UF | IFAS Extension
UNIVERSITY of FLORIDA

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LESSON 5

Marine Ecosystems—
Coral Reefs & Open Ocean

LESSON 5: Marine Ecosystems - Coral Reefs & Open Ocean

OBJECTIVES:

- Identify characteristics of marine ecosystems.
- Identify common and endangered species found in marine ecosystems.
- Discover the interdependence of marine communities.
- Develop an understanding of coral reef ecology.
- Discover the characteristics of open ocean life zones.
- Define ways in which the human population values and utilizes ocean resources.
- Identify ways in which human activity has affected marine ecosystems.
- Develop an understanding of marine resource conservation.

LESSON TIME: 45 minutes to 2 hours (for field trip)

ADVANCED PREPARATION: Read the BACKGROUND BASICS on Marine Ecosystems. Review activities and choose appropriate one(s) to use. Secure necessary materials as described.

PURPOSE:

To become familiar with marine ecosystems, including coral reefs and ocean zones.

DO:

Here are some learning activities and suggested ways to implement the activities in Lesson 5.

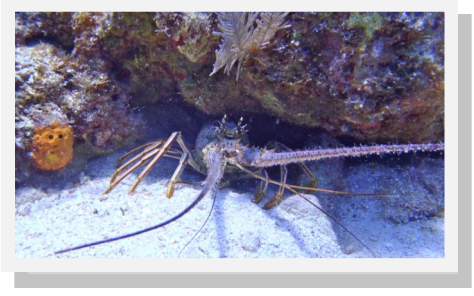
5.1 List plants and animals that live in the ocean. This list may include turtle grass, sargassum, phytoplankton, sea turtles, tuna, flounder, sharks, etc. Describe the food chains and food webs that these organisms exist in through WATER WEB.

5.2 Discuss how fish are caught, including techniques used by the youth themselves. Talk about how fishing technology has improved through the centuries in OCEAN HARVEST.

5.3 Visit a local fish market and identify fish that can be purchased for human consumption in FISHY BUSINESS.

5.4 Determine sustainable yields for a population of fish through a simulation activity called THE TOO MUCH GAME.

5.5 Discover that coral reefs are homes to many organisms and how to protect and conserve coral reefs in WHERE'S MY HOME, WHERE'S MY FOOD.



REFLECT

After completing the activities in this lesson, help youth reflect on what they have learned by asking the following questions:

- **Where are reefs found in Florida?**

  Reefs in Florida can be found from Biscayne Bay to Key West. Some reef-like formations can be found off the coast of West Palm Beach and off the extreme southwestern coast of Florida.

- **Name various ways reefs can be destroyed.**

  Reefs can be destroyed by dropped anchors, oil spills, garbage, erosion, careless divers and snorkelers, and tropical fish collectors.

- **Name some ways that people can help preserve the reefs that still exist.**

  Use marked buoys to anchor instead of dropping the anchor on top of reef formations, use caution while diving: never stand on coral, kick near coral, or touch coral. Always bring trash back to shore and dispose of it properly. Human developments can help be maintaining septic systems and by reducing storm water runoff. Shipping interests should use caution near reefs and marine sanctuaries. Bilge water and other effluents from large ships should be disposed of in proper areas.

APPLY

Help youth apply what they learned to their daily lives.

- What does sustainable mean? Is it possible to have sustainable ocean harvests? Do we need to determine what the population of each species is before we can harvest them? How would you determine this information?
- Find out facts from a Sea Grant Agent, Department of Environmental Protection, or other agency. Contact the state associations for both groups to determine each side's view point before you determine a solution.
- Name different types of regulations that biologists might apply to catching fish in Florida.
- Make a list of other natural resources that are regulated. List agencies that have authority over some of these resources?

BACKGROUND BASICS...Marine Ecosystems

Marine ecosystems cover an area greater than 70 percent of the Earth's surface. They contain some of the most diverse organisms and least known habitats of our planet. The ecological aspects of **oceanography** (the field of science that studies oceans) includes the distribution and interdependency of marine communities and ways they are influenced by the environment. Let's begin by looking at some of Florida's ocean ecosystems and factors that might influence these areas...

All ocean environments are influenced at least somewhat by currents. Currents can influence water temperature, salinity, nutrients and even weather patterns. These currents may occur due to the daily fluctuation of the tides or may be more constant "rivers" within the open seas. One such current or "river" is a very dominant factor influencing Florida's southern and eastern coastal areas. The **Gulf Stream** is a current which moves northward along the entire east coast of Florida eventually turning eastward across the north Atlantic. The currents of the Florida Straits along with other currents of the Caribbean and Atlantic help form the Gulf Stream. This current of warm water (86 degrees in summertime to 75 degrees in winter) may vary from 25-40 miles in width. At some points, such as the Palm Beach area, the Gulf Stream flows within several miles of the coast while at others it may be 75 or more miles offshore.

The warm water of the Gulf Stream has an effect on coastal water temperatures and can help moderate coastal air temperatures as well. The reef ecosystems of south Florida are very dependent on the Gulf Stream and currents of the Florida Straits for warm water during winter periods. Fish populations are also influenced by the warmer temperatures and nutrient rich waters which the current provides. Species including the billfish, tuna, mackerel, cobia, mullet, and tarpon are found in the Gulf Stream and surrounding waters. Seasonal migrations take place from north to south but overall the area provides a year round abundance of plankton feeding baitfish and associated predatory species.

Florida's offshore ecosystems along the peninsula are significantly different between the east and the west coasts. The east coast has a more abrupt drop off from shallow coastal waters to the deep water areas. Within several miles of shore, boaters can find themselves in 60-100 ft. of water on the continental shelf. The width of the continental shelf varies along this coast from several miles to 80 miles or more. On average the incline is about 13 feet per mile out to a depth of approximately 600 feet where the shelf drops off to the ocean bottom.

Along the western panhandle, particularly around Destin, drop offs occur within several miles of the shoreline. By comparison the west coast along the peninsula has a very gentle decline that averages only two feet per mile. This gradual slope is characterized by a sandy bottom and hard bottom, with outcrops of limestone rock at various depths. In some areas near Tampa, known as the "middle grounds," the limestone outcrops form significant reef habitat with relief of up to 55 feet.

Ocean Life Zones

Farther offshore, in the Gulf of Mexico, environments differ greatly in depth, light penetration, temperature and pressure. Marine scientists use these differences to categorize oceans into different zones. Oceans consist of two major divisions: the shallow areas along continents, called the neritic region, and the deep water oceanic region. If one searches the web, there are a number of illustrations of the different life zones in the ocean.

Neritic Region

The offshore area that extends from the low tide line to the end of the continental shelf is called the **neritic region**. This region makes up only 8 percent of the total area of the oceans, but is so fertile that most marine life is concentrated in these nutrient rich waters. This zone is 10 to 200 miles wide and reaches depths of 200 meters. The temperature and water depth, as well as nutrients and sediments received from land create an environment that is rich in life, particularly in the shallower **littoral zone** (about 15 meters deep) and the narrow **intertidal zone**. These areas are highly favorable to both large schools of surface swimming fish (pelagic) and benthic organisms. Benthic organisms, or benthos, are the marine organisms that live on or close to the ocean floor.

Oceanic Region

The oceanic region consists of the bathyal, abyssal and hadal zones. The **bathyal zone** contains the slope and rise of the continental shelf to a depth of 2,000 meters. This zone is regarded as a geologically active area with underwater avalanches and slides. In the upper regions of the

bathyal zone, the dim light forms an area sometimes referred to as the **twilight zone**. Only about 1 percent of the sunlight penetrating the ocean's surface reaches below this upper boundary. The dim light makes photosynthesis impossible, so plants are absent, and predators make up a greater proportion of the total population than in the neritic zone.

Many small fish and crustaceans that dwell in surface waters during the night spend their daylight hours in the safety of the twilight zone. Although this may protect them from predators on the ocean surface, they are also an important part of the diet for fish and squid which permanently inhabit the bathyal zone. Those consumers are in turn the prey of larger species, such as sharks and eels. The remains of animals eaten by predators sink downward and together with organic material from the continental shelf form the primary food source of benthic organisms. The scarcity of food in this zone has produced many special adaptations particularly for predators. Some, such as the viper fish, possess a gaping mouth with long curved teeth in order to capture and hold prey. Other species can produce light in complex bioluminescent organs. This light is then used to lure smaller prey species within striking distance of predatory jaws.

The **abyssal zone** is considered the deep ocean zone, reaching depths of 5,000 meters. It is the largest environmental unit in the world, covering over 75 percent of the total ocean area and more than 50 percent of the entire earth. Although life in the abyssal zone is relatively scarce due to darkness, cold temperatures, and great pressure, a wide variety of marine organisms dwell there. These organisms are entirely dependent on organic detritus sinking from the surface waters above. The detritus is eaten by shrimp, prawns, and benthic organisms which are in turn eaten by predatory fish.

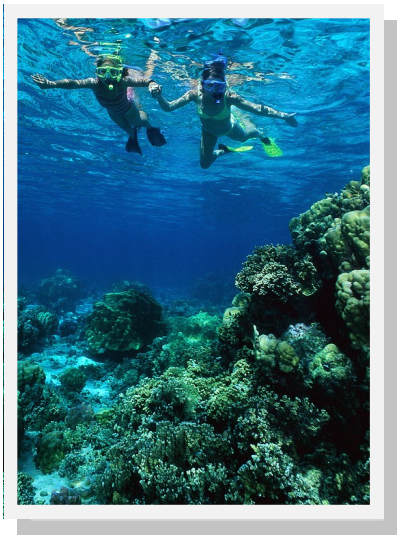
Like the inhabitants of the lower **bathyal zone**, many abyssal organisms are bioluminescent in response to the absence of sunlight. The light-producing organs serve as indicators for species recognition, as well as lures for attracting prey. Because the sparse amount of prey is not sufficient to sustain a large body, most abyssal fish are smaller in comparison to shallow water species. They also possess many unusual adaptations in order to capture and digest almost any food that becomes available. Fish, such as the gulper eel, have large mouths for consuming prey that are larger than themselves. Others such as the angler fish have pliable jaws and expanding guts for the same purpose.

The **hadal zone** makes up only one or two percent of the ocean and is located in narrow oceanic trenches. These zones are considered the deepest areas in the ocean reaching depths

of 6,000 to 11,000 meters, at the bottom of the Marianas Trench in the western Pacific. Light is absent from the hadal zone, where the temperature is near 1 degree Celsius, and pressures are exceedingly high (up to 1,100 times greater than atmospheric pressure). In spite of these inhospitable conditions, several hundred species of animals have been collected or photographed in this zone. Due to the pressure, life is limited to small detritus feeding benthos such as sea cucumbers and bacteria absorbing tube worms, which inhabit the deep sea ooze at the bottoms of trenches.

These open ocean zones, represent some of the last frontiers on the planet and contain an abundance of valuable and intriguing ecological information. As oceanographers develop new techniques to explore the depths, they gain more information about the organisms that live there, the food webs these organisms are part of, and how these areas may influence global weather patterns. An understanding of our marine ecosystems will gain increasing importance as we face challenges of future exploration, preservation, and sustainable exploitation of our planet's resources. Now, let's explore ecosystems that may be a bit more familiar to us.

Coral Reefs



Beneath the smooth blue-green surface of Florida's ocean water lies an ecosystem which is as rich in plant and animal life as a tropical rainforest. It isn't necessary to hack our way through a hot, steamy jungle to observe the beauty and color of this ecosystem. We can simply don a mask and snorkel then plunge into the underwater world of the coral reef ecosystem.

There are more than 68 million square miles (600,000 sq. kilometers) of coral reef in the world's oceans. In the United States, coral reefs are only found off the southeastern coast of Florida, around Hawaii and the islands in the American Pacific region. Corals require year round water temperatures above 64 (F.) degrees to survive. This limits distribution of corals to approximately 22 degrees latitude north or south of the equator. The water must also be clear and clean for corals to develop. Corals will generally grow in waters from 10-130 feet deep. The depth at which corals can

grow is determined by the amount of sunlight that is able to penetrate the water column. Therefore, in areas of better water clarity, corals will exist at greater depths.

Corals come in many different shapes, sizes, and colors, but there are basically two types: stony and soft. The stony corals are hard, with names like elkhorn, staghorn, and brain coral which describe the ways they are shaped. Soft corals look more like underwater plants that sway with the currents. Sea plumes, sea fans, and sea whips are examples of soft corals.

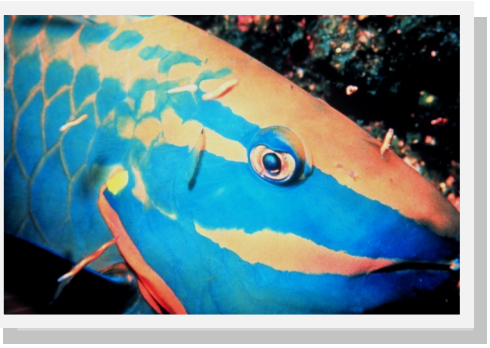
All corals are made up of small marine animals called **polyps** which range in size from 1/16 inch to 10 inches. A living polyp looks like a soft little sack with a circle of tentacles that wave around its mouth to catch bits of food drifting through the water. Corals also get food from tiny single celled plants, called **zooxanthelle**, that live inside their tissue. *(Photo: NOAA)*

Every coral structure is composed of many individual polyps living side by side in **colonies**. They are all joined together by a slippery outer skin to form a living coral. As the polyps grow they bud and branch out, sprouting and building new layers. Corals that enlarge by adding length to branch tips, like staghorn coral, may grow up to 4 inches annually. However, studies in Florida have shown that large boulder corals may only add a half inch per year. As the polyps multiply and grow over long periods of time, their skeletons form large masses of coral rock. The hard skeletal matter is made of calcium carbonate--the same substance that forms our bones, chalk, teeth, and sea shells. Thus, it requires hundreds of years for a coral reef to develop and a mature living reef may be 5,000 to 10,000 years old.

Corals form three different types of reef; the **fringing** or **bank reefs** which border the shorelines in tropical seas, **barrier reefs**, which form farther offshore, and **atoll reefs**, which develop around volcanic islands, or other geologic formations, producing a central lagoon as the island sinks into the ocean. There is one barrier reef in Florida, extending from Biscayne Bay to the southern tip of the Keys. Fringing reefs also occur in the Keys and are further classified into four subtypes, according to where they are found: patch, hard bottom, outer bank, and deepwater banks.

Patch reefs are circular areas of coral habitat found scattered throughout the sea grass beds in shallow waters up to 50 feet deep. **Hard bottom reefs** also occur in shallow waters where a

rocky sea floor is covered by a thin layer of living coral. The **outer bank reefs** are farther from shore where waters deepen, corals grow higher here providing more relief and habitat for larger fish. **Deepwater banks** occur when the sea floor drops off to depths of more than 100 feet. Corals begin to diminish at these greater depths depending on the water clarity and amount of sunlight available.



A large reef ecosystem may contain up to 3,000 different species of plants and animals. These organisms rely on the reef for food, shelter and breeding habitat; damsel fish and wrasses use corals for protection, triggerfish eat sea urchins living on the reef, parrotfish use their "beaks" to graze the algae covered corals. Red, brown, and green algae, as well as a wide variety of sponges and gorgonians, live on and among the corals. Crabs, lobsters, shrimp and marine worms also find homes in the crevices and holes of the coral formations. *(Photo: NOAA)*

There are numerous **symbiotic relationships** in which two dissimilar species live closely together and are interdependent upon each other. When this relationship benefits both species it is called **mutualism**. For example, porkfish are "cleaners" eating from the teeth of groupers in a mutualistic relationship. The most commonly known symbiosis is **parasitism** in which one species benefits and the other is harmed. Nearly every animal living on the reef has one or more parasites living on or in it. Another symbiotic relationship occurs when one organism benefits but the other does not, this is called **commensalism**. Ringed anemones and urchin crabs live in a commensal relationship (the anemone protects the crab from predators), as do pistol shrimp and gobies (the goby alerts shrimp to predators)

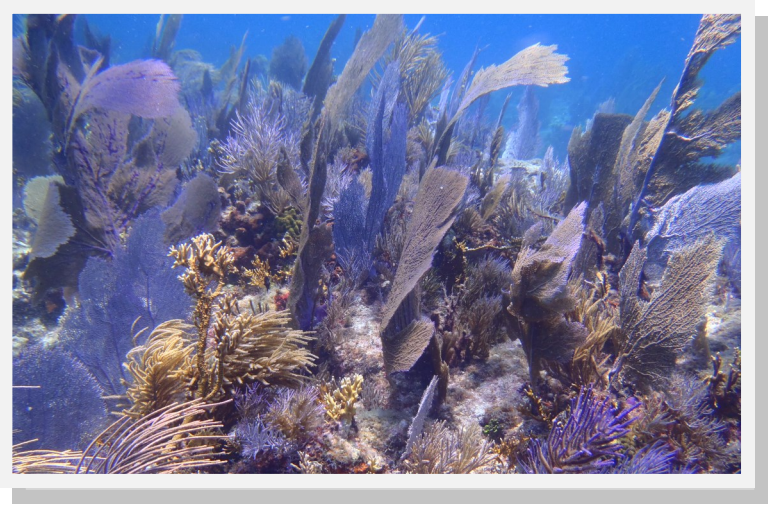
CONCLUSION

Florida's marine ecosystems play a major role in the state's economy. Deep sea and offshore fishing produce commercial and sport industries worth millions of dollars annually. The beauty of the ocean, beaches and coral reefs also draw visitors from all over the world making tourism the number one industry. Reefs protect the shoreline against destructive storms and beach erosion by slowing down the movement of ocean waves thus saving millions of dollars in costly repairs. All these factors have been successful in motivating people to protect and not destroy the fragile reefs and offshore areas surrounding the Florida Peninsula.

However, threats to the health and survival of marine ecosystems increase with greater usage and population growth. Shoreline development and harbor dredging disrupt life on the reef and continental shelf. Silt from soil erosion can smother reef organisms. Pollution such as sewage, chemicals, and oil reduces fish populations and kills coral. Over harvesting of valuable reef organisms upsets the natural balance of the ecosystem, and exploitation of prized fish populations will mean fewer fish in the future.

One way in which our reefs can be preserved from destruction by man is through the establishment of marine preserves, which are areas protected by state and federal laws. The John Pennekamp Coral Reef State Park in the Florida Keys is the world's first such preserve with over twenty square miles of protected marine communities. The Biscayne Bay National Monument and the Florida Keys Coral Reef Marine Sanctuary are two other examples of areas where the fragile marine life of the coral reef has been identified as a treasure to be preserved.

The open ocean contains an abundance of valuable and intriguing ecological information. However, the great depth of some zones makes exploration difficult and knowledge of these areas remains limited. An understanding of our marine ecosystems will gain an increasing importance as we face challenges of future exploration, preservation, and sustainable exploitation of our planet's resources. The oceans and seas are vast and intricate frontiers that deserve our interest, respect and concern.



Activity 1: Water Web

OBJECTIVES: For youth to

- Collect information about marine organisms.
- Create a mural of different examples of marine food chains.
- Identify examples of marine food webs.
- Describe the interrelationships in a marine ecosystem.

LIFE SKILLS:

- Acquiring, analyzing and using information.

SUNSHINE STATE STANDARDS

SC.7.L.17.1 Explain and illustrate the roles of and relationships among producers, consumers, and decomposers in the process of energy transfer in a food web.
C.5.L.17.1 Compare and contrast adaptations displayed by animals and plants that enable them to survive in different environments such as life cycle variations, animal behaviors, and physical characteristics.

MATERIALS

- A large bulletin board or enough wall space to create a mural 4' x 8'
- Large pieces of blue paper for background, construction paper
- Markers, crayons, pens
- Tape, glue, pins, scissors
- Resource materials on marine life: magazines, books, brochures, etc.

TIME: 2-3 hours, can be split into two phases of 1 or 1½ hours each

ADVANCED PREPARATION

Instructor should create folders of information on selected marine plants and animals. Include pictures cut from magazines, calendars, and articles of information from nature journals or other sources. If possible, select a variety of plants and animals so folders contain examples of primary producers and secondary or tertiary consumers, like sharks. Find examples of vertebrates and invertebrates, predators and prey. Use the information on phytoplankton provided in this activity as your own example, to illustrate the first key component in the marine food web.

INTRODUCTION

A food chain shows the transfer of energy from one organism to another. Plants form the base of almost every food chain on Earth, using the sun's energy to make their own food through photosynthesis. Like animals on land, most animals that live in the ocean depend on plants for food. The most important marine plants are single-celled plants called phytoplankton. Millions of these tiny plants can be found drifting in the sunlit layers of water wherever there is enough light and nutrients to support their growth.

There are dozens of different species of phytoplankton. Diatoms and dinoflagellates are two of the larger, more common ones. Under a microscope, phytoplankton appear in many different shapes: some are round, some are elongated, some have long whip like flagella that are used for locomotion. They can reproduce sexually or asexually, and some species of dinoflagellates can reproduce in number so rapidly that the ocean waters become discolored. The "red tide" is caused by these dinoflagellates and is also toxic to many forms of marine life. Tiny animals called zooplankton feed upon phytoplankton, as do clams, oysters, mussels, and small fish. Can you guess what kinds of animals eat zooplankton?

We are going to learn more about marine organisms and what they feed on in the following research exercise.

Do

- Divide the group into teams of two to four youth. Ask each team to brainstorm all the components they think they would need to make a healthy ocean. Invite them to share their ideas with the rest of the class.
- Starting with the examples of plankton in the introduction, make a list of plants and animals that live in the ocean. This list may include turtle grass, sargassum, phytoplankton, sea turtles, tuna, flounder, sharks, etc. Have everyone participate and write down as many examples as possible on a large sheet of paper so everyone can see it.
- Have each team select a marine organism to study. Allow them to choose one of the prepared folders if they wish. Make sure the teams select a wide variety of plants and animals. Depending on the size of the group, you might want to assign an organism to each team to make sure that all levels of the food chain are adequately represented.
- Instruct teams to collect as much information as possible about their organism. Animal teams should answer the following questions:
    - In what part of the ocean does this animal live? (in the deep waters, in the coral reef, in the sea grass bed)
    - What does it need to survive?
    - Does it require shelter?
    - What animals does it prey on? Does it eat plants?
    - What animals prey on it?
    - How does the animal influence its environment?
    - Plant teams should answer these questions:
    - What does the plant need to survive?
    - At what depth is it found?
    - Does it live near other plants? If so, what kinds?
    - What animals live with this plant?
    - What animals eat this plant?
    - How does this plant influence its environment?

- Ask teams to find photographs or drawings of their plant or animal. They may want to create their own drawings or representations using construction paper and markers
- While the research is being done, create the mural board by covering a wall space or bulletin board with blue paper. Place the drawing of phytoplankton in the mural.
- Give youth about an hour to complete their work. When everyone has finished their research, direct their attention to the mural. Explain that they are going to create a representation of an ocean ecosystem. Then, reintroduce the phytoplankton. Ask for a team who has researched an animal that eats phytoplankton to come forward, affix their drawings or pictures to the mural, then report their findings to the rest of the group.
- When the first presentation is finished, draw a circle around the organism in the mural using a black marker and then draw an arrow from the phytoplankton to the organism that consumes it. Continue adding to the mural until it is complete, connecting the prey to the predators as each one is presented. When you are finished you will have illustrated a food web.
- Ask each team to make sure that no connections have been missed, that each organism is appropriately attached to the other components of the mural. Observe and discuss the relationships of the resulting food web.

REFLECT

- **The arrows in our web show the flow of food energy from one organism to the next. All the arrows leading from the phytoplankton, which are producers, point to other organisms called consumers. Why are they called consumers?**

  They are called consumers because they cannot make their own food. They must consume other organisms to survive.

- **Which animals would probably have trouble surviving if there were suddenly no more phytoplankton?**

  All animals would be effected, even if they are remotely connected, because the plankton forms the base of the food web.

- **Are there any organisms in the web that are not important to the ecosystem as a whole?**

  No, because everything is connected. Some organisms may be more essential than others in maintaining a healthy ecosystem, but all elements are needed to create a balance. When a connection is broken, it will directly or indirectly affect others.

- **What important elements are not included in our web?**

  Answers could include any species of plant or animal left out, or any major components of marine ecosystems like a coral reef of mangrove forest.

- **What about human beings? Do they belong in the web?**

  Yes, man is a "top predator," feeding on many of the other organisms in this ecosystem.

APPLY

- After learning about the importance of phytoplankton in marine food webs, have everyone take a close-up look at plankton using a microscope. Can you identify different kinds of plankton?
- Paint a mural of ocean life on a wall! On an indoor or outdoor wall space, first draw your plants and animals with pencil, then use water-based paints to create a colorful marine scene. Use plenty of blue and green for a watery background, and when it is dry, cover the mural with a coat of varnish to keep it from deteriorating. Title your work of art with a phrase or slogan.
- How do humans fit into the "Water Web"? Do you eat or use anything from the marine environment? If so, create a water web with you as the "top predator." How do you affect the marine environment?

Activity 2: Ocean Harvest

OBJECTIVES: For youth to
- Identify historical and contemporary fishing techniques.
- Explain the concepts of sustainable resources and conservation.
- Explore the relationship between humans and the sea.

LIFE SKILLS:
- Acquiring, analyzing and using information.
- Problem solving and decision making.

SUNSHINE STATE STANDARDS
SC.4.L.17.4 Recognize ways plants and animals, including humans, can impact the environment.
SC.7.L.17.3 Describe and investigate various limiting factors in the local ecosystem and their impact on native populations , including food, shelter, water, space, disease, predation, and nesting sites.
SC.912.L.17.18 Describe how human population size and resource use relate to environmental quality.
SC.912.L.17.15 Discuss the effects of technology on environmental quality.

MATERIALS
- Nets with different mesh sizes (onion bags, potato bags, fruit bags, cloth, garden netting)
- One pound each of lima beans, pinto beans, black beans, lentils and rice
- Four containers big enough to hold 1/4 of the grain and beans
- Field notebooks
- Pencils

TIME: 30 Minutes

SETTING: Classroom

INTRODUCTION

Fish are the main source of protein for nearly half of the earth's five billion people. Humans have fished since prehistoric times and probably started by wading into shallow wetlands using their bare hands or clubs. Later, they built rock weirs or dams on streams and rivers, trapping and spearing the fish in holding ponds. People made hooks, lines, and baskets to catch fish, and eventually developed nets. Nets substantially increased catch size, changing fishing from a small scale subsistence activity to a major economic venture. A great variety of nets were developed, for catching different species in different habitats. Gill nets, purse seines, trammel nets, and drift nets greatly improved the catch rate.

Boats and rafts have been used for fishing since the Stone Age. The technology gradually improved from dugouts to sailing vessels, to steam and diesel-powered vessels. Each technological advance expanded human fishing territory, until today we can fish anywhere in the world.

Nets and boats made it possible to catch increasingly larger amounts of fish. Commercial fishers now routinely use sonar fish-finders, radio communications, spotter aircraft, computerized navigational equipment, at sea catch processing, and other sophisticated tools. However, these technologies have created problems, such as accidently killing other marine life, over-harvesting, and destruction of marine habitats.

For example, in large commercial net operations, mixed species are caught inadvertently along with the target species. The unwanted fish must be culled from the nets

and returned to the sea or sorted later. Sometimes these unwanted fish are used for oil, animal feeds or other products.

Today, nearly fourteen million tons of sardines, herring, and anchovies are netted commercially each year. Approximately thirty-two million tons of other kinds of fish are caught annually. Japan, Russia, and China catch more fish than other nations. With increasing sources of fish, new markets were created. Currently, human consumption of fish as food is only 35% of the total catch. The remainder are used for fertilizer, oil, pet food, and fish meal to feed livestock.

There are serious concerns about excessive fishing of some species. The single most critical issue in species survival may be suitable habitat. Inshore breeding grounds are being lost at an alarming rate. Shoreline development, municipal/industrial wastes, and dredging activities are all contributing to this loss. Because no one knows how many fish there are in the sea, it is difficult to know how the populations of species may have changed.

Many commercial fishers are reporting fewer fish in many traditional fishing sites. Concerns about reduced populations have led more countries to extend territorial limits and develop more stringent regulations for freshwater and marine fisheries. Enforcement of these regulations is very difficult. There are success stories, however. Some species seem to have reached a balance between catch and reproduction rates. In the Great Lakes, a few species have been brought back into a dynamic balance after previous depletion of populations by excessive fishing and pollution.

Do

- Prepare the "ocean" by mixing all the beans and grains. Then divide the mixture equally into the four containers. These are the four "fishing grounds." Divide the group into four teams and assign a fishing ground to each one.
- As a group, decide what type of fish each bean will represent. For example, the lima beans may be salmon, lentils may be red snapper, pinto beans may be tuna, and rice may be herring. Make a large chart matching the beans and grains with the fish they represent and place it so everyone can see it.

- Discuss how fish are caught, including techniques used by the youth themselves. Talk about how fishing technology has improved through the centuries.
- Cut out coarse netting, about four inches by six inches, making one net for every three people. To simulate commercial fishing, have everyone make one pass with a net through the fishing ground. They must hold the net in only one hand, so that the distance between their thumb and first finger is the catching area. Give each person a sheet of paper for a "boat" to put their catch in. Count the number of each kind of fish caught and record it on the chart.
- Repeat the procedure using both hands to hold the net, and record the catch.
- Return all the fish to the ocean and fish again with finer nets (less than 1/4-inch mesh). Again, record the results.
- Now after returning the fish to the ocean, tell the group that all the fish, beans through rice, are different sizes of the same species. Catching a fish smaller than the black bean size will cost them a point. Appoint two people in each team to a regulatory agency that will give the fishers ten seconds to return all undersized fish to the ocean after each netting. After ten seconds, the regulatory agents will count the undersized fish still left and fine the fishers one point for each one. Have them dip with the fine net.
- Repeat with the larger mesh nets, and record results.

REFLECT

- **How does this game compare to harvesting fish from the ocean?**

  The large nets do not discriminate, many species are caught in the net in addition to the targeted species.

- **Has commercial fishing technology helped or hindered ocean harvests?**

  Technology has made it possible to meet the increasing demands for fish products but, as a result has seriously depleted some stocks of fish.

- **Should fishing regulations be imposed worldwide? Why or why not?**

APPLY

- Research fishing techniques of the past. How did Calusa Indians fish? European Settlers? Prepare a skit to demonstrate various fishing practices of the past.
- What does sustainable mean? Is it possible to have sustainable ocean harvests? Do we need to determine what the population of each species is before we can harvest them? How would you determine this information?

Activity 3: Fishy Business

OBJECTIVES: For youth to:

- Identify at least five fish living in Florida's marine environment.
- Describe the identified fish characteristics and habitats.
- Identify three harvest methods for fish in Florida.

LIFE SKILLS:

- Acquiring, analyzing and using information.

SUNSHINE STATE STANDARDS

SC.7.L.17.3 Describe and investigate various limiting factors in the local ecosystem and their impact on native populations , including food, shelter, water, space, disease, predation, and nesting sites.
SC.912.L.17.18 Describe how human population size and resource use relate to environmental quality.
C.5.L.17.1 Compare and contrast adaptations displayed by animals and plants that enable them to survive in different environments such as life cycle variations, animal behaviors, and physical characteristics.

MATERIALS

- Fishing Lines: Angler's Guide to Florida's Marine Resources
- A variety of fresh fish
- India ink or printing ink, or water-based ink
- Rice paper, fabric or plain paper

TIME: 2 hours for field trip, 1 hour for fish printing

SETTING: Fish Market, indoors.

ADVANCED PREPARATION

Select a local fish market that your group might visit. Contact the market in advance and arrange for a brief presentation by an employee. Suggest that you are interested in finding out about the various species of fish that the market handles, where they come from and how they are handled.

INTRODUCTION

There are dozens of fish species in Florida's coastal and open waters. The commercial fishing industry and recreational fishing are extremely important to the economy of Florida. It is necessary to recognize fish, know their characteristics, feeding habits, the habitat in which they live and the specific regulations for a species before attempting to cast that line or net. **Fishing Lines: Angler's Guide to Florida Marine Resources** is an excellent resource for fish identification and rules and regulations regarding fishing. This publication can be found and downloaded online at http://myfwc.com.

A local fish market is an excellent resource for fish identification and to learn about the commercial aspects of fishing in Florida. After reviewing Fishing Lines, plan a trip to a fish market.

DO

- Have youth develop questions for the fish market manager, or other fish market employee. Encourage youth to include questions on fish species available for sale, any restrictions which apply to those species, (size limits, seasonal availability, quantity limits, etc.) What are various harvest methods for fish? How does the fish arrive at the market and how is it stored?
- Make a list of the fish available for sale at the time of the visit. Ask the fish market manager or use the Fishing Lines publication to learn facts about each fish species.

- At the fish market, pick out several fish for making fish prints! Fish printing or gyotaku is an ancient Japanese technique of capturing detailed printed impressions from fish.
- Use one of three types of ink: India ink, printing ink or water-base ink if the fish will be eaten after printing. Make sure to cover the working surface with lots of newspaper before printing. Paint the fish completely on one side with the ink of choice.
- Place paper or fabric on top of the inked side of the fish and press lightly over the entire fish.
- Carefully lift the paper or fabric from the fish. Lift the paper straight off the fish to avoid smearing. If water-based ink is used, the fish can be washed, cleaned, and eaten, or frozen for future use.

REFLECT

- **How many different fish were available for sale at the time of the visit?**
- **Name five fish you saw.**
- **In what habitats can these fish be found?**
- **What are the capture methods for various commercially harvested fish?**
- **Do you feel laws are fair or unfair concerning fish harvests? Why?**
- **Do we know if these populations are a sustainable resource?**

APPLY

- There are often conflicts between commercial fisherman and recreational fisherman. Why are there conflicts? Determine what you think can be done to solve conflicts. Find out facts from a Sea Grant Agent, Department of Environmental Protection, or other agency. Contact the state associations for both groups to determine each side's view point before you determine a solution.
- What would it take to open a fish market in your area? Would it be profitable? Could you guarantee fish all the time? Contact your local fish market or grocery store fish market about the availability of fish on a year round basis.

Activity 4: The Too Much Game

OBJECTIVES: For youth to:

- Discover that collecting too much of a marine resource is not always the best choice.
- Understand the concept of sustainable yield as it relates to fishery resources.

LIFE SKILLS:

- Problem solving and decision making.

SUNSHINE STATE STANDARDS

SC.4.L.17.4 Recognize ways plants and animals, including humans, can impact the environment.
SC.6.N.1.4. Discuss, compare, and negotiate methods used, results obtained, and explanations among groups of students conducting the same investigation.
SC.8.N.4.1 Explain that science is one of the processes that can be used to inform decision making at the community, state, national, and international levels.
SC.8.N.4.2 Explain how political, social, and economic concerns can affect science, and vice versa.

MATERIALS

- Fishing Lines: Angler's Guide to Florida Marine Resources
- A variety of fresh fish
- India ink or printing ink, or water-based ink
- Rice paper, fabric or plain paper

TIME: Approximately 30 minutes

SETTING: Indoors anywhere large enough for the small groups to separate and play the game.

ADVANCED PREPARATION

Count out 16 peanuts, goldfish crackers or other food item you might use and put these into the boxes that will be used by the groups. Copy the rules to a chalkboard or make enough copies on small note cards for each group of four.

Introduction

The Taking Too Much? game is designed for you to think about how fish populations might be harvested and how this harvesting activity can be sustained (maintained) over a long period of time. Imagine that you are a member of a fishing village and you that you fish for several species of fish. The most valuable species is the "community grouper" an imaginary species of fish. This species is an extremely valuable food fish and travels in large schools making it relatively easy to catch.

The object of this activity is to attempt to make a living from the sea. To do this you must catch fish but how many fish during each fishing trip is the question you must determine. You will be allowed several rounds (or seasons) to fish in your ocean. See how well you can maintain the community grouper fishery in your ocean while sharing the resource with other members of your fishing village. (The **Fishing Lines** publication can be found and downloaded online at http://myfwc.com.)

Do

- Divide your group into teams of four each and give each team a box with the 16 "Fish." Go over the rules as follows: During each round you will have two fishing trips in which you may harvest fish. You will be limited to a harvest of three fish per round per person. It is your decision as to how many fish you take but remember you must earn a living by fishing.

- Remember, no fish may be returned to the ocean after it is caught. The fish in the ocean will reproduce just as natural populations might. Make sure that all members of your group can see how many fish you have harvested. After each round is finished wait for instructions from your leader before continuing.
- After each group of fishers has harvested their portion during a round, replenish the stock in each box by doubling the number that remains. Then repeat the procedure for another round or season. Continue playing up to three or four rounds with two fishing trips per round per person.
- If any group wipes out their population of community grouper then they should sit out the remaining rounds.
- Have each group keep track of their catch to report at the end of the activity.
- This catch data can be entered on a sheet of newsprint or on a chalkboard. Once the data is recorded let the participants eat their catch.

REFLECT

- **Which group harvested the most fish at the end of all the rounds? Why do you think this group did better than the others? Did any single individual do better than all the others? Why?**
- **Once the group went through a round did you begin to talk about how many each member of the group should catch? Did the fish population do better once the group began to cooperate?**
- **What was the best number of fish to harvest per person per round to insure the greatest numbers that would be replenished and the greatest numbers to harvest?**

The answer should be two per person per round. This harvest rate would leave eight fish in the box. The leader could then replenish the population with eight new fish after each round, bringing the population back to 16.

- **Could this population of community grouper be sustained or maintained over long periods of time?**

  Yes, the answer to the question above would provide the most consistent results unless the group let the population grow by not harvesting or limiting harvest for a season. Although, this may not be possible in nature because populations have a carrying capacity that would not allow them to grow beyond a certain number.

- **If each person harvested three fish per round, how many fish would the leader be able to replenish?**

  Three fish times four fisherman would equal twelve fish, leaving four in the box. The leader could only replenish four fish bringing the population back to only eight fish for the next round.

- **Could the fishing group actually increase the number of fish in their ocean?**

  Yes, if the group harvested only one per person per season the remaining twelve fish would be replenished to increase the total to 24 in the ocean.

- **How would regulations in the real fishing world help maintain populations? What might happen if no regulations were established?**

  Regulations would limit the number of fish harvested and thus help quarante adequate stocks for future years.

- **Name different types of regulations that biologists might apply to catching fish in Florida.**

  Answers might include: Length limits, Boat limits, closed seasons, daily bag limits, and equipment restrictions (e.g., net or mesh sizes).

- **Make a list of other natural resources that are regulated. Are some of these resources more fragile or limited than others? Why? What agencies have authority over some of these resources?**

  Forest resources and wildlife are regulated by various agencies including the Florida Game and Freshwater Fish Commission, the U.S. Forest Service, and the U.S. Fish and Wildlife Service. Other resources may be very fragile due to the reproductive capacity of the species. For example: Sharks have very few offspring compared to some fishes that may lay millions of eggs each year. Sharks also take longer to mature before producing young.

APPLY

- Conserving marine resources is necessary to insure future harvesting from the sea. Make a list of everything you can think of that we harvest from the marine environment in Florida. Do you use any of these products in your daily lives?
- Contact a Sea Grant Agent to learn about all the variety of marine life that is harvested. These Agents may also have information on regulations and amounts that are harvested in Florida waters.
- Call the Florida Marine Patrol in your area and ask for a copy of the most current regulations. Review these to determine if specific regulations apply in the areas you might fish.
- Visit a local fish house and see if a tour might be possible. Prepare a list of questions to ask about harvest methods, equipment restrictions, and quotas.

Activity 5: Where's My Home, Where's My Food?

OBJECTIVES: For youth to
- Discover that coral reefs are homes to many animals.
- Identify predator/prey relationships within coral reef communities.
- Discover that coral reef destruction affects many animals.
- Determine ways to protect or conserve coral reefs.

LIFE SKILLS:
- Acquiring, analyzing and using information.

SUNSHINE STATE STANDARDS
SC.4.L.4 Recognize ways plants and animals, including humans, can impact the environment.
SC.5.L.15.1 Describe how, when the environment changes, differences between individuals allow some plants and animals to survive and reproduce while others die or move to new locations.
SC.7.L.15.3 Explore the scientific theory of evolution by relating how the inability of a species to adapt within a changing environment may contribute to the extinction of that species.

MATERIALS
- Coral reef creature pictures cut out individually
- Yarn
- Chairs or cardboard boxes to form the "reef" structure. (Need a sufficient number of chairs or boxes to support reef dwellers minus one.)
- Whale sounds music (optional)

TIME: 30 minutes
SETTING: Outdoors or large inside area.

ADVANCED PREPARATION
Find at least eight photos or illustrations of reef inhabitants. Youth might also draw pictures of reef inhabitants. The Audubon Field Guides can be used to find photos and illustrations. These guides will also provide information related to food habits of reef inhabitants. Cut these pictures out and use yarn to make the picture a "necklace."

INTRODUCTION

Coral reefs are home to a diverse array of animal species. These animals are dependent on coral reefs for their survival. Each animal in the reef ecosystem has a special habitat, some dwell in crevices, others move over the reef surface (i.e., starfish). After youth are assigned a reef creature, have them think about where their creature might live in the reef.

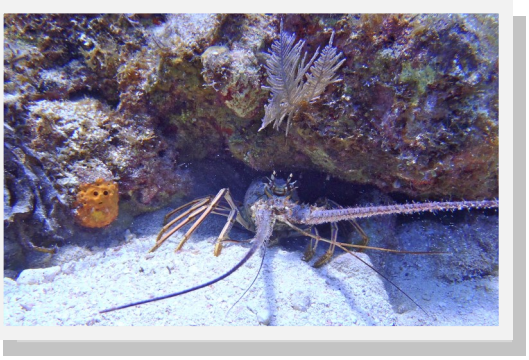
There are several ways in which coral reefs are destroyed, including boaters who carelessly drop their anchors on the reef causing parts to break off, ocean pollution such as oil spills and garbage from boats, erosion from land areas which causes soil and sentiment to block sunlight, careless divers and snorklers who touch the reef or hit coral with their fins, and tropical fish collectors who damage the reef in their collecting efforts.

"Where's My Home/Where's My Food" will help youth to visualize how coral reef destruction affects animals dependent on this habitat for survival. This activity will also help youth understand the food relationships between reef inhabitants.

DO (Part 1)

- Cut out pictures of reef animals and use yarn to make the picture a "necklace." Use one picture for each youth. Each youth will represent one reef animal.
- Divide youth into two groups. All youth that are reef fish will be group one and group two will be reef "dwellers." Reef dwellers can be lobsters, shrimp, crabs, octopus, sea slugs, starfish, etc.

- All reef animals should find a place around the "coral reef" by sitting in a chair.
- When the leader says, "Find a hiding place," reef animals will get up and begin searching for a new hiding place. As in musical chairs, a hiding place (chair) should be removed. When the leader says, "Hide, here comes a predator!" the reef animals will stop their search and sit in a chair (or in a box that represents a reef crevice). One youth should be a shark and will eat the animal without a hiding place, or this animal must leave the reef. Any animal without a hiding place will not survive.
- Each time a round is played, the shark should "eat" the homeless animal and a hiding place should be taken. Remind youth that reefs take a long time to form but can be destroyed in a very short time.
- Continue the game until there are no more hiding places. Have youth talk about ways in which the reef can be destroyed and how these affect the entire reef community.



(Part 2)

- Use the activity sheet FEEDING METHODS and unscramble the names of the predatory reef fish.

REFLECT

- **What will happen to the shark?**

  The shark will eventually die because it will have nothing to eat since the reef was destroyed.

- **Name various ways reefs can be destroyed.**

  Reefs can be destroyed by dropped anchors, oil spills, garbage, erosion, careless divers and snorkelers, and tropical fish collectors.

- **Where are reefs found in Florida?**

  Reefs in Florida can be found from Biscayne Bay to Key West. Some reef-like formations can be found off the coast of West Palm Beach and off the extreme southwestern coast of Florida.

- **What businesses rely on the reefs in Florida for there survival?**

  The primary businesses that rely on coral reefs are recreational fishing, commercial fishing, diving, snorkeling, and glass bottom boats.

- **Name some ways that people can help preserve the reefs that still exist.**

  Use marked buoys to anchor instead of dropping the anchor on top of reef formations, use caution while diving: never stand on coral, kick near coral, or touch coral. Always bring trash back to shore and dispose of it properly. Human developments can help be maintaining septic systems and by reducing storm water runoff . Shipping interests should use caution near reefs and marine sanctuaries. Bilge water and other effluents from large ships should be disposed of in proper areas.

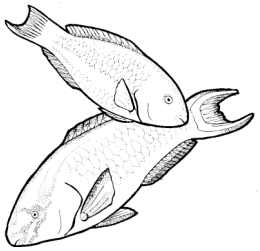
APPLY

- Research agencies and organizations with an interest in coral reefs. (There are many in Florida!) What do they do to educate about reefs? What do they do to help preserve reefs? Hint: check the Internet for additional information on agencies that have marine and reef interests.
- Choose a reef animal to learn more about. Do we know how stable the population of this creature is? How many exist today? Is this animal endangered? What can you do to protect this animal?

Feeding Methods—Ways of Survival

Unscramble the names of these reef animals

This predator has an unusual mouth which helps it bite off chunks of the reef for food.



FSRAPTOIHR

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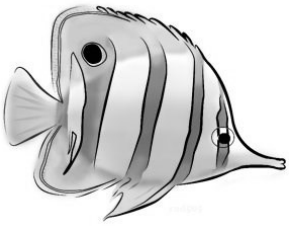
This predator has a long pointed mouth to take tiny prey from the reef and small cracks.



HFTYFBELUTRIS

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This predator feeds on bivalves. It has radial symmetry and its body is covered with small spines.

EATASRS

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This predator feeds on zooplankton—an assortment of tiny animals floating or drifting in the ocean current.

LRPLYOPCAO

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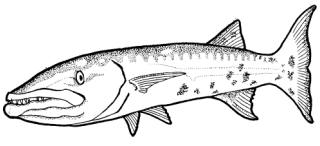
This predator is able to move quickly to seize small fish in it's sharp teeth.



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