Evaluating Hydrological stressors by Monitoring Mussel Behaviours

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ABSTRACT

Since future climatic scenarios predict an increase in the number and intensity of extreme events, such as droughts and floods, understanding how low and high flow conditions affect aquatic organisms is crucial for the conservation of freshwater biodiversity and ecosystem services. On the other hand, the response of riverine animals to flow intensity and flow conditions can be rapid and unambiguous, i.e., well correlated. In this work, we present an experimental study on the relation between hydrodynamics and biotic communities in fluvial ecosystems and assess the behavior of the animal as a biological early warning system (BEWS) for hydro-morphological change, including sediment transportation.

Freshwater mussels (FM) have been identified as suitable biological indicators to assess environmental stressors to detect disturbances on ecosystems since 1950 (Hiscock, 1950). Kramer et al. (2001) started to use the monitoring of the mussels as a BEWS since 2001, but the suitability of FM for monitoring the impact of hydraulic stressors is still lacking. During the last two decades, these methodologies have been used to measure the presence of pollutants in water bodies. To reach this aim, the Valvometric method has been used, based on the use of Hall sensors (real-time remote monitoring tool) to get the data. The behavioral responses of mussels are characterized by valve opening amplitudes and opening-closure frequencies. We relate these behaviors to hydrological conditions and sediment transport mimicking the onset of floods. The experiments conducted in a laboratory flume (Fig. 1) were carried out by starting with a stage of constant discharge (without sediment transport) followed by an abruptly increased value of discharge, which in most cases is accompanied by sediment transport. Hall sensors and magnets were fixed on the shells of mussels (Fig. 2) and connected to an Arduino system. The opening and closing of the valve were continuously monitored, along with the hydro-morphological conditions. FMs maintained a constant valve gaping frequency that characterizes their normal behavior (feeding and movement). FMs promptly reacted to extreme discharge conditions with sediment transport by increasing valve gaping frequencies, shifting from normal to transition behavior. We checked that a minimum number of animals is necessary to reach some degree of accuracy in the statistical treatment of the data. Most mussels (87 to 97%) reacted promptly to increased discharge with sediment transport, showing a transition from their normal behavior to a significantly higher valve gaping frequency, and the intensity of their reaction significantly increased from the lowest to the highest stress levels. Fig. 3 shows the frequency of mussel gapping during the experiments. We can observe that there is a threshold between the experiments without and with sediment transport on the bed (bedload) which is 0.025 Hz. Therefore, if the responses of mussels

are higher than 0.025 Hz, the condition is with high variation which meant sediment transport has started. In the end, FMs response to hydro-morphological was fast and accurate, showing that they can be used as a reliable BEWS, under general flow conditions.

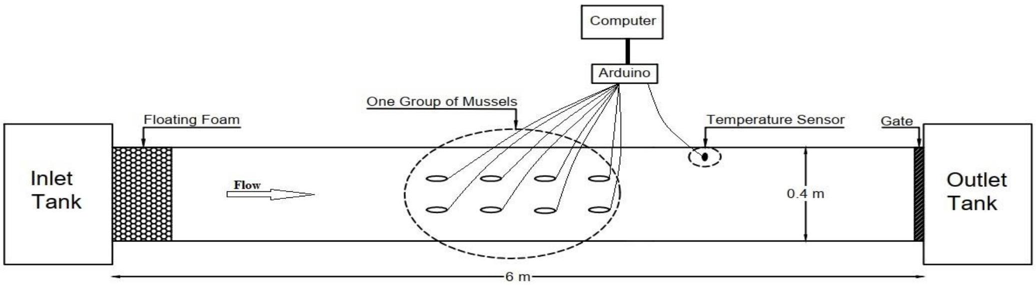

Fig. 1. *Plan of experimental flum*

Fig. 2. Freshwater Mussels with Hall Sensors

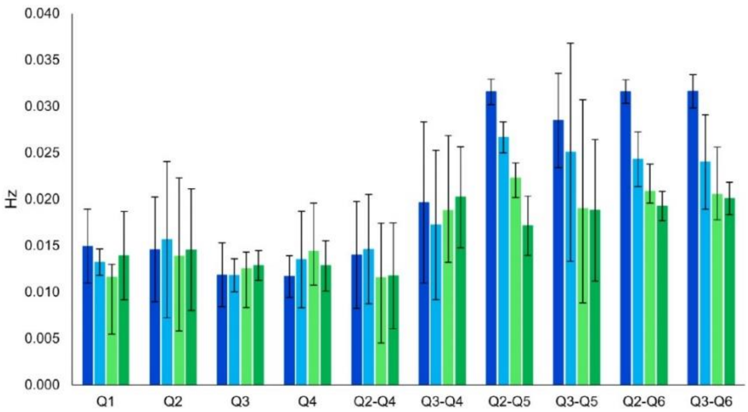

Fig. 3. Response of FMs (Frequency) versus different flow conditions: Q1 to Q4 are Constant discharge without sediment transport, Q5 is discharge with low sediment transport, Q6 is discharge with high sediment transport

Acknowledgments

This work has been supported by the Italian PRIN 2017 project Enterprising (2017SEB7Z8).

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