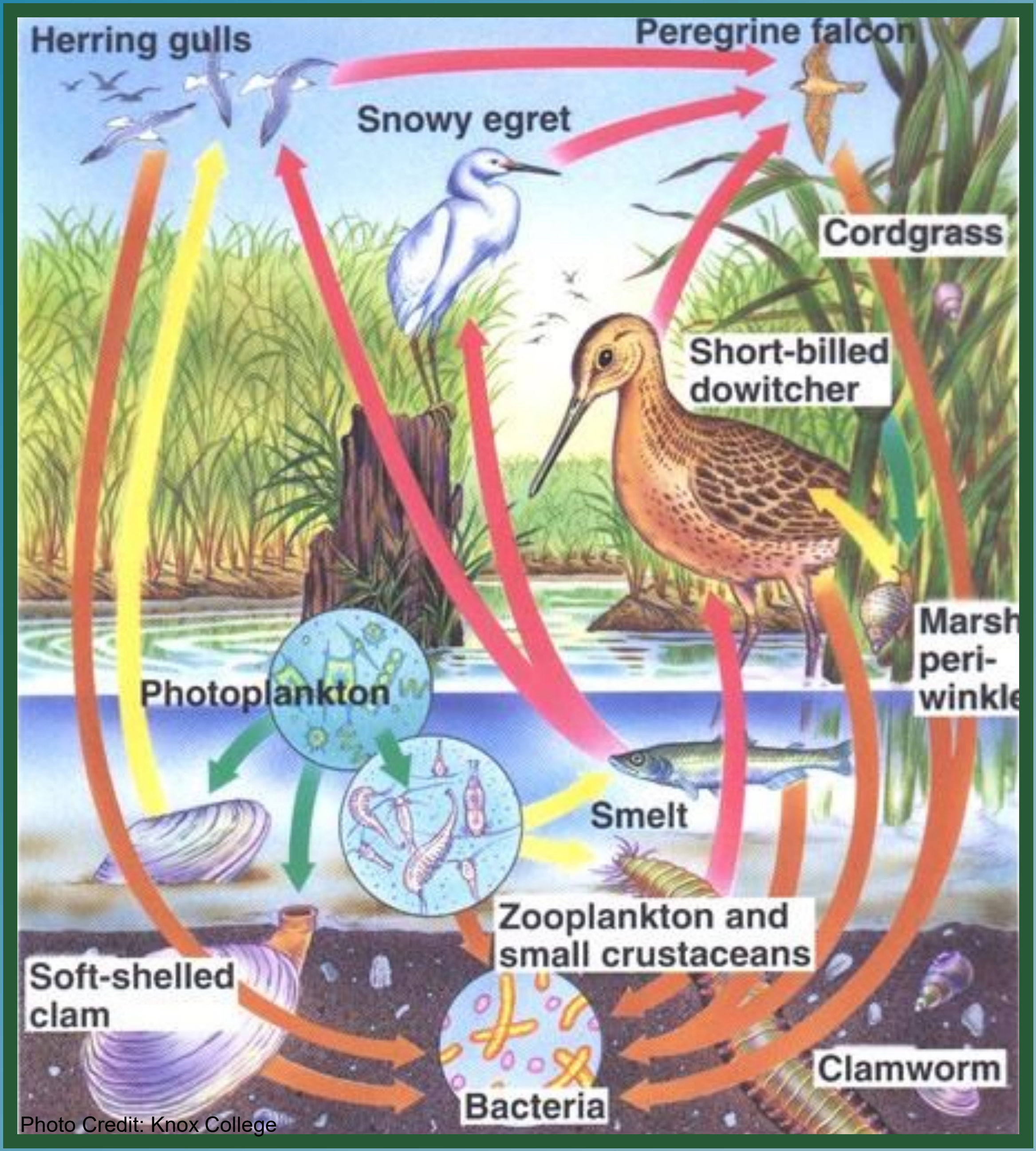
Notes from the Field

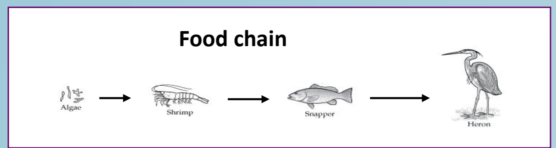
Young Scientist Newsletter

Salt Marsh Food Webs



December 2017

If you examine an **ecosystem**, you'll start to see "chains" of predator-prey interactions. For example: a heron eats a fish, which ate a shrimp, which ate algae, which produced its own food through **photosynthesis**. A **food chain** shows us how energy moves through an ecosystem. Simple chains don't give us a good picture of the system as a whole.



A **food web** combines many food chains and demonstrates how complicated an ecosystem is. Take the heron we mentioned before: it actually has a diverse diet and doesn't just eat fish. Herons also eat shrimp, crabs, frogs, lizards, insects, turtles, snakes, other birds and even small rodents. All of those prey items in turn feed on a variety of other plants and animals. If we build a food web around the diet of a heron, it will allow us to see the many ways marsh inhabitants are connected through their predator-prey relationships.

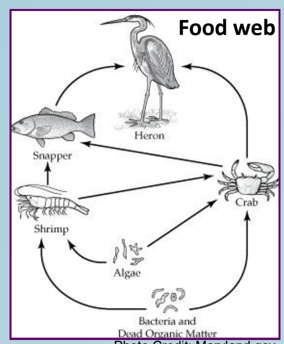


Photo Credit: Maryland.gov

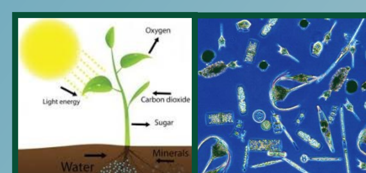
As we dive into more complex food webs and examine the mountain of knowledge within them, it is important to define a couple of key terms:

Food webs show us how **energy** moves through an ecosystem. The simplest definition of energy is "the ability to do work" and it applies to nearly every section of science and the way the universe works. In terms of food webs, energy is a property of matter that is transferred and transformed between living organisms.

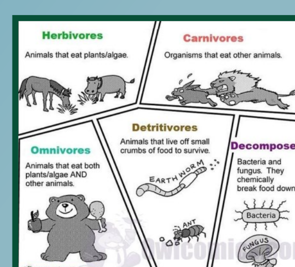
An **autotroph** is an organism that can produce its own food using light, water, carbon dioxide or other chemicals. They are also commonly called **producers**. The most common example of an autotroph is a plant but the list also includes algae, **phytoplankton**, and some bacteria.

A **heterotroph** is an organism that must consume or absorb other organisms to survive. This group of organisms is also referred to as **consumers**. All animals, fungi, and most bacteria are consumers and can be further described by what makes up their diet: **carnivores** (meat eaters), **herbivores** (plant eaters), **omnivores** (meat and plant eaters), **decomposers** (dead and decaying material eaters).

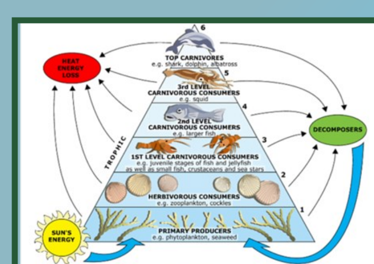
A **trophic level** refers to a level or position in a food chain or web that includes all organisms that get their energy in the same way or from the same type of prey items. Level 1 are primary producers or autotrophs (plants). Level 2 are primary consumers (herbivores), levels 3 and 4 are other omnivorous and carnivorous consumers, and level 5 are apex predators. An **ecological (or energy) pyramid** displays these levels and shows how energy is transferred and lost as it moves through the levels (more on page 4).



Examples of autotrophs
Photo credit: Differencebtw.com (L), Marinephytoplankton.org (R)



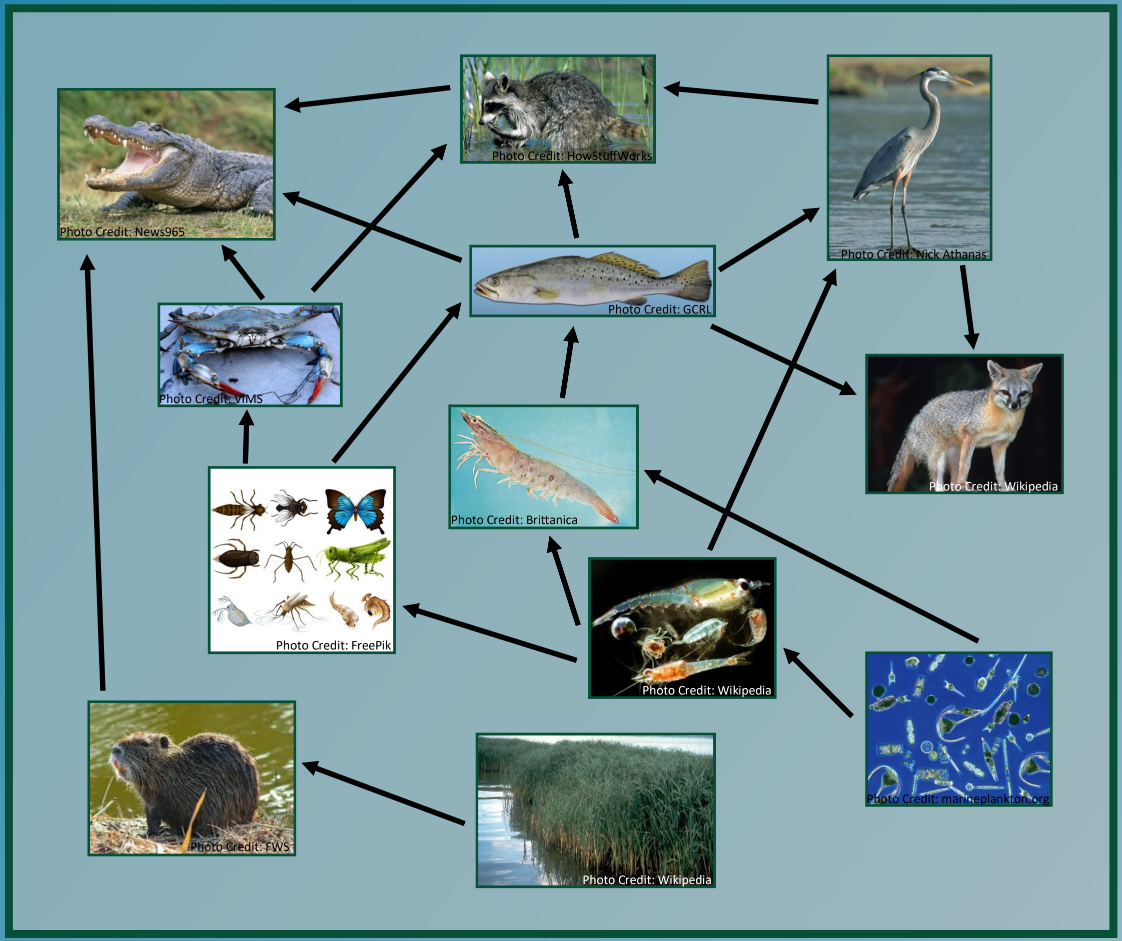
Five types of heterotrophs
Photo credit: Owlcomics.com



An ecological or energy pyramid
Photo credit: TES Teaching

A food web is an excellent tool for learning about the inner workings of an ecosystem.

Food webs demonstrate the many ways different animals and plants are connected and how they rely on each other for survival. Looking back at the simple food web built around the heron, we can see the variety of prey items that make up the heron's diet. We could expand that to include all of the plants and animals their prey items eat (shrimp, insects, grass, etc) as well as any animals that hunt herons or their eggs (foxes, raccoons, alligators, etc). If we repeat that process with each organism in the expanding web, we would begin to see the complexity within a single ecosystem.



If all the living things within a food web are connected, then the loss of one organism can affect the entire web. Let's first look at what would happen if too many shrimp were removed. Shrimp are a key prey item for many carnivorous fish within the above food web. If their numbers are greatly reduced, fish will depend more heavily on other prey items, such as smaller fish and insects. There is now the potential for the populations of these organisms to be driven down which could impact the other organisms that eat them as well as the things they eat. Fortunately, most ecosystem food webs are able to withstand quite a bit of change if the change occurs in those middle trophic levels. It would be far more devastating if a primary producer were reduced or removed. Phytoplankton not only produce more than half of the oxygen in the Earth's atmosphere, they are the base that the rest of aquatic food webs are built upon. The removal of phytoplankton would eventually lead to the loss of nearly all other living things.

A food web is also useful for showing how humans influence natural ecosystems in the form of overfishing, poaching, and invasive species:

Overfishing is when too many individual fish are removed. Those that are left cannot reproduce fast enough to rebuild the population. Not only is this bad for that fish species but it can disrupt the balance of the overall food web by eliminating a key prey item and/or predator. We often hear about the overfishing of cod, tuna or shrimp and how it impacts the economy and the availability of those fish for humans consumption. However, the removal of large predatory fish, such as sharks, can have significant impacts on other fish populations and the overall ecosystem. A shark will eat many different kinds of fish and helps keep fish populations in balance. If sharks are removed from the system, fish populations may grow out of control and eat their own prey items out of existence. Overfishing can result in a decrease in both species and size diversity. This is often referred to as "fishing down the food webs".

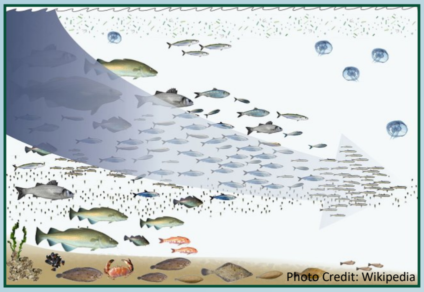


Photo Credit: Wikipedia
Fishing down the food web

Poaching is the illegal hunting or capturing of wild animals. It includes hunting out of season, using illegal traps or bait, removing animals from reserves and other protected areas, and killing protected species like those on the endangered species list. The most talked about example of poaching is the illegal killing of large African animals such as rhinos, elephants and big cats. These are protected animals because there are few left in the wild. The loss of one or two adult rhinos will have a major impact on the future of the wild population. The poaching of deer, elk, moose and bears may not get the same media coverage but it may actually have a larger impact on the ecosystem as a whole. An uncontrolled deer population could quickly destroy plant life and spread disease. The removal of too many deer may result in the overgrowth of plants and fewer prey items for larger predators. Without the top down control from the deer, faster growing plants may out compete their slower growing neighbors and further alter the local food web.

Photo Credit: Louisiana Sports-

An **invasive species** is any organism that is non-native to a given area and causes harm. The invasive species may out compete or overcrowd native species (ex: Chinese tallow crowds out native trees and restricts sunlight to ground level grasses) or reproduce quickly because of the lack of natural predators (ex: Nutria are rodents that reproduce quickly, have few predators and destroy wetlands). Most invasive species were first introduced due to human activity – both accidental and intentional. Zebra mussels arrived from Europe in the ballast water of ships in the late 1980s and are now outcompeting native shellfish and clogging drainpipes in waterbodies all over the United States. Kudzu was brought in from Asia as an erosion control method in the early 1800s but quickly crowded out native plants due to its rapid growth rate and resistance to many herbicides. Not all introduced species are harmful but it is nearly impossible to predict how a non-native species will affect a new environment beforehand. Making scientific studies important before introducing a new species.


Photo Credit: Gulf Research Institute
Chinese tallow


Photo Credit: Science Daily
Nutria


Photo Credit: St. Croix River Association
Zebra mussels


Photo Credit: The Nature Conservancy
Kudzu overgrowth

Energy Flow

The Law of Conservation of Energy states that energy is neither created nor destroyed, but rather transferred and transformed. For of food webs, this means that the energy from the sun is transformed into food energy for plants through photosynthesis. The plant can then use that energy to grow, bloom, and reproduce until an **herbivorous** or **omnivorous** consumer comes along and eats the plant. The energy is then transferred to the animal and fuels the animal's movement and growth. This process continues up to the higher trophic levels of the chain.

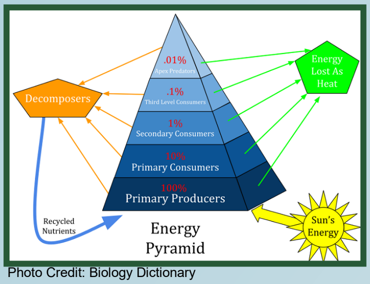


Photo Credit: Biology Dictionary

With every step in the chain, about 90% of the available energy from the last step is lost because each organism uses it. Energy is needed for movement, growth, reproduction, and the chemical reactions that keep the body functioning. Some energy is also lost to the atmosphere as heat. This means that a consumer must eat often to fulfill its nutrient requirements.

Decomposers play an important role in an ecosystem because they are able to recycle nutrients and return them to the system. These organisms act as a "clean-up crew" by consuming dead animals, decaying plant matter, and the waste of living animals. The majority of decomposers are microscopic bacteria but there are others that are visible to the naked eye. An earthworm is a decomposer that consumes soil and microorganisms and produces a nutrient rich waste that enriches the soil. Fungi absorb nutrients from plants and animals and produce enzymes that help break down organic material. On an energy pyramid, decomposers are typically added as a separate, but linked, component because they can contribute to the cycle at any point. Occasionally you will see a pyramid with decomposers at the top like the one below to the left.

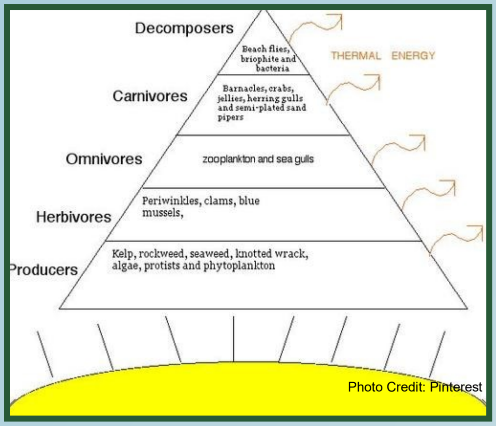


Photo Credit: Pinterest

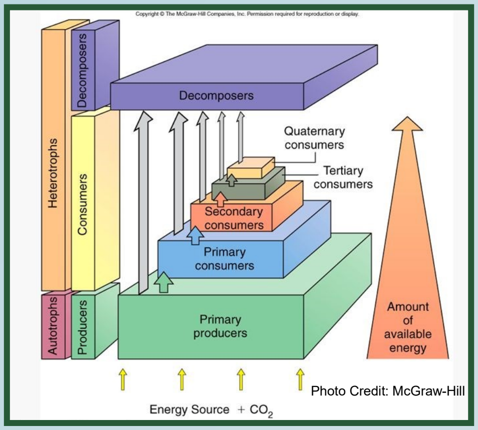


Photo Credit: McGraw-Hill

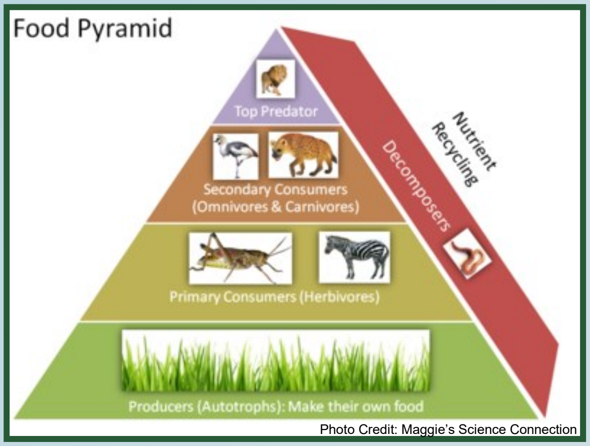


Photo Credit: Maggie's Science Connection

CWC Science!

A group of scientists from the Coastal Waters Consortium studying the Seaside Sparrow and marsh soil have found evidence that traces of Macondo oil (from the Deepwater Horizon spill) have entered terrestrial food webs. The study, published in the journal *Environmental Research Letters* and featured in the news, looked at the amount of carbon-14 in the feathers and stomach contents of Seaside Sparrows to determine if they were being exposed to oil. Feather samples provided evidence of long-term exposure while testing stomach contents gave a more recent "snapshot" view into what the birds are exposed to currently. They found that each examined bird had less radioactive carbon-14 which indicates that they had been exposed to, and had collected, oil remnants in their bodies.

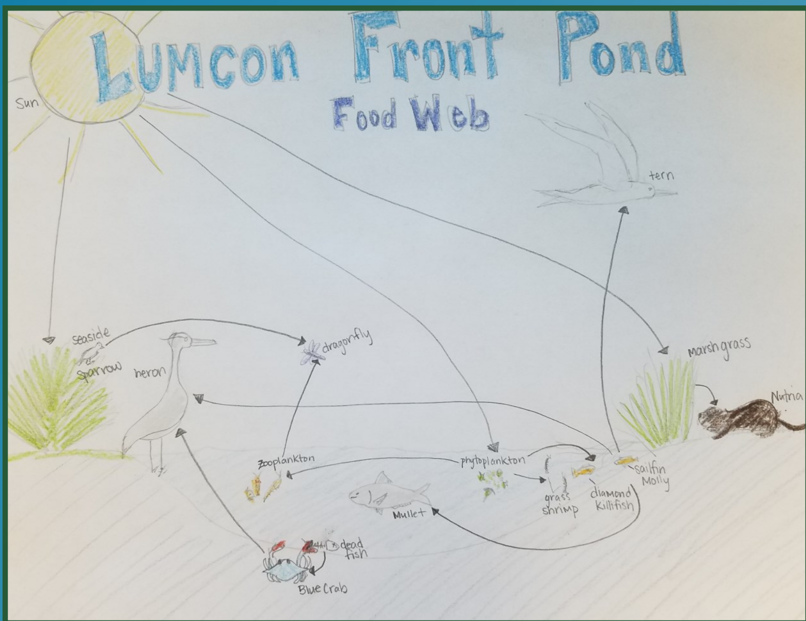
The Seaside Sparrows is a common songbird and a year-round resident in Louisiana marshes. They feed on both terrestrial and marine invertebrates which means there are many carriers of pollutants. Because it spends its entire life in the marsh, the Seaside Sparrow is considered an **indicator species** in regards to the overall health of the ecosystem. Discovering the chemical fingerprint of Macondo oil in these birds shows that the oil is not simply in the sediment anymore. It means that organisms lower in the ecological pyramid are consuming or absorbing remnants of oil and then being eaten by members of higher trophic levels. "At first, you may not imagine that a terrestrial bird would be impacted by an oil spill in the ocean, but in nature boundaries are often blurry," explained CWC scientist Dr. Andrea Bonisoli Alquati. "As a result, contaminants that are supposed to stay in aquatic environments can make it 'onto' land."[1]

This was a small study, with a sample size of only 10 birds, but it is giving researchers a glimpse into the long-term and widespread effects of off-shore oil spills. "At least for Deepwater Horizon, there has been a lot more emphasis on marine or offshore-type resources, and a little bit less emphasis on wildlife species in shore -- particularly in the marshes and coastal wetlands,"[2] concluded Scott Zengel, a coastal ecologist with Research Planning, Inc. The connections between aquatic and terrestrial ecosystems are often forgotten so hopefully studies like this one will bring attention back to the interconnectedness of different systems.

[1]Hays, B. (2016, Nov 16) *Scientists find land-based birds affected by Deepwater Horizon oil spill*. Retrieved from www.upi.com
[2]Woo, M. (2016, Nov 16) *Oil from Deepwater Horizon found in terrestrial birds*. Retrieved from www.insidescince.org

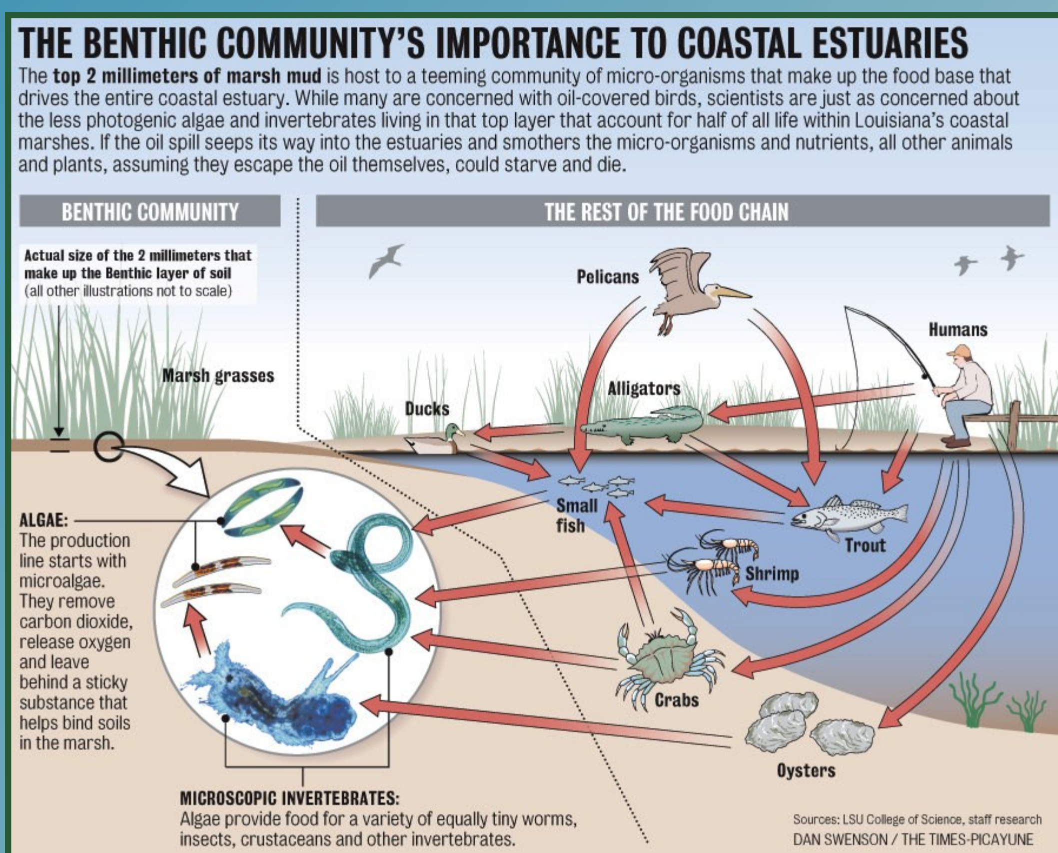
Photo Credit: EcoWatch

Things to think about...



Draw your own food web:

Identify a community or mini ecosystem in your area and draw the food web. Remember an ecosystem is defined as all the living things in a given area that interact with each other and with the non-living things around them. Therefore, your backyard, your garden, your neighborhood park, or a local bayou can all be mini ecosystems. As a young scientists, you can **get out there and observe** one of these spaces and try to identify the plants and animals that take advantage of the available resources. ●What's living in the soil? ●Which animals live in your space all the time and which animals move in and out? ●Are there nests or burrows where young animals are being protected and nurtured? ●Who eats what and how do each group of living organisms interact with each other? ●Does the community change during colder months? ●Why? ●What role do you play in the ecosystem?



Glossary of Terms

Autotroph/Producer— an organism that can produce its own energy using sunlight, water, carbon dioxide, or other chemicals.

Ecosystem—all of the living things (animals, plants, organisms), in an area, interacting with each other and with their non-living environment (weather, soil, water, sun, etc).

Energy— the ability to do work. In terms of food webs, energy is a property of matter than is transferred and transformed between living organisms.

Energy/Ecological Pyramid— a graphical model of how energy flows through a system.

Food Chain— a simple, linear representation of the predator/prey relationships within an eco system.

Food Web— a complex display of connected food chains.

Heterotroph/Consumer— an organism that cannot produce its own food and must consume or absorb other organisms to survive. A heterotroph can be a **carnivore** (a meet eaten), an **herbivore** (a plant eater), an **omnivore** (eats both meat and plants), or a **decomposer** (consumes dead or decaying matter).

Indicator Species— a plant or animal that can tell you how healthy an ecosystem is by whether it is present or absent in that ecosystem.

Invasive Species— a non-native species in a given area that causes, or is likely to cause, economic or ecological harm or harm to human health.

Overfishing— to deplete the stock of fish in a body of water by removing too many individuals.

Photosynthesis— the process by which green plants and some other organisms use sunlight to produce their own energy from carbon dioxide and water. Photosynthesis in plants generally involves the green pigment chlorophyll and also produces oxygen.

Phytoplankton— aquatic, free-floating, photosynthetic organisms that are typically microscopic.

Poaching— the illegal practice of hunting or stealing animals on private land or through the use of illegal weapons, traps or bait.

Trophic Level— a level or position in a food chain or web that includes all organisms that get their energy in the same way or from the same type of prey items.

Photo Credit: Geology.com

For More Information:

Check out these short YouTube videos:

- “Fabulous Food Chains” — Crash Course Kids
- “Food Webs” — Crash Course Kids
- ”Food Chains for Kids: Food Webs, the Circle of Life, and the Flow of Energy” — Free School
- “Food Webs and Energy Pyramids: Bedrocks of Biodiversity” — Amoeba Sisters

Other Resources:

- Autotroph—National Geographic
  https://www.nationalgeographic.org/encyclopedia/autotroph/
- Anthropogenic Stressors & Modern Food Web Ecology — Mike McCann, Ph.D.
  https://mccannecology.weebly.com/food-webs.html
- National Invasive Species Information Center — USDA
  https://www.khanacademy.org/science/biology/ecology/intro-to-ecosystems/a/food-chains-food-webs
- Food chains & food webs — Khan Academy
  https://www.khanacademy.org/science/biology/ecology/intro-to-ecosystems/a/food-chains-food-webs
- Food chains & food webs — WWF Global
  http://wwf.panda.org/about_our_earth/teacher_resources/webfieldtrips/food_chains/
- Food Web Facts — Idaho Public Television
  http://idahoptv.org/sciencetrek/topics/food_chain/facts.cfm
- How the Biosphere Works — BBC
  http://www.bbc.co.uk/bitesize/standard/biology/biosphere/how_it_works/revision/2/
- The Role of Decomposers — Socratic
  https://socratic.org/biology/the-elements-of-an-ecosystem/the-role-of-decomposers

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