The effects of the Eurasian beaver (*Castor fiber*) on hydrology and nutrient dynamics at variable spatial scales

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Aims

The Eurasian beaver (*Castor fiber*) is the largest species of rodent in Europe and is noted for its ability to engineer its habitat[2,3]. After an absence of several hundred years, the Eurasian beaver has been reintroduced to multiple sites within the UK[1]. The purpose of this study is to better understand the hydrological effects of beaver dams at spatial scales from the individual beaver dam to the sub-catchment scale using field and numerical modelling approaches. The effects of beaver dams on water quality and sediment storage will also be investigated.

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Methods

A 1.6 km headwater stream in Scotland with about twenty five beaver dams along the channel was instrumented to asses changes in flow over the sequences of dams. Locations of flow measurement enabled appraisal of both a sequence of three beaver dams, and alterations in discharge over about twenty dams (Fig 1). Flow is gauged by three v-notch weirs with corresponding stilling wells and pressure transducers (Fig. 1), and additionally an ultrasonic Doppler flow meter (Starflow, Unidata). Regular volumetric gauging and dilution gauging is used to appraise the accuracy of the discharges recorded. Additionally, twenty one dipwells were installed to assess the effect of beaver on localised groundwater levels in the floodplain (Fig. 2). Four dipwells were instrumented with pressure transducers and all are also manually measured at regular intervals. Data from the stream has been used to construct a hydraulic model using the MIKE 11 platform.

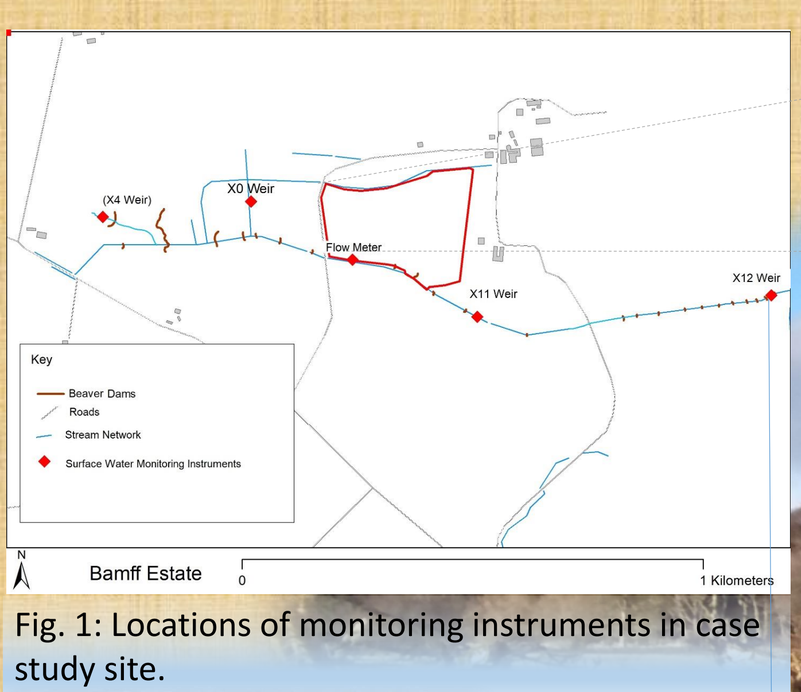

Fig. 1: Locations of monitoring instruments in case study site.

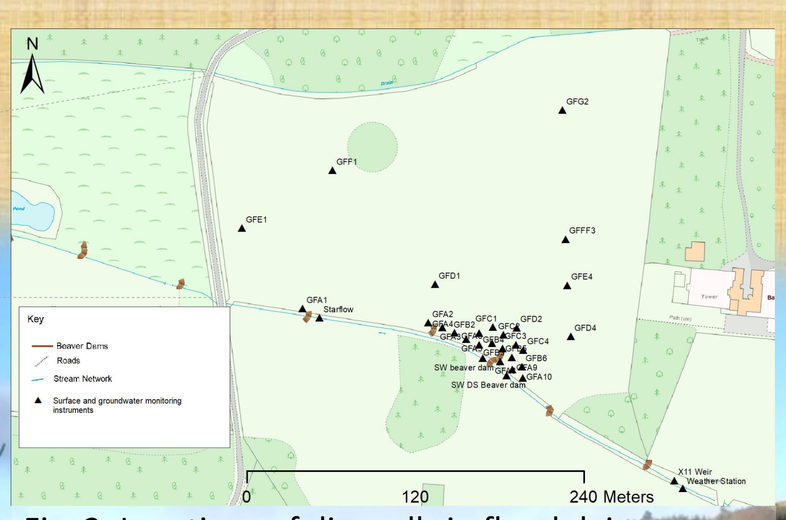

Fig. 2: Locations of dip wells in floodplain adjacent to two beaver dams.

Fig. 3: Monitoring weir with stilling well instrumented with pressure transducer.

Results and discussion

River flow

A sequence of three beaver dams did not appear to appreciably affect peak discharge during storm events during the Autumn and Winter 2017/18 (Fig. 4). However, it appears that the hydrograph recession is slower downstream of the dam sequence. It is still to be determined whether these results will be replicated at larger spatial scales and in different seasons.

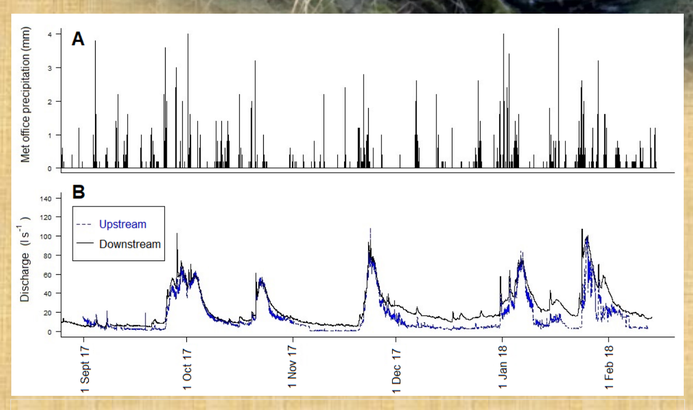

Fig. 4: A. Precipitation B. Stream discharge upstream and downstream of three beaver dams.

Groundwater

In the area of floodplain monitored, shallow groundwater levels suggested that under conditions monitored so far, water seeped from the beaver ponds into the adjacent floodplain. Downstream, where beaver dams were not present, and stream levels were consequently lower, the hydraulic gradient suggested that this water would return to the stream (Fig. 5).

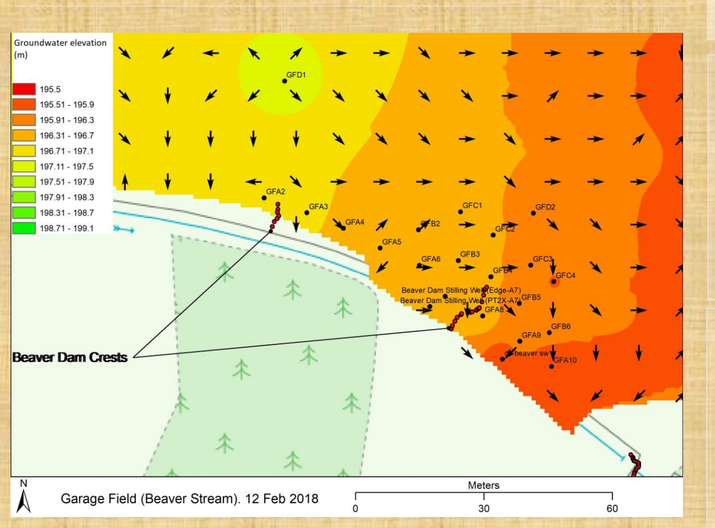

Fig. 5: Interpolated flow directions based on groundwater levels in February 2018.

Preliminary model results

Initially, the challenge is to determine how to best represent beaver dams in the model. Formulae for broad crested weirs with have been tested to represent dams. Simulations represent water levels within beaver ponds and downstream discharge relatively accurately. Simulations suggest peak discharges are more persistent when beaver dams are absent (Fig. 6). Next steps will involve representing the wider catchment including groundwater within a coupled model, MIKE SHE.

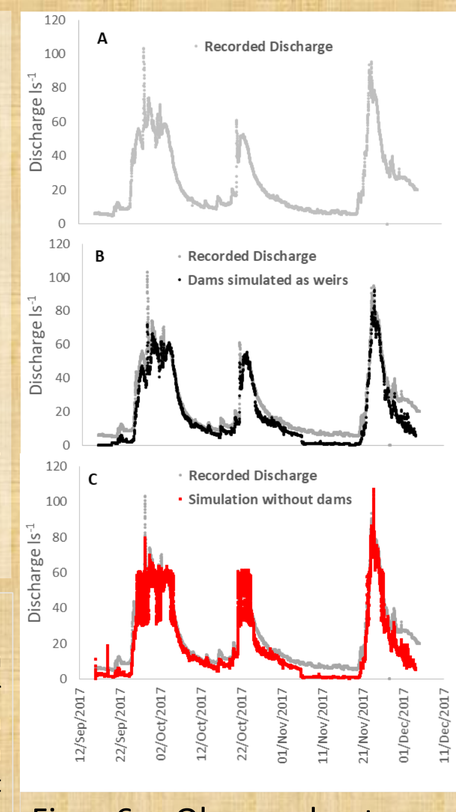

Fig. 6: Observed stream discharge (A), compared to MIKE 11 model simulations of discharge with dams simulated (B), and no dams simulated (C).

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Selected references

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