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Temperature-driven river utilisation and preferential defecation by cattle in an English chalk stream

Trevor Alan Bond *, David Sear, Mary Edwards

University of Southampton, Building 44, University Road, Southampton, Hampshire, SO17 1BJ, United Kingdom

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ABSTRACT

Cattle have the potential to be important geomorphic and ecological agents in the low-energy, high biodiversity chalk rivers of southern England. To improve our understanding of cattle–river interactions, a unique high temporal resolution study of cattle behaviour and distribution was conducted across 500 h on a chalk river in Hampshire, England (UK) between April and October 2010. It was observed that cattle spent approximately 2% of their time in the aquatic environment and approximately 7% of their time in the riparian zone. Cattle activity and distribution varied according to the time of day and the time of year. A statistically significant correlation was recorded between the amount of time spent in-stream by cattle and air temperature. Cattle also defecated five times more frequently in-stream than the average defecation frequency, contributing greater than expected direct organic matter and nutrient inputs. The study suggests that the impacts of cattle in chalk river environments may have been underestimated, particularly at a time of global warming.

1. Introduction

Groundwater-fed chalk rivers and their associated floodplain wetlands are at the forefront of the conflict between biodiversity conservation and optimal land management (Environment Agency, 2004; Raven et al., 1998). Characterised by stable planforms, low stream densities and clear, alkaline waters, chalk rivers are internationally recognised for their ecological value, with nearly four thousand kilometres of chalk river reach in England; the largest number of chalk rivers of any European country (Jackson and McLeod, 2000; Lawton et al., 2010; Mainstone, 1999; Sear et al., 2003; Smith et al., 2003).

The conservation of chalk rivers is a key concern for land managers, with ten chalk river Sites of Special Scientific Interest and four candidate Special Areas of Conservation across the UK (Environment Agency, 2004; Mainstone, 1999; Raven et al., 1998). However, pressures on these ecosystems, including water abstraction, urbanisation, agriculture, water pollution, fine sediment inputs and invasive species establishment, can act against sustainability objectives (Clothier, 2009; Environment Agency, 2004; Mainstone, 1999; UKBAP, 1995). One pressure whose effects within the chalk river environment are poorly understood is cattle grazing.

Although much has been written about the ecological and geomorphological consequences of cattle grazing in certain ecosystems (Kauffman and Krueger, 1984; Trimble, 1994; Trimble and Mendel, 1995), there are few studies analogous to chalk rivers. Nonetheless, the supposedly generic effects of cattle grazing, such as river bank destabilisation and plant mortality, have been cited in land management plans as a basis for cattle exclusion in English chalk rivers (Lawton et al., 2010; Raven et al., 1998), despite several studies from other environments that suggest cattle can enhance habitat heterogeneity and species richness (Curry et al. 2008; Hiernaux et al., 1999; Pykälä, 2005).

To date there have been few studies into the way in which cattle behave in chalk river environments, with the limited existing body of literature focusing solely on the consequences of allowing cattle access to chalk rivers (Harrison and Harris,

* Corresponding author. Tel.: +44 23 8059 4612, +44 7905 731 317(mobile).
E-mail address: Trev.Bond@soton.ac.uk (T.A. Bond).

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2002; Summers et al., 2005, Summers et al., 2008). This dearth of studies is not specific to chalk rivers, and highlights a broader research gap; how and why do cattle interact with watercourses?

2. Materials and methods

2.1. Site descriptions

The study was conducted across two adjacent chalk river sites in Hampshire, England: the northern and southern Midlington sites on the River Meon at Droxford. The northern Midlington site covers 29 ha and is bisected by the River Meon which runs for 1200 m through the site. Access to the River Meon at the north Midlington site is partially restricted by barbed-wire fencing that runs for 600 m along its length, leaving 600 m of accessible river. The southern Midlington site is 19 ha in size, with 770 m of accessible river and no river-side fencing. Both sites share a landscape and cultural history that is characteristic of southern-England chalklands. Evidence of water meadow management is clear, with numerous artificial drainage ditches across both sites, superimposed upon relict floodplain channels (Everard, 2005). Neither site contained water troughs, although both drainage ditches and floodplain channels were observed to retain surface water following large precipitation events.

Hydrologically, the River Meon is typical of a classic English chalk river, with a groundwater dominated flow regime, stable temperatures, and a non-flashy flood hydrograph (Sear et al., 1999; Smith et al., 2003). The river is 34 km in length with an average discharge of 0.98 ms^{-3} and recorded flow velocities in excess of 1 ms^{-1} within the study reach. Water quality is naturally high; clear, alkaline and mineral-rich (Smith et al., 2003).

Geomorphologically, the floodplain soil is characterised by a shallow, humus-rich surface layer containing silt alluvium and deep peat subsoils with small fragments of chalk (Melville and Freshney, 1982). In-stream sediments are predominately flint gravel-based, although fine sediment accumulates in areas of slow flow (Smith et al., 2003). Pool-riffle sequences are present, as well as cattle-made bank landforms, or cattle ramps; destabilised, shallow banks created by cattle repeatedly entering and leaving the aquatic environment (Trimble, 1994; Trimble and Mendel, 1995). River depth does not exceed 2 m at either site, with the majority of the river at a suitable depth for cattle access and river crossing (<1 m depth).

Ecologically, the sites provide an array of different habitats and support a large number of common chalk river organisms, including riparian plants (e.g. *Carex riparia*), emergent aquatic macrophytes (e.g. *Mentha aquatica* and *Nasturtium officinale*), fish (e.g. *Thymallus thymallus*, *Salmo trutta* and *Lampetra planeri*), invertebrates (e.g. *Ephemeroptera* spp.) mammals (e.g. *Arvicola terrestris*), birds (e.g. *Motacilla cinerea* and *Ardea alba*) and amphibians (e.g. *Rana temporaria*: Mainstone, 1999; Raven et al., 1998; UKBAP, 1995).

The climate of the area is temperate; typical of southern lowland England. In the study year (2010) total precipitation was 100 mm below average and air temperature in the summer months was approximately 0.5 °C above average (compared to values from 1971 to 2001; Fig. 1: UK Met Office, 2010).

2.2. Study animals

From April until late-October 2010, the northern Midlington site was occupied by 35 Holstein bullocks aged between 10 and 12 months at the time of introduction (approximately 1.5 livestock units per hectare). Over the same period the southern Midlington site was occupied by 33 Holstein bullocks aged between 8 and 10 months at the time of introduction (approximately 2 livestock units per hectare). The northern Midlington site is separated from the southern Midlington site by a road, and cattle were not able to move between the two sites.

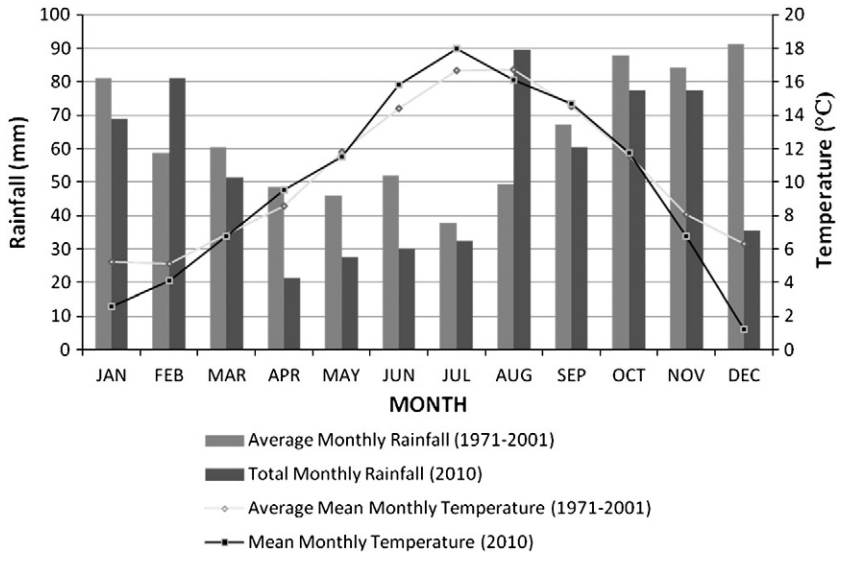

Fig. 1. Climate data for southern England (Southampton Weather Station: UK Met Office, 2010).