What Goes Around Comes Around:

How Long-Term Weather Patterns Affect Plants in Carolina Bay Wetlands

Meet the Scientists

Ms. Chrissa Stroh, Coastal Ecologist: I have wonderful science experiences every day! Watching the sun rise, seeing birds fly overhead, or observing the neat shapes of flowers and leaves on plants outside. One of my favorite science experiences was visiting the Volcano Arenal (**är** ah nul), an active volcano in Costa Rica. I was there as the sun was going down, and was able to see and hear red-hot lava rocks tumbling down the sides of the volcano.

Dr. Diane De Steven, Wetland Plant Ecologist: My favorite science experience is working in the field and observing the plants and animals of different habitats. I can get a break from city noises, hear the quiet sounds of nature, and appreciate the great diversity of life. My research has allowed me to visit tropical rainforests, prairies, mountain forests, deserts, and (of course) many types of wetlands.

Dr. Glenn Guntenspergen, Landscape Ecologist: As a young boy, I owned and read every Tom Swift, Jr., book ever written. Those books inspired me to become a scientist, and throughout my adult life I have had a steady stream of inspiring science experiences—all of which I treasure.

Glossary

classification (**cla** suh fuh **ka** shun): A method used by scientists to group or categorize species of organisms.

vegetation (ve juh **ta** shun): Plant life.

wetland (**wet** lend): Areas of land with a lot of soil moisture.

aquatic plants (uh **kwat** ik plants): Plants growing or living in or upon water.

marsh plants (märsh plants): Plants growing in dry areas outside wetlands.

woody plants (**wood** e plants): Plants growing in dry areas outside wetlands in the ecosystem.

freshwater (fresh **wä** tür): Water source that has low amounts of salt concentration.

ecosystem services (**e** ko sis tem **sür** vis es): Environmental health benefits provided by a community of plant and animal species.

drought (drowt): A period of dry weather with little or no rain.

ecosystem (**e** ko sis tem): Community of plant and animal species interacting with one another and with the nonliving environment.

model (**ma** del): A simplified example of a system in science.

cyclical (**sik** kli kül): Occurring in a pattern that typically happens again and again.

indicator (**in** di ka tôr): Something that symbolizes something else.

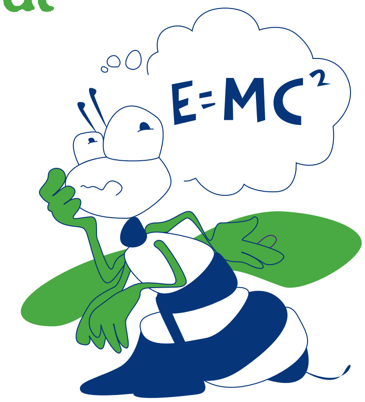
sample (**sam** pul): A small part of a group.

annual (**an** u ul): Occurring every year.

concentric (kän **sen** trik): Having a common center.

population (päp yoo **la** shun): The whole number of individuals of the same type occupying an area.

Thinking About Science



When scientists want to solve a problem, they collect information to understand the problem. To understand the information, scientists sometimes use a technique called **classification**. Classification helps scientists group and categorize many things into simpler groups. This technique can create groups that can be compared to each other. For example, if someone gave you a bag of

Pronunciation Guide

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

Accented syllables are in bold.

coins, would it be easier to count the coins one by one? Or would it be easier to put the pennies with each other, the quarters with each other, and so on? It is much easier to count the money by classifying it rather than counting the coins one by one.

In this study, scientists classified **vegetation** in and around **wetlands**. The scientists classified the plants into three groups: **aquatic plants**, **marsh plants**, and **woody plants**. Aquatic plants include plants like water lilies that are found growing in water. Marsh plants, like grasses, can grow in shallow areas between deeper water and dry areas. Woody plants, like trees and shrubs, are plants that live in dry areas outside wetlands. This type of classification helps scientists to simplify and compare the data they collected in the study area.

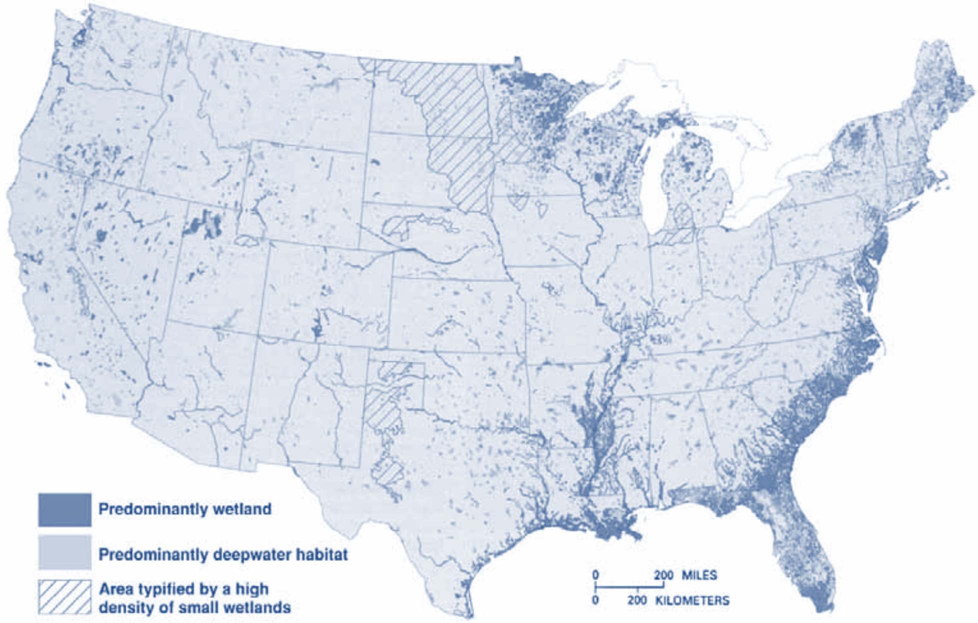


Figure 1. Wetlands of the United States of America. Image created by Robert H. Yuhas of the United States Geological Survey.

Thinking About the Environment

Why should we care about **freshwater** wetlands? Freshwater wetlands play an important role in an ecosystem by providing **ecosystem services** throughout the world (**figure 1**). Freshwater wetlands help clean the water by removing pollution. They act like a storage unit when floods occur. Water is held in the wetland rather than flooding people's homes and cities. These wetlands are also homes and breeding areas for many different types of wildlife – For example, ducks, frogs, salamanders, beavers, fish, alligators, and many more. Freshwater wetlands depend on rainfall to stay wet. When a **drought** occurs, the water levels drop. Sometimes the wetland dries up all the way. If there is not enough water in the wetland, then this can change how the wetland does its job in the ecosystem. The scientists in this study were interested in how different amounts of rainfall affect wetlands.

Introduction

Shallow land depressions can be found within some forests of the United States. These depressions are filled by rainfall, particularly in the spring when the rains are most frequent. In certain areas of the Southeastern United States, these wet depressions are called Carolina bays (**figure 2**). Throughout the summer months, Carolina bays dry up as rain becomes less frequent and the temperature increases. The period from when the Carolina bays are filled by rain to the time they dry up is called a hydroperiod (**hi** dro **per** e ud). When these bays have water, aquatic plants grow in the water, and marsh plants or woody plants grow along the wet edge of the wetlands (**figure 3**). A Carolina bay is a freshwater wetland.

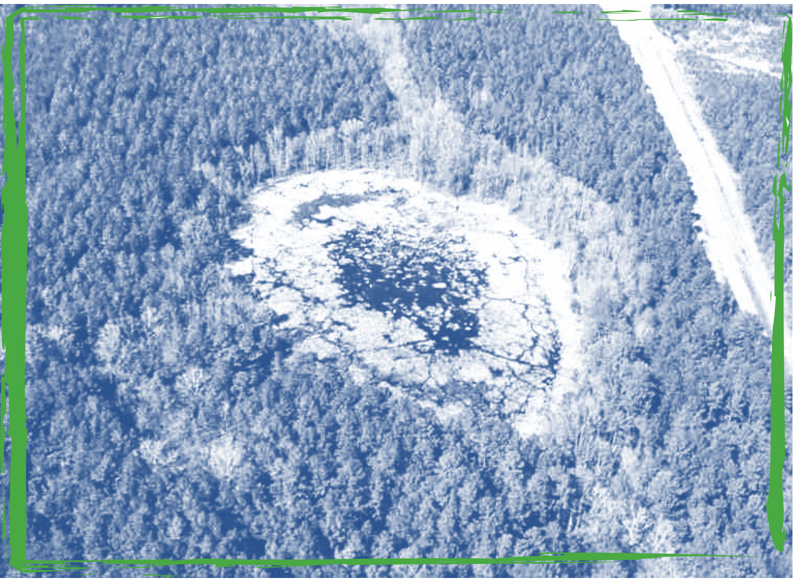


Figure 2. A Carolina bay.

What does hydro mean? "Hydro" can be a part of many different words, but it always relates to water (**figure 4**). Knowing what hydro means can help you understand what the whole word means. For example, *hydrology* means the study of water. Dehydrate means loss of water for normal body function. What do you think *hydro*power means?

Figure 3. A Carolina bay filled with water and aquatic plants.

Figure 4. The energy created by damming waterways is called hydropower.

You may recall that freshwater wetlands provide a lot of benefits. (See "Thinking About the Environment.") The scientists in this study were interested in whether prolonged periods of drought may enable trees and other woody plants to grow into the wetlands during the long dry periods. If that happened, the wetlands could change into a forested wetland (swamp.) This is called the directional **model**. It is called directional because the bays would change in only one direction. Think about how people develop and change. Think about how people change from being a baby to child to teenager to adult. People do not go from baby to teenager to baby to teenager to adult. Human development represents a directional model.

Other scientists proposed that Carolina bays could survive long periods of drought. This is called the **cyclical** model, because in this model the bays always return to their aquatic ecosystem.

Those scientists, however, had only studied Carolina bays for short periods of time. The scientists in this study wanted to study Carolina bays over a longer period of time. The question they wanted to answer in this study was: Over a long period of time following periods of drought, do Carolina bays become more forested or do they always return to their aquatic ecosystem?

Reflection Section

- What would happen to the Carolina bays if the directional model were correct? What would happen if the cyclical model were correct?
- What question did the scientsts ask?

Method

The research was conducted in an area in the Savannah River Site in South Carolina along its border with Georgia in the Southeastern United States (**figure 5**). The scientists identified seven Carolina bays in this area. In the spring, each of these bays was filled with water. The smallest bay was 4.5 hectares and the largest was 12 hectares.

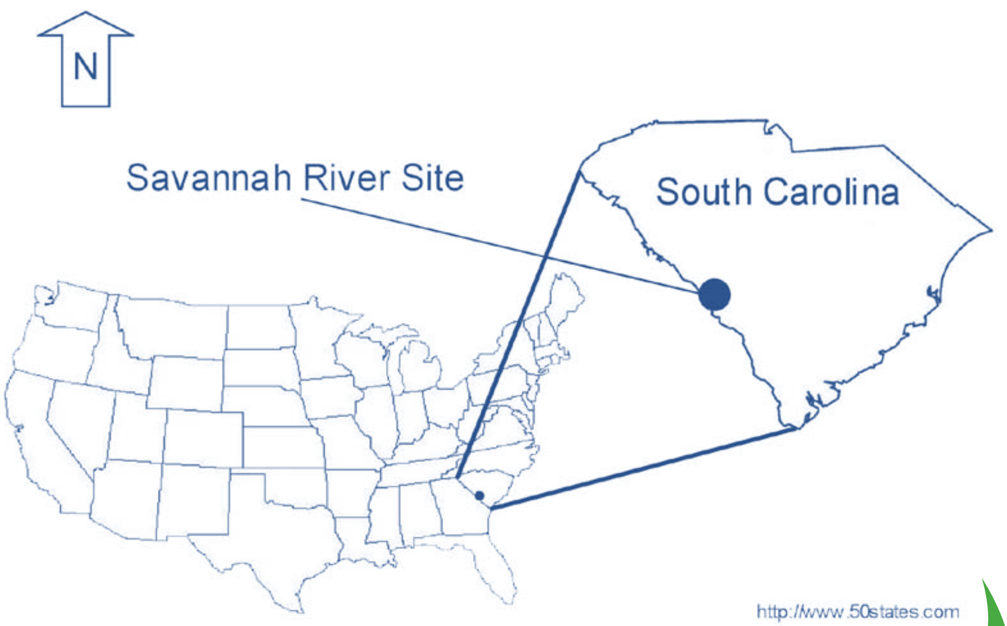


Figure 5. The study area was located in the Savannah River Site in South Carolina along its border with Georgia in the Southeastern United States.

Number Crunches

How many acres were the smallest and largest bays? Hint: Multiply the number of hectares by 2.47 to find out.

To answer their question, the scientists decided to use the type of vegetation and the depth of the water as **indicators**. To measure water depth, the scientists used a water gauge (**figure 6**). The water gauge also helped the scientists to measure hydroperiod.

Figure 6. Water gauge in a forested swamp.

The bays were too large to identify all of the plants growing in them. To decide where in each bay the scientists would identify plants, they developed a special system to **sample** the vegetation. The scientists placed a post in the middle of each Carolina bay. They connected eight cables to the center post. Each cable was pulled out to the edge of the bay and connected to a post at the water's edge. The cables were evenly spaced. Each cable was marked every 10 meters (**figure 7**).

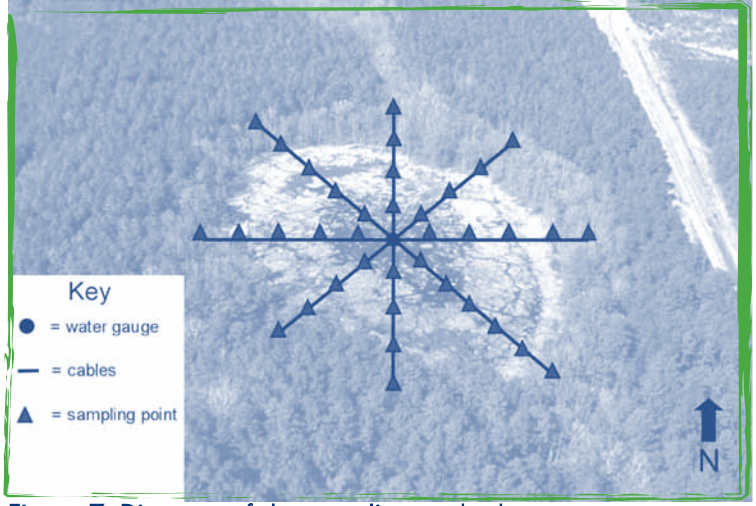


Figure 7. Diagram of the sampling method.

Number Crunches

How many yards apart were the cables marked? Hint: Multiply 10 meters by 1.09 to find out. How many feet apart were the cables marked?

Scientists recorded the types of plants growing under the eight cables in the places that had been marked. (See Ms. Stroh's photo, page 21.) They then classified the vegetation into three types, depending on how much water the plant needed to survive. The types were aquatic plants, marsh plants, and woody plants (**figure 8**).

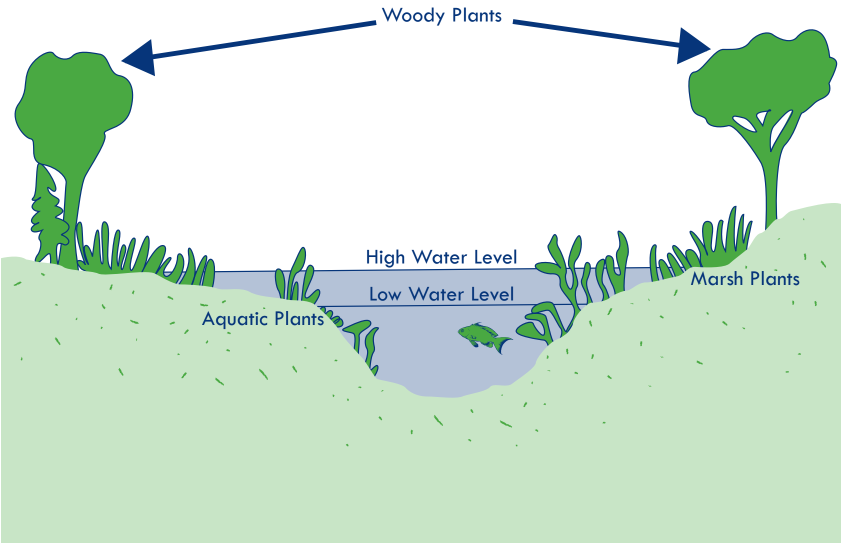


Figure 8. Examples of the three types of vegetation identified by the scientists.

Number Crunches

Although the bays were not a perfect circle, you could draw an imaginary circle with the post as the center (see **figure 7**). You know that a circle has 360 degrees. If the eight cables were evenly spaced, how many degrees apart was each cable?

The scientists also collected information about **annual** rainfall (**figure 9**). This way, they could identify times of drought. The scientists collected information about water depth and vegetation in the summers from 1983 to 2003. They also recorded the hydroperiod of each bay for every year.

Reflection Section

- How do you think changes in rainfall affected the aquatic plants, marsh plants, and woody plants around the wetland?
- An ecosystem is a very fragile system. When something disrupts the balance, the ecosystem may take years to recover. Do you think rainfall only affects vegetation in the current year or can rainfall affect how vegetation grows the next year? Explain.

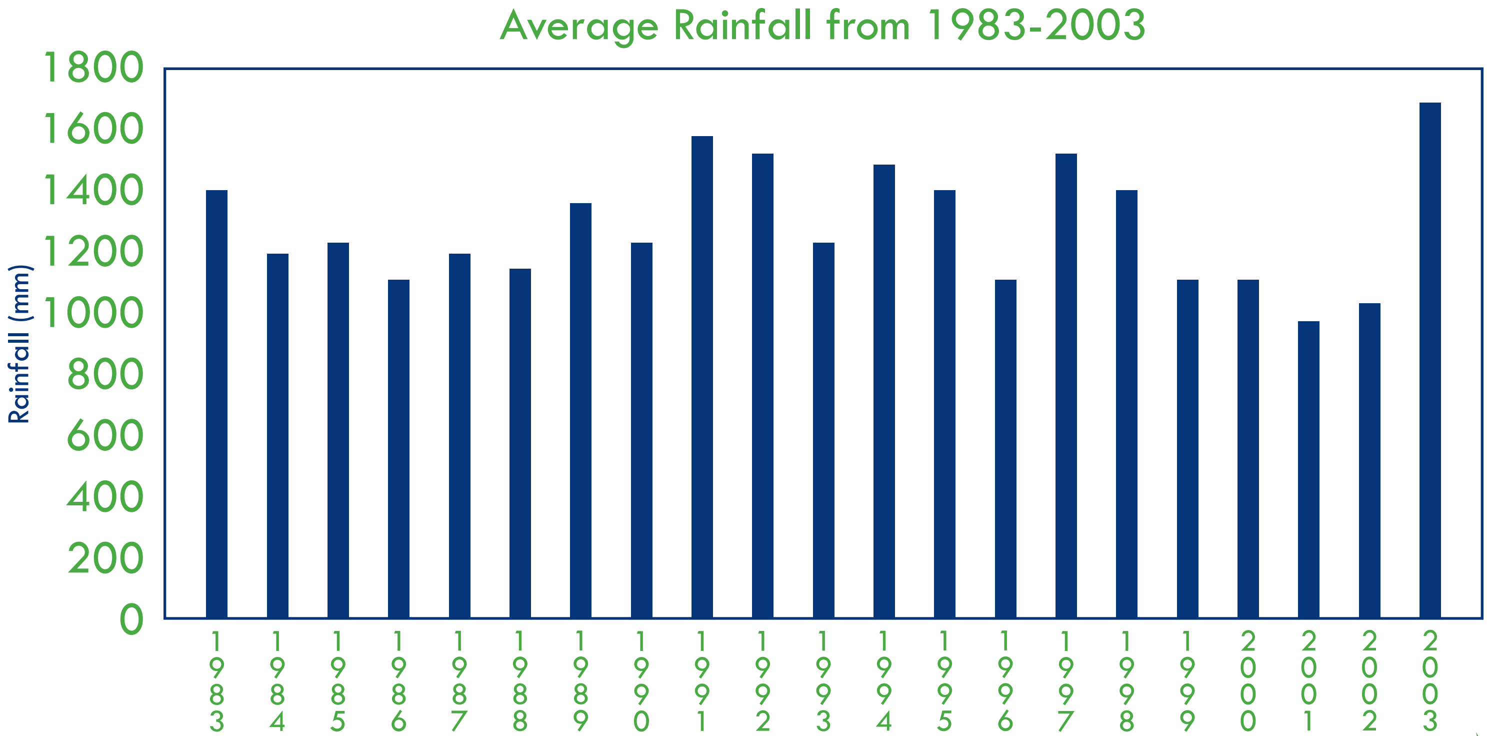


Figure 9. Average annual rainfall at the Savannah River Site from 1983 to 2003.

The scientists then compared the amount of rainfall, water depth, and hydroperiod with the type of vegetation growing in each Carolina bay. They did this over a 15-year period, paying close attention to what happened to the vegetation after a period of drought.

Findings

The scientists found that over a long period of time, the bays' vegetation patterns show a cyclical model rather than a directional model. The scientists also found that vegetation patterns were influenced by current-year rainfall and last year's rainfall. It can take up to a year for the water in a bay to recover from a drought period (**figure 10**)!

The scientists discovered that when the bays were the driest, the fewest amounts of aquatic plants were found because of the low water levels in each bay. Instead, woody and marsh plants could grow and expand into the wetland. When the rains returned, the vegetation started to change again. During this recovery period, the deeper water caused woody and marsh plants to decrease. Once the bays contained a lot of water, the aquatic plants appeared again (**figure 11**).

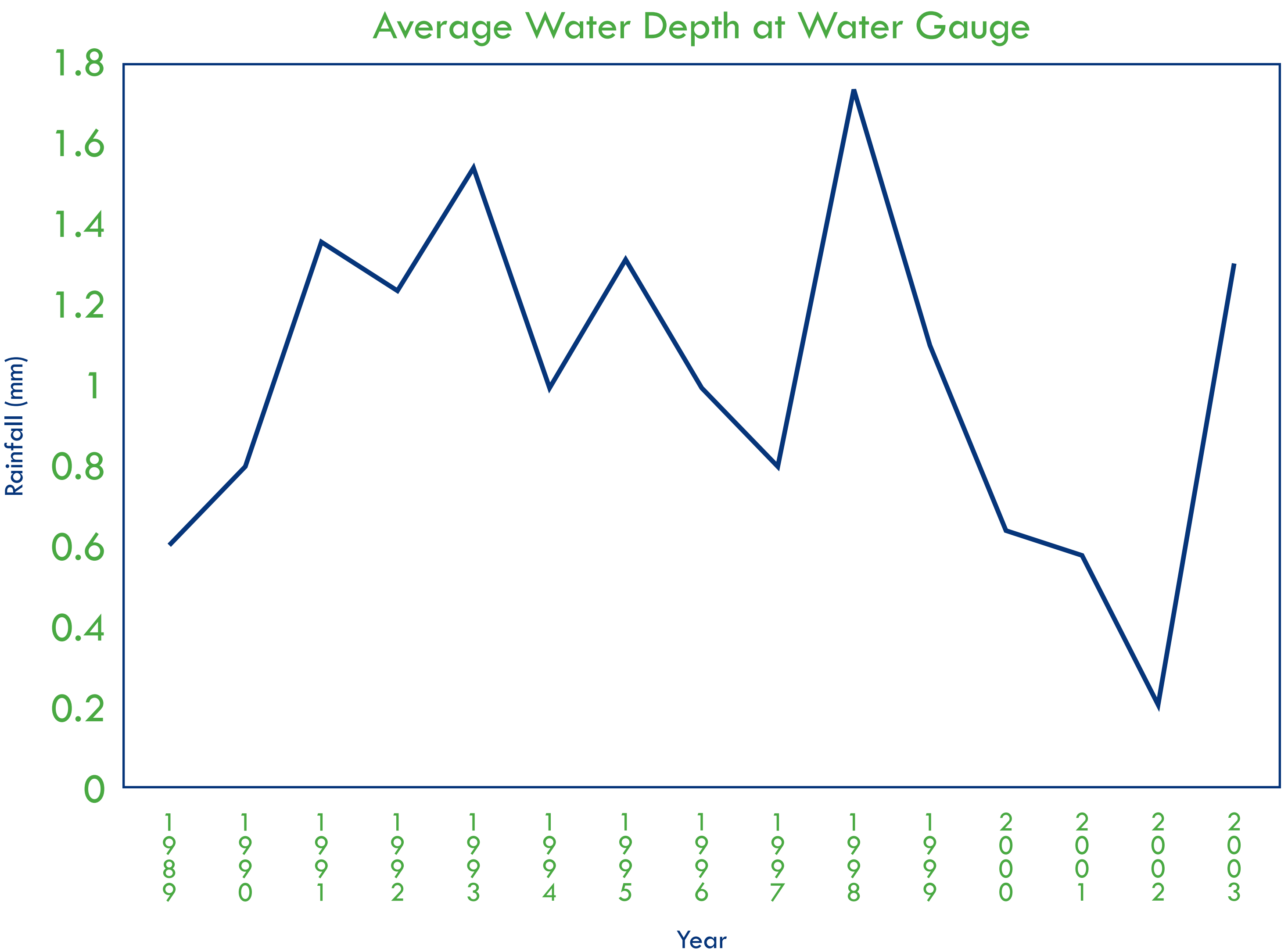


Figure 10. The graph shows the average maximum water depth at the water gauge of seven Carolina bays from 1989 to 2003. Compare this graph with figure 9.

Reflection Section

- How is the pattern of a person's development similar to or different from a Carolina bay?
- How do you think aquatic plants return to the bay after a drought period?

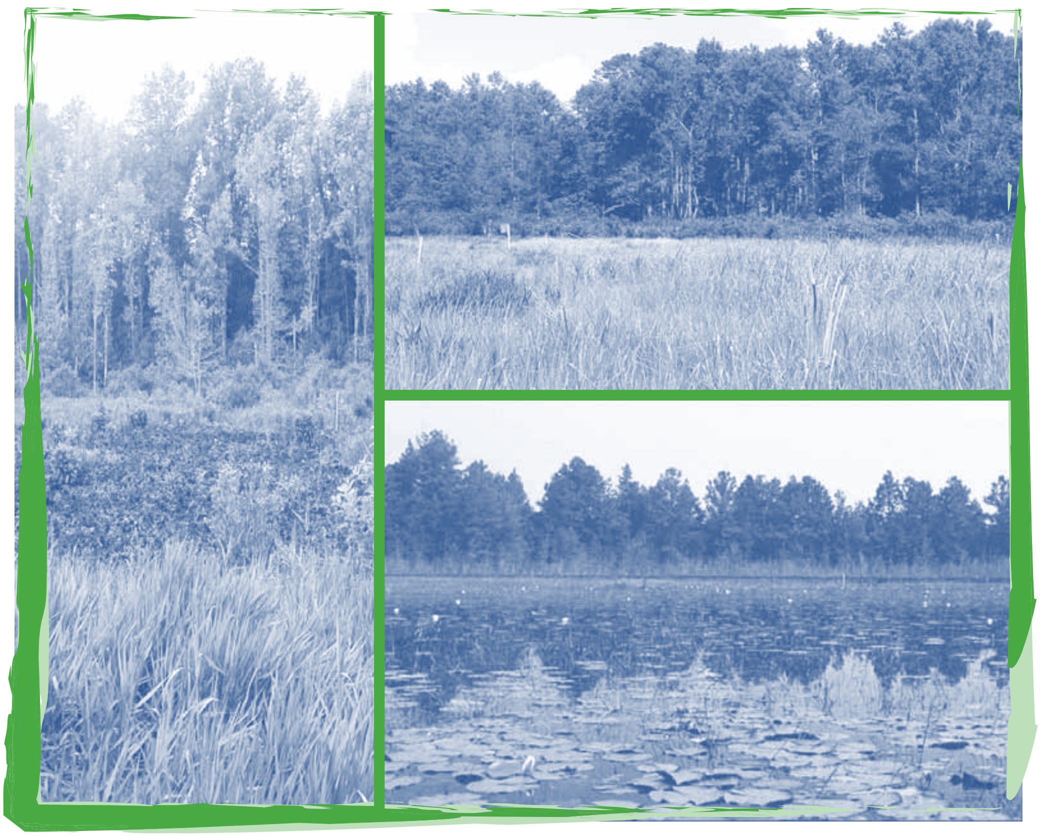


Figure 11. This image shows the bay in different phases. The photo to the left shows the bay in the driest period. The top right photo shows the bay in the between phase. The bottom right shows the bay in the wettest phase.

Discussion

The scientists gained a better understanding of Carolina bays' vegetation patterns. Carolina bays' vegetation patterns show a cyclical model over a long period of time, depending on the amount of rain. These findings will help predict how other freshwater wetlands around the world might change over long periods of time.

Over the next 30 to 60 years, it is predicted that the world will experience climate change, likely changing annual rainfall. Climate change may decrease or increase rainfall. Although scientists do not know what will happen in the future, climate change could affect wetlands around the world. This study helps scientists understand what might happen to Carolina bays and wetlands like them as climate change occurs.

Reflection Section

- How could climate change affect wetlands?
- What would happen if all the Carolina bays dried up completely? How do you think this would affect the surrounding ecosystem? Think about plants, animals, and humans.

This article was adapted from Stroh, C.L.; De Steven, D.; and Guntenspergen, G.R. (2008). Effect of climate fluctuations on long-term vegetation dynamics in Carolina bay wetlands. *Wetlands*. 28:17-27. http://www.srs.fs.usda.gov/pubs/ja/ja_stroh001.pdf.

FACTivity

Time Needed: One class period; indoor or outdoor.

This FACTivity will represent the methods the scientists used to collect vegetation data in the study. The question students will answer in this FACTivity is: How well does sampling work to represent the entire **population** of something being studied?

Materials Needed:

- 200 dried beans (3 different colors: 80 beans represent aquatic plants, 70 beans represent marshy plants, and 50 beans represent woody plants (NOTE: You are starting with 40-percent "aquatic" beans, 35-percent "marshy" beans, and 25-percent "woody" beans. This will be important to remember later on!).
- 8 pieces of string or yarn, each 6' long with knots or tape every foot.
- Three pieces of thin rope or thick string (one piece 20-25', one piece 35-40', and one piece 55-60'), with the ends tied to make three large loops.
- A toilet plunger.
- A large piece of fabric, about 7-8' square (an old sheet works well).
- 48 paper plates with the center cut out (leaving only about 1" so that the plate becomes a ring.
- Paper and pencil for recording data.
- Chart to record data (see below).

Think about the different types of plants in a Carolina bay wetland. Then think about how the scientists sampled areas in the Carolina bays. You will do something similar in this FACTivity.

Take the large piece of fabric and place it on the ground. This area is the water in the wetland. Remember wetlands are not perfectly round, so students may cut the fabric to make the wetland into a unique (but somewhat round) shape. Have students chose a center point of the wetland and place the toilet plunger at this point.

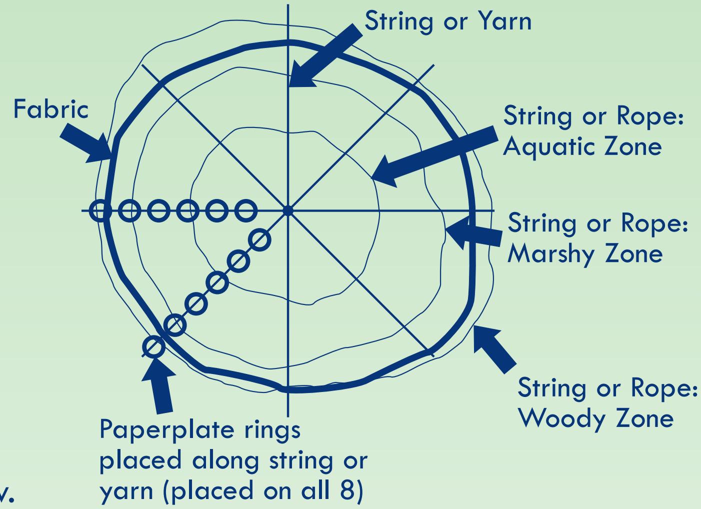
The three pieces of looped string indicate the different vegetation zones. Each looped string will be placed on the "wetland," around the center. The first zone from the wetland is the aquatic plants (the smallest loop), the second is the marshy plants (the next biggest loop), and the third is the woody plants (the largest loop). The zones should be somewhat concentric around the center pole, and the largest loop may go outside of the "wetland." Scatter the appropriate color beans in the right zone.

Divide the class into eight groups. Give each group a piece of string. Tell the groups to attach all eight pieces of string to the pole. Stretch out the string away from the pole like eight equal pieces of pie. Tell the students to place the paper plate rings at each knot in the string, with the center of the ring at the knot. (Compare with photo, page 21.) For the area closest to the pole, start at the second knot. Have the students count and record the number and color of the beans in each zone located within the ring. Each group will count the beans within six rings. One student will record the zone and the total number of beans found within all of the rings in each zone.

Repeat this exercise at least three times. To record observations provide each group with a copy of this chart. Remember, not every one of these boxes will be filled out. This should become clear as you do the FACTivity.

Student Names:

	Ring 1	Ring 2	Ring 3	Ring 4	Ring 5	Ring 6	Total Number
Aquatic Zone							
Marshy Zone							
Woody Zone							



Then, add the number of beans in each category from all eight groups and put the numbers in the chart below.

	Aquatic Zone	Marshy Zone	Woody Zone
First Sampling			
Second Sampling			
Third Sampling			
Total Number			

Add the total number of beans that fell under all of the rings for each sampling. (Add the last row of the chart above and record the number below.) Then add across to get the total number.

Aquatic Zone	Marshy Zone	Woody Zone	Total Number

Now calculate the percentage of each color of beans you found in your samples compared to the total number of beans in all of the samples. Write this in the table below. You will do this by dividing the total number found in the rings (from each zone, columns 1 to 3 from the chart above) in each zone by the total number of beans in all of the rings (column 4 from the chart above).

Aquatic Zone	Marshy Zone	Woody Zone

Now, compare the 3 percentages above with the original percentages. (You can find the percentages in the first line under "Materials" at the beginning of this FACTivity). How do the numbers compare? Did your sample percentages resemble the percentages of the population of beans? Why do you think this is so? Answer the question posed at the beginning of this FACTivity. Why do scientists often choose to take a sample of what they study and not identify or study every individual? If you continued to sample three more times, do you think your sample percentages would come closer to the population percentages? Why or why not?

If you are a Project Learning Tree-trained educator, you may use activity #29, "Rain Reasons" and # 71, "Watch on Wetlands" as an additional resource.

Additional Web Resources:

USGS's National Wetlands Research Center
http://www.nwrc.usgs.gov/

EPA's Wetlands, Oceans, and Watersheds Kids' Page
http://www.epa.gov/owow/kids.html