I'll Huff and I'll Puff and I'll Blow Your Trees Down!

Meet Dr. Francis:

I like being a scientist because I have an enormous curiosity about nature, and science gives me an opportunity to be personally involved in the unraveling of its mysteries.

Dr. Francis

Thinking About Science

When scientists study something, they usually like to plan their experiments in advance. They do this so that they have more control over the experiment. When scientists study *natural*

disasters, they cannot always plan their experiments. This is because people do not always know when or where a natural disaster will occur. Natural disasters include events like hurricanes, tornadoes, landslides, volcanoes, and floods. The scientists in this study wanted to study the effects of a hurricane. As part of their research, they needed to know the wind speed of the hurricane as it blew across different places. Because they did not know where or when the hurricane would blow, they had to rely on measurements made by other people. You can see that scientists sometimes have to use *data* collected by other people. Can you think of examples of when you have to do the same thing? (Hint: Think about the weather forecast or about medical information. What other different kinds of information do you use that are collected by other people?)

Thinking About Ecology

In the natural world, feedback and control are important principles to understand. Feedback is a response to something that occurs, and its result is usually some kind of control on the system. Feedback can be positive as when it accelerates (ak **sel** ür a̲ts) a process, or negative when it slows down a process. In this study of hurricane damage, feedback was provided by trees. In response to the hurricane's strong winds, the trees shed their leaves. Once the trees lost their leaves, the hurricane's winds could no longer do much more damage to the trees. This provided some control by limiting how much more damage the wind could do to the trees. Can you think of examples of feedback and control in your own body?

Thinking About the Environment

In nature, some events are *cyclical*. The seasons are an example of a cyclical natural event because they repeat themselves every year. Day and night are also examples of a cyclical event because they are repeated daily. Can you think of other cyclical events that are *predictable*? Cyclical events happen in nature all of the time. Some cycles are not as exact as other cycles. Hurricanes, for example, are cyclical because they occur in the tropics every year between June and November. However, we do not know exactly what day a hurricane will occur during that time. Can you think of other cyclical events that are not as easily predictable?

Glossary:

natural disaster (**nach** ur ul di **zas** tür): A natural happening that causes much damage or suffering.

data (**da** tuh): Factual or measurement information.

cyclical (**sik** lik o̲o̲l): Like a cycle; when events continue to happen in the same order.

predictable (pre̲ **dik** tüh bül): Easy to tell what one thinks will happen in the future.

feedback (**fe̲d** bak): A response, often one that sets a process in motion. The response can then also be affected by the process it set in motion.

species (**spe̲** se̲z): Groups of organisms that resemble one another in appearance, behavior, chemical processes, and genetic structure.

compacted (käm **pak** ted): Closely and firmly packed together.

analyze (**an** ä li̲z): To study or examine carefully.

modify (**mäd** uh fi̲) To make a small change in.

Pronunciation Guide

a̲	as in ape	ô	as in for
ä	as in car	u̲	as in use
e̲	as in me	ü	as in fur
i̲	as in ice	o̲o̲	as in tool
o̲	as in go	*ng*	as in sing

Accented syllables are in **bold**.

Introduction

When a hurricane occurs, a lot of damage can be done to buildings and other structures. One of the most visible types of damage occurs to trees. When hurricanes occur, trees lose most of their leaves. The scientists in this study wanted to know more about the extent of damage to trees following a tropical hurricane in Puerto Rico (Figure 1). When Hurricane Hugo occurred in September of 1989, the scientists decided to study the damage done to the trees in Puerto Rico (Figure 2). Hurricane Hugo was a category 4 hurricane (Table 1).

Caribbean hurricanes are formed at the West Africa coast. Atmospheric conditions push hurricanes to the islands in the Caribbean Sea and up the east coast of the United States (Figure 3).

Figure 2. Tree damage following Hurricane Hugo.

Reflection Section

- The scientists knew that overall, Hurricane Hugo had winds of between 131-155 mph (210-249 kph). Why do you think they wanted to measure wind speed at different places in Puerto Rico?
- Do you think that hurricane damage to a tree with leaves is greater than to a tree without leaves? Why or why not?

Method

The scientists wanted to understand how much tree damage was done by the

Figure 1. Location of Puerto Rico

Category	Wind speed
1	74-95 mph/ 119-153 kph
2	96-110 mph/ 154-177 kph
3	111-130 mph/ 178-209 kph
4	131-155 mph/ 210-249 kph
5	156+ mph/ 250+ kph

Note: If you want to convert miles per hour (mph) to kilometers per hour (kph), multiply the number of mph X 1.61. To convert from kph to mph, multiply the number of kph X .621.

Table 1. Saffir-Simpson Hurricane Scale

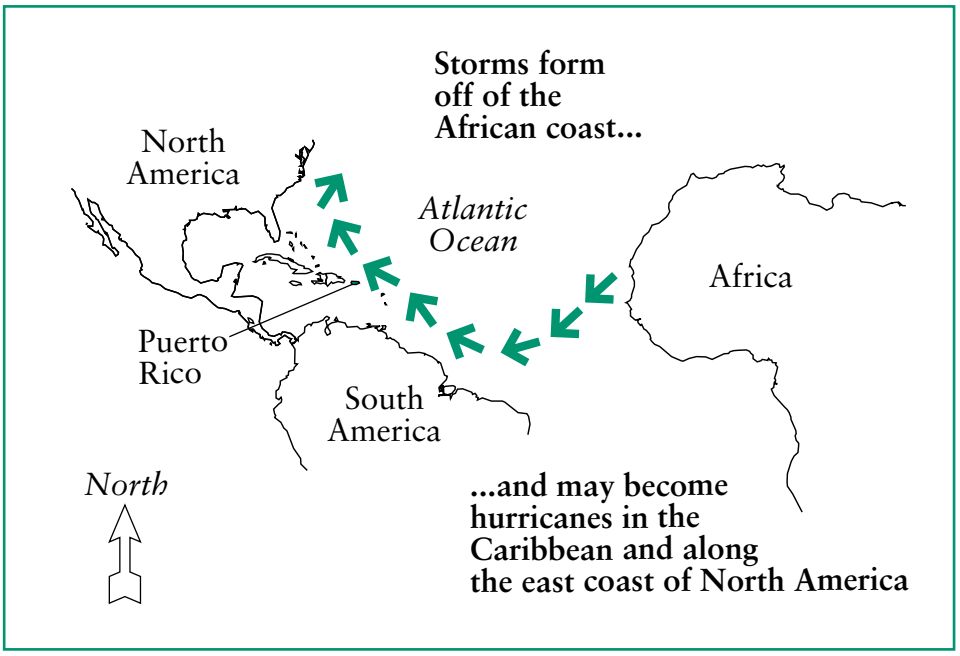


Figure 3. Tropical hurricanes in eastern North America begin as tropical storms on the west African coast.

hurricane at different wind speeds. To do this, they had to study the trees in areas where wind instruments were placed before Hurricane Hugo occurred. The scientists observed 81 different *species* of trees in 18 different areas. They observed damage to 1,226 trees. The scientists put each of the trees in one of five categories, based on how much damage they observed. They then compared palm trees with broad-leafed trees, to determine whether one kind of tree had more damage than the other (Figure 4). For the palms and the broad-leafed trees, they compared the amount of damage with the wind speed.

Figure 4. Palm and broad-leafed trees.

Reflection Section

- Why did the scientists study trees that were located near wind instruments?

- Look at the leaf shapes in Figure 4. Do you think the scientists found a difference in damage to trees with different kinds of leaves? Why or why not?

Results

The scientists found out many things about the harm done to trees during Hurricane Hugo. First, they found that larger trees had more damage than smaller trees. They also found that palm trees had less damage than broad-leafed trees. They also discovered that after broad-leafed trees lose their leaves to the wind, there is less damage to the trees. Up to a point, the hurricane's winds continued to do more damage as they blew faster. However, when the wind blew over 100 kph (multiply 100 by .621 to find out how fast this is in miles per hour), it did not do much more damage (Figure 5). By then, most of the leaves had blown off of the trees.

Reflection Section

- Why do you think the palm trees had less damage than the broad-leafed trees?

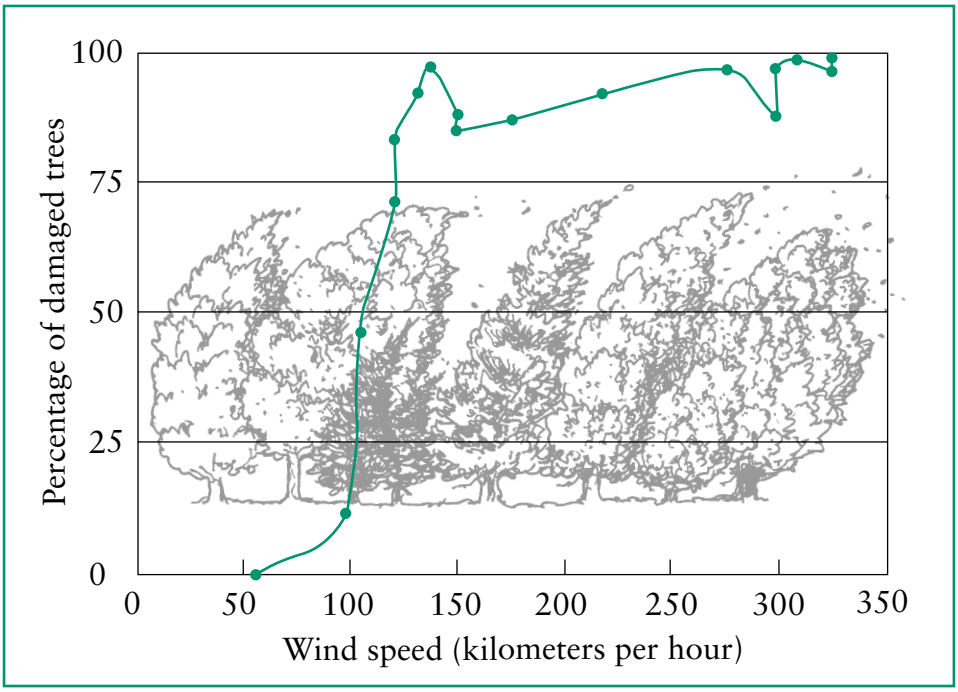


Figure 5. Most of the damage to trees happens when winds blow up to 100 kilometers per hour.

- With your class, discuss whether anyone has ever seen a tree that has been blown over or broken by the wind. How tall was the tree? How big was its trunk? Are there any similarities among the damaged trees seen by your classmates? What are the similarities?

Implications

Where hurricanes can occur often in an area, people must be careful where they plant trees or locate their homes and other buildings. Trees should only be planted in deep, well-drained soils that are not *compacted*. If a hurricane is coming, a broad-leafed tree might be protected by cutting off its leaves. Hurricanes are cyclical natural events in the Caribbean and the Eastern United States. Because they cannot be controlled, people must learn to live with them.

Reflection Section

- Should people who live in areas where hurricanes occur build their homes next to big broad-leafed trees? Why or why not?

- Hurricanes might cause damage to buildings and some trees. Do you think there are any natural advantages to hurricanes? Why or why not? If you think there are advantages, what might they be?

FACTivity:

The scientists in this study had to rely on instruments that were near, but not at, their study areas. They also had to rely on instruments that were maintained by other people. In this FACTivity, you will answer the question: Can weather measurements made by other people in distant places be accurate for another area or situation? We use such measurements every day, such as when we hear local reports of the current temperature. This FACTivity will help you think about whether you can trust weather measurements that are not made exactly where you are located. The method you will use to answer the question is as follows: Get an outdoor thermometer and place it outside in the shade. Observe and record the temperature every afternoon, for a week, at the same time of the day. You can use the example on the next page as a guide. Before beginning your observations, find another source for the current temperature in your city or town. You may be able to call a special phone number, the local airport, a local radio station, search the internet, or use a weather radio. Record the reported temperature for the same time (or within 1 hour of the same time) as your observed temperature, using the chart on the next page as a guide. To help you *analyze* the differences between observed and reported temperatures, you will create a bar chart from your table (See an example of a bar chart at the end of the first FACTivity). Now compare the

Sample chart for recording temperatures.

	Monday	Tuesday	Wednesday	Thursday	Friday
Observed Temperature (F or C)					
Reported Temperature (F or C)					

temperature you observed on your thermometer with the reported temperature. Are the two daily temperatures the same or different? Do you think the reported temperature is an adequate measure of the temperature at your school? Why or why not?

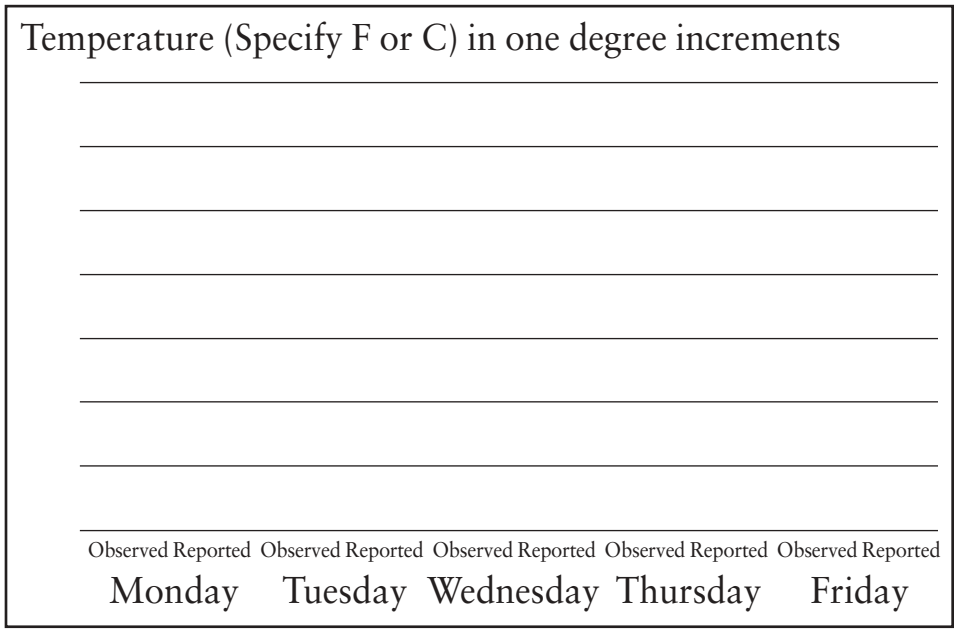
You may also record the observed and reported temperature at different times throughout the day for the week. The more observations you have to compare, the more accurate your findings will be. If your findings are more accurate, will you have more or less confidence in your answer to the FACTivity question? Why?

Convert your temperatures from Centigrade to Fahrenheit or from Fahrenheit to Centigrade. Then make a new bar chart using the converted measurements. Compare the bar charts. How are they similar? How are they different? This is how you do the conversion:

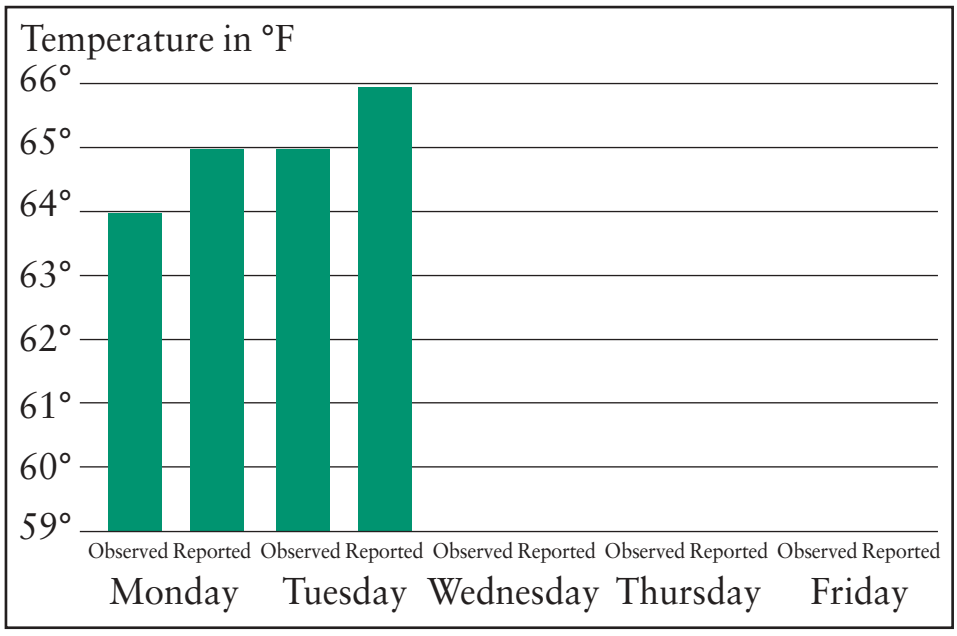
If you know Fahrenheit: Subtract 32 from the temperature, then multiply by .55

If you know Centigrade: Multiply the temperature by 1.8, then add 32

Sample bar chart (histogram) for analyzing temperatures.



Example of a bar chart



Another FACTivity!

Want to measure wind speed the old-fashioned way? Here's a *modified* version of a scale developed to help British sailors estimate wind speed in the days before wind instruments were available. Why do you think the British sailors could not have used this scale, the way it is presented here? (Hint: Where would British sailors be when they needed to estimate wind speed?) What part of the scale has been modified?

Speed in mph	Name	Common Effects
0-1	Calm	Smoke rises straight up
1-3	Light air	Smoke drifts
4-7	Light breeze	Feel it on your face and see leaves rustle
8-12	Gentle breeze	Leaves on the move and flags wave
13-18	Moderate wind	Dust, leaves, and paper fly. Branches move
19-24	Fresh wind	Small trees sway
25-31	Strong wind	Large branches move. Whistles through wires
32-38	Gale	Trees sway. Hard to walk
39-46	Fresh gale	Twigs snap off trees
47-54	Strong gale	Branches break. Shingles blow loose
55-63	Storm	Trees break. Buildings damaged
64-72	Violent storm	Widespread damage
73-Higher	Hurricane	Extreme damage
From: Cox, J. D. (2000). Weather for dummies. Foster City, CA: IDG Books, p. 90.		

From Francis, John K. and Gillespie, Andrew J. R. (1993). Relating gust speed to tree damage in Hurricane Hugo, 1989. *Journal of Arboriculture*, 19(6): 368-373.