Meet the Scientist!

Dr. Hugo Magaña,
fisheries biologist

My favorite science experiences are teaching about photosynthesis and studying food webs. In this photo, I was collecting algae from which I would later create pure diatom cultures. Diatoms are one-celled algae. I then created diatom pucks from those cultures. You will learn about diatoms and diatom pucks in this article!

What Kind of Scientist Did This Research?

fisheries biologist: This scientist studies fish living in the wild, including what they eat, their habitat, and how they interact with their environment.

Thinking About Science

Of all the talents needed by scientists, one of the most surprising is creativity. To solve problems and answer questions, scientists need to think in new ways. Albert Einstein once said, “I am enough the artist to draw freely upon my imagination. Imagination is more important than knowledge.” Einstein meant that to discover new things, we must use our imagination and our creativity.

In this research, you will read about a creative way to study fish. The scientist in this study used his imagination and technology to learn something new about a small minnow that lives in the Rio Grande. The Rio Grande is a river in the Southwestern United States.
Thinking About the Environment

The Rio Grande is a long river. The Rio Grande’s headwaters are in Colorado. The river runs through Colorado and New Mexico. The river leaves New Mexico and forms part of the United States boundary with Mexico in Texas (figure 1). In the past, the Rio Grande was a wide, shallow, meandering river (figure 2). In the 1940s, people began to change the river. They created dams to control floods (figure 3). People also dug channels to divert water from the river to their agricultural fields. The Rio Grande is different today than it was before the 1940s.

Figure 1. The Rio Grande flows from Colorado and eventually forms part of the United States boundary with Mexico.

Figure 2. Before the 1940s, the Rio Grande was a wide, shallow river with many bends. Photo by Chuck Murphy.

Figure 3. Dams were built on the Rio Grande to control floods. This is the Elephant Butte dam. Photo courtesy of the United States Bureau of Reclamation.
Because of the changes made to the Rio Grande since the 1940s, the river now provides a lower quality habitat for some fish and other aquatic animals. Some of the fish that thrived before the 1940s are not doing as well in the changed Rio Grande. One of these fish is the Rio Grande silvery minnow (*Hybognathus amarus*) (figure 4).

In the past, the silvery minnow was the most abundant fish in the river. Now, the silvery minnow is listed as endangered by the U.S. Fish and Wildlife Service. When a species is listed as endangered, it means its population may disappear in all or in many of the areas where it lives.

**Figure 4.** The Rio Grande silvery minnow is a small fish. An adult may reach 3.5 inches, or 8.89 centimeters. Is this illustration of the silvery minnow life-sized? How do you know? Illustration by Stephanie Pfeiffer.

**Introduction**

Many changes have occurred in the Rio Grande since the 1940s. (See “Thinking About the Environment.”) These changes created a river that is deeper and faster. This different habitat has created problems for the Rio Grande silvery minnow population. So few silvery minnows now live in the Rio Grande, the fish is in danger of becoming extinct.

**WHERE DO SILVERY MINNOWS LIVE AND WHAT DO THEY EAT?**

Silvery minnows prefer slow-moving water. These minnows are found in eddies. These eddies are formed by debris in the water and in shallow pools. In the summer, silvery minnows stay in shallow water that is less than 20 centimeters (7.9 inches) deep. In the winter, the minnows stay in water between 31 and 40 centimeters (12.2-15.75 inches) deep. Silvery minnows prefer to swim near the river bottom. The minnows prefer to swim there because they feed near the river bottom. Silvery minnows are covered with taste buds all along their underside, head, and mouth. These taste buds allow silvery minnows to detect food even when they cannot see in slow-moving, turbid water. Look at the photo of Dr. Magaña on page 28. He is standing in turbid water.

When water flow is slow, algae are the preferred food of the Rio Grande silvery minnow. Algae are aquatic plants that create their own food. Silvery minnows eat aquatic invertebrates during floods when the water is flowing quickly. Aquatic invertebrates are small animals, such as insects, crustaceans, mollusks, and worms, that live in water. Invertebrates do not have a backbone (figure 5).
Figure 5. Invertebrates are animals without a backbone. Are humans invertebrates? How do you know? Is the silvery minnow an invertebrate? Illustration by Stephanie Pfeiffer.

To rebuild the population of Rio Grande silvery minnows, biologists raise the minnows in fish hatcheries (figures 6a and 6b). Biologists feed the minnows in the hatcheries with food that is made in factories (figure 7). This food is unlike the minnows’ natural food. When the minnows are released into the Rio Grande, 95 percent of them starve or are eaten by other animals. Some scientists believe that the minnows starve because they do not recognize their natural food sources.

Figure 6a. Rainbow trout raised in a North Carolina fish hatchery. Photo by Babs McDonald.

Figure 6b. Fish hatcheries do not provide a natural environment for young fish. Photo by Babs McDonald.

Number Crunch

Before the 1940s, silvery minnows could be found in 3,862 kilometers (2,400 miles) of the Rio Grande. Today, silvery minnows are found in 280 kilometers (174 miles) of the Rio Grande. Write the distance today compared with the distance in the 1940s as a fraction.

Extension: In what percentage of their past habitat are silvery minnows found today?
The scientist in this study was interested in the natural diet of silvery minnows. Silvery minnows are mostly plant-eaters. Young silvery minnows eat algae. The type of algae they feed on is made up of diatoms.

**What are diatoms?**

Diatoms are one-celled algae that live in colonies (figure 8). A diatom’s cell wall is made of silica. Silica is used to make glass. When the diatom dies, its interior decays, leaving the skeleton of silica behind. Scientists investigate these skeletons to discover clues about past environmental conditions.

**Figure 7.** Emily Melear-Daniels feeds fish in a North Carolina fish hatchery. When fish are released into streams, they have to find their own food. Photo by Babs McDonald.

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**Figure 8.** *Nitzschia palea* is a species of diatom. This is an individual diatom. Individual diatoms cannot be seen without a microscope. Photo courtesy of Dr. Hugo Magaña.

The scientist thought that silvery minnows raised in fish hatcheries could be taught to recognize and eat natural food sources, such as diatoms. If silvery minnows could learn to recognize natural food sources while in hatcheries, fewer might die of starvation after their release into the Rio Grande. If fewer minnows die of starvation, the silvery minnow population might be saved from extinction.

The scientist wanted to answer this question: Can young silvery minnows be taught to recognize natural food sources such as diatoms?
State in your own words what problem the scientist was trying to solve.

Use your imagination to brainstorm ways that young silvery minnows might be taught to recognize their natural food sources.

Methods

The scientist used eight aquaria. (Aquaria is the plural form of aquarium.) Each aquarium held 37.85 liters (10 gallons) of water. Two of the aquaria were used for holding fish. Six of the aquaria were used for feeding trials. The scientist randomly selected young fish from the two aquaria. Then, the scientist placed 1 fish in each of the six aquaria until 10 fish were in each aquarium (figure 9).

Figure 9. The scientist used aquaria to do his experiment. You may have similar aquaria in your classroom or at home. Photo courtesy of Dr. Hugo Magaña.
The scientist grew diatom colonies in petri dishes (figures 10 and 11). In this case, a colony is like a community consisting of a large number of tiny organisms. As if using a cookie cutter, the scientist used a cylinder to remove part of the diatom colony from the petri dish. The resulting piece of the diatom colony looked like a hockey puck. The scientist, therefore, called the diatom colony pieces “pucks.”

The scientist placed 6 pucks each on 6 pieces of Plexiglass®. Each puck was the same distance apart. Each piece of Plexiglass® was placed into an aquarium holding the 10 young minnows. To observe the fish, the scientist videotaped each aquarium. The scientist could, therefore, view the video later and observe the fish (figure 12). The scientist timed the number of minutes it took young minnows to locate and sample diatoms from the pucks. This process was repeated six different times.

The scientist then waited between 5 and 17 days. During this time, he fed the young minnows regular aquarium flake food. He then repeated the process used before with the pucks. The purpose of this experiment was to determine whether young minnows that had previous experience would quickly recognize their natural food.
**Figure 12.** The scientist used video cameras to observe and record the feeding behavior of young minnows. The cameras were operated by Matt Julius, shown here. Photo courtesy of Dr. Hugo Magaña.

**Findings**

The scientist found that minnows not previously exposed to pucks took an average of 250 seconds to locate the pucks and sample the diatoms (figure 13). Minnows introduced previously to pucks took an average of 49 seconds to begin feeding. Some of the minnows began eating from the pucks within 4 seconds.

**Figure 13.** The minnows ate from the diatom pucks. Illustration by Stephanie Pfeiffer.
Based on the findings, what conclusion would you reach about minnows’ previous experience with finding and sampling natural food sources?

Do you think the timing difference between inexperienced and experienced minnows could be due to something other than previous experience? Why?

**Discussion**

This study’s purpose was to discover if young silvery minnows can learn to quickly recognize and feed on natural foods. If the minnows can learn, they may have a better chance of survival after being released into the Rio Grande. Some silvery minnows learned to locate natural food after just 30 seconds. Days to weeks later, they remembered what they learned. They quickly located the natural food and began eating.

The scientist observed that once the first minnow began eating, other minnows quickly joined. Another advantage of training minnows is that a trained minnow might be a role model for other minnows. If untrained minnows see a trained minnow sampling a natural food, the untrained minnows may also try the food.

The scientist believes that silvery minnows hatched and raised in fish hatcheries can be taught to identify natural foods. This teaching may help prevent the silvery minnow population from becoming extinct.

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**Number Crunches**

How many whole minutes are contained in 250 seconds?

How many minutes and seconds are in 250 seconds?
Is it important to save the silvery minnow population from becoming extinct? Why? Is it important to save any species from becoming extinct? Why?

The scientist observed that when other minnows saw one minnow eating, they quickly joined. Name one instance where you observed the same kind of behavior in humans. Your example does not have to be related to food, but to an observation of humans imitating or following others.


Glossary

abundant (a bun dənt): Marked by great plenty.
aquatic (ə kwä tik): Growing or living in or often found in water.
debis (də brē): The remains of something broken down or destroyed.
divert (də vərt): To turn from one course or use, to another.
eddy (e dē): A current of air or water running against the main current or in a circle.
endangered (in dān jər ed): Being in danger or peril.
extinct (ik stiŋ(k)t): No longer existing.
habitat (ha bə tat): The environment where a plant or animal naturally grows and lives.
hatchery (ha chə rē): A place for hatching eggs.
headwaters (hed wä tərz): The beginning and upper part of a stream or river.
meander (mē an dər): A turn or winding of a stream.
petri (pē trē): A small shallow dish with a loose cover used for cultures in science labs.
population (pä pyə lā shən): A group of one or more species of organisms living in a particular area or habitat.
randomly (ran dom lē): Selecting in such a way that each has an equal chance of being selected.
turbid (tər bəd): Clouded or discolored by the material from a liquid that settles to the bottom (sediment).

If you are a trained Project Learning Tree educator, you may use Activity 45: Web of Life or Activity 88: Life on the Edge.

Accented syllables are in bold. Marks and definitions are from http://www.merriam-webster.com.
FACTivity

Time needed:
One class period.

The question you will answer in this FACTivity is:
How are diatoms important parts of an ecosystem? As you learned in the “By the Light of the Silvery Minnow” article, diatoms are one-celled organisms that live in colonies. A diatom’s cell wall is made of silica. In this FACTivity, you will create your own model of a diatom.

Materials
• Bubble solution (purchased or create your own using 1 part dish soap to 10 parts water)
• Drinking straws (2 per student)
• Yarn, cut into 2-foot sections (1 piece per student)
• Tray with edges (to hold bubble solution)

The method you will use to answer this question is:

1. You will need two drinking straws and a piece of yarn approximately 2 feet long. You will thread your yarn through the drinking straws and tie it at the end to create a rectangular shaped diatom model (figure 14). Your teacher will slowly pour the bubble solution into the tray, about 1 centimeter in depth. Pouring slowly will prevent foaming.

2. Taking turns with other students, you will use your straw and string model to create a diatom. Hold one of the straws of the model and immerse it into the tray of bubble solution. Gently raise it out of the pan and allow the extra soap to drip off. Hold your diatom up so that you can see the light reflecting off the silica cell wall.
3. After all of your classmates have created a bubble diatom model, your teacher will hold a class discussion about diatoms as a life-form. Some facts you may discuss are:

   a. Diatoms are living aquatic organisms that use sunlight to turn carbon dioxide and water into food and oxygen.
   b. Diatoms live in both fresh and salt water, in rivers, lakes, and ponds. They can be found throughout the world in areas that are wet.
   c. Algae are made up of diatoms. The green algae on stones at the water’s edge are likely a population of millions of tiny diatoms.
   d. Diatoms are a basic, natural food source for many other animals, including silvery minnows.

4. Using the article and class discussion as a reference, answer the question posed at the beginning of this FACTivity. Compare your diatom model with figure 8. What are the similarities and differences?

**Figure 14:** The diatom model will look similar to this when it is completed. Illustration by Stephanie Pfeiffer.

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**Web Resources**

**Diatoms**

**How to Make a Diorama Fish Habitat**

**Student-based Monitoring Program of the Rio Grande in New Mexico (video)**
http://www.bosqueschool.org/bemp.aspx

**Fish and Wildlife Service-Southwest Region Fisheries Education**
http://www.fws.gov/southwest/fisheries/education.html

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“By the Light of the Silvery Minnow” was taken from a song title. The song is “By the Light of the Silvery Moon.” The song was written and first recorded in 1909 and was performed by Doris Day in 1953. The melody was also recorded by the Muppets in 2011.