Wonderful Water

An Environmental Education Programme

Mangrove Ecosystems in TCI

Overview and Field Trips

and

1: Mangrove ecosystems in TCI and their importance

Teachers' Guide

TCI
Education Department

Wonderful Water

An Environmental Education Programme

Mangrove Ecosystems in TCI

Overview and Field Trips, and

1: Mangrove ecosystems in TCI and their importance

Teachers' Guide

Target Age Group - 9-11 years

This environmental education programme has been produced by the UK Overseas Territories Conservation Forum (UKOTCF) and the Turks and Caicos Department of Education.

It was part-funded by the Overseas Territories Environment Programme (OTEP) of the UK Department for International Development and the Foreign and Commonwealth Office.

The project was developed from an original idea by Mr Edgar Howell, Director of Education, Turks and Caicos Islands, and these materials developed by a team co-ordinated by Ann Pienkowski, Environmental Education Co-ordinator, UKOTCF. It is hoped that through the teaching materials developed for this project, students in TCI will gain a greater understanding of the importance of the water ecosystems in TCI, and the need to conserve these.

As a possible model to assist environmental education in other areas of the Caribbean (especially UK Overseas Territories) these materials will be made available to a wider audience.

Contents

Introduction

In devising these teaching materials, reference was made to the TCI Science Curriculum for Grade 5 and 6, and the science teaching materials currently being used in primary schools in TCI.

A curriculum framework has been developed, which links the Wonderful Water themes to curriculum requirements. As part of the curriculum framework, expected levels of achievement for a particular stage in a students' education have been developed into statements of competency which can be used to assess the levels students have reached. The purpose of these statements of competency is to support teachers in their review of students' progress. The objectives given in the pupils' materials relate to these statements of competency.

Assessment criteria / Statements of competency

These level statements relate to levels of attainment given in the Science National Curriculum for England, but are compatible with such statements about expected attainment in many other curricula.

This table gives the level (L) a child is expected to achieve at a particular stage in their schooling:

End of grade:	Expected attainment related to curriculum levels (from National Curriculum for England)		
	Slower progress	Most pupils	Faster progress
4	L2	L3	L3/4
5	L2/3	L3/4	L4/5
6	L3	L4	L5

Mangrove Ecosystems in TCI - Overview of sections with statements of competency

The assessment criteria / statements of competency, which relate to this unit on Mangrove Ecosystems in TCI, and their importance, are given below. These can be used to guide progression.

1. Mangrove ecosystems in TCI and their importance:

Knowledge about Mangrove Ecosystems

L2: Match animals and plants to a wetland ecosystem using pictures or photographs.
L3: Know that a healthy ecosystem is balanced (enough food and water for the plants and animals to live and reproduce successfully)
L4: Know that an ecosystem is a community of living things that sustains itself.
L5: Recognise that a healthy ecosystem supports a wide variety of living things, not just large numbers of individuals (biodiversity).

Knowledge about why the mangrove ecosystem is important

L2: Know one reason why a mangrove ecosystem is important.
L3: Give at least 2 examples of how mangroves benefit people
L4: Give at least 3 examples of how mangroves benefit people.
L5: Discuss what the effects would be, on people living nearby, of losing mangroves

2. Adaptations in the mangrove ecosystem:

Knowledge about adaptations in the mangrove ecosystem

L2: Recognise that different living things are found in different places, and with help say why a plant or animal is suited to a place [mangrove]
L3: Identify ways in which an animal or plant is suited to its environment [mangrove].
L4: Provide simple explanations for animal and plant behaviour that helps them survive and cope with change (eg changing physical conditions on the coast)
L5: Explain how more complex features help animals and plants survive in a named habitat (eg mangrove)

3. Feeding relationships in the mangrove ecosystem:

Knowledge about feeding relationships in the mangrove ecosystem

L2: Know that plants are eaten by animals, and some animals eat other animals.
L3: Know that plants are eaten by animals, and some animals eat other animals. Understand that this relationship is called a food chain, and shows energy flow.
L4: Recognise that feeding relationships exist between plants and animals in an ecosystem, and describe these relationships using food chains and terms (eg predator, prey, consumer, producer)
L5: Use a combination of food chains within an ecosystem to produce food webs, and understand the role of decomposers.

4. Threats to the mangrove ecosystem:

Knowledge about threats to the mangrove ecosystem

L2: Know that human activities can damage the environment.
L3: Explain 2 ways in which human activities damage the environment.
L4: Give examples of how human activities cause environmental effects, using terms such as pollution, reclamation, drainage, erosion.
L5: Understand the ways by which human activity (such as draining or polluting a wetland, over exploitation) can change the environment and affect the plants and animals living there.

These threats include **pollution:**
L2: Name a source of pollution which could affect a wetland.
L3: Explain how pollutants can harm plants and animals.
L4: Describe how plants and animals in a food chain can be affected by pollutants.
L5: Describe how the abundance and distribution of organisms may be affected by pollutants and relate this to food webs

and **invasive species:**
L2: Know what an invasive species is.
L3: Give one reason why invasive species are a threat to ecosystems.
L4: Know that a lack of resources and / or increased predation affects numbers of plants and animals.
L5: Know that an invasive species can seriously affect an ecosystem by excessive predation and / or removal of resources.

5. Mangroves and Climate Change:

Knowledge about Climate Change and Mangroves

This includes aspects of **Geography:**

L2: Know that climate is the general weather in one place over a long time.
L3: Know that climate changes over a long time, but human activities have caused changes to happen quickly.
L4: Know that manmade "Greenhouse Gases" are causing the earth to heat up.
L4: Know the meaning of terms such as atmosphere, solar radiation, reflection, Greenhouse Gas, layer.
L5: Understand the process by which "Greenhouse Gases" are causing the world to heat up.

Knowledge about environmental effects of climate change

L2: Know that climate change will affect the environment.
L3: Provide simple explanations of how climate change might affect mangroves.
L4:Know some of the ways in which climate change can change wetlands (in TCI) and know how climate change could affect lives and activities of people.
L5: Understand some of the ways in which climate change can change wetlands in TCI, and explain what effect this could have.

6. Caring for mangrove ecosystems:

Knowledge about environmental protection, caring for mangrove ecosystems

This includes aspects of **Geography:**

L2: Recognise how people affect the environment.
L3: Recognise how people seek to improve and sustain their environment.
L4: Understand that people can both improve and damage the environment
L5: Recognise how people try to manage environments sustainably

and **Science:**

L2: Know that different living things are found in different places because they need different things to live.
L3: Identify things in the [wetland] environment which the animal or plant needs to survive.
L4: Identify ways in which the plant or animal might be threatened.
L5: Identify ways in which the [wetland] environment might be damaged, and suggest suitable conservation strategies.

7. Classification of organisms in the mangrove ecosystem:

Knowledge about Classification of living things in a mangrove ecosystem

L2: Sort living things into groups using simple features
L3: Sort organisms into broad groups using easily observable features
L4: Group animals and plants scientifically by specific features. Know that the major groups of animals are vertebrates and invertebrates and that the major groups of vertebrates are mammals, fish, birds, reptiles and amphibians
L5: Understand the importance of classification and classify living things into the major taxonomic groups

The pupils' text provides key information for pupils.

The teachers' guide contains further information and resources for teachers, suggested activities for pupils, and example pupil worksheets.

The suggested pupil activities and worksheets can be carried out by individuals, pairs or small groups.

These materials are a working draft, and any suggestions for further activities, amendments and improvements are welcome.

Any comments / suggestions should be sent to the UKOTCF Environmental Education Co-ordinator, Ann Pienkowski. Email apienkowski@ukotcf.org

Background information for Mangrove Ecosystems and their importance

Wetland ecosystems in the Turks and Caicos Islands parts 1 and 2 explained the concept of an ecosystem, presented brief descriptions of the different wetland ecosystems found in TCI, and introduced information about biodiversity, population size and invasive species. This material looks at the mangrove ecosystem in more detail.

Mangrove Ecosystems in TCI

The materials on mangroves enable teachers to deliver the curriculum requirements through a study of the mangrove ecosystems in TCI. The sections on manroves are:

1: Mangrove ecosystems in TCI and their importance
2: Adaptations in the mangrove ecosystem
3: Feeding relationships in the mangrove ecosystem
4: Threats to the mangrove ecosystem
5: Mangroves and climate change
6: Caring for mangrove ecosystems.
7: Classification of organisms in the mangrove ecosystem

Background Information for 1 – Mangrove Ecosystems and their importance

It is important that students gain an understanding of the links between living things, and their own place in the world. This is key to understanding how the actions of people can affect plants and animals. Almost every living thing on our planet is dependent on energy from the sun, and the links from the sun's energy ultimately to ourselves are very complex.

Different ecosystems are not generally isolated totally from each other. The mangrove ecosystem links closely with both coral reef and seagrass bed ecosystems. It also links with terrestrial ecosystems inland from the mangroves. The mangrove ecosystem is a key component in the stability of these.

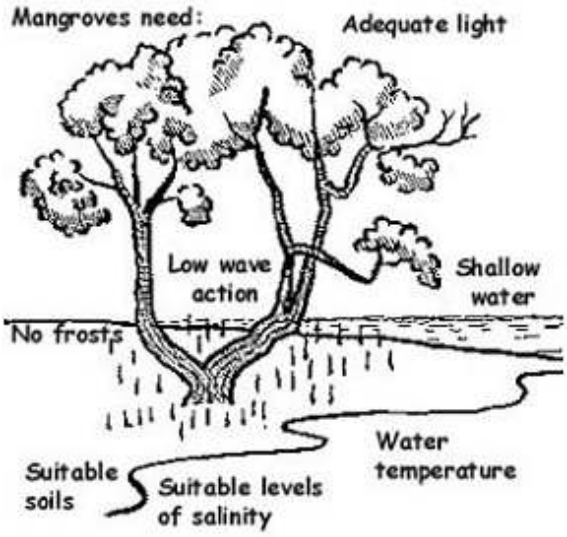
What is a mangrove Ecosystem?

Mangrove forests make up one of the most unique ecosystems on earth in that they thrive where no other trees can survive, the transition zone between the ocean and land. The mangroves, in turn, provide shelter for an incredible variety of terrestrial and aquatic organisms.

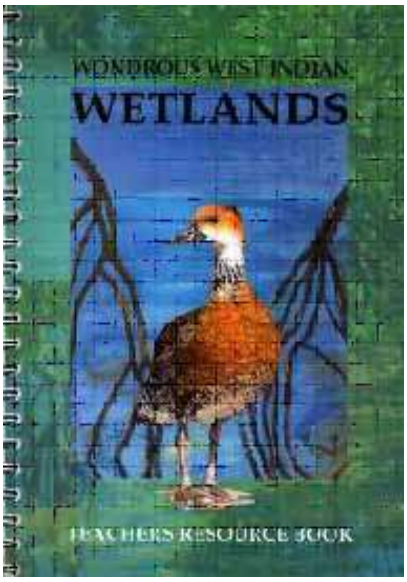
Mangrove forests develop in areas where high energy waves are absent and sediments accumulate. Tidal flooding largely influences the structure and appearance of mangrove forests. Although most mangrove forests are found submerged in water along the coastline, they can also extend to the flood plain's outer limits, which are often dry and only occasionally flooded when the water reaches its highest point. Mangroves are adapted for the salty conditions and frequent flooding in the ocean's tidal range and have ways of dealing with excessive salt.

Trees in a mangrove swamp must be able to withstand a wide range of factors. Mangrove swamps are found in areas with warmer water and where the coldest temperature is higher than 20 degree C. The plants must be able to survive being submerged twice a day by tidal changes. Plants must be able to withstand evaporation during the intertidal period due to the fact it can cause a rise in the salinity level. In fact, the intertidal zone, landward of the sea, has a higher salinity than sea water, due to evaporation. So the Black Mangrove which occurs in this area is more tolerant of salt than the Red Mangrove, which occurs at the sea water edge.

The sediment around mangrove areas is generally composed of very fine silt or mud particles. These densely packed particles make the sediment very oxygen poor. When water fills up the spaces within the soil, oxygen from the atmosphere cannot circulate into the soil, and the soil becomes anoxic or anaerobic (without oxygen). The only organisms that can survive and thrive in this oxygen free environment are bacteria. The bacteria can reduce sulphur instead of oxygen for respiration giving these environments a very distinct and strong smell of sulphur (rotten eggs). The bacteria on the other hand provide an important first step in the mangrove community food chain. Bacteria are decomposers that break down and convert all dead organic material into useful nutrients that are released into the water. These can, in turn, be utilised by other organisms in the surrounding water. So even though the sediment in mangrove communities itself does not provide a good habitat for much marine life, the surrounding water can sustain an enormous diversity of organisms.



This diagram summarises what mangroves need.



Many useful teaching resources about mangroves have been produced. Although not specifically focused on TCI many provide valuable extra teaching resources, and will be referenced in the Teachers' Guide and Resource Book where appropriate. In particular, note should be made of the *Wondrous West Indian Wetlands* teaching resource.

This is a programme of BirdsCaribbean. Workshops to introduce this programme to educators in TCI were held, in TCI, in Spring 2011. A Teachers' Resource Book was given to all participants. If you do not have one, ask if your school does. Resource kits, for teachers to borrow, were given to DECR. Please contact DECR if you wish to use these resources.

Chapters of the Wonderful West Indies Wetlands Teachers' Resource book relevant to this section are:

Chapter 1: Mangrove species and identification; features, adaptations and life history. This includes student activity sheets "What do you think about wetlands?", "Mangroves – Spot the difference."

Chapter 6: Seeing for yourself. Information about planning a field trip, suggestions for field work activities, and codes of behaviour for students when on a field trip.

Mangrove Field Trips

There are mangroves on each of the Turks and Caicos Islands. Because the water conditions in TCI vary so much with the season and the amount of recent rain, it is important for teachers to check out a site before taking students. This not only gives an idea of what might be of interest for the students, but will enable the teacher to assess any safety or access issues.

Field trip preparation

Before the trip, ask children what they think when they hear the word "mangrove".

Ask the students to write the word "mangrove" in the middle of a piece of paper, and then record their views. This can be repeated afterward the field trip, and the "before" and "after charts compared. One way of recording what they think and know about mangroves is through a Mind Map. This is explained later on.

Chances are they will come up with many negative terms, such as "buggy" or "swampy". After the trip it may be instructive to repeat this exercise to see if the word "mangroves" now calls to mind the importance of this tree.

Before visiting sites, students need to be prepared about the appropriate way to behave around wildlife. They should be instructed:

- to walk, not run
- to speak very quietly
- to avoid scaring animals – don't approach too closely
- to collect the minimum of material (and, for animal specimens, return to the same place afterwards)
- not to damage trees
- to take all trash home

This is common sense, but is not obvious to all students.

It is also important to stress "Take only memories and leave only footprints" to students during field trips. For a field trip to the mangroves, students will need to have sturdy shoes that can get wet, and other sensible clothing. Be prepared for bugs!! Sun hat and sunscreen might also be desirable. Depending on timing, they might also need to take food and water.

Equipment which might be useful:

Buckets
Nets (or strainers or sieves)
Specimen pots (eg margarine tubs with lids)
Collecting bags (eg plastic shopping bags)
Hand lenses
Underwater viewing glass
Binoculars
Digital Camera
Video Camera
Tape recorder
Notebooks, small pieces of paper (for labelling specimens) and pencils.
Measuring equipment (eg thermometer, ruler, tape measure)
Identification guides

The Wondrous West Indian Wetlands Resource Book has some instructions for making a viewing glass, a net and a sieve box. A making equipment activity is a good for developing practical skills, including following instructions and measuring accurately.

During the field trip

Take opportunities during the field trip to point out some of the following:

- Mangroves are found in sheltered locations.
- Mangrove seeds sprout on the tree, and can float.
- How the mangrove roots trap silt and mud, thus stabilizing the land and slowly building up the soil.
- Many small creatures, including the young of reef animals, live amongst the roots of the mangroves.
- Many birds and insects live amongst the branches of the mangroves.
- Many sea plants and algae live in the mangroves, because the mangroves create a very nutrient-rich environment.
- The mangrove leaf detritus, forming a key component of the mangrove food chain or food web.
- Any signs of pollution, eg litter.

Student activities during the field trip can include:

Drawing and photographing of living organisms in situ – avoiding the need for collection. Leaf and bark rubbings provide a good way of recording leaf shape and structure.

Collection of different examples of leaves, flowers, fruits (on trees and floating) emphasizing taking only the minimum amount of material needed and avoiding damage to the trees.

If possible, collect a few red mangrove propagules so that you can grow some red mangroves at school (see activity sheet **Grow your own mangroves**)

Collection of specimens of water and examination of these with a hand lens.

Drawings and photographing of specimens collected, so that they can be released back into the environment.

Note-taking and recording. Encourage systematic recording of observations, for example date, time, weather.

When observing animals, encourage students to note: name (if known), time, where they are, what they are doing, sketch (if time) or take photo.

For plants, students should try to note: where the plants are, what condition they are in (eg flowering, with seeds on, condition of leaves), whether a specimen is taken (and if so remember to label the specimen with collection details).

A spotting sheet, or checklist, can support students with their note-taking - see example provided

Observation using senses

Use senses to observe the mangroves. Think of nouns, adjectives and verbs that describe what you see, hear, feel and smell. Recording can be done in a table:

Noun	Adjectives	Verbs

Listen and create a Sound Map

Everyone in the group needs to be quiet! Pupils close their eyes and listen to the sounds around them. When they hear something, they make a mark on a piece of paper to record the sound – eg wavy lines to represent the wind. Encourage students to position their marks to show direction and relative distance from themselves.

Be a good observer

Ask the pupils to complete an observational scavenger hunt, using their senses. This can be timed (eg 5 or 10 minutes as appropriate)

They could be asked to try to find:

- 3 aquatic creatures
- 3 birds
- 3 other animals, or signs of them
- 3 different plants
- 2 signs of people
- Something that smells pleasant
- Something that smells unpleasant
- Something that feels: smooth, rough, sharp, wet dry
- Something that might be food for a bird, crab, fish

Make a video

This needs to be planned beforehand, so that students know what they should try to film, and whether they need to write a script.

The video will need editing after the field trip, using freely available software such as Windows Moviemaker.

There are some examples on YouTube which can give some ideas. Although the quality of some of these is not high, they should encourage students to try themselves.

These were made by a group of young students from Florida: St Marks Messengers of the Mystical Mangrove (Florida)

Try:
Water of the mangrove park
http://www.youtube.com/watch?v=9bePJrgo--8

and White Mangrove
http://www.youtube.com/watch?v=huPmmcupkig&feature=related

If the links do not work, you can find their videos by going to the YouTube website and searching for St Marks Messengers of the Mystical Mangrove.

After the field trip

Discuss with the class what they saw on the field trip. Get students to work in groups and design posters. Encourage them to keep their words short and simple. They should express themselves in words that they understand.

The posters can include drawings and photos obtained on the field trip, or produced from specimens brought back from the field trip.

Poster topics can include:

- Identification of different mangrove species
- The growth of mangroves illustrating how the mangrove grows from a fruit which sprouts, floats in the water for a distance, orients itself vertically and settles. The poster might show how, over the years, the mangrove shore is always growing seaward.
- The mangrove food chain showing the many types of plants and animals living in the mangroves and how they depend on each other for food.
- Adaptations of living things in the mangroves to their harsh environment
- Threats to the mangrove ecosystem, which can include their own observations of pollution and damage eg litter.

Grow your own mangroves

Collect some mangrove propagules (sea pencils). Cut the tops off of plastic juice and milk bottles, fill them with a ½ sand and ½ soil mixture, leaving about two inches of space to the top. Place the sea pencil (broad side into the soil) in the soil and fill the container with fresh water. Even though the red mangrove lives in the sea, it loves fresh water because it doesn't have to work so hard to remove salt. In a few weeks leaves will sprout from the sea pencil. Remember to keep the container filled with water at all times. Red mangroves cannot tolerate drying out at all. They will die immediately if they are allowed to dry. When the plants are mature, check with DECR about a good place to plant them out. Or you can sink them into a pond in the school yard.

Make a mangrove model

Make an underwater and above water mangrove mobile, with prop roots and tree branches. Hanging from the prop roots can be all the creatures that depend on the mangrove and live in the sea. In the tree branches can be birds and insects.

The *Wondrous West Indian Wetlands* resource book has detailed instructions for building a mangrove model.

Mind Mapping

Mind Maps are an excellent way to help students make links and connections about a topic. Since Mind Maps combine pictures and words, they are excellent activities for all students. Special needs students who are non-writers can do Mind Maps alongside a gifted student. Mind Maps help children organise information, develop new ideas, and help them remember information.

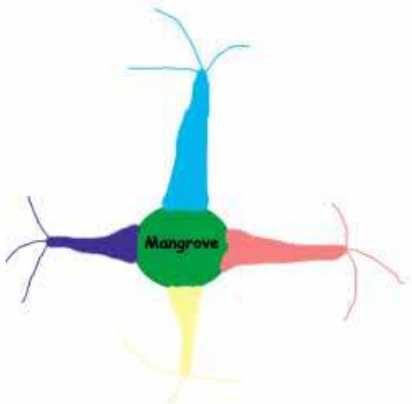
Mind Mapping (it is sometimes called concept mapping) involves drawing a spider diagram, and then expanding the diagram to show information and ideas about the main topic using drawings, colours and short word phrases.

A good reference book is **Tony Buzan's Mind Maps for Kids**, ISBN: 978-0-00-717702-8 Published by Harper Thorsons.

If this is the first occasion that the students have been introduced to Mind Maps, explain that this is a way of creating a diagram which records information and ideas about a subject.

How to Draw a Mind Map

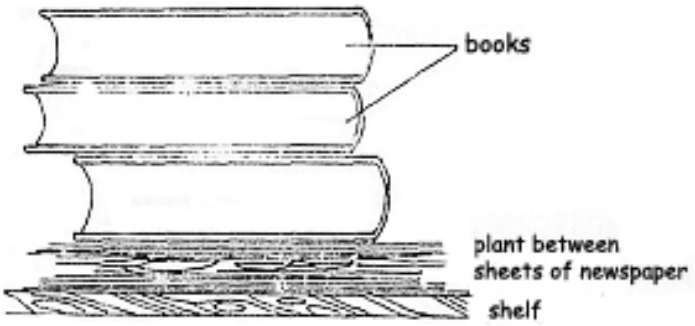
1. Place a drawing or picture of a main topic on the board or in the middle of a blank sheet of paper that is landscape style (wider than it is tall). If the topic is mangroves, draw a mangrove tree and / or write the word mangrove in the centre.
2. Make branches coming away from the centre topic. Start with four and use a different colour for each branch. You can add more branches if you need to.
3. Make smaller branches coming from the large branches. The colour of the smaller branches will be the same as their main branch.
4. Brainstorm main ideas around the topic. Draw or put keywords above the branches. For mangrove the main branches could be seawater, animals, people, tourists. Get ideas for the labels for different branches from the students by asking them questions. The Key Vocabulary suggestions (see later) can also provide starting points for a mind map
5. Think of smaller sub-topics that relate to the branch keywords. An example of smaller topics around the sub-topic animals might be names of animals which live in the mangrove forest.
6. Continue to add drawings and words to the map. Then, all together in one diagram, the facts or ideas about mangroves are presented.



There is no right or wrong way to do a mind map. Here is one example of a blank mind map.

Create a school or class Herbarium

Plants can be pressed using several large, heavy books and sheets of newspaper. Lay specimens on sheets of newspaper, cover with several more sheets of newspaper and then rest several large books on top of this. Leave for several weeks in a dark, dry, airy cupboard (sometimes difficult to find a place like this in the tropics!!)



The pressed plants can be mounted onto paper, collection details and other information, for example name of plant, noted on the sheet, and this information kept in a folder for future reference. This is the start of a herbarium.

This photo shows a pressed and mounted sample of White Mangrove

Language activities

Factual Writing

A field trip provides an excellent platform to encourage students to write. Here are some suggestions for writing tasks.

1. An account of the field trip. This could be in the form of a newspaper or magazine article.
2. A factual report about an animal or plant in the mangrove ecosystem. This could be structured under suggested headings, for example: description, habitat, special adaptations, food and nutrition, reproduction, threats.
3. Interview. Students can pair up, interview each other about the field trip, and then write the interview. Or the interview can be presented orally as if it were a radio broadcast.
4. Word or character restricted writing. Restricting how much students can write can really focus their thinking. When recalling their mangrove field trip experience, you could ask for "Twitter" sentences where students are restricted to 140 characters. Or give a word limit, eg 25, 50 or 100 words.

Creative writing

A field trip also provides a great experience from which to generate creative writing, eg poems

Acrostic (vertical) poem, where each line starts with the letter which spells the title.

M
A
N
G
R
O
V
E
S

Haiku

Haiku are very short poems, which came originally from Japan. Unlike many kinds of poems, they do not rhyme.

Traditional Japanese Haiku have a special pattern, and only 3 lines.

Line 1 has 5 syllables
Line 2 has 7 syllables
Line 3 has 5 syllables.

Check that the students know what a syllable is. They can work out how many syllables in a word by chanting the word, and clapping to count the syllables.

You do not have to stick rigidly to this. A Haiku poem should try to paint a picture. It usually provides a snapshot of something relating to nature.

To get students started, you can suggest a plan for the Haiku. For example:

Title: the subject
Line 1: where the subject is
Line 2: what the subject is doing.
Line 3: compare it to something.

Or

Title: the subject
Line 1: its habitat
Line 2: something it sees or hears
Line 3: the way it moves.

Create a Rap

The Wondrous West Indian Wetlands Resource Book gives a good model, to get you started.

Reading and comprehension

These activities can be based on the text in the Pupils' Text Book

Comprehension

The teacher can make up questions based on the text, which the students can answer. An example is given in the last section of this guide.

Question and answer quiz

Ask each student to come up with a question and write it on a piece of paper, with the answer on the back. Put all the papers into a box. Draw them out one by one and read to class to answer (teacher can do this, or students can take in turn). Answers can be given by individuals, or teams – with points awarded if conducted as a team game.

Identify missing words

Create a missing word passage, based on the text in the Pupils' book. An example is given in the last section of this guide.

Learning Key Vocabulary

Unscramble the words. Give students "scrambled" key words, and ask them to re-arrange the letters to work out the words.

Suggested Key Words: buffer, buttonwood, carbon, climate, coast, ecosystem, ecotourist, filter, hurricane, juvenile, lagoon, leaves, mangrove, mollusc, nursery, pneumatophore, protect, root, salt, sheltered, snorkel, species, storm

The Double Puzzle creator scrambles the letters in words for you:
http://puzzlemaker.discoveryeducation.com/DoublePuzzleSetupForm.asp

A good free wordsearch maker is available at
http://www.teachers-direct.co.uk/resources/wordsearches/

A good free crossword maker is available at
http://puzzlemaker.discoveryeducation.com/CrissCrossSetupForm.asp

There are examples of these in the Activity Sheets section.

Speaking and Listening through discussion

Here are some suggested discussion topics which can be used as follow-up from a field trip, and / or to consolidate learning within other sections of the mangrove ecosystem unit.

Why are mangrove ecosystems important? Students should be able to give at least 3 examples.

What is balance in nature? Can students give some examples.

What difference does it make to the mangrove ecosystems, whether we dispose of our waste products (litter, oil, chemicals) responsibly or not?

Why are the tiny organisms, the bacteria, the algae so important to the mangrove system and ultimately to all life?

Why is a mangrove habitat often likened to a nursery?

How does energy flow through the mangrove ecosystem? (Food chains and food web)

How do the mangroves help the economy?

What are some examples of employment that can come from mangrove ecosystems?

What can we do to help look after and protect our amazing mangroves?

What do mangroves need to grow well?

Why are mangrove ecosystems important?

The pupils' text book explains why mangroves are important, giving 8 reasons. It is important that they gain an understanding of the importance of the mangrove ecosystem to the local economy. Healthy coral reefs and fisheries are vital for the livelihoods of many people in TCI who work in tourism related industries. The mangroves are very important in maintaining healthy coral reefs. It has been estimated that the value of the ecosystem services provided by the coral reefs to TCI is $57 million per year. Mangroves mitigate the effects of storm surges and hurricanes, and their role as a carbon sink is very important in reducing Carbon Dioxide levels in the atmosphere - a key in combating global warming and climate change.

Mangrove Ecosystem Services

A healthy mangrove ecosystem provides many environmental services to the community, which can be given a monetary value, as if they had to be paid for.

Food, nesting and nursery grounds. Many animals including commercially important fish, conch and lobster, spend a part of their lives sheltering and feeding in the complex network of mangrove roots.

Improved access to safe water and sanitation. Mangroves are the Earth's natural filtering system, capable of absorbing pollutants such as heavy metals and other toxic substances, as well as nutrients and suspended matter (e.g. sewage).

Not only this but they facilitate **soil accretion** thus stabilising the coastline by catching sediment washed out by heavy rain. This essential service helps to protect coral reefs and seagrasses that have developed a dependent relationship with mangroves over thousands of years.

Corals and seagrasses need clear water in order to feed, photosynthesise and thrive creating yet more habitat for all manner of marine creatures.

Reduced vulnerability to environmental shocks and stresses. Mangroves and coral reefs form natural barriers which provide shore protection both under normal sea conditions and during hurricanes. At least 70-90% of the energy of wind-generated waves is absorbed by mangroves depending on their health and maturity.

Carbon dioxide absorption. Mangroves absorb carbon dioxide, storing carbon in their sediments therefore lessening the impact of global warming.

Protecting the existing mangroves in TCI, and restoring mangroves where they have previously been destroyed, will reduce the vulnerability of the coast to environmental shocks and stresses caused by storms and hurricanes. It will also help reduce coastal erosion, leading to property loss, and improve water quality for associated marine ecosystems, providing safe haven and nursery grounds for important marine species.

The Mangrove Action Project has extracted some information from a study by Costanza and others in 1997, and Ronnback in 1999 about how much a mangrove forest is worth.

The figures they have extracted (per hectare of mangrove forest per year) are:

Fishery products	$3400
Recreation (Ecotourism)	$500
Storm Protection	$1700
Wastewater Treatment and other environmental services	$6840

These are a very rough guide, and probably an underestimate, especially the value of recreation, but they make the point that mangroves do have a monetary value.

There are also other economic possibilities. Apparently the honey made from Red Mangrove flowers is highly sought after. Are there any bee-keepers in TCI making use of this resource?

The Mangrove Action Project has many resources and links which may be of use:
http://mangroveactionproject.org/education/

Following a field trip, students should be aware of some of the important functions of mangrove ecosystems. However, it might not be feasible to undertake a field trip to the mangroves. Many of the activities suggested as follow-up to a field trip can be used to stress the importance of

mangroves, even if a field trip has not been undertaken. The students' work can be supported by photographs (eg Powerpoint presentations of the photos used in the pupils' book) and video. As well as videos already available online, teachers may choose to take their own video of the mangroves to show to students in class.

Two examples of available online video are:

A Mangrove Lecture
http://www.youtube.com/watch?v=atMnKyKcZV8&feature=related

Mangroves teeming with life
http://www.youtube.com/watch?v=kR6-RUeNrQg&feature=related

Mangrove plant speciments can be brought into the classroom for observation and discussion.

Powerpoint presentations of the photographs used in the pupils' text can be used to stimulate discussion and support learning.

Example Student Activity Sheets

Mangrove Spotting Sheet

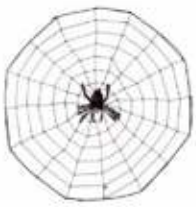
You can use this sheet to record what you see in the mangroves. Can you spot Red Mangrove, and its prop roots, Red Mangrove sea pencil seed (propagule), Black Mangrove and it snorkel roots (pneumatophores), Buttonwood and its seeds, leaf detritus, animals like crabs, fish, worms, spiders, birds.









You can record anything else you see here, or on the back of this sheet or in your notebook.

Be a Good Observer

Can you find these things in the mangroves? Write or draw what you find in the boxes.

3 aquatic creatures			
3 birds			
3 other animals or signs of them			
3 different plants			
2 signs of people			
Something that smells pleasant			
Something that smells unpleasant			
Anything else that interests you			

Grow your own mangroves

Collect some mangrove sea pencils (propagules). Cut the tops off of plastic juice and milk bottles, fill them with a ½ sand and ½ soil mixture, leaving about two inches of space to the top.

Place the sea pencil (broad side into the soil) in the soil and fill the container with fresh water. Even though the red mangrove lives in the sea, it loves fresh water because it doesn't have to work so hard to remove salt. In a few weeks leaves will sprout from the sea pencil.

Remember to keep the container filled with water at all times. Red mangroves cannot tolerate drying out at all. They will die immediately if they are allowed to dry.

When the plants are mature, check with DECR about a good place to plant them out. Or you can sink them into a pond in your school yard.

Use the space below to keep notes about how your sea pencil grows.

Missing Words

Mangroves are special and important

Fill in the missing words to complete these sentences about mangroves and why they are important.

Mangroves are very _____ trees. They can live in _____ water, which kills most other _____. Many different kinds of plants and _____ live in the mangrove forest.

The dense _____ of the mangrove trap sand and mud, so they help to build _____. Mangroves also help to keep coral _____ healthy. They _____ the water so that it remains clear. They help to _____ the land from storms and hurricanes.

Mangroves are important for people too. Many _____ fish and molluscs grow amongst the mangrove roots. So the mangroves act as a _____ for the larger fish which people eat. Mangroves support the _____ industry, and so help provide jobs for people.

Use these words to complete the sentences:

animals, filter, land, nursery, people, plants, protect, reefs, roots, salt, special, tourist, young

What do you know about mangrove ecosystems in TCI?

Answer these questions, in complete sentences if you can. Use the information about mangroves in the book to help you.

1. Do mangroves grow in cold or warm temperatures?

2. Which species of mangrove trees grow in TCI?

3. Which species of mangrove grows nearest to the sea?

4. If you licked the bottom of a black mangrove leaf, what would it taste like?

4. Why is the mangrove an amazing plant?

6. How do mangroves help our coral reefs?

7. Why are mangroves important to fishermen?

8. Write your own sentence about something else you know about mangroves.

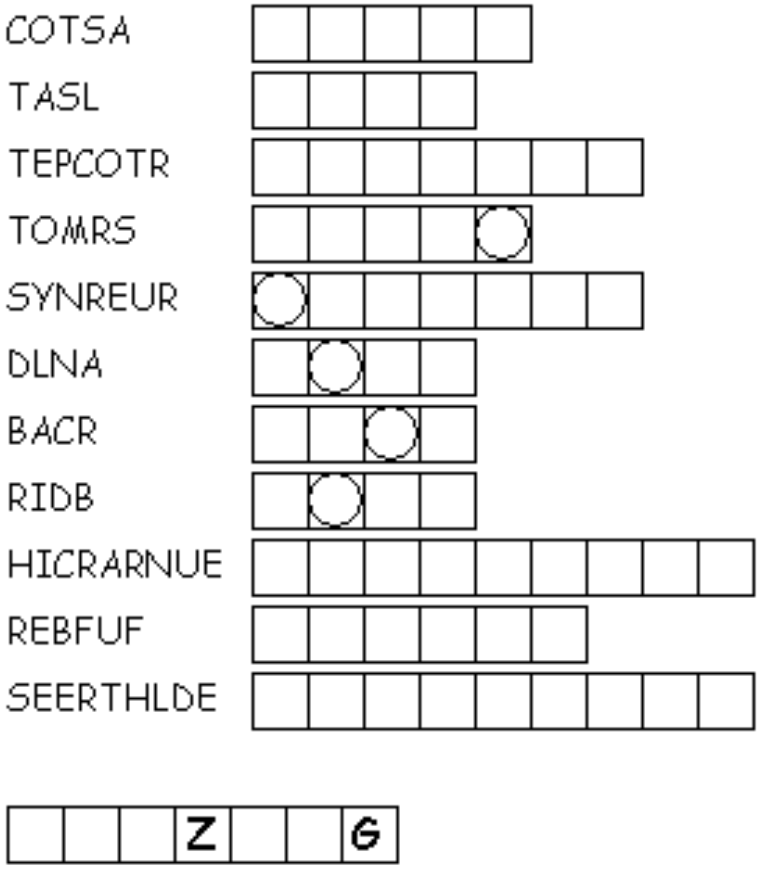
Amazing Mangroves Wordsearch

y	j	g	h	t	e	e	s	i	p	n	e	o	o
s	e	u	r	s	r	h	t	t	r	f	e	a	a
h	n	c	v	m	a	n	g	r	o	v	e	n	r
r	i	o	o	e	e	l	r	e	t	i	n	u	b
l	u	s	r	t	n	e	t	t	e	o	d	r	e
f	g	k	n	k	o	i	h	h	c	t	e	s	c
c	o	a	s	t	e	u	l	b	t	t	a	e	o
c	a	r	b	o	n	l	r	e	l	o	m	r	t
l	a	g	o	o	n	i	a	i	m	c	t	y	o
s	n	o	r	k	e	l	f	n	s	e	r	b	u
b	u	f	f	e	r	o	o	t	u	t	a	s	r
b	u	t	t	o	n	w	o	o	d	t	u	g	i
e	h	s	y	a	c	s	o	i	w	a	i	g	s
p	n	e	u	m	a	t	o	p	h	o	r	e	t

Words to find:

buffer, buttonwood, carbon, coast, ecotourist, ecotourist, filter, juvenile, lagoon, mangrove, nursery, pneumatophore, protect, root, salt, snorkel

Unscramble the Mangrove Words

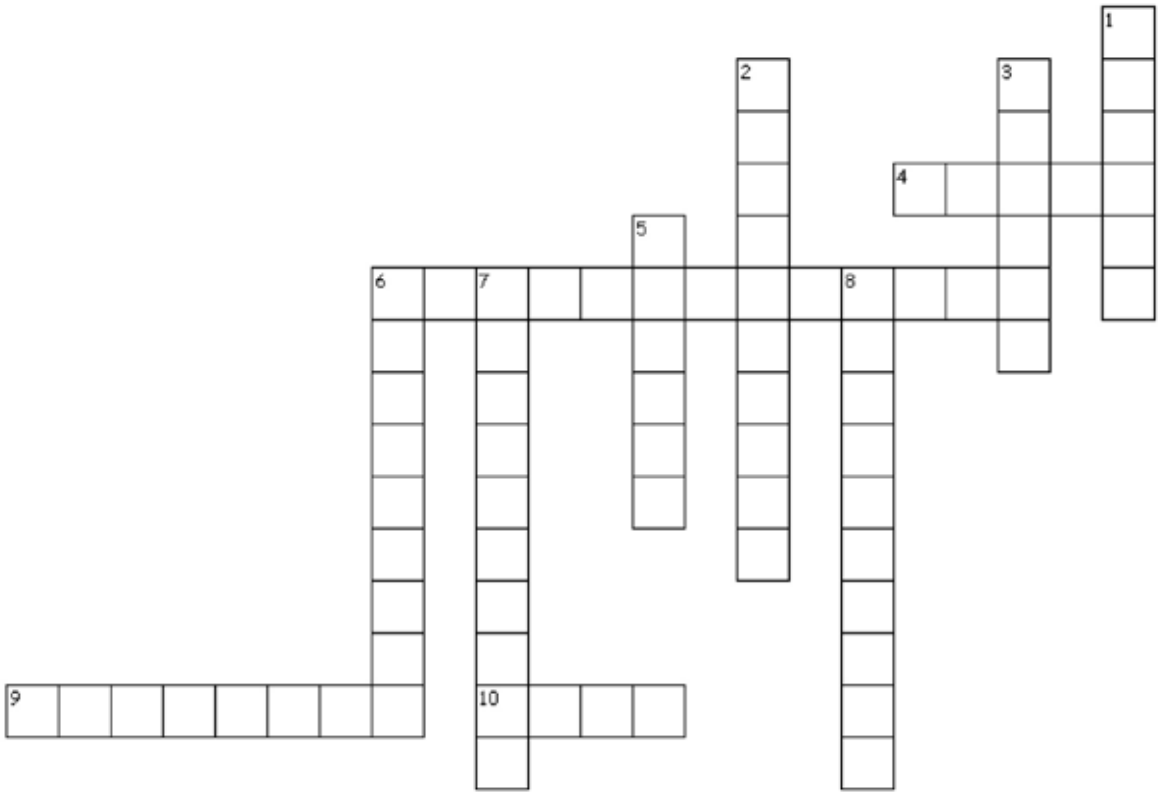


Unscramble each of the clue words.
Take the letters that appear in boxes ◯ and unscramble them for the final message.

Created by Puzzlemaker at DiscoveryEducation.com

Mangrove Crossword

Created by Puzzlemaker at DiscoveryEducation.com



Across
4. Zone where the mangrove forest grows
6. The black mangrove gets oxygen to its roots through this structure
9. Another word for young
10. Mangroves are not killed by _____

Down
1. The mangrove does this to keep the water clear.
2. This tree is found in the mangrove forest but is not a true mangrove
3. This part of the mangrove tree is used for photosynthesis.
5. Mangroves grow in sheltered places like a _____
6. The name of the red mangrove seed.
7. Someone who enjoys the mangrove for recreation.
8. Mangroves protect the land during _____