Food Chain Frenzy:

An Exploration of North Carolina's Estuarine Ecosystem

Lesson plan developed by:

Summary

This lesson plan allows students to explore food chains in North Carolina's estuaries and surrounding salt marshes through hands-on and group activities. Students begin by playing an introductory game called "Wetlands Race" which showcases the importance of grasses in estuarine habitats as well as introduces key concepts and vocabulary words. After the game, students are assigned to an estuarine organism, split into groups and tasked with organizing themselves into food chains based on the function they serve in the ecosystem (producers, consumers, or decomposers). Group discussion, along with an accompanying worksheet, will allow students to think critically about issues such as pollution and how it might impact the estuarine ecosystem. Through this exercise, students should be able to classify an organism's role in a food chain and identify key characteristics of an estuarine ecosystem.

Materials

- "Wetlands Race" Game instructions and materials (included)
- Organism and Pollution Flashcards (included)
- Construction paper (to mount flashcards on)
- A board to display estuary profile on that cards can be "stuck" to (felt board, whiteboard, chalkboard, projector, or Smart Board)
- Either Velcro, magnets or tape to go on the back of Organism Flashcards (depending on the surface you choose to display estuary profile on)
- Student worksheet and Answer Key (included)
- Trophic Level Color Key (included)
- Estuary Profile image (included)

Duration

- 45 minutes – 1 hour

Grade Levels

- 5th

Setting

- Indoors/Classroom

Vocabulary

Food chain
Predator
Prey
Producer
Consumer
Decomposer
Estuary
Submerged aquatic vegetation (SAV)
Brackish water
Salt marsh
Pollution

Objectives

- Explain what a food chain is
- Classify an organism's role in a food chain based on the function it serves in the ecosystem (producer, consumer or decomposer)
- Identify key characteristics of an estuarine ecosystem
- Calculate the amount of energy needed to fuel different trophic levels
- Assess how removing an organism from a food chain could impact an ecosystem

North Carolina Essential Standards

- 5.L.2: Understand the interdependence of plants and animals with their ecosystem.
    - 5.L.2.1: Compare the characteristics of several common ecosystems, including estuaries and salt marshes, oceans, lakes and ponds, forests, and grasslands) in terms of their ability to support a variety of populations.
    - 5.L.2.2: Classify the organisms within an ecosystem according to the function they serve: producers, consumers, or decomposers (biotic factors). 5D/E3a
    - 5.L.2.3: Infer the effects that may result from the interconnected relationship of plants and animals to their ecosystem.

Common Core

- 5.NBT.1: Recognize that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents in the place to its left.

Next Generation Science Standards:

- 5-LS2: Ecosystems: Interactions, Energy, and Dynamics
    - 5-LS2-1: Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

Virginia Standards of Learning

- 5.5: The student will investigate and understand that organisms are made of one or more cells and have distinguishing characteristics that play a vital role in the organism's ability to survive and thrive in its environment. Key concepts include
    c) traits of organisms that allow them to survive in their environment.

- 5.6: The student will investigate and understand characteristics of the ocean environment. Key concepts include
    c) ecological characteristics.

- 6.5: The student will investigate and understand the unique properties and characteristics of water and its roles in the natural and human-made environment. Key concepts include
    f) the importance of protecting and maintaining water resources.
- 6.7: The student will investigate and understand the natural processes and human interactions that affect watershed systems. Key concepts include
    a) the health of ecosystems and the abiotic factors of a watershed;
    e) estuaries;

Background Materials for Teachers

Video on coastal estuaries (Time 0:00–3:35):
https://www.youtube.com/watch?v=W7_p6c1woHg

Video on the 10% Rule (Trophic level energy transfer)
https://www.youtube.com/watch?v=ScizkxMlEOM

What is an estuary?

An **estuary** is a place where rivers meet the sea. This unique habitat is home to a variety of plant and animal species that have adapted to the mixture of fresh and salt water, also known as **brackish water**. Estuaries are bordered by **salt marshes** which are coastal wetlands dominated by grasses and frequently inundated by tides. These shallow, brackish waters and marshy, intertidal habitats are what allow estuaries to be one of the most productive ecosystems on earth. Estuarine ecosystems provide food, shelter, nursery habitat, breeding grounds and migration stopovers for many fish and other aquatic animals.[1] In fact, over 75 percent of fisheries species spend time in an estuary at some point during their life cycle.[2] One key feature of an estuarine ecosystem that helps to sustain this abundant productivity is submerged aquatic vegetation.

What is submerged aquatic vegetation?

Underwater grasses or **submerged aquatic vegetation** (SAV) are plants that grow underwater. They are similar to seagrass but grow in the shallow, brackish waters of the sounds and its tributaries. They provide many ecosystem functions:

- Habitat, food, and shelter for aquatic life
- Absorb and recycle nutrients like nitrogen and phosphorus
- Absorb carbon dioxide from the water
- Stabilize the shoreline by absorbing wave energy
- Add oxygen to the water
- Filter sediment
- Act as a gauge of water quality

SAV is an extremely important habitat for fish and waterfowl, and by extension it is important to the hunters and fishermen that reside in and flock to eastern North Carolina. SAV has great ecological and economic value, and North Carolina's SAV resources are more abundant than most. The larger Chesapeake Bay is estimated to have only approximately half of North Carolina's 138,000 acres.

[1] http://portal.ncdenr.org/web/apnep/fastfacts
[2] http://portal.ncdenr.org/web/apnep/fastfacts

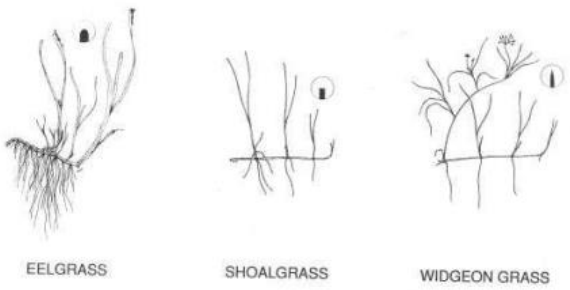
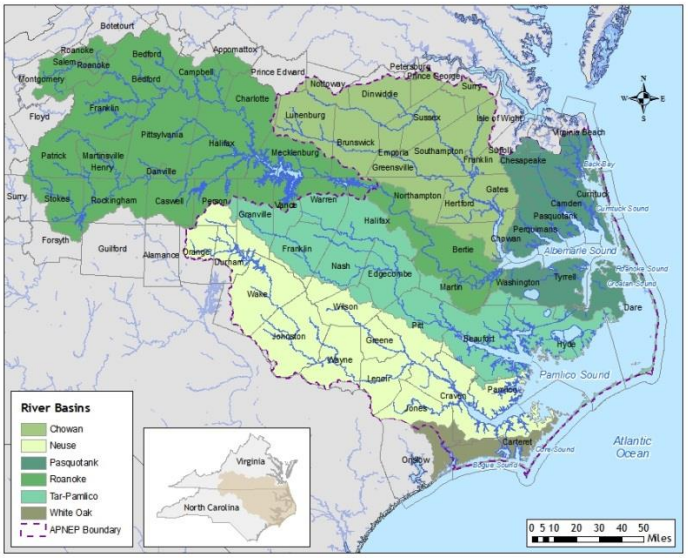


Image: Three common SAV species in NC.

The Albemarle-Pamlico Estuarine System

The Albemarle-Pamlico Estuarine System is comprised of an extensive complex of creeks, rivers, swamps, marshes, and open water sounds dominating northeastern North Carolina. This ecosystem is one of the largest and most important in the United States. Covering approximately 3,000 square miles, the waters of the system comprise the second largest estuarine system on the East Coast of the United States, exceeded in area by only the Chesapeake Bay. With a watershed exceeding 28,000 square miles and encompassing cities like Raleigh and Greenville, NC, there is a large human influence on the estuarine ecosystem. Albemarle Sound is not directly connected to the Atlantic Ocean and Pamlico Sound has very few inlets; both lay behind an extensive chain of barrier islands referred to as the "Outer Banks". Located at the convergence of the warmer Gulf Stream and the cooler Labrador Current, the Albemarle-Pamlico Sounds are critical to fisheries in North Carolina and all along the east coast.



Map: Major river basins and sounds of the Albemarle- Pamlico Estuarine System

What inputs could jeopardize the health of an estuarine ecosystem?

Pollution is defined as "the contamination of air, water, or soil by substances that are harmful to living organisms. Pollution can occur naturally, for example through volcanic eruptions, or as the result of human activities, such as the spilling of oil or disposal of industrial waste."[3]

- Runoff- Pesticides, automobile fluids like oil or grease, and metals such as mercury or lead have all been found to pollute estuaries. These substances can enter an estuary through industrial discharges, yard runoff, streets, agricultural lands, and storm drains.[4] When these toxins sink into the sediment and are consumed by plants and animals, they can pass along these dangerous toxins to other organisms in the food chain.
- Bacteria- Shellfish, such as oysters, clams, and mussels, are filter feeders but they can also consume bacteria and viruses that are present in the water. High levels of certain bacteria can indicate contamination by human or animal waste, which means that any organism that consumes these filter feeders is at risk of infection.
- Suspended sediment- Eroded soil and organic material that is moved from the land to the water is called suspended sediment. Runoff from agricultural lands and construction sites have increased suspended sediment loads in waterways. This sediment can affect estuaries by decreasing visibility for organisms and blocking sunlight to underwater plants. Large amounts of suspended sediment make the water murky and when the sediment settles to the bottom, it covers up organisms that live on the bottom such as oysters and underwater grasses.
- Nutrients (Nitrogen and Phosphorus)- Nutrients are essential for plant life and are used in agriculture to enhance crop growth. However, when washed into rivers and estuaries, nutrients can lead to excess phytoplankton or algae growth called a bloom. These blooms can block sunlight from reaching submerged aquatic vegetation (SAV) and can consume all oxygen from the water causing fish kills. Some blooms even produce toxins which can be harmful to human health.
- Dissolved oxygen concentrations- Dissolved oxygen concentrations are the amount of tiny oxygen bubbles in the water column. Very low dissolved oxygen levels can be caused by algal blooms which occur when excess nutrients in the water lead to an overgrowth of algae. Low dissolved oxygen levels can be very dangerous for fish and shellfish species.
- Herbicides- Herbicides are used on lawns and agricultural fields to kill unwanted plants like weeds. However, when these herbicides are washed into rivers and estuaries, they can cause damage. For example, herbicides can kill submerged aquatic vegetation (SAV) beds which are used by many organisms for protection from predators. When they are no longer able to hide in grass beds from predators, organisms such as fish and shrimp are much more likely to be eaten.

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[3] The American Heritage® Science Dictionary. Houghton Mifflin Company. 13 Feb. 2017. <Dictionary.com http://www.dictionary.com/browse/pollution>.

[4] http://oceanservice.noaa.gov/education/kits/estuaries/media/supp_estuar09a_toxic.html

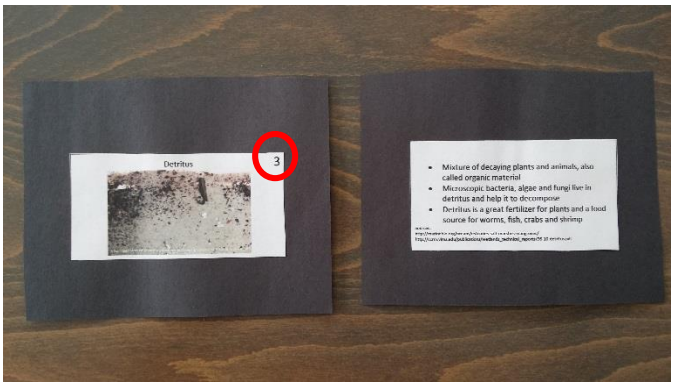
Activity Overview

Engage

Begin lesson by playing the attached game called “Wetlands Race”. This game will showcase the importance of submerged aquatic vegetation (SAV) in an estuarine ecosystem while also introducing the students to vocabulary words such as **estuary, submerged aquatic vegetation, predator** and **prey**. Materials needed for the game and instructions are included in the attached document.

Explore

Each student will be given an Organism Flashcard (attached document) and the number on the top right corner of their card is the group, or food chain, they are a part of. Here is a picture of the front and back of an Organism Flashcard:



Each group has 5 organisms in it and there are a total of 6 groups (up to 30 students). First, have students fill out “Section 1” of their worksheets based on their organism. Then, have the students gather in their groups, discuss their Organism Flashcards and arrange themselves into a food chain. When all groups have finished organizing their food chains, show them the Trophic Level Color Key (can either draw on a board or display on a projector) so they can check whether or not they have arranged themselves correctly.

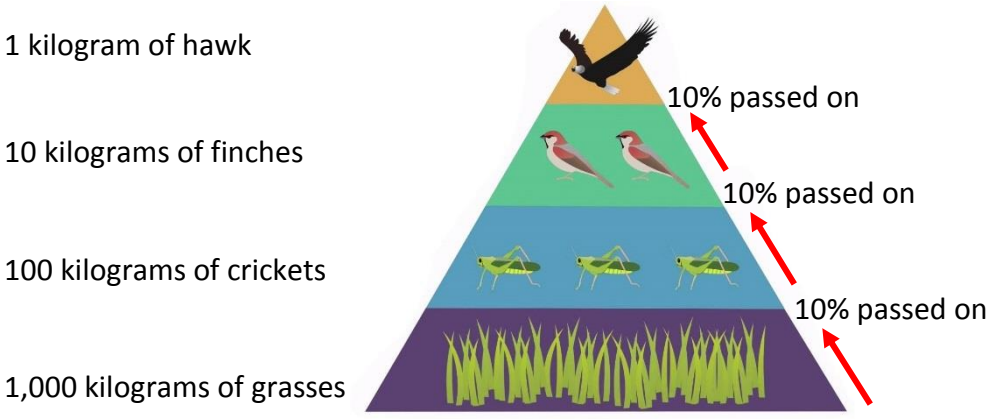
NOTE: Some groups have Phytoplankton (primary producers) and some have Detritus (decomposers) for the lowest trophic level in their food chains. Technically speaking, decomposers are below primary producers in a food chain or food web. However, for the purposes of this activity, they appear to be on the same trophic level. Please feel free to make the distinction between the two levels if you deem it necessary for your classroom.

Explain

Have students fill out “Section 2” of their worksheets. Then, as a class, go over the questions together and have some of the students share their answers. This is a chance to present the formal definitions of the following vocabulary words: **food chain, predator, prey, producer, consumer** and **decomposer**.

“Section 3” of the worksheet covers the 10% Rule and can either be done individually or as a class. This concept may be new to some students and it may be helpful to do an example together. Here is an example from a different ecosystem:

Only 10% of what is consumed by an organism it passed on to fuel the next organism in a food chain.



Source: https://www.youtube.com/watch?v=0glkXIj1DgE

In this example, it takes 1,000 kilograms of grasses to fuel 1 kilogram of hawk. This is a good opportunity to review moving decimal places with your students.

There is also a helpful video on the 10% Rule in the “Background Materials for Teachers” section that you can play for your class.

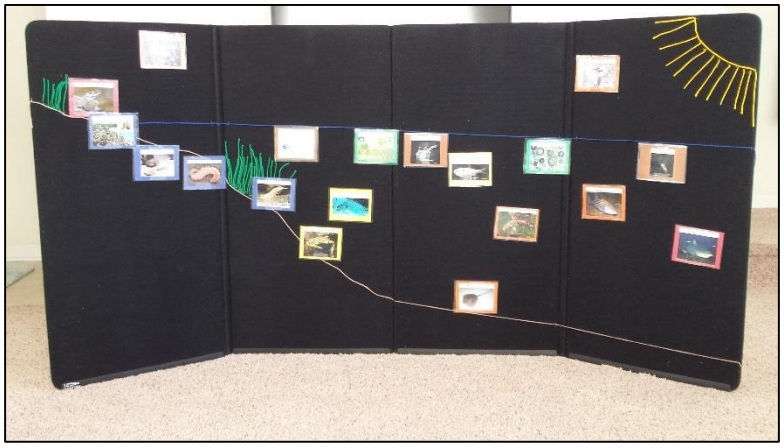
Elaborate

Included at the end of the Organism Flashcards document (attached), are Pollution Flashcards. The number on the top right corner of the Pollution Flashcard tells you what group (or food chain) receives that flashcard. Distribute the flashcards to the groups and have them read and discuss how their pollutant might alter or interrupt their food chains. Students can fill out “Section 4” of the worksheet as a group.

Encourage them to think about the “chain reaction” that occurs when even just one organism in a food chain is affected by pollution. In other words, how will the populations of the organisms above and below the affected organism be changed? In theory, if an organism is removed from a food chain, the population of its prey will increase and the population of its predators will decrease.

Evaluate

Have the students come up one group at a time and place their organism where they think it lives in the estuary. You can either display the Estuary Profile image (attached) on a projector, draw an estuarine profile on a whiteboard, or design one with yarn on a felt board (as shown below).



Students can then fill out "Section 5" of their worksheets.

Extension (optional)

Have students sit in a circle with their organism cards on the floor in front of them. Give a ball to one student and have them role it to someone else in the circle who has an organism that either eats their organism or is eaten by their organism. Let them continue until everyone has gotten the ball rolled to them at least once.

This activity will showcase the interconnectivity of food chains in an ecosystem and introduce the concept of food webs.

For more information on submerged aquatic vegetation (SAV):

http://portal.ncdenr.org/web/mf/habitat/SAV

http://portal.ncdenr.org/web/apnep/sav-map

References

Albemarle-Pamlico National Estuary Partnership 2012 Albemarle-Pamlico Ecosystem Assessment: http://www.apnep.org/c/document_library/get_file?uuid=1c126d0c-2589-40c7-ac41-125f99ad0c70&groupId=61563

Albemarle-Pamlico National Estuary Partnership 2012 Comprehensive Conservation and Management Plan: http://apnep.org/c/document_library/get_file?uuid=e6600731-daed-4c5f-9136-253f23c9bbcf&groupId=61563

Name:
Group Number:

Food Chain Frenzy Worksheet

Section 1:

1. What is the name of your organism?

2. What does your organism eat and/or what eats your organism?

3. Write one interesting fact about your organism.

Section 2:

4. Define what a food chain is in your own words.

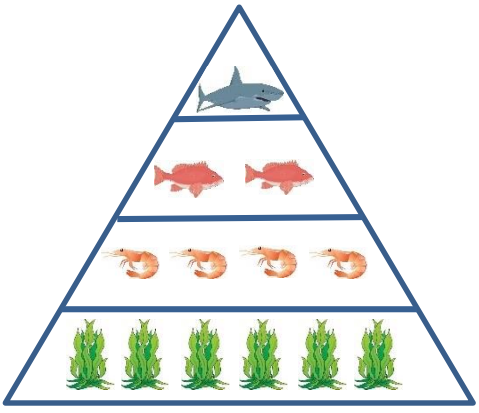
5. Is your organism a predator, a prey or both? Explain.

6. Is your organism a producer, consumer or decomposer? How do you know?

Section 3:

The 10% Rule: Only 10% of what is consumed by an organism it passed on to fuel the next organism in a food chain.

Use the 10% rule to calculate how many kilograms of shark can be fueled by 3,000 kilograms of algae.



_____ kilograms of shark

_____ kilograms of fish

_____ kilograms of shrimp

___3,000_____ kilograms of algae

Section 4:

7. What is causing the pollution in your ecosystem?

8. How is the pollution impacting your food chain?

9. What organisms in your food chain are being affected by the pollution?

Section 5:

10. Take a look at the estuary profile with all of the organisms on it. Take some time to draw a food chain below with your organism in it and at least TWO other organisms that were NOT in your group during the activity.

Food Chain Frenzy Worksheet (Key)

Section 1:

1. What is the name of your organism?
   Answer will vary for each student.

2. What does your organism eat and/or what eats your organism?
   Answer will vary for each student. If they are the top predator, they will only be able to provide a prey and if they are a producer or decomposer they will only be able to provide a predator.

3. Write one interesting fact about your organism.
   Answer will vary for each student.

Group 1: Bull Shark Atlantic Stingray Steamer Clam Copepod Diatoms	**Group 2:** Osprey Red Drum Blue Crab Eastern Mudsnail Algae
Group 3: American Alligator American Oystercatcher Eastern Oyster Crab Larvae Detritus	**Group 4:** Atlantic Sharpnose Shark Striped Bass Spot Bristle Worm Algae
Group 5: Great Egret Summer Flounder Mummichog Brown Shrimp Detritus	**Group 6:** Coyote Brown Pelican Atlantic Menhaden Fish Larvae Detritus

Section 2:

4. Define what a food chain is in your own words.
   A **food chain** is a sequence of organisms in an ecosystem through which nutrients and energy are passed. Each species in a food chain is the food of the next member of the chain. Food chains begin with plants and end with animals.

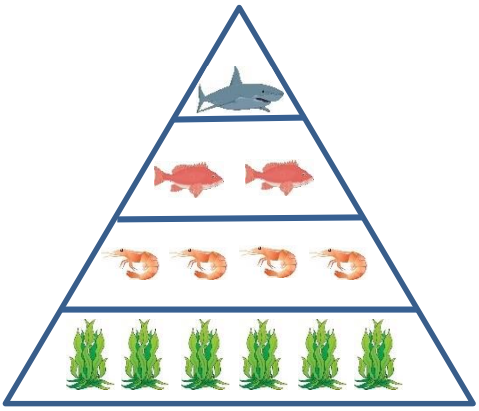
5. Is your organism a predator, a prey or both? Explain.
   Answer will vary for each student.
   A **predator** is an animal that captures and eats other animals.
   A **prey** is an animal hunted or captured by another animal for food.

6. Is your organism a producer, consumer or decomposer? How do you know?
   Answer will vary for each student.
   A (primary) **producer** is an organism that is able to produce its own food through photosynthesis (or chemosynthesis).
   A **consumer** is an organism that feeds on plants (primary consumer) or animals.
   A **decomposer** is an organism, usually bacteria or fungus, that breaks down dead or decaying plants and animals.

Section 3:

The 10% Rule: Only 10% of what is consumed by an organism it passed on to fuel the next organism in a food chain.

Use the 10% rule to calculate how many kilograms of shark can be fueled by 3,000 kilograms of algae.



___3_____ kilograms of shark

___30_____ kilograms of fish

__300_____ kilograms of shrimp

__3,000_____ kilograms of algae

Section 4:

7. What is causing the pollution in your ecosystem?
   Answer will vary for each group. Group 1-Bacteria; Group 2-Low Dissolved Oxygen; Group 3-Suspended Sediment; Group 4-Nutrients, Group 5-Herbicides; Group 6-Runoff

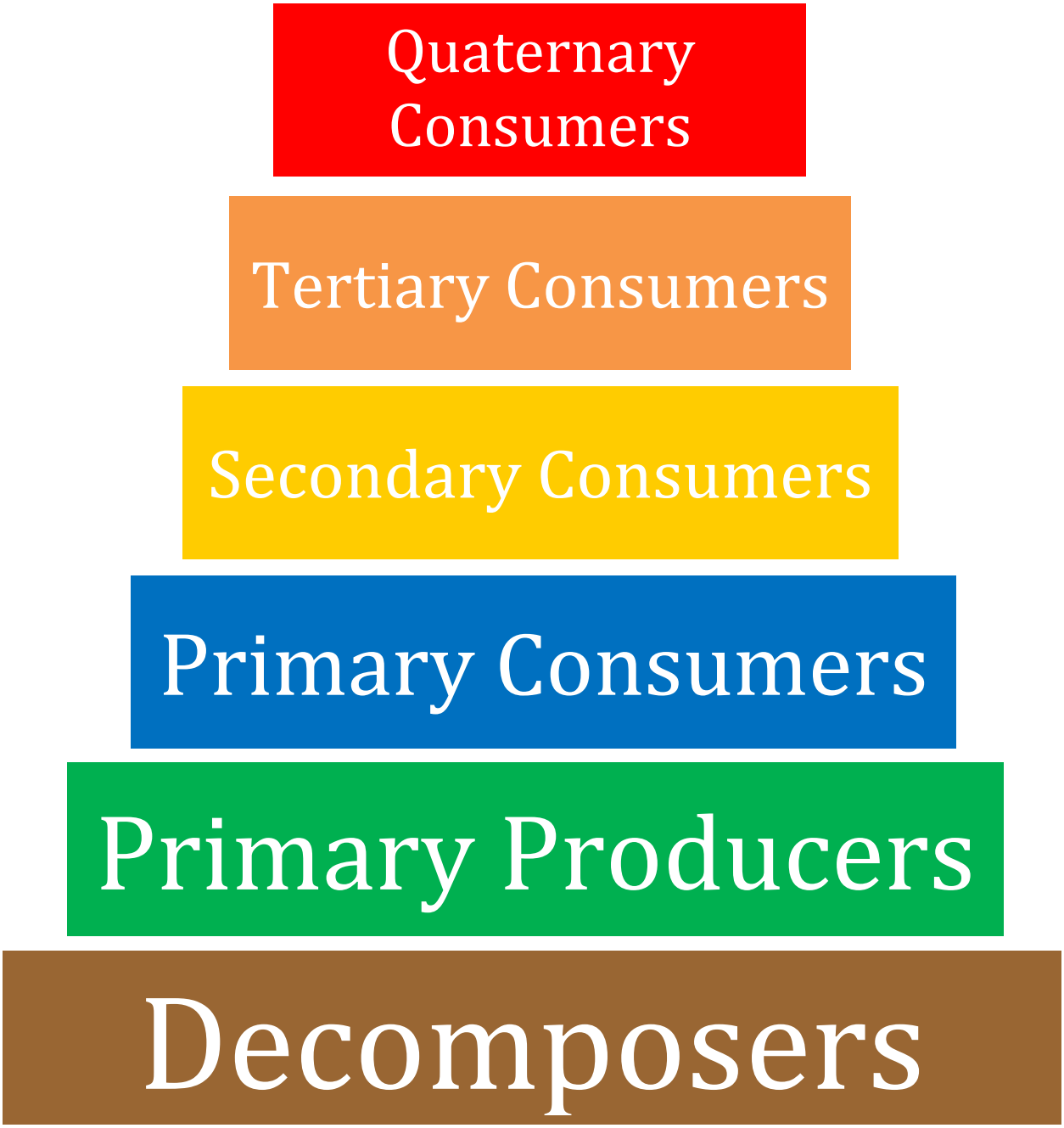
8. How is the pollution impacting your food chain?
   Answer will vary for each group/student.

9. What organisms in your food chain are being affected by the pollution?
   Answer will vary but should address the concept that all organisms, either directly or indirectly, are affected by pollution. When an organism is impacted by pollution it sets off a chain reaction because organisms in a food chain build off of each other.

Section 5:

10. Take a look at the estuary profile with all of the organisms on it. Take some time to draw a food chain below with your organism in it and at least TWO other organisms that were NOT in your group during the activity.
    Answer will vary for each student.

Trophic Level Color Key



Estuary Profile

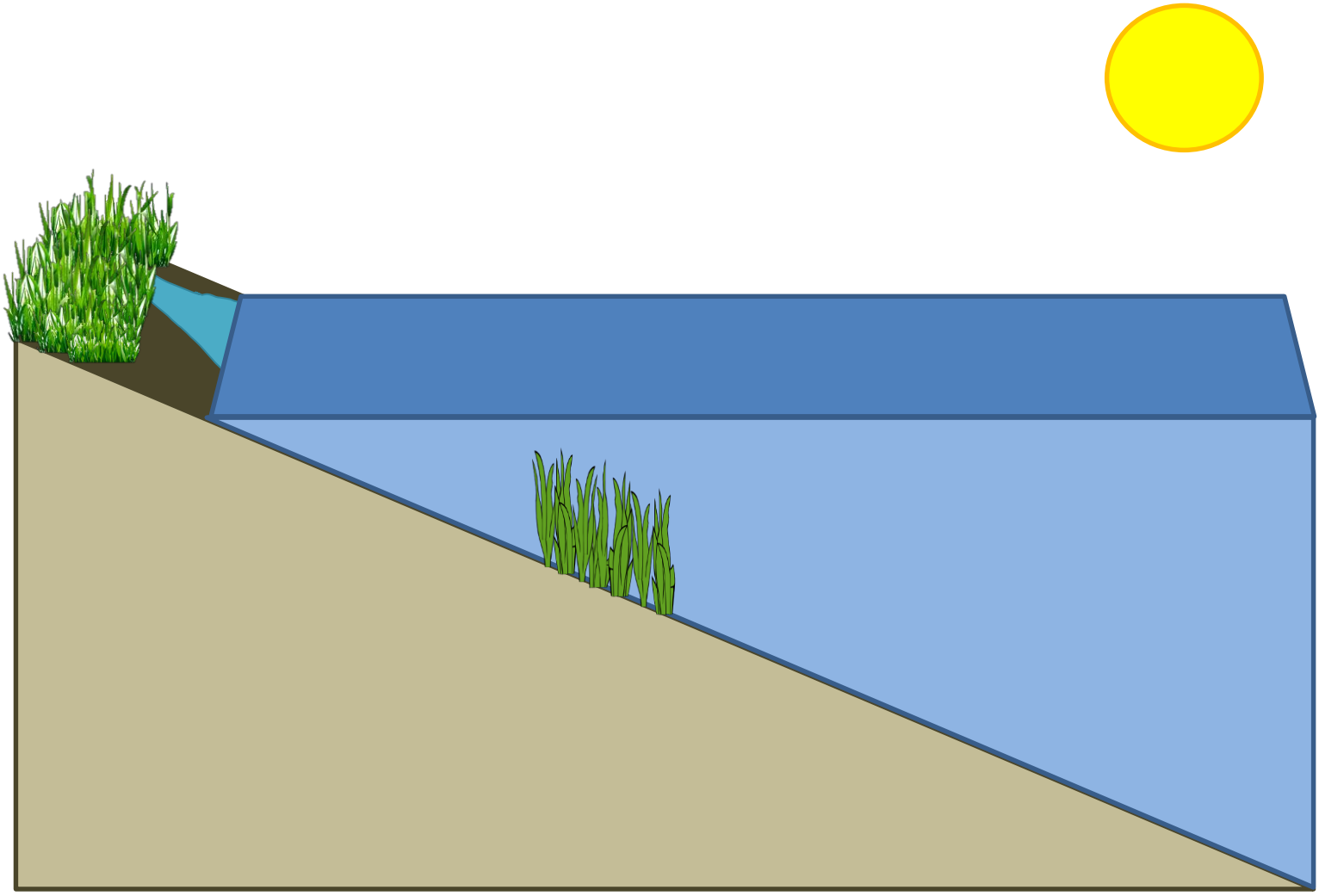


Image Sources:
https://www.pinterest.com/pin/346003183853264502/
https://clipartfest.com/categories/view/e7df990c432cbe64cc44f6e7000e7158c4c2db40/cartoon-shrimp-clipart.html
http://www.cartoonpics.net/r-cartoon-fish-41-cartoon-fish-red-snapper-2337.htm
http://www.clipartkid.com/cartoon-shark-cliparts/
https://fr.dreamstime.com/photo-libre-de-droits-herbe-image39006295
http://www.clker.com/clipart-11512.html