The Ecology of Poole Harbour
John Humphreys and Vincent May (editors)

15. Sika Deer Trampling and Saltmarsh Creek Erosion: Preliminary Investigation

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A one-year investigation into the effect of trampling by Sika Deer *Cervus nippon* on the erosion of saltmarsh creek sides compared the rates of erosion in creek sections crossed by deer with those in control areas. Significantly greater erosion of creek sides was detected in the areas where deer crossed the creeks. The greater the frequency of deer crossings (as measured by number of footprints), the greater was the rate of erosion. Erosion rates were related to loss of creekside vegetation, particularly *Puccinellia maritima*. The methods developed during the investigation provide a basis for further investigation.

Introduction

A distinctive feature of saltmarshes is the often complex system of drainage channels, termed creeks (Long and Mason, 1983) that play a vital role in marsh ecology, hydrology and nutrient dynamics (Gosselink and Mitsch, 1986; Ranwell, 1972). Any change in creek size may alter water flow velocity (Wang *et al.*, 1999) with a concomitant alteration in material transport and sedimentation characteristics of the creek (Adam, 1990).

Large populations of introduced Sika Deer *Cervus nippon* use saltmarshes around Poole Harbour. Their agility means that they can easily jump across creeks only a few metres wide and thus access large areas of marsh. A comparison of aerial photography of the saltmarsh creeks suggested that between 1971 and 1998, the areas most heavily grazed by deer had lost many of the first-order creek channels, whereas minimally grazed areas typically showed an increase in first-order channels. Although there are difficulties with the assessment of changes in area between images (Shi *et al.*, 1995), the loss of defined creek channel is consistent with the proposition that trampling is modifying the channel network.

This chapter describes an investigation into whether trampling by Sika Deer crossing creeks has an impact on the rate of erosion of the creek sides. To achieve this, the following factors were measured:

(i) the rates of erosion of creek sides in areas where deer cross the creeks and in control areas where no deer cross
(ii) the relationship between rates of erosion and number of deer footprints
(iii) the relationship between rates of erosion and abundance of creekside vegetation.

Methods

The study site was an area of saltmarsh between Shipstal Point and Gold Point, Arne. Creek sections crossed by deer were located by following deer tracks across the marsh. Fifteen 1 m sections of creek crossed by deer and 15 control sections (i.e. not crossed by deer) were chosen at random from areas across the study site. The rate of erosion of each creek was measured between February 1999 and February 2000 by comparing the cross-sectional area of each creek section using the datum technique (Lawler, 1993). From this, the percentage area newly eroded between February 1999 and February 2000 was calculated.

The usage by deer of each crossing was measured in three ways.

(i) Footprint counting. Prints were found to last normally at least 7 days so the count was achieved by smoothing away all existing prints in each area and then returning a week later to record the number of prints deposited over that week. An estimate was made of the number and orientation of deer prints within 1 m x 1 m areas immediately either side of each creek-crossing every 2–3 weeks between March 1999 and March 2000.

(ii) Trampleometer. Bayfield's (1971) method for monitoring walker pressure on footpaths was adapted for use in the marsh. An array of 66 nails was embedded into the mud at each site with a spacing of 10 cm and covering an area of 0.5 m x 1 m. Each nail had a loop of 5-amp fuse wire soldered to its head. To set the trampleometer, all loops were pulled up and it was then left in place for a week. After this time, a record was made of the number of flattened loops.

(iii) Infra-red gate. An attempt was made to calibrate both of the above indices against actual counts of number of deer crossing the creek by setting up an infra-red beam and counting the number of times it was broken. However, comparison of deer movements with the infra-red counter records showed that deer were frequently not recorded and so this method was abandoned.

The percentage cover of each plant species within the 1 m x 1 m areas immediately either side of each creek-crossing was recorded in February 1999 and February 2000.

Results

Creek sections crossed by deer were found to be significantly more eroded than control creeks ($t = -3.40$, $P = 0.002$) (Figure 1). A significant correlation was found between erosion and the number of footprints pointing across the creek (Spearman rank $r = 0.518$, $P = 0.048$). No significant relationship was detected using the trampleometer (Spearman rank $r = 0.469$, $P = 0.53$), possibly because deer sometimes detected and avoided the trampleometer.

Creek sections crossed by deer were significantly less vegetated than control creeks ($t = -7.49$, $P < 0.001$) (Figure 2). Further analysis showed that, at the level of individual plant species in creeks crossed by deer, the loss of cover of *Puccinellia maritima* was significantly correlated with increased erosion (Spearman rank $r = -0.527$, $P = 0.043$).

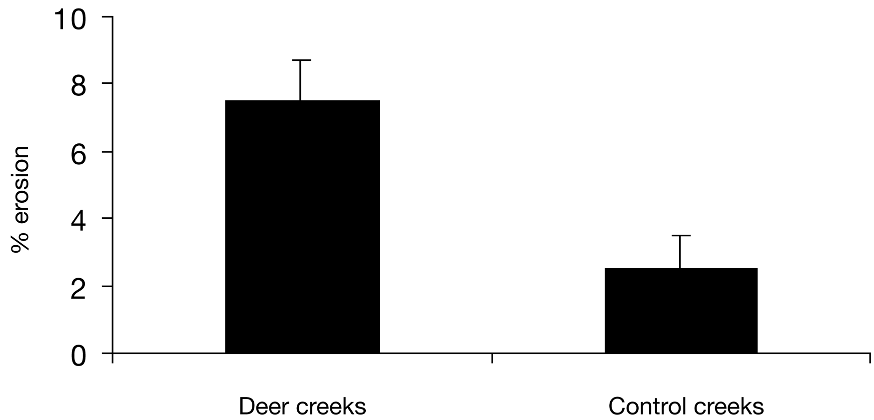

Figure 1 Mean percentage erosion in creek sections crossed by deer and in control section. Error bars show the standard error for each mean.

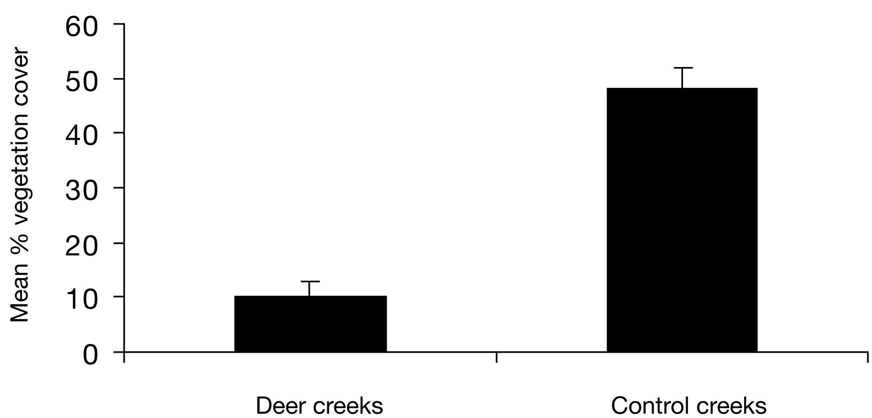

Figure 2 Mean percentage total vegetation cover in creek sections crossed by deer and in control section. Error bars show the standard error for each mean.

Discussion

The results from this preliminary study indicate that creek sections crossed by deer erode more quickly than control areas and that this is related to deer trampling. Trampling, like other forms of mechanical loading, can have direct effects on erosion rates by causing reduced soil porosity and increased compaction (Ford and Grace, 1998; Adam, 1990). Reduced porosity results in greater friction between particles decreasing sediment cohesion (Pestrong, 1965) and in turn increasing erosion rates (Shi *et al*., 1995). Future investigations will need to consider these effects.

Trampling can also have an indirect effect on erosion via its impact on vegetation cover. In the current study, a strong relationship between increased erosion and the loss of cover of *Puccinellia maritima* was found. Plant species are well known to differ in their abilities to bind sediments and baffle tidal currents (Gabet, 1998; Garofalo, 1980; Chapman, 1974). *Puccinellia maritima* is a shallow-rooted, stoloniferous grass that is particularly effective at colonizing and stabilizing bare mud (Hubbard, 1967). Its loss may assist the erosion around creeks.

Many factors can influence creek erosion rates: this study has shown the potential for deer activity to be a contributory factor in significant localized erosion of creek sides. However, the impact of deer trampling may simply be accelerating wider trends in saltmarsh morphodynamics. Both the local scale effects of trampling and their relation to wider trends in Poole Harbour need to be explored further.

Acknowledgements

We thank Neil Gartshore and all the staff at RSPB Arne for their assistance during this investigation.

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