Quick Frozen Macroinvertebrates

(Stream Superheroes Pre- Lesson)

Audubon Center of the North Woods

Purpose: Sometimes the tiniest, most unexpected creatures can teach us BIG, important lessons. But first we must understand the role of macroinvertebrates in the aquatic food web. In this class we will first identify what a macroinvertebrate is, then play an active game of freeze tag to identify the role of macroinvertebrates. Finally we will see how macroinvertebrates are indicator species for bodies of water.

Concepts:

- Aquatic macroinvertebrates are organisms without a backbone that live in water that can be seen with the naked eye.
- Aquatic macroinvertebrates play an important role in the ecosystem.

Learning Outcomes: Students will be able to

- Indentify what a macroinvertebrate is.
- Define indicator species
- Understand how macroinvertebrates fit into the aquatic food web.

Minnesota Academic Standards: (example)

Science:

7.4.2.1.1 Identify a variety of populations and communities in an ecosystem and describe the relationships among the populations and communities in a stable ecosystem.

7.4.3.2.3 Recognize that variation exists in every population and describe how a variation can help or hinder an organism's ability to survive.

7.4.4.1.2 Describe ways that human activities can change the populations and communities in an ecosystem.

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CLASS LENGTH: 50 MINUTES

AGES: GRADES 4-8

SEASON: ALL

GROUP SIZE: UP TO 30 STUDENTS

SAFETY: There will be running and tagging in this game so pick an area that is suitable.

MATERIALS:

- Food tokens, at least 2 different colors (enough for 3 per student, poker chips work great)
- 2-5 orange vests to identify predators.
- Cones or objects for boundary lines.
- 4-5 hula hoops to serve as safe zone.
- Optional: bandannas or flags to use instead of tagging.
- Optional: sandwich bags or paper bags or plastic cups to represent prey stomachs (1 for every student).

PRE-CLASS PREP (15 MIN):

- Read background materials.
- Gather materials: chips, hula hoops, cones, vests, and bandannas.
- Optional: Set up cones for game before class. This can be done during as well.

CLASS OUTLINE: (Class sequence of events)

I. Introduction - __10___ min.
II. Class experience - __30___ min.
III. Conclusion – __5___ min.

I. Introduction (_10__ min)

A. **Grabber** – Take some water from a local stream, creek, or lake and place it in a clear jar and place on table so students can see. Start by asking students if there is anything in the water. Then go on to explain that there are tiny animals living in the water that need a microscope to be seen. These are called zooplankton. Unlike us, these zooplanktons do not have a backbone, or vertebrate. Therefore they are called microinvertebrates, micro because they are microscopic, and invertebrates because they have no backbone. There are other tiny animals that live in the water that you can see without the aid of a microscope, and since they do not have a backbone, they are called macroinvertebrates; Macro, because they are "big," and invertebrates, because they do not have a back bone. Since these macroinvertebrates live in water, they are called aquatic macroinvertebrates. Stream Superheroes focuses on macroinvertebrates. Today we will learn why macroinvertebrates are important by playing a game.

II. Class Experiences (_30 min)

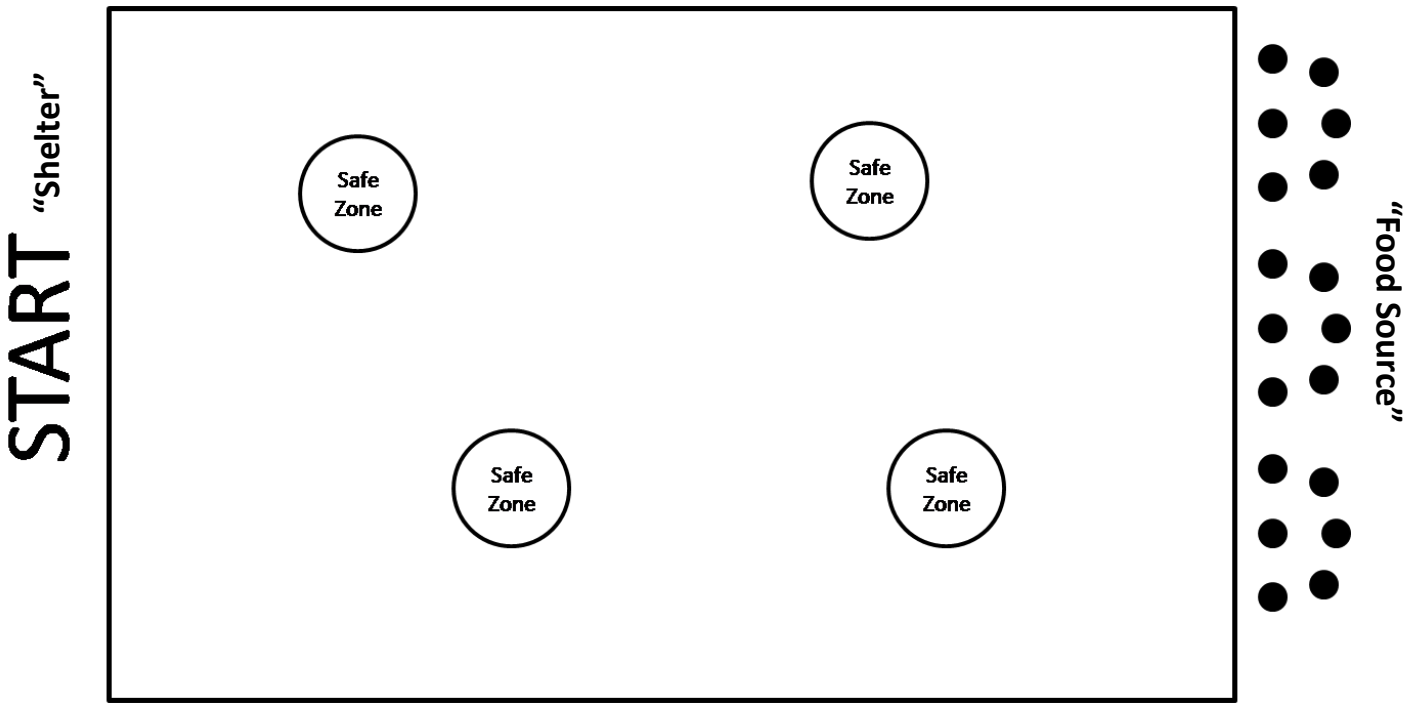
A. **Lesson Preview** – Let the students know that they will be taking a class at the Audubon Center of the North Woods (ACNW) called Stream Superheroes. This class will prepare them to learn about the superheroes living in Windmill Creek at ACNW.

B. **Quick Frozen Critters – Aquatic version (variation from ProjectWild's curriculum)**

Take the students outside to a field or use a gym. If you have not done so already, mark the boundaries of the field – the bigger the playing field the more running the students will do. Go through all instructions before assigning students their roles as either predator or prey. Predators will represent largemouth bass and prey will represent macroinvertebrates.

Procedure:

1. Designate one end as the food source and the other end as shelter. *(See diagram below)*



2. Place 4 or 5 hula hoops on the open area between the "shelter" and the "food." These represent additional shelter or "cover" for the prey and can be distributed randomly on the field. In this aquatic case these shelter areas would represent piles of rocks (crevices to hid in) or large areas of thick aquatic vegetation. (If hula hoops are not available, rope might be used, or chalk on asphalt.)

3. Food tokens are placed in the "food source" zone on the ground. Place 3 food tokens for each prey animal (student). These food tokens represent zooplankton. (Not all macroinvertebrates eat zooplankton. Some also eat phytoplankton or microscopic plants.)

4. Clearly identify predators using safety vests, armbands, or other means. All other student will become prey. There should be 1 predator per 4-6 prey. Optional: Give students who will be the prey a bag or cup to represent their stomach. Food tokens can be placed in stomach for easy carrying and less cheating.

5. Use a whistle or some other pre-arranged signal to start each round. All students start at the same time. When a round begins, have the prey start from their "shelter." The task of the prey animals is to move from the permanent shelter to the food source, collecting ONE token each trip and returning to the permanent shelter. To survive, prey must obtain 3 food tokens. Life in the water is not easy for macroinvertebrates though, there are largemouth bass on the hunt. They need to be alert to possible predators. If they spot a predator, they can use various appropriate prey behaviors, including warning other prey that a predator is near. Prey have 2 ways to prevent themselves from being "eaten:" they may "freeze" any time a predator is within 5 feet of them, or they may run (swim) to cover (with at least one foot in the hula hoops). Frozen prey may blink but otherwise should be basically still without talking. Predators cannot guard shelter zones.

6. Predators start the activity anywhere in the open area between ends of the field and are randomly distributed between the food and permanent shelter. Predators attempt to capture prey to survive, **tagging only moving, not frozen, prey**. Predators must each capture two prey in order to survive. Captured prey are taken to the sidelines by the predator who captured them. OPTIONAL/RECOMMENDED: Prey can have bandannas in their pockets that the predators have to capture to represent the successful predation.

7. Set a time limit of no more than 5 minutes for each round of the game. Remind prey that they can remain frozen for as long as they like, but if they do not have enough food at the end of the activity, they will starve to death. In nature, an animal must balance the need to find food with the sometimes conflicting need for safety. At the end of each round, change predators. All prey who have been eaten may rejoin the game.

8. After 2 rounds of normal play, without telling students, choose one color of the food tokens to become a polluted food source. All the macroinvertebrates that survive the predators at the end of round 3 must show their tokens. If they have more than one of the polluted color they die from contamination. If they die, they need to sit out the next round. This represents a declining macroinvertebrate population and the effects it has on fish populations. Example: If you have red and blue tokens, the red tokens become the polluted pieces. If a student has 2 red and 1 blue, they did not survive because of too much pollution in the water. If the student has 1 red and 2 blue, they survive. This will represent a pollution somewhat intolerant macroinvertebrate.

9. Play the next round with the same predators. Students who were prey that were "eaten" will remain dead, and those who died due to pollution must also sit out. This round should be a shorter round ~3 minutes.

10. Play one more regular round, once again switching roles. Everyone who has been eaten or died because of pollution will rejoin the game. This time, switch the color of the polluted tokens. Now if they have 1 blue piece they do not survive. The students now represent a pollution sensitive macroinvertebrate. The students who did not have any pieces of pollution are pollution tolerant species of macroinvertebrates.

III. Conclusion (_5__ min)

For the conclusion, discuss the different ways they escaped predators. What was the easiest or the most effective? What techniques did the predators use to capture their prey? Have the students then relate how this would work in an aquatic environment. Now talk about the pollution. What happened to the aquatic ecosystem when pollution was introduced into the system? Briefly touch on the fact that there were macroinvertebrates that had different pollution tolerances. Different macroinvertebrates have different pollution tolerances and researchers can tell the health of a stream by the species that they find. This is why macroinvertebrates are called an indicator species. If there are pollution sensitive species found in a stream, then researchers can tell that the water quality is very good and vice versa. At ACNW, they will sample a stream, and assess the water quality by the macroinvertebrates that they find.

IV. Assessment

A. For a homework assignment, have students draw out 2 aquatic food cycles from the game, one without pollution, one with pollution. Also have students include humans in the food chain. Also, have students give a definition of indicator species in their own words.

V. Extensions/Variations

1. Have the prey use different modes of locomotion to get from one end to the other, ex: hopping, walking, backwards, etc.
2. If possible play in a pool. Use the shallow end, and the students have to dive for their food tokens.

VI. Background Information

Pollution Tolerance Classification (taken from ACNW's Stream Superheroes lesson plan)
Scientists group macroinvertebrates according to their tolerance of pollution in the water. The following describes their tolerance and physical adaptations that allow them to survive in those conditions.
Group I: Pollution Intolerant/Sensitive: These organisms are considered "pollution sensitive." They are intolerant of nutrient pollution (from sources such as sewage and fertilizer) and of decreased oxygen levels. If pollution increases, macroinvertebrates in Group I will die. In their ideal habitat – cold, clear streams with high oxygen levels – you would find a diverse and abundant group of stoneflies, alderflies, and dobsonflies. They feed on naturally available food sources such as decaying leaves.
Group II: Somewhat Intolerant/Sensitive: Organisms in this group have a higher tolerance for nutrient pollution, but are still mainly intolerant of decreased levels of oxygen. This group contains a diverse number of species, such as mayfly nymphs, caddisflies, riffle beetles and water penny beetles. They can be found in different areas within the stream. Cranefly larva and crayfish live in riffles; dragonfly and damselfly nymphs live in pooling water. Mussels and clams don't move – they are found on the bottom, clinging to rocks. Scavengers and omnivores like aquatic sowbugs and scuds feed on decomposing organic matter.
Group III: Pollution Tolerant: As the name of the group suggests, these macroinvertebrates can tolerate severe nutrient pollution and low levels of oxygen. They often have adaptations to get their oxygen from the surface of the water. Midge larvae feed on a variety of plant and animal food sources. Blackfly larvae thrive in the nutrient-filled water of sewage treatment plants. Aquatic worms and leeches tolerate stressed, low oxygen environments. Left-hand snails have special air-breathing adaptations and bloodworms (midge larva) have special blood that helps move oxygen through the body.

Macroinvertebrate Information:
From http://www.k12science.org/curriculum/dipproj2/en/fieldbook/macro.shtml
Macroinvertebrates are organisms that do not have a backbone and are visible without a microscope. In most streams, the energy available to organisms is stored in plants and made available to animal life either in the form of leaves and algae that are eaten by macroinvertebrates. In turn, the macroinvertebrates are a source of energy (food) for larger animals such as fish, which are a source of energy (food) for birds, raccoons, and humans.

Macroinvertebrate Indicator Species Information:
From **http://www.krisweb.com/aqualife/insect.htm**
Aquatic macroinvertebrates are good indicators of stream quality because:

- They are affected by the physical, chemical, and biological conditions of the stream.
- They can't escape pollution and show the effects of short-and long-term pollution events.
- They may show the cumulative impacts of pollution.
- They may show the impacts from habitat loss not detected by traditional water quality assessments.
- They are a critical part of the stream's food web.
- Some are very intolerant of pollution.
- They are relatively easy to sample and identify.

Largemouth Bass Diet Information:
From http://www.dnr.state.mn.us/snapshots/fish/largemouthbass.html
Largemouth bass eat underwater insects, other fish, frogs, snakes, and sometimes even ducklings.

Zooplankton Information:

From http://science.jrank.org/pages/7466/Zooplankton.html
Zooplankton are small animals that occur in the **water** column of either marine and **freshwater** ecosystems. Zooplankton are a diverse group defined on the basis of their size and function, rather than on their taxonomic affinities.

Most **species** in the zooplankton community fall into three major groups—Crustacea, Rotifers, and Protozoas. Crustaceans are generally the most abundant, especially those in the order Cladocera (waterfleas), and the class Copepoda (the **copepods**), particularly the orders Calanoida and Cyclopoida. Cladocerans are typically most abundant in freshwater, with common genera including *Daphnia* and *Bosmina*. Commonly observed genera of marine calanoid copepods include *Calanus*, *Pseudocalanus*, and *Diaptomus*, while abundant cyclopoid copepods include *Cyclops* and *Mesocyclops*. Other crustaceans in the zooplankton include species of opossum shrimps (order Mysidacea), amphipods (order Amphipoda), and fairy **shrimp** (order Anostraca). Rotifers (phylum Rotifera) are also found in the zooplankton, as are protozoans (kingdom **Protista**). **Insects** may also be important, especially in fresh waters close to the shoreline.

Most zooplankton are secondary consumers, that is, they are herbivores that graze on **phytoplankton**, or on unicellular or colonial **algae** suspended in the water column. The productivity of the zooplankton community is ultimately limited by the productivity of the small algae upon which they feed. There are times when the **biomass** of the zooplankton at any given time may be similar to, or even exceed, that of the phytoplankton. This occurs because the animals of the zooplankton are relatively long-lived compared with the algal cells upon which they feed, so the turnover of their biomass is much less rapid. Some members of the zooplankton are detritivores, feeding on suspended organic detritus. Some species of zooplankton are predators, feeding on other species of zooplankton, and some spend part of their lives as **parasites** of larger animals, such as **fish**.

Zooplankton are very important in the food webs of open-water ecosystems, in both marine and fresh waters. Zooplankton are eaten by relatively small fish (called planktivorous fish), which are then eaten by larger fish. Zooplankton are an important link in the transfer of **energy** from the algae (the primary producers) to the ecologically and economically important fish community (the consumers).

Species of zooplankton vary in their susceptibility to environmental stressors, such as exposure to toxic chemicals, acidification of the water, **eutrophication** and **oxygen** depletion, or changes in **temperature**. As a result, the species assemblages (or communities) of the zooplankton are indicators of environmental quality and ecological change.

VII. References

- ProjectWild: Quick Frozen Critters Curriculum
- Audubon Center of the North Woods: Stream Superheroes Lesson Plan
- http://www.krisweb.com/aqualife/insect.htm
- http://www.dnr.state.mn.us/snapshots/fish/largemouthbass.html
- http://science.jrank.org/pages/7466/Zooplankton.html
- http://www.k12science.org/curriculum/dipproj2/en/fieldbook/macro.shtml