Sound and Signal: How Fishes Hear and Communicate Through Sound
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Questions

Do you have any suggestions to do zebrafish would be sensitive and hear lower frequencies around 10-100 Hz? If so how we measure and quantify acoustics components particle motion and sound pressure in a small fish tank?

Yes, zebrafish are sensitive at least to approximately 100 Hz and perhaps even lower, but not many studies have tested zebrafish or other fishes lower than 100 Hz. Most studies have struggled to produce stable acoustic signals below 100 Hz due to technical and physical constraints. Off-the-shelf underwater speakers are typically too small to generate such long wavelengths (a 100 Hz tone in water spans ~15 m), which require large transducers capable of substantial diaphragm excursion. However, most speakers cannot move their diaphragms far enough or displace enough water to create stable low-frequency output. In addition, driving sounds below 100 Hz demands significant power, and most projectors cannot supply it without introducing distortion. Consequently, hearing studies on fishes and invertebrates rarely test below 100 Hz—not because of the animals' sensory limits, but because of the limits of available equipment.

Are there any studies showing at a microscopic level how the inner ear of fish, the sensory tissue, is impacted by loud human made noise in the ocean, such as oil/gas exploration and extraction, etc.?
There have been a number of studies that focus on how the sensory tissue in the inner ears of fish may be damaged by intense underwater sounds. You can read a summary of hearing loss in fishes and find references to a number of published studies here: https://dosits.org/animals/effects-of-sound/potential-effects-of-sound-on-marine-fishes/hearing-loss-in-fishes/

Are the photophores also used for conspecific communication along with the sound?
The photophores (produce bioluminescence) found on the "bottom" of the fish (ventral surface) have been found are used to counterilluminate - to cancel out their own shadow!

But I am not sure if it is known if these photophores - as you see in really intricate patterns - are used for communication, but it would be really interesting to research that more…Perhaps Prof Sisneros knows. We can ask him, and try to get back to you about this.

Check out: https://biolum.eemb.ucsb.edu

I agree that the photophores on the midshipman's body are generally thought to function primarily as camouflage, helping the fish blend in with other bioluminescent organisms during nocturnal foraging in the open ocean. This strategy likely reduces predation risk while allowing them to feed more effectively under low-light conditions. To my knowledge, there is no current research directly investigating whether midshipman also use these photophores for intraspecific communication. Exploring the potential role of photophores in signaling—whether for mate attraction, social interaction, or territorial behaviors—would be a fascinating direction for future study.

Do fish make tonal calls, and can some of them have very clear diel patterns?
Yes, the advertisement call of the male midshipman is highly tonal in nature and is commonly referred to as a “hum.” Like many other soniferous fishes, midshipman produce a variety of sounds for communication, some of which are distinctly tonal. In this species, males exhibit a strong tendency to call at night when they are most active, resulting in a pronounced diel rhythm to their vocal behavior. This nocturnal calling pattern is not unique to midshipman but is also characteristic of other nocturnally active sonic fishes, where temporal patterns in vocalization likely serve both ecological and evolutionary functions, such as reducing predation risk and synchronizing reproductive activity.

Do we understand fish auditory mechanisms for hearing in high background noise environments like moving water, e.g. rapids in rivers?

This is an excellent question and one that remains unresolved for fishes. Many species are thought to possess mechanisms that help suppress background noise and enhance the detection or discrimination of biologically relevant signals, but the precise processes are not yet well understood. Uncovering how fishes achieve this form of auditory filtering is an active area of research. Both my lab and that of Paul Forlano at CUNY Brooklyn College are very interested in pursuing these questions, and we hope to shed more light on this fascinating topic soon. Stay tuned!