Hard of herring? Not us, say crabs (Update)

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Louisiana blue crabs sit in the bottom of a container at a fish market in Westwego, Louisiana on June 17, 2010

In new research published in the journal *Proceedings of the Royal Society B*, Northeastern University professor Randall Hughes and her team at the Marine Science Center in Nahant, Mass. are the first to show that sound plays at least as much of a role in mud crabs' reaction to fish behavior as other widely studied cues—and possibly more.

Fish are not silent creatures. Just like the terrestrial world, there's a

veritable symphony of sound echoing under the sea. Indeed, the black drum fish was the subject of many a phone call to the Miami police back in 2005, when their midnight mating calls were waking up the locals, said Hughes.

But sex is just one of the many things that get fish mouthing off: they also use their watery voices to relay distress, find prey, defend their nests, and attract mates.

All this noise got Hughes and her colleagues thinking. If fish are vocal creatures, can their prey hear them? And if so, how do they react? Fear is an important part of ecological communities. Their work—as well as that of researchers around the globe—has shown that the visual and chemical cues that fish dispatch into their environment can cause prey, such as mud crabs and shrimp-like crustaceans called amphipods, to go into hiding. But until now, no one had ever studied the way prey species react to fishes' auditory cues.

"We showed that these crabs change their behavior in response to acoustic signals," she said. "They're just as strong as chemical cues."

In the first step of the experiment, the team—which also includes Northeastern assistant professor of marine and environmental science David Kimbro and David Mann, an expert in marine acoustics based at Loggerhead Instruments in Sarasota, Florida—looked at whether mud crabs respond to fish sounds. They put the crabs into mesocosms—experimental environments designed to mimic the natural world—containing food in the form of juvenile clams. They then submerged a microphone into the tank and transmitted various types of sound recordings of oyster toadfish, hardhead catfish, and black drum fish.

"We pretty quickly saw that the crabs weren't feeding as much in

response to the predator sounds," Hughes said.

The catfish and black drum had the most pronounced effect on the crabs' behavior, likely because they move on and off the reef during feeding times whereas the toadfish stick around all the time. "Prey usually respond differently if the cue is constant versus variable," Hughes said. "It makes sense—if a cue is constant, you're going to have to eat sometime, so you become desensitized to it."

Once the researchers determined that the prey do indeed change their behavior in response to predator sounds, they decided to confirm that this was due to the crabs' ability to actually hear them, rather than some other hidden variable. Other researchers have examined terrestrial crabs' ability to hear, but no one has looked at the capacity among marine crabs, which are very different animals.

To perform this experiment, the team implanted electrodes into the "statocyst" at the base of the mud crabs' antennae. This is a tiny sac containing a mineral mass and thousands of sensory hairs. It's typically thought to be important for marine animals' balance, but, Hughes said, "If they're going to respond to sound pressure or particle acceleration, that's where it would happen."

And indeed it did happen. The electrode signals showed a strong correlation with particle acceleration when the crabs were stimulated with fast pulses of noise. They didn't hear the same way we do—through the imposition of sound waves on our auditory machinery—but rather through billions of displaced particles knocking against the tiny hairs inside their statocysts.

The study is the first to show that marine crabs are able to hear and opens up a wide range of questions for the team to probe in the future. The researchers have already collected soundscapes from reefs up and

down the eastern seaboard and hope to use that data to examine questions such as whether mud crabs on all reefs show the same behaviors, or if they're only sensitive to locally dominant predator sounds.

More information: Predatory fish sounds alter crab foraging behaviour and influence bivalve abundance, *Proceedings of the Royal Society B*, rspb.royalsocietypublishing.or … .1098/rspb.2014.0715

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