Listening to data could be the best way to track salmon migration

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Sound could be the key to understanding ecological data: in a new study in *Heliyon*, researchers have turned chemical data that shows salmon migration patterns into sound, helping people hear when they move towards the ocean from one river to another. The approach - called sonification - enables even untrained listeners to interpret large amounts of complex data, providing an easier way to interpret "big data."

The authors, from the University of Idaho, Eastern Washington University and University of Virginia in the US, and the University of Tampere in Finland, say turning salmon migration data into sound could help scientists feel less overwhelmed by interpreting big data. As a result, they may be more engaged with the experience, leading them to spend more time exploring big data in a meaningful way.

"We have shown that it is possible to convey salmon movement using sound alone, and that people without prior training can intuitively determine when fish transition from one river to another," said Dr. Jens Hegg, first author of the study from the University of Idaho. "Our study is the first step in creating this sort of audio display, which could be a very helpful way to explore large datasets."

Salmon migration is changing as a result of human impact; in the Snake River in Idaho, USA, the behavior of young Chinook salmon is evolving rapidly. To understand the changes, researchers need to study their movement patterns in detail, over large geographical areas and short time scales.

One way to track their movement is by studying the chemistry of the salmon's balance and hearing organ - an ear stone, called an otolith. The fish's movements are recorded in the otolith like tree rings, with chemicals being deposited every day the fish is alive. The otolith record contains details about where the fish has been and how long it stayed there, but statistical tools don't capture the nuances of movement timing. Visual analysis quickly becomes too complex to interpret, so the team decided to take a different approach.

"Most scientists rely on visual displays of their data in the form of tables and graphs," said Prof. Jonathan Middleton, one of the authors of the study from Eastern Washington University and the University of Tampere. "Our research team wanted to break the mold on traditional approaches to reviewing data: we are proposing to add sounds as an auditory representation, giving scientists another perceptual field to analyze and interpret their data."

The team tested their approach by presenting the sounds in a survey to untrained listeners. They asked the listeners to identify movements, with an increasing number of fish. The results showed that the listeners were most sensitive to changes in pitch and tone, and that the group performed better as a whole compared to individuals alone.

They also presented the sonifications with and without visualizations of the data, such as graphs. The listeners identified movements better without the visualizations, suggesting sound alone is a more effective way to convey the salmon migration data.

The results suggest sonification could be a useful way to process data for crowdsourcing, and the approach might also translate to other areas of ecology. For salmon migration, there's still a way to go: now that they have shown the approach has potential, in order to apply the approach, the team will need to create tools to explore the detailed data from

otoliths using sound.

"Our ears are highly analytical organs that give us much more information than we realize in all aspects of our lives, and we can harness that to learn things about the world in new ways," said Dr. Hegg. "It is always a gamble to reach beyond your comfort zone and try something completely crazy. Without combining across disciplines, and having faith in other ways of looking at things across the spectrum from science to art, these approaches that sound crazy but have potential wouldn't get a chance to succeed."

More information: "The Sound of Migration: Exploring data sonification as a means of interpreting multivariate salmon movement datasets" by Jens Hegg et al. DOI: 10.1016/j.heliyon.2018.e00532

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