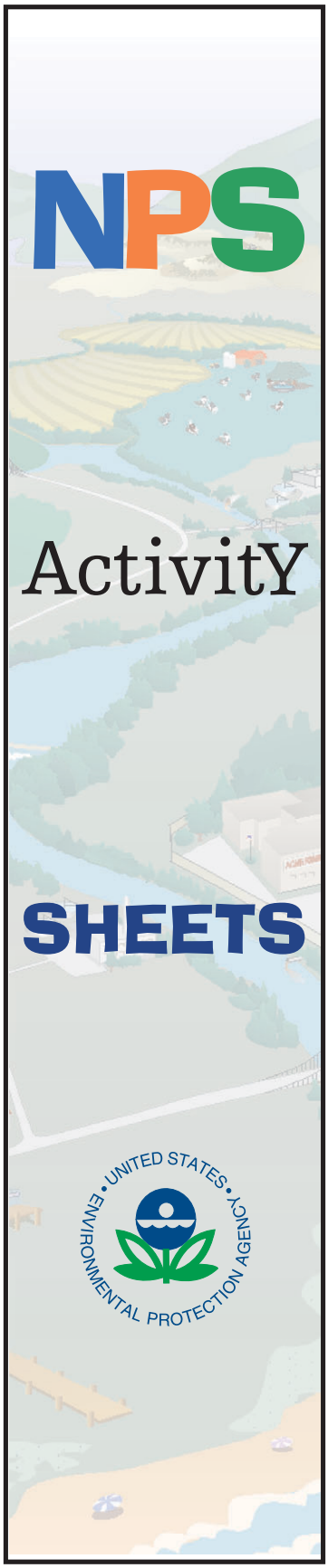



Activities to Accompany

# Bon Voyage to Bad Boating Habits

For Grades 6 - 8

**Objectives:**
Students will learn about common boating-related threats to waterways. They will learn about the problems created in waterways by recreational boaters and discuss ways boaters can change their behaviors to reduce their impact on waterways. Students will also learn about the history of water pollution through a study of the Cuyahoga River. They will create a commercial to raise awareness about boating-related pollution. Exercises will also help students explore the reliability of information on the Internet by comparing various articles on MTBE, a common gasoline additive that can contribute to water pollution, and expose students to the problems associated with unintentionally transporting invasive species in ballast water. An experiment that will help students visualize measurements parts per million is also included.

**Exercises:**
Exercise I. When Does Water Burn?!?
Exercise II. Creating a Better Boating Commercial
Exercise III. MTBE Motives
Exercise IV. Exotic Invasive Stowaways
Exercise V. One in a Million

**Time Required:**
Individual exercises are designed to be approximately ½ hour to 45 minutes long. The time to complete an exercise can be longer if the optional additional exercises are explored. Exercises I, II and V are well-suited for an in-class activity. Exercises III and IV are better suited for individual or small-group research and writing projects.

**Curricular Standards and Skills:**

Natural Science:
- Invasive species
- Units for water quality measurement
- Drinking water standards

Civics:
- The history of water pollution
- The media
- The Clean Water Act

Language Arts:
- Reading comprehension
- Critical thinking
- Research
- Public speaking
- Comparing sources

Math
- Percents
- Fractions

**Vocabulary:**

aquatic environment
ballast water
bilge water
boat mechanic
biodegradeable
Clean Water Act
eutrophication
hull
invasive species
marine biologist
marine police officer
marine sanitation device
methyl tertiary-butyl ether (MTBE)
ordinance
phosphates
wake

**Web sites:**

Duke University News
http://www.dukenews.duke.edu/Environ/browner.htm

Editorial: The Fire Is Quenched (*Post-Gazette* article on the restored Cuyahoga River)
http://www.post-gazette.com/forum/19990630edriver2.asp

EPA's American Heritage Rivers—The Cuyahoga River
http://www.epa.gov/rivers/98rivers/fscuya.html (optional)

Cuyahoga River Research Report from Case Western Reserve University
http://www.cwru.edu/artsci/engl/marling/60s/pages/richoux

The MTBE Resource
http://www.mtbe-eresource.com/what.cfm

U.S. Geological Survey MTBE Information
http://wwwsd.cr.usgs.gov/nawqa/pubs/factsheet/fs203.98.pdf

Environmental Protection Agency MTBE Information
http://www.epa.gov/mtbe

Ballast Water a Vehicle for Exotic Marine Species Invasions (*Gulf of Maine Times*)
http://www.gulfofmaine.org/times/summer98/1a.html

Minnesota Sea Grant's Field Guide to Aquatic Exotic Plants and Animals
http://www.seagrant.umn.edu/exotics/fieldguide.html

Federal Drinking Water Standards
http://www.cce.cornell.edu/factsheets/wq-fact-sheets/fact2.htm

# Exercise I.
# When Does Water Burn?!?


In 1969 Ohio's Cuyahoga River caught fire and sparked a movement that fought for strict regulations on industrial pollution and resulted in legislation aimed at cleaning up the nation's rivers. Read the following two articles about Ohio's burning river, the Cuyahoga, and answer the questions that follow.

1. *Post-Gazette* editorial: The Fire Is Quenched
http://www.post-gazette.com/forum/19990630edriver2.asp

2. EPA's American Heritage Rivers—The Cuyahoga River
http://www.epa.gov/rivers/98rivers/fscuya.html

## More to the Story

The articles you read share only a brief history of the Cuyahoga River and the environmental movement started by its burning. If you are interested in finding out more about the historic event, the Web site http://www.cwru.edu/artsci/engl/marling/60s/pages/richoux provides a good brief history of the event and has links to pictures and articles dating back to 1969. You can also use your library to search for newspaper and magazine articles that were published about the event.

**Questions About the Cuyahoga**

1. How can water burn?

The part of Cleveland through which the Cuyahoga River runs is still highly industrialized, but today the water is much cleaner than it once was.

2. How can some of the suggestions provided in the "Bon Voyage to Bad Boating Habits" article prevent incidents like the Cuyahoga River burning?

3. What happened when people found out about the burning river? Why did people react that way?

4. How was this event important in starting the movement to control water pollution?

5. What national law now protects waterways from this kind of disaster?

## The Media: Changing the Course of History

What is the role of the media in drawing attention to societal issues? What are some limitations of media coverage? For example, when does a news source become part of an active call to action? Is it supposed to be impartial and just report the news, or should it urge a particular mode of action?

# Exercise II.
# Creating a Better Boating Commercial

You're a natural resources specialist at your local environmental agency. One of your jobs is to spread the word about environmentally responsible boating behaviors. With your production team, you create a television commercial that encourages boaters to behave in environmentally responsible ways.

## Preparing Your Message

**1. Message Content**
List the environmentally responsible behaviors mentioned in the article that you want to include in your commercial.

**2. Setting Up the Commercial**
Discuss the setup of your commercial. How can you get the information out in a way that it is both interesting and informative? What setting are you going to use in your commercial? Who will your spokespeople be? (TV news people, boating enthusiasts, environmental agency personnel, or possibly a mascot you create to speak for your cause).

**3. Planning the Media Campaign**
Where will you show this video so that it will be most effective? At whom is the commercial aimed? What age group of people would be the best target?

**4. Writing the Script**
Now that you have thought through the message you want to get across, the setting of your commercial, and your targeted audience, you're ready to write your script. Be sure to include the behaviors you listed in question 1 and write so your targeted audience (determined in question 3) will find the message interesting and understandable.

# Drawing Conclusions

How effective do you think commercials like this are? To support your conclusion, give examples of other effective or ineffective commercials designed to change people's behaviors (For examples, Smokey the Bear, anti-drug commercials, anti-smoking commercials, etc.) Are there more effective ways to get boaters to be friendlier to the environment?

## Further Activity

Practice your commercial and perform it before your class. Or if you have a video camera available, videotape your commercial. Use props, costumes, and interesting settings to make your commercial appealing. As a class, vote on the most persuasive commercial.

# Exercise III.
# MTBE Motives

The Internet is a useful tool for gathering information. It is always important however to check the source. Information is often written up and presented by companies, the government, or other organizations to convey particular messages. The same information might be presented in different ways depending on who is presenting it.

The excerpt below is from a Web site maintained by a New York State law firm (http://www.mtbe-eresource.com/what.cfm). Compare the information presented in this article with that in other methyl tertiary-butyl ether (MTBE) information sources. The chart on the following page will help you compare information from different sources.

## Other MTBE Information Sources

U.S. Geological Survey
http://wwwsd.cr.usgs.gov/nawqa/pubs/factsheet/fs203.98.pdf

Environmental Protection Agency
http://www.epa.gov/mtbe

## What Is MTBE?

MTBE (methyl tertiary butyl ether) is a synthetic chemical that is added to gasoline to improve air quality as part of the Clean Air Act (CAA). MTBE is usually added to Reformulated Gasoline (RFG), oxygenated fuel and premium grades of unleaded gasoline. MTBE improves air quality because it contains oxygen in each molecule. It is considered to be an oxygenate. When oxygenates are added to gasoline, they reduce the amount of carbon monoxide, which is the poisonous gas that cars produce.

The Environmental Protection Agency's (EPA) RFG program requires oxygenates to be used in gasoline in areas where there is severe ozone pollution. In approximately 84 percent of the RFG, MTBE is the oxygenate being used. Oxyfuel, which usually contains ethanol as the oxygenate, is supposed to be used in areas with severe carbon monoxide pollution. However, in some areas, MTBE is used as the oxygenate in oxyfuel.

The problem with MTBE is that it's contaminating the soil, air and drinking water, and may be causing health issues for people that are exposed to it. Since there is such a large amount of gasoline (much of it containing MTBE) being produced and distributed everyday, there are many ways for MTBE to be released into the soil, air and water. It can leak from underground storage tanks (USTs); accidental fuel spills; automobile and tanker accidents; motorized recreation on lakes and drinking water reservoirs; spills and drips when refueling automobiles, lawnmowers, tractors and other machines; and leaks from pipelines and aboveground storage tanks.

Studies are being conducted to find out how MTBE affects people who have been exposed to it. It has been found that when a person drinks water that has been contaminated by MTBE, which smells and tastes like turpentine, the person's liver will convert it into formaldehyde and tertiary butyl alcohol (TBA), which a person's body has a hard time eliminating from the body. When MTBE gets into the air it is converted into tertiary butyl formate (TBF), which causes problems in a person's respiratory system.

Many of the symptoms that people are experiencing due to MTBE exposure include a long-lasting cough, sinus problems, headaches, nervousness, dizziness, nausea, insomnia, watering eyes, irritated eyes and skin rash. If you're experiencing any of these symptoms, it doesn't necessarily mean that they're due to MTBE exposure. These symptoms are very similar to other diseases and illnesses, so you may want to consult a physician.

Extensive research is being done to figure out how to get MTBE out of the soil, air and drinking water. Some head way has been made in cleaning up the soil, but the major problem is getting it out of the drinking water. MTBE is very mobile, less degradable and more soluble in water than other gasoline toxins, which makes it nearly impossible to remove it. The only real solution to the MTBE problem seems to be to take it out of the gasoline. Some states such as California, Colorado, Connecticut, Maine, Michigan, Minnesota, New York and South Dakota don't use MTBE in the gasoline anymore. Many other states are moving towards banning MTBE as well. The EPA has placed MTBE on its list of contaminants, but the Agency is still studying the possible health affects associated with MTBE.

# MTBE Information

| Information Source 1 | Information Source 2 | Information Source 3 |
|---|---|---|
| | | |
| **1. What are the sources of MTBE?** | | |
| **Information Source 1** | **Information Source 2** | **Information Source 3** |
| | | |
| **2. What are the benefits of MTBE?** | | |
| **Information Source 1** | **Information Source 2** | **Information Source 3** |
| | | |
| **3. How much gasoline in the United States contains MTBE?** | | |
| **Information Source 1** | **Information Source 2** | **Information Source 3** |
| | | |

| **4. What are alternatives to MTBE?** | | |
|---|---|---|
| **Information Source 1** | **Information Source 2** | **Information Source 3** |
| | | |
| **5. What are the disadvantages of using MTBE?** | | |
| **Information Source 1** | **Information Source 2** | **Information Source 3** |
| | | |
| **6. How does MTBE affect humans?** | | |
| **Information Source 1** | **Information Source 2** | **Information Source 3** |
| | | |
| **7. What is unknown about MTBE?** | | |
| **Information Source 1** | **Information Source 2** | **Information Source 3** |
| | | |
| **8. What does the author recommend as a solution?** | | |
| **Information Source 1** | **Information Source 2** | **Information Source 3** |
| | | |

| 9. Is this article objective or subjective? Give reasons why. (Answer for all three sources you used.) | | |
|---|---|---|
| **Information Source 1** | **Information Source 2** | **Information Source 3** |
| | | |

## Motive

What could a law firm gain by writing an article about MTBE?

# Exercise IV.
# Exotic Invasive Stowaways


**Dangerous Stowaways**
Some boating-related environmental problems have nothing to do with the chemicals released by boat motors or the solvents used to clean boats. Sometimes simple plants and animals can be a big problem.

Large cargo boats often take on ballast water after unloading large loads. This water is transported to the next port and released when a new cargo load is placed on the boat. Because the boats take on untreated water directly from outside the ship, they often pick up plants and animals with the water. These plants and animals are then released in a new location when the water is let out. These exotic (meaning from another area) aquatic species can travel across the world in this way. When released in a new location, sometimes the plants or animals die immediately because of different water conditions; for example, the water might be too cold for them at the new location. Other times the species grow and reproduce rapidly because there is no natural predator to keep the population under control. Species that do well in a new location are known as exotic invasive species, and they can be very hard to control.

Choose one of the species of concern in the article "Ballast Water a Vehicle for Exotic Marine Species Invasions" found at http://www.gulfofmaine.org/times/summer98/1a.html, or pick a species of concern in your local area.

Report your findings on the nature of the species, where it is found, and where it came from. Also include the ecological disturbance that it has caused. In your report, you might want to include a picture of the invader or a map of the world indicating with arrows how the exotic species got to its new location.

## Want to know more about exotic invasive species?

More information on this topic can be found at the following web sites:

The Gulf of Maine Council on the Marine Environment
http://www.gulfofmaine.org/times/summer98/1a.html

Minnesota Sea Grant's guide to invasive exotic aquatic species
http://www.seagrant.umn.edu/exotics/fieldguide.html

# Exercise V.
# One in a Million

Substances in water are often measured in parts per million (ppm), parts per billion (ppb), or even parts per trillion (ppt). This activity is adapted from *Science Demonstration Projects in Drinking Water* (U.S. EPA Water Resource Center, Washington, DC, "One in a Million" by Steve Vandas).

Agencies like the U.S. Environmental Protection Agency determine what concentration of a contaminant in water could be considered dangerous. If a substance is highly toxic, it could be dangerous even if it is present only in parts per trillion; if the substance is less toxic, it could be dangerous if present in parts per million.

## Using Measurements in Real Life

State or federal drinking water standards are a real life example of where parts per million measurements are used. You can find standards for some drinking water contaminants on the Internet. For example, the federal standard for lead in drinking water is discussed at http://www.cce.cornell.edu/factsheets/wq-fact-sheets/fact2.htm

**Materials**

- 1 eye dropper for each group
- 6 small, clear plastic cups (the smaller the better) for each group
- One 472 mL clear plastic cup filled ¾ full of water for each group
- 1 bottle of food coloring for the teacher/presenter

## Pre-Experiment Discussion

- What is the largest number of things you can clearly visualize in your mind?
- Can you visualize a group of 1,000 people? Are you able to differentiate between 800 or 1,200 people and 1,000?

**Procedure**

1. Review working with percentages by completing the sheet "Reviewing Percents."

2. Food coloring is usually a 10 percent solution. Draw this on your calculations page.

3. Using the eye dropper, have one member from each group add nine drops of water to the small cup containing the food coloring. Stir well. Draw this on your calculations page and figure out the concentration of the food coloring. Label the concentration of food coloring on the cup.

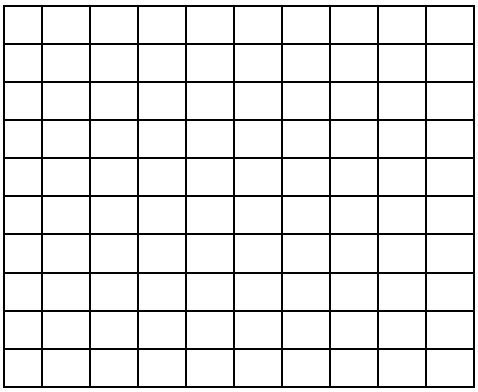
4. Use the eye dropper to transfer one drop of the 1-part-in-100 solution to a third small plastic cup. Add nine drops of water to this solution. Stir well. The concentration has again been changed by a factor of 10. Draw this concentration on your calculations page, figure out the concentration of food coloring, and label the concentration on the cup.

5. Transfer one drop to the 1-part-in-1,000 solution to the next small plastic cup. Add nine drops of water. Stir well. The new concentration is part in 10,000 parts of solution.

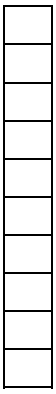
6. Continue to dilute one drop of each new solution with nine drops of water until you create a solution with a concentration of one part per million. Be sure to label the concentration of food coloring present in each cup.

**Reviewing Percents**

1. The dye in food coloring is usually in a 10 percent solution. This means that out of 100 parts of food coloring you have 10 parts of actual dye and 90 parts water. Illustrate this idea below.



2. If you had only 10 parts of the solution (divide 100 by 10), you would have only 1 part of food coloring (again, divide by 10). Illustrate this idea below.

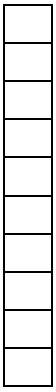


3. So, if you had one part dye, how many parts of water would you have to add to get a 10 percent solution? (Hint: Count the white squares.)

4. If you had a solution with only 1 part dye and 99 parts of water, what percentage would this solution be?

**Calculations**

1. Fill in the concentration of dye in the one drop of food coloring in your cup. (Hint: remember this is a 10 percent solution and you figured out what a 10 percent solution looks like while reviewing percents.)

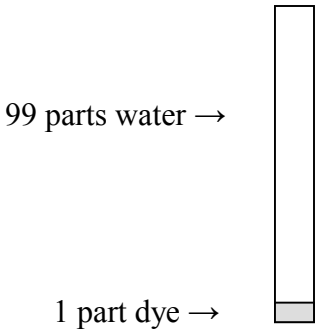


2. To this one drop of solution, you added nine drops of water. Draw the result.

| | | |
|---|---|---|
| 1 drop of food coloring | + | 9 drops of water |

3. What is the fraction of dye in this solution? What percent is this equal to?

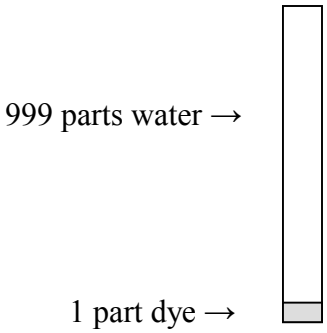
4. Take one drop of the above solution and add nine drops of water.




1 drop of food coloring in 1/100 solution + 9 drops of water

5. What is the fraction of water in this solution? (Do you see a pattern developing?)

6. Take one drop of the above solution and add nine drops of water.




1 drop of food coloring in 1/1,000 solution + nine drops of water

7. What is the fraction of water in this solution?

8. What is the fraction when 9 drops of water are added to one drop of the solution formed in question 7?

9. What is the fraction when 9 drops of water are added to one drop of the solution formed in question 8?

10. What is the fraction when nine drops of water are added to one drop of the solution formed in question 9?

**Discussion**

1. In which cup do you first observe no visual evidence that food coloring is present?

2. Since you cannot see any evidence of color present in the cup, how do you know there is food coloring in the cup?

3. Can you think of an experiment that you could do to prove there is food coloring present in each cup?