

Week 3: Prey and Predator

This week's lecture is all about the coral reef ecosystem and reef food chain. Like all ecosystems, the coral reef food chain is a complex interaction with many species that is carefully balanced by nature. Therefore, this week all the activities are geared toward the food chain, predator prey interactions, and survival of the fittest. Like all food chains, there are natural checks and balances that keep species in check but what happens when invasive species like the Lionfish are introduced?

Exercise 1:

Food Chain Models

(This may be better for younger classes)

Materials:

- string
- coat hanger
- pictures of plants and animals
- scissors
- glue

Teachers:

Instead of the students, each making a model you can make one big model with pictures on the white board if it would work better. Have extra pictures of animals so when you add the invasive species you can show how other populations will increase dramatically.

Have students make a food web and discuss which organisms are producers, consumers, carnivores, omnivores etc. Discuss the transfer of energy from each organism. Talk about bioaccumulation in the higher levels of the food web. You can also demonstrate how bringing in an invasive species can affect the other species in that biome.

What is happening?

Students are able to visualize the relationships animals from an ecosystem have. They can identify the role that each organism has in the ecosystem and they can visualize what happens when an invasive species is introduced into the ecosystem.

How this relates to Jessica and Bruce:

There are invasive species everywhere. The one Jessica and Bruce are dealing with the most is the Lionfish. The Lionfish is an invasive species that is from the Indo Pacific Ocean. The Lionfish are carnivores that eat anything from little shrimp to numerous types of small fish. They reproduce very quickly and have large brood numbers to ensure the growth of the next generation. They also have venomous dorsal spines to deter possible predators. Since they can reproduce quickly and with in large numbers

and they have no known predators the population is quickly becoming too large for the ecosystems to handle. They are killing high amounts of the native small fish and some of the juveniles of the bigger fish species. When they eat the native herbivore fish the algae starts to grow out of control. If the algae is not kept in check, it will compete with the corals and eventually it will smother the coral. Once the coral dies, the rest of the ecosystem will follow.

Definitions:

-Biome: climatically and geographically defined as contiguous areas with similar climatic conditions on the Earth, such as communities of plants, animals, soil, and organisms, are often referred to as ecosystems.

-Ecosystems: A community of living organisms in conjunction with nonliving components of their environment interacting as a system.

-Producers: An autotrophic organism capable of producing complex compounds from simple inorganic molecules through the process of photosynthesis or through chemosynthesis.

-Consumers: An organism that generally obtains food by feeding on other organisms or organic matter due to lack of the ability to manufacture own food from inorganic sources; a heterotroph

-Biotic: of, relating to, or resulting from living things, especially in their ecological relations

-Abiotic: physical rather than biological not derived from living organisms

-Heterotroph: An organism deriving its nutritional requirements from complex organic substances

-Autotroph: An organism that is able to form nutritional organic substances from simple inorganic substances

-Herbivore: an animal that feeds on plants

-Carnivore animal that feeds on flesh

-Omnivore: an animal that eats food of both plant and animal origin.

-Bioaccumulation: the accumulation of substances, such as pesticides, or other organic chemicals in an organism.

-Invasive Species: An organism that is not native and has negative effects on our economy, our environment, or our health.

Questions:

1. What is a producer?
2. Give an example of a producer.
3. What is a consumer?
4. Give an example of a consumer.
5. How do invasive species affect the ecosystems?
6. What happens to the ecosystem if the primary producers are removed?
7. What happens to the ecosystem if one of the apex predators is removed?

Related topics:

What are some invasive species found near you?

How do people affect the ecosystems near you?

Sedimentation from inland are now being washed out to the corals because of development in the keys. If the sediment covers the corals what happens to the ecosystem? Is something similar happening near you? Can you find somewhere else that this is happening?

Exercise 2:

Camouflaged Toothpicks

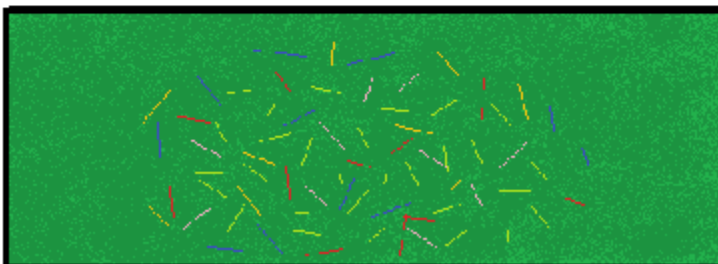
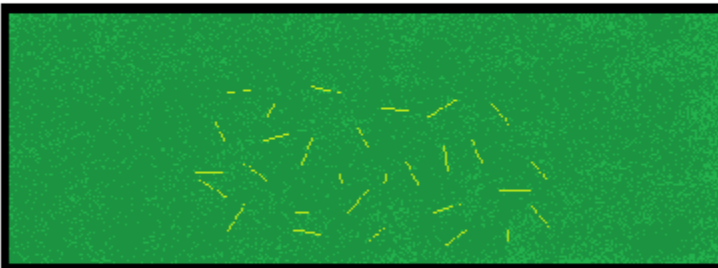
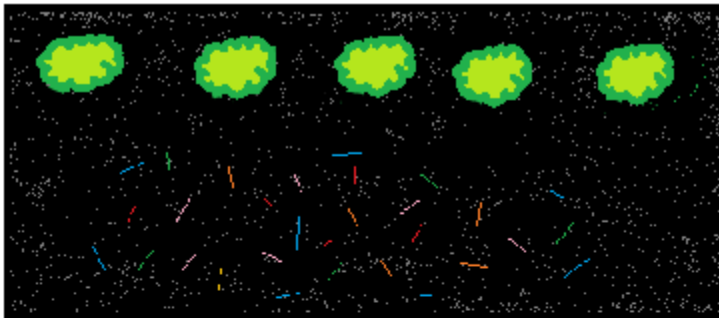
Materials:

- colored toothpicks
- wood toothpicks

Have a jar of the colorful toothpicks (that can be found at Wal-Mart) and pour them out in an area where they will stand out. A mulched flowerbed, gravel, or grassy areas work well. These toothpicks represent the prey. The students represent the predators.

Have the students eat (pick up) as many prey as they can. You can put a time limit on how long they have to find the "food." Ask students how much food they collected.

Now do the same experiment with toothpicks that match the environment. For example, green toothpicks in a grassy area or all gray toothpicks in a gravel area. Now see how many each student collected. Now for the third round, tell the students that a new invasive species has been introduced to the ecosystem and it is poisonous! Pick a color that stand out such as the red toothpicks and tell the students they cannot eat the red ones. (You can use all the colored toothpicks for this one.) Now let the students find their prey! Ideally, this last round should have a mix of colors some that match the background (camouflaged prey) some that do not match the background and the red toothpicks that cannot be eaten.



What is happening?

In the first round, all the colors stood out from the background making them easy prey. If the prey has some form of camouflage, like in round two, then it makes them harder targets for the predators thus helping ensure the survival of the species. This shows how important camouflage can be to prey. The third round demonstrates how the populations can shift due to invasive species and/or predation. In the third round, students would have had an easy time finding the red ones but they cannot eat those so they were left to continue growing in population. The harder ones to find like the green ones would not have been eaten as much leaving the other colors to be the main prey. This would shift the population dynamics leaving the invasive species, the camouflages species and almost wiping out the other species involved. While this is not the perfect demonstration of what happens, it does show some of the story. In reality, the invasive species are eating the prey too, competing with the other predators and together they can essentially wipe out an entire species if it is left unchecked.

How this relates to Jessica and Bruce:

Colors and patterns found on animals in the ocean play an important role in survival. Jessica and Bruce see many fish in the ocean that have great camouflage. Some examples are Flounder, Scorpionfish, Trumpetfish, Leafy Sea Dragons, Pipefish and Frogfish all have great camouflage. Having good camouflage works for some fish but others prefer to stand out. In fact, they have bright bold vibrant colors to warn predators that they are dangerous. Lionfish are one example of having showy colors. Predators do not eat them because they are venomous and the population is continuing to grow. Scientists have recognized that this is occurring and they are trying to help eliminate the Lionfish species. Some people tried to introduce Lionfish to predators, like the Grouper and Eels, in an attempt for these predators to start eating the Lionfish. This sounds like a good plan however, what they are seeing is that the Grouper and Eels just want a free meal from divers and they are not hunting the Lionfish as people had originally hoped. They have introduced one new predator for the Lionfish, humans! Lionfish are very tasty fish and are now starting to make appearances on restaurant menus. While commercially the Lionfish does not currently have much value, it will in the future. As an attempt to control the population of Lionfish places in Florida actually, hold Lionfish derbies to see who can catch the most Lionfish.

Definitions:

-Camouflage: The use of any combination of materials, coloration or illumination for concealment, either by making animals or objects hard to see or by disguising them as something else.

Questions:

1. What round was the easiest to find prey?

2. Which round was the hardest to find prey?
3. What are some animals that have good camouflage?
4. How does camouflage help animals survive?
5. How do showy colors also help animals survive?

Related topics:

Mimicry

Darwin's finches: evolution lessens competition for the same food source

False eyespots

Squid and octopi iridescence, reflectins, and chromatophores

Survival of the fittest

Genetic load in populations

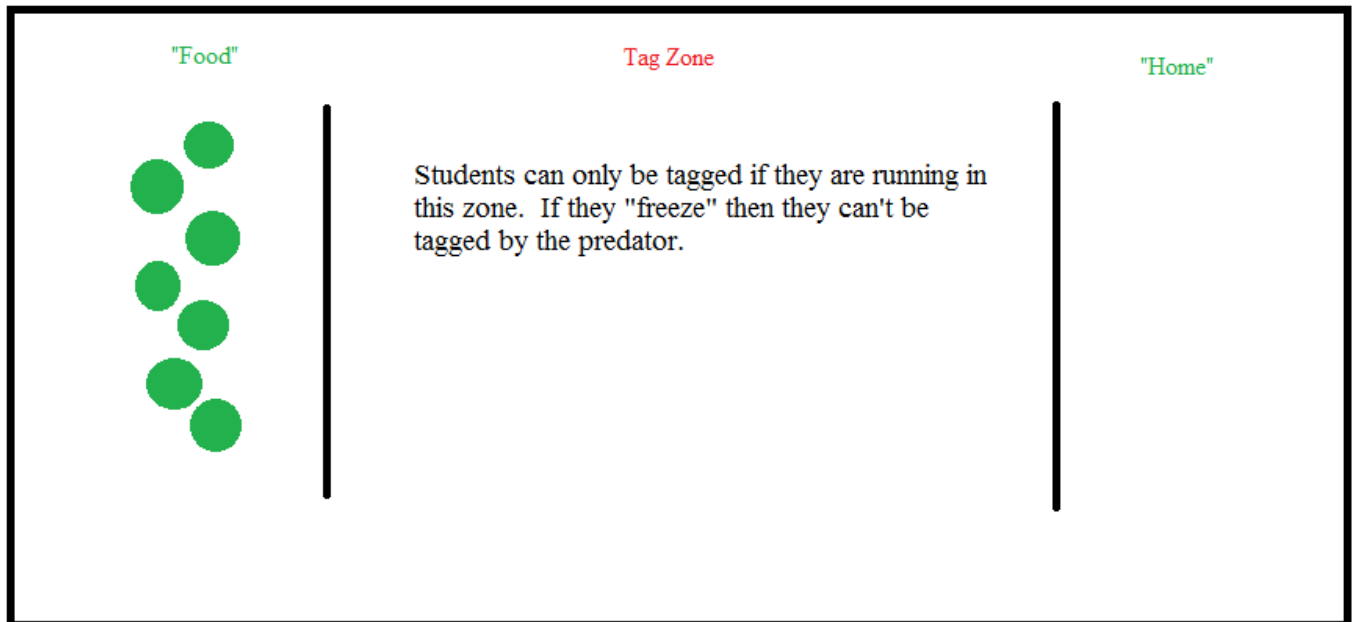
Exercise 3:

Predator Prey Tag

Materials:

- duct tape
- food objects (these can be anything that they can pick up and run with)
- pictures of animals with camouflage are helpful but not necessary

Tape off two lines on the ground about 20-30yards apart. Behind one line place objects that represent food. The second line represents "home." Pick a handful of kids to be the predators /"it." They stand in between the home line and the food line. have the other kids run from the home line to the food line and collect food and bring it home without being tagged "eaten". If the kids freeze then the predator cannot see them because they have camouflaged themselves and they cannot be tagged. If the kids are running then the predators, can see them and can be tagged/eaten.



What is happening?

Students are acting out the use of camouflage for survival. In many cases, animals in the wild are not only camouflaged, but they have behaviors that allow them to use the camouflage in a manner that maximizes their chances of survival. It is easy to pick out prey that is moving and stands out from their background but so patterns that do not look like camouflage actually work when the animal is being still.

How this relate to Jessica and Bruce:

Sometimes it is not just about looks when dealing with camouflage. In the ocean, many fish use camouflage to survive. Divers see some of these fish and think that,

they would be easy to spot swimming around. With the camouflage along with certain behaviors, these fish really do blend in with their background. Some fish like the Trumpetfish have adapted behaviors that work with their camouflage. The trumpet fish will swim horizontally but it prefers to float vertically in the water to blend in with the gorgonians (sea fans, sea whips, sea rods etc). They can be seen floating along with the sea rods and even swaying with the currents. This helps not only camouflage the trumpet fish from predators but it also helps camouflage it from its prey.

Questions:

1. What is camouflage?
2. How is a species camouflage important for their survival?
3. Why is camouflage important to predators?
4. How do behaviors help the effectiveness of camouflage?
5. Name one animal that has good camouflage.

Related topics:

How do our eyes see? We are predisposed to see movement and edges.

What are different types of camouflage? Changing color, behaviors, mimicry,

Parrotfish have adapted a mucous cover to hide their smell at night so predators cannot find them

Survival of the fittest

Exercise 4:

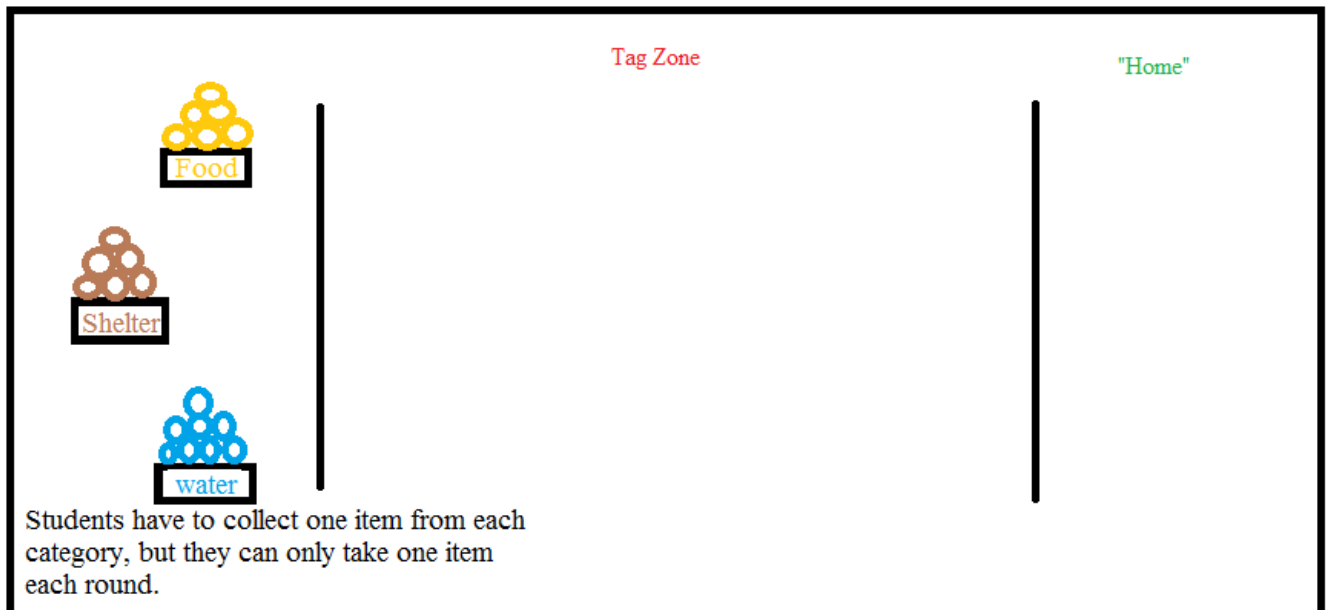
Surviving Winter Tag

Materials:

- objects to represent food
- objects to represent water
- objects to represent shelter (again these need to be something the kids can run with)
- 3 containers to hold the objects (plastic laundry baskets, cardboard boxes etc)

Tap off two lines on the ground about 20-30 yards apart. The area behind one line represents home. The area behind the other line is where the food objects are placed. You will need three different objects to represent food water and shelter. For example, three different colored balls would work. You can use whatever you have available that kids can run with. Place the objects in three piles at one end of the field/gym area.

You may want to use boxes, or containers to hold the objects in place. Explain to the students that they need one object from each of the three categories to survive the winter. They will get three chances to collect the items they need but they can only collect one item at a time. Pick one or two students to be the predator/"it" the first round. The predator stands in the area between the two lines. After three runs, see how many students collected all three items to survive the winter. If the predator tags them, they have to put the object that they are carrying back into the bin and they return home empty handed. If they do not have an object, yet their run is over and they return home empty handed. You can play another round with more predators. Now how many survived the winter?



What is happening?

All living organisms need certain conditions to be met in order to survive. In this activity, students are trying to survive the winter by obtaining food, water, and shelter. If not all three conditions are met then the students do not make it through the winter. In the first game it was easier for students to obtain the needed items to survive however, if the number of predators is increased, it makes the chances of survival smaller. This is a great introduction into carrying capacities and limiting factors. If only one or two water objects were given most of the students would die because they would not be able to obtain all three of the needed items. In this case, it is easy to see that water was the limiting factor; there was not enough water in the environment to support the population. What would happen if we left the amount of items the same and added another classroom of students? Then we are demonstrating what happens when we have exceeded our carrying capacity; there are not enough items to support everyone.

How this relates to Jessica and Bruce:

When the lionfish are prevalent in an area, they will eat all the herbivore fish. These herbivore fish eat all the algae present in that area. When all of the herbivore fish are gone the algae is able to flourish. The algae will compete with the corals for sunlight and can actually smother the corals. When the corals die, they are taking away needed food and shelter from other fish that rely on the coral for survival.

Scientists have also seen a big impact from commercial fish being over fished. The worldwide humans consume tons of fish every year. Fish that are higher in the food chain are typically in high demand commercially. If specific species are fished and collected in amounts that the population cannot sustain themselves, then we are eradicating not only a fish that may have been prey for other animals but we are taking out predators for other fish. When the predators are eradicated, the prey populations are allowed to grow out of control and that can trickle down the food chain having negative effects on the ecosystem as a whole. What if there were no predators in the tag game? All of our prey could survive as long as we had enough supplies.

Definitions:

-Carrying capacity: The largest number of individuals of a particular species that can survive over long periods in a given environment, this level depends on the effect of the limiting factors.

-Limiting Factors: limits the growth or development of an organism, population or process

-overfishing: practice of commercial and non-commercial fishing which depletes a fishery by catching so many adult fish that not enough remain to breed and replenish the population. The fish get fewer and fewer, until finally there is none to catch.

Questions:

1. What three things do organisms need to survive? Food water and shelter
2. What is a carrying capacity?
3. What are limiting factors?
4. What happens if there was not enough food for all the animals?

Related topics:

Logistic growth and carrying capacity: Have humans reached the carrying capacity?

Predator prey cycles/lag models.

Survival of the fittest

Sustainable fishing (sustainable fish on menus)

What are we eating? Humans are working their way down the food chain commercially due to overfishing

Exercise 5:

Shark Teeth ID

Materials:

- sets of sharks teeth
- pictures of sharks teeth if you don't have the actual teeth
- pictures of the sharks are helpful but not necessary
- dichotomous key

Links for keys:

- <http://paleobiology.si.edu/pdfs/sharktoothKey.pdf>
- <https://www.flmnh.ufl.edu/fish/sharks/fossils/identificationguide.html>

Teachers:

For younger students here is a link that uses monsters and body shapes of sharks to introduce dichotomous keys. Encourage the students to tell you where the shark lives and behaviors based on the body size of the shark.

http://71science.weebly.com/uploads/1/9/7/3/19738457/dichotomous_key_activity_monsters_sharks.doc

- <http://emantaxonomyproject.weebly.com>
- http://www.pacname.org/OCEP/activities/Tooth_Shark.doc

Have students look at sharks' teeth or at pictures of different kind of sharks' teeth.

Using a dichotomous key have the students identify the genera of sharks that the teeth belong. The above link has great information on shark teeth and it has a dichotomous key for the students to use. Ask the students to identify key differences between the teeth of different species. Ask the students to speculate what kind of diet each species has.

What is happening?

Sharks teeth play an important role for scientists. Scientists can learn a lot about a species of shark just by looking at their teeth. In fact, some of the extinct species of sharks have been identified just by their teeth. Scientist can hypothesize how big the shark was and what it ate just by examining the teeth. There are four general types of sharks' teeth. Teeth that are long and narrow are from sharks that typically eat fish.

Their teeth are said to be needle like in order to grab slippery, streamlined fish. Teeth that are thick plate-like teeth are used for crushing. Sharks that have these types of teeth typically eat crustaceans and bivalves, such as lobster, crabs, oysters, etc. Nurse sharks for example have a highly specified diet and like to eat lobster tails. They actually have a specialized way of catching the lobster and eating just the tail. Teeth that have sharp points and serrated edges are from sharks that typically eat bigger animals such as seals and other mammals. The sharp serrated edges are perfect for cutting and tearing flesh. The last type of teeth comes from the biggest sharks in the water such as whale sharks and basking sharks. These sharks are actually filter feeders, which mean they filter water through their gills and eat the plankton and krill

found in the water. These sharks do have teeth however; they are very small and are not very useful. Sharks' teeth are continuously produced and are formed in rows in the shark's mouth. When a shark loses a tooth, the next tooth in the row moves up and fills the hole. Certain species of sharks can lose approximately 30,000 teeth in a lifetime.

Making connections:

The Whale shark and the Basking shark are the two biggest sharks in the water yet they eat the smallest organisms in the water. How do they get enough food to support themselves?

How this relates to Jessica and Bruce:

Jessica's Story:

Like most people I would watch Shark Week and Jaws and I would think to myself "What are these people thinking?! Are they crazy?! I would never willingly swim with sharks and feed them!" You know that rule "never say never"? Well I am now a proud crazy person who has swam with sharks, on multiple occasions I might add. I was like most people and I had a fear of sharks growing up. It was not until I started diving that I actually encountered sharks and realized that they are not mindless eating machines. I actually paid money to go on a shark dive (without a cage) where about 20 divers went into about 70 ft of water and the dive-master had a five-gallon bucket of shark food. He would make a noise and let the sharks know that we were there and that we had food. And in came the sharks! We swam with and fed about 12 sharks and it was an experience I will never forget. The sharks were curious for sure about what we were, but they have done this a few times and knew that the only thing they wanted was in the 5-gallon bucket. When we swam with the sharks before we fed them, THEY would always keep a safe distance from US! When the dive master opened the bucket, the sharks got the food and left! Now, I tell you all of this to say that what we see and hear on TV and the news is not always the most accurate. Yes, there are shark attacks every year but the statistics are actually low when you consider the number of people who are in the water every year. In fact, if you do some research you may be surprised to find that there are much more deaths by normal daily activities than by shark attacks; such as, car wrecks, falling down stairs, falling coconuts, falling soda machines etc. I will add that I do have respect for these creatures and while I enjoy seeing them, a too friendly shark makes me nervous. :)

Related topics:

Most people have seen or heard about JAWS and because of this, most people have an unreasonable fear of the sharks.

Talk about sharks and conservations.

How do sharks hunt? Specialized senses sharks use to detect prey.

Is a great white really at the top of the food chain? Orca attacks great white

Definitions:

- apex predators: predators with no natural predators of their own
- Herbivore: an animal that feeds on plants
- Carnivore animal that feeds on flesh
- Omnivore: an animal that eats food of both plant and animal origin.
- enamel: a hard ceramic which cover the exposed part of your teeth
- dentin: hard, dense, bony tissue forming the bulk of a tooth beneath the enamel

Questions:

1. How are sharks teeth different from humans' teeth?
2. How are long pointy teeth good for catching slippery fish?
3. What type of food do you expect a shark with flat teeth to eat?
4. What type of food do you expect a shark with serrated teeth to eat?

Related Topics:

Shark Attacks
Shark Conservation

Links:

food chain/adaptations:

Awesome NOAA lesson plan

[http://csc.noaa.gov/psc/seamedia/Lessons/G4U3L2% 20Food% 20Chains% 20and% 20Food% 20Webs% 20in% 20an% 20Ecosystem.pdf](http://csc.noaa.gov/psc/seamedia/Lessons/G4U3L2%20Food%20Chains%20and%20Food%20Webs%20in%20an%20Ecosystem.pdf)

<http://www.hawkquest.org/TA/XL/Foodchain.pdf>

Predator prey games:

<http://www.superteacherideas.com/science21-predator-prey.html>

http://primaryscience.ie/media/ds_30yards/resources/07_dps_activity_sheet_3_survival_game.pdf

Shark info:

Shark key

<https://www.flmnh.ufl.edu/fish/sharks/fossils/identificationguide.html>

Best shark key

<http://paleobiology.si.edu/pdfs/sharktoothKey.pdf>

Easy shark teeth characteristic

http://www.pacname.org/OCEP/activities/Tooth_Shark.doc

Younger practice w dichotomous key monsters and sharks

http://71science.weebly.com/uploads/1/9/7/3/19738457/dichotomous_key_activity_monsters_sharks.doc

Shark plans

http://c0026106.cdn1.cloudfiles.rackspacecloud.com/df6dd8c2be0b463db3ec696536381b47_shark-4-8.pdf

Fun futuristic dichotomous key

<http://emantaxonomyproject.weebly.com>

Shark teeth info

<http://www.sharksavers.org/en/education/biology/shark-teeth1/>

Shark attacks

<https://www.flmnh.ufl.edu/fish/sharks/White/World.htm>

Answers:

1. What is a producer?
 - a. An autotrophic organism capable of producing complex compounds from simple inorganic molecules through the process of photosynthesis or through chemosynthesis
2. Give an example of a producer.
 - a. Plants
3. What is a consumer?
 - a. An organism that generally obtains food by feeding on other organisms or organic matter due to lack of the ability to manufacture own food from inorganic sources; a heterotroph
4. Give an example of a consumer.
 - a. Answers will vary.
5. How do invasive species affect the ecosystems?
 - a. They disrupt the natural ecosystem in the area. They can compete with native species for resources causing a strain on predators and prey that rely on the native species.
6. What happens to the ecosystem if the primary producers are removed?
 - a. The first level in the food chain is removed and the rest of the food chain will either die or be forced to relocate to where the primary producers are still available.
7. What happens to the ecosystem if one of the apex predators is removed?
 - a. The prey that would be eaten is allowed to grow uncontrollably. With a high population numbers they can strain the prey that is below them and it can strain the food chain all the way to the primary producers.
1. What round was the easiest to find prey?
 - a. The first round when all of the prey stood out
2. Which round was the hardest to find prey?
 - a. Answers may vary depending on the class size. It should be the second or third rounds
3. What are some animals that have good camouflage?
 - a. Answers vary
4. How does camouflage help animals survive?
 - a. Allows the organism to blend into the environment to hide from possible predators and prey
5. How do showy colors also help animals survive?
 - a. Yes. Many animals have bright showy colors to warn possible predators that they are poisonous
1. What is camouflage?
 - a. The use of any combination of materials, coloration or illumination for concealment, either by making animals or objects hard to see or by disguising them as something else.
2. How is a species' camouflage important for their survival?
 - a. It aids in protection from potential predators and it provides concealment when hunting for prey
3. Why is camouflage important to predators?
 - a. It helps hide the animal when it is hunting prey

4. How do behaviors help the effectiveness of camouflage?
 - a. Behaviors help animals imitate objects, or other animals that are not edible or poisonous to deter predators. Trumpetfish will turn vertical in the water and sway with the current in an attempt to look like sea whips.
5. Name one animal that has good camouflage.
 - a. Answers will vary
1. What three things do organisms need to survive?
 - a. Food water and shelter
2. What is a carrying capacity?
 - a. The largest number of individuals of a particular species that can survive over long periods in a given environment, this level depends on the effect of the limiting factors.
3. What are limiting factors?
 - a. limits the growth of development of an organism, population or process
4. What happens if there was not enough food for all the animals?
 - a. The population would decrease in size
1. How are sharks teeth different from humans' teeth?
 - a. Answers vary. Sharks have multiple rows of teeth. Sharks teeth are continuously lost and replaced. Sharks teeth have different shapes and sizes compared to humans' teeth.
2. How are long pointy teeth good for catching slippery fish?
 - a. Fish
3. What type of food do you expect a shark with flat teeth to eat?
 - a. Crustaceans and bivalves
4. What type of food do you expect a shark with serrated teeth to eat?
 - a. Marine mammals

Tennessee State Standards:

Grade 6 :Embedded Inquiry

Conceptual Strand

Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.

Guiding Question

What tools, skills, knowledge, and dispositions are needed to conduct scientific inquiry?

Grade Level Expectations

GLE 0607.Inq.1 Design and conduct open- ended scientific investigations.

GLE 0607.Inq.2 Use appropriate tools and techniques to gather, organize, analyze, and interpret data.

GLE 0607.Inq.3 Synthesize information to determine cause and effect relationships between evidence and explanations.

GLE 0607.Inq.4 Recognize possible sources of bias and error, alternative explanations, and questions for further exploration.

GLE 0607.Inq.5 Communicate scientific understanding using descriptions, explanations, and models.

Checks for Understanding

0607.Inq.1 Design and conduct an open-ended scientific investigation to answer a question that includes a control and appropriate variables.

0607.Inq.2 Identify tools and techniques needed to gather, organize, analyze, and interpret data collected from a moderately complex scientific investigation.

0607.Inq.3 Use evidence from a dataset to determine cause and effect relationships that explain a phenomenon.

0607.Inq.4 Review an experimental design to determine possible sources of bias or error, state alternative explanations, and identify Questions for further investigations.

0607.Inq.S Design a method to explain the results of an investigation using descriptions, explanations, or models.

State Performance Indicators

SPI 0607.Inq.1 Design a simple experimental procedure with an identified control and appropriate variables.

SPI 0607.Inq.2 Select tools and procedures needed to conduct a moderately complex experiment.

SPI 0607.Inq.3 Interpret and translate data in a table, graph, or diagram.

SPI 0607.Inq.4 Draw a conclusion that establishes a cause and effect

relationship supported by evidence.

SPI 0607.Inq.5 Identify a faulty interpretation of data that is due to bias or experimental error.

Grade 6 :Embedded Technology & Engineering

Conceptual Strand

Society benefits when engineers apply scientific discoveries to design materials and processes that develop into enabling technologies.

Guiding Question

How do science concepts, engineering skills, and applications of technology improve the quality of life?

Grade Level Expectations

GLE 0607.T/E.1 Explore how technology responds to social, political, and economic needs.

GLE 0607.T/E.2 Know that the engineering design process involves an ongoing series of events that incorporate design constraints, model building, testing, evaluating, modifying, and retesting.

GLE 0607.T/E.3 Compare the intended benefits with the unintended consequences of a new

GLE 0607.T/E.4 Describe and explain adaptive and assistive bioengineered products.

Checks for Understanding

0607.T/E.1 Use appropriate tools to test for strength, hardness, and flexibility of materials.

0607.T/E.2 Apply the engineering design process to construct a prototype that meets certain specifications.

0607.T/E.3 Explore how the unintended consequences of new technologies can impact society.

0607.T/E.4 Research bioengineering technologies that advance health and contribute to improvements in our daily lives.

0607.T/E.5 Develop an adaptive design and test its effectiveness.

State Performance Indicators

SPI 0607.T/E.1 Identify the tools and procedures needed to test the design features of a prototype.

SPI 0607.T/E.2 Evaluate a protocol to determine if the engineering design process was successfully applied.

SPI 0607.T/E.3 Distinguish between the intended benefits and the unintended consequences of a new technology.
technology.

SPI 0607.T/E.4 Differentiate between adaptive and assistive engineered products (e.g., food, biofuels, medicines, integrated pest management).

Grade 6: Standard 2 - Interdependence

Conceptual Strand 2

All life is interdependent and interacts with the environment.

Guiding Question 2

How do living things interact with one another and with the non-living elements of their environment?

Grade Level Expectations

GLE 0607.2.1 Examine the roles of consumers, producers, and decomposers in a biological community.

GLE 0607.2.2 Describe how matter and energy are transferred through an ecosystem.

GLE 0607.2.3 Draw conclusions from data about interactions between the biotic and abiotic elements of a particular environment.

GLE 0607.2.4 Analyze the environments and the interdependence among organisms found in the world's major biomes.

Checks for Understanding

0607.2.1 Compare and contrast the different methods used by organisms to obtain nutrition in a biological community.

0607.2.2 Create a graphic organizer that illustrates how biotic and abiotic elements of an environment interact.

0607.2.3 Use a food web or energy pyramid to demonstrate the interdependence of organisms within a specific biome.

0607.2.4 Create poster presentations to illustrate differences among the world's major biomes.

State Performance Indicators

SPI 0607.2.1 Classify organisms as producers, consumers, scavengers, or decomposers according to their role in a food chain or food web.

SPI 0607.2.2 Interpret how materials and energy are transferred through an ecosystem.

SPI 0607.2.3 Identify the biotic and abiotic elements of the major biomes.

SPI 0607.2.4 Identify the environmental conditions and interdependencies among organisms found in the major biomes.

Grade 7 : Embedded Inquiry

Conceptual Strand

Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.

Guiding Question

What tools, skills, knowledge, and dispositions are needed to conduct scientific inquiry?

Grade Level Expectations

GLE 0707.Inq.1 Design and conduct open- ended scientific investigations.

GLE 0707.Inq.2 Use appropriate tools and techniques to gather, organize, analyze, and interpret data.

GLE 0707.Inq.3 Synthesize information to determine cause and effect relationships between evidence and explanations.

GLE 0707.Inq.4 Recognize possible sources of bias and error, alternative explanations, and questions for further exploration.

GLE 0707.Inq.5 Communicate scientific understanding using descriptions, explanations, and models.

Checks for Understanding

0707.Inq.1 Design and conduct an open-ended scientific investigation to answer a question that includes a control and appropriate variables.

0707.Inq.2 Identify tools and techniques needed to gather, organize, analyze, and interpret data collected from a moderately complex scientific investigation.

0707.Inq.3 Use evidence from a dataset to determine cause and effect relationships that explain a phenomenon.

0707.Inq.4 Review an experimental design to determine possible sources of bias or error, state alternative explanations, and identify questions for further investigation.

0707.Inq.5 Design a method to explain the results of an investigation using descriptions, explanations, or models.

State Performance Indicators

SPI 0707.Inq.1 Design a simple experimental procedure with an identified control and appropriate variables.

SPI 0707.Inq.2 Select tools and procedures needed to conduct a moderately complex experiment.

SPI 0707.Inq.3 Interpret and translate data in a table, graph, or diagram.

SPI 0707.Inq.4 Draw a conclusion that establishes a cause and effect relationship supported by evidence.

SPI 0707.Inq.5 Identify a faulty interpretation of data that is due to bias or experimental error.

Grade 7 : Embedded Technology & Engineering

Conceptual Strand

Society benefits when engineers apply scientific discoveries to design materials and processes that develop into enabling technologies.

Guiding Question

How do science concepts, engineering skills, and applications of technology improve the quality of life?

Grade Level Expectations

GLE 0707.T/E.1 Explore how technology responds to social, political, and economic needs.

GLE 0707.T/E.2 Know that the engineering design process involves an ongoing series of events that incorporate design constraints, model building, testing, evaluating, modifying, and retesting.

GLE 0707.T/E.3 Compare the intended benefits with the unintended consequences of a new technology.

GLE 0707.T/E.4 Describe and explain adaptive and assistive bioengineered products.

Checks for Understanding

0707.T/E.1 Use appropriate tools to test for strength, hardness, and flexibility of materials.

0707.T/E.2 Apply the engineering design process to construct a prototype that meets certain specifications.

0707.T/E.3 Explore how the unintended consequences of new technologies can impact society.

0707.T/E.4 Research bioengineering technologies that advance health and contribute to improvements in our daily lives.

0707.T/E.5 Develop an adaptive design and test its effectiveness.

State Performance Indicators

SPI 0707.T/E.1 Identify the tools and procedures needed to test the design features of a prototype.

SPI 0707.T/E.2 Evaluate a protocol to determine if the engineering design process was successfully applied.

SPI 0707.T/E.3 Distinguish between the intended benefits and the unintended consequences of a new technology.

SPI 0707.T/E.4 Differentiate between adaptive and assistive engineered products (e.g., food, biofuels, medicines, integrated pest management).

Grade 8 : Embedded Inquiry

Conceptual Strand

Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.

Guiding Question

What tools, skills, knowledge, and dispositions are needed to conduct scientific inquiry?

Grade Level Expectations

GLE 0807.Inq.1 Design and conduct open- ended scientific investigations.

GLE 0807.Inq.2 Use appropriate tools and techniques to gather, organize, analyze, and interpret data.

GLE 0807.Inq.3 Synthesize information to determine cause and effect relationships between evidence and explanations.

GLE 0807.Inq.4 Recognize possible sources of bias and error, alternative explanations, and questions for further exploration.

GLE 0807.Inq.5 Communicate scientific understanding using descriptions, explanations, and models.

Checks for Understanding

0807.Inq.1 Design and conduct an open-ended scientific investigation to answer a question that includes a control and appropriate variables.

0807.Inq.2 Identify tools and techniques needed to gather, organize, analyze, and interpret data collected from a moderately complex scientific investigation.

0807.Inq.3 Use evidence from a dataset to determine cause and effect relationships that explain a phenomenon.

0807.Inq.4 Review an experimental design to determine possible sources of bias or error, state alternative explanations, and identify questions for further investigation.

0807.Inq.5 Design a method to explain the results of an investigation using descriptions, explanations, or models.

State Performance Indicators

SPI 0807.Inq.1 Design a simple experimental procedure with an identified control and appropriate variables.

SPI 0807.Inq.2 Select tools and procedures needed to conduct a moderately complex experiment.

SPI 0807.Inq.3 Interpret and translate data into a table, graph, or diagram.

SPI 0807.Inq.4 Draw a conclusion that establishes a cause and effect relationship supported by evidence.

SPI 0807.Inq.5 Identify a faulty interpretation of data that is due to bias or experimental error.

Grade 8 : Embedded Technology & Engineering

Conceptual Strand

Society benefits when engineers apply scientific discoveries to design materials and processes that develop into enabling technologies.

Guiding Question

How do science concepts, engineering skills, and applications of technology improve the quality of life?

Grade Level Expectations

GLE 0807.T/E.1 Explore how technology responds to social, political, and economic needs.

GLE 0807.T/E.2 Know that the engineering design process involves an ongoing series of events that incorporate design constraints, model building, testing, evaluating, modifying, and retesting.

GLE 0807.T/E.3 Compare the intended benefits with the unintended consequences of a new technology.

GLE 0807.T/E.4 Describe and explain adaptive and assistive bioengineered products.

Checks for Understanding

0807.T/E.1 Use appropriate tools to test for strength, hardness, and flexibility of materials.

0807.T/E.2 Apply the engineering design process to construct a prototype that meets certain specifications.

0807.T/E.3 Explore how the unintended consequences of new technologies can impact society.

0807.T/E.4 Research bioengineering technologies that advance health and contribute to improvements in our daily lives.

0807.T/E.5 Develop an adaptive design and test its effectiveness.

State Performance Indicators

SPI 0807.T/E.1 Identify the tools and procedures needed to test the design features of a prototype.

SPI 0807.T/E.2 Evaluate a protocol to determine if the engineering design process was successfully applied.

SPI 0807.T/E.3 Distinguish between the intended benefits and the unintended consequences of a new technology.

SPI 0807.T/E.4 Differentiate between adaptive and assistive engineered products (e.g., food, biofuels, medicines, integrated pest management).

Grade 8 : Standard 5 - Biodiversity and Change

Conceptual Strand 5

A rich variety of complex organisms have developed in response to a continually changing environment.

Guiding Question 5

How does natural selection explain how organisms have changed over time?

Grade Level Expectations

GLE 0807.5.1 Identify various criteria used to classify organisms into groups.

GLE 0807.5.2 Use a simple classification key to identify a specific organism.

GLE 0807.5.3 Analyze how structural, behavioral, and physiological adaptations within a population enable it to survive in a given environment.

GLE 0807.5.4 Explain why variation within a population can enhance the chances for group survival.

GLE 0807.5.5 Describe the importance of maintaining the earth's biodiversity.

Checks for Understanding

0807.5.1 Select characteristics of plants and animals that serve as the basis for developing a classification key.

0807.5.2 Create and apply a simple classification key to identify an organism.

0807.5.3 Compare and contrast the ability of an organism to survive under different environmental conditions.

0807.5.4 Collect and analyze data relating to variation within a population of organisms.

0807.5.5 Prepare a poster that illustrates the major factors responsible for reducing the amount of global biodiversity.

0807.5.6 Prepare graphs that demonstrate how the amount of biodiversity has changed in a particular continent or biome.

State Performance Indicators

SPI 0807.5.1 Use a simple classification key to identify an unknown organism.

SPI 0807.5.2 Analyze structural, behavioral, and physiological adaptations to predict which populations are likely to survive in a particular environment

SPI 0807.5.3 Analyze data on levels of variation within a population to make predictions about survival under particular environmental conditions.

SPI 0807.5.4 Identify several reasons for the importance of maintaining the earth's biodiversity.

National Standards:

Middle School Life Sciences:

1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. MS-LS2-1
 - a. Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.
 - b. Assessment Boundary: none
1. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. MS-LS2-4
 - a. Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.
 - b. Assessment Boundary: none

Independent Relationships in Ecosystems

1. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. MS-LS2-2
 - a. Clarification Statement: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.
 - b. Assessment Boundary: none

Natural Selection and Adaptations:

1. Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment. MS-LS4-4
 - a. Clarification Statement: Emphasis is on using simple probability statements and proportional reasoning to construct explanations.
 - b. Assessment Boundary: none
2. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. MS-LS1-4
 - a. Clarification Statement: Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds, and creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.
 - b. Assessment Boundary: none

Human Impacts

1. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. MS-ESS3-4
 - a. Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.
 - b. Assessment Boundary: none