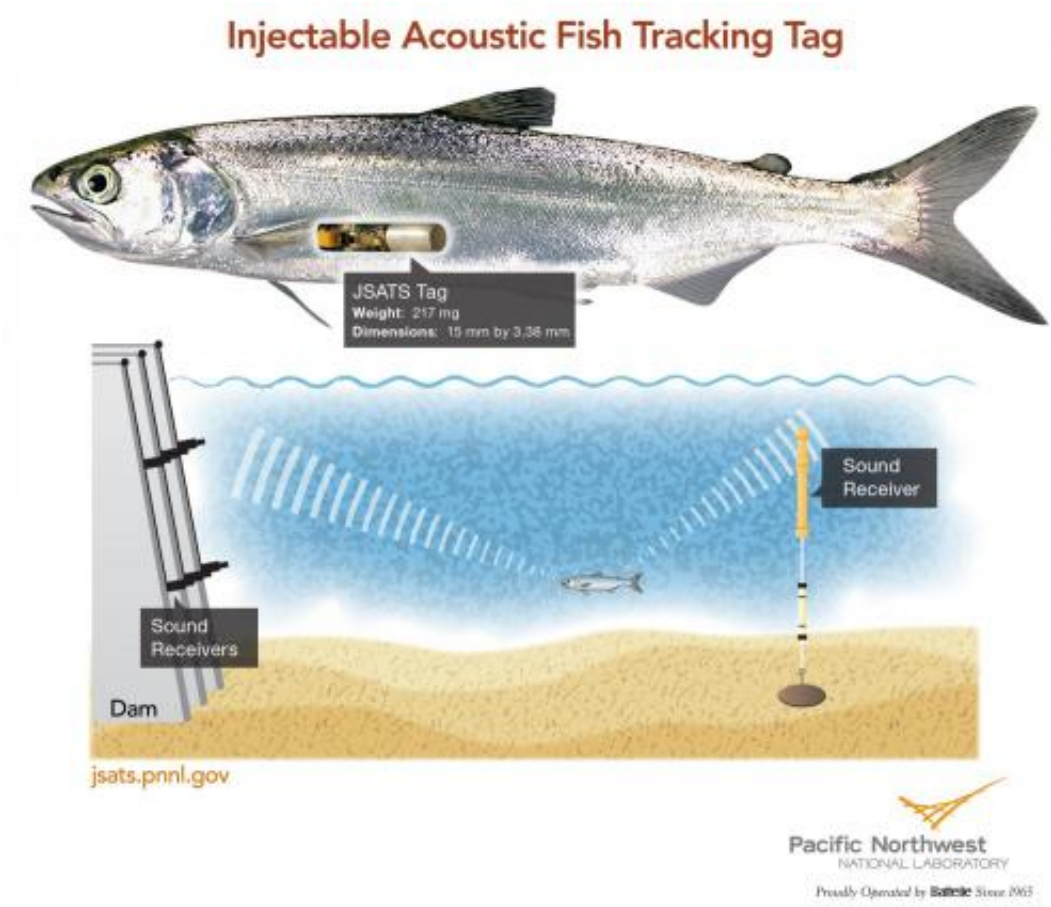
Tracking fish easier, quicker, safer with new injectable device

January 29 2015



Pacific Northwest National Laboratory's new injectable acoustic fish-tracking tag is so small it can be inserted into a fish with a syringe. The new tag is three times lighter than earlier versions, making it safer for fish and able to more accurately record fish passage through dams. Credit: PNNL

Fish no longer need to go under the knife to help researchers understand exactly how they swim through hydroelectric dams, thanks to a new injectable tracking device described in the journal *Scientific Reports*.

The new injectable acoustic fish tag allows researchers to safely and quickly insert the small device into young fish with a syringe similar to those used to treat humans. Injecting the tag, instead of surgically inserting it as earlier versions required, is less invasive and enables fish to heal faster, which can also provide more reliable information about fish behavior.

"Our new tag essentially allows fish to undergo a quick outpatient procedure," said Zhiqun "Daniel" Deng, a scientist at the Department of Energy's Pacific Northwest National Laboratory. "Tags have been used to track and evaluate fish movement for decades, but this is the first acoustic transmitter that can be inserted with a simple needle injection."

Salmon sound system

PNNL began developing its Juvenile Salmon Acoustic Telemetry System, also known as JSATS, in 2001 at the request of the U.S. Army Corps of Engineers, which operates dams in the Pacific Northwest. That system - which includes tags, sound receivers and software - was initially designed to provide a more accurate picture of how young salmon migrate from their birthplace in Columbia River Basin waters to the open Pacific Ocean. The system's use has since expanded to other fish species, for a variety of waterpower structures, and beyond the Northwest, including in California, Australia and Brazil.

Tags release quiet beeps that are picked up by receivers placed in rivers, lakes and other water bodies as tagged fish swim by. Receiver data helps researchers map out the precise 3-D location of each fish and determine if fish are injured during their travels. That information can help make

dams more fish-friendly by revising their operations or altering their physical structure. Hundreds of thousands of young fish have been studied with JSATS tags over the years.

Though the earlier JSATS tag provided a very detailed picture of fish migration, researchers worried that the mere presence of their tag - which was about three times heavier in 2007 than today's injectable tag - could alter fish behavior and make tag-gathered data less reliable for small fish. The earlier tags were also large enough to require surgery, with technicians creating a small incision into each anesthetized fish, manually inserting tags and hand-stitching incisions closed. Studies showed surgically tagged fish might not behave the same as untagged fish if the ratio of the tag weight to fish weight is too big. As a result, PNNL staff worked to make a progressively smaller and lighter tag, with the eventual goal of being able to inject their tag with a syringe.

"Minimizing the impact dams have on fish requires us to study and understand how changes at dams affect their behavior and survival. A critical assumption of any research is that the animals being studied represent their entire population," said M. Brad Eppard, a fisheries biologist with the Portland District of the U.S. Army Corps of Engineers and a co-author on the paper. "The new injectable tag helps us ensure the individual fish we study represent the fish in the Federal Columbia River Power System by allowing smaller-sized fish to be tagged."

Tricked-out tags

PNNL's new injectable tag is about as big as two grains of rice placed next to each other lengthwise. It weighs just 217 milligrams when dry, is 15 millimeters long and 3.38 millimeters in diameter. Half of the cylindrical tag contains a tiny 3-volt battery. The other half consists of a miniature circuit board and a transducer, which makes the tag's beeping noise. New features include the addition of a temperature sensor and the

ability to adjust sound levels, release two unique tracking codes alternatively, and program the tag to be silent for a pre-determined amount of time.

The injectable tag can intermittently beep as often as every 0.4 seconds, or less frequently, depending on a study's particular needs. Thanks to the new tag's powerful battery, lab tests showed the tag can release sound for an average of 120 days when beeps are sent every three seconds. In comparison, PNNL's previous tag only lasted 23 days under the same conditions.

Inserting the new tag into fish also takes substantially less time than the previous version. Injecting the tag with a syringe takes just 20 seconds, while the old tag's surgery required at least two minutes. The shorter period reduces the cost of fish-tagging studies, as the manual labor of handling fish and inserting tags is the most expensive part of these studies.

Fishing for the right size

During the summer of 2013, about 700 juvenile salmon implanted with the injectable tag were released in the Snake River in Washington state. Initial results indicated survival was higher in fish carrying the injectable tag than those with the older tag. Research is ongoing to fully evaluate how the tags affect fish and to determine the smallest fish that is suitable for safe injectable tagging.

PNNL intends to transfer the new injectable tag to a commercial vendor that will independently manufacture and sell it. Discussions are ongoing with several companies that have expressed interest in licensing the technology.

Deng and his team are continually working to improve their fish tag. An

even smaller tag is being developed for juvenile eels and lamprey, and a longer-lasting tag was made for sturgeon last year.

More information: Z.D. Deng, T.J. Carlson, H. Li, J. Xiao, M.J. Myjak, J.Lu, J.J. Martinez, C.M. Woodley, M.A. Weiland, M.B. Eppard, "An injectable acoustic transmitter for juvenile salmon," *Scientific Reports*, Jan. 29, 2015, DOI: 10.1038/srep08111

Provided by Pacific Northwest National Laboratory