Hydrodynamic Stressing and the Response of Endangered Freshwater Pearl Mussels (*Margaritifera Margaritifera*) to Turbulent Flows

NERC iCASE studentship

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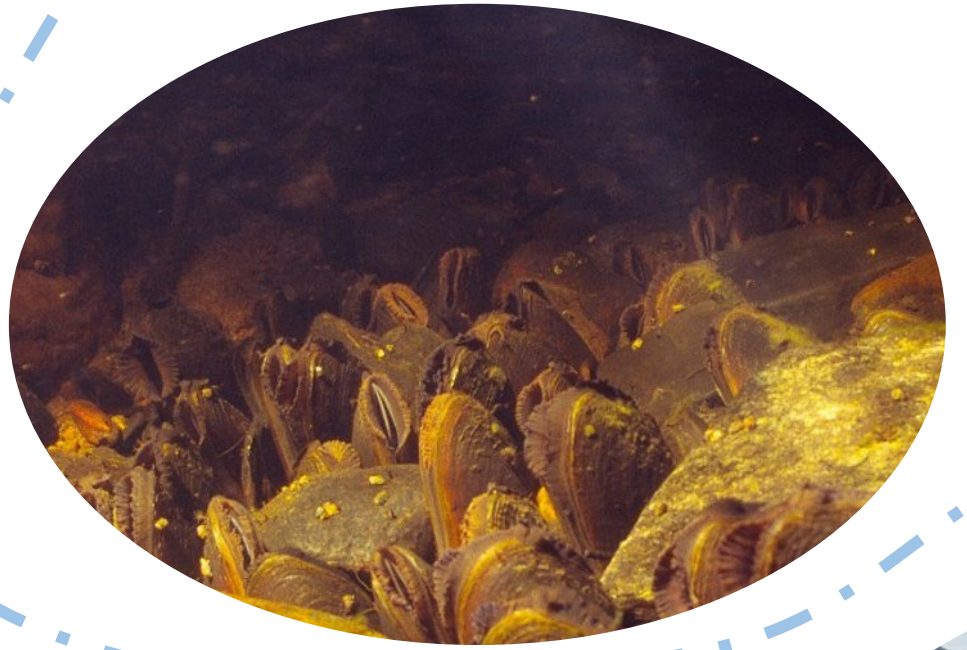
SSE

NERC SCIENCE OF THE ENVIRONMENT

SAGES Scottish Alliance for Geoscience, Environment and Society

SCENE Loch Lomond

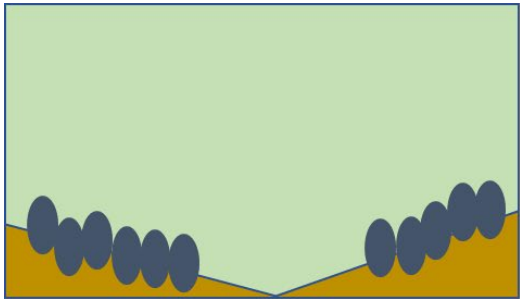
DEFINING PREFERABLE HABITAT

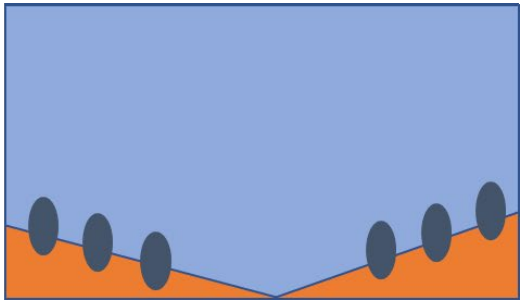


Populations of the freshwater pearl mussel, *Margaritifera margaritifera*, a rare, long lived freshwater bivalve have shown substantial declines across the Holarctic range.

Scottish rivers retain some of the last reproductively viable (functional) populations

Many Scottish rivers containing functional populations are regulated to some extent





Attempts to reverse decline focus on reintroduction and restoration schemes, which often result in temporary losses to populations.

Success of conservation management relies on understanding species' habitat preferences

Habitat assessments largely inconsistent and often neglect complexity of hydrodynamics. Methods that are inexpensive, easy for practitioners to use/ understand, but also account for complex hydrodynamics are required.

AIM

To provide a direct, non-intrusive, low-cost and accessible tool to assist conservation management in examining complex near bed hydrodynamics

HYPOTHESIS

The utilization of inertial microelectromechanical sensors (MEMS), housed within mussel shells, can provide an accurate method of measuring near bed hydraulic parameters across a range of behavioural metrics

OBJECTIVES

- To expand on research concerning the use of inertial microelectromechanical sensors (MEMS) for the assessment of coarse sediment particles entrainment, by assessing their utility when housed in empty freshwater mussel shells (the particle).
- To examine the three-dimensional displacement in the particle in response to increasing hydraulic forcing across two behavioural metrics
- To analyse the sensor output for variables that provide responsive and accurate methods for quantifying changes in hydraulic conditions
- To analyse the hydrodynamic forces acting on the mussel resting on the bed surface, towards assessing adverse hydraulic conditions.

METHODOLOGY

Undertaken in well-controlled lab conditions with large recirculating flume system, run at a range of flow regimes

Preliminary tests

Shell laid horizontally on marble matrix

Stepped increase in pump frequency for 1 hour.

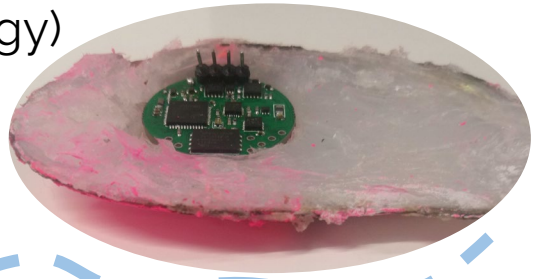
Analysis of averaged acceleration and angular velocity in flow direction (Figures 1 and 2)

Sensors

Record three-dimensional displacement

Used remotely.

Placed in empty mussel shells (3 x sizes; representing variation in age & morphology)



Experimental protocol

Shell laid horizontally on marble matrix.

Each shell size: test 11 pump frequencies, five repeats with same pump frequency – each 10min.

Now replicating with shell partially buried (how mussels often observed in wild)

ADV

Profiles taken 1mm in front of fixed shell and 1mm behind; examining more complex hydrodynamics.

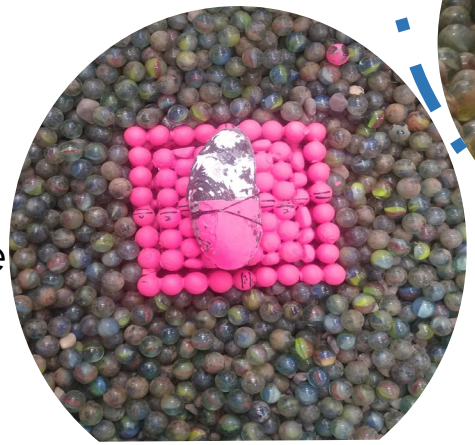
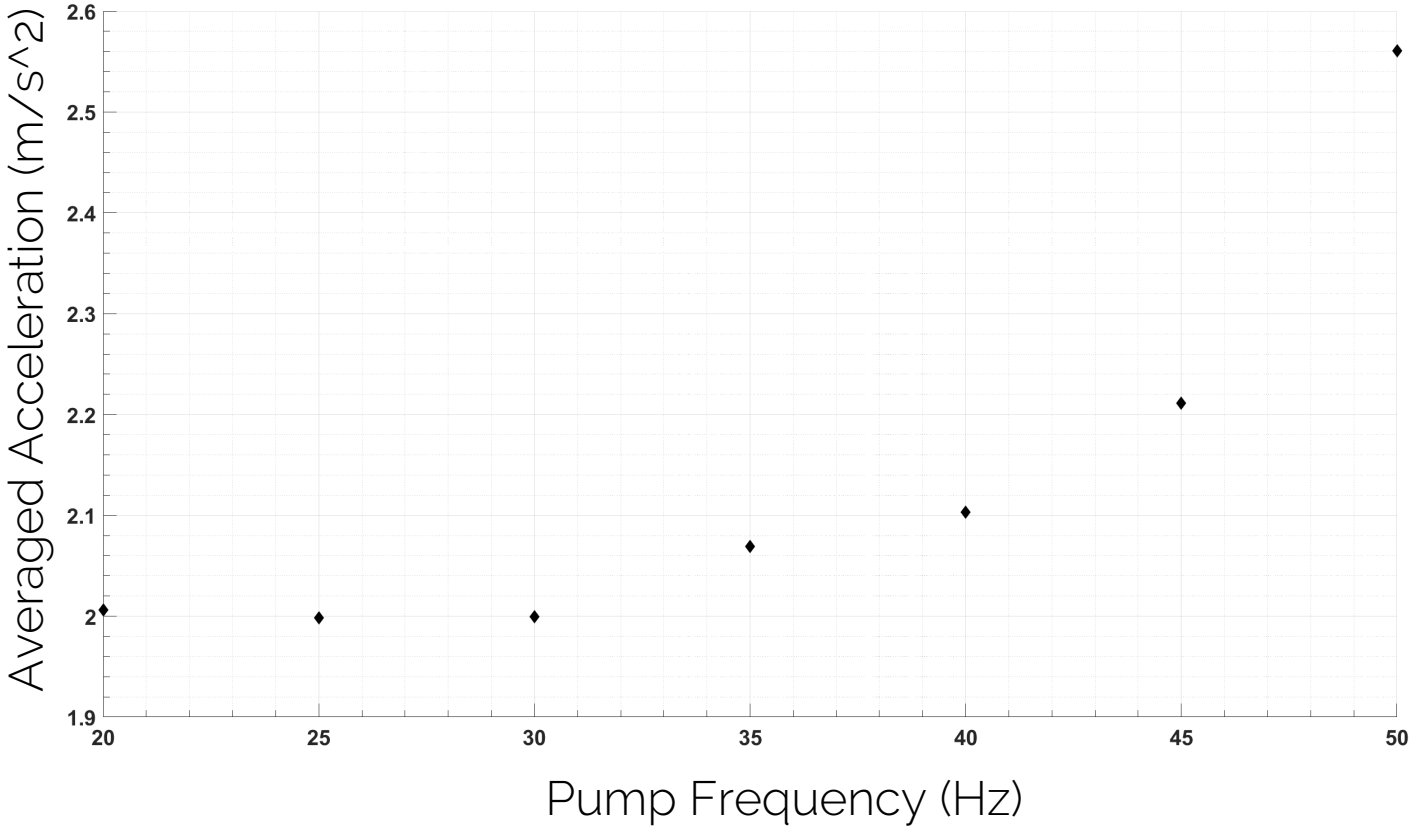


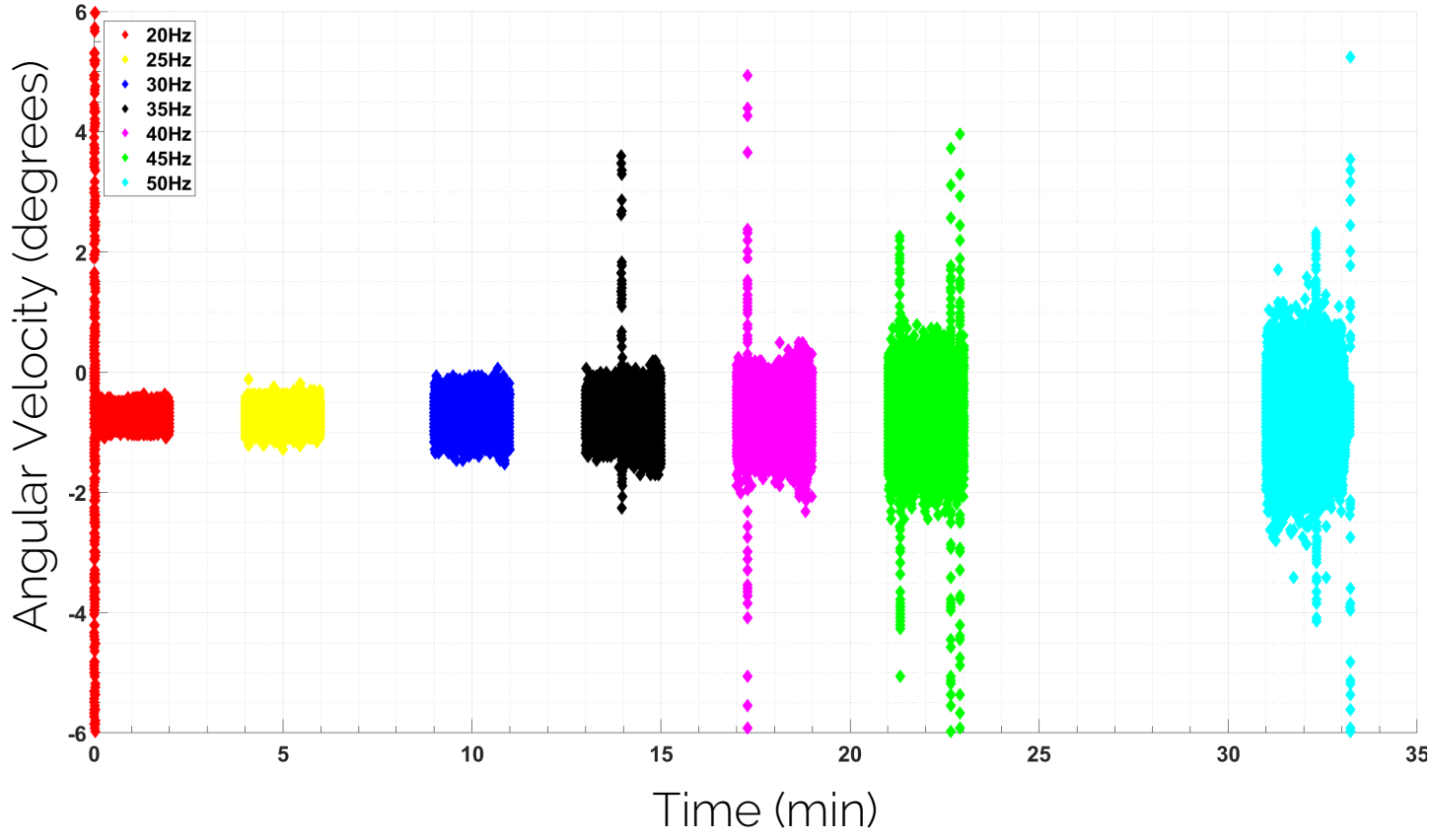
Figure 1. Averaged acceleration in the direction of flow in response to increasing pump frequencies



Preliminary results

Acceleration in the direction of flow increases with increasing the pump frequency, on average

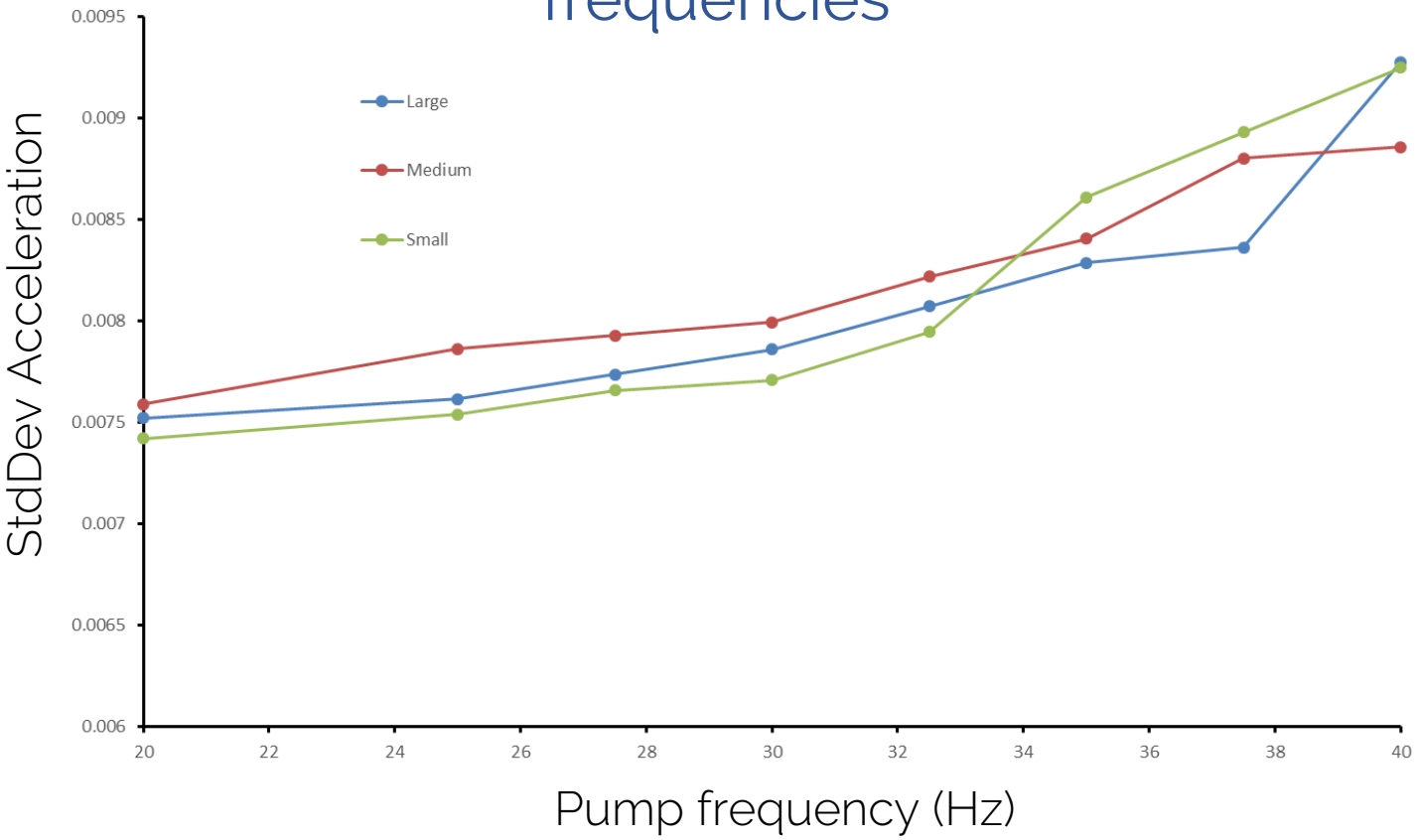
Figure 2. Angular velocity in the direction of flow for different pump frequencies



Preliminary results

Angular velocity gets a wider range with increasing the pump frequency with occasions of sudden increase due to flow events with high impulse/energy

Figure 3. Standard deviation of averaged acceleration across three dimensional axes for three particle sizes across different pump frequencies



At different shell sizes, standard deviation of total acceleration across three dimensional axes, is relatively consistent in response to increasing pump frequency

CONCLUDING REMARKS

Preliminary results and still much to do in terms of analysis

Yet to see how the sensor output alters with changes in positioning of shell to reflect mussel behavioral differences

Early raw analysis suggest a strong link between increasing hydraulic stress on the shells and variation in acceleration across the three dimensional axes

If perfected in the lab, research would represent the first to employ such sensors for ecological assessment and identification of optimal habitat for a freshwater species

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