INTERNATIONAL ORIENTEERING FEDERATION

A PHYSICAL MODEL
FOR COMPARING
THE TRAMPLING IMPACT OF
LARGE GRAZING MAMMALS WITH
ORIENTEERING AND OTHER
OFF-TRACK RECREATIONAL ACTIVITIES

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A PHYSICAL MODEL FOR COMPARING THE TRAMPLING IMPACT OF LARGE GRAZING MAMMALS WITH ORIENTEERING AND OTHER OFF-TRACK RECREATIONAL ACTIVITIES

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SUMMARY

Without the availability of detailed experimental data relevant to a particular terrain, it is difficult to predict the likely level of trampling damage from a large scale off-track recreational activity, such as orienteering. However, if large domestic or wild animals are present in the terrain and their numbers and the time they spend in the terrain can be reasonably estimated, it may be possible, by calculation, to relate their observed trampling damage to that expected of the recreational activity.

A simple model, based on physical principles, is proposed for calculating the relative trampling damage of recreational activities compared with that from large grazing mammals in the terrain. Use of the model for a case study of a large orienteering event suggests that the impact of the event would be negligible compared with that from a single grazer, this result arising from the very much greater time in the terrain spent by the grazer.

This model is offered as a predictive tool for land managers to assess the acceptability or otherwise of a large recreational off-track activity.

Contents

1. Introduction

In the absence of objective data on the trampling impact on soils and vegetation by off-track recreational activities, such as orienteering, relevant to the areas under their control, land managers and ecologists have to use subjective judgement about the acceptability of the activity. For large orienteering events, for example, with more than 1000 participants, there is a common perception that there is potential for widespread unacceptable levels of vegetation trampling. In such circumstances the land managers may refuse access as an environmental precautionary measure.

However, it may be possible to gain an insight into the potential trampling impact of the off-track recreational activity specific to the terrain in question, if there are large grazing mammals, domestic or wild, in the terrain and their numbers and time in the terrain can be reasonably estimated. This paper offers a simple physical model for comparing the trampling impact of a large grazing mammal with that of a recreational human being. Land managers can make objective judgements about the level of acceptability of the trampling damage from the grazers and relate this to the expected level of damage from the recreational activity as calculated by the model.

2. A simple physical model

The prime variable in damage to vegetation by trampling is considered to be the underfoot pressure (Cole and Bayfield (1993), Liddle (1997), Chapter 2). Although low forces and pressures may not be damaging, due to the elasticity of plant material, once the elastic limit is exceeded, as occurs with human and large mammal trampling, damage results. The relationship between pressure and damage is considered to approximate to linearity over the range comparing man and large mammals.

The second variable is the number of foot placements. Provided the foot placements affect undamaged vegetation, a reasonable starting assumption, this variable will also be linear. The physical relationship between damage and the two variables is then:

$$\text{Damage} \propto \text{Underfoot pressure} \times \text{No of foot placements} \qquad 1.1$$

The number of foot placements is given by the average stepping rate and the length of time that the subject is moving across the terrain. The relationship revises to:

$$\text{Damage} \propto \text{Underfoot pressure} \times \text{Stepping rate} \times \text{Time in motion} \qquad 1.2$$

In comparing the impacts of man and large quadrupeds the underfoot pressure exerted whilst moving in the terrain depends on the weight of the subject and the number of feet in contact with the ground. For a walking and running human the weight is essentially carried on one foot at any one time. For a large mammal the matter is more complex. If walking slowly, such as when grazing, there are three feet in contact with the ground at any one time. If moving with a brisker purpose, it has only two feet in contact with the ground at any one time (Gray 1953).

The relationship 1.2 becomes:

$$\text{Damage } D \propto (W / n \,.\, A) \;\text{x}\; s.T \qquad 1.3$$

where W = the weight of the subject;
A = underfoot area for each limb;
n = the number of feet in contact with the ground whilst moving
(n = 1 for human; n = 3 for a grazing mammal);
s = number of steps taken per unit time
T = time moving about the terrain

The damage (D) may be any of a number of indicators, such as the area affected or the mass of material showing signs of impact. The relationship 1.3 could be converted to an equation, were the constant of proportionality known. However, if it is assumed that the constants of proportionality are broadly similar for grazing mammals and man for a given damage indicator, then an equation comparing the trampling damage of a large grazer (g) with that of a human (h) can be established:

The equation is:

$$D_g / D_h = [(W / 3 \,.\, A) \text{ x } s.T]_{grazer} \;/\; [(W / 1 \,.\, A) \text{ x } s.T]_{human} \qquad 1.4$$

An example of the practical use of Equation 1.4 is given in the following case study.

3. Case study of Braunton Burrows Biosphere Reserve

The Braunton Burrows coastal sand dune area in the South West of England near the town of Barnstaple is a Site of Special Scientific Interest (SSSI) and a pending National Nature Reserve (NNR). The 12 km^2 site contains a number of rare plants, which accord its high conservation status. It is also the most important part of the North Devon UNESCO Biosphere Reserve. It might be expected that conservation management of a nature area of such importance would exclude public access or, at least, restrict access to designated routes or walkways. However, the site is unusual in that it has been used for military training since the early part of the last century. Access by the military is mostly on foot but there is also movement by specialised terrain vehicles. In view of the continued military use the landowners also permit casual public access. It is also relevant that the UNESCO Biosphere Reserve designation indicates a balanced relationship between people and nature.

In at least one important respect the military access to the area is beneficial to the ecology of the site. This is in assisting the maintenance of bare sand cover, essential for the survival of certain species, such as the rare Great Sea Stock *Matthiola sinuata*, which requires a shifting sand habitat. Therefore, the UK government nature advisory body which oversees the conservation of the site accepts that the military and casual public presence on the site is an unusual but essential element in its conservation management. This acceptance did not extend to additional access. In 1990 an application was made to hold a regional orienteering event with about 1000 entrants. The advisory body, then the Nature Conservancy Council, turned down the application on the grounds that the trampling damage from the event would be unacceptable.

However, it was learned that there were difficult management problems with the dune vegetation. The character of the dunes has been shaped by grazing, mostly by rabbits. Since 1954, when *myxomatosis* greatly reduced the population, and since reduced again by *viral haemorrhagic disease*, rabbit numbers have been less than 1% of their pre-1954 levels. Consequent upon the near total loss of grazing, the dunes have been progressively covered with coarse grasses and scrub to the detriment of the thyme-rich turf upon which many of the plant and animal specialities depend. Mowing the rank vegetation had taken place for many years but had not proved as effective as hoped. Instead the NCC favoured grazing by cattle and planned to introduce 200 head of moorland cattle into the dunes.

It is possible, using Equation 1.4, to compare the trampling impact of a single cow in the terrain for one year with that from an average adult orienteer. For grazing cattle, but not for orienteers, it is necessary to make a ‘lying down’ correction to their time in the terrain. Vickers (2003) reports that dairy cattle require 8 hours per day for this resting purpose. It is assumed that moorland cattle exhibit similar requirements and an average of 8 hours per day is taken as the period during which the contribution to overall vegetation damage can be ignored.

A correction is also needed to take account of different stepping rates for grazing mammals and human recreationists. In order to determine approximate values for the average number of steps per unit time, the author observed grazing cattle and walkers. In the case of grazing cattle this appears to be very variable, much less so for walkers. The observations showed, as might be expected, that there are more foot placements when moving from one grazing patch to another, although there can be considerable shuffling within the grazing patch. There are also periods of stasis. Observations of moorland cattle revealed a foot placement average of 43 ± 25 steps per minute and, for walkers 87 ± 12 steps per minute.

The data to be inserted are:

For the subject weights	W_{grazer} = 500 kg;	W_{human} = 75 kg;
Underfoot areas	A_{grazer} = 65 cm^2;	A_{human} = 200 cm^2;
Time in terrain total	T_{grazer} = 8760 h (1 y);	T_{human} = 1.25 h;
Time in terrain on feet	T_{grazer} = 5840 h;	T_{human} = 1.25 h;
Stepping rate	s_{grazer} = 43 min^{-1};	T_{human} = 87 min^{-1};

$$D_g / D_h = [(500 / 3 \times 65) \times 43 \times 5840]_{grazer} \; / \; [(75 / 1 \times 200) \times 87 \times 1.25]_{human}$$

$$= 15789$$

The calculation suggests that one cow, present in the terrain for one year, is equivalent, in terms of potential vegetation damage, to about 15,000 adult orienteers, in the terrain for an average of 1.25 hours each. For the proposed herd of 200 cattle the equivalent ratio is about 3 million orienteers.

Notwithstanding the approximate nature of the calculation and its assumptions, the conclusion that the trampling by competitors in the proposed large orienteering event was likely to be negligible compared with that of a year's grazing by a single cow, let alone a herd of 200 is convincing. The Nature Conservancy Council accepted this conclusion and withdrew their objection to the event based on trampling concerns.

4. <u>Discussion</u>

The case study calculation shows a very substantial difference between the damage from just a single large grazing mammal and a large orienteering event. The bulk of the difference is due to the grazer's much greater time in the terrain, the damage rates of man and grazer being broadly similar.

The model is simple but based on sound principles of physics. A number of assumptions have been made to maintain simplicity. It is questionable whether re-examining these assumptions and improving the sophistication of the model would make any major practical difference to the conclusion of the case study comparison, which is that the trampling damage from a large orienteering event is very much less than that from a single large grazing mammal. To invalidate that conclusion a factor of at least one order of magnitude would need to be produced.

There is, however, one difference between the pattern of damage by grazers and orienteers. The grazers' interest is focussed on grazing areas, so that their trampling damage is areal, although, when not grazing, they do have favoured routes in crossing areas. The orienteers' interest is on moving from one control point to the next, so their trampling damage tends to be more lineal, especially in the vicinity of the control points. This can produce visible trails of marked vegetation. Such trails are temporary, effectively vanishing in one, two or three growing seasons, depending on the nature of the affected vegetation (Mendoza 2008).

In conclusion it is suggested that orienteering and other off-track recreations wishing to access terrain which contains large grazing mammals may find this model, and the conclusions to which it gives rise, simple and effective for presenting a case to land managers.

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Communications

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