Food for the Soil:

Soils and the Amount of Salmon-Derived Nutrients in Southeast Alaska

Glossary words are in bold and are defined on page 21.

Meet the Scientist!

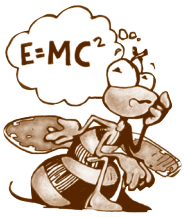
Dr. David D'Amore,
Soil Scientist

My favorite science experience was conducting bird surveys in the forest. I assisted the bird survey crew and had to get up before dawn, which meant 2 a.m. in Alaska. We hiked up into the forest, sat down in an area, remained very quiet, and listened to the different birds calling in the early morning light. During my normal work days, I would be moving around making all kinds of noise, measuring trees, shouting instructions, or digging soil pits. I was amazed to hear the "noise" of the forest once I was quiet enough to listen.

Thinking About Science

Science is a process of asking questions, learning, and understanding. Sometimes, scientists will make a discovery. The scientists find out later, through more research and experiments, that what they recently discovered may be a little bit different than what they originally found. This process is why thinking critically and asking questions about what you read and learn is important. You may be the one who comes up with a new way of thinking about something.

As you read this article, take a few moments to write down some questions you have about what you are learning. Use the space provided below or write your questions on a separate sheet of paper. At the end of the article, see if your questions were answered. If not, ask your teacher for more information or do a little extra research about what you want to know. Scientists engage in this process of reading, reflecting, forming questions, and researching continually. Now it is your turn.



Questions

Thinking About the Environment

Have you heard the word "nutrient?" What does the word nutrient make you think about? Nutrients are substances that nourish living organisms. Nutrients are essential for **sustaining** life and keeping people and the environment healthy. A lack of nutrients can lead to illness. What is one type of nutrient you need to stay healthy? In the natural environment, many different nutrients are needed to help keep the environment healthy. In this study, the scientist was particularly interested in nutrients found in the soil. Some common nutrients in the soil are nitrogen, phosphorus, calcium, and potassium. The main nutrient that the scientist learned about in this study was nitrogen.

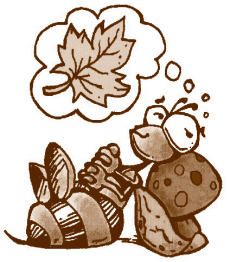


Figure 1. The nitrogen cycle explains the relationship of the element nitrogen to other elements, plants, animals, and bacteria.

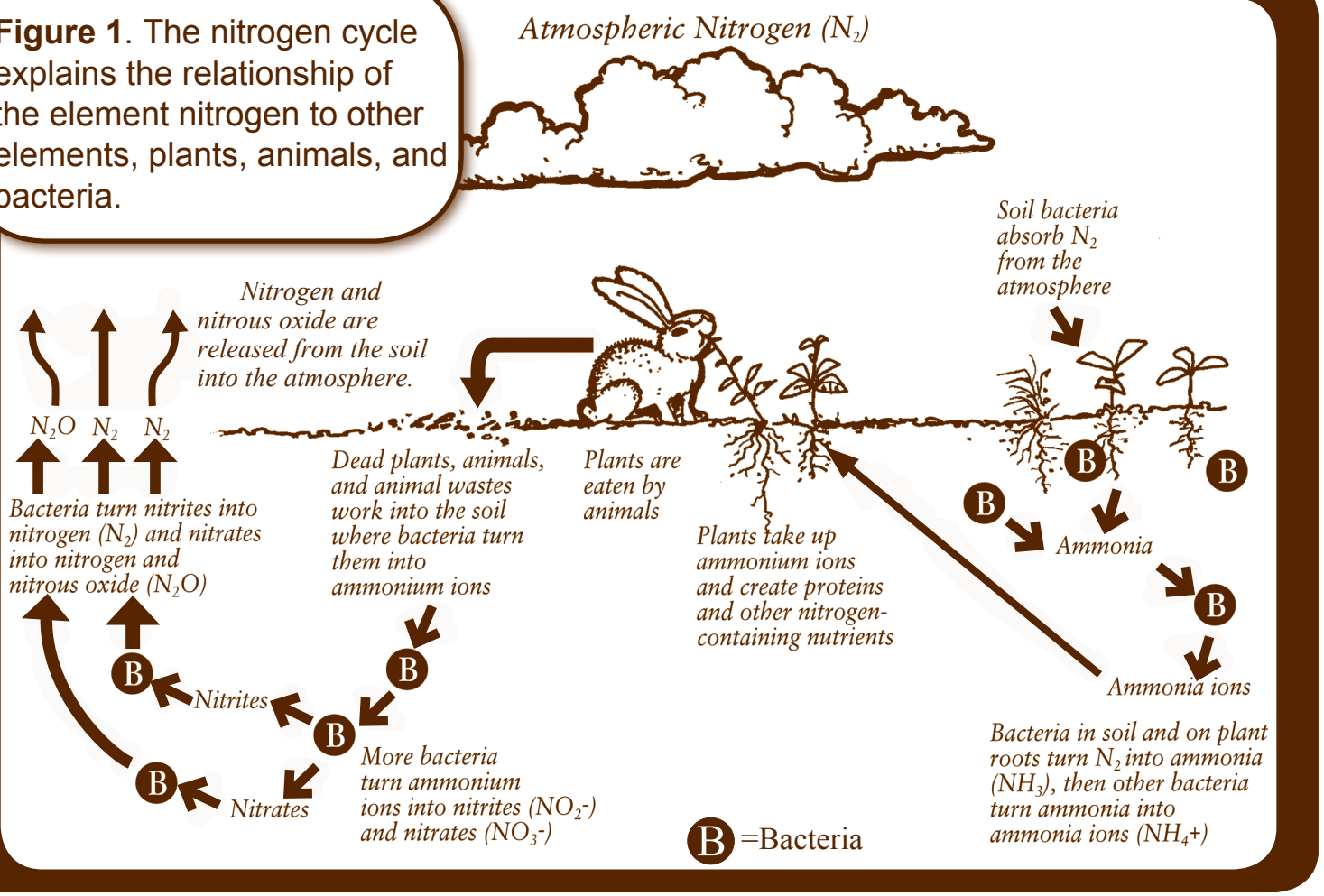


Illustration by Michelle Glenn.

Nitrogen in Our Environment

Did you know that nearly 80 percent of Earth's atmosphere is made up of nitrogen (N_2)? Nitrogen is found in many different forms all around us (figure 1). Plants and animals need nitrogen to grow and maintain their tissues. Even though 80 percent of Earth's atmosphere is made up of nitrogen, most of that nitrogen is in a gaseous form that plants and animals cannot use. The nitrogen needs to be changed into a more useable, solid form.

Certain types of plants and bacteria help change the nitrogen into a useable form. This process is called "nitrogen fixation." Plants that are not nitrogen fixers typically get their nitrogen from the soil. Other organisms have fixed the nitrogen these plants get from the soil. Humans need nitrogen, too. Humans get most of their nitrogen from food.

Another interesting fact about nitrogen is that it has two stable **isotopes,** ^{14}N and ^{15}N. Scientists can identify the different proportion of isotopes in living and once-living things. Identifying these different proportions helps scientists figure out the source and flow of nitrogen in a particular area. In this study, scientists wanted to know how much nitrogen in the soil was coming from salmon. Look at figure 1. How do you think salmon fit into the nitrogen cycle?

Introduction

Salmon-derived nutrients (SDN) come from lots of **spawning** salmon (figure 2). The nutrients are distributed through many different ways. Bears and other **piscivores** may carry the salmon to different locations. Additionally, SDN can be found during floods, through the breakdown of salmon **carcasses**, and in the urine and feces of piscivores (figures 3a and 3b). Scientists have found that these nutrients are helpful to water and land habitats that lack some of the nutrients.

The scientist in this study wanted to find out how the role of SDN may change in a certain type of landform. **Geomorphology** is the study of landforms and the processes that shape these landforms. In this study, the scientist wanted to examine the soil geomorphology of an area. Specifically, the scientist looked at how **alluvial soil** affected the role of SDN in the North Pacific coastal rainforests of southeast Alaska (figures 4 and 5).

Figure 2. Spawning salmon provide nutrients. Photo courtesy of U.S. Fish and Wildlife Service.

Figure 3a and 3b. A bear is a piscivore. Name one other piscivore.

Photos courtesy of Steve Hillebrand, U.S. Fish and Wildlife Service.

Figure 4. Alluvial soil forms from material that river water deposits onto floodplains.

Photo courtesy of Dr. David D'Amore.

Figure 5. Coastal temperate rainforests are cool and moist. The area studied by the scientist is a coastal temperate rainforest. Temperate rainforests lie between the tropical and polar regions of Earth.

Poster courtesy of Paul Kratter, http://www.paulkratter.com.

Reflection Section

In the form of a question, describe what the scientist wanted to learn.

Why are nutrients important?

Number Crunch

Earth's Climate Regions

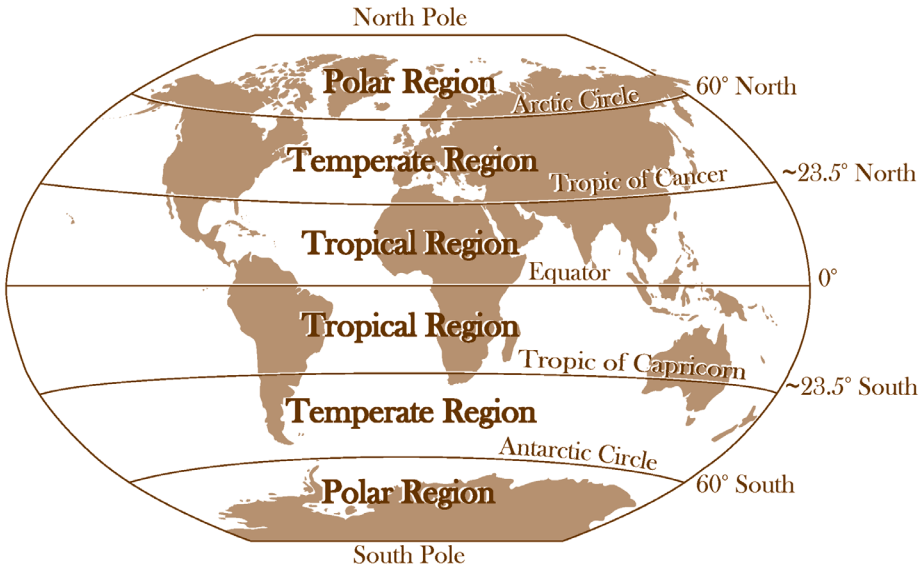


Illustration by Stephanie Pfeiffer.

What percentage of Earth is covered by the temperate region? Hint: Figure out how many degrees of latitude are in both temperate zones combined. Divide this amount by 180 degrees. You divide by 180 because the combined number of degrees latitude from the north pole to the south pole is 180. Degrees of latitude are imaginary lines around Earth used to identify the distance between the Equator and the poles.

Methods

The scientist chose seven **watersheds** on Prince of Wales Island. Prince of Wales Island is located in southeast Alaska and is a coastal temperate rainforest. Within these watersheds, the scientist chose eight study locations (figure 6). The scientist determined the locations by looking at the types of floodplain channels and alluvial soil maps. The study locations that the scientist sampled included two different soil series. The names of the soil series are Tonowek and Tuxekan (figure 7). A soil series is a way to classify individual soils that have similar characteristics.

To classify the soils found at each site, the scientist used shovel and **auger surveys** to identify the features of each soil (figures 8a, 8b, and 8c). The scientist took samples from the same place three times (figure 9). He then weighed and dried these samples. The scientist determined the amount of carbon and nitrogen in each sample by using a carbon and nitrogen analyzer (figure 10). The scientist also measured the amount of different nitrogen isotopes in different soils.

Reflection Section

As a class, look at a watershed map of your area. What watershed do you live in? Why do you think watersheds are important? (For more information on watersheds, check out these Web sites: http://cfpub.epa.gov/surf/locate/index.cfm and http://ga.water.usgs.gov/edu/watershed.html).

Why do you think the scientist took samples from the same area three times?

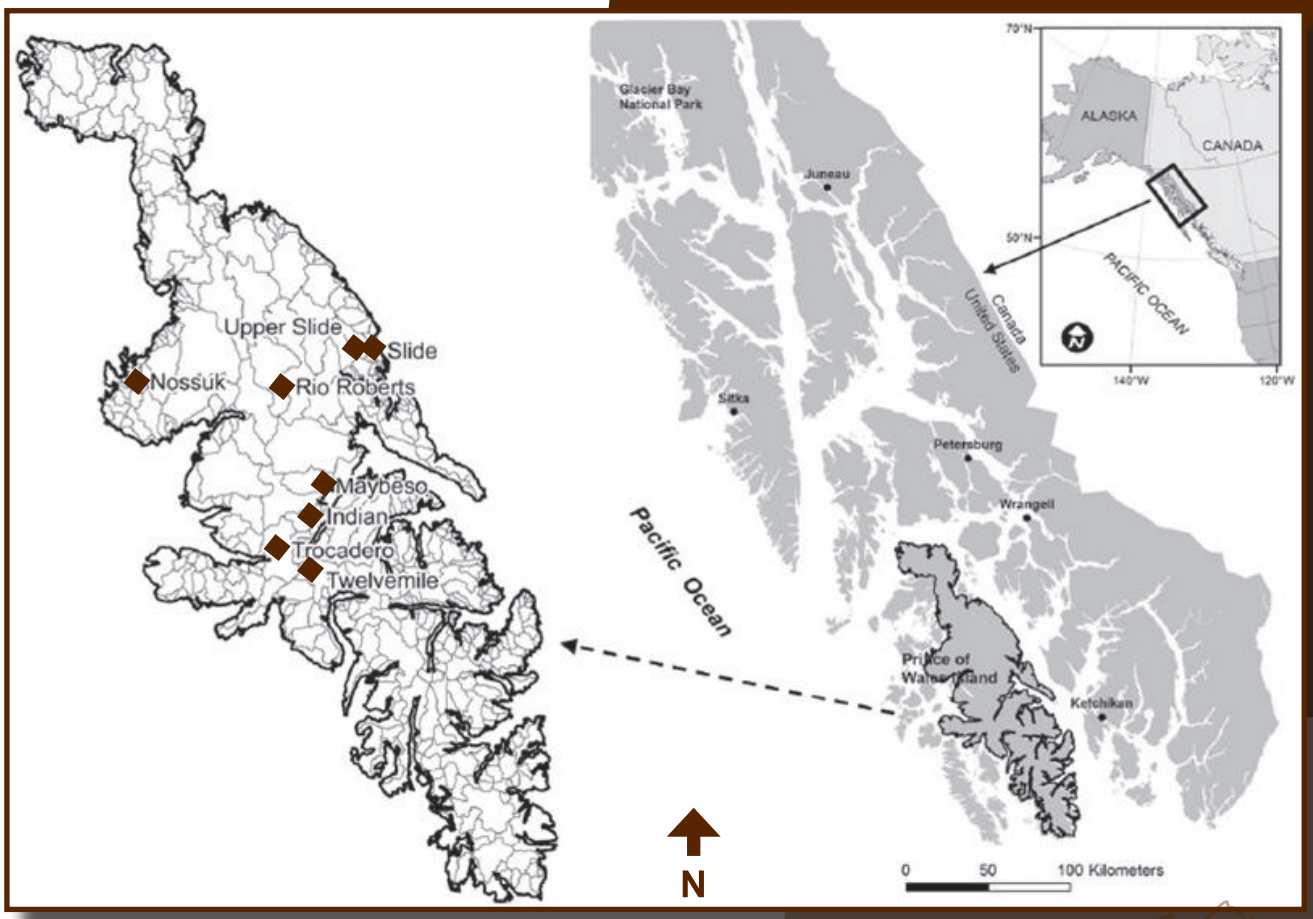


Figure 6. The study locations are labeled with names and designated by a diamond shape.

Figure 7.

Study Location	Soil Series Studied
12-mile	Tonowek and Tuxekan
Indian	Tonowek and Tuxekan
Maybeso	Tonowek and Tuxekan
Nossuk	Tonowek
Rio Roberts	Tonowek and Tuxekan
Slide	Tonowek
Trocadero	Tonowek
Upper Slide	Tonowek

Note: Where both Tonowek and Tuxekan are mentioned in the chart, it means that both soils were examined at the study location.

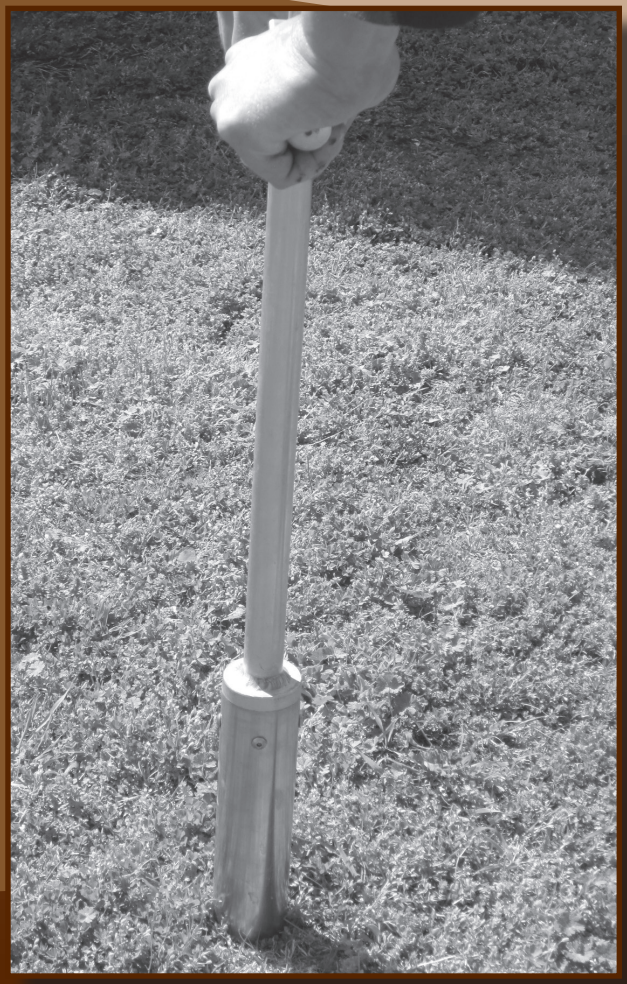
8a

Figure 8. An auger is commonly used to study soils because it enables scientists to take a deeper sample of the soil. Photos 8a and 8b are of a soil auger, also known as a bucket auger. Photo 8c shows a soil corer.

Photos courtesy of Jessica Nickelsen, with thanks to Dr. Mac Callaham, Forest Service.

8b

8c



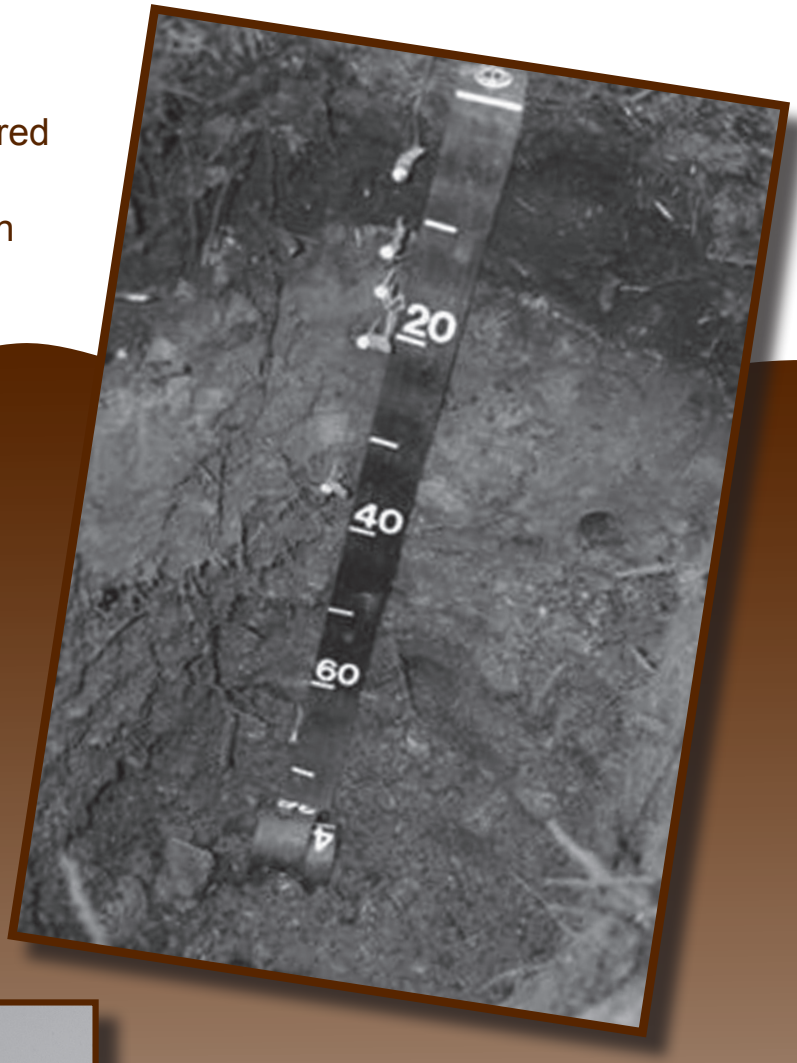


Figure 9. The scientist measured the depth of the soil using a flexible measuring tape at each location.

Photo courtesy of Dr. David D'Amore.

Figure 10. Carbon-nitrogen analyzers help scientists determine how much carbon and nitrogen are in a sample. The analyzer in this picture helps determine carbon, nitrogen, and hydrogen concentrations.

Courtesy of the University of Kentucky Center for Applied Energy Research (http://www.caer.uky.edu/).

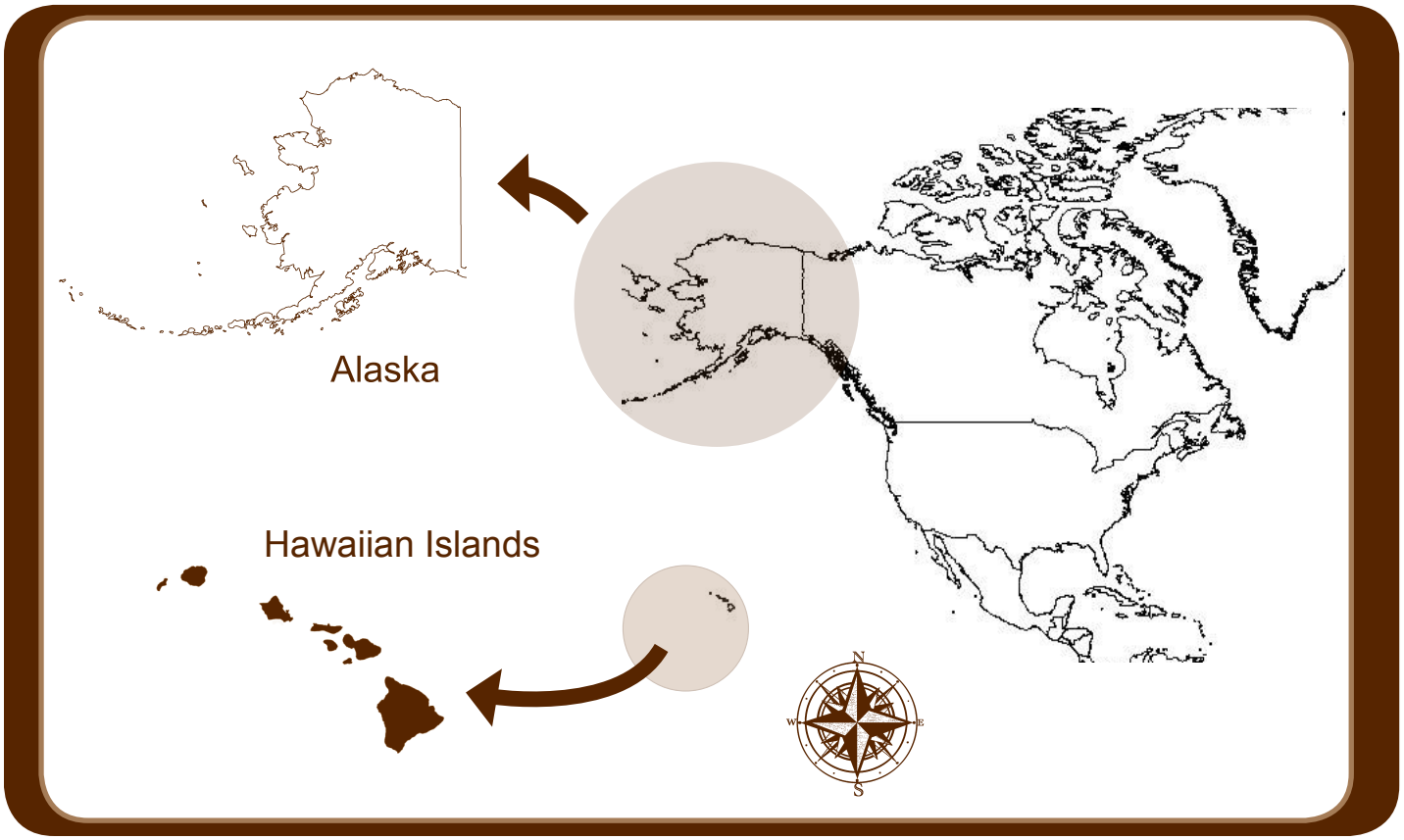
Does a Soil's Age Affect Its Nitrogen Content?

The Island of Hawai'i is the largest and the youngest of the Hawaiian Islands. Comprised of ash from four volcanoes, the soils on the Island of Hawai'i are relatively young when compared with **continental** soils. Hawai'i is about 400,000 years old. Scientists have found that soils on the Island of Hawai'i are low in nitrogen. These soils have had less time than continental soils to acquire nitrogen from plants and from the remains of dead plants and animals. (See figure 1 on page 9.)

The scientist in this study of southeastern Alaska was interested in the amount of nitrogen in the soil. Do you think the scientist would find more or less nitrogen in Alaskan soil than is present in soils on the Island of Hawai'i?

Because comparing the Alaskan soil to the Hawaiian soil was out of the scope of this scientist's study, we do not have an answer. Alaskan soils, however, are older than Hawaiian soils. So, logic would suggest that Alaskan soils are higher in nitrogen than soils on the Island of Hawai'i.

Pretend you are a scientist interested in this comparison. Write a research question that you might want to answer.



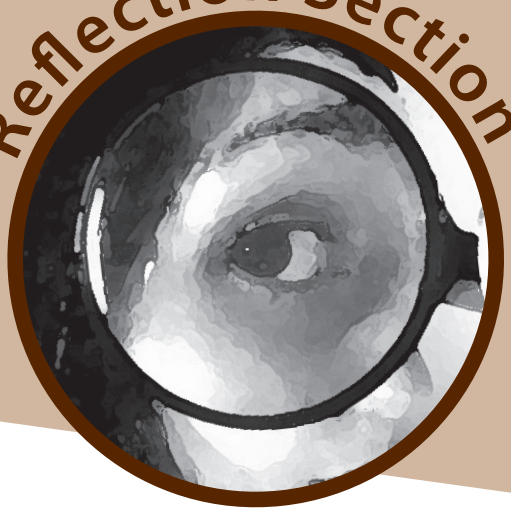
Findings

The scientist found the type of soil series can affect the amount of nutrients available. He found that carbon and nitrogen concentrations were higher in Tuxekan soils when compared with Tonowek soils. The scientist discovered that the Tonowek and Tuxekan soils are located very close to streams with a high degree of salmon spawning. The amount of nitrogen isotopes found in the two soil series varied depending on the depth of the soil sample taken.

In addition, the age of the soil affected the amount of nutrients present. The nutrient results were consistent with the ages of the soil. Tonowek soils are young and do not have a lot of **organic** material such as nitrogen. The Tuxekan soils are older and have more organic material from plants.

The amount of ^{15}N isotope in the Tonowek soils ranged from 1 to 4 parts per thousand, with a **mean** of 2.2 parts per thousand. Almost all of the Tuxekan soils had more than 4 parts per thousand of ^{15}N isotope, with a mean of 6.1 parts per thousand.

Reflection Section



Which soil had a higher concentration of nitrogen?

Why would you want to know the mean value of a range of numbers?

Discussion

The scientist found that different types of soils were related to the amount and form of nitrogen in the soil. This finding means that it is important for scientists to take into account the different soil types present when trying to estimate the effect of SDN. Now that the scientist knows it is important to include soil type in a study of SDN, he can create a better model to determine the importance of SDN in a particular area.

Reflection Section

If the scientist does not take into account the amount of nitrogen in the soil, what might happen to his estimate of how much nitrogen is available from SDN?

Imagine a forested area near your house or a forested area you have visited before. How do you think the nitrogen cycle applies to this area?

Glossary

alluvial soil (ə **lü** vē əl soi(ə)l): A fine-grained soil that tends to be fertile. It is typically deposited by water flowing over floodplains or in riverbeds.

auger survey (**o** gər **sər** vā): The examination or inspection of soil with a variety of tools made like a spiral or screw and used for boring holes or moving loose material.

carcass (**kär** kəs): The dead body of an animal or other once living thing.

continental (kän tə **nen** təl): Of, relating to, or characteristic of a continent.

geomorphology (**jē** ō mor **fä** lə jē): The study of landforms and the processes that shape these landforms.

isotope (**ī** sə tōp): Any of two or more species of atoms of a chemical element with the same atomic number and nearly identical chemical behavior but with differing atomic mass or mass number and different physical properties.

mean (mēn): The average in a set of numbers.

organic (or **ga** nik): Of, relating to, or derived from living organisms.

piscivore (**pī** sə vor): A fish-eating animal.

spawn (**spän**): To produce young especially in large numbers.

sustain (sə **stā**): Keeping up or prolonging life.

watershed (**wä** tər shed): A land area that delivers water and sediment to a major river via small streams.

Accented syllables are in **bold**. Marks are from http://merriam-webster.com.

Adapted from D'Amore, D. V., Bonzey, N.S., Berkowitz, J., Ruegg, Janine, and Bridgham, S. 2011. *Holocene soil-geomorphic surfaces influence the role of salmon-derived nutrients in coastal temperate rainforests of southeast Alaska.* Geomorphology 126: 377-386. http://www.treesearch.fs.fed.us/pubs/39654

The title "Food for the Soil" is derived from the saying, "Laughter is food for the soul." This saying means that laughter helps improve a person's mood and makes people feel better overall. To find out more about how laughter may improve health, check out http://www.umm.edu/news/releases/laughter2.htm.

If you are a Project Learning Tree-trained educator, you may use PLT Activity #70, Soil Stories, as an additional resource.

If you are a Project WILD-trained educator, you may use WILD Activity Eco-Enrichers as an additional resource.