# LESSON #5: "MYSTERY OF THE DANCING CAT"

## OVERVIEW:

*This lesson continues on the topic of ecological impacts of hazardous waste and focuses specifically on the process of biomagnification. Students will read a case study about mercury poisoning in Minimata, Japan. Students will construct a food web diagram of a Minimata Bay ecosystem and then they will create a graph of mercury concentrations versus food chain position. This lesson also incorporates the idea of environmental justice.*

## SUB-QUESTION:

How do toxic materials accumulate in food webs?

## Ways of Knowing Urban Ecology:


| | *Students will…* |
|---|---|
| ***Understand*** | • Understand the interrelated roles of individual organisms and species in a food web. *(ecosystem change, ecosystem state and structure)*<br>• Recognize the relationship between mercury concentration and food chain position. *(ecosystem change, ecosystem state and structure)*<br>• Understand the complex relationships between hazardous waste and biomagnification. *(ecosystem change, ecosystem state and structure)* |
| ***Talk*** | • Discuss and debate the positions and responsibilities of various actors in an example of an environmental injustice. |
| ***Do*** | • Graph the mercury concentrations in the various parts of a food web.<br>• Construct a model of biomagnification.<br>• Analyze the simulated process of biomagnification. |
| ***Act*** | *No specific goals connected with acting on urban ecology in this lesson.* |

## SAFETY GUIDELINES:

No specific safety issues are associated with this lesson.

## PREPARATION:

### Time:

1-2 class periods

Day 1: Activity 5.1
Activity 5.2
Activity 5.3 (Optional)
Day 2: Activity 5.4 (Optional)

**Materials:**

**Activity 5.1**

Student handouts
Power Point (optional )
LCD projector (optional )
Food web cards (optional)
Poster paper (optional)
Colored markers (Optional)

**Activity 5.2**

Four plastic 2 liter soda bottles
Green food coloring
Post-it notes (or small pieces of paper with tape)

**Activity 5.3 (optional)**

Student handouts
Power Point (optional)

**Activity 5.4**

Power Point presentation
Internet access

## INSTRUCTIONAL SEQUENCE

**Activity 5.1: The Mystery of the Dancing Cat**

1. Tell your students that you will be exploring an example of an environmental injustice, and learning about the concept of biomagnification.
2. Have your students complete the pre-reading activity.
3. Read the story "The Mystery of the Dancing Cat" (as a class or individually) on pages 1-3
4. Allow time for the students to read the information on the organisms of the Minamata Bay food web
5. Encourage your students to return to the pre-reading activity and change any responses as necessary.
6. Students should complete the post-reading activity and fill in the blanks in the sentences with heterotroph or autotroph and write their trophic level (producer, consumer, etc.).
7. Students should complete the food web by adding all the correct arrows and labeling each organism as either: producer, primary, secondary or tertiary consumer.

**Teaching Alternative**

Complete the food web in small groups. Give each group a cut-out of the Minimata bay organisms, a sheet of poster paper and markers to draw arrow.

8. Have your students add Humans and Cats at the top and complete the food web.

9. You may display the completed food web on a Power Point slide and discuss any differences your students may exhibit.

**Graphing Mercury Concentrations:**

10. Based on the food web diagram and the table, have the students complete the graph and answer the question at the bottom of the page. There is some amount of variability in terms of the order in which you place the organisms among the secondary and tertiary consumers. For example the Crabs could be placed as either secondary or tertiary consumers. The overall impact on your trend line is minimal.
11. Allow students time to complete the graph on their own. Afterward complete the graph together as a class (on the overhead or show the Power Point slide of the completed graph).
12. Extrapolate the trend line to the mercury concentrations in humans and cats (off the chart).
13. Explain to the class how to read the graph and verbalize it. (As x increases y increases → As you move higher in the food web the concentration of mercury increases). Be sure they write this in the space provided.

**Activity 5.2: Bioaccumulation Visualized:**

The goal of this activity is to show how toxins move up the food web and increase in concentration at higher trophic levels. This provides a good visual follow-up to the graphing exercise.

1. Fill the four soda bottles with water to the top and place them on a table in plain view of the class.
2. Write the word "BIOMAGNIFICATION" on the board and ask students to define it (break up BIO-, then –MAGNIFICATION). Tie this into the trend of increasing concentration up the food web that was inferred from the graph.

**Teacher Background Knowledge**

Biomagnification is the process by which anything—in this case, toxins—moves up the food web and increases in concentration at higher trophic levels. This can be measured by examining *ecosystem state and structure*.

3. Select a volunteer to help with the demonstration. This volunteer should stand with you near the bottles. Show them how to use the food coloring dropper.
4. The process you will actually be modeling is a simplified 4-step food "chain." Phytoplankton→ Zooplankton→ China Fish→ Human. Write these four steps on individual pieces of paper/post it notes (you can have the volunteer write these).
    - Line the 4 bottles in a row and explain that this will represent the food web (the flow of energy). With the class, place each piece of paper in the proper order, starting with the phytoplankton and moving up to the human.
5. Explain that in this activity mercury will be represented by the green food coloring. Also explain that 1 drop will be the small concentration found in the phytoplankton (demonstrate by having the volunteer add 1 drop to the bottle marked "phytoplankton").
6. Now you should also explain that in this model food web each organism will eat 2 of its prey (note how this is like real life, we don't eat just 1 of anything).

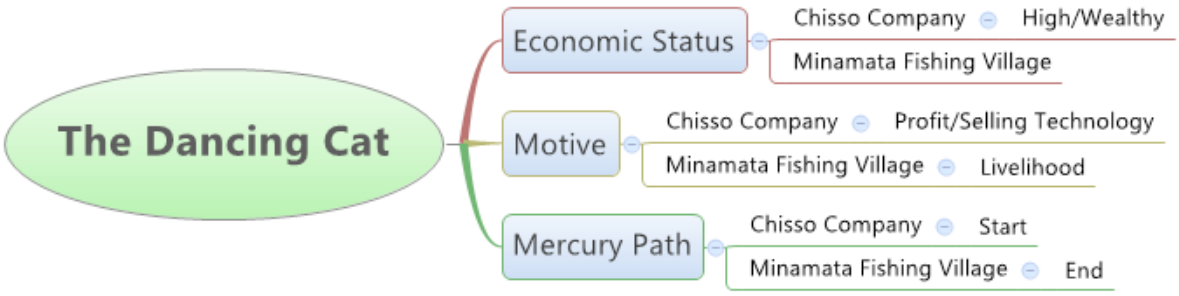
- Have the class point out that the zooplankton should have 2 drops, since it eats 2 phytoplankton in this model.

7. Repeat this step for each level until you reach humans (which should have 8 drops). Make sure the volunteer mixes them well and then places them in the correct order to show the class the increasing color.
8. Ask the class to explain the trend (color gets darker) and then explain how this is just like the mercury concentrations in the Minamata story, this is biomagnification.
   - Relate the results back into the story of the people and cats dying.
9. Have the students read the last page summary (or read it as a class out loud).

**Activity 5.3: Framing Injustice**

This brief activity is meant to provide a social context for the Minamata story the students have learned and set up the homework. You will create a concept map.

1. On the board, write the words "Chisso Company" and "Minamata Fishing Village" near each other. Or use the attached Power Point to illustrate the relationship of the groups. Alternatively, use free concept mapping software such as XMind (http://www.xmind.net/) or FreeMind (http://freemind.sourceforge.net/). Both of these programs run on Windows, Mac, and Linux computers.
2. First outline the economics of the two parties. Ask what status the Chisso Corporation has with money. They should identify that the company has a high economic standing (wealthy) and that they're motive is profit (selling technology). When the students identify profit, write it in parentheses near or beneath the Chisso Company.
3. For the Minamata Fishing Village have the students identify that they are "poor." You can note that the protagonist in the story has to work at the factory.
4. Next trace the path of the mercury. It starts at Chisso and goes to the fishing village. Get the students to identify this and draw an arrow labeled as mercury.
5. One option for how it can be represented with XMind, for example is:




6. Open discussion as to the implications of this problem. For example, what are the implications that the Chisso Company is wealthy and is motivated by profit? Does wealth and profit mean that the company wouldn't care about the environment or about people? Can the Minimata Fishing Village fight against the polluting practices of the Chisso Company without the same resources, monetary and otherwise?

**Concluding the Lesson**

1. Students should answer the reflection questions:
    - In your own words, define biomagnification?
    - How did knowing about the food web help solve the mystery?

**Activity 5.4: Congenital Minamata Disease (Optional)**

1. Read part 2 of the Minamata Case study about Congenital Minamata disease. Show the photographs of congenital mercury poisoning using the PowerPoint slides.
2. Discuss the hourglass picture from the Power point slide.
    - How does this photo illustrate the Law of conservation of Matter?
    - How does the photo illustrate Environmental Injustice?
3. In Wikipedia (http://en.wikipedia.org/) look up the term Minamata Disaster:
What is the most interesting point you learned from this web page?
4. Define Environmental Justice:
5. Visit the webpage (http://www.ejnet.org/ej/principles.html) and read the "Principles of Environmental Justice." Pick your favorite principle and describe why you like it.
Principle #_____ I liked this principle because…

**Concluding the Lesson:**

1. Ask students to make a connection between the Minimata Story and the e-waste example from Lesson 3
2. Create a similar concept map for the e-waste example from Lesson 3.