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Chalk streams and grazing mute swans

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The chalk streams of southern and eastern England, with their crystal clear, gently flowing waters, are one of our most iconic ecosystems and are famous for game fishing. They are also among our most important wildlife habitats, with many designated as SSSIs and SACs, due to their abundant and diverse flora and fauna. These conservation designations require the UK to maintain or restore these rivers to favourable condition. Sadly, these watercourses and their plant community face a number of threats to their value as conservation areas and fisheries. Water abstraction from the rivers and their aquifers contributes to low flows, which reduces plant growth and encourages algal blooms which smother the plants, further reducing abundance. Low flows combine with soil run-off from agriculture to cause siltation of the gravel river bed, which makes growing conditions less suitable for aquatic plants. Algal blooms are exacerbated by nutrient pollution from agriculture and human settlements. These problems have contributed to the observed decline in river condition, known as chalk stream malaise. More recently, conservationists and anglers have become concerned that flocks of non-breeding Mute Swans *Cygnus olor* reduce plant abundance, which in turn degrades habitat for invertebrates, fish and other animals. For example, an angler survey found that 15% ranked grazing by swans in the top three factors contributing to chalk stream malaise, ranking it sixth overall (Frake & Hayes 2001). The media love conflict, and some national newspapers have reported concerns under sensationalist headlines such as 'Anglers in a flap as swans wreak havoc on rivers' (*e.g.* Elliott 2004). What has been lacking from the debate is an examination of the evidence of the these alleged impacts.

The chalk stream aquatic plant community

The most common chalk stream plant is Stream Water Crowfoot *Ranunculus penicillatus* spp. *pseudofluitans*, a perennial, submerged species which extends its branching stems up to 2m downstream of its roots (Dawson 1976). Other common species include Blunt-fruited Starwort *Callitriche obtusangula* and Eurasian Watermilfoil *Myriophyllum spicatum*. These plants fulfil a range of key ecological roles, modify the river and provide suitable conditions for wildlife. Plants within the river channel physically hold back the flow of water, creating a deeper wetted area than an unvegetated channel; this function can be vital for preventing low flows in late summer and autumn. This also keeps the water table high in the surrounding pasture fields and so increases the drought resilience of the river and floodplain. Plants increase and diversify the habitat available to other species, as well as providing food and cover from flow and predators. Chalk streams are perhaps best known for their Atlantic Salmon *Salmo salar* and Brown Trout *Salmo trutta*, which in turn support game fisheries. These salmonids are only part of the diverse fish community of chalk streams, which in particular support abundant Bullhead *Cottus gobio*. Chalk streams are famous for their rich invertebrate communities, including mayflies, stoneflies, and caddisflies, and may also include rare species such as White-clawed Crayfish *Austropotamobius pallipes*. In turn, these invertebrate and fish species support recovering populations of Eurasian Otter *Lutra lutra*, the top predator of chalk stream ecosystems. In recognition of the role of water crowfoot in sustaining a productive and diverse ecosystem of high conservation value, the plant is protected under the EU Habitats Directive (92/43/EEC), which requires the UK to maintain or restore rivers with these plants to favourable condition.

The impacts of swan grazing on plants

Grazing damage to plants is very obvious; the preferences of swans for the more nutritious leaves and stem tips reduces the normally bushy Water Crowfoot to short cropped stems (O'Hare *et al*. 2007). When food becomes scarce even these stems may be eaten, leaving only the root network in the river gravels. O'Hare *et al*. (2007) compared plant abundance in reaches in early summer with and without flocks of swans on the River Frome in Dorset, and reported that abundance was 49% lower where the flocks fed. Similar reductions were also reported for the River Wylye in Wiltshire (Porteus *et al*. 2008). In 2010 we investigated the effects of swans on plants between March and September across 20 sites on the River Frome, taking into account the effects of water temperature, shading by riparian trees, and the distance from the river source. We found that swans reduced plant biomass (*i.e.* quantity) between July and September, and reduced plant cover (*i.e.* the proportion of the river bed that was vegetated) between May and September (Wood *et al*. 2012). For example, between July and September a flock of 15 swans could halve the plant biomass in a typical reach with 15% shading, whilst 30 swans could remove all the above ground biomass in the same reach. We found no effects earlier in the year, perhaps because there were fewer swans and the plants grow more vigorously during this period. Crucially, the effects of grazing on the plant community do not appear to carry over into subsequent years. From repeated plant surveys we found no relationship between the grazing pressure in 2009 and aquatic plant biomass in 2010 (Wood 2012). This is perhaps unsurprising, for two reasons. Firstly, the tough and complex root network of Water Crowfoot means that swans struggle to uproot plants, and so regrowth from roots can occur. Secondly, the scouring winter floods wash many ungrazed plants away and thus reset the plant community.

The number of Water Crowfoot flowers in early summer was reduced, both because swans eat flowers and because they eat the tissues which are growing to the surface to produce the flowers. A flock of 13 or more swans could halve the proportion of stands flowering, whilst a flock of 26 swans could prevent Water Crowfoot producing any flowers (Wood *et al*. 2012). Crucially, 13 or more swans were likely to reduce the percentage of stands flowering below the 25% conservation target for this plant community (JNCC 2005). In addition to flowering, plant species composition and abundance are also among the attributes used to assess the conditions of SSSIs and SACs (JNCC 2005). Through their negative effects on the chalk stream plant community, swans could contribute to ‘unfavourable’ conservation status at SSSI and SAC sites.

The wider effects of swan grazing

We do not yet fully understand the wider effects of swan grazing on the chalk stream ecosystem, for example on the invertebrate and fish communities. Certainly there have been many complaints, particularly from anglers, that swan grazing damage is associated with reduced invertebrate and fish abundance. For example, anglers on the River Kennet have observed a sudden decline in invertebrate abundances which coincided with a period of intense grazing. Unfortunately, there have been no published studies of the knock-on effects of grazing on chalk stream fauna. If swans do have an impact on fauna, we need to know the size of this impact, which species are affected, how frequently the impacts occur, and for how long the impacts persist. Whilst the effects of grazing on fish species are unknown, the aesthetic damage caused by plant loss due to swan grazing reduces the value of chalk stream reaches as fisheries (Fox 1994). Some evidence has also emerged that grazing effects on plants may affect river hydrology. A study by Wessex Water (2008) reported that a period of intense grazing by a flock of swans coincided with a decline in river depth of approximately 30% at a site on the River Wylye.

How widespread are the effects of swan grazing?

To understand the impact of swan grazing, we need to know where and when grazing damage could occur. Swan grazing damage to the chalk stream plant community have currently been reported for larger chalk streams including the River Frome (Dorset), River Avon and its tributaries (Hampshire and Wiltshire), River Test (Hampshire), River Itchen (Hampshire) and River Kennet (Wiltshire and Berkshire). The wider channels of these larger rivers allow flocks of non-breeding adults and juveniles to congregate and thus cause grazing damage. These flocks are seldom seen on the narrower channels of smaller rivers. Evidence suggests that swan flocks only use part of a chalk river, and as a consequence grazing damage will be localised. A survey of the Hampshire Avon and its major tributaries in 1999 and 2000 found evidence of swan grazing damage at 33% of sites on the Avon itself, 38% of sites on the Nadder, 40% of sites on the Wylye, 25% of sites on the Till, but no sites on the Bourne (Wheeldon 2003). On the River Frome, flocks use approximately 20% of the river course (Wood 2012). Given that the British Mute Swan population appears to have stabilised, it is unclear whether the grazing problem will spread to other rivers.

The use of the river channel by flocks of swans predominantly occurs between late spring and autumn. River use by non-breeding swans seems to be linked to water velocity, with birds preferring lower current speeds as these require less energy to be expended swimming. Consequently, flocks typically enter the river between April and May when flow speeds are low enough to make river feeding more efficient than pasture feeding. These birds generally remain on the river until the first heavy autumn rains of October cause the river to become swift and murky (Wood *et al*. 2013a). Some non-breeding birds may spend the July moulting period on a nearby estuary, returning to the river afterwards. Flock birds spend winter and spring grazing the flooded improved pasture fields, where they eat grasses (Trump *et al*. 1994; Wood *et al*. 2013a). In the River Frome catchment, the fertiliser enriched pasture fields around dairy farms were particularly popular with flocks. This pattern of habitat use suggests that grazing damage to the river is only likely to occur during summer and autumn, which matches the pattern of complaints from conservationists and anglers.

The management of the swan grazing conflict

The evidence suggests that, whilst swan grazing is not having the widespread destructive effect on chalk streams that factors such as abstraction, nutrient pollution and siltation are, swans may have localised impacts on the plant community which could reduce the conservation and angling value of affected sites. What management action could we take to reduce grazing damage where it occurs? Mute Swans are native to Britain, with fossils found from approximately 5000 years ago (Northcote 1980), and so management must recognise that swans are a natural occurrence in chalk streams. Swans are protected under the EU Wild Birds Directive (2009/147/EEC). These conservation designations present us with legal obligations to look after both swans and chalk streams.

Improving the environmental condition of chalk streams could make them more resistant to the effects of grazing, for example by improving growth conditions for Water Crowfoot. Water velocity has been identified as a key variable, as flocks avoid faster flowing reaches (Parrott & McKay 2001). Velocity regulates when the swans can enter the river and thus the length of the grazing season, as when the flow is too fast the birds must expend so much energy swimming that river feeding becomes inefficient (Wood 2012). Measures to increase water velocity in affected areas could be used to shorten the grazing season and displace swans to other river reaches or adjacent habitats such as pasture fields (Wood 2012). Increased flow is also known to improve water crowfoot growth whilst decreasing siltation and epiphytic algae, so this option has a number of benefits. Similarly, reducing nutrient pollution would improve aquatic plant growth by preventing plants becoming smothered by blooms of epiphytic algae.

Another strategy could be to reduce swan densities in affected areas, either by exclusion or reducing population size. River managers have tried unsuccessfully to fence off areas of river to exclude flocks, and swans tolerance of people makes scaring a labour-intensive option. Swans aggressively defend their breeding territories from other swans, and so by encouraging nesting in an area we could prevent flocks from entering and causing grazing damage. The density of pairs and their families are typically too low to cause any serious damage themselves (Wood *et al*. 2012). However, attempts to encourage nesting at desired locations on the Hampshire Avon failed, with not a single pair using the nesting platforms provided (Parrott & McKay 2001). Furthermore, territorial defence may fail to protect an area where the flock is too large or the river too wide, as observations suggest that the breeding pair would be overwhelmed. Removing the swans themselves is unlikely to be a successful, or popular, management strategy. In 1978 on the River Wylye 70 swans were killed illegally, yet the population recovered in less than 5 years (Trump *et al*. 1994). Translocations of swans away from affected areas have been attempted at least twice; Maudsley (1996) described 11 swans moved from the River Wylye to the River Taymar in 1986, and 26 swans from the River Kennet to the River Severn in 1988. In view of the continued complaints of grazing on both rivers, these translocations do not appear to have eased the problem. A population modelling study concluded that only by translocating 60% or more of non-breeding swans each year could grazing damage on the River Frome be prevented (Wood *et al*. 2013b). Given the large and widespread swan population in Britain, coupled with the risk of transferring grazing problems, translocations are unlikely to be a useful solution. Limiting nests to two cygnets each year by oiling additional eggs has been suggested as a method of reducing population size (Watola *et al*. 2003). However, results to date have been disappointing. A trial on the River Wylye in the late 1990s was abandoned after several years as the seasonal movements of birds within and between different river catchments, together with the large between-year differences in swan breeding success, made it difficult to detect any change in overall population size (Watola *et al*. 2003). Two separate population modelling studies have concluded that, whilst it can reduce numbers, it is unlikely to reduce them sufficiently to prevent grazing damage, and so further management would be needed (Watola *et al*. 2003; Wood *et al*. 2013b).

The abundant and nutritious aquatic vegetation offers swans high quality feeding areas, and so strategies which make rivers less attractive feeding areas or make another area more attractive could be worth exploring. Such habitat management should focus on shifting flocks of swans away from sensitive areas, for example areas that support rare species or valuable fisheries. Conflicts between swans and farmers in the River Tweed in Scotland have been reduced by planting sacrificial crops of Oilseed Rape *Brassica napus* (Spray *et al*. 2002). Goose grazing has also been managed successfully using sacrificial crops. Unfortunately, because grasses routinely grown near chalk streams such as Perennial Ryegrass *Lolium perenne* are tough and difficult to digest, models suggest that even high densities of fertilised grass are unlikely to draw swans away from Water Crowfoot (Wood 2012). However, a range of alternative plant species could be explored.

Conclusions

The evidence shows that swan grazing can reduce plant abundance, prevent flowering, reduce water depth and reduce fishery value. However, these effects seem to be limited to a small number of sites on larger chalk streams. The results of attempted management have been disappointing, and we currently have no simple effective means of preventing grazing damage. However, our understanding of the effects of swans on the chalk stream ecosystem has been growing rapidly, which gives us hope for future solutions. In particular, combining strategies which improve river condition and move swans away from sensitive areas could offer a way of managing grazing effects.

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