Bream (*Abramis brama* (L.)) as zoogeomorphic agents and ecosystem engineers: Implications for fine sediment transport in lowland rivers

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1. Introduction

Experiments in lakes have demonstrated that bream *(Abramis brama (L.))* influence ecosystem dynamics through bottom up mechanisms as a result of bioturbation caused by benthivorous feeding (Volta *et al*. 2013). Although this level of bioturbation, and thus sediment entrainment, can alter the fundamental biogeochemical cycles and food web dynamics in lentic ecosystems (Breukelaar *et al*. 1994, Persson & Svensson, 2006), research is yet to assess this potential effect in riverine ecosystems or evaluate this bioturbation mechanism as a driver of fluvial sediment flux.

Given their extensive geographical distribution and the observed shoals of bream commonly exceeding one thousand individuals, it is plausible that bream are an important biological constituent of the fine sediment cascade within riverine systems.

This poster will discuss the core findings from *ex-situ* experiments designed to evaluate some of the likely controls on bream bioturbation.

Complimentary *in-situ* experiments will assess the feeding behaviour of bream in their natural environment converting suspended solids concentration (SSC) into an estimate of the biogenic sediment flux to calculate the bream component of the sediment budget.

2. Experimental Design

Two size classes of bream (44.8 - 45.5 cm & 28.4 - 30.1 cm) and one size class of roach (*Rutilus rutilus* (L.)) (18.5 - 29.3 cm) were captured for *ex-situ* experiments from the River Witham.

An initial set of experiments assessed the impact of different fish densities (both species separately) and food availability on bioturbation. The experimental design involved three levels of two factors - number of fish (1-3), and food availability. The latter involved seeding experimental feeding trays with different macroinvertebrate densities: 0, 50, 100 & 200% of natural abundances measured in the River Witham. The key dependent variable was turbidity - as a measure of sediment suspension.

A second set of experiments followed the same parameters, however both species were combined at an equal ratio up to 3 fish. The 100% food density matrix was used as a proxy to assess any inter and/or conspecific interaction effects between the two species.

The experimental tank (Figure 1.A) was split into two sections, the holding area and the experimental area, which were divided by a Perspex screen. The holding area contained fish husbandry equipment (filter, temperature control unit and air pumps) with the experimental area containing a sediment tray (60 x 20 x 8 cm), an infrared (IR) camera and a turbidity sonde.

Procedure

1. Chironimidae larvae were seeded onto the sediment tray at the required density.
2. Fish were added to the holding area of the experimental tank for 30 minutes to acclimatise, before entering into the experimental zone.
3. Once fish were in the experiment zone, the divide was closed and a continuous record of turbidity, supported with video recording were taken throughout the experiment.
4. After one hour, fish were put back into the holding tank.
5. Experiments were replicated three times for each treatment.

FIGURE 1

A. Experimental set up outlining both the holding area (back) and experimental area (front).
B. IR camera image of a 2- fish experiment as feeding commences.
C. IR camera image during the same 2-fish experiment displaying an increase in turbidity.

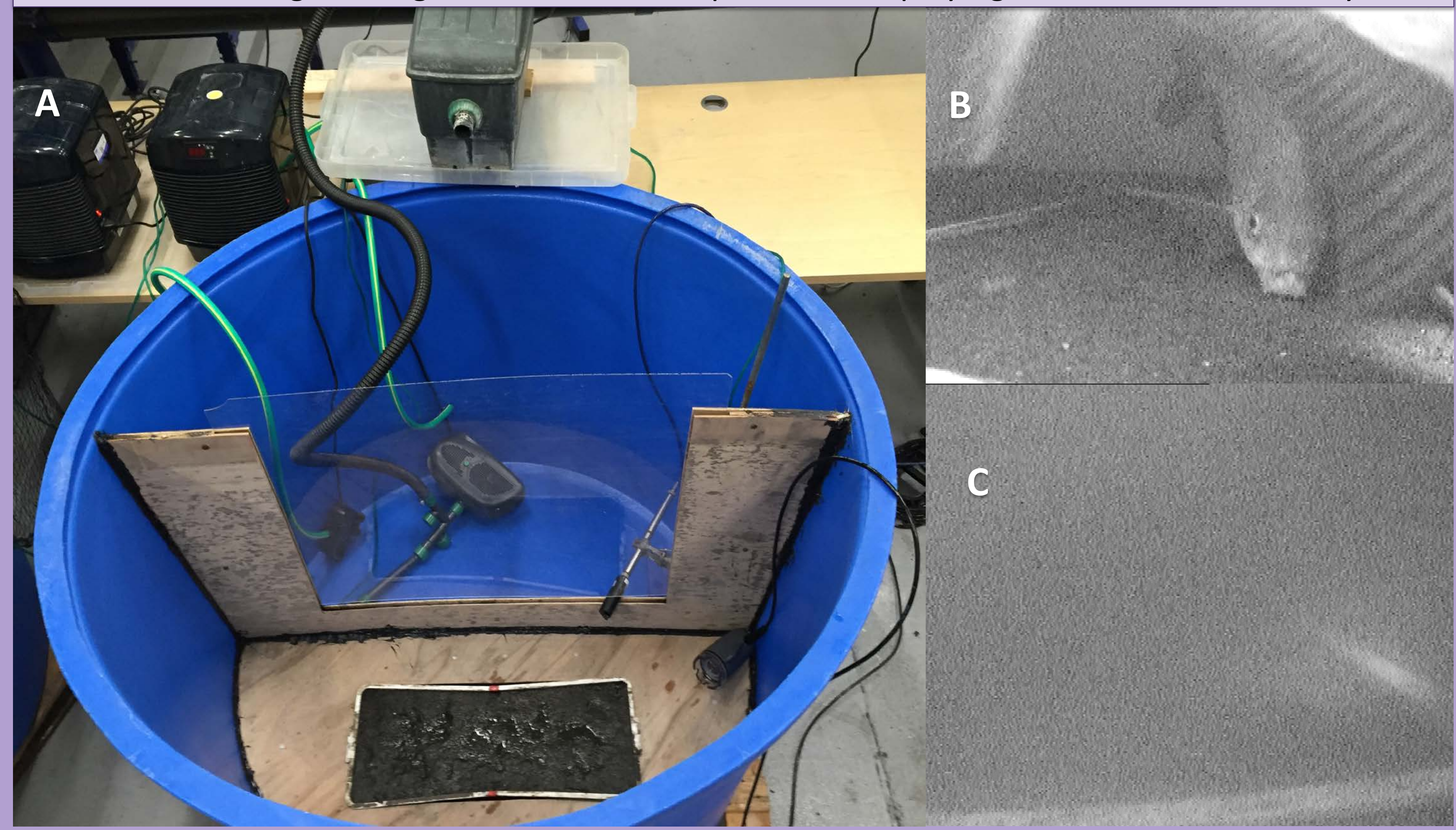
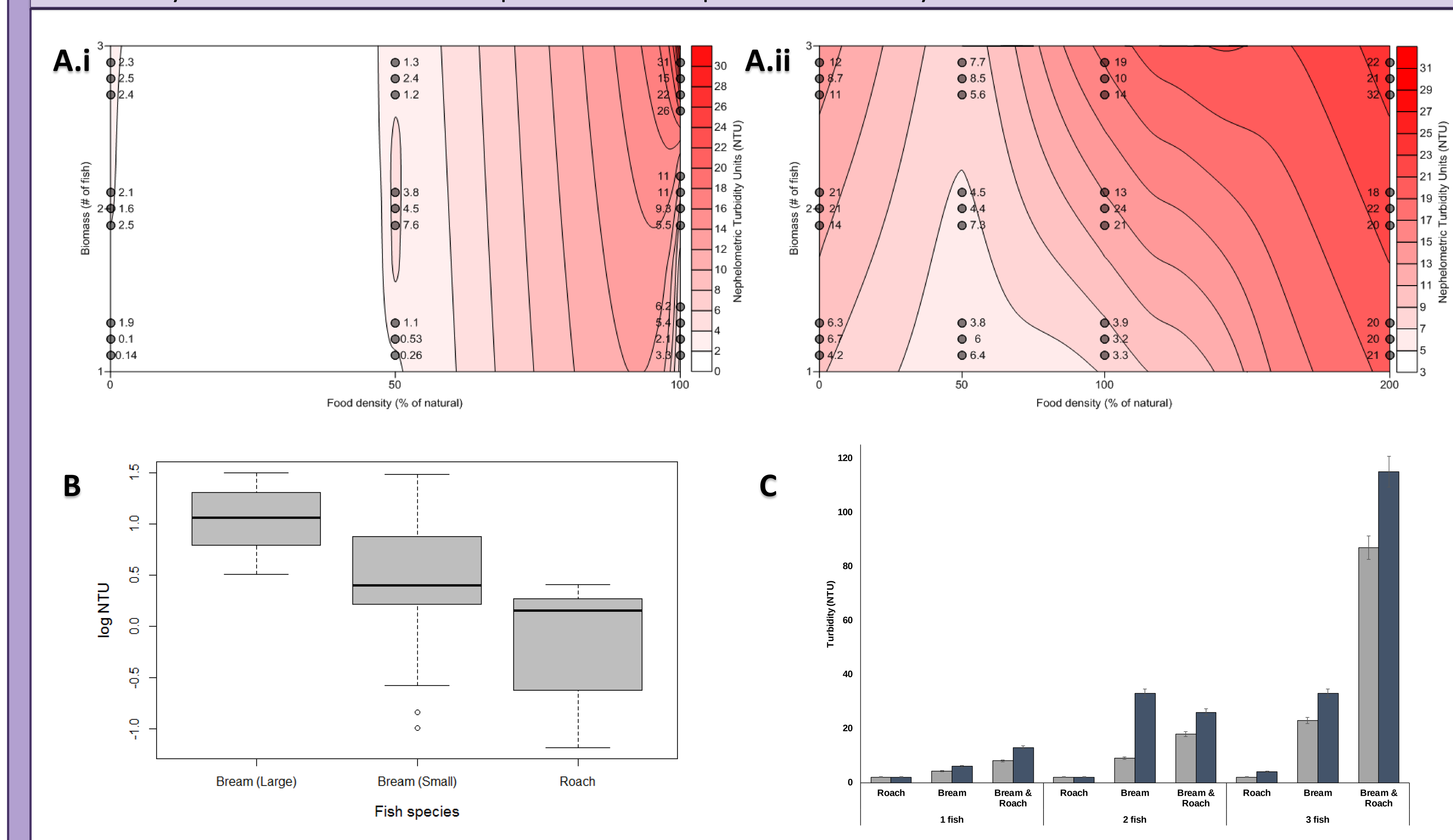


FIGURE 2

A. Turbidity contour plots of small (i) & large bream (ii), whereby food density and fish number are plotted against turbidity on the Z axis. The numbers on the plots represent the mean NTU value for each experiment.
B. Observed turbidity created by both bream size classes and roach. Box plot shows median values (solid horizontal line), 75th & 25th percentile values (box outline), 90th percentile values (whiskers), and outlier values (open circles).
C. Experimental differences between three different fish treatments at 100% density. Grey bars represent the median turbidity value and the blue bars represent the 90% percentile turbidity values.



4. Results

- Substantial increases in turbidity were associated with bream feeding, as indicated in the still imagery taken from video footage (Figure 1.B & 1.C).
- A General Linear Model (GLM) was conducted upon the dataset where the LOG mean turbidity for each experiment was calculated and used as the dependent variable.
- Turbidity was shown to significantly increase *($p = < 0 .001$)* with each experimental parameter (highest recorded turbidity 1172 NTU).
- Roach were shown not to be an zoogeomorphic agent with low recorded turbidity values in each experiment (< 5 NTU).
- When bream and roach were combined, turbidity increased by an average of 120% (6.6 NTU to 15 NTU) and further again at the 90th percentile by 240% (32 NTU to 110 NTU).

Bream induced turbidity significantly increases with:

1. **Fish size (*$p = < 0.001$*) – Figure 2.B**
2. **Fish biomass (*$p = < 0.001$*) – Figure 2.A**
3. **Food availability *($p = < 0.001$)* – Figure 2.A**
4. **Presence of other species (*$p = < 0.001$*) – Figure 2.C**

5. Discussion

1. Video review has shown that turbidity was caused by the foraging of bream. This was caused by the expunging of sediment during their filter feeding process.
2. The levels of recorded turbidity scaled with each experimental parameter.
3. The large increase in recorded NTU levels during both the bream only and combined experiments show that turbidity is likely to be driven by both conspecific and interspecific interactions, in addition to environmental factors.
4. As bream and roach commonly shoal together, the turbidity levels associated with the combined experiments are likely to represent the natural sediment concentrations.
5. Complementary field work is currently underway to quantify the frequency-magnitude characteristics of the fine sediment plumes that feeding shoals of bream generate in lowland UK rivers.

The impact that bream create upon turbidity is shown to increase with each factor discussed. Given that bream commonly shoal in the hundreds, bream can be seen to be a significant geomorphic agent in the sediment transfer process in lowland rivers.

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