Reef HQ Education

Teaching Unit

Food Webs and Interrelationships

Middle School

In this Reef HQ Education program students investigate the highly complex and amazing food webs and interrelationships found on the Great Barrier Reef.
Students will develop an understanding of the complex ecological structures and interrelationships found on the Great Barrier Reef.

Curriculum Links

Completing this Reef HQ Education Program will develop students' ability to:

- Apply ideas of energy transfer and transformation to explain the importance of photosynthesis and respiration;
- Make generalisations about the types of interaction which take place between living and non-living parts of the environment;
- Collect information about the structure and function of living things and relate structure and function to survival;
- Examine and prepare scenarios that describe the potential long-term effects of changes in biodiversity caused by human action on ecosystems;
- Explain why certain reef creatures live together in specific areas of the reef;
- Organise data into a meaningful and useful forms; and
- Appreciate the benefit that certain reef creature interrelationships have.

The following unit includes suggestions for activities that can be completed before and after your Reef HQ visit.

Reef HQ Visit

This teacher resource is linked to a class visit to Reef HQ. The Reef HQ visit will enable students to:

- Observe a highly diverse reef ecosystem;
- Observe reef creatures and their peculiar behaviours;
- Observe reef creature interrelationships within the reef ecosystem;
- Investigate some of the interrelationships that exist between reef creatures;
- Appreciate the varying ecological levels within reef ecosystems and the links that form food chains and food webs;
- Develop an appreciation for the fact that organisms are competing for resources with the reef ecosystem;
- Understand that ecosystems are cyclic in nature; and
- Investigate the connection between the living and non-living components of the reef environment.

Theme Overview

In natural systems there is no form of waste. All organisms, dead or alive are sources of food for other organisms. These ongoing feeding relationships between various species of plants and animals are called food chains. As on land, there are also many different food chains in the reef ecosystem. Together these food chains form interconnected networks called food webs that show the true relationships between organisms living in an ecosystem.

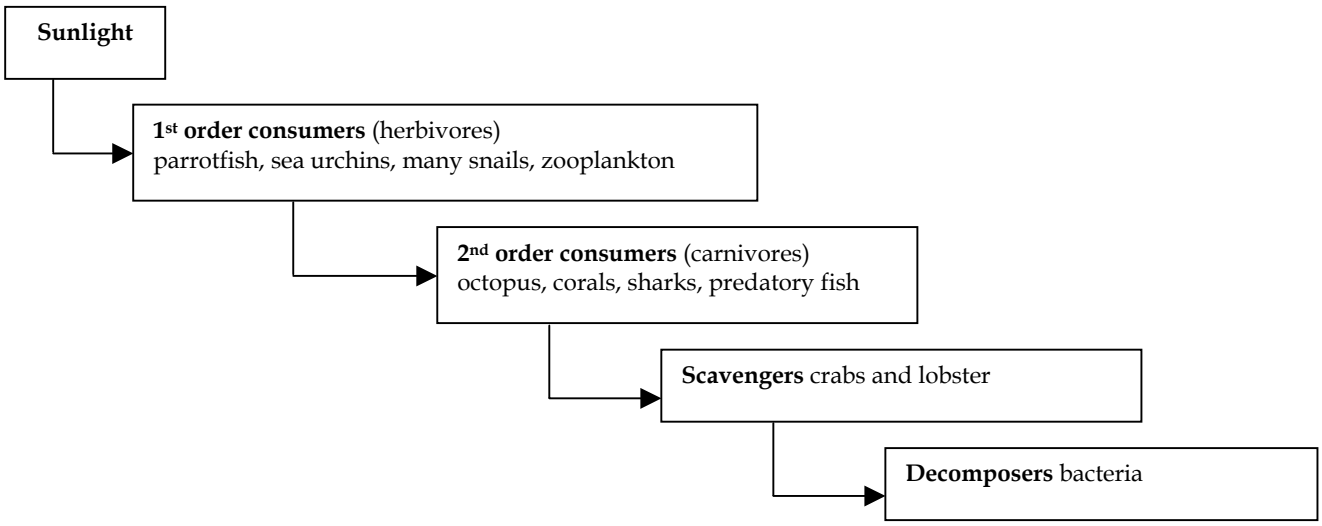
The web of life

Coral reefs are powered by sunlight, which provides the energy for marine plants and corals. These organisms in turn construct the reef that provides the habitat and food for the rest of the reef community.
Like most ecosystems coral reefs are a complex web of life. Marine plants form the basis of this web by producing organic material. This is achieved through the process of ***photosynthesis***, where the energy of the sun is used to convert carbon dioxide and water into oxygen and carbohydrates. Because they produce their own food, plants are known as ***producers***. About three-quarters of the total amount of carbon dioxide removed from the water each day on a reef is directly used in the process of photosynthesis. The remainder is utilised by marine algae and corals in the production of limestone allowing for the continual growth and expansion of the reef.

Much of the organic material produced by plants is consumed by ***herbivores*** (animals that feed upon plants) these in turn are consumed by ***carnivores*** (animals that feed upon other animals). Animals that feed on both plants and other animals are known as ***omnivores***. ***Scavengers*** feed upon dead organisms. Ultimately the left over dead plants, animals and wastes are consumed by ***decomposers*** (mainly bacteria) that cycle organic matter back to carbon dioxide and nutrients.
All of the reef's organisms play a vital role in the reef ecosystem. The creatures of the reef cannot only be classified by their physical appearance but also by their function in the reef's ecosystem.

Self-sufficiency and recycling of nutrients are vital for the survival of a coral reef. However, small but important losses and gains of nutrients occur within any reef system. The exchange of planktonic eggs and larvae between reefs ensures biodiversity, prevents inbreeding and allows for depleted species to be replaced. Plankton adds input into coral

reefs as a source of food for corals, fish and a myriad of other creatures. Even though plankton only comprises an estimated one per cent of the total food turnover on a reef, its input plays a vital role in maintaining the structure and balance of a coral reef community.



Food Webs and Interrelationships – Activity Ideas

Tuning In

What Do We Already Know?

KWL (Know, Want to Know, Learning) Charts serve as a fabulous class shared resource. A KWL chart has three sections prior knowledge (Know), curiosity knowledge (Want to Know) and acquiring knowledge (Learning). Use a KWL chart to organise and help the children categorise their thoughts.

What do we already know about Food Webs and Interrelationships? ***Know***	What do we want to know about Food Webs and Interrelationships? ***Want to Know***	Where will we find the information to help us learn about Food Webs and Interrelationships? ***Learning***

Use large poster sheets, which can be displayed in the classroom and added to as the unit of work progresses. As a class, fill in the KWL Chart at the beginning of the unit. During the unit and at the end of each session allow time to update the KWL Chart. When the unit is complete finalise the KWL Chart.

One way of adding to your chart and stimulating student's interest is to provide a range of texts on Food Webs and Interrelationships. Allow students a short period of time where they are to find an interesting fact to list in the ***Learning*** column of the KWL Chart. This

could also be used as a time for confirming information and extending the vision of this unit of work.

Food Chain/Food Web/Producer/Consumer/Scavenger/Decomposer
Define each of these terms. You may wish to use the *Glossary* at www.reefed.edu.au

Devise a marine food chain that consists of one each of these. Compare this to an urban food chain or the school food chain.

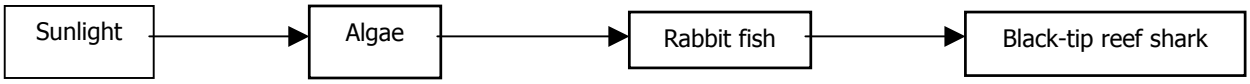
Using some of the food chains developed, design a food web.

Choose an organism and find out about whether it is a producer, consumer, scavenger or decomposer. Write a creative story about the day in the life of your organism.

Preparing to Find Out

Who's Coming For Dinner?

In the food chain



Hint: The arrowhead always points to the organism that is using or consuming.

Sunlight is the primary source of energy, algae are producers, the rabbit fish is a first order consumer and the black-tip reef shark is a second order consumer.

Discuss the various roles organisms play in a food web, students can search and cut out pictures of organisms in magazines and newspapers to create a display. Students may wish to download and print images from *GBR Explorer* or the *Visual Library* found at www.reefed.edu.au

As a class, sort through the pictures and paste them under the headings of consumers, producers and scavengers on a display board. The dietary terms could be added after the animals have been sorted into their web order roles. This will act as a resource for teachers and students to refer to throughout this unit.

Interrelationships

Define predator and prey. Have students consider the following question. What physical characteristics might you need to be an effective predator? What types of strategies do organisms use to avoid becoming prey?

Define symbiosis, mutualism, commensalism and parasitism. Give an example of each one in the marine environment. See if the students can find an example of each one in their lives.

Finding Out

Visit Reef HQ and explore the reef up close. Encourage students to develop a list of questions they want answered about the Great Barrier Reef.

GBR Explorer
Use the Great Barrier Reef Marine Park Authority's reef education website

www.reefed.edu.au

The "GBR Explorer" is like an online encyclopaedia about the Great Barrier Reef.

Sorting Out

Diagrammatical Representation
Students select a variety of organisms from the marine environment that form its complex food web. Using these organisms, students construct a 3D model, diorama or mobile that shows the interrelationships between the organisms.

Consumer Classification
All organisms need a supply of energy and nutrients (sunlight, carbon, oxygen, nitrogen, hydrogen, for example). However, there are marked differences in the ways that animals and plants obtain their nutrients and energy. Classify reef creatures by the way they obtain their food and energy *e.g. producers, consumers, and decomposers*.

Consumers eat other organisms, and several types exist, including:

- Herbivore – animals that eat plants
- Carnivore – animals that eat other animals
- Omnivore – animals that eat both plants and animals
- Piscivore – animals that eat fish
- Planktivore – animals that eat plankton.

Illustrate examples of the interrelationships between these different types of consumers and the foods they eat. Students may wish to develop a power-point presentation that highlights these interrelationships.

Going Further

Pyramids of numbers
In most reef communities there will always be a large number of producers that form the foundation of the food web consisting of a large number of herbivores, fewer carnivores and finally a small number of apex predators.
This activity uses fictional data that can be used to build a pyramid of numbers. It is important that students are made aware that this data very simplified and does not take into account other feeding relationships such as scavengers, filter feeders and omnivores.

Organism	*Type of feeding*	*Number*
Halimeda	Producer	100
Turtle Weed	Producer	50
Phytoplankton	Producer	10000
Zooplankton	Herbivore	1000
Stinging Hydroid	Carnivore	10
Parrot fish	Herbivore	12
Octopus	Carnivore	5
Sea urchin	Herbivore	10
Linkia seastar	Herbivore	15
Brittle star	Carnivore	6
Surgeon fish	Herbivore	7
Blue Tang	Herbivore	8
Moray Eel	Carnivore	4
Black Tip Reef Shark	Carnivore	2

Using the data provided students can create the pyramid of numbers for this reef community. Insure that students group producers, herbivores and carnivores together before constructing the pyramid.

Hint: Students can draw the pyramid on graph paper and assign an appropriate scale to produce a pyramid made of rectangles, each directly proportional to the number of organisms in that food level.

Some ecosystems have inverted pyramids of numbers, that is they have a very small number of producers and large numbers of consumers discuss with students what types of communities may have inverted pyramids of numbers.

Energy budgets

Pose the question " If a single gull, eats five fish a day. A fish eats twelve sea urchins a day. A sea urchin eats nineteen barnacles a day. How many barnacles have to be in the ecosystem for one gull to survive for one day?"

Consider the following question. "With reference to energy transfers explain why it takes a smaller area to provide food for a herbivore compared to high intake carnivore?"

The discussion that follows could focus on competition for food resources and the need for balanced numbers of organisms in an ecosystem.

Examine with the students the benefits that particular living things bring to the reef community. This maybe that they are a predator to another reef creature that reproduces quickly, they may clean up the reef, they may be a food source etc…

Cause and Effect Wheels
Construct a cause and effect wheel that examines and predicts what may happen to the reef if one or more of these reef creatures were to die out. For example, what could possibly happen if all crown of thorns were to die out?

Making Connections

Flow of Energy
Using prepared cards illustrating a range of species found at the Great Barrier Reef, focus on the interdependence of living things. Each card represents one species. On the back of each card, provide information on what the organism eats, and what eats it. Give one to each student (students can prepare their own cards from a list of species). Nominate one student to be the Sun. Give that student a ball of wool or string. Students identify one plant species that gets energy directly from the Sun. The ball is passed first to that student and then to one that holds the card of a small herbivore. From there, the ball is passed to a student holding the card illustrating a species that eats the herbivore, and so on until it reaches the end of the food chain (a top predator). Repeat the process always starting from the Sun. Each series of connections from the Sun to a top predator is an example of a food chain. Continue making food chains until each student is holding the string (or wool) at least once. The matrix of connections made by the string is an example of a food web.

Describe a "working reef" in terms of general ecological principles *e.g. the reef is powered by sunlight, which provides the energy for marine plants and corals. These organisms in turn construct the reef that provides a habitat for the rest of the community*.

Photosynthesis/Respiration
Using the word equation for photosynthesis (water and carbon dioxide in the presence of sunlight produces sugar and oxygen) and respiration (sugar and oxygen breaks down to form water and carbon dioxide and produce energy) compare and contrast these two functions. Discuss with students the cyclic nature of ecosystems and how both these processes serve as a catalyst for the other

Coral Bommie Food Web
A coral bommie can be referred to as a big city with lots of diverse and interesting inhabitants. Some creatures come out only during the day and some only come out at night, some move around a lot and others move around little, and still others don't move around at all. But together these communities of creatures all work together in such a way to make the reef a sustainable environment.
A coral biologist observed the organisms living around a coral bommie and recorded notes on their feeding habits.

Organism	***Observations***
Coraline algae	Like corals, coralline algae deposit calcium carbonate. By growing over coral rubble they act as cement to bind the reef together. Like other plants algae obtains nourishment via the process of photosynthesis.
Turf algae	This algae growing upon the bommie wall is the primary food source for many of the reef's herbivores. Many herbivorous species such as parrotfish, surgeonfish and damselfish can be seen feeding in this zone.
Phytoplankton & Zooplankton	Phytoplankton are microscopic plants that make up part of the planktonic community. They are eaten by zooplankton. Planktonic species are found in the water column around coral bommies. In most marine ecosystems phytoplankton are the primary producers.
Staghorn coral	Symbiotic zooxanthellae photosynthesise sunlight during the day at night coral polyps extend tentacles and feed on planktonic species.
Tubular sponge *Clathria sp.*	Filter planktonic food particles from the water.
Papuan jellyfish *Mastigias papua*	Use tentacles covered in million of stinging cells to feed upon planktonic species.
Magnificent sea anemone *Heteractis magnifica*	Attach them selves firmly to reef. Many contain a zooxanthellae single-celled alga that photosynthesises sunlight. They also use their tentacle to capture small fish such as damselfish and chromis.
Comb Jellies *Beroe sp.*	Carnivorous feeding on zooplankton

Cuttlefish *Sepia sp.*	Nocturnal hunters feeding on crustaceans and herbivorous reef fish.
Christmas Tree Worm *Spirobranchus giganteus*	Christmas tree like gills filters and captures plankton and food particles from the water.
Crayfish	Scavenger feeding on dead matter and detritus.
Crown of thorns starfish *Acanthaster planci*	Coral-eating species. The crown of thorns favours the faster growing coral species such as staghorn.
Tiger Shark *Galeocerdo cuvier*	An aggressive and indiscriminate feeder that will eat just about anything dolphins, seabirds, fish, stingrays, sea snakes and turtles.
Parrotfish	Teeth fused to form strong beak that allows them to scrape turf algae off rocks.
Damselfish	Graze on turf algae growing on rocks.
Butterflyfish	Feed on turf algae and also bite the ends of anemone tentacles.
Beaked leatherjacket *Oxymonacanthus longirostris*	Feed exclusively by picking individual coral polyps.
Red emperor *Lutjanus sebae*	Nocturnal predator feeding small herbivorous fish, cuttlefish, crabs and shrimps.
Humphead maori wrasse *Cheilinus undulatus*	Carnivorous feeding on invertebrates, small reef fish and sometimes feeding on crown of thorns starfish.
Cleaner wrasse *Labroides dimidiatus*	Feeds on the external parasites of reef fish.
Hawksbill turtle *Eretmochelys imbricata*	Feed on a wide range of food including algae, crustaceans, sponges and jellyfish.

The feeding relationships that can be found in the bommie community can be represented as a food web. Use the information in the table to construct a cross-sectional diagram of the coral bommie and represent the food web that exists there.

What is the original source of energy for this community? Justify your answer.

Does the bommie community contain any producer organisms? If so list them.

Identify the following:
- Apex predator or top consumer
- First order consumers
- Second order consumers
- Competitors
- Symbiotic relationships
- An organism that fits into different a trophic level in different food chains. Draw the food chains.

Taking Action

Community Education
Students can help increase others awareness of an endangered species by designing a poster, brochure or information sheet. This project should detail the species, why is it endangered and what people can do to help. Display these posters on school notice boards, during school assemblies or in the school library.

Submission/Proposal
Take the information gathered during the completion of this unit and develop a formal submission or proposal to be sent to local, state or federal members with regard to a species that is threatened or endangered.

Creating Popular Culture
Students can develop slogans that encourage protection of endangered and threatened species. Screen print T-shirts or calico bags and sell them to raise money for field trip or school environment group.

Become a Reef Guardian School
This is an exciting, innovative program that encourages students, teachers, parents and friends to become involved in protecting our environment and the Great Barrier Reef. Reef Guardian Schools are environmentally active and participate in reef education through activities and environmentally friendly initiatives. Students and teachers promote best environmental practices and the importance of Reef protection to their communities. To find out more go to:

http://www.reefed.edu.au/guardians/

Websites

Queensland Studies Authority – Science Syllabus
http://www.qsa.qld.edu.au/yrs1to10/kla/science/docs/syllabus/syllabus.pdf

Reef ED
www.reefed.edu.au

Great Barrier Reef Marine Park Authority
http://www.gbrmpa.gov.au

Reef HQ
http://www.reefHQ.com.au

Australian Institute of Marine Science
http://www.aims.gov.au/

CRC Reef
http://www.reef.crc.org.au/

Department of Environment and Heritage
http://www.deh.gov.au/

Department of Primary Industries
http://www.dpi.qld.gov.au/home/default.html

National Geographic - Virtual World "Great Barrier Reef"
http://www.nationalgeographic.com/earthpulse/reef/reef1_flash.html

References & Resources

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Webber, H. & Thurman, H. (1991) *Marine Biology 2nd Edition*. New York: Harper Collins Publishers.