

Lesson 5 - Study Materials for the 2010 State Marine Ecology Event: The following information will be used to develop 5-8 multiple-choice questions that will be ADDED to Section 5 of the MEE. Study suggestion: Develop questions using the information below and place them on flash cards. "Quiz" each other using the flash cards. This information comes from the 4-H Marine and Aquatic Ecosystems Leaders Guide.

Lesson 5: Coral Reefs and the Open Ocean

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) study 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.

The Florida Gulf Stream

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 that 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.

Offshore Ecosystems

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 ft 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'.

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: shallow areas along continents, called the **Neritic Region**, and the open-water, often deep **Oceanic Region**.

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. In most of the region, light penetrates to the bottom supporting a rich diversity of plant life. 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 extends seaward from the edge of the continental shelf. It consists of the **bathyal**, **abyssal** and **hadal zones**. The **bathyal zone** includes the area of water over the continental slope and rise 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 that 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 then eaten by shrimp, prawns, and benthic organisms that in turn are 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 1 or 2 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 on 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** that 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.

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.

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.

Vocabulary to know! *Try to make these into flash cards and write down an interesting fact or two about each stated in Lesson 5.*

1. oceanography
2. Gulf Stream
3. continental shelf
4. oceanic region
5. neritic region
6. bathyal zone
7. twilight zone
8. abyssal zone
9. viper fish
10. bioluminescent organ/bioluminescence
11. detritus
12. hadal zone
13. coral polyp
14. coral reefs
15. zooxanthelle
16. bank reef
17. barrier reef
18. atoll reefs
19. patch reefs
20. symbiotic relationship

Find these answers in the lesson!

1. Why is the Gulf Stream important to Florida's marine life?
2. How is the east coast seafloor different from the west coast seafloor?
3. What ocean region is the most rich in marine life and why?
4. What are some adaptations that deep sea animals have that help them survive?
5. What do corals need in order to grow?
6. Where is Florida's barrier reefs located?
7. Why are coral reefs important?
8. Can you explain the difference between mutualism, parasitism, and commensalisms? Can you give examples of each one?