CONSERVATION AND SUSTAINABLE USE

OF THE

MESOAMERICAN BARRIER REEF SYSTEMS PROJECT

(MBRS)

Belize – Guatemala – Honduras - Mexico

TEACHERS' GUIDE FOR PRIMARY SCHOOLS

Infusing the Mesoamerican Barrier Reef Systems Themes Into the Primary Schools Curricula

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Document Adaptation and Editing

MBRS Project Team

PROLOGUE

The main objective of the MBRS Teachers' Guide is to enable educators to take full advantage of the students' readiness and capability to learn; to improve understanding and retention; to present complex, overwhelming problems and possible solutions to the threats facing coral reefs in more solvable, understandable pieces.

The guide also presents students with different ways to take action to save the reefs, thereby instilling in them the understanding and confidence that they can improve the environment in which they live.

The Teachers' Guide is organized into sections, namely, Background Information, Lesson Plans, Resources and Annexes. The lessons plans are formatted as follows: Grade(s), Subject, Objective, Concept, Material and Procedures.

The Background Information provides teachers of all grades with extensive information about the MBRS, so that they can effectively instruct their students and use the lesson plans. It addresses three major areas:

1. Coral Reef Biology and Ecology describes the anatomy, reproduction and feeding behaviours of coral polyps, coral reef partner ecosystems as well as their geographic location and formation.

2. People and Coral Reefs explains the coastal development and pollution, alternative livelihoods, Marine Protected Areas, biodiversity of the coral reef ecosystem and describes the protection and predation techniques of the myriad of marine life that makes up the coral reef food chain. This section also introduces four native coastal peoples and shows how they are taking action to protect their marine environment.

3. Transboundary connectivity emphasizes the economic and ecological importance of coral reef resources to both humans and ecosystems. It demonstrates the marine transboundary inter-relationships, the anthropogenic threats that reefs are facing and possible solutions to these problems.

Each lesson provides the teacher with clear educational objectives and an interdisciplinary index to relate the curriculum to pertinent subject areas, such as natural science, social studies, biology and geography. It also provides guidelines for presentation of the material, and suggestions for follow-up to and extension of the lessons.

Additional activities and resources are at the end of the Teachers' Guide. It is a resource section containing a glossary, bibliography, references for students, a list of coral reef-related organizations, educational merchandise, and action programs. This material supports and enhances the teachers' ability to present information about coastal and marine resources in an efficient and thorough manner, and to expand the students' study and involvement with reefs if desired.

Table of Contents

Introduction

This guide has been prepared as part of the Mesoamerican Barrier Reef System project Environmental Education Component. The MBRS extends some 1,000 km from the Yucatan Peninsula to the Bay Islands of Honduras, including the second longest barrier reef in the world. Due to the MBRS' uniqueness in the Western Hemisphere for its size, reef types and luxuriance of corals, the MBRS project was established. The project addresses the conservation and sustainable use of MBRS resources.

This guide offers educators the opportunity to integrate coral reef education into their lessons. The guide is a compilation of lessons that help to bring the themes related to the Mesoamerican Barrier Reef System into the classroom. The themes, ranging from coral biology to transboundary issues, relate to the coral reefs and other relevant coastal and marine ecosystems.

Knowledge of natural systems helps children understand the interconnections between all life and the way human actions affect these systems. Alternative solutions cannot be explored unless children have an understanding of the basic processes involved. It should be linked with a critical knowledge of the social systems that shape their lives. Only this combination provides an adequate basis for understanding causes, exploring alternative solutions, making decisions and taking responsible action. Learning to respond thoughtfully to issues is an important part of growing up and needs to be part of the school curriculum.

Education for sustainability can enrich many subject areas. It draws on scientific knowledge and understanding as well as the processes of making predictions, obtaining and evaluating evidence. While it is an excellent vehicle for spoken and written language work, it also uses mathematical data and geographical skills and knowledge. It promotes historical understanding and can provide a stimulating and relevant context for work in almost every other area of the curriculum.

How to Use this Guide

The guide is divided into four areas:

Section I MBRS Thematic Areas
Section II Table School Curricula for countries
Section III Table of Lessons
Section IV Lessons

There are two ways to access the lessons.

1. Go to the section that contains your country's tables of curriculum areas, find the relevant subject area under your country curriculum. Find the appropriate topic and find the corresponding lesson number. Go to the main section of the guide and find that lesson. Some topic areas of the curriculum have more than one corresponding lesson, just choose the one you wish to use.

2. Go to the section that contains the table of lessons. You can review the list of objectives on the list and choose the lesson you would like to use.

SECTION I

Mesoamerican Barrier Reef System Project (Thematic Areas)

Coral Reef Biology & Ecology		
Coral Biology & Geology	BIO1	Formation of coral reefs: the three types
	BIO2	Biology of coral types
Reef Organisms	ORG1	Vertebrates
	ORG2	Plants
	ORG3	Invertebrates
Coral Reef Ecology	ECO1	Level of organization (individual, population, community)
	ECO2	Relationships among organisms
	ECO3	Food chain, food web
	ECO4	Natural disturbances to coral reefs: coral bleaching, hurricanes
Coral Reef Partner Ecosystems	PAR	Connectivity between coral reefs, seagrass beds and mangroves
People & Coral Reefs		
Goods & Services of Coral Reefs: coastal protection, fisheries, biodiversity, sand, building materials, medicinal cures	SVC	
Reef Fisheries	FIS	
Coastal Development & Pollution	DEV	
Alternative Livelihoods	ALT	
Marine Protected Areas	MPA	
Transboundary Connectivity		
	TR1	Fish Spawning Aggregations
	TRA2	Ocean Currents (moving larvae & pollutants)
	TRA3	Fishing

SECTION II

Tables of School Curriculum With Link to Appropriate Lessons

Primary Education Plan - Mexico

Primary Education Plan - Mexico						
	GRADE 1		**GRADE 2**		**GRADE 3**	
		Lesson(s)		**Lesson(s)**		**Lesson(s)**
NATURAL SCIENCE	The Environment & its Protection: ***Man transforms Nature*** (the production of familiar products)	**36**	Living Things *Living & Non-living Things in the Immediate Environment* -general similarities/differences	**10, 15**	Living Things*:* *Environment & Protection* -water & air & relation w/ plants, animals	**18**
			Living Things & their Environment -differences/similarities between plants & animals -characteristics of some plants in the community -characteristics of some animals in the community	**10, 11** **12, 15,** **16**	*Natural Resources of the Community & the Region* –their relationship w/products used in the home & community -necessary care for preservation & improvement	**26, 27** **28, 29** **31,33**
			The Care & Protection of Living Beings in Environment: plants, animals, humans	**13** **33**	*Origin & Destination of Rubbish* (organic, inorganic) produced in home & community	**35, 43**
			Living Things in Terrestrial & Aquatic Evironments -aquatic environments	**2, 5,** **15, 20**	Science, Technology & Society *Natural Resources of the Community & Region* –the relationship of resources w/products used at home & community -methods for rational use of natural resources	**26, 27** **28, 29** **30, 31**
			Environment & their Protection *Changes in the Environment* -Natural changes & those caused by man	**37, 38,** **40**		
			Problems of Environmental Deterioration: -contamination of water, air, earth	**32, 35**		
			Care & Protection that is Required by Living Things	**28, 33**		

Primary Education Plan - Mexico

Primary Education Plan - Mexico						
	GRADE 4		**GRADE 5**		**GRADE 6**	
		Lesson(s)		**Lesson(s)**		**Lesson(s)**
NATURAL SCIENCES	Living Things *Notion of Ecosystem* -biotic & abiotic factors -types of organisms that inhabit ecosystems (producers. consumers, decomposers) -food chains -levels of organization (individual, population, community) -examples of ecosystems	**9, 13** **15,17** **18,** **37** **21**	Environment & its Protection *Human's Influence to Create, Control & Regulate Conditions of some Ecosystems*	**38, 39**	Living Things *Large Ecosystems* -features of principal ecosystems -biotic & abiotic factors -interaction of humans w/environment & changes in ecosystems	**1, 4,** **5, 9** **14, 15**
	Environment & its Protection *Natural Resources of the Country* -cattle-rearing, agriculture, forestry -forms of rational exploitation of resources	**27, 29** **30, 36**	*Contamination of Air, Water, Ground*: -consequences of contamination on living things; -actions to counteract contamination	**35, 40** **33, 42**		
	Processes of Ecological Deterioration of the Country	**27, 38** **39**				

Primary Education Plan - Mexico

Primary Education Plan - Mexico						
	GRADE 1		**GRADE 2**		**GRADE 3**	
		Lesson(s)		**Lesson (s)**		**Lesson(s)**
GEOGRAPHY	Countryside & City *Man Transforms Nature Env. Problems in Country & City*	**22**	Life in a Locality *Changes that have Taken Place in the Environment. by Society's Action & Natural phenomena* *Activities that Cause Environmental Deterioration & Ways to Avoid it.*	**22, 23** **38, 39** **32, 33** **34, 40,**	Resources & Population *Physical Characteristics.* - rivers, lakes, coasts *Natural Resources* -natural resources & their use/exploitation -environmental deterioration & its location -conservation of resources	**5, 9** **27, 28** **26, 27,** **29, 30,** **31, 36**

Primary Education Plan - Mexico						
	GRADE 4		**GRADE 5**		**GRADE 6**	
		Lesson(s)		**Lesson(s)**		**Lesson(s)**
GEOGRAPHY	Physical Characteristics & Natural Resources of Mexico *The Large, Natural Areas of Mexico* *Conservation of Natural Resources & Main Sources of Environmental Deterioration*	**5, 8** **14** **31, 34** **35, 36** **40**	American Continent: Natural Resources & Economic Activities *Physical Characteristics of America:* -climate zones & principal natural regions; - natural resources & distribution *Regions & Economic Activities of the American Continent*: -environmental problems caused by human activities	**5,6,** **7** **28, 31** **32, 34,** **35, 36**	Physical Characteristics of the Earth The Earth's Great Natural Regions, Location & Characteristics	**5,6** **7,8**
	Mexico: Principal Economic activities *Farming, Fishing, Forestry, Mining*	**29, 31**			Productive Activities of the World *Main Natural Resources* -their use -main global environmental problems	**27, 28** **30, 31**

Primary Education Plan - Belize

Upper Primary Education-Belize		
SCIENCE	**GRADES 5 & 6**	
		Lesson(s)
	Living Things *Environment is living and non-living things interacting with each other.* *Ecosystems: reefs, mangroves, rainforests* -Interrelationships & dependence that exists within the environment -The effects of society on the environment and the need to conserve and protect it	**10, 13** **14, 20** **22,**
	Many Living Things in the world (land/water) *The Classification System* ▪ *Plant kingdom* ▪ *Animal Kingdom* -How living things develop different characteristics to adapt & survive in the environment -Structure & function of living things in relation to the categories in which they are grouped	**5, 11** **13, 19**
SOCIAL STUDIES	Physical Environment of Belize *Natural Regions (landscapes of Belize)* *Types of Natural Resources as influenced by Natural Landscapes of Belize* -How different landscape features and natural resources relate to human activity	**5,7 8, 22,** **27, 28, 31**
	Natural Resources and Settlement -How natural resources influence the settlement & development of Belize -How the distribution of natural resources across the world affects human activity & settlement	**36**

Primary Education Plan - Honduras

Basic Primary Education Plans - Honduras						
	GRADE 1		**GRADE 2**		**GRADE 3**	
		Lesson		**Lesson**		**Lesson**
NATURAL SCIENCE	Plants Plants identified by their living environment (terrestrial, aquatic)	**21**	Vertebrate Animals Most common animals in the community Animals according to external characteristics, feeding habits (herbivores, carnivores, omnivores); reproduction (oviparous, viviparous), uses, habits (mammals, birds, reptiles, amphibians, fishes)	**12** **11, 17**	Animals are Living Things & Interdependence with Plants & Humans Differences between Vertebrate & invertebrate Similarities & differences among mammals, birds, fishes Importance of sea as a place where animals with food value live The role of animals in ecological equilibrium (food chains)	**9, 12** **15** **9, 15, 17, 18**
	Animals Animals identified by their environment (aquatic, terrestrial)	**12**	The Importance of the Life of Animals Nutritional & economic values of birds & fishes, mammals Measures to protect wildlife at point of extinction.	**31** **42**		
	Animals are Living Things Measures of protection for animals	**15**				
	Humans are Part of Nature Benefits humans get from nature	**12**				

Primary Education Plan - Honduras

Basic Primary Education Plans - Honduras						
	GRADE 4		**GRADE 5**		**GRADE 6**	
		Lesson		**Lesson**		**Lesson**
NATURAL SCIENCE	Animals are Living Things Functions: feeding, respiration, reproduction Role of animals in the food chain Need to protect animals	**2, 3** **10, 17 18** **22**	Animals are Living Things Interdependent with Plants & Humans Similarities/differences between vertebrate, invertebrates Importance of animals to maintain ecological equilibrium	**5, 9,** **5,14, 15, 37, 41**	Plants & Animals are Connected in the Environment Relationships among living things of an aquatic & terrestrial community Species compete to live	**5, 9, 16** **6, 19**
					Sensibility for the Protection of Animals & Plants Importance of rational use of resources in the conservation of plants & animals Valid applications to protect and conserve plants & animals Project in conservation & environmental protection coordinated with the community	**22, 27** **30, 36** **33, 42, 43**

Primary Education Plan - Honduras

Primary Education Plans - Honduras						
	GRADE 1		**GRADE 2**		**GRADE 3**	
		Lesson		**Lesson**		**Lesson**
SOCIAL STUDIES	The Community Physical characteristics of the local community (relief, vegetation, fauna, water)	**12**	Relief of the District Different relief forms (mountains, valleys, rivers) Influence of relief on socio-economic development of the local community Benefits from natural resources Benefits that result from conservation & rational use of natural resource	**5, 31** **22, 23, 24, 25, 26, 27**	Aspects of the Geography of Honduras Importance of relief forms (mountains, valleys, rivers, lakes and seas)	**15, 21**
	The Community Existing natural resources The usage of natural resources emphasizing economic value Care of natural resources	**5** **12** **34** **41, 42**	Social Attitudes Actions that contribute to the betterment and conservation of the environment	**42, 43**	Social Attitudes Behaviour that contributes to conservation & betterment of the environment	**42, 43**

Primary Education Plan - Honduras

Primary Education Plans - Honduras						
	GRADE 4		**GRADE 5**		**GRADE 6**	
		Lesson		**Lesson**		**Lesson**
SOCIAL STUDIES	Ability to Use Maps & Globes Honduras in the context of the Central America Isthmus Countries & oceans that border Honduras Principal natural regions of Central America Isthmus (mountains, rivers, lakes, valleys, gulfs, bays & islands)	**4,** **5, 7,** **8**	Productivity of America The most important natural resources of America The relation between technological development & the adequate use of natural resources	**5, 14** **26, 30, 36**	The Productivity of the Countries of the World Participation of the State in the conservation of natural resources Importance of rational use of natural resources for the good of humankind	**34** **22, 23,** **24, 25,** **26, 27**
	Demographic Information of Central America Territorial line of Honduras w/relation to the Central American Isthmus	**8, 29**	Positive Social Attitudes The importance of the rational use of natural resources	**21, 22, 26, 27, 28**		
	Positive Social Attitudes Measures that contribute to conservation of the environment	**30, 33**				
	Geography of Honduras Advantages & importance of the location of Honduras in Central America Importance of conservation & protection of natural resources	**5, 8, 14** **32,36**				

Primary Education Plan - Guatemala

Basic Primary Education Plan (based on Environmental Education plan)-Guatemala					
Grade 1 & 2		**Grade 3 & 4**		**Grade 5 & 6**	
	Lesson		Lesson		Lesson
Knowledge about Animals -Define terrestrial & aquatic animals. Describe terrestrial & aquatic habitats. - Benefits from animals Attitudes of respect, care and love for animals	**15** **5, 9, 10** **26, 27** **32, 41**	Animals Fauna of the community	**12**	Families and Environment Use of Natural Resources by family	**29, 30**
				World of Animals Ecosystem: types of ecosystems Relationships in an ecosystem Interrelationships among living things: symbiosis, parasitism, mutualism Habitat Food Chain	**5** **10, 16** **9, 15** **10, 17**
				Animals in danger of extinction Through Fishing Why do we need to protect some species?	 **29, 30** **31, 33**
				How Trees Die Deforestation Causes & consequences of deforestation	 **38**

SECTION III

List of Lessons with MBRS thematic codes

	Lesson Title	Grade(s)	Themes (relative to MBRS)	CODE
Lesson 1	What is a Coral Polyp?	4-6	Coral Biology	BIO1
Lesson 2	Mealtime for Corals	2-4	Coral biology	BIO1 ECO2
Lesson 3	Coral Reproduction	3-6	Coral reproduction	BIO1 TRA2
Lesson 4	Grow your own coral Reef	3-6	Coral Biology & Geology	BIO1/2
Lesson 5	Explore the Coral Reefs	2-6	Conditions for coral reef development Types of coral Reef Organisms	BIO1/2 ORG1/2 TRA2
Lesson 6	Chance of Success	4-6	Conditions for coral reef development	BIO1/2 TRA2
Lesson 7	Corals Need Clear Water to Live	6+	Conditions for coral reef development	BIO1 DEV
Lesson 8	Mapping the Reefs	4-6	Coral reef location	BIO2
Lesson 9	Build a Reef	3-6	Organisms that make up a reef ecosystem Relationships among organisms on reef	BIO1 ORG1/2/3 ECO2
Lesson 10	The Coral Reef Community	4-6	Reef organisms Food Chain, web	ORG2/3 ECO2/3
Lesson 11	Coral Reef Cafe	3-5	Adaptation of reef organisms for feeding	ORG2/3 ECO3
Lesson 12	Under the Sea	1-4	Reef Organisms	ORG1/2/3
Lesson 13	Coral Reef Race for Survival (Game)	4-6	Coral Biology & Geology Reef organisms Human actions that affect coral reef Coral reef conservation	BIO1/2 DEV MPA
Lesson 14	Students as Coral Reef Scientists	4-6	Coral Biology Coral reef ecology	BIO1/2 ECO2 ALT DEV
Lesson 15	Treasure Hunt	2-6	Coral Biology & Geology Reef Organisms Services & Functions of coral reefs	ORG BIO1/2 SVC PAR TRA2/3
Lesson 16	Partner Wanted	2-6	Relationship of Organisms	ORG2/3 ECO2
Lesson 17	Dinnertime on the Reef	2-4	Relationship of Organisms Food Chain	BIO2 ORG2/3 ECO2/3
Lesson 18	Web of Life	2-4	Food Chain	ORG1/2/3 ECO3
Lesson 19	Survival in the Sea	2-4	Reef Organisms	ECO2 FIS TRA1/3
Lesson 20	Hula Hoop Habitats	2-6	Reef Organisms Connectivity between coral reefs, seagrass beds, mangroves	ORG1/2/3 PAR
Lesson 21	Sea Connections	5-6	Food Chain Human actions that affect coastal environments Connectivity between coral reefs, seagrass beds, mangroves	ORG1/2/3 ECO3 PAR DEV TRA
Lesson 22	Save the Mangroves	6+	Values of coastal systems Conservation	PAR DEV ALT
Lesson 23	Sensational Seagrass	4-6	Values of coastal systems	ORG1 PAR
Lesson 24	Mangrove Community	3-6	Values of coastal systems	ORG1 PAR
Lesson 25	Barrier to Erosion	4-6	Goods & Services of Coral Reefs	SVC DEV TRA2

Lesson 26	Products of the Sea	6+	Services, functions of sea/reef Conservation/Alternatives	SVC ALT
Lesson 27	Harvesting the Reef	4-6	Goods & Services of the coral reefs Reef Fisheries Natural disturbances to coral reefs	ECO4 SVC FIS DEV TRA3
Lesson 28	The Coral Conservation Game	6+	Services, functions of coral reefs Reef Fisheries Human actions that affect ecosystems	BIO1/2 SVC FIS DEV TRA3
Lesson 29	Fishing Forever*	6+	Fisheries Alternatives	FIS ALT
Lesson 30	Fishing for the Future	4-6	Reef Fisheries Conservation/Alternatives	SVC FIS ALT TRA3
Lesson 31	Depletion of Marine Resources	2-6	Human Action that affect coral reefs Fisheries	SVC FIS DEV TRA3
Lesson 32	A Marine Short Story	2-4	Characteristics of coral reef Human action that affect coral reef	SVC DEV
Lesson 33	Design Tasks for Coral Reef Marine Reserve	4-6	Human actions that affect coral reefs Conservation	SVC FIS DEV MPA TRA3
Lesson 34	Grief on the Reef	3-6	Human actions that affect reef organisms Conservation	FIS DEV ALT
Lesson 35	Fishy Tales	1-4	Human actions that affect reef organisms	ECO2 DEV
Lesson 36	How Do We Use the Sea	4-6	Human actions that affect the sea	FIS DEV SVC ALT MPA TRA3
Lesson 37	Survival Factors	4-6	Reef Organisms Human actions that affect ecosystems	ECO1/2 DEV FIS ALT TRA3
Lesson 38	Biological & Physical Agents of Change	6+	Natural Phenomena & organisms that affect coral reef Actions that affect the coral reef	ECO4 SVC DEV
Lesson 39	Threats to the Coral Reef	4-6	Natural disturbances to coral reefs Human actions that affect ecosystems	ECO4 DEV TRA2/3
Lesson 40	What if the Reef Dies	5-6	Coastal Development & pollution	DEV
Lesson 41	What Happens with the Reef?		Ecological relationships among organisms Fisheries	ECO2 TRA3
Lesson 42	Personal Actions	ALL	Coral Reef Conservation	PAR DEV ALT
Lesson 43	Green Points Challenge	ALL	Coral Reef Conservation	

SECTION IV

LESSONS

Lesson 1 BIO1

WHAT IS A CORAL POLYP?

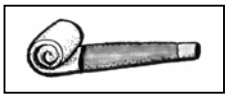
Grade(s): 4-6
Subject(s): science

Objectives

Understands the structure and function of cells and organisms
Understands relationships among organisms and their physical environment

Materials

- Copies of planktonic pictures
- String or yarn
- Tape
- Paper plate
- Party flutes



Procedure

Plankton Roundup

Students will be intrigued to learn that the tentacles of corals bear an arsenal of pistol-like stinging cells.

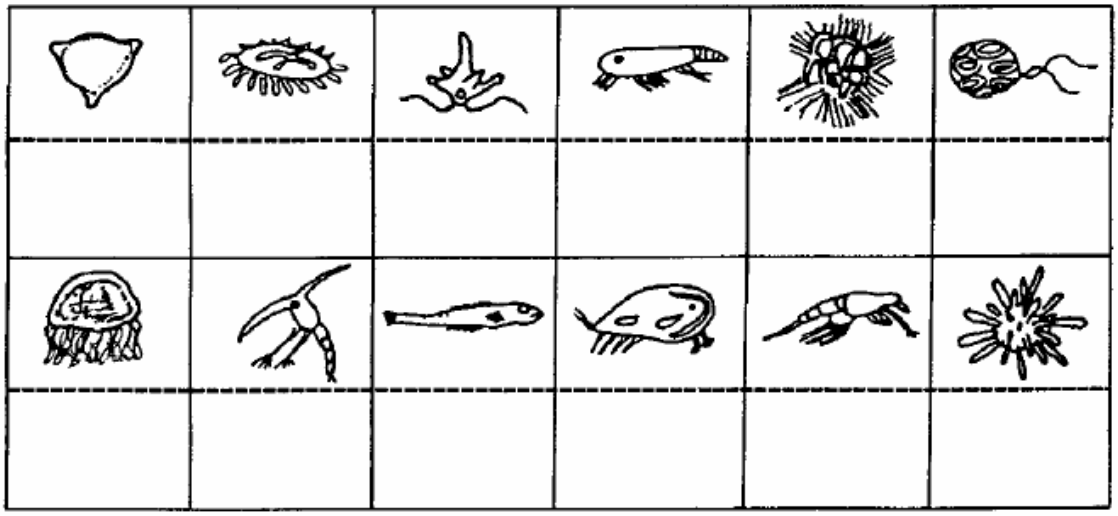
The following game mimics this unusual hunting equipment and provides a magnified glimpse at the zooplankton that are an important part of the diet of many corals.

1) Cut out the squares on the following page and write a point value (between 1 and 5) on the back of each. Fold the squares in half, with planktonic pictures on the outside, and seal each with a small piece of tape. Use short lengths of string or yarn to hang the folded squares from the rim of a paper plate. Tie another piece of string or yarn to the middle of the plate and suspend it in a doorway, with plankton dangling below.

2) Tell students that they will pretend to be coral polyps. Point out that a coral polyp has *many very tiny* stinging cells. Also remind the class that zooplankton are so *small* as to be all but invisible to the naked eye. The students will use blow-up party favors (pictured above) to mimic individual stinging cells being fired at zooplankton. Have the students ("coral polyps") take turns "shooting" zooplankton. If a student succeeds in hitting a zooplankton when he or she inflates a party favor, cut the folded square from the string and hand it to the student. If a student hits more than one square, the turn is forfeited and no zooplankton are collected.

3) After four rounds of "shooting" (or when all plankton are gone), have students unfold the squares they have collected. The student with the most points is the winner.

Source: Dr. Sharon H. Walker,R. Amanda Newton, Dr. Alida Ortiz, Coral Reefs: An English/Spanish Compilation of Activities for Middle School Students, J.L. Scott Marine Education Center & Aquarium, 2001



Cut on solid lines. Fold on dashed lines.

Lesson 2

MEALTIME FOR CORALS

BIO1 ECO2

Grade(s): 2-4
Subject(s): science

Objectives

Understands relationships among organisms and their physical environment
Explain how corals feed

Concept: This activity illustrates the feeding activity of a coral colony. Individual polyps, though connected, feed independently.

Materials

- Old bedsheet or material with holes
- Surgical gloves
- Markers
- Crackers, biscuits or sweets

Procedure:

Cut X's in several places in an old bedsheet to create holes large enough for children's hands to fit through. Give each child a surgical glove to represent one coral polyp. Discuss how much bigger their polyps are than a real coral polyp (usually about the size of an eraser on the end of a pencil). Explain that coral polyps live symbiotically with plants, single-celled algae called zooxanthellae. Students may choose to put dots of gold or green marker on their gloves to represent the zooxanthellae.

Have students crouch beneath the sheet that is suspended between chairs or desks. You can't fit the whole class under one bedsheet, so you may take turns or use several sheets to do the feeding activity. When they reach up through the holes in the sheet, feed them goldfish crackers or biscuits, which they will have to pull back through the sheet to eat.

EXTENSION: CORAL WARS

Concept: Corals recognize their own kind. They don't attack their own species even if it's a different colony.

Procedure:

If you use several sheets, each one may represent a different kind of coral. Explain to students that sometimes coral colonies of different species attack each other when they grow too close together, stinging each other with their nematocysts and leaving behind white, scarred dead coral on the other colony.

If neighboring "colonies" abut each other, they may attack each other. However, you need to set strict rules of engagement, such as, only a light tap on your neighbor is permitted, so these coral colonies aren't damaged!

Tell students that different colonies of the *same* species, although they may look different depending on factors such as the amount of sunlight each receives, don't attack each other. Therefore, they need to determine if the neighboring colony is the same species they are. Since all humans are the same species, why can't they get along?

Source: Dr. Sharon H. Walker,R. Amanda Newton, Dr. Alida Ortiz, Coral Reefs: An English/Spanish Compilation of Activities for Middle School Students, 2001, J.L. Scott Marine Education Center & Aquarium

Lesson 3

CORAL REPRODUCTION

BIO1 TRA2

Grade(s): 3-6
Subject(s): science

Objectives

Understand how coral reproduce.

Materials

- Copy of background information on coral reproduction and diagram
- Clay or play dough
- Jar with lid
- Styrofoam
- Waxed paper
- Foil
- Colorful plastic tape
- Toothpicks
- Pipe cleaners
- Beads
- Silver glitter
- Markers
- Blue food coloring
- Glue

Procedure

1. Present an overview of coral reproduction to the class. You may wish to use the figure on the preceding page to prepare a blackboard diagram or to make an overhead transparency.

2. Give students lumps of modeling clay and instruct them to mold (i) a single coral polyp, (ii) a polyp as it begins to divide, with a "bud" appearing, and (iii) two polyps that have resulted from division.

3. Ask students to draw comic strips that illustrate, in sequence, the process of coral reproduction.

4. The massed coral spawning event that occurs annually on the Great Barrier Reef has been described as an "upside down snowstorm," with flurries of egg and sperm packets released into the sea simultaneously. The following craft depicts the magical beauty of coral spawning.

5. Provide each student with a clean empty babyfood jar. Ask students to create miniature coral reefs using styrofoam, waxed paper, foil, colorful plastic tape, toothpicks, pipe cleaners, beads, and other supplies. The corals may be colored with waterproof paint and permanent markers.

6. Have students anchor their corals onto their jar lids using modeling clay (or a glue gun, used with close teacher supervision).

7. Fill the babyfood jars with water tinted with blue food coloring. Add a small amount of silver glitter to each jar and then twist the lid tightly on the jar, sealing the outside rim with rubber cement.

8. Have students turn their jars over (so the reef will be at the bottom) and gently shake them to simulate coral spawning.

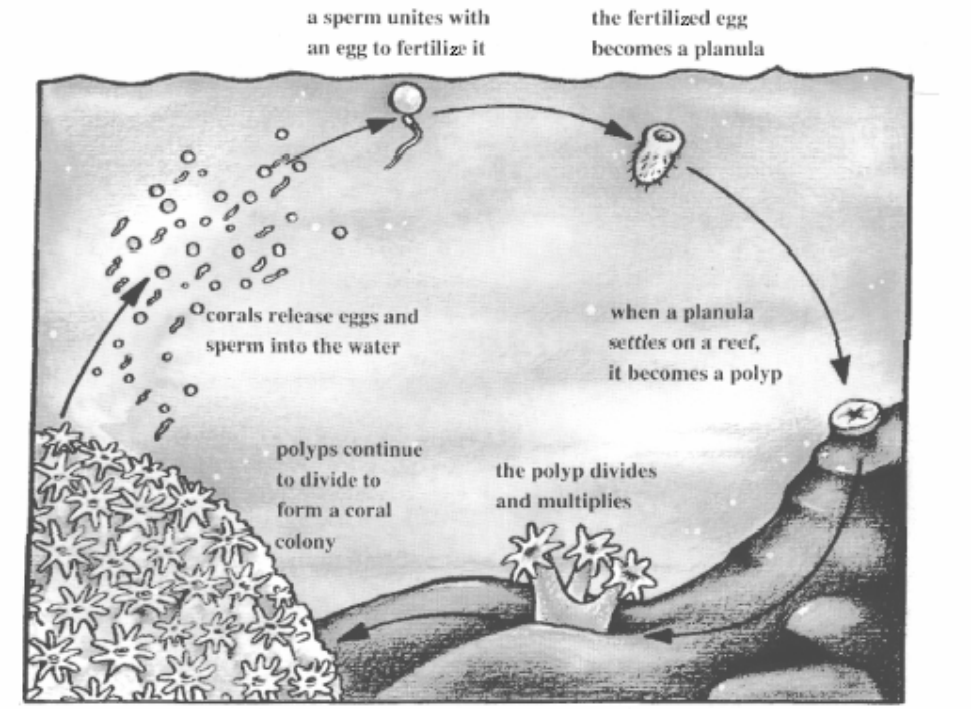
9. Explain to students that coral spawning is a *rare* event. Furthermore, unlike snow flakes (and glitter) which settle to the ground, coral egg and sperm packets *rise* toward the surface of the ocean.

Coral Reproduction

Corals reproduce by releasing their eggs and sperm into the water. This is called spawning. Most corals spawn at exactly the same time. During a mass spawning, the water is filled with brightly colored bundles of eggs and sperm. The sperm and egg cells join to form larvae called **planulae**. The planulae drift in the ocean as plankton for up to thirty days. When a planula finally settles, it turns into a single coral polyp. This polyp divides to make two polyps, and each new polyp continues to divide, eventually forming a coral colony.

Corals spawn only once a year. It is not known why corals spawn at the same time, but some ecologists think that the answer might be related to the fact that spawning always occurs a night or two after the full moon.

On different reefs, coral spawning happens at different times of the year. On the Great Barrier Reef, corals spawn in late spring or early summer, often in November. On Ningaloo Reef in Western Australia, the mass spawning happens in autumn, in March or Apri



Source: Dr. Sharon H. Walker,R. Amanda Newton, Dr. Alida Ortiz, Coral Reefs: An English/Spanish Compilation of Activities for Middle School Students, 2001, J.L. Scott Marine Education Center & Aquarium

Lesson 4

GROW YOUR OWN CORAL REEF

BIO1 BIO2

Grade(s): 3-6
Subject(s): science

Objectives

Understand the conditions corals need to grow
Understand the time it takes for corals to grow and what affects their growth

Background: Have students learn about coral reefs, the environment they live in, what affects them, and their beauty. They can then grow their own reef. It is a fun project, and will give the students some appreciation for the time that it takes for the reef to grow, and that constant care will only keep it thriving.

Materials:

- piece of string
- water
- sugar
- toothpicks
- small gumdrops or hard candies
- food coloring
- small container

Procedure

1. Make a saturated solution of water and sugar in container, by adding sugar until it will no longer dissolve in the solution. Add food coloring to make it an attractive color.

2. Suspend a piece of string from a short popsicle stick or toothpick over container so the string is suspended through the sugar solution.

3. Leave the string and sugar water for a few days and observe crystals growing up the string.

4. Place gumdrops or other hard candy on the bottom, and allow crystals to form on them.

5. When the solution is gone, mix another sugar water solution of another color. Drop the same string into that solution and allow crystals to 'grow'.

You now have your own "reef!"

Discuss

How long did it take for the little crystals to grow?
Have students research the factors for coral growth, the growth rate and factors that affect their growth.
Students share their finding and answer the question: What are some factors that affect the growth of corals? What could be done to help corals?

Source: *Grow your own coral reef,* PROJECT OCEANOGRAPHY University of South Florida, SPRING 2000

Lesson 5

EXPLORE THE CORAL REEFS

BIO1
BIO2
ORG2
ORG3

Grade(s): 2-6, secondary
Subject(s): science, geography

Objectives

Understand how coral reefs are formed
Describe types of corals found within the Mesoamerican Barrier Reef System
Identify some organisms found on coral reefs

Materials

- Copies of student's page
- Coral reef worksheet
- Reference materials
- Clay

Procedure

1.Photocopy copies of student's page and worksheets and distribute to students. You can let them pair up and share pages.

2. Students should research why coral reefs grow in particular parts of the world. Use the coral reef research sheet to map out the coral reefs in the world

3.Using the reference materials, the library, internet have students write and illustrate a story pretending they are an animal living on the coral reef. Include 3-5 facts learned about the coral reef. Explain to students that they will be giving an oral presentation to their classmates.

4.Create a diorama displaying at least five different animals that you have learned about that live on the coral reef.

5. Use clay to build two different types of corals that are found on the reef

Adapted from W. Brooks, L. Price, A. Abbuhl *Explore the Coral Reefs* San Diego City Schools, Triton Project 1998

Explore Coral Reefs – Student Page

Introduction 

Pretend you are an oceanographer traveling in a submarine. Suddenly, you see the most beautiful school of fish you have ever seen. You wonder where you are and realize you have entered the amazing world called the **CORAL REEF!**

The Task 

Now, you are the oceanographer. Work with a partner to explore the fascinating world of the coral reef! As you explore the environment you will:

- Use the coral reef worksheet to map out where coral reefs are located.
- Use resource books and world wide web to learn how coral reefs are formed.
- Use clay to build two different types of corals found on the reef.
- Create a diorama displaying at least five different creatures found in the coral reefs.
- Write and illustrate a story, pretending you are an animal living on the coral reef.

The Process 

As you explore the Coral Reef using the resources you will:

1. Use the coral reef research sheet to map out the coral reefs in the world
2. Write and illustrate a story pretending you are an animal living on the coral reef. Include 3-5 facts that you have learned about the coral reef. Give as an oral presentation to your classmates.
3. Create a diorama displaying at least five different animals that you have learned about that live on the coral reef.
4. Use clay to build two different types of corals that are found on the reef

Evaluation 

You will give an oral presentation. Make sure that your presentation includes:

1. 3-5 facts that you have learned about the coral reef.
2. Information you have learned about 3-5 animals found on the coral reef.

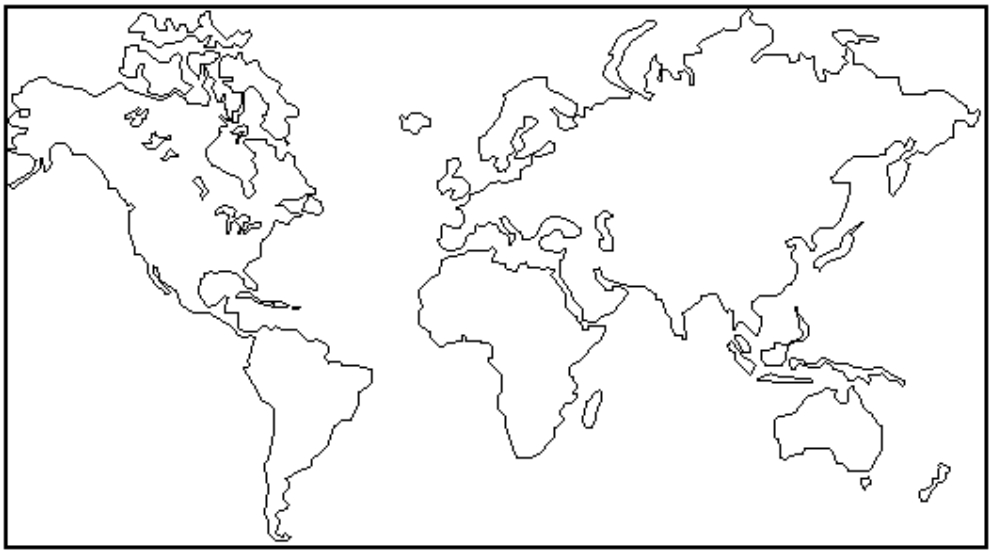
 **Conclusion**

Now that you have learned so much about the coral reefs, share your learning experience with your family and friends.

CORAL REEF MAP WORKSHEET

Student Name -

_____



Lesson 6

BIO1
BIO2
TRA2

A CHANCE OF SUCCESS

Grade(s): 4-6, secondary
Subject(s): science, geography

Objectives:
Learn about the physical factors that limit where coral reefs develop.
Understands relationships among organisms and their physical environment
Knows the physical processes that shape patterns on Earth's surface

Materials:
- 1 die
- copy of score card

Procedure:
1. Lead students in a discussion about what things might limit where coral reefs develop. Ask them to name some of the conditions they know reef-building corals need to survive. *(Right water temperature; clear, shallow water; strong wave action to bring in nutrients)* Write these on the board.
Explain to students that a site must meet all these criteria for a reef to successfully establish and thrive.

2. Show students the die and explain that they'll be playing a game in which they'll all be coral planulae in search of a settling site. Each student will roll the die three times, once for each survival factor.

3. Explain that to survive, they must roll one of these numbers when casting the die for that condition:

Temperature = 2,3,4,5 (1 too cold, 6 too hot)
Substrate/depth = 1,2,3,4 (5,6 too deep)
Wave action = 4,5,6 (1,2,3 too weak to bring in nutrients)

4. Place the score sheet on an overhead projector, or have a student keep score on the board.

5. Invite students up one at a time to roll the die. Be sure to state what factor they're rolling for each time. If they get a good number for all three rolls, they qualify for the next round.

6. Gather the qualifying "planulas" [planulae] in front of the class for the final round. Ask each student the following questions:
! What are coral temperature requirements?
! What are depth requirements?
! Why do reef-building corals need strong wave action?
Those students that can answer the questions are the winning polyps.

7. Remind your students that corals release thousands of eggs and sperm, some of which join and develop into planulae. Do they think all the planulae survive? Why not? Explain

that the reproductive process leans towards high numbers to allow for high mortality. Many planulae are eaten by marine animals before they settle and attach to the bottom. By producing hundreds of thousands of eggs at a time, a coral polyp increases the chance that one of its offspring will mature and reproduce, the measure of a species' survival success.

Deeper Depth: Calculate the percentage of planulae that survive each round.

NAME	WATER TEMPERATURE	WATER DEPTH	WAVE ACTION

Source: Dr. Sharon H. Walker,R. Amanda Newton, Dr. Alida Ortiz, *Coral Reefs: An English/Spanish Compilation of Activities for Middle School Students,* J.L. Scott Marine Education Center & Aquarium,2001

Lesson 7

BIO1 DEV

CORALS NEED CRYSTAL CLEAR WATER TO LIVE

Grade(s): 6+
Subject(s): science, geography

Objectives:
Understands relationships among organisms and their physical environment
Understand that clean, clear water is essential for coral growth

Turbidity

Turbid water might be described as "murky" in appearance; the clearer the appearance of the water, the lower its turbidity. When turbidity is high, water loses its ability to support a diversity of aquatic organisms. Solid particles—such as sediment—suspended in the water can block out light that aquatic plants and organisms need. Suspended solids can also absorb heat from sunlight, raising the temperature of the water. As the water becomes warmer, it loses its ability to hold oxygen. This causes dissolved oxygen levels to drop, further reducing the number of plants and animals that can live in the water.

You will use a Secchi disk to measure turbidity. A Secchi disk is a scientific tool for measuring the relative clarity of deep water. The clearer the water, the lower the turbidity. The murkier the water, the higher the turbidity.

Materials

- Plastic lid, white or light-colored, 20 cm (about 8 in) in diameter
- One black waterproof marker
- Several meters of fishing line
- Flagging tape or strips of colored ribbon
- Meter stick
- Eyebolt with 2 nuts and washers
- Several sharpened pencils

Procedure:

1. Use a sharpened pencil to punch a hole in the center of the plastic lid.

2. Use your waterproof marker to divide the top (outside) of the lid into four pie-shaped pieces of equal size (see illustration). Color the upper left and lower right sections black.

3. Thread a nut and washer (in that order) onto the eyebolt.

4. With the nut and washer on the eyebolt, insert the eyebolt through the hole in the center of the lid. Then add the other washer and nut (in that order) to the eyebolt on the underside of the lid (see illustration).

5. Tie one end of the fishing line to the eye of the eyebolt.
Using the meter stick, measure out from the eyebolt 250 centimeters (about 10 in) along the line, and tightly tie ribbon around the line. Continue tying ribbons to the line every 250 centimeters. In the field, you will lower the Secchi disk into the water. As

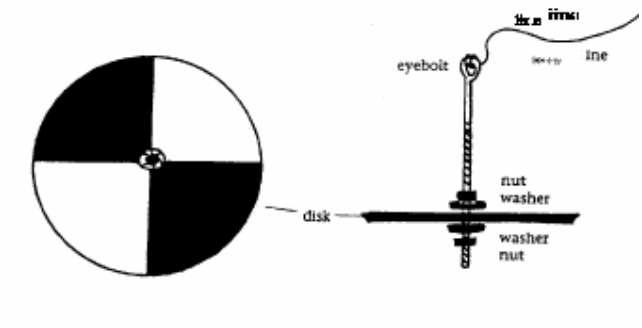
soon as you can no longer see it, you will stop and count the number of ribbons to determine the turbidity level.

Field Experiment

1. If possible, stand on a bridge over the water at your aquatic site. If there is no bridge, simply conduct this experiment from the bank. Lower the Secchi disk into the water just to the point where you can no longer see it.
2. When you can no longer see the Secchi disk, count the number of ribbons remaining above the surface of the water. Subtract this number from the total number of ribbons on the line to calculate the number of ribbons submerged with the disk. This is your turbidity reading.

Example: Suppose you count 10 ribbons above the water at the time you can no longer see your Secchi disk. If your fishing line has a total of 15 ribbons, you would subtract 10 from 15, and your turbidity reading would be 5.
If your Secchi disk reaches the bottom and you can still see it, you should still record the number of ribbons submerged with the disk. If you are still able to see the disk after it has reached the bottom, what do you think it means?

Discuss student findings. Was the turbidity high? What does this mean?



Repeat the experiment one or two times. Record the turbidity each time. To get an average of your Readings, add the turbidity readings and then divide by the number of times you did the experiment.

Source: Dr. Sharon H. Walker,R. Amanda Newton, Dr. Alida Ortiz, *Coral Reefs: An English/Spanish Compilation of Activities for Middle School Students*, J.L. Scott Marine Education Center & Aquarium, 2001

MAPPING THE REEFS

Grade(s): 4-6
Subject(s): geography, science

Objective(s)
Understands the characteristics and uses of maps, globes, and other geographic tools and technologies
Understands the characteristics of ecosystems on Earth's surface
Locate coral reefs on a world map.

Materials:

- A map of the world;
- Copies of the *Coral Reefs of the World* map (below), the *Coral Reef Map* and the *Geography Map Key* (one of each for every group of two students);
- Two copies of the list of *Geography Clues*;
- Thin colored markers (ink pens may be substituted)

Procedure:
1. Before class, cut the two copies of the *Geography clues* sheet into strips with one clue per strip.

2. Divide the class into groups of two.

3. Hand out a copy of the *Coral Reefs of the World* map, a *Coral Reef Map*, and a *Geography Map Key,* one for every two students. Hand out one clue strip per group.

4. Referring to the *Coral Reefs of the World* map, students should mark the location of coral reefs around the world using a colored marker. Referring to the world map, students then need to answer the geography clues and mark their location on the *Coral Reef Map* with the clue number.

5. Then they should record the name of the location on the *Geography Map Key.* The number of letters in the location will also serve as a clue.

6. After completing both of these steps for a clue, one member of the team should exchange theoriginal clue for another clue. This process should be repeated until all thirteen clues have been used.

7. As each group completes the locating and recording section, have them work together (or separately) to complete the follow-up question.

8. Have the class share their answers.

Source: Dr. Sharon H. Walker,R. Amanda Newton, Dr. Alida Ortiz, Coral Reefs: An English/Spanish Compilation of Activities for Middle School Students, 2001, J.L. Scott Marine Education Center & Aquarium

GEOGRAPHY CLUES

Each of these locations has coral reefs.

1. Group of islands northeast of Cuba

2. Central American country bordering the Caribbean and Guatemala

3. Fifteen percent of the world's coral reefs are located in this sea

4. Large island off the eastern coast of Africa

5. Largest ocean in the world

6. Largest barrier reef in the world, located off the eastern coast of Australia

7. Island country south of Cuba

8. Central American country adjacent to South America

9. United States peninsula state

10. United States island state

11. Collection of many islands located in the South China Sea

12. Body of water between Africa and Asia

13. A group of islands in the Pacific where Kwajalein, the world's largest atoll, is located

GEOGRAPHY MAP KEY

1. _ _ _ _ _ _ I S _ _ _ _ _
2. _ _ _ _ _ _
3. _ _ _ _ _ _ _ _ _
4. _ _ _ _ _ _ _ _ _ _
5. _ _ _ _ _ _ _
6. _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
7. _ _ _ _ _ _ _
8. _ _ _ _ _ _
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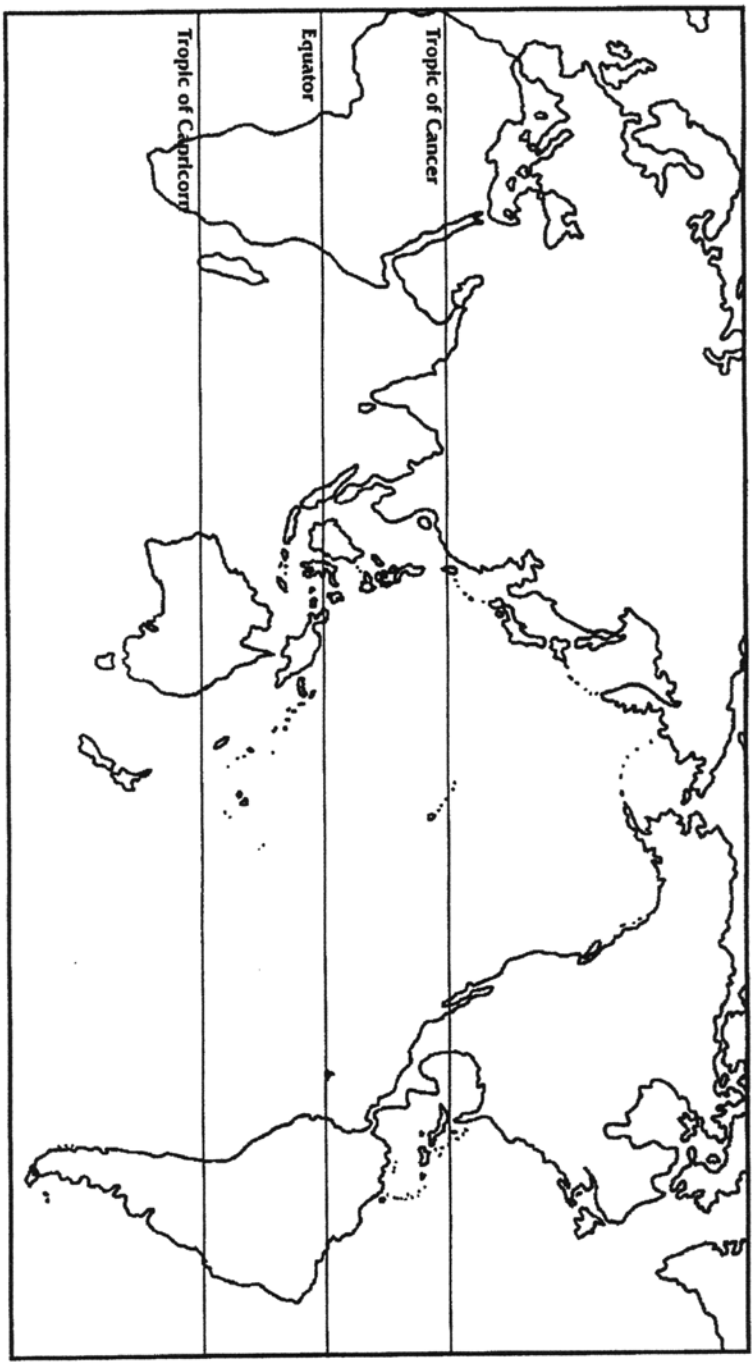
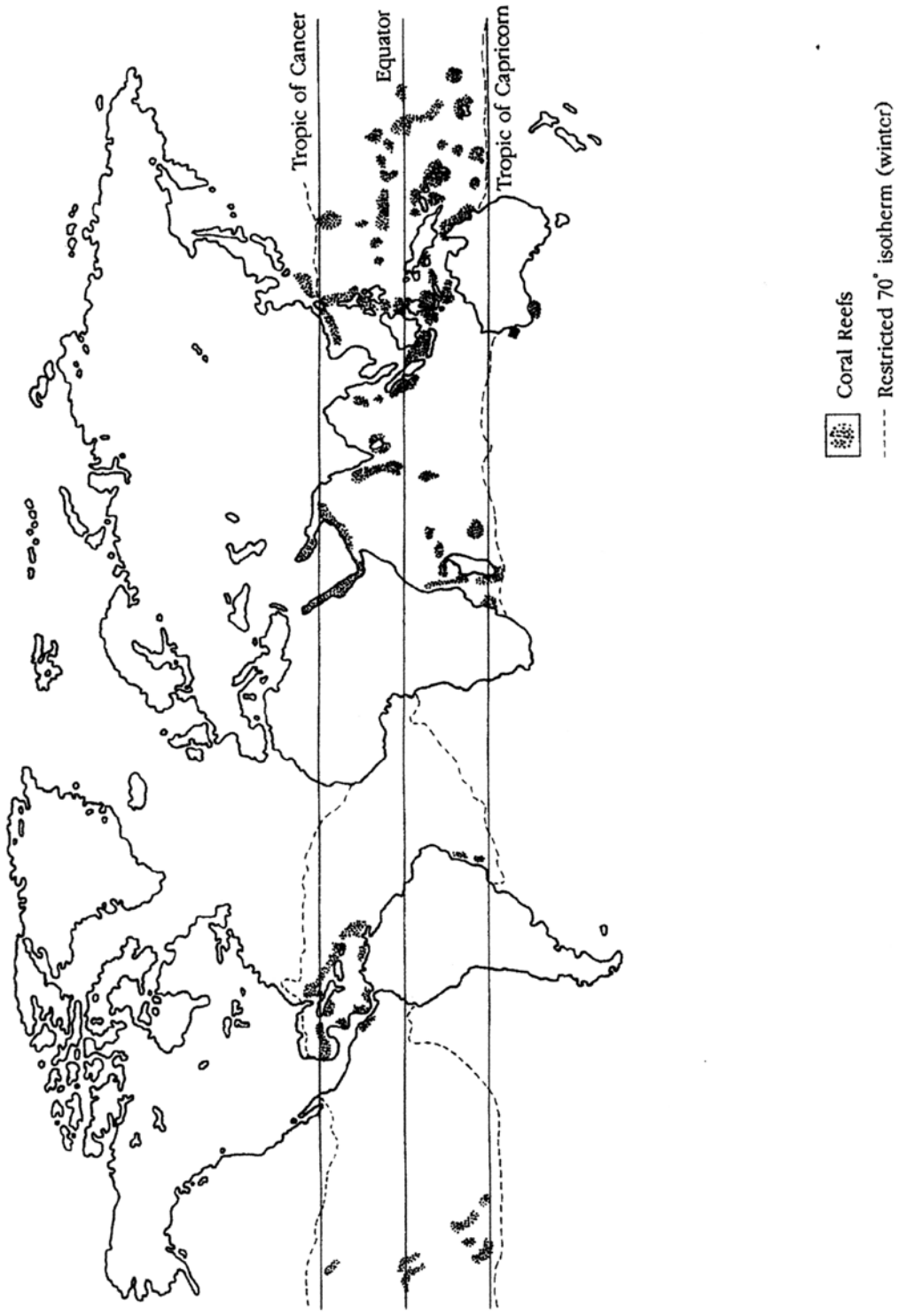
10. _ _ _ _ _
11. _ _ _ _ _ _ _ _ _ _ _ _
12 _ _ _ _ _
13. _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

Follow up: Describe in general terms where these coral reefs are located. _____



CORAL REEF MAP


Tropic of Cancer
Equator
Tropic of Capricorn
Coral Reefs
Restricted 70° isotherm (winter)

Lesson 9

BUILD A REEF

ORG1
ORG2
ORG3
ECO2

Grade: 3-6
Subject(s): Science

Objective:
Understand the organisms that make up the coral reef ecosystem.
Understand the relationships among the organisms in the coral reef ecosystem.

Background
If you look closely at a reef ecosystem, you see that it ismade up of hundreds of thousands of tiny animals called coral polyps plus various other algae and marine animals. Together these make up the coral rim-reef community. All these organisms live together, sometimes helping each other and sometimes fiercely competing with each other. Survival is very important. This coral rim-reef is an active place teeming with inhabitants competing for food and space.

Materials
- Scissors
- Envelopes
- Elmer'sGlue
- Coral Reef Organism Worksheet
- Colored Pencils, Markers, Crayons, Paint or Brushes
- Paper (8.5 x 11 inches of paper, ex. Construction paper) or poster board
- Sticky Tac (putty-like material used to affix items on walls)
- Blue cellophane (plastic wrap) [optional]
-

You can build your coral reef many different ways- by yourself on one sheet of paper or work with a group to build an almost life-sized reef on a bulletin board display. Choose the size reef you're going to build and here's how to get started.

PROCEDURE

1.Gather together all the materials needed- paper, glue, scissors, and worksheet.

2.Give students a sheet that has drawings of all the types of organisms might be seen on a reef in the MBRS.

3.After they have found the organisms (using reference materials), color them according to what they saw on the page.

4.Have students cut out each of the organisms. As soon as they finish cutting out each organism, place it in an envelope.

Build the Reef

A. Take the pieces out of the envelope and spread them all out on the desktop to see what they are and how they will be used to build your reef. What should go on the paper first? Have students think about the order in which they will put the organisms on the paper. Make a plan!

Hints: 1. Think about which organisms can be found on the bottom?
2. Are any of the organisms growing attached to something else?
3. Which organisms are swimming?

4.Where do you think you'll find the phytoplankton and zooplankton (the really tiny organisms that we've made large enough for you to see)?

B. Using a tiny piece of Sticky Tac, place the organisms on the paper according to your plan.

C. Have students use reference materials to figure out if their plan for arranging the organisms is correct. Have the students ask the questions:

1. Does your paper look like the pictures in the references? It does? Great!

2. Do you need to move something? Carefully lift up the organism and move it where it should be.

D. Now students are ready to glue their organisms to the paper. They have to glue down the paper organism but also have to remove the Sticky Tac. Students should decide upon the steps that they'll need to take to accomplish both these things.

E. Check to make sure that they don't have any globs of glue showing on your paper? Do you think you'd see that on a coral reef?

F. One last thing students need to do is to sign their name to your paper. If they decide to add blue cellophane to the paper, add it now that everything else is completed. Cut a piece a just slightly wider than the paper. Add a small amount of glue to the left and right sides of the cellophane and attach it to the reef paper

G. Congratulations- students have built a reef!

TEACHER HINTS

Following is a list of suggested steps for preparing this activity:

- Photocopy the *Build a Reef Activity Sheet* and the accompanying *Coral Reef Orgnaism Worksheet*
- Crayons and colored pencils are easier to use and less messy than markers, If you use colored paper as the background to build your reef upon, then you may want to use clear cellophane or Saran Wrap (instead of the blue. Use the blue cellophane if you use white paper for your background.
  * There are steps in the building of the reef that require the students to problem solve. Act as a guide or facilitator but do not give your students specific answers or directions. Guide their thinking or reasoning. What they should realize is that corals need to be placed first as they are the platform upon which many of the remaining organisms grow or swim above.

EXTENSIONS

1.Bulletin Board: You will need to enlarge the organisms to build your reef on a bulletin board. Make sure you enlarge **all** the organisms by the same amount. For instance, 100% may be large enough for your size board, so you may have to cut the organism sheet in half and enlarge half at a time. Try different percentages until you arrive at a size large enough for your purposes. Since these organisms will be so much larger, have one student color one organism. The board will then be a collaborative

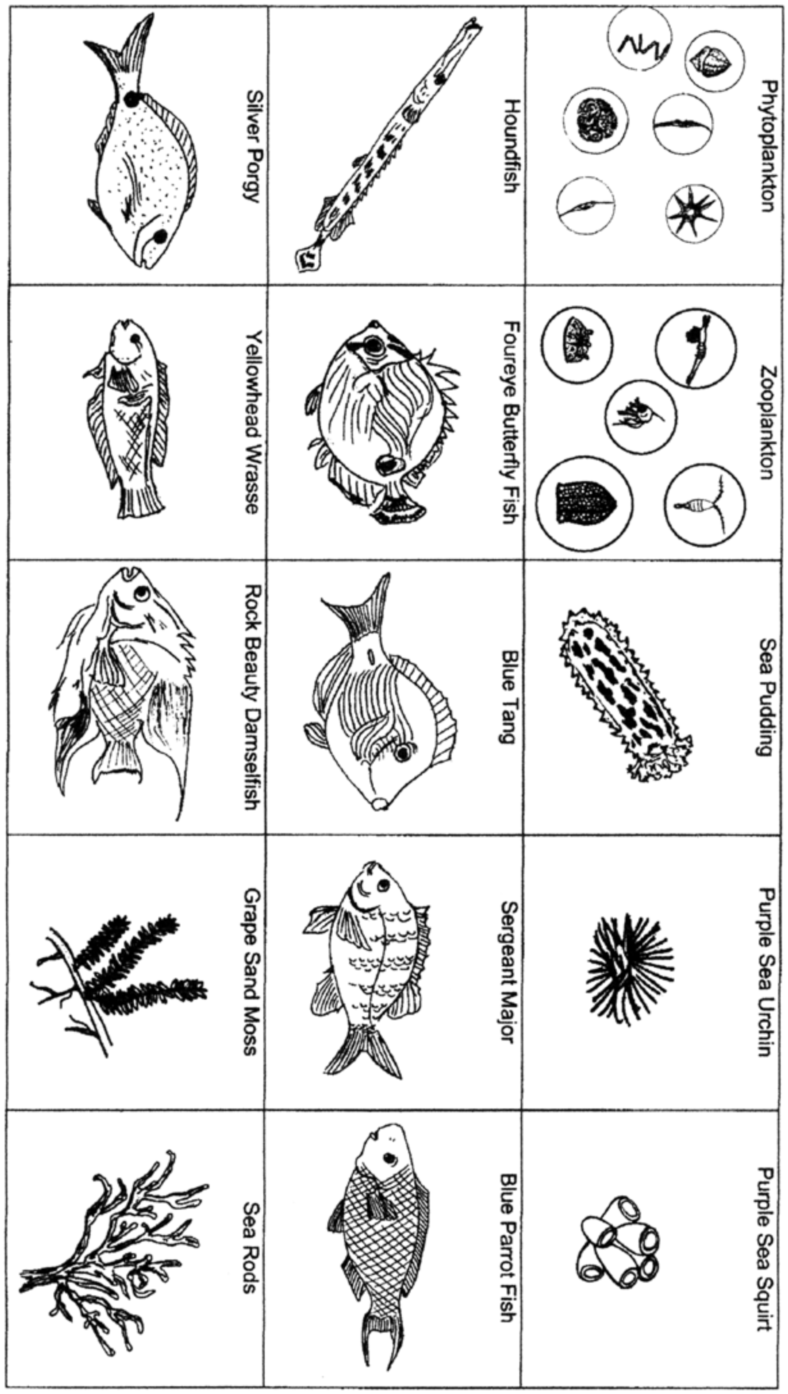
effort. Add dimensionality to your board by stuffing some of the organisms, such as the brain coral, with newspaper or paper towels.

2.Mobile: Instead of building a reef, you can make a mobile using the *Coral Reef Organism Worksheet*. Enlarge the organisms slightly and then color them as for the reef-building activity. Have your students cut out each organism or even just cut out representative organisms instead of the entire collection. Use coat hangers, sticks, wooden dowels, or Styrofoam plates (with holes punched around the perimeter) from which to suspend the reef organisms.

3.Transparency Overlays: Instead of photocopying the *Coral Reef Organism Worksheet* onto regular copy paper, copy it onto transparency sheets. You may make the copy darker than you would for regular photocopying. [Boxes of transparencies can be obtained for low cost- you don't need high quality transparency sheets.] You will use another blank transparency sheet (instead of paper) to build your reef upon. Use permanent markers to color the organisms, again in the appropriate colors seen on the web site. Carefully cut out the outline of each of the organisms that have been colored. Follow the same directions as for the paper reef-building activity except use double-sided transparent tape to attach the organisms to the blank transparency sheet. You can still attach the blue cellophane over the completed reef. Have a showing of the completed reefs. Place each reef on an overhead projector or hang them in a sunlit window.

Source: Pat Pierce and Cheryl Schroeder, *Build a Reef,* BBSR and TCOE Coral Web Site Team 1999
http://www.coexploration.org/bbsr/coral Funded by a grant from the Goldman Foundation,

CORAL REEF ORGANISM WORKSHEET



CORAL REEF ORGANISM WORKSHEET

Hat Coral 	Mustard Hill Coral 	Star Coral 
Common Sea Fan 	Mustard Hill Coral 	Star Coral 
Common Sea Fan 	Sea Whips 	Sea Pens 

CORAL REEF ORGANISM WORKSHEET

Common Brain Coral

Common Brain Coral

Common Brain Coral

Small Brain Coral

Small Brain Coral

Small Brain Coral

Lesson 10

THE CORAL REEF COMMUNITY

ORG2
ORG3E
CO2
ECO3

Grade(s): 4-6
Subject(s): Science

Objectives:
Name at least six animals common to the Mesoamerican coral reef ecosystems.
Explain the role of some animals.
Describe energy transfer from the sun, to plants, to plant-eaters, and to animal-eaters.
Define the term "food web," and ecosystem.

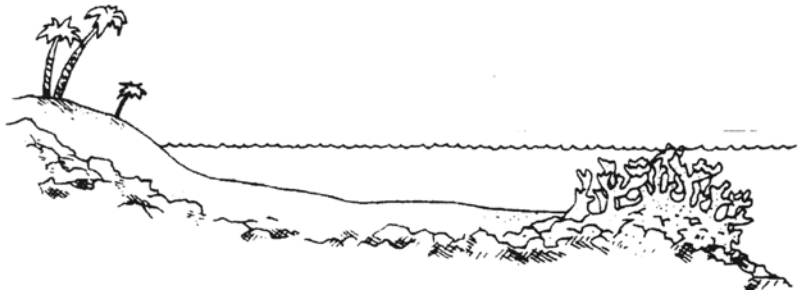
Materials

- Coral Reef Clue Cards (last pages of lesson plan) Cut & paste on cardboard
- Coral Reef Cards (illustrated cards)
- Thumb Tacks (about 30)
- Bulletin Board
- Large piece of newsprint with Reef Outline drawn upon it
- Blackboard and chalk
- Student Background to read to students

Procedure:
1. Prior to activity assign background reading to students. [E.g., *Coral Reef Coloring Book* written and illustrated by Katherine Orr, © 1988, Stemmer House Publishers, Inc.]
Cut out the Coral Reef Clue Cards (last page of lesson plan). Paste them to light cardboard. Cut out the illustrated Coral Reef Cards (following Clue Cards). Paste them to light cardboard.
Put them in a basket or box.

2. On a large sheet of newsprint, draw the outline of a coral reef system as shown below. Make a large drawing, so that there will be enough room to pin the Reef Cards in place. Color and add other details (no plants or animals on the cards) according to your artistic talents.

3. Post this drawing on the classroom bulletin board. Keep extra tacks nearby.
On the blackboard, write three headings: Plants, Animal-eaters, Plant-eaters, Plant-and-Animal eaters.



4. In class read Student Background (below) aloud.

5. Pass out Reef Cards, one per student. If there are cards left over, give some students two or more. If there are too few cards, have students team up.

6. Explain the outline of the reef you have drawn. Tell students that they must do three things with their cards:

(a) First, they must listen to you read clues, raising their hands as soon as the Coral Reef Clues describe the animal or plant on their Reef Card. You can call on students for the name of their animal or plant, or, for a livelier atmosphere, have students call out the name.

(b) Secondly, the first student to name the correct animal or plant must pin their card to the part of the reef community where their creature belongs. They should explain their reasoning to the class.
(c) Thirdly, they must write their animal or plant's name on the blackboard, underneath one of the headings you have written there. Pause to make sure that everyone understands these instructions.

7. Begin reading Coral Reef Clues at random, one card at a time. DO NOT READ THE LAST STATEMENT ON EACH CARD. Allow time for students to think about the clues. Repeat if necessary. (Sometimes, several students will raise their hands at once. Tell them keep their hands up until they hear a clue which does not apply to their creature. This will probably happen several times. Students will soon realize that *your* clues proceed from general to specific information.)

8. When a student correctly identifies an animal or plant, have student show the class what it looks like, and then pin the card on the reef outline. The student should explain the position—why they place the card where they do—seaward beyond the reef, or between reef and shore, or on the reef itself. Also, tell the students to consider if the animal or plant is to be placed on the bottom, floating, or swimming in the water?

9. Give the student the corresponding Coral Reef Clues Card. Ask student to re-read the clues and decide which column on the blackboard applies to the creature on the card. Student should write the animal or plant's card under one column, explaining why to class.
Student should sit down again, keeping the Clue Card.

10. Then read another Reef Card Clue. Continue until all cards have been pinned on the reef outline. If the game begins to lag, have students place cards on reef drawing, but write the plant or animal's name in the correct blackboard column while you go ahead and call new clue cards.

11. After all the plants and animals have been written in one of the three columns, discuss the following questions with the class:

- What common characteristics are shared within each group?
- Can we tell which group is the most important?
- What would happen if all the animal-eaters disappeared from the reef?
- What would happen if all the plant-eaters disappeared?
- What would happen if all the plants died?
- Can a coral reef be healthy if any of the groups disappeared?

Student Background:

Hundreds of different types of plants and animals live in coral reefs—certainly more than we could learn about here. In the following activities, we will learn about members of important groups of reef dwellers and reef-neighbors. First, we will just get to know them, finding out about where they live on the reef, and interesting details of the way they live. Next, we will investigate their eating habits. You know that you must eat food in order to grow and to have enough energy to go to school, play, and just to be healthy. Think for a moment about that phrase "to have enough energy."

What do people mean when they talk about that kind of "energy"? (Discuss.)

All living things, plants and animals alike, need energy. Energy is the ability to do any kind of work—to move, to grow, even to think takes energy.

If energy is so important, where does it come from? (Discuss.)

We get it from the plants and animals we eat. But where do animals and plants get energy from? Animals get energy from eating plants and animals, just as do we. But what about plants? They don't eat. Does anyone know where plant energy comes from? (Discuss.) They too need energy for growing and reproducing. When you eat a mango, you are eating energy that the mango plant has transformed into food.

Plants harvest energy from the sun. That's where energy begins—for us, and for the creatures of the reef. Plants change the sun's energy into plant tissues—leaves, stems, or seaweeds. Large numbers of animals eat those plants, and other animals eat them, in turn.

Some scientists organize communities of living things according to "who-eats-who." This type of organizing tells them how energy from the sun is transferred among members of natural communities such as coral reefs.

There are three main groups in this system:

- Animal-eaters or Carnivores. These animals prey only upon other animals.
- Plant-eaters or Herbivores. These animals eat plants only.
- Plant-and-animal-eaters or Omnivores. These animals have a mixed diet of both plants and animals.

Can you think of examples of these groups? (Discuss.)

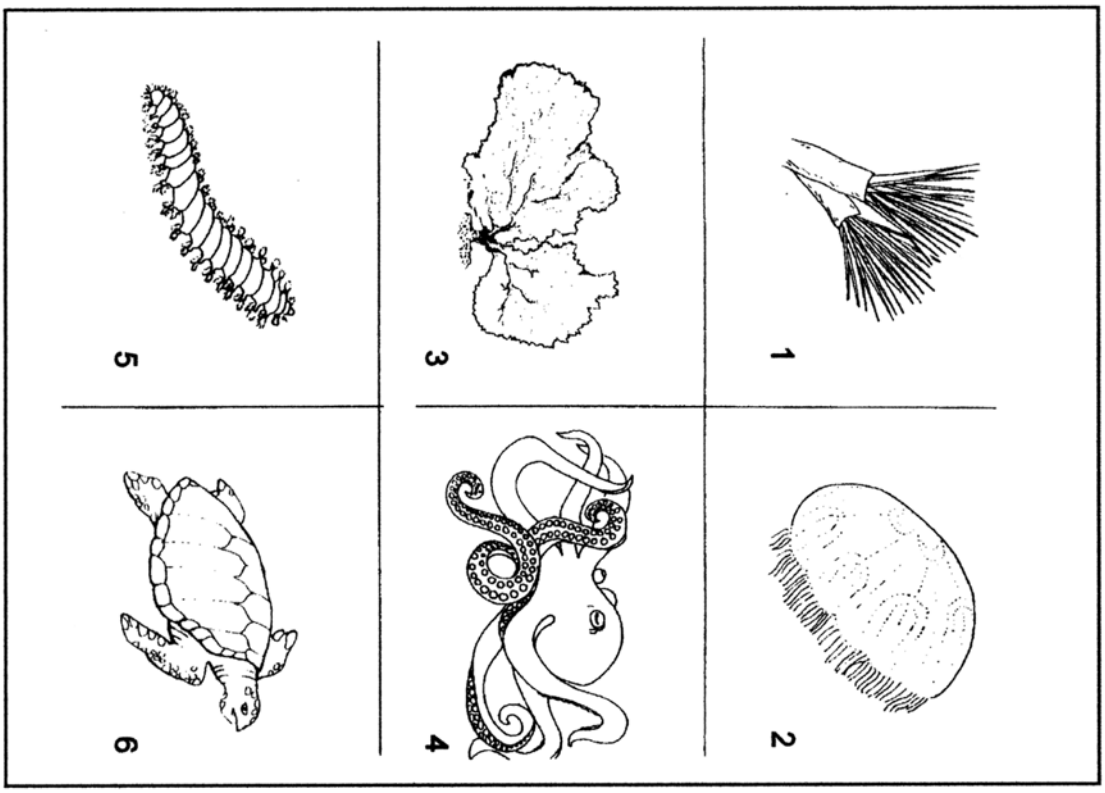
Today's activity looks at the complex web of food and eating relationships that exist in a coral reef. In fact, scientists call these relationships a food web. You are going to make a coral reef food web in the classroom, after you learn some of the creatures that live there.

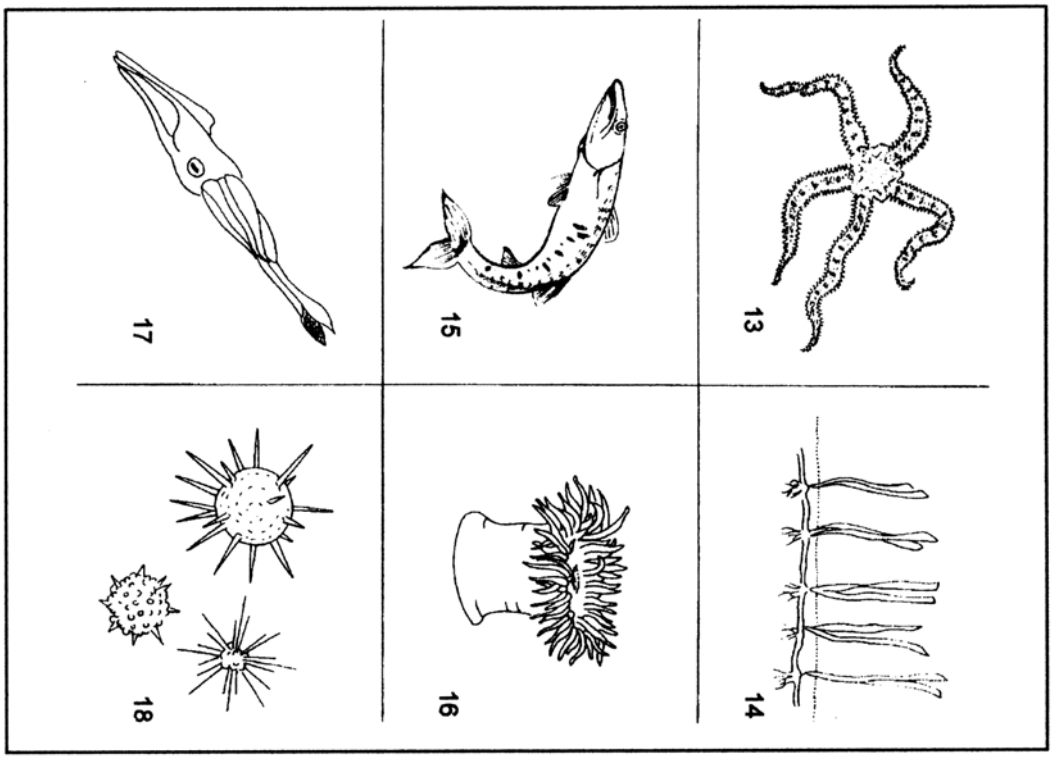
The food web you make here will not be totally realistic. This is because you will not learn the amounts of various animals and plants that live in a coral reef. In the ocean, there are relatively larger numbers of small bottom dwellers that eat plants, small fishes of all kinds, and the plants themselves. Very large animals, such as sharks, have no other creatures that eat them—unless we are talking about baby sharks. Extremely small sharks probably get eaten by many large fish. It is hard to show such a complex food web in your classroom. But, you will get the idea of how food webs work. That's the most important idea.

I live in a hard tube that I build for myself. I draw myself quickly into my tube if I need to hide from some animal trying to eat me. With my gills, I catch tiny, drifting animals called "zooplankton." I have fine, thin gills on my head. They filter my food. I am a type of worm with bristles. I am a FEATHER DUSTER WORM.	I have a radial, or circular type body outline. I swim freely on the surface of the ocean. My stinging tentacles catch fish, which I eat. I am almost clear and transparent. Loggerhead turtles eat me. I am a MOON JELLYFISH.
I am a whole colony of animals, all alike. I grow into a fan-shaped creature that waves back and forth in the water. With my tentacles I catch small drifting animals called "zooplankton." Fireworms eat me. I am a type of "soft" coral. I am a SEA FAN.	I possess neither shell nor backbone. I crawl along the bottom and hide in cracks and holes of the reef. I can change color quickly, and hide in a cloud of inky water. I catch clams and snails. Eels and groupers eat me. I have eight arms. I am an OCTOPUS or SCUTTLE.
My body is divided into many segments. Each segment has legs below and bristles above. My bristles sting! I crawl around the reef and eat coral polyps. I am a type of worm with many bristles. I am a FIREWORM.	I have a backbone, four flipper-like legs, and a hard shell. I breathe air Lizards and snakes are closer relatives to me than fishes. I visit the coral reefs and seagrass beds. There I eat sponges and sea grasses, especially turtle grass. People kill many animals like me for our meat and shells. People and dogs eat our eggs, which are laid on beaches. We are in danger of disappearing from the face of the Earth. I am a GREEN SEA TURTLE.
I am a "jointed-leg" animal, with a hard outer shell for a skeleton. I have ten limbs. Two of my limbs are much larger than the others. They have claws which I use to catch and crush my food. I eat small fish, pieces of sea animals, and other things I find on the sea bottom. I especially like eating sea urchins and snails. I am a CORAL CRAB.	I have a backbone, scales, and fins. I am bright red, with big, round eyes. I have very sharp spines on my top fin. I hide under corals. I swim through the water and eat shrimp and small fish. I have to be careful though, because Groupers and Eels eat me. I am a SQUIRREL FISH.
I am one individual in a colony of animals just like me. I have tentacles with stingers. I deposit a stony skeleton below me. I catch small drifting animals called "zooplankton." Colonies of animals like me make up a coral reef. Parrotfish and Foureye Butterfly Fish eat me. I am a CORAL POLYP.	I live in a beautiful, spiraling shell. I move along the sea bottom and eat algae. I lay my eggs in the sand. Spiny lobsters eat me when I am small. When I am bigger, people catch me for food. I am a type of snail. In the past, there were many like me in the Caribbean. Now we have become harder to find. I am a QUEEN CONCH.
I have a radial, circular-type body form. I drift freely through the water, though you may find me washed up on the beach. I feed on small animals called zooplankton. I am almost clear and colorless. Jellyfish eat me. I am called a SEA WALNUT	My soft backbone and skeleton are made of cartilage. I look like a fish, but I am not a true fish. I have a good sense of smell, and two whisker-like "barbels" near my mouth. The barbels help me find food. I eat clams, crabs, and lobsters. I sleep in coral reef caves. Many people are afraid of me, but I am seldom dangerous to them. I am a NURSE SHARK.

I am a spiny-skinned animal, with a star-shaped body. **I have five long, thin arms. I move on many tiny feet on the bottom of my arms.** **If I lose an arm, I can grow one in its place!** **I eat algae and bits of dead plants and animals on the reef.** **I hide from daylight in dark cracks and crevices of the reef.** **I am a BRITTLE STARFISH**	**I don't eat food because I make my own food using energy from the sun.** **I grow on the sandy bottom between the reef and land.** **I am a plant.** **I have long, thin leaves.** **Many young fish, shellfish, and other animals find shelter among my leaves.** **Turtles eat me.** **I am TURTLE GRASS.**
I have a backbone, fins, and scales. **I have a long, smooth body, and very sharp teeth.** **I swim very fast.** **I eat many small fish such as four-eyed butterflyfish, and parrotfish.** **Few other animals bother me, but humans sometimes catch me.** **I am a BARRACUDA.**	**I have a tube-shaped body with tentacles.** **I usually grow attached to a solid surface, such as rocks or seashells.** **My tentacles catch small fish.** **Sometimes I grow on seashells in which crabs are living.** **I steal bits of food from the crab, and protect it from octopuses and other crabs.** **I am eaten by starfish and sea slugs.** **I am a SEA ANENOME.**
I have a soft body, with ten long arms. These arms help me swim freely and quickly—to people it looks as if I am swimming backwards. **Two of my arms are long tentacles which catch my food—small fish.** **I can change color quickly.** **Sharks and people eat me.** **I am very fast.** **I am a SQUID or a CUTTLEFISH.**	**I belong to a group of unrelated animals that come in many shapes. The only thing we have in common is that we are very tiny.** **You could see me only through a magnifying glass or a microscope.** **Some of my group grow up to be larger animals. Some stay tiny.** **Probably trillions of animals like me drift through a reef's waters.** **Some of my group eat tiny algae plants. Others eat members of our own group!** **I am a ZOOPLANKTON.**
I have a backbone, fins, and scales. **I am round-shaped almost like a coin.** **I eat zooplankton (during parts of my life), the soft polyps of corals, and various worms.** **I have two big spots near my tail. It fools bigger fish—such as barracudas—that try to eat me.** **I am a FOUREYE BUTTERFLYFISH**.	**I am a jointed-leg animal, with a hard, outside skeleton.** **I have ten legs.** **After I lay my eggs, I carry them under my curled-under tail.** **I have two large antennae which I use to defend myself.** **I eat snails, worms, and crabs.** **Groupers eat me.** **People catch and eat so many like me that not many of us are left.** **I am a SPINY LOBSTER.**
I am a spiny-skinned animal, with a circular body shape. **I eat algae growing along the reef and ocean floor.** **I have long spines to protect myself.** **Turbot, or queen triggerfish eat me.** **I am a LONG-SPINED SEA URCHIN or SEA EGG.**	**I have a backbone, fins, and scales.** **My funny mouth looks like the beak of a bird.** **I am brightly colored.** **I am one of the largest reef fish, but I also eat algae growing on dead coral and inside coral polyps.** **Barracudas eat me.** **I am a PARROTFISH.**
I have a backbone and fins. I am quite big. **I am not a shark or a fish, however. My body is warm, like yours.** **I breathe air.** **I come in from the open sea to visit the edge of the reef.** **I often travel in schools, or groups.** **I eat tuna, sardines, and other fish that swim in schools.** **I am a DOLPHIN or PORPOISE.**	**I have a backbone, fins, and scales.** **I have a soft skeleton, like my relative, the shark.** **I have a barb on my tail. It has a nasty sting.** **My body is very flat, and I spend most of my time lying partly buried on the sandy bottom.** **I eat snails, crabs, and clams.** **I am a RAY.**

I have a backbone, fins, and scales. I have a big mouth, and am marked with spots and stripes. I can swim, but usually I keep still and try not to be seen. I am eaten by sharks, and caught by fishermen. I eat small fish like Squirrel fish. I am a GROUPER.	I have a backbone, am an air-breather, and live on land. I eat groupers, turtles, squid, parrotfish, conch, and many other animals. I often catch so many animals on the reef that they have a hard time surviving. Sometimes, things that I do on land hurt animals and plants of the reef. I use coral to decorate my body. I am a HUMAN BEING.
I have a backbone, gills, fins, and tiny scales. I am well-known for my large, fierce jaws. I am long and snake-like. I eat octopuses, squirrel fishes, and sometimes eat chunks off careless SCUBA divers. I am a MORAY EEL.	I am a plant. Some plants in my group are so small that they drift in the water without being seen. Others grow large, leafy or grass-like. Some plants in my group grow on stones or dead coral. I need only sunlight, water, and substances dissolved in the water to live. I am eaten by snails like the queen conch, parrotfish, and many baby fish and sea creatures. I am ALGAE. When I drift in the water, I am called PHYTOPLANKTON.

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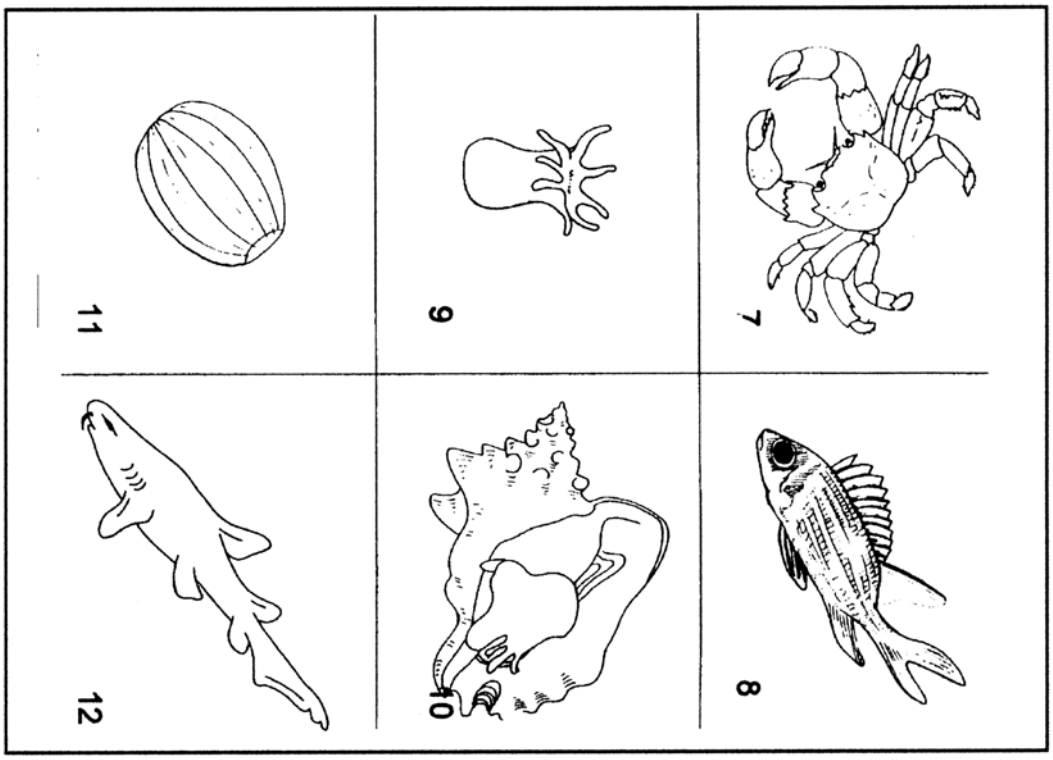
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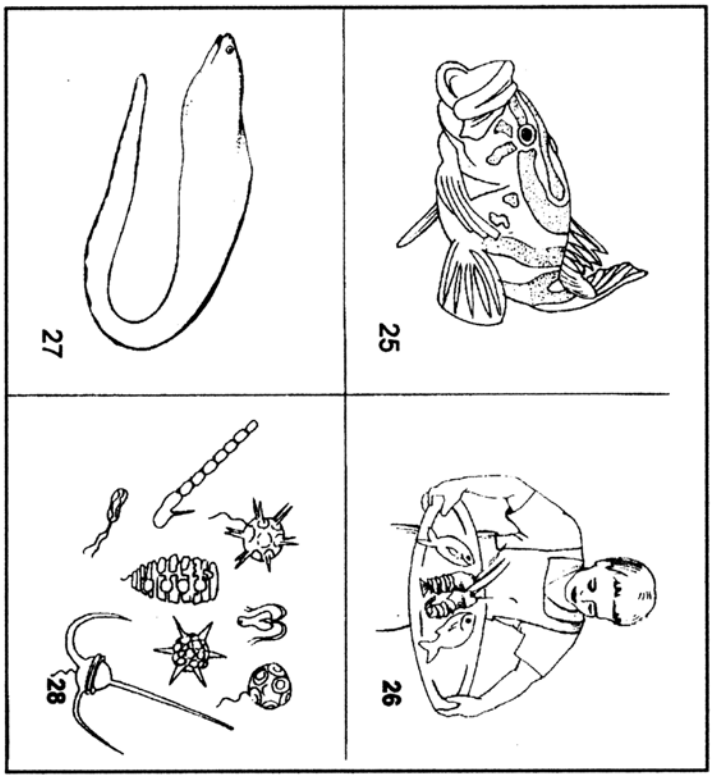
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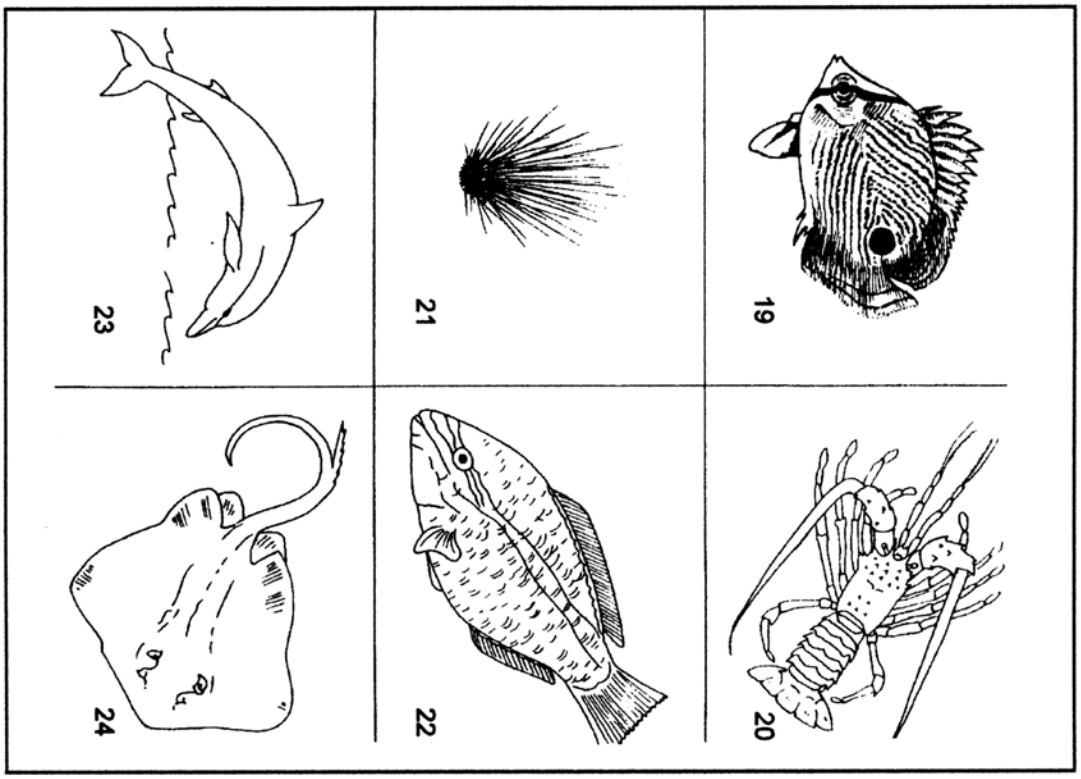
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Lesson 11

CORAL REEF CAFE

ORG2
ORG3E
CO3

Grade(s): 3-5
Subject(s): science

Objective(s):
Simulate the variety of methods with which different fishes on a reef feed.
Learn how the size and shape of a fish's mouth and teeth provide hints about what type of food it eats.

Materials:
- Pictures of a parrotfish, porcupinefish, butterflyfish
- Several clay blocks with little holes scooped out
- Sunflower seeds: approx. one cup (240 ml)
- Small bowl (for pistachios)
- Approximately 1 cup pistachios
- One piece of hard rock
- One pair of tweezers
- One pair of pliers
- One clothespin or chip bag closer

Teacher Prep Notes: Pictures of the parrotfish, porcupinefish and butterflyfish can be found in library books or on the Birch Aquarium at Scripps website: www.aquarium.ucsd.edu. This activity would work well as a science station in a corner of the classroom. Students can experience this activity by using their skill and dexterity. Remind students that a simulation is a way of acting like something, in this case a fish. The tools they will use in this activity represent the mouths of some of the fishes who live on the reef.

Background: Coral reefs support a huge diversity of fishes and invertebrates; in fact, coral reefs are one of the most diverse places on the entire planet. Each animal is adapted to take advantage of a certain niche in the coral reef habitat. Survival strategies, breeding strategies, even feeding strategies all have evolved to allow each animal to take full advantage of the habitat. Fishes on the reef pick, scrape, crunch, or even tear to get their food. Their mouths are shaped to match their feeding style. In this exercise, students will look at several fishes and compare tools to the shape and function of the fishes' mouths.

Procedure:
1. Set up space for this activity to include a flat working surface. In one area of the working surface, set the clay blocks on the table, with the side with holes facing up. Pour some sunflower seeds into the nooks and crannies of the blocks.

2.Arrange an area for the bowl of pistachio nuts and another for the large rock. All three sections can be side by side on one table. Then place the tweezers, pliers and clothespin on the table.

3.Ask students to investigate which tools are most effective at picking up each different type of seed or nuts. Remind students that the tools used represent the types of mouths certain

fishes have depending on what type of food they eat. Have students compare the tools they have used to the three different fish pictures. Have them figure out what mouth form and function matches each of the tools.

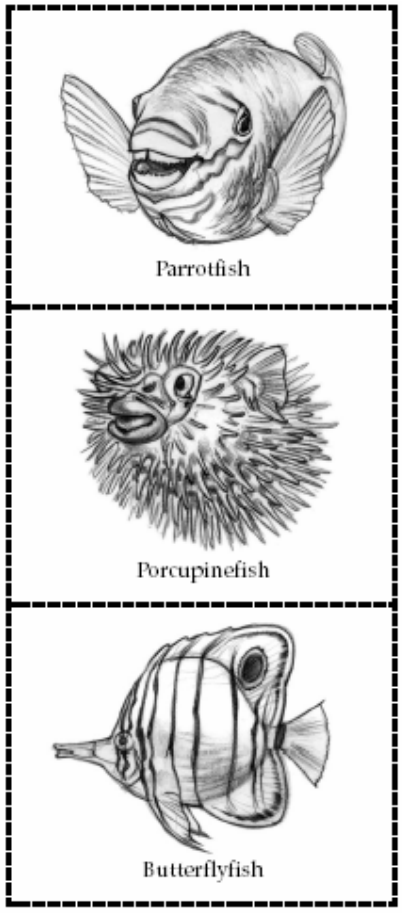
3.Ask students to answer the following questions and discuss their answers.

- There are bits of food in the reef's cracks and crevices for those that can reach them.**Which tool would be best for picking food from the cracks?**
- Hard-shelled reef inhabitants like snails and crabs are tasty treats for those that can crush them. **Which tool would be best for cracking hard shells?**
- Coral tissue and the algae within them are nutritious meals for those that can scrape it from the coral's hard skeleton. **Which tool would be best for scraping?**

Taking It Further: Have the students do research to figure out what the butterflyfish, parrotfish, and porcupinefish eat and whether it matches their theory of mouth function. Visit a local pet store or a local aquarium to determine if you can tell what fishes eat. Ask the staff of the store or the aquarium to confirm your thoughts.

Adapted from MacGillivray Freeman's *CORAL REEF ADVENTURE* National Science Foundation

Species for Identification



Lesson 12

UNDER THE SEA

ORG1 ORG2 ORG3

Grade(s): 1-4
Subject(s): art/science

Children will create an undersea environment in their classroom while researching interesting facts about their favorite sea creatures.

Materials

- Crayons, colored pencils, markers
- Crepe paper (blue, green, red, yellow, pink)
- Paper plates
- Construction paper
- Index cards
- Yarn or string
- Books or magazines with pictures or illustrations of fish

Procedure

1. Discuss with children the different kinds of sea creatures found within coral reefs of the Mesoamerican Barrier Reef System and ask them to choose their favorites. On the board or chart paper, list each child's name and favorite sea creature. Then explain to children that during the next week they are to find out as much as they can about their favorite sea creature so they can tell the class about it at the end of the week. Suggest to children that they write interesting facts about their sea creature on index cards. Children may also want to make illustrations to help them describe their favorite sea creature. Provide books and magazines for the children to look through and arrange for them to have some research time in the school library.

2. Then begin to decorate the classroom by hanging blue and green crepe paper across the room to create the sea water. Then have children draw and cut out a picture of their favorite fish or other sea creature. Make sure that children decorate both sides of their fish. Then hang the fish from the ceiling or display them around the classroom walls. Continue to create an undersea world in the classroom by using some or all of the following ideas.

    - Brainstorm with children things that might be found on the around a coral reef, an octopus cave, or a lobster trap. You can decorate, or simply refer to, areas in your classroom as these undersea landmarks. For example, the reading corner may become a coral reef (pipe cleaners can be used to make coral), a bookshelf could become a sunken ship.

    - Invite children to bring in any sea shells they may have at home to display around the room. You may want to bring in some tapes of ocean sounds to play in the Background during the week.

3. At the end of the week have children share with each other what they have learned about their favorite sea creature. You may want to celebrate with a special snack, such as saltwater taffy or crackers shaped like fish.

Adapted from *Under the Sea* ,Houghton Mifflin 2001

Lesson 13

THE "CORAL REEF RACE FOR SURVIVAL" GAME

BIO1 BIO2 DEV MPA

Grade(s): 4-6
Subject(s): science, geography

Objectives:
Understands the conditions for coral survival and development into coral reefs
Understands relationships among organisms and their physical environment
Understands the characteristics of coral reef ecosystems
Understands how human actions modify the physical environment
Understands the survival needs of corals in their natural habitat and some of the destructive influences of human behaviors.
Discuss coral conservation efforts.

Materials:
- Four "planula" badges (or headbands).
- Enough "coral" badges (or headbands) to provide one for each student in the class.
- Three copies of each of the two **planula survival cards** listing requirements for a planula (larva or young stage coral) to successfully settle on the bottom.
- Three copies of each of the two **planula disaster cards** listing conditions in which planula can not settle.
- Two copies of each of the four **reef survival cards** detailing coral survival needs.
- One copy of each of the eight **reef disaster cards** listing damage to coral reefs caused by human activity.
- Two containers to hold the cards—one container (basket, bag, box) for **planula survival and disaster cards** and one for **reef survival and disaster cards**.
- Floor space for students to sit and form coral reefs by linking arms.

Procedure and Game Directions:
1. Divide the class into two teams. The object of the game is to see which team will be the fastest to build a healthy reef.

2. Clear an area on the floor for children to sit and "form coral reefs."

3. Ask each team to choose one boy and one girl to represent planulae, (the coral larvae or young stage) that will start their reef formation. Each student wears a planula badge on a headband or pinned to clothes.

4. Each planula student takes a turn pulling a **planula card** from the **planula card** container. If they chose a **planula survival card** listing appropriate places for corals to settle, ask them to read the card aloud to their classmates. Then they go to the front of the room and settle on the floor. If both planulae from the same team are successful, they sit (settle) together, linking arms. Once they sit, they are no longer planulae, but have transformed into a young coral colony, and trade in their planulae badges for coral badges. The teacher might remind students that, "On a real reef, coral planulae are settling all the time, but for our game, we will just have them settle once to get us started."

5. If the planulae students pull a **planula disaster card,** they cannot settle. They return to their seats. Their team has to choose another pair of planulae. But they will be a turn behind the other team.

6. The new corals take turns pulling numbers from the **reef card** container. If they choose a **reef survival card** listing appropriate conditions for coral growth, the coral students can then select two other students to join them. The chosen students link arms with their coral teammates and are given coral badges. A coral reef is beginning to form. If the corals choose **reef disaster cards,** the reef cannot grow so the reef loses a coral (the student who drew a **reef disaster** number returns to the team.)

7. If a team has only one coral on the reef and that coral receives a **disaster card**, he or she returns to the team and two other students are selected as planulae.

8.The teams keep taking turns drawing cards and adding or losing corals to the reef. (When choosing new "corals" try to give turns to students who haven't been chosen previously). After each drawing, the students read their cards aloud to insure that students understand why their reef grew or not. The object is to see which team is fastest to build a reef of ten corals. (Or you may decide on the number that means a team has won.) You may not consider it a healthy reef until all the students on one team become corals. But that may take considerable time, just like building real coral reefs.

Source: Dr. Sharon H. Walker,R. Amanda Newton, Dr. Alida Ortiz, Coral Reefs: An English/Spanish Compilation of Activities for Middle School Students, J.L. Scott Marine Education Center & Aquarium,2001.

PLANULA SURVIVAL CARD
Congratulations!

You have just settled on a clean, hard lava rock!

You grow and become a coral colony!

PLANULA SURVIVAL CARD
Congratulations!

You have just settled on a clean, hard section of old coral reef!

You grow and become a coral colony!

PLANULA DISASTER CARD
Too Bad!

You have just settled in shifting sands and cannot attach and grow into a coral colony!

Return to your team

PLANULA DISASTER CARD
Too Bad!

A Hawaiian sergeant fish or mamo eats you! No chance to settle now!

Return to your team.

REEF DISASTER CARD
Too Bad!

People decide to save money by dumping sewage close to shore. This causes algae to grow over the reef so that the corals cannot receive the sunlight they need to grow!

LOSE ONE CORAL FROM YOUR REEF!

REEF DISASTER CARD
Too Bad!

A golf course uses fertilizes incorrectly. Rain washes the fertilizer onto the reef helping the algae to grow. The coral is shaded from needed sunlight.

LOSE ONE CORAL FROM YOUR REEF!

REEF DISASTER CARD
Too Bad!

A huge oil tanker hits your reef, tearing a huge hole in the ship's side. The reef is bathed in thick, black oil.

LOSE ONE CORAL FROM YOUR REEF!

REEF DISASTER CARD
Too Bad!

To prevent floods, humans line the stream beds with concrete. They clear ground for new houses and roads. Now whenever it rains, mud and freshwater pour over the reef, smothering the corals.

LOSE ONE CORAL FROM YOUR REEF!

REEF DISASTER CARD
Too Bad!

Someone decides to break off a coral head to take home.
They spray paint it neon pink and sell it illegally!

LOSE ONE CORAL FROM YOUR REEF!

REEF DISASTER CARD
Too Bad!

Hundreds of people come to admire you. But they walk all over you, break your branches and tear your delicate living tissues.

LOSE ONE CORAL FROM YOUR REEF!

REEF DISASTER CARD
Too Bad!

A fisherman pours bleach over you to force fish out of your branches!

LOSE ONE CORAL FROM YOUR REEF!

REEF DISASTER CARD
Too Bad!

A sailboat pauses overhead so snorkelers can admire your coral community.
Unfortunately, they drop an anchor right on your "head."

LOSE ONE CORAL FROM YOUR REEF!

REEF SURVIVAL CARD
Congratulations!

You spend the day bathed in sunlight. Your zooxanthellae make plenty of food for themselves and for you!

ADD TWO NEW CORALS TO YOUR REEF!

REEF SURVIVAL CARD
Congratulations!

You spend the year in clear,clean saltwater free of silt and sediment. This allows you to receive all the sunlight you need for growth.

ADD TWO NEW CORALS TO YOUR REEF!

REEF SURVIVAL CARD
Congratulations!

You spend the year in saltwater just the right temperature for your growth! (64 to 86 Degrees F.)

ADD TWO NEW CORALS TO YOUR REEF!

REEF SURVIVAL CARD
Congratulations!

You capture several small plankton animals for food.

ADD TWO NEW CORALS TO YOUR REEF!

Lesson 14

BIO1
BIO2
ECO2
ALT
DEV

STUDENTS AS CORAL REEF SCIENTISTS

Grade(s): 4-6
Subject(s): science, geography

Objectives
Represent the structure and symbiotic relationship of a coral reef ecosystem.
Identify the major conditions in which coral reefs can grow (light, temperature, sediments, salinity, depth of sea).
Describe where coral reefs grow.
Identify the types of reefs found within the Mesoamerican Barrier Reef System

Lesson context:
The main topic of investigation for this mission is protection of coral reefs. To address the overall problem, students will need to have a basic understanding of coral reefs. During this lesson, students participate in the following hands-on activities about coral reefs:
- drawing a picture of coral reefs,
- discussing symbiosis and relating it to coral reefs,
- constructing paper models of different types of island coral reefs, and
- building different types of coral reefs with Plaster of Paris.

Based on the understanding of what coral reefs are, how they work, what features they have, and where they grow, students can determine what data they will need to collect to evaluate whether restrictions should be applied to tourism, recreation, or commercial enterprises around the coral reefs within the Mesoamerican Barrier Reef System.

Estimated time required: 2 to 3 class periods
Materials
- Activity sheets for these activities
- Construction paper, cardboard
- Plaster of Paris, clay

Activity 1: What is a Coral Reef?
Inform students that they will be participating in different activities in order to develop their understanding of coral reefs. Involve students in the demonstration and initial discussion of a coral reef's structure and location.

1. Show students a short movie that includes the motion of coral and other marine invertebrates and ask them what questions come to mind with the focus on the structure

2.Ask students
- What is a coral reef?
- How do they live?
- Where do they live?

3. Prompt students to draw a picture of coral reef s on *Activity Sheet 1: What Does a Coral Reef Look Like?*

Activity 2: Coral Reef Symbiosis

1. Introduce the concept of symbiosis by having students think about a time when they helped each other and it turned out they were helping themselves too.

2. Prompt students to write a brief explanation of what they investigated. See *Activity Sheet 2: Coral Reef Symbiosis.*

Activity 3: Constructing three paper models that describe coral reefs.

1. Ask students to research the types of coral reefs See *Activity Sheet 3: Researching the Types of Coral Reefs*

2. Divide your students into three groups and assign each group to create one of the following types of coral reefs. Show students animation of how a reef progression from a fringing reef to a barrier reef and then finally to an atoll.

- Making a fringing reef
- Making a barrier reef
- Making an atoll

3. Prompt students to write a brief explanation of what they investigated.

4. After students build different types of coral reefs, have them share with each other the important characteristics of each.

5. Explore the conditions under which coral reefs can grow and have students build different models of coral reefs.

Activity 4: Goldilocks and Coral Reefs

1. Introduce the lesson by reminding the students the story of *Goldilocks and Three Bears*

o What kinds of chairs did Goldilocks find in the bear's house?
o Why did Goldilocks think that *Little bear's* chair was made just for her?
o Why did Goldilocks think that Papa bear's pie and Mama bear's pie were not tasty?

o Like a Goldilocks story, can we find favorable conditions that coral reefs can grow well—not too extreme in temperature, salinity, wave action, depth of sea?

2. Prompt students to explore the growing conditions that coral reefs can grow well by investigating resource materials.

3. Tell students to write a brief explanation of what they investigated. See *Activity Sheet 4: Goldilocks and Coral Reefs*

4. Provide students with the various images of the Mesoamerican coral reefs.
o Brain coral
o Elkhorn coral
o Finger coral

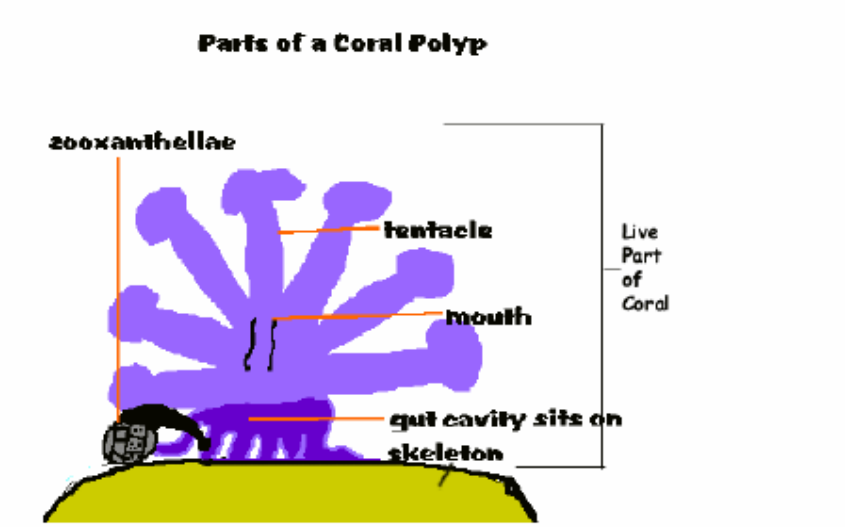
4. Ask students to find where the Mesoamerican Barrier Reef is located and whether there are coral reefs near where they live.

Adapted from *Students AS Coral Reef Scientists,,* (Kaams) Kids as Airborne Scientists, NASA, 2002

Activity Sheet 1: What Does a Coral Reef Look Like?

Name:

1. Draw a picture of a coral reef and label its features.



<Reference> http://library.thinkquest.org/J002237/corals/partscoralpolyp.gif
Teacher Note: In reality, each polyp in the picture is extremely small, about 1mm across.

2. What does your picture show about real coral reefs?

A coral reef is made up of the shells of single, small marine animals called coral polyps. When coral polyps grow into a group they are called a coral colony. As polyps die, new ones grow on top of the old empty shells. Over time, the collection of shells left behind by dead coral polyps and dead coral colonies build large groups of rock-like structure called a coral reef. Although the entire coral reef looks like a lot of large rocks, the top surfaces are actually covered with new coral colonies that are very much alive.

Activity Sheet 2: Coral Reef Symbiosis

1. Did you have a time when you helped someone and it ended up benefiting both of you? Please write about this situation in 1-2 paragraphs.

Examples:

• Boosting another person up to reach something of importance to both –like a cookie they would share.

• Running a relay race

• A grandparent living in the same house as their children. They are provided with room and board for free, while they baby-sit for the parents, or do the laundry.

2. What you described in item 1 is symbiosis. Combine what you learned from this experience and what you found out about its definition to define symbiosis in your own

Symbiosis means sustaining the life of each other by living together in harmony. What students should have described in answer one was an action whose purpose was to benefit the other.

3. Define zooxanthellae.

Zooxanthellae are one-celled yellow-brown (dinoflagellate) algae that live symbiotically in the reef-building corals.

4. Why do we say that coral reefs live symbiotically?

Inside the sac of each coral polyp lives a one-celled algae called zooxanthellae (zoo-zanthely). The algae gives off oxygen and other nutrients that the coral polyps need to live and in return the polyp gives the algae carbon dioxide and other substances the algae needs. In addition to the symbiotic relationship between zooxanthellae and the coral polyps, many other fish live symbiotically with the coral reefs.

5. Why do coral reefs grow so near the surface of the water?

Because the algae (zooxanthellage) need sunlight to create food through photosynthesis, they live in ocean waters less than 100 meters deep.

6. Why do you think that symbiosis is important to coral reefs?

Without the algae, the coral could not live. Without the coral, giving off carbon dioxide and other substances, the algae could not live.

Activity Sheet 3: Researching the Types of Coral Reefs

Name:

1. What is the difference between *fringing*, *barrier*, and *atoll* coral reefs?

The main difference between each type of reef is the distance it lies from the beach shoreline.

2. Define *fringing* coral reefs.

Fringing reefs attach themselves to the beach where they can find much food and clean, rather than muddy, freshwater. These are the simplest and most common kind of reef.

3. Define *barrier* coral reefs.

Barrier reefs grow out from the beach as far as 100 km from shore, often rimming and protecting a relatively deep lagoon on the ocean side. Some are 2000 km in length. The lagoon is a common place for boats to dock, and therefore can threaten the coral.

4. Define *atolls*.

Atolls are circular, surrounding a lagoon. Its upper surface is nearly flat with steep outer slopes. They are found far from land. Charles Darwin, solving the puzzle of how they are formed, determined that they formed around islands that are sinking. As the island sinks, the reefs continue to grow upward at the same pace, and therefore remain visible.

Activity Sheet 4: Goldilocks and Coral Reefs

Name:

1. Where do coral reefs grow?

Coral reefs can be seen throughout the tropical and subtropical Western Atlantic and Indo-Pacific oceans, generally within 30 degrees N and 30 degrees S latitudes.

2. Why do you think that coral reefs only occur between certain latitudes, and then only within certain areas?

Studies have shown that most reefs grow well between the temperatures of 79-80 degrees F. The temperature is ideal year round in these locations, not too hot, and not too cold.

3. What major factors limit where coral reefs can found? List 5 major factors limiting the occurrence
of coral reefs.

Factor	Requirements	Why is it important
Temperature	64-86F (18-30C)	Stable temperature between 64-86F is necessary for the survival of coral reefs.
Salinity	33-36 parts per thousand	
Light	The maximum dept for actively growing coral is 70m.	The need for light for coral reefs' symbiotic plant is thought to limit reef building corals to shallow water.
Wave action	Reef development is generally more abundant in areas that are subject to strong wave action	Waves carry food, nutrients and oxygen to the reef. Waves distribute coral larvae. Waves prevent sediment from settling on the coral reef.

Activity Sheet 5: Analyzing their Living Conditions

Name:

1. Search for locations where coral reefs can be found.

• Where is the Mesoamerican Barrier Reef System?

1. Do you think that the area around the Mesoamerican Barrier Reef are ideal environment for a coral reef? Why?

They have a stable temperature. Salinity is perfect, and there is enough wave action.

2. Do you think that coral reefs could live in your area? Why or why not?

This answer depends on the location of your school. Test the salinity, temperature, wave action and sediment in water near you to determine this.

Lesson 15

BIO1
BIO2
ORG
SVC
PAR
DEV
TRA2
TRA3

TREASURE HUNT

Grade(s): 2-6
Subject(s): science

Objectives

Describe a coral reef, the types and the way coral reproduce
Describe organisms found on the Mesoamerican Barrier Reef
Identify other marine ecosystems that support coral reefs
Explain the importance of coral reefs
Understand how ocean currents affect the marine ecosystems of the Mesoamerican Barrier Reef
Understand how human actions affect coral reefs

Students use a treasure map to help them locate answers to corresponding science questions.

Materials

- Reference materials, such as encyclopedias, nonfiction books, children's magazines, and science textbooks, if possible access to the internet
- Index cards

Procedure

1. For the treasure hunt, you will need to prepare questions about a topic in science, such as coral reefs, and then write each question on an index card. (The number of questions depends upon the size of your class). Some questions about coral reefs might be:
    - What is a coral reef?
    - Why are algae important for coral reefs?
    - What are the types of coral reefs?
    - What are the two ways coral reefs reproduce?
    - What creatures would you expect to find on a coral reef?
    - Where are coral reef found in the Americas?
    - What are two partner ecosystems of the coral reef?
    - What can happen if some of the environmental conditions in one of the coral reef partner changes?
    - What creatures would you find in mangroves and on coral reefs?
    - List five reasons why coral reefs are important?
    - Do various countries in Central America share the resources of coral reefs?

- How do ocean currents affect the Mesoamerican Barrier Reef System?
- What are some of the three threats that coral reefs face?
- What are actions that have been taken to protect coral reefs?

2. Create an icon or symbol for each reference source and place those books and magazines in different parts of the classroom. Use the icons and the locations to create sites on a "treasure map" that students can follow to find the answers to their questions. Number the treasure sites on the map to correspond to the questions. Each student or group will need their own map.
3. Have each student or group choose three questions and use the treasure map to help them find answers to their questions.
4. Encourage students to footnote each answer with the source they used to answer the question and write it in the style you normally require for writing reference sources.

Teaching Options

- Have students work in groups to make their own treasure maps. They can research a topic of interest, develop three questions about the topic, and create a treasure map that other students can use to answer those questions. You might want to make the basic map and have students create their own icons and other symbols to personalize their maps. Once each group has finished their maps, arrange a map swap and let the treasure hunt begin.
- Work with the whole class to create a treasure map large enough to display in your school hallway. Invite other classes to go on a treasure hunt. The library, computer lab, or even other teachers could be locations (resources) on the map.

Adapted from *Treasure Hunt* Houghton Mifflin 2001

Lesson 16

ORG2
ORG3
ECO2

PARTNER WANTED

Grade(s): 2-6
Subject(s): Science

Objective

Understand relationships among organisms and their physical environment
Understand the relationships among reef organisms

Materials

- Copies of "want ads"

Procedure

1. Read to the students the following about coral reef partnerships.

2. Make copies of the "want ads" below and pass them out to the students.

3. Have the students try to identify which of the reef buddies (described below) might have placed each ad and which might have responded to each ad. To do this they should match up the "box numbers" for each ad. For example, the first ad (box 1) represents an ad that an anemone might place. It goes with the ad in box 4, which represents a clownfish's ad. The kids could write "box 1 box 4" for their answer.

Partners for Life

Clownfish and Sea Anemone:
Several species of fish and invertebrates spend part or all of their lives in association with sea anemones. A clownfish, in fact, will never stray far from its anemone host. The fish avoids its enemies by staying nestled among the anemone's stinging tentacles. Scientists believe clownfish have a special mucous coating that prevents anemone stinging capsules from firing. Many scientists think that the most important thing clownfish do for their anemone hosts is to protect them by chasing away animals such as butterfly fish, which often eat anemones.

Pistol Shrimp and Goby:
In sandy areas of a coral reef, the pistol shrimp sometimes shares its burrow with a fish called a goby. The pistol shrimp spends most of its time digging and cleaning out its burrow. This shrimp finds food near the entrance of its home but can't sense when predators are near as well as the goby can. The goby hovers near the shrimp's burrow, and when a predator approaches, it flicks its tail and dives for cover inside the burrow. This signals danger and sends the shrimp down into the burrow too. Without the goby's alarm signal, the shrimp might not be able to escape danger in time.

Hermit Crab and Sea Anemone:
A few species of hermit crabs—crabs that live in the empty shells of sea snails—usually have sea anemones attached to their shells. The anemones protect the crab from enemies—especially the octopus, which eats hermit crabs but is very sensitive to anemone stings. The anemones may also help camouflage the hermit crab. Scientists aren't sure whether hermit crabs feed their anemone partners. But the anemones do get a free ride around the reef from the hermit crabs. By riding from place to place on top

of a crab, an anemone probably gets scraps of food it might not have been able to get on its own.

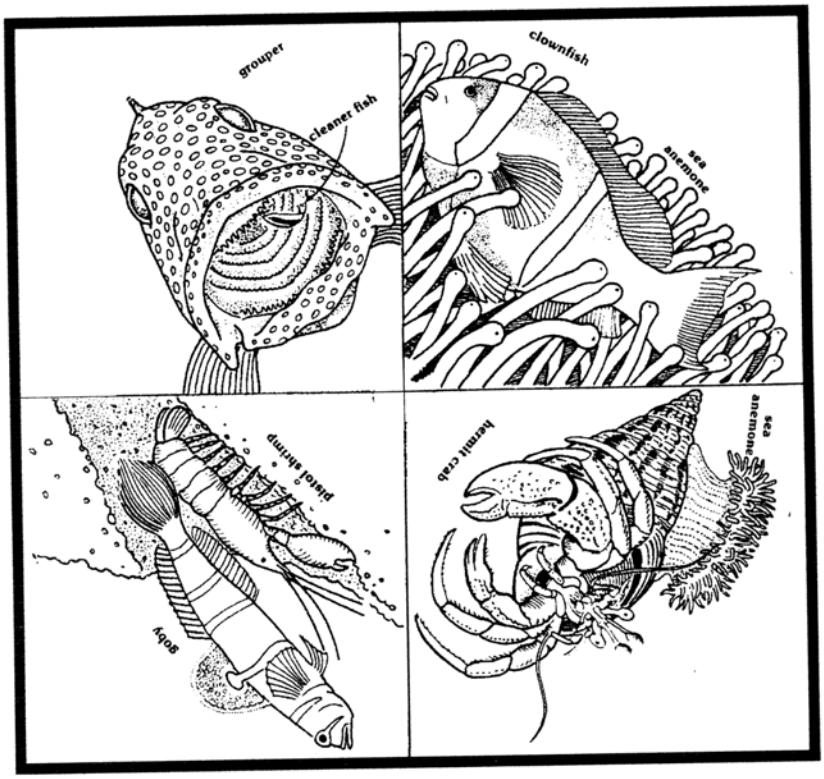
Cleaner Fish and Grouper:
Several species of small fish and shrimp perform a cleaning service for other fish. A cleaner fish usually stays in a small territory known as a cleaning station. When a potential "customer" enters the cleaning station, the tiny fish does a little "dance" identifying itself as a cleaner. The customer may be a large predator such as a grouper. But it recognizes the colors and movements of the cleaner fish and allows itself to be cleaned without harming the smaller fish. The cleaner fish even cleans up the wounds of reef fish, which helps them heal. In turn, the cleaner fish gets its food as it picks off pests and food particles from the larger animal's scales, mouth, and gills.

Source: Dr. Sharon H. Walker,R. Amanda Newton, Dr. Alida Ortiz, Coral Reefs: An English/Spanish Compilation of Activities for Middle School Students,

THE REEF WEEKLY

WANT ADS

Safe and secure place for rent. I'll take in anyone that can keep unwanted company away. Write only if you can stand my "stinging" personality. Write: Coral Reef/Box 1	Strong digger in need of a "watchdog." Bonus: Plenty of extra space in my burrow. Write: Coral Reef/Box 5
Seeking extra protection and a disguise. Willing to take on hitchhikers. Write: Coral Reef/Box 2	Worried about safety? I can provide the added protection you need in exchange for a free ride around the reef. Write: Coral Reef/Box 6
Need a cleaning? Count on me! I'll keep you spotless and healthy in exchange for meals. Write: Coral Reef/Box 3	In search of a personal groomer. I have a "tough guy" image, but with the right partner, I'm gentle as a lamb. Write if you want to eat in peace. Write: Coral Reef/Box 7
Fish needs bodyguard and good home. (Not easily "stung.") Willing to help protect home from danger. Write: Coral Reef/Box 4	"Lookout" fish in search of a ready-made underground hideout. Lots of guard-duty experience. Write: Coral Reef/Box 8



Lesson 17

DINNERTIME ON THE REEF

BIO2
ORG2
ORG3
ECO2
ECO3

Grade(s): 2-4
Subject(s): science

Objectives

Identify the main parts of a coral reef.
Describe organisms found within the Mesoamerican Barrier Reef System
Describe a coral reef food chain.

Materials

- Copies of Activity Page
- Additional reference books with pictures of coral reefs.

Procedure

1. Using the Introduction as a guide, present the coral reef as an example of a dynamic ecosystem. Within every ecosystem, physical conditions such as temperature and the amount of sunlight affect and are affected by the organisms in an environment, such as plants, animals, and microscopic organisms. Ask students if they have ever visited a coral reef or seen pictures of one. Perhaps they can name some of the fish that live there. (*Angelfish and barracuda might be two fish that students can recognize.*) You might also refer students to one of the many reference books with colorful photographs of coral reefs.

2. Tell your students that each dynamic ecosystem consists of many interacting parts, each using energy and producing wastes. Ask them to speculate why coral reefs host an abundance of marine life. (The key is that the coral reef receives a wealth of sunlight, which causes algae within the reef to produce an abundance of food. The waves crashing over the reef distribute oxygen and food throughout the ecosystem, creating a hospitable environment for animals). Tell your students that many kinds of living things makeup the coral reef community: producers (plants), filter feeders (animals that take in microscopic plants and animals from the water), grazers (algae eaters), predators (animals that eat other animals), and scavengers (animals that eat the remains of dead creatures). A complex food web connects all of these living things. You might wish to write the five organism types on the blackboard and ask students to suggest an animal that fits into each type.

3. Give each student a copy of Activity Page. Tell the class to examine carefully the diagram as you describe some of the following organisms found along a coral reef:

    - At the highest point (crest) of the reef, large, dome shaped, brain coral forms huge boulders. Colorful parrotfish, their large front teeth fused together like a parrot's beak, scrape algae off the coral rock. (*Refer to the Introduction to remind students that coral grows with the help of algae.*) Nearby, the queen angelfish sports an electric-blue, crown-like growth and eats sponges, which in turn feed on microscopic life.

- On the outer reef, Elkhorn coral extends its branches like sign posts and withstands the constant pounding of the waves. Sea fans expose themselves to the prevailing current to receive food, while predators like the barracuda ready themselves for the hunt.

- Between the reef and the shore is a quieter environment known as the lagoon. Here the turtle grass is dense, protecting the young members of reef species. Schools of French grunts who stay among the corals all day move to the grass beds at night to hunt for small crustaceans like grass shrimp. Nearby, a pink-tipped anemone floats food its way by waving its tentacles.

2. Ask your students to complete the Activity Page by writing their answers on a blank piece of paper. When they finish, discuss the correct answers with them. Be sure to emphasize that all of the organisms depicted in the diagram are related to each other in a vast food web.

For the Teacher

ANSWER KEY TO ACTIVITY PAGE

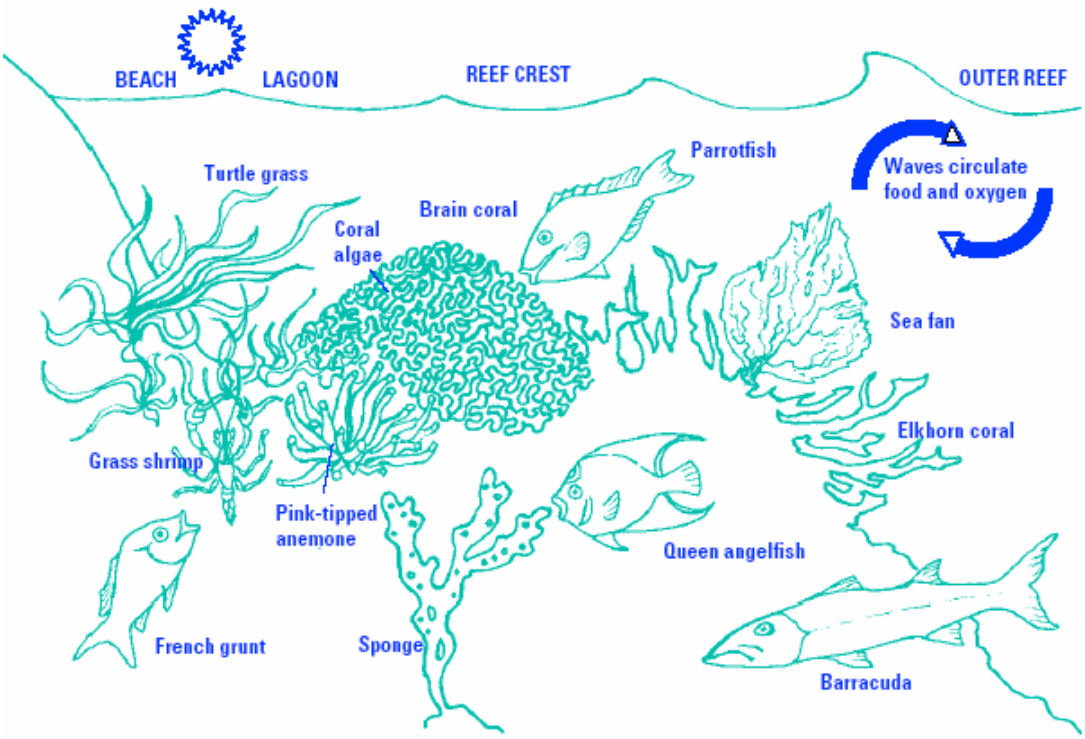
1.brain 2. reef crest 3. algae 4. parrotfish 5. food 6. oxygen 7. sea fan 8. barracuda 9. outer 10. lagoon 11. grass shrimp 12. French grunt 13. pink-tipped anemone

Dinnertime on the Reef, Art to Zoo Contrasts in Blue: Life on the Caribbean Coral Reef and the Rocky Coast of Maine, Smithsonian Office of Elementary and Secondary Education, November/December 1996

ACTIVITY PAGE

It's always dinnertime for some animals on the coral reef. Fill in the missing words as you observe what's on the menu for these reef organisms.

Corals such as the ____1___ coral live in the highest part of the reef, the ___2__ _____. Corals are tiny animals that live together in large, stony colonies as big as boulders. Inside the coral are __3___ that produce food and oxygen using sunlight. A __4___ grazes on the coral to get food. The crashing waves circulate __5___ and ___6___. A nearby _____ 7___ is a filter feeder that uses waves to capture its dinner. The __8___ is a predator that patrols the ___9__ reef, looking for other fish. In the calmer waters of the __10___, a little ____11_ _____ scavenges through the lagoon. Watch out! A hungry ____12_ _____ is coming closer. Nearby, a _____ __13___ _____ waves its tentacles to take in its food.



Lesson 18

ORG1
ORG2
ORG3
ECO3

WEB OF LIFE

Grade(s): 2-4
Subject(s): Science

Objective
Describe the relationships between living and non-living things in a coral reef ecosystem
Understand the idea of a food web using the coral reef system as an example.

Materials:

- Balls of string, rope, twine
- Role cards: Photocopies of cards representing: sun, plants (producers), herbivores (primary consumers), carnivores (secondary consumers)

Procedure

1. Have students sit or stand in a circle.
2. Distribute one role card to each student.
3. Begin by using the string to connect sun to plants
4. Connect plants to herbivores (plant eaters) and herbivores to sun.
5. Connect meat eaters to appropriate plant eaters. Meat eaters should also be connected to the sun.
6. Make as many connections as possible until each student is holding strings coming from different directions.
7. Ask the students to imagine what would happen is the plants were killed by pollution. Those who are affected drop their strings. What If the herbivores were all fished out? Who is affected? Discuss how changing one component can affect the whole ecosystem. Ask students how they affect the environment in which they live.

Expansion
Have children work individually or with a partner to draw their own web, using arrows to indicate the interdependence among the components. Students can also construct their own models or mobiles using a wire clothes hangar and string to connect the sun, water, air, soil, plants and animals.

Interpreting Biodiversity. American Museum of Natural History. Center for Biodiversity Conservation

Lesson 19

SURVIVAL IN THE SEA

ECO2
FIS
TRA1
TRA3

Grade(s): 2-4
Subject(s): science

It's a fish eat fish world under the sea - find out why.

Objectives:
Understand stages in different types of life cycles (including metamorphosis) of familiar living things.

Procedure:
After reading the table below, answer question 1, 2 and 3.

1,000
A
B
C
D
E
F
G
Total Survival

A fish has just laid 1000 eggs in the sea.

A. Half of these were eaten by small fish.

B. A person fishing pulled up an anchor with lots of seaweed and 62 of these fish eggs were caught in it.

C. During a huge storm 38 fish eggs were washed ashore.

D. Of the remainder one quarter of these were blown into a rock pool which dried out in the hot sun.

E. Once the remaining eggs had hatched into small fish 42 were then eaten by bigger fish.

F. One third of the fish left grew into medium sized fish and were eaten by seals.

Questions:
1. How many fully grown fish from the initial 1000 eggs laid were left to survive and reproduce in the sea?

_____

2. Why is it important for some sea creatures to have many eggs?

_____

_____

3. What might happen to a species like this fish if she released only a few eggs?

Expansion
Have students discuss how human actions may also affect the survival of eggs.
What does this mean for fisheries? For health of coral reefs?

Source: *Survival in the Sea,* Nature's Nautical Nurseries. The State of Queensland (Department of Primary Industries) 2002. Queensland Government Gateway

Lesson 20

HULA HOOP HABITATS

ORG1
ORG2
ORG3E
CO1
ECO2
PAR

Grade(s): 2-6
Subject(s): science

Objectives:
Identify the most common type of animal or plant that lives in marine habitats.
Examine the internal and external structure of living things, including animals' respiratory systems and plant systems, and account for observed similarities and differences in terms of adaptations.

Introduction:
Have fun creating your own mini habitats – just place a hula hoop on the floor and name it a type of habitat, then create the creatures and plants that live there.

Materials:
- Four hula hoops.
- Cutouts of the animals and plants listed below.
- Reference materials such as Coastal Treasures of Belize, Mangrove Ecology Workshop

Procedure:
1 Beforehand, have students choose one animal or plant and find out information about their chosen organism.

2 Take a piece of paper and tape, and label each of the hoops a different habitat (mangrove, seagrass, open water, and coral reef) associated with coastal areas.

3 Have each student place each of the animals and plants into the hoops.

4 Draw a table on the blackboard for each of the habitats and give a reason why each animal was placed there.

5 Can students explain why these plants and animals live in this habitat?

Source: *Hula Hoop Habitats,* Nature's Nautical Nurseries - An educational module from the Queensland Fisheries Service, 2002.

List of animals and plants

Fish	**Seagull**
Whale	**Pelican**
Plankton	**Flathead**
Whiting (fish)	**Squid**
Bream (fish)	**Sea snail**
Tailor (fish)	**Sand whelk**
Mangrove seed	**Mud whelk**
Microbes in mud	**Beach worm**
Seagrass	**Blood worm**
Mangrove	**Oyster**
Mud	**Prawns**
Sand	**Crabs**
Gravel	**Jellyfish**
Gum tree	**Shark**
Rocks	**Crab larvae**
Coral	**Prawn larvae**

Lesson 21

ORG1
ORG2
ORG3
ECO3
PAR
DEV
TRA3

SEA CONNECTIONS

Grade(s): 5+
Subjects: biology, geography, science

Objectives

Identify producers & consumers from three coral reef partner ecosystems
Describe the delicate balance among organisms in each environment.
Construct a food chain or web from a seagrass, mangrove, coral reef ecosystem
List some of the human activities that can upset the balance in the environment.

Materials

- Student page
- Globe or regional/country map
- Playing cards to be copied and cut out
- Heavy or construction paper for photocopying or pasting cards
- Scissors

Procedure

1. Motivate students by rapidly spinning a globe and asking them to approximate how much of the region is covered by ocean/sea. Ask them to think about the variety of marine organisms and habitats that must exist on our watery planet, which is over three-quarters ocean. Have students try to locate each of the following on a regional or country map: a mangrove area, seagrass bed, coral reef.

2. Describe to your students some of the amazing biodiversity of marine life, including organisms in coral reefs, seagrass beds, and mangroves. Challenge students to match each of the three ecosystems you have described with the correct location on the map. Ask them to name some producers and consumers from each ecosystem. Producers always begin the food chain and, in the sea are generally algae. All the other organisms are consumers.

3. In advance, photocopy the two pages of playing cards and paste copies onto heavy paper. Cut each sheet into nine cards. Each complete deck will have twenty-seven playing cards and is suitable for a group of up to four players. After cards are cut out they may be laminated.

4. Divide students into groups of three. Pass out a deck of cards to each group and the Rules of the Game Page to each player. Read through the directions together. Make sure that students understand that they will be trying to collect all four cards from one ecosystem in order to see how they connect to each other. Tell students that only four organisms have been chosen from each ecosystem for the game, but that these representative organisms are part of much bigger food webs from each ecosystem. Read through the Disconnect and Reconnect cards to make sure students understand how they are used in the game.

5. As students start playing, circulate among the groups. As a player is carrying out the directions on a Disconnect card, have that student explain to you the relationship of the organisms within that ecosystem and tell in his or her own words the impact of the card.

6. As a student from one group wins, you might interrupt play to let that student describe the winning hand to the class. Use this as a jumping-off point to talk about how food chains and food webs connect the producers and consumers in an ecosystem. As the students resume playing, tell them that the winner from each group should lay out the winning cards to form a food web for other players to see. Then they can divide and trade the remaining cards so that each player has all five cards of one ecosystem— a winning hand.

7. Ask students to fill in their charts using their cards. Spot check the diagrams of each ecosystem. Student food chains and food webs should show a pattern of producers first, then primary consumers (those that eat producers directly), followed by predators. If students use arrows to connect the organisms, the arrow's point should mean "eaten by."

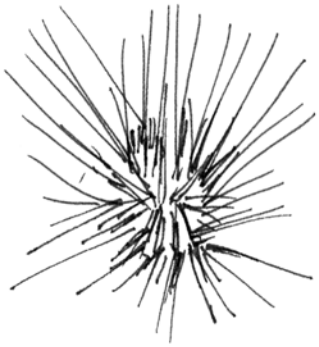
8. When students have finished their pages, discuss which of the Disconnect cards prevented them from winning. This can lead to a discussion of the regional problem of overfishing. Explain to students that when too many people haul their fishing nets and cast their lines in the same waters, too few fish are left to reproduce. In addition, some fishing grounds have become polluted, so the overall result is a dramatic drop in the fish population. For example, the overfishing problem is so great in some countries such as the US that the government has to limit or halt fishing until certain populations recover. Among those on the "hardest hit list" are the Pacific king crab and the Atlantic too. cod and haddock. Even the mighty bluefin tuna, which can weigh fifteen hundred pounds and swim as fast as a speeding car, is down to only 10 percent of its 1980s population. Commercial fishing practices of the past have also harmed nontarget species. In some places enormous driftnets up to sixty kilometers long were set over huge areas of ocean. The fine filaments would catch thousands of fish by the gills, but many other animals would get caught, too.

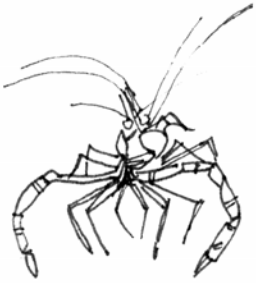
Turtles, birds, sharks—even whales and dolphins—drowned in these nets. Loud cries from conservationists and governments brought about a ban on these driftnets, although shorter nets are still used close to shore. Other fishing gear still in use catches and kills young fish and other unwanted animals by mistake.

9. Ask students to imagine that they make their living catching fish, as some of their parents and grandparents did. Ask them to think about how they would feel if the government set a limit on their catch. Their first reaction might be to the loss of income; however, over the long term they should be concerned with finding ways to prevent the disappearance of the species.

10. Ask students if they've ever played the card game Go Fish. Then ask them why the game they have just played could be called Don't Go Fish. They might answer that overfishing causes the reduction or loss of desirable and profitable species of fish and shellfish. It also disturbs the delicate balance of producers and consumers in each marine ecosystem. The purpose of the card game is to show how both natural events and human activities, such as overfishing, can disturb this balance and break the links that connect species in an ecosystem.

Source: Sea *Connections,* Ocean Planet Smithsonian Center for Education & Mueseum Studies, 1998
seawifs.gsfc.nasa.gov/ocean_planet.html

Disconnect Deforestation causes siltation! Sediments suffocate coral polyps, the most damaging problem to coral reefs. If you have any coral reef cards, lose your next turn until the reef recovers.	SG **Seagrass**  makes food	SG **Urchins**  eat seagrass
MA **Barracuda**  eats snapper & other fishes	SG **Eagle rays**  eat urchins	SG **Tiger sharks**  eat rays & other fishes
MA **Snapper**  feeds on worms	MA **Mangrove leaf litter**  provides food	MA **Worms**  feed on leaf litter

Disconnect **Dredging!** Seagrass areas are dug up to clear for marina. Smothers the seagrass. If you have any seagrass cards, keep them but you lose your next turn.	CR **Grouper**  feeds on other fish such as butterflyfish	CR **Butterflyfish**  feeds on coral shrimp
Disconnect **Chopping down mangroves!** As a result, no areas for juvenile snappers, they are likely to be eaten quickly. If you have mangrove cards, discard them and take new cards.	CR **Algae**  makes food	CR **Coral Shrimp**  eats algae
Disconnect **Pollution from the Land!** Pollution from pesticides, and sewage harms all ecosystems. Whatever cards you are collecting, you lose two turns until the ocean recovers.	**Reconnect** **Good news!** Because of international and regional agreements on overfishing, give the player that went before you a needed card from your hand. Ask for and receive one card that you need from any other player.	**Reconnect** **Good news!** Because of regional agreements on handling pesticide and sewage pollution, give the player that went before you a needed card from your hand. Ask for and receive one card that you need from any other player.

Sea Connections Student Page

In Sea Connections, you and your team will play a card game. The playing cards represent some of the plants and animals that are connected together in the food webs of three different marine ecosystems. The cards show how these ocean producers and consumers depend on one another. The objective of the game is to collect all five cards from one ecosystem. What will get in your way are Disconnect cards. These cards describe events that harm ocean ecosystems and interrupt the connections among the living things that are found there.
Rules of the Game

1. Decide who will be the dealer in your group. The dealer shuffles the pile and deals each player five cards face down, then places the remaining cards in a pile face down. The dealer turns the first card up next to the rest of the deck to start a discard pile.

2. Group your cards by the icon in the top left corner. The icons represent:
seagrass bed
mangrove
coral reef

The object is to collect five cards in one suit, which will include all the animals and plants from one ecosystem. For example, if you were dealt two cards from the coral reef, you may wish to collect all the cards from that ecosystem. (There are three suits, so each player should be trying to collect a different suit.)

3. When it is your turn, pick up the top card from the pile. If you don't need it, place it face up on the discard pile. If you wish to keep it, discard a different card from your hand. If you pick up a Disconnect card, use it during that turn. If you are dealt a Disconnect card, use it during your first turn. If you are dealt more than one Disconnect card, use one at each turn. You may use a Reconnect card at any time. Make sure that you finish each turn with five cards.

4. If the player before you discards a card that you want, you may pick it up instead of drawing from the face-down pile.

5. The first person to collect five cards in one suit wins. If no one wins the first time through the deck, the dealer shuffles the cards in the discard pile and you continue playing.

Sea Connections Date Chart

What suit did you collect?

_____

_____

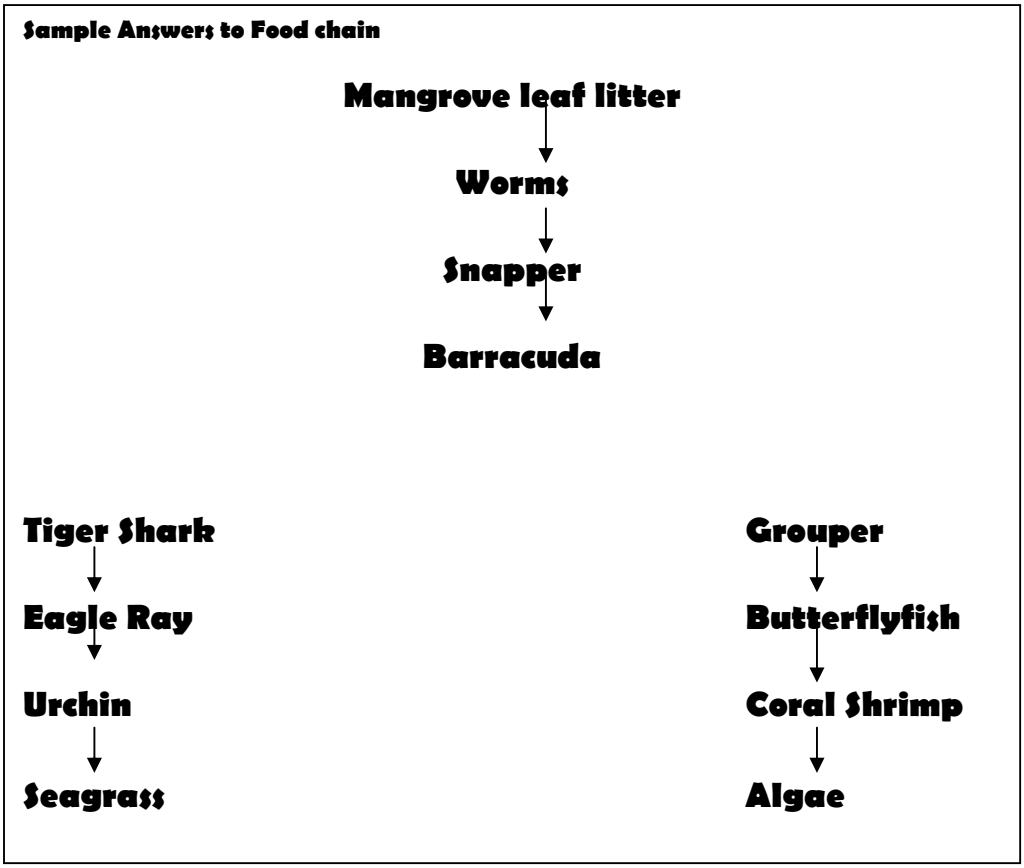
What are the some of the living things found in this marine ecosystem?

_____

_____

Draw a food chain or food web that shows how the producers and consumers in this ecosystem are related. Use arrows to mean "eaten by . . ."

Sample Answers to Food chain



Lesson 22

SAVE THE MANGROVES

PAR DEV ALT

Grade(s): 6
Subject(s): science, social science

Take part in this fun role play and put your case to save or destroy the mangroves!

Objectives:
Examine issues related to the conservation of mangroves areas and the needs of different commercial and community groups.

Describe the values underlying personal and other people's actions regarding familiar places.

Make justifiable links between ecological and economic factors and the production and consumption of a familiar resource.

Predict the impact of changes on marine environments by comparing evidence.

Materials

- Role play cards (see following pages)
- Reference materials on mangroves, eg. Coastal Treasures of Belize, Mangrove Ecology Workshop Manual

Procedure:
The game:
1. Each player or group of players, takes on the role of a particular interest group that will be involved in deciding the future of a given area of mangroves/foreshore in a local area. One group takes on the role of the local government, council who must decide the future of the mangrove area.

2. Each group follows the objectives outlined on their role card and bases their arguments around these points. These views are expressed firstly at a public meeting and then later in a spirit of compromise during the lobbying and decision-making process.

3. Finally the council brings down its decision—hopefully along the lines of protecting the mangroves for those interested groups. However the council should also make provisions for other groups to use nearby areas that are not as susceptible to environmental damage.

Examples of possible council decisions

- Area of mangroves protected because of arguments put forward by local birdwatchers, local fishers/crabbers, offshore fisher.
- An old dump - no longer in use - made available for trail bikers club.
- Heavily logged forest made available for skirmish war games club on the provision that they undertake a replanting scheme of native plants to return forest to original condition.
- Developers passed on to a neighbouring council which has an area of land needed for development.

- Wastewater treatment plant implementing land disposal of sewerage effluent into cane farms with runoff to mangroves

Source: *Save the Mangroves,* Nature's Nautical Nurseries - An educational module from the Queensland Fisheries Service, 2002.

Role Play Cards

Ecotourist association
We want:
1. Setting aside of mangrove area for mangrove canoe trips.
2. Establishment of a small store and landing for briefing tourists and storage of canoes.
3. Establishment of a toilet and shower block and car park.

Offshore fishers (trawlers)
We want:
1. Preservation of mangroves so young fish and prawns will have a nursery in which to live and grow. Adult prawns and fish will still be able to be caught offshore.
2. Preservation of mangroves as the vital producers in the food chains upon which catches depend.

Local council
We want:
1. To reach a planning solution to cater for a majority of the rate payers.
2. To study the local area to find sites (eg, old farm areas no longer used) which could be put to use by the community.
3. To decide on a solution which is best for the long-term welfare of the community.
4. Establishment of a sewerage land disposal unit.

Developers
We want:
1. Mangroves destroyed to enable filling and levelling of site.
2. Construction of four multistorey high-rise (ten floors max.) buildings, including one hotel.
3. Tennis courts and nine-hole golf course.

Local birdwatchers group
We want:
1. Mangrove area to be preserved so that birds will have a place to feed and live.
2. Banning of all fishing and other activities (apart from bird watching) in the area so birds are not scared away.
3. The erection of 'hides' from which to observe and film birds.

Local football club
We want:
1. Mangrove area to be filled (possibly using area as a dump)and then levelled and turfed as a new playing site.
2. Light towers for night football.
3. A grandstand with clubrooms.
4. Car parking facilities.

Local fishers/crabbers
We want:
1. Mangrove area to be left untouched so local fish and crabs will have a place to live.
2. Size limits and bag limits on fish and crabs to preserve numbers for the future.

Lesson 23

SENSATIONAL SEAGRASS

ORG1 PAR

Grade(s): 4+
Subject(s): science, geography

Introduction:

Seagrasses are flowering plants that grow underwater in marine environments. Generally they are restricted to shallow waters in bays and inlets. Seagrasses are valuable breeding and feeding grounds for large numbers of fish and invertebrate species. Some seagrass beds in the Mesoamerican Barrier Reef System may be under threat. For species such as the manatee (sea cow) which feeds only on seagrass, this is a major concern.

Objectives:

Research the role that seagrasses play in marine habitats
Identify locations where seagrasses grow.
Classify values that underpin campaigns and organisations associated with human or environmental rights.
Predict the impact of changes on environments by comparing evidence.

Procedure:

Do some research on seagrasses

1. Where are there some seagrass beds in the Mesoamerican Barrier Reef System?
• Draw a map to show the location of seagrass beds in your district or local area.
• Identify, if possible or visit this area or make some phone calls to organizations who may be monitoring it.
2. What type of seagrass is it?
3. What sea creatures live amongst the seagrass?
4. Is this seagrass under any threat? If so, what are they? Or what are some of the threats to seagrass beds?
5. Make a brochure to distribute to the local community about the importance of seagrass in that area or design a poster to display.

Did you know?

The anchor from one cruise boat can destroy an area of seagrass the size of a football field! What can be done to limit the problem?

Where to see seagrass meadows.

Questions:

1. Where is the Glover's Reef Atoll?
2. Looking at the map, where is the greatest concentration of seagrass?
3. Looking at the depth of the sea, where are seagrass beds found?
4. Is seagrass found on the Reef? Why or why not?

Source: *Sensational Seagrass,* Nature's Nautical Nurseries - An educational module from the Queensland Fisheries Service,2002.

Lesson 24

ORG PAR

MANGROVE COMMUNITY

Grade(s): 4-6
Subject(s): science

Objectives

Observe and record the diversity and distribution of populations associated with mangrove ecosystem.
Study interrelationships among organisms and between organisms and the physical environment.
Consider the effects of disturbing the mangrove ecosystem.
Identify some of the mangrove species present in within the MBRS based on vegetative and reproductive characteristics

Curriculum links: Community, habitats, biological factors, physical factors.

Materials

- Meter stick or 2m tape measure
- Field notebooks and pencils
- Knife or scraper for collecting
- Bucket, tray, plastic bags or small jars
- Clipboard
- Activity sheets
-

Time required: 1 - 2 hours of field work and analysis.

Procedure

Question: How are mangrove ecosystems and the organisms that live within them different from other ecosystems?

1. Before going on the field visit, a session on mangroves. Hand out Information Sheets for students to prepare the night before (homework). Choose a field site, mangroves with accessible trunks or prop roots well colonized by benthic organisms.

2. Select a good low tide when trunks will be accessible; obtain references to local marine life.

3. Review the Student Activity Sheets with students.

4. Break the large group into smaller groups of equal size. Each small group will spend approximately 45 minutes. Collect samples of flowers and leaves at each site for examination in the laboratory session.

5.Students will examine leaves, stems/trunks, aerial roots, flowers, flints, and propagules of mangroves to determine whether they are red mangrove, black mangrove, and/or white mangrove. Observe the leaves, roots and if possible, propagules. Students should try to identify what type of mangrove/s are at the site.

6. Students should closely observe the organisms within the mangroves. Remember to tell students to look from the top within the canopy as far down into the water as they can. If possible, carefully collect samples of organisms for identification on the shore. Examine the small animals closely. Determine the names of as many organisms as possible and try to recognize any special physical features.

7. Measure roughly the width of each band of organism distribution relative to the tide level. Combine information on the levels of each zone and on the tidal cycle to calculate the frequency and duration of exposure for each zone.

8. Try to explain the distribution of organisms in terms of their resistance to exposure to air, their vulnerability to predation by animals in the water, or other factors.

9. Try to observe any behavior of the organisms such as feeding, defense, respiration, movement. If there are few or no organisms at certain levels, try to explain why (changing heights of the sediment, grazing, pollution, storm scour, sedimentation, turbidity, etc.).

Follow Up

On return to the classroom, students should organze their data.

Based on their notes from the Activity Sheet, prepare a diagram showing the location of common organisms on a mangrove trunk relative to the tide levels.

Students should be divided into groups to discuss their observations and conclusions. Students should discuss the total picture of the mangrove ecosystem formulated from the data in the field class or from references should be discussed. Students data could be compared with data from other areas. Any similarities or differences

Discuss with the class what may happen with different kinds of mangrove disturbance (logging, filling, polluting, changing water circulation). Review with the class the values of mangroves.

Edited by ILKA C. FELLER, MARSHA SITNIK, *MANGROVE ECOLOGY: A Manual for a Field Course, A Field Manual Focused on the Biocomplexity on Mangrove Ecosystems,* Smithsonian Institution, Washington 1996

Dahl, A.L., *FIELD WORK IN MARINE ECOLOGY FOR SECONDARY SCHOOLS IN TROPICAL COUNTRIES,* United Nations Educational, Scientific AND Cultural Organization - Division of Marine Sciences, Paris, 1990

Students

Things to consider before going into the field:

Wear sturdy shoes. Remember when walking in/among mangroves, not to walk in others tracks (because of the danger of sinking deeper in the mud) and keep close to a supporting plant.

STUDENT ACTIVITY SHEET

1. Ensure you have your materials.
2. You can work in pairs.
3. Use the Record Sheet to write in your observations.
4. Have a good look at the mangrove trees. Choose a tree and make some sketches to try to identify which type of mangrove tree it is. Make a quick drawing of the site.
5. Take a closer look at the leaves. Draw a picture of a leaf.
6. Are there any propagules on the trees or on the ground. Draw one if there is.
7. What about the roots of the mangrove? Draw these too.
8. Now have a good look around the mangrove trees. Do you see any organisms? In the leaves, on the trunk, the roots, in the water, the mud? Make a list on your sheet, of what you see.
9. Look closely at the organisms and ask:
   What is it?
   Where does it live?
   Why is it found here and why does it behave like that?
   What are its needs?
   How is it related to other living organisms and how does it adapt to the physical environment?

Mangrove Community Record Sheet

Leaves

Sketch or trace the shape of a leaf.

What is the leaf arrangement (alternate or opposite)?

Are there hairs, glands, or other structures on the blade or petiole?

Aerial Roots

Describe:
color
texture
shape
Describe type (prop, drop, pneumatophores, etc.):

Sketch the aerial root system:

Flowers

Sketch a flower:

How many petals?
How many sepals?
How many stamen?

Fruit/Propagules
Sketch a black-mangrove fruit and propagule:

Seedlings
Indicate the cotyledons, hypocotyl, and epicotyl

Faunal diversity in the supratidal zone. You will examine the species composition of the fauna associated with arboreal habitats along a gradient from a low intertidal mangrove fringe along a channel to a high intertidal mangrove stand on the landward side of a mangrove forest.

Observe and list species:

Type of Organisms	Location (where is it found)	Special Features
1.Vertebrates		
Birds		
Reptiles		
2. Invertebrates		
Snails		
Crabs		
Insects		
Others		

Any signs of human impact

What makes Mangrove forests unique and important?

Not many species of trees can thrive in an environment of saline or salty water. One of the few exceptions is the mangrove. Mangroves are trees that grow along muddy beach shorelines. This area of the shoreline is called the tidal zone. Mangroves are able to filter out the salt from water through the undersides of their leaves or at the surface of their roots. Mangroves have exposed roots that breathe through their pores. The prop roots that are submerged underwater during high tide are exposed during low tide, sticking out of the mud substrate.

Mangroves are important to the coral reef ecosystem because they provide: coastal protection; a place for small fish and other marine life to grow; and food through leaves and leaf matter for fish to eat. Mangroves, with special help from their prop roots, slow down strong ocean waves and in this way protect the beach shoreline from erosion. The calm waters of a mangrove forest are also good places for small fish and other marine life to grow until they are large enough to move to the coral reef. The leaves of the mangrove drop into the water and become rotten. This litter known as detritus serve as food for some fish and marine life. The young, or juveniles of some species such as shrimp use mangroves as areas in which to grow (nursery areas) before moving out to deeper water. Other species come into mangrove areas to breed, and many large fish live in or visit mangroves to feed on smaller creatures.

Corals, seagrass beds, mangrove forest are the major life-support systems of the coastal zone. These ecosystems are connected by interactive processes that maintain their stability and functional roles. Interconnections among these ecosystems are of the following forms: physical, nutrient transport, animal migrations and human impact.

Physically, mangrove forests trap the eroded soil from upland terrain to filter the sediments flowing to the seagrass beds and coral reefs. Seagrass beds stabilize the sea bottom through its roots so that particles going to the coral reefs are controlled. On the other hand, coral reefs reduce the potential damage that can be caused by the wave and current actions reaching the seagrass beds and mangrove forests. The most evident interaction between these ecosystems is animal migration where different species of fish and invertebrates pass, feed and spawn in each ecosystem.

Unfortunately, many mangrove areas throughout the world have been destroyed. Mangroves usually grow in flat, muddy insect-ridden areas, which very few people regard as worthy of saving. As a result, mangrove areas are often used as garbage dumps or the trees are cut down and the land filled in for housing or other development. Human impacts on one ecosystem, e.g. discharge of toxic wastes, will largely affect all other costal ecosystems.

Types of Mangroves

There are four species of mangroves in Belize namely :

Red Mangroves - (Rhizophora mangle) are easily distinguished by their sprawling prop roots that resemble stilts which makes them look like they are walking on water. Their most interesting feature is their cigar-shaped propagules which are not seeds but germinated plants. These torpedo-shaped seeds also drop into the water and float with the current to a suitable location to take root.

Black Mangroves - (Avicennia germinans) can be easily identified by its numerous breathing tubes, which stick up from the surrounding soil. These tubes allow the tree to take in oxygen from the salty water. The white flowers that appear year-round are rich in nectar, which often attract bees. The black mangrove forms seeds, called "propagules," that are shaped like lima beans and begin to grow while they are still attached to the parent tree. Eventually, they drop into the water and, after floating to shore, take root to make more black mangroves.

White Mangroves - (laguncularia racemosa) have roots that are not distinctive. The white mangrove usually appears farther inland and on higher ground than the other two species of mangrove. Because of where the white mangroves live, they are not as affected by the coastal waves and tides. However, they also need a way to excrete salt. They depend on bumps at the base of the leaves to help remove salt from their system. Their propagules are also very small.

Buttonwood - (Conocarpus erectus) is a tree associated with mangrove forests and has a very distinctive silvery-grayish color. They are found mainly along the boundaries of wetlands or swamps.

What's in a Mangrove Forest?

Invertebrates

Snails

A species of periwinkle is common in Belize mangrove forests. It migrates between mean high water level and the tops of red-mangrove trees. It feeds on fungi found in a very narrow zone just above the mean high water level (Kohlmeyer & Kohlmeyer 1987). Brown, semicircular scars on leaf surfaces are evidence of the damage caused by these snails.

Crabs

The mangrove tree crab is found throughout the neotropics. It moves up and down the bole and aerial roots of red mangrove. This omnivorous crab feeds on red mangrove leaves and propagules in the canopy, on algae and detritus in the intertidal zone, and on insect larvae. Its feeding damage in the canopy is recognized by the presence of distinctive, rough-edged cuts and scrapings on the upper surface of leaves. The red-clawed mangrove tree crab also climbs trees and moves about under the prop roots. It has been observed feeding on mangrove propagules, leaf litter, insects, and organic material it drags from the water. The hairy land crab is the largest land crab on Belize's mangrove islands. This species frequently occurs in large colonies under dense mangrove cover, builds extensive burrows near the upper limits of the high tide, and scavenges mangrove leaf litter. In areas where these crabs are abundant, they clean the forest floor of leaf litter and propagules. The Soldier Crab, a terrestrial hermit crab, is frequently found in mangrove areas with slightly higher tidal elevation, as well as on sand cays and in the coastal scrub adjacent to the mangrove community. The mangrove forest floor and open mud flats also teem with several species of fiddler crabs, which build burrows in the peat. The male of each of these species has a distinctive enlarged fiddler claw.

What's in a Mangrove Forest?

Vertebrates

The diversity of vertebrates associated with mangrove islands in Caribbean is low, and there are no endemic species. Most vertebrates found on offshore islands and cays occur in greater numbers on adjacent mainland mangrove forests. This situation is strikingly different from Australian mangrove communities, where there are many endemic species, especially birds.

Birds:

In Belize, the most common land birds residing on offshore mangrove cays are the Mangrove Warbler and the Yucatan Vireo. Both species are insectivorous. The Mangrove Warbler typically feeds by gleaning insects from leaves in the outer canopy, and the Yucatan Vireo feeds in the mid-canopy. The Mangrove Cuckoo, Greattailed Grackle, Osprey, White-crowned Pigeon, Yucatan Woodpecker, and Green-breasted Mango also reside in these swamps.

Belize's mangrove forests also provide nesting sites for several species of resident aquatic birds, including the Clapper Rail, Magnificent Frigatebird, Brown Booby, Great Blue Heron, Yellow-crowned Night Heron, Tricolored Heron, Little Blue Heron, and Brown Pelican. Although the Clapper Rail is more often heard than seen, one can occasionally catch a glimpse of it walking in the intertidal region under red mangrove prop roots and feeding on crabs. Frigatebirds, boobies, and pelicans typically nest in large colonies in the mangrove canopy, but feed offshore. Great Blue Herons and other wading birds can be found nesting in the canopies of large black mangrove trees and feeding in adjacent shallow ponds and dwarf red mangrove stands. Green-backed Herons frequently build their nests low in the branches of red mangrove fringe along protected channels. Besides supporting these resident species, Belize's mangrove forests on the cays and along the coast also provide important stopovers for neotropical and nearctic migratory land and wading birds, such as the Northern Water Thrush, Ruddy Turnstone, Black-bellied Plover, Sanderling, Least Sandpiper, and Spotted Sandpiper. The aquatic species spend their summers in North America and overwinter in the South American tropics.

Rookeries in mangrove forests can affect both biotic and abiotic components of this ecosystem. Increased availability of nutrients from bird guano results in higher mangrove productivity and growth rates, in comparison with areas that are not rookeries.

Reptiles

Only a few reptile species are known from Belize's mangrove cays (Campbell 1998; Platt *et al.* 1999). One small lizard, *Anolis sagrei,* is virtually ubiquitous in these mangrove swamps. It is commonly seen on tree trunks and limbs, where it feeds on ants, termites, and other insects. This species lays its eggs in tree holes. Although more cryptic in their behavior, the boa constrictor, ground iguana or "Wish Willie" and two gecko species are also commonly encountered on the cays.

The islands at Turneffe, particularly in the northern cays, are also home to a large population of the American crocodile (Platt *et al.* 1999). Although crocodiles are extremely shy and difficult to observe, their trails or "slides" are commonly seen among the mangrove roots along narrow creeks.

Lesson 25

SVC DEV TRA

BARRIER TO EROSION

Grade(s): 4-6
Subject(s): science

Objectives:
Explain how barrier reefs protect shorelines from waves and storms.

Materials

- Large, shallow tray (baking pan, plastic container)
- Sand
- Rocks
- Water
- Board to make the waves
- A coral reef (any solid structure that will be just below the water level)

Procedure

1. Place the rocks and sand on one end of the tray to create the mainland area.
2. Elevate the end of the tray that has the land area.
3. Position the coral reef a distance from the land area.
4. Slowly add water until the reef is submerged and the land area is above water level.
5. Put the board in the water near the low end of the tray and push back and forth to create waves.
6. Observe what happens to the land.
7. Now remove the coral reef and repeat the wave action, observing what changes occur to the land.

Processing the results

1.Sketch the land before and after the wave action with the barrier reef in place. 2.Sketch the land before and after the wave action WITHOUT the coral reef. 3.Predict what would happen to coasts along the MBRS if large sections of the coral reef were to die.

Source: *Barrier to Erosion*, BBSR and TCOE Coral Web Site Team 1999. http://www.coexploration.org/bbsr/coral
Funded by a grant from the Goldman Foundation, Gail Swenson.

Lesson 26

PRODUCTS OF THE SEA

BIO
FIS
SVC
ALT
TRA3

Grade(s): 6+, secondary
Subjects(s) science

Objectives:
Understand the sea provides lots of services for humans.
Identify new sustainable ways to use the sea and its resources.

Materials:

- Products from the sea: pumice stone, calcium pills, aquarium filters

Procedure:

1. Bring to class various products that come from the sea, or visit a local store to investigate such products. Calcium pills (crushed oyster shells), toothpaste (carrageen seaweed), and aquarium filters (diatoms) are good examples.

2. Discuss with students how these products are harvested or produced. Are they harvested sustainably?

3. Divide students into pairs or groups of 3. Challenge students to develop imaginary new products using the sea as a source. The products must be supported with a plan that details where the raw material will be found, how it will be harvested, how the marketing will be done, and scientific facts that support the notion that the product will actually do what it is advertised to do.

4. Have the groups present their products to the class. Review the products as a class. Were they harvested in a sustainable way? Is the resource inexhaustible?

Source: *Products of the Sea,* ***Green Teacher*** Planet Earth Pages: Oceans and Seafaring, Mark Madden, Anne Springs Close Greenway, South Carolina.

Lesson 27

ECO4
SVC
FIS
DEV
TRA3

HARVESTING THE REEF

Grade(s): 4+
Subject(s): social studies, geography

Objectives:

Understand that coral reefs provide important functions for humans.
Identify human & natural actions that affect reefs and coastal resources.
Identify actions to deal with threats to reef

Materials

- A set of the cards on Resource 3 for each group of 4-5 pupils.

Procedure

• Explain to pupils that coral reefs are very important sources of fish as well as productive habitats for other creatures. The library and the Internet could be used for research.

• Pupils now imagine they are managers of a community based coral reef reserve and, in groups of 4 or 5, confront a number of problems which threaten 'their' reef – over fishing, coral collecting, sediment smothering and disease (Cards 1-4). Three possible remedies are printed on the base of each card. Problems can be tackled locally, nationally or internationally, and pupils can either develop their own responses or use the options to structure discussion.

• Once the groups have worked through Cards 1-4, introduce Card 5 – the 'joker' in the pack – which looks at the problem of coral bleaching. Class discussion ensues. Pupils will hopefully understand that although the stress on coral in recent decades (disease, predation, pollution, etc) may contribute to the widespread die back, coral bleaching – caused in part by climate change – represents a much bigger problem. Care should be taken to guide students past any sense of frustration at the exercise and what it represents – see Debrief below.

Debrief

By introducing the link between a so-called 'marine problem' and climate change, we have moved pupils on to the 'bigger picture'. Educationally, this can be a challenge. Some pupils may feel indifferent or that the 'solution' is beyond their control. Talk them through the logic of the position: urgent global problems require global attention; there are a number of avenues through to a world stage (governments and regional bodies such as the EU, major corporations sensitive to bad publicity, global NGOs, the media);and as global citizens they do have a voice and a role to play. It might also be helpful to discuss with students what policies and actions would lead, in a practical way, to a reduction of the future impact of climate change. This is all complex stuff, but if pupils understand that the fossil fuel burning activities of humankind in the past several decades may have unintentionally doomed the majority of coral reefs – regardless of how we now manage them – they have taken a step towards understanding that the state of the whole system shapes the condition of its parts. And this, in itself, is a vital educational building block.

Card 1

Overfishing

55% of all ocean fish species are coastal dwellers. These are fished for food and also for the aquarium trade, etc. Too much fishing is taking place

Option 1 Collectively decides how many of each species can be caught each year and by whom.
Option 2 Ban fishing in certain areas all together.
Option 3 Educate visitors and others not to choose tropical fish or trade in them.

Card 2

Coral collecting

Many corals are very attractive to look at and there is trade for them for tourists – sometimes illegal

Option 1 Airlines choose not to carry any baggage containing coral –revealed by x-rays.
Option 2 Educate visitors with posters, etc not to coral reef products.
Option 3 Collectively decide how much coral and what type can be sold and share proceeds.

Card 3

Sediment smothering

Sand and silt are washed from the islands and continents or rivers. Deforestation and bad agricultural practices make it much worse. Sediment covers the coral, killing it.

Option 1 Construct sediments traps and barriers in rivers.
Option 2 Persuade farmers and others not to cut forests or destroy other habitats.
Option 3 Lobby government to have stricter regulations about cutting mangroves.

Card 4

Disease

Black band disease was first seen in 1973. It is caused by a three layer complex of blue green algae, the bottom layer of which releases a deadly toxin. Many other diseases have become a serious problem since then.

Option 1 Reduce the number of nutrients in the water from sewage, agriculture, etc.
Option 2 Support research into the causes of diseases – little is known.
Option 3 Help reduce global warming which appears to have encouraged diseases to take hold.

Card 5

The Joker

Coral Bleaching

Occurs on reefs all over the world and is so called because the blue-green algae in corals to die and corals turn white. Climate change is thought to be a cause of this phenomena brought on by rising sea temperatures.

Lesson 28

BIO
SVC
FIS
DEV
ALT
TRA3

THE CORAL CONSERVATION GAME

Grade(s): 6+
Subject(s): science, geography

Objectives:
Name four ways that coral reefs benefit people.
Name four ways that people damage coral reefs and corals.
Discuss important factors in "managing" a coral reef.
Give pro and cons of exploiting commercial uses of coral reefs.

Understands the characteristics of ecosystems
Understands how human actions modify the physical environment

Materials:
- Game boards (You may duplicate the enclosed game board by copying its folded quarters and taping it together. Make enough game boards for four players per game.)
- One piece of notepaper per student, and pen or pencil.

Make copies in the following quantities:
- Game Board: one board per game (four students)
- Chance Cards: one set per game
- Option, Spinner, Token page: one per game
- Game Summary sheet: one per game
- Currency: twenty pages per game

Student Background:
Today you will play a game called The Coral Reef Game. On the game board you will use, the game is drawn on the outline of a coral that looks something like elkhorn coral—a rapidly-growing coral.

In this game, you are a fisherman who makes at least part of your living from coral. You have a problem shared by nearly all fishermen—if you take lots of coral, you make good money at first. But if you and others do this for too long, the coral will not be able to grow back fast enough. Then, there will be none, or very little, and you will have lost the source of your business.

The secret, of course, is wise use and protection of the natural resource you make a living from. And that is no easy task, as you will see from the game you are about to play.
The object of this game is to arrive at the FINISH space with the most coral. Coral grows on offshore reefs around the island and amounts of coral are measured in centimeters. Players may also gain centimeters of other types of coral, such as the valuable but delicate black coral. Players should keep a record of all the centimeters of coral they gain or lose throughout the game.
Use the tally sheet you have been given. You should also carefully control the amount of money you have. As the game starts, assume that one inch of coral is worth about $500.

Procedure:

1. Prior to class assign background reading. [E.g., *Coral Reef Coloring Book* written and illustratedby Katherine Orr, © 1988, Stemmer House Publishers, Inc.

2. This game requires copying, if the entire class is to play the game at once. If you cannot make copies, have students play the game in groups of four, during several class periods. Use your judgement as to whether to have students help you assemble Game Boards, cut Chance and Option cards, assemble spinners and tokens (glued on cardboard, for best use), and cut up currency.

3. Divide the class into groups of four. Have them move desks together to play.

4. Distribute game boards, spinners, tokens, and currency (20 sheets of money per game, $2,000 per player). Give each student an Option Card also. Keep spare currency on the side, "in the bank" for payments to players.

5. Read **Background** and remaining instructions (5-11) to students.

6. Begin at the **START** space with $2,000 and 25 centimeters of coral. Shuffle the **CHANCE** cards and place them face down near the board. Now, write down your beginning assets on a sheet of notepaper.

Organize your notepaper like this: **(Show on blackboard. . .)**

Coral	Money
Start: +25 cm	+2,000
Turn 1	. . . . .
Turn 2	. . . . .
Etc.	. . . . .

7. Two to four players may play at one time. Spin the spinner to see who moves first. The player with the highest number will move first. Play then goes around the board to the left.

8. Move around the games board by moving your token the number of spaces hown on the spinner. Change your amount of money and coral as the board and **CHANCE** cards direct.

9. Early in the game you will have to choose which path you wish to take around the board. The regular path may be followed, or you may choose the "High Finance Bypass" and take extra risks in order to finish earlier. You may not back-track after choosing one path or the other.

10. If you spin **CHANCE** or land on a **CHANCE** space, pick up the top CHANCE card and do as it instructs. Then put the card back on the bottom of the deck.
11. Each player receives on **OPTION** card as the game starts. This card gives you an opportunity to make a deal with other players, buying or selling any amount of coral for which a price can be agreed. Once you have used your option card, you must give it up.

12. You cannot go "in the red" and spend more than you have, and if you run out of money, you are no longer a competitor for coral. The same rule applies to running out of coral. You may continue to play in hopes of gaining more money or coral, but if you should be required to spend money or lose centimeters that you do not have, you are out of the game.

13. You must land exactly on the **FINISH** space to complete the game. The first player to reach **FINISH** earns an additional $1,000, but the game is not over until all players have finished or been eliminated. The winner is the person having the most coral. It is possible that there will be no winner!

14. After each group has finished their game, fill out the Game Summary Sheet together.

15. Discuss the Game Summary with the class. If you live in a coral reef area, be sure to discuss important negative and positive influences going on nearby.

Summary Sheet

1. In the chart on the following page, list human and natural factors your group encountered in the game.
2. For each factor, note below its positive or negative effect on the amount of coral (+ or - cm) and its positive or negative economic impact (+ or - dollars).
3. Discuss how the results of human factors change. Can people alter natural events as well? How and with what impacts?

Natural Factors

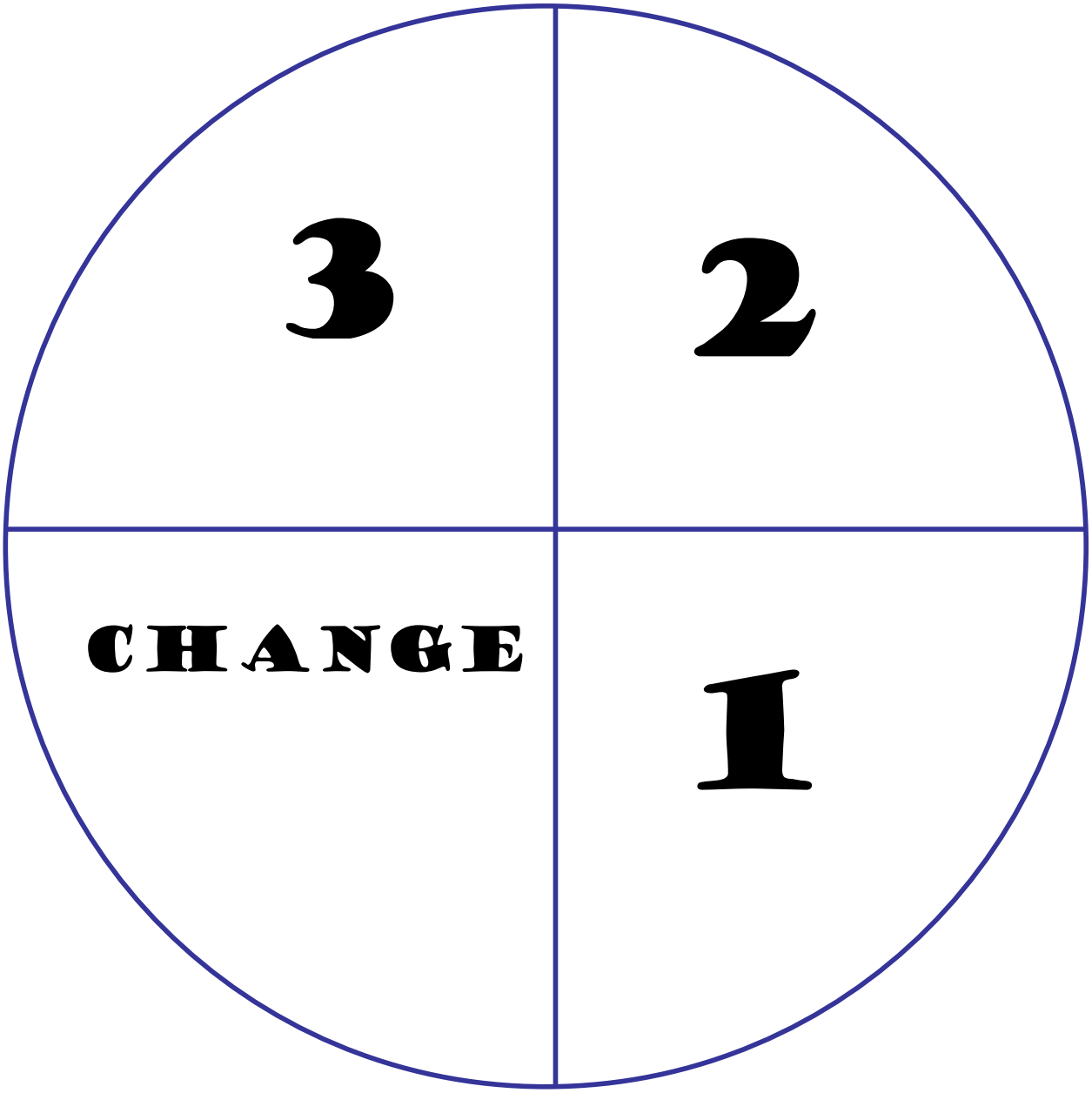
Type of Factor	**Effects on**	
	Coral	**Economics**
e.g. Hurricane	-5cm	-$800

Human Factors

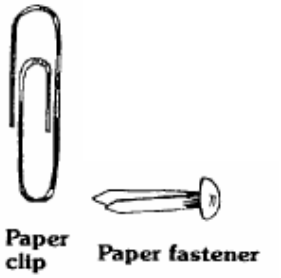
Type of Effect	**Effects on**	
	Coral	**Economics**
e.g. Island Festival	-4cm	+$350

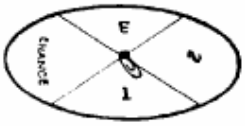
OPTION	**OPTION**
OPTION	**OPTION**

Officials decide not to dredge the harbors this year. Silting of reefs is prevented, but trade drops off. Lose $2,000 and gain 5cm of coral.	**Fertilizers from fields wash into water. Excessive algae growth threatens coral. Spend $1,000 for runoff control, or lose 8cm.**
Hurricane bypasses the islands, and expected rains do not come. Fresh water can kill coral, but this time disaster was prevented. Take another turn.	**Loss of species diversity (fewer types of animals) makes the reef more susceptible to ecological disturbances. All players lose 5 cm.**
People all over the Caribbean watch a television program about the importance of coral reefs. Surveys show increased knowledge and improved altitudes. All players gain 5cm.	**Stop to visit the underwater park. Skip one turn.**
Coral reefs break the force of waves and prevent destruction of beach property when violent storms come. Collect $3,000 for protecting the coastline.	**A harbor festival brings in new customers for coral. You may exchange up to 10cm and receive $500 per 3cm.**
Warm waters and gentle waves in the coral lagoons and encourage more tourists to visit these areas. All players earn an extra $1,000.	**Classrooms teach children about the value of the reef. Protection allows 5cm more to grow for all players.**
The price tourists will pay for good coral specimens goes up 25% may sell up to 25cm to other players if a price can be agreed upon.	**Brain corals resist damage better than branching forms. Take another turn.**
The island hosts a water festival drawing many tourists. Great damage to reefs from anchors, hull-dragging, and unlicensed collectors. All players lose 12cm.	**Parrotfish eat algae that competes with coral. You gain 3cm.**
Barracudas eat most of the queen triggerfish. Urchin population explodes and coral loses 5cm. If you choose to skip one turn, 3 cm of coral can grow back.	**Dead coral skeletons are inhabited by sea anemones that compete with live corals. Lose one turn.**
Island-hopping. Exchange places with any player you choose.	**Corals provide shelter for cleaning shrimp. Take another turn.**
Scuba divers with spearguns take many groupers from the reef. Spend $500 for protection against this.	**Toxic chemical spill is caused by the player on your left. Collect $2,000 in damages from that player.**

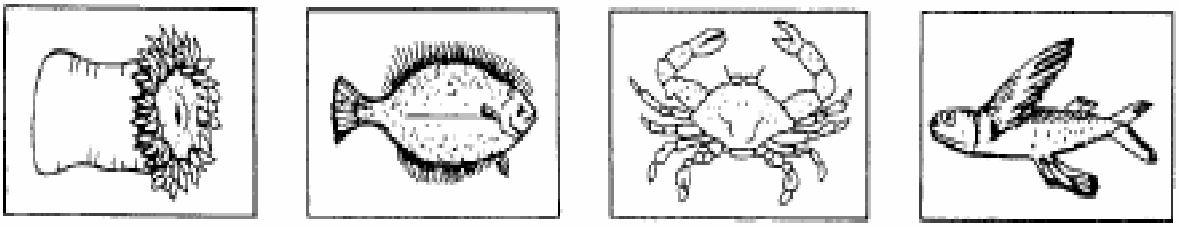


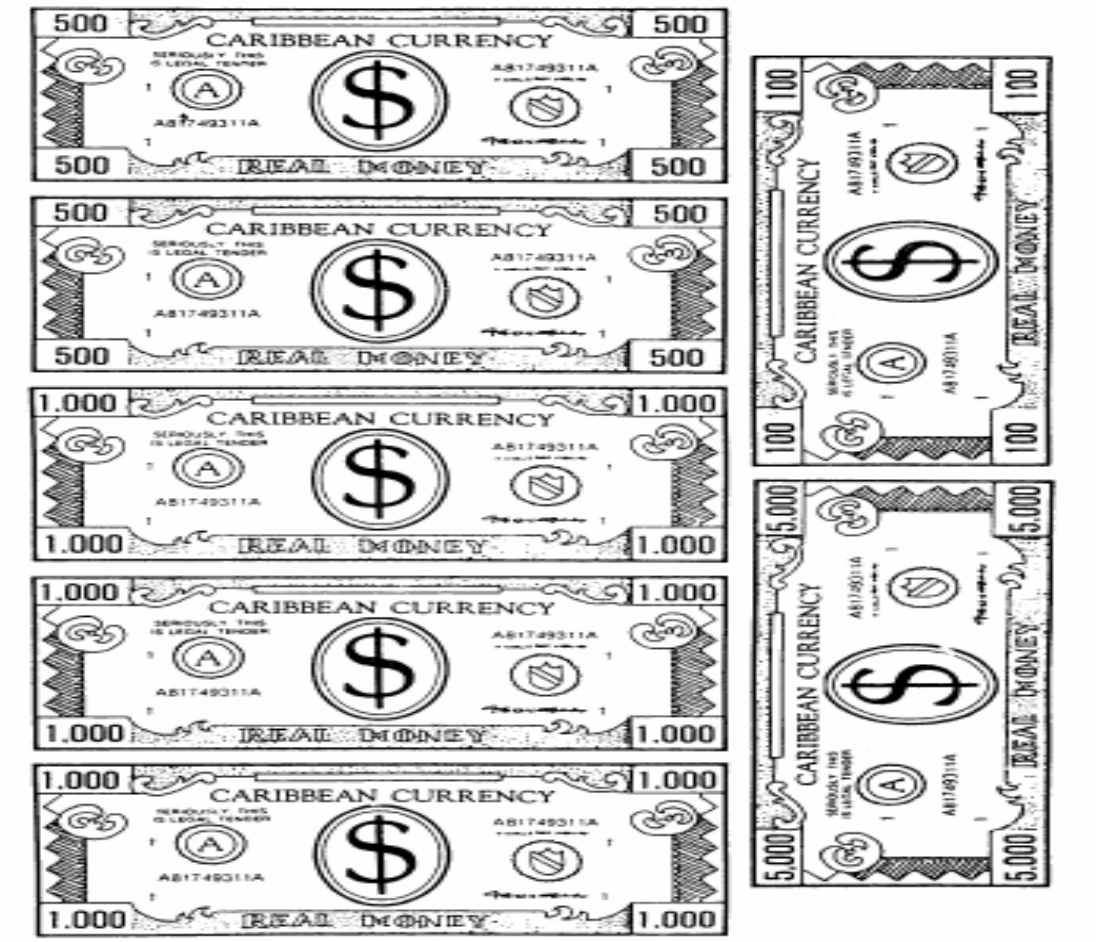
Cut out the spinner and paste it onto a piece of cardboard. Punch a hole in the center and put a paper fastener through the hole so it will hold the paper clip and allow it to spin.





Tokens (Cut out and color)




500
CARIBBEAN CURRENCY
REAL MONEY
1.000
100
5.000

Lesson 29

FISHING FOREVER?

FIS ALT TRA3

Grade(s): 6+
Subject(s): social studies, geography

Objectives:
Understand that resources, such as fishes can be depleted.
Recognize alternatives for sustainable fishing

Materials
- Copies of Resource 1 and 2 for each pupil.

Procedure
• Pupils are orientated towards marine fishing through, for example, questions about how much and what sort of fish they eat. What do pupils know about sea fishing? What are their perceptions of changes in the price of sea fish, if any, over recent times?

• Hand out copies of Resource 1 to groups of 4-5 pupils, and allow 10 minutes or so for them to make sense of the information and comment on the main trends. (The trend is for over fishing in almost all waters, and for the price of fish to rise above that of alternatives such as chicken.) Invite pupils to ask questions to clarify their understanding of one or two technical phrases such as 'bycatch' in Table 1 (fish of the 'wrong' species or size accidentally caught and then dumped as they are not worth storage or are without a ready market; also includes marine mammals, turtles, seabirds).

• Pupils now imagine they are in charge of an international body looking at making fishing sustainable – defined at this stage as 'allowing it to go on forever'. They have to recommend changes for one or more of the three groups of fishers (see Table 1), knowing that too much fishing is currently taking place overall. Making a table using the headings below may help pupils in their analysis and comparison work:
Which group wastes the least fish?
Which group uses fish as part of staying alive (subsistence)?
Which group supports most people in a job?
Which group uses most fuel per unit of fish caught?

Debrief
Sustainability, we are sometimes told, gives equal priority to human needs, maintaining the viability of the above hint at the social equity side of sustainability. Hopefully the sense of preserving fish stocks is self-evident. It seems that as soon as sustainability becomes the framework for the discussion rather than 'What would you do about over fishing – if anything?', then certain things follow – at least in theory. Perhaps as teachers we need to be up-front about these criteria so that pupils receive feedback on how far they have recognized social, environmental and economic apsects, or whether their analysis is more limited – for example, 'Everyone has to catch 10% less' or more sophisticated – 'The needs of small scale fishers are important as they are fishing to stay alive, but they do use lots of fuel which causes other environmental problems', and so on. Does this conflict with teaching approaches which say axiomatically 'Pupils should make up their own minds, based on the evidence'?
Some teachers have said that assuming a global 'free market' is also assuming a context and criteria,yet we rarely even bother to explain this when asking pupils to weigh up evidence. What do you think?

Extract 1

There are two types of consumers for fish. The ones linked to local, small scale fishers is made up of people with low incomes or in traditional cultures for whom fish is an important part of the diet. The ones linked to the commercial markets and the medium and large scale fishers are largely in the industrial world, and they eat fish as a luxury item or supplement to an already balanced diet. Reduction in fish consumption here would not affect nutrition.

Extract 2

Fish caught for fish meal is used for animal feed. If the portion of the world catch that now goes for animal feed were offered for human consumption, the world food fish supply would go up by 40% – preserving today's average supply of 13kg per person per year until 2017 without increasing overall catch – and if this fish only went to rich nations it would preserve average consumption until 2030.

Table 1 Comparing fishers by scale of operation

Comparison	Large scale	Medium scale	Small scale
Number of fishers employed	200,000-300,000	900,000-1 million	14-20 million
Earnings per fisher ($ per year)	15,000	8,000	500-1,500
Marine fish caught for human consumption (million tons per year)	15-20	15-20	20-30
Marine fish caught for fish meal, fish oil and so on (million tons per year)	10-20	10-20	almost none
Bycatch (million tons per year)	5-10	5-10	almost none
Fishers employed per $1 million investment	1-5	5-15	60-2,000
Fuel consumption (million tons per year)	7.6	12.8	26.3
Fish per ton of fuel (tons of fish)	2.6-3.9	1.6-2.3	0.8-1.1*

Source: Worldwatch Institute based on FAO and other sources. *Several million small-scale fishers use motorized boats.

Figure 1

World fish catch, 1950–1993

Figure 2

Comparison export prices, 1975–1991

Lesson 30

FISHING FOR THE FUTURE

SVC
FIS
ALT
TRA3

Grade(s): 4+
Subject(s): social studies, biology, geography

Objectives

Consider social, environmental, and economic impacts of overfishing.
Identify sustainable fishing practices.
Understand that fishing does not always remain within boundaries

Overview

Through a fishing simulation, students model several consecutive seasons of a fishery and explore how technology, population growth, and sustainable practices impact fish catch and fisheries management.

Materials

- Plain M&Ms, one 14-ounce bag for up to 30 students or beans
- Peanut M&Ms, one 14-ounce bag for up to 30 students or beans
- Small cups, 1 per student
- Serving bowls, medium size, 1 per group
- Spoons, 1 per group
- Straws, 1 per student
- Watch, for timing activity
- Handout *Fishing Log*, 1 per student
- Handout *Fishery Facts*, 1 per student

Preparation

1. Students will simulate fishery activity in different oceans. As the students progress through the fishing seasons, they will likely overfish their oceans and will have to migrate to other oceans to meet their basic needs. Most groups will eventually create a total crash of fish stocks in all the oceans.

2. Check for peanut allergies in your class. You can do the activity using only plain M&Ms, if necessary.

3. For a class of 20, you will have five or six groups of 3–4 students each. Each group will start with 20 plain and 10 peanut M&Ms. Count out the first round of M&Ms and place them in cups or bags. As a pre- or post-activity reference, have students read the handout *Fishery Facts*.

Introduction Discussion

1. Introduce and discuss the concept of sustainability using the following definition: "Sustainability is meeting the needs of the present without limiting the ability of people, other species, and future generations to survive." Ask why sustainability might be an important goal for a society and what might be difficult about realizing this goal.

2. Tell students that today they're going to go fishing and explore some of these sustainability concepts

Procedure

1.Explain the game rules:

Each student will be a "fisher" whose livelihood depends on catching fish.
Peanut M&Ms represent the largest and most valuable fish (tuna, swordfish, et cetera).
Plain M&Ms represent the next most-valuable fish (cod, salmon, et cetera).
Each fisher must catch at least two fish (large or small) in each round to survive (i.e., get enough fish to either eat or sell).
When the fishing begins, students must hold their hands behind their backs and use the "fishing rod" (straw) to suck "fish" (M&Ms) from the "ocean" (bowl) and deposit them into their "boat" (cup).

The fish remaining in the ocean after each fishing season represent the breeding population, and thus one new fish will be added for every fish left in the ocean (bowl).

5. Divide the class into groups of 3 or 4 students and have each group choose an ocean name such as North Atlantic, North Pacific, Arctic, Mediterranean, et cetera.

6. Give each group one serving bowl and each student one cup, one straw, and one copy of the handout *Fishing Log*.

7. Put 20 plain and 10 peanut M&Ms in each group's bowl.

8. Start fishing" and give the students 20 seconds for the first "season" of fishing.

9. Have each fisher count his or her catch (M&Ms in their cup) and record the data in their *Fishing Log*.

10. Fishers who did not catch the two-fish minimum must sit out for the following round.

11. Add one new fish for every fish left in the ocean (bowl).

12. Allow fishers to use their hands on the straws during the second session to represent "new technology."

13. After the second fishing season, give one fisher from each group a spoon representing more new fishing technology such as trawl nets, sonar equipment, et cetera. Continue the game for round three.

14. Ask, "What happened when ocean group [name] ran out of fish? How are the fishers going to survive now?" (One option is to move to another ocean.) Allow students to "invade" other ocean groups when their ocean is depleted, but don't tell them that they can do this beforehand. Fishers may either go as a group to another ocean or they may disperse to other oceans.

15. Repeat fishing, recording, and replenishing fish stocks until either sustainable fishing is achieved or until all (or most) groups fish out their ocean.

Inquiry/Critical Thinking Questions

- What happens when a commonly owned resource is overused?
- What are the impacts of overfishing or exploiting a natural resource?
- How can we establish and maintain the sustainable use of a resource?

Reflection

Use the following sample questions to lead a discussion about the activity:

- "How did you feel when you realized that you had depleted your fish stock?"
- "How did you feel when other fishers joined your ocean group?"
- "How does this activity relate to real ocean and fishery issues?"
- "What's missing in this game?" (Impacts to nonhuman animals that rely on fish for their survival, population growth, et cetera.)
- "What happens to a resource when you have infinite population growth, growing technology, and a finite resource?"
- "Are there any commonly owned resources in our region or community? If so, what are some similar issues around them, and how can they best be managed?" (Air is a commonly used resource—how do we deal with air pollution? Forestry or animal grazing rights also sometimes create similar discussions. You might also talk about city, national parks, and other public lands, and the competing uses and needs.)

4. Have students brainstorm ways to have a sustainable fishery. What rules could be developed? (For example, limits on type of equipment allowed, amount and type of fish, shorter seasons.)

Class Projects/Action Ideas

• Students can research which fish are harvested in a sustainable manner and which are being depleted. Have them do an advertising campaign in their school promoting the consumption of sustainable fish and avoiding the consumption of threatened fish. (This might include researching the kind of fish served in your school cafeteria, developing a system that protects threatened fish, and presenting it to the principal.) For recommendations about which seafood to buy or avoid, check out the Monterey Bay Aquarium's website "Seafood Watch" at www.montereybayaquarium.org or the Audubon website "What's a Fish Lover to Eat?" at http://magazine.audubon.org/seafood/guide/.

Have students research a local fishery and include interviews with local fishers, biologists, and other people involved with the fishery.

• Have students investigate fish farming and its environmental and economic impacts.

• Have students research laws relating to economic use of public lands by private companies and individuals. Determine whether these laws balance environmental protection and economic development. If not, outline new laws to create such a balance.

• Visit the United Nations Food and Agriculture Organization Fisheries Resource website at www.fao.org/fi. For information and pictures about the state of the world's

fisheries, see the New International Magazine on-line issue on fishing at www.newint.org/issue325/facts.htm.

- Do a watershed planning/protection project to help protect fisheries from environmental damage.
- Participate in a beach or river cleanup project.

Variations

1. Use two types of dried beans instead of M&Ms. Be sure that the beans are large enough so that the students cannot suck them through the straws.

FISHING LOG

OCEAN

GROUP:_____FISHER:_____

Record your group's catch and fish left in ocean after each season:

SEASON	CATCH			FISH LEFT IN OCEAN
	High-Value Fish	Medium-Value Fish	Total Catch	
1				
2				

Write a brief description of the status/health of your fishery

_____

_____

SEASON	CATCH			FISH LEFT IN OCEAN
	High-Value Fish	Medium-Value Fish	Total Catch	
3				
4				

Discuss changes in fishing practices or regulations. Are any fisheries in trouble? What did they do and how did that impact your fishery?

_____

_____

_____

SEASON	CATCH			FISH LEFT IN OCEAN
	High-Value Fish	Medium-Value Fish	Total Catch	
3				
4				

Write a brief description of the status or health of your fishery now:_____

_____

How could you have made your fishing sustainable

_____

_____

FISHING FOR THE FUTURE—FISHING LOG

FISHING FOR THE FUTURE—FISHERY FACTS

The world's fisheries are under more pressure than ever before. From 1950 to 1990, there was a fivefold increase in the world annual fish catch. The average yearly per-person fish consumption in the industrialized world (59 pounds) is three times that of people in the developing world (20 pounds). Fish demand remains high: An additional 15.5 million tons of fish will be required by 2010 just to maintain current rates of fish consumption. Today, 70 percent of the planet's marine stocks are fully exploited or overexploited.

The number of people fishing and practicing aquaculture worldwide has doubled since 1970. More than 21 million people are full-time fishers, and 200 million depend on fishing for their livelihood. Asia contains the vast majority of the world's fishers. In the early 1950s, developed countries took 80 percent of the world's fish catch. Today, they take only 36 percent of the catch, while developing countries take 64 percent.

The technology used to catch fish and the number of fish caught per fisher varies enormously. Modern fleets are the most environmentally destructive, as they use enhancements such as airplanes, radios, seafloor maps, and video sonar to track down fish schools. Once they have found the fish, these fleets use large nets to drag up not only the targeted fish but also coral, the seafloor, and around 27 million tons annually of "by-catch"—nonmarketable fish that are killed and thrown overboard.

To compensate for reduced wild fish stocks, more and more fish are being farmed. Nearly a third of all fish for food is harvested from aquaculture. For every 11 pounds of beef grown globally, there are now 4.5 pounds of farm-raised fish produced. Fish farming causes environmental destruction comparable to the replacement of rain forest with cattle ranches. About 11 pounds of wild ocean fish need to be caught to feed each pound of farmed species. Thailand, which has one of the biggest aquaculture industries, has lost half its mangrove forests due to shrimp farming. Densely stocked salmon farms in British Colombia, Canada, produce waste (including fertilizer, effluent, and fishmeal) equivalent to that generated by half a million people.

Despite these numbers, there is still hope for the world's fisheries. Fisheries can be restored through the adoption of sustainable fishing practices. With the proper incentives, fishers can be encouraged and rewarded in their effort to sustainably manage marine resources. For example, partnerships between local communities and scientists in the central islands of the Philippines resulted in the establishment of marine reserves to help manage overexploited fisheries. The establishment of no-fishing zones in the reserves has increased catches in adjacent fishing grounds. Another solution is to use the power of the market to encourage sustainable fishing practices. The Marine Stewardship Council together with the World Wildlife Federation and Unilever, one of the largest makers of fish products, has developed a certification process that includes a label telling consumers that fish products came from fisheries certified as sustainable.

References: *The New Internationalist* magazine issue 325, www.newint.org; The United Nations Food and Agriculture Organization, www.fao.org; Environmental News Service, February 2002, www.enn.co

Lesson 31

SVC
FIS
DEV
TRA3

DEPLETION OF MARINE RESOURCES

Grade(s): 2-6, secondary
Subject(s): geography

Description

Through the following activity, students will hypothesize that as the next generation comes along, there will be fewer resources available to them and eventually, there could be nothing at all. In addition the number of people using a resource and the amount each person uses are critical in determining the rate at which resources, both renewable and non renewable, get used up.

Objectives

Understand that some resources like fishes can be depleted
Understand that the resources of the Mesoamerican Barrier Reef System have no boundaries and are shared among the various countries

Materials

- A large jar or other container filled with ready-to-eat popcorn
- Fourteen index cards labeled as follows; two cards that say *First Generation*, 4 cards that say *Second Generation*, and 8 cards that say *Third Generation*.
- A box or hat to hold the index cards
- Fifteen paper lunch bags for students
- A supply of extra popcorn (out of sight of the class) for those students who do not participate directly in the simulation

Procedure

1. Ask fourteen students to each draw one index card from the container.
2. Ask the students not to tell the others what the index card says.
3. Give these students each a lunch bag.
4. Explain to the class that the popcorn in the jar represents a fish population, the Nassau grouper.
5. Ask the two students with the 1st generation index cards to come up to the big jar of popcorn. Tell them they can put as much of the popcorn as they want into their paper lunch bags while the rest of the class watches.
6. When the two 1st generation students have filled their bags, ask the 2nd generation students to come up and put as much of the remaining popcorn as they want into their lunch bags.
7. When they have finished, have the 3rd generation students come up and put whatever is left into their lunch bags.

After the 3rd generation takes their turn, begin the class discussion

Teacher Tip

Students will probably eat as much of the popcorn as they can without any thought as to who will come after them. By the time the 3rd generation students are finished, there

should be little or no popcorn left. Some of the generation coming next people will therefore have little or none at all. Do not discuss what is happening to the popcorn until all the generations have gotten their popcorn. Some students will begin to realize what is happening. Some students in the 2nd generation may think of the 3rd generation and not take as much. The teacher should just watch and listen without making any comments.

Discussion Points

1. Discuss with the class what is happening to the world popcorn supply.
2. Hold up the empty fifteenth paper lunch bag and ask if anything was left for Generation Next.
3. Review the definitions of renewable resource, and non renewable resource.
4. Relate these definitions to the popcorn simulation.
5. Now tell the students that the popcorn represents the supply of fishes. The students work in groups of 4 and discuss the importance of individual responsibility in conserving resources and ways to involve others in conservation efforts.

   The students should use these discussion points and write their answers in the form of a report. The report should include the following points.

   - What happened to the total amount of the resources?
   - How much was left for each successive generation?
   - Did any of the students who were part of this simulation think about those who might be eating after them, or were they only trying to get as much popcorn as they could?
   - What parallels do the students see between what happened in class and what occurs in the outside world?
   - What are the critical factors in determining the rate at which resources, both renewable and non renewable get used up, including: the number of people using the resource and the amount each person uses.
   - What is the individual responsibility for resource conservation?
   - What steps could individuals take to advocate change in people treatment of natural resources such as fishes?
   - If a resource is renewable, does that mean it will continue to exist no matter what people do?

Assessment

Each student will turn in their own report after they have gone over the discussion points. Each group of 4 will create a slogan that advocates personal responsibility for resource conservation

Adapted from *Depletion of Natural Resources Simulation* Franklin Institute Science Museum/ Online Museum

Lesson 32

SVC DEV

A MARINE SHORT STORY

Grade(s): 2-4
Subject(s): Science, Geography

Objective(s):
Understands relationships among organisms and their physical environment
Understands the characteristics of ecosystems
Understands how human actions modify the physical environment
Understand how human actions harms the on coral reefs.

Materials: Copies of story

Procedure:
1. Ask a student to read the following story aloud.

CORAL REEF

Near a very beautiful island, surrounded by an immense sea, is a precious place. It is a place where multicolor fishes, lobsters of different sizes and many little animals live. Everyone likes to go there to visit. Do you know what the name of the place is? Coral reef.

One day, a boy went fishing with his father in a small boat. To get hold of a lobster, they stepped all over the corals, breaking and destroying the delicate structures. The little corals began to cry, "Why do you all hurt us so much? Don't kill us! We help all the inhabitants of this island."

The little boy and his father were scared when they heard hear those words. With amazement, they asked, "Who hurt you?"

The little corals answered back, "People—grasping us, when they throw boat anchors overboard they hurt us, the divers step on us. Also, when it rains very hard, all the sediments that people drain run into the sea and make it hard for us to breathe. Every day many of our brothers die."

The boy and his father were very saddened. From that day on they promised to take good care of the corals in the reef and to tell other people what had happened to them so that others also would not destroy the reef.

2. Discuss the content of the story, reviewing the different ways in which corals are harmed.
3. Ask each student to write his/her own short story, or they can write collectively in a small group, about a coral reef and how we can protect it.
4. Comment on the students' stories.
5.Ask them to illustrate the above story.

Source: Dr. Sharon H. Walker,R. Amanda Newton, Dr. Alida Ortiz, Coral Reefs: An English/Spanish Compilation of Activities for Middle School Students, 2001, J.L. Scott Marine Education Center & Aquarium

Lesson 33

SVC
DEV
FIS
ALT
MPA
TRA3

DESIGN TASKS FOR A CORAL REEF MARINE RESERVE

Grade(s): 4-6
Subject(s): social studies, geography

Objectives

Understand how human actions modify the physical environment
Explain how human actions affect coral reefs
Identify actions that can be taken to help coral reef environments

Procedure

1. Explain to the class that a coral reef can be legally protected by setting up a coral reef marine reserve. Specific rules and regulations will then govern the use of the reef and the waters surrounding it. Some countries such as New Zealand have enacted strict limitations to safeguard their marine reserves (e.g., **no** killing or removal of marine life, **no** construction or dumping nearby). Such tight controls have not yet been imposed in reserves in the U.S.A. or many other parts of the world where reefs are endangered.

2. Tell the students to...
Imagine that the Department of Conservation decides to establish a coral reef marine reserve in your area. You accept the contract from the Department of Conservation or from regional authorities for the following design tasks:

*(Each class member chooses **one** of the following:)*
- a brochure or pamphlet advertising the coral reef marine reserve for local use
- a notice-board display that describes reef etiquette for visitors (e.g., snorkelers, divers)
- a brochure, describing the marine reserve, for oversea tourists
- a poster about the marine reserve for distribution in grade schools or high schools

3. The class as a whole may share ideas on what rules and practices will be enforced in the new reserve.

4. Post the accompanying examples in the classroom to assist students in coming up with ideas for their projects. Suggest that students use their *imagination* if they do not have facts.

5. Provide large sheets of newsprint, typing and ruled notebook paper, poster board, pens, markers and poster paint for the design tasks. Encourge the students to make their designs "user friendly," presenting important information, perhaps reducing the emphasis on what is not allowed and suggesting *positive* things to do in the marine reserve. Tell them to do their best to create designs with ***impact***.

Display the best efforts around the school, in local shops, or send them to the local newspaper for publication.

Because you are a diver, you're already more aware of and more alarmed by changes in our environment than most.

Living coral reefs attract millions of snorklers and scuba divers each year. By the year 2000 there will be 10 million new divers in North America alone.

The dive operators who gave you [this bulletin] share an increasing awareness and growing concern for the protection and wise management of the coral reef ecosystem.

There is no question about divers causing damage. More than one million U.S. divers impact coral reefs 36 million times each year. Our coral reefs are being used up faster than they can replenish themselves.

Many divers still believe corals are an inexhaustible resource composed of an inanimate, indestructible rock.

A study by the University of South Florida has confirmed that divers can pose a serious threat to our coral reefs. The average scuba diver knocks, bumps into, pushes over, or kicks living corals an average of seven times for every 30 minutes under water. Snorklers have at least one negative contact with the corals for every 30 minutes in the water.

Every diver, novice and expert alike, is a vital link in nature's complex eco-system.

Each of us can help protect the world's coral reefs. The problems are critical ... but not hopeless. YOU CAN MAKE A DIFFERENCE!

Source: Adapted from "**Piggy Divers Wreck Our Reefs**" produced by Dr. Joe Strykowski. The Star Thrower Foundation, P.O. Box 2200, Crystal Crystal River, Florida 34423 Tel: (352) 563-0022, Fax: (352)563-2064. Used with permission.

National Marine Sanctuary Program

Florida Keys

NOAA

REEF ETIQUETTE

Your visit to the Florida Keys National Marine Sanctuary will delight you with beautiful coral formations and a variety of reef organisms in a tropical reef setting.

Please follow the guidelines and regulations below while in the Sanctuary:

Just touching coral may cause damage to this fragile animal, therefore, do not allow your hands, knees, fins, gauges or tank to contact the coral.

Marc Gill

When anchoring, the anchor, anchor chain or line should not be in contact with coral. Use mooring buoys that are provided. If one is not available, ask to tie off to another stern. If neither option is available carefully anchor in sand.

Corals, shells, sea biscuits and other animals, living or dead, cannot be removed from the Key Largo or Looe Key National Marine Sanctuaries.

The red and white divers down flag must be flown while SCUBA diving or snorkeling. Boats must slow to no-wake speed within 100 yards of a dive flag. Divers should stay within 100 yards of their dive flag.

Spearfishing, possession of spearfishing equipment or of speared fish is not allowed within the boundaries of the Key Largo National Marine Sanctuary. Within the Looe Key National Marine Sanctuary, spearfishing is not allowed, however, equipment may be stowed and not readily available onboard. Call the Florida Marine Patrol concerning other closed areas.

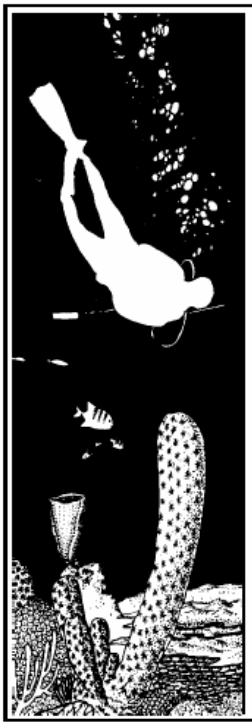
Florida law requires a fishing license. Special stamps are required for lobster, snook and tarpon. Applicable size, bag limits and seasons must be observed when harvesting seafood products. Consult State and Federal authorities for current regulations.

Marc Gill

Source: "**Reef Etiquette/Safe Boating Tips**." Florida Keys National Marine Sanctuary, Upper Keys Region, P.O. Box 1083, Key Largo, Florida 33037. Used with permission.

Source: (Figure at left) © Reef Relief, P.O. Box 430, Key West, Florida 33041 Tel: (305)294-3100 Fax: (305)293-9515 All rights reserved, reprinted with permission.

Source: (Figure below) Lynne Hinkey-Mac-Donald, "*You can help protect our coral*," **Coast Notes**: Fact sheet #28, A Virgin Islands Marine Advisory Services Publication, University of the Virgin Islands. University of Puerto Rico Sea Grant College Program. Used with permission.



You can help protect our corals

1. Never stand on or touch the coral reef.
Coral is **not** a rock. Each coral colony is made up of tiny living animals called **polyps**, which are closely related to sea anemones. Touching, holding, standing on or kicking coral can crush and kill these animals. The coral polyps are connected and completely interdependent. **When you harm one, you hurt the entire colony.** It may take years for a coral to fully recover from an injury, and corals grow very slowly. Even small breakages can cause long-term or even irreparable damage. If you must stand while swimming, snorkeling or diving, please stand only on sandy-bottomed areas.

2. Don't feed the fish.
Bread, cooked vegetables, cheese and other human foods are indigestible for fish. They may fill up on these foods, but they can't assimilate the nutrients so may easily become weakened or sick. In addition, these foods disturb the natural balance of ocean life and may contribute to harmful algae growth and the decline of other species.

3. Swim without stirring up the sand.
Stirred up sand can cover corals, sponges and other animals and plants. This is called **siltation**, and it **can injure or even kill these organisms**. Besides, sand suspended in the water column interferes with our view of fish and other marine life. Keep track of where you kick your feet and flippers. Make sure they don't touch the coral or stir up the sand.

4. Pick up any trash you find in the water and place it in a garbage can.
If no garbage cans are available, take trash home and dispose of it properly. Plastic bags and other litter in the water may be mistaken for food by turtles, sea birds and other organisms. If eaten, marine debris can suffocate and starve animals. Or it may entangle or otherwise fatally injure them.

5. Use only waterproof sunscreen.
Some sunscreens wash off in the water and become a pollutant. At high-use beaches, washed off sunscreen can pose a real problem for marine plants and animals. Use only waterproof sunscreen or wear a t-shirt when you swim.

6. Use the restrooms.
Urine adds unwanted nutrients to the water. These nutrients encourage algae growth, which can limit the amount of sunlight that reaches the reef. Corals depend on sunlight for energy. With insufficient light, reefs will die.

7. Take only photos. Leave only footprints.
The health of our marine ecosystems depends upon a delicate balance of many natural processes. Removing organisms from the waters or beaches, or adding any new substances (trash, food, pollutants) can seriously disturb the balance Nature has created. To ensure the beauty and health of the Virgin Islands' environment for future visits and for future generations, please take only photos and leave only footprints.

8. Share this information with a friend.
Teach others to care for the Virgin Islands' reefs and beaches for the enjoyment of all.

Lesson 34

FIS DEV ALT

"GRIEF ON THE REEF": A SOAP OPERA

Grade(s): 3-6
Subject(s): geography

Objectives

Understands the characteristics of ecosystems
Understands how human actions modify the physical environment
Understands how physical systems affect human systems
Understands the changes that occur in the meaning, use, distribution and importance of resources
Understands global development and environmental issues

People trying to reach decisions about coral reef management and conservation can be much like a daytime soap. There are friends and there are enemies, there are triumphs and there are tragedies, there is confidence and there is uncertainty. In order to better understand the complexity of the issues and stakes, students become representatives of various public and private interest groups in a fictitious episode of "Grief on the Reef."

Procedure

DAY ONE: Write the following roles on slips of paper. You may wish to omit some of the roles.

government authority
commercial fisherman
recreational scuba diver
scientist
recreational angler
tourist resort developer
conservationist artist who draws inspiration from nature
underwater photographer
owner of a coastal industry that pollutes
coastal native manager of a souvenir shop
collector of tropical fish for pet shops

1. Explain to students that they will be writing and presenting a soap opera drama about a public hearing on how nearby coral reefs will be managed. The production will be called "Grief on the Reef." Have students draw from a hat to discover their part in the soap opera drama. Then help the students understand the concerns and perspectives of the various characters.

2. Raise questions about policies to protect reefs that might be proposed at the hearing. What would be the consequences to all the parties involved? For example, should coastal industry and development be restricted if these pollute or muddy the seawater? If so, how would restrictions affect the local economy? How much fishing and collecting should be allowed? Will the tourist trade suffer if coral trinkets and shell souvenirs cannot be sold? Would it be wise to make the reef a marine sanctuary that can be visited by divers, or to completely restrict access except to scientists? You may wish to furnish some background information for student research. Discuss what reef management proposals might be offered at the public hearing by the different members of the cast.

DAY TWO: Lead the class in deciding on a story line for "Grief on the Reef." Once a coherent plot has been agreed upon, appoint a group of students to collaborate on writing a script that includes parts for all characters. Place another group of students in charge of scenery and props.

DAY THREE: The writing of the script should be completed. After the teacher has edited the script, copies should be made and sent home with students so they can learn their parts.

DAY FOUR: Rehearse the play several times. Scenery and props should be ready for the final performance.

DAY FIVE: Perform "Grief on the Reef" before another class of students or an audience of parents. If possible, videotape the production, occasionally zooming in on the faces of the characters to create a sense of melodrama. Allow students to replay and critique their soap opera. How do they expect a real public meeting would differ from their theatrical version?

Lesson 35

ORG3
ECO2
DEV
TRA2

FISHY TALES

Grade(s): 1-4
Subject(s): science

Summary:
Fred the Fish encounters numerous pollutants on his trip from the reef. Students engage in Fred's story as they add pollutants and observe their effects on a sponge replica of a fish.

Objectives:
Understand the effects of water on plants, animals, and people.
Describe some destructive effects of organisms in water.
Accept responsibility for ecological problems.

Materials:

- Wide-mouth quart jar
- Cold water
- Fred the Fish script page (cut into strips)
- Yarn needle
- Small weight
- String
- Scissors
- Fish cut from sponge
- Baby food jars/paper cups

Put the following materials, each, in a paper cup or baby food jar. Number each cup or jar.

- 1 tbsp. of soil.
- 1 tbsp. brown sugar ("fertilizer")
- 1 tbsp. pancake syrup ("oil")
- 10-20 punched paper dots ("litter")
- 1/4 cup warm, soapy water
- 2 drops red food coloring ("sewage")
- 4 drops green food coloring ("toxic water").

Background For Teachers:
All living things need water. Students have experimental background with fish and most recognize that fish cannot live without water. It would be cruel, and not necessary, to take fish out of the water to prove they need water. Students can learn vicariously through videos and fish tales. Fish must have a continuous supply of clean water either through a filter, changing water in a bowl, or unpolluted stream water in the natural environment.

Procedure

1. Prepare Fred the Fish by cutting from a sponge in the shape of a fish (see lab preparation illustration and instructions). Introduce Fred the Fish and tell students he has grown up in a coral reef with clean water. He is going to go exploring away from his protected home environment. He will travel in areas he has never been before. We are going to go with him and share his adventure.

2. Tell students, "I have prepared some pollutants, and we will watch the effect of the pollutants on the water and the fish during an adventure with Fred the Fish." Assign eight students to be responsible for the pollutants. Hand each of them one of the numbered cups to dump into Fred's "river" at the appropriate time.

3. Cut Fred the Fish script into numbered parts and distribute story strips to those students who do not have baby food jars.

4. Have the students read the script strip in order, and have the students with the pollutants dump them on cue. Each time a "pollutant" enters the water ask, "How's Fred?" The students should decide on a one-word description of how Fred looks. Write the descriptor on the board or chart paper.

5. After all ingredients have been dumped in the jar, ask, "How's Fred?" Have students respond. Lift Fred out and discuss changes in his appearance due to the water's pollution. Describe what has happened, how Fred looks, and why.

6. Discuss what the class can do to keep fish healthy and help them have a clean, safe environment. Make up a class clean water slogan.

Extensions:

1. As a closing activity to check for understanding, have the students design their own fish on paper and create a tale about it. For example, have students tell where it would live, what it would do, what kind of water it would live in and what it would do if its water got polluted. Have students dictate their tale at the computer, print their tale, and cut out the words and glue them on their picture. Have a "Fish Tales" bulletin board section.

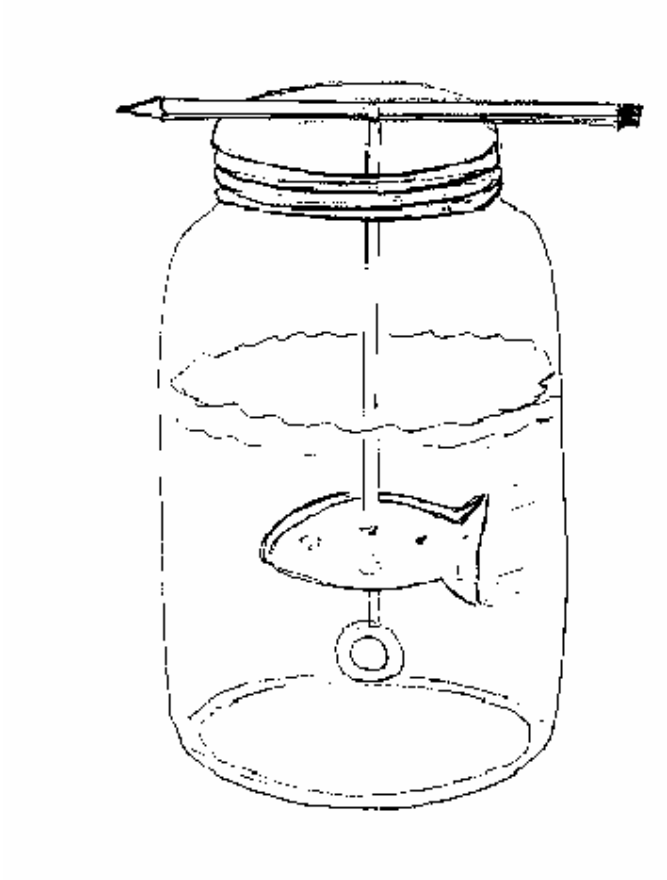
Source: Utah LessonPlans 1997 19:52 PM *Adapted from Chilton-Stringham, P., Wolanin, J., (1995). *Water, Stones, and Fossil Bones.* "Fred the Fish." pp. 54-56. National Science Teachers Association.

Fred the Fish Script

1	Imagine crystal clear water as it is in a coral reef. In this reef lives Fred the Fish. Fred has lived in this reef all his young life but wants to swim to a new place to spawn.	How is Fred?
2	Fred swims near a tourist spot where boats are leaking oil.	Dump syrup into Fred's jar. How is Fred?
3	Fred swims near an island where too much sewage is produced and starts seeping into the sea.	Squeeze 2 drops of red food coloring into Fred's jar. How is Fred?
4	Fred swims near an island where mangroves have been cleared and there are no roots to hold the soil together. A little storm pushes soil into the sea.	Dump soil into Fred's jar. How is Fred?
5	Fred swims near the coast where people cut down mangroves to build their house. They put fertilizer on their lawn. It rains and the fertilizer washes into the sea.	Add brown sugar to Fred's jar. How is Fred?
6	Fred swims near a popular swimming spot. Some people had a picnic and did not throw their sandwich and chips wrappers into the garbage can. The wind has blown the garbage into the sea.	Sprinkle paper dots into Fred's jar. How is fred?
7	Fish has followed the coastline to the edge of the city where the factories are. There are rules that say factories may not dump all their products into the river, but sometimes they dump just a little thinking it won't hurt anything.	Pour warm soapy water into Fred's jar. How is Fred?
8	Fred is almost at his spawning site. But there is a dangerous part with barrels containing poisons are leaking. The rain is washing the poison into the water.	Squeeze 4 drops of green food coloring into Fred's jar. How is Fred? Will Fred survive? Why or why not?

Fred the Fish

Prepare a fish, "Fred" cut from a sponge. Thread the yarn needle with string and sew through the "fish" sides. Have the string extend about an inch past the fish and tie a weight (washer/nut) to the end to anchor the fish. Pour water in the jar and have the water about 2 inches above the fish.



Lesson 36

HOW DO WE USE THE SEA?

DEV
FIS
SVC
ALT
MPA
TRA3

Grade(s): 4-6
Subject(s): social studies, geography

Objectives:
Identify human actions that affect the sea.

The sea is a very important part of our life on Earth. We take many of the things we need from the sea. We also put many of the things we don't want into the sea. So what do we take out and what do we put in?

Materials

- Copies of cards
- Blank sheets of paper

Procedure

1. Put students into groups of four.

2. Give each group a set of cards. Have them shuffle the cards and deal them between students. The students take it in turns to read the cards out loud and divide them into two piles:

Pile 1	Pile 2
The ways in which people *put* things into the sea	The ways in which people *take* things out of the sea.

3. Take a blank sheet of paper and draw a line to divide into two columns. Put the two headings under each column:

Column 1	Column 2
Things we put into the sea	Effects on the marine environment

4. Now take the cards from Pile 1, shuffle them and deal them out again. Take it in turn to read cards and make a list of all the things people put into the sea in one column and all the effects this has on the marine environment on the other side.

5. Take another blank sheet of paper and draw a line to divide it into two columns. Label each column:

Column 1	Column 2
Things we take out of the sea	Effects on the marine environment

6. Now take the cards from Pile 2, shuffle them and deal them out. Each student will read a card and this time make a list of all the things we take out of the sea in one column and all the effects this has on the marine environment in the other column.

7. Write a paragraph describing the threats facing the marine environment and the animals because of the things people do.

Source: *Seabirds and the Sea,* RSPB Curriculum Guide 8-14 yrs. Royal Society for the Protection of Birds, England, 1995.

Many people depend on the fish from the sea for most of their food. Overfishing could lead to a decline in the supply of fish.	**Fish is used to make animal feed and fertilizer to help food grow on land.**
Many cities are built on the coast. The waste from these cities are dumped into the sea. These damage the habitats of marine wildlife.	**Human sewage is dumped in the ocean and pollutes the sea and damages the animals that live in the sea. It is also a health risk to swimmer and people eating shellfish.**
Mangrove forests are found at the edge of the sea. They are cut down for timbered or cleared for development. Many marine animals lose their homes. Coasts are more liable to flooding.	**Pesticides and fertilizers from agricultural run-off the land into the rivers and make their way to the oceans. They cause algal blooms that deplete the oxygen supply in the sea.**
Plastic fishing nets, plastic rings holding drink cans and tiny pellets used to make polythene are all discarded at sea. These can harm wildlife.	**Fishing provides lots of jobs for people. But the nylon filament nets used to catch fish also trap many sea mammals and seabirds as they chase fish.**
Industry dumps dangerous chemicals and other waste products into the sea. Marine animals can be damaged by the pollution.	**Sea turtles have been hunted for their shells and meat. Some turtles are threatened with extinction.**
Oil is transported from one country to another by sea. Accidents sometimes happen which damage wildlife. Oil from ships is also deliberately put into the sea when empty tanks are flushed out.	**The oceans are rich in mineral wealth like metals which are running out on the land. Mining the oceans will damage the habitats of the animals that live on the sea floor.**

Lesson 37

ECO1
ECO2
DEV
FIS
ALT
TRA3

SURVIVAL FACTORS

Grade(s): 4+, secondary
Subjects: social studies, geography

Objective:
Understands relationships among organisms and their physical environment
Analyze the impact of humans on the coral reef ecosystem as a result of human social, political, and economic activities.
Understands the characteristics of coral reef ecosystems
Understands how human actions modify the physical environment

Materials:
- copies of Survival Factor cards, copies of Identity cards enlarged 200%
- small construction paper squares (five per student)
- yarn

Procedure:
1. Copy and cut Survival Factor cards and Identity cards. Attach yarn to Identity cards so students can wear them around their necks.

2. Have students stand in a circle. Pass out Identity cards. Each student now represents a life-form found in a coral reef ecosystem.

3. Give each student five paper squares. Explain that each square represents a population of organisms. [A population is made up of all the organisms found in a specific area.]

4. Tell students that you're going to read some statements that describe events that take place everyday that might or might not affect the reef and its inhabitants. Explain that if they think the statement you read would make it difficult or impossible for their organism to survive, they must put one of their paper squares on the floor in front of them. When students have one square left, they must stand on one foot. When they lose their balance and fall, they must sit down—this species is no longer found on the reef. They also must sit down when they run out of squares.

5. Continue to play until everyone is sitting.

6. Discuss the game with students. Tell them that their species became endangered when they became few in number, as represented by the one paper square. Explain that endangered refers to a population that is in danger of extinction, or disappearing completely. Was it easy for the students to stay in the game when they reached the point of standing on one foot? When a species becomes endangered, they're on shaky survival ground.

Deeper Depths:
Have students compare and contrast other habitats (old growth forest, wetlands, desert) and their survival factors. What survival factors are the same for each habitat? Different? How can each one of us make a difference in protecting the balance in each type of habitat?

Source: Dr. Sharon H. Walker,R. Amanda Newton, Dr. Alida Ortiz, Coral Reefs: An English/Spanish Compilation of Activities for Middle School Students, 2001, J.L. Scott Marine Education Center & Aquarium Source:

Recreational boaters drop anchors on you.	A tourist takes you from the reef to carry home as a souvenir.
An oil tanker spills thousands of gallons of oil into the water over you.	You swallow some abandoned fishing line.
Agricultural fertilizers have washed into the sea, so now there is a lot more algae in the water around you.	To make money from the tropical fish trade, collectors use dynamite and cyanide, a poison, to stun and capture you and your relatives.
You become tangled in a drift net.	Large pieces of your skeleton are broken off and sold for use in home aquariums.
Ocean pollution from pesticides, heavy metals, and garbage is surrounding you.	The water temperature surrounding the reef mysteriously rises, causing you to expel your zooxanthellae.
A snorkler sits on you and pokes around to get a better look at marine life.	A tropical forest is cleared, washing topsoil down river and into the ocean in the vicinity of your home, a large reef ecosystem.
A scuba diver takes more than the legal limit of your species.	Coastal development destroys the beach you breed on.
Human population growth increases.	Humans think you're delicious, and actively hunt you.

IDENTITY CARDS

pillar coral	zebra moray eel	monk seal
hawksbill sea turtle	queen conch (snail)	painted triggerfish
green sea turtle	four-eyed butterflyfish	trumpet triton(snail)
lined sea horse	king crab	brain coral
barracuda	striped shrimp	elkhorn coral
star eyed hermit crab	sharpnose pufferfish	emperor angelfish
cowfish	sea urchin	sea anemone
anemone fish	blue-barred parrotfish	stony coral
little star coral	slipper lobster	sea star
branching coral	reef octopus	moorish idol (fish)

Lesson 38

ECO4 SVC DEV

BIOLOGICAL & PHYSICAL AGENTS OF CHANGE ON A CORAL REEF

Grade(s): 6+, secondary
Subject(s): Science

Objective:
Compare the agents of change on a coral reef and in a forest.

Background:
A reef is made of coral and coralline algae that form a structure used by other organisms as a dwelling place. A coral reef, like a forest, is a complex community of many associated plants and animals. Organisms act as agents of change to cause the reef to grow or be destroyed. Physical conditions also determine the growth or destruction of the reef.

Biological agents of change include all the plants and animals that build up and destroy reefs. See Table 1. Reef-building agents are organisms that secrete the calcium carbonate skeletons that form the reef. *Crack-filling agents* are organisms that produce sediment or live in the cracks and crevices of the reef. *Passive agents* use the structure of the reed to live and hide in. They do not affect the reef structure but may eat other reef organisms or be eaten by them. *Destructive agents* erode the reef by grinding, chewing, or boring into it.

Physical agents of change—waves, currents, pollution, moving sand, silt deposits, fresh water, and severe shifts in temperature—kill corals and wear away the reef. See Table 1.

Materials:
- copies of Table 1 & 2

Procedure:
1. Divide students into groups.

2. Fill in Table 2 with examples of specific agents that affect the structure of a forest.

3. Compare Table 2 with Table 1 and discuss the similarities and differences between the agents of change on a coral reef and in a forest.

Questions:
1. What do we mean by the "structure" of a forest? Of a reef? Describe the structure of the reef.
2. In what ways are corals in a reef like trees in a forest? How are they different?
3. What happens to the trees when they die? To the corals?
4. What are the differences between the growth of a tree and the growth of a forest? What are the differences between the growth of a single coral colony and the growth of a coral reef?
5. Compare the biological and physical agents that damage a forest and a coral reef. How are they similar? How are they different?
6. How does the amount of sunlight affect the growth of a coral reef? A forest?

Table 1Coral Reefs

Agents of change	**Examples**
Constructive agents	
Crack fillers	Encrusting coralline algae Fragments of corals Molluscs Echinoderms
Passive agents	Boring sponges Coral-eating fish (parrotfish) Worms Sea urchins & sea stars Boring molluscs
Destructive biological agents	
Constructive physical agents (builders)	
Destructive physical agents	

Table 2 Forests

Agents & conditions of change	**Examples**
Forest builders	
Forest floor organisms	
Passive residents	
Destructive organisms	
Constructive physical agents	
Destructive physical agents	

Source: Dr. Sharon H. Walker,R. Amanda Newton, Dr. Alida Ortiz, Coral Reefs: An English/Spanish Compilation of Activities for Middle School Students, J.L. Scott Marine Education Center & Aquarium, 2001.

Lesson 39

THREATS TO THE CORAL REEF

ECO4
DEV
TRA2
TRA3

Grade(s): 4-6
Subject(s): geography, science

Objective(s):
Understands relationships among organisms and their physical environment
Understand how human actions modify the physical environment
Identify how natural and human actions impact on the coral reef.

Coral reefs have existed for millions of years. They have survived countless large and small changes in the environment. But today, coral reefs around the world are threatened as never before. Reefs in at least twenty countries, including the United States, Mexico, Indonesia, Japan, and Australia, are showing signs of stress and distress. Coral reefs in Florida are disappearing at an alarming rate. Coral diseases and **coral bleaching** occur when the water off Florida is no longer clear and clean, or when the water temperatures rise. In Hawaii, beautiful coral reefs have been damaged or killed by sewage pollution, dumped waste, or dredged mud. Many scientists agree that if the trend continues for another twenty or thirty years, there may not be any healthy coral reefs left on earth.

Procedure
Read below about threats to coral reefs. Put an **N** next to the natural threats (caused by nature) and an **H** next to the human threats (caused by people). Which do you think are more dangerous to coral reefs—natural events or the activities of people?

____1. Hurricanes and tropical storms break and topple coral and batter fish.
____2. Construction on or near the reef destroys coral or muddies the water, so that corals smother.
____3. Overfishing and destructive fishing methods (such as using dynamite, cyanide, bleach, fish traps, gill nets, or huge forty-mile-long drift nets) spoil the reef ecosystem.
____4. Too much rain dilutes the water, so that it isn't salty enough for corals.
____5. Marine debris is dangerous to corals, birds, sea turtles, fish, and other marine animals.
____6. Divers, snorkelers, and fishermen damage the reef with boats, anchors, and heavy gear. Even touching coral or standing on it can kill it.
____7. Changes in currents can smother corals in mud.
____8. Collecting tropical fish, corals, and shells strips the reef of life.
____9. Pollution from oil spills, chemical wastes, run-off from farms and factories, and sewage ruins the water quality that corals need.
____10Natural predators, such as parrotfish, sponges, and sea urchins, eat corals or weaken it by boring into it.
____11 Warmer water caused by the greenhouse effect may cause coral bleaching, a dangerous condition that occurs when corals lose their algae partners.

Source: Dr. Sharon H. Walker,R. Amanda Newton, Dr. Alida Ortiz, Coral Reefs: An English/Spanish Compilation of Activities for Middle School Students, J.L. Scott Marine Education Center & Aquarium, 2001

Lesson 40

BIO1 DEV TRA2

WHAT IF THE REEF DIES?

Grade(s): 5+
Subject(s): science

Objectives

Understand some aspects of reef ecology.
Understand how pollution affects reef organisms
Consider what can be done to insure reef survival.

Background

Coral reefs are sensitive living structures found in warm marine waters around the world. Several forces are acting on reefs and scientists are learning more about the contribution reefs make to the immediate ecosystem as well as to the larger biosphere.

PURPOSE: How might sewage discharge affect a marine ecosystem? Powdered milk will represent the sewage - the more milk, the more sewage present. Yeast will represent plants growing in the marine ecosystem. The amount of plant growth will be determined by the length of time it takes for the blue color to disappear.

Materials

Bakers yeast	Powdered milk (to represent the sewage)
Timer (watch or clock)	blue coloring
graduated cylinder (10, 25, or 50ml)	
Test tubes and rack	Measuring spoons or gram balance

Procedure

1. Place 3 test tubes in a rack, and label tubes 1 and 2 as "sewage", label # 3 as a CONTROL.
2. Place ½ tsp. (1.0 g) powdered milk into #1 test tube.
3. Place 2 tsp (4.0 g) powdered milk into a #2 test tube.
4. Add ½ tsp (1.0g) yeast to all 3 test tubes.
5. Add 15 ml of water to each tube. MIX WELL.
6. Add 20 drops blue coloring to tube # 1, RECORD THE EXACT TIME, AND MIX.
7. Add 20 drops of blue coloring to tube # 2 , RECORD THE EXACT TIME, AND MIX.
8. Repeat for tube #3.
9. Observe tubes 1,2,3 and NOTE THE EXACT TIME WHEN THE BLUE COLOR DISAPPEARS.

Processing the results

1.Create a data table to display your results.
2.Create a line graph of your results.
3.Predict what would happen if you used 1 tsp. of powdered milk in this experiment.
4.How might sewage discharge near a coral reef affect the health of a reef system?
5.Refer to http://reefrelief.org to research your answer to question # 4. Were you correct based on data collected from reef sites? Explain.

Source: BBSR and TCOE Coral Web Site Team http://www.coexploration.org/bbsr/coral
Funded by a grant from the Goldman Foundation, Gail Swenson., 1999

Lesson 41

WHAT HAPPENS WITH THE REEF?

ECO1 ECO2 ALT DEV

Grade(s): 6+

Subject(s): science, geography

Objectives

Learn what happens to a coral reef when fish are removed from the habitat.
Understand the relationship between organisms and their environment.

Materials

- Reference materials & the web site http://coexploration.org//bbsr/coral to research how these reef organisms obtain their nutrition: coral polyps, phyoplankton, zooplankton, parrot fish and algae.

Processing the results

1. Have students research the feeding habits of the reef organisms: coral polyps, phytoplankton, zooplankton, parrot fish and algae.

2. Students can share their findings and answer the questions: Which organisms are in competition for living space on the reef? Explain your answer. What will happen when over fishing depletes the parrot fish population? Explain.

3. Sketch a coral reef habitat as it would look after the parrot fish had been removed.

4. Which organisms would have a growth in population and which would have a decline? Explain.

5. Summarize the changes that would occur in the Mesoamerican Barrier reef area if a coral reef died. How would the sea and coast look?

Source: BBSR and TCOE Coral Web Site Team 1999 http://www.coexploration.org/bbsr/coral
Funded by a grant from the Goldman Foundation, Gail Swenson

Lesson 42

PERSONAL ACTIONS

PAR DEV ALT

Grade(s): All
Subject(s): geography

Objectives

Investigate hoe different activities that have a negative impact on the environment
Identify positive activities to address the negative impacts.

Procedure:

Create a fish habitat certificate.

A certificate is awarded for completing any or all of the following suggested student activities:

- Wrote an essay on the importance of fish habitats to prawns
- Found a photograph of a mudcrab
- Explained to the class why you can't collect seaweed or marine plants
- Watched seabirds on the shore and described how they fly, what they eat, how they behave towards each other
- Arranged a visit to the class by a local fisheries officer
- Carefully released undersized fish
- Caught fish for only one meal
- Cleaned up fishing line from the shoreline and put it in the bin
- Collected garbage from the foreshore
- Found a lure and brought it to class explaining what type of fish it was designed to catch
- Walked carefully through the mangroves
- Participated in building a mangrove boardwalk
- Identified two mangrove species
- Observed crabs come out of their holes at low tide and described them to the class
- Caught a legal sized fish and explained why it was legal to the class
- Found out about fishing ethics from Fisheries department or conservation organizations
- Explained how mangroves survive in mud and anaerobic soils
- Explained what acid sulfate soils are
- Explained fines, why we have them, who gets them, and why we do it
- Described a local fish habitat to the class
- Found out about a marine conservation volunteer program
- Studied media images as they relate to fishers of different ages, gender, disability and ethnicity
- Researched how native ethnic groups use fish habitats and mangroves
- Studied a religious or spiritual belief relating to fishing

Nature's Nautical Nurseries - An educational module from the Queensland Fisheries Service. The State of Queensland (Department of Primary Industries) 2002.

Lesson 43

PAR DEV AI T

GREEN POINTS CHALLENGE!

The Challenge

Working in teams, your challenge is to earn the greatest number of Green Points. Green Points are actions that people can take that will have a positive effect on the environment. There are five different levels of these points: the higher the level, the greater the effect on the environment. Actions taken in higher levels earn more points.

Materials

- A Green Points Scorecard for each person in each team
- A tally sheet
- A Gould Green Points trophy

The Game

1. Form teams. Each team should give themselves a name. Teachers can form teams and compete if they wish. Just warn them that the competition will be stiff.

2. Use the *Green Points Scorecard* Study this scorecard carefully, and in the weeks before World Environment Day, plan out how your team can earn the most points. For each action in Level 1, you will earn one point; for each action in Level 2, you will earn two points, and so on. It is pretty obvious that you should spend more effort on actions in the higher levels if your team hopes to win this Challenge.

3. Hold a Gould Green Points Challenge for a 24 hour period. Each member of a team should use the Green Points Scorecard to record their actions. It is important that someone, who is not in your team, should witness each action and write their initials in the appropriate box. For example, if you turned off a tap properly, then ask a friend, who saw you do this, to sign their initials in the box under Level 1 for the Category of Water Conservation. Each person can only count one action for each box.

4. Use the tally sheet to work out the score for your team.

The Rules

1. Each person can only count one action for each box.

2. Each action can only be counted if a person from outside the team initials it. (This won't be necessary in the toilet action in Water Conservation.)

3. Actions can only be counted for a 24 hour period.

The Celebration

Make a Green Points trophy, using mainly reused or recycled materials. Present this to the winning Green Team.

The Gould Green Points Challenge, The Gould League, Envir*onment Australia*

Green points Scorecard

CATEGORY	LEVEL 1 *Basic action* 1 Green Point	LEVEL 2 *Action involves a wise choice* 2 Green Points	LEVEL 3 *Action requires some effort* 3 Green Points	LEVEL 4 *Action requires greater effort* 4 Green Points	LEVEL 5 *Action involves persuading others* *5* Green Points
Water pollution/ quality	Don't drop litter as it could end up in a water way	Pick up a plastic bag that is litter and place it in a rubbish bin	Pick up after your pet dog	Sweep a path instead of hosing it down	Put up a display in local shopping centre that shows the consequences of litter in waterways
Water conservation	Turn off a tap properly or Turn off a dripping tap	Use the half flush button in the toilet where appropriate	- Take a shorter shower or - Have shallower bath or Turn off a tap while brushing your teeth	Wash your bike or your parents' car on the lawn, using a bucket of water	Tell an adult about any leaking tap and urge them to have it fixed quickly
Litter	Put your litter in a rubbish bin	Pick up other people's litter	Use things that create less litter	Join in a clean-up event.	Encourage others not to drop litter
Waste	Put recyclable drink container into the correct recycling containers or Try to recycle cardboard.	Use a reusable lunch box and drink bottle for your lunch at school	- Use both sides of a sheet of paper or - Give old things away to charity or -Use rechargeable batteries	Fix a broken toy or pen rather than buy a new one	Encourage others to buy things made from recycled materials
Shopping	- Buy a drink in a packaging that can be recycled or - Buy fresh food that is made locally	Swap something instead of buying a new one	Buy something second-hand	Buy something that will last a long time	Put up a display to encourage others to use their own bags in supermarkets or Make recycled shopping bags and sell these to parents
Soil quality	Place fruit and vegie scraps into a compost bin or worm farm	Use home compost on the garden	Place mulch on garden beds	Plant trees and other plants in revegetation projects	Join a conservation group to help in environmental projects
Energy conservation (and greenhouse gases)	Turn off a light when no-one is in the room	Keep doors closed when rooms are heated or cooled or Keep the fridge door closed when it is not being used	Put on a jumper when it is cool, rather than turn on a heater or Use a personal fan in hot weather, instead of turning on the air conditioner	Help to hang the washing on the line, instead of using the clothes drier	Ask an adult to: - change a computer monitors to energy saving mode or - use cold water for washing clothes
Transport (and	Walk short distances, instead of being	For travelling longer	Ride a bike for a short trips	Use public transport for a	Persuade your family to -- use public

CATEGORY	LEVEL 1 ***Basic action*** **1 Green Point**	LEVEL 2 ***Action involves a wise choice*** **2 Green Points**	LEVEL 3 ***Action requires some effort*** **3 Green Points**	LEVEL 4 ***Action requires greater effort*** **4 Green Points**	LEVEL 5 ***Action involves persuading others*** ***5* Green Points**
greenhouse gases)	driven there by car	distances, car pool with your friends		longer journeys	transport or - do things together locally, instead of driving long distances
Air pollution	Speak to a friend by phone or email, rather than travel to your friend's place by car	Get in the car promptly. Don't let the car idle for long periods	Offer to cut the grass using a hand lawn mower	If you can share a car for school or going out, do so.	Persuade your parents to use the gas / oil / electric heater, instead of burning wood or briquettes
Biodiversity	Protect all native plants and animals	- Keep your cat inside at night. or - Place a bell around its neck. or - Keep your dog under control when taken for a walk	Remove weeds from school gardens, so that they can't invade natural areas	Plant more native and indigenous plants and fewer introduced plants	- Create a habitat for creatures in the corner of your garden or - Join a group that cares for natural environments

OTHER ACTIVITIES

Art

Treasuring Biodiversity (Performance)

Choose a very large and a very small inhabitant of the ocean. Write a play or dance that shows how they are interdependent. Explain through the story their value for human survival.

Language

Treasuring Biodiversity (Song/Poem)

Choose a very large and a very small inhabitant of the ocean. Write a song or poem to explain their value for human survival.

ABC in the Sea

Can you find examples of local marine animals and plants to match each letter of the alphabet.

Biodiversity News

Collect newspaper articles about biodiversity issues. Put these together to create a newsletter. Report on the good and bad news. Highlight the impact of our actions on biodiversity.

Wavy Sentences

This activity is to encourage second graders to be creative in their writing about the ocean. The students write their descriptive sentences about the ocean in up and down patterns, depicting the waves of the ocean. The students then add color and ocean animals creating an exciting colorful language art experience.

Sandcastle Writing

Have students keep a journal during your study of oceans. On a large piece of heavy cardboard, draw a picture of a sandcastle. Find a castle picture and copy it using the overhead. With an x-acto knife cut out three sides of the windows and doors creating a flap. Write a journal activity to glue behind each flap. Close the windows and doors. Each day a student chooses a window or door to open, reads the journal assignment to the class and puts it on the board. Create a special journal for your ocean unit with a decorated cover. Submitted by Jason Donahue, Grade 1 M.E.S.

Fishy Stories

Have students choose a sea animal from one of the books and write a story about it. They should tell about its environment, what it eats and how it protects itself. Students should make an illustration for their story. The stories and illustrations could be separated and used for a matching activity.

Clothes Line Story

Divide students into small groups and assign a different scene from the story for them to recreate. Use white drawing paper, construction paper and crayons. When students are finished have them pin their story parts, in order to the clothes line.

Guess Who?

On index cards write the names of different ocean animals. Students draw a card and research the animal on it. On the back of the card they should write facts about their animals such as; where it lives, what it eats, what color/shape it is, is it a predator or prey? When finished, they can swap with a partner to guess what animal the description is for.

Poems

Read aloud some poems about the ocean. Then work on innovation. Brainstorm some things that could be changed about a particular poem-its title, the creatures mentioned, adjectives, etc. Make a Word Bank on the chalkboard, chart paper, or over-head. Then replace the words in the original poem with words from the Word Bank. Have students write a poem about "A Day in the Life of (their chosen sea animal)".

Sea Animal Acrostics

These are a great way for students to recall facts about sea animals. Write an ocean word down the chalkboard. Brainstorm words that begin with each letter. Be sure to use some ocean words. List them on the board. As a class use the words to create and acrostic about the animal. In no time at all students will be doing their own.

ABC Ocean Book

Write each letter of the alphabet on a sheet of paper. Have students draw a letter. They choose a sea animal whose name begins with that letter. Then draw the animal or find a picture of it to glue to the page. Write facts about the animal under the picture. When all the letters have been finished, photocopy and staple all the pages into a book for each child to take home.

New Animal

Pretend you have just discovered a new animal in the ocean. Tell where you found it, what it looks like, what it eats, and what its name is. How would it behave?

Mathematics

Biodiversity in the Sea

Draw up a chart or graph that compares the diversity of animal groups on land, in freshwater and in the sea. Compare diversity in different parts of the sea such as sandy beaches, coral reefs rocky shores, kelp forests and represent these on a graph. Research and compare biodiversity among countries.

Biodiversity Olympics 2000

What are the events for a marine animals Olympics games, venues, rules and contestants. Who will be the winners? Which MBRS sea animal is the fastest, biggest, smallest, most legs, most amazing feats,etc) Present record in different ways.

EVALUATION

Not all the lessons have the provision for formal evaluation, but for those lessons that feature presentations, story, play, essay writing, or creative activities the generic rubric assessments are useful.

GENERAL SCORING RUBRIC

SCORE	DESCRIPTION
CATEGORY 4	• The student completes all important components of the task and communicates ideas clearly. • The student demonstrates in-depth understanding of the relevant concepts and/or process. • Where appropriate, the student chooses more efficient and/or sophisticated processes. • Where appropriate, the student offers insightful interpretations or extensions (generalizations, applications, analogies).
CATEGORY 3	• The student completes most important components of the task and communicates clearly. • The student demonstrates understanding of major concepts even though he/she overlooks or misunderstands some less important ideas or details.
CATEGORY 2	• The student completes some important components of the task and communicates those clearly. • The student demonstrates that there are gaps in his/her conceptual understanding.
CATEGORY 1	• The student shows minimal understanding. • The student addresses only a small portion of the required task(s).
CATEGORY 0	• Response is totally incorrect or irrelevant.
BLANK	• No response.

For evaluating presentations, a rubric has been designed to determine the students abilities and efforts into developing their presentation.

	Quality of Presentation
4	Topic is related to theme and is presented imaginatively. The presentation is extremely creative and effectively tells a clear, concise story that stands on its own. Project excellently flows logically from beginning to end. Physical appearance of project shows sophistication and attention to detail in terms of typing & proofreading, neatness, etc.
3	Topic is related to the theme. The exhibit is interesting and tells a clear story that stands on its own. The project adequately flows from beginning to end. Good physical appearance of project. Minor flaws in attention to detail in terms of typing, proofreading, neatness, etc
2	Topic shows vague references to the theme. The exhibit tells an unclear story and is missing vital elements. The project cannot stand on its own. Major errors in attention to detail.
1	Topic is not related to the theme. No exhibit. Overall project lacks clarity. Gross errors in attention to detail.

GLOSSARY

Algae - Tiny, floating, aquatic plants that drift in the sunlit surface or of the ocean and often ocean and often give water a greenish color. Scientifically known as pltotoplankton, these plants exist as producers at the bottom of many food chains.

Asexual reproduction - a natural process by which some plants and animals produce offspring within themselves, without the production of eggs or without fertilization from another plant or animal.

Atoll - a type of coral reef that grows in the shape of a circle, enclosing or nearly enclosing a lagoon.

Barrier reef - a type of coral reef that lies parallel to a beach shoreline and protects a lagoon.

Brackish water: A mixture of sea water and fresh water (as occurs near the mouths of rivers).

Calcification - a process that takes place in the body of the coral polyp, with assistance from zooxanthellae algae, by which the dissolved limestone in ocean water is changed into solid limestone, and is laid down beneath the coral polyp in the species specific skeletal pattern. This accumulative process results in the building of coral reef structures.

Calcium carbonate: The white limestone material which makes up the skeletons of coral polyps and the shells of molluscs; the chalk used on blackboards is mostly calcium carbonate.

Carnivore: An organism that eats animals.

Catch Quota: The maximum catch permitted to be taken from a fishery; such a limit applied to the total catch from a fishery is often referred to as a global quota (as distinct from an individual quota).

Cnidae - stinging cells that exist on the tentacles of the coral polyp and assist the polyp in capturing zooplankton that are passing by in ocean currents.

Consumer - a plant or animal which gets its energy by consuming, or eating other living things.

Coral colony - a group of coral polyps that takes the specific shapes of that species of coral.

Coral polyp - a small aquatic animal with a tube-shaped body and a mouth surrounded by tentacles; coral polyps are responsible for the production of coral reefs.

Coral reef - a collective structure consisting of dead skeletal limestone that has accumulated over time and a result of the coral animals that cover the structure's

surface. As a result of a series of ecological relationships, the coral reef structure is directly responsible for the production of much of the earth's fish and marinelife.

Coral reef ecology - the study of the relationships between the living and non-living things that exist in and around the coral reef environment.

Deforestation - the removal of trees and vegetation from land; the most common cause of soil erosion.

Dependent relationship - a type of relationship in which one thing needs or relies on another for its continued existence.

Dissolved substance - a material that has been mixed in liquid to form a solution.

Ecology - the study of the relationships between living and non-living things in any environment.

Ecosystem - any environment where living and non-living things have relationships; the basic unit of study in ecology.

Ecologically Sustainable Development (ESD): Use of the environment which aims to meet present needs without compromising the ability of future generations to have the same privilege; development based on the sustainable use both of species and ecosystems, the maintenance of essential ecological processes, and the preservation of biological diversity.

Extinction: The total disappearance of a species.

Fisheries regulations: Controls designed to either restrict effective fishing effort (input controls), or to restrict the total catch (output controls) to predefined limits in a fishery.

Food web - an interdependent and interconnecting pattern of producer and consumers, predator and prey.

Fringing reef - a type of coral reef that grows parallel and near to a beach shoreline.

Habitat - the place or kind of place in which it is natural for an animal or plant to live or grow.

Hard coral - a group of coral species known as stony coral that forms the hard, calcium carbonate skeleton in several shapes; other include the brain corals, fungus or mushroom corals, staghorn and table corals, flower pot corals, bubble corals and lettuce corals.

Herbivore: An animal which eats plant material.

Inner reef - the part of a barrier reef or atoll that faces the lagoon.

Interaction - the result of one thing acting on another.

Interdependent relationship - a type of relationship wherein both or all members of a relationship are dependent on one another.

Invertebrate - an animal that does not have a backbone.

Lagoon - a shallow, pond-like body of water that is usually connected to a larger body of water, such as a river, lake or sea; the body of water between a barrier reef and a beach shoreline, or surrounded by an atoll.

Larvae: The young stages of many marine animals including corals; most larvae are small and drift in the sea before becoming adults.

Limestone - a common, naturally occurring form of calcium carbonate of which coral reef structures are made.

Mangroves ecosystem - the environment of saline-tolerant trees that live in the tidal zone of the ocean, and all the other non-living and living things that have relationships there. marine biologists - persons who study the life and processes of the ocean.

Marine life - animals that live in the ocean including coral polyps, sea urchins, clams, shells, worms, crabs, octopuses, squid, etc.

Marine Protected Area (MPA): A marine reserve, park, or other area protected from uncontrolled human access and use by the application of various restrictions on activities, development and exploitation.

Overfishing - the harvest of fish or marine life at a rate and volume that destroys the ocean's ability to provide such harvest in the future; the unsustainable harvest of fish and marine life.

Partner ecosystems - ecosystems that work together to maintain the diversity, productivity and ecological balance of other, nearby or connected ecosystems, or of the broader ecosystem of which they are a part.

Photosynthesis - the process by which plant material is formed from water, nutrients and carbon dioxide using energy absorbed from sunlight.

Phytoplankton - small aquatic plants that drift in the sunlit surface of the ocean; commonly known as algae, these plants exist as producers at the bottom of many food chains.

Plankton - small aquatic plants and animals that drift in the ocean; types include algae, phytoplankton, zooplankton and zooxanthellae.

Predator - an animal that hunts for food, or otherwise eats another animal.

Prey - an animal that is hunted or consumed for food by another animal.

Producer - a plant that manufactures plant material from water and carbon dioxide using energy from sunlight and nutrients in a process known as photosynthesis.

Primary producers: Plants, including algae and phytoplankton, which use sunlight and nutrients.

Prop roots - roots of mangrove trees that are extended out of the muddy soils and submerged in sea water at high tide, but are exposed at low tide; assist in slowing wave action and protecting soft mangrove soils against erosion.

Quota: A limit on the weight of fish which may be caught in a particular stock or area; a bag limit is a quota (usually in numbers of fish caught) applied to recreational fishers.

Reef flat - the space between a fringing reef and the beach shoreline covered by water at high tide but has almost no water on it at low tide and where coral growth is minimal.

Reef front - the outside edge of all types of coral reefs; the side of a coral reef facing the open ocean, where coral growth is most extensive; also known as the reef face.

Seagrass ecosystem - the environment of aquatic plants called seagrasses that live in the tidal zone of the ocean, and all the other non-living and living things that have relationships there.

Sediment - sands, silts, or soil mixed into, carried by, or deposited from water.

Settled polyp - the larvae of a coral polyp that has come to attach itself to a clean, hard surface and begins to grow.

Sexual reproduction - a natural process by which some plants and anhnals produce offspring as a result of the production of eggs and the fertilization from another plant or animal. shallow - water that is not deep.

Silt - fine soil mixed into, carried by, or deposited from water as sediment.

Siltation - the accumulation of silt in the bottom of waterways or bodies of water.

Soft corals - a group of coral species that are thick and fleshy, and that move and wave in ocean water currents. These corals do not produce calcium carbonate

Species: A distinct group of animals or plants able to breed among themselves, but unable to breed with other groups.

Stinging cells - mechanisms located on the tentacles of coral polyps that enable them to capture passing zooplankton; similar in appearance to poison darts or recoiling darts; scientifically known as cnidae.

Subsistence fishing: The catching of fish to eat rather than to sell.

Symbiosis: A relationship between two different creatures which live together for the benefit of both. Plant cells (called zooxanthellae) have a symbiotic relationship with coral polyps.

Symbiotic relationship - a relationship between two living things that live together for the benefit of both.

Tentacle - the arms that surround the mouth of a coral polyp; the site of stinging cells called cnidae which enable the polyp to capture passing zooplankton.

Tidal zone - the area along the beach shoreline that is affected by the rise and fall of the tide.

Unsustainable - the present use, consumption or harvesting of natural resources that can not be continued into the future.

Vertebrates - animals that have backbones.

Waste water - water used in domestic or industrial process and as a result contains pollution that has potentially harmful substances.

Zooplankton - small animals, or larvae or larger animals, which drift in the ocean.

Zooxanthellae - small aquatic plants that live in symbiosis within coral polyps which allows it to manufacture its own food and the deposition of a calcium carbonate skeleton; a type of algae; a type of phytoplankton.

Michael King & Sarah King, Environmental Education Module: The Oceans and Coastal Areas and their Resources, Western Samoa

ADDITIONAL RESOURCES

abc teach –unit with activities, pictures on reefs
http://abcteach.com/directory/theme_units/habitats/coral_reef/

Bermuda Biological Station for Research & College of Exploration
www.coexploration.org/bbsr/coral/lessons/

Bridge Ocean Sciences Teachers Resource Centre
www.vims.edu/bridge/

Coral Reef Alliance – online catalog, photobank, lessons
www.coralreefalliance.org

CREST (Coral Reef Education for Students and Teachers) Manual
www.marine.org/content/CREST/CREST_manual.html

Discovery School
www.Discoveryschool.com

Endangered Reefs – information on reefs in danger
www.eco-pros.com/endangeredreefs.htm

International Coral Reef Information Network
www.coralreef.org/tools/teachers.html

KaAms Kids as Airborne Scientists
www.higp.hawaii.edu/kaams//prof/whatiscr/over.html

Nature's Nautical Nurseries – Fact and activity sheets on seagrasses & mangroves
www.dpi.qld.gov.au/extra/nnn/activity_home.html

Neptune's Web
http://pao.cnmoc.navy.mil/educate/neptune/teacher.htm

Ocean Planet
http://seawifs.gsfc.nasa.gov/OCEAN_PLANET/HTML/search_educational_materials.html

Reefbase –online information system with maps
www.Reefbase.org

Reef Education Network – Activities for students and teachers
www.reef.edu.au

Smithsonian Education
www.si.edu/resources/lessons/currkits/ocean/main.html

The Teachers Corner – online resource for educators
www.theteacherscorner.net

Terrax – hands on unit on coral reefs
http://terrax.org/teacher/lessons/australia/reef/reefplan.aspx

Under the Sea – Mrs. Seagrave's Quest Class – lessons, activities for teachers and students
www.geocities.com/Athens/Athrium/5924/underthesea.htm

Water Matters
www.watermatters.org

WWF Learning UK
www.wwflearning.co.uk/ativities/

Year of the Ocean
www.yoto98.noaa.gov/kids

42explore
www.42explore.com/index.htm

Coastal Treasures of Belize, Belize Audubon Society

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SECTION V

Annex

Official Endorsement of the MBRS Infusion Document

Endoso Oficial del Docuento de Infusión de las Temáticas del Sistema Arrecifal Mesoamericano SAM, Julio del 2003

Infusión de Temáticas Sobre el Sistema Arrecifal Mesoamericano (SAM)

Dentro de las Currículas y sus Planes de Educación en los Niveles de Primaria y Secundaria de Belice, Guatemala, Honduras y el Estado de Quintana Roo, México

ENDOSO OFICIAL

1

Endoso Oficial del Documento de Infusión de las Temáticas del Sistema Arrecifal Mesoamericano SAM, Julio del 2003

Los Representantes de los Ministerios de Educación Pública de Belice, Guatemala Honduras y del Estado de Quintana Roo, México

Reunidos en San Pedro Sula
El 14 de Julio del 2003

Considerando

1. Que el Proyecto para el Sistema Arrecifal Mesoamericano (SAM) es un organismo internacional, cuyos objetivos se orientan a promover la conservación y el uso sostenible de los recursos del SAM en Belice, Guatemala, Honduras y México. Concebido como tal durante la "Declaración de Tulúm" en junio de 1997 y dependiente de la Comisión Centroamericana de Ambiente y Desarrollo (CCAD).

2. Que el Proyecto SAM es parte esencial del proceso de integración entre los países del Istmo Centroamericano y México.

3. Que los países del SAM, a través de los compromisos adquiridos con el Proyecto, de manera conjunta se han propuesto impulsar la infusión de las temáticas del SAM dentro de la Curricula y Planes de Estudio en la región.

4. Que la Comisión de Areas Naturales Protegidas de la Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT) cómo punto focal del Proyecto SAM en México, ha delegado a la Secretaría de Educación Publica del Estado de Quintana Roo, para el endoso del Documento de Infusión de Temáticas del SAM

5. Que la Educación para la Sostenibilidad Ambiental es beneficiosa para la conservación y el desarrollo del Sistema Arrecifal Mesoamericano, porque permitirá a los estudiantes comprender y, por ende dirigir eficientemente los temas costero marinos dentro de su propio ambiente.

6. Que el aprendizaje para responder a temas ambientales costero marinos es una parte importante de la formación integral y necesita formar parte de la Curricula y de los Planes de Estudio .

2

7. Que de los objetivos del Proyecto SAM, se crearon tres temas principales de educación, con veinte áreas temáticas, se relacionaron con los Planes de Estudio de los países del SAM, los cuales demostraron compatibilidad.

8. Que los principios generales de la conectividad transfronteriza se integrarán en la curricula a través de los Planes de Estudio.

9. Que la Guía de Maestros para la Infusión de Conceptos del SAM ayuda a los maestros a incorporar los principios transfronterizos en las lecciones, a través del entendimiento obtenido de la Guía sobre la forma de presentar estos principios dentro de los temas de objeto del aprendizaje.

10. Que los Planes Educativos de los países del SAM, ofrecen muchas oportunidades de introducir los temas relacionados con "La Gente y los Arrecifes, biología y ecología de comunidades coralinas relacionados con los conceptos del SAM.

11. Las asignaturas que facilitan la integración fácil de temas del SAM en escuelas primarias son los Estudios Sociales o Ciencias Sociales, la Gografía y las Ciencias Naturales. Las materias pertinentes en institutos de enseñanza secundaria son la biología, la geografía y los estudios sociales.

12. Que los planes para las lecciones incorporados a las Guías del Maestro conectan a las áreas temáticas con las asignaturas apropiadas, ofreciendo actividades para cumplir adecuadamente los objetivos del SAM y los Planes de Estudio vigentes en los países del SAM.

POR TANTO ACORDAMOS:

a) Facilitar la infusión de las temáticas del SAM, contenidas en el Apéndice A del documento de Infusión de Conceptos, dentro de las curricula educativa, en los niveles primario y secundario de los respectivos países o estados.

b) Completar la inclusión total de las temáticas del SAM, descritas en el Apéndice A del Documento de Infusión de Conceptos del SAM, dentro de las Curricula y sus Planes de Estudio en un plazo no mayor de dos años académicos.

Endoso Oficial del Documento de Infusión de las Temáticas del Sistema Arrecifal Mesoamericano SAM, Julio del 2003

c) Encomendar esta adecuación de conceptos a las Unidades Curriculares Ministeriales o al organismo competente dentro del sistema educativo de cada uno de los países signatarios.

d) Desarrollar las temáticas del SAM a través de las asignaturas de Estudios Sociales o Ciencias Sociales, Geografía y Ciencias Naturales para primaria y Biología y Geografía en institutos de enseñanza secundaria, haciendo la respectiva adecuación.

e) Participar activamente en la planificación y el desarrollo de los talleres nacionales de capacitación sobre el uso de las Guías del Maestro, para los niveles de primaria y secundaria.

f) Asegurar la implementación local de los conceptos del SAM, principalmente dentro del área de influencia del Proyecto SAM y evaluar su impacto.

g) Hacer del conocimiento público el presente acuerdo de Infusión de Conceptos y su vigencia a partir de su suscripción.

Dado en la Ciudad de San Pedro Sula, Departamento de Cortés, República de Honduras, a los catorce días del mes de Julio del 2003.

Armando Leiva
Ministerio de Educación de Belice

Elder Romeo León
Ministerio de Educación de Guatemala

Will Renan Diaz
Secretaría de Educación Pública de Honduras

Claudio Padilla Medina
Secretaría de Educación Pública del Estado de Quintana Roo, México

Patricia Panting
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SERNA, Honduras