


SCHOOLS FOR A HEALTHY ENVIRONMENT

LIFE AROUND US

Module 3

Educational Development Centre

unicef

ACKNOWLEDGEMENTS

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CONTENTS

INTRODUCTION

This Module is designed to be used by teachers and facilitators during relevant school and/or Environment Club activities. Each Module provides the curriculum linkages which would help the teachers in choosing activities when planning the lessons during the weekly meetings. Each section of the Module follows the similar format of a seven step inquiry model. The inquiry model is chosen to be followed in the activities because this method focuses on student centred learning. When applying the steps of the inquiry model the teacher will act as a facilitator and the students will:

- gain a deep understanding of the subject matter
- develop thinking and reasoning skills
- develop problem-solving skills
- have their intellect challenged
- take greater responsibility for their own learning
- understand the relationship between what they are studying and the real world
- have varied and interesting learning experiences

The seven steps used in the Inquiry Model are as follows:

1. Tuning In
2. Deciding Directions
3. Finding Out
4. Sorting Out
5. Drawing Conclusions
6. Considering, Planning and Taking Action
7. Evaluation and Reflection

Each of the 6 Modules has been designed with subheadings for purpose, time, materials required and procedure. These subheadings have been included to guide teachers to plan and conduct the activities. The times provided with each activity are suggested times to help the teachers plan the class. This is a guide only; some activities may take less or more time. The inquiry process is based on developing critical thinking and problem solving skills, so the duration of activities should be related to the interest and development of the student's knowledge and skills. Each Module has also been designed with Student Resource Sheets and Teacher Information Sheets for each section, to assist in preparing for and conducting activities. Sample Student Resource Sheets have also been provided to guide teachers as to the kind of responses expected on each Sheet. Once again, this is offered as a guide and responses should not be limited to the suggested ones. Each Module has been written in plain English, however for some subjects it has been necessary to include more technical terms. A glossary has been included at the end of the Modules to explain these technical terms. Where possible photos and illustrations have also been included in each Module to explain or demonstrate specific activities.

These Modules are also accompanied by 2 toolboxes; one for indoor equipment and one for outdoor equipment. The toolboxes provide the physical materials needed to conduct the activities with the required materials being specified for each activity. The toolboxes also contain reference materials, posters and Flip Charts providing the necessary background for these Modules. The contents of the toolboxes and instructions for care and maintenance are included in the following pages.

OVERVIEW OF THE MODULES

There are 6 teaching and learning Modules in this series that are linked to themes in the Environmental Studies curriculum. Each Module provides instructions for a number of activities that might be used with a class to explore aspects of the issue that is being addressed. These Modules do not comprise a complete unit; rather they may be used to supplement other work being done within a topic area and what is found in the established syllabus.

Module 1:
Ourselves

1. Island Environment
2. Traditional Knowledge
3. Environmental Impact Assessment
4. Common Diseases and Prevention

Module 2:
Earth

1. Weather
2. Safe Drinking Water
3. Water Quality Monitoring

Module 3:
Life Around Us

1. Mangroves
2. Beaches
3. Coral Reefs
4. School Gardens

Module 4:
Resources from the Environment

1. Energy used at School and at Home
2. Conservation, Management and Reuse of Water
3. Managing Waste
4. Reduce, Reuse, Recycle
5. Composting Waste

Module 5:
Interdependence

1. Food Web
2. Exploring my Atoll
3. Ecological Footprints

Module 6:
Science and Technology

1. Wind Energy
2. Solar Energy

ENVIRONMENTAL STUDIES CURRICULUM LINKS

	MODULE	SECTIONS	Grades 1 - 3	Grade 4 - 5	Number of lessons
1	OURSELVES	Island Environment		x	3 - 4 lessons
		Living by Traditional Knowledge		x	3 - 4 lessons
		Environmental Impact Assessment		x	4 - 6 lessons
		Common Diseases and Prevention	x		4 - 6 lessons
2	EARTH	Weather	x		4 - 6 lessons
		Safeguarding Drinking Water		x	4 - 6 lessons
		Water Quality Monitoring		x	4 - 6 lessons
3	LIFE AROUND US	Mangroves		x	4 - 6 lessons
		Coral Reefs		x	4 - 6 lessons
		Beaches		x	4 - 6 lessons
		School Gardens	x		3 - 4 lessons
4	RESOURCES FROM THE ENVIRONMENT	Energy used at Home and School	x		4 - 6 lessons
		Conservation, Management and Reuse of Water	x		4 - 6 lessons
		Managing Waste	x		4 - 6 lessons
		Reduce, Reuse, Recycle	x		4 - 6 lessons
		Composting Waste		x	3 - 4 lessons
5	INTERDEPENDENCE	Food Web		x	3 - 4 lessons
		Exploring My Atoll	x		3 - 4 lessons
		Ecological Footprints		x	4 - 6 lessons
6	SCIENCE AND TECHNOLOGY	Wind Energy	x		4 - 6 lessons
		Solar Energy		x	4 - 6 lessons

TOOLBOX CONTENTS

DRY KIT		
	Item	Details
1	Plastic vials/jars screw top	100-300ml.
2	Hand lenses	Magnification x 3, lens diameter 90mm, plastic handle.
3	Long handled tongs	Jaws corrugated inside, length 150x200mm, stainless steel.
4	Insect catching nets	Hand net for insects, overall length 1.48m, diameter 250mm.
5	Plankton nets	Plankton net, nylon monofilament netting, with tough nylon collar, diameter 300mm, overall length 900mm, brass frame with 7m tow line and a PVC filter, aperture size 0.1mm and 0.3mm.
6	Thermometers	Mercury in glass, permanent amber markings, with anti-roll clip, range -10 to 110o Celsius, 6mm diameter with reinforced bulb, in plastic case.
7	Globe of earth	Rubber ball - globe of the earth, fully numbered meridian ring, diameter of globe 30 cm.
8	Twine	Brightly coloured nylon twine (20m).
9	Measuring tape	Sturdy, length 50m.
10	Measuring tape	Length 1 meter.
11	Student microscope	Monocular head rotates 360 degrees and has a 10x eyepiece. DIN 4x, 10x and 40x glass achromatic optics on the triple nosepiece.
12	Binoculars	Magnification 7×50, waterproof.
13	Litmus paper	Red and blue.
14	pH strips	Full Range pH from 1 to 14, colour reference chart with clearly printed pH values and instruction leaflet.
15	Low cost water monitoring kit	Provides simple and non-hazardous method of testing 8 basic water quality parameters: coliform bacteria, dissolved oxygen, BOD, Nitrate, pH, Phosphate, Temperature and Turbidity.
16	Water quality - H_2S	Bottle with hydrogen sulphide strip (H_2S water test kit).
17	Compass	90 mm in diameter and 22 mm high, and graduated in easy-to-read increments, waterproof.
18	Measuring staff	Metre pole sections in red and white.
19	Jars with screw top lids	500ml with wide lid.
20	Measuring containers	Clear plastic, capacity 1000ml, show divisions every 10ml.
21	Torch	Solar, kinetic, magnetic LED, waterproof.
22	Gloves	Cloth gloves (10 small and 10 medium).
23	Safety spectacles	Clear frames, should be able to wear over prescription spectacles.
24	Sediment sorting trays (3 sizes)	Diameter or length up to 30, Plastic sieve, aperture size 0.1mm, 0.3mm and 0.5mm.
25	Stopwatch	0.1sec, 30sec, 15min dials, diameter 45mm, housed in a plastic case, water proof.
26	Garden fork	Children's garden fork with plastic handle.
27	Garden spade	Children's garden spade with plastic handle.
28	Solar cell educational kit	Comprises of Solar cell module, solar energy introductory booklet; Small DC motor, screws and nuts, wire with motor clips; colour spinner discs; paper aero plane and bird models; plastic turnables with 4 sizes, 5/82, 1.52, and 22; plastic fan spinner.
29	Weather kit	Australian Geographic Weather Watch kit, comprises of rain gauge, thermometer, wind speed indicator flap and measuring cylinder. (www.australiangeographic.com.au)
30	Coral watch kit	Coral watch reef education package, The University of Queensland, Brisbane, Australia.
31	Cubic metre set and corner inserts.	A set of three alternately coloured dm triangle metre sticks, nine blank triangle metre sticks and eight corner blocks for the construction of an accurate internal dimension cubic metre.
32	Spring balance	Spring scale, calibrated in grams (to weigh up to 50kg).

DRY KIT		
	Item	Details
Identifications Guides:		
1	Plastic cards	Plastic card set containing pictures and names of fish and other invertebrates.
2	Field Guide	Field guide to Maldivian Birds & Beach Ecosystems (2008).
3	Field Guide	Field guide to Maldivian Plants (2008).
4	Field Guide	Field guide to Maldivian Mangroves (2008).
Flip Charts:		
1	Weather, Water, Waste and Energy	Weather, Water, Waste and Energy Flip Chart (2008).
2	Environment and Biodiversity	Environment and Biodiversity Flip Chart (2008).
Reference Books:		
	Subject	Author, year of publication, title, publisher and ISBN
1	Biodiversity	Krys Kazmierczak (2000) *A field guide to the Birds of India, Sri Lanka*, Pakistan, Nepal, Bhutan, Bangladesh and Maldives, Gopsons Papers Ltd, ISBN 81-87107-04-9
2	Biodiversity	Dr. R.C. Anderson, *Living Reefs of the Maldives*, Novelty Publishers, ISBN 99915-801-1-5
3	Biodiversity	Dr. R. Charles Anderson, (2005), *Reef fishes of the Maldives* Manta Marine Pvt. Ltd, ISBN 99915-5401-7
4	Biodiversity	National Centre for Linguistic and Historical Research, (2002), *Gasgahaagehi*, ISBN 99915-1-016-8
5	Biodiversity	National Centre for Linguistic and Historical Research, (2001), *Dhivehi raajjeygai hedhey baeh meyvaa*, ISBN 99915-1-009-5
6	Biodiversity	National Centre for Linguistic and Historical Research,(2002), *Maamelaameli*, ISBN 99915-1-025-7
7	Traditional Knowledge	National Centre for Linguistic and Historical Research, (2004), *Dhivehi Raajjeyga Huri Aasaaree Thanthan*, 99915-1-063-X
8	Traditional Knowledge	National Centre for Linguistic and Historical Research, (2002), *National Museum*, ISBN 99915-1-016-8
9	Traditional Knowledge	Naseema Mohamed and P.Ragupathy (2005) *Inscriptions of Maldives No 1*, National Centre for Linguistic and Historical Research, ISBN 99915-1-069-9
10	Traditional Knowledge	Naseema Mohamed, (2006), *Essays on early Maldives*, National Centre for Linguistic and Historical Research, ISBN 99915-1-083-4
11	Traditional Knowledge	Dr.Philos Egil Mikkelsen, (2000), *Archeological excavations of a Monastery at Kaashidhoo*, National Centre for Linguistic and Historical Research, ISBN 99915-1-013-3
12	Traditional Knowledge	National Linguistic and Historical Research, (2006), *Vihivana garunuge thereyga Dhivehi Raajje 1*, Novelty press, ISBN 99915-1-061-3
13	Traditional Knowledge	National Centre for Linguistic and Historical Research, (2006), *Vihivana garunuge thereyga Dhivehi Raajje 2*, Novelty press, ISBN 99915-1-084-2
14	Traditional Knowledge	National Centre for Linguistic and Historical Research,(2006), *Vihivana garunuge thereyga Dhivehi Raajje 3*, Novelty press, ISBN 99915-1-085-0
15	Traditional Knowledge	National Centre for Linguistic and Historical Research , (2006), *Vihivana garunuge thereyga Dhivehi Raajje 4*, Novelty press, ISBN 99915-1-069-6
CD:		
1	Hygiene and sanitation	UNICEF hygiene and sanitation TV advertisement clips
2	Biodiversity	Coral Watch Reef Education CD, in the Coral Reef Education Package (see above)

WET KIT		
	Item	Details
1	Snorkel	Colourful, snorkelling - Ordinary
2	Masks	Colourful, snorkelling - Small 8 , Medium 12
3	Booties	Colourful, snorkelling - Small 5 , Medium 10, Large 5
4	Footwear / Gumboots	Rubber footwear, gumboots
5	Kick boards	Swimming boards for children (ages 6-13)

OPERATION AND MAINTENANCE OF TOOLBOXES:

- Toolbox Log – each time someone takes any equipment from the toolbox they should sign for which pieces they are using and sign again when they return them. An equipment log will be kept in each toolbox.
- Paper materials – it is important that books, posters, Flip Charts and pictures be kept in a dry place that is well aerated and free from insects. If these materials do get wet it is important to dry them immediately and not to put wet items back with the dry items.
- Outdoor equipment – if any equipment is used outdoors it is very important to ensure that it is clean and dry before it is put away. It is important to store this equipment in a dry, well aerated area that is free from insect or animal damage.
- Wet equipment – some equipment such as masks, snorkels, booties, etc are made for using in the ocean, but if you don't rinse them in fresh water after each use they will quickly become damaged. It is important to store this equipment in a dry, well aerated area that is free from insect or animal damage.
- Specialist equipment – some items don't just need care in storage they need skill in setting them up for correct use. Binoculars for example need to be calibrated for use – different people may need it adjusted for their eyesight.
- Damage – if items are damaged beyond use it may be possible to get replacement items from your local Teacher Resource Centre. They only have limited replacement items so keep your toolboxes in good order.

MODULE SUMMARY

This Module has been developed to complement the theme 'Life around Us' in the Environmental Studies curriculum. The Module mainly looks at humans in the environment and the living things that form the habitats which are the Maldives. A duty of care is the theme of the Module. A duty of care draws together the knowledge gained by learning, observation and investigation of the plants and animals which share the Earth with us and encourages students to be aware of their environment.

As living things make up the environment, an effective environmental program should focus its activities on living things and their interactions between the environment, for it is the human activities that brings turbulence to nature. Consequently the interrelated network of relationships between living things and the environment is the main focus of this Module.

This Module would definitely alert the students to be more cautious about living things, and care for them, believing that they are an important component in the natural cycle of the environment.

The table below depicts the toolbox contents needed for the practical application of this Module.

Item	Details	Section
Plastic vials/jars screw tops	100-300ml	1
Hand lenses	Magnification x 3, lens diameter 90mm, plastic handle.	1
Insect catching nets	Hand net for insects, overall length 1.48m, diameter 250mm	1
Binoculars	Magnification 7×50, waterproof	1, 3
Thermometers	Mercury in glass, permanent amber markings, with anti-roll clip, range -10 to 110°Celsius, 6mm diameter with reinforced bulb, in plastic case	1
Footwear/ gumboots	Rubber footwear, gumboots	1
Globe: planet Earth	Rubber ball - globe of the Earth, fully numbered meridian ring, diameter of globe 30 cm.	1
Measuring tape (50m)	Sturdy, length 50m	1 and 4
Student microscope	Monocular head rotates 360 degrees and has a 10x eyepiece. DIN 4x, 10x and 40x glass achromatic optics on the triple nosepiece.	1
Spring balance	Spring scale, calibrated in grams (to weigh up to 50kg)	1
Gloves	Cloth gloves (10 small and 10 medium)	1
Twine	Brightly coloured nylon twine (20m)	1 and 3
Low cost water monitoring kit	Provides simple and non-hazardous method of testing 8 basic water quality parameters: coliform bacteria, dissolved oxygen, BOD, Nitrate, pH, Phosphate, Temperature and Turbidity	1 and 3
Jars with screw top lids	200-300ml wide lid	1 and 2
Snorkel	Colourful, snorkelling – ordinary	2
Booties	Colourful, snorkelling - Small 5 , Medium 10, Large 5	2 and 3
Safety spectacles	Clear frames, should be able to wear over prescription spectacles.	3
Sediment sorting trays	Diameter or length up to 30, Plastic sieve, aperture size 0.1mm, 0.3mm and 0.5mm	3
Stopwatch	0.1sec, 30sec, 15min dials, diameter 45mm, housed in a plastic case, water proof	3
Garden fork	Children's garden fork with plastic handle	4
Garden spade	Children's garden spade with plastic handle	4

Item	Details	Section
Flip Charts		
Environment and Biodiversity Flip Chart (2008)	General Environment and Biodiversity	1, 2 and 3
Water, Weather, Waste and Energy Flip Chart (2008)	Water, Weather, Waste and Energy	4
Field Guides		
Field Guide to Maldivian Mangroves (2008)	Field Guide to Maldivian Mangroves	1
Field Guide to the Maldivian Birds and Beach Ecosystems (2008)	Field Guide to the Maldivian Birds and Beach Ecosystems	2 and 3
Field Guide to the Maldivian plants (2008)	Field Guide to the Maldivian Plants	3 and 4
Reference Books		
Biodiversity	Dr. R.C. Anderson, Living Reefs of the Maldives, Novelty Publishers, ISBN 99915-801-1-5	2
Biodiversity	Dr. R. Charles Anderson, (2005), Reef fishes of the Maldives Manta Marine Pvt. Ltd, ISBN 99915-5401-7	3
Biodiversity	Krys Kazmierczak (2000) A field guide to the Birds of India, Sri Lanka, Pakistan, Nepal, Bhutan, Bangladesh and Maldives, Gopson Paper Ltd.	3
Biodiversity	National Centre for Linguistic and Historical Research (2002) Maamelaameli	4
Biodiversity	National Centre for Linguistic and Historical Research (2002) Gasgahaagehi	4

1 MANGROVES

Grade: 4 to 5
Number of lessons: 4 to 6 lessons

Purpose

To become aware of who lives in mangroves and why it is important to protect them.

Key questions

Key focus questions for this section are:

- Why are mangroves important?
- Who lives in mangroves?
- What can people do to protect mangroves?

Links with other Modules

Resources from the Environment

Toolbox

Physical materials

Plastic vials, hand lenses, large forceps, insect catching nets, binoculars, thermometers, footwear/gumboots, globe - planet earth, measuring tape (50m), student microscope, clipboards. Spring Balance, gloves, string, water monitoring kit, jars with caps for samples.

Flip Charts

Environment and Biodiversity Flip Chart

Field Guides

Field Guide to Maldivian Mangroves

Preparation

You will need to refer to the pages on Mangroves in the Environment and Biodiversity Flip Chart for the beginning of this section of the Module. Read *Teacher Information Sheets 1.1 and 1.2* in order to familiarise yourself with the background to mangroves and *Teacher Information Sheets 1.3 and 1.4* to know how to prepare for a field trip.

1.1 TUNING IN

The following activities help to engage and focus students' interest on the topic.

ACTIVITY 1: FOOD WEB CHASEY- LIFE IN THE MANGROVE

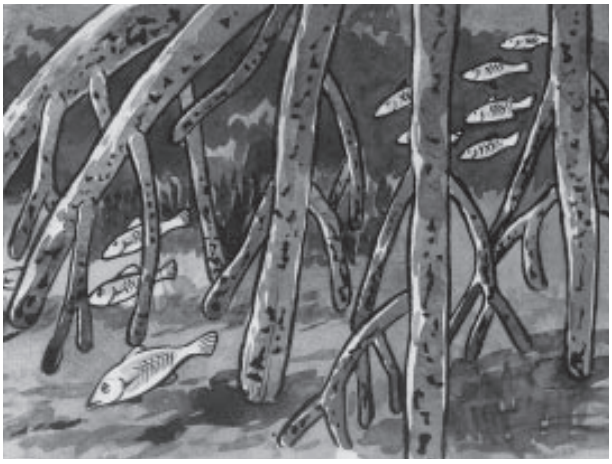
Purpose: To become familiar with each mangrove creature and their place in the mangrove food web.
Time: Approx. 1-1.5 hours
Materials Required: A4 paper or Bristle board, markers, coloured pencils
Resource / Information Sheets: 1.1 Student Resource Sheet – Life in a Mangrove

Procedure

This activity can be played as a game. 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.



Many animals, such as fish, live in the mangroves.

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

ACTIVITY 2: GETTING THE BALL ROLLING

Purpose: To encourage students to share what they already know about mangroves.
Time: Approx. 1 hour
Materials Required: Globe of Earth
Resource / Information Sheets: N/A

Procedure

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. For example 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 e.g. 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.

Students getting the ball rolling about mangroves.

ACTIVITY 3: CLUE CARDS

Purpose: To identify mangrove creatures.
Time: Approx. 1 hour
Materials Required: Bristle board, markers
Resource / Information Sheets: N/A

Procedure

Students devise clues through which others must guess a mangrove creature, for example: I have long legs, I have a long beak and grey feathers; What am I?

These clues are written on the outside of folded cards. On opening the card, the answer will be found written and illustrated inside.

1.2 DECIDING DIRECTIONS

The following activities will assist students to decide on the directions they wish to take in their research.

ACTIVITY 4: I SPY A MANGROVE

Purpose: Students identify a mangrove and the living and non-living things they will find there.
Time: Approx. 30 minutes
Materials Required: Environment and Biodiversity Flip Chart
Resource / Information Sheets: 1.2 Student Resource Sheet- I Spy a Mangrove

Many animals depend on mangrove habitats.

Procedure

Show students the page 'Mangroves: an ecosystem' from the Environment and Biodiversity Flip Chart. Ask students to point out all the living and non-living things on the page. Students make a list of the plants, animals and human structures, etc., they might find in the mangrove on *Student Resource Sheet 1.2*.

Teacher collates student responses onto class chart. Example of chart:

Living things		Non-living things	
Plants present	Animals present	Human structures	Litter

ACTIVITY 5: WHAT DO WE KNOW?

Purpose: To help establish what students already know about mangroves and focus the investigation.
Time: Approx. 1.5 hours
Materials Required: Paper and pencils, Environment and Biodiversity Flip Chart.
Resource / Informaton Sheets: N/A

Procedure

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 are the features of mangroves? (How do they get oxygen?)
- What kinds of animals and plants live in mangroves?

- What do humans use mangroves for?
- What are the things that can harm mangroves?

Once students have compiled their lists, show students the pages 'Mangrove identification' and 'Life in the Mangroves' from the Environment and Biodiversity Flip Chart. Explain to the students the main features of mangroves and the many types of animals found in the mangroves.

Now ask students to return to their four groups and try and think of more responses to the focus questions. Display the four lists and share. Students underline questions in one colour that they are sure about. Underline in another colour things they are not sure about. Develop a common list for the whole class from the separate brainstorms.

The issues that may be raised or topics identified for further investigation from the mangrove investigation may be:

- Sedimentation –depth and analysis of sediment
- Human activities in the mangrove – any or all of these activities might impact on the mangrove environment. For example, people fishing may leave fishing line behind
- Mangrove debris – includes waste brought in by the sea, as well as household waste dumped amongst the mangroves
- Water quality – measure the pH, and presence of salt in different parts of the mangrove
- Plants and animals – mangroves serve as a critical link between marine and terrestrial environments.

Identify the steps that need to be taken for further study to occur, from the questions that have been raised by previous discussions. The following may need to be considered:

- What questions do we need to ask about mangroves?
- How are we going to conduct our inquiry?
- What sort of timeline do we need to set?
- What type of information do we need and how do we find and collect this information, e.g. organise an excursion or locate resources.
- What is the best way of allocating tasks e.g. forming small groups or creating individual projects?
- How will we organise or present our findings?

1.3 FINDING OUT

The following activities involve students in shared experiences that provide new information about the topic and stimulate curiosity.

ACTIVITY 6: FIELD TRIPS

Purpose: To provide students with the opportunity to observe, record, identify, classify and investigate.
Time: Approx. 2 hours or more on 2 trips.
Materials Required: Notebook, pencil, Field Guide to Maldivian Mangroves, Field Guide to Maldivian Plants, and Field

Guide to Maldivian Birds & Beach Ecosystems. Ask students to wear long pants and shoes.
Resource / Information Sheets: 1.3 Student Resource Sheet- Describing the Physical Environment, 1.4 Student Resource Sheet- Plant and Animal Recording Sheet, 1.5 Student Resource Sheet- Plant and Animal Identification Sheet

Procedure

Make sure when you are making field notes, you record the following:

- the name of the animal or plant observed
- date
- area
- time
- other details

Suggested activities while on your field trip include:

Bird watching

- Wear colours that blend in with the environment.
- Move quietly and gently in small groups.
- Avoid making sudden noises.
- Try not to move when the bird is calling.

To identify a bird look for:

- What it is doing.
- Proportions e.g. long or short legs, large or small head compared to body, angle of tail and body.
- Size – compare it to a bird you know e.g. the same size as a crow
- Shape of the beak.
- Colours and patterns – position on the body.
- Where it is located e.g. perched in a tree.
- With large groups of birds make an estimate of the number.

Other ideas for bird watching activities:

- Record the excursion through photography, video, art or written accounts;
- Invite an expert to accompany the excursion to identify mangrove flora and fauna;
- Visit the area during different times of the year and record any changes;
- Try to use your data to make observations about the ecosystem. Store your findings (such as in a computer) to be added to next year, to build up a complete picture of your chosen area.

Binoculars can help identify birds from a distance during bird watching activities.

Describing the physical environment in the mangroves.

Describing the Physical Environment

Record information about the physical environment of the mangrove site being visited on *Student Resource Sheet 1.3.* This is a good opportunity to bring technology into the activity through encouraging the students to devise apparatus to measure wind strength. The following equipment will be necessary to obtain further information about the physical environment:

- Thermometers to measure the temperature of soil which is exposed and soil with plant growth.
- Thermometers to measure the temperature of the air
- A pH testing kit to test the pH of soil
- Information about average annual rainfall could be obtained from local authorities.

Plant and animal observations

Take time to quietly observe the plant and animal life present. Look through the Field Guide to Maldivian Mangroves to help identify the plants and animals that are present. You may also find it helpful to look through the Field Guide to Maldivian Plants and Field Guide to Maldivian Birds and Beach Ecosystems. Students record their sightings on *Plant and Animal Identification Sheets*.

- plants
- invertebrates
- mammals
- birds
- reptiles and
- amphibians.

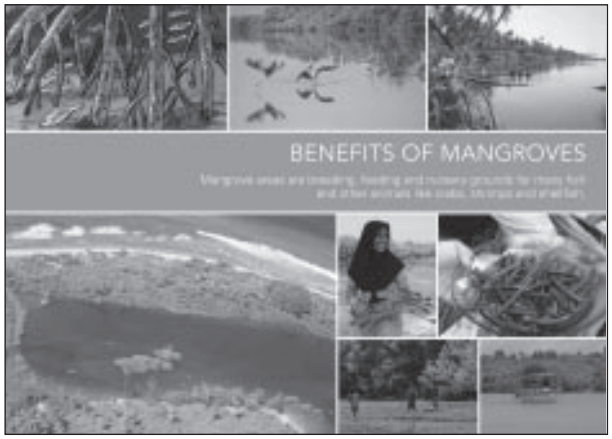
Refer to *Student Resource Sheet 1.4* and *Student Resource Sheet 1.5.*

ACTIVITY 7: HUMAN ACTIVITIES IN THE MANGROVES

Purpose: To carefully observe the human activity in the mangrove over a period of time.
Time: Approx. 2 hours or more on 2 trips.
Materials Required: Note pad, pen or pencil, Environment and Biodiversity Flip Chart.
Resource / Information Sheets: 1.6 Student Resource Sheet- Human Activities in the Mangrove

Procedure

Show students the pages 'Benefits of Mangroves' and 'Protecting Our Mangroves' from the Environment and Biodiversity Flip Chart. Discuss with the students the benefits of mangroves and how we can act to protect the mangroves. Discuss some of the threats to mangroves.



Observe and record in *Student Resource Sheet 1.6,* the different types of activities occurring in the mangrove. Include details on time of day, who or what was involved, how many people etc. The more detailed the better.

Back in the classroom draw up a timeline of activities.

Divide the activities in to two groups:

- Activities that might harm the mangrove.
- 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.

Further activities

Conduct a survey of people's opinion of the mangrove or of issues you have identified.

ACTIVITY 8: MANGROVE DEBRIS

Purpose: To observe, measure and record the debris in the mangrove.
Time: Approx. 2 hours.
Materials Required: Note pad, pen or pencil.
Resource / Information Sheets: 1.7 Student Resource Sheet- Waste in the Mangrove

Procedure

Prepare the class by explaining the activity and going over safety tips:

- Do not go near any large drums
- Be careful with sharp objects
- Wear gloves
- Stay out of sinking mud
- Don't lift anything too heavy

Unfortunately waste is commonly dumped into the mangroves.

Choose a location in the mangrove, and record that location. Using a tape measure (25 m) measure out a transect line that starts in the mangrove and runs towards the sea.

Record the type of waste and its location in *Student Resource Sheet 1.7.*

Back in the classroom group the waste e.g. plastic, Styrofoam, glass, rubber, metal, paper, wood, and cloth.

Discuss the possible origins of the materials collected:

- materials from the sea e.g. fishing floats
- materials that came from nearby communities e.g. household goods
- materials that may have come from either group e.g. rope

ACTIVITY 9: WATER QUALITY IN THE MANGROVES

Purpose: To measure the quality of the water in the mangroves.
Time: Approx. 1 hour.
Materials Required: Sampling containers, water test kit.
Resource / Information Sheets: 1.7 Student Resource Sheet- Waste in the Mangrove

Procedure

Remove the cap of the sampling container. Rinse the bottle with sea water. Hold the jar near the base and plunge the jar below the water. Allow the water to flow in for about 30 seconds. Cap the full jar whilst under water.

Choose which of the qualities of the water you would like to measure.

- Faecal coliform bacteria
- dissolved oxygen
- pH
- temperature
- turbidity

Refer to tool kit guide for instructions on how to do tests.

Discuss the results of the tests. If any of the results indicate the water is different to normal levels discuss the possible reasons for this.

Further activities

Continue to monitor water quality and send results to water authorities to assist them with their research.

1.4 SORTING OUT

Students at this stage will be collating, processing, analyzing and presenting the information in a variety of ways. Students will have the opportunity to further explore any questions that may have arisen when they were investigating. This would also be a good time to revisit some of the initial activities from Tuning In or Deciding Directions sections, for the students to witness how their knowledge has increased.

ACTIVITY 10: SUMMARISING DATA

Purpose: To collate data gathered from excursions to the mangroves.
Time: Approx. 1 hour, 20 minutes.
Materials Required: Completed Plant and Animal Identification Sheets from previous activities.
Resource / Information Sheets: N/A

Procedure

Students complete their investigation sheets.

- animals and plants
- features of mangroves
- uses of mangroves
- harming mangroves

Groups take it in turn to report on what they discovered. One way of doing this is to organise the groups so that there are representatives from each investigation. Each person reports to the group on what they discovered. For example compare the most common species observed in the mangroves.

Information should be added to the original four lists that were devised at the initial stages of this section of the Module.

After visiting the mangroves, it is important to sort out the data that was collected.

ACTIVITY 11: REPRESENT THE EXPERIENCE

Purpose: Students record the features of mangroves through a choice of mediums.
Time: Approx. 1.5 – 2 hours
Materials Required: Natural materials such as bark, grass, twigs, water based paint, paper, markers, pencils
Resource / Information Sheets: N/A

Procedure

Art – This may be a general response or specific to the students' investigations. They may show something they saw at the mangroves or show their findings using a variety of art materials.

You may suggest some watery 'art', such as using water colours, drawing with chalk on wet paper, using weak solution of paint and water to wash over a picture done in pastel.

Use photographs to display various aspects of the mangrove area.

Make models of the mangroves that you visited. Use natural materials such as bark, grass, twigs, and rocks to bring the model to life.

Written reports – As a class write a story to report on your visit to the mangrove area. Students may write individual reports on their visit.

1.5 DRAWING CONCLUSIONS

The following activities will help students to interpret information, establish connections and confirm/reject or modify predictions.

ACTIVITY 12: CONCEPT MAP OF A MANGROVE

Purpose: Students draw conclusions about what they have learnt.
Time: Approx. 1 hour
Materials Required: Ten small cards for each student and large sheets of paper.
Resource / Information Sheets: N/A

Procedure

By now students should have the understanding that:

- there are links between human activity and survival of animals and plants; and
- it is our responsibility to look after the environment, as we can be affected too.

Links can exist between actions such as planting trees and the conservation of endangered habitats and the living creatures within them.

Provide ten small cards for each student. On one of the cards students write 'mangroves'. On the remaining cards they write any words or draw pictures about mangroves that they think are the most important ones. On the big sheets of paper it is the student's task to organise the cards on the paper in a way that makes sense to them. They have to show how the words relate to each other with a series of lines connecting the cards. Words or phrases are written on the lines to make the connections clearer.

Students share their maps with a partner, group or class.

1.6 CONSIDERING, PLANNING AND TAKING ACTION

As a result of students being actively involved in decision making throughout the inquiry process, it is hoped that they will be empowered to take action which has positive personal, community and global effects. Some suggestions are listed below:

ACTIVITY 13: TAKING ACTION ON MY ISLAND

Purpose: To consider, plan and take action on issues with mangroves.
Time: Minimum 30 minutes
Materials Required: Pens, paper, markers
Resource / Information Sheets: Teacher Information Sheet 1.5- Case study

Procedure

Share with students the Case Study of Huraa Environment Club in *Teacher Information Sheet 1.5.* Discuss with students ways to raise awareness on mangroves in your community. Some suggestions for taking action on your island include:

- Clean up the mangrove
- Write to the island authorities about the protection or upkeep of the local mangrove.
- Write a brochure for public distribution to raise awareness of the importance of mangroves.
- Complete an Environmental Impact Assessment.
- Start a Youth Environment Club.

Students taking action to replant mangroves on K. Huraa.

1.7 EVALUATION AND REFLECTION

At this stage it may become evident that there is a need to return to some stages of the inquiry process to clarify knowledge or refine skills.

The following questions may be asked:

- Are you happy with the ways in which your information was gathered, analysed and presented?
- Is there anything you would change?
- Are there things you need to investigate further?
- Students could record the concepts they have developed in a poster or an information brochure on mangroves.

ACTIVITY 14: LESSONS LEARNT

Purpose: To consider, plan and take action on issues with mangroves.
Time: Minimum 30 minutes
Materials Required: Pens, paper, markers
Resource / Information Sheets: Teacher Information Sheet 1.5- Case study

Procedure

Ask students to write down:

- Four important ideas/concepts/information/values I have learnt in this section of the Module are ……
- Two things I now want to do for myself and for others are…….

Ask students to decide what they would like to do with the results of their research and discussion.

1.1 STUDENT RESOURCE SHEET

LIFE IN THE MANGROVE

Draw or sketch the following:

Birds	Mosquitoes
Small fish	Jellyfish
Big Fish	Small prawns
Crabs	Hermit crab

1.2 STUDENT RESOURCE SHEET

I SPY A MANGROVE

Make a list of plants, animals and human structures that may be found in the mangroves.

Living things		**Non-living things**	
Plants present	Animals present	Human structures	Litter

1.2 EXAMPLE OF COMPLETED STUDENT RESOURCE SHEET

I SPY A MANGROVE

Make a list of plants, animals and human structures that may be found in the mangroves.

Living things		**Non-living things**	
Plants present	Animals present	Human structures	Litter
Kandoo	Crabs	Boardwalk	Nappies
Randoo	Fish	Jetty for fishing	Plastic bags and bottles
Coconut tree	Birds	Plastic pipe	old shoes

1.3 STUDENT RESOURCE SHEET

DESCRIBING THE PHYSICAL ENVIRONMENT

Wind strength

Light Breeze Gale

1 2 3 4 5

Light intensity

Dull Bright

1 2 3 4 5

Temperature

Sun _____C

Shade _____C

Average Annual Rainfall

_____ mm rainfall

Water Turbidity (visual)

Clear Opaque

1 2 3 4 5

Soil texture _____

Soil temp	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Bare ground								
Soil with plant growth								
Soil under water								

1.3 EXAMPLE OF COMPLETED STUDENT RESOURCE SHEET

DESCRIBING THE PHYSICAL ENVIRONMENT

Wind strength

Light Breeze Gale

1 (2) 3 4 5

Light intensity

Dull Bright

1 2 3 4 (5)

Temperature

Sun __31__C

Shade __29__C

Average Annual Rainfall

__1500__ mm rainfall

Water Turbidity (visual)

Clear Opaque

1 2 3 (4) 5

Soil texture ___smooth____

Soil temp	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Bare ground	35°C	34°C						
Soil with plant growth	30°C	28 °C						
Soil under water	27 °C	26 °C						

1.4 STUDENT RESOURCE SHEET

ANIMAL RECORDING SHEET

Observing Mangrove Animals

Write the name or draw the picture of the animals you see.

Describe or draw the habitat of each animal.

If possible, describe or draw the food eaten by each animal.

1.4 STUDENT RESOURCE SHEET

PLANT RECORDING SHEET

Observing Mangrove Plants

Write the name or draw a picture of the plants you can see.

1.5 STUDENT RESOURCE SHEET

ANIMAL IDENTIFICATION SHEET

Observing Mangrove Animals

Record information about the mangrove animals you observe using descriptions and illustrations.

Name and drawing of animal	Number observed	Description of habitat	Food source
Invertebrates			
Birds			
Reptiles			
Fish			

1.5 STUDENT RESOURCE SHEET

PLANT IDENTIFICATION SHEET

Observing Mangrove Plants

Record information about the mangrove plants you observe using descriptions and illustrations.

Name of plant	Description and drawing of plant	Number observed
Grasses		
Shrubs		
Trees		

1.5 EXAMPLE OF COMPLETED STUDENT RESOURCE SHEET

ANIMAL IDENTIFICATIONS SHEET

Observing Mangrove Animals

Record information about the mangrove animals you observe using descriptions and illustrations.

Name and drawing of animal	Number observed	Description of habitat	Food source
Invertebrates Crabs 	50+	Likes the mud. Lives in holes in the mud.	Eats mud
Birds Heron 	1	Sits in tall tree and comes to water to eat.	Eats small fish.
Reptiles			
Fish			

1.6 STUDENT RESOURCE SHEET

HUMAN ACTIVITIES IN THE MANGROVE

Observe and record human activities in the mangrove over a period of time.

Time of day	Who or what involved	How many people	Description of activity

1.6 EXAMPLE OF COMPLETED STUDENT RESOURCE SHEET

HUMAN ACTIVITIES IN THE MANGROVE

Observe and record human activities in the mangrove over a period of time.

Time of day	Who or what involved	How many people	Description of activity
8am	Fishermen	2	Fishing in the mangroves.
9am	Young women	4	Collecting seeds from Kandoo to eat.
10am	Older woman	1	Dumping waste near mangroves.
4pm	Youth group	10	Planting mangrove seedlings.

1.7 STUDENT RESOURCE SHEET

WASTE IN THE MANGROVE

Observe and record waste in the mangroves.

Item	Type of waste	Location

1.7 EXAMPLE OF COMPLETED STUDENT RESOURCE SHEET

WASTE IN THE MANGROVE

Observe and record waste in the mangroves.

Item	Type of waste	Location
Old shoes	Human made. Waste from nearby communities.	Near boardwalk.
Fishing net	Human made. Waste from nearby communities.	Near beach.
Rope	Human made. Waste from nearby communities or from the sea.	Near beach.
Nappies	Human made. Waste from nearby communities.	Near boardwalk.
Plastic bags	Human made. Waste from nearby communities or from the sea.	Near boardwalk.

1.1 TEACHER INFORMATION SHEET

MANGROVES ARE WETLANDS

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.

More recently, there has been an increase in community awareness of the value and needs of wetlands. New approaches to management are being developed and work is being done to rehabilitate damaged and degraded wetlands.

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 act like big spongy filters, taking up water and sediment in run-off during rain storms, removing the sediments, recycling nutrients and putting oxygen into the water.

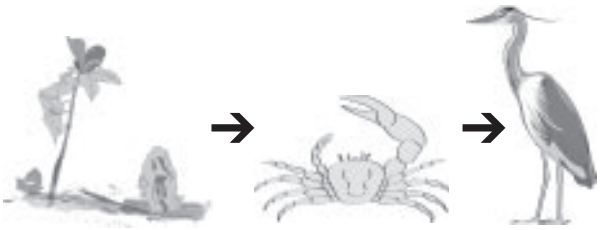
Wetlands support an enormous variety of plants, invertebrates, fish, amphibians, reptiles, birds and mammals. Many species can survive nowhere else. Many unique, rare and endangered species are found only in wetlands.

Many migratory birds depend on wetlands, which means that 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.

An example of a wetland on the islands of the Maldives is the mangroves habitat.

Mangroves

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. A simplified diagram of a food chain to be found in the mangrove area is illustrated on this page.



Decaying leaves → crabs → seagulls

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 (e.g. leaves) 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.

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 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.

Mangrove areas are important because:

- They have murky muddy water that give young fish a place to hide, making it difficult for predators, like birds and big fish, to catch young animals.
- 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).
- Mangrove areas are good for breeding, feeding and nursery grounds for many fish and other animals like crabs, shrimps and shellfish.
- They provide good sources of food and income for communities.
- They provide recreation areas where children play or people might fish.

Mangrove habitats are endangered in the Maldives and need to be protected for many reasons.

Traditional uses of Mangroves

- 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.

Mangrove threats

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 dirt 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 waste – 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 the 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

Through education people can be inspired to care for mangroves.

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 mangrove, invite people to speak to the class, give the students awareness projects that involve people in their homes and the community, such as developing posters.
- 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 mangrove.
- Mangrove reserves – by creating areas of the mangrove as a reserve will ensure protection of the mangrove for the future.
- Protection of endangered species – healthy mangroves provide a home for endangered and protected species.

1.2 TEACHER INFORMATION SHEET

FLORA AND FAUNA IN THE MANGROVES OF THE MALDIVES

Mangrove species in the Maldives

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	Common name
Rhizophora mucronata	Thakafathi	Tall-stilted Mangrove
Ceriops taga	Karamana	Yellow Mangrove
Lumnitzera racemosa	Burevi	Black Mangrove
Rhizophora apiculata	Ran'doo	Red Mangrove
Avicennia marina	Baru	Grey Mangrove
Bruguiera cylindrica	Kandoo	Small-leafed Orange Mangrove
Bruguiera gymnorrhiza	Bodavaki	Large-leafed Orange Mangrove, Oriental Mangrove
Excoecaria agallocha	Thela	Milky Mangrove, Blind-your Eye Mangrove
Heritiera littoralis	Kaharuvah	Looking Glass Mangrove
Sonneratia caseolaris	Kulhlhavah	Mangrove Apple

Features	Name of plant			
	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.

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.

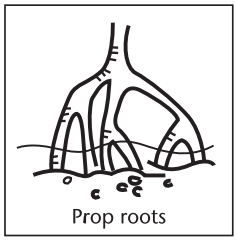
The roots:

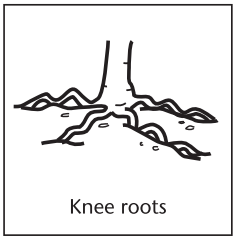
- Anchor the plant
- Absorb minerals
- Exchange gases (Oxygen (O_2) and Carbon Dioxide (CO_2))

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.


Prop roots


Knee roots

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

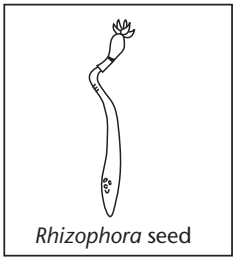
Mangroves usually grow in flat, soft muddy ground. When the long, thin and pointed mangrove seeds fall vertically to the ground, they are able to stick upright in the soft mud.

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.


Rhizophora seed


Bruguiera seed

Mangrove flowers

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

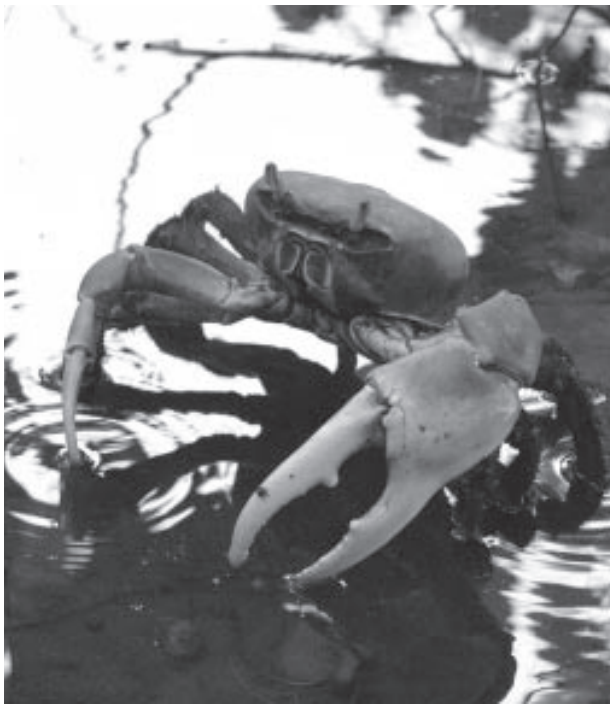

Rhizophora flower


Bruguiera bud

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 Palm
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

Fish in mangroves.



Crab in the mangroves.

Birds

Amaurornis phoenicurus	Dhivehi Kan'bili	Maldivian Water Hen
Anas querquedula	Reyru	Garganey
Ardea cinerea (rectirostris)	Maakana	Eastern Grey Heron
Ardeola grayii (phillipsi)	Huvadhoo raabondhi	Maldivian Pond Heron
Arenaria melanocephala	Rathafai	Black Turnstone
Bubulcus ibis (coromandus)	Iruvaahudhu	Cattle Egret
Butorides striatus albidulusi	Dhivehi Raabon'dhii	Little Heron
Egretta garzetta	Kuda iagana	Little Egret
Phoenicopterus ruber	Gudi gudaa dhooni	Flamingo
Tringa hypoleucos	Fidhana	Common Sandpiper
Numenius phaepus	Bulhithun'bi	Whimbrel

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

References Field, C.D. (1995) 'Journey Amongst Mangroves'. International Society of Mangrove Ecosystems, Okinawa, Japan, 140 pp.

Bird in mangroves.

1.3 TEACHER INFORMATION SHEET

PREPARATION FOR THE FIELD TRIP

Ensure that all necessary preparation and arrangements are made before the field trip.

It is important that the SAFETY of the students is ensured at all times.

Below are some suggestions to ensure your trip is safe, successful and enjoyable.

Setting a date

- Ask permission from the Head Teacher. Ensure the timetable is covered to release the students and teachers to spend time at the mangroves.
- Check if you need to ask permission from the Island Office to access the mangrove area.
- Check the Tide Chart – it is important that you get there during or just before low tide. Choose a day when the low tide is around 9.00 am.
- You will need extra helpers, such as voluntary parents or school committee members, to accompany and supervise the groups during field activities.
- Invite a local expert on the flora and fauna of the island's mangroves, to assist with identification, such as fisherman, field officers for the Ministry of Environment, Water and Energy.

Introduction to the mangroves

- Invite people to speak to your class about the importance of mangroves.
- Have students predict what they will see, hear and touch at the mangroves.
- Emphasise the importance of disturbing as little of the area as possible.
- Check with the Island Office whether they have aerial photos of your island. If you can get photos at different times you can compare the changes over time.

Teacher's responsibilities

- Seek permission from the Head Teacher.
- Seek permission if required to access the area for the field trip.
- Book transport if required.
- Organise equipment and any other resources such as paper and pencils for the clipboards, and copies of activity sheets that may be prepared by you.
- Prepare a first aid kit to be taken on the trip. Ensure it has band-aids, antisceptic cream, spray for stings and bites, mosquito repellent.
- Ensure that students bring proper clothing and shoes.
- Prepare a list of materials that students will need on the trip.
- Send this list to the parents together with a letter requesting permission for their children to join the field trip.
- Check the weather forecast prior to departure in case new arrangements need to be made.
- Check whether students have enough water to drink.
- Take the roll and do a headcount before you leave and once you return from the mangroves.
- Clean the area of litter at the end of the field trip. Ensure no personal belongings are left behind.
- Ensure all students reach home safely.
- Divide the class into working groups (about three students per group). Try to arrange class assistants to assist with supervision of these groups.
- Check with local experts which parts of the mangrove might have mud that students might sink too deeply into. Remember to make students aware of that area and to stay away from it.

Have fun!!!

1.4 TEACHER INFORMATION SHEET
BINOCULARS

Binoculars are one of the handiest and most widely used of all optical instruments. A binocular is a very useful optical aid that can be used to enhance and bring out detail in distant objects, be it birds, nature, sports or astronomy. Binoculars will generally provide you with detailed wide fields of view that cannot be matched by either the unaided eye or spotting scope/telescope. This is because binoculars capture and present the image to both eyes, this can show up to 40% more detail than using a single eye on its own.

What do those numbers mean? 7x50, 10x50?

This describes the power versus the diameter of the front lens. Technically, for example, we can say that a 10x50 has a magnification of 10 times (10x) and an objective lens aperture of 50mm. The front lens is called the objective lens and the diameter is known as the aperture.

A binocular that has 10x magnification (power) means that an object will appear ten times closer than it actually is. For example a bird 100m away when viewed through a 10x binocular will appear as if it is only 10m away.

Resolution (the ability of a binocular to show you small details) is also governed by lens diameter and is directly proportional to the diameter. In other words the bigger the lens, the better the detail.

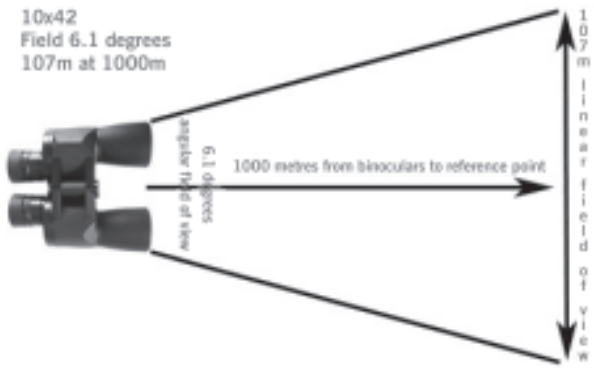
Minimum Focus Distance or Near Focus

Another important factor is the minimum focus distance (how close you can get to an object and still see a sharp image of it in your binocular). This near focus capability is important for watching butterflies, the critical identification of birds in the field, or observing the detail of insects or plants. A close focus distance of under 5m is ideal for many bird watching situations.

The actual close focus distance is dependant to some extent on your own eye characteristics; however the specification is made assuming 20/20 vision.

Depth of Field

This is simply the distance in front of and behind the point of sharpest focus that an image still remains usefully focused in binoculars. A good depth of field minimizes the constant refocusing needed to keep objects sharp as they move about in the field of view. The higher a binoculars



magnification, and the closer it is focused and the shallower its depth of field will become.

A wide field of view makes it easier to quickly find a target as there is more area covered in your view and once located is easier to keep in the field.

Inter pupillary Distance

This is the distance between the pupils of your eyes, measured from centre to centre. If a binocular can't fold down or open up enough for its exit pupils to line up with the pupils of your eyes, a shadow will cut off part of the image you see in one eyepiece or the other.

Safety with Binoculars

Binoculars should be handled with care. Whenever students use binoculars the strap should be placed around their neck so that it is not accidentally dropped on the ground. Dropping binoculars on the ground can damage the internal lenses. Binoculars should always be returned to its case in a clean and dry state. This will help to maintain this piece of equipment in a good condition for all students to use.

1.5 TEACHER INFORMATION SHEET

CASE STUDY - K. HURAA ENVIRONMENT CLUB

K. Huraa School has an Environment Club that runs after school. Of the 170 children that attend the island school sixty children belong to the environment club. They recently assisted in completing a wall mural which is now outside the island office on the Island, opposite the new Youth Building that is being built. The leader of the club said the next dream they would like to achieve is to replant the trees damaged by the 2004 tsunami. They are sourcing trees from a nursery that distributes seedlings to the islands. They are also planning to grow seedlings from the mangroves to replace damaged trees.

Mangrove seedlings will be replanted to replace damaged trees.

Wall Mural by Hurriyya Club, Huraa along with help from Live & Learn Environmental Education.

2 CORAL REEFS

Grade: 4 to 5
Number of lessons: 4 to 6 lessons

Purpose

To become aware of what lives in coral reefs and why it is important to protect them.

Key questions

Key focus questions for this section are:

- Why are coral reefs important?
- What lives in coral reefs?
- What can people do to help coral reefs?

Links with other Modules

Resources from the Environment, Interdependence

Toolbox

Physical materials

Snorkels, goggles and booties

Reference books

Dr. R.C. Anderson, Living Reefs of the Maldives, Novelty Publishers.

Dr. R. Charles Anderson, Reef fishes of the Maldives (2005) Manta Marine.

Flip Charts

Environment and Biodiversity Flip Chart

Field Guides

Field Guide to Maldivian Birds and Beach Ecosystems

Field Guide to Maldivian Plants

Preparation

You will need to refer to the pages on Coral Reefs in the Environment and Biodiversity Flip Chart for this section of the Module. Read the *Teacher Information Sheets 2.1 and 2.2* in order to familiarise yourself with coral reefs.

2.1 TUNING IN

The following activities help to engage and focus students' interest on the topic.

ACTIVITY 1: ON THE EDGE

Purpose: To familiarize students with examples of coral reef animals and plants that have been greatly reduced in number.
Time: Approx. 1 hour
Materials Required: Environment and Biodiversity Flip Chart
Resource / Information Sheets: 2.1 Teacher Information Sheet- Introducing Corals and Coral Reefs; 2.2 Teacher Information Sheet- Threats to Coral Reefs

Procedure

Show students the Flip Chart page 'Threats to Coral Reefs' and discuss the natural and human threats to coral reefs. The students divide into groups to investigate species in the Maldives that are endangered, focusing on factors which might be causing the species to be threatened. As a class collate a list of threats to species. Classify the suggested threats according to whether impact is natural or human. The list can be expanded as the students' knowledge increases.

The teacher can pose questions like, 'How can we obtain further information on threats to coral reef species?'

2.2 DECIDING DIRECTIONS

The following activities will assist students to decide on the directions they wish to take in their research.

ACTIVTIY 2: CORAL REEF LIFE

Purpose: To develop questions to guide research on the Maldives coral reefs.
Time: Approx. 45 minutes
Materials Required: Environment and Biodiversity Flip Chart
Resource / Information Sheets: 2.1 Teacher Information Sheet- Introducing Corals and Coral Reefs; 2.2 Teacher Information Sheet- Threats to Coral Reefs

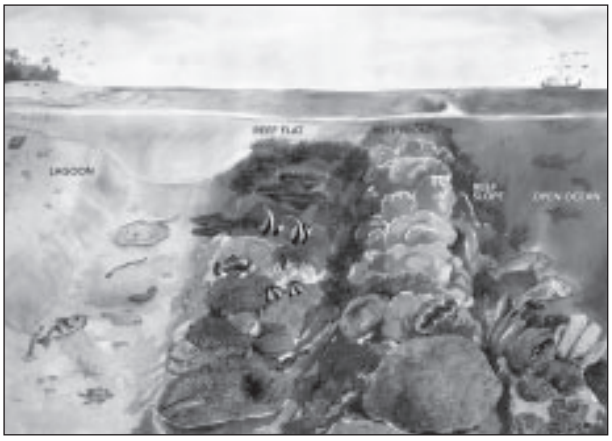
Procedure

Show students the Flip Chart pages 'Coral Reef System' and 'Common Reef Animals' and discuss with students the types of plants and animals found in coral reefs. Explain that in the Maldives the coral reefs are very rich in biodiversity, because they contain many different organisms. Using the ideas that have been raised in the previous activity, ask the students to develop hypotheses or 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.

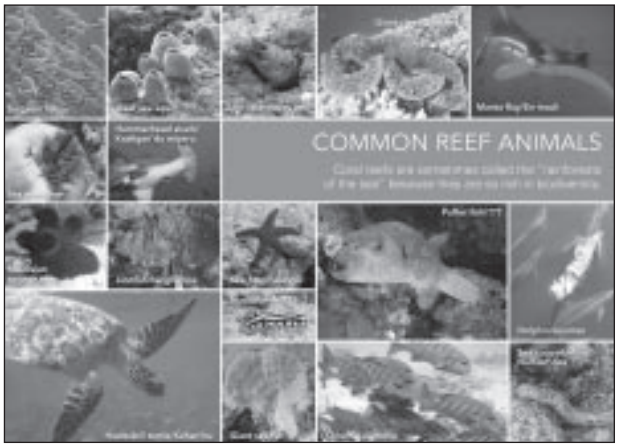
- What are the features of coral reefs?
- What animals and plants do you find living in coral reefs?
- How do humans use coral reefs?
- What can cause harm to coral reefs?
- Does it matter if coral reefs are harmed?
- What can you do to save coral reefs from being endangered?
- What can humans do to manage the world resources in harmony with other life on earth?

From the questions that have been raised by previous discussions, identify the steps that need to be taken for further study to occur. The following may need to be considered:

- What questions do we need to ask about coral reefs?
- How are we going to conduct our inquiry?
- What sort of timeline do we need to set?
- What types of information do we need and how do we find and collect this information? (e.g. organise an excursion or locate resources).
- What is the best way of allocating tasks? (e.g. forming small groups or creating individual projects)
- How will we organise or present our findings?



Coral Reef systems



Common reef animals

2.3 FINDING OUT

The following activities involve students in shared experiences that provide new information about the topic and stimulate curiosity.

ACTIVITY 3: CORAL CLASSIFICATION ACTIVITY

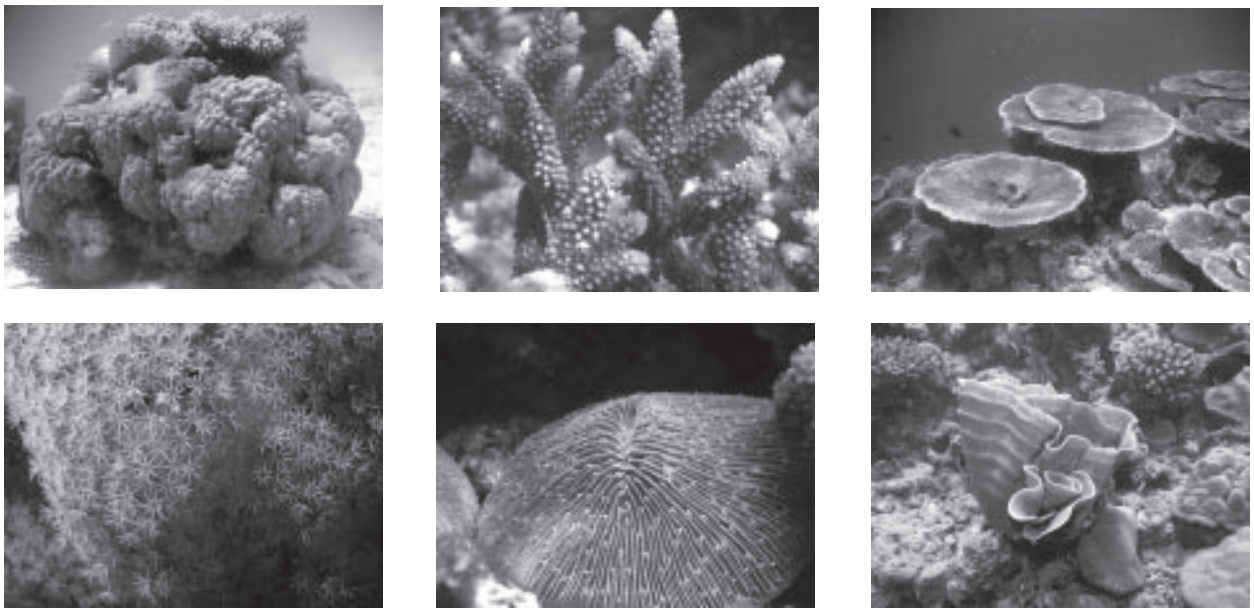
Purpose: To observe and draw the most common types of corals on the reef.
Time: Approx. 2-2.5 hours
Materials Required: Environment and Biodiversity Flip Chart, snorkelling equipment, Coral watch kit, Coral watch reef education CD
Resource / Information Sheets: 2.1 Student Resource Sheet- Coral Classification; 2.2 Student Resource Sheet- Coral watch data sheet; 2.3 Student Resource Sheet- Coral questions; 2.1 Teacher Information Sheet- Introducing Corals and Coral Reefs; 2.3 Teacher Information Sheet- Coral Bleaching

Procedure

Show students the Flip Chart page 'Coral Identification' and discuss with students the main types of corals found in coral reefs, as shown below. Ask the students to sketch the corals on *Student Resource Sheet 2.1*. Ask students to explain the main differences between the different types of corals. Explain to students about the cause and effects of coral bleaching.

If possible arrange for a snorkelling trip to a nearby coral reef to show students the corals underwater. Alternatively teachers can take students to the reef at low tide, when corals are exposed. Prepare for this trip by identifying good locations where these corals are likely to be seen and make the necessary safety arrangements with students. Explain to students how to use 'coral health chart'.

Spend about ten minutes with each type of coral to obtain an accurate picture of what is taking place on, in or around the coral. Using the 'coral health chart' try to assess the health of the corals you see underwater. Write down the results on *Student Resource Sheet 2.2*



Top row: Boulder Coral; Branching Coral; Plate Coral. Bottom row: Soft Coral; Mushroom Coral; Leafy Coral

Back in the classroom sketch the corals on *Student Resource Sheet 2.1*. On the lines below your diagram, list any other marine organisms that you observe on, in or around the corals. With the information gathered, complete the answers on the *Student Resource Sheet 2.3*.

For older students you may want to record the data in the excel spreadsheets on the CD 'Reef Education CD'. Students can then calculate averages and present findings as graphs.

Once you have collected data about your local reef, you may want to share it with local authorities or environmental agencies such as the Ministry of Environment, Energy and Water or the Marine Research Centre.

ACTIVITY 4: OBSERVING AND RECORDING PLANTS AND ANIMALS ON THE CORAL REEF

Purpose: To observe and record plants and animals on the coral reef.
Time: Approx. 2 hours or more on 2-3 occasions
Materials Required: Environment and Biodiversity Flip Chart, snorkelling equipment
Resource / Information Sheets: 2.4 Student Resource Sheet- Animals and Plant identification; 2.4 Teacher Information Sheet- Preparation for the Field Trip

Procedure

If possible arrange for a snorkelling trip to a nearby coral reef to show students the plants and animals underwater. Prepare for this trip by identifying good locations where plants and animals are likely to be seen and make the necessary safety arrangements with students. Using the snorkelling equipment, students identify 10 items on the coral reef and record where they saw the item on the *Student Resource Sheet 2.4*. If they do not know the name of object then draw a sketch next to the number.

As an alternative, teachers can show students the coral reef pages of the Environment and Biodiversity Flip Chart and discuss the plants and animals of the coral reef.

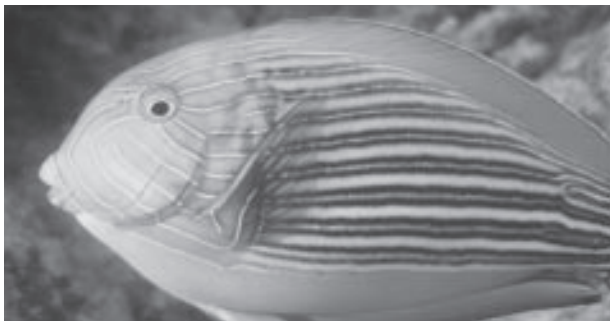
Students research one of the items they saw underwater or on the Flip Chart pages. Describe its shape, colour, size and draw a picture.

Follow up activities

Students also observe and research habits, diet, movement, reproduction, protection and any unusual or interesting features of the plants and animals of the coral reef. Include ways it might be affected by humans and how it might be protected.

2.4 SORTING OUT

Students at this stage will be collating, processing, analysing and presenting the information in a variety of ways. Students will have the opportunity to further explore any questions that may have arisen when they were investigating. This would also be opportune time to revisit some of the initial activities from Tuning In or Deciding Directions sections, for the students to witness how their knowledge has increased.



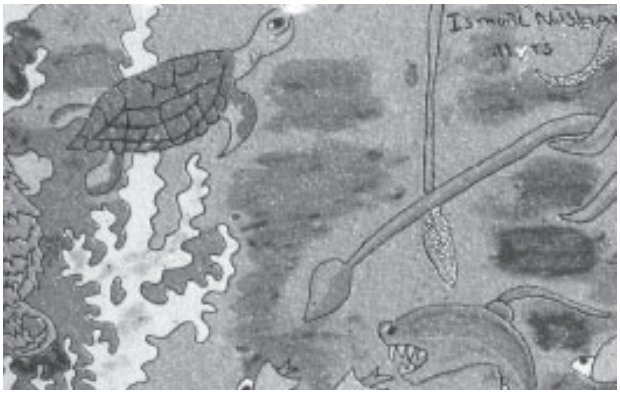
Coral reefs in the Maldives are very rich in biodiversity.

ACTIVITY 5: CORAL REEF MURAL AND WALL STORY

Purpose: To create a wall mural of the coral reef site in the classroom.
Time: Approx. 2 hours or more on 2-3 occasions
Materials Required: A large piece of cardboard or cloth and a variety of materials (markers, paint, coloured pieces of cloth or paper)
Resource / Information Sheets: 2.4 Teacher Information Sheet- Preparation for the Field Trip

Procedure

Using a large piece of cardboard or cloth and a variety of materials, students can create a wall mural of the coral reef site in the classroom. Then add photos, captions and short descriptions to record the students' experiences. Students can use the wall mural to develop their skills at printing using a variety of materials such as sponges and cardboard etc., also washes with pastel underneath or water colours.



Coral reef murals in Male'.

2.5 DRAWING CONCLUSIONS

The following activities will help students to interpret information, establish connections and confirm/reject or modify predictions.

ACTIVITY 6: FUTURE WHEELS

Purpose: To use a future wheel to demonstrate understanding of the importance of coral reefs.
Time: Approx. 1 hour
Materials Required: Pen or pencil
Resource / Information Sheets: 2.5 Student Resource Sheet- Future Wheels

Procedure

By now students should have the understanding that:

- there are links between human activity and survival of animals and plants,
- it is our responsibility to look after the environment, as we can be affected too.

Ask the students to demonstrate their understandings of the importance of coral reefs, by using a Future Wheel to record the consequences of 'no coral reefs'. A future wheel is similar to concept map, but with a focus on cause and effect. The wheel begins with a central cause and then radiates out showing direct and indirect consequences.

The issue is written in the centre of the circles. In this case 'No coral reefs'. The first question is 'What are the immediate consequences?' The group discusses what they think these might be and record them. Each is linked to the central point by a single line.

Next students discuss what consequences may follow on. These can be a double line. The end result is a Future wheel showing the range of possible consequences likely to flow from a particular issue. Different relationships may be observed between different areas.

Refer to *Student Resource Sheet 2.5* for the outline of the Future Wheel.

2.6 CONSIDERING, PLANNING AND TAKING ACTION

As a result of students being actively involved in decision making throughout the inquiry process, it is hoped that they will be empowered to take action which has positive personal, community and global effects.

ACTIVITY 7: CLEAN UP THE REEF

Purpose: To plan an action to raise awareness about the need to protect coral reefs.
Time: Approx. 1- 2hours
Materials Required: Pen or pencil, waste collection bags
Resource / Information Sheets: 2.5 Teacher Information sheet – Case Study: Reef Clean Up 2000

Procedure

Read the case study in *Teacher Information Sheet 2.5* to the students and ask students to consider what action they might take on their island. Suggestions might include:

- Write to the island authorities about the protection or upkeep of the local coral reefs.
- Write a brochure for public distribution to raise awareness of the importance of coral reefs.
- Clean up a nearby reef of waste materials and debris.

Cleaning up the reef is one way to take action on this issue.

ACTIVITY 8: AWARENESS PROJECT

Purpose: To develop an awareness project about the conservation of local coral reefs.
Time: Approx. 1 hour per day for 3-4 days
Materials Required: Markers, coloured pencils, cardboard
Resource / Information Sheets: N/A

Procedure

Divide students into groups and ask each group to think about what kinds of awareness project they might develop about the conservation and protection of coral reefs. Some suggestions are outlined below:

- Create posters for school or the local community that informs others of coral reef issues.
- Give talks to other year levels or the community on issues and action.
- Create a school notice board or newspaper that draws attention to coral reef issues.
- Form an environment club at school with representatives from each class.
- Create public art to raise awareness amongst the community

Allow students time to carry out their awareness project.

2.7 EVALUATION AND REFLECTION

At this stage it may become evident that there is a need to return to some stages of the inquiry process to clarify knowledge or refine skills.

The following questions may be asked:

- Are you happy with the way in which your information was gathered, analysed and presented?
- Is there anything you would change?
- Are there things you need to investigate further?

ACTIVITY 9: MY CORAL REEF

Purpose: To make generalisations about coral reefs.
Time: Approx. 1 hour
Materials Required: Pens, notebooks
Resource / Information Sheets: 2.6 Student Resource Sheet- My Coral Reef

Procedure

Students can complete *Student Resource Sheet 2.6* by writing or drawing responses to the following questions:

- Things that are common in coral reefs
- Things that are rare in coral reefs
- Ways we harm coral reefs
- Ways we help coral reefs

This enables students to reflect on what they have learnt about coral reefs and also indicates to the teacher how the students' understandings of coral reefs have developed.

Other ideas for reflecting or evaluating:

- Filling in a questionnaire,
- Brainstorming about an issue related to coral reefs, and
- Keeping journals throughout the time students are studying the topic.

ACTIVITY 10: LESSONS LEARNT

Purpose: To reflect upon what the students have learnt.
Time: Approx. 10 minutes
Materials Required: Pens, notebooks
Resource / Information Sheets: N/A

Procedure

Ask students to write down:

- Four important ideas/concepts/information/values I have learnt in this section of the Module are ……
- Two things I now want to do for myself and for others are…….

Ask students to decide what they would like to do with the results of their research and discussion.

2.1 STUDENT RESOURCE SHEET

CORAL CLASSIFICATION

Sketch the corals you have observed in the boxes below:

Branching coral	Boulder coral
Plate coral	Soft coral
Solitary/Mushroom coral	Leafy coral

2.2 STUDENT RESOURCE SHEET

CORAL WATCH DATA SHEET

Date of survey: _____/_____/_____
Day Month Year

Time collected: (ie.14:00 or 2pm) _____

Weather: sunny / cloudy / raining

Your activity: reef walking / snorkelling / diving

	Colour Code		Coral Type Br=Branching	Bo=Boulder	Pl=Plate	So=Soft
example	L: D2	D: E5	Br	Bo	Pl	So
1	L:	D:	Br	Bo	Pl	So
2	L:	D:	Br	Bo	Pl	So
3	L:	D:	Br	Bo	Pl	So
4	L:	D:	Br	Bo	Pl	So
5	L:	D:	Br	Bo	Pl	So
6	L:	D:	Br	Bo	Pl	So
7	L:	D:	Br	Bo	Pl	So
8	L:	D:	Br	Bo	Pl	So
9	L:	D:	Br	Bo	Pl	So
10	L:	D:	Br	Bo	Pl	So
11	L:	D:	Br	Bo	Pl	So
12	L:	D:	Br	Bo	Pl	So
13	L:	D:	Br	Bo	Pl	So
14	L:	D:	Br	Bo	Pl	So
15	L:	D:	Br	Bo	Pl	So
16	L:	D:	Br	Bo	Pl	So
17	L:	D:	Br	Bo	Pl	So
18	L:	D:	Br	Bo	Pl	So
19	L:	D:	Br	Bo	Pl	So
20	L:	D:	Br	Bo	Pl	So

2.2 EXAMPLE OF COMPLETED STUDENT RESOURCE SHEET

CORAL WATCH DATA SHEET

Date of survey: 17 / 02 / 2008
Day Month Year

Time collected: (ie.14:00 or 2pm) 2pm

Weather: (sunny) / cloudy / raining

Your activity: reef walking / (snorkelling) / diving

	Colour Code		Coral Type Br=Branching	Bo=Boulder	Pl=Plate	So=Soft
example	L: D2	D: E5	Br	Bo	Pl	So
1	L: D2	D: E5	(Br)	Bo	Pl	So
2	L: B2	D: E5	Br	Bo	(Pl)	So
3	L: C2	D: C6	Br	Bo	Pl	So
4	L: C1	D: C3	Br	Bo	Pl	(So)
5	L:	D:	Br	Bo	Pl	So
6	L:	D:	Br	Bo	Pl	So
7	L:	D:	Br	Bo	Pl	So
8	L:	D:	Br	Bo	Pl	So
9	L:	D:	Br	Bo	Pl	So
10	L:	D:	Br	Bo	Pl	So
11	L:	D:	Br	Bo	Pl	So
12	L:	D:	Br	Bo	Pl	So
13	L:	D:	Br	Bo	Pl	So
14	L:	D:	Br	Bo	Pl	So
15	L:	D:	Br	Bo	Pl	So
16	L:	D:	Br	Bo	Pl	So
17	L:	D:	Br	Bo	Pl	So
18	L:	D:	Br	Bo	Pl	So
19	L:	D:	Br	Bo	Pl	So
20	L:	D:	Br	Bo	Pl	So

2.3 STUDENT RESOURCE SHEET

CORAL QUESTIONS

The following questions relate to the data you have collected, and the results you have obtained from the coral watch kit.

1. Which coral type was the most common?

.....

2. Which coral type was the least common?

.....

3. Which colour score had the highest frequency?

.....

4. Check what the weather conditions were like at your location before you arrived. Have there been any unusual weather patterns experienced at your location recently? If yes, what were they, and what impact do you think they would have had on the reef?

.....

.....

5. What was the average colour score for each coral type? (Use 'Coral watch' colour sheets)

Coral Type	Colour Score
Branching	
Boulder	
Plate	
Soft	

6. How would you rate the general health of the reef at this point in time, based on the data you have collected and analysed together with your general observations? Explain your reasoning.

.....

.....

.....

2.3 EXAMPLE OF COMPLETED STUDENT RESOURCE SHEET

CORAL QUESTIONS

The following questions relate to the data you have collected, and the results you have obtained from the coral watch kit.

1. Which coral type was the most common?

Plate coral was most common around our island.

2. Which coral type was the least common?

Boulder coral was least common.

3. Which colour score had the highest frequency?

4. Check what the weather conditions were like at your location before you arrived. Have there been any unusual weather patterns experienced at your location recently? If yes, what were they, and what impact do you think they would have had on the reef?

No, the sea was very calm before we went snorkelling.

5. What was the average colour score for each coral type? (Use 'Coral watch' colour sheets)

Coral Type	Colour Score
Branching	1
Boulder	3
Plate	2
Soft	2

6. How would you rate the general health of the reef at this point in time, based on the data you have collected and analysed together with your general observations? Explain your reasoning.

The reef is not very healthy. Most of the corals do not have much colour.

Many are still bleached.

2.4 STUDENT RESOURCE SHEET

ANIMAL AND PLANT IDENTIFICATION

Record information about the animals and plants you observe using descriptions and illustrations.

Name and drawing of animal	Number	Description of habitat	Food source

2.4 EXAMPLE OF COMPLETED STUDENT RESOURCE SHEET

ANIMAL AND PLANT IDENTIFICATION

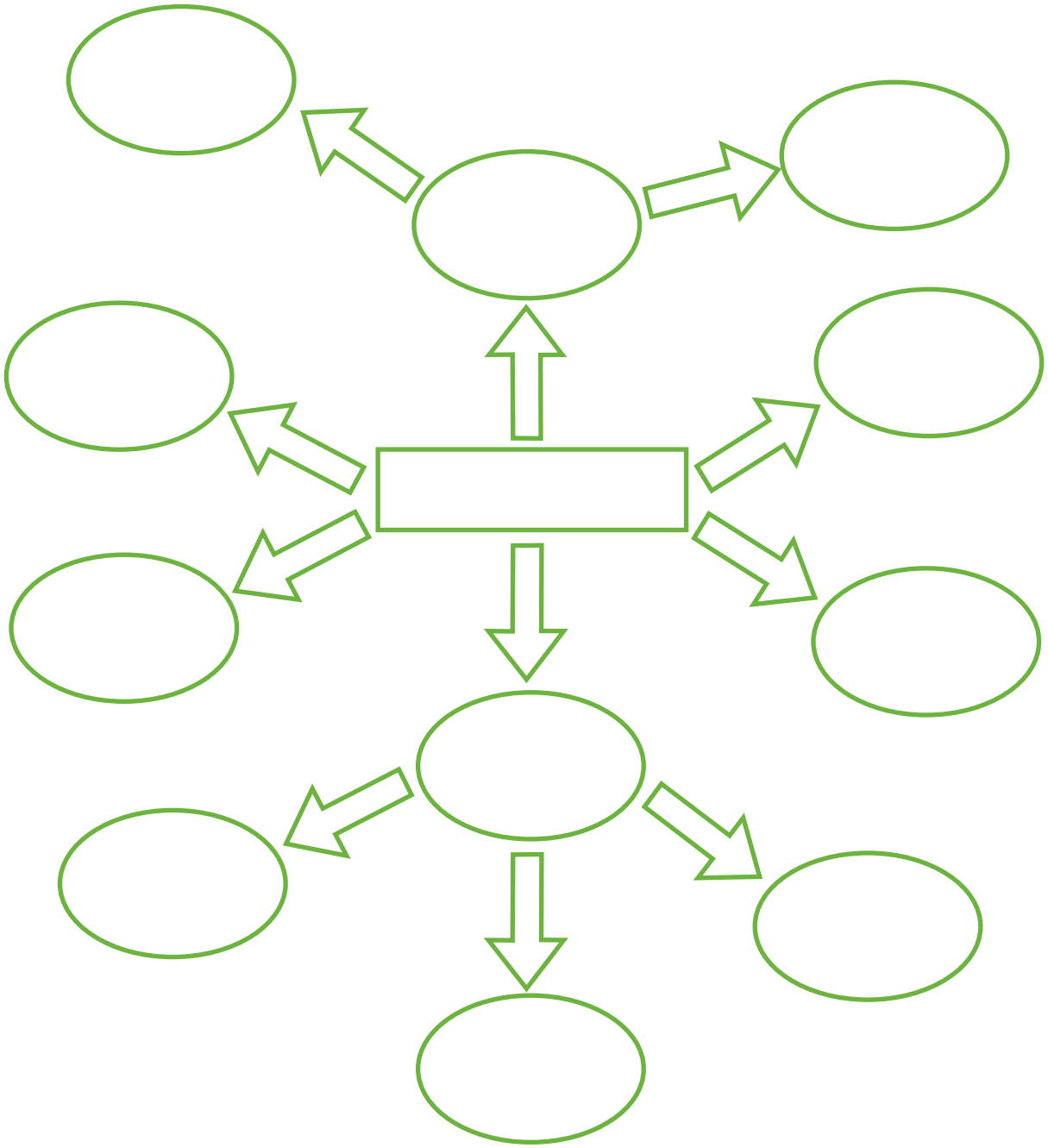
Record information about the animals and plants you observe using descriptions and illustrations.

Name and drawing of animal	Number	Description of habitat	Food source
Turtle 	1	Likes to live near corals and sponges.	Sponges, squid, jellyfish
Fish 	50+	Likes to live near corals.	Small fish, insects.

2.5 STUDENT RESOURCE SHEET

FUTURE WHEELS

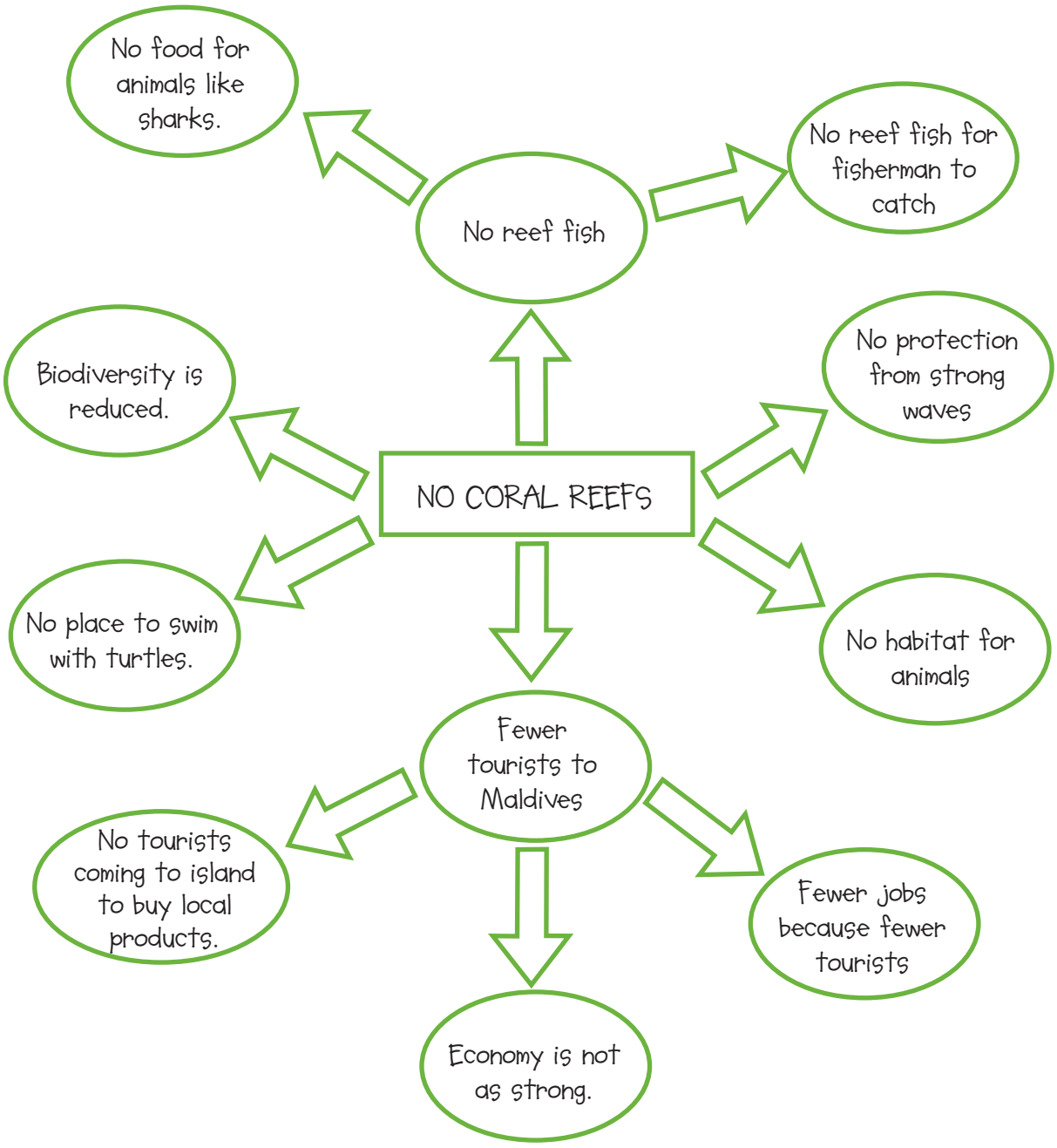
A future wheel is similar to concept map, but with a focus on cause and effect. The wheel begins with a central cause and then radiates out showing direct and indirect consequences.



2.5 EXAMPLE OF COMPLETED STUDENT RESOURCE SHEET

FUTURE WHEELS

A future wheel is similar to concept map, but with a focus on cause and effect. The wheel begins with a central cause and then radiates out showing direct and indirect consequences.



2.6 STUDENT RESOURCE SHEET

MY CORAL REEF

Use words and pictures to fill in the four sections of this table.

- Things that are common in coral reefs.
- Things that are less common in coral reefs.
- Ways in which we can harm coral reefs.
- Ways in which we can help coral reefs.

Common	Less common
Harm	Help

2.1 TEACHER INFORMATION SHEET
INTRODUCING CORALS AND CORAL REEFS

What is a coral reef?

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.

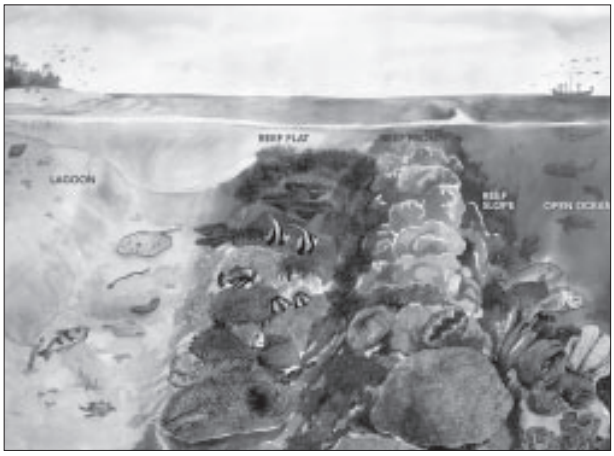
There are 3 basic types of coral reefs:

- 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

Coral reefs are important ecosystems in the Maldives with rich biodiversity.

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.

What are corals?

Corals are in fact animals within the phylum Cnidaria. 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. The word 'coral' groups together a wide variety of animals. Members include soft corals, hard corals, red and black corals.

Interestingly, hard corals are also part-plant, because they contain single-celled algae called zooxanthellae within their cells. 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.

Types of corals to be seen in the Maldives

In the Maldives there are over 250 species of coral. If you are snorkelling 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

Coral reefs: Rainforests of the Sea

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.

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

2.2 TEACHER INFORMATION SHEET
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.

Tourists buying souvenirs can threaten the reef.

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

Pollution from waste can poison the reef.

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.

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.

2.3 TEACHER INFORMATION SHEET
CORAL BLEACHING

Coral bleaching occurs when corals change colour, generally from dark brown to a lighter shade of brown or white. The colour change is generally caused by a loss of zooxanthellae from the coral's tissue, but can also be associated with a decrease in the concentration of photosynthetic pigments within the zooxanthellae. Coral bleaching is a reaction to stress and can be caused by a variety of environmental factors including:

- elevated or decreased water temperatures
- changes in water salinity
- increased solar irradiance (both visible and ultraviolet)
- elevated exposure to chemical contaminants

It is important to distinguish that there are two distinctly different types of bleaching: localised and mass bleaching. Localised bleaching occurs over small geographical regions and can be caused by any of the above factors. Mass bleaching occurs over large geographical regions and is caused by increased water temperature over extended periods of time, together with increased levels of ultraviolet light. Sea temperatures are predicted to continue to rise and thus mass bleaching is expected to occur more frequently, and with greater intensity. This could lead to the death of large areas of coral reefs worldwide within a few decades. 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.

Very little is known about trends of coral bleaching on a global scale. Currently coral health monitoring mainly occurs around a few reefs that are regularly visited by scientists. There are many questions that will have to be answered in order to try and save the reefs. The Coral Health Charts can be used by anyone - scientists, schoolchildren, tourists and politicians. The Charts are based on the actual colours of bleached and healthy corals. Each colour square corresponds to a concentration of symbiotic dinoflagellates (symbionts) contained in the coral tissue. The concentration of symbionts is directly linked to the health of the coral. All you have to do is match the colour of the coral with one of the colours on the chart. You then record the matching colour codes, along with coral type (species if possible), on your data sheet. Once you collect a lot of data you can also send it to the CoralWatch website www.coralwatch.org. If many people around the world, participate in the monitoring program we will be able to answer many questions about coral bleaching.

Reference: www.coralwatch.org
MoEC (2004) 'State of the Environment Maldives' Ministry of Environment and Construction

Coral bleaching is a major concern in the Maldives.

2.4 TEACHER INFORMATION SHEET

PREPARATION FOR THE FIELD TRIP

Ensure that all necessary preparation and arrangements are made before the field trip.

It is important that the SAFETY of the students is ensured at all times.

Below are some suggestions to ensure your trip is safe, successful and enjoyable.

Setting a date

- Ask permission from the Head Teacher. Ensure the timetable is covered to release the students and teachers to spend time at the coral reefs.
- Make sure the group size is not too large – it is important that adults are able to watch the students at all times so as to reduce any accidents.
- Check if you need to ask permission from the Island Office to access the coral reef area. Find the easiest place to access.
- Check the Tide Chart – it is important that you get there during or just before low tide. Choose your day and time accordingly.
- You will need extra helpers, such as voluntary parents or school committee members, to accompany and supervise the groups during field activities.
- Invite a local expert on the flora and fauna of the island's coral reef, to assist with identification, such as fisherman and others from various relevant government and non government agencies.

Introduction to the coral reefs

- Invite people to speak to your class about the importance of the coral reef.
- Have students predict what they will see, hear and touch at the coral reef.
- Emphasise the importance of disturbing as little of the area as possible.
- Check with the Island Office whether they have aerial photos of your island. If you can get photos at different times you can compare the changes over time.

Teacher's responsibilities

- Seek permission from the Head Teacher and Parents.
- Seek permission if required to access the area for the field trip.
- Book transport if required.
- Organise equipment and any other resources such as paper and pencils for the clipboards, and copies of activity sheets that may be prepared by you.
- Prepare a first aid kit to be taken on the trip. Ensure it has band-aids, antiseptic cream, spray for stings and bites, mosquito repellent.
- Ensure that students bring proper clothing and shoes.
- Prepare a list of materials that students will need on the trip.
- Send this list to the parents together with a letter requesting permission for their children to join the field trip.
- Check the weather forecast prior to departure in case new arrangements need to be made.
- Check whether students have enough water to drink.
- Take the roll and do a headcount before you leave, during the activity and once you return from the reef.
- Clean the area of litter at the end of the field trip. Ensure no personal belongings are left behind.
- Ensure all students reach home safely.

Divide the class into working groups (about three students per group). Try to arrange class assistants to assist with supervision of these groups.

Have fun!!!

2.5 TEACHER INFORMATION SHEET

CASE STUDY - REEF CLEAN UP 2000

An annual event supported by PADI international, under the name of Project AWARE, Maldivers has been involved in the clean up of a large area of the Male' west side house reef, since the beginning of the new millennium.

Maldivers diving centre is solely based on diving; which is an activity that needs a healthy marine environment. Also, the members and staff of Maldivers have always had a great love for the environment; understanding the fragile nature of the existence of countries like Maldives, who are dependant on a protected, marine and urban environment, Maldivers took it as a patriotic duty as citizens of Maldives to clean up the local coral reef.

Reef Clean Up 2000 was launched on 5 June 2000, the first World Environment Day of the new millennium at 7am and finished at 5pm. More than a hundred members of Maldivers, Bluepeace, and Studio 1 actively participated in organizing and implementing the launching of Reef Clean-up 2000. Apart from the organizers, Bodybuilding Federation of Maldives, Surfing Association and Club Eagles actively participated in launching the event.

Prior to the Reef Clean Up 2000Project other reef cleanup programs have been conducted as part of annual World Environment Day Programs, as well as Clean Up Maldives program executed by the Government in 1998. These programs have helped create greater awareness amongst the populace on issues regarding the environment. In the past, none of these programs were able to develop into a sustainable program whereby any part of the reef has been completely cleaned of the marine debris. The overwhelming amount of debris cover on the western face of Male' reef has reached an alarming scale.

Maldivers has been carrying out the program since 2000 every year and also been sharing details of their findings to the public. In the past three years alone Maldivers has picked up more than 12 truck loads of debris and waste. More than 150 volunteer divers participated in the last couple of Clean Up's. As the initial area of Clean Up had far more than expected amounts of debris and waste, Maldivers still are working on the same site. Every year more divers and supporters of the program join in and more recognition is given to the program hence its sustainability assured.

http://www.maldivers.net

3 BEACHES

Grade: 4 to 5
Number of lessons: 4 to 6 lessons

Purpose

To become aware of what lives on beaches and why it is important to protect them.

Key Questions

Key focus questions for this section are:

- Why are beaches important?
- Who lives on beaches?
- What can people do to help beaches?

Links with other Modules

Resources from the Environment

Toolbox

Physical materials

Safety spectacles, booties, water monitoring kit, sediment sorting trays, binoculars, plastic vials or jars with screw top lids – 200-300ml with wide lid, brightly colored nylon twine, stopwatch

Reference books

Dr. R.C.Anderson, Living Reefs of the Maldives, Novelty Publishers

Dr. R.Charles Anderson, Reef fishes of the Maldives (2005) Manta Marine Pvt. Ltd

Krys Kazmierczak (2000) A field guide to the Birds of India, Sri Lanka, Pakistan, Nepal, Bhutan, Bangladesh and Maldives, Gopsons Papers Ltd

Flip Charts.

Environment and Biodiversity Flip Chart

Field Guides

Field Guide to Maldivian Birds and Beach Ecosystems

Field Guide to Maldivian Plants

Preparation

You will need the pages on Beaches in the Environment and Biodiversity Flip Chart for the beginning of this section of the Module. Read the *Teacher Information Sheets 3.1, 3.2, 3.3, 3.4 & 3.5* in order to familiarise yourself with beaches.

3.1 TUNING IN

The following activities help to engage and focus students' interest on the topic.

ACTIVITY 1: OBSERVE THE BEACH AND MAKE A MAP

Purpose: To develop a general picture of the beach and gather as much information as possible based on simple observations.
Time: Approx. 2-2.5 hours
Materials Required: Compass, measuring staff (pole with measured sections in red and white)- 1 metre, Environment and Biodiversity Flip Chart
Resource / Information Sheets: 3.1 Student Resource Sheet- The Beach (now and then)

Procedure

Show students the 'Beach Systems' page in the Environment and Biodiversity Flip Chart and discuss the different types of plants and animals that may be observed on a beach. Also discuss with students the 3 main types of beaches in the Maldives: sandy, rocky and sandstone.

Observe and record - Divide the students into groups, and have these students walk the length of the beach writing down everything that they see. If the beach is very varied, the student groups may be given different items to look for, e.g. one group might record buildings and roads, another group vegetation and trees, a third group might record the type of activities in which people are engaged on.

Items to look for include:

- Beach material (sand stones, rocks), colour, variation in material along different sections of the beach.
- Animals e.g. crabs, birds, domestic animals, shells of animals.
- Plants and trees e.g. seaweeds and seagrasses, grasses and plants, trees behind the beach.
- Debris, litter, pollution, e.g. waste on the beach or floating in the water.
- Human activities e.g. fishing, fishing boats on the beach, walkers, people doing exercise, swimmers, picnic groups.
- Buildings behind the beach, restaurants, houses and hotels, public accesses to the beach, litter bins, signs, jetties, etc.
- Sea conditions e.g. the sea is calm or rough.
- Objects in the sea e.g. mooring buoys, boats at anchor, rafts, etc.

Draw a map of the beach (see *Student Resource Sheet 3.1*). This can be done as a class exercise, or each student can develop their own map. Encourage students to make detailed observations e.g. identify trees.

Discuss the map with the class. Decide which characteristics to monitor and measure (e.g. animals, sea conditions).

Mapping the beach.

3.2 DECIDING DIRECTIONS

The following activities will assist students to decide on the directions they wish to take in their research.

ACTIVITY 2: HOW THE BEACH USED TO LOOK

Purpose: To research information on how the beach used to look and make comparisons with the maps drawn by the class.

Time: Approx. 2-2.5 hours

Materials Required: Past aerial/topographic maps of the island, community elders with local information about the beaches.

Resource / Information Sheets: 3.1 Student Resource Sheet- The Beach (now and then)

Procedure

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 students 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?
- 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?

Some of these issues may be raised or topics identified for further investigation from the beach investigation by students. These include:

- ***Erosion or accretion*** – Erosion takes place when sand or other sediment is lost from the beach and the beach gets smaller. Accretion takes place when sand and other material is added to the beach, which as a result gets bigger.
- ***Beach composition*** – A beach consists of loose material, of varying sizes. The actual material itself can tell a lot about the stability of the beach.
- ***Human activities on beach*** – Human activities include anything people do on the beach, from picnicking to swimming, mining sand to fishing. Any or all of these activities might impact on the beach environment. For example, picnickers who leave their waste behind might cause a bad smell and attract a lot of flies.
- ***Beach debris*** – Beach debris includes garbage left behind by beach users, as well as materials – natural and people made – washed onto the beach by waves or transported by rivers. The presence of litter on the beach, is unattractive, and has health and economic impacts on beach users and local communities, and is potentially harmful to marine wildlife through entanglement and ingestion.
- ***Water quality*** – The condition or quality of coastal waters is very important for health and safety reasons and also for visual impact. Disease-carrying bacteria and viruses associated with human and animal wastes pose threat to humans by contaminating seafood, drinking water and swimming areas. Eating seafood and swimming where the water quality is poor can result in hepatitis, gastrointestinal disorders, and infections. Examples of sources of bacterial contamination can be leaking septic tanks, poorly maintained sewage treatment plants, discharges from boats, and run off from the land during heavy rains and storms. Excessive quantities of nutrients like nitrates and phosphates can cause rapid growth of marine plants, and result in algal blooms.
- ***Wave characteristics*** – waves are the main source of energy that causes beaches to change their shape, size and sediment type. They also move debris between the beach and offshore zone. Waves are generated by the wind blowing over the water.
- ***Currents*** – currents also have a role to play in moving sediment.
- ***Plants and animals*** – beaches have a diverse and transitional ecosystem that serve as a critical link between marine and terrestrial environments.

ACTIVITY 3: ORGANISING OURSELVES

Purpose: To identify the steps that need to be taken for further study to occur.
Time: Approx. 20-35 minutes
Materials Required: Pen, notebooks
Resource / Information Sheets: 3.1 Teacher Information Sheet- Beaches

Procedure

From the questions that have been raised by previous discussions, identify the steps that need to be taken for further study to occur. The following may need to be considered:

- What questions do we need to ask about beaches?
- How are we going to conduct our inquiry?
- What sort of timeline do we need to set?
- What types of information do we need and how do we find and collect this information? e.g. Organise an excursion or locate resources.
- What is the best way of allocating tasks? e.g. forming small groups or creating individual projects.
- How will we organise or present our findings?

3.3 FINDING OUT

The following activities involve students in shared experiences that provide new information about the topic and stimulate curiosity.

ACTIVITY 4: EROSION OR ACCRETION?

Purpose: To measure over time the accretion or erosion of the beach on your island.
Time: Approx. 1-1.5 hours over a month
Materials Required: Measuring tape, notebook, pen or pencil
Resource / Information Sheets: N/A

Procedure

Measure the distance from a fixed object behind the beach (such as a tree or building to the high water mark) using a measuring tape. The high water mark is the highest point to which the waves reached on that particular day. Select which building or tree you are going to use. Describe the object to assist with relocating it for the next measurement.

With two people, one standing at the chosen object and the other standing at the high water mark, extend a measuring tape between the two on the ground and stretch it tight. Record the measurement together with date and time of measurement.

Repeat the measurement at two other points along the beach. It is suggested to measure either end of the beach and in the midway along the beach. You may also take photographs of each point.

Measuring beach profiles: A beach profile or cross section is an accurate measure of the slope or width of the beach, which when also repeated over time gives further information of the erosion and accretion on the beach. Repeat these measurements regularly, if possible monthly. The data will show how the beach has changed over the period monitored.

Erosion is a common issue on many islands in the Maldives.

Further Activities

What happens to beaches when big storms/cyclones strike? When was the last big storm and what happened?

Has the sea level around your island changed over the last 50 years? Who would know? Discuss with some of the people who have been on the island the longest.

Determine the effects of structures made by people on erosion and accretion. Measure the distance from the structure to the high water mark and continue to measure it over time. If a jetty, measure from a point on either side of the jetty.

ACTIVITY 5: BEACH COMPOSITION

Purpose: To observe, describe and record the composition of the beach in order to get a further insight into the stability of the beach.
Time: Approx. 2-2.5 hours
Materials Required: Measuring tape or ruler, notebook, pen or pencil, plastic bags, magnifying glass
Resource / Information Sheets: 3.2 Student Resource Sheet- Sediment Analysis Chart

Procedure

Divide students into 4 groups and visit your nearest beach. In groups note and record the colour, size and texture of material on the beach. A ruler or measuring tape can help distinguish between the larger sizes. Use plastic bags to collect samples of materials from different locations on the beach e.g. high water mark, beneath trees.

Back in the classroom make a sketch map with a legend showing the location of objects and materials on the beach. Discuss where the different materials might originate e.g. coral reef.

Refer to *Student Resource Sheet 3.2.* Variations in size and shape will provide information about the different zones on the beach and processes that shape these zones.

ACTIVITY 6: HUMAN ACTIVITIES ON THE BEACH

Purpose: To carefully observe the human activity on the beach over a period of time.
Time: Approx. 2 hours per day on 2 occasions (morning and afternoon)
Materials Required: Notebook, pen or pencil
Resource / Information Sheets: 3.3 Student Resource Sheet-Human Activities on the Beach

Procedure

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. The more detail the better. Use *Student Resource Sheet 3.3.*

Back in the classroom draw up a timeline of activities.

Divide the activities in to two groups:

A. Activities that might harm the beach

B. Activities that do not harm the beach or may do some good for the beach

Discuss what can be done to stop or reduce the harmful activities

Human activities can have harmful effects on the beach.

ACTIVITY 7: BEACH DEBRIS

Purpose: To observe, measure and record the debris on the beach.
Time: Approx. 2-3 hours
Materials Required: Notebook, pen or pencil, Field Guide to Maldivian Birds and Beach Ecosystems
Resource / Information Sheets: 3.4 Student Resource Sheet-Debris on Beach

Natural and human made debris can be found along our beaches.

Procedure

Show students the page 'Special things on the beach' in the Field Guide to Maldivian Birds and Beach Ecosystems. Point out some of the beach items in the Field Guide and ask students to identify the items. Discuss with students that debris can be found on our beaches, some of which is natural and some of which is human made.

Prepare the class by explaining the activity and going over safety tips;

- Do not go near any large drums
- Be careful with sharp objects
- Wear gloves
- Stay out of dune areas
- Do not lift anything too heavy

Choose a location on the beach, and record that location. Draw a line in the sand that runs across the beach to the sea. Investigate 5metres (5yards) either side of the transect line for debris. Record the type of debris and its location on *Student Resource Sheet 3.4.*

Back in the classroom group the debris e.g. plastic, Styrofoam, glass, rubber, metal, paper, wood, glass, cloth.

Discuss the possible origins of the materials collected.

A. materials from the sea e.g., fishing floats

B. material that came from careless beach users or nearby communities e.g., picnic leftovers

C. Material that may have come from either group e.g., rope

ACTIVITY 8: WATER QUALITY

Purpose: To measure the quality of seawater.
Time: Approx. 1.5 hours each week for 1 month.
Materials Required: Notebook, pen or pencil, water monitoring kit, sampling containers
Resource / Information Sheets: 3.3 Teacher Information Sheet- Understanding Water Quality Indicators

Procedure

Remove the cap of the sampling container. Rinse the bottle with sea water. Hold the jar near the base and plunge the jar below the water and towards the waves. Allow the water to flow in for about 30 seconds. Cap the full jar whilst under water.

Choose which of the qualities of the water you would like to measure.

- Faecal coliform bacteria
- dissolved oxygen
- biochemical oxygen demand

- nitrate
- phosphate
- pH
- temperature
- turbidity

Refer to water monitoring kit guide for instructions on how to do tests.

Monitor the quality of the seawater every week for 1 month. Write up the results on large paper and pin the paper to the classroom wall so all students can see the results. If any of the results indicate that the water quality is changing, discuss the possible reasons for this.

ACTIVITY 9: WAVE CHARACTERISTICS

Purpose: To observe, measure and record wave characteristics.
Time: Aprox. 2-2.5 hours
Materials Required: Notebook, pen or pencil, measuring staff (pole with measured sections in red and white), compass
Resource / Information Sheets: 3.5 Student Resource Sheet- Wave characteristics; 3.4 Teacher Information Sheet- Wave Characteristics

Procedure

Explain the three main characteristics of waves: height, the wavelength and the direction (*Teacher Information Sheet 3.4*).

Height: estimate the height or use the measuring staff. One person holds the staff and walks into the sea to where the waves are breaking. The observer records where the wave crest cuts the staff. The height of five different waves should be taken and then the average taken.

Wavelength: Measure time in seconds for eleven wave crests to pass a fixed object. Use a stop watch. Start the timing when the first wave passes the object and stop the watch when the eleventh wave passes the object.

Direction: Using a compass, sight the compass along the direction from which the waves are coming, which will be at right angles to the wave crests.

Track the wave characteristics over time (e.g. over a term).

Further Activities

Investigate what causes waves and why waves can differ in size, direction and length. Correlate changes in the width of the beach and the amount of debris on the beach with the wave height.

Waves are made when wind blows over the surface of the sea.

ACTIVITY 10: CURRENTS

Purpose: To measure the long shore current (i.e. the current that runs parallel to the beach).
Time: Approx. 1.5-2 hours on 3 different occasions.
Materials Required: Notebook, pen or pencil, stick, Styrofoam, stopwatch
Resource / Information Sheets: 3.6 Student Resource Sheet- Current

Procedure

One observer walks into the water and places a piece of Styrofoam in the water, as near as possible to where the waves are breaking.

The observers on the beach stand by the stick, observing the direction in which the piece of Styrofoam moves. After one minute, the maximum distance the piece of Styrofoam has moved is measured along the beach starting from the stick. This is recorded. The measurement is made again after 2 minutes and after 5 minutes.

The distance moved after 5 minutes is used to determine the current speed in ft/second or cm/second. The direction in which the piece of Styrofoam moved must also be recorded on *Student Resource Sheet 3.6*.

Measurements can be repeated at several different places along the beach to see if the current speed and direction is the same or whether it varies. Measurements are repeated at different times of the day.

If the piece of Styrofoam does not move much, but just remains in a pool near the stick, that means there is no longshore current that day. This activity can be repeated on different days in different months to see whether the speed and direction of the currents change.

Back in the classroom discuss the direction of the longshore current to the source of the beach material. For example some of the material on the beach originates from an adjacent beach or coral reef. Discuss the impact of jetties in the area and the role of longshore currents.

ACTIVITY 11: STRENGTH AND FLOW OF CURRENTS

Purpose: To measure the strength and flow of the currents around the island.
Time: Approx. 4-5 hours
Materials Required: Plastic bottle, sand, 10 m string and stopwatch
Resource / Information Sheets: 3.7 Student Resource Sheet- Speed and Direction of Currents

Procedure

Fill the base of the plastic bottle with sand. Screw on the lid. Tie one end of the string to the top of the bottle.

Place the bottle in the water, one of the students holding on to the spool with the remainder of the string as the bottle drifts away.

The other student times how long it takes for 10 m of the string to unravel.

Repeat this measure at around 6 other points around the island. At each point three measurements should be taken and the average recorded. Record the measurements on the *Student Resource Sheet 3.7*.

Make a map of the island and record any major sites like the school, the jetty or the channel into the lagoon. Record on the map the 6 points where measurements were taken.

Draw arrows to indicate the flow of the current.

Measure the current flow and speed at a different time of the day. If the currents are moving in different direction and at a different speed, discuss why that might be.

Beaches are an important ecosystem for many plants and animals.

ACTIVITY 12: OBSERVING AND RECORDING PLANTS AND ANIMALS ON THE BEACH

Purpose: To observe and record plants and animals on the local beach.
Time: Approx. 3-3.5 hours
Materials Required: notebook, pencil, Field Guide to Maldivian Birds and Beach Ecosystems, Field Guide to Maldivian Plants
Resource / Information Sheets: 3.8 Student Resource Sheet- Beach animals and plants

Procedure

Divide the students into groups of 4 students at different sections of the beach (at least 15 metres apart). On the local beach quietly observe the beach environment. Firstly observe the beach plants. Students should consider what types of plants are present (e.g. grasses, shrubs or trees). Draw a picture of the plants in *Student Resource Sheet 3.8* and estimate how many plants are present at this location. Using the Field Guide to Maldivian Plants students should also try and identify the plants.

Now ask students to look closely at the animals that live on the beach. Look on the sand, in the trees, near the water. What types of animals are present (e.g. birds, reptiles, invertebrates)? Draw a picture of the animals in *Student Resource Sheet 3.8* and estimate how many animals are present at this location. Using the Field Guide to Maldivian Birds and Beach Ecosystems students should try and identify the animals.

Further Activities:

Students also research habits, diet, movement, reproduction, protection and any unusual or interesting features. Include ways it might be affected by humans and how it might be protected

ACTIVITY 13: UNDERSTANDING THE ROLE OF COASTAL VEGETATION

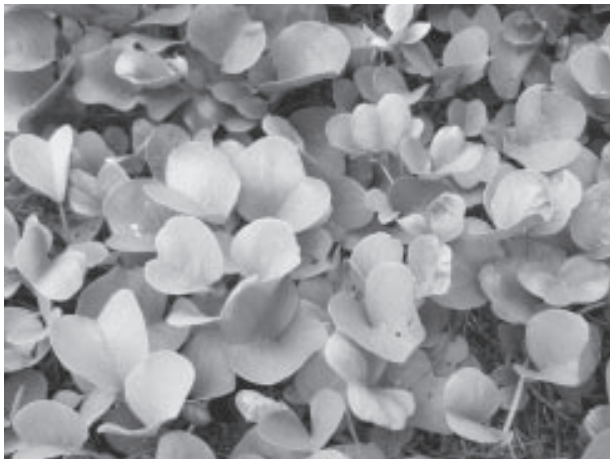
Purpose: To identify the types of vegetation found on the beach (e.g. frontal dune zone, backdune zone, forest zone)
Time: Approx. 3 hours
Materials Required: Measuring tape, note book, pen or pencil, large paper, markers, Environment and Biodiversity Flip Chart, Field Guide to Maldivian Plants
Resource / Information Sheets: N/A

Procedure

Show the students the Flip Chart page 'Beach Systems' from the Environment and Biodiversity Flip Chart. Discuss the different types of beaches found in the Maldives and show students the diagram of a beach. Explain that beach vegetation is very important in preventing beach erosion. Some plants such as grasses and vines (e.g. Goat's Foot vine/Thanburu) can be found in the front beach zone, whilst shrubs and herbaceous plants (e.g. Sea Lettuce/Magoo) can be found in the backdune zone further away. Further into an island, coastal woodlands (e.g. Coconut/Dhivehi Ruh) can be found.

At the beach select a location where a number of different types of beach vegetation can be found. Using the measuring tape mark 2 m intervals from the seaward edge of vegetation, inland to the coastal woodland. Then students should walk this transect and note down the number of plant species present every 2 m. Using the Field Guide to Maldivian Plants identify or describe the plants.

Back in the classroom draw a profile of the beach showing the different types of beach vegetation. Discuss the reasons why some plants prefer to live in different zones of the beach. Discuss the importance of beach vegetation. Ask the students to forecast what would happen to the beach environment if all the vegetation was removed for a new development project such as 100+ room hotel complex.



Beach vegetation provides a habitat for many animals and helps to keep sand on the beach.

ACTIVITY 14: MONITORING BEACHES FOR NESTING TURTLES

Purpose: To monitor whether there are turtles nesting on the island.
Time: Approx. 2 hours on 2 occasions (night or early morning from March- November)
Materials Required: Binoculars, torch, notebook, pencil
Resource / Information Sheets: 3.2 Teacher Information Sheet- Sea turtles, Field Guide to Maldivian Birds and Beach Ecosystems

Procedure

Explain to students that many turtles are endangered because of over harvesting in the past, and many countries have programs to conserve marine turtles and their eggs. In the Maldives sea turtles are protected by law and can not be killed, caught or taken from Maldivian waters.

Using the Field Guide to Maldivian Birds and Beach Ecosystems show students two types of sea turtles found in the Maldives (e.g. Hawksbill turtle and Green Turtle). Explain the different features of these 2 turtles. Ask the students to think about why sea turtles are endangered and the threats they face. What can you do to help conserve marine sea turtles?

Check with environmental agencies (Ministry of Environment, Energy and Water) or a local conservation group if there is a special beach on your island where turtles nest. If there is a beach where turtles come to nest, arrange for a night excursion to the beach. Monitoring may consist of night-time watches at key nesting beaches, monitoring beaches early in the morning for evidence of turtle tracks and monitoring nesting activity for emerging hatchlings.

Very quietly observe the beach for any signs of turtles. If a turtle emerges, make sure that students maintain a good distance from the turtle, so as not to stress the animal. In the early morning hours check for turtle tracks and signs of nesting. Make sure students do not disturb the turtle nests!

Beaches are very important places for turtles, such as the Hawksbill and Green Turtles.

Further Activities

Conduct research to find out which turtle species nest in your country and how many successful nests are laid. Compare these figures with historical information.

3.4 SORTING OUT

Students at this stage will be collating, processing, analysing and presenting the information in a variety of ways. Students will have the opportunity to further explore any questions that may have arisen when they were investigating. This would also be opportune time to revisit some of the initial activities from Tuning in or Deciding Directions sections, for the students to witness how their knowledge has increased.

ACTIVITY 15: SUMMARISING DATA

Purpose: To collate data gathered from excursions to the beach.
Time: Approx. 1 hour, 20 minutes.
Materials Required: Completed Student Resource Sheets from previous activities.
Resource / Information Sheets: N/A

Procedure

Students complete their investigation sheets:

- Maps of the beach
- Sediment analysis
- Human activities of the beach
- Debris on the beach
- Wave characteristics
- Speed and direction of currents
- Animal and plant identification

Groups take it in turn to report on what they discovered. One way of doing this is to organise the groups so that there are representatives from each investigation. Each person reports to the group on what they discovered.

ACTIVITY 16: REPRESENT THE EXPERIENCE

Purpose: Students record the features of beaches through a choice of mediums.
Time: Approx. 1.5 – 2 hours
Materials Required: Natural materials such as bark, grass, twigs, water based paint, paper, markers, pencils
Resource / Information Sheets: N/A

Procedure

Art

This may be a general response or specific to the students' investigations. They may show something they saw at the beach or show their findings using a variety of art materials.

You may suggest some watery 'art', such as using water colours, drawing with chalk on wet paper, using weak solution of paint and water to wash over a picture done in pastel.

Use photographs to display various aspects of the beach area.

Make models of the beaches that you visited. Use natural materials such as bark, grass, twigs, and rocks to bring the model to life.

Written reports

As a class write a story to report on your visit to the beach area. Students may write individual reports on their visit.

3.5 DRAWING CONCLUSIONS

The following activities will help students to interpret information, establish connections and confirm/reject or modify predictions.

ACTIVITY 17: CONCEPT MAP OF A BEACH

Purpose: Students draw conclusions about what they have learnt.
Time: Approx. 1 hour
Materials Required: Ten small cards for each student and large sheets of paper.
Resource / Information Sheets: N/A

Procedure

By now students should have the understanding that:

- there are links between human activity and survival of animals and plants; and
- it is our responsibility to look after the environment, as we can be affected too.

Links can exist between actions such as planting trees and the conservation of endangered habitats and the living creatures within them.

Provide ten small cards for each student. On one of the cards students write 'beaches'. On the remaining cards they write any words or draw pictures about mangroves that they think are the most important ones. On the big sheets of paper it is the student's task to organise the cards on the paper in a way that makes sense to them. They have to show how the words relate to each other with a series of lines connecting the cards. Words or phrases are written on the lines to make the connections clearer.

Students share their maps with a partner, group or class.

3.6 CONSIDERING, PLANNING AND TAKING ACTION

As a result of students being actively involved in decision making throughout the inquiry process, it is hoped that they will be empowered to take action which has positive personal, community and global effects. Some suggestions are listed below.

ACTIVITY 18: TAKING ACTION ON MY BEACH

Purpose: To consider, plan and take action on issues with beaches.
Time: Minimum 30 minutes
Materials Required: Pens, paper, markers
Resource / Information Sheets: N/A

Procedure

Discuss with students ways to raise awareness on beach issues in your community. Some suggestions for taking action on your island include:

- Organise a clean up of the beach.
- Write to the island authorities about the protection or upkeep of the local beaches.
- Write a brochure for public distribution to raise awareness of the importance of beaches.
- Conduct a survey of people's opinion of the beach or of issues you have identified.
- Continue to monitor water quality and send results to water authorities to assist them with their research.
- Create a poster highlighting the threats to turtles.
- Write a story about the life of a grain of sand.

3.7 EVALUATION AND REFLECTION

At this stage it may become evident that there is a need to return to some stages of the inquiry process to clarify knowledge or refine skills.

The following questions may be asked:

- Are you happy with the ways in which your information was gathered, analysed and presented?
- Is there anything you would change?
- Are there things you need to investigate further?

Students could record the concepts they have developed in a poster or an information brochure on beaches.

ACTIVITY 19: LESSONS LEARNT

Purpose: To reflect upon what the students have learnt.
Time: Approx. 10 minutes
Materials Required: Pens, notebooks
Resource / Information Sheets: N/A

Procedure

Ask students to write down:

- Four important ideas/concepts/information/values I have learnt in this section of the Module are ……
- Two things I now want to do for myself and for others are…….

Ask students to decide what they would like to do with the results of their research and discussion.

3.1 STUDENT RESOURCE SHEET

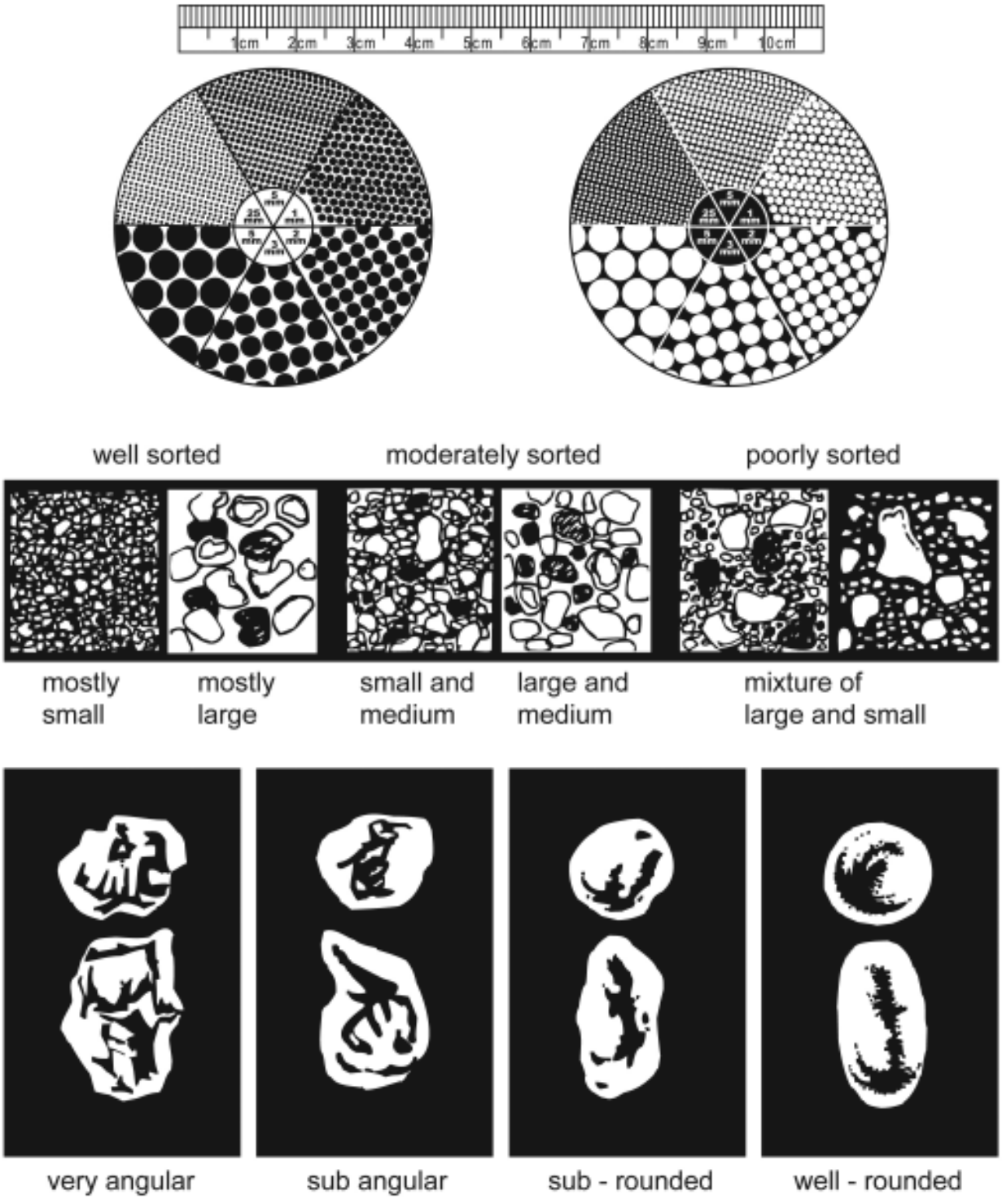
THE BEACH (NOW AND BEFORE)

Draw how the beach looks now.

Draw how the beach used to look.

3.2 STUDENT RESOURCE SHEET

SEDIMENT ANALYSIS CHART



Reference Cambers, G and Ghina, F (2005) Introduction to Sandwatch: An educational tool for sustainable development UNESCO

3.3 STUDENT RESOURCE SHEET

HUMAN ACTIVITIES ON THE BEACH

Time of Day	Who or what involved	How many people	Description of activity

3.3 EXAMPLE OF COMPLETED STUDENT RESOURCE SHEET

HUMAN ACTIVITIES ON THE BEACH

Time of Day	Who or what involved	How many people	Description of activity
8am	Older woman	1	Dumped waste on the beach.
8.30am	Men	3	Threw fish waste in the sea near the beach.
9am	Workers	5	Collected sand from the beach.
4.30 pm	Students	7	Played football on the beach.

3.4 STUDENT RESOURCE SHEET

DEBRIS ON THE BEACH

Item	Type of debris	Location

3.4 EXAMPLE OF COMPLETED STUDENT RESOURCE SHEET

DEBRIS ON THE BEACH

Item	Type of debris	Location
Nylon rope	Maybe from sea or community	Main beach– transect 1
Old Shoe	Maybe from sea or community	Main beach– transect 1
Coconut shell	Maybe from sea or community	Main beach– transect 1
Tuna can	From community	Main beach– transect 1
Fishing float	From sea	Main beach– transect 1
Shell of a crab	From the sea	Main beach– transect 1

3.5 STUDENT RESOURCE SHEET

WAVE CHARACTERISTICS

Observe, measure and record the following information:

Height	**Wavelength**	**Wave direction**
Wave 1	Wave 1	
Wave 2	Wave 2	
Wave 3	Wave 3	
Wave 4	Wave 4	
Wave 5	Wave 5	
Average: Height/5	Wave 6	
	Wave 7	
	Wave 8	
	Wave 9	
	Wave 10	
	Wave 11	
	Average: Time/11	

3.5 EXAMPLE OF COMPLETED STUDENT RESOURCE SHEET

WAVE CHARACTERISTICS

Observe, measure and record the following information:

Height	Wavelength	Wave direction
Wave 1 1m	Wave 1 2 seconds	North East
Wave 2 1.1m	Wave 2 3 seconds	
Wave 3 1.3m	Wave 3 2 seconds	
Wave 4 1.5m	Wave 4 4 seconds	
Wave 5 1m	Wave 5 3 seconds	
Average: 1.18m Height/5	Wave 6 5 seconds	
	Wave 7 2 seconds	
	Wave 8 3 seconds	
	Wave 9 3 seconds	
	Wave 10 4 seconds	
	Wave 11 2 seconds	
	Average: 3 seconds Time/11	

3.6 STUDENT RESOURCE SHEET

CURRENT

Location	Time	Distance	Direction
1	1 min		
	2 min		
	5 min		
2	1 min		
	2 min		
	5 min		
3	1 min		
	2 min		
	5 min		

3.6 EXAMPLE OF COMPLETED STUDENT RESOURCE SHEET

CURRENT

Location	Time	Distance	Direction
1	1 min	2m	East
	2 min	3m	East
	5 min	5m	East
2	1 min	5m	East
	2 min	7m	East
	5 min	10m	East
3	1 min		
	2 min		
	5 min		

3.7 STUDENT RESOURCE SHEET

SPEED AND DIRECTION OF CURRENTS

Record the speed and direction of currents.

Point A

Time taken (seconds)	
Reading 1	
Reading 2	
Reading 3	
Total	
Average	
Speed (metres/seconds)	
Direction:	

Point B

Time taken (seconds)	
Reading 1	
Reading 2	
Reading 3	
Total	
Average	
Speed (metres/seconds)	
Direction:	

Point C

Time taken (seconds)	
Reading 1	
Reading 2	
Reading 3	
Total	
Average	
Speed (metres/seconds)	
Direction:	

3.7 EXAMPLE OF COMPLETED STUDENT RESOURCE SHEET

SPEED AND DIRECTION OF CURRENTS

Record the speed and direction of currents.

Point A

Time taken (seconds)	
Reading 1	120 seconds
Reading 2	100 seconds
Reading 3	140 seconds
Total	360 seconds
Average	120 seconds
Speed (metres/seconds) 1m/12 seconds	
Direction: East	

Point B

Time taken (seconds)	
Reading 1	300 seconds
Reading 2	350 seconds
Reading 3	280 seconds
Total	360 seconds
Average	310 seconds
Speed (metres/seconds) 1 m/31 seconds	
Direction: East	

Point C

Time taken (seconds)	
Reading 1	
Reading 2	
Reading 3	
Total	
Average	
Speed (metres/seconds)	
Direction:	

3.8 STUDENT RESOURCE SHEET

ANIMAL IDENTIFICATION

Record information about the beach animals you observe using descriptions and illustrations.

Name and drawing of animal	Number	Description of habitat	Food source
Invertebrates			
Birds			
Mammals			
Reptiles			
Amphibians			

3.8 STUDENT RESOURCE SHEET

PLANT IDENTIFICATION

Record information about the beach plants you observe using descriptions and illustrations.

Name of Plant	Description and drawing of plant	Number observed
Grasses		
Shrubs		
Trees		

3.1 TEACHER INFORMATION SHEET
BEACHES

What is a beach?

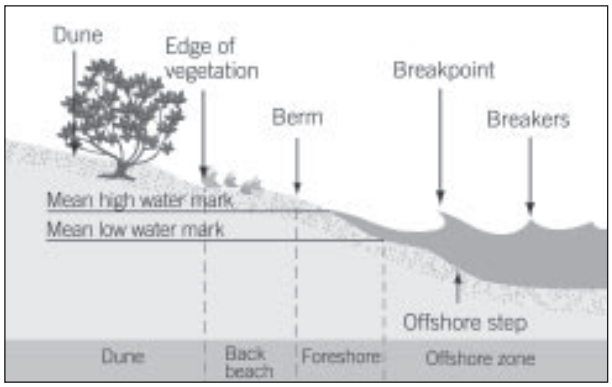
A beach, or strand, is a geological formation consisting of loose rock particles such as sand, gravel, shingle, pebbles, cobble, or even shell along the shoreline of a body of water. Some geologists consider a beach to be just this shoreline feature of deposited material. Beaches are often made up of sand particles, and in many islands the term 'beach' may be used only for sandy beaches. However, a beach may be made up of clay, silt, gravel, cobbles or boulders, or any combinations of these.

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 beach) 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.

Beaches as habitat

A beach is more than a zone of loose particles found where the water meets the land. It is also a coastal ecosystem. An ecosystem is the basic unit of study of ecology and represents a community of plants, animals and micro-organisms, linked by energy and nutrient flows that interact with each other and with the physical environment. 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.

3.2 TEACHER INFORMATION SHEET
SEA TURTLES

Hawksbill Turtle

Scientific name: *Eretmochelys imbricata* (order Testudines)

Dhivehi name: Kahanbu

Despite laws being in place, international trade in hawksbill shells and use of meat and eggs continue in many countries. The global survival of the species is at threat because of this.

Distribution: Hawksbill Turtles like coastal reefs, rocky areas and lagoons. Although it is a marine animal for most of the time, it does have a very special connection to beaches. This is where the life of a Hawksbill Turtle begins. The Hawksbill Turtle is listed as an endangered species globally, partly due to changes in beach ecosystems around the world. This species has been protected under Maldivian law since 1995. No person is allowed to kill, catch or take this species from Maldivian waters.

Description: A Hawksbill Turtle has a beak-like mouth, hence the name, two claws on each flipper, and a thick brown shell (carapace). Some people say the beak-like mouth makes this turtle look a little like a bird. Hawksbills nest on beaches in tropical oceans of the world, often sharing with Green Turtles. Nests are often found under vegetation (e.g. trees or shrubs). Sponges are the main food of Hawksbills when they enter shallow coastal waters and begin feeding.

Hawksbill Turtle swimming.

Hawksbill Turtle with beak-like mouth.

Green Turtle

Scientific name: *Chelonia mydas* (order Testudines)

Dhivehi name: Velaa

If you have the chance to see this animal laying eggs they look like they are crying. But they are really just keeping their eyes moist.

Distribution: Besides the Hawksbill Turtle, which is frequently observed, the Green Turtle is the most common turtle species in the Maldives. This turtle lives near coastlines and in areas with sea grass beds. Although it is a marine animal for most of the time, it does have a very special connection to beaches. This is where the life of a Green Turtle begins. This species has been protected under Maldivian law since 1995. No person is allowed to kill, catch or take this species from Maldivian waters.

Description: If you are very lucky, a female Green Turtle may be seen on the beach scooping out a nest, laying eggs or making her way back to the water. Or you may see her tracks leading up and down the beach. During the turtle's nesting season from March to November, around 100 eggs per nest are laid. A Green Turtle may come ashore 6-8 times at two weekly intervals to nest. It is herbivorous and mainly feeds on algae and sea grass. The Hawksbill Turtle has a different diet (mainly invertebrates in the reef) to the Green Turtle so the two species are not in direct competition. Unfortunately they do face the same human threats of egg harvesting, habitat destruction and hunting.

Green Turtle trail marks on the beach.

Green Turtle laying eggs.

Green Turtle on a beach.

3.3 TEACHER INFORMATION SHEET

UNDERSTANDING WATER QUALITY INDICATORS

Faecal coliform bacteria

Faecal coliform bacteria themselves are not harmful; however they occur with intestinal pathogens (bacteria or viruses) that are dangerous to human health. Hence, their presence in water serves as a reliable indicator of sewage or faecal contamination. These organisms may enter waters through a number of routes, including inadequately treated sewage, stormwater drains and leaking septic tanks.

Dissolved oxygen (DO)

Dissolved oxygen (DO) is an important indicator of water quality and is measured as percentage saturation. Much of the dissolved oxygen in water comes from the atmosphere. After dissolving at the surface, oxygen is distributed throughout the water column by currents and mixing. Algae and aquatic plants also deliver oxygen to water through photosynthesis. Natural and human induced changes to the aquatic environment can affect the availability of dissolved oxygen. For instance, cold water can hold more oxygen than warm water, and high levels of bacteria from sewage pollution can cause the percentage saturation to decrease.

Biochemical oxygen demand (BOD)

Biochemical oxygen demand (BOD) in general the higher the biochemical oxygen demand, the worse the quality of the water. Natural sources of organic matter include dead and decaying organisms. However, human activities can greatly increase the available organic matter through pollution from sewage, fertilisers or other types of organic wastes. The decomposition of organic wastes consumes the oxygen dissolved in the water- the same oxygen that is needed by animals such as fish.

Nitrate

Excess nitrate will cause increased plant growth and algal blooms, which may then out-compete with the native submerged aquatic vegetation. The excess algae and plants may smother the habitat used by the aquatic fauna and other decomposition can lead to oxygen depletion. Sources of nitrate in coastal wastes include runoff containing animal wastes and fertilisers from agriculture or the discharge of sewage.

Faceal contamination can be tested using H_2S bottles.

Phosphate

Phosphate is a fundamental element in metabolic reactions in animals. Sources and effects of excess phosphates are similar to those of nitrates. High levels may cause overgrowth of plants and increased bacterial activity and decreased dissolved oxygen levels.

pH

The pH scale ranges from 0-14, 0 is very acidic and 14 is very alkaline. Freshwater usually has pH values between 6.5 and 8.2. Saltwater usually has pH values between 7.5 and 8.5. Most organisms have adapted to life in water of a specific pH and may die if it changes slightly. The pH level can be affected by pollution.

Temperature

Temperature affects many physical, biological and chemical processes, e.g. the amount of oxygen that can be dissolved in water, the rate of photosynthesis of plants, metabolic rates of animal and the sensitivity of organisms to wastes and diseases. It is most often measured in degrees Celsius. Many factors affect water temperature. These include changes in air temperature, cloudiness and currents. Wastes discharged into water can also affect temperature.

Turbidity

Suspended matter usually consists of organic debris and inorganic matter (clay, soil particles). Turbidity should not be confused with colour, since darkly coloured water can still be clear, not turbid. High turbidity reduces the amount of light entering water reducing plant growth.

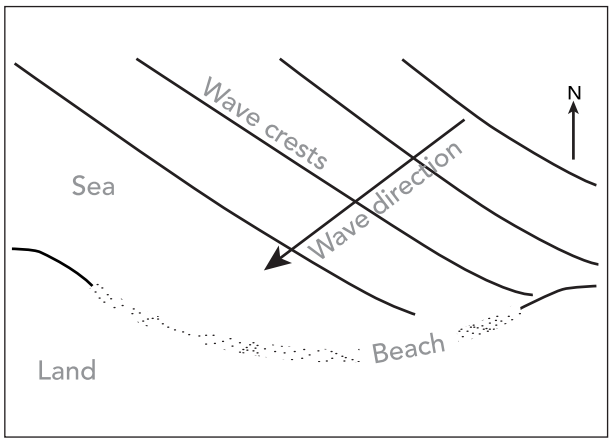
Reference Cambers, G and Ghina, F (2005) Introduction to Sandwatch: An educational tool for sustainable development UNESCO

3.4 TEACHER INFORMATION SHEET
WAVE CHARACTERISTICS

What are waves?

Waves are the main source of energy that causes beaches to change in size, shape and sediment type. They also move marine debris between the beach and offshore zone. Waves are made by the wind blowing over water.

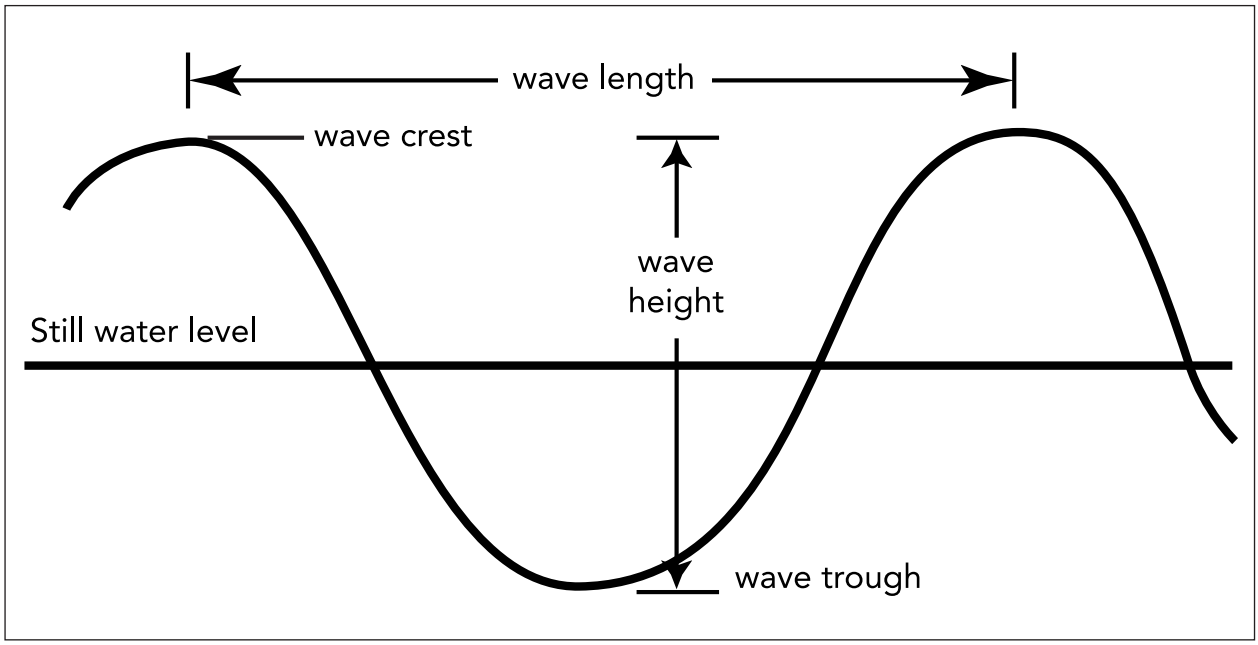
The three main characteristics of waves are the height, the wavelength and the direction from which they approach (see diagram below). Wave height is the vertical distance from the crest of the wave to the trough. Wave period is the time measured in seconds between two successive wave crests. Wave direction is the direction from which the waves approach.



Wave height is measured by having an observer with a graduated staff or a ranging pole (pole with measured sections in red and white) walk out into the sea to just seaward of where the waves are breaking, and then to have the observed record where the wave crest and the following wave trough cut the staff; the difference between the two is the wave height. Alternatively, an estimate may be made of the wave height. Often it is best to have 2 observers independently estimate wave height and then to compare the results. The height of at least five separate waves should be estimated and the average taken.

Wave period is the time in seconds for eleven wave crests to pass a fixed object, or if no such object exists, the time for eleven waves to break on the beach. Use a stopwatch if available.

Wave direction is the direction from which the waves approach and is measured in degrees. This can be measured with a compass, standing high up on the beach and sighting the compass along the direction from which the waves are coming.



Include reference Cambers, G and Ghina, F (2005) Introduction to Sandwatch: An educational tool for sustainable development UNESCO

3.5 TEACHER INFORMATION SHEET

PREPARATION FOR THE FIELD TRIP

Ensure that all necessary preparation and arrangements are made before the field trip.

It is important that the SAFETY of the students is ensured at all times.

Below are some suggestions to ensure your trip is safe, successful and enjoyable.

Setting a date

- Ask permission from the Head Teacher. Ensure the timetable is covered to release the students and teachers to spend time at the beaches.
- Check if you need to ask permission from the Island Office to access the beach area.
- Check the Tide Chart – it is important that you get there during or just before low tide. Choose a day when the low tide is around 9.00 am.
- You will need extra helpers, such as voluntary parents or school committee members, to accompany and supervise the groups during field activities.
- Invite a local expert on the flora and fauna of the island's beaches, to assist with identification, such as fisherman, field officers for the Ministry of Environment, Water and Energy.

Introduction to beaches

- Invite people to speak to your class about the importance of the beaches
- Have students predict what they will see, hear and touch at the beaches.
- Emphasise the importance of disturbing as little of the area as possible.
- Check with the Island Office whether they have aerial photos of your island. If you can get photos at different times you can compare the changes over time.

Teacher's responsibilities

- Seek permission from the Head Teacher.
- Seek permission if required to access the area for the field trip.
- Book transport if required.
- Organise equipment and any other resources such as paper and pencils for the clipboards, and copies of activity sheets that may be prepared by you.
- Prepare a first aid kit to be taken on the trip. Ensure it has band-aids, antiseptic cream, spray for stings and bites, mosquito repellent.
- Ensure the students bring proper clothing and shoes.
- Prepare a list of materials that students will need on the trip.
- Send this list to the parents together with a letter requesting permission for their children to join the field trip.
- Check the weather forecast prior to departure in case new arrangements need to be made.
- Check whether students have enough water to drink.
- Take the roll and do a headcount before you leave, during the activity and once you return from the beach.
- Clean the area of litter at the end of the field trip. Ensure no personal belongings are left behind.
- Ensure all students reach home safely.
- Divide the class into working groups (about three students per group). Try to arrange class assistants to assist with supervision of these groups.

Have fun!!!

4 SCHOOL GARDENS

Grade: 1 to 3
Number of lessons: 3 to 5 lessons

Purpose

Students investigate the source and production of fruits, vegetables and processed products.

Key questions

Key focus questions for this section are:

- Where do fruit and vegetables come from?
- What do they need to survive?
- Why do people need fruit and vegetables?

Links with other Modules

Resources from the Environment, Ourselves

Toolbox

Physical materials

Garden fork, garden spade, measuring tape, seeds (varieties that grow well in local conditions), poster paper

Reference books

National Centre for Linguistic and Historical Research (2002) Maamelaameli

National Centre for Linguistic and Historical Research (2002) Gasgahaagehi.

Flip Charts

Weather, Water, Waste and Energy Flip Chart

Preparation

You will need to refer to the page on School Gardens in the Weather, Water, Waste and Energy Flip Chart for the beginning of this section of the Module. Read the *Teachers Information Sheets 4.1, 4.2, 4.3, 4.4 and 4.5* in order to familiarise yourself with school gardens.

4.1 TUNING IN

The following activities help to engage and focus students' interest on the topic.

ACTIVITY 1: WHAT'S GOOD FOR YOU?

Purpose: To investigate the vitamins and minerals in vegetables and fruit.
Time: Approx. 2 hours
Materials Required: Pens, notebooks, large paper, markers, coloured pencils
Resource / Information Sheets: N/A

Procedure

Divide students into 4 groups. List the fruits and vegetables you eat on the large paper. Next to the names draw pictures of the fruits and vegetables. Investigate the vitamins and minerals in these fruits and vegetables and the role they play in nutrition.

Identify some fruit and vegetables you could plant in your school garden to increase your vitamin and mineral intake for a more healthy diet.

ACTIVITY 2: INVERTEBRATES IN ACTION- THE GOOD, THE BAD AND THE UGLY

Purpose: To learn about a number of invertebrate species found in agricultural areas and their roles (both positive and negative) in the environment.
Time: Approx. 3.5 hours
Materials Required: Pens, notebooks, large paper, markers, coloured pencils
Resource / Information Sheets: 4.1 Student Resource Sheet- The Good, the Bad and the Ugly

Procedure

Students are divided into six groups. A different card is given to each group from *Student Resource Sheet 4.1*.

Students have 10-15 minutes to prepare a five minute presentation of the insect on their card. Students can do this by preparing a poster, a play, a song, a dance or a formal talk.

Once the presentations are over the class can discuss:

- Which insect did you think was the best, the worst and the ugliest?
- Why are invertebrates so important?
- How would these species affect food production?
- What sort of invertebrates can be found in the garden or the schoolyard?
- What would be their importance?

Many insects play an important role in ecosystems, such as pollinating flowers.

ACTIVITY 3: FRUITS AND VEGETABLES- WHERE ARE THEY FROM?

Purpose: To develop an awareness of where fruits and vegetables in the Maldives come from.
Time: Approx. 1.5 hours
Materials Required: Pens, notebooks, large paper, markers, coloured pencils
Resource / Information Sheets: N/A

Procedure

From Activity 1 each student should select 1 fruit or vegetable from the list of names on the large paper. Each student will then research this fruit or vegetable in detail.

How is this fruit or vegetable grown? Is it grown on a tree (e.g. papaya) or on a vine (e.g. watermelon)? Where is the chosen fruit or vegetable grown? Does it grow in the Maldives (e.g. bananas) or is it imported from another country (e.g. apples, oranges)? Is it used fresh or processed? If processed, where and how?

Suggest a favourite recipe or way of serving and eating the selected fruit or vegetable.

Present the information on a poster and display it in the classroom.

Papaya is an example of a fruit that grows in the Maldives.

4.2 DECIDING DIRECTIONS

The following activities will assist students to decide on the directions they wish to take in their research.

ACTIVITY 4: DIFFERENT TYPES OF SCHOOL GARDENS

Purpose: To research different types of school gardens.
Time: Approx. 1-2 hours
Materials Required: Pens, notebooks, Weather, Water, Waste and Energy Flip Chart
Resource / Information Sheets: 4.1 Teacher Information Sheet- Different types of gardens

Procedure

Show students the page 'School Gardens' in the Weather, Water, Waste and Energy Flip Chart. Ask students to list the benefits of a school gardens.

As a class discuss the different types of gardening techniques. The teacher can introduce hydroponics, local plant gardens, herb gardens, fruit and vegetable gardens etc.

A vegetable garden.

Hydroponics: Huraa

Students in groups research different methods. As a class decide on a method or methods for your school garden.

Research what materials and design you will need for your school garden, and how you will obtain them. Present the plan to the School Management.

ACTIVITY 5: ORGANISING OURSELVES

Purpose: To identify the steps that need to be taken for further study to occur.
Time: Approx. 20-30 minutes
Materials Required: Pens, notebooks
Resource / Information Sheets: N/A

Procedure

Identify the steps that need to be taken for further study to occur, from the questions that have been raised by previous discussions. The following may need to be considered:

- What questions do we have to ask about fruits and vegetables?
- How are we going to conduct our inquiry?
- What sort of timeline do we need to set?
- What types of information do we need and how do we find and collect this information? e.g. locate resources.
- What is the best way of allocating tasks? e.g. forming small groups or creating individual projects?
- How will we organise or present our findings?

4.3 FINDING OUT

The following activities involve students in shared experiences that provide new information about the topic and stimulate curiosity.

ACTIVITY 6: SITE PLAN FOR SCHOOL GARDEN

Purpose: To design a site plan for a school garden.
Time: Approx. 1 hour
Materials Required: Large piece of paper, markers, coloured pencils
Resource / Information Sheets: N/A

Procedure

On a large piece of paper, draw the area of your garden. Mark important landmarks like classrooms and drinking taps.

Using different coloured pencils for each different type of plant, colour in how you would like your garden to look.

Include notes on your map to explain to others why you think this is the best way to plant your garden.

Display your maps in your classroom and ask others what they think of your design.

ACTIVITY 7: SITE PREPARATION

Purpose: To prepare the area for the school garden.
Time: Approx. 3 hours
Materials Required: Mulch, garden fork, bags or buckets to carry weeds away
Resource / Information Sheets: 4.2 Teacher Information Sheet- Composting

Procedure

Consider whether your garden is going to be planted in soil on the ground or planter boxes raised off the ground. If you decide on planter boxes you will need to construct those and fill them with soil. You could use wood for the sides, or weave

palm leaves to create the walls. Create circular plots with the soil heap up to the sides of the wall to form a saucer shape. This will capture moisture and have it run to the centre of the patch.

Remove weeds from the site that might compete with your plants and loosen the soil with the garden fork in preparation for planting seeds.

Lay mulch on the site to increase the nutrients in the soil. Compost could be added to the soil (for more information on composting see *4.2 Teacher Information Sheet*).

A school garden using pots and old containers.

4.4 SORTING OUT

Students at this stage will be collating, processing, analyzing and presenting the information in a variety of ways. Students will have the opportunity to further explore any questions that may have arisen when they were investigating. This would also be a good time to revisit some of the initial activities from Tuning In or Deciding Directions sections, for the students to witness how their knowledge has increased.

ACTIVITY 8: REVISING AND REVISITING

Purpose: To revisit and revise questions on fruits and vegetables.
Time: Approx. 50-60 minutes.
Materials Required: Strips of card
Resource / Information Sheets: N/A

Procedure

Revisit original ideas about fruit and vegetables and their plan for the school garden.

Is there anything students wish to add or change?

Revisit our questions about fruit and vegetables. Each student can select a question for which they can provide an answer. Write the answer on a strip of card and display.

4.5 DRAWING CONCLUSIONS

The following activities will help students to interpret information, establish connections and confirm/reject or modify predictions.

ACTIVITY 9: GOOD NUTRITION

Purpose: To draw conclusions on what has been learnt and share information with the community.
Time: Approx. 1.5-2 hours
Materials Required: Pens, notebooks, paper, coloured pencils
Resource / Information Sheets: N/A

Procedure

By now students should have the understanding that:

- there are links between plants such as fruit and vegetables and the health of humans
- it is our responsibility to ensure we have a healthy diet

Create an information brochure to distribute to the community on the importance of fruit and vegetables. Describe the vitamins and minerals in the fruit and vegetables on your island and in your school garden and their importance to your health and well being.

4.6 CONSIDERING, PLANNING AND TAKING ACTION

As a result of students being actively involved in decision making throughout the inquiry process, it is hoped that they will be empowered to take action which has positive personal, community and global effects. Some suggestions are listed below:

ACTIVITY 10: PLANTING THE SCHOOL GARDEN

Purpose: To establish a school garden.
Time: Approx. 50-60 minutes.
Materials Required: A digging tool, gloves (optional), water, plants or seeds, guards or stakes to protect plants (if required)
Resource / Information Sheets: 4.3 Teacher Information Sheet- Looking after the Good Guys (Worms); 4.4 Teacher Information Sheet- Natural Soil Improvers; 4.5 Teacher Information Sheet- Pest Control

Procedure

Select your plant and where you would like to plant it in your garden. Remove any mulch away from the surface so that you can see the soil.

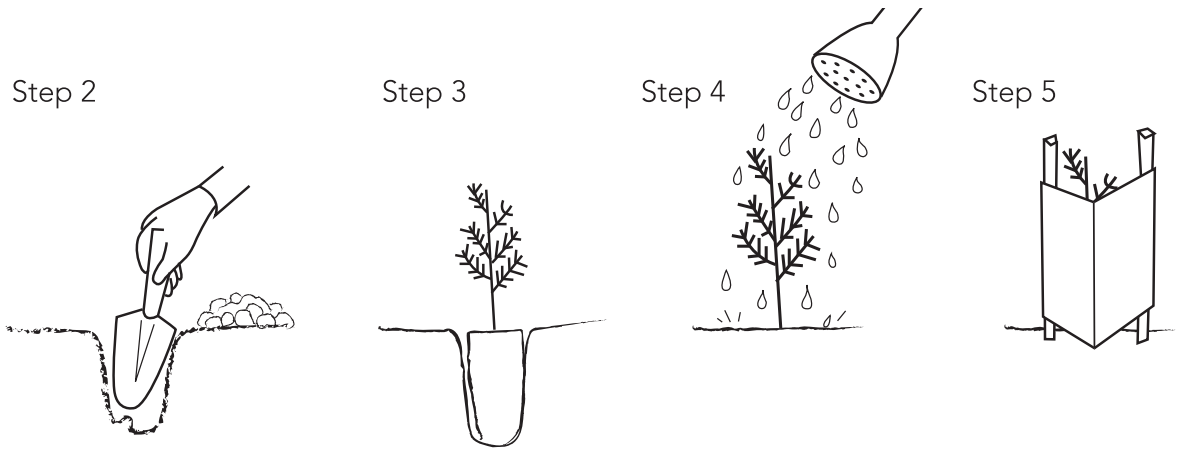
With your digging tool make a hole the same size as the pot of your plant. Make sure that you keep the soil you remove neatly to the side.

Carefully remove your plant from the pot, making sure that you do not pull on the plant and damage the foliage. Only remove the pot when you are close to your hole, so that you do not have to travel with it unprotected. Place your plant in the hole, making sure the top of the plant's soil is level with the ground (as pictured below). Use the soil you removed earlier to fill in any gaps around the plant – make sure you don't leave any big air pockets. Think of tucking someone into bed, and gently firm the soil around the stem of the plant.

Now you need to give your plant a drink of water. Make sure you cover the mulch back over the plant as well, that will help to reduce moisture evaporation.

It may be necessary to guard your plant to protect it from animals, weeds or even humans! If so, place the stakes at even distances around the stem of your plant and carefully cover this with the guard, making sure you protect the foliage of your plant while you are doing it.

You have done an excellent job. Now you need to make sure you look after and maintain your garden for the future.



4.7 EVALUATION AND REFLECTION

At this stage it may become evident that there is a need to return to some stages of the inquiry process to clarify knowledge or refine skills. The following questions may be asked:

- Are you happy with the ways in which your information was gathered, analysed and presented?
- Is there anything you would change?
- Are there things you need to investigate further?

ACTIVITY 11: HOW DOES YOUR GARDEN GROW?

Purpose: To observe and record the growth of the plants in the garden over a period of time.
Time: Approx. 1 hour per week
Materials Required: Pen, notebook, pencil
Resource / Information Sheets: 4.2 Student Resource Sheet- How are things growing? 4.3 Student Resource Sheet- Plant Growth

Procedure

A very important part of your school garden project is the ongoing monitoring of your garden. It is vital to keep track of how the garden is going. If you didn't set up a photo point at the start of the project, do so now. Your garden will change very quickly and photos provide a great visual record of your achievements. Mark the photo point well so it is clear when you return over the years! As part of the monitoring of your garden you should record:

- the growth rate of the plants each month (e.g. monitoring height of plants, drawing pictures of the garden)
- the number of healthy plants and how many have died
- a list of native birds and animals observed
- pest plants that have been removed
- pest animals that have been sighted

Students can learn much from monitoring and maintaining the school garden.

Things to do:

- Collate and graph the average growth of each type of plant.
- Take a picture of your garden, to compare with the picture you took at the beginning of the program. Make sure you take it from the same place to make the best comparison.
- Create a plant progress time line.
- Keep a close eye on the size of your plants. Once the foliage is growing strongly in and above the guard, it's time to remove the guard and let the plants spread even further.

ACTIVTIY 12: FRUIT AND VEGETABLE PMI

Purpose: To reflect on what students have learnt.
Time: Approx. 20 minutes
Materials Required: Pen, notebook, pencil
Resource / Information Sheets: 4.4 Student Resource Sheet- Fruit and Vegetable PMI

Procedure

Students use *Student Resource Sheet 4.4* to write down individually or in groups:

- The Pluses – the good things they discovered about growing fruit and vegetables.
- The Minuses – the not so good things they discovered about growing fruit and vegetables.
- Interesting –the interesting things they discovered about growing fruit and vegetables.

Share with the class.

4.1 STUDENT RESOURCE SHEET

THE GOOD, THE BAD AND THE UGLY

Provide one insect card to each group. Then each group will prepare a presentation on each insect.

Spider 	Beetle 
Mosquito 	Fly 
Snail 	Worm 
Butterfly 	Centipede 
Earwig 	Ant 

4.2 STUDENT RESOURCE SHEET

HOW ARE THINGS GROWING?

Each month record the following information from your school garden:

Plant Measurements		
Plant name	Month	Height (cm/inches)

4.2 EXAMPLE OF COMPLETED STUDENT RESOURCE SHEET

HOW ARE THINGS GROWING?

Each month record the following information from your school garden:

Plant Measurements		
Plant name	Month	Height (cm/inches)
Chilli plant A	February	10 cm
Chilli plant B	February	8cm
Papaya plant	February	15cm
Kopee Faiy plant	February	30cm

4.3 STUDENT RESOURCE SHEET

PLANT GROWTH

Sketch what the plants look like:

Week 1

Week 2

Describe the plants

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Week 3

Week 4

Describe the plants

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4.3 STUDENT RESOURCE SHEET

PLANT GROWTH

Sketch what the plants look like:

Week 5

Week 6

Describe the plants

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Week 7

Week 8

Describe the plants

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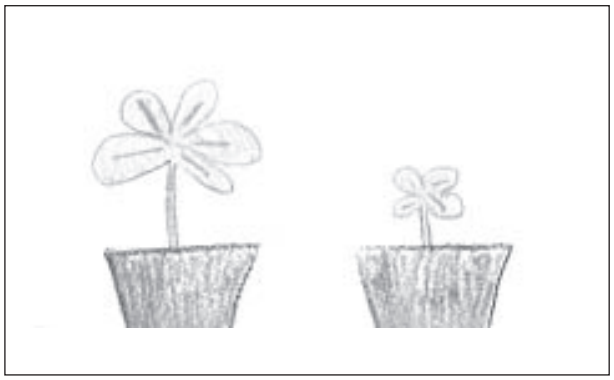
4.3 EXAMPLE OF COMPLETED STUDENT RESOURCE SHEET

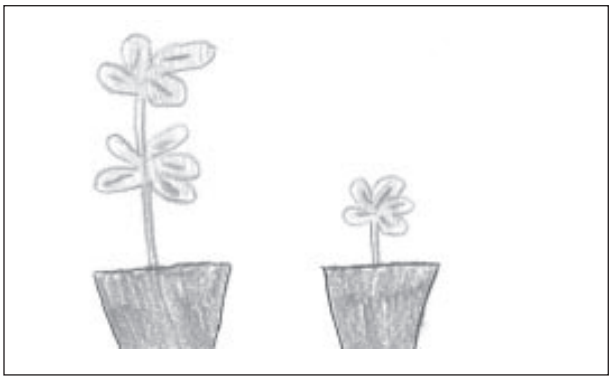
PLANT GROWTH

Sketch what the plants look like:

Week 1



Week 2

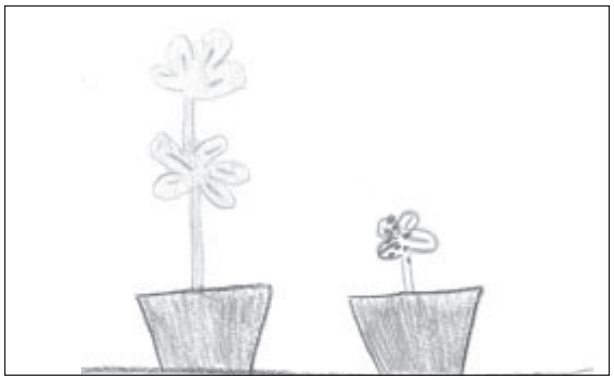


Describe the plants

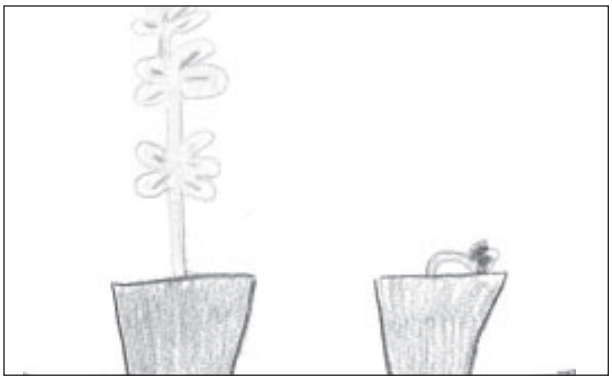
One plant is growing really fast. The other is growing very slowly.

Both plants have started to grow, but one plant is growing faster.

Week 3



Week 4



Describe the plants

One plant is not looking healthy; it has black spots on its leaves. The other plant looks very healthy and strong.

One plant has died. Maybe it had too much sunlight or not enough water?

4.4 STUDENT RESOURCE SHEET

FRUIT AND VEGETABLE PMI

Plus	Minus	Interesting

4.4 EXAMPLE OF A COMPLETED STUDENT RESOURCE SHEET

FRUIT AND VEGETABLE PM

Plus	Minus	Interesting
I liked going outside of the classroom and planting the seeds. The papaya plant grew very fast. I liked to watch it grow each week.	Some times it was hot outside. Also some seeds did not grow at all.	Some plants grew faster than others. It was interesting to see which plants grew faster than others.

4.1 TEACHER INFORMATION SHEET
DIFFERENT TYPES OF GARDENS

A garden is a planned space, usually outdoors, set aside for the display, cultivation, and enjoyment of plants and other forms of nature. The garden can incorporate both natural and man-made materials. There are many different types of gardens, including a flower garden, fruit and vegetable garden, herb garden, organic garden (without any chemicals), local plant garden and a hydroponic garden.

Hydroponics

In natural conditions, soil acts as a mineral nutrient reservoir but the soil itself is not essential to plant growth. When the mineral nutrients in the soil dissolve in water, plant roots are able to absorb them. When the required mineral nutrients are introduced into a plant's water supply artificially, soil is no longer required for the plant to thrive. Hydroponics is a method of growing plants using mineral nutrient solutions instead of soil. Terrestrial plants may be grown with their roots in the mineral nutrient solution only or in an inert medium, such as gravel or mineral wool. A variety of techniques exist.

Herb Garden

A herb garden is a garden specifically designed and used for the cultivation of cooking and/or medicinal herbs. Typical herbs include rosemary, parsley, and basil.

Fruit and Vegetable garden

A fruit and vegetable garden is specifically designed to grow fruit and vegetables for eating. In the Maldives many fruits and vegetables can be grown, including:

Common name	Dhivehi name	Scientific name
Fruits		
Coconut Palm	Dhivehi Ruh	*Cocos Nucifera*
Papaya	Falhoa	*Carica papaya*
Watermelon	Karaa	*Citrullus vulgaris*
Guava	Feyru	*Psidium guajava*
Vegetables		
Pumpkin	Baraboa	*Cucurbita moschata*
Egg plant	Bashi	*Solanum melongena*
Kale	Kopee Faiy	*Brassica olearcea*
Tomato	Vilaathu bashi	*Lycopersicum esculentum*

Hydroponics: Huraa

Coconut palm planting.

Local plant garden

In recent years more people have become interested in local plant gardening. In the Maldives there are many plants adapted to local conditions. If we plant local plant gardens we can increase biodiversity, provide a habitat for many animals and conserve water. Seeds for local plants are available on our islands. Students can be encouraged to identify local plant species and collect seeds for planting in the garden. Such plants may include:

Common name	Dhivehi name	Scientific name
Coconut Palm	Dhivehi ruh	*Cocos nucifera*
Coast Hibiscus	Cotton Tree Dhiggaa	*Hibiscus tiliaceus*
Portia Tree	Hirundhu	*Thespesia populnea*
Sea Lettuce	Half Flower tree Magoo Gera	*Scaevola taccada*
Tree Heliotrope	Octopus Bush Boashi	*Argusia argentea*
Indian Almond Tree	Midhili / Meedheli	*Terminalia catappa*
Ball Nut	Funa	*Calophyllum inophyllum*

References: http://en.wikipedia.org/wiki/Hydroponics

4.2 TEACHER INFORMATION SHEET
COMPOSTING

What is compost and how is it useful?

Compost is organic matter (plant and animal residues) which has been rotted down by the action of bacteria and other organisms, over a period of time. Many types of organic matter, such as leaves, fruit and vegetable peelings and manures can be used to make compost. The end product is very different from the original materials. It is dark brown, crumbly and has a pleasant smell.

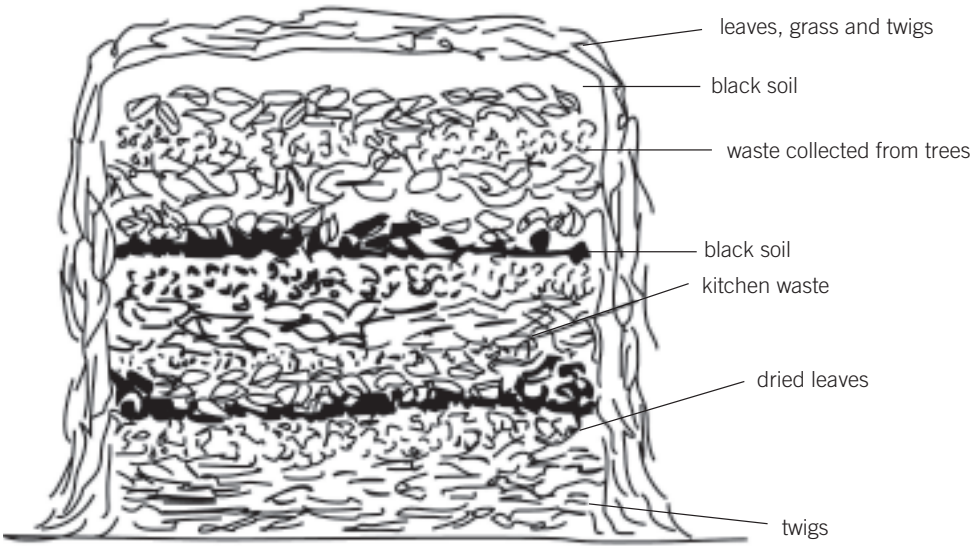
Compost is cheap, easy to make and is a very effective material that can be added to the soil, to improve soil and crop quality.

- Compost improves the structure of the soil. It allows more air into the soil, improves drainage and reduces erosion.
- Compost helps to stop the soil from drying out in times of drought by holding more water. By improving soil structure, compost makes it easier for plants to take up the nutrients already in the soil.
- Compost may also improve soil quality by adding nutrients. This can help to produce better yields.
- Compost can reduce pest and disease problems in the soil and on the crop. The crop will be stronger and healthier and therefore resist pest and disease attack.

Compost is a better way of feeding plants than using chemical fertilisers. These fertilisers provide nutrients for plants but do not improve soil structure or quality. They usually only improve yields in the season in which they are applied. Compost is not washed away through the soil like chemical fertilisers, so the beneficial effects are longer lasting. Plants that are grown with chemical fertilisers are more attractive to pests because they have greener, sappy growth.

Households and farms produce many materials which can be used to make compost. Making compost makes use of materials that may otherwise be wasted. Some of these wastes could also be used for other purposes. For example palm fronds may be needed for construction or kitchen wastes may be needed to feed livestock. A choice will need to be made as to whether to use such materials for the compost heap or not.

Nearly all organic matter can be used to make compost but different items will take varying amounts of time to decompose and form different end products. For example, fruit on its own will go slimy and coconut leaves will go dry and dusty. . This is because different types of organic matter contain different proportions of carbon and nitrogen. In general, young, living material that decomposes fast contains low levels of carbon but high levels of nitrogen.



Banana leaves help to keep the moisture in the compost pile.

Tough, dead material, for example palm fronds and stalks, decomposes slowly and contains large amounts of carbon but low amounts of nitrogen. Too little nitrogen rich material and the decomposition will be slow; too much and the heap will become acid and smelly.

Compost recipe for beginners:

Choose the correct position – a shady, sheltered area to avoid too much evaporation, for example under a tree is ideal.

First put a layer of coarse material such as broken–up palm leaves, sticks, twigs, dry leaves and torn newspaper on the bottom of the heap. This layer should be about the thickness of the width of one of your hands (8-12 cm). This step is important because it allows air to flow through the heap.

Then add a thin layer (1-2 cm) of rich soil or finished compost from a previous heap. Add enough water to make everything moist.

You are ready to start adding your food scraps to the heap. Each time you add kitchen scraps to the heap, also add a different thin layer (1-2 cm) of one or more of the following:

- green leaves
- soil or compost from a previous heap
- coarse material, eg, tree pruning, sticks, twigs and leaves
- shredded newspaper
- wood ash
- fresh herbs

When you have finished layering, cover the heap with sacking, grass thatch or banana leaves to protect it against evaporation and heavy rain as this will wash away all the nutrients.

Turn the heap often to get good quality compost quickly, you need to turn the heap every few weeks with a fork or shovel. If your heap is wet and smelly – turning will help it dry out. If it's too dry turn it and then water.

Safety precautions

For health reasons, it is very important to take the following precautions when handling compost or soil:

- Wash your hands after handling compost or soil materials.
- Protect broken skin by wearing gloves.
- Avoid confined spaces for handling compost or soil materials.
- Keep compost moist to prevent the spores or bacteria in compost from becoming airborne.
- Gently wet dry compost to allow dust-free handling.
- Avoid direct inhalation of dry compost.

4.3 TEACHER INFORMATION SHEET

LOOKING AFTER THE GOOD GUYS (WORMS)

Worm farms are a good solution for people who don't have room for a compost bin, and even for those who do not have a garden. You can make one from polystyrene fruit containers or wooden boxes. You will need a surface area of around 30x50 cm for each person in the house. A cover with airholes in it will protect your worms from birds and stop the farm from drying out too quickly. Worms need to be kept moist, but not wet and cool but not frozen! The farm needs to have drainage and needs to be watered periodically to keep it moist.

The easiest way to get started is to find some worms in the garden. You can just pour the worms and their bedding material into the box and add some kitchen scraps to get them going.

If you add too much food or green waste it will start to rot before the worms get around to eating it. Start with a small amount and add more when it has all been eaten. As the worms multiply you will be able to add more scraps at a time. Worms can eat about half their body weight in food per day. If you use a starter pack with about 1000 worms in it, you can feed them about 250g of scraps to start with.

You can add anything to your worm farm that is leftover from preparing your dinner and you can also add some garden wastes. Worms need their food to be chopped up a bit for them. You can feed them kitchen scraps, paper, egg shells, and weeds. Worms don't digest seeds, so if you feed them weeds that have gone to seed you may need to further compost, or alternatively solarise the worm castings before you use them in the garden. You can add small amounts of chopped up citrus to the worm farm, but meat scraps are likely to attract rats and mice and are best avoided.

When the bottom tray fills up, you can add another tray to the top of the old one. Put some scraps in the top tray and when the worms have eaten all the scraps in the bottom, they will migrate up to the top one. When all or most of the worms have moved into the top tray you can put the castings from the bottom tray into the garden. In a small amount of space you can stop hundreds of kilograms of food from going to landfill in a year. This will reduce your contribution to the greenhouse effect and will improve your garden at the same time.

4.4 TEACHER INFORMATION SHEET
NATURAL SOIL IMPROVERS

Generally speaking, plants grown in a healthy, well-balanced soil will have an increased resistance to disease.

How does compost help?

Compost combined with well-rotted bird and animal manure will adequately supply the organic matter and humus needs of most soils. Organic fertilisers consist of combinations of animal manures, compost and products of plant and animal matter, such as seaweed and blood and bone meal. Animal manures alone vary greatly in their nutrient content.

Why use organic fertilisers rather than chemical ones?

- They are a permanently renewable resource and require less energy for their manufacture than chemical fertilisers. This also means they are cheaper.
- By recycling important nutrients, humus and organic matter back into the soil, they feed beneficial soil micro-organisms and build good soil structure, in contrast to soluble chemical fertilisers, which do not contribute to soil health at all.
- Soils high in organic matter are better able to hold moisture.
- They do not damage important soil microflora and fauna, such as earthworms, whereas inorganic fertilisers do by dramatically lowering soil pH.
- They do not contain heavy metal residues, such as cadmium, which have been found in ingredients of some artificial fertilisers.
- It is very difficult to overdose plants with organic manures.

Natural Fertilisers & Soil Conditioners

Compost

Well made compost that contains a large number of ingredients from many different sources will have adequate amounts of most essential major and trace elements. Compost, combined with any animal manures produces the best and safest all purpose fertiliser, containing both major and minor elements.

Animal Manures

All animal manures provide valuable sources of nutritional elements for plant life. When combined with compost as part of the composting process, the final material provides the best all purpose fertiliser. When using manure straight on the garden, care should be taken that it is not too 'hot', i.e. that it has been broken down or weathered sufficiently. Use of composted manures eliminates smells and provides five times the nutrition as fresh manures.

Fowl Manure

Is very high in nitrogen and phosphorus. Therefore, care must be taken that it is well rotted or composted before applying it to the garden.

Dynamic Lifter

An organic general fertiliser based on chicken manure, which is fully processed and sterilised. It is suitable for every feeding situation and application encountered by the home gardener. It is easy to use, non-burning and impurity free. It slowly releases nutrients into the soil as it breaks down.

Seaweed Extracts

There are several commercially available liquid fertilisers on the market, which are very beneficial, particularly for establishing plants and as a tonic for unhealthy plants.

Fish Emulsions

These are organic liquid fertilisers.

Wood ash

Scattered in layers in the compost heap, they will do the job of lime in "sweetening" the whole mass.

Leaf mulch

Although leaf litter is not high in nutrients, it has a very important role in the garden, creating within the soil a crumbly texture, which allows good water retention without water logging. Wherever there is leaf mulch, earthworms will abound. The more worms, the healthier the soil, which is one of our most important natural resources.

4.5 TEACHER INFORMATION SHEET
PEST CONTROL

There is a rapidly increasing need to change what we spray and sprinkle around the garden to keep it disease and insect free. It has been evident from the first use of sprays and powders that not only do they kill the insect, fungus or weed that is the problem, they can also eradicate helpful flora and fauna that are part of the natural biological web within the garden.

Don't poison the worms and friends

Many gardeners do not realise that when top using an all purpose fertiliser they are systematically exterminating their extremely helpful earthworm population (see Teacher Information Sheet, Looking after the Good Guys – Worms). The same conditions apply when controlling plant disease. Some may control plant pests, but also kill pest predators, compounding the original problem. The residue of these sprays and powders can also build up in the soil, getting into your home produced food chain and poisoning the soil for years.

How can you control pests and diseases naturally?

The best way to control plant diseases is to prevent them occurring in the first place. This can be achieved with healthy cultivation methods:

- Choose plants that match your garden's conditions and are pest-resistant.
- Water to encourage strong root systems and avoid humid conditions.
- Add organic matter to soils as fertilisers, composts and mulches - to encourage microbes that attack plant pathogens, to supply nutrients to plants keeping them strong and healthy.
- Use fish emulsions to boost the plant's immunity to pest and disease attack.
- Fertilise to strengthen plants eg. ensure plants have adequate potassium (promoting thick cell walls).
- Remove weeds that can harbour pests, and
- Try some companion planting (flowering plants attract beneficial predatory and parasites that are natural enemies of the pests, especially aphids, whitefly, mealybug and caterpillars).
- Crop rotation is important
- Plant sanitation is very important (e.g. don't take plants from an infested area to uninfested area without cleaning tools etc, remove unhealthily plants).

Healthy cultivation methods will certainly improve the vigour of your plants, however, for a variety of reasons, plants may still succumb to disease, especially during

Problem	Non chemical control	Recommended chemical control
Ants	Control scale or aphids that ants are attracted to.	No need (beneficial to garden)
Aphids	Manual squashing, avoid killing natural predators, hose aphids off leaves, use light traps at night for collecting adults	Neem oil or Pyrethrin
Caterpillars	Manual squashing, attract predators like birds	Dipel or Derris Dust
Snails and Slugs	Mulching or home made traps	Multiguard
Black Spot	Decrease humidity around plants	Triforine
Downy Mildew	Decrease humidity around plants	Copper hydroxide
Leaf Curl	Pick off diseased leaves	Copper hydroxide at budburst if bad last year
Powdery Mildew	Decrease humidity around plants	Dusting Sulphur
Rusts	Decrease humidity around plants	Mancozeb

Beans are a type of legume which helps to add nitrogen to the soil.

seasons when pest populations naturally increase. In a diverse garden total pest control is undesirable. Acceptable amounts of all pests create food for other desirable organisms, especially those that are pest predators.

What if pests still invade?

However, if pest levels do become unmanageable, we ask you to consider the environmental impact of the pest control measures you employ. We recommend controlling plant disease with non-chemical means if possible.

The table on the previous page suggests how to use these principles to control some common garden pests:

Companion Planting

Alternative Pest Control

Many vegetables grow well with other plants in the garden and, using a few basic principles, organic gardeners can really have nature on their side in the biological control of pests.

The most commonly documented companion plants repel pests when planted alongside vegetables. Other plants attract pest predators to the vegetable patch. Some plant roots secrete substances that repel pests or provide nutrients to the plants around them. These plant interactions can work in specific ways between two or three types of plants or species.

Peas and Beans add nitrogen to the soil.

For example, legumes (peas, beans, etc.) trap nitrogen from the air with nodules on their roots. When these crops have finished producing you can dig them into the soil so that the nitrogen is available to the next crop. Being leafy vegetables, the brassica family (Kopee faiy etc.) require a lot of nitrogen to grow, so it makes sense to follow pea crops with Kopee faiy that can use this free nitrogen source.

The ecosystem approach

Many of these relationships are fairly general. The best results come from an ecosystem approach to gardening, using a wide variety of herbs and ornamental plants alongside the edible crops planted in the garden.

4.6 TEACHER INFORMATION SHEET
INTERNET RESOURCES

Sustainable Agriculture

http://www.schoolgardenwizard.org/
http://www.kidsgardening.com/school/searchform.asp
Both sites contain information about establishing school gardens.

http://landlearn.netc.net.au
Supported by Victorian Department of Primary Industries. LandLearn provides a structure and support for schools to incorporate studies of sustainable agriculture and natural resource management into the curriculum in the context of:

- A holistic approach to environmental education for a sustainable future; Victorian Essential Learning Standards;
- Education priorities and guidelines, including 'Educating for a Sustainable Future' - a National Environmental Education Statement for Australian Schools;
- Scientific research and the promotion of science in schools;
- Partnerships with related education programs.

http://www.freshforkids.com.au/
A website supported by the Sydney markets all on fruit and vegetables.

http://oisat.org/cropsmap.htm
Tropical vegetable and fruit crops and their integrated pest management, including recipes for low toxicity sprays and guidelines for making a variety of traps.

http://www.extento.hawaii.edu/kbase/crop/cropmenu.htm
Information on identification and management and pests and diseases on crops in Hawaii, many of which occur in the Maldives.

http://www.ipm.ucdavis.edu/
Integrated Pest Management for pests and diseases of many crops, as practiced in California, USA.

http://www.agridept.gov.lk/doa/links.php?heading=Vegetables
Sri Lankan Dept of Agriculture site on general crop management practices.

http://susveg-asia.nri.org/
Integrated pest management of brinjal, tomato and beans.

http://www.avrdc.org/LC/home.html
Good information on many vegetable crops.

http://www.farmerfred.com/plants_that_attract_benefi.html
A list of plants to attract beneficial insects.

http://pmep.cce.cornell.edu/profiles/extoxnet/index.html
Extensive information on the toxicity of active ingredients in most pesticides.

GLOSSARY

Accretion
An increase in size as a result of accumulation. (e.g. the accretion of sand on a beach)

Algae
Photosynthetic organism of a group that lives mainly in water and includes the seaweeds. Algae differ from plants in not having true leaves, roots, or stems.

Bio Degradable
Easily broken down.

Biodiversity
The variety of life on earth.

Breeze
A light current of air; a gentle wind.

Carnivore
An animal that eats other animals.

Combustible
Material that can burn.

Crustacean
An invertebrate animal with several pairs of jointed legs, a hard protective outer shell, two pairs of antennae, and eyes at the ends of stalks. Lobsters, crabs, shrimp and crayfish are crustaceans.

Debris
Fragments of something that has been destroyed or broken into pieces or discarded material, such as waste.

Degrades
To cause damage or destruction to part of the environment as a result of human activity.

Detritus
Organic debris formed by the decomposition of plants or animals.

Decay
To rot or become rotten; decompose

Dredging
The removal of soil or material from the bottom of a river, lake, or harbour.

Ecosystem
A community of plants, animals and micro-organisms that are linked and that interact with each other and with the physical environment.

Endangered
Threatened with extinction, as a species of plant or animal; to have put in a dangerous situation.

Environment
Everything that surrounds a living thing and affects its growth and health.

Environment Impact Assessment
An EIA is a document which describes the likely environmental effects of a proposed development.

Erosion
Wearing away of the earth's surface by wind or water.

Estuaries
Section of a river meeting the sea where the tide flows in, causing fresh and salt water to mix.

Gale
A very strong wind.

Habitat
The area where an animal, plant or micro-organism, lives and finds the nutrients, water, sunlight, shelter and other essential needs for survival.

Herbivore
An animal which eats only plants.

Hydroponics
Growing plants in liquid nutrient, without soil.

Insects
Small six-legged animal with a body that has well-defined segments, including a head, thorax, abdomen, two antennae, three pairs of legs, and usually two sets of wings. Bees and flies are insects.

Invertebrates
Animal without a backbone, e.g. an insect or worm.

Minerals
Inorganic substance in nature. The human body requires minerals to live.

Mulch
Protective covering of organic material laid over the soil around plants to prevent erosion, keep in moisture, and sometimes enrich the soil.

Non Bio Degradable
Cannot be easily broken down.

GLOSSARY

Nutrition
The process of absorbing nutrients from food and processing them in the body in order to keep healthy or to grow.

Opaque
Not clear. Difficult to see through.

Photosynthesis
The process by which green plants or algae use sunlight to produce carbohydrates (starch). Oxygen is released as a by-product of photosynthesis.

Rare
Not happening or found often.

Reclamation
To fill an area with soil or debris to gain space.

Rehabilitate
To restore to good condition, operation, or capacity.

Sediment
Material which settles out of a liquid to form a layer.

Sewage
Fluid containing water borne, domestic and human waste.

Species
A group of organisms that has a unique set of characteristics that distinguishes them form other organisms.

Sustainability
Meeting the needs of the present without diminishing the ability of people, other species or future generations to survive.

Terrestrial
Belonging to land, rather than the sea or air.

Vitamins
Organic substance essential to nutrition in animals.

Wildlife
Wild animals that live independent of humans.

Weed
A plant considered undesirable, unattractive, or troublesome, especially one growing where it is not wanted, as in a garden.

Reference definitions sourced from http://encarta.msn.com/dictionary

All kids are gifted,
some just open their packages earlier

Educational Development Centre
unicef