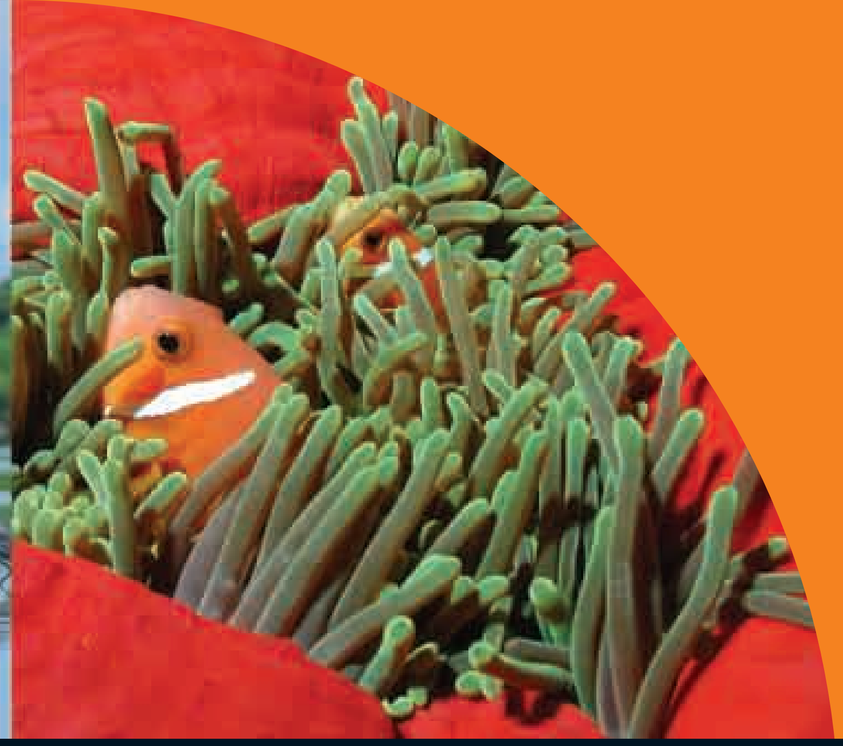
ENVIRONMENT



SCHOOLS FOR A HEALTHY ENVIRONMENT

BIODIVERSITY

Educational Development Centre

unicef

1. ABOUT THE FLIP CHART:

This Flip Chart is designed to be used by teachers and facilitators during relevant school and/or Environment Club activities.

The Flip Chart consists of 2 sections:


1. Environment


2. Biodiversity.

Each section contains background information which should be read out to students. The sections also include activities relevant to that topic. There are suggested times allocated to each activity to help you plan the lesson.

- On the front of each page is the illustration, visible so the students can find a context for the discussion. The front of the page also contains diagrams for the activities.
- On the back of the pages is a BACKGROUND FOR TEACHERS, which provides you with information to support the lesson. You may want to use some of the facts in your discussion. Also on the back of pages are the discussion points which you should read out to stimulate class discussion.

KEY

To make teaching easier, each page has a key based on the following elements:


This refers to discussion points that should be read out and discussed with students


This icon refers to information that needs to be recorded in the student's notebook


Refers to handouts that should be given to students


Observations that students can make continuously in and outside of school time

2. BEFORE YOU START:

- Before the class, the teacher should read and familiarize themselves with the Flip Chart.
- Ensure you have all the materials you need to conduct the lesson.
- Organise the students around the Flip Chart, ideally seated in a semi circle. Ensure they all can see the Flip Chart clearly.

3. DURING THE CLASS:

- Allow the students time to look at the picture page, and then share some of the relevant theory with the group.
- Make the activity as enjoyable and practical as possible – students remember more when they feel happy.
- Try to get everyone to participate. If they are observing in one activity ensure they are more actively involved in the next activity.

Developed for Educational Development Centre,
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LIVE&LEARN
Environmental Education

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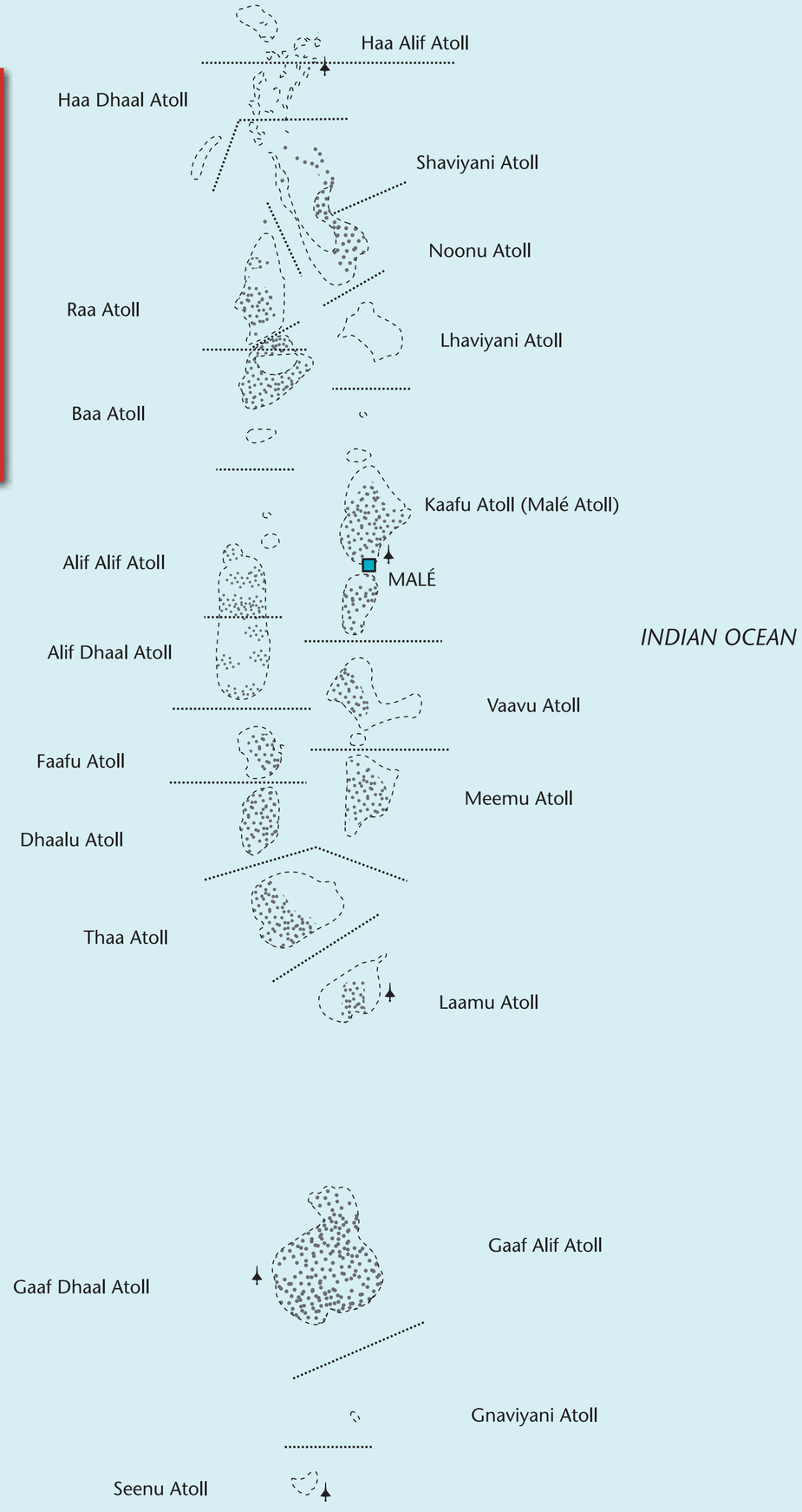
CONTENTS:

FLIP CHART LINKS TO THE ENVIRONMENTAL STUDIES CURRICULUM

ARABIAN SEA

THE MALDIVES

- There are approximately 1190 islands in the Maldives with some form of vegetation on them.
- Approximately 200 are inhabited islands.
- Approximately 990 are uninhabited.
- There are 26 distinct geographical atolls. The 26 atolls are divided into 20 administrative regions, with the capital Male' making up a separate administrative unit.
- The Maldives is 860km long and 130km wide.
- Thuraakunu in Haa Alif atoll is the most northerly island, Gan is the most southerly island in Seenu atoll.
- More than 99% of the country is water (115,000km^2) with less than 0.3% land (300km^2).



INDIAN OCEAN

30 minutes

BAD ENVIRONMENTAL PRACTICES

OBJECTIVE: To highlight some island practices that affect the environment negatively.

BACKGROUND FOR FACILITATOR

WATER

Water is one of the most basic of human needs. Without water, life could not exist. It is the most valuable resource in the world. We must make every effort to keep this resource clean. Water pollution has many causes and characteristics. In the Maldives one of the most common causes of water pollution is from septic tanks or sewerage systems that leak into the groundwater. Also, rainwater tanks can become contaminated if leaves and other materials are not cleaned from the roof. Waste that enters water sources (e.g. wells) can have potential health impacts and cause other environmental problems. Water and sanitation are among the most important determinants of public health.

NUTRITION

Although the Maldives has developed very quickly over the last few decades, in 2001 a health survey revealed that there are quite high malnutrition rates, with 30% of children under five years of age underweight and 25% have stunted growth (MoH, 2004). The underlying causes of malnutrition relate to inadequate health care practices, poor environmental sanitation and the lack of a balanced healthy diet.

POLLUTION

When pollution occurs it can affect the land, the air and the water: the environment becomes unhealthy and dangerous for people, plants and animals to live in. There are 4 main types of pollution: water pollution, land pollution, air pollution and noise pollution. For example, in the Maldives water can be polluted from sewage discharging into the lagoon, the land can be polluted from the use of chemicals or pesticides, the air can be polluted from burning of plastics and powerhouses, and cars can cause noise pollution.

WASTE

Waste management is one of the biggest environmental challenges in the world. As populations grow so do waste problems. Also, as populations become more wealthy people consume more products and services and this changes the types of waste produced. Many modern wastes are non-organic (e.g. plastics, metals) and societies are not acting to effectively reduce, reuse and recycle these types of wastes. These non-organic wastes take many years to breakdown, so they remain in the environment for a long time. In the Maldives waste that is inappropriately dumped onto beaches or in mangroves can become sites for mosquito breeding, or otherwise wash into the ocean where it can damage the reef. Once in the ocean, wastes like plastic bags can be caught up in boat engines or cause turtle deaths when they are mistakenly eaten because they look like jellyfish.

IMPORTANCE OF MANGROVES

Mangroves are small shrubby trees that are tolerant to seawater and live in the inter-tidal zone. However, mangrove forests are not recognized for the important role they play as fish and bird breeding habitats and in maintaining water quality. In the Maldives mangroves are threatened and need to be protected. However, currently mangroves are cut down and used for firewood and waste is inappropriately dumped in forest areas which can act as sites for mosquito breeding.

IMPORTANCE OF BEACH SYSTEM

Beaches are continuously changing – from day to day, month to month, and year to year – as the natural forces of wind and water meet the land. The islands of the Maldives are known as Reef Islands and there is a close relationship between the islands, the beaches and the surrounding reef platforms. In the Maldives, beaches change as a result of the different monsoons. During the southwest monsoon the waves come from the west and southwest and sand is moved so that in many cases it builds up on the eastern side of the islands. During the northeast monsoon the reverse happens, with the waves and currents coming from the northeast and sand often builds up on the western side of the islands. But at some beaches, sand is continually lost, so the waves attack the land behind the beach, and this is called erosion. Beach erosion and beach build-up are natural processes, but often human action interferes with the natural processes and makes erosion more severe. Human activities that influence the beach, include sand and coral stone mining, trampling on coral reefs, building harbours and jetties and dredging.

IMPORTANCE OF CORAL REEF SYSTEMS

Coral reefs are not just made up of corals; they are also made up of millions of other plants and animals which rely on each other for survival. Coral reefs provide animals with shelter and food – the habitat for survival. The Maldives depends on the coral reef system for its major livelihoods: fisheries and tourism. So it is very important to maintain healthy coral reef systems by avoiding unsustainable practices such as coral mining and overfishing. Also we need to be careful with how much fertilizer we apply to crops on our islands. If we apply too much, it washes away in the rain and can flow into the sea. Coral reefs are very sensitive to fertilizers (called nutrients) and high levels of nutrients can affect coral growth and even cause coral death.

PROTECTED AREAS

Protecting resources and managing them helps to ensure sustainable livelihoods for the future. Cutting down too many trees, taking too many fish and capturing threatened animals, such as birds and turtles, are all unsustainable practices that reduce livelihood opportunities. Many birds and animals are protected in the Maldives as they are considered endangered. Birds, such as the White-Breasted Waterhen (Kanbili) and animals such as turtles (Kahan'bu) should not be kept in captivity.

GLOBAL WARMING

The atmosphere acts as a natural greenhouse trapping the Sun's heat near the Earth's surface keeping our planet at the right temperature. Without this 'Greenhouse Effect' we would not be able to survive on Earth. However, our modern life and the growth in the global population are causing huge changes to this natural 'Greenhouse Effect'. Whenever we use energy in our cars and boats, we use fossil fuels and this adds large amounts of greenhouse gases, especially carbon dioxide, to the atmosphere. These gases are trapping more heat on earth causing the Earth to heat up- this is known as Global Warming. Many scientists are concerned that increased temperatures will lead to sea level rises and changes to our climate (e.g. some countries may experience drier climates). In the Maldives such changes may lead to changes in fisheries, as tuna may migrate to places with more favourable temperatures (MHAHE, 2001). Also, corals have a limited range of temperatures that they can survive in, so if temperatures rise, the coral reefs may also be affected. The sea surface temperature in the Maldives does not vary much (28-30°C), however in 1998 the El Nino Phenomenon caused sea surface temperatures to rise by 31.4°C, which caused severe coral bleaching across the country and killed 80% of living corals (MoEC, 2004). This is a major concern for the Maldives.

DISCUSSION POINTS

A. What do you feel when you see this picture?

B. Would you like to live in this environment? Why?

C. Can you identify some bad practices?

D. What do you see that is similar to your island?

E. What bad practices could you reduce in your community? How?

1 hour

ACTIVITY
MY ENVIRONMENT

Materials: Pen, paper and pencils

Action: Choose and carry out activitiy/s with students:

- Write to the island authorities about the main environmental issues on your island.
- Draw a set of posters showing the environmental issues for display at school or around your island.
- Write a story or play about the changes on your island and how we can act to solve the problem.

A display might be made of the posters, and a concert held featuring stories and songs and the student's plays and stories.

References: Ministry of Health (2004) '*The Maldives Health Report 2004*' Ministry of Health, Republic of Maldives
MHAHE (2001) '*First national Communication of the Republic of Maldives to the United Nations Framework Convention on climate Change*' Ministry of Homes Affairs, Housing and Environment
MoEC (2004) '*State of the Environment Maldives*' Ministry of Environment and Construction


SCHOOL

30 minutes

GOOD ENVIRONMENTAL PRACTICES

OBJECTIVE: To highlight some island practices with less impact on the environment.

BACKGROUND FOR FACILITATOR

WATER

Water for human consumption can be collected from wells or rainwater. Drinking water needs to undergo a process of purification. The quality of drinking water can be controlled through a combination of protecting water sources and effective treatment/purification processes. This is especially important in the Maldives where the groundwater is contained in a shallow freshwater lens. Rainfall moves through the ground and recharges this freshwater lens. However, it takes a long time to recharge this water, so it is important to reduce the amount of water we use so that there is enough water for everyone. Also, we need to be careful that the water is not contaminated by seawater or by leaks from septic tanks. Once the freshwater lens is contaminated it can be very difficult to clean. Recently in the Maldives harvesting of rainwater has become common practice. This allows us to capture more rainwater and relieve some pressure on the groundwater system. Provided that the water collected is clean, rainwater harvesting can be a useful way to conserve this precious resource. Cleaning roofs and tanks regularly is part of harvesting clean rainwater.

NUTRITION

To maintain health and avoid disease a variety of foods needs to be eaten.
A variety of foods include vegetables, fruit, cereals, meat and fish. Healthy mothers are more likely to have healthy babies. To increase the chance of a healthy baby, breast feeding is recommended.

POLLUTION

Pollution problems can be reduced through protection of our natural resources and better waste management techniques. At the community level, separation of organic and non organic waste, composting, reducing, reusing and recycling waste can help. Air quality can be improved through regular maintenance of engines, by riding bicycles or using a sailing dhoni. The quality of resources: such as water, air and land affects our health and our livelihoods.

WASTE

Waste management has become one of the most important issues in the Maldives. Effective waste management requires communities to take ownership of waste issues, starting from the household level, by separating, reducing and reusing waste. Waste can be divided into 2 major groupings: organic and non-organic. Organic materials (such as food waste, palm leaves) can be reused through making compost. This helps to make a healthy garden either at home or school! Non-organics (such as plastic, metals) can be reused or reduced. For example, you can grow plants in old cooking oil containers or buy products in bulk instead of individual packaging or even use a cloth bag when you go shopping. At school you can help by not throwing waste on the ground, but instead putting it into litter bins. Hazardous waste should be stored separately away from water sources and transported off the island periodically. Each island should have an Island Waste Management Plan outlining how to deal with waste at the island level.

IMPORTANCE OF MANGROVES

Mangroves are known to have many uses in the Maldives, including timber for boat building, fencing, dyeing of fishing lines and the fruits of two mangrove species, *Sonerratia caseolaris* (Kulhlhavah) and *Brugueira cylindrica* (Kandoo), are edible (Kanvinde, 1999). In the Maldives mangroves are threatened and need to be protected; there is still so much to learn about these habitats. A nationwide survey of the country's mangrove resources is urgently required and efforts, such as planting mangroves, need to be considered to conserve these important habitats.

IMPORTANCE OF BEACH SYSTEMS

Beach erosion and beach build-up are natural processes, but often human action interferes with the natural processes and makes erosion more severe. A healthy beach is the best form of sea defence – it absorbs wave energy and it reforms naturally after a storm. Leaving the beach sufficient space to move naturally, to change its size and shape, is important in maintaining beach health. Ensuring new buildings are a 'safe' distance from the dynamic beach zone, helps conserve the beach and the buildings. Ensuring there is as wide a band of vegetation as possible between buildings and the sea is the best way, the cheapest way and the most long lasting way of coping with beach erosion.

IMPORTANCE OF CORAL SYSTEMS

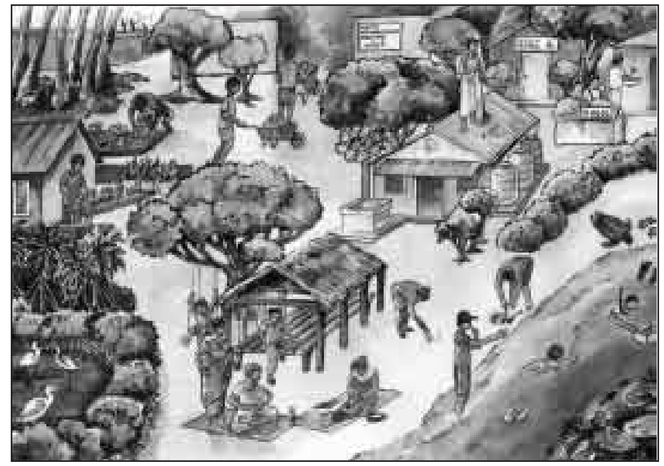
Biodiversity is defined as the range of living things in an ecosystem. In the Maldives coral reefs are very rich in biodiversity in terms of area and the number of living things (MoEC, 2004). This diversity is amongst the richest in the region and the coral reefs of the Maldives are significant on a global scale as well, being the 7th largest in the world, and contributing 5% of the worlds reef area (MoEC, 2004). For example, a total of 1090 fish species have been officially recorded to date (MoEC, 2004). In the Maldives, people are very dependent on the natural resources that biodiversity provides for their livelihoods, especially fishing and tourism. Coral reef systems also provide a sea-defence against the waves and currents of the oceans (MoEC, 2004). To maintain a healthy and beautiful reef, we can avoid walking on coral or using coral for construction as well as avoiding throwing non-organic wastes (such as metals and plastics) into the lagoon. From time to time we can also help clean up the reef around the island.

PROTECTED AREAS

Most scientists believe that the best way to prevent loss of wild species is to establish and maintain a network of protected areas. Protected areas are legally established sites, managed for conservation objectives and are an essential way of saving plant and animal species. The Maldives has 25 marine protected areas. In 2006 4 new protected areas were designated by the Ministry of Environment, Energy and Water (MEEW). These include Baa Atoll's Olhugiri (natural habitat of the protected sea bird, Great Frigate), GA. Hithaadhoo (natural habitat of the protected Lesser Frigate Bird), ADh. Hurasdhoo (unique geomorphological formation and a fragile environment) and K. Huraa (mangroves which are threatened). By learning and visiting these protected areas we can appreciate the importance of conserving this biodiversity for our families now and in the future.

GLOBAL WARMING

Global warming is an example of a global environmental issue. Only by acting together can the world address global warming. Although the Maldives is a small country and contributes very little to global greenhouse emissions (0.01%) it is very susceptible to the impacts of global warming (MHAHE, 2004). The Maldives has played a major role in raising awareness about this issue. In fact the Maldives was the first country to sign the Kyoto Protocol, which is an agreement that 169 of the world's countries signed showing their commitment to reducing the emission of greenhouse gases. By switching off our appliances (eg air conditioners, lights, stereos) when we are not in the room, or walking to work instead of catching a taxi, we can reduce how much energy we use and limit our emissions of greenhouse gases.



DISCUSSION POINTS

A. What do you feel when you see this picture?

B. Would you like to live in this environment? Why?

C. Can you identify some good practices?

D. What do you see here that is similar to your island?

E. Do you think islands were better or worse in the past? Why?

F. What good practices could you promote and introduce to your community?

10-20 minutes

ACTIVITY
MY ISLAND HOME

Materials: Pen and paper

Action: List important issues in your community related to this module. What have you learnt that you can implement on your island to make positive change? What action will your group take and who will be responsible for this? Write down answers on a piece of paper.

References: Hemal S. Kanvinde (1999) '*Maldivian Gender Roles In Bio-resource Management*' FAO, Bangkok
MoEC (2004) '*State of the Environment Maldives*' Ministry of Environment and Construction, http://www.environment.gov.mv/protected_areas.php


WASTE
MANAGEMENT
CENTRE
HEALTH
CENTRE
SCHOOL

30 minutes

TRADITIONAL KNOWLEDGE THEORY

Traditional knowledge is the local knowledge that is unique to a culture or society. Other names used are: 'local knowledge. 'folk knowledge', 'people's knowledge', 'traditional wisdom' or 'traditional science'. Traditional knowledge is possessed by Indigenous peoples around the world, as well as other peoples who have maintained a very close relationship to the natural environment for a very long time, such as in the Maldives. For these people traditional knowledge remains important in many aspects of day to day life, such as fishing, agriculture, food preparation, health care, navigation on land and sea and interpretation of meteorology and climate (ICSU, 2002). Although the word 'traditional' is used, this knowledge is far from being static. Traditional knowledge has continually evolved as each successive generation of people has met challenges, with each generation adding to the stock of knowledge.

Traditional knowledge can be distinguished from science by a number of characteristics.

At a workshop held in Inuvik, Canada, in November 1995, a group of Inuit people agreed on a list of six characteristics for traditional knowledge:

- Our knowledge is practical common sense, based on teachings and experience passed on from generation to generation.
- Our knowledge is 'knowing the country'; it covers knowledge of the environment and the relationship between things.
- Our knowledge is holistic – it cannot be compartmentalised and cannot be separated from the people who hold it. It is rooted in the spiritual health, culture and language of the people. It is a way of life.
- Our knowledge is an authority system. It sets out the rules governing the use of resources – respect; an obligation to share. It is dynamic, cumulative and stable. It is truth.
- Our knowledge is a way of life – wisdom is using knowledge in good ways. It is using the heart and the head together. It comes from the spirit in order to survive.
- Our knowledge gives credibility to people.

Source: Adapted from Alan, R. Emery and Associates (1997) Guidelines for Environmental Assessments and Traditional Knowledge. A Report from the Centre for Traditional Knowledge of the World Council of Indigenous People (draft), Ottawa, p. 3.

LOSS OF TRADITIONAL KNOWLEDGE

Traditional knowledge is in danger of being lost around the world. Although universal formal education systems are important for human development, such universal systems may also limit the use and spread of traditional knowledge and languages by introducing 'modern' knowledge and academic ways of learning. Furthermore, as science and technologies have been adopted, traditional knowledge has often been overlooked or neglected as a resource, often discriminated against as 'old wives tales'. Finally the knowledge is being lost as elders, who preserve such knowledge, are dying and the facilities to document and protect such knowledge are lacking. Today, there is a serious risk that much traditional knowledge is being lost and, along with it, valuable knowledge about ways of living sustainably on the earth.

TRADITIONAL KNOWLEDGE IN THE MALDIVES

People have lived in the Maldives for many centuries. In order to survive, Maldivian people have had to maintain very close links with the environment, especially the marine environment. From this close connection with the environment, a great deal of traditional knowledge has been acquired.

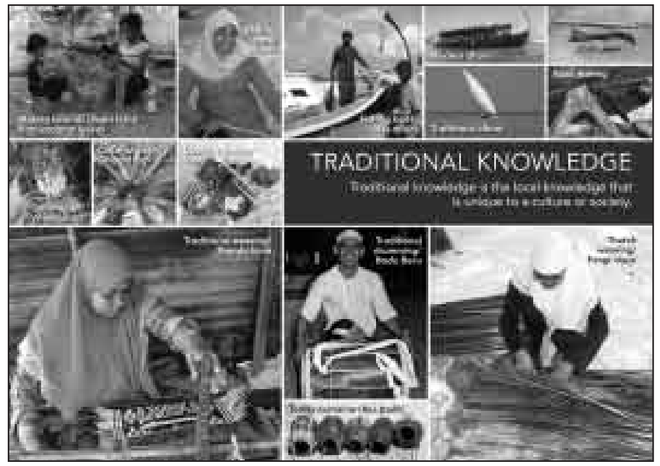
For example:

- Maldivians use local resources effectively. Maldivian boat makers have extensive traditional knowledge about how to make dhoni's from coconut wood. The traditional dhoni is one of the oldest known sea transporting vessels in the Maldives. However as more and more boats are made of fiberglass, traditional dhoni building is declining.
- Also Maldivian people can use the coconut tree in many ways, not just for food or coconut milk. Women can make coir rope (roanu) from coconut husks, thatch leaves together to make roof materials (fangi) or baskets (vashi) or make brooms (iloshi fathi) from the mid-rib of the palm leaves. Palm toddy (raa), a sweet drink, can be made from fermented coconut sap and coconut oil (theyo) can be made from heating up dried coconut and squeezing the oil out, for use on the hair and body. The charcoals from the coconut shell (naashi) can be used to bake cakes or barbeque fish, or put inside an iron because the charcoals keep the heat for a long time. The fibre from the coconut palm (ilaa) can also be used as a strainer and the coconut shell can be made into a toddy container (raa badhi).
- Maldivian fisherman identify and follow local birds to locate schools of fish.
- Maldivian fisherman use a pole and line technique which is more sustainable, compared to other fishing techniques (e.g. trawling which damages reefs).
- Early Maldivians studied the weather and climate carefully and based on these observations developed a Nakaiy calendar for the Maldives. The calendar predicts how minor climatic changes such as the Monsoons (Hulhan'gu and Iruvai) affect fishing and the weather (Jauhary and Chamberlain, 1998).
- There is also considerable knowledge in the area of traditional medicine. Though traditional forms of medicine have not been completely documented, some 122 species of plants with medicinal properties have been recorded in the Maldives (Kanvinde, 1999). Also the Glory lily plant (Vihalagondi) shown on this Flip Chart page be used as traditional medicine. The juice of the leaves can be used to kill head lice (ERC, 2006). With the increasing popularity of western medicine, together with loss of habitat and a lack of texts about local biodiversity, this Traditional knowledge is being lost.
- Traditional knowledge also exists regarding agriculture. Local men and women on Kelaa Island are knowledgeable about and able to identify different crop varieties (Kanvinde, 1999). Maldivian farmers also use traditional pest control practices (Hunter, 1996). For example, to prevent rats gaining access to coconuts, a split palm leaf can be placed around the trunk of the tree to stop the rats climbing up the tree (Hunter, 1996). In recent years this traditional knowledge has been ignored as scientific technologies (such as pesticides) have been introduced.

TRADITIONAL KNOWLEDGE AND SUSTAINABLE DEVELOPMENT

To live on Earth without compromising the ability of future generations to also live here, we must achieve sustainable development. Science and technology has contributed to great improvements in human development. However, science does not have all the answers. The value of traditional knowledge for sustainable development must also be recognized. By acknowledging and valuing traditional knowledge along with science, there will be a broader knowledge base to pursue sustainable development. There is an urgent need to stop the loss of traditional knowledge and develop support programs to record, protect and conserve this knowledge.

References: ERC (2006) '*Our Medicinal Plants*' Environment Research Center, Ministry of Environment, Energy and Water
Hemal S. Kanvinde (1999) '*Maldivian Gender Roles In Bio-resource Management*' FAO, Bangkok
International Council for Science (2002) ICSU Series on Science for Sustainable Development No. 4: '*Science, Traditional Knowledge and Sustainable Development*'.
A Riyaz Jauhary, A I Chamberlain (1998) '*Understanding Fisheries Science 1*' Educational Development Center, Ministry of Education, Republic of Maldives
Hunter, D (1996) '*Traditional pest control and agricultural development in the atolls of the Maldives*' Indigenous Knowledge and Development Monitor, 4(3). Online: http://www.nufficcs.nl/ciran/ikdm/.



DISCUSSION POINTS

A. What are the similarities between traditional and modern life in the Maldives?

B. What is traditional knowledge?

C. Why is traditional knowledge important?

D. How is the traditional knowledge of the Maldives being used today?

30 minutes

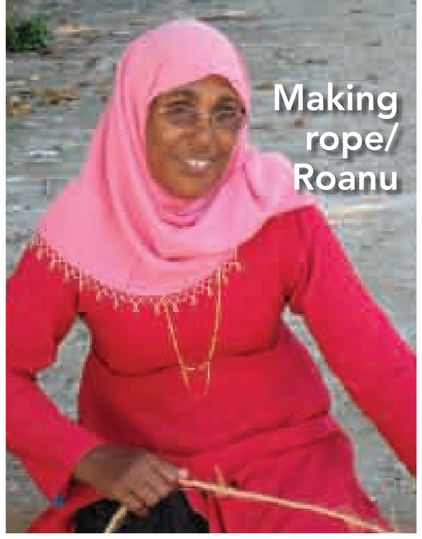
ACTIVITY 1
TRADITIONAL AND MODERN LIFE

Material: Pen and paper

Action: Ask students to share with a friend what they know of the following aspects of traditional and modern life in the Maldives:

- Where their ancestors came from and how they arrived here
- Similarities between how they live now and traditional ways of living
- Differences between how they live now and traditional ways of living
- Reasons for changes from traditional to modern ways of living

Ask students to report to the whole class and make a summary.



TRADITIONAL KNOWLEDGE

Traditional knowledge is the local knowledge that is unique to a culture or society.

40 minutes

ECOLOGICAL FOOTPRINT THEORY

Human beings have had a great impact on the natural world – their footprints can be seen just about everywhere on the planet. Everywhere we go, and in everything we do, we leave an impression, an effect, like footprints on the beach. Each time we take a breath, a meal, wash, go to school, play a game, comb our hair, buy a new T-shirt – everything we do changes our physical world just a tiny little bit. If you could add together all the tiny changes, or footprints, we create every day, we would understand our own, individual ecological footprint.

If we could then add together all the other footprints for the other people living in the world, we would find that humanity's Ecological Footprint is over 23% larger than what the planet can support. In other words:

We now need 1.23 Planet Earth's' to support the lifestyle of the human race.

It now takes more than one year and two months for the Earth to regenerate what we use in a single year.

This is the same as spending 23% more money than you have.

Although populations and economies continue to grow each year, planet Earth remains the same size (WWF, 2005). Therefore we are living beyond our ecological means on Earth. Unless we make changes to the way we live, we will continue to use the natural resources on Earth and our ecological footprint will get bigger and bigger.

ECOLOGICAL FOOTPRINTS BY COUNTRY

The footprint of a country is the total area required to produce the food, fibre and timber that it consumes, absorb its waste and provide space for its infrastructure. In general, Ecological Footprints decrease with a smaller population size, lower consumption per person, and higher resource efficiency. Once the footprint is calculated it is compared against biological capacity- the ability of nature to produce these resources that we depend on (WWF, 2005).

Country	Ecological Footprint (global hectares per person)
Bangladesh	0.5
India	0.8
Sri Lanka	1.1
Malaysia	3.0
Japan	4.3
France	5.8
Australia	7.7
USA	9.5

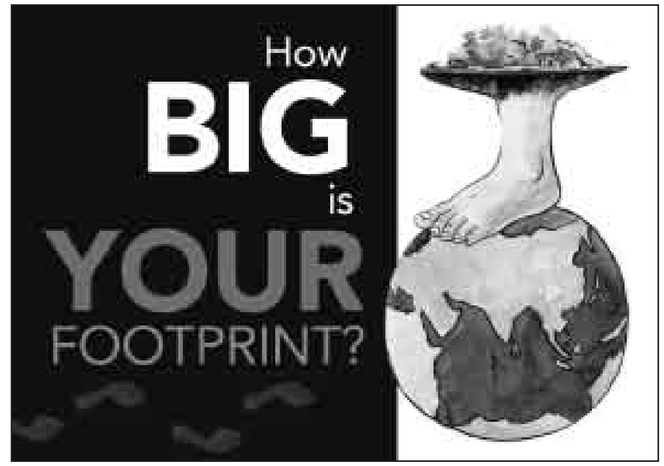
The Maldives is located within the Indian Pacific region, one of the most populous on the planet. In fact the Asia Pacific region includes 55% of the world's population. In 2005 the footprint of this region was 1.7 times as large as its own biological capacity. This means that, at its current rate of consumption, the region needs more than one and a half times its own land and sea space to support its resource demands (WWF, 2005). The ecological footprint of the Maldives has not been calculated, however Table 1 shows the respective footprints for some other countries.

As can be seen from the table the average footprint of an Asian resident is still far smaller than the average footprint of people living in Europe, North America, Australia or Japan. People living in these countries have very high ecological footprints and will need to make major changes in order to live sustainably on Earth. Countries in Asia Pacific also need to manage ecological resources effectively. We all need to be aware of our ecological footprint and reduce it where possible. If we do not act promptly to reduce our ecological footprint, 'critical ecosystems' will be eroded beyond the point at which they can easily recover (WWF, 2005) and as time moves on we will become more and more dependent on fewer and fewer ecological resources.

SUSTAINABLE LIVING

We cannot move to another planet once Earth is exhausted, so we must learn to live more gently now. We can all make changes to how we live in order to live more sustainably on Earth. Some suggestions from WWF (2005) include:

1. **Biocapacity**. We need to increase or at least maintain our ecological resources. This means protecting soil from erosion and degradation, protecting wetlands and mangroves, protecting the quality of groundwater, and maintaining healthy fisheries. It includes taking action to protect ecosystems from climate change and eliminating the use of toxic chemicals that degrade ecosystems. In the Maldives we can protect our environment by disposing of waste carefully (e.g. not disposing of oil/chemicals in the ocean), by reducing the amount of plastic bags we bring home and turning off the fan or air conditioner when you are no longer in the room.
2. **Resource efficiency in producing goods and services.** Nowadays technology allows us to produce goods and services very efficiently from a given amount of ecological resources. As a result, the average Ecological Footprint per person has stayed relatively constant. In the Maldives we can buy "Eco-friendly" products that have been produced in a more environmentally friendly way (e.g. recycled paper, phosphate free detergents).
3. **Consumption of goods and services per person.** The potential for reducing per person consumption depends in part on the person's income level. People living at or below subsistence may need to increase their absolute consumption levels to move out of poverty. Wealthy individuals could cut their consumption levels of goods and services, thus reducing their footprints, without seriously compromising the quality of their lives. In the Maldives people have become more affluent in recent times. When we go to the shop we can buy a tin of biscuits in bulk, rather than in small individual plastic packets. Or instead of upgrading to a new mobile phone each year, we can buy one phone that is used for many years. By doing either of these things we can reduce how much we consume each year.
4. **Size of the population.** Addressing population growth will be especially critical for the Asia-Pacific region, which is already home to half the world's people. Population growth can be reduced by supporting measures that lead to families choosing to have fewer children. Offering women better education, economic opportunities and health care are three proven approaches. In the Maldives the size of the population is quite small, however as the islands in the Maldives are quite small and fragile, population densities on an island level need to be considered. People living in Male' have a larger ecological footprint than people who live in the other atolls.



DISCUSSION POINTS

A. Who has an Ecological Footprint and why is it important?

B. What is your Ecological Footprint?

C. What is the effect of this footprint?

D. How can you reduce your Ecological Footprint?

20 minutes

ACTIVITY
OUR NEEDS & DEMANDS

Materials: Pen and paper

Action: Divide students into seven groups (as below) and ask each group to name ten things they use in the category that comes from the Earth:

Food Water Energy Transport
Clothes Shelter Entertainment

Ask students to write their lists on the chalkboard for discussion.

Theory: Everything that we use comes from the Earth. Many of the resources we use are non-renewable, which means that we cannot make them again. For example, the fuel used in Dhoni's and cars is non-renewable energy that formed over thousands of years under the ground. We also use renewable resources, which we can renew or make again. These include wood or food that we can grow ourselves. In the Maldives many products are not made locally, but are imported from other countries. We use the ecological resources of other countries to meet our needs (e.g. clothes, motorbikes).

References: WWF (2005), "*Asia- Pacific 2005 The ecological footprint and natural wealth*"
WWF- World Wide Fund for Nature www.footprintnetwork.org

How BIG is YOUR FOOTPRINT?

20 minutes

MANGROVES: AN ECOSYSTEM

Wetlands are among the most important life support systems on Earth. Yet they are some of the most threatened natural environments. Mangroves, swamps, tidal mudflats, estuaries, rivers and streams are all wetlands, whether freshwater or saline. Wetlands can be permanent but many, especially in the tropics expand and contract with the seasons.

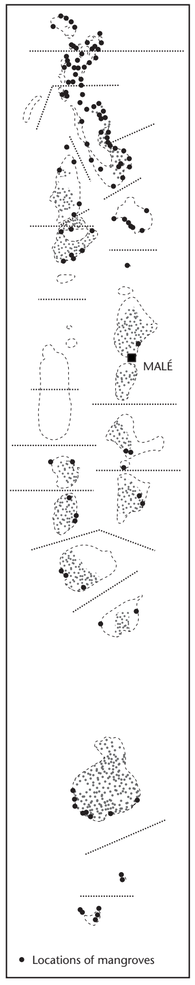
Five types of wetlands exist in the Maldives: mangroves, marsh lands, sea grass beds, inland water bodies, and coral reefs. In this Flip Chart we will look at two types of wetlands found in the Maldives: mangroves and coral reefs.

WHY ARE WETLANDS IMPORTANT?

Wetlands enable marine, aquatic, and land animals to meet and interact. They are places where:

- sediments are collected and soils and landforms are built.
- wetlands moderate water quality and quantity. Acting as vast spongy filters, wetlands take up run-off, extracting sediments, recycling nutrients, oxygenating the water, and releasing these gradually back into the system.

Wetlands support an enormous variety of plants, invertebrates, fish, amphibians, reptiles, birds and mammals. Many species can survive nowhere else.
Many unique, rare and endangered species are found only in wetlands. Many migratory birds depend on wetlands; which means the well being of wetlands has implications for animals in other countries. Wetlands are important sources of fish, crustaceans, shellfish and other food for people.



• Locations of mangroves

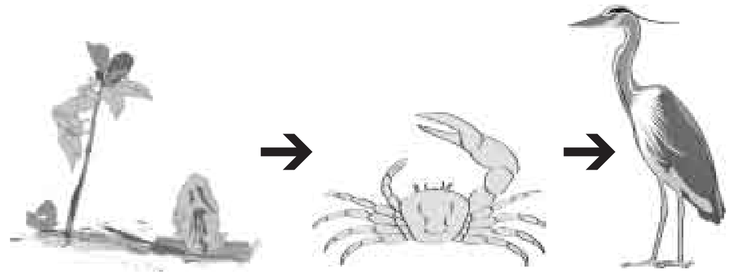
Courtesy of Environment Research Center

MANGROVES

The term mangrove may be used to refer to both an individual mangrove plant and to the habitat or ecosystem, in which it lives (Lovelock, 1993). On this Flip Chart page there is an illustration of a mangrove ecosystem- which is a 'community of plants, animals and micro-organisms that are linked and that interact with each other and with the physical environment. The mangroves together with the mudflats and adjoining seagrass areas form the coastal wetland system. Within this system there are numerous plants and animals whose survival depends on the continuous interaction of the different food chains. In areas where mangrove roots are permanently submerged under water, they may host a wide variety of organisms, including algae, barnacles, oysters, which all require a surface for anchoring while they filter feed. Mangrove crabs also play an important role in the ecosystem by eating the decaying leaves. A simplified diagram of a food chain to be found in the mangrove area is illustrated here.

A close examination of a basic food web within the mangrove system reveals the input of dissolved organic materials from marine and terrestrial sources. There is also an input from the plants and animals within the mangrove itself. This is in the form of excrement and decaying organic matter which mixes with the sediments (known as detritus).

Interruption of the cyclic pattern of the food web by depletion or removal of any of the components will have negative effects on the whole of the mangrove ecosystem.



Decaying leaves → crabs → heron

In the Maldives mangroves form in the low areas of the island where sediment can settle and mangrove trees can grow. Mangroves grow in thick brown 'mud' which is a mixture of silt and clay, which are rich in organic matter (detritus). Animals like crabs like to burrow into the mud. Soils below the surface are usually full of water (waterlogged), do not have much oxygen and contain a lot of organic matter breaking down at a very slow rate. Since there is no oxygen only certain types of bacteria can live in the mud. These bacteria breakdown the organic matter and produces hydrogen sulphide gas which turns things black and smells of rotten eggs!

20 minutes

ACTIVITY
FOOD WEB CHASEY: LIFE IN THE MANGROVE

Materials: Cards with characters to be hung around the necks of students

Herons	Large fish - Tilapia,mullets	Snails
Crabs	Shrimps	Small fish
Mosquitoes	Lizards	Spiders

Action: Allow the children time to become familiar with their character. How does it move? What sound does it make? What does it eat? What might it eat? The students might make signs, drawings, masks or costumes and practise how the mangrove animal moves.

In playing the game select a large open area. Each student finds their own special spot to rest. When you call 'go' all the mangrove creatures leave their safe places and try to catch someone they can prey on. If one of the creatures are caught they link arms with their catcher, and together they try to catch another creature. The creatures can return to their safe place anytime.

Students record the mangrove characters and recreate the food web on paper.

Theory: The mangrove ecosystem is made up of many plants and animals that are interdependent on one another. This is an activity to help children become familiar with each mangrove creature and their place in the mangrove food web. This activity helps to bring the food web of the mangroves to life.

DISCUSSION POINTS

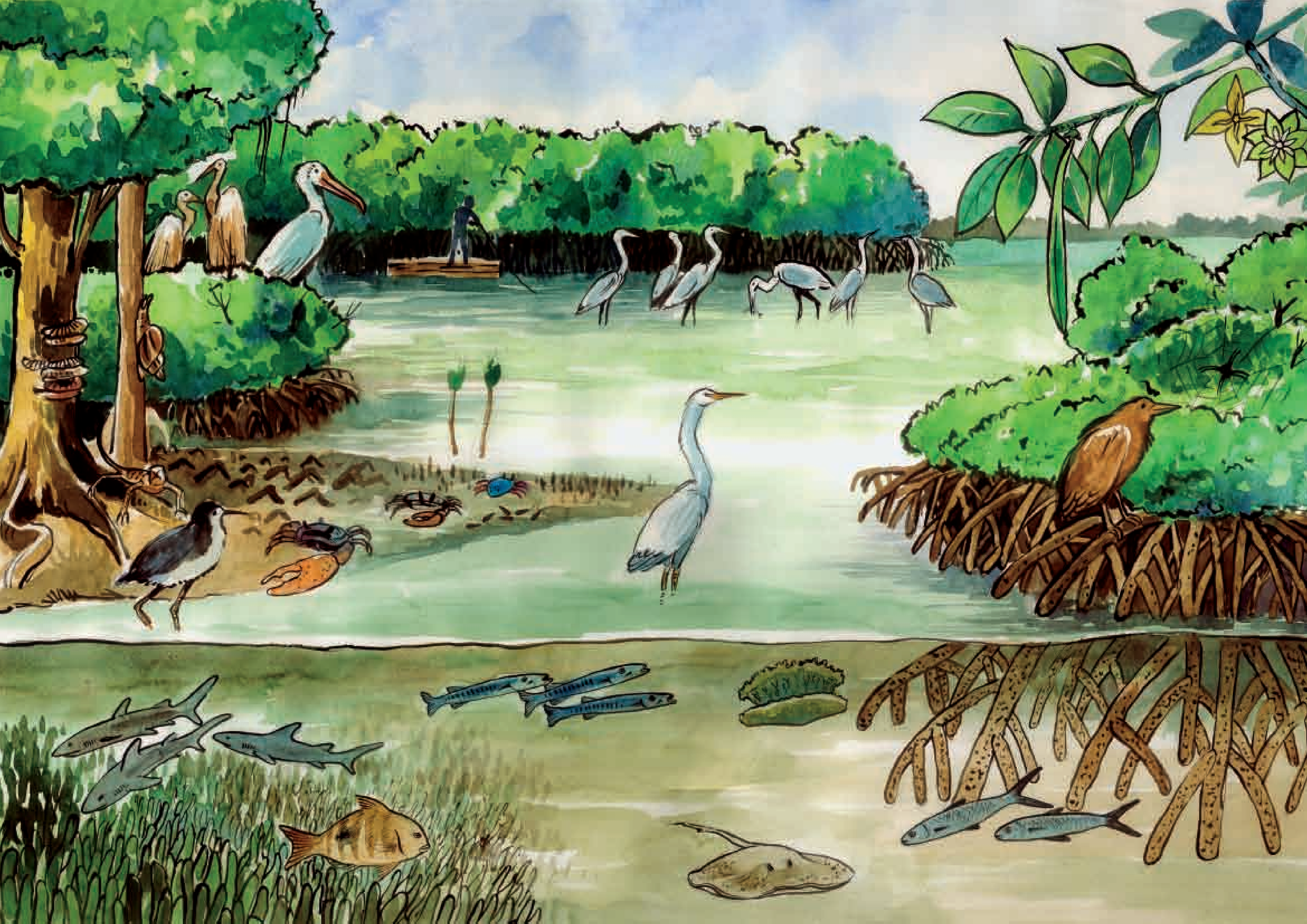
A. What is a wetland?

B. How many types of wetlands are present in the Maldives?

C. What types of plants and animals can you see in the mangroves?

D. What types of animals are at the top of the food web?

Reference: Lovelock, C (1993) *Field Guide to the mangroves of Queensland,* http://www.aims.gov.au/pages/reflib/fg-mangroves/pages/fgm-qld-index.html



30 minutes

MANGROVE IDENTIFICATION

HOW DID MANGROVES COME TO THE MALDIVES?

'Scientists believe that the earliest mangrove species came from the Indo-Malayan region, where there are far more mangrove species than anywhere else in the world'. Because mangrove seeds can float, it is believed that the seeds floated to the Maldives from countries such as India many millions of years ago (Mangrove Action Project, 2007).

MANGROVE SPECIES

There are approximately 70 species of mangroves in the world. Approximately 40 species occur in South East Asia (Field, 1995). Mangroves are mainly restricted to the tropics, but some are found in sub-tropical areas, such as Japan and New Zealand (Field, 1995). There are approximately 10 species of mangroves found in the Maldives. These are listed below:

SCIENTIFIC NAME	LOCAL NAME
Rhizophora mucronata	Ran'doo
Ceriops tagal	Karamana
Lumnitzera racemosa	Burevi
Rhizophora apiculata	Thakafathi
Avicennia marina	Baru
Bruguiera cylindrica	Kandoo
Bruguiera gymnorrhiza	Bodavaki
Excoecaria agallocha	Thela
Heritiera littoralis	Kaharuvah
Sonneratia caseolaris	Kulhlhavah

FEATURES OF MANGROVES

Mangrove trees are amazing, as they are among the few trees that can grow in salty water as well as in a mixture of seawater and fresh water. However, mangrove trees and shrubs come in many different shapes and forms. The following table outlines some of the features of 4 types of mangroves, including *Rhizophora, Ceriops*, *Lumnitzera* and *Bruguiera*.

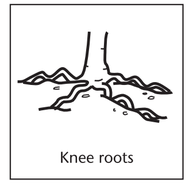
Features	*Rhizophora* species	*Ceriops* species	*Lumnitzera* species	*Bruguiera* species
Height	Grows to 20 m tall.	Grows to 5 m tall.	Grows to 6 m.	Grows to 25 m tall.
Bark	Rough, brown to dark grey bark.	Cream coloured bark with dark brown spots.	Grey and fissured bark.	Dark and rough bark.
Leaves	Tips of the leaves are blunt.	Rounded leaf point, light green in color.	Small (about 7 cm long) light green, fleshy leaves with an indentation at the end.	Large (10-20 cm) leaves which occur in clumps at the end of branches.
Flowers	Small, white flowers.	Flowers are very small (<1 cm, usually 0.5 cm). Propagules are slender and long,	Small five petaled white flowers	The flowers can be red or white and remain attached to the propagule when it falls.
Seeds	1-2 cm in diameter, 20-40 cm long and tapered at one end.	Long thin brown seed.	Fruits are about 2 cm long, green and capsule-shaped.	Green and cigar-shaped, between 10 and 20 cm long.
Roots	Prop roots, mostly above the ground.	Buttress and knee roots.	Small knee type above-ground roots.	Buttresses at the base of the trunk and knee roots.
Where it is found	Occurs low in the intertidal zone, where its roots are submerged during high tides.	Often occurring as short, stunted trees, they may grow to 5 m high in areas having some freshwater influence.	Landward edge of the mangroves.	Often occurs in areas that have some freshwater input.

References: Field, C.D. (1995) '*Journey Amongst Mangroves*'. International Society of Mangrove Ecosystems, Okinawa, Japan, 140 pp.
http://www.mangroveactionproject.org/

MANGROVE ROOTS

The *Rhizophora* has 'prop roots'. These roots can sprout from very high in the tree. The older the tree the higher the roots are located. The *Ceriops* has 'knee roots'. These roots come in and out of the soil.


Prop roots


Knee roots

The roots:

- Anchor the plant
- Absorb minerals
- Exchange gases (oxygen and carbon dioxide)

Roots can only absorb water from the surroundings and excludes most of the salt. The extensive root system slows down the wave action and water flowing through them. This reduces erosion by holding the earth together so it does not wash away from the land into the lagoon and reef, killing the coral. As a result, mangrove shores continue to grow towards the sea.

MANGROVE LEAVES

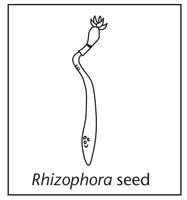
Mangroves have a medium-sized, thick waxy leaf that helps prevent excessive water loss. Like other plants, the green leaves of the mangrove use the light of the sun to make food; this process is called photosynthesis. When dead leaves fall into the water, they decay providing nutrients for the soil and food for animals like crabs, prawns and some fish. The *Rhizophora* leaves have blunt tips while *Bruguiera* have pointed tips.

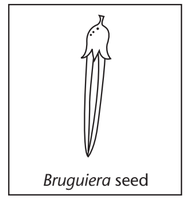

Rhizophora leaves


Bruguiera leaves

MANGROVE SEEDS

Mangroves usually grow in flat, soft muddy ground. When the long, thin and pointed mangrove seeds fall vertically to the ground, they are able to stick upright in the soft mud.


Rhizophora seed


Bruguiera seed

Some mangrove trees have seeds that start to grow while they are still on the tree. When the young plant is big enough to survive it falls into the water or mud. Those young plants float around until they find a muddy area to grow. The seeds can float which help them disperse and grow in new areas.

Mangrove trees are constantly exposed to strong wind and waves. The new plants, when established in the soil, are able to withstand wave action.

The *Rhizophora* seed curves at the top, while the *Bruguiera* seed is straight.

MANGROVE FLOWERS

The flower of the *Rhizophora* is small and yellow, while the *Bruguiera* flower is bigger and can be white or pink.


Rhizophora flower


Bruguiera bud

DISCUSSION POINTS

A. How many species of mangroves can be found in the Maldives?

B. Describe some of the features of mangroves?

C. What does the root system of mangroves do?

20 minutes

ACTIVITY
WHAT DO WE KNOW ABOUT MANGROVES?

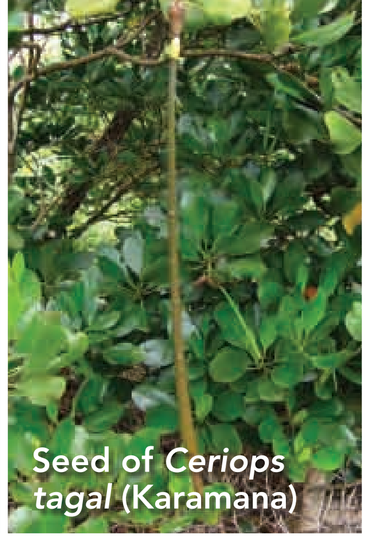
Materials: Paper and pencils

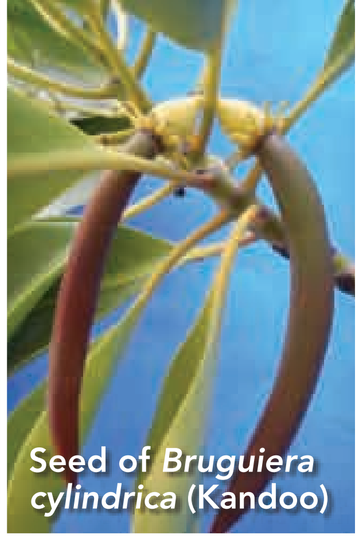
Action: Students are divided into four groups. Each focus question below is looked at by a group. The group may respond through words or pictures or both.

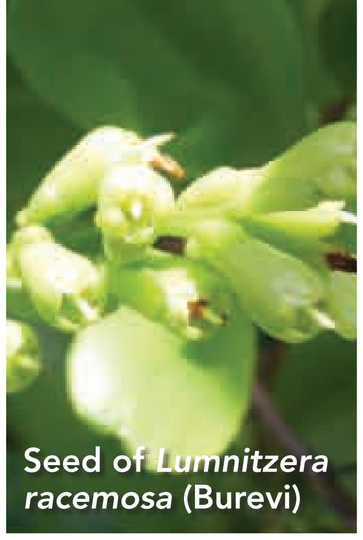
- What kinds of animals and plants live in mangroves?
- What do humans use mangroves for?
- What are the things that can harm mangroves?
- What are the features of mangroves?

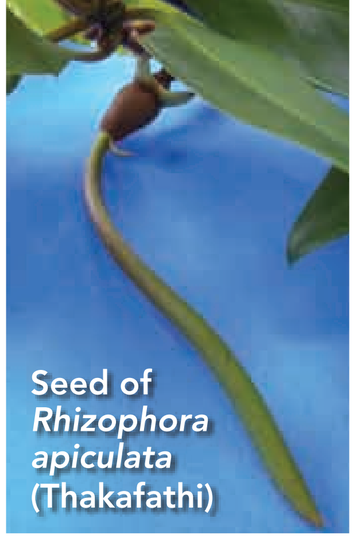
Display the four lists and share. Underline in another colour things they are not sure about?

Theory: This is an activity to help establish what students already know about mangroves.


Seed of *Ceriops tagal* (Karamana)


Seed of *Bruguiera cylindrica* (Kandoo)


Seed of *Lumnitzera racemosa* (Burevi)


Seed of *Rhizophora apiculata* (Thakafathi)


Seed of *Rhizophora mucronata* (Randoo)

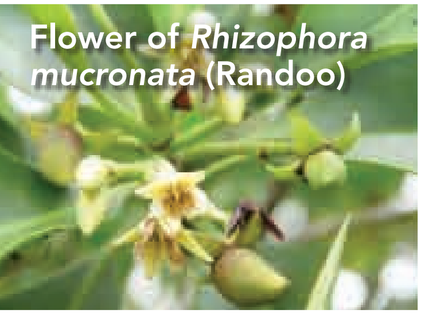

Seed of *Bruguiera gymnorhiza* (Bodavaki)


Seed of *Sonneratia caseolaris* (Kulhlhavah)


Seedlings of *Rhizophora apiculata* (Thakafathi)

MANGROVE IDENTIFICATION

Mangroves have a medium-sized, thick waxy leaf that helps prevent excessive water loss.


Flower of *Rhizophora mucronata* (Randoo)


Flower of *Bruguiera cylindrica* (Kandoo)


Flower of *Bruguiera gymnorhiza* (Bodavaki)


Knee roots of *Bruguiera cylindrica* (Kandoo)

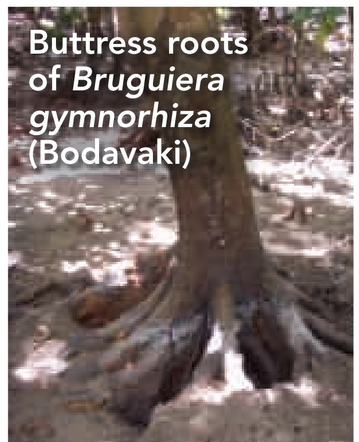

'Aerial roots'


Flower of *Sonneratia caseolaris* (Kulhlhavah)


Flower of *Lumnitzera racemosa* (Burevi)


Aerial roots of *Rhizophora mucronata* (Randoo)


Peg type roots of *Sonneratia caseolaris* (Kulhlhavah)


Buttress roots of *Bruguiera gymnorhiza* (Bodavaki)


Prop roots of *Rhizophora apiculata* (Thakafathi)


Flower of *Rhizophora apiculata* (Thakafathi)


Flower of *Ceriops tagal* (Karamana)

15 minutes

LIFE IN THE MANGROVES

Mangroves are the only ecosystems in the Maldives which are wide and large enough to carry an abundance of animals and mangrove plants, thus making it one of the richest biodiversity spots (ERC, 2007). Within this system there are numerous plants and animals whose survival depends on the continuous interaction of the different food chains. Apart from mangrove trees there are many other life forms found in the mangroves. These include:

Scientific names	Local names	Common names
TREES		
Cocos nucifera	Ruh	Coconut tree
Hibiscus tilaceous	Dhigga	Beach hibiscus
Pemphis acidula	Kuredhi	Ironwood
Cordia subcordata	Kaani	Sea Trumpet
Mangrove animals		
FISH		
Sphyraena	Farutholhi	Barracuda
Dasyatidae	Narunagoo madi	Stingray
Mugilidae	Mekunu	Mullet
Tilapia	Futumas	Parrotfish
Chanos chanos	Beyn'gu	Milkfish
Triaenodon obesus	Olhufathi miyaru	White tip Reef shark
CRUSTACEANS		
Brachyura	Kakuni	Crabs
Palinura		Lobsters
Dendrobranchiata		Prawns
Coenobita species	Baraveli	Land Hermit Crab
BIRDS		
Amaurornis phoenicurus	Kan'bili	Maldivian water hen
Anas querquedula	Reyru	Garganey
Ardea cinerea (rectirostris)	Maakana	Eastern grey heron
Ardeola grayii (phillipsi)	Huvadhoo Raabon'dhi	Maldivian pond heron
Arenaria melanocephala	Rathafai	Black turnstone
Bubulcus ibis (coromandus)	Iruvaahudhu	Cattle egret
Butorides striatus albidulusi	Dhivehi Raabon'dhi	Little Heron
Egretta garzetta	Kuda iagana	Little egret
Tringa hypoleucos	Fidhana	Common sandpiper
Numenius phaepus	Bulhithun'bi	Whimbrel
Phoenicopterus ruber	Gudi gudaa dhooni	Flamingo
REPTILES		
Hemidactylus brookii	Hoanu	Gecko
Calotes versicolor	Bondu	Lizard
Lycodon aulicus	Harufa	Snake
MAMMALS		
Pteropus giganteus	Vaa	Flying fox
INSECTS		
Anisoptera	Dhon dhooni	Dragonfly
Lepidoptera	Koka	Butterfly
Culicidae	Madiri	Mosquito

reference: www.erc.gov.mv

20 minutes

ACTIVITY
FIELD TRIP

Materials:

Student requirements:

- Long pants
- Socks and shoes
- Hat and sunscreen
- Notebook and pencil
- Insect repellant

Field equipment:

- Identification guides
- First aid kit
- Binoculars
- Invertebrate collection – 1metre square of calico, plastic vials, hand lenses, large forceps, catching nets.

Plant and animal observations:

Take time to quietly observe the plant and animal life present. Students record their sightings on *Plant and Animal Identification Charts*.

- Plants
- Invertebrates
- Mammals
- Birds
- Reptiles and
- Amphibians.

Refer to Module 3: Life Around Us (Section 1)

Theory: Wetlands are often considered as dirty, useless and mosquito ridden places. However, the wetlands are important spots of biodiversity. This activity helps to provide students with the opportunity to observe, record, identify, classify and investigate life in the wetlands. By raising awareness about the rich biodiversity in the wetlands, students can start to consider ways to protect this important place.

DISCUSSION POINTS

A. Why do wetlands have so much biodiversity?

B. What are some of the animals that live in the wetlands?

C. Have you seen any of these animals on your island? Which ones?

D. Have you or your family seen any changes in the animals that are present in the wetlands?

Whimbrel/Bulhithun'bi

Maldivian Little Heron/ Dhivehi Raabon'dhi

Grey Heron/ Maakana

Cattle Egret/ Iruvaahudhu

House Crow/ Kaalhu

Garganey/Reyru

LIFE IN THE MANGROVES

Mangroves are the only ecosystems in the Maldives which are wide and large enough to carry an abundance of animals and mangrove plants, thus making it one of the richest biodiversity spots.

Agamid lizard/Bon'du

Bream/Lahfilolhu

Tilapia/Futumas

Crab/Kakuni

Hermit crabs

Mushrooms/ Handi kuda

Yellow paper wasp

Flying Fox/Vaa

Upside down jellyfish/ Firuaunu mudhaa

Sea grass/Moodhu vina

Fungi/Fungus

Snail

Dragonfly/Dhon dhooni

Nerites/Golhaa

Crab/ Kakuni

15 minutes

BENEFITS OF MANGROVES

Mangrove areas are important because:

- Mangrove areas are good for breeding, feeding and nursery grounds for many fish and other animals like crabs, shrimps and shellfish.
- Mangrove root systems anchor soil and prevent erosion in the coastal zones.
- Mangroves act as wave breakers and thus protect the coasts and the communities from strong wind and high waves, even tsunamis.
- Mangrove tree root systems trap and reduce the amount of sediment entering the lagoon and smothering the coral (silt sedimentation).
- They provide good sources of food and income for communities.
- They provide recreation areas where children play or people might fish.

HABITAT FOR ANIMALS

Mangroves are an important habitat for many plants and animals. However 'few animals use mangroves as their only habitat. Some live mainly in the mangroves, while others move in and out of the mangroves seasonally, at different stages of their life cycle or even depending on the tide' (Lovelock, 1993).

Mangrove areas are good for breeding, feeding and nursery grounds for many fish and other animals like crabs, shrimps, insects and shellfish. Many fish from the ocean (such as barracudas, bream etc) come into the mangroves to breed and raise young fish before they go back out into the ocean. Mangroves also have a lot of organic matter for fish to eat. Mangroves have murky muddy water and root systems in the water that give young fish a place to hide, making it difficult for predators, like birds and big fish, to catch young animals. These nurseries for fish and other marine life are very important to the Maldives commercial fisheries.

Also many other animals live in the mangroves, such as crabs (kakuni). Crabs have been shown to be very important animals in the mangroves (keystone species). Some crabs are leaf eaters, while others eat algae or organic matter in the soil (Lovelock, 1993). Crabs scoop up chunks of sediment into their mouth, where its contents are sifted through. After anything edible is eaten, be it algae, or other decaying organic matter, the remaining sediment is replaced in the form of a little ball. One of the most conspicuous species is the Fiddler Crab which has an enlarged orange claw. Scientists have found that when crabs are removed the mud is not as aerated and this affects the health of the mangroves. Molluscs, like like nerites (golhaa), are often visible on the muddy soil around the base of mangrove trees (Lovelock, 1993).

Many species of birds, such as Grey Herons (Maakana) and Maldivian Pond Herons (Huvadhoo Raabondi), can also be seen in the mangroves, usually with their head in the water eating fish. Birds may also be seen nesting in tall mangrove trees or walking between the roots of trees looking for small crabs and shellfish. Mangroves are also important for migratory birds that visit the Maldives from time to time, as well as for mammals such as flying foxes (fruit bats) that can be seen roosting during the day (Lovelock, 1993).

RELATIONSHIP BETWEEN MANGROVES, SEA GRASS AND CORAL REEFS

In the Maldives, most of the mangroves grow in areas protected by a coral reef. The mangroves and the coral reefs have a special relationship. The coral reef breaks and reduces the force of the waves providing the mangroves with calm waters, while the mangrove roots act as a sieve filtering water and dirt, which can harm the coral reefs.

Mangroves act as wave breakers and in this way protect the coasts and the communities from strong wind and high waves, even tsunamis. Mangroves can also help to reduce flooding during heavy rainfall. Mangrove root systems anchor soil and slow down currents, so that rainwater flowing into mangroves will be slowed down, trapping sediments and nutrients (Lovelock, 1993)

This helps to protect our coral reefs and also helps to purify water moving into the freshwater lens underneath the island. When wetlands such as mangroves are removed, water moves much more quickly over land entering the lagoon and smothering the coral (silt sedimentation). This can leave low-lying coastal areas more susceptible to damage from cyclones and storm surges (Lovelock, 1993).

'Mangroves, sea grass beds and coral reefs are linked together by the water masses that move in and out with the tide, and by the animals that move between these habitats' (Lovelock, 1993). The mangroves are rich in organic matter and nutrients and tides and currents transport these from the mangroves to sea grass beds and inshore coral reefs. These nutrients help the seagrass to grow which are important habitats for turtles, and fish. The relationship between the mangroves, sea grass and coral reefs is dependent on how close the habitats are to one another (Lovelock, 1993).

HUMAN USES OF MANGROVES IN THE MALDIVES

In the Maldives people use mangroves in a variety of ways. These include:

- Mangrove wood can be used in cooking, heating and constructing shelters. Mangrove wood can be used to produce charcoal, tannins for dying and leather protection, medicinal products, furniture, construction of fishing gear, some food and drinks, and many other products.
- Mangroves provide food in the form of fish, crabs and mussels from the mangrove waters. Vinegar and cooking oil could also be obtained from the mangrove plants.
- Bridges and poles for fish traps are also made using the mangrove timber.

20 minutes

ACTIVITY
GETTING THE BALL ROLLING

Materials: Ball

Action: Students sit in a circle and throw the ball (planet Earth) around. As each student catches the ball they must make a statement about mangroves. e.g. fish live in mangroves. At this stage any statements about mangroves are acceptable.

Students or the teacher writes down these ideas. These statements can be grouped according to a common theme eg. animals and plants found in a mangrove, values of mangroves, changes that have occurred to mangroves and how they are being managed. This information could be displayed on a big poster and added to as the students further their studies.

Theory: Very little information is known about mangroves in the Maldives. However, mangroves are a threatened ecosystem and need to be protected. This is an activity to encourage students to share what they already know about mangroves.

DISCUSSION POINTS

A. What is the relationship between mangroves and coral reefs?

B. Describe some of the benefits of mangroves?

C. What traditional uses of mangroves occur in the Maldives?

References: Lovelock, C (1993) Field Guide to the mangroves of Queensland
http://www.aims.gov.au/pages/reflib/fg-mangroves/pages/fgm-qld-index.html

BENEFITS OF MANGROVES

Mangrove areas are breeding, feeding and nursery grounds for many fish and other animals like crabs, shrimps and shellfish.

20 minutes

PROTECTING OUR MANGROVES

Mangroves are an important part of our island environment. Many plants and animals live in them and depend on them. Sadly many people consider the mangroves to be dirty, useless and mosquito ridden places, without understanding that the destruction of these areas endangers our way of life.

THREATS TO THE MANGROVES INCLUDE:

- Poor land management – when land is cleared for construction or agricultural purposes, the soil is easily washed away during heavy rains. If this soil and sediment reaches the mangrove forest it can cover the roots and kill the trees, which in turn will affect the animals that live in the water. Cutting of trees leads to physical damage to trees.
- Cutting the mangrove forest – large areas of mangroves are being cleared and filled. These reclaimed areas alter or stop the amount of fresh water entering the mangroves. Mangroves need a mixture of fresh and sea water to grow, any changes in this mixture will affect the growth and health of the trees.
- Water pollution and rubbish – oil from boats and spills create a thin film that sticks to the mangrove roots. Household waste like plastic bags and containers cover the mangrove areas endangering the wildlife that lives there. In some areas sewage is disposed in the mangroves, which results in excess growth of algae that can kill other marine life.
- Dredging in marine areas – leads to increased sedimentation in mangroves

TAKING CARE OF THE MANGROVES

One of the greatest challenges we face in taking care of mangroves is to balance the needs of people that use it or live nearby, and the future of the mangroves as a habitat for plants and animals.

One of the most important things that we can do for the mangroves is to take responsibility for them and get involved with caring for them. Teachers, students and communities can help restore and maintain mangrove areas.

We need to focus on long term strategies for sustainability of the mangroves but also develop and carry out short term projects to address the immediate needs of the mangrove.

SOME SUGGESTIONS FOR TAKING CARE OF THE MANGROVES:

- **Education** – visit the mangroves, invite people to speak to the class, give the students awareness projects that involve people in their homes and the community, such as posters or information pamphlets.
- **Monitoring** – this means keeping an eye on the health and wellbeing of the mangrove forest and its animals. Check the way people are using it. Observe if the trees and other plants and animals are healthy, or if the numbers have changed. If possible keep a record of the data in the island office.
- **Awareness** – community awareness activities can be done in schools, in meetings with different groups and the local authorities. You can teach with your actions and provide a good example by the way you use and respect the mangroves.
- **Reforestation** – many mangrove areas have been destroyed. Replanting mangroves can be an interesting and good teaching and learning activity. Cuttings can be taken of the plants and grown in a nursery area in the school to be replanted in the mangroves.
- **Mangrove reserves** – by creating areas of the mangrove as a reserve will ensure protection of the mangroves for the future. Some important sites in the Maldives have been officially protected by the Ministry of Environment, Energy and Water. Twenty six sites have been protected including mangrove and reef ecosytems.
- **Protection of endangered species** – healthy mangroves provide a home for endangered and protected species.

20 minutes

ACTIVITY
HUMAN ACTIVITIES IN THE MANGROVES

Materials: Note pad and pen or pencil

Action: Discuss the different types of human activities occurring in the mangroves.

Draw up a timeline of activities. Divide the activities into two groups:

- Activities that might harm the mangroves
- Activities that do not harm the mangrove or may do some good for the mangrove

Discuss what can be done to stop or lessen the harmful activities.

Theory: Mangroves are currently threatened in the Maldives. It is important to understand the threats to the mangroves. Many of the threats come from human activities. This activity helps students to carefully observe the human activity in the mangroves over a period of time and become aware of those activities that might be harmful.

DISCUSSION POINTS

A. What are some of the human activities that take place in the mangroves in the Maldives?

B. What types of activities might harm the mangroves or the animals that live there?

C. What are some of the ways that we can take care of the mangroves?

PROTECTING OUR MANGROVES

Sadly many people consider the mangroves to be dirty, useless and mosquito ridden places, without understanding that the destruction of these areas endangers our way of life.

Threats to mangroves

Protecting our mangroves

30 minutes

CORAL REEF SYSTEM

The sea contains a vast range of habitats. Around the world you can find rocky shores, coral reefs, estuaries and sandy beaches to name just a few. In the Maldives the coral system is the most common ecosystem. Coral reef systems only occur in warm tropical clear waters which are shallow enough for sunlight to enter so that the corals can grow. The Great Barrier Reef (off the coast of NE Australia) is the largest coral reef in the world. It is over 2000 km long and is the only living system that can be seen from outer space. The coral reefs of the Maldives are also very important, being the 7th largest in terms of area.

Coral reefs and lagoons provide food and shelter for a great variety of living things than most habitats in the world. Somewhere between 30-40% of all fish species are associated with coral reefs. Coral reefs provide food and shelter for a large range of animals such as crabs, clams and reef fish. Coral reefs also protect the coastline from large ocean waves during storms.

There are 3 basic types of coral reefs:

Fringing reefs, barrier reefs and atolls.

Fringing reefs grow at the edges of continents and islands. Barrier reefs are separated from the shore line by a lagoon. Whereas atolls are coral reefs in the shape of a circle around a lagoon. This is the type of coral reef that is found in the Maldives.

It is possible to divide up the reef into zones which are characterized by distinctive environmental conditions and by their dominant or abundant organisms. Different organisms have adapted to and colonized various zones, thus reducing competition. The reef can be divided into the following zones:

- lagoon
- reef flat
- reef front
- reef slope

LAGOON

A lagoon is the water enclosed by a coral reef. In the shallow water near the beach there is very little water movement. This is where sand is deposited and there is little exchange of sea water with the open sea. The lagoon water is poor in nutrients and is easily heated by the sun. The zone is likely to dry out during very low tides, so only a few organisms can survive here. Hermit crabs and Ghost crabs scavenge for dead organisms, while sea cucumbers digest bacteria and algae attached to sand grains. Pipefish, Picasso fish are also found here, as well as stingrays that lie flat under the sand.

REEF FLAT

The reef flat is the area between the reef front and the sandy shallows. Sea water sweeps in from the open ocean and this zone is dominated by fragile branching corals, whose large surface areas make maximum use of the sunlight. Many species like to live here. Damselfish, butterfly fish and angelfish are common. Many fish spawn in this zone attaching their eggs to dead coral.

REEF FRONT

The reef front is the area between the reef flat and the reef slope. The reef front gets the full impact of the waves and the surge of water as the tide comes in. During the day shoals of fish come to the edge of the reef to feed. Common species include the giant clam and parrot fish can be found here scraping off the top most layer of coral blocks.

REEF SLOPE

The reef slope is the area after the reef front that runs down into the ocean depths. As you go down the slope the amount of light and wave action also goes down. The corals are dominated by the flat topped corals which can absorb a lot of light. You can find nocturnal animals such as moray eels and groupers that lie idle until nightfall. You can also find feather stars, soldier fish and squirrel fish. At the bottom of the reef slope are soft corals, sea-whips and sharks.

OPEN OCEAN

Beyond the coral reefs, where the sea-floor drops away to great depths, the sea is perhaps the most difficult environment in which marine organisms live. Fish such as tuna, anchovies, barracudas and sailfish can be found here as well as mammals such as whales and dolphins. Many organisms can be found in the first 100m depth of ocean because light is available for phytoplankton to grow (major food source).

1 hour

ACTIVITY
RESEARCHING CORAL REEFS

Materials: Pen and paper

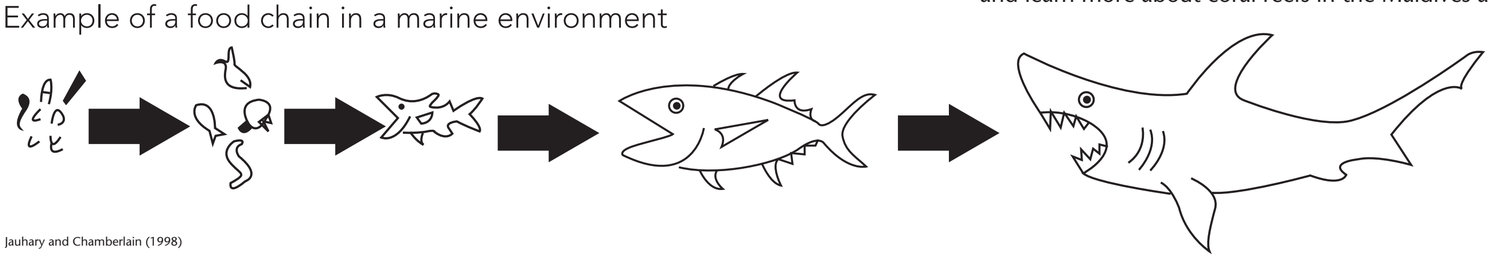
Action: Ask the students to develop questions they want answered concerning Maldives coral reefs. The following are examples of some Focus Questions which could guide the students in their research on the Maldives Coral reefs.

- What are the features of coral reefs?
- What animals and plants do you find living in coral reefs?
- How do humans use coral reefs?
- What can cause harm to coral reefs?
- Where else can we find coral reefs?
- Where is the largest coral reef system?

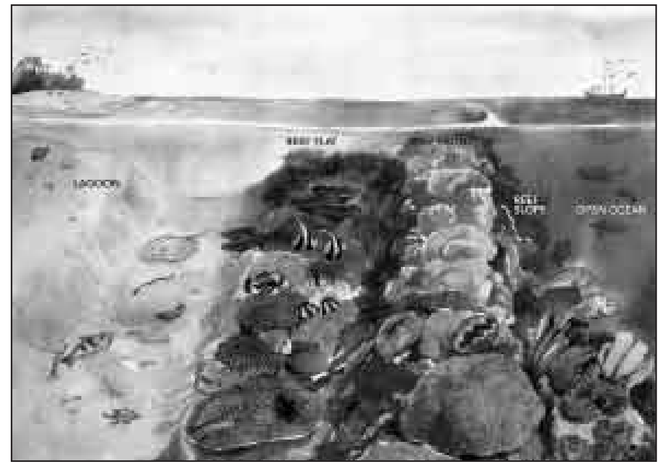
Ask the students to conduct research on coral reefs to answer their questions. They can use books in the library, speak to elders in the community or use the internet (where available).

Theory: Coral reef systems are the most common form of ecosystems in the Maldives. Students should be encouraged to critically think about and learn more about coral reefs in the Maldives and elsewhere.

Example of a food chain in a marine environment



Jauhary and Chamberlain (1998)



DISCUSSION POINTS

A. What type of reef system is found in the Maldives?

B. Why is it more difficult for organisms to live in the shallow lagoon?

C. What types of organisms might you see on the reef slope?

D. How many reef fish can you name?

References: A Riyaz Jauhary, A I Chamberlain (1998) '*Understanding Fisheries Science 1*' Educational Development Center, Ministry of Education, Republic of Maldives


REEF FLAT
REEF FRONT
LAGOON
REEF
SLOPE
OPEN OCEAN

20 minutes

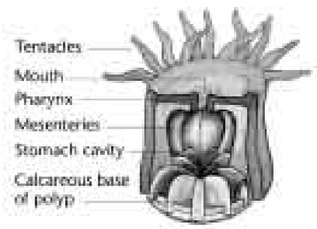
CORAL REEF IDENTIFICATION

Cnidaria (or coelenterates) include corals, jelly fish and sea anemones. Jelly fish are found floating in all marine environments. Corals and sea anemones are found at the bottom of the lagoon and in the reef. Corals in particular are very important to the Maldives. Corals vary enormously in size, shape and colour. Sometimes it is difficult to believe that they are a mass of tiny delicate organisms, responsible for the individual coral masses and together form huge coral reefs. Each individual is called a coral polyp. Coral is a type of animal. The word 'coral' groups together a wide variety of animals. Members include soft corals, hard corals, red and black corals.

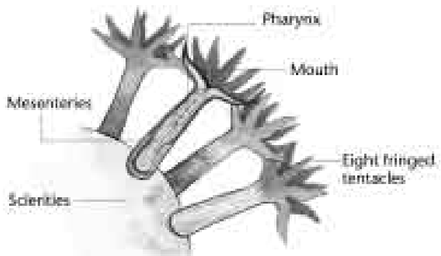
FEATURES OF CORALS

The body of the coral polyp is cup shaped. This surrounds an opening, the mouth, where water, food and waste passes in and out. In the hard corals the disc is surrounded by six tentacles (or multiples of six), but in the soft corals they are surrounded by eight tentacles. The tentacles contain stinging cells called nematocysts that are used for catching food. Corals take up calcium and carbonate from seawater to build an inner skeleton called corallite. Coral reefs grow very slowly (5mm per year). Over the years millions of coral polyps in colonies create the framework of the coral reef. Soft corals look like colorful plants and are not reef-building since they do not produce the hard calcified skeleton of many hard corals.

In living coral the tissue of the coral polyp usually gives the coral a brownish colour. In reef building hard corals the colour of the coral depends on zooxanthellae (algae), which live inside them. The Coral gets nutrients (food) from the zooxanthellae, and lots of oxygen, and, most importantly, the presence of the zooxanthellae enables the hard coral to secrete the skeleton. Without zooxanthellae there would be no coral reefs! The relationship between the coral and the zooxanthellae is called a 'symbiotic relationship' because both receive benefits from the relationship. The zooxathellae have a safe place to live and the coral gets extra food and oxygen from the algae during the day.



THE STRUCTURE OF A HARD CORAL POLYP



THE STRUCTURE OF SOFT CORAL POLYPS

REPRODUCTION

Coral colonies reproduce both sexually and asexually. In sexual reproduction, the coral polyps release both eggs and sperm into the water (coral spawning). Once fertilized the egg develops into an organism called a planula. The planula swims among the other plankton or finds a suitable substrate to attach itself to. Sexual reproduction results in the formation of a new colony. When this polyp buds a new polyp is made adding to the size of the colony. This is called asexual reproduction. It starts budding to form a new colony. When a new polyp grows out of the side of an existing polyp it is called extra-tentacular budding.

TYPES OF CORALS TO BE SEEN IN THE MALDIVES

In the Maldives there are over 250 species of coral. If you are snorkeling or diving in the coral reefs you may see many different types of corals, but some of the more common corals you may see include:

1. Table/Plate Coral
2. Branching Coral
3. Solitary Mushroom Coral
4. Foliaceous/Leafy Coral
5. Boulder/Massive Coral

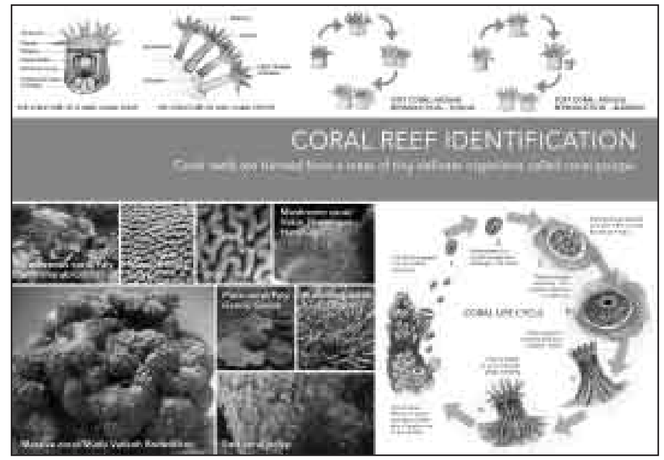
30 minutes

ACTIVITY
CORAL TYPES

Materials: Large white paper and coloured pens or pencils

Action: In groups, draw a poster showing the 5 main types of corals. On the poster write words around the corals describing the different features of each coral. Display these posters in your classroom or around key locations at your school to remind everyone of how special our coral reefs are!

Theory: Corals are one of the most common types of animals found in the Maldives. Students should be encouraged to know the main types of corals, so they understand how special and diverse the coral reef environment is.



DISCUSSION POINTS

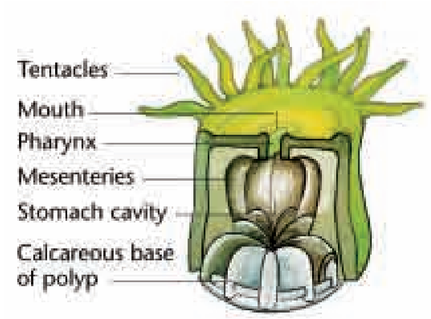
A. What are the main differences between a hard and soft coral?

B. What is the name of the algae that live inside corals?

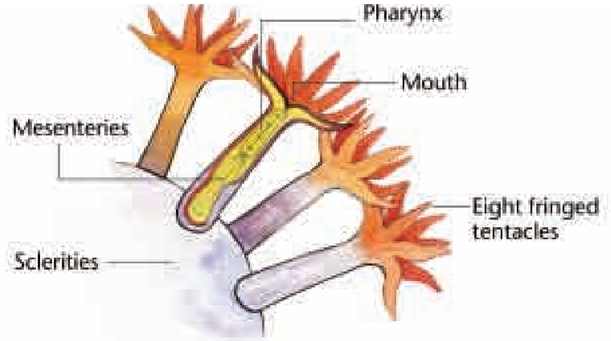
C. Why do corals need to have sunlight?

D. What is the difference between sexual and asexual reproduction in corals?

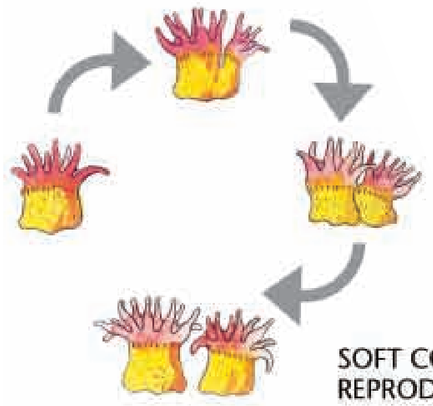
References: *Understanding Fisheries Science 1* (1998) by A Riyaz Juahary and A I Chamberlain, *Living Reefs of the Maldives* (2001) by Dr. R.C. Anderson, Marine Research Centre (1996), *Fishes of the Maldives* Marine Research Centre, Ministry of Fisheries, Agriculture and Marine Resources, Maldives, Holliday, L (1989) *Coral reefs: a global view by diver and aquarist Less Holliday; consultant Elizabeth Wood,* Salamander Book, London



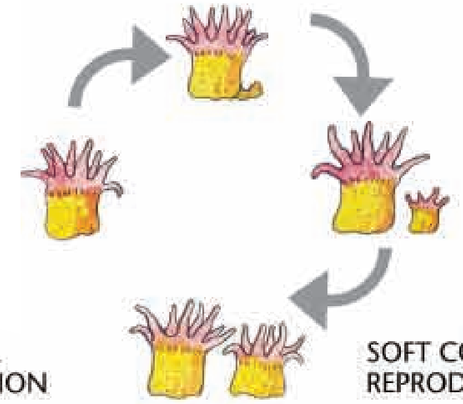
THE STRUCTURE OF A HARD CORAL POLYP



THE STRUCTURE OF SOFT CORAL POLYPS



SOFT CORAL: ASEXUAL REPRODUCTION – FISSION



SOFT CORAL: ASEXUAL REPRODUCTION – BUDDING

CORAL REEF IDENTIFICATION

Coral reefs are formed from a mass of tiny delicate organisms called coral polyps.

Foliaceous coral/Faiy vaththarah/Olhifa

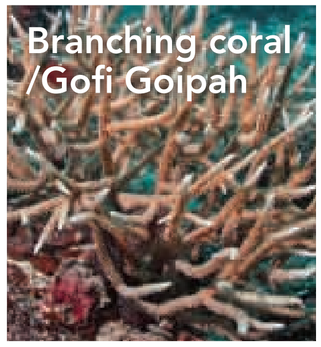
Massive coral polyps

Brain coral

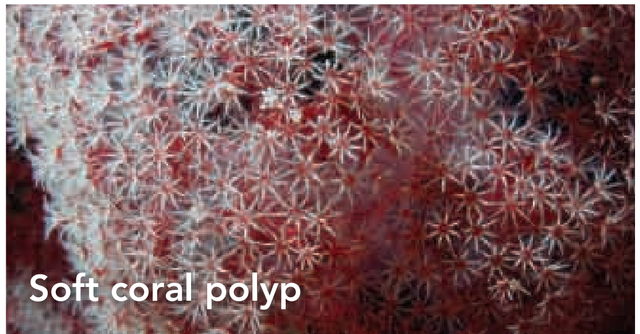
Mushroom coral/ Vakin Thanehgai Harunulaa

Massive coral/Mudu Vahkoh Bodethikoh

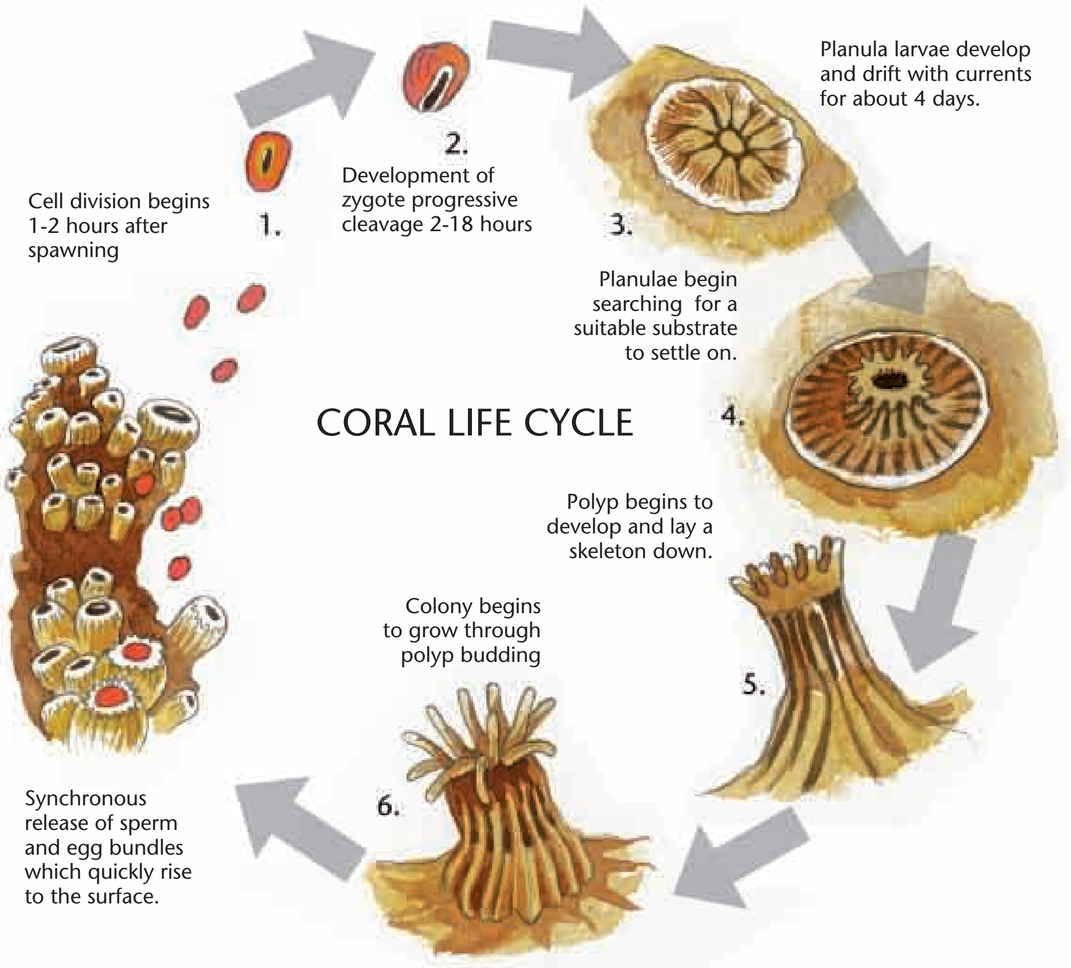
Plate coral/Faiy Gandu Gadah



Branching coral /Gofi Goipah



Soft coral polyp



CORAL LIFE CYCLE

20 minutes

COMMON REEF ANIMALS

Coral reefs are among the most biologically diverse ecosystems on earth. Second only to tropical rain forests in the number of species that live there, they are sometimes called the 'rainforests of the sea'. In the Maldives coral reefs are the most common ecosystem with very rich biodiversity. In the Maldives it is estimated that there are 36 species of sponges, 83 species of echinoderms, 145 species of crab, 48 species of shrimp, 5 species of turtle, 1090 species of fish and sharks, 21 species of whale and dolphin and about 250 species of reef building corals.

INVERTEBRATES

What is an invertebrate? Invertebrates are animals without a backbone.

- **Sponges** (Phylum Porifiera) are very simple animals found in all parts of the marine environment and especially in coral reefs. They can be many different colors from pale green to bright orange. Some form a thin layer over stones or have spongy bodies. Because they are supported by water they have weak skeletons.
- **Sea star, sea urchin, sea cucumber, feather star, brittle star** (Phylum Echinodermata). The word echinoderm means 'spiny skin' because they have an external skeleton made of hard plates. You will know animals from this phylum because they usually have five sided symmetry, such as the sea star. Echinoderms are solitary marine animals. Some echinoderms such as feather stars, are filter-feeders, filtering plankton and detritus from the surrounding water or from the sea bed. The majority of sea stars, sea urchins, sea cucumbers, and brittle stars are not filter-feeders. For example sea stars eat by extending out one of their 2 stomachs and digesting food in this way. Sea stars are found in tropical coral reefs, but can also be found in arctic and temperate waters. All are free-living animals which crawl over rocks and coral or live on sandy bottom of lagoons.
- **Clams, octopus, squid, cuttlefish** (Phylum Mollusca). The animals from this phylum are soft-bodied animals that may or may not have a skeleton (shell) and a muscular 'foot'. It consists of more than 80,000 different species, mostly aquatic. Molluscs live not only in the sea, but on land, in rivers and lakes.
    - A clam is a bivalve (a shell with 2 halves). Clams are frequently found on coral reefs. They do not have a head, they are filter feeders finding food from the surrounding water. Often zooxanthellae also live in the mantle of a clam giving clams beautiful colors and providing nutrients to the clam.
    - Cuttlefish, squid and octopus are from the family Cephalopoda. The octopus has 8 arms with suckers on the underside and lives in holes in coral or in shallow water. They come out at night to hunt marine creatures. The squid and octopus do not have a skeleton, but the cuttlefish does have an internal skeleton.
- **Crabs, lobster** (Phylum arthropoda) are crustaceans that live on the coral reefs. There are over 30,000 species including barnacles, prawns and shrimps. Most crustaceans are tiny animals called zooplankton. The body is composed of segments or a shell (carapace). Each segment usually has limbs which help it to swim, crawl or eat food. The Maldivian lobster is from this phylum and is found in shallow water. It hides during the daytime, but comes out at night to eat dead organisms.

VERTEBRATES

What is a vertebrate? These are animals with a backbone or vertebral column made up of vertebrae. Hence animals with vertebrae are called vertebrates.

- **Tuna, Reef Fish, Moray Eels, Sharks, turtles, dolphins and whales** are all examples of vertebrates found in the marine environment.
- **Tuna, reef fish, rays and sharks** belong to the group of animals called Pisces. This group has over 25,000 different species of fish. Fish are aquatic organisms and are found in all parts of the marine environment. Tuna and parrotfish are called bony fish because their skeletons are made of bone. Whereas sharks are cartilaginous fish because their skeleton is made of cartilage. The white-tipped reef shark is common in the Maldives coral reefs – they feed on a variety of reef fish including moray eels.
- **Turtles** belong to the Reptile class with crocodiles and snakes. Reptiles have dry and scaly skin, have strong limbs and use lungs to breathe air. Turtles have also adapted to living on land. They come to the beach to lay eggs. The Hawksbill turtle and Green Turtle are common turtles found in the Maldives and are a common resident of coral reefs. Hawskbill turtles mainly eat sponges. Turtles have a very different life cycle from other reef organisms, since they mature at the age of 30-50 years and reproduce only every couple of years (6-8). This is one of the reasons why this reef animal is so vulnerable!
- **Dolphins and whales** are mammals just like humans. They are warm blooded, give birth to live young and have lungs so they must come to the surface to breathe oxygen. This is different to fish that have gills to breathe oxygen in the water.

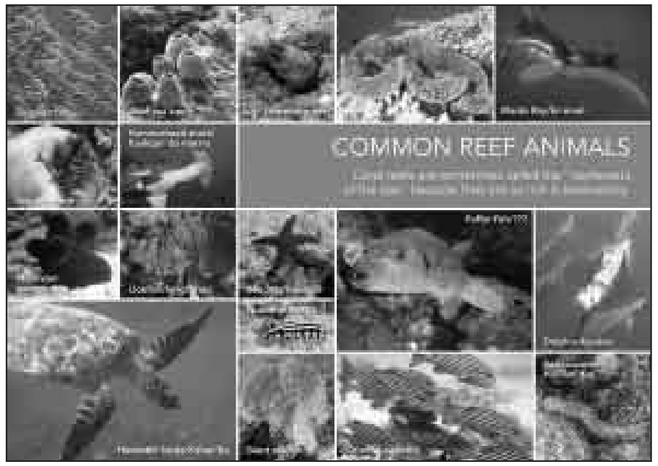
30 minutes

ACTIVITY
RAINFORESTS OF THE SEA

Materials: Large white paper and coloured pens or pencils

Action: Ask students to draw a poster showing their favourite animal from the coral reef as it lives in its environment. On the poster write words around the corals describing why they like the animal. Display these posters in your classroom or around key locations at your school to remind everyone of how special our coral reefs are!

Theory: Corals are one of the most common types of animals found in the Maldives Students should be encouraged to know the different types of animals found on the coral reef, so they understand how special and diverse the coral reef environment is.



DISCUSSION POINTS

A. What is an invertebrate?

B. Name three invertebrates?

C. What are the differences between a whale and a fish?

D. Why are coral reefs an excellent habitat for so many animals?

References: *Understanding Fisheries Science 1* (1998) by A Riyaz Juahary and A I Chamberlain, *Living Reefs of the Maldives* (2001) by Dr. R.C. Anderson, Zahir, H and Naeem, I (1997) *Fishes of the Maldives* Marine Research Centre, Ministry of Fisheries, Agriculture, Maldives

Blue surgeon fish/
Noo Kaalhu

Reef sea squirt

Spot face moral eel/
Kalhu ven/Maa ven

Giant clam/Gaahaka

Manta Ray/En madi

Sea anemone/
Moodhu maa/
Maa gandhu

Hammerhead shark/
Kaaligan'du miyaru

COMMON REEF ANIMALS

Coral reefs are sometimes called the 'rainforests of the sea' because they are so rich in biodiversity.

Maldivian
sponge slug

Lionfish/Fanhaamas

Sea Star/Fasingili

Puffer fish/Koli

Dolphin/Koamas

Nudibranch/
Moodhu lumboa

Hawksbill turtle/Kahan'bu

Giant sea fan

Oriental Sweetlip/Kandu guruva

Sea cucumber/
Huifilan'daa

30 minutes

THREATS TO CORAL REEFS

Corals and coral reefs are extremely sensitive. Slight changes in the reef environment may have devastating effects on the health of entire coral colonies. These changes may be due to a variety of factors, but they generally fall within two categories: natural disturbances and anthropogenic disturbances. Although natural disturbances may cause severe changes in coral communities, anthropogenic disturbances have been linked to the vast majority of decreases in coral cover and general colony health when coral reefs and humans occur together.

Although much of the coral reefs degradation is directly blamed on human impact, there are several natural disturbances which cause significant damage to coral reefs. The most recognized of these events are cyclones, which bring large and powerful waves to the tropics. These storm waves cause large corals to break apart and scatter fragments about the reefs. After the storm, these slow growing corals might easily be overgrown by quicker growing algae. In addition, these storms generally bring heavy rain which increases runoff and sedimentation.

There are also some animals in coral reefs that feed on corals. These include the parrotfish, crown-of thorns and pincushion star fish. Other organisms directly compete with corals for space, such as sponges (Terpios hoshinota). Under 'normal' conditions, these animals are just part of the ecosystem and control the diversity of the different coral reef species. It's only when they occur in large numbers, usually as a consequence of some environmental disturbance or stresses, that they can have a significant negative impact on reefs. For example in recent years there have been a number of outbreaks of crown-of–thorns on coral reefs around the world, such as the Great Barrier Reef in Australia. The crown-of-thorns, Acanthaster planci is a large starfish which feeds on corals by using its stomach to digest the living tissue layer. When this starfish are in large numbers, there is intense competition for food and most corals will be eaten. Such a reef can take 10 years or more to recover.

Coral reefs have survived for tens of thousands of years of natural change, but many may not be able to survive the changes brought by humans.

Roughly one-quarter of coral reefs worldwide are already considered damaged beyond repair, with another two-thirds under serious threat. Specific major threats to coral reefs and their habitats include:

Destructive fishing practices: These include cyanide fishing, blast or dynamite fishing, bottom trawling, and muro-ami (banging on the reef with sticks). Bottom-trawling is one of the greatest threats to cold-water coral reefs.

Overfishing: This affects the ecological balance of coral reef communities, warping the food chain and causing effects far beyond the directly overfished population.

Careless tourism: Careless boating, diving, snorkeling, and fishing happens around the world, with people touching reefs, stirring up sediment, collecting coral, and dropping anchors on reefs. Some tourist resorts and infrastructure have been built directly on top of reefs, and some resorts empty their sewage or other wastes directly into water surrounding coral reefs.

Pollution: Urban and industrial waste, sewage, agrochemicals, and oil pollution are poisoning reefs. These toxins are dumped directly into the ocean or carried by river systems from sources upstream. Some pollutants, such as sewage and runoff from farming, increase the level of nitrogen in seawater, causing an overgrowth of algae, which 'smothers' reefs by cutting off their sunlight.

Sedimentation: Erosion caused by construction (both along coasts and inland), mining, logging, and farming is leading to increased sediment in rivers. This ends up in the ocean, where it can 'smother' corals by depriving them of the light needed to survive. The destruction of mangrove forests, which normally trap large amounts of sediment, is exacerbating the problem.

Coral mining: Live coral is removed from reefs for use as bricks, road-fill, or cement for new buildings. Corals are also sold as souvenirs to tourists and to exporters who don't know or don't care about the long term damage done.

Climate change: Corals cannot survive if the water temperature is too high. Global warming has already led to increased levels of coral bleaching, and this is predicted to increase in frequency and severity in the coming decades. Such bleaching events may be the final nail in the coffin for already stressed coral reefs and reef ecosystems.

One of the greatest threats to coral reefs is human expansion and development. As development continues to alter the landscape, the amount of freshwater runoff increases. This land based runoff may carry large amounts of sediment from land-clearing areas, high levels of nutrients from agricultural areas or septic systems. In addition to runoff, outflows from water treatment plants and large power plants are the cause of much damage to coral reefs. Sewage entering the coral reef ecosystem greatly increase the nutrient levels surrounding their outflow pipes. As with all these factors, the basis for the continued degradation of coral reefs is the increasing size of the human population.

As this population increases, so does the harvest of resources from the sea. Due to overfishing, reef fish populations have been greatly decreased in some areas of the world. The removal of large numbers of reef fish has caused the coral reef ecosystems to become unbalanced and allowed more competitive organisms, such as algae, which were once controlled by large fish populations, to become dominant on reefs in many regions. Due to decreased yields, fishermen have been forced to change their methods in order to catch enough fish to sustain their needs. In some areas this means fish traps with small mesh diameters which catch even the small juvenile fish. In other areas of the world, the use of explosives or poisons has become quite common. Not only do these practices kill all fish in the affected areas, but they also severely damage the corals in these areas.

Corals are also very popular as decorations. Often, when people vacation in tropical locations surrounded by beautiful reefs they want to take coral souvenirs home. In order to do this, they either collect pieces of coral themselves or buy pieces from a "curios" shop. These shops receive their corals from commercial collectors who select well developed colonies which will make them the most money. This is very damaging because a large amount of the most healthy corals are selected.

Coral reefs also receive much damage from both commercial and private vessels. The leakage of fuels into the water and the occurrences of spills by large tankers are extremely damaging to local corals. Boat anchors are also very damaging to reefs by breaking and destroying entire colonies. The grounding of large sea-going vessels also results in large sections of coral reefs being destroyed. It has also been found that the anti-fouling bottom paints used by many boats contribute to the formation of toxic concentrations of Tributyl tin and several other chemical compounds which may be harmful to corals or other coral species.

Since most corals mass spawn and produce floating gametes, pollutants and toxins on the surface can effect coral reproduction and development for a large area. Therefore, much care must be taken to reduce or prevent the spillage and leakage of contaminants into the water as well as to improve cleanup procedures of such accidents.

There are a great number of threats to coral reefs, and most of the threats can be attributed either directly or indirectly to humans. Work must be done quickly to protect our threatened resources. The list of solutions to the many coral reef problems is extensive. These range from better methods of development in order to decrease runoff, to the installation of permanent moorings at heavily used anchorage sites. Whatever the solutions, there always needs to be adequate enforcement to ensure proper techniques are being followed. Unfortunately, enforcement has not been great enough in the past and will probably not be in the future. Therefore, the education and cooperation of people throughout the world is necessary if coral reefs are to survive.

DISCUSSION POINTS

A. What is happening around your island that is harmful to coral reefs?

B. What can you do to protect the coral reefs?

C. How would you encourage coral growth on the reefs of your island?

1 hour

ACTIVITY
CORALS IN DANGER!

Materials: Pen and paper

Action: Divide the students into groups to list all the factors which might be causing the corals to be threatened. As a class collate a list of threats to coral reefs. Classify the suggested threats according to whether the impact is natural or human. The list can be expanded as the students' knowledge increases. Against each of the threats to coral reefs ask students to make suggestions for solutions to remove or reduce these threats.

Theory: There are a great number of threats to coral reefs, and most of the threats can be attributed either directly or indirectly to humans. Students need to critically think about the many threats to coral reefs and how communities can play a part in reducing these threats, especially from their own island.


Some sponges can overgrow corals

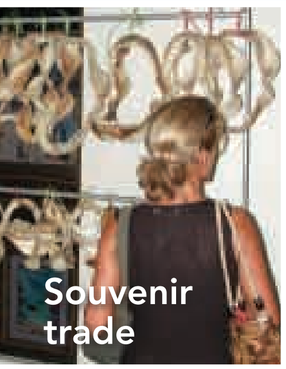

Crown of Thorns/Kashi Boa


Parrotfish biting coral

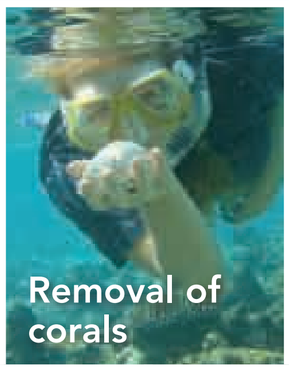

Coral with parrotfish bites

THREATS TO CORAL REEFS

Coral reefs have survived for tens of thousands of years of natural change, but many may not be able to survive the changes brought by humans.


Souvenir trade

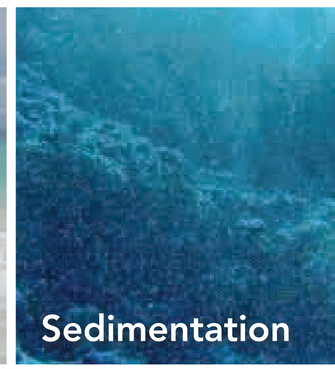

Coral breakage


Removal of corals

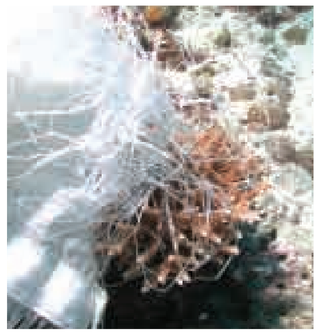

Sewage leaks


Algal growth from nutrients


Beach reclamation


Sedimentation


Water pollution




Waste on the reef


Anchor damage

PROTECT THE REEF

20 minutes

BEACH SYSTEMS

A **beach**, or **strand**, is a geological formation consisting of loose rock particles such as sand, gravel, shingle, pebbles, cobble, or even shell along the shoreline of a body of water. Some geologists consider a beach to be just this shoreline feature of deposited material. There are several conspicuous parts to a beach, all of which relate to the processes that form and shape it. The part mostly above water (depending upon tide), and more or less actively influenced by the waves at some point in the tide, is termed the **beach berm**. The berm is the deposit of material comprising the active shoreline. The berm has a **crest** (top) and a **face** — the latter being the slope leading down towards the water from the crest. At the very bottom of the face, there may be a **trough**, and further seaward one or more **longshore bars**: slightly raised, underwater embankments formed where the waves first start to break.

The sand deposit may extend well inland from the *berm crest*, where there may be evidence of one or more older crests (the **storm beac**h) resulting from very large storm waves and beyond the influence of the normal waves. At some point the influence of the waves (even storm waves) on the material comprising the beach stops, and if the particles are small enough (i.e. sand), winds shape the feature. Where wind is the force distributing the grains inland, the deposit behind the beach becomes a **dune**.

The line between beach and dune is difficult to define in the field. Over any significant period of time, sand is always being exchanged between them. The **drift line** (the high point of material deposited by waves) is one potential demarcation. This would be the point at which significant wind movement of sand could occur, since the normal waves do not wet the sand beyond this area. However, the drift line is likely to move inland under assault by storm waves.

HOW BEACHES ARE FORMED

Beaches are deposition landforms, and are the result of wave action by which waves or currents move sand or other loose sediments of which the beach is made as these particles are held in suspension. Alternatively, sand may be moved by **saltation** (a bouncing movement of large particles). Beach materials come from erosion of rocks offshore, as well as from headland erosion and slumping producing deposits of scree. A coral reef offshore is a significant source of sand particles.

The shape of a beach depends on whether or not the waves are constructive or destructive, and whether the material is sand or shingle. Constructive waves move material up the beach while destructive waves move the material down the beach. On sandy beaches, the backwash of the waves removes material forming a gently sloping beach. On shingle beaches the swash is dissipated because the large particle size allows percolation, so the backwash is not very powerful, and the beach remains steep. Cusps and horns form where incoming waves divide, depositing sand as horns and scouring out sand to form cusps. This forms the uneven face on some sand shorelines.

There are several beaches which are claimed to be the "World's longest", including Cox's Bazar, Bangladesh (120kms), Fraser Island beach, 90 Mile Beach in Australia and 90 Mile Beach in New Zealand and Long Beach, Washington (which is about 30km). Wasaga Beach, Ontario on Georgian Bay claims to have the world's longest freshwater beach.

BEACHES AND RECREATION

Beaches have long been a popular attraction for tourism and recreation. Especially popular are seaside resorts and large white sand beaches. Residents and tourists alike use beaches as a place for leisure and sport. The relatively soft formation of sand is comfortable to sit or lie on, and entering and exiting the water is far easier across a sand beach than a rocky shore. The waves present at beaches add to the enjoyment and make the sport of body surfing and related activities possible. One of the many attractions of a sand beach, especially for children, is playing with the sand, building sand castles and other constructs. Walking the beach is also popular. People usually walk the beach with bare feet. It is typically done near the shore line, where the sand is wet and therefore more convenient to walk on.

ARTIFICIAL BEACHES

Some beaches are artificial; they are either permanent or temporary (For examples see Monaco, Paris, Rotterdam, Hong Kong and Singapore).

The soothing qualities of a beach and the pleasant environment offered to the beachgoer are replicated in artificial beaches, such as "beach style" pools with zero-depth entry and wave pools that recreate the natural waves pounding upon a beach. In a zero-depth entry pool, the bottom surface slopes gradually from above water down to depth. Another approach involves so-called urban beaches, a form of public park becoming common in large cities. Urban beaches attempt to mimic natural beaches with fountains that imitate surf and mask city noises, and in some cases can be used as a play park.

Beach nourishment involves pumping sand onto beaches to improve their health. Beach nourishment is common for major beach cities around the world; however the beaches that have been nourished can still appear quite natural and often many visitors are unaware of the works undertaken to support the health of the beach. Such beaches are often not recognised as artificial.

BEACHES AS HABITAT

A beach is an unstable environment which exposes plants and animals to harsh conditions. Some small animals burrow into the sand and feed on material deposited by the waves. Crabs, insects and shorebirds feed on these beach dwellers. The endangered Piping Plover and some tern species rely on beaches for nesting. Sea turtles also lay their eggs on ocean beaches. Seagrasses and other beach plants grow on undisturbed areas of the beach and dunes.

1-1.5 hours

ACTIVITY
MAKING A MAP OF THE BEACH

Material: Larger paper and markers

Action

- Set a time during the cooler daylight hours to visit the beach
- Brief the group on their tasks
- Divide the group into pairs and make sure each pair has a notebook and pen
- Each pair writes down, or draws all the different features they observe at the beach, e.g.
  - Tide
  - Beach materials (sand, stones), rock outcrops, timber, garbage, oil
  - Buildings on or behind the beach, access points, sea defences
  - Drainage ditches, outfall pipes
  - Waves, wind direction, plants and animals, turtle nesting areas
  - Vegetation behind and on the beach
  - Number of people and what are they doing,
  - Fishermen, fish pots, nets, engines

Group returns to the meeting place and together they make a master sketch plan; often it is best to make a rough version and then a final version.

DISCUSSION POINTS

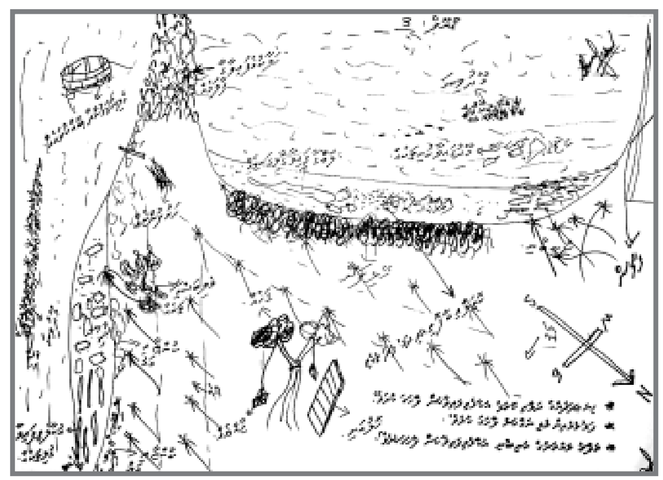
A. How do people use the beach on your island?

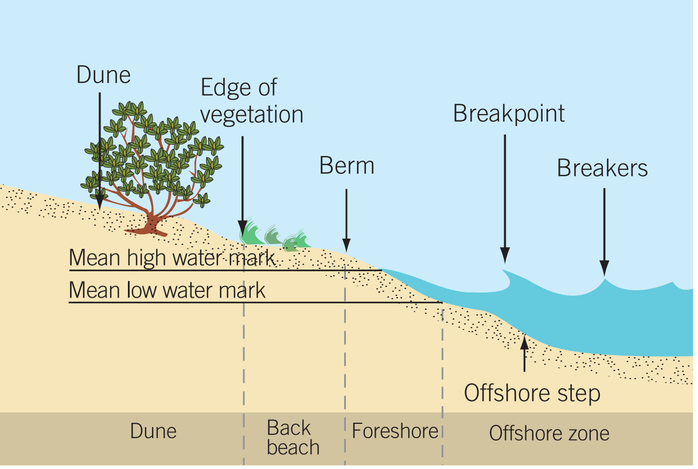
B. What is your favourite activity on the beach?

C. Why do you think the beach moves?

D. What types of animals and plants can be found on the beach?

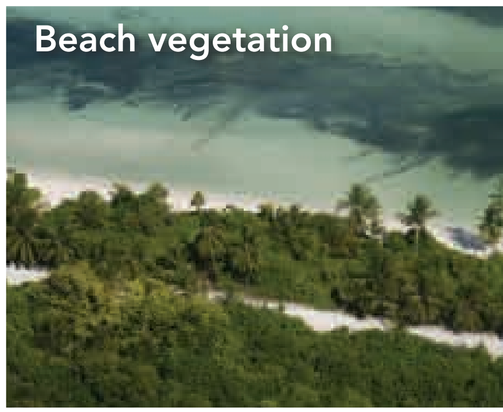
Activity: sample sketch map





BEACH SYSTEMS

A beach is an unstable environment which exposes plants and animals to harsh conditions.



15 minutes

THREATS TO BEACHES

THREATS TO BEACHES

Beaches are areas of continuous change where the natural forces of wind and water interact with the land. These changes have been taking place for millennia and are the result of both natural forces and human activities. Natural forces include wind, waves, currents, tides and also extreme weather events such as storms and tsunamis. Human activities that influence the beach include sand and coral mining, trampling on coral reefs, building harbors and jetties and dredging and reclamations. Beach erosion takes place when the beach and the land behind the beach is worn away by the action of the waves and a new coastline is established further inland.

A healthy beach is the best form of sea defence- it absorbs wave energy and it reforms naturally after a storm. Leaving the beach sufficient space to move naturally to change its size and shape, is important to maintaining beach health. Ensuring new building are a 'safe' distance from the dynamic beach zone, helps conserve the beach and the buildings. Ensuring there is a wide band of vegetation as possible between buildings and the sea is the best way and most long lasting way of coping with beach erosion.

In the Maldives beaches are very important to every island. On many islands attempts have been made to minimize erosion through the construction of seawalls, groynes and breakwaters. On some islands sand is dredged from the bottom of the lagoon by a suction dredge and pumped onto the beach. However dredging can cause a great deal of turbidity (suspended particles in water) that can cause damage to coral reefs and sea grass beds, so it is necessary to take special measures such as using silt curtains and creating settling ponds on the beach to prevent the sediment from reaching the sea.

Another major threat to the beaches is from inappropriate waste disposal. Unfortunately beaches are often dumping grounds for waste and litter!

Traditionally we have thrown our waste either on the beaches, in the forests or at sea, and because it was mostly organic it would break down quickly and not cause many problems. However wastes are no longer just made of organic materials; they also are made from metals, plastics and hazardous wastes. Also, we are producing a lot more waste. This means that dumping mixed waste around our islands at different places on the beach or forest, or burning it, is no longer effective in removing waste from our islands. These new wastes do not breakdown quickly, so the wastes remain on our islands for longer, possibly affecting our health, environment and jobs.

Every day waste is dumped onto the beach, which looks horrible, smells bad and can affect our health! If this waste gets washed into the sea, other animals such as turtles can accidentally eat plastic bags and they can die!

Due to intense use by the expanding human population, beaches are often dumping grounds for waste and litter, necessitating the use of beach cleaners and other cleanup projects. More significantly, many beaches are a discharge zone for untreated sewage in most underdeveloped countries; even in developed countries beach closure is an occasional circumstance due to sanitary sewer overflow. In these cases of marine discharge, waterborne disease from fecal pathogens and contamination of certain marine species is a frequent outcome.

1 hour

ACTIVITY 1
HOW THE BEACH USED TO LOOK

Materials: Notepad, pens, maps, photographs

Action: Research information on how the beach used to look and make comparisons with the maps drawn by the class. Aerial and topographic maps can be obtained from government departments responsible for lands and surveys or you could talk to community elders or leaders.

When comparing past maps with present maps ask:

- How has the beach changed?
- Are the changes good or bad?
- How have we contributed to these changes?
- Do you prefer the beach as it was in the past or how it is now?
- How do you think the beach will look in ten years time?

Theory: By researching their own beach, students will be able to critically think about how their beach has changed over time and how these changes have come about. By leaving the classroom, students can apply this knowledge to their local environment.

1 hour

ACTIVITY 2
HUMAN ACTIVITIES ON THE BEACH

Materials: Notepad, Pencil or pen

Action:

1. Observe and record the different types of activities occurring on the beach. Include details on time of day, who or what was involved, how many people and the details of the activity. The more detail the better. Write down the activities in your notepad.
2. Back in class draw up a timeline of activities.
3. From the activities recorded in your notepads, categorize each activity into two groups and write on a large piece of paper:
   A. Activities that might harm the beach
   B. Activities that do not harm the beach or may do some good for the beach
4. Display the large piece of paper in your classroom and discuss what can be done to stop or reduce the harmful activities occurring on your beach.

Theory: By observing activities on their own beach, students will be able to critically think about threats to beaches and how they can take action to deal with these threats. By leaving the classroom, students can apply this knowledge to their local environment.

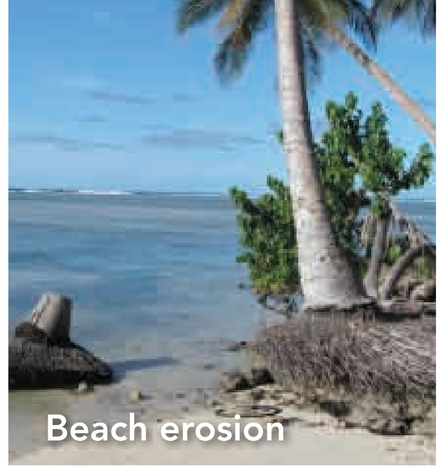
DISCUSSION POINTS

A. How do people use the beach on your island?

B. What are the things they could do to keep their beach clean?

C. What are some of the threats to beaches?

D. What are some of the threats to the beach on your island?



THREATS TO BEACHES

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