A Superior Connection

Vertical Migration and the Lake Superior Food Chain

Grade Level: 3-5

Activity Duration: 45 min – 1hr

Overview:
I. Set Up
II. Introduction – what's in the lake
III. What are you?
IV. Lake Superior food chain
V. Diel Vertical Movement
VI. The story of Diel Vertical Movement
VII. Scientific method/wrap up

Summary: Organisms in the lake do not stay in one place all the time. Scientific investigations have shown us that creatures migrate up and down in the water column throughout the day. Through demonstrations and hands-on activities, students will understand how organisms are connected in Lake Superior, why organisms migrate up and down in the lake, and how scientists use the scientific method to answer questions about Lake Superior

Topic: Lake Superior, food chain, food web, diel vertical migration, scientific method

Goals: Students will understand diel vertical migration and why diel vertical migration is important to the nutrient cycle of the lake food chain

Objectives:
Students will be able to:
1. Name two organisms living in Lake Superior
2. Name two organisms that are connected in Lake Superior and how they are connected
3. Describe why Lake Trout move to the surface of Lake Superior at night
4. Describe how the steps in the scientific method are used to ask and answer scientific questions

The following lesson and kit were developed for Partners in Education, a collaborative effort of Great Lakes Aquarium, MN SeaGrant, and UMD to bring water education to local classrooms.

Minnesota State Standards

Science:

3.4.1.1.1 – Life Science, Structure and Function in Living Systems
Benchmark: Compare how the different structures of plants and animals serve various functions of growth, survival, and reproduction.

3.4.1.1.2 – Life Science, Structure and Function in Living Systems
Benchmark: Identify common groups of plants and animals using observable physical characteristics, structures, and behaviors.

5.4.1.1.1 – Life Science, Structure and Function in Living Systems
Benchmark: Describe how plant and animal structures and their functions provide an advantage for survival in a given system.

5.4.2.1.1 – Life Science, Interdependence Among Living Systems
Benchmark: Describe a natural system in Minnesota, such as a wetland, prairie, or garden, in terms of the relationships among its living and nonliving parts, as well as inputs and outputs.

Environmental Literacy Scope and Sequence

Benchmarks:

- In social systems that consist of many parts, the parts usually influence each one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched, or misconnected. (3-5)

Concepts addressed in this lesson: biotic factors, abiotic factors, groups, cause and effect, cycles, ecosystem, migration, predation, habitat, interactions and relationships, species

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

Materials in Lesson Kit:

Dress-up kits:

- Lake Trout – brown or green t-shirt & tan eyes
- Kiyi – white t-shirt and large white eyes
- Mysis – white t-shirt, short "antennae" & two black eyes
- Copepod – tan t-shirt, long "antennae" & one black eye
- Green Algae – green cape and sunglasses

Definition Sheets:
phytoplankton, zooplankton, macroinvertebrates, & diel vertical migration
Large species pictures (lake trout, kiyi, mysis, copepod, green algae)
Fill in the Blank Sheets (5) – lake trout, kiyi, mysis, copepod, & green algae
Living/non-living pictures for k-2 lesson
Species size comparison
Food Chain Cards (6 of each) – lake trout, kiyi, mysis, copepod & green algae
Foam sun with string
Foam bouy, two fish, and rocks & four cardboard stands
Wet wipes/rag
Rope (3 pieces)
Shape cards

Background Information:

People once thought that fish were stratified throughout Lake Superior. In 2001, Dr. Tom Hrabik and other scientists discovered through sonar that fish were in different places during the day and night. They also discovered that their movements were consistent with the movement of plankton. Phytoplankton are found at a deep chlorophyll layer 35 meters below the surface of Lake Superior. They need to be far enough below the surface of the lake to reduce their chances of being preyed upon but also need to be close enough to the surface to capture the sun's energy to photosynthesize. As the sun goes down, zooplankton (which do not 'like' light) come up to the deep chlorophyll maximum to graze on phytoplankton. Then a chain reaction occurs: macro organisms come to up to feed on zooplankton, forage fish come up to feed on macro invertebrates, and predator fish come up to feed on forage fish. This movement allows for nutrients to cycle through the water column in Lake Superior. When the fish move up to the surface, their waste contain nutrients that the phytoplankton use as building blocks in photosynthesis. If they stayed at the bottom, these nutrients would never reach the surface.

Even though our understanding of Lake Superior has grown considerably in recent years, scientists are still trying to uncover the mysteries of fish movement. By using the

scientific method, scientists like Dr. Tom Hrabik are able to scientifically explain their observations of fish movement.

I. Set-Up

Organize Food Chain Cards to be easily accessible during activity.

Place dress-up props for Diel Vertical Migration activity in piles.

Tape shape signs around the room.

Place props to turn classroom into Lake Superior in appropriate places (rocks, 2 fish, buoy)

II. Introduction - What's in the Lake?

Ask the students about their experience with Lake Superior. Start by asking questions like:

Have they ever gone swimming in Lake Superior?
Have they ever gone fishing in the lake?
Seen a sunset by Lake Superior?
Seen big waves?
Is there anything they like about Lake Superior?

Draw a cross-section of the lake on the board and ask the students what is in Lake Superior. Once a response is given, ask the students where in the lake the creature shared or object named would like it to be and write it up on the board. Tell the students that this lesson is all about what lives in Lake Superior, where everyone like to be and how it is all connected.

III. What Are You?

Activity Introduction

Take out the Food Chain Cards and introduce them to the class. Explain that soon each student will become a part of the Food Chain. It may be helpful to start introducing the organisms that may have been mentioned at the start of the lesson, such as forage fish and predator fish. Use the large species cards to help give a visual of what each organism looks like. After each organism is introduced, teach the students the action/have students make up an action that represents that organism. Use the definition sheets to help introduce phytoplankton, zooplankton, and marcoinvertebrates. Ask the students if they know what the word invertebrate means (without backbone). Explain that the word plankton means to wander or drift.

Zooplankton are animals that can be very small (at times microscopic) and have a limited ability to propel themselves through the water. Phytoplankton are organisms that are very small as well; they drift with the currents of the water, and produce food using the sun. What else uses the sun to produce food? (plants) What is that process called? (photosynthesis)

Actions:

Phytoplankton (Green Algae) – Take one arm and pretend you are holding a bowl, use the other arm and pretend you have a spoon and you are mixing. This action represents the fact that phytoplankton make their own food.

Zooplankton (Copepod) – Put both hands in front of mouth and moves your fingers. This action represents the copepod using its appendages to gather food and filter it into their mouth.

Macroinvertebrate (Mysis) – Use your arms and do the front crawl. This action represents the opossum shrimp being able to swim – or move against the current, unlike the zooplankton.

Forage Fish (Kiyi)- Stretch both arms out in front of you and put your palms together. Move your hands so they open and close. This action represents the smaller forage fish.

Predator Fish (Lake Trout) – Stretch both arms out in front of you and bend and spread your fingers to look more like jagged teeth. Then move your arms up and down like a big mouth. This motion represents the larger fish with teeth.

Activity

Review the organisms and the actions for each. Directions: Pass out the Food Chain Cards: each student will become the creature on the card by doing the described action. Each student has to the find other students with the same organism by using the correct action. Students must move and find each other without speaking. Once they are in their groups, they will be given the correct fill-in-the-blank sheet and a dry erase marker. One person is the recorder and will write each answer in the blank and another person will be the speaker and share what they learned with the rest of the class. All the members of the group must work together to find the correct answers. When all the groups are finished, the speaker from each group will take turns sharing the information about their organism with the rest of the class. Make sure the class pays close attention to what each organism needs to survive. (and hold on to that Food Chain Card – the students will need them for the next activity)

Food Chain Cards:

Green Algae (Phytoplankton)

Fill in the Blanks:

Green algae are _____. They use the ____ and _____ to make food. They are the color _____. They cannot move against the current so they move by _____.

Word Choices: Sun, Phytoplankton, Drifting, Nutrients, Green

Copepod (Zooplankton)

Fill in the Blanks:

Copepods are _____. They are so small, you need a _____ to really see them. They eat _____ and _____. They cannot move against the current so they move by _____.

Word Choices: Microscope, Plants, Zooplankton, Drifting, Animals

Mysis (Macroinvertebrate)

Fill in the Blanks:

Mysis are _____. This means they don't have a backbone. They eat both _____ and _____. They are only found in water that is _____. They use their legs to _____ through the water.

Word Choices: Swim, Animals, Plants, Cold, Macroinvertebrates

Kiyi (Forage Fish)

Fill in the Blanks

Kiyi are _____. They like to eat smaller animals like _____. They have _____ that help them to see. They only live in lakes that have _____ water.

Word Choices: Large Eyes, Macroinvertebrates, Cold, Fish

Lake Trout (Predator Fish)

Fill in the Blanks:

There are ___ types of lake trout, lean and fat. Lean lake trout are found in water that is shallow and has a _____ temperature. Fat lake trout are found in cold water that is _____. They are a _____, which means they hunt smaller fish.

Word Choices: Two, Cold, Deep, Predator

When every group has had a turn, then pull out the size comparison sheet to give the students an idea of the relative size.

IV. Lake Superior Food Chain

Each student should look at the back of their card and find out what shape they have. Signs for the shapes are spread around the room; each student needs to find the correct shape to match the back of their card and gather in a group next to the appropriate sign.

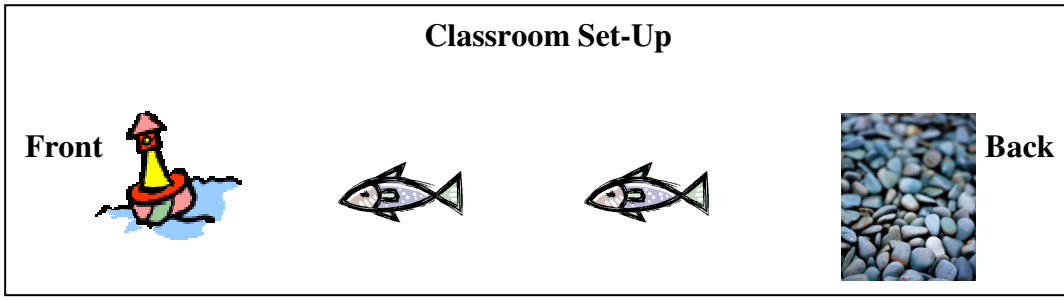
When they are in their new groups, have the students think about how the organisms they just enacted are connected. They are going to create a line that represents the food chain among these organisms. Some things to think about: What do they eat? What may eat them? Have the students line up in the order of the food chain they think exists among the organisms – who would eat whom? When all the groups are lined up in some sort of order, have them think about their connections. What connections did the students come up with? Is there more than one way that the organisms can be connected? Why did they make those connections?

Explain that things are a little more complicated in ecosystems. Things are connected in many different ways, which is why it is more like a web than it is a chain. Tell the students that they are going to explore more about how these organisms are connected.

V. Diel Vertical Movement

Set up this activity by setting up the bouy, two fish, and rocks to represent different water depths in your classroom. One bouy is up at the front of the classroom to represent the surface. Set one fish up a little bit below that to represent lake depth at 115 feet. Set another fish farther down from that to represent a lake depth of 350 feet. The rocks are at the back to represent the bottom of the lake. Give them a point of reference: 300 feet is the length of a football field. The rocks are put the farthest away and represent the bottom of the lake.

Classroom Set-Up



Explain that you have turned the room into Lake Superior. It is almost like we cut Lake Superior in half and laid it on its side. The front of the classroom is the surface of the water, and the rear of the classroom is the bottom of the lake. All the different objects represent different depths of the lake. Have the students imagine that they are in Lake Superior. Ask the students to describe what the water feels like near the surface of the lake. What would it feel like at the bottom? Have the students think about the physical properties of the lake such as temperature and sunlight. Use the props for reference. Compare the lake temperature to something familiar like a fridge. The average temperature of Lake Superior is a chilling 39 degrees Fahrenheit. A fridge is generally set between 38 and 45 degrees.

Choose five students; one to represent each of the organisms. They are going to wear the costumes to help teach the rest of the class more about them, particularly where and why these species move throughout Lake Superior. Have the class consider what these organisms need to survive. Where do they think each of these organisms is found in Lake Superior?

Phytoplankton – Green Algae - (green cape and sunglasses): The student wears the green cape because the phytoplankton produce their own food through photosynthesis. To capture the sun's energy, they have special light receptors called chlorophyll, which are green. They also have sunglasses because phytoplankton are always in the sun. What do phytoplankton need to survive? (sunlight) Where is the most sunlight going to be? (near the surface) Place the phytoplankton student near the surface of the lake.

Zooplankton – Copepod – (t-shirt, one black eye, long antennae): Copepods are members of the crustacean family, so they have ten legs. The student already has four limbs (two arms and two legs) and so with the extra six on the t-shirt, they have ten total. They only have one eye. This eye is not the same as ours, it can really only detect light. Copepods have long antennae that they use to feel. Zooplankton need to eat phytoplankton in order to survive. So where in the lake would they live?

Macroinvertebrates – Mysis – (t-shirt with orange spot, two eyes, and short antennae): You can almost see right through mysis, and their insides are orange. They have two eyes and two antennae. They are a member of the crustacean family, just like the copepods, so they have ten legs, as well. Mysis are omnivores that will eat both algae and zooplankton. Where would they be located in Lake Superior?

Forage Fish – Kiyi – (white t-shirt, two white eyes): Kiyi are a forage fish. They have large eyes near the sides of their head that helps them to see predators. ("Eyes on the front, born to hunt; eyes on the side, born to hide") They also have shiny scales. The

lighter scales are on the belly, so if a predator was looking up at them, kiyi would blend in with the light from the sky. If something was looking down at them, their darker scales on their back would blend in with the shadow and the lake floor. Kiyi eat macroinvertebrates such as mysis. They need to be located near their food.

Predator Fish – Lake Trout – (dark t-shirt and tan eyes): Lake Trout are predators; they have eyes in the front of their head. This helps them to have depth perception so they can catch their food. They also have counter-shading (light scales on the belly and dark scales on the back) that helps them to avoid being seen. Lake Trout eat forage fish so they need to be in a place where they can find food as well.

Now all the species/students are hanging out near the surface of Lake Superior. Is this where they are located in nature? What would be the problem if they were all found here? There isn't enough space! There are predators everywhere! But in nature, these animals have found a way to escape the dangers of living near the surface and still have found ways to get food. This solution is called DIEL VERTICAL MIGRATION. (Be sure this goes up on the board and folks say it a few times.) Diel means day, vertical means up and down the water column, and migration is the movement of organisms to satisfy one of their habitat needs. In this case they are satisfying their need for food and safety.

Plankton cannot survive without sunlight, so phytoplankton need to be far enough away from the surface to escape predation but close enough to be able to receive sunlight. But sunlight isn't the only thing they need, they need nutrients, too. Where would they get those nutrients? Let's come back to that. Zooplankton don't really like light. They'll come up the water column as darkness approaches and graze on the phytoplankton. Mysis are the same way; they are going to travel up near the zooplankton at night so they can feed. What is going to follow the mysis to the surface? Kiyi! And then what will be following the Kiyi? Lake trout! But when the sun starts to come out, zooplankton will start to leave, and pretty soon everything will follow. When it is dark, they will go into dark places of the lake to reduce the chances of being eaten. Remember those nutrients that the phytoplankton need? Think about where they come from and what happens when the zooplankton, invertebrates, and fish come up to the surface. Are they just eating all the energy or does some of it leave their body in the form of excretions? These are the nutrients that the phytoplankton need. If the fish stayed near the bottom, where would all the nutrients stay?

Now we that we know that the organisms move throughout the lake, let's put it all together. The story is going to be read through twice. The first time, only five students are going to act it out. The second time, invite the whole class to join in. Before you start the second story, have the kids stand in the lake and think about the number of

organisms of each species. Which organism do they think has the greatest number of individuals? Which one has the least? Have the kids reorganize themselves so there are fewer lake trout and more plankton. Tell the kids to use their actions from the earlier activity to represent each of the organisms while the story is told.

VI. The Story of Diel Vertical Migration

One fine summer morning, the sun was shining brightly in the sky over Lake Superior (which just happens to be the greatest lake of them all). Under the sparkly waters, there lived tiny microorganisms called **phytoplankton** drifting just below the surface. These **phytoplankton** were **green algae** and very busy converting the sun's energy into food through a process called photosynthesis. They were so busy that they didn't even realize how fast the time had gone and the sun was already moving towards the horizon. As daylight was coming to an end, **zooplankton** such as **copepods** started moving towards the surface of the lake. The day turned to night and pretty soon the **zooplankton** were enjoying a feast of phytoplankton. But they were not the only ones hunting that night. Behind them macro-organisms such as **mysis** had followed them to the surface in search of food. But **mysis** are not picky eaters. They will feed on **green algae** as well as the **copepods**. Pretty soon, the kiyi swam up and opened its mouth wide. These **foraging fish** need a lot of **mysis** and other macroinvertebrates in order to survive. So much was happening in Lake Superior, that no one noticed the **lake trout** and other top **predator fish** that had recently swam up to join in the action and started feeding on the **kiyi**. The organisms were so busy feeding and evading predators, that it was the tiny **zooplankton** that first noticed that night was drawing to an end and a sliver of light appeared above them. The zooplankton, as quickly as they could, migrated down to the deep, cold waters of Lake Superior. Soon the **mysis** followed and found places to spread out and hide from predators. Then the **fish**, both forage and predator, went back down to the cold waters as well. The sun was up, the **phytoplankton** were drifting as they were photosynthesizing and another day in Lake Superior had begun!

Have the students sit back down and gather the Food Chain Cards and props.

VII. Scientific Method and Wrap Up

We have learned a lot about food chains in Lake Superior and how it is all connected. Refer them to the drawing at the beginning of class. Is there anything that they would like to add? Would they like to move any of the organisms to a new location?

We just saw how organisms like zooplankton and fish will come up to feed each day. Did I just make this up? At one time, scientists thought that fish and organisms were just scattered throughout the lake, but just recently, scientists have made observations that

challenge the way we look at the movement of fish in Lake Superior. Scientists like Dr. Tom Hrabik use the scientific method to answer questions about Lake Superior. Use the scientific method cards to compare what we learned today to Dr. Hrabik's research.

Scientific Method:
Observe and Explore
Ask Questions
Select a question that can be answered through investigation
Experiment or observe to answer a question
Reflect on what happened
More questions

Dr. Hrabik's research all started because scientists made an observation that fish were in different places during the day and night and the movements were similar every day. So they started to gather information and learned about what each organism needs to survive. Then they made some predictions about why these fish were migrating. When they conducted experiments to test their hypothesis, they found that each of these organisms moved every night because their prey moved to the surface every night. Scientists like Dr. Hrabik have helped us understand a great deal about what is going in Lake Superior. Even though there has been a lot of research, there are still a lot of questions out there. Based on the observations that you made today in class, what did you notice? And based on these observations, what do you wonder about? For example, today I noticed that zooplankton do not like light and so during the day they go and hide. I wonder if they get eaten by other animals while they are hanging out in the dark. Think about these questions and share them with someone sitting by you.

After You Have Taught This Lesson:

- Collect all kit materials and return them to the lending kit box.
- Fill out a "Lending Library Report" – be sure to include information about damaged or missing materials.
- Return kit to Great Lakes Aquarium by the due date.