Life in the Mangroves

1. OVERVIEW

Through constructing a mangrove ecosystem storyboard, students will explore the function of mangrove ecosystems and how organisms depend on mangroves for food, shelter and reproduction.

2. LINKS TO CURRICULUM

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3. OBJECTIVES

Students will:

- Understand what mangroves are and how they support a diverse ecosystem.
- Understand the lifecycle of mangrove-dependent species such as barramundi.
- Investigate mangrove communities through food chains and food webs.

4. TEACHER BACKGROUND INFORMATION

A mangrove is a land plant that is able to live in salt water. These plants come in all shapes and sizes of trees and shrubs. They have developed a number of specialised adaptations that enable them to live in intertidal regions (the area between high tide and low tide). Mangrove areas are highly fertile habitats, supporting a rich diversity of animal species.

There are 15.5 million hectares of mangroves worldwide. The total mangrove area in Australia is 11,600 square kilometres, or over a million hectares. Mangroves grow in sheltered shores and are more plentiful in the warm tropical regions in the north of Australia. A few species are found in southerly regions. In Western Australia, mangroves are most common in the Kimberley and Pilbara regions, Exmouth, Shark Bay and the Abrolhos Islands. There is also a distinct mangrove community found in the Leschenault Inlet at Bunbury in the State’s south-west.
Mangroves live in a harsh environment: the mud is regularly flooded, and it is low in oxygen and high in salt. Waves and tides batter the plants and make it hard for mangrove seedlings to survive.

Many mangrove species use a number of methods to cope with the problem of excess salt. These include:

- filtering it out through their roots;
- excreting the salt through special salt glands in the leaves; and
- depositing the salt in the older leaves and bark, which then drop from the tree.

Mangroves have extensive underground root systems, that support and anchor the plants. As oxygen levels are poor below the surface, they can’t rely on these underground roots to absorb oxygen like other terrestrial plants. Many mangroves therefore have adapted aerial roots above the mud.

Mangrove mud contains large amounts of dead plant and animal matter (detritus), which is broken down by billions of bacteria. Because the mud is so thick and wet, oxygen can’t get any deeper than the first couple of centimetres. Therefore the bacteria that live in the mud are anaerobic, i.e., able to survive without oxygen. These bacteria produce sulphur dioxide, which is more commonly known as rotten egg gas.

Some mangroves give their seeds a better chance of surviving in this harsh habitat. Large numbers of seeds are produced and many of these germinate (sprout leaves and roots) on the tree itself instead of dropping off. Other mangroves provide a large food store for their seeds before dropping them. Many mangrove seeds and seedlings are dispersed by water – they float and grow rapidly after falling off the tree, allowing them to quickly attach themselves in the mud if conditions are right.

Mangrove communities have the effect of slowing down currents and encouraging an accumulation of mud and sediment that harbours an abundance of invertebrate life.

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**Figure 1** Life cycle of barramundi (*Lates calcarifer*).
Mangroves protect the coastline by creating a buffer from storms and reducing erosion, filtering pollutants from land runoff, and trapping silt and sediments.

Mangroves are important nursery areas for many marine animals, providing shelter and protection for the juveniles that depend upon this habitat. They are also important as a food source, forming the base of rich food webs based on the breakdown of detritus – mostly leaf litter from the mangroves themselves. Many species of fish spend at least a part of their lives in mangrove communities.

**Food chains**

In order to survive, every living organism needs some form of energy (food). A food chain is a simple representation of the feeding relationships between species within a habitat or ecosystem. It depicts the transfer of food energy and matter from one organism to the next – from producers (algae and plants) through a succession of plant-eating and meat-eating consumers, to decomposers.

Energy transfer is illustrated through the use of arrows in the direction of energy flow. The primary energy source in any food chain is the sun. The amount of energy in a food chain is greatest at the bottom or base of the chain (i.e., the sun) and smallest at the top of the food chain (i.e., the top predator).

**Figure 1** A diagrammatic representation of a simple food chain in a mangrove environment.

Animals that directly eat primary producers are called primary consumers. Primary consumers are eaten by secondary consumers; secondary consumers are then eaten by tertiary consumers, and so on. The top of the food chain always ends with a top or apex predator – an organism that has few natural enemies (such as humans).

Plants and algae manufacture their own food using photosynthesis; hence they are called primary producers. It is in this way that the energy from the sun powers the base of the food chain.

Consumers are animals that cannot manufacture their own food and so need to consume other organisms for energy. Animals that eat primary producers (like plants) are called herbivores. Animals that eat other animals are called carnivores, and animals that eat both plants and other animals are called omnivores.

Detrivores (or decomposers) are organisms that break down and feed on dead and decaying organic material, recycling it back into the ecosystem as energy and nutrients for primary producers to use again.

**Food webs**

As mentioned above, food chains are simplistic representations of the relationships of living organisms in an ecosystem. Most consumers feed on many species and in turn are fed upon by many other species. A food web is a number of interconnected food chains displaying the flow of energy and matter through an ecosystem.
There are very complex interactions taking place in food webs, with the survival of one organism interdependent on the survival of another. Any changes or shifts within an ecosystem can have flow-on effects for other organisms in the complex network of the food web. In extreme situations, the whole balance of the food web can be altered.

A number of things can alter marine food webs, for example:

- Removal of key species can cause a ripple effect throughout the food web.
- Depletion of top predator species, like seals, whales, sharks and large fish may unbalance species lower down the web – referred to as a top-down effect.
- Habitat destruction or alteration that can affect the population and diversity of marine animals in an area.
- Natural competition between different types of animals.
- Natural and climate change-induced variability in nutrient availability for marine food webs.
- Introduction of invasive non-native or pest species.
- Fish kills, low oxygen levels, water temperatures increases, and pollution events.

Figure 2 A diagrammatic representation of a simple food web in a mangrove environment.
5. TEACHER PREPARATION

This lesson plan can be adapted to different learning phases by altering the complexity of the information delivered through the activities.

The lesson plan includes instructions to build a mangrove ecosystem storyboard in the classroom. This will require some preparation, however, a range of resources have been included. A mangrove scene can be used to project the image on a whiteboard. Alternatively a scene can be developed on the floor using fabric or a tarpaulin, or painted on a large piece of fabric or cardboard.

A range of mangrove organisms need to be printed, cut-out and laminated. Depending on your situation these organisms can be attached to the mangrove scene on the whiteboard with a magnet, on a felt or fabric board with Velcro or simply used on the classroom floor. Alternatively, students can draw them.

6. PROCEDURE

**ACTIVITY 1: What are Mangroves?**

This activity will introduce what mangroves are, their basic biology and where they are found. This activity is run using the Internet but can be adapted as a discussion or comprehension activity.

**Steps**

1. Lead a discussion with students about mangroves. Has anyone seen a mangrove? Where? How would you describe a mangrove?
2. Show Appendix 1: Mangrove Flashcards to the students to help stimulate discussion.
3. Instruct students to browse the Internet using Student Worksheet 1: What are Mangroves?
4. Have students share and discuss their responses with the class.

Related Resources

- Marine WATERS Lesson Plan: Marine Connections

Student Worksheet

1. What are Mangroves?
**ACTIVITY 2: Mangrove Creature Feature**

Students will investigate one animal or plant that depends upon mangroves for survival.

**Steps**
1. Students choose a mangrove-dependent animal from the following list:
   a. Barramundi
   b. Estuarine crocodile
   c. Mud crab
   d. Mudskipper
   e. Fiddler crab
   f. Mangrove jack
   g. Prawns
   h. Archerfish
   i. Other
2. Students conduct a research project on the species using the questions in Student Worksheet 2: Mangrove Creature Feature.
3. Students can present their findings via an assignment, poster, or presentation.

**ACTIVITY 3: Mangroves as a Habitat**

In this activity, a mangrove ecosystem will be constructed using the organism templates provided. A story about the lifecycle of barramundi will be read out aloud to demonstrate the interactions between abiotic and biotic elements of a mangrove ecosystem.

**Steps**
1. Assemble the mangrove ecosystem storyboard using Appendix 2: Templates for Mangrove Ecosystem.
2. Distribute organism templates to students to place on the storyboard at the appropriate time in the story. Instruct them that when the organism is mentioned they are to place the card on the mangrove storyboard where they think it is most appropriate, listening to the clues contained within the story.
3. Read Appendix 3: Mangrove Story out aloud and remind students to listen carefully and place their organism on the storyboard as it is mentioned.
4. Conclude with a discussion. Why do organisms live where they live? How are they adapted to living in mangrove ecosystems? How would the organisms respond in high and low tide conditions? What might happen if the trees were not there? What do herbivores and carnivores eat in a mangrove community? What are other roles played by mangroves? What would happen if one of the animals was removed from the ecosystem? What influences do humans have on the ecosystem?
5. Keep the mangrove storyboard intact for Activity 4.
ACTIVITY 4: Food Web

Students investigate the feeding relationships of a mangrove ecosystem and construct a food web.

Steps

1. Allocate each student one of the marine organisms used in Activity 3.

2. Instruct students to construct a food chain using their marine organism and other marine organisms used in Activity 3. Allow students enough time to complete the task, and check and monitor answers.

3. With food chains complete, begin to construct a food web on the mangrove storyboard. Using string, white board marker or other methods, connect food chains together to develop a food web.

4. See how far the class can develop the food web. Wrap up the activity before the food web becomes too confusing and cluttered.

5. An option at this point could be ask students to construct this food web by representing their allocated marine organism. Lengths of string can be used to connect students in food chain. One student will need to represent the Sun.

6. Create a scenario that results in one of the components in the ecosystem disappearing, e.g., such as overfishing, habitat destruction or pollution. Remove the chosen organisms from the food web by asking students that were allocated those organisms to drop their pieces of string and sit down.

7. As a student’s plant or animal is removed from the food web, the class should be able to see the effects it has on dependent and related plants and animals in the web. Follow the effects of that plant or animal’s disappearance through the food web until all string has been dropped and all of the students are sitting down. The only student still standing should be the sun.

EXTENSION ACTIVITY

Invite local Indigenous community members to share their knowledge with students about local mangrove environments. Organise students to prepare questions such as:

- Where are the local mangroves?
- What plants are there?
- What animals are there?
- How do Indigenous people use the mangroves?
- How do Indigenous people look after the mangroves?

Explore symbols used to represent nature in Indigenous art. Create a picture of the mangroves using some of the symbols. Visit this website for examples of symbols and their meanings: http://www.aboriginalartstore.com.au/aboriginal-art-culture/aboriginal-symbols-glossary/

Related Resources

Appendix 2: Templates for Mangrove Ecosystem


What are Mangroves?

1. What are mangroves?
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

2. Where are mangroves found in the world?
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

3. Where are mangroves found in Western Australia?
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

4. How do mangroves survive being submerged in saltwater?
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

5. What animals live in and among mangroves?
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

6. Why are mangrove forests muddy and smelly?
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

7. How do mangroves reproduce?
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
8. Why are mangroves important along coastal environments?

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

9. What are some of the major threats to mangroves?

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
Mangrove Creature Feature

1. What is my scientific name?
   ___________________________________________________________
   ___________________________________________________________

2. What type of animal or plant am I?
   ___________________________________________________________
   ___________________________________________________________

3. Where am I found?
   ___________________________________________________________
   ___________________________________________________________

4. What do I look like?
   ___________________________________________________________
   ___________________________________________________________

5. How big do I grow?
   ___________________________________________________________
   ___________________________________________________________

6. What do I eat?
   ___________________________________________________________
   ___________________________________________________________

7. Why are mangroves important to me?
   ___________________________________________________________
   ___________________________________________________________
   ___________________________________________________________

8. Include an interesting fact about me.
   ___________________________________________________________
   ___________________________________________________________
   ___________________________________________________________
   ___________________________________________________________
   ___________________________________________________________
APPENDIX 1: Mangrove Flashcards

Mangrove Flashcards

Dense mangrove forest

Aerial view of mangrove and tidal creek

Comparison at high (left) tide and low tide (right)

Underwater shot of roots
APPENDIX 1: Mangrove Flashcards continued...

Commercial fishing

Recreational Fishing

Mangroves in an urban/Industrial area

Estuarine crocodile
APPENDIX 1: Mangrove Flashcards continued...

Mud crab

Plankton

Barramundi

Seagrass

Illustration © R.Swainston/www.anima.net.au
APPENDIX 2: Templates for Mangrove Ecosystem

Mangrove Scene Template

Illustration © Richard McKenna
<table>
<thead>
<tr>
<th>Organism Templates</th>
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<tbody>
<tr>
<td>Mangrove tree</td>
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<tr>
<td>Mangrove tree</td>
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<td>Sea eagle</td>
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<tr>
<td>Fruit bat</td>
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<td>Estuarine crocodile</td>
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<td>Bull shark</td>
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<td>Lizard</td>
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<td>Mud crab</td>
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<td>Fiddler crab</td>
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## Organism Templates

<table>
<thead>
<tr>
<th>Barramundi eggs</th>
<th>Barramundi larvae</th>
<th>Juvenile barramundi</th>
<th>Adult barramundi</th>
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<tbody>
<tr>
<td>Mud whelk</td>
<td>Mangrove Jack</td>
<td>Mullet</td>
<td>Prawn</td>
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<tr>
<td>Sea jelly</td>
<td>Shorebirds</td>
<td>Recreational fisher</td>
<td>Frog</td>
</tr>
<tr>
<td>Archerfish</td>
<td>Mudskipper</td>
<td>Clouds</td>
<td>Snake</td>
</tr>
<tr>
<td>Plankton</td>
<td>Turtle</td>
<td>Sun</td>
<td>Mangrove flower</td>
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Illustrations: IAN Image Library (ian.umces.edu/imagelibrary/) – most, Roger Swainston – mud crab and cherabin, Clipart.com and Shutterstock.com
Mangrove Story (for Activity 3)

Mangroves are an amazing plant, as they have to survive and grow in some of the harshest conditions in the world.

Who can tell me what conditions these are? [They grow in salt water on the edge of the ocean]. Today, I’m going to tell you a story that I hope will show you just how important mangroves are to some of the species we find in our waters. In fact, we will put some of the species we put up on the board today.

Barramundi was born from an egg. When his mother laid her eggs, she hid them in among the roots of a mangrove tree early in the wet season. While some of his brothers were washed upstream on the high tide, he was lucky enough to stay put. What an interesting world for him to grow up in and what an exciting place to explore. And there’s so much for him to eat! What are some of the things you think he eats when he is still so small? [Mostly microscopic (teeny tiny) plants and animals called plankton. There are thousands of them!]

Now, barramundi doesn’t stray far from the mangrove roots and fallen trees. Why do you think that is? [There are lots of others who would like to make a meal of him. It is also such a productive environment. Briefly describe why]. He spends his days watching the world around him. Who else do you think Barramundi might share his shelter with? [Crabs scurrying from their burrows for food (they eat detritus, the muddy layer of ooze underneath the dead mangrove leaves); mudskippers dancing from the water to the mud banks, always wary of anything that moves; sea jellies that float in and out with the tide; oysters that scratch his back as he moves between the maze of mangrove roots; and bull sharks who make a feast of anything that goes past] Oh what a very busy place this is!

Barramundi has to be very careful because if it is dinner time for him and his friends, it must be dinner time for other animals in the mangroves. From the surface of the water, he catches a glimpse of a slow-moving shadow above him. He moves quickly back into his place in the mangrove roots. “Just in time,” he thinks, as the shadow sprints towards the water. What do you think it is? [Any one of the birds (pelican, osprey, cormorant, sea eagle) that live in the mangroves – a very hungry bird]. The bird flies away juggling an unlucky mullet in its long beak.

As the clouds become a more permanent feature in the sky and the wet season sets in, Barramundi is bigger and braver and decides to move out of his comfortable home in the mangrove roots to see what the river is like closer to the freshwater. Here, he notices the species of mangroves are different. Why do you think that is? [They are better suited to the fresher water.]

Discuss zonation]. “Hmmm… looks like there are some interesting things to eat here,” thinks Barramundi and makes himself a new home among the branches of a fallen tree. He sits, still and silent in the branches, waiting for a small fish to stray from the school. Barramundi opens up his big mouth, sucks in a huge amount of water and ‘boof’, snaps up the fish for a tasty meal.

As he gets older, he will eat almost anything that will fit in his mouth. He enjoys insects (for example, dragonflies, mosquitoes), prawns (a real favourite), frogs and fish, including other barramundi, mullet and archerfish. His relatives have even been known to eat baby crocodiles!

With all this food around him, Barramundi is a very happy fish. When he’s not busy eating, Barramundi uses his big bright orange eyes to watch what goes on above, in the mangrove forest around him. What are some of the things you think he might see? [He sees fruit bats hanging upside down, asleep after a long night hunting for food; snakes slithering in the tree branches trying to warm their bodies when the sun comes out from behind the cloud; mud whelks camouflaging eating algae from the mud; lizards scurrying back to their homes, the beautiful flowers of the mangrove tree growing into propagules that almost bump him on the head when they fall to the water, ready to begin their journey downstream].

At the start of the wet season a couple of years later, Barramundi decides it is time for a change and swims back towards the mouth of the river. Enjoying the sights of his old home again and smiling as the seagrass tickles his belly closer to the river mouth, he gets a big fright when he bumps into a hawksbill turtle making a feast of some funny looking sea sponges. Barramundi is now much bigger, almost 60 cm, and laughs at himself for being so afraid. He realises he is now an adult and it’s time for him to grow up. And this means having some young barramundi of his own.

After the first full moon in November, when the water is much warmer, Barramundi spawns in the hope that they will find suitable eggs and develop into tiny barramundi in the roots of the mangroves just like he did when he was much younger. Why do you think he has moved down the river to have the babies? [Barramundi requires brackish (salt) water to spawn. In some populations, such as dams, all barramundi are actually male and need to be artificially stocked in order to maintain the population].

Barramundi goes on with his life, becoming much bigger as he swims around the mangroves, eating lots...
of delicious food, spawning during the wet season in the hope of having many more young. “This is the life!” he thinks. He does this for a couple more years before he starts to sense some changes. Now something very, very strange is happening to Barramundi. Does anyone know what it is? He is changing into a female barramundi – barramundi are hermaphroditic and change sex from male to female at around 5 years of age or 70-80 cm. Imagine if I came to school one day and all the boys in the class had turned into girls!

Barramundi finds the change a little strange at first but quickly gets used to being a ‘she’. She certainly likes being a lot bigger than a lot of the other animals and quickly convinces a Mangrove Jack that she should move into his comfortable home in the snag of a fallen tree. Wet seasons come and go, and barramundi continues to live a very happy life, eating lots, producing lots of young barramundi as a female she can produce 32 million eggs! and enjoying the wonderful world of the mangroves.

Then one day, Barramundi sees a delicious cherabin dangling in the water. “This looks too easy,” she thinks. Tempted by how easy it is, Barramundi opens her mouth, sucks in a huge amount of water and ‘boof’, snaps it up. Barramundi realises straight away that something isn’t right. She can’t swallow the cherabin and struggles to get back to her place in the roots. Something is pulling her. What do you think has happened?

She struggles and struggles, jumps high out of the water, but just can’t pull away. After a long time fighting, barramundi tires and gets dragged to the bank of the river. Exhausted, she feels herself being lifted out of the water. She has been caught by a recreational fisher. The fisher and his friends are excited and make a lot of noise as Barramundi is the biggest fish they have ever caught. She is a very big fish, over 1 m long.

The fisher quickly poses for a photo, gives Barramundi a big wave goodbye and puts her back in the water. Why do you think the fisher put Barramundi back? Luckily for Barramundi, the fisher had a copy of the Recreational Fishing Guide and knew the correct techniques for releasing fish. Large female barramundi are very important to the sustainability of barramundi stocks. In some locations in Western Australia, these large fish are not allowed to be caught. After a short while, with all of her energy back, a very happy Barramundi flicks her tail out of the water in thanks and swims back to her place in the mangroves.

Barramundi promises herself never to be so tempted by such an easy feed again and goes on to live a very happy life and produce many more young. She is a very important part of this interesting world of the mangroves.