ehp

LESSON:

Making Sports Green

Summary: Students review what the National Football League (NFL) did to reduce the environmental impact of Super Bowl XL. Students review the NFL plan to offset greenhouse gases for Super Bowl XL, then calculate the production of greenhouse gases for a sporting event for their school district (optional) and make recommendations for reducing the environmental impact of sporting events.

Lesson Type: Extension Lesson—This lesson extends the discussion of a topic addressed within an article in *EHP Student Edition*.

***EHP* Article:** "Putting the Earth into Play: Environmental Awareness and Sports"
EHP Student Edition, August 2006, p. A286–A295
http://ehponline.org/members/2006/114-5/focus.html

Objectives: By the end of this lesson, students should be able to:

1. estimate the production of greenhouse gases (carbon dioxide) for sporting events;
2. determine an appropriate carbon mitigation plan; and
3. develop a plan to reduce the "environmental footprint" of sporting events.

Class Time: Part 1, 45 minutes; Part 2, 45 minutes (homework may be added to each part of the lesson.)

Grade Level: 9–12

Subjects Addressed: Environmental Science, Health, Social Studies, Mathematics, Language Arts

Prepping the Lesson (15–30 minutes)

INSTRUCTIONS:

1. Download the entire August 2006 *EHP Student Edition* at http://www.ehponline.org/science-ed/, or download just "Putting the Earth into Play: Environmental Awareness and Sports" at http://ehponline.org/members/2006/114-5/focus.html.

Part 1

2. Review the Instructions, Student Instructions—Part 1, and the article.

Part 2 (optional)

3. Review the Student Instructions—Part 2.
4. Decide which school sporting event you will use in the lesson. You could select your school's homecoming football game or another well-attended game.
5. Obtain the following information (or be prepared to have your students obtain it:
   - your school's utility usage information for a few months, including the month when the sporting event is held. See Notes & Helpful Hints for more information;
   - your school's utility company's carbon dioxide emissions rate. See Notes & Helpful Hints for more information. If your utility company generates electricity through nuclear or hydroelectric power, then the CO_2 emissions rate will be zero as these methods do not produce CO_2;
   - your school's attendance record for the selected sporting event. See Notes & Helpful Hints for more information (optional);
   - a map of your school district to estimate average driving distance to your school (or wherever the sporting event is held) for home team fans and away team fans.

MATERIALS (per student):
- 1 copy of *EHP Student Edition,* August 2006, or 1 copy of "Putting the Earth into Play: Environmental Awareness and Sports"
- 1 copy of the Student Instructions—Part 1 and Part 2

MATERIALS (per class):
- Your school's monthly utility usage (in kilowatt-hours) for a few months in the past year, including the month when the sporting event (e.g., football homecoming game) is held.
- Your school's utility company's carbon dioxide emissions rate.
- Your school's attendance records for the sporting event, preferably including an estimate of home team fans and away team fans. Be sure to gather the records for the same timeframe as the utility usage.
- A map of your school district boundaries with miles noted.
- A state or regional map with a mileage key and/or an estimate of the distance (in miles) between the location of the sporting event and the high school of the away team.

VOCABULARY:
- carbon dioxide
- greenhouse gases
- kilowatt-hours

BACKGROUND INFORMATION:
All of the necessary information is provided in the article.

RESOURCES:
Environmental Health Perspectives, Environews by Topic page, http://ehp.niehs.nih.gov. Choose Built Environment, Energy, Land Use

Greenhouse Gases and Society, http://www.umich.edu/~gs265/society/greenhouse.htm

National Energy Information Center, Energy Information Administration, US Department of Energy, http://www.eiatdoe.gov/oiaf/1605/ggccebro

U. S. Environmental Protection Agency, Global warming, http://yosemite.epa.gov/oar/globalwarming.nsf/content/index.html

U.S. Department of Energy and Environmental Protection Agency. 2000. *Carbon Dioxide Emissions from the Generation of Electric Power in the United States*. Available at http://www.eia.doe.gov/cneaf/electricity/page/co2_report/co2report.html.

U.S. Environmental Protection Agency. 2000. Average annual emissions and fuel consumption for passenger cars and light trucks. http://www.epa.gov/otaq/consumer/f00013.htm.

U.S. Department of Transportation. 2001. The 2001 National Household Travel Survey: distribution of household personal vehicles by type, in percent, http://www.bts.gov/publications/highlights_of_the_2001_national_household_travel_survey/html/table_a05.html

Implementing the Lesson

INSTRUCTIONS:
Part 1

1. Divide students into small groups and have students complete Part 1 of the Student Instructions. Have students brainstorm ways sporting events can impact the environment.
2. Come back together as a class and write a class-generated list on the board (Step 1).
3. Hand out the article and have students read the article. (Reading could be assigned as homework.).
4. Discuss the article and add to the list of environmental impacts of sports on the board (Step 2).
5. Have students complete Step 3 of the Student Instructions and discuss their conclusions about the National Football League's initiative to offset carbon dioxide produced by the Super Bowl.

Part 2

6. Assign small groups to obtain the appropriate data for Part 2, or obtain the data yourself:
   - estimate of the sporting event's utility usage (in kilowatt-hours)
   - the utility company's carbon dioxide emissions rate (in pounds per kilowatt-hour)
   - the attendance record for the sporting event, preferably including an estimate of home team fans and away team fans, OR the number and type of vehicles driven to the sporting event, preferably including whether the vehicle was driven by a home team fan or an away team fan
   - the average distance driven by home team fans
   - the average distance driven by away team fans
7. Provide the appropriate data for Part 2 or have your students share the data they collected if they obtained the data.

8. Have students complete the remainder of Part 2 of the Student Instructions.
9. As a class, discuss students' reactions and conclusions about carbon dioxide production and their recommendations for mitigation of the environmental impacts of the selected sporting event (Step 9a).
10. Have each student share his/her choice for the highest priority action item (Step 9b) to reduce the "environmental footprint" of the sporting event. As a class discuss and decide on the top one or two action items.
11. To make the activity even more meaningful, have students write a class letter to the superintendent, principal, athletic director, and/or booster club highlighting their concerns and recommendations for reducing the environmental impacts of sporting events. The letter should include:
    - estimates and evidence (e.g. utility statements) to support their arguments
    - a brief summary of national (e.g., NFL) and international (e.g., Olympics) trends to reduce the environmental impact of sports and/or a discussion of community values
    - a description of the chosen solution(s) and why they were chosen
    - ideas about how to easily implement the solutions

NOTES & HELPFUL HINTS:

- School buses could also be added to the calculations, and students could research the carbon dioxide emission rates for buses.
- To obtain your school's **utility usage** information in kilowatt-hours, talk to a school administrator, such as the business administrator. You will want to obtain the usage for a few months, in particular the month when the sporting event you selected is held and months when few or no sporting events are held. Ideally these bills will come from similar weather seasons, as there may be significant differences in bills in the summer and winter.
  To estimate utility usage for the specific sporting event, review at least two utility bills (such as one during a month with the sporting event and the other during a month without the sporting event) and calculate the difference between the two bills. Students could also estimate utility use by collecting data such as type of lighting, approximate number of lights, wattage, and how long they are on during the event.
- To obtain your school's utility company's carbon dioxide emissions rate in pounds of carbon dioxide per kilowatt-hour, call your school's utility company for their exact carbon dioxide emission rate. Or, use the national average emissions rate of 1.341 lbs of carbon dioxide per kilowatt-hour.
- To obtain your school's attendance record for the specific sporting event, talk to your school athletic department. If possible, include an estimate of home team fans and away team fans. This will be used to estimate the number of vehicles, distance driven, and amount of gasoline used.
- As homework or extra credit, students could count the number and type of vehicles at the sporting event. You may want to discuss why counting vehicles is a more accurate approach. (All vehicles have a different emission rate, which is affected by miles per gallon, type of fuel used, and type of vehicle. For example, a hybrid vehicle will have a much lower carbon dioxide emission rate than the average rate for cars/station wagons.)
- To estimate the average distance driven by home team fans, determine the distance, in miles, from the location of the sporting event to the midpoint of the district.
- To estimate the average distance driven by away team fans, determine the distance, in miles, from the location of the sporting event to the high school of the away team.
- You may want to partner with the Language Arts/English teachers to have the students write and edit the letter. This is an excellent opportunity to have the students practice writing for a "real" audience to implement change in school actions or policies.
- Instead of using a school sporting event, students could obtain the appropriate data for a local professional sports team (e.g., a minor league baseball team).
- Students could even present or send letters to the district school board and/or sports booster club to initiate changes in environmental impacts of sporting events across the entire district.

Aligning with Standards

SKILLS USED OR DEVELOPED:

- Communication (note taking—oral, written)
- Comprehension (listening, reading)
- Computation
- Critical thinking and response

- Experimentation (data analysis)
- Observation
- Reading maps and legends
- Tables and figures (reading)
- Unit conversions

SPECIFIC CONTENT ADDRESSED:

- Greenhouse gases
- Environmental impact of sports

NATIONAL SCIENCE EDUCATION STANDARDS MET:

Science Content Standards

Unifying Concepts and Processes Standard

- Systems, order, and organization
- Evidence, models, and explanation
- Change, constancy, and measurement
- Evolution and equilibrium

Science as Inquiry Standard

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Physical Science Standard

- Structure and properties of matter

Life Science Standard

- Interdependence of organisms

Science in Personal and Social Perspectives Standard

- Personal and community health
- Natural resources
- Environmental quality
- Natural and human-induced hazards

Assessing the Lesson

Part 1

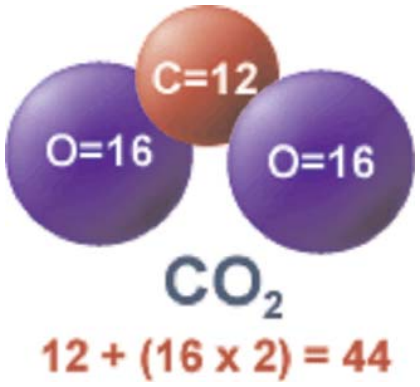
Step 1&2: Student answers will vary but may include different sports such as skiing, golfing, NASCAR, soccer, and football.

Step 3: Calculate how to offset the carbon dioxide produced by the Super Bowl by planting trees. Note: Units for carbon dioxide production and carbon absorption in the article are in tons (1 ton = 2,000 lbs).

a) How many tons of carbon dioxide were produced by the Super Bowl from transportation and utility usage (from the article)?
500 tons

b) Carbon dioxide is composed of one carbon atom and two oxygen atoms. A carbon atom has an atomic weight of 12, and an oxygen atom has an atomic weight of 16; therefore, each carbon dioxide molecule has a molecular weight of 44. What fraction of the weight of carbon dioxide is due to carbon? Show your calculations.

12/44 = 0.273



c) Calculate the amount of **carbon** produced by the Super Bowl.

500 tons of carbon dioxide × 0.273 (answer to Step 3b) = 136.5 tons of carbon

d) How many trees are needed to absorb 75 tons of **carbon** (from the article)? **250 trees**

e) Calculate the number of trees needed to absorb 1 ton of **carbon**.

250 trees ÷ 75 tons of carbon = 3.33 trees per ton of carbon

f) How many trees are needed to offset the total amount of **carbon** produced by the Super Bowl?

136.5 tons of carbon (answer to 3c) × 3.33 trees per ton of carbon (answer to 3e) = 455 trees

g) Explain why you think the NFL's plan to offset greenhouse gases by planting trees was or was not sufficient

Student answers will vary. Students should provide a clear and logical written response that provides examples to support their opinion.

Part 2

Step 4: Calculate the production of carbon dioxide for a sporting event from utility usage. Data for these calculations may be provided by teacher or obtained from school administrators.

Answers will vary depending upon utility and transportation usage. Answers are provided for a sample sporting event.

Sporting Event: **Homecoming Football Game**

Utility Usage

a) Electricity Used (in kilowatt-hours) = **500 kW-h**

b) Carbon Dioxide Emissions Rate (in pounds/kilowatt-hours) = **1.341 lbs of CO_2/kW-h (national average emissions rate for electricity)**

c) Estimated Carbon Dioxide Produced (students should show their calculations and units) = **500 ~~kW-h~~ × 1.2341 lbs of CO_2/~~kW-h~~ = 670.5 lbs of CO_2**

Step 5: Calculate the production of carbon dioxide for the same sporting event from transportation usage. Data for these calculations may be provided by teacher or obtained from school administrators.

Transportation Usage

a) Average Total Attendance at Sporting Event = **864 people**

b) Estimate Total Number of Vehicles = **288 vehicles (864 ÷ 3)**

Home Team Fans = **193 vehicles (288 × 67%)**

Away Team Fans = **95 vehicles (288 × 33%)**

c) Estimate the Type of Vehicles Using the Average National Distribution.

Home Team Fans

Cars/Station Wagons = **116 (193 × 60%)**

Vans/SUVs = **40 (193 × 21%)**

Light Trucks = **37 (193 × 19%)**

Away Team Fans

Cars/Station Wagons = **56 (95 × 60%)**

Vans/SUVs = **20 (95 × 21%)**

Light Trucks = **19 (95 × 19%)**

d) Estimate the Number of Miles Driven by Home Team or Away Team Fans.

Home Team Fans = **7 miles**

Away Team Fans = **15 miles**

e) Estimate the Number of Miles Driven per Vehicle Type.

	Home Team Fans			**Away Team Fans**		
	# of Vehicles	Avg. # Miles Driven/Vehicle	Total Miles Driven	# of Vehicles	Avg. # Miles Driven/Vehicle	Total Miles Driven
Cars/Station Wagons	116	7 miles	812	56	15 miles	840
Vans/SUVs	40	7 miles	280	20	15 miles	300
Light Trucks	37	7 miles	259	19	15 miles	285

f) Estimate Carbon Dioxide Produced.

	Home Team Fans			**Away Team Fans**		
	Total Miles Driven	Carbon Dioxide Emission Rate per Mile	Total Carbon Dioxide Produced (lbs)	Total Miles Driven	Carbon Dioxide Emission Rate per Mile	Total Carbon Dioxide Produced (lbs)
Cars/Station Wagons	812	0.916 lb	743.79	840	0.916 lb	769.44
Vans/SUVs	280	1.15 lbs	322.00	300	1.15 lbs	345.00
Light Trucks	259	1.15 lbs	297.85	285	1.15 lbs	327.75
		Total	1,363.64		Total	1,442.19

g) Calculate the total **carbon dioxide** produced by all vehicles in pounds.

1,363.64 lbs + 1,442.19 lbs = 2,805.83 lbs

Step 6: Calculate the total carbon dioxide produced for both utility usage and transportation usage in pounds.

Carbon Dioxide Produced from Utility Usage (in pounds) = **670.5 lbs**

Carbon Dioxide Produced from Transportation Usage (in pounds) = **2,805.83 lbs**

Total Carbon Dioxide Produced (in pounds) = 3,476.33 lbs

Total Carbon Dioxide Produced (in tons) = 1.74 tons

Step 7: Calculate the total **carbon** produced for both utility usage and transportation usage in tons.

1.74 tons of carbon dioxide × 0.273 (answer to Step 3b) = 0.48 tons of carbon

Step 8: How many trees are needed to offset the **carbon** produced by your sporting event?

0.48 tons of carbon (answer to Step 7) ÷ 3.33 trees per ton of carbon (answer to Step 3e) = 2 trees (rounded up to the next whole number)

Step 9: Student answers will vary. Grade based upon the thoroughness of the answer. Students should explain clearly and logically which aspects of the plan they would implement first and why.

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Give us your feedback! Send comments about this lesson to ehpscienceed@niehs.nih.gov.

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STUDENT INSTRUCTIONS: Making Sports Green

Part 1

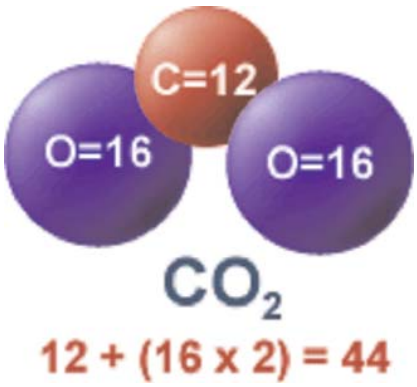
Step 1: As a group, brainstorm ways that sporting events can impact the environment. Write your list below.

Step 2: Read the article "Putting the Earth into Play: Environmental Awareness and Sports," *EHP Student Edition*, August 2006, p. A286–A295. As you read the article, add to your list, in Step 1 additional ways that sporting events can impact the environment.

Step 3: Calculate how to offset the carbon dioxide produced from the Super Bowl by planting trees. Note: Units for carbon dioxide production and carbon absorption in the article are in tons (1 ton = 2,000 lbs).

a) How many tons of **carbon dioxide** were produced by the Super Bowl from transportation and utility usage (from the article)?

b) Carbon dioxide is composed of one carbon atom and two oxygen atoms. (Plants store the carbon and release the oxygen back into the environment so it is the carbon that is of most concern.) A carbon atom has an atomic weight of 12, and an oxygen atom has an atomic weight of 16; therefore, each carbon dioxide molecule has a molecular weight of 44. What fraction of the weight of carbon dioxide is due to carbon? Show your calculations.



c) Calculate the amount of **carbon** produced by the Super Bowl:

National Institute of Environmental Health Sciences
Community Outreach & Education Program

d) How many trees are needed to absorb 75 tons of **carbon** (from the article)?

e) Calculate the number of trees needed to absorb 1 ton of **carbon**.

f) How many trees are needed to offset the total amount of **carbon** produced by the Super Bowl?

g) Explain why you think the NFL's plan to offset greenhouse gases by planting trees was or was not sufficient.

Part 2 Sporting Event:_____

Step 4: Calculate the production of carbon dioxide for a sporting event from utility usage. Data for these calculations may be provided by your teacher or obtained from school administrators.

Utility Usage

a) Electricity Used (in kilowatt-hours) = _____

b) Carbon Dioxide Emissions Rate (in pounds/kilowatt-hour) = _____

c) **Estimated Carbon Dioxide Produced =** _____

Step 5: Calculate the production of carbon dioxide for the same sporting event from transportation usage. Data for these calculations may be provided by your teacher or obtained from school administrators.

Transportation Usage

a) Average Total Attendance at Sporting Event = _____

b) Estimate Total Number of Vehicles = _____

(if unknown, divide total attendance by 3 to estimate three people per car)

Home Team Fans = _____

(if percentage of home team fans is unknown, estimate 2/3 of total vehicles)

Away Team Fans = _____

(if percentage of home team fans is unknown, estimate 1/3 of total vehicles)

c) Estimate the Type of Vehicles Using the Average National Distribution. According to the National Household Transportation Survey, the national average distribution of personal vehicles for the United States is 60% cars or station wagons, 21% vans or SUVs, and 19% light trucks. Show your calculations.

Home Team Fans

Cars/Station Wagons = _____

Vans/SUVs = _____

Light Trucks = _____

Away Team Fans

Cars/Station Wagons = _____

Vans/SUVs = _____

Light Trucks = _____

d) Estimate the Number of Miles Driven by Home Team or Away Team Fans.

Home Team Fans = _____

(If unknown, estimate the number of miles from the event location to the midpoint of the district)

Away Team Fans = _____

(If unknown, estimate the number of miles from the event location to the high school of the away team)

e) Estimate the Number of Miles Driven per Vehicle Type:

	Home Team Fans			Away Team Fans		
	# of Vehicles	Avg. # Miles Driven/Vehicle	Total Miles Driven	# of Vehicles	Avg. # Miles Driven/Vehicle	Total Miles Driven
Cars/Station Wagons						
Vans/SUVs						
Light Trucks						

f) Estimate Carbon Dioxide Produced.

	Home Team Fans			Away Team Fans		
	Total Miles Driven	Carbon Dioxide Emission Rate per Mile	Total Carbon Dioxide Produced (lbs)	Total Miles Driven	Carbon Dioxide Emission Rate per Mile	Total Carbon Dioxide Produced (lbs)
Cars/Station Wagons						
Vans/SUVs						
Light Trucks						
		Total			Total	

g) Calculate the total carbon dioxide produced by all vehicles in pounds.

Step 6: Calculate the total **carbon dioxide** produced for both utility usage and transportation usage in pounds.

Carbon Dioxide Produced from Utility Usage (in pounds) =

Carbon Dioxide Produced from Transportation Usage (in pounds) =

Total Carbon Dioxide Produced (in pounds) = _____

Total Carbon Dioxide Produced (in tons) = _____

Step 7: Calculate the total **carbon** produced for both utility usage and transportation usage in tons. (Use the answer from Step 3b as a reference.)

Step 8: How many trees are needed to offset the **carbon** produced by your sporting event? (Use the estimate from Step 3e.)

Step 9: The National Football League (NFL) aims to lessen the environmental impact of the Super Bowl on the local and global environment. The NFL Environmental Program collaborates with local organizations in the host city to keep the Super Bowl cleaner and greener through several initiatives:

- reduce solid waste through recycling potential waste materials, such as soda cans and plastic bottles
- reduce solid waste through reusing other potential waste materials, such as leftover decorative materials, building materials, office supplies, and other reusable items by donating these items to local charities

- reduce food waste by donating extra prepared food from Super Bowl events to local food bank or food rescue organizations
- organize a sports equipment and book donation project to donate these items to needy children throughout the host city
- develop environmental guidelines for use by Super Bowl vendors and contractors to incorporate green principles into areas such as transportation, meeting planning, and food and beverage service
- implement the "Carbon Neutral" initiative, which seeks to offset the greenhouse gas emissions produced by Super Bowl events by planting hundreds of seedling trees (this project, begun at Super Bowl XXXIX in Jacksonville, Florida, is the NFL's way to respond to the long-term problems associated with greenhouse gas production

a. Develop a plan to reduce the environmental impact of the sporting event you investigated at your school.

b. Which aspects of the plan would you implement first and why?