Figure 5. Fish ladder on the Río Espíritu Santo. The fish ladder is on the far right, below the people. It looks like a ramp in this photo.

Reflection Section

- Although the scientists' suggestions may help protect the shrimp population and still allow people to use the stream water, some people may not want to follow the suggestions. Can you think of reasons why people may not want to follow these suggestions? (Hint: Everything costs money to build and take care of. Who would pay for the fish ladders?)

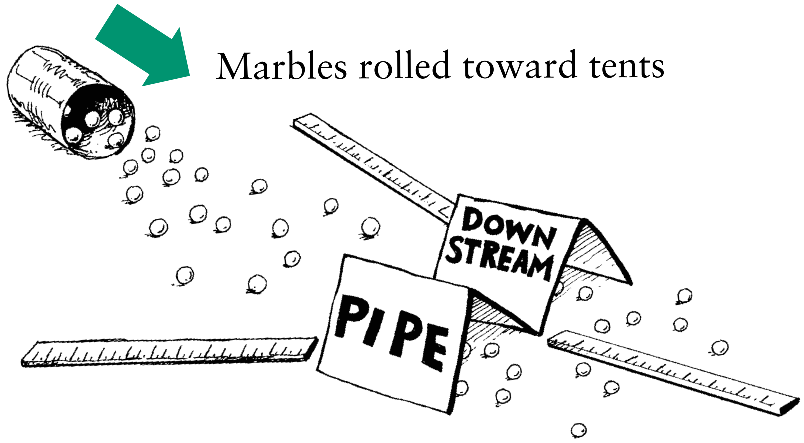
- Do you think that the scientists' suggestions are a good compromise between protecting the river shrimp and providing water for human use? Why or why not?

Discovery FACTivity

For this FACTivity, you will answer the question: What is the difference between having a 50 percent chance of having something happen, and having less or more than a 50 percent chance? You will use marbles to show how some river shrimp get caught in the pipes, and other shrimp are able to drift downstream. In the study you just read, each shrimp had just over a 40 percent chance of floating into the pipe, and almost a 60 percent chance of floating downstream (that means that if 10 shrimp were floating downstream, 4 would go into the pipe, and 6 would float downstream). Look again at Figure 4. Fortunately for the shrimp, each one had better than a 50 percent chance of drifting downstream.

In this FACTivity, each shrimp will have a 50 percent chance of floating into a pipe, and a 50 percent chance of floating downstream. Each station that you construct will *simulate* a stream with a pipe. You may make three or four identical stations, with six to eight students per station. For each station, you will need 3 yardsticks, 1 piece of 22- by 28-inch posterboard, 100 marbles, and a coffee can. Cut the posterboard along its width into two equal-sized pieces and fold each piece in half to make tents. Write "downstream" on one tent, and "pipe" on the other. Place the tents side by side, and lay one yardstick on each side of the tents. Place the third yardstick between the tents, at the back (see diagram on page 12).

Three students will be stationed behind the tents. One student will catch and count the marbles coming through one tent, the other will catch and count the marbles coming through the other tent. A third student will record the number of marbles coming through each tent. You may use the chart below as an example to record your observations. Place the 100 marbles (simulating 100 shrimp) in the coffee can. Another student, standing about 6 feet (or 2 meters) back, will gently roll the marbles toward the tents. The student should aim for the center of the tents. Do not roll them too hard—remember, they are shrimp floating downstream! The students behind the tents should catch and record the number of shrimp floating "downstream" and the number floating into the "pipe." The shrimp that floated into the pipe will die. The shrimp that floated downstream should be taken back upstream and rolled toward



the tents again. Every time you roll the marbles, the marbles represent the offspring of the shrimp that successfully returned upstream to reproduce. Continue to roll the marbles until all of the shrimp have died (rolled into the pipe). Now that you have made and recorded your observations, you will need to *analyze* them. Calculate the percentage of shrimp going into the pipe each time. How many times does it take for all of the shrimp to drift into the pipe? Now calculate the average percentage going through the pipe by adding the numbers in second column and dividing them by the number of rolls. This tells you the overall average percentage of shrimp drifting through the pipe.

Record the average percentage of your shrimp drifting through the pipe. Compare your percentage to the percentage that the scientists found in their study (42 percent). Why do you think your percentage is different than 42 percent? What is different about your experiment and the stream's flow? If you rolled your marbles straight down the middle, your overall percentage should have been close to 50 percent. Was it? If not, what may have caused your percentage to be different? Why do you think each shrimp in the Rio Spiritu Santo had better than a 50 percent chance of drifting past the pipe?

Sample form for recording your observations. Begin with 100 marbles

	# through pipe	% through pipe	# floating downstream	% floating downstream
1st roll	32 (for example)	32 or .32	68	68 or .68
2nd roll	Begin with 68 marbles – Record #	# through pipe divided by 68	Subtract number through pipe from 68	Divide # floating downstream by 68
3rd roll	Begin with # floating downstream			
4th roll				
5th roll				
6th roll				
7th roll				
8th roll				
9th roll				
10th roll				

From Benstead, Jonathan P., March, James G., Pringle, Catherine M. and Scatena, Frederick N. (1999). Effects of a low-head dam and water abstraction on migratory tropical stream biota. *Ecological Applications*, 9(2): 656-668.