

# SAVING ENDANGERED FISH With Binary Code

Ben and Hannah are researchers at Utah State University who use binary patterns and special electronic equipment to tag and track endangered fish. The fish that he studies are the razorback sucker and the Colorado pikeminnow. These two fish species are native to the San Juan River in the tribal lands of the Navajo nation and cannot be found anywhere else in the world. These fish are **endangered**, which means they are at risk of extinction.



**Ben Stout**  
PhD Ecology, Utah State University



**Hannah Moore**  
M.S. Ecology, Utah State University



*The razorback sucker is an endangered species of fish that is native to the deserts of the Colorado River Basin. This fish does not live anywhere else in the world.*



*The Colorado pikeminnow is an endangered species of fish that is native to the deserts of the Colorado River Basin. This fish does not live anywhere else in the world.*



## The Razorback Sucker

The razorback sucker can grow up to 3 feet in length and weigh up to 13 pounds. These fish are known to live for over 40 years. They lay sticky eggs that attach to gravel on the bottom of the river. They can see ultraviolet light, and they send warning signals to other razorbacks intruding into their territory using ultraviolet colors that we cannot see. Razorback suckers used to inhabit much of the Colorado River Basin but commercial fishing, river damming, habitat loss and predation by nonnative fishes have caused great declines in their populations. It is a critically endangered fish and has been federally protected since 1991.



*The razorback sucker was once found throughout Arizona, California, Colorado, Nevada and New Mexico. Now it is only found in the Colorado River upstream of the Grand Canyon and in Lake Mead, Lake Mohave, Lake Havasu and Lake Powell.*



## The Colorado Pikeminnow

The Colorado pikeminnow can grow up to 6 feet in length and weigh up to 100 pounds. Before laying its eggs, a pikeminnow migrates up to 100 km upstream because young pikeminnow babies can't fight currents. After hatching, the babies drift 100 km back downstream, feeding mostly on insects before they are strong enough to navigate the rivers they live in. When the young fish grow big enough, they become predators and feed exclusively on other fish. Pikeminnow populations have been in decline due to commercial fishing, river damming, habitat loss and predation by nonnative fishes. They were added to the endangered species list in 1967.



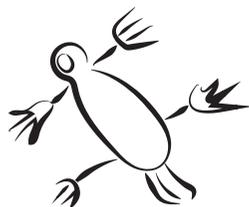
*The Pikeminnow species was once found throughout Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming, as well as in Mexico. Now it is only found in the Colorado River Basin.*





## Invasive fish can harm native fish

One of the biggest threats to the razorback sucker and the Colorado pikeminnow are other invasive species of fish. An **invasive species** is a species that is artificially introduced to an ecosystem. Many years ago, non-native trout and bass were introduced into the rivers of the Colorado River Basin for sport fishing. Trout and bass are easy to raise and stock in rivers for sport fisherman to catch for fun. People did not realize that introducing new species of fish into the rivers would harm the native fish populations. Because the native fish evolved without competition from other types of predatory fish, their natural behaviors make them easy targets for the aggressive bass and trout. Bass and trout gobble up all the eggs that any pikeminnow and razorback sucker lay. River damming, fishing and habitat loss also threaten the razorback sucker and the Colorado pikeminnow.



## Ancient people lived with the native fish

For thousands of years, the razorback sucker and the pikeminnow have existed at the top of the food chain in the rivers they live in. These are the fish that the ancient Anasazi, and later the Native American Indians would have seen in their rivers. Ancient dwellings, ruins and pottery fragments can still be found on the banks of the river that these fish live in. Introducing invasive species of sport fish to the river was a grave mistake. Now we must protect the razorback sucker and the pikeminnow from extinction. Researchers like Ben and Hannah have been making progress in monitoring and protecting these fish.



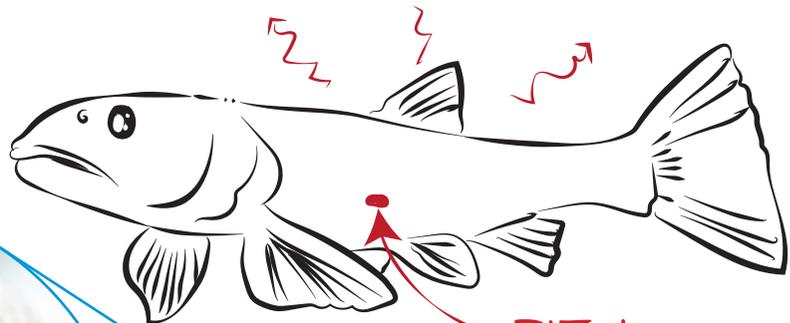
*Ancient people lived in harmony with the pikeminnow and the razorback sucker. In modern times we have hurt the populations of these fish and now we must find ways to protect them.*



## The fish are tagged using binary code

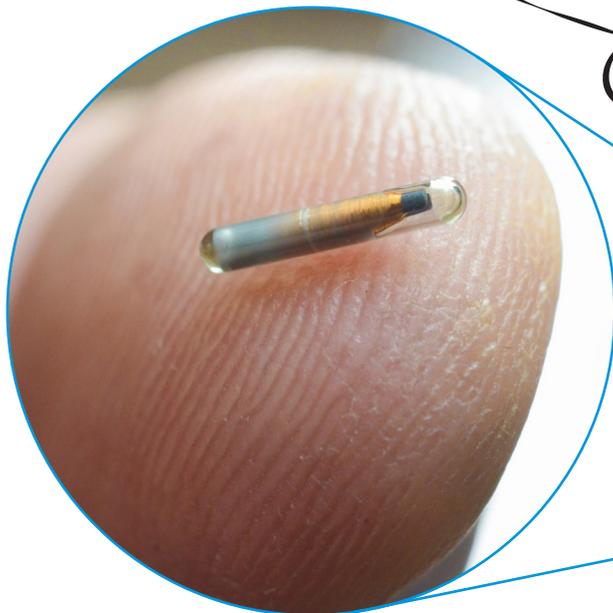
To help an endangered species of fish, it is important to understand how the fish live and what their habits are. Researchers and the department of fish and wildlife track and study the habits and movements of the fish. To do this, they catch and tag the fish with radio tags called pit tags. When a fish is caught, a tag is inserted into the belly of the fish and remains there for the rest of the fish's life. The tag does not harm the fish. The tag allows researchers to find the fish in the future. The tiny tags are made using a scannable magnetic binary pattern. This magnetic sequence is contained in a glass bead the size of a grain of rice. Each tag contains an eight-digit binary pattern that can be used to detect and identify each individual fish in the future.

*A PIT tag is used to identify the fish during its entire life.*



**PIT tag**

*The tag is inserted into the belly of the fish.*

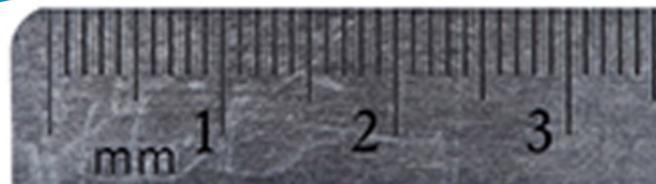


*Each pit tag is about the size of a rice grain.*

*Each pit tag contains a scannable binary pattern made from magnetic and nonmagnetic spaces that represent 1's and 0's.*



**1 0 0 0 1 1 0 1** *This unique number is used to identify the fish.*



## Antennae on research rafts detect the fish

Ben teams up with other ecologists to raft the San Juan river frequently. They have special rafts that are equipped with large antennae that can detect the pit tag of any fish that they float over. Can you see the large blue pad floating in front of this research raft? The blue pad contains the antennae that detect the fish. Every time the raft floats over a tagged fish it makes a ping sound and records the fish's location. With the data collected, Ben can learn how far the fish migrate so we can better know how to protect them. The ecologists also watch to see if farm-raised fish introduced into the river as part of a recovery program are able to survive.



*The large blue pad is an antenna that can detect tagged fish. By rafting the river over and over they can watch how fish move and migrate during different times of the year.*

### Disciplinary Core Ideas

#### PS4.C: Information Technologies and Instrumentation

"Digitized information can be transmitted ... by high-tech devices, such as computers or cell phones. These devices can receive and decode information, or convert it from digitized form to a usable form for people."

*The sophisticated, waterproof antenna mounted to Ben's raft and the computer in the raft box is an example of a high-tech device that senses and decodes information to convert it from a magnetic binary pattern to digital information stored in the memory of his computer.*