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How do animals communicate in complex hydrodynamic environments? Linking hydraulics and ecology in rivers.

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Animals make decisions about the suitability of habitat and their reaction to other organisms based on the sensory information that they first obtain from the environment and other organisms within that environment. Sensory information, such as sounds, scents, vibrations and visual cues, is transported, transmitted, masked and filtered by fluvial processes, such as turbulent flow. Despite the fundamental importance of this information in dictating how animals interact with the environment, only limited attention has been paid to the environmental controls on the propagation of sensory signals and cues through fluvial systems.

Aquatic animals use and respond to hydraulic characteristics when navigating their environment and selecting habitat. There is evidence that some animals can also sense the presence of other organisms from the hydraulic characteristics of their wake. This implies that at least some aquatic animals can differentiate between the turbulent flow generated by the presence of living organisms and ambient turbulence generated by the environment. We investigate whether there are specific flow characteristics, distinct from the ambient environment, that potentially flag the presence of organisms to other animals.

Acoustic Doppler and Particle Image Velocimetry measurements in a series of laboratory flume experiments quantified the flow around living Signal Crayfish (Pacifastacus leniusculus) and two inanimate objects of equivalent shape and size. Experiments were repeated across a gradient of turbulence intensities generated over nine combinations of flow velocity and relative submergence.

Flows downstream of living crayfish were distinct from inanimate objects, with greater turbulent intensities, higher energy in low- to intermediate frequencies, and flow structures that were less coherent in comparison to those measured downstream of inanimate objects. However, the hydrodynamic signature of crayfish became masked as the intensity of ambient turbulence exceeded that generated by living crayfish. This was particularly the case at low relative submergence.

These results demonstrate the importance of the fluvial environment in controlling the transmission of sensory information and suggest that the ability of organisms to sense the presence of crayfish from their hydraulic signature is likely to be limited in many situations in rivers. Thus, animals in rivers may have to rely on other senses, such as sight or hearing, especially where depth is low relative to substrate roughness and where velocities are relatively high.