Wonderful Water

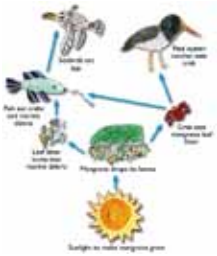
An Environmental Education Programme

A Watery World

Mangrove Ecosystems in TCI

3. Feeding Relationships in a Mangrove Ecosystem

Teachers' Guide



TCI
Education Department

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Target Age Group - 9 - 11 years

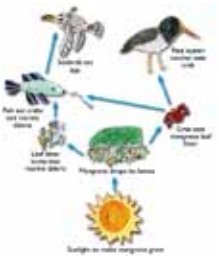
This environmental education programme has been produced by the UK Overseas Territories Conservation Forum (UKOTCF) and the Turks and Caicos Department of Education.

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

3. Feeding Relationships in a Mangrove Ecosystem: statements of competency

The assessment criteria / statements of competency, which relate to the unit on Feeding Relationships in a Mangrove Ecosystem are given below. These can be used as guides to progression.

Feeding relationships

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.

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 illustration in this guide, and those in the pupil text, will be provided as powerpoint pdfs.

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

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

Not every food chain starts with the sun - information for teachers

Of course, the sun is the source of energy for the vast majority of food webs, including the mangrove ecosystem. However, there are deep-sea hydrothermal vents where the food web does not rely directly on the sun, or on photosynthesis. It is worth being aware of this, as this fairly recent discovery received a lot of publicity, and students might have come across this. It is for this reason the the pupils' text on page 4 of the pupils' book states "Nearly every living thing on our planet is dependent on energy from the sun."

The American Museum of Natural History has an excellent website with lots of information and resources for educators:
https://www.amnh.org/content/search?SearchText=hypothermal+vents+

The text below is taken from this website:

Life at Deep-Sea Hydrothermal Vents

Deep below the surface of the oceans, beyond the levels reached by sunlight, live abundant and diverse communities of animals. Tiny microbes or bacteria called Archaea, fantastic red-tipped, white tube worms, gigantic clams, mussels, crabs, shrimp, starfish, and deep-water skates all live at deep-sea hydrothermal vents. All of these animals depend on a food chain that does not rely directly on the sun or on photosynthesis (the production of food by plants using sunlight), as most other life on Earth does. Instead, the tiny Archaea, which form the basis for this unique food chain derive energy and nutrition from the hot, mineral-rich waters venting from the sulfide structures. The Archaea use sulfide instead of sunlight to create food, a process analogous to photosynthesis called chemosynthesis .

Autotrophs are organisms that get energy directly from sunlight. These include green plants. Archaea, in contrast, are chemoautotrophs. They get their energy by oxidizing the minerals in the black smoke. Most animals on Earth are heterotrophs, which means that they get their energy by eating autotrophs, chemoautotrophs, or other heterotrophs. Humans, cats, dogs, tube worms, and clams are all heterotrophs.

In 1977, scientists were totally surprised to discover dense communities of animals living at deep-sea hydrothermal vents. In fact, the very idea of communities of large animals based on the process of chemosynthesis rather than photosynthesis was beyond the imagination of most people. Since their discovery, biological research has resulted in a good basic understanding of the physiology and ecology of these hydrothermal life forms. More than three hundred species of vent animals have been identified, and the list grows with the discovery of every new vent. There is still a great deal to learn, and this expedition, which combines the expertise of biologists and geologists, will provide key observations that will advance our understanding of these animals and ecosystems.

Life in the Extreme

A key characteristic of the bacteria that support the food chain at deep-sea hydrothermal vent communities is a tolerance for high temperatures that is much greater than ours. Some species

of vent bacteria can exist at temperatures as high as 110°C! This is why these bacteria are called thermophyllic or heat-loving. Some of the larger animals also are observed to live at warm temperatures. For example, the temperatures inside some tube worms, built directly on vent chimneys, have been measured at 40°C, and another kind of worm, the Pompeii worm, has been photographed leaving its tube and swimming near a temperature probe that recorded 110°C. These temperatures are wildly extreme by any standard for marine life. We don't know how the Pompeii worm can withstand such high heat. Other vent animals live on chimney walls but not at the hottest spots. Instead they are bathed in warm water that is the product of mixing between the hot waters from the chimneys and the cold ocean bottom water.

Do these animals really exist totally independent of the sun? Not really. Although these vent communities don't depend directly on sunlight for their energy and nutrition, the sun does play a critical role. The bacteria require oxygen to synthesize organic matter from the inorganic compounds present in the vent fluids. This oxygen, which is present in abundance throughout the ocean, is a waste product of photosynthesis, which uses the sun's energy.

The website has some great photos showing some of these animals, for example giant tubeworms:

Energy flow through the mangrove ecosystem

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. Nearly every living thing on our planet is dependent on energy from the sun (see above), and the links from the sun's energy ultimately to ourselves are very complex. A study of food chains and food webs, linked to the mangrove ecosystem, will help students to understand the importance of energy flow, and start to consider the effects of upsetting the natural balance.

Energy flow through the mangrove ecosystem food webs starts with the sun, but the role of decomposers in making this energy available to many of the primary consumers in the mangrove ecosystem is extremely important. In many other food chains and food webs the primary consumers get their energy directly from eating the plants,such as the rock iguana.

Mangrove nutrients enter the marine food web when the mangrove leaves drop from the tree and fall into the water. Some nutrients are immediately leached out, providing nourishment for plankton.

Bacteria, fungi and other decomposer organisms feed on the mangrove leaf, gradually breaking it down into smaller and smaller pieces. The leaf fragments are both food and growing surface for a great assortment of tiny plants and animals that decompose the leaf.

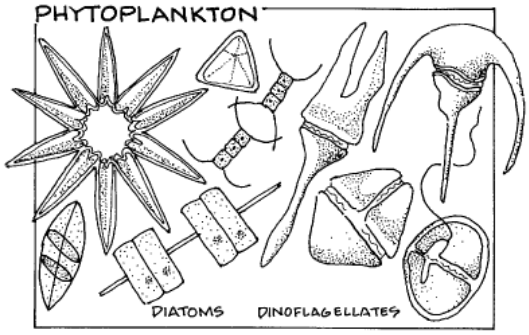
This community of decomposer organisms becomes food for many small invertebrates and fish larvae including shrimp, crabs and worms.
Larger invertebrates and fish feed on the smaller ones.

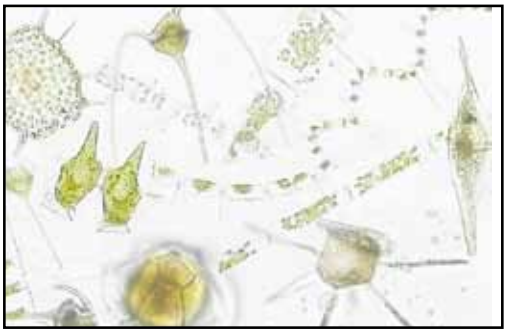
At each step in the food chain, the community of decomposer organisms, the fungi and bacteria, are digested while the mangrove particle itself is usually passed through the gut intact, Once, excreted, the particle grows a new community of decomposer organisms and can be eaten again by some other creature. Thus the particle can be eaten and excreted many times, each time growing a new community of nutritious decomposers.

Plankton

Plankton are microscopic organisms that float freely with sea currents and in other bodies of water. Plankton is made up of tiny plants (called phytoplankton) and tiny animals (called zooplankton). The word plankton comes from the Greek word "planktos" which means "drifting."

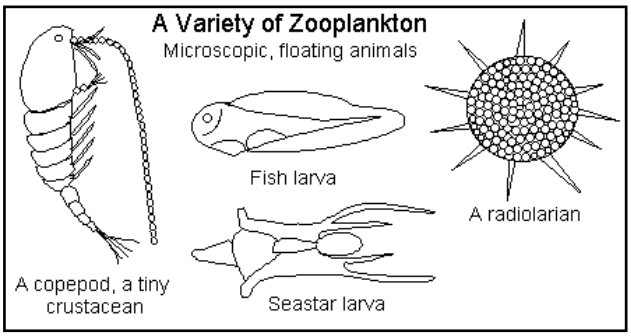
Phytoplankton: Phytoplankton are primary producers (also called autotrophs). Phytoplankton use chlorophyll to convert energy (from sunlight), inorganic chemicals (like nitrogen), and dissolved carbon dioxide gas into carbohydrates.





Zooplankton: Zooplankton are microscopic animals that eat other plankton.

- Some zooplankton are larval or very immature stages of larger animals, including molluscs (like snails and squid), crustaceans (like crabs and lobsters), fish, jellyfish, sea cucumbers, and seastars (these are called meroplankton).
- Some zooplankton are single-celled animals, like foraminifera and radiolarians.
- Other zooplankton are tiny crustaceans, like Daphnia and copepods, which are like small shrimps.



Activities to consolidate learning

Reading and comprehension

Activities based on the text in the Pupils' Text book. The teacher can make up questions based on the pupils' text, or the food chains and food webs on pages 9, 10 and 12. An example is given in the Activities Sheet section.

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 cleass 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 Activity Sheets section.

Learning Key Vocabulary

Suggested key words:

carnivore, chain, consumer, decomposer, detritivore, detritus, energy, herbivore, omnivore, plankton, predator, prey, producer, sun, web

Use these key words to create:

Wordsearches

Crosswords

Scrambled words

Websites which can create such puzzles for free are:

http://puzzlemaker.discoveryeducation.com/

http://www.teachers-direct.co.uk/resources/wordsearches/

Some examples of these are provided in the Activity Sheets section

Students can also be asked to produce a key words glossary, where they explain in their own words what these key vocabulary words mean.

Mangrove Connections Game

The aim of this activity is to build a complex model of a mangrove food web, with follow-up discussion on what would happen if .....

Scenarios for follow-up discussion on "What would happen if ...?" scenarious could be:
- The mangroves were cut down.
- Overfishing removed the crabs.
- Pollution destroyed the decomposers.
- Pollution killed the plankton.

You will need a large ball of string., and some cards showing key answers; sun, mangrove or buttonwood, detritus, crab, plankton, isopods, small fish, large fish, crab, shark ...

Ask the students to sit in a circle, and ask questions. As students give correct answers, give them an answer card. If the answer cards are on loops of string, the student can hang them round their necks.. This can re-inforce learning for the whole group.

Stand in the centre and ask "What do we call the trees that grow at the sea edge?"

Pass the start of the string and answer card to the student who provides a correct answer, eg "mangrove" or "buttonwood". [If a student offers pine, or casuarina, explain that the pine grows further inland, and the casuarina is an alien invasive species, originally from Australia, and it is harming the TCI environment by preventing native vegetation from growing.]

Ask "What happens to the mangrove leaves before they can be eaten by an animal?"

Whoever answers "The leaves become part of the detritus." is linked to the "mangrove" with the string, and given the 'detritus' card.

"What eats detritus?" is the next question, and the student with correct answers such as "Crabs, Plankton, isopods, ..." should all be linked to the detritus, and given the answer cards.

Continue to build up links by asking questions such as "What eats plankton?" [Answer: small fish, filter feeders such as bristle worms.}

And so on, until you get to top predators [herons and egrets, sharks]

Close the game by posing the question "What happens if we remove all the ..... [crabs, plankton, mangroves, detritus ...]

Ask the student who is "removed" to tug on the string, the student who feels the tug tugs on their string, and so on.

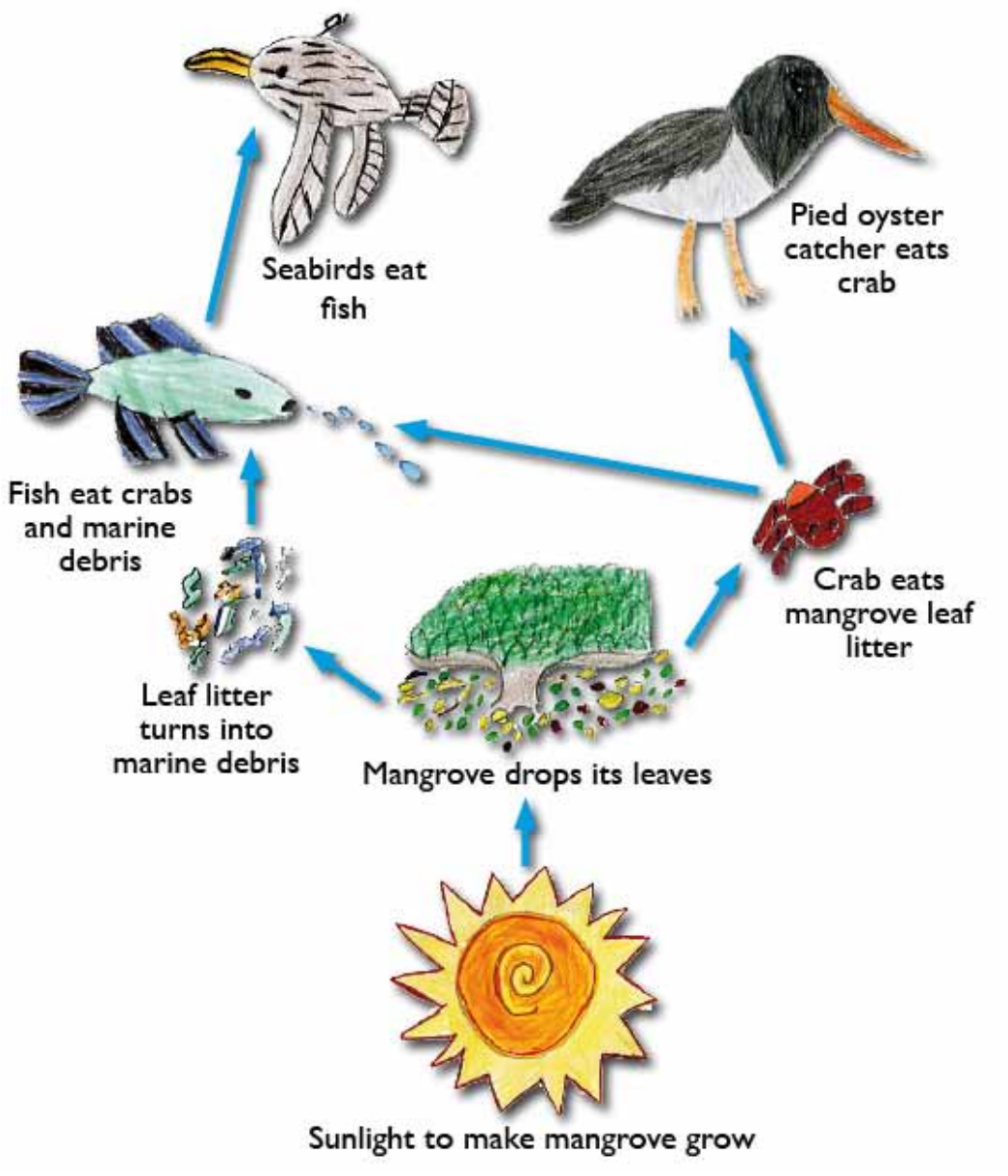
Anyone who feels the tug is affected by the removal of one part of the food web.

Discuss, including the affect on related ecosystems such as coral reef.

Create a Mangrove Food Chain / Food Web Poster

Students can work individually, but this activity is probably more productive if students work in in pairs or small groups. The latter approach encourages co-operations, communication and sharing of knowledgte. Information sources can be the Pupils' Text, internet, or supplementary information provided by the teacher.

To get students started, a model could be provided, eg:



Students can be challenged to produce food chains or simple food webs based on the information given for mangrove ecosystems in TCI. They can be further challenged to identify: producers, consumers, decomposers, prey, predators, herbivores, carnivores, omnivores. The learning can be re-inforced by asking students to prepare a presentation to the rest of the class on their work.

Mangrove Connections Chant / Rap

Use the model of the Skeleton song:

The foot bone connected to the leg bone,
The leg bone connected to the knee bone,
The knee bone connected to the thigh bone,
The thigh bone connected to the back bone,
The back bone connected to the neck bone,
The neck bone connected to the head bone,
Oh see dem skeleton bones.

to create a mangrove connections song / chant / rap

For example:

The heron gets energy from the crusty crab
The crab gets energy from the quick fish
The quick fish gets energy from the small fish
The small fish gets energy from the plankton
The plankton gets energy from the rotten stuff
The rotten stuff comes from the mangrove leaf
The mangrove gets energy from the sunshine
So this is how our mangroves live.

Your students will do better!

You can start from the other direction, of course:

Our mangroves get energy from the sunshine
The detritus comes from the mangrove leaf
.....

The student's compositions can be combined into a performance for other students or parents, made into a book, converted into illustrated posters, etc.

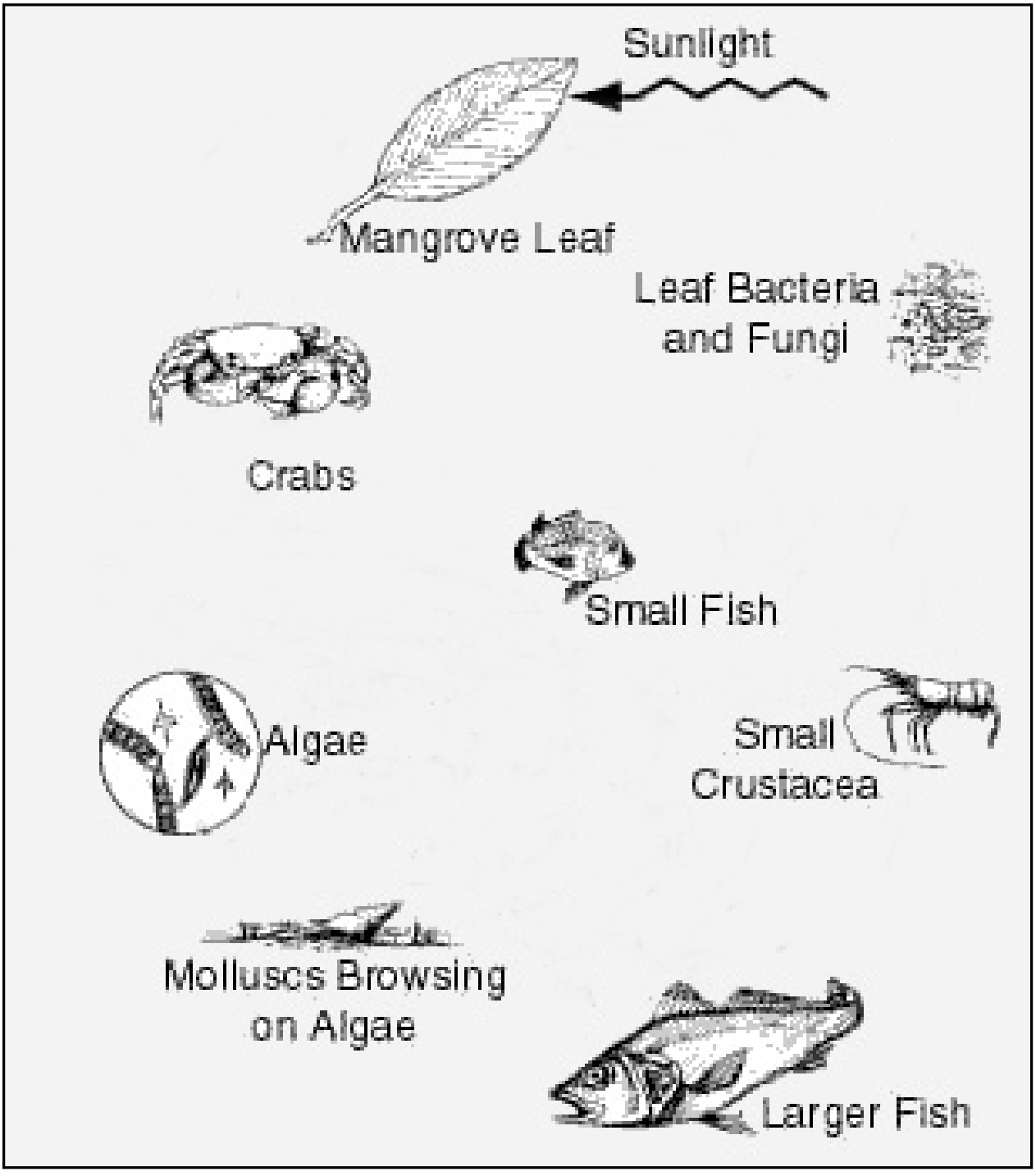
Wondrous West Indian Wetlands Teacher Resource Book - Relevant Activities

This teaching resource has these activities relevant to this unit of work:
Mangrove Food Chain Relay: Activity 2-1, pp 63-67
Living Web: Activity 2-J, pp 68-69.

If you, or your school, do not have a copy of this resource, copies should be available from DECR or the Education Department. If you are unable to find a copy, please contact apienkowski@ukotcf.org.

Example student activity sheets

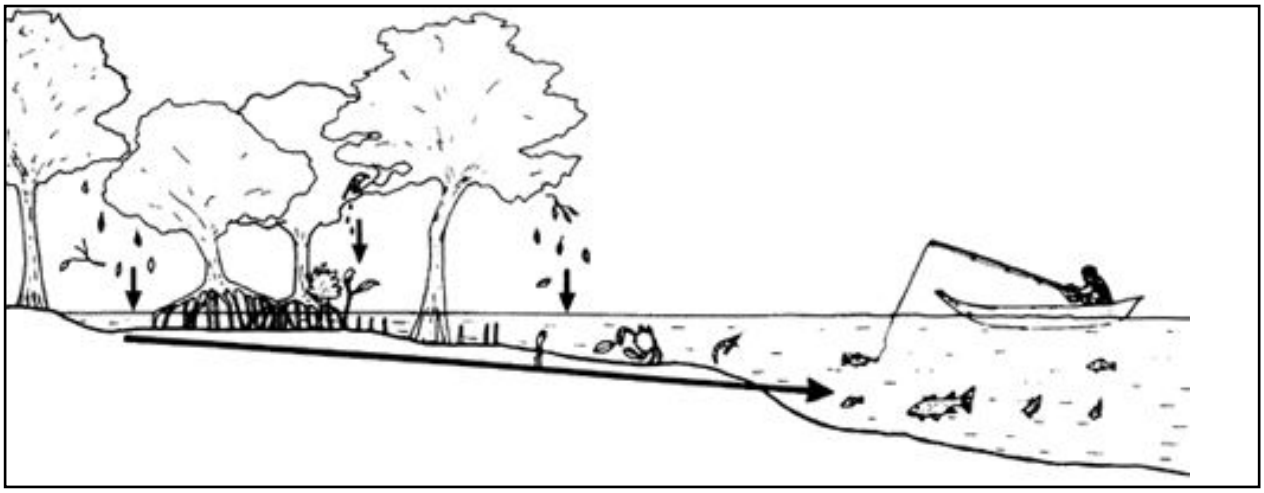
How does the energy flow?



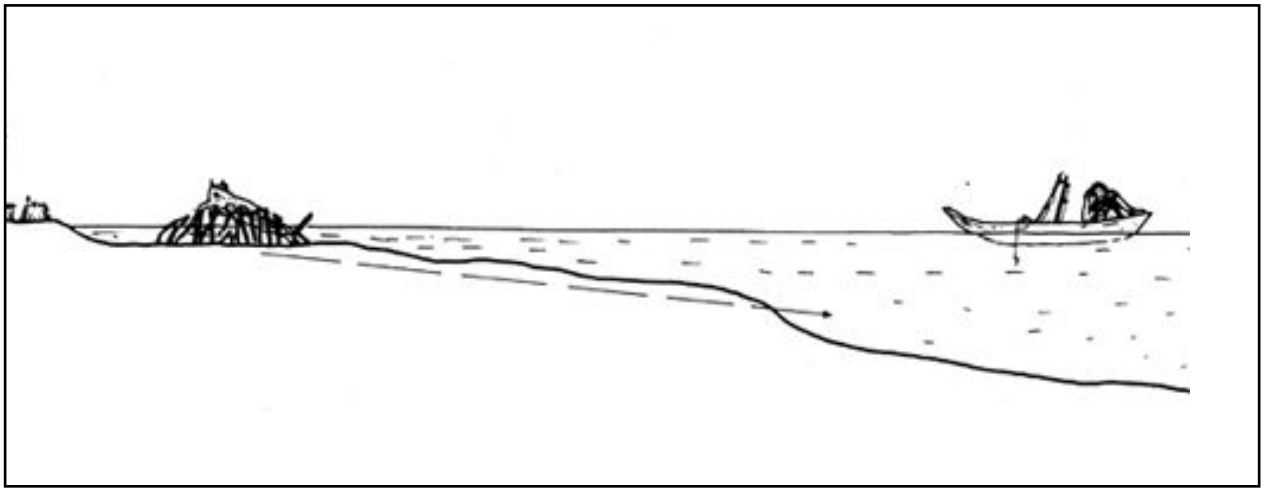
Students can use the illustration above for a variety of tasks, eg:
Draw different food chains
Draw the diagram with arrows to show feeding relationships and energy flow
Discuss what would happen if one of the elements were removed.

Good fishing, bad fishing

Explain how the feeding relationships shown in this picture mean that the fisherman has a good catch.



And why there are no fish for him to catch in this picture.



Your teacher will tell you whether you should write about these pictures, or prepare a talk about them.

What do you know about feeding relationships in a mangrove ecosystem?

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

1. What is detritus?

2. Name a consumer in the mangrove ecosystem.

3. Name a carnivore in the mangrove ecosystem. What does it eat?

4. Name a predator in the mangrove ecosystem. What is its prey?

5. What do the arrows in a food chain or food web show?

6. Why is a mangrove tree called a producer?

7. How does the sun's energy enter the mangrove ecosystem food chain

8. Why are decomposers so important in the mangrove food chain or food web.

Feeding Relationships in a Mangrove Ecosystem - Wordsearch

Feeding Relationships in Mangroves

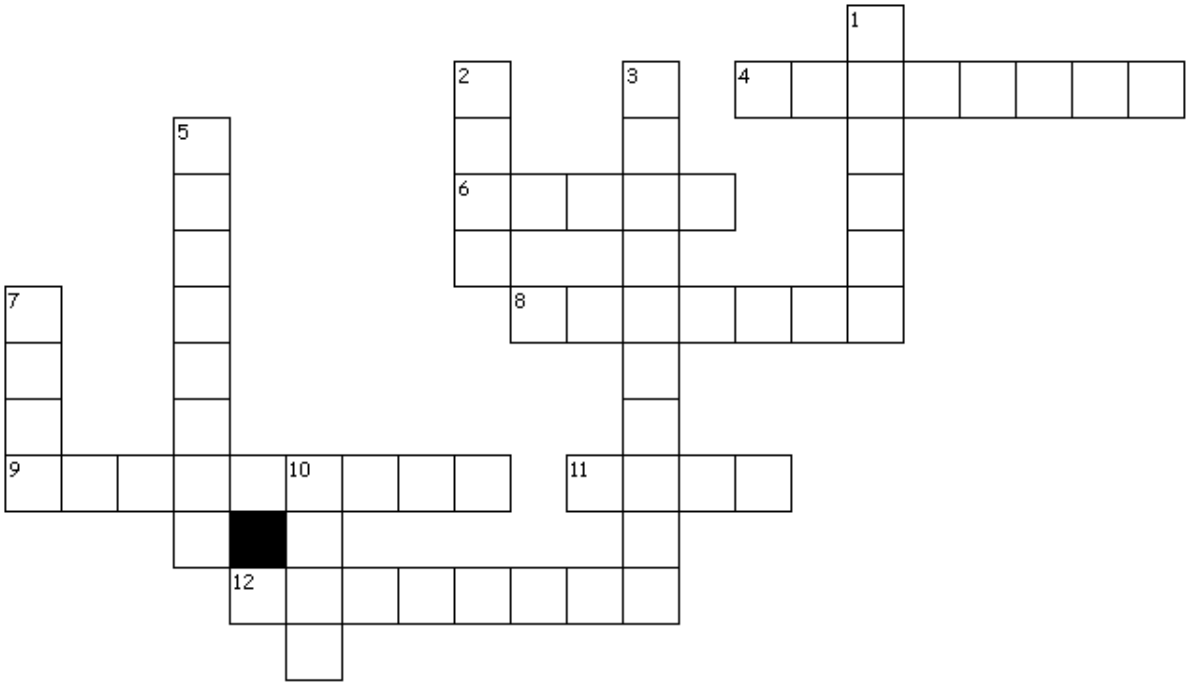
d	c	a	r	n	i	v	o	r	e	h	p
e	d	r	l	i	t	r	p	r	r	e	l
t	e	p	w	e	b	a	o	o	i	r	a
r	c	c	r	g	f	v	t	e	r	b	n
i	o	a	e	o	i	a	e	e	c	i	k
t	m	e	o	n	d	a	m	b	h	v	t
i	p	o	m	e	e	u	e	e	a	o	o
v	o	o	r	f	s	r	c	l	i	r	n
o	s	p	l	n	a	u	g	e	n	e	e
r	e	i	o	p	r	e	y	y	r	n	s
e	r	c	f	n	g	m	y	f	u	a	r
d	e	t	r	i	t	u	s	s	c	o	h

Words to find:

carnivore, chain, consumer, decomposer, detritivore, detritus, energy, herbivore, omnivore, plankton, predator, prey, producer, sun, web.

Puzzle created by **http://www.teachers-direct.co.uk/resources/wordsearches/**

Feeding Relationships in a Mangrove Ecosystem - Crossword



Across

4. A _____ catches and eats other animals.
6. This animal is a carnivore.
8. Omnivores eat plants and _____.
9. Bacteria _____ the mangrove leaf.
11. This animal eats detritus.
12. Decomposers turn the mangrove leaf in _____.

Down

1. Mangrove _____ use the sun's energy to make food.
2. This animal is eaten by herons.
3. Some fish are carnivores and some are _____.
5. _____ float in the water.
7. Animals cannot make their own _____.
10. _____ are animals which are eaten by other animals.

Puzzle created by **http://puzzlemaker.discoveryeducation.com/**

Feeding Relationships in a Mangrove Ecosystem - Missing words

Living things _____ on one another. Animals get energy by _____ plants or other animals. Plants make their own _____ using energy from the _____. The _____ of the plants do this. In the mangrove ecosystem, decomposers are very _____. They break the leaf down into _____. This releases the energy from the mangrove leaf to the rest of the food _____ .

Fill in the gaps using these words:

chain, depend, detritus, eating, flowers, food, important, leaves, sun