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PNNL-29192

Tagging a smaller size class of fish: can it be done?

September 2019

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U.S. DEPARTMENT OF ENERGY

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Introduction.

There is a new acoustic tag that is smaller than any other acoustic tags on the market and can be used for implantation in and active monitoring of smaller fish. It is called the Eel-Lamprey Acoustic Tag (ELAT; 11.4 mm in length, weighing 0.088 g). Developed by researchers at Pacific Northwest National Laboratory (PNNL), the ELAT has the potential to be implanted into very small fish (possibly 30–95 mm in fork length [FL]). This would allow researchers to tag a smaller size class of fish compared to the existing size guidelines for acoustic tags presently available on the market. The smallest commercially available tag is 15 mm in length, weighing 0.216 g.

The current minimum size guideline for implanting fish with an acoustic tag is 95 mm FL. However, this does not accurately represent the entire size range of fish in survival studies, as smaller fish (< 95 mm FL) usually comprise a large proportion of the size classes of fish that migrate from the river. When only larger fish are tagged in survival studies, survival results are biased towards the larger size classes of fish and may not be representative of the entire population. Biased survival estimates are particularly concerning for species listed as threatened or endangered under the Endangered Species Act (ESA), and for species that encounter dams or other structures impeding their movement. As regulations are becoming more protective of ESA-listed species, many of which are also migrating species, additional telemetry studies are warranted. Furthermore, there is a need for a smaller acoustic tag that allows researchers to study small fish (< 95 mm FL) to minimize potential bias. Although developed for eels and lamprey, the new ELAT is smaller than other acoustic tags and has the potential to be used in juvenile salmonids. However, we cannot confidently utilize results from ELAT-implanted salmonids in the field until biological testing is performed in a laboratory setting to understand behavioral effects of the ELAT and to identify a minimum size threshold.

We performed two studies to evaluate the effects of the ELAT in small juvenile Chinook Salmon (an ESA-listed species; 36–99 mm FL). The first was a survival, ELAT retention, and growth study and the second was a swimming performance study. Both studies were performed at 12 °C and 17 °C to represent out-migrating fish in the Willamette River basin (OR), and the Columbia and Snake river basins (OR and WA), respectively. Our goal was to identify a minimum size threshold for Chinook Salmon that can be implanted with an ELAT where survival, ELAT retention, growth, and swimming performance would not be affected compared to an untagged population.

Survival, Retention, and Growth Study.

We tagged a total of 519 fish and held them for 50 days to evaluate survival, ELAT retention, and growth of tagged (ELAT-implanted) treatment fish compared to untagged (control) treatment fish. The battery life of the existing ELAT is 30 days. The next version of the ELAT—currently being developed by PNNL—will be the same size and weight as the existing version but will last for 50 days with a new battery. All fish ranged from 36–99 mm FL (0.3–9.9 g in weight) and were generally distributed equally within the size range, treatments, and temperatures. No fish ≥ 58 mm FL died or expelled their ELAT.

There were no significant differences in survival (i.e., fish that survived and retained their ELAT) among the two temperatures, therefore we combined these data for a more robust analysis. We estimated minimum size thresholds at three survival rates (90%, 95%, and 99%)

for FL, weight, and tag burden (i.e., the weight of the tag relative to the weight of the fish), to accommodate a variety of potential study objectives (Table 1). The survival, retention, and growth study successfully demonstrated that **we can tag a smaller size class of fish**. For **95% survival**, the minimum size threshold would be **55 mm FL**.

Table 1. Minimum size thresholds and 95% confidence intervals for three variables and three corresponding survival rates (i.e., fish that survived and retained their ELAT) of juvenile Chinook Salmon implanted with an ELAT.

Variable	Survival rate	Size threshold	Confidence interval (95%)
Fork length	90%	52.4 mm	50.1–56.5 mm
	95%	54.7 mm	51.9–59.7 mm
	99%	59.6 mm	55.7–66.8 mm
Weight	90%	1.5 g	1.3–1.9 g
	95%	1.6 g	1.4–2.1 g
	99%	2.0 g	1.7–2.8 g
Tag burden	90%	6.8%	5.2–7.9%
	95%	5.4%	3.4–6.7%
	99%	2.3%	0.7–4.1%

Swimming Performance Study.

We tagged a total of 241 fish to evaluate swimming performance of fish in the tagged treatment compared to fish in the untagged treatment. Swimming performance was measured by timing how long a fish could sustain its maximum swimming speed. Fish in this study ranged from 40–99 mm FL (0.5–11.7 g in weight) and were generally distributed equally within the size range, treatments, and temperatures. Tagged fish < 40 mm FL did not survive during the survival, retention, and growth study; therefore, we did not include fish < 40 mm FL in the swimming performance study.

Similar to the first study, no significant differences among the two temperatures were observed and data for both temperatures were combined. For the swimming performance study, we estimated the **minimum size threshold** for tagged fish to be 50.6 mm FL, or **51 mm FL** for practical use. The corresponding weight and tag burden ranges for fish 50–51 mm FL were 1.2–1.4 g, and 6.2–7.3%, respectively. This minimum size threshold most closely aligns with a 90% survival rate from the survival, retention, and growth study. The swimming performance study also successfully demonstrated **we can tag a smaller size class of fish**.

Conclusions.

The purpose of this LDRD was to answer the question, 'Tagging a smaller size class of fish: can it be done?'. To answer this question, we performed two laboratory studies using the new ELAT. Our goal was to identify a minimum size threshold for Chinook Salmon that can be implanted with an ELAT where survival, ELAT retention, growth, and swimming performance would not be affected compared to an untagged population. We found that we can successfully tag a smaller size class of fish with the ELAT. Specifically, if a study objective was to require **95% survival** (i.e., fish that survive and retain their ELAT) with **no impairment to growth or swimming performance** (compared to an untagged population), the **recommended minimum tagging size is 55 mm FL**. This is a 42% decrease in length compared to the existing tagging

guidelines for the smallest commercially available acoustic tag (55 mm compared to 95 mm FL). The next steps of this study include publishing our results in a peer-reviewed journal to broadly communicate to the scientific community that the new ELAT could have profound impacts on the long-term recovery of ESA-listed salmonids.

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