Let's Clear the Air:

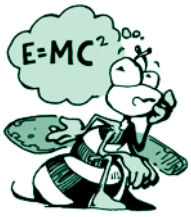
The Danger of Forest Fire Smoke to Firefighters

Meet Mr. Reinhardt:

I like being a scientist because I get to solve hard problems for people. I also learn more about what is true, rather than what is thought to be true.

Meet Mr. Ottmar:

I like being a scientist because I can provide new knowledge and develop tools to help *forest managers* to become better *stewards* of the land.



Thinking About Science

Science can be classified into two very broad categories. These categories are called basic science and applied science. When a scientist conducts basic science, he or she is working on answering a question that adds to our knowledge but may not directly help to solve an immediate problem. *Astronomers*, for example, are scientists that conduct basic science. In the USDA Forest Service, most of the research conducted is in the applied science category. When a scientist conducts applied science, he or she is trying to solve an immediate problem. In this study, the scientists wanted to measure some of the health risks from fighting wildland fires. They also wanted to find an easy way for firefighters to determine those risks. In applied science, the results of research can be applied to an immediate problem.

Glossary:

forest managers (**för** est **man** ij ürs): Skilled individuals that take care of natural resources.

stewards (**stoo** ürds): People that take care of large areas of land.

astronomers (uh **staw** no mürs): Scientists that study the stars, planets, comets, etc.

fire managers (fir **man** uh jürs): People whose job it is to prevent or control wildland fires.

data (**da** tuh): Facts or figures studied in order to make a conclusion.

sample (**sam** pul): A part or piece that shows what the whole group or thing is like.

analyze (**an** uh liz): To separate something into its parts in order to examine them.

average (**av** rij): The number determined by dividing the sum of two or more quantities by the number of quantities added.

scale (skal): A series of marks along a line, with regular spaces in between, used for measuring.

relationship (re **la** shun ship): When two or more things are connected in some fashion.

Pronunciation Guide

a	as in ape	ô	as in for
ä	as in car	u	as in use
e	as in me	ü	as in fur
i	as in ice	oo	as in tool
o	as in go	*ng*	as in sing

Accented syllables are in **bold**.

Thinking About the Environment

The natural environment provides humans and other animals with what we need to live. This includes, for example, air, water, and a temperature that is neither too hot nor too

cold. Sometimes, however, parts of the natural environment can become dangerous for humans and other living things. The danger can be natural, as when a volcano or flood occurs, or can be caused by human activity. When humans pollute the air, for example, the air might be dangerous to breathe. In this study, the scientists studied the danger of the smoke coming from wildfires to humans. Wildfires are wildland fires that can start naturally from events like lightning, but often they are caused by careless human action. When firefighters fight a wildfire, they might breathe in harmful chemicals contained in the smoke. You can see that the natural environment provides support for humans and other life most of the time. Sometimes, however, parts of the natural environment can pose a danger to humans and other living things.

Introduction

Smoke from wildland fires contains hundreds of chemicals. These chemicals can be gases, liquids, or solid forms. The chemicals that cause the most hazard to human health are carbon monoxide (mä **näk** si̲d) gas (CO), a group of gases called aldehydes (**äl** duh hi̲dz), and tiny particles of solid matter that are small enough to be breathed in. The effects of breathing wildland fire smoke include eye and throat irritation, shortness of breath, headaches, dizziness, and nausea (**nä** ze̲ uh). Breathing in carbon monoxide can also cause people to become mentally confused.

Figures 1 and 2. *Firefighters at a fire.*

When firefighters fight fires, they are exposed to smoke for various lengths of time (figures 1 and 2). Some firefighters are sent to a wildfire when it first starts. These firefighters are closer to the actual fire and breathe in a lot of smoke, but typically only do so for a short amount of time. Other firefighters fight fires that have been burning for at least a few hours or days. These firefighters fight the fire for more hours at a time, but do not usually get as close to the flames or smoke. The scientists in this study wanted to measure the danger smoke poses to firefighters. They also wanted to find an easier way for *fire managers* to estimate the danger from breathing in the dangerous chemicals found in wildland fire smoke.

Reflection Section

- What is the problem the scientists were trying to solve?
- Do you think that this problem is important? Why or why not?

Method

The scientists collected *data* from two kinds of wildfires. The first kind is called an **initial attack wildfire**, and it is the kind that firefighters are able to control within hours of being started. The second kind is called a **project wildfire**. Project wildfires take days, and even months, to control. Firefighters at initial attack wildfires work close to the fire, but they work for short periods of time. They are the emergency crews of firefighting. Firefighters at project wildfires take more time and have to develop specific plans for fighting the fires because they are so large and difficult to put out. They usually work farther away from the actual fire, but they work for longer periods of time.

The scientists gave firefighters special battery-powered equipment to wear. The equipment included three containers that collected *samples* of smoke. The containers hung on the firefighter's chest. When firefighters went to a

fire, they hung this equipment on the outside of their fire-fighting suits. While they were fighting the fire, the equipment automatically collected the smoke. The scientists took the smoke samples to their laboratories to *analyze* the smoke. The scientists were interested in two measurements. First, they wanted to know the *average* amount of different dangerous chemicals the firefighters breathed in during the time that they were fighting fires. Second, they wanted to know the maximum amount of dangerous chemicals that were breathed in at any one time.

The scientists also asked people working near the fires to estimate how much smoke firefighters were breathing in. They gave them a *scale* from 1 to 5, and asked them to assign a number to the smoke at different times (figure 3).

Reflection Section

- Why do you think that the containers were hung on the firefighters' chests, instead of on their backs?
- What is the difference between the average and the maximum amount of something? Why do you think that the scientists wanted to know both of these measures?

Findings

The scientists measured the smoke for 30 days of wildfires. One hundred and twenty-nine firefighters wore the equipment that collected the smoke samples (table 1). Over the 30 days, 1,763 samples were collected by the scientists. (On the average, how many samples were collected from each firefighter?)

The scientists discovered that, except for in some cases, there was not much danger to firefighters from breathing smoke. Firefighters were in danger from smoke when the wind was facing them, sending smoke in their direction. Firefighters were also in danger from smoke when they spent long periods of time putting out smoldering stumps and logs. Initial attack firefighters were in danger from smoke when they had to surround a fire quickly. These are the emergency firefighters that try to control a wildfire shortly after it starts. Fortunately, these firefighters do not spend much time in smoky conditions. This is because they usually put the fire out very quickly. The scientists discovered that there is a close *relationship* between the amount of different dangerous chemicals in smoke. When carbon monoxide levels rose, so did the levels of aldehydes and the amount of tiny particles of solid matter being breathed in (figure 4).

Figure 3. *Classification of how much forest fire smoke was in the air.*

NUMBER	SMOKE CONDITIONS
1	None
2	Light
3	Medium
4	Heavy
5	Very heavy

Table 1. *Results of smoke samples collections.*

Type of Wildfire	Number of Days	Number of Firefighters
Initial Attack	13	45
Project	17	84
Total for All Fires	30	129

Figure 4. *When carbon monoxide levels rose, the amount of particles in the smoke rose also.*

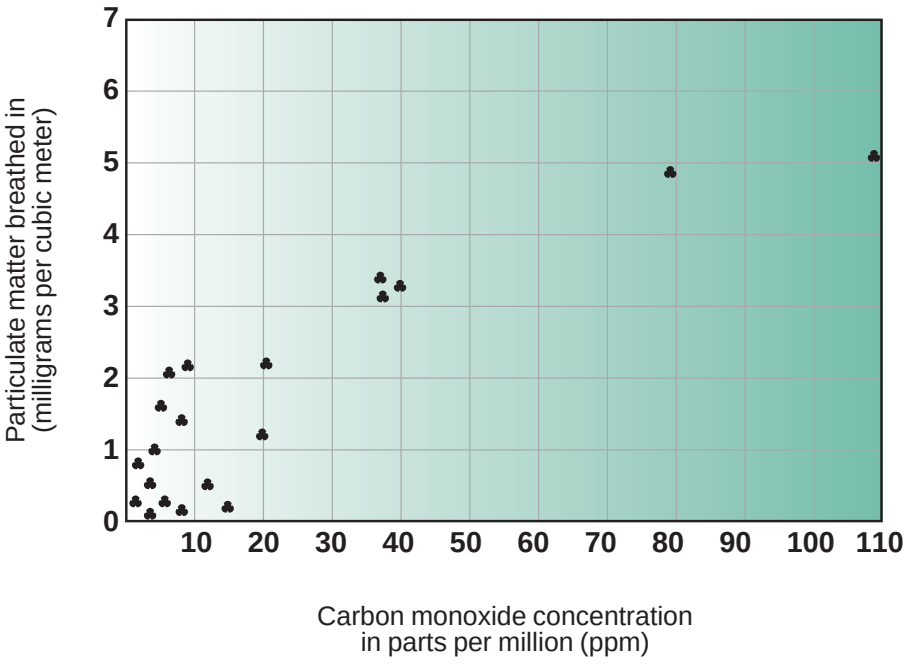


Figure 5. *No smoke. Rating of 1*

What do you think the scientists discovered about people's ability to estimate the amount of smoke occurring near a wildfire? They found that people working near a wildfire were able to accurately estimate how smoky the conditions were. In other words, when a person gave the smoke a low rating, there were not many dangerous chemicals measured by the equipment. When a person gave the smoke a high rating, the equipment measured a high level of dangerous chemicals (figures 5-9).

Figure 6. *Light smoke. Rating of 2*

Figure 7. *Medium smoke. Rating of 3*

Figure 8. *Heavy smoke. Rating of 4*

Figure 9. *Very Heavy smoke. Rating of 5*

Reflection Section

- Based on the results of this research, do you think that there will ever be much danger for firefighters from breathing smoke? Why or why not?
- Why do you think that it is important to know that when one dangerous chemical is measured in the smoke, there are other dangerous chemicals as well?

Implications

Although firefighters do not usually breathe in dangerous amounts of smoke, they do so occasionally. This especially happens when a wildfire has just started. Because people can estimate how smoky the conditions are, firefighters should be trained to determine when the conditions are too smoky and dangerous. If conditions are too smoky, firefighters should limit the amount of time they are breathing the smoke. Equipment should also be used that measures the amount of carbon monoxide in the smoke. By using equipment to measure the amount of carbon monoxide in the smoke, the amount of danger from many chemicals can be determined.

Reflection Section

- What are the advantages of training firefighters to estimate the danger from smoky conditions over using equipment to measure the amount of dangerous chemicals in smoke?
- What are the disadvantages of having firefighters estimate the danger from smoky conditions compared to using equipment to measure the amount of dangerous chemicals in smoke?

FACTivity

The question you will answer in this FACTivity is: How consistently can you and your classmates estimate the amount of smoke coming from a wildland fire? The method you will use to answer this question is: Examine the photographs in figures 5-9 of the article above. Pay particular attention to the amount of smoke in the photograph and the rating assigned to each. Each student will take a piece of paper and create the form at the top of the next column.

Next, each student will look at the photographs on the next page and rate the amount of smoke in each one from 1-5. Write your rating in the form beside the correct number for each photograph. After everyone is finished, nominate someone to record the ratings on the blackboard. For each photograph, record every student's rating. Now count the number of times each rating was given. For each photograph, you can create a bar chart (see example on page 13). Use the form on page 13 to record the number of ratings for each photograph.

Photograph #	Rating (1-5)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	

Evaluating the bar charts should tell you how consistent you and your classmates are in your ratings of the amount of smoke from wildland fire photographs. Would you say that you are consistent, not consistent, or mixed? What is it about the bar charts that tells you that?

From Reinhardt, T. E. and Ottmar, R. D. (2000). Smoke exposure at western wildfires. Res. Pap. PNW-RP-525. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 72 p.

Photograph #1

Photograph #2

Photograph #3

Photograph #4

Photograph #5

Photograph #6

Photograph #7

Photograph #8

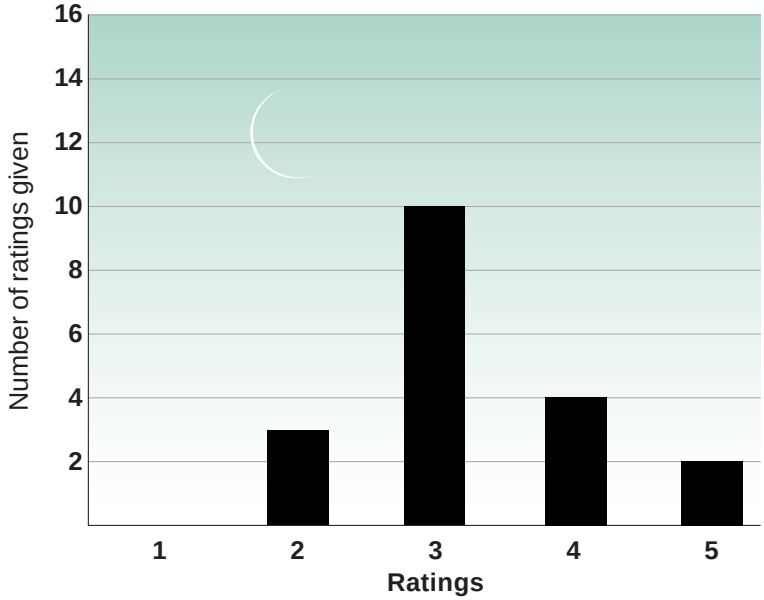
Photograph #9

Photograph #10

Photograph #11

Photograph #12

Photograph #	No. of 1's	No. of 2's	No. of 3's	No. of 4's	No. of 5's
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					



Example of bar chart

Photograph 1 1 = No smoke, 5 = Very heavy smoke

Fire Safety Tips

Here are some tips from the Arkansas Fire Prevention Commission (kuh **mish** un) to help keep you safe from uncontrolled fires in your home:

1. Plan two escape routes out of your home and practice using them.
2. Be sure you can open all doors and windows from the inside.
3. Call the fire department AFTER you have left the building.
4. DON'T stop to get valuables.
5. Never re-enter a burning building.
6. Plan a place to meet outside of your home.
7. If your clothing catches on fire, stop, drop, and roll. Do not run. Call for help.

The Story of Smokey Bear

When a Japanese submarine shelled the southern California coast during World War II, people were worried that more attacks might start forest fires. So the USDA Forest Service began a program to make everyone aware of the dangers of forest fires. They wanted an animal to represent forest fire prevention and they decided on a bear. This bear was to have a short nose, be brown or black, and have a face that looked smart and friendly. They also wanted him to wear a ranger hat and blue jeans. They named this bear "Smokey" after "Smokey Joe" Martin, a fire chief from the New York City Fire Department.

Until 1950, Smokey was just a character drawn on posters asking people to help prevent forest fires. Then in 1950, someone was careless with a match, cigarette, or campfire in the Lincoln National Forest in southern New Mexico. This was the start of a terrible forest fire. After the fire passed and the smoke cleared, the only living thing the firefighters saw was a badly burned bear cub clinging to a blackened tree. The little bear was taken to the ranger station, where people bandaged his burned paws and helped him to become healthy again. They called this cub "Smokey," and he became the first living symbol of Smokey Bear.

When Smokey's burns healed, he was sent to live at the National Zoo in Washington, DC. Over the years, thousands of people from around the world came to see Smokey Bear. Smokey died in 1976, and he is buried near his original home in southern New Mexico at Smokey Bear State Park.