Objective: Students will model how pollutants are accumulated and passed from prey to predator in a freshwater food chain and will work with mathematic percentages.

SC Science Standards:

5-2.4 Identify the roles of organisms as they interact and depend on one another through food chains and food webs in an ecosystem, considering producers and consumers (herbivores, carnivores, and omnivores), decomposers (microorganisms, termites, worms, and fungi), predators and prey, and parasites and hosts.

5-3.6 Explain how human activity (including conservation efforts and pollution) has affected the land and the oceans of Earth.
Tag-a-Toxin Lesson Plan

Focus Question: How are toxins passed through the food web?

Overview:
In this game of tag, students will model how pollutants are accumulated and passed from producer to predator in a freshwater food web.

Duration: 50 minutes

Materials: (*Recommendations based upon class of 30)
- 300 wooden craft sticks (in variety of colors)
- Timer/stopwatch
- 15 1 Pint zip lock bags
- 7 1 Quart zip lock bags
- 4 plastic shopping bags
- 4 trash bags
- Clue Cards

Vocabulary:
Bioaccumulation- a general term for the build up of substances in an organism’s tissues.
Carnivore - an organism that feeds on other animals
Consumer – an organism that actively catches its prey or scavenges on dead, decaying plant and animal matter
Food web – interconnected food chains
Food chain – the path of food from a given final consumer back to a producer
Herbivore -an organism that feeds on plants
Decomposer – organisms such as bacteria and fungi, that break down waste or dead animals, and can cause infectious disease.
Pollutant - a waste material that pollutes air, water or soil.
Producer - an organism that produces its own food; for example, green plants make their food through the process of photosynthesis
Toxin - a poisonous substance produced by living organisms (Note: this is a non-essential for 5th grade.)

Advanced Preparation:
- Copy, laminate and string Clue Cards
- Reserve outdoor field, playground or gym
Tag-a-Toxin Lesson Plan

Procedures:

Addressing Prior Knowledge:

Begin the activity by introducing a food chain found in a freshwater stream. Ask students what are the producers in a stream, as well as what feeds on producers in this freshwater environment create several freshwater food chains. Begin building out a food web on the board using the generated food chains. Introduce the words toxins and pollutants. Ask students to define these and give examples. Accept all answers.

Preparing for the Activity:

Present the Focus Question and explain to students that they will be playing a field game. The purpose is to model how toxins move along in a food chain in a freshwater environment.

1. Divide the class into 4 groups based upon trophic level: (*Recommendations based upon class of 30.)
   - ½ (*15 students) are zooplankton such as water fleas, nematodes, and rotifers (primary or first level consumers)
   - ¼ (*7 students) are secondary or second level consumers such as snails, insect larvae and mussels (invertebrate omnivores and herbivores), such as bluegill and small bass fish, turtles and
   - 1/8 (*4 students) are tertiary high level or third level consumers such as mammals, birds and fish,
   - the remaining 1/8 (*4 students) are humans or high level or fourth level consumers (tertiary, quaternary and apex are high school standard terms)
   (Note: It is not important to have the proportions exact. You need to have a greater number of lower level consumers than upper level ones.) This activity’s primary focus is conceptualizing pollutants moving through a food chain/web, not the structure of the web.

2. Distribute the Clue Cards appropriately to each child. Students should put the string around their neck to hang the card, hands free.

3. Distribute the zipper seal bags: pintsize to primary consumers (zooplankton, copepods and rotifers), quart size seal bags to secondary consumer (snails, insect larvae and mussels, bluegill, small bass fish and turtles, plastic grocery bags to tertiary consumers (mammals, birds and fish), and trash bags to the quaternary consumer (AKA Apex Predator; humans).

4. Toss the sticks (phytoplankton) among the playing field in a random order. Playing field should be a large enough space that students have to move around to eat and tag others (not too close by to each other). Do not tell the students that the colors indicate phytoplankton that has consumed potentially harmful pollutants. After the game is over, the students will learn after that only the natural-varnished sticks represent plankton that are not polluted. See the table:...
Tag-a-Toxin Lesson Plan

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Color</th>
<th>Effects on animals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollutant Free</td>
<td>Natural Wood</td>
<td>This stick with the absence of paint indicates a phytoplankton that has not been affected by any pollutants.</td>
</tr>
<tr>
<td>Mercury</td>
<td>Red</td>
<td>Mercury is an element found in nature and is commonly found in coal, which SC uses for energy. When coal is heated at power plants, mercury is released in the smoke and is deposited in water or runs off into the water.</td>
</tr>
<tr>
<td>Debris</td>
<td>Orange</td>
<td>This includes trash, litter and other types of solid waste from human activities. Many deaths are due to animals living in environments where there is a lot of debris. Animals become entangled in the trash or eat the debris and die.</td>
</tr>
<tr>
<td>Chemicals</td>
<td>Yellow</td>
<td>Many chemical wastes are produced from burning the town’s trash at the incinerator, exhaust from gasoline-powered automobiles, etc. They stick to the sediments in the water where many small animals live and feed. In turn, these toxins are passed on to their predators.</td>
</tr>
<tr>
<td>Bacteria</td>
<td>Blue</td>
<td>Some bacteria, viruses, and protozoa can cause illnesses, like from high fever to skin diseases. They enter waters through a variety of routes, including untreated sewage, storm water drains, septic systems, runoff from agriculture, and sewage dumped overboard from boats.</td>
</tr>
<tr>
<td>Pesticides</td>
<td>Purple</td>
<td>Pesticides are man-made chemicals to control insect and plant pests. After humans apply pesticides, they can run off into surface waters or sink into groundwater where they are consumed by animals and can remain for many years.</td>
</tr>
</tbody>
</table>

5. Students use their Clue Cards to identify their prey. When prey is identified on the field, then they must do the action on the card (like hop on two feet, walk backwards, etc.) to the prey and gently touch the student on (only) the shoulder. Review these expectations with the class, as well as safety.

6. When the whistle blows, the game will begin. The zooplankton will receive a 15 second head start to begin their action (specified on Clue Card) to gather the “phytoplankton” by picking up the sticks from the floor and placing them in the bag. Next, the secondary consumers will be sent in for 15 seconds to “hunt” for food. They are to search for their prey by moving forward with their specified action and tagging the primary producers safely. Once the primary consumers are tagged, they are to give up their sticks (which will be placed in the predator’s bag) and return to the sidelines and sit down. The teacher sends out the tertiary consumers (who will be moving as indicated on the Clue Card) and waits 20 seconds. Then, the apex predators are sent in for only 1 minute (walking as specific on Clue Cards). Students are to repeat the process of finding prey listed on their card, gently tagging prey, taking their sticks, meanwhile continuing to search for more food. Remind prey to avoid
Tag-a-Toxin Lesson Plan

being caught by their predator. Students can only escape by moving in the manner described above. All others will be eliminated. **Before playing out these actions, ask each consumer level if they know who/what to eat and how to move on the field.**

7. Before beginning the game, tell students that they will be responsible for knowing what kind of animal ate them, as well as the higher order animals, especially the tertiary consumer, that ate their predator.

**Let the Games Begin!**

Take the class to the field or gym. This game should not take longer than 10 minutes to play. **You may want to repeat the activity once or twice to give students a chance to test out different roles and to ensure that everyone understands who/what to eat and to remember who ate them (for most consumer levels).** If you conduct multiple rounds, be sure to count and record the number of sticks collected by each surviving student before beginning a new round. Once all of the food is eaten, return to the classroom to wrap up.

**Summarizing what you learned:**

8. When back in the classroom, identify the tertiary consumers. Separate the tertiary consumers in the different corners of the classroom. Students should identify the tertiary consumer that eventually consumed their predator and begin working to answer the questions in their group. They will work in the groups determined by what tertiary consumer ate them.

9. Distribute Datasheet. Review with students once they are completed.

10. **EXTRA:** As an extra step, what percentage of prey was polluted through the food chain (and bioaccumulation) versus those that were not polluted? Was any consumer not affected by polluted prey in their hunt for food?

**Teacher Primer: Bioaccumulation** – recommend introducing this concept only if teacher feels that class is prepared to understand it.

**Bioaccumulation**- a general term for the build up of substances in an organism’s tissues. These substances include pesticides (DDT is an example), methyl mercury, and other organic chemicals. Organisms intake these substances through breathing, feeding, contact with skin and by other means. These substances become stored in the organism’s tissue so that the concentration in the tissue is greater than what is found in the organism’s environment. Organisms with high trophic levels generally take more energy, and thus consume more food. As a result, the concentrations of these toxic substances are greater in high trophic level animals, such as humans, alligators, eagles, swordfish, shark, and tuna.

**Credits:**

Adapted from Monterey Bay Aquarium Research Institute bioaccumulation exercise, The GLOBE Program.
SC Riverine Food Web

Graphic provided, with permission, by SC Department of Natural Resources
Tag-a-Toxin Lesson Plan

Student Name/s: ______________________________________________________________

Date: ___________________________ Class/Period: __________________________

Students that have bags of sticks remaining after the game should please count your sticks and complete the data

<table>
<thead>
<tr>
<th>Name of Animal</th>
<th>Consumer Level</th>
<th>Number of Plain Sticks</th>
<th>Number of Painted Sticks</th>
<th>Total Number of Sticks</th>
</tr>
</thead>
<tbody>
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**Analyze & Apply**

1. Which animal had the greatest number of toxins? Why?

2. What consumer level has the greatest toxicity? Why?
Extend

1. What organisms from the Critter Clue Cards might humans consume?

2. Predict if the toxic levels in humans who consume these organisms will be high or low? Why?

Summarize

Answer today’s Focus Question using examples from the Field Activity.

Focus Question: “How are toxins passed through the food web?”
Critter Clue Cards - make 5 copies of this page.

**Primary or 1st level Consumer**
- Walk with big strides
- **Worm**
  - Eats Algae

**Primary or 1st level Consumer**
- Walk with big strides
- **Microscopic Animal**
  - Eats Algae
  - Image from yale.edu

**Primary or 1st level Consumer**
- Walk with big strides
- **Water Flea**
  - Eats Algae
### Secondary or 2nd level Consumer

**Snail**

*Hop with two feet*

**Eats Primary Consumers:**

Water Fleas, Worms and/or Microscopic Animals

---

### Secondary or 2nd level Consumer

**Insect Larvae**

*Hop with two feet*

**Eats Primary Consumers:**

Water Fleas, Microscopic Animals

---

### Secondary or 2nd level Consumer

**Mussels**

*Hop with two feet*

**Eats Primary Consumers:**

Microscopic Animals

---

**Mayfly Nymph**

Image taken from clean-water.uwex.edu
### Secondary 2\textsuperscript{nd} level Consumer

**Hop with two feet**

**Bluegill Fish**

*Eats Primary Consumers:*

*Water Fleas, Worms and/or Microscopic Animals*

[Image taken from sas.usace.army.mil]

### Secondary or 2\textsuperscript{nd} level Consumer

**Hop with two feet**

**Juvenile Bass Fish**

*Eats Primary Consumers:*

*Water Fleas, Worms and/or Microscopic Animals*

[Image taken from swansea.ac.uk]
Secondary or 2nd level Consumer

Hop with two feet

Turtle

Eats Primary Consumers:
Water Fleas, Worms and/or Microscopic Animals
### Secondary 2nd level Consumer

**Hop with two feet**

**Insect Larvae**

**Eats Primary Consumers:**
- Water Fleas
- Worms
- and/or Microscopic Animals

[Image of Damselfly larva](http://life.bio.sunysb.edu/marinebio/)

### High level or 3rd level Consumer

**Walk on all fours**

**River Otter**

**Eats:**
- Snails
- Insect Larvae
- Mussels
- Small fish
- and/or Reptiles
<table>
<thead>
<tr>
<th>High level or 3&lt;sup&gt;rd&lt;/sup&gt; level Consumer</th>
<th>Mink</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walk on all fours</td>
<td></td>
</tr>
<tr>
<td>Eats Snails, Insect Larvae, Mussels, Small fish and/or Reptiles</td>
<td></td>
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</tbody>
</table>

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<thead>
<tr>
<th>High level or 3&lt;sup&gt;rd&lt;/sup&gt; level Consumer</th>
<th>Raccoon</th>
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<tbody>
<tr>
<td>Walk on all fours</td>
<td></td>
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<tr>
<td>Eats Snails, Insect Larvae, Mussels, Small fish and/or Reptiles</td>
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<tr>
<th>High level or 3&lt;sup&gt;rd&lt;/sup&gt; level Consumer</th>
<th>Duck</th>
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<tbody>
<tr>
<td>Walk on all fours</td>
<td></td>
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<tr>
<td>Eats Snails, Insect Larvae, Mussels, Small fish and/or Reptiles</td>
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Make 2 copies of this page.

<table>
<thead>
<tr>
<th>High Level or 4th level Consumer</th>
<th>Man</th>
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<tbody>
<tr>
<td>Walk backwards</td>
<td></td>
</tr>
<tr>
<td>Eats Mammals, Birds and/or Fish</td>
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<table>
<thead>
<tr>
<th>High Level or 4th level Consumer</th>
<th>Man</th>
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<tbody>
<tr>
<td>Walk backwards</td>
<td></td>
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<tr>
<td>Eats Mammals, Birds and/or Fish</td>
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# Tag-a-Toxin Lesson Plan

## Class Behavior Rubric

<table>
<thead>
<tr>
<th>Name</th>
<th>Follows Directions 35 points</th>
<th>Completes Task 35 points</th>
<th>Uses Appropriate Voice/Behavior 10 points</th>
<th>Cleans Space 10 points</th>
<th>Total Pts (out of 100)</th>
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Tag-a-Toxin Lesson Plan

Lesson Plan Information

Written by Ms. Elizabeth Joyner for Clemson University Carolina Clear program, a comprehensive stormwater education and public involvement program in South Carolina.

Published December 2010 and reviewed by S²Mart Center staff in November 2010.

An interactive whiteboard lesson does accompany this field activity and can be downloaded at www.clemson.edu/carolinaclear.

Please share your feedback and use information with us. This program would like to continue to offer educational resources for South Carolina citizens and would appreciate your feedback, photos, information and comments you would like to share.

For more information, please contact Katie Giacalone, kgiacal@clemson.edu. For more information about Carolina Clear, please visit our website.

Thank you!