ACTIVITY 5

Planet Plankton

Estuary Principle

Estuaries support an abundance of life, and a diversity of habitat types.

Research Question

What are plankton and why are they important in the estuary?

Introduction

Plankton are found in almost any of Earth's many bodies of water. They exist in vast, unimaginably large numbers and form the biological base of aquatic food webs. Not only that, but the plant-like phytoplankton are responsible for most of the transfer of carbon dioxide from the atmosphere to the ocean, a process known as the carbon cycle, and produce more than 60% of the oxygen in the air we breathe. In this activity, students will learn about different types of plankton and their importance to life in estuaries.

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This curriculum was developed and produced for:

The National Oceanic and Atmospheric Administration (NOAA) and The National Estuarine Research Reserve System (NERRS)

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TEACHER GUIDE

Planet Plankton

Research Question

What are plankton and why are they important in the estuary?

Content Objectives

Students will understand that:

- Plankton are very small, diverse organisms.
- Plankton are important to Earth's atmosphere and climate.
- Plankton are critical to maintaining life in estuaries.

Exercises

Exercise 1: What Are Plankton?

Students observe plankton and then construct plankton models that can be tested for their slowness in sinking.

Exercise 2: Catching Plankton

Students build their own plankton nets and then use the plankton nets to collect plankton.

Exercise 3: Magnify Your Plankton

Students use a hand lens or microscope to observe plankton, then sketch and describe form and function.

Assessment Questions

Assessment questions based on content covered in *Planet Plankton* can be downloaded on the web page for this activity in the Middle School Curriculum section of the Estuary Education website at estuaries.noaa.gov.

Vocabulary

Diatom – one of the large groups of phytoplankton. They are mostly single-celled and have cell walls made of silica (SiO_2), or what you might call a "glass house."

Dinoflagellate – another large group of phytoplankton. From the Greek language, "dinos" means to whirl or spin, and "flagellum" means a whip-like tail. Under a microscope we can see them spinning as their flagella propel them through the water.

Plankton bloom – very rapid plankton reproduction that can often cause the water to become green, red or brown. A "red tide" is the result one type of bloom.

Plankton – free-floating organisms that drift in water, unable to swim against currents; name derived from the Greek word planktos meaning 'wanderer' or 'drifter.'

Photosynthesis – the process by which plants convert light energy into chemical energy (food) using carbon dioxide, water, and minerals. This process produces oxygen.

Phytoplankton – microscopic photosynthesizing plant-like organisms that drift with the currents; microalgae including diatoms and dinoflagellates.

Zooplankton – animal plankton. Like the phytoplankton, they drift with the currents; many are microscopic but also include larger animals such as jellyfish. Many have some power of locomotion, especially in terms of vertical migration, and use this to avoid predators or to increase their chances of finding food.

EXERCISE 1

What Are Plankton?

Estuary Concept

Plankton meet their survival needs through an array of diverse adaptations.

Focus Questions

- What are plankton and where are they found?
- What are some of the adaptations that help plankton survive?

Performance Tasks

Students will:

- Define plankton as floating or drifting plants or animals that live in the water and observe that there is an enormous diversity of plankton.
- Explore ways in which plankton have adaptations that help them avoid sinking below the sunlit photic zone.

Overview

It is important for plankton to maintain their position in the water column. There are two parts to this exercise. In the first part of the exercise, students observe the diversity of plankton. In the second part of the exercise, students will construct plankton models with simulated adaptations that slow sinking. The winner of the race is the "plankton" that sinks the slowest!

Time Required

Two to three 45-minute class sessions

Teacher Background

Plankton are floating or drifting organisms that live in water. The term "plankton" comes from the Greek word "planktos" which means to drift or wander. Plankton are found in bodies of water ranging from fresh to salty, including rivers, streams, ponds, lakes, the ocean, and estuaries.

Plankton are usually so small that they can only be observed with a microscope or hand lens. They come in many shapes and sizes. Scientists usually divide them into two main groups: the phytoplankton and the zooplankton. Phytoplankton are plant-like organisms. Like terrestrial plants, they use photosynthesis to turn sunlight, minerals, and carbon dioxide into food and oxygen. Zooplankton are animals. They feed on phytoplankton and other zooplankton. Zooplankton are usually microscopic, but large jellyfish are considered to be zooplankton as well. Some zooplankton, such as the copepod, will remain plankton their entire lives. These are known as holoplankton. The meroplankton, animals such as barnacles and crabs, are plankton for only part of their lives.

Some plankton have adapted body structures that allow them to move around a bit, but even the strongest of these swimming plankton are carried by water currents as well. Some types of plankton have the ability to move up or down in the water column, sometimes hundreds of meters every day. They do this to avoid predators or to find food. These plankton still depend on currents for their horizontal movement.

Phytoplankton are particularly important to supporting life in Earth's ocean, estuaries, and other bodies of water. Phytoplankton are the primary producers in these freshwater and marine food webs. They make food through the process of photosynthesis and then become food for everything from zooplankton to whales. Additionally, phytoplankton are responsible for producing most of the oxygen in Earth's atmosphere.

Preparation

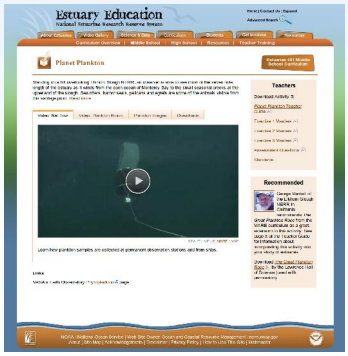
Part 1, A Plethora of Plankton

1. You may choose to use this part of the exercise as a pre- or post- activity to Part 2, *The Great Plankton Race*, or use it as a stand-alone exercise. You might also consider substituting Session 1 of MARE's *The Great Plankton Race*, which covers the same plankton introductory material.
2. Make copies of the Student Master: *A Plethora of Plankton.*
3. Students will benefit from seeing the color plankton images on the Teacher Master projected on a screen as they work on the Student Master: *A Plethora of Plankton.*

Part 2, The Great Plankton Race

4. Download MARE's *The Great Plankton Race* from the web page for this activity in the Middle School Curriculum section of the Estuary Education website at estuaries.noaa.gov. This document contains descriptions of three separate activity sessions covering more than a week of class time. We are recommending that you read the entire document, but that you only do Session 2, also called *The Great Plankton Race*, with your class. The document you download includes everything you will need to do the plankton design and race activity.
5. Gather the materials you will need for the activity and make copies of the handouts for your students. Begin this preparation enough ahead of time that that you will be able to gather materials and become familiar with the activity.

You'll find multimedia and other resources for this activity in the Middle School Curriculum section of the Estuary Education website: http://estuaries.noaa.gov.



Procedure

Part 1, A Plethora of Plankton

1. Distribute copies of Student Master: *A Plethora of Plankton.*
2. Project color images of the plankton on the Teacher Master for students to see as they complete the questions on the sheet.
3. Discuss with your students how they chose which plankton were phytoplankton and which were zooplankton. Which plankton where difficult to label? This could be pursued in a variety of ways.

Questions and Possible Answers

Q1. Examine the plankton images above. Circle the zooplankton.

Students should circle the copepod, polychaete larva, crab larva, and jellyfish.

Q2. Place an X above the photosynthetic phytoplankton images.

Students should place an X above the diatom and dinoflagellate.

Q3. What evidence did you use to make your choices?

Materials

Part 1, *A Plethora of Plankton*

Per student

- Student Master: A Plethora of Plankton
- Color transparency copies of Teacher Master: A Plethora of Plankton or access to computer with projector

Part 2, *The Great Plankton Race*

You will find a materials list in your downloaded copy of MARE's The Great Plankton Race. Look for the "What You Need" section of the document. You are looking for the materials list for Session 2. (If you choose to do the other two sessions of MARE's *The Great Plankton Race*, their materials lists are also found here.)

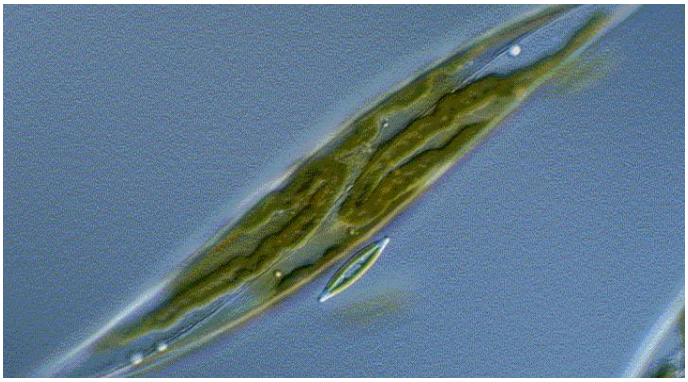
Students will probably choose the plankton that look like animals as their zooplankton. Similarly, they may determine that the diatom is a phytoplankton based on its green color. Students may have a little more difficulty determining whether the dinoflagellate is a plant or animal.

Part 2, The Great Plankton Race

4. You will find teacher support, materials lists, student instructions, handout masters, and answers to student questions (and yours!) within the MARE teaching materials for the exercise, *The Great Plankton Race*. This activity is Session 2 in the MARE document, also called *The Great Plankton Race*. You will find everything you need in the document you download from the web page for this activity in the Middle School Curriculum section of the Estuary Education website at estuaries.noaa.gov.

TEACHER MASTER

A Plethora of Plankton

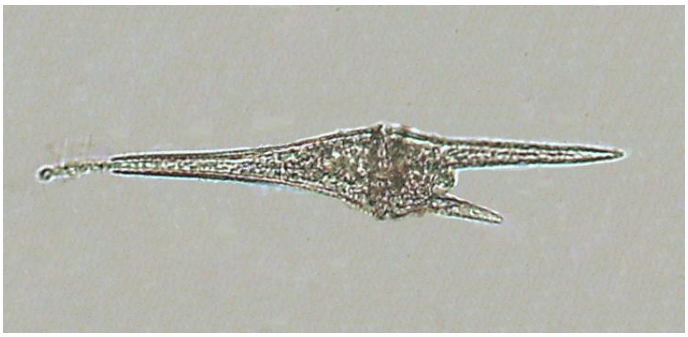


Diatom
Credit: Elkhorn Slough NERR

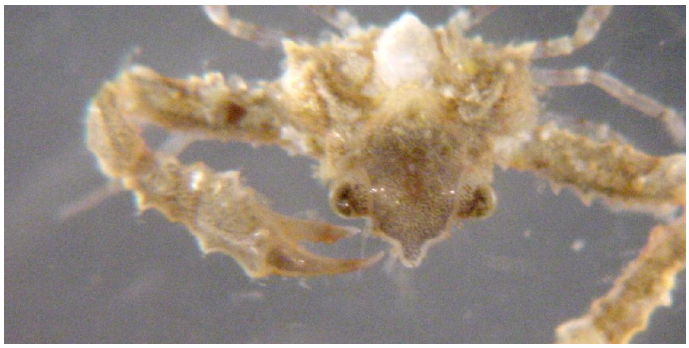
Polychaete larva
Credit: Elkhorn Slough NERR

Jellyfish
Photographer: Kevin Raskoff
Credit: Hidden Ocean 2005 Expedition: NOAA Office of Ocean Exploration.

Copepod
Photographer: Russ Hopcroft
Credit: Hidden Ocean 2005 Expedition: NOAA Office of Ocean Exploration.



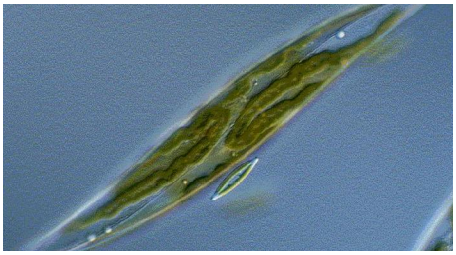
Dinoflagellate
Credit: Minami Himemiya
Used under Creative Commons license



Crab larva
Photographer: Jerry Mclelland
Credit: Charleston Bump Expedition 2003. NOAA Office of Ocean Exploration; Dr. George Sedberry, South Carolina DNR, Principal Investigator

STUDENT MASTER

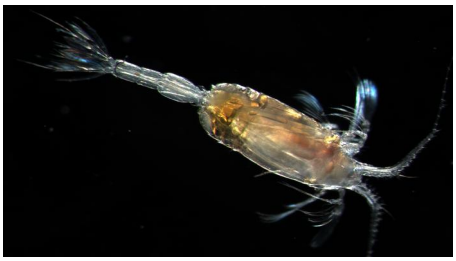
A Plethora of Plankton



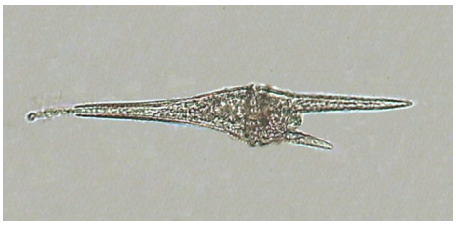
Diatom

Polychaete larva

Jellyfish



Copepod



Dinoflagellate

Crab larva

Plankton are floating or drifting plants and animals that live in water. Plankton are usually so small that we can only observe them with a microscope or hand lens. They come in many shapes and sizes, and scientists usually divide them into two main groups, the phytoplankton and the zooplankton.

Phytoplankton are plant-like organisms. Like plants on land, diatoms and other phytoplankton use photosynthesis to turn sunlight, minerals, and carbon dioxide into food. They produce oxygen during the process, which is good thing for us. Phytoplankton are responsible for most of the oxygen in Earth's atmosphere. It's important that phytoplankton stay near the sunlit (or photic) zone where they are able to get enough light to conduct photosynthesis.

Zooplankton are animals. The zooplankton, such as the polychaete larva, eat phytoplankton and other zooplankton. Zooplankton are larger than phytoplankton, but are usually microscopic as well. The zooplankton also need to stay near the photic zone, since that's where most of their food is found.

Questions

Q1. Examine the plankton images above. Circle the zooplankton.

Q2. Place an X above the photosynthetic phytoplankton images.

Q3. What evidence did you use to make your choices?

EXERCISE 2

Catching Plankton

Estuary Concept

Technology is needed to collect plankton for observation.

Focus Question

How can you collect an organism as small as plankton for observation?

Performance Tasks

Students will:

- Build a simple plankton collection net.
- Test the plankton net in the ocean, lake, pond, or other body of water.
- Collect plankton samples and observe plankton in the field with hand lens, etc.

Teacher Background

Plankton vary in size and so does the mesh size of scientific plankton nets. A plankton net made from a common window screen would capture many of the larger plankton while allowing the smaller phytoplankton to pass through and "escape." The nylon fabric from a stocking has a finer mesh and will capture more plankton. Even so, many of the smaller plankton will continue to wash through the fabric.

Teacher Preparation

View the *Net Tow* video on the web page for this activity in the Middle School Curriculum section of the Estuary Education website at estuaries.noaa.gov. This video shows how plankton samples are collected at permanent observation stations or from ships. The video highlights sampling devices, including devices similar to the plankton nets the students will be constructing in this exercise. The video also shows excellent images of plankton.

Follow the instructions on the Student Master: *Catching Plankton* to make a plankton net that students can look at as an example. This will also help you know what difficulties students might encounter during the process and will help you determine the right materials for the job.

Decide ahead of time whether you want to have your students work in groups, pairs, or alone when building their plankton nets. Depending on where you will be collecting plankton, you may decide that 8 nets are better than 20.

You may want students to bring notebooks or journals to the field so that they can sketch what they see and record their observations of the body of water where the plankton were collected, what they saw when they magnified samples, etc.

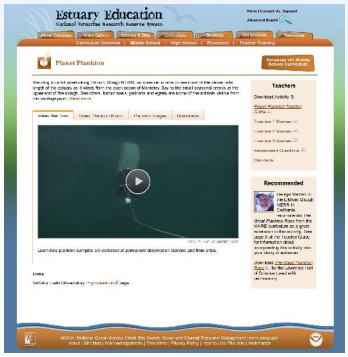
Overview

Plankton are usually very small organisms. To collect plankton, a special piece of scientific equipment, called a plankton net, is used. In this exercise, students make their own plankton nets from wire and a nylon stocking. Students then use the plankton net to collect plankton in a body of water such as the ocean, an estuary, a stream, a pond, or a lake. In Exercise 3: Magnify Your Plankton, students will make observations of the plankton they have collected in this exercise.

Time Required

One 45-minute class session to construct plankton nets, plus additional time away from the classroom to collect plankton in a suitable body of water

You'll find multimedia and other resources for this activity in the Middle School Curriculum section of the Estuary Education website: http://estuaries.noaa.gov.



Procedure

1. Before they start constructing their plankton nets, show your students the video, *Net Tow* on the web page for this activity in the Middle School Curriculum section of the Estuary Education website at estuaries.noaa.gov. Discuss plankton size and the use of different mesh sizes in plankton nets with your students after they view the video.
2. Students follow the instructions on Student Master: *Catching Plankton* to construct their own plankton nets.
3. Monitor student work as they construct their plankton nets. Be sure you feel that these student-made plankton nets will withstand being towed (gently) in water to collect plankton.
4. Arrange to take your students to a pond, lake, stream, river, estuary, or the ocean to gather plankton with their plankton nets.
5. Researchers tow their plankton nets behind boats. You and your class probably won't have that as an option! Remember that the important thing is to move as much water through the plankton net as possible. A plankton net is a sieve! Here are a few ways for your students to tow the net without a boat:

   If you are collecting at a river or stream where there's moving water, drop the net into the water current and allow water to flow through the stationary net for several minutes.

   Put the plankton net into the water and pull it along as you walk back and forth along a dock.

   Make sure you have a good length of rope tied to the bridle ring of the plankton net. Toss the plankton net into the water, as far away from you as possible, and then pull it back toward you. Repeat this several times, allowing water to drain through the mesh prior to each successive throw.
6. After towing the net, have students wash all of the plankton inside the net down into the bottle by repeatedly lowering and raising the plankton net in the water, allowing the net to drain each time.
7. You may be able to keep the plankton alive for about 24 hours if you refrigerate the samples. Collect student samples and get them into an ice chest (if you are away from school) and then into a refrigerator as soon as you return to school. Students should then do Exercise 3: *Magnify Your Plankton* the next day.

Materials

Per student

- Student Master: *Catching Plankton*

Per team:

- Thin wire, 50 cm (~20 in) (A thin coat hanger will work. It is malleable enough while still maintaining its shape when in use.)
- Duct tape
- Nylon stocking or one leg cut from a pair of panty hose
- Heavy thread and needle
- Small plastic bottle
- Heavy string
- Scissors
- Key ring
- Lightweight rope (such as parachute cord) to attach to completed net for towing
- Per class for plankton collection trip:
- Hand lenses and/or simple microscopes
- Medicine droppers
- Small sample observing dishes (e.g., plastic Petri dishes)
- Containers for transporting plankton back to school
- Duct tape or other materials to repair nets

Questions and Possible Answers

Q1. Why did you use a nylon stocking as part of the plankton net? What would happen if you made a plankton net using flexible window screen? Why is it important to use a fine mesh fabric when constructing a plankton net?

The homemade plankton net was made from a nylon stocking because the nylon material would allow water to pass through, but was a fine enough mesh that the holes would not allow the plankton to pass through. A net only works when the holes in the mesh are small enough to trap the target organisms.

Answers to the following two questions are related to each student's personal experience using his or her plankton net. Please accept all answers.

Q2. What difficulties did you encounter in collecting plankton using your plankton net? Could you make the plankton net differently to solve the problem?

Without a boat to pull the plankton net through the water or a current to flow through the net, a student's biggest challenge is likely to be moving enough water through the net in the amount of time available to collect sufficient plankton. One possible change might be to use a net with a wider mouth that would filter a larger volume of water.

Q3. What method did you use to move water through your plankton net? How successful was that? Do you think another method might have been more successful?

Answers will vary. Students should show some understanding that maximizing the amount of water moving through the net will have an impact on the net's ability to trap sufficient amounts of plankton.

STUDENT MASTER

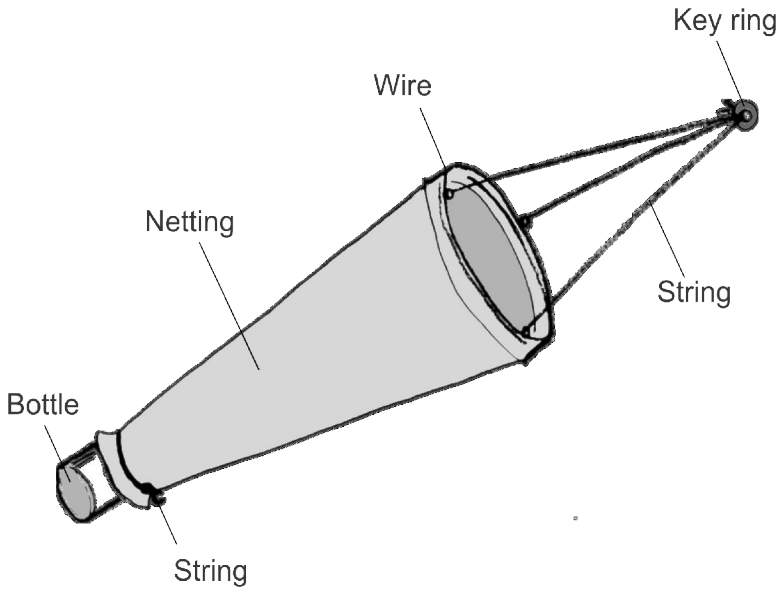
Catching Plankton

If you want to make first-hand observations of living plankton taken from your local river or estuary, you have to catch them! Plankton are usually very small and difficult to see. To catch (or collect) plankton, you'll need a specialized piece of scientific equipment called a plankton-net. This net is made of fine mesh that has holes large enough to allow water to pass through, but tiny enough so that plankton cannot pass through.

Let's start by making your own plankton net:

Procedure

Construct Your Plankton Net



1. As you construct your plankton net, you may want to refer to the diagram. Your teacher should also have one plankton net made ahead of time that you can look at as an example.
2. Bend the wire into a circle and wrap the ends around one another. Use duct tape to secure the wrapped ends and cover the sharp points.
3. Roll the largest opening of the stocking several times around the wire ring. Sew the stocking to the wire using the heavy thread and needle. Use duct tape to cover and protect the stocking.
4. Cut off the foot of the stocking and discard that piece. Now open the narrow foot end of the remaining stocking and insert the mouth of a small bottle. Wrap a piece of heavy string around the outside of the stocking and bottle mouth and tie the string tight to secure the stocking to the top of the bottle. Use duct tape to reinforce the connection between the bottle and string.
5. Cut three pieces of string, each about 50 cm long. These will become the "bridle" to tow your net. Tie the strings at equal intervals around the wire opening to the net. Tie the three loose ends of string to a key ring. This is the bridle ring. Your plankton net is now complete and ready to catch plankton!

Use Your Plankton Net

6. You'll need to find a body of water and then devise a way to move the net through the water. Usually scientists tow a plankton net behind a boat. Since you probably don't have access to a boat, what are some other ways you might have to move water through the plankton net?
7. If you decide to tow your plankton net, tie a length of strong string to the bridal ring so that you can pull your net through the water. The plankton will become concentrated in the bottle.
8. When you have finished towing the plankton net, rinse the inside of the net with water so that plankton on the inside of the net get washed down into the collection bottle. When you are done, untie the string around the mouth of the bottle and carefully remove the bottle.
9. View the water contents in your collecting bottle. Do you observe particle motion even after the water has stopped moving? If you do, then those are your zooplankton!

10. If you've brought observation instruments to the collection site with you, then use an eye dropper to place a few drops of water from your collection jar into a viewing dish. View the plankton in the viewing dish through a hand lens or a microscope. What do you see?

Discussion Questions

Q1. Why did you use a nylon stocking as part of the plankton net? What would happen if you made a plankton net using flexible window screen? Why is it important to use a fine mesh fabric when constructing a plankton net?

Q2. What difficulties did you encounter in collecting plankton using your plankton net? Could you make the plankton net differently to solve the problem?

Q3. What method did you use to move water through your plankton net? How successful was that? Do you think another method might have been more successful?

EXERCISE 3

Magnify Your Plankton

Estuary Concept

Close observation under a microscope or hand lens will reveal the great diversity of adaptation and anatomical detail of phytoplankton.

Focus Question

How can we identify the anatomical details of plankton?

Performance Tasks

Students will:

- Identify that plankton are organisms with many body parts.
- Determine that plankton have developed a variety of adaptations to aid in survival.
- Observe and sketch plankton in order to train their eyes to see more detail.

Teacher Background

Generally speaking, phototaxis is the movement of an organism either toward or away from light. Moths have positive phototaxis; they move toward the light. Cockroaches have negative phototaxis; they scurry away from the light. Some houseplants display both phototaxis and phototropism, which is growing toward a light source. For plankton that have the ability to move, it makes sense for them to move into the photic zone. Phytoplankton need to be in the photic zone so that they can use the sunlight filtering into the water in their photosynthetic life processes. Zooplankton have eyespots that sense light and they tend to migrate to the shallower waters at night when there are fewer predators.

Teacher Preparation

1. Watch the video *Plankton Bloom* on the web page for this activity on estuaries.noaa.gov. This video shows researchers on a ship excited about encountering a red, dinoflagellate plankton bloom.
2. Make copies of Plankton Identification from NASA's "*Visit to an Ocean Planet*" curriculum. You will find it under "Downloads" on the web page for this activity on estuaries.noaa.gov.
3. Make copies of NOAA's *Common Phytoplankton Key*. You will find it under "Downloads" on the web page for this activity on estuaries.noaa.gov.
4. Make copies of Student Master: *Magnify Your Plankton*.
5. Students will be observing actual plankton samples in this exercise. If your students are not going to use the plankton samples collected in Exercise 2: *Catching Plankton*, then you will need to either purchase plankton samples or collect samples yourself. See additional notes on plankton samples on the *Plankton Identification* sheet.

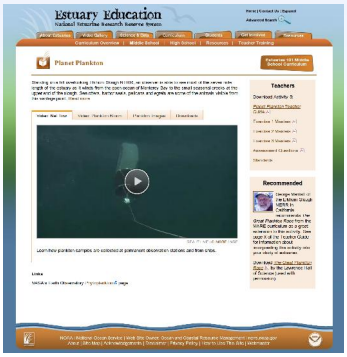
Overview

In this exercise, students make accurate observations of plankton by magnifying plankton samples, drawing what they see, and responding to questions about the form and function of observed plankton features.

Time Required

One 45- minute class sessions

You'll find multimedia and other resources for this activity in the Middle School Curriculum section of the Estuary Education website: http://estuaries.noaa.gov.



Procedure

1. Begin this exercise by showing your students the video, *Plankton Bloom*. Ask students how they would go about collecting a plankton sample at sea. Does the size of the plankton determine what you use to collect a sample? How were the collection techniques of the researchers in the video similar to or different from what your students did in Exercise 2: *Catching Plankton*?
2. Distribute copies of the Student Master: *Magnify Your Plankton*, the *Common Phytoplankton Key*, and the *Plankton Identification* sheet to your students. Explain to yours students that they are going to use the plankton samples they collected (or other samples) to identify different types of plankton. Review the directions on the Plankton Identification sheet and explain to students that they will be recording their observations on the Student Master: *Magnify Your Plankton*.
3. If it's been a while since your students have used microscopes, you may want to review class rules for the use and handling of microscopes.
4. Once students have completed the exercise, discuss the following question in class: "Why is plankton important in the estuary?" If necessary, have student revisit material in the web page for this activity, *Planet Plankton*, found in the Middle School Curriculum section of estuaries.noaa.gov.

Materials

Per class

- One or more microscopes with magnification between 40x and 100x
- A set of hand lenses
- Plastic or glass Petri dishes or similar small, clear containers
- Student plankton samples collected in Exercise 2: *Catching Plankton*
- Computer with Internet connection for showing plankton images and video clips linked to this exercise.

Per student or team

- Copies of P*lankton Identification, Common Phytoplankton Key*, and the Student Master: *Magnify Your Plankton*.

STUDENT MASTER

Magnify Your Plankton!

It's time to take a closer look at some plankton! Use a microscope or good hand lens to take a closer look at a plankton sample. Start with one or two drops of water containing the concentrated results of your plankton tow from Exercise 2 or from some other sample provided by your teacher.

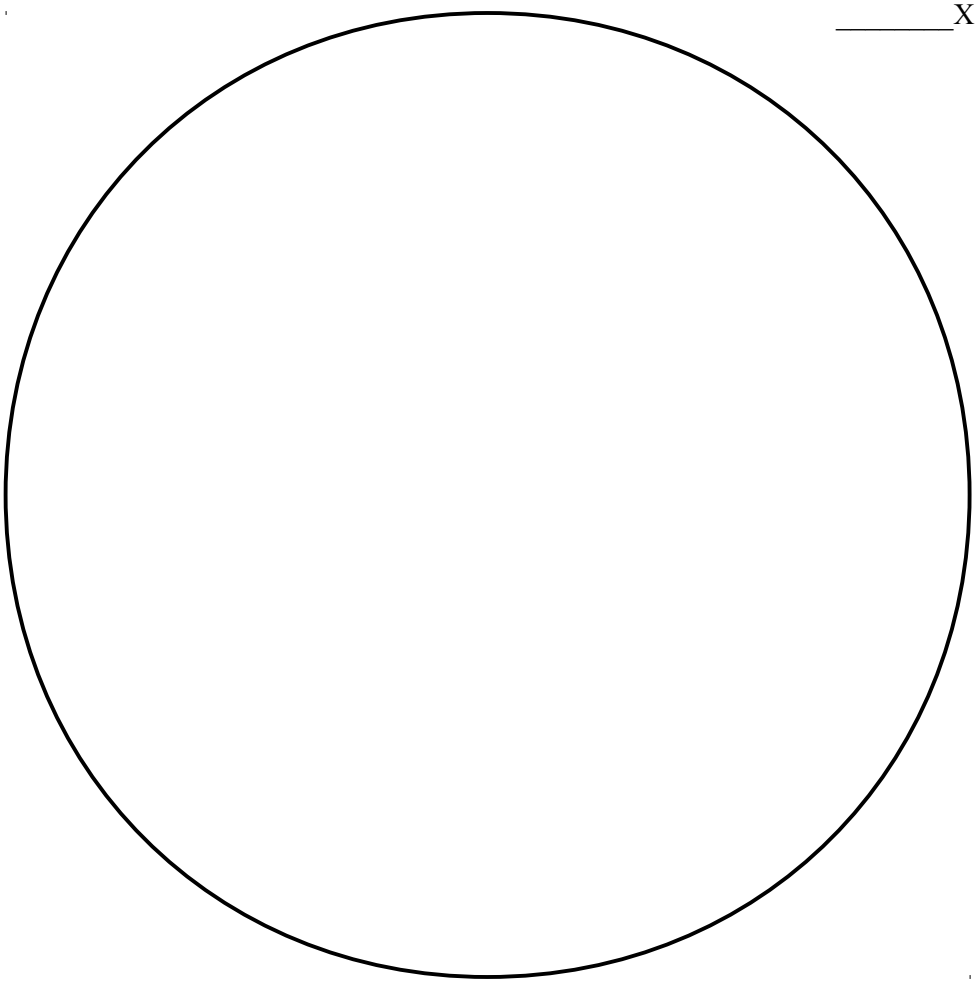
If you want to further concentrate a sample before observing, try putting your larger container of plankton near a bright window or a lamp. Many plankton are phototactic, which means that they are attracted to light. After a minute or two near the light, you should notice many plankton swarming nearer the light source. Don't keep the light on for too long! You don't want the water getting too warm, as that won't be good for the plankton. When you have concentrated some plankton nearer the light, use a medicine dropper to take a sample from the area with the most plankton. Use that sample for your observation.

As you look at the plankton, ask yourself the questions, "What do these plankton need for survival?" and "What features am I able to observe that might help these plankton meet one or more of those needs?" One reminder: These microscopic organisms are often transparent, so look into their bodies and see what parts are actively pumping, contracting, or flowing. Hearts, cilia, flagella, jaws, and circulatory fluids are just some of the moving parts you might see.

Questions

In the circle, sketch one of the plankton you observe.

_____X magnification



Would you guess that this plankton is plant-like (phytoplankton) or an animal (zooplankton)? Why?

Does this plankton have appendages? (e.g., legs, antennae, claws, etc.)

Does this plankton have eyes?

How does this plankton get around?

Are you able to see special features (adaptations) on this plankton that might help it to meet one or more of its survival needs?