debris or foam moving away from the beach, a break in the pattern of the waves arriving at the beach, choppy or churning water, or an area of water that has a different colour.

To find out more: <http://oceanservice.noaa.gov/education/tutorial_currents/welcome.html> <http://www.ripcurrents.noaa.gov/overview.shtml>

B, Shaping life on the planet

How have the oceans affected life on Earth?

Life began in the oceans more than 3 billion years before it appeared on land. The oceans have helped create the conditions for life on Earth and did you know that over half of the oxygen we breathe has come from the oceans?!

The oldest record of life comes from marine bacteria known as ***cyanobacteria*** (or blue-green algae), which formed large layered structures in the marine environment called ***stromatolites***. You can still see examples of them today along the coast of Western Australia. About 1200 million years ago, the first algae evolved and over the following 700 million years we see evidence of worms and other soft bodied organisms similar to jellyfish. Around 500 million years ago we see an ‘explosion’ of life (which itself lasted several million years) and the appearance of ***molluscs*** (such as snails), ***echinoderms*** (including starfish) and organisms with clam like shells. The fish first appeared somewhere between 500 and 440 million years ago. It wasn’t until 440-410 million years ago that life first ventured on to land.

The ocean has also played a role in the dispersal of life around the planet. In a similar way to wind on land helping with the scattering of pollen and some plant seeds, the ocean’s currents are important for the dispersal of eggs and sperm, the larvae that develop from fertilised eggs and other microscopic marine creatures. Ocean currents also help with the distribution of nutrients and heat around the planet, influencing what can survive where. For example, the warm ocean current of the Gulf Stream means that the waters of the North East Atlantic are warmer than those of the North West Atlantic; this allow ***temperate*** ***species*** to live further north than would otherwise be expected in the North East Atlantic.

Ocean food webs

The oceans contain a huge diversity of life ranging from microscopic organisms such as viruses, bacteria and other single celled organisms, to the largest animal on the planet, the blue whale. All of these organisms are linked together in a complex web with many of the smallest organisms being primary producers that form the basis of all marine ***food chains*** or ***webs***. ***Primary producers*** can convert the energy from the sun into food materials through the process of ***photosynthesis*** and in so doing, release oxygen into the atmosphere. In the water column this is done by ***phytoplankton***, microscopic organisms that float with the ocean currents, but in shallow coastal waters, seagrasses, kelps and other seaweed also contribute to primary production. These primary producers form the basis of most marine ***food chains*** or ***food webs***.

Primary producers are preyed upon (eaten) by marine ***herbivores***. Herbivores only eat plant material and include some ***zooplankton*** (microscopic marine animals), ***echinoderms*** such as sea urchins, many marine ***molluscs*** (or snails) such as periwinkles and limpets, ***bivalves*** such as mussels and oysters, some fish species as well as larger animals such as ***manatees***. Many marine animals, however, eat other marine animals (i.e. they are ***carnivores***), such as sharks, seals, some sea birds, some octopus, many fish species as well as many molluscs. Others still are ***omnivores***, eating a mixture of plant and animal life (e.g. many whales and turtles, crabs, some sea birds). Another important group are the scavengers or ***detritovores***, these feed on dead animals and plants and their wastes and include a number of marine worms, crabs, starfish and fish. In the depths of the ocean where light is limited and no photosynthesis occurs, many species found there are detritovores, living off ***marine snow***, the bodies of organisms that live higher up in the ocean and fall to the ocean floor when they die.

Not all ocean food webs depend upon primary producers that can photosynthesise. It was originally thought that in the deep sea where no light reaches, there was limited life. With the improvements in deep sea exploration technology it has been shown that the deep sea is full of a multitude of different life forms that cannot be completely supported by marine snow. We now know that ***hydrothermal*** ***vents*** and ***cold seeps*** on the ocean floor (associated with volcanic activity) support food webs that are dependent on other sources of energy. Hydrothermal vents and cold seeps release sulphur-rich chemicals or hydrocarbons which are converted by bacteria into a source of food in a process known as ***chemosynthesis***, these bacteria in turn provide a food source for other marine animals.

To find out more: <http://www.classroomatsea.net/general_science/food_webs.html>

Marine habitats

Just as there is a diversity of habitats on land, there is also a diversity of habitats in the oceans. These can be divided according to physical characteristics (see table 1) but also according to biological ones (see table 2). Biological habitats are also known as biogenic habitats and are typically (but not always) found at the coast; they are modified by the animals and plants that grow there. It would be very easy to dedicate an entire book to talk about each these habitats and the marine life found in them, but all we can do here is provide an introduction and links showing where you can go to find out more about them.

**Table 1: Physical marine habitats**

|  |  |  |  |
| --- | --- | --- | --- |
| **Physical marine habitats** | **Characteristics** | **Importance to people** | **For more information** |
| Frozen oceans | Found in both the Arctic and Antarctic, sea ice covers about 25 million square kilometres (about two and a half times the size of Canada). The ice forms and melts in the ocean. In summer the sun can shine for 24 hours, but in winter there is 24 hour darkness. The marine life found here is often specially adapted to the extreme climate: some organisms contain substances to stop their blood freezing, others have thick layers of fat or dense hair, others still migrate to warmer waters when the harsh winter arrives. | These are important for marine wildlife, but they play a crucial role in regulating the global climate. For the people who live in these frozen environments, the sea ice is an important source of food, it is also central to their culture. Increasingly, the frozen oceans are also becoming important for tourism | <http://nsidc.org/cryosphere/seaice/index.html> |
| Intertidal zone | Found all over the planet, including any part of the coast that is exposed by changes in the level of the tide (e.g. rocky shores, mudflats, sandy beaches). They are a harsh environments that are sometimes covered by seawater and sometimes exposed. Marine life needs to be adapted to dry and wet conditions, salty and fresh water, high and low temperatures and to be able to hold on tight to prevent being washed away by waves. | This coastal zone is important for many human activities, including tourism, leisure and recreation, wildlife watching, for fishing, aquaculture and the collection of other marine resources (e.g. seaweeds). People also like living near these areas. | <http://www.thewildclassroom.com/biomes/intertidal.html> |
| Estuaries and deltas | These are found where rivers meet the sea. They are very productive areas supporting a diversity of life and are important areas for breeding and juvenile fish and migrating birds. Many estuaries and deltas are under threat from coastal development. The animals and plants found here need to be adapted to changes in salinity and sediments brought by the rivers. Many animals burrow in the sediments to avoid these changes, but some can tolerate them and others have ways to control them. | Estuaries and deltas are important for fishing and aquaculture; people have been draining them to provide land for agriculture and coastal development; and they are important for recreational activities such as wildlife watching. They are also store a lot of carbon, the organisms living there can breakdown waste products and they protect the coast from storm damage. | <http://water.epa.gov/learn/kids/estuaries/index.cfm> |
| Open ocean | This also refers to the pelagic zone or water column, and forms the largest part of the marine environment.  Light only enters the top 200m of water and this is where most primary production occurs (i.e. photosynthesis by phytoplankton). It is an important habitat for fish and their predators e.g. sharks, as well as whales and oceanic birds such as puffins, albatross, petrels and shearwaters  It is important for fishing, recreational activities and commercial transport. Some marine organisms, such as plankton, drift with the ocean currents while others are strong swimmers, others still propel themselves through other means (e.g. squids) | People use the open ocean for fishing, transport and recreation. It also plays an important role in the regulation of our climate as marine life draws down carbon dioxide from the atmosphere. The circulation of the water in the open ocean also transfers heat around the planet. | http://wwf.panda.org/about\_our\_earth/blue\_planet/open\_ocean/ |
| Deep ocean | This is the part of the water column beyond 200m where little light reaches. Below about 500m, oxygen levels become very low. Below 1000m it is pitch black and you find no living plant life there. Beyond 4000m the water is extremely cold and under very high pressure. Hydrothermal vents provide important hotspots for a food chain that is not dependent on light as an energy source. Marine life shows many adaptations to this zone, for example some fish have more efficient gills or move little to cope with low oxygen levels; many animals produce their own light and are bioluminescent; some migrate to the surface to feed at night and others feed on marine snow (detritus or dead cells/bodies that fall from the surface). Some animals have no eyes and their bodies are transparent. | The deep ocean is becoming increasingly important for fishing and for bioprospecting, the search for new products and medicines to support the growing human population. | <http://www.nhm.ac.uk/nature-online/insite/discovering-understanding/F51.html> |
| Seabed | This extends from the coast to the depths of the ocean. 50% of the seabed is abyssal plain, a relatively flat and featureless place, but the seabed also contains long chains of mountain (e.g. the east Pacific Rise and the Mid Atlantic Ridge) with volcanoes and deep sea (or hydrothermal) vents as well as deep trenches (e.g. the Marianas Trench). Extinct volcanoes, known as seamounts are also common and are important habitats for fish and the fishing industry. | Shallow parts of the seabed support very productive and diverse habitats such as coral reefs, seagrass meadows, bivalve beds and kelp forests that are important for fisheries. The seabed is also used for cable laying and telecommunications, and people are exploring the seabed to look for minerals, oil and gas. Organisms living here also bury our waste products, helping to keep the oceans healthy. | <http://www.bbc.co.uk/nature/habitats/Benthic_zone> |

**Table 2: Biogenic coastal habitats**

|  |  |  |  |
| --- | --- | --- | --- |
| **Biological marine habitats** | **Characteristics** | **Importance** | **For more information** |
| Coral reefs | Found all over the planet from the tropics to the polar regions. Tropical reefs contain hard bodied corals. Deepsea corals don’t form reefs, but are found in banks. Soft bodied corals are found in temperate and polar regions. | They are the rainforests of the sea, providing habitat for other species. They are also important for the fishing industry and for tourism where reefs are shallow. Many medicines are being developed from coral reef species. They also protect the coast from storm damage and erosion. | <http://www.coral.org/> |
| Seagrass beds | These marine flowering plants are also found all around the world, often in dense meadows. In the tropics they are found near coral reefs. They are in decline due to human activities such as fishing, disturbance from boats and pollution. | They are important habitats for other marine species including commercially important fish. They play an important role in the sequestration and storage of carbon, they slow water currents at the coast, encouraging sediments to accumulate and preventing coastal erosion. They are used as fertilisers, for fillings in mattresses and are woven to make furniture, carpets and rugs. | <http://www.seagrasswatch.org/seagrass.html> |
| Kelp forests | Found mostly in temperate and polar regions and often associated with estuaries and deltas and sheltered coastlines. They are very productive and where the water clarity is good, kelp can grow 30cm a day and reach 60m in height! | Like seagrasses they are important habitats for other marine species including commercially important fish (lobster fisheries are often associated with kelp). They also alter the flow of water, encouraging the accumulation of sediment and reduction of coastal erosion. Many cosmetics and pharmaceuticals contain products derived from kelp. Kelp has also been used traditionally as a fertiliser. | <http://inchinapinch.com/hab_pgs/marine/kelp/kelp.htm> |
| Mangroves | Mangroves are trees that have adapted to having their roots wet most of the time. Their roots are specially adapted to obtain oxygen when the tide is in and have ways of removing salt, either through their leaves or by preventing it entering their roots. They are found in the tropics and sub-tropics along sheltered coastlines such as muddy estuaries, sheltered lagoons, bays and inlets. They are under threat from aquaculture (e.g. shrimp farming), the reclamation of land for urban development and agriculture. | Mangroves play many important functions such as protection of the coast against storm damage; encouraging the accumulation of sediments and nutrients; they act as a source of food, wood, new medicines, dyes and tanins; they provide an important habitat for many marine species including commercially important fish. They also trap rubbish and other pollutants, which is good for the surrounding water, but bad for the mangroves. | <http://www.bbc.co.uk/nature/habitats/Mangrove> |
| Salt marshes | Salt marshes are the mangroves of temperate and higher latitude areas and like mangroves are found in sheltered coasts, estuaries and deltas. They consist of herbs, grasses and low shrubs that can live in the intertidal zone. They are also under threat from land reclamation, but also nutrient runoff and pollution from land. | They have many of the same functions as mangroves, such as the provision of habitat for other species including migrating birds; protection of the coast against erosion and storm damage; and encouraging the accumulation of sediments and nutrients. | <http://www.theseashore.org.uk/theseashore/Saltmarsh%20section/Saltmarsh%20introduction.html> |
| Bivalve beds | These are concentrations of bivalves such as oysters and mussels that form structures that provide habitat for other marine species such as worms and other crustaceans. They are found in the intertidal zone and are one of the most threatened marine habitats in the world. They have been declining due to overharvesting by people, increased sediment accumulation, invasive species, pollution and disease. | Bivalve beds are an important source of food for other marine species, as well as for people. Bivalves are filter feeders; this means that they feed by taking in water inside their shells and removing small particles from it. It has been suggested that they could be used to help clean up water and remove excess nutrients from it.  **IMPORTANT**: unless you know the quality of the water where bivalves are found, **DO NOT** harvest them for personal consumption as they may contain toxins that can cause severe illness in people. | <http://www.naturalengland.org.uk/ourwork/marine/protectandmanage/mpa/mcz/features/habitats/nativeoysterbeds.aspx>  <http://www.naturalengland.org.uk/ourwork/marine/protectandmanage/mpa/mcz/features/habitats/bluemusselbeds.aspx> |

C, Weather and climate

Before beginning to understand how the oceans affect our weather and climate, it is important to understand the difference between the two. The ***weather*** is what we experience, day by day (it is the condition outside), it includes the cloud cover, rainfall, air temperature, air pressure, wind and humidity (moisture content in the air). The ***climate*** is the long-term average weather you would expect in a particular location across the different seasons; it is the overall picture.

You might think that what goes on in the atmosphere is most important to our weather and climate, but the oceans also play an important role. In fact, the atmosphere and ocean are very closely linked and when scientists try to predict how our future weather and climate may change, they need to model both the atmosphere and the ocean.

Find out more at: <http://oceanservice.noaa.gov/education/pd/oceans_weather_climate/weather_and_climate_basics.html>

How do the oceans influence our weather?

Both the atmosphere and the oceans ***absorb*** (or take up) heat from the sun’s rays. This causes the warm air and water to rise. As the warm air moves upwards, it gradually cools and eventually returns to the Earth’s surface; this movement of the air causes winds to occur. In the ocean, as explained in section A, the warm surface water moves towards the poles, cooling as it does so and eventually sinking below the surface. This linked movement of air and water allows the heat of the sun to be transferred around the planet.

Some of heat from the sun causes the water from the very surface of the ocean to change from liquid to vapour (i.e., it evaporates). This forms an important step in the ***water cycle*** (also known as the ***hydrological cycle***). This water vapour rises up with the warm air and as it reaches cooler parts of the atmosphere, it ***condenses*** (changes back from water vapour into liquid water) to form clouds, usually with the help of dust particles. As more water vapour enters the atmosphere and as more cooling occurs, raindrops form (or snow or hail stones in colder areas). Once these raindrops are big enough, they eventually fall back to the Earth’s surface. Most of the rain we get on land originally started off as seawater in the ocean and may have travelled thousands of miles before it fell over land. Have a think about that journey the next time you’re getting wet in the rain!

The weather that results from this continual heating and cooling of the atmosphere and the oceans is complicated by a number of other factors, such as the latitude (how close you are to the equator or poles), the presence of land and its temperature, the volume of water evaporating into the atmosphere, and the turning of the Earth, to name just a few. These factors influence the type of cloud that forms, but also the strength and directions of the wind. For example, ***fog*** forms when water vapour remains close to the Earth’s surface and is normally the result of local conditions, such as the meeting of a warm ocean current with a cooler one, or the meeting of warm water with cool land (or vice versa). The foggiest place on Earth is the Grand Bank off the coast of Newfoundland where the warm Gulf Stream (travelling north) meets the cold Labrador current (moving south).

Thunder storms result from the very rapid upward movement of air and water vapour from the Earth’s surface. They are often accompanied by strong winds. One special, and often very violent, form of thunder storm is the ***hurricane*** (also known as the ***typhoon*** or ***tropical cyclone***, depending on where you live); they are made up of many thunder storms together. Hurricanes form out to sea over large areas of warm water in the tropics. They produce extremely strong winds, torrential rain, thunder and lightning and are associated with ***storm surges*** (a rise in sea level over and above the normal tide level). The damages caused by hurricanes can be extensive. For example, Hurricane Mitch, which hit Honduras and Nicaragua in 1998, caused flooding and mud slides, and resulted in more than 19,000 deaths and approximately US$ 5 billion (in 1998 US$) of damage. Hurricane Katrina, which hit the Louisiana coastline of the USA in 2005, resulted in US$ 81 billion of damage (in 2005 USD) and caused 1836 deaths.

To find out more: <http://oceanservice.noaa.gov/education/pd/oceans_weather_climate/welcome.html>

Global climate change and impacts on the oceans

The oceans absorb, store and slowly release large quantities of heat. The oceans therefore stop extremes of temperature on nearby land (which is why coastal areas have milder climates than continental areas) and over the Earth as a whole. Globally our climate is changing, and whether you believe this is as a consequence of human actions and the increase of ***greenhouse gases*** in the atmosphere (e.g. carbon dioxide, methane, nitrous oxides) produced from the burning of fossil fuels, cement production and other human activities, or as a result of natural change, we need to understand what is happening in the oceans if we are to understand how ***climate change*** will affect people.

As more and more heat is trapped in the atmosphere, more and more of that heat is transferred to the oceans, causing the temperature of the oceans to rise. The very slow circulation of the oceans means that it will take centuries to millennia for this heat to move around the planet and eventually be returned to the atmosphere, which means that the temperature of the oceans is likely to continue increasing over time. The impact of this temperature change is resulting in rising sea levels (because warm water takes up more space than cold water) and the melting of polar ice caps and inland glaciers. It is also increasing the risk of storm surge damage and flooding and is thought to be responsible for the growing intensity of extreme weather such as hurricanes and other climatic changes on land. In addition, rising temperatures are thought to be causing changes in ocean currents and salinity (with polar regions becoming warmer and fresher and the tropics becoming warmer and more salty) and reducing the availability of oxygen in sea water (known as ***hypoxia***). As the sea temperature increases, the ability of oxygen to dissolve in seawater and the mixing of oxygen rich surface waters with deeper waters are expected to decrease. These changes have implications for both marine and terrestrial life, including humans (see below).

It is not only heat that is trapped in the oceans; the oceans are also responsible for the absorption of gases such as carbon dioxide from the atmosphere. As more carbon dioxide enters the atmosphere, more of it enters seawater through a natural chemical reaction. The reaction between carbon dioxide and seawater causes the pH of seawater (or the level of acidity of the seawater) to change, becoming slightly more acidic, a phenomenon known as ***ocean acidification***. This has many consequences for marine life, especially those that build shells and other hard protective structures, because the building blocks for those shells become less available in more acidic conditions.

To find out more: <http://climate.nasa.gov/kids/bigQuestions/oceanHappening/> <http://www.sciencenewsforkids.org/2011/04/sea-changes/>

How are climate change and ocean acidification affecting marine life and people?

The oceans are continually changing and many of the patterns of change that we are seeing today have occurred before during different periods of Earth’s geological past. What concerns scientists today is the speed at which change is taking place. Sea temperatures have risen on average by 0.1°C over the last century, while over this time ocean pH has dropped by 0.1 pH units (although this is not equal around the world, some areas have seen much larger temperature and pH changes and other much less). It doesn’t seem like much though, does it? The problem is that there is no evidence of such rapid change having taken place in the past. So what do all these changes mean for marine life and for people?

*Changes in species distributions:*

* Temperature changes are causing poleward shifts of species whose body temperatures vary with the environment, they are then followed by species that eat them.
* Localised extinctions and changes in diet of species when they cannot move or cannot move as quickly.
* Changes in fish distributions have implications for the fishing industry, with fishers having to move or travel further to catch their preferred species. Alternatively they need to target new species or identify new sources of income.

*Sea level rise:*

* Sea level brings with it the danger of flooding, especially of low level coastal land.
* Flooding is likely to be problematic in places such as Bangladesh, Vietnam, China and India where they do not have the resources to deal with sea level rise and island nations vulnerable where people do not have a place to move to.
* Coastal agricultural land may also suffer as salt water enters the soil making it unusable for growing food.
* Coastal erosion will also increase with loss of habitat for marine and coastal life.

*Ice melt:*

* The loss of sea ice is affecting coastal communities in the Arctic, reducing their hunting grounds and changing their hunting times because the migration of important species is changing.
* Animals that have adapted to life at the edge of the sea ice (e.g. polar bears, narwhals, seals and cod) find it difficult to find prey as the ice disappears.
* In some areas toxic and radioactive materials have been stored in the frozen ground, and these could be released into the environment, including the sea.

*Changing ocean circulation:*

* Changing atmospheric conditions affect ocean conditions which in turn affect weather and climate around the world.
* These changes will affect species distributions both on land and in the ocean.
* Currents that already change direction periodically will change more frequently (e.g. the El Niño Southern Oscillation).

*Extreme weather and storm surges:*

* The frequency and ferocity of extreme weather, such as hurricanes, is likely to increase.
* The impacts will be felt most heavily at the coast.
* Wealthy countries will tend to suffer greater economic losses, while the human loss is often greater in developing countries.

*Hypoxia (reduced oxygen):*

* The impacts are likely to be felt in coastal waters, especially where pollution is already a problem, and in the open ocean.
* This could lead to the death of marine life and ***dead zones*** that are have lost their fisheries resources and the food webs that support them.

*Ocean acidification:*

* An increase in the acidity of the oceans (and associated changes) makes it more difficult for marine life to build shells and other hard structures (e.g. shells).
* The cycling of nutrients may change and there is expected to be a general change in marine biodiversity.
* Coral reefs and the food webs they support are likely to be badly affected with implications for the people who depend on them for their livelihoods through fishing and tourism.
* The fishing and aquaculture industry may be affected, especially where they are dependent upon shellfish.

D, People and oceans

Throughout human history people have had a very close relationship with the oceans. When ancient humans left Africa, archaeologists increasingly believe that they followed the coast into southern Asia, using marine resources as they went.

The earliest archaeological evidence of sea voyages comes from Crete and suggests that they were made sometime between 700,000 and 130,000 years ago. Human tools dating from this time have been found in caves along the south coast of the island. They must have been brought by seafaring people as Crete has been separated from the mainland for more than 5 million years. By 50,000 years ago, humans would have been hardy seafarers; they had reached Australia, a trip that would have required crossing hundreds of kilometres of ocean.

There is less evidence of fishing, especially off-shore fishing, but recent discoveries suggest that fishing from boats may have occurred up to 42,000 years ago, with fishing in shallow coastal areas having gone on since about 140,000 years ago. It is thought that a lot of the evidence of coastal activities by humans may have disappeared as the sea level rose after the last ice age.

Today, human use and dependence on the ocean is extensive, with few places untouched by human activities. Between 1992 and 2005, the World’s coastal population grew by 56%, compared to a global population growth of 14%. Approximately half of the World’s population now live within 200km of the coast, and 21 of the world’s 33 ***megacities*** (cities with a population of more than 10 million) are located in coastal areas. With more and more people moving to coastal areas, they are placing increasing demands on coastal resources. They need food and freshwater, houses, shops, hospitals, schools, transport facilities, methods of energy generation, space for leisure and recreation, systems for removing waste… The list is endless and all of these uses are changing not just the coastal environment, but also the open ocean and its deepest depths.

The next sections describe some of the uses people make of the oceans and what the impacts of these uses are, but this list is not complete as people are always finding new uses for marine life (e.g. exploration for minerals, new medicines, and renewable energy generation).

Fishing

Fishing is the most widespread human activity in the marine environment. Fish are caught to provide human food, but also for animal feed, to provide food for fish farmed in aquaculture, and to provide young fish for aquaculture. Fish are an important source of dietary protein and essential amino-acids, vitamins, minerals and fatty acids (e.g. omega-3). More than 2 billion people worldwide are dependent upon marine life for the majority of their dietary protein intake.

In 2009, FAO estimated that the global marine fish catch was 96.2 million tonnes, a figure that has remained more or less stable since the 1990s, although the volume of catch for many individual species has declined. Globally, approximately 44.9 million people are thought to be directly employed in fisheries and aquaculture (both marine and freshwater), and 180 million in the fishing and aquaculture industry as a whole (e.g. including capture, processing, transport etc.). All of these activities support the livelihoods of approximately 540 million people (about 8% of the global population).

The decline in global fish stocks is of concern, because as the human population continues to grow, the demand for fish is also growing. Scientists are particularly concerned about over-fishing and the fact that the rate at which we are catching fish is greater than the rate at which fish populations can recover through reproduction and growth. In coastal waters, individual countries or groups of countries have introduced a number of measures to try to reduce over-fishing, such as quotas limiting the amount of fish that can be caught, limits to the number of days that fishers can spend at sea and can fish for, and closures of certain areas of the sea to fishing (or particular types of fishing). Similar management approaches have been developed for the high seas that are not controlled by individual countries. Despite this, illegal and unreported fishing is still a problem and some of the incentives to reduce fish catch have led to unintended consequences. For example, quotas limiting the volume of fish that a ***fisher*** (people who go fishing) can catch have meant that any excess fish or unwanted fish are returned to the ocean. These unwanted fish, or ***by-catch***, usually do not survive and the effect on fish populations is therefore the same as if the fish had been caught and landed.

Fishing therefore affects fish populations, but also the interactions between those fish and other marine species. For example, it removes prey species that were a source of food for seabirds and marine mammals and it may remove predators that control the populations of other species. Certain types of fishing also change the structure of the seabed. Just like a farmer ploughing a field, fishing gear that is towed along the seabed affects the species and communities that live on top of the seabed as well as those that live within it. Scientists also suspect that fishing will affect the ability of fish populations to adjust to the impacts of climate change. Exploited fish populations are more vulnerable because their breeding capacity is reduced.

There are many different ways that people catch fish using a variety of different tools or gears. Some of these are known as static methods with fishers leaving fishing gear (e.g. pots and nets) in an area for some time before they return to see if they have caught anything. Other types of gear need to be towed along behind a boat (e.g. trawl nets and dredges), either in the water or along the seabed. To find out more about these different fishing methods, visit the FAO website <http://www.fao.org/fishery/geartype/search/en>. There are also some interesting video clips on the internet that show how these different fishing gears are used e.g. <http://www.youtube.com/watch?v=BCb2TT5GW7k>

Aquaculture

Despite the fact that the level of catch of marine fish has appeared to have reached its limit (or perhaps gone over its limit), the demand for fish around the world has continued to grow. This has led to the development of aquaculture or fish farming. In 2000, over a quarter of all fish consumed by humans came from fish farms and by 2007, this had increased to approximately 44%. Although aquaculture can maintain the supply of fish, it can also have negative impacts on the marine environment. These include coastal habitat degradation and loss; pollution; the introduction of exotic and invasive species; and the spread of diseases (of both humans and other animals). For predatory fish such as salmon, fish still need to be caught from the wild to feed them, with all the problems associated with overfishing and exploitation of resources mentioned above.

To find out more: <http://www.fao.org/fishery/aquaculture/en>

Transport and commerce

Did you know that approximately 90% world trade is carried out by sea? The food that you eat and clothes that you wear may have travelled long distances by sea before you got them. There are more than 50,000 merchant ships transporting goods around the world with more than a 1 million people (known as ***seafarers***) working on them. In 2008 the international shipping industry estimated that it transported over 7.7 million tonnes of ***cargo*** (goods) including oil and oil products, minerals such as iron ore, coal, grains and a multitude of other products, including people, electronic goods and vehicles. Maritime transport is cheap compared to other forms of transport and is considered to be the least environmentally damaging form of commercial transport (compared to land and air). Improvements in shipping technology have reduced its impact on marine pollution, but maritime transport is still a significant contributor to world greenhouse gas emissions due to the amount of shipping that takes place (it is responsible for about 3% of global greenhouse gas emissions).

Ships travelling around the world may also carry some unexpected passengers. Sometimes marine species attach to ships hulls, but ***ballast water*** is also a problem. To ensure ships are stable, especially when they are carrying light loads, they take on ***ballast*** in the form of seawater. This water is held in a tank or series of tanks and is transported from port to port. As section B explains, seawater contains a myriad of marine life and when ballast tanks are filled with water, marine organisms are taken on board as well. When the ballast is emptied into new environments (close to the destination port), the marine organisms it contains may become ***invasive***, which means that they grow and reproduce better and more effectively than the native species. This may result in ecological change with native species becoming locally extinct. Examples of invasive species include the mitten crab which is native to northern Asia and has been introduced to Western Europe, the Baltic Sea and the west coast of North America; a fish called the round goby which is native to the Black, Asov and Caspian Seas and has been introduced to the Baltic Sea and North America; and a seaweed called the Asian Kelp with is native to northern Asia and has been introduced to southern Australia, New Zealand, the west coast of the USA, Europe and Argentina.

Find out more: <http://www.marisec.org/> <http://www.imo.org/ourwork/environment/ballastwatermanagement/Pages/Default.aspx> <http://www.imo.org/MediaCentre/Multimedia/Video/Pages/InvadersOfTheSea.aspx>

Waste disposal***: microbial contamination, nutrients, inorganic compounds, solid waste***

Although we probably don’t like to think so, the oceans have long been used as a place to dispose of our waste. Waste enters the oceans from a number of sources: it may be deliberately dumped at sea, run-off from land, introduced through rivers or accidently lost. It includes municipal, industrial and agricultural wastes and run-off. Approximately 80% of the pollution in the marine environment comes from land-based activities. A lot of what enters the marine environment is diluted and dispersed, and eventually breaks down through physical and biological processes (although this may take centuries). The problem we face now is that the volume of waste we put into the marine environment is leading to environmental damage. In some coastal regions and enclosed seas (e.g. Baltic Sea), it is particularly problematic, but no part of the marine environment is untouched. Solid waste, such as plastics, has been found from the poles to the equator, from the coast to the deepest depths of the sea, and within both the water column and the seabed.

Between 50 and 90% of rubbish found at the coast is plastic and most of the rubbish floating on the oceans is plastic. Rubbish that doesn’t get washed back to land can travel thousands of kilometres on ocean currents and eventually accumulates in the 5 ocean ***gyres*** (large systems of circulating ocean currents). The floating rubbish patch in the North Pacific gyre is thought to be about twice the size of Hawaii, although media reports suggest it could be as large as continental USA! Apart from being unsightly, this rubbish threatens marine life if they eat it or become tangled in it, and it can also transport invasive species in the same way that ships hulls do.

Other forms of pollution that can be problematic include sewage (both human and animal) and the run-off of nutrients from agricultural land. Untreated sewage entering the sea contains bacteria and viruses that affect the quality of the seawater and many make it unsuitable for both recreational activities and for commercial use (e.g. the harvesting of shellfish). Contact with contaminated water can lead to a number of health problems for human and marine life alike.

The impacts of excessive nutrients entering the marine environment causes a phenomenon called ***eutrophication***. All the extra nutrients cause phytoplankton and other algae to grow and reproduce. When these algae and phytoplankton die, they fall to the seabed and are broken down by microbes. The process of breakdown uses up the oxygen in the water causing the water to become ***hypoxic*** (reduced in oxygen) and in extreme cases, ***dead zones*** occur. As the name suggests, few marine species can survive for long in dead zones. In 2011, 530 dead zones had been identified around the world.

Another problem associated with eutrophication is the formation of ***harmful algal blooms***, the rapid growth of tiny algae (phytoplankton) that produce toxins. Harmful algal blooms are becoming much more common around the world and are of concern because the toxins they produce are associated with intestinal problems and respiratory irritation in people if they come into contact with them. A famous example of a harmful algal bloom is the Florida red tide. Year round monitoring is undertaken of the Florida coastal waters to ensure that people can take the right action when the organism that causes the red tide is present (e.g. stop eating shellfish collected from the affected area and avoid swimming in the sea if necessary).

Find out more:

Ocean rubbish patches: <http://5gyres.org/>

Eutrophication and dead zones: <http://www.wri.org/project/eutrophication>

Harmful algal blooms: <http://www.cdc.gov/nceh/hsb/hab/default.htm>

Recreation and tourism

The oceans are a great source of inspiration to people and provide numerous opportunities for leisure and recreation activities such as diving, sailing, surfing and swimming. Some marine ecosystems such as beaches and corals are particularly important for recreation and tourism and provide important sources of income and economic development. At the same time, recreation and tourism can place considerable demands on coastal and marine resources and where it is poorly planned, can have negative effects on the coastal and marine environment. For example, divers can damage coral reefs if they don’t take care with their flippers or they remove pieces of coral; the construction of hotels and other infrastructure can lead to more waste and pollution entering the sea; and the cleaning of beaches for recreational users can affect the ecology of the surrounding area.

In recent years, the health and well-being effects of the marine environment have been increasingly recognised. It has long been acknowledged that visiting green spaces like forests, parks and fields can have positive effects on our mental health, but similar evidence has been unavailable for blue spaces like rivers, lakes and the oceans. Recently it has begun to emerge that blue spaces may have an even more powerful effect on our well-being and initiatives are being created to encourage people to interact more regularly with the marine environment (e.g. the Blue Gym). You may also find that your doctor or dentist has an aquarium in his or her surgery as the presence of fish and water is known to calm patients and reduce anxiety!

To find out more: <http://wwf.panda.org/about_our_earth/blue_planet/problems/tourism/tourism_pressure/>

<http://www.bluegym.org.uk/>

Who has responsibility for the oceans?

This is a very good question. When countries first started exploring the world by sailing ship, it was agreed by the governments of the time that no one should own the oceans and this agreement was known as the ***Freedom of the Seas Doctrine*** or the ***Law of the Sea***. This included all of the ocean apart from a three mile (five km) wide strip along a country’s coastline which was considered part of that country’s sovereign territory. Beyond the three mile line, the oceans were available for use for all countries, including land locked ones, for trade and commerce, and the resources within the oceans (e.g. fish) were all considered common property.

In 1967 the United Nations initiated a new, formal treaty called the ***UN Convention on the Law of the Sea (UNCLOS)***, which was completed in 1982 and came into force in 1994. The Convention defines two key areas: ***territorial seas*** and ***exclusive economic zones***. Territorial seas extend for 12 nautical miles (14 miles or 22.2km) from the coast of a country and are governed by that country’s laws. Narrow straits that are important for shipping remain as international waters. Exclusive economic zones extend 200 nautical miles (230 miles or 370 km) from a country’s coast and give that country rights to the resources on the seabed. Some countries, however, have requested extensions of their exclusive economic zones to the edge of the continental shelf (up to 350 nautical miles or 400 miles/650 km). In addition to defining the rights of individual countries, the UNCLOS obliges all states to protect and preserve the sea and requires cooperation among states to achieve this.

In addition to UNCLOS, a number of other international organisations and pieces of legislation are in place to control human activities and protect the marine environment. For example:

* **International Seabed Authority** is responsible for organising and controlling mineral related activities and protecting the marine environment from damage.
* **The International Maritime Organisation** has responsibility for the safety and security of shipping and the prevention of pollution by ships. It is also responsible for initiatives such as GloBallast which aims to reduce the spread of invasive species and the London Protocol which aims to control marine pollution.
* The **Food and Agriculture Organisation** (FAO) has developed a Code of Conduct for Responsible Fisheries, a voluntary code which sets out principles and international standards of behaviour for responsible management and conservation of fish stocks.
* **Regional** **Fisheries Management Organisations** set regulations for fisheries management beyond individual countries exclusive economic zones.
* The **Ramsar Convention** aims to protect wetlands including salt marshes, mangroves, seagrass beds, coral reefs and other marine areas no deeper that 6m at low tide.
* The **Convention on Biological Diversity** aims at conserving global biodiversity including marine biodiversity.
* The **Convention on Trade in Endangered Species of Wild Fora and Fauna** regulates cross border trade with the aim of protecting endangered species.
* The **World Heritage Convention** aims to identify, protect and conserve areas of importance to all humanity for their cultural and natural significance, including marine sites.

Despite these international treaties and conventions, sadly, very little of the marine environment is protected from human activities and the general status of the marine environment is thought to be in decline. Very small particles of plastic rubbish, for example, have been found in the deepest trenches of the oceans; large areas of coastal habitats are lost every year to aquaculture, tourism development and other human activities; we are continually trying to catch more fish that the oceans can provide; and marine biodiversity is being lost faster than we can identify it.

This has created a lot of interest internationally in the idea of ***marine protected areas***. Marine protected areas would function in a similar way to national parks and conservation zones on land, but they may also take away the rights of people to fish or carry out other activities within those areas. Consequently, while evidence suggests that marine protected areas may help with the recovery of marine areas, they are contentious, especially where the loss of user rights means people’s livelihoods are negatively affected.

How can you get involved?

Protection of the marine environment is not just about international agreements and conventions. Many actions are taken by individual countries (e.g. the designation of marine protected areas, the seasonal closure of fisheries, prevention of the development along sensitive stretches of coastline), but the responsibility for the oceans also falls to each and every one of us.

There are lots of things we can change about our daily lives that will ultimately affect the oceans. We can buy sustainably sourced fish; reduce our use of plastics, especially plastic bags that may end up being washed out to sea; buy cleaning products that are safe for marine and other aquatic organisms; and take part in beach cleans. We can also educate others about how important the marine environment is to humans and how we need to take care of it (see the activities associated with this section).

E, Exploration and action

To know how to protect and manage the oceans it is important to understand how they work, what lives in them and where. We’ve been exploring the oceans for millennia, but as mentioned in section A, less than 10% of the ocean has been explored. Marine scientists from around the world are therefore continuing to study the oceans, trying to find out more about them, how they affect people and how human activities are changing them.

Here are a few examples of research aimed at exploring the marine environment:

The sea from space

Early ocean exploration was undertaken by ship, but the coverage of this was relatively limited. Today, you don’t have to get your feet wet if you want to explore the oceans and you can even avoid going to sea. Remote observation using instruments mounted on to satellites have rapidly increased our knowledge of the oceans. NASA and other space agencies have launched a number of satellites with instrumentation designed to measure different characteristics of the ocean, for example, the satellite Aquarius measures sea surface salinity; the SeaStar satellite, fitted with an instrument called SeaWiFS (no longer in use), measured ***ocean colour*** (a measure of phytoplankton abundance and distribution); and MERIS, mounted on the European Space Agency Platform, also measures ocean colour. These instruments then relay the information collected to receivers on Earth for processing. The advantage of satellite observations is that vast amounts of data can be collected relatively quickly and for long periods of time. The data collected, however, do need to be checked against detailed measurements made by sampling the oceans directly, so ocean exploration is still an active area of research. To find out more, try these websites:

SeaWiFS: <http://oceancolor.gsfc.nasa.gov/SeaWiFS/TEACHERS/sanctuary_1.html>

Aquarius: <http://aquarius.nasa.gov/index.html>

The Catlin Arctic Survey

If we want to know more about our changing environment, we need to collect more information, and this is what the Catlin Arctic Surveys were all about. In 2009, 2010 and 2011, scientists and polar explorers went to the Arctic to collect information aimed at improving scientific understanding of the processes involved in climate change and its impacts. The first survey tried to answer the question of “How long will the Arctic Ocean’s sea ice cover remain a year-round feature of our planet?”; the second survey focused on the effects of carbon dioxide on the Arctic Ocean; and the third sought to answer questions about how changes in the seawater beneath the floating sea ice may be affecting the ocean currents that influence the climate and weather patterns around the world. Each survey has involved explorers trekking across parts of the Arctic sea ice and in 2010 and 2011 a temporary Arctic Ocean research station was created for hardy scientists to take samples and carry out experiments. Find out more: <http://www.catlinarcticsurvey.com/>

To the bottom of the sea: Okeanos Explorer in the Gulf of Mexico

Following the Deepwater Horizon oil spill in the Gulf of Mexico in 2010, it was recognised that there is a growing need to better understand the deep-water habitats not just in the Gulf, but also around the world. In March and April 2012, the Okeanos Explorer, a research vessel owned by NOAA (National Oceanic and Atmospheric Administration, USA) set out to explore the deep-water habitats of the northern Gulf of Mexico. They aimed to explore the diversity and distribution of deep-sea habitats such as cold seeps, deep coral communities, canyons and shipwrecks, and the marine life associated with them. The team of scientists and technicians out at sea was backed up by another team based on-shore. They planned to map the seafloor using sonar and to use a remotely operated vehicle (ROV) called Little Hercules and underwater cameras to examine the underwater habitats. To find out more about the expedition and how they got on, visit the expedition website: <http://oceanexplorer.noaa.gov/okeanos/explorations/ex1202/welcome.html>

The open ocean and the water column

Before the 1850s, most scientists thought that the oceans below 500m must be lifeless because of the absence of light, the cold temperatures and the high pressure, but as new evidence began to emerge, scientists began to question whether this was actually true. Two biologists therefore proposed an expedition, which was funded by the British Government, to explore the physics, chemistry, geology and biology of the deep sea. Between 1872 and 1876, the HMS Challenger, a British Royal Naval vessel travelled almost 70,000 nautical miles (130,000km) around the world, with the crew surveying and exploring as she went. During the expedition, approximately 4,700 new species of marine life were discovered! When the ship departed Portsmouth, UK, it carried 21 officers and 216 crew members. By the time it returned only 144 people remained owing to deaths, desertion, people being left ashore due to illness and planned departures.

Today similar expeditions (or cruises) are still going on, for example the Atlantic Meridional Transect (fortunately without the loss of crew members!). The Atlantic Meridional Transect (AMT) is a voyage of approximately 13,500km between the UK and the South Atlantic with the crew undertaking biological, chemical and physical oceanographic research along the way. The first voyage was undertaken in 1995 and since then 22 cruises have taken place.

To find out more about the HMS Challenger expedition visit the website of the UK’s Natural History Museum: [www.nhm.ac.uk/nature-online/science-of-natural-history/expeditions-collecting/hms-challenger-expedition/index.html](http://www.nhm.ac.uk/nature-online/science-of-natural-history/expeditions-collecting/hms-challenger-expedition/index.html). To find out more about the AMT cruise, visit the AMT cruise website: <http://www.amt-uk.org/>

Census of Marine Life

The Census of Marine Life was a 10 year international research effort involving 2,700 scientists from over 80 different countries who took part in 540 expeditions and many, many hours of research back on land. The Census aimed to look at the different kinds of marine species (their ***diversity***), where they are found (their ***distribution***) and how many there are of each species (their ***abundance***). Although the project officially ended in 2010, the work of the Census is still ongoing. It has created the most comprehensive inventory of marine life to date, which by January 2011 contained an immense 30 million records! It contains entries from the North Pole to the South Pole, from the surface ocean to the deep sea, and of the smallest marine organisms (bacteria) to the largest (whales). It discovered more the 1,200 new species with many organisms still awaiting formal identification. Knowing what species are currently in the oceans, where and in what quantity will make it much easier to understand how marine life is changing.

To find out more, visit the Census of Marine Life website: <http://www.coml.org>, but also seen news articles such as the one in the National Geographic: <http://news.nationalgeographic.com/news/2010/10/101004-census-of-marine-life-new-species-oceans-science/>

Marine exploration is not only carried out by scientists working for universities and research institutes. Many commercial companies are also exploring the oceans looking for new products that can be used to develop medicines, for new forms of renewable energy, and of course, new deposits of oil and gas.

You can also get involved though. Although some monitoring and exploration is extremely expensive requiring specialist equipment, ships and in-depth training, some of it just requires time, easily obtainable equipment such as note pads and pens, measuring tapes and guide books to marine organisms. Some exploration ideas are included in the activities relating to this section, but there are also tools that you can use to explore the ocean from your computer, for example, ocean in Google Earth 5 allows you to dive beneath the surface, explore the seafloor, learn about ocean observations and discover new places.

Enjoy and be amazed!

Activities

Key points to remember:

1. Activities are coded according to age group, where:

➀ refers to activities for those aged 5-10

➁ refers to activities for those aged 11-15

➂ refers to activities for those aged 16-20

1. Some activities are suitable for more than one age group, but for the older age group, the activities are extended. Where possible, the older age group are expected to complete the main activity and the extension. The coding is only indicative though, and you may find that an activity coded for one group is also suitable for another age group. Please note that for very young children, all activities will need to be either adult led, or the children will need to be accompanied by an adult.
2. To obtain the challenge badge, children and young people need to complete **two** activities from sections A, B, C, D and E, where:

A = What and where are the oceans?

B = Shaping life on the planet

C = Weather and climate

D = People and oceans

E = Exploration and action

A. What and where are the oceans?

1. Where are the oceans? **➀➁**

*Learning aim: To identify and name the five oceans on the Earth and to learn some key facts about the ocean/sea closest to where you live*

*Materials: a map of the Earth or globe. Maps to label can be printed from* [*http://www.enchantedlearning.com/language/english/label/oceans/*](http://www.enchantedlearning.com/language/english/label/oceans/)

Have a look at a map or globe of the Earth. Together with your group leader/teacher talk about what the main colour is that you see on your map/globe? Why is it this colour? Can you name the five main oceans? And how many names of seas can you spot on your map/globe? Which is the closest sea to where you live and which is the closest ocean? What other features does your map/globe show and name in the ocean? Draw your own map of the world’s oceans and label as many oceans and seas as you can or pick an ocean or sea and go and find out more information about it. For small children it may be better to get them to work as a group or to give them a map of the world and ready-made labels to stick to it.

Together with your group leader/teacher, talk about what you already know about the oceans. Things to discuss could include how many oceans are there, what the oceans are called, which is the closest ocean to where you live, what is the difference between an ocean and a sea, what is the water in the oceans like, what lives in the oceans and how do people use the oceans.

***Extension***: in pairs or on your own, find out some key facts about the oceans and the ocean closest to where you live, for example, which is the biggest ocean? How big is the ocean (or sea) closest to where you live? Which is the deepest/shallowest ocean? What human activities go on in the sea closest to where you live? Put together a short quiz for the rest of your group. What would be a good prize for the winners?

2. What is the difference between seawater and freshwater? **➀**

*Learning aims: To understand what makes seawater different to freshwater, understand the meaning of density and how salt and temperature affect the density of water.*

*Materials: large clear plastic beakers or containers (at least 1litre in size, a bottle will do), measuring jugs, scales, salt, food colouring (at least one colour), tap water, some seawater (if possible), cloths for wiping up spillages.*

*If you don’t have access to seawater, make your own! Mix approximately 18g of salt (about 3 heaped teaspoons) with 500ml of freshwater until it has completely disappeared (or dissolved). That’s all there is to it!*

As a group, discuss with your teacher what you think are the differences between seawater and freshwater (water that comes from rivers). Ask your teacher/group leader to explain why seawater is salty and why different areas of the ocean and different seas are more salty than others? Which is the most salty sea in the world and which is the least salty? Can you find these places on the map of the World?

The presence of salt in seawater makes it more dense (heavier) than freshwater. Together with your teacher/group leader, take 500ml of freshwater and 500ml of seawater. Add some food colouring to one of the water samples (it doesn’t matter which as long as you remember which one you added it to). Pour the freshwater into the large clear plastic container. Then, very carefully and very slowly, pour the seawater into the same container. What happens? Why do you think this is? What do you think happens when rainwater falls on the sea?

You can also try this with hot water and cold water (get your teacher/group leader to help you with the hot water). Which is denser, the hot or cold water?

Draw a picture of your experiment and write a short description of what you did, what happened and why you think this was.

3. Evaporation and how to get salt from seawater **➀➁**

*Learning aim: To understand the meaning of evaporation and how evaporation can be used to get salt from seawater. Older children will also learn about salt.*

*Materials: A shallow dish with sides (a baking tray might do), seawater, a protected outside area or a sunny windowsill, scales. If you don’t have access to seawater, use the instructions in activity A2 to make your own.*

Together with your teacher/group leader, pour 1-2 cm of seawater into the baking tray and leave it in the sun. Slowly, slowly the water will evaporate (or disappear into the atmosphere) leaving only the salt behind. Try to guess how long it will take for the water to disappear. Ask the person in the group with the closest guess to taste the crystals left in the tray once the water has gone to make sure they really are salt.

Once all the water has evaporated, collect up the salt and weigh it. How much water would you need to get 100g of salt?

***Extension***: On your own, find out some interesting facts about salt. For example, what is salt? Why is salt important for humans? Why shouldn’t we drink salty water? How much salt is in seawater and has seawater always been this salty? When you buy sea-salt from the shops, how is it extracted from the sea? What do we use salt for? Make up a poster of key salt facts.

Here are a few websites to get you going: <http://www.marinebio.net/marinescience/02ocean/swcomposition.htm>

<http://www.saltsense.co.uk/funzone/funfacts.html>

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4. Evaporation and how to get freshwater from seawater **➀➁**

*Learning aim: To further demonstrate evaporation and to illustrate how freshwater can be obtained from seawater.*

*Materials: a large metal pan, a cup, a clean piece of clear plastic or plastic food wrap, sticky tape, small stones or other weights, seawater.*

Together with an adult, pour seawater into a large metal pan until it is about 4 cm deep and put it in a sunny place. Place the cup in the middle of the pan. If the cup starts to float, put a weight into it, but make sure it is clean as the cup is where you will collect your freshwater and someone needs to test it! Cover the top of the pan with the clear plastic or plastic food wrap, do this quite loosely, but not too loosely as you don’t want the plastic to touch the cup. Attach the plastic to the pan with the sticky tape making sure it is securely fastened and that nothing can get into the pan. Put a weight on to the plastic so that the plastic sags over the cup. You may need to adjust the plastic slightly if the plastic now touches the cup.

Over time, the heat from the sun will cause the water to evaporate, but as the evaporated water touches the plastic it will form drips which will run down the plastic and collect in the cup. When there is enough water in the cup, ask a volunteer to taste the water in the cup to show it really is freshwater!

***Extension***: How else to you think freshwater can be removed from salt water? Individually or in pairs, find out other ways to remove the salt from freshwater. Design an experiment to demonstrate this or put together a presentation for your group to show how it could be done if you had the right equipment. How is this done industrially in countries where freshwater is scarce?

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5. Creating waves **➀**

*Learning aim: To understand the role of the wind in creating waves and to think about how people can use waves*

*Materials: large shallow trays/pans at least 10cm deep, water, paper fans (or electric fans if available), and cloths for wiping up spillages.*

This experiment demonstrates how waves are formed, but before starting, discuss with your teacher/group leader what you already know about waves. What are they? How do you think they are formed? How do you think people use waves?

If you have more than one pan available, divide into small groups with one pan per group. Each group should also have one fan (this could simply be some paper, but if electric fans are being used, make sure there is also an adult with you as it is important to use the fan safely and not to let the fan get close to the water).

Fill each tray with about 7-10 cm of water. What do you think will happen if someone now starts to fan the water? Write down what you think will happen.

Get one person to stand or sit about 30cm away from the pan. Gently start waving the fan up and down (or direct the electric fan towards the pan and turn it on to its lowest setting). What do you see? Is it what you predicted? Were there waves? Did water overflow from the tray? What do you think will happen if the fanning gets faster? Try it out and see.

Once you have completed the experiment, get back into a single group and compare your group’s findings with the others.

6. Radio broadcast on Tsunamis **➁➂**

*Learning aim: To understand the causes of tsunamis and to experience what it might be like to be a radio journalist or person being interviewed.*

*Materials: Article from National Geographic News in 2009 about the tsunami in Samoa and American Samoa (*[*http://news.nationalgeographic.com/news/2009/09/090929-tsunami-warning-samoa-earthquake.html*](http://news.nationalgeographic.com/news/2009/09/090929-tsunami-warning-samoa-earthquake.html)*), access to the internet or people who have experienced a tsunami. Dictaphone or other recording device.*

Tsunamis are very destructive waves that are not caused by the wind but by underwater earthquakes, volcanic eruptions or landslides. They can be very damaging. There may be no warning that the underwater earthquake or landslide has taken place, but there are a number of warning signs for tsunamis and pieces of advice that can be followed to help you and your friends and family stay safe in the event of a tsunami. Read the article on the Samoa quake and in small groups, put together radio broadcast about tsunamis and tips on surviving them. One of you could be the interviewer and another could be a tsunami expert that is being interviewed. If you know someone who has experienced a tsunami, ask them if they would be happy to talk to you about their experiences. If not, get another member of your group to imagine what it might be like to have seen a tsunami and to talk about this to the interviewer. You might want to write a script before you start recording...

Once you have created your radio broadcast, talk about your experiences with the rest of the group. What did you enjoy about it and what didn’t you like. How would you do it differently if you were to do it again?

If you don’t have access to a dictaphone or other recording device, act out your script in front of the rest of your group.

***Extension***: Find out more about the impact of the 2004 Asian tsunami. Why was the effect of the Asian tsunami worse in some areas than others? How did the vegetation at the coast influence the effect of the tsunami? Write an article for a fictional newspaper about the impact of the Asian tsunami in a particular area, point out the role of coastal vegetation in protecting against damage and why it is important to protect and if possible improve what vegetation is already there.

7. Time and tide wait for no man **➁➂**

*Learning aim: To understand how the sun and moon affect the tides and the meaning of gravity*

*Materials: three different size balls, one representing the Earth, one representing the moon and one representing the sun, a hoop slightly larger than the ball representing the Earth (could be made out of stiff wire if needed). This video may also help:* [*http://www.youtube.com/watch?v=KBTsESF1w-I*](http://www.youtube.com/watch?v=KBTsESF1w-I)

What do you already know about the tides? In a group, discuss with your teacher/group leader what you know. Ask your teacher/group leader to explain how gravity plays a role (where gravity is the degree of attraction between objects – similar to a magnet - the strength of which depends on the mass (or weight) of the object and the distance between them) and how the sun and the moon both affect the tides. The strongest gravitational pull occurs between the side of the Earth that is facing the moon and the moon, causing the oceans to be pulled towards the moon. This causes a tidal bulge. Find out what spring and neap tides are and try to work out where the sun and moon might be when these occur. How does the turning of the Earth affect the tides?

These concepts can be difficult to understand, so identify 4 volunteers from your group to act out how the movement of the sun, moon and Earth affect the tides. One person needs to hold the Earth ball, a second needs to hold the hoop around the Earth representing the oceans, a third holds the moon about 50cm away from the Earth and a fourth holds the sun a couple of metres away from the Earth (this is not to scale; if it were, the person holding the sun would have to be about 200 metres away!).

First put the Earth, moon and sun in a straight line. Move the hoop so that the side closest to the moon is as far away from the Earth’s surface as possible. This demonstrates a spring tide.

Now put the Earth between the moon and the sun. What do you think happens to the oceans? Where should the hoop go? (Remember that despite the sun being bigger, the gravitational pull of the moon is stronger than the gravitational pull of the sun, because the moon is much closer to the Earth).

Now put the Earth and moon in line and the sun at a right angle to the Earth. What happens to the oceans now? Where should the hoop go?

Draw a series of diagrams to explain the movement of the tides in relation to the sun and the moon.

***Extension***: Find out how the shape of the land affects the tidal range. Where in the world has the highest and lowest tidal range, and why? Try to get hold of the tidal range data (tide heights) for a year for your closest beach/part of the coast. Plot the tidal range on a graph (use a computer to help you). What can you tell from this graph? Why are the tides particularly high at certain times of year? If you can’t get hold of tidal range data, have a think about how people use the tides and tidal range information. Why it is important for some people to know when high and low tides will be? Give a short talk to the rest of your group about what you have found out.

8. Ocean currents: surface and deep water **➁➂**

*Learning aims: To understand how ocean currents are formed and why they are important to the planet*

*Materials: access to the internet, map of deep-water ocean currents*

**Note: this activity requires an understanding of gravity as well as density and how salinity and temperature affect the density of seawater. If you are unfamiliar with this, you may want to carry out activity A2.**

If you have access to the Internet, watch this video clip about currents:

[www.montereyinstitute.org/noaa/lesson08.html](http://www.montereyinstitute.org/noaa/lesson08.html)

In a group, together with your teacher/group leader, discuss what you have just learnt from the video clip (if you don’t have access to the internet, use the information included in the section for teachers/group leaders). For example, how many different types of current were named in the clip? What were the two most important types of current? What is a gyre? Using your knowledge of density and how the salinity and temperature of water affect the density of seawater, explain the how deep water currents work and how water circulates around the ocean. Why do you think ocean currents are important?

Individually or in pairs, write down ten facts about currents (you may want to watch the video clip again). Put these on the wall of your meeting room (if you are allowed) as part of an ocean display.

***Extension***: some currents don’t always flow in the same direction and are known to oscillate between different directions. One such example is the El Niño Southern Oscillation. Find out what you can about the El Niño Southern Oscillation and write a short technical article about how it works and what the changes in the direction of the currents mean for marine life and the people who use the area for fishing. What happens elsewhere around the world (e.g. in Australia and Africa) in an El Niño year? How has the El Niño Southern Oscillation been changing in recent decades? What is considered responsible for this change?

9. Surface currents: follow the journey of the plastic ducks… **➁➂**

*Learning aims: To better understand the concept of surface ocean currents and why it is important to know where these surface currents flow*

*Materials: Article “Thousands of rubber ducks to land on British shores after 15 year journey”*

<http://www.dailymail.co.uk/news/article-464768/Thousands-rubber-ducks-land-British-shores-15-year-journey.html>

Read the article about the rubber ducks and their journey around the planet. The ducks have been following the surface ocean currents, directed flows of water that are caused by the wind. Write a story or a poem about the journey that the rubber ducks have had. Include some description within the story about the role of ocean currents.

***Extension***: How has knowing about currents helped users of the oceans (e.g. sailors, fishers, maritime transport, yachts people etc.). What else has been found floating around the oceans? Have you ever found anything on the beach? Where might it have come from? Put together a poster to explain what you’ve found out about ocean currents.

10. Rip currents and staying safe at the beach **➁➂**

*Learning aims: To understand what is a rip current, how to spot one when you are at the beach and what to do if you are swimming and get caught in one.*

*Materials: paper for making posters or leaflets, coloured pens, pencils or paints, rip current leaflet* [*http://www.ripcurrents.noaa.gov/signs/rip\_brochure\_final.pdf*](http://www.ripcurrents.noaa.gov/signs/rip_brochure_final.pdf)

Rip currents can be very dangerous and are responsible for many swimmers getting into trouble while swimming in the sea. Individually or in groups find out about what causes rip currents, identify what are the signs you can see from shore that suggest a rip current may be present at the beach and find out how you might be able to escape from a rip current if you are caught in one. Create a leaflet, poster or series of posters explaining what you have found and give a short talk to the rest of your group to make sure they are also aware of rip currents and know how to stay safe when swimming at sea.

***Extensions***: Find out how many people get into distress each year at your local beach because of rip currents. Do you know any life guards or are there any on your local beach? Invite one to come and talk to your group about staying safe on the beach.

B. Shaping life on the planet

1. What do you know about life in the oceans? **➀➁**

*Learning aim: To learn the names of different marine creatures*

*Materials: pictures of marine life, reference books or internet access, paper, coloured pens and pencils or paints, scrap materials for making a collage or model (e.g. different types and colours of paper).*

Together with your group leader/teacher, talk about what you think lives in the oceans. What is the biggest animal you can think of that lives in the sea? What is the smallest? What lives at the coast and what lives out to sea? Once you’ve talked with your teacher/group leader, have a look at the pictures and reference books and make a list of all the animals and plants that you can think of that live in the sea. Working with an adult, make a drawing, collage or model of what you think life underwater might look like and use it to put together an ocean display in your meeting room or at your school or community centre.

***Extension***: Do you know any marine biologists or people who are knowledgeable about the sea? Is there a marine laboratory near-by? If yes, invite someone to come and talk to you and your group about life in the oceans. If not, do a bit of research yourself. Find out about a marine animal or plant that interests you. How big is it? Where does it live? What does it eat and what eats it? How long does it live? Can people use it for anything? Give a short talk to your group about what you have found out. Make sure to bring a picture or drawing of it along with you to show them.

2. What animal am I? **➀➁**

*Learning aims: To help children and young people with the identification of marine animals and plants in a fun way.*

*Materials: pictures of common marine animals and plant from your area.*

Before starting the game, in a group, have a look at all the pictures. Working with an adult, start thinking about how you might describe the animals and plants that you see. Are there any similarities between the animals and plants in the pictures? If yes, sort them into groups. Write down the common features of these groups. Once everyone is familiar with the animals and plants, bring all the pictures back together and mix them up. Get one person to pick a picture and ask them to describe it to the rest of the group without giving away the name of the animal or plant in the picture. Get the rest of the group to guess what the animal or plant is.

***Extension***: Create your own marine life game using pictures and descriptions of marine animals and plants. You could focus just on animals and plants that you find at the beach nearest to you, or you could find out about any marine habitat that interests you and base your game on that instead.

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3. Visit the coast **➀➁**

*Learning aims: To find out what marine creatures live at the coast and learn to be responsible when exploring the natural world*

*Materials: warm and waterproof clothes (if necessary), suitable footwear for walking on a wet shore (and possibly over rocks), paper and pens, clipboards or something to rest on, copy of the seashore code, seashore guide book (if available), camera (optional).*

Ask your teacher/group leader to organise a group visit to the beach at low tide. This could be your local beach or it might be somewhere further away. Before you go, make sure you read the seashore code and remember, even if you live next to the coast, make sure you don’t go alone (take an adult with you) and make sure you tell someone where you are going.

Look for animals and plant that are living on the shore, they might be right next to the water’s edge or much higher up the beach. Look underneath rocks, but be sure to put them back carefully as you found them so that anything underneath is not exposed to the sun or predators. Are there any rock pools? What can you see in them? Can you see any holes in the sand? What might be living in them?

In groups or individually, draw pictures of the animals and plants that you have found. Do you know what they are? If yes, label each picture, if not, have a look in a seashore guide book to see if you can find out. If the guide book doesn’t help or you don’t have one, write a description of the animal or plant and take the picture and its description home with you to find out later.

**Note to teachers/group leaders: some marine organisms are poisonous and can sting and should not be touched. Find out before the visit if there are any organisms that should not be touched at the beach where you are going.**

***Extension***: Put together a poster or leaflet of the plants and animals you might find at your local beach to help your friends and family identify them the next time they go to the beach. Feeling more ambitious? You could try putting together a whole guide book.

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4. Study and map the coast **➁➂**

*Learning aims: To understand the physical environments in which marine organisms live and identify the human impacts on these physical environments*

*Materials: clipboards, paper, pens, camera (optional), seashore guide book*

This can be either a desk-based exercise, involve a visit to the coast or a mixture of the two. If a visit to the coast is involved, make sure you read the seashore code before you go.

Desk-based: In small groups, find as much information as you can about your local beach (if you don’t have a local beach, choose any beach or piece of coast that interests you) from books, pictures, photographs, the internet and people you know. Using this information, draw a map of the area showing where the different physical features are (e.g. areas of sand, rocks, rock pools, cliffs, mud), the coastal vegetation (e.g. salt marsh, mangroves, scrub) and human developments (e.g. houses, shops, other buildings, roads and car parks). Include some information on your map about what you might find just offshore (e.g. is there a reef there?). What marine life do you think you will find in the different parts of the beach and just offshore? Annotate your map to show what you might find there.

Field activity: Using the observations you make while you are at the coast draw a map as above.

Each person in the group can draw a separate piece of the beach/coast with each section of map being joined together at a later stage to be displayed, or the group can work together on one larger map.

**Extension**: Think about the different ways that people are using the piece of coast that you have just mapped. How might these activities affect the habitats you have described on your map and the marine life that lives in them? For example, ask yourself the question “what used to be in the places where the buildings are now?”. How do you think the habitats and the sea have influenced the human activities that go on in this piece of coast/beach? If you don’t know, why not ask someone who lives there. Annotate your map with some answers to these questions.

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5. Filming the coast **➁➂**

*Learning aim: To produce a short 5 minute documentary film about your local coast describing the habitats, what marine life you will find there and how the marine life is adapted to living there. Learn about how to make a good film and what preparation is needed before filming.*

*Materials: information about your local coast, video camera or other recording device (e.g. many mobile phones can also record videos), microphone.*

This activity could build on activity B3; it can also be linked to activity C10.

Creating a short film will require careful planning. Do you know anyone who has made a film before? If you do, ask them for some advice. If not, have a look on the internet for tips on how to make a good film. Also have a look at existing wildlife documentaries, perhaps you can pick up some tips from them.

Before filming, you will need to decide what your message is. What do you want to tell people about? Do some research about the coastal area where you want to make your film before you begin. What is special about the location? Where are the interesting places and things to see? What animals and plants live there and how are they adapted to conditions there? Do you need any props? Is there an expert you can interview?

Start by writing a script and make sure it is finished before you start filming. Try to get some feedback on it. Once you have completed the filming, hold a premier with your group. You could also upload it to the internet or send it off to a film festival (there are many that have categories for students or young people).

***Extension***: Think about the human impacts at the location where you have been filming. How are they affecting marine life there? What can be done to protect the area? Add a couple of extra minutes to you film to talk about these issues.

6. What eats what? **➀➁**

*Learning aims: To understand marine food chains and learn about how different marine animals and plants interact with each other.*

*Materials: pictures of marine animals and plants ranging from phyto- and zoo-plankton, seaweeds, to bivalves and snails, starfish, corals, fish (large and small), whales, dolphins, sharks, turtle and humans.*

In a group, talk with your teacher/group leader about marine food chains. Talk about what animals might be predators (animals that eat other animals or plants) and what animals or plants might be prey (animals or plants that are eaten by other animals). Also talk about herbivores (animals that only eat plants), carnivores (animals that only eat other animals) and omnivores (animals that eat both other animals and plants). Can you name some marine herbivores, carnivores and omnivores? Where do humans fit in?

Using the pictures, get your teacher/group leader to demonstrate what a marine food chain might look like. Once everyone is familiar with the idea of a food chain, split into smaller groups. Each group should be given 5 or 6 cards and should try to create the longest food chain they can. The group with the longest chain should then describe their chain to the other groups. Swap the cards and repeat the exercise two or three more times.

***Extension***: Pick one or two marine animals that you find interesting (e.g. whales, sharks, giant squid, seals, turtles...). Does anything eat them (do they have any predators)? What do they eat (what are their prey) and what does their prey eat (what is their prey’s prey)? What happens to them when they die? Draw a diagram of their food chain. You might find that their food chain is not a chain at all but a much more complicated web.

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7. Modelling the deep seabed **➀➁**

*Learning aims: To explore life on the deep seabed and the different physical features that are found there.*

*Materials: pictures of the deep seabed, glue, sticky tape, paint, paper, card, anything that might be useful to make a model (e.g. empty yoghurt pots and bottles, toilet roll inners, plastic bags, straws...)*

Only about 100 years ago most people thought the deep seabed was flat and featureless. New technologies have allowed us to look more closely at the deep seabed and scientists have discovered a number of interesting features including long chains of mountains, volcanoes and deep sea vents, sea mounts, oceanic islands and deep ocean trenches. You can see pictures of these on the internet: try the Monterey Bay Aquarium Research Institutes website on seafloor life: <http://www.mbari.org/topics/biology/bio-seafloor.htm> or do a search for deep sea floor images.

After having a look at some of pictures, create a model of the deep seabed. What features are you including? Try to include some marine animals too.

**Extension**: On the 26th March 2012, James Cameron, film director, producer and deep sea explorer travelled to the deepest place on Earth: Challenger Deep in the Marianas Trench (10.99 km or 6.83 miles below the surface of the ocean). Write a short article about his journey. How long did it take him to reach the bottom of Challenger Deep? How long did he stay there? What did he see? What were the challenges he and his team faced in reaching the deepest place on Earth? How do you think he felt when he reached the bottom?

To find out more, and to see an interview with James Cameron, visit the official expedition website: <http://deepseachallenge.com/>

8. Other marine habitats **➁➂**

*Learning aims: To improve research skills and learn about unfamiliar marine habitats*

*Materials: access to the internet and/or reference books*

Most of the activities in this section have focused on your local beach or coast. This activity is an opportunity to find out more about another marine environment that might interest you, for example the arctic, the open ocean, the deep sea, estuaries and deltas, coral reefs or rocky shores. Where you choose depends on you!

Once you have decided on your habitat, find out where in the world it is found, what lives there, how the marine life you find there is adapted to living there and what human activities go on there. Put together a poster (or series of posters) describing what you have found.

**Extension**: repeat the exercise for another marine environment that you find interesting.

9. Favourite marine life **➁➂**

*Learning aim: To find out more information about your favourite marine life and develop your presentation and speaking in public skills*

*Materials: access to the internet and reference books, computer and projector (optional)*

This activity should be carried out individually and independently. The aim is to give a short presentation to the rest of your group about your favourite marine creature, be it animal, plant or other. Remember not all marine life lives in the sea, some of it lives next to it and some of it lives above it (think of birds such as albatrosses).

To help you with your presentation and to allow you to include pictures, you could use a computer programme such as PowerPoint. Before you do, make sure you have a projector that connects to your computer.

In your presentation, describe your organisms of choice (what does it look like?), where you can find it around the world (what is its distribution?), how big is the global population of it (what is its abundance?), how do people affect it, and any other interesting fact that you can find out about it.

***Extension***: Just like on land, some marine species are endangered with very few of them left. This is your opportunity to find out about endangered marine species. Prepare a poster with details of ten endangered marine species, giving a few facts about these species, including how many of them are left in the wild and why they are endangered.

10. Evolution of life **➁➂**

*Learning aim: To understand the origins of life and when different marine animals and plants appeared on the earth.*

*Materials: access to the internet and reference books, paper, coloured pens and/or pencils (or you could draw this on a computer if you have access)*

Life on Earth began in the oceans millions of years ago as simple celled organisms such as bacteria. What came next? How long was it before the marine life we see today, such as fish, seaweeds, starfish, sea urchins, worms and shelled animals appeared. Individually or in small groups, put together an evolutionary time line that can be used as a mural for your meeting room/classroom wall. Mark on this when life first ventured onto land and when humans put in their first appearance.

***Extension***: How have scientists discovered all this information about the evolution of marine life? What methods do they use to find out? Write a short technical article explaining how they get their information and the challenges they face in working out the story of life on Earth. Present this to the rest of your group, together with a completed evolutionary timeline.

C, Weather and climate

1. The water cycle **➀➁**

*Learning aims: To understand the water cycle, the meaning of evaporation, condensation, precipitation and collection, and the difference between liquid water and water vapour.*

*Materials: paper, coloured pens and/or pencils*

To complete this activity you need to draw a diagram of the water cycle, but first, talk with your teacher/group leader talk about how the water cycle works. All the water on the planet goes round and round in a cycle, sometime being freshwater and sometimes being seawater. When the sun shines on seawater it heats up and some of the water evaporates (turns from liquid to vapour). Think about a puddle, what happens to it when the sun comes out? Where does the water go?

This water vapour stays in the air until it meets small particles like dust. This causes the water vapour to condense (turns back to liquid) and when enough of it condenses it forms a cloud. When enough water has accumulated in the cloud, it can start to rain, a process called precipitation. When the rain falls it is collected on land as lakes and rivers which eventually flow out to sea, or it collects directly in the sea. This cycle then starts all over again.

Draw a picture of this cycle (ask an adult to help if you are stuck); make sure you include the sea, the sun, clouds, raindrops and some land with arrows between them. Label each arrow with the different processes of evaporation, condensation, precipitation and collection.

If you need some help there is lots of information about this on the internet. See for example: <http://www.kidzone.ws/water/index.html>; you can also find lots of videos of the water cycle on YouTube.

***Extension***: Extend your diagram to show how water can also fall as snow or hail, get trapped in ice (both on land and at sea), enter rivers, streams and groundwater reserves. Also, find out what proportion of water on the Earth is freshwater and what proportion is seawater. Include this information in your diagram.

2. Make your own cloud! **➀**

*Learning aim: To better understand the concepts of evaporation and condensation, and how clouds are formed*

*Materials: 2 litre clear plastic bottle, matches (make sure you have an adult with you) and warm water.*

Together with an adult, add warm water to the bottle until it is about one third full and put the lid on it. This warm water will start evaporating (especially if you place it in the sun), adding water vapour to the air inside the bottle. This is the first step in making a cloud.

Squeeze the bottle and release it. What happens? Nothing should happen, but the squeeze represents the warming that goes on in the atmosphere and the release represents the cooling. If water droplets appear on the sides of the bottle (this is known as condensation), shake the bottle to get rid of them.

Take the lid off the bottle. Carefully light a match and hold the match near the opening of the bottle for a few seconds (make sure you have an adult with you when you do this and for very young children, ask the adult to light the match).

Then drop the match into the bottle and quickly put the lid back on, trapping any smoke inside. Smoke is made up of many small particles such as dust. These particles are the second ingredient for making clouds.

Once again, slowly squeeze the bottle hard and release. What happens this time? You should see a cloud form inside the bottle when you squeeze it, but when you release it, the cloud disappears!

[*www.WeatherWizKids.com*](https://harris.pml.ac.uk/owa/redir.aspx?C=30c813a45c044cb48e133a0b7478331a&URL=http%3a%2f%2fwww.WeatherWizKids.com) *kindly gave permission to reproduce this activity. Go to the website for other interesting weather information and experiments.*

3. And now make some fog… **➀**

*Learning aim: To understand how fog forms and the meaning of condensation*

*Materials: a glass jar, a sieve or strainer, water and ice cubes*

Fill up the glass jar with hot water (make sure you have an adult with you and be careful not to burn yourself). Pour out almost all of the water, but leave about 3 cm in the bottom of the jar. Put the sieve or strainer over the top of the jar and place a few ice cubes (3 or 4) into the sieve or strainer. Watch what happens?

The cold air from the ice cubes meets the warm, moist air in the jar causing the water to condense and form an eerie fog.

[*www.WeatherWizKids.com*](https://harris.pml.ac.uk/owa/redir.aspx?C=30c813a45c044cb48e133a0b7478331a&URL=http%3a%2f%2fwww.WeatherWizKids.com) *kindly gave permission to reproduce this activity. Go to the website for other interesting weather information and experiments.*

4. Hurricanes, cyclones and typhoons **➁➂**

*Learning aim: To understand the impacts of hurricanes/cyclones/typhoons can have on people.*

*Materials: information on hurricanes from* [*www.WeatherWizKids.com*](http://www.WeatherWizKids.com) *(see annex)*

On your own, read the information provided about hurricanes (remember that hurricanes, cyclones and typhoons refer to the same phenomenon, they are just called different things in different parts of the world). Put together a multiple choice quiz about hurricanes and see what the other members of your group know about them. Once everyone has finished, collect the quiz sheets and find out who is the winner. Before announcing the winner, give the correct answers to you group.

***Extension:*** Find out about a hurricane, cyclone or typhoon and write a newspaper article about it. When did it occur and how strong were the winds? Where did it make landfall? What preparations were made by the communities living along the coast before it made landfall? What damage did the hurricane/cyclone/typhoon cause? Could anything have been done to have prevented the damage? If you live in an area where hurricanes/cyclones/typhoons occur, perhaps you could interview a friend or family member about their experiences and include some of their stories in your article.

[*www.WeatherWizKids.com*](https://harris.pml.ac.uk/owa/redir.aspx?C=30c813a45c044cb48e133a0b7478331a&URL=http%3a%2f%2fwww.WeatherWizKids.com) *kindly gave permission to reproduce the information on hurricanes. Go to the website for other interesting weather information and experiments.*

5. Changing oceans **➀**

*Learning aim: To introduce climate change and how it is affecting the oceans*

*Materials: introductory notes provided in this booklet for teachers/group leaders*

Teachers/group leaders, ask your group what they think the word climate means? Then ask what they think climate change means? Ask them what they already know about climate change. Start introducing information about how climate change is affecting the oceans and get the group to think about what this may mean for them and their families. Play a chain game with the first person starting off by saying one of the impacts of climate change on the ocean and what it would mean to them. For example, if sea temperatures rise too high, many coral reefs may die. The next person in the group then says a new issue and so on around the group. If children get stuck, ask others in the group to help them out. Once everyone has said something, either try going around the group again or get the children to list the ways that people use the sea and how climate change is affecting these uses.

*This activity is based upon one developed by the Marine Education Trust, who gave their permission for its use.*

6. The oceans and climate change: rising temperatures **➀➁**

*Learning aim: To understand the causes of sea level rise, the effect of melting of sea ice and land ice on sea level and how sea level rise is affecting people.*

*Materials: a large pan or tray at least 10cm deep, a heavy object that can represent an island, such as a rock or a brick (it must not float or absorb water!), a marker pen (one that won’t be washed off with water), ice cubes, water.*

Place your heavy object in the pan to represent an island (you can decorate this with trees, houses and people if you want to). Pour in cold water into the pan until the bottom of the island is covered. Add some ice cubes to the pan (you will need quite a lot) and mark on the island the level of the water before the ice has melted. The ice represents the sea ice found in the Arctic and Antarctic. Leave the pan, checking regularly to see when all the ice has melted. Once all the ice has gone, look at your island again and the mark of the water level? What has changed?

In a second version of this experiment, set it up as before, but instead of placing the ice in the water, put the ice on your island. This ice represents the ice in glaciers and on mountain tops. Make sure you mark the water level before the ice has melted. Once all the ice has gone, what has changed? How do the findings from this experiment differ from the findings from the first one? What do you think is the cause? What does this mean for global sea level rise?

***Extension***: Rising sea levels and melting ice due to rising temperatures is problematic for people all around the world. Make a poster explaining how people in different parts of the world may be affected by sea level rise and ice melt.

7. Rising sea temperature and marine life impacts **➁➂**

*Learning aim: Using coral reefs as an example, to understand the implications of rising sea temperatures on marine life and to recognise that different species will respond in different ways.*

*Materials: pictures of healthy coral reefs and bleached reefs, background information on corals and coral bleaching, collection of materials for building a model reef including white and coloured paper, cardboard tubes, coloured plastics, pieces of wood, anything that might be useful.*

Corals are fascinating creatures. Many people think that corals are made out of stone, but they are actually made up of colonies of individual coral polyps. Coral polyps build themselves external skeleton-like structures to protect and support their soft bodies and it is these hard structures that help form the corals that you see on reefs.

Corals are different colours because small algae (zooxanthellae) live inside the coral tissue. These small algae use photosynthesis to produce food which is released to the coral poly in exchange for the protection that they provide. When the seawater temperature is too warm, the algae produce toxins which harm both themselves and the coral polyps. The polyps expel the algae, even though they need them to survive. Without the algae, the corals appear to be white. The white (or bleached) corals become weakened and more susceptible to disease. Many corals do not recover from bleaching and die.

In small groups, using the materials you have collected, build a model of a coral reef. Make part of it a healthy reef and the other part a bleached reef. Include labels on your reef to explain what has happened to the bleached reef.

***Extension***: what do changing sea temperatures mean for other marine species? Find out how phytoplankton and zooplankton might be affected by temperature change. What will these changes mean for the species that prey upon them? How will animals that grow on the seabed be affected by temperature changes in the water? What will this mean for the fish that we eat? Make a presentation to the rest of your group about what you have found.

8. Ocean acidification: the other CO2 problem **➀➁➂**

*Learning aim: to understand the concept of pH, what ocean acidification is and what it means for marine life.*

*Materials: Watch the animation on ocean acidification* [*http://www.youtube.com/watch?v=55D8TGRsl4k*](http://www.youtube.com/watch?v=55D8TGRsl4k)*; small jars (jam jars will do or plastic containers), water, vinegar (or coca cola (or any similar fizzy drink) or fruit juice, such as orange or apple juice), carbonated water, shells (or pieces of dead coral, sea urchin skeleton or you can use egg shells), pH indicator strips (these can be bought in many pet shops, aquarium shops or garden centres, if you can’t find any, you can make your own pH indicator solution using red cabbage* [*http://science.howstuffworks.com/innovation/everyday-innovations/experiment1.htm*](http://science.howstuffworks.com/innovation/everyday-innovations/experiment1.htm)*).*

Once you have watched the animation discuss with your teacher/group leader what you think are the impacts of ocean acidification on marine life. Why might this be important to you and your friends and family?

Also discuss with your teacher/group leader what acidity is and how it is measured using a pH scale.

Next, in small groups, take 3 jars. Into one jar add some tap water, into a second jar add some vinegar (or a fizzy drink or fruit juice) an in the third jar add some carbonated water. What do you think is the pH of each liquid? Measure the pH of each liquid and write it on a label on or next to each jar.

Given what you have learnt from the ocean acidification animation, what do you think will happen to the pieces of shell once you have added them to each of the different liquids?

Before adding a shell into each jar, examine the shell (or dead coral or sea urchin skeleton) and make a short description of it (this could include its length and weight). Add the shell into each jar and make sure it is completely covered by the liquid.

Check the jars at 30 minute intervals, record your observations. What is happening to the shell in each liquid? Come back the following day and what has happened? Check your shells every day for a week and record what you see. After a week, remove your shell from the liquid, allow it to dry and weigh it again. Has anything happened? Why do you think this is?

**Extension**: design some publicity information to raise awareness of ocean acidification. You can choose the format. It could be anything from a cartoon strip to a poster to a newspaper article to a short radio programme or video clip. Circulate the information as widely as possible at your school/college, within your community, on the internet: where ever you can.

9. A short guide to the oceans and climate change **➁➂**

*Learning aims: To summarise the many impacts of climate change on the oceans*

*Materials: large pieces of paper or card for posters, colouring pens and pencils, pictures of the ocean, marine life and the activities people carry out on and in the sea. If you have access to a computer, you could design your poster electronically.*

Discuss with your class/group the impacts of climate change on the oceans and how those impacts might affect people. Create a poster or leaflet showing the main impacts and how human activities related to the sea are already changing and might change in the future. Once you have completed the poster or leaflet, display is somewhere where lots of people will see it (e.g. at your school or community centre). You could also make several copies and display it in many locations.

***Extension***: what can be done to reduce the impacts of climate change? How can you and your family, friends and community change your behaviour to support this? Create a list of everyday activities that you can easily change about your life to help reduce your impact on climate change and the ocean. Start a campaign. Try to be ambitious and encourage your community to change their activities. Make up a leaflets and posters of activities and distribute them widely among your community.

10. Get filming - why are the impacts of climate change on the oceans important to me? **➁➂**

*Learning aims: To encourage young people to think about how climate change and its impacts on the ocean may affect them and their communities and what can be done to reduce its impacts.*

*Materials: information about your local coast and how climate change may affect it and the activities that people do there, video camera or other recording device (e.g. many mobile phones can also record videos), microphone.*

Often when we think of climate change we think about how it will affect other people. This activity is all about how it might affect you and your local community. This could be an extension to activity B5 or it could stand alone.

Think about the ways that people use your local beach (or an area of coast that you have visited) and given what you have learnt about climate change and its impacts on the oceans, think about how climate change may affect your local beach and what you can do there. Do you know anyone who is knowledgeable about your local beach or the effects of climate change on the oceans? Perhaps you could interview them.

The advice for this activity is the same as for activity B5:

* Before filming, you will need to decide what your message is.
* Start by writing a script and make sure it is finished before you start filming.
* Try to get some feedback on your script.
* Once you have completed the filming, hold a premier with your group.
* You could also upload it to the internet or send it off to a film festival (there are many that have categories for students or young people).

D, People and oceans

1. How do people use the marine environment? **➀➁**

*Learning aim: To identify the many ways that people use the oceans and coast and have an understanding of the many products we use in our everyday lives that come from the oceans*

*Materials: pictures of activities that people do in the marine environment and things that we use from the oceans, paper and glue or sticky tape*

In a group, talk with your teacher/group leader about the different ways people use the oceans (this could also include a visit to the coast or your local harbour). Think about all the activities that go on at the coast: what activities can you do when you are at the beach? Are there any ports or harbours near-by? What goes on there? What activities go on out to sea? Can you think of any ways that people use the seabed? What about ways that people use the water itself?

Once you’ve done that, have a think about the products or things that we use from the oceans. Think about things that we eat and objects around your home that might have come from the ocean. What about medicines? Do you think we get any of them from the ocean? Is there anything else?

Collect pictures from magazines, newspapers and any other source that show these activities. If you can’t find any, why don’t you draw a picture?

Individually or in small groups, make a collage/scrap book showing all these different uses and products. If you are making a collage you might want to make one big picture, or you might want to make two: one showing the different activities people do in and on the ocean and one showing the different products we get from the oceans.

***Extension***: Many uses of marine products are a bit hidden. Did you know, for example, that you probably put some seaweed in your mouth when you last cleaned you teeth? Many toothpastes contain a product called alginate that comes from seaweed. Find out more about how seaweeds are used. What food products contain seaweed? Are there any medicines that come from seaweeds? And how do farmers and gardeners use seaweed? At your next meeting/class, report back what you have found. Who found out the most uses?

2. Let’s talk about fish **➀**

*Learning aim: to find out about fish that are landed locally, how they were caught and where they have come from*

*Materials: note books or paper and clip boards, pens or pencils, camera (optional)*

With your group leader/teacher, organise a visit to your local fish market. If there is no fish market close by, you could visit an individual seller of fish (a fishmonger) or a fish counter at your local supermarket.

How many different types of fish can you see? What about shellfish? Find out where the fish have come from. Are they deep sea fish or have they been caught near the coast? Who caught them? Were they local fishers or fishers from elsewhere? And how were they caught? Have any of the fish being sold come from a fish farm? Which was your favourite fish?

Draw pictures of the different fish and shellfish (or take pictures of them if you have a camera) and add information to your drawings about what they are called, how big they are, where they have come from and how they were caught. Bring everyone’s drawings/pictures together and make a display.

3. A day in the life of a fisher **➀➁➂**

*Learning aim: To understand what it might be like to be a fisher*

*Materials: paper and pens or pencils*

Fishers are people who go fishing and their livelihoods depend upon fish. Do you know any fishers? If not, is there a fishing port near-by? Ask your group leader/teacher to invite a fisher to talk to you and your group about his (or her) day to day activities. Or if you prefer, you could interview them. If you do, make sure you have a list of questions ready before they arrive.

Things that you might want to find out from the fisher include: What time to they get up and leave home in the morning? How long do they stay away from home? What do they do when they first get to their boat? Where do they take their boat? What are they trying to catch? What fishing gear do they use? How long do they leave their gear in the sea? What do they do with the fish that they have caught? Do they go fishing all year round? What do they do when the weather is bad?

After they have gone, talk with your teacher/group leader about what you have heard and then write a story about a day in the life of a fisherman.

***Extensions***:

**➁** In addition to finding out about a typical day in the life of a fisher, during your interview, find out about how fishing has changed. Many fishers come from fishing families and their parents and grandparents may also have been fishers or they may have heard stories from older fishers. They will have seen many changes in the way fishers go about fishing (e.g. fishing technology has changed) and they may have seen changes in the type of fish that they catch and the port into which they land their fish. Why do they think these changes have occurred and what are their concerns about the future of fishing? Instead of writing a story about a day in the life of a fisherman, write a description of what you have been told in the style of a newspaper article about how fishing has changed over time and what may happen to fishing in the future.

**➂** Do all fishers have the same experiences? Interview some additional fishers who use different types of fishing gear (e.g. one who uses static gear such as rods, pots or nets, and one who uses towed gear such as trawls or dredges) or have different sized boats. How do their days differ? What changes have they seen over time and how do their experiences compare? In your newspaper article, add information about how the experiences of the different types of fishers. Why not try to get your article published? Ask your local newspaper or magazine; if you know about making websites, upload it onto the internet.

4. How do fishers catch fish? **➁➂**

*Learning aim: To understand the different ways that fishers catch fish and the impact of the different fishing methods on the marine environment*

*Materials: pictures of different fishing gear, information from the FAO website on the different types of fishing gear* [*http://www.fao.org/fishery/geartype/search/en*](http://www.fao.org/fishery/geartype/search/en)

*If you have good access to the internet, there are many video clips on YouTube that demonstrate the use of different fishing methods. For example:*

*About trawling:* [*http://www.youtube.com/watch?v=g1TPeM9EAK0&feature=related*](http://www.youtube.com/watch?v=g1TPeM9EAK0&feature=related)

*Fishing for lobsters:* [*http://www.youtube.com/watch?v=MdkU678ZwjA&feature=related*](http://www.youtube.com/watch?v=MdkU678ZwjA&feature=related)

Individually, find out about one or two different fishing methods and gears using the information sheets provided by FAO. Give a short presentation to your group about your choice of gear. In addition to talking about how the gear works, include information about where the gear is used (deep or shallow water) and on what sort of boat (large industrial boats, small inshore boats, or directly from the shore?) and where in the world they are used. Find out about the impacts of your chosen gear on the marine environment. If it is thought to cause damage to the marine environment, how can it be made less damaging?

***Extension***: as a small group of 4 or 5, organise a debate about the sustainability of fishing and the use of different fishing gear. Each person in the group is tasked with finding out the pros and cons of a different type of fishing gear or gears, make sure at least one person finds out about trawling and dredging and another about static gear. You may also want to find out about industrial fishing vs. artisanal fishing. In front of the rest of your group or class (and invite other people too if you would like), each person in the group should make a short presentation about why their form of fishing is best and justify why more effort should be given to it. Once you have finished your presentations, invite the audience to ask questions. When all the questions have been discussed, ask the audience to vote on which form of fishing they think is most sustainable.

5. Finding out about aquaculture **➁➂**

*Learning aim: To find out about aquaculture, why aquaculture is growing, what species are used in aquaculture, the environmental impacts of aquaculture and how aquaculture can be made more environmentally friendly*

*Materials: Information about aquaculture such as the Monterey Bay Seafood Watch aquaculture fact sheet:* [*http://www.montereybayaquarium.org/cr/cr\_seafoodwatch/content/media/MBA\_SeafoodWatch\_AquacultureFactCards.pdf*](http://www.montereybayaquarium.org/cr/cr_seafoodwatch/content/media/MBA_SeafoodWatch_AquacultureFactCards.pdf)

Individually or in small groups find out all you can about aquaculture and the types of aquaculture that are carried out in your country. Do you know anyone who works in the aquaculture industry? Is yes, ask them about their opinions on aquaculture, you could also invite them to come and speak to your group.

Put together a presentation explaining what is aquaculture and why we need it. Explain the different types of aquaculture that are used in your country and their benefits and disadvantages.

***Extension***: there are many new approaches to aquaculture being developed that aim to reduce its environmental impact, such as polyculture aquaculture that includes the production of seaweeds, bivalves and fish. Spend a few minutes at the end of your presentation talking about these. Why do you think they have been slow to be taken up by the industry and what can be done to encourage their further development?

6. Having fun at the seaside **➀➁➂**

*Learning aim: learn about the benefits of exercise and find out about the different recreational activities you can get involved with at your local beach. Start to explore the environmental impacts of marine recreation and tourism.*

*Materials: magazines and newspapers (travel sections might be useful), visit the beach, cameras, paper, pens and pencils*

As a group, talk with your teacher/group leader about the different recreational and fun activities that you can take part in when you are at the beach. How many can you list? Talk about why it might be good for you to take part in these different activities? Is there an activity that you would like to take part in? Which one is it and why do you want to give it a try?

Using the magazines and newspapers that you have brought from home, try to find pictures of these activities to make into a display. If you can’t find any, start drawing...!

***Extensions***:

➁ Beach users survey: the next time you visit your local beach (either with your group or with your friends and family – remember, never go alone), take your list of beach activities with you and count how many people are taking part in the different activities. Are there any activities that you missed off your list? What is the most popular activity? Make sure you record the date of your visit, this way, if another member of your group or class visits the same beach you can compare your findings. Report your findings back to you group/class. What do they think about what you have found?

➂ Impacts of tourism: read the article “How tourism is taking the turtles from Kenya's blue waters” <http://www.guardian.co.uk/environment/2011/dec/12/tourism-turtles-kenya-population> This article describes how tourism and related recreational activities are impacting the coastal environment and what it means for turtles. What does it make you think? Is tourism and recreation at the coast a good or bad thing? What can be done to ensure that tourism and recreation do not cause an excessive impact on the marine environment? Discuss these issues with your group, then thinking about your local beach or favourite beach destination, individually or in a small group, put together an action plan to make sure tourism and recreation don’t become a problem there.

7. Marine transport and trade **➁➂**

*Learning aim: find out the different ways that the oceans are used for transport and trade; understand some of the environmental impacts of ocean transport*

*Materials: visit to your local port or harbour, (if not possible to visit) information materials about your nearest port or harbour, camera*

Together with the rest of your group, visit your local port or harbour. If it is not possible to visit, gather information materials about your nearest port or harbour. Find out what cargo passes through the port/harbour – make sure you include people on your list! What volume of cargo passes through the port/harbour in a year? How many people leave or enter the port/harbour every year? How many boats/ships use the port/harbour every year? How big are the biggest ships that use the port/harbour? Put together a leaflet or poster or some other form of display describing the activities that go on there.

***Extension***: One environmental problem associated with marine transport is that of invasive species (species that are native to other areas, but become established in new areas and can cause ecological damage in their new homes as they take over from the species already living there). Ask the port or harbour authorities if there are any marine invasive species in the area. If yes, find out how they got there, where they have come from and what is being done to control them. If there are no invasive species, find out about a marine invasive species of your choice (perhaps one that is a problem elsewhere in your country). Make a poster of all the information you can find out about this (or these) species including where they have come from, when they first appeared, what problems they are causing and what, if anything, is being done to control them.

8. Boats and seafarers **➀➁➂**

*Learning aims: to build a model boat that floats and imagine what it would have been like as an early explorer to cross the ocean in open boats.*

*Materials: recycled materials including bottles and other plastic objects (e.g. pipes, yoghurt pots, plastic sheeting), small pieces of wood, aluminium foil, paper, card, string, glue, sticky tape – anything you think you might need...*

The challenge of this activity is to build a small boat that floats and doesn’t tip over (capsize). The winning boat will be the one that carries the greatest cargo (you can decide what this cargo should be, it could be small coins or grains of rice or any other small items, or perhaps you want a bigger challenge? Maybe an egg or an apple). You can do this either in small groups or as individuals.

Before you start building your boat, have a think about what might be important for keeping a boat upright and balanced. You might also want to draw a design for your boat before you start. If you have access to the internet, you might be able to get some tips about what makes for a successful model boat.

Once everyone in your group has made their boat, you will need to find somewhere calm to test them. If you are testing them in a local river, lake or at the beach, make sure you take an adult with you as well as the necessary safety precautions. You could also ask at your local swimming pool or as a last resort, if you have a bath at home, fill it up and set sail.

**Extension**: Many of the early seafarers and explorers would only have had open boats with sails for making long sea voyages. Imagine what it would have been like to travel across the oceans in a boat like that, how might they have felt when they lost sight of land or how frightening it must have been when the weather turned bad. Write a short story or poem imagining what it might have been like. Read it to the rest of your group when it is finished. Maybe you could enter it into a local writing competition.

9. The problem with plastic... **➀➁➂**

*Learning aim: understand the impacts of rubbish in the marine environment and how it affects marine wildlife. Younger children will also practise sorting, counting and weighing objects*

*Materials: buckets or bags for collecting rubbish, gloves, scales, pens and paper, glue*

Together with your teacher/group leader, organise a visit to your local beach/coast and, as a group, spend a couple of hours there collecting all the rubbish you can find. Young children must be accompanied by an adult at all times and instead of collecting the rubbish, they could just record what they see, while the older children and adults actually do the collecting.

If you are collecting rubbish, make sure you use gloves to protect your hands and if you find anything sharp or that you are unsure of, don’t pick it up but get an adult to take a look first. Once you have finished, put all the rubbish together in a big pile. What have you found? Sort the rubbish into different types such as plastic bottles, plastic bags, glass, cans, rope and so on. Count the number of pieces of rubbish you have of each type and then weigh them. What do you have the greatest number of? And what weighs the most?

Taking examples of the different types of rubbish, use them to make a display (make sure they are clean first) in your school or regular meeting place. Next to the different types of rubbish include a label saying how many pieces and the weight of that type of rubbish you found.

Invite your parents and friends to either join the rubbish collection or to see the results of your work.

***Extensions***:

➁ Find out about how long different items of rubbish last in the marine environment. Some things will break down quite quickly, but others will take much longer. Also find out about the dangers of rubbish to marine life. Add this information to the labels on your display.

➂ Get the media involved. Invite a local journalist or radio presenter to join your beach clean. If no one is available, write a report about the event for the local newspaper. Include a picture or two.

Rubbish isn’t the only thing that we put into the marine environment, people put any number of waste products and contaminants into the oceans. If you feel really strongly about the problems associated with this, why don’t you start a campaign (see activity E8).

10. Marine protected areas: are they the answer to better ocean protection? **➁➂**

*Learning aim: to understand who has responsibility for the oceans and the role that marine protected areas can play*

*Materials: National Geographic article about Marine Protected Areas* [*http://education.nationalgeographic.com/education/encyclopedia/marine-protected-area/?ar\_a=1&ar\_r=3#page=1*](http://education.nationalgeographic.com/education/encyclopedia/marine-protected-area/?ar_a=1&ar_r=3#page=1)

Read the article by the National Geographic about marine protected areas and discuss among your group the advantages and disadvantages of them for both people and marine life. Put together some information about the advantages and disadvantages that you can give to your friends, family and other people in your community. You can decide on the format.

***Extensions:*** Role play: the aim of this role play is to decide whether your local beach and surrounding area (or another place on the coast that you have visited) should be made into a Marine Protected Area. You will need to decide whether it should be a highly protected MPA where no one can use it or whether some users will still be able to carry on using it. You might also want to decide whether there will be different zones in the MPA with different levels of protection (e.g. one zone that no one can use, another zone that can be used for recreational activities and a third that can be used for some fishing activities).

In a group, think about all the different people who might be involved in a marine protected area. This will include the people who currently use the area (e.g. recreational groups, tourists, fishermen), the businesses that support them (e.g. local hotels, developers, dive businesses and charter boat operators), those who will enforce the MPA (e.g. local authorities), those who are campaigning for the designation of the MPA (e.g. conservation organisations, both NGOs and government organisations) and the general public. Designate a role to everyone in your group keeping one person as a chair. Each individual needs to think about the reasons why they think the marine protected area is a good or bad idea, and how it might benefit or disadvantage them. They also need to be aware of the opinions of other users so that they can argue with or against them.

Invite an audience to listen to your debate. Give everyone a few minutes to speak and to state whether they are for or against the MPA and their reasons why. During this time, the chair should write down the key points raised. Once everyone has had a chance to speak, get everyone to join in to discuss the pros and cons of the MPA. If the discussion continues for too long, the chair will have to bring it to an end. The chair also has the responsibility of summarising the key issues at the end of the debate.

Once the chair has summarised the issues, ask the audience to vote. Should there be an MPA or not?

*This activity is based upon one developed by the Marine Education Trust, who gave their permission for its use.*

E, Exploration and action

1. Ways to explore your own coast **➀➁**

*Learning aim: to build an underwater scope to look at life under the water surface and build a hydrophone to listen to underwater sounds*

*Materials: For the underwater scope you will need a large plastic tub (like the ones you get yoghurt in) or a plastic tube, clear plastic food wrap, elastic bands or sticky tape.*

*For the hydrophone you will need: a small microphone that can be attached directly to some earphones, a balloon, a small piece of rubber tubing to put in the neck of the balloon, non-hardening clay or putty, a cable tie, some grease and oil free lubricant and some small coins.*

To build an underwater scope, cut off the end of the plastic tub so that it becomes a tube. Cover the end with clear plastic food wrap and make sure it is securely attached to the tube using elastic bands or sticky tape. The next time you go to the beach, together with an adult find a sheltered, shallow and calm part of the sea (a rock pool would be ideal) and have a look at what is going on underwater by inserting the end of the tube with the plastic on into the water. The water should push the clear plastic up slightly making it act as a lens and magnifying what you see! Write down what you see and/or draw pictures and tell the rest of your group about it.

***Extension***: now build a hydrophone so that you can listen to underwater sounds. There are many instructions for building a hydrophone on the internet, but the instructions provided by <http://nemohousing.com/?page_id=296> are probably the easiest to follow. You can also purchase the hydrophone kit from this website it you want.

* Put a small microphone inside the balloon (the thicker the balloon the better). You may need the help of the water based lubricant to do this, such as a soap solution, but be careful not to get the microphone too wet.
* Add some small coins to the balloon to make sure that it will sink when you put it in water.
* Connect the headphones to the microphone.
* Make a plug for the neck of the balloon using a piece of thick rubber latex tubing, run the microphone/headphone cord through the tube and fill it with non-hardening clay or putty.
* Make sure there is a tight seal around the neck of the balloon using the cable tie.

The next time you go to the beach, try it out. What can you hear?

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2. Exploring the open ocean **➀➁**

*Learning aims: to learn about early ocean studies, understand about the conditions on board early survey ships*

*Materials: pictures and written information about the HMS Challenger expedition. The UK’s Natural History Museum provides a useful starting point* [*http://www.nhm.ac.uk/nature-online/science-of-natural-history/expeditions-collecting/hms-challenger-expedition/index.html*](http://www.nhm.ac.uk/nature-online/science-of-natural-history/expeditions-collecting/hms-challenger-expedition/index.html) *and so does the website of the National Maritime Museum, Greenwich, London:* [*http://www.rmg.co.uk/visit/events/gallery-favourites-online/hms-challenger-and-the-creatures-of-the-deep*](http://www.rmg.co.uk/visit/events/gallery-favourites-online/hms-challenger-and-the-creatures-of-the-deep)

As a group, find out the route of the HMS Challenger expedition and draw it onto a map of the world. Try to find pictures of the different species that were found. How many new species did the expedition find? Make your own copies of some of the new species found. Show them to the rest of the group and explain what they are.

***Extension***: As a group, watch the video about the HMS Challenger expedition on the UK’s Natural History Museum’s website and gather further information about the expedition. Talk among your group about what life might have been like on the boat if you were a member of the crew. How might life have differed if you were an officer or a scientist? Write two letters home, one as if you were a member of the crew and one as if you were a scientist. Explain your day-to-day routine, but also how you feel being away from home for so long and what it is like to live upon the ocean.

3. Census of Marine Life **➀➁**

*Learning aims: to be inspired by marine life*

*Materials: access to the internet and the Census of Marine Life website (*[*http://www.coml.org/*](http://www.coml.org/)*), craft materials such as paints, paper, coloured pens and pencils… anything that might be useful*

If you have access to the internet, have a look at the Census of Marine Life website, focus in particular on the pictures and the many weird and wonderful marine organisms that have been identified and described. Using your creative skills, draw or paint a picture, make a model or use any craft method that you like to bring to life one of the pictures you have seen of a marine creature.

***Extension*:** What’s new? Find out about one or two of the news species that have been discovered. Draw a picture of the organism(s) and annotate it with information and details of where it was found? Who found it? What does it do?

4. Studying the oceans **➁➂**

*Learning aim: to understand how scientists study the marine environments, to*

*Materials: reference materials about marine expeditions*

Choose a marine ecosystem that interests you (for example, the deep sea, the open ocean, coral reefs, mangroves, salt marshes, rocky shores) and think about what you would like to find out about it: what research questions do you have?

How do you think scientists would go about answering your question(s)? Imagine you have the opportunity to carry out some fieldwork to collect data about this ecosystem. How would you choose to go about it? Would you use satellite data? Would you need to do a survey by boat? Could you take samples from the shore?

Find out how you could collect the information that you would need to answer your questions. You could start by asking your science teacher at school and looking in your science text books, but many scientific studies now have their own websites with blogs and you can follow live what the scientists are getting up to on their trips (for example, see the Changing Oceans expedition website: <http://changingoceans2012.blogspot.co.uk/>)

***Extension***: Do you know any marine scientists? Is there a marine laboratory near to where you live? If you don’t have a marine laboratory near you, perhaps there are some commercial businesses or people who work for them nearby that also undertake marine research and expeditions (e.g. hydrographic surveyors, businesses that explore the marine environment looking for oil, gas and minerals). Invite an expert to give a talk to your group about studying and working in the marine environment and the different ways that this can be done.

5. Exploring the Arctic **➁➂**

*Learning aim: to learn about research in the Arctic, what living in the Arctic might be like and how the Arctic is changing.*

*Materials: reference materials on the Arctic. There are a number of websites focusing on the Arctic, for example:* [*http://www.discoveringthearctic.org.uk/*](http://www.discoveringthearctic.org.uk/)*,* [*http://oceans.digitalexplorer.com/resources/frozen-oceans-international-resources/#cmp*](http://oceans.digitalexplorer.com/resources/frozen-oceans-international-resources/#cmp) *(you will need to register on this website to access materials)*

You’ve just been offered the opportunity of a lifetime to join the next survey/expedition to the Arctic to explore how human activities are affecting the oceans in polar regions.

What research question do you think you and your team of researchers should focus on? What experiments or observations do you think you should carry out? How long will you go for?

What do you think living in the Arctic might be like? What will you need to take with you, not just for your experiments, but also to keep you alive and well? For example, where will you sleep, what clothes will you need and what will you eat?

Write a short diary about your trip and the discoveries that you have made. What lessons have you learnt and what is the key message you want people at home to know?

***Extension***: Many people live in the Arctic and near the Arctic and depend on its natural resources. Find out how climate change and retreating sea ice is changing the way that these people live. Make a short presentation to the rest of your group about what you have found out.

***Additional actions***

Many of the activities described in sections A-E involve actions that you can take to raise awareness of the marine environment, but here are a few more things that you can do:

6. World Oceans Day **➀➁➂**

*Learning aim: To celebrate the wonders of the oceans, its beauty and importance*

*Materials: Access to the internet and the World Oceans Day website* [*http://worldoceansday.org/*](http://worldoceansday.org/)*, also try this page for activity ideas:* [*http://worldoceansday.org/?page\_id=59*](http://worldoceansday.org/?page_id=59)

Every 8th of June is World Oceans Day, a day dedicated to celebrating the beauty and importance of the oceans. As a group, organise a day of celebration at your school or in your community. The World Oceans Day website has a number of ideas of things that you can do, from wearing blue to raise awareness of the oceans – perhaps you could design a logo for a t-shirt especially for the day – organising treasure hunts, sand sculpture competitions, beach parties and festivals.

You can do whatever you want, just use your imagination. The events you organise can be a great way of spreading the word about how wonderful the oceans are, how much people need them and how fragile and in need of protection they are. You can use the event to display the materials you have produced from other activities you have completed as part of this challenge badge.

7. Reduce your use of plastic **➀➁➂**

*Learning aim: encourage behaviour change and understand the impact of plastic on the marine environment.*

*Materials: old items of clothing or other unwanted material, needle and thread (although a sewing machine would be easier), a pattern for making a shopping bag (design your own or try http://tipnut.com/35-reusable-grocery-bags-totes-free-patterns/)*

Start making your own shopping bags and encourage your family to use them every time they go shopping so that they don’t need to use plastic ones. If you and your group can make enough of them, you could ask your local shop to start using them or give them away outside your local shop or shopping centre, explaining to shoppers what you are doing and why. You could also encourage the people you know to start making their own.

8. Campaign for your local beach or raise awareness of marine environmental problems **➀➁➂**

*Learning aim: how to organise a campaign about an issue that is important to you, how to persuade other people that the issue is also important to them*

*Materials: this will vary according to your individual campaign needs*

Together with your teacher/group leader and as a group, think about any problems at your local beach or your local coastal area that you would like to see changed? Maybe go on a visit to the beach to see the problem first hand. Or is there an issue nationally or internationally that you think local people should be aware of? Perhaps overfishing, pollution, coastal development, anything that takes your fancy…

Start up a campaign to raise awareness of the topic. This will need careful planning and you will need to think about things like:

* Who is your audience?
* How will you reach your audience?
* How long should your campaign last?
* What outcome would you like to achieve?

There are many ways that you can reach your audience.

* You might start by writing a letter to people in your community to persuade them to change their behaviour.
* You could make posters informing people of the problem and put them in conspicuous places around your community
* You could hold an event and give out leaflets explaining the issue
* You could try to get the local media involved – newspaper, radio or television
* You could make your own film or radio programme (ask some professionals for help)
* Is there any other way that you can think of?

9. Take the Seafood Watch Challenge - **➀➁➂**

*Learning aim: understand how the choices you and your family make about seafood affect the marine environment*

*Materials: information about fish and shellfish species that are endangered by overfishing. Try the Monterey Bay Aquarium* [*http://www.montereybayaquarium.org/cr/cr\_seafoodwatch/sfw\_consumers.aspx*](http://www.montereybayaquarium.org/cr/cr_seafoodwatch/sfw_consumers.aspx) *and the Marine Stewardship Council* [*http://www.msc.org/cook-eat-enjoy/fish-to-eat*](http://www.msc.org/cook-eat-enjoy/fish-to-eat)

Many common fish that we see in fishmongers and at fish counters in shops are in danger because of overfishing or the way that they are caught or farmed causes damage to the marine environment and other marine species. Discuss with your teacher/group leader what you know about fishing and using the information and handy guides provided by the Monterey Bay Aquarium or the Marine Stewardship Council, encourage your family and friend’s families to change the seafood that they buy for sustainably harvested seafood.

You can take this even further by trying to encourage your local restaurants, cafes and shops to do the same or to buy from suppliers that only source sustainably caught/farmed seafood.

You can also take the Monterey Bay Aquarium’s seafood watch challenge and sign up to be a Seafood Watch Advocate and take part in seafood watch activities throughout the year.

10. Citizen science **➀➁➂**

*Learning aim: contribute to a research project by providing data*

*Materials: note pad and pen*

There are often many opportunities to take part in citizen science projects, research projects undertaken by universities and research institutes around the world that rely on the public to provide information to them. Talk with your teacher/group leader about opportunities for taking part in citizen science projects in your area.

One of the most well-known in the marine environment is Jellywatch (<http://www.jellywatch.org/>). Jelly fish are becoming increasingly common along many stretches of coast and because they can affect many human activities (such as swimming and other recreational activities, fishing, the uptake of cooling water into power stations), scientists are interested in knowing more about where jellyfish are found and what species are present. The next time you are at the coast, take a note pad and pen with you and if you see a jellyfish, write down a description of it and where you saw it. Jellywatch is also interested in other marine life, such as red tides (a harmful algal bloom), squids and anything that you think is unusual for your area.

Other organisations are also interested in things like sightings of whales and dolphins (e.g. Whale and Dolphin Conservation Society <http://www.wdcs.org/index.php> and the Seawatch Foundation <http://www.seawatchfoundation.org.uk/>).

Are there any organisations in your area conducting citizen science? Try to find out and send them any information that they might find useful – this could include the date and time of your sighting, and how many of the animal of interest you saw.

Additional Resources

All of the websites below contain links to educational materials about the oceans, including lesson plans, experiments, articles, blogs and videos.

The educational page of the National Ocean Service provided by NOAA (the US National Ocean and Atmospheric Administration): <http://oceanservice.noaa.gov/education>

The Ocean Portal from the Smithsonian National Museum of Natural History: <http://ocean.si.edu/ocean-and-you>

NOAA website providing educational materials focusing on expeditions and explorations: <http://oceanexplorer.noaa.gov/edu/materials.html>  
   
Enchanted Learning website on oceans and seas: <http://www.enchantedlearning.com/themes/ocean.shtml>  
   
Franklin Institute treasures @ sea website for exploring the ocean through literature: <http://www.fi.edu/fellows/fellow8/dec98/intera.html>

BBC science and nature webpage focusing on the oceans: <http://www.bbc.co.uk/nature/blueplanet/>

Educational materials provided by the Oceans for Youth Foundation: <http://www.oceansforyouth.org/>

Ocean education from the National Geographic: <http://education.nationalgeographic.com/education/program/oceans-education/?ar_a=1&force_AR=True>

Just Add H2O, the educational webpage of the UK’s National Marine aquarium:

<http://www.justaddh2o.tv/>

The Monterey Bay Aquarium animals and activities page: <http://www.montereybayaquarium.org/efc/default.aspx?c=tn>

The Monterey Bay Aquarium also has a site dedicated to teachers: <http://www.montereybayaquarium.org/lc/teachers_place/>

World Oceans Day: <http://worldoceansday.org/>

Glossary

**Absorb:** to take something up or retain it, for example, both the oceans and the atmosphere take up heat from the sun’s rays.

**Aerosols:** small particles in the atmosphere, such as ice and dust, around which water condenses and forms raindrops.

**Ballast:** a heavy material included in ships to help them maintain stability and prevent capsizing.

**Ballast Water:** water held in tanks within the hulls of large ships to maintain stability.

**Bays:** a body of seawater that is partially enclosed by land, such as the Bay of Bengal, the Bay of Biscay and Baffin Bay.

**Bivalves:** marine and freshwater molluscs whose bodies are enclosed inside two shells that are hinged together. They mainly feed by filtering particles out of the water.

**Brackish Water:** water that has a salinity (salt content) that is less than seawater, but greater than freshwater. It can result in estuaries from the mixing of freshwater from the rivers with seawater.

**By-Catch:** most fishers intend to catch a specific fish or several specific fish, but during this process many additional fish are caught unintentionally. These unintentionally caught fish are known as by-catch.

**Cargo**: the goods or produce transported by ships (or other forms of transport).

**Carnivores:** these are animals that gain all (or the vast majority) of their nutritional needs from eating other animals. Carnivore literally means meat eater.

**Chemosynthesis:** a biological process that involves the use of inorganic substances such as methane and hydrogen sulphide as a source of energy to convert carbon molecules and nutrients into organic matter. It is an alternative to photosynthesis for producing food when no light is present.

**Climate:** this is the long-term average, or overall picture, of the everyday weather experienced in a location.

**Climate change:** is a long-lasting change in weather patterns that may occur over long periods lasting decades to millennia. It is caused by many factors including volcanic eruptions, changes in ocean currents, changes in the activity of the sun and human activities.

**Cold seeps:** these are found on the ocean floor where hydrogen sulphide, methane other hydrocarbon fluids escape from the ocean floor. The animals found here use chemosynthesis to produce food.

**Condense:** the change of a gas or vapour into a liquid.

**Currents:** are continuous and directed movements of water. In the oceans they are caused by the tides, wind and differences in the temperature and salinity of seawater.

**Cyanobacteria:** also known as blue-green algae, these bacteria produce food through the process of photosynthesis. They are well known for their blooms (periods of rapid reproduction and growth) which make the water turn a green-blue colour.

**Dead zones:** these are areas of the ocean, often close to the coast, where little oxygen is found in the water and sediments making it difficult for marine life to live there. The number of dead zones in our oceans is growing.

**Density:** the mass (or weight) of a unit of something under specific conditions of temperature and pressure.

**Detritovores:** important organisms for decomposition, they obtain their nutritional needs by eating the dead bodies of other animals and plants, and the waste products of other animals.

**Echinoderms:** are only found in the marine environment and include starfish, sea urchins and sea cucumbers. There are over 70,000 known living species of echinoderms in the oceans.

**Eutrophication:** commonly occurs in coastal waters because of the presence of excessive levels of nutrients. It results in the fast growth of phytoplankton and other marine algae which can contribute to the creation of dead zones.

**Evaporation**: the process causing liquids to change into gases or vapours.

**Fisher**: people who go fishing and whose livelihoods depend on fish.

**Food chains**: the links between organisms, showing what eats what. They show how energy passes between individuals, starting with primary producers.

**Food webs:** this is a more complicated version of a food chain, showing that more than one animal may have the same food source.

**Gravity:** a force that refers to the level of attraction between two objects

**Greenhouse gases**: these are gases in the atmosphere that can absorb and emit (or radiate) heat. They include water vapour, carbon dioxide, methane, nitrous oxides and ozone.

**Gulfs**: a large area of seawater partially enclosed by land. Gulfs are usually much bigger than bays. Examples include the Gulf of Mexico, the Gulf of Aden and the Gulf of Bothnia.

**Gyres**: these are large systems of rotating ocean currents, usually associated with wind driven currents. There are five major gyres: one in the north Atlantic, one in the south Atlantic, one in the north Pacific, one in the south Pacific and one in the Indian Ocean

**Harmful algal blooms:** are the result of the very fast growth and reproduction of algae that can produce toxins that are harmful to other marine organisms and humans. The blooms vary in colour from purple to pink to red to green. The frequency of harmful algal blooms is thought to be increasing, the exact cause of which is unknown, but some appear to be the result of human activities including pollution and eutrophication.

**Herbivores:** animals that only eat plants, algae and photosynthesising bacteria as a source of food.

**Hurricane:** are extremely intense tropical storms that form out in the oceans producing very strong winds and heavy rain. Also known as typhoons and tropical cyclones.

**Hydrological** **cycle:** also known as the water cycle, the hydrological cycle describes the movement of water from the sea to the atmosphere to the land and back to the sea. It also describes the changes in state of the water from liquid to vapour and solid.

**Hydrothermal vents:** found on the ocean floor where heated water escapes, often associated with volcanic activity.

**Hypoxia:** this occurs in ocean environments when the level of dissolved oxygen in seawater becomes reduced and can no longer support marine life. In extreme cases, dead zones occur.

**Inland seas:** these are land locked bodies of water or salt lakes that show characteristics similar to seas.

**Invasive species:** animals, plants and other species that have been introduced to an area from elsewhere, either by accident or on purpose, and negatively affect the native habitat by out-competing native species.

**Manatees:** herbivorous marine mammals, also known as sea cows.

**Marine Protected Areas:** protected areas in the marine environment in which some or all human activities are restricted. They have many aims including the protection, conservation and restoration of marine habitats and cultural or historical resources found in the area.

**Marine snow:** marine detritus (dead bodies and waste products) that fall from the upper ocean into the deep sea.

**Megacities**: cities with a population of more than 10 million people living in them.

**Molluscs**: a diverse group of invertebrate animals (they do not have a backbone) including snails, squids and octopus. About 23% of all named marine organisms are molluscs.

**Neap tides:** these tides have a less extreme tidal range and occur when the moon is in its first or third quarter.

**Ocean acidification:** the term given to the increase in acidity (or decrease in pH) observed in the oceans as a result of the rapid uptake in carbon dioxide by seawater over the last century.

**Omnivores:** animals that eat both plant and animal material as a source of food.

**Photosynthesis:** a biological process that uses light as an energy source to convert carbon dioxide and other nutrients into a source of food. It is the process used by plants and algae to produce foods such as sugar.

**Phytoplankton:** small, microscopic marine organisms that drift with the ocean currents. They live in the upper layers of the ocean and use photosynthesis to produce food.

**Primary producers:** are organisms that can photosynthesise and are the basis for all marine food chains or webs.

**Rip currents:** these are narrow, fast moving flows of water that travel away from the coast. They can occur at any beach where waves break.

**Salinity:** the concentration or amount of salt dissolved within seawater.

**Seafarers:** people who work at sea.

**Seas:** a large body of salt water connected to an ocean. Often the word sea is used interchangeably with the word ocean.

**Seawater:** the water found in an ocean or the sea. It differs from freshwater because of the concentration of dissolved salts found in it.

**Spring tides:** tides that produce higher high tides and lower low tides than average and occur when the moon is new or full (second or fourth quarter).

**Storm surges:** caused by high winds, storm surges cause a rise in seawater resulting in higher than usual tides that may cause flooding at the coast.

**Straits:** a narrow channel of water that connects two larger bodies of water, for example the Straits of Gibraltar (which connects the Mediterranean Sea with the Atlantic Ocean) and the Bering Straits between Alaska and Siberia, which connects the Pacific Ocean with the Arctic Ocean.

**Stromatolites:** layered structures formed by microorganisms, including blue-green algae, and trapped sediments. They form in shallow, coastal waters and provide some of the oldest records of marine life.

**Surface currents:** these are wind driven currents that form in the top 400m of the ocean surface.

**Temperate** **species:** these are species that live in temperate zones, the areas between the tropics and the polar regions where the temperatures are relatively moderate with few extremes in winter and summer.

**Tidal range:** this is the difference between the highest and lowest tides in an area.

**Tides**: are the rise and fall of the sea due to the gravitational pull of the moon and sun and the turning of the Earth. Most places sea two high and low tides per day.

**Tropical cyclone:** see hurricanes.

**Tsunamis**: these may be extremely powerful waves caused by changes on the seabed including earthquakes, volcanic eruptions and underwater landslides.

**Typhoon:** see hurricanes.

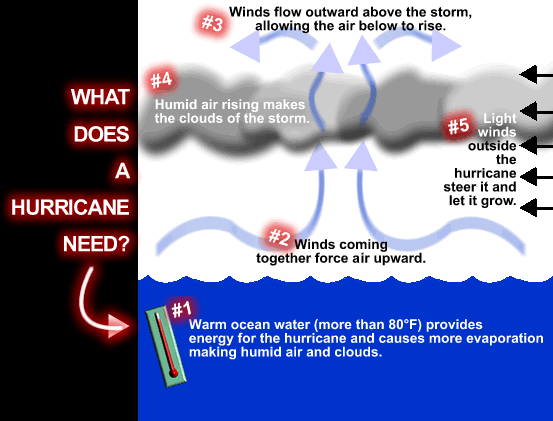
**Weather:** the conditions outside experienced on a day to day basis including the cloud cover, rainfall, air temperature, air pressure, wind and humidity (the amount of water vapour in the air).

**Zooplankton:** microscopic marine animals that float with the ocean currents. Some zooplankton spend all of their lives as plankton, but others only spend their young (juvenile) stage as plankton, developing into larger adult phase (e.g. jellyfish and other fish species).

Annex 1: Hurricanes

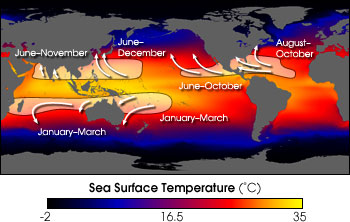
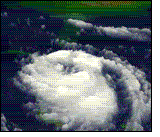
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**What is a hurricane?**  
A hurricane is a huge storm! It can be up to 600 miles across and have strong winds spiralling inward and upward at speeds of 75 to 200 mph. Each hurricane usually lasts for over a week, moving 10-20 miles per hour over the open ocean. Hurricanes gather heat and energy through contact with warm ocean waters. Evaporation from the seawater increases their power. Hurricanes rotate in a counter-clockwise direction around an "eye" in the Northern Hemisphere and clockwise direction in the Southern Hemisphere. The centre of the storm or "eye" is the calmest part. It has only light winds and fair weather. When they come onto land, the heavy rain, strong winds and large waves can damage buildings, trees and cars.

****  
If you live an area that's prone to hurricanes, then an emergency kit can be a big help for you. A [hurricane survival kit](http://www.survival-goods.com/) is designed to give you all the basic things you need to survive and be safe, from a way to get clean water for yourself to first aid kits and other helpful tools.   
  
**How do hurricanes form?**  
Hurricanes only form over really warm ocean water of 80°F or warmer. The atmosphere (the air) must cool off very quickly the higher you go. Also, the wind must be blowing in the same direction and at the same speed to force air upward from the ocean surface. Winds flow outward above the storm allowing the air below to rise. Hurricanes typically form between 5 to 15 degrees latitude north and south of the equator. The [Coriolis Force](http://www.weatherwizkids.com/Weather%20Words.htm) is needed to create the spin in the hurricane and it becomes too weak near the equator, so hurricanes can never form there.   
  
  
[**Click Here**](http://www.comet.ucar.edu/nsflab/web/hurricane/311.htm) to learn more about hurricanes from UCAR.  
  
**What is storm surge?**  
Storm surges are frequently the most devastating element of a hurricane. As a hurricane’s winds spiral around and around the storm, they push water into a mound at the storm’s center. This mound of water becomes dangerous when the storm reaches land because it causes flooding along the coast. The water piles up, unable to escape anywhere but on land as the storm carries it landward. A hurricane will cause more storm surge in areas where the ocean floor slopes gradually. This causes major flooding.

As you watch the storm-surge animations, notice the effect that the physical geography of each coastline has on storm surge. Also, note the waves on top of the ocean's surface. Wind, waves, and sea-level rise all contribute to storm-surge damage.

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| **Shallow-Water Coastline** |
| Storm Surge |
| **Deep-Water Coastline** |
| Storm Surge |

With technology the way it is, there are computer models that allow forecasters to predict the amount of storm surge that will affect a coastal area. These are called Slosh Models and take into account a storm’s strength, its path, how the ocean shallows, and the shape of the land. Then it calculates how much storm surge a hurricane will probably cause.  
  
**When does hurricane season start?**  
The Atlantic hurricane season is from June 1 to November 30, but most hurricanes occur during the fall months. The Eastern Pacific hurricane season is from May 15 to November 30. (Below is a graphic that shows you when hurricanes are most active across parts of the world.)  
  
  
**Who names hurricanes?**  
From 1950 to 1952, tropical cyclones of the North Atlantic Ocean were identified by the phonetic alphabet (Able-Baker-Charlie-etc.), but in 1953 the US Weather Bureau switched to women's names. The rest of the world eventually caught on, and naming rights now go by the World Meteorological Organization, which uses different sets of names depending on the part of the world the storm is in. Around the U.S., only women's names were used until 1979, when it was decided that they should alternate a list that included men's names too. There's 6 different name lists that alternate each year. If a hurricane does significant damage, its name is retired and replaced with another.  
[**Atlantic Hurricane Names**](http://www.weatherwizkids.com/hurricane-atlantic-names.htm)  
[**Eastern Pacific Hurricane Names**](http://www.weatherwizkids.com/hurricane-pacific-names.htm)  
  
**What is the difference between a hurricane and a typhoon?**  
Nothing except geography. Tropical storms occur in several of the world's oceans, and except for their names, they are essentially the same type of storm. In the Atlantic Ocean, Gulf of Mexico, and the Eastern Pacific Ocean, they are called hurricanes. In the Western Pacific Ocean, they are called typhoons. In the Indian Ocean, the Bay of Bengal, and Australia, these types of storms are called cyclones.  
  
(This is a satellite animation of Hurricane Georges, which struck the Mississippi Gulf coast in 1998.)  
  
**Who are the "Hurricane Hunters"?**   
The brave "hurricane hunters" work for the National Oceanic and Atmospheric Administration (NOAA). Each mission lasts about ten hours, with the crews passing four to six times through the storm. The planes carry radar, sophisticated computers, and weather instruments that determine characteristics such as temperature, air pressure, wind speed, and wind direction inside the hurricane. The crews also release instruments that measure temperature, air pressure, and wind at different levels as the devices drop through the hurricane toward the ocean. By mission's end, NOAA can warn everyone in the hurricane's path. (Below is a satellite image of Hurricane Mitch back in October 1998. The Hurricane Hunters flew into the eye of Mitch just as this Category 5 hurricane with winds of 155 mph smacked right into Central America.)

|  |  |
| --- | --- |
| Hurricane Mitch | Hurricane Hunters Plane |

**What is coastal beach erosion?**  
Coastal beach erosion is the wearing away of land, the removal of beach or dune sediments by wave action, tidal currents, wave currents, or drainage. Waves are generated by storms, wind, or hurricanes and can cause coastal erosion. This may take the form of long-term losses of sediment and rocks, or merely the temporary redistribution of coastal sediments.  
  
**HurricaneHurricanes...Past and PresentHurricane**  
[**Tropical Tracks:**](http://www.weatherwizkids.com/hurricane-tropical-tracks.htm) Click to see the tracks of this year's storms.  
  
[**Past Hurricane Info:**](http://weather.unisys.com/hurricane/index.html) Click to find all the data and information about a specific hurricane by just knowing the year.  
  
**HurricaneKnow the Lingo**Hurricane   
**TROPICAL STORM WATCH** - Tropical Storm conditions with sustained winds from 39 -74 mph are possible in your area within the next 36 hours.

**TROPICAL STORM WARNING** - Tropical Storm conditions are expected in your area within the next 24 hours.

**HURRICANE WATCH** - Hurricane conditions with sustained winds of 74 mph or greater are possible in your area within the next 36 hours. This WATCH should trigger your family's disaster plan, and protective measures should be initiated. Especially, those actions that require extra time such as securing a boat and leaving a barrier island.

**HURRICANE WARNING** - Hurricane conditions are expected in your area within 24 hours. Once this WARNING has been issued, your family should be in the process of completing protective actions and deciding the safest location to be during the storm.

**COASTAL FLOOD WATCH** - The possibility exists for the inundation of land areas along the coast within the next 12 to 36 hours.

**COASTAL FLOOD WARNING** - Land areas along the coast are expected to become, or have become, inundated by sea water above the typical tide action.

**SMALL CRAFT ADVISORY** - A small craft advisory is a type of warning issued by the National Weather Service, most frequently in coastal areas. It is issued when winds have reached, or are expected to reach within 12 hours, a speed marginally less than that which is considered gale force, usually 25-38 mph.

[**Click Here**](http://iwin.nws.noaa.gov/iwin/iwdspg1.html) to see if there are any active warnings in your area.  
  
**HurricaneHurricane Stages**Hurricane

|  |  |
| --- | --- |
| Tropical Wave | A low pressure trough moving generally westward with the trade winds. |
| Tropical Disturbance | An organized area of thunderstorms that usually forms in the tropics. Typically, they maintain their identity for 24 hours and are accompanied by heavy rains and gusty winds. |
| Tropical Cyclone | A generic term for any organized low pressure that develops over tropical and sometimes sub-tropical waters. Tropical depressions, tropical storms, and hurricanes are all example of tropical cyclones. |
| Tropical Depression | An organized area of low pressure in which sustained winds are 38 mph or less. |
| Tropical Storm | A tropical cyclone with maximum sustained wind speeds that range from 39 to 73 mph. |
| Hurricane | A tropical cyclone with sustained winds of at least 74 mph. |

**HurricaneSaffir-Simpson Hurricane Scale**Hurricane

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Category | Winds (MPH) | Pressure (Millibars) | Pressure (Inches) | Storm Surge (Feet) | Damage |
| 1 | 74-95 | <980 | <28.94 | 4'-5' | Minimal |
| 2 | 96-110 | 979-965 | 28.91-28.50 | 6'-8' | Moderate |
| 3 | 111-130 | 964-945 | 28.47-27.91 | 9'-12' | Extensive |
| 4 | 131-155 | 944-920 | 27.88-27.17 | 13'-18' | Extreme |
| 5 | >155 | <920 | <27.17 | >18' | Catastrophic |

To learn more about hurricanes, [**Click Here**](http://www.pinellascounty.org/emergency/hurricane_videos.html) to watch a variety of videos teaching you the ins and outs of nature's fury. I would like to give a special thanks to Pinellas County Emergency management for putting these instructional videos together.  
  
**HurricaneHurricane Safety TipsHurricane**  
**BEFORE A HURRICANE**: Have a disaster plan and a pet plan ready. Before a storm threatens, contact your veterinarian or local humane society for information on preparing your pets for an emergency. Board up windows and bring in outdoor objects that could blow away. Make sure you know which county or parish you live in and know where all the evacuation routes are.   
Prepare a disaster supplies kit for your home and car. Include a first aid kit, canned food and a can opener, bottled water, battery-operated radio, flashlight, protective clothing and written instructions on how to turn off electricity, gas, and water. Have a NOAA weather radio handy with plenty of batteries, so you can listen to storm advisories. Have some cash handy as well, because following a hurricane, banks and ATMs may be temporarily closed. Make sure your car is filled with gasoline.  
  
**DURING A HURRICANE**: Stay away from low-lying and flood prone areas. Always stay indoors during a hurricane, because strong winds will blow things around. Leave mobile homes and to go to a shelter. If your home isn’t on higher ground, go to a shelter. If emergency managers say to evacuate, then do so immediately.

**AFTER A HURRICANE**: Stay indoors until it is safe to come out. Check for injured or trapped people, without putting yourself in danger. Watch out for flooding which can happen after a hurricane. Do not attempt to drive in flooding water. Stay away from standing water. It may be electrically charged from underground or downed power lines. Don’t drink tap water until officials say its safe to do so.

[**Evacuation Tips:**](http://www.weatherwizkids.com/hurricane-evacuation-tips.htm) Here is a list of tips on what you should do, if you chose to evacuate as a hurricane approaches.

[**Hurricane Supply Checklist:**](http://www.weatherwizkids.com/hurricane-checklist.htm) Here is a list of what you will need if you chose to stay at your home during a hurricane.

Illustrations

The illustrations used in this booklet are a selection from the over 10 000 drawing received from various drawing competitions. See [www.yunga.org](http://www.yunga.org) or register to our free list server to find out about current and new competitions and activities.

This challenge badge is part of a series of challenge badges being developed by UN agencies and other organizations involved in YUNGA. Badges are or will be developed on Agriculture, Biodiversity, Climate Change, Energy, Fish, Forests, Hunger, Nutrition, Oceans, Water, and other themes.

To see existing badges go to [www.fao.org/climatechange/youth/63380/en](http://www.fao.org/climatechange/youth/63380/en) and [www.yunga.org](http://www.yunga.org).

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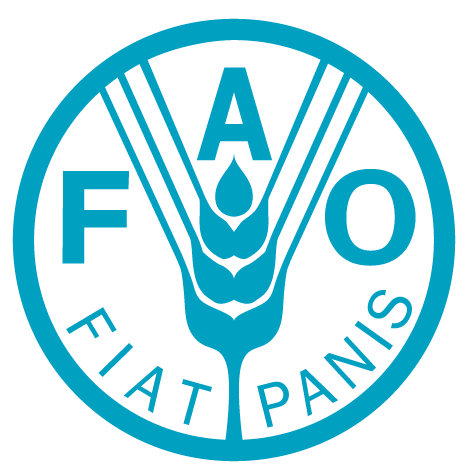
Add names of groups that tested and FAO staff that contributed and provided technical inputs.

*This badge has been developed with the kind financial support of the* ***Swedish International Development Agency (Sida)****.*[www.sida.se](http://www.sida.se)

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*For further information*

Youth and United Nations Global Alliance (YUNGA)

Food and Agriculture Organization of the United Nations (FAO)

Viale Delle Terme Di Caracalla, 00153 Rome, Italy

E-mail: children-youth@fao.org

Website: www.fao.org/climatechange/youth/en