Student monitors fish movement using ear bone

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LAS CRUCES - An entire life history spills details from a metabolic standpoint, water temperature and the locations of fish at a given age can be determined from information on a shard of ear bone smaller than a grain of rice.

New Mexico State University graduate student Nathan Chase conducted research using otolith microchemistry to determine movements of two species of fish native to the Pecos River.

"Essentially what I'm doing is tracking fish movements using otoliths, which are the inner ear bones of the fish," Chase said. "As the fish grows, new layers are deposited on the outside edge of the otolith, growing much like tree rings."

His presentation at the annual meeting of the student chapters of the American Fisheries Society and The Wildlife Society in Pinetop, Ariz., took first fisheries presentation.

In a 15-minute exhibition, Chase explained to the audience how he determined the age of the fish and learned about their movements from isotopic shifts seen in data collected from the otoliths.

By first analyzing the bedrock geology, Chase learns how the rock types contribute to the patterns of strontium isotope ratios in the water. The isotopes are taken in via the gills and eventually revealed on the otolith, exposing a detailed account of where the fish resided and where it moved depending on the varying isotopic shifts.

In an area Chase refers to as the "Highway 70 site," isotopic mixing occurs, showing a difference between upstream and downstream water chemistry.

"The way I look at those otoliths, it's like a biological black box," Chase said. "Similar to an aircraft, except what otoliths are recording is water chemistry throughout the life of the fish." Plaines Killifish are a species that prefer low velocity water and can tolerate a wide range of habitat conditions.

Researchers assume these fish may not move large distances and were used to characterize river water chemistry. Pecos Bluntnose Shiner are a pelagic broadcast spawning species whereby males release semi-buoyant non-adhesive eggs that passively drift downstream while developing. Spawning is cued by high flow events in the river historically and now to large-scale block releases from Fort Sumner Dam, which may make eggs drift much farther downstream than they used to.

"We didn't know very much about fish movements after they grew post-hatch, but we thought they must swim upstream to offset downstream drift as young," Chase said.

Both are relatively small-bodied fish, but they utilize the river in very different ways.

Online: Watch a video interview with NMSU graduate student Nathan Chase on his research using the ear bone of fish by reading this story at LSUN-NEWS.com.

Pecos Bluntnose Shiner are solely found between Fort Sumner and Brantley Reservoirs near Roswell, which is just a fraction of their historic range.

"We don't really know how far they can swim back upstream or if that's really the strategy they use," says Chase.

In November 2013, he collected about 150 fish from a range of sites along the river. Using lethal sampling, Chase opens the brain case to expose the sagittal otolith. Once all remaining tissue is removed in the lab, the bones are sanded down to reveal the core.

Chase lines up 24-30 on a slide using equipment from University of California, Davis/Interdisciplinary Center for Plasma Mass Spectrometry. There, he is able to run the laser across the face of the otolith to generate line scan profiles for the life of the fish. Pairing and overlaying the growth bands with the data collected on the movement, Chase can see where a particular fish was during a certain time in its life.

"It's cool to see the other side of the life history of the fish," Chase said.

The data shows upstream movements of about 56 kilometers from the U.S. 70 site to the highest site. If fish move from below the U.S. 70 site to one of the higher sites, Chase can tell how far it has gone because of the capture site and distance.

Data showed three isotopically unique areas (above U.S. 70, at U.S. 70 and U.S. Highway 70) to the Pecos River, where the U.S. 70 site was considered a mixing zone for water chemistry. Springs coming up from a Permeable salt deposit influence water chemistry around U.S. 70.

Essentially, bedrock geology drives water chemistry values observed in the river. The bedrock water is flowing through influences water chemistry and more specifically strontium. Older rock that has had more time for rubidium-87 to radio genetically decay into strontium-87 and rock types that contain more rubidium tend to have higher strontium-87 to strontium-86 ratio values.

Otoliths readily take in strontium in place of calcium, which makes up the calcium-carbonate matrix of the otolith in fish.

"I'm essentially tracking fish movements with geology, since otoliths record ambient water chemistry throughout the life of the fish," Chase said.

Chase grew up in Pinetop, Ariz., and graduated as Northland Pioneer College's 2009 Outstanding Associate of Science graduate. He has plans of becoming a fish biologist.