Behavioural quantification of welfare in farmed red deer

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ABSTRACT

Red deer have recently been introduced to the intensive domestic environment, where there are many social and physical constraints not experienced by wild deer. Aspects of the social environment likely to affect welfare include group size, density and composition. Physical aspects of the pasture environment which may influence welfare are shade, shelter, wallows and opportunities for ranging behaviour, while variables in the handling environment which are probably important are pen construction and lighting. Various methods have been employed to assess welfare in red deer. Studies of confined deer have indicated that they respond to aversive conditions at pasture by pacing along fencelines, and in the handling environment by nosing doors and walls. Preference testing has compared different handling environments and treatments, and demonstrated that human presence, novelty and mechanical restraint were aversive. Results from detailed studies of velvet antler removal suggest that improved methods of providing analgesia are possible. Research into modifying the basic character of farmed deer through genetic selection or intensive handling of deer calves has been instigated. Overall, high welfare standards in deer production systems are a realistic goal. There are no long-established traditions to adhere to, and a foundation of productive assessment techniques and results has been established.

Keywords: red deer, welfare, behaviour, assessment techniques, review.

INTRODUCTION

Deer were introduced to an intensive domestic environment just over two decades ago, when feral animals were captured in the forests and high country of New Zealand and transferred to the pastoral environment to establish a farming industry to supplement supplies of wild-shot venison to Europe. The main species caught was red deer (*Cervus elaphus*). Farming procedures were established largely through trial and error application of techniques used for other domestic species, modified to accommodate the relative agility and flighty nature of deer. Today there are over one million deer, mostly red, on farms in New Zealand. Venison and velvet antler are the major products, and there are markets for co-products such as deerskins, tails and pizzles (Fennessy *et al.*, 1991).

Over the last 20 or so years, deer industry concerns have shifted from the development of live capture and basic husbandry techniques to the marketing of products from deer. Domestic and overseas markets for agricultural products are becoming increasingly influenced by public concern for animal welfare, and it is recognised within the deer industry that this concern could be used to competitive advantage, by marketing high quality products from deer raised in systems which achieve high standards of animal welfare (McKendry, 1992).

Ensuring good welfare in farmed deer does not necessarily entail providing natural environments and minimal human interference. What is required is a system in which the specific needs of the species are met and negative aspects of handling are minimised. Thus research must be directed at (1) the social and environmental needs of deer, (2) the aversive components of handling procedures, and finally (3) altering the basic character of the farmed animal to suit the domestic environment, through selection or intensive handling.

This article reviews the above three areas of research. For each topic, background information on existing husbandry practices is followed by a description of relevant methodology, then findings to date from studies of red deer and directions for future work are discussed.

1. SOCIAL AND ENVIRONMENTAL NEEDS

a) Background

In their natural state, red deer are principally a temperate woodland species (de Nahlik, 1974; Clutton-Brock *et al.*, 1982), with feeding habits classified as intermediate between grass-roughage eaters and concentrate selectors (Hofmann, 1985). Habitat requirements include shade, and shelter during cold weather (de Nahlik, 1974). Wallows are utilised by both stags and hinds (Clutton-Brock *et al.*, 1982). Information on ranging and social behaviour in wild deer comes from studies of red deer on the island of Rhum off the Scottish mainland. Annually, individual hinds ranged over 190 ha, while stags inhabited a smaller range of 110 ha, and there were diurnal and seasonal patterns of movement within these ranges. Densities were about 15 deer/km^2. Hinds tended to live in home ranges overlapping those of their mothers, while stags dispersed from their dams' ranges between the ages of two and four years, to form loose associations with other stags. Male social behaviour altered during the rut when stags became intolerant of each other's presence and moved into areas occupied by hinds, where dominant individuals defended and mated with a group of females. Hinds sought high, isolated sites for parturition and early care of the young, then rejoined the herd

2-3 weeks later. Calves were suckled for 5-7 months, or longer if their dams were not pregnant (Clutton-Brock *et al.*, 1982).

The habitat of deer farmed intensively in New Zealand is vastly different from the habitat of wild deer. On intensive lowland deer farms, large herds of animals are generally rotationally grazed at high stocking densities on improved grass-clover pasture. Some similarity in social conditions between wild and farmed deer exists because the sexes are segregated, but groups are further segregated on the basis of age. Normal patterns of dispersal are prevented, as stags are held together during the rut (only a few selected animals are allowed access to hinds) and pre-parturient hinds often cannot become physically or spatially isolated from other hinds. Calves and dams are often permanently separated prior to the rut, when the calves are 3-4 months old, although post-rut weaning does occur (Moore *et al.*, 1985).

b) Assessment techniques

The activities of deer at pasture can be used to determine their welfare status. Behavioural indicators of inadequate confinement conditions include apathy, stereotypy, misdirected or aggressive behaviour, and inability to carry out normal behaviour (Fraser and Broom, 1990). Adequate conditions might be indicated by play, which tends to occur in environments where social and physical needs have been met (Fraser and Broom, 1990; Fagen, 1981). Needs for specific stimuli can be determined by providing animals with an environment rich in stimuli and observing how they spend their time (Arey *et al.*, 1991), or by providing a choice between environments offering different stimuli (O'Connell *et al.*, 1991).

c) Research on red deer

Social environments

Although welfare is not necessarily optimised by providing natural conditions, it may be worthwhile to investigate whether any of the social constraints of the farm environment are aversive to deer. Social variables which might be modified experimentally include group size, density and composition. Optimal social conditions may vary according to an individuals's sex, age, and the time of the year.

Weaning of calves at 3-4 months of age disrupts the normal social relationship between calves and hinds, and observations of disease-susceptibility in newly weaned calves indicate that the process is stressful (Mackintosh and Henderson, 1984; Griffin *et al.*, 1988). A behavioural study showed that the major responses to weaning were a decrease in resting and an increase in grazing and stereotyped pacing along fencelines (Pollard *et al.*, 1992a). Weaning stress was apparently reduced in that study through modifications to the social and physical environment as the presence of an unrelated adult hind and indoor confinement reduced pacing behaviour and improved weight gains. The calves tended to mimic the behaviour of the unrelated hind. This was demonstrated experimentally when avoidance of a novel object and a human was reduced if the hind also approached these stimuli (Pollard *et al.*, 1992a). The presence of the hind may have simulated a natural situation, by providing calves with a social model which substituted for the role of the dam, or perhaps the role of a leader hind as found in wild deer (Delap, 1957). Simulation of natural situations may have other applications in reducing social stress in farmed deer, for instance in situations where spatial isolation of pre-parturient hinds is not possible, cover or barriers providing visual isolation might be utilised.

Perhaps the most notable finding in the behavioural study of weaning was the increase in pacing behaviour seen in the separated calves. Fenceline pacing is also seen in stags and hinds during periods when individuals normally leave the herd (during the rut and prior to parturition, respectively), and during the rut, is most prevalent in subordinate stags (Blaxter *et al.*, 1974). It also occurs in newly captured animals and those attempting to join others in adjacent paddocks (Moore *et al.*, 1985). These observations indicate that measurement of pacing under experimental conditions may be a means of identifying social conditions which are aversive to farmed deer.

Because of the effect of social factors on fence-pacing, the social environment needs to be carefully controlled when behavioural studies are used to assess the effects of other factors such as handling treatments. This was illustrated in two experiments aimed at comparing the relative aversiveness of velvet antler removal and administration of pre-velveting analgesia (Matthews *et al.*, 1990) and also ear-tagging (Matthews and Cook, 1991). When observed at pasture the handled deer spent more time pacing than deer which had been left undisturbed in their paddock. Within the handled deer, no effect of the different treatments was found. One interpretation of the experimental findings was that pacing occurred because the handling treatments had been stressful, and the lack of difference in the behaviour of the handled groups indicated that the degree of stress was the same for all treatments (Matthews et al., 1990; Matthews and Cook, 1991). However the deer were separated from their usual social group when observed (L.R. Matthews, pers. comm.). Thus the deer may have paced because they were separated, rather than because of the previous handling treatments. Pacing also appeared to be related to disturbance by humans (L.R. Matthews, pers. comm.), as it initially decreased, but resumed the following morning when an observer arrived (Matthews et al., 1990; Matthews and Cook, 1991).

Physical environments

Deer kept at pasture often have little or no access to shade, shelter or wallows, and ranging behaviour is severely limited in small paddocks. As these environmental features are utilised by wild deer it is likely that farmed deer would benefit if they were provided. An initial assessment could be made by providing a large paddock with cover and wallows, and recording usage. It would also be worthwhile to compare the frequency of play behaviour in this enriched environment with that in a typical pasture, as play may prove to be experimentally useful as an indicator of environmental sufficiency. A more experimental approach would be to use a barrier to prevent access to a physical commodity which was normally available. This may induce pacing behaviour, as deer apparently pace when they are attempting to obtain food, shelter or water (Moore *et al.*, 1985).

d) Summary

Group size, composition and density, access to shade, shelter and wallows, and opportunities for ranging may affect the welfare of deer at pasture. Improved environments may be identified by activities, particularly stereotyped pacing along fencelines as an indicator of unfavourable conditions, and play as an indicator of favourable conditions. Other measurements include the time spent using specific stimuli, time spent in environments offering different stimuli, and pacing behaviour when access to the stimulus is prevented. Improvements in social situations may possibly be achieved by simulating natural situations, as with providing weaned calves with the company of an adult hind.

2. HANDLING

a) Background

Farmed deer must be periodically mustered into yards and subjected to routine husbandry treatments such as anthelmintic drenching, vaccination, ear-tagging, and velvet antler removal. At some time in their lives most also experience transportation for relocation or slaughter. During handling they are subjected to reduced control over physical and social environments, reduced social space, and other stimuli such as human presence, noise and unfamiliar surroundings. There is clearly some capacity for improvement of handling procedures. In a survey of 15 666 farmed red deer slaughtered during 1990-1991 in a North Island deer slaughter premises, 1.5% showed acute traumatic defects (recent wounds, bruises or fractures), and 1.2% showed chronic defects (Selwyn and Hathaway, 1992). Overall, due to physical damage, first grade skins account for less than 10% of all deer hides (Fennessy *et al.*, 1991).

b) Assessment techniques

Behavioural techniques to identify improved environments for close confinement of deer for handling and transport are the same as those described above for pasture environments, namely observation of activities and preference testing between different environments. Expected behavioural responses to the acute stressors encountered during handling include a reduction in normal behaviour (e.g. grooming), increased aggression, extreme responsiveness or withdrawal (Fraser and Broom 1990). Improved handling treatments can be identified using a y-maze preference test, in which the animals are taught to anticipate receiving one treatment if they enter the left-hand arm and an alternative treatment if they enter the right-hand arm (Grandin *et al.*, 1986). Another method of assessing handling treatments is to administer the treatment at the end of a single race and use the time taken to move down the race for successive treatments as a measure of aversiveness (aversion testing; Rushen and Congdon 1986). Measurement of behaviour during and following handling can also be worthwhile. Combined with analgesic treatment, behavioural observation can help to establish whether a handling procedure was painful (Wood *et al.*, 1991).

c) Research on red deer

Physical environments

Physical components of handling and transportation environments which might be modified to improve the welfare of deer include lighting, construction materials, pen size and position, and race and loading ramp design. Preferred environments should be identifiable, as deer demonstrated an ability to make consistent choices for specific environments in an experiment carried out in a t-maze in a deer yard. Nine stags were given the choice of entering either an empty pen, or a pen containing a person (Trial A) or an object (Trial B). In each trial, eight of the nine stags preferred to enter the empty pen three times in succession (Pollard *et al.*, 1991). The experiment followed preliminary trials in which problems were encountered with severe positional bias and rapid movement of the subjects through the testing area. These respective problems were overcome by placing the test in a neutral position relative to the yard exits, and by using subjects which were relatively tame (J.C. Pollard, unpublished data).

Social environments

As with the pasture environment, important variables to investigate in closely confined deer are group size, density and composition. Initial trials have measured responses to social isolation and mixing with unfamiliar animals (Pollard *et al.*, in press). Both treatments were associated with increases in walking and nosing at enclosure perimeters, and increased heart rate. A greater frequency of aggressive behaviour and decreased grooming was also observed during social mixing. The findings supported the contention that mixing of different social groups contributed to pre-slaughter handling stress (Alexander, 1988; Kay *et al.*, 1981; MacDougall *et al.*, 1979; Selwyn and Hathaway, 1990). The behavioural responses common to both stressors were increased walking and nosing at walls and doors. Thus as with pasture environments, activities directed at enclosure perimeters may be indicative of aversive conditions. Against this suggestion however, was the observation that hand-reared hinds nosed the ground and walls of a novel testing race more often than naturally-reared hinds, and this behaviour was interpreted as exploration (Blaxter *et al.*, 1988). Different forms of nosing behaviour may exist, one associated with attempting to escape and one associated with exploration, and it is clear that loose definitions of behaviour should be avoided if definitive comparisons between environments are to be made.

Handling techniques (i) Restraint

Deer must be restrained for administration of animal health and artificial reproduction treatments, and velvet antler removal. Restraint is likely to be aversive because it subjects the deer to close human presence without control over the situation. Mechanical, electrical and chemical techniques are available, and trials have investigated responses to the first two methods. Preference testing in a y-maze (as described in Section 2b) was used to compare responses to restraint versus no-restraint treatments in a mechanical crush. Deer were given a choice of entering a crush in which they were restrained, or a crush which they were allowed to walk

through without restraint. They learnt rapidly (within one exposure to each treatment) to enter the crush they were allowed to walk through, and when forced to enter each crush, took progressively longer to enter the side where they were to be restrained (Pollard *et al.*, 1993). These results indicated that preference testing has potential for comparing different handling treatments carried out under restraint, or different methods used for restraining deer. However preferences may be more difficult to measure when similar treatments are compared, as the rate of learning is related to stimulus intensity (Kimble, 1955; Boren *et al.*, 1959).

Responses to electrical restraint were investigated using aversion testing, in which 19 deer were repeatedly subjected to electroimmobilisation at the end of a single handling race. No increase in the time taken to move down the race towards the handling area was found (Stafford and Mesken, 1992). The findings contrasted with studies of sheep (Rushen and Congdon, 1986) and cattle (Pascoe and McDonell, 1986) in which electroimmobilised animals took progressively longer to enter the handling area, and with other indications that the treatment is highly aversive (Stafford and Mesken, 1992). Velveted deer also showed no increase in reluctance to enter the treatment area (Matthews *et al.*, 1990; Pollard *et al.*, 1992b), despite evidence that velvet antler removal is aversive (see below). Thus aversion testing may not be a suitable means of assessing responses of red deer to handling treatments. This is not due to an inability to anticipate receiving a specific treatment as deer avoided crush restraint in the preference test described above. Perhaps their strong aversion to humans (Blaxter *et al.*, 1988) results in a high motivation to escape from the handler drafting them into the treatment area, which overrides any tendency to avoid being treated.

Handling techniques (ii) Velvet antler removal

Velvet antler is harvested primarily for sale, but its removal also prevents later injuries from hard antlers, and damage to soft antlers if stags are handled in the velvet stage. Velvet is growing, innervated tissue, and is typically removed under local anaesthesia, with the stag restrained either chemically or mechanically. There are indications that this procedure is aversive to deer. Struggling and tachycardia were seen in stags velveted under mechanical restraint and local anaesthesia (Matthews and Cook 1991; Matthews *et al.*, 1992; Pollard *et al.*, 1992b), and the heart rate of velveted stags increased when they were re-exposed to the treatment area the following day (Pollard *et al.*, 1992b). When two stags were velveted without local anaesthesia, struggling and tachycardia were more pronounced (Matthews and Cook, 1991).

A different line of research has investigated the effect of velvet removal on the subsequent behaviour of stags. Activities of nine stags which were restrained only, or restrained and velveted, were recorded indoors during the first three hours following treatment, and then recorded at pasture 3 and 6 hours later. During all observation periods the behaviour of the velveted stags differed from that of restrained stags (Pollard *et al.*, 1992b).

Handling procedures (iii) Ear tagging

Ear-tags are inserted without anaesthesia, usually when calves are young. When three one-year-old deer were tagged under mechanical restraint, their behavioural reaction to the procedure was "strong" and heart rate was elevated (Matthews and Cook, 1991). A comprehensive assessment of responses to tagging would involve determining the effects of age and application technique. Alternative methods of identification such as depigmenting compounds (Stookey *et al.*, 1992) could also be investigated.

d) Summary

The welfare of deer in close confinement for handling and transport will be affected by the same social factors as deer at pasture, plus the physical stimuli of indoor environments and handling treatments. Deer have shown an ability to choose between different physical environments, and unfavourable social conditions are identifiable by increased activities directed at enclosure perimeters, similar to the stereotyped pacing behaviour seen in unfavourable pasture environments. The relative aversiveness of different handling treatments can be compared using preference testing in a y-maze. Overall, research into handling techniques and farm procedures has the potential to make a significant improvement to the welfare of farmed deer.

3. ALTERING BEHAVIOURAL CHARACTERISTICS

a) Background

An alternative approach to modifying farming procedures to improve welfare is to utilise animals which are amenable to the domestic environment. Several authors have proposed that genetic selection for farmed deer with desirable behavioural characteristics might be carried out (Beatson, 1986; Yerex, 1982; Pearse, 1988). In accordance with Fennessy (1987) a successful selection programme must have a clear, measurable objective, the character selected for must be heritable, and there must be variation for the desired character within the population subject to selection. While no objective data are available, it appears that the latter two requirements are satisfied in red deer, as some genetic strains have reputations for quietness (Fennessy, 1989). Thus it remains to clearly define desirable behavioural characteristics and develop a reliable measurement technique. A second method of altering behaviour is to intensively handle animals, particularly when they are young (Denenberg, 1969). For instance, cattle handled twice daily for two weeks at 8-10 months of age were less aggressive and showed less avoidance of humans than non-handled cattle when tested at 15 months (Boivin *et al.*, 1992). Hand-rearing is probably not a suitable method of taming deer, as it is labour-intensive and both stags and hinds can become highly aggressive (Blaxter *et al.*, 1974; Moore *et al.*, 1985), perhaps because social behaviour normally directed at other deer is transferred to humans.

b) Assessment techniques

Open field testing provides a controlled means of measuring individual temperament to allow comparisons between

genetic lines (Hemsworth *et al.*, 1990) or the effects of different handling treatments (Boissy and Bouissou, 1988). The technique involves placing an animal in an enclosure, usually with an additional stimulus such a novel object or human, and measuring movement within the pen and the frequency of activities such as nosing the ground, defecation and vocalisation. Other measures of temperament include responses to human approach (Boissy and Bouissou, 1988) and ease of movement through yards (Tilbrook *et al.*, 1989).

c) Research on deer

Selection

Open field testing was used to assess the behaviour of groups of six calves (Pollard et al., 1992a) and the technique was subsequently modified to test individual calves. A combination of open field testing, and responses to human presence and drafting was used to describe individual behavioural profiles in newly weaned deer (J.C. Pollard, unpublished data).

Taming

A comparison of the relative tameness of hand-reared versus dam-reared deer was made by recording the responses of individuals to human approach in a 25m handling race (Blaxter *et al.*, 1988). The dam-reared animals could not be approached as closely, moved passed the human in the race at a faster gait, and were more likely to hold their head up and grind their teeth when they were close to the human, compared with the hand-reared deer. They also showed less exploratory behaviour (smelling the ground and race walls). No effects of different handling treatments given after 12 months of age were found within naturally-reared deer, but there was some indication that hand-reared animals became less tame if they subsequently had little contact with humans.

A less definitive study of the effects of different rearing techniques on the behaviour of red deer calves was made by Krzywinski (1984). It was subjectively assessed that the greatest degree of tameness was achieved by rearing isolated calves in the company of humans. Some calves were successfully tamed by separating them from their dams at 1-2 months and confining them in a dark shelter for 10 days, while intensive handling of calves in the company of their tame dams was said to result in a poor degree of tameness.

From the above studies it appears that any taming programme should be carried out when calves are young. Given that indoor confinement of weaned calves is desirable (Moore *et al.*, 1985; Pollard *et al.*, 1992a) perhaps a convenient method of achieving a moderate degree of tameness would be to maximise human contact with weaners during an extended period indoors.

d) Summary

Improvements in deer welfare may be effected through modification of the behaviour of the animal through genetic selection or intensive handling. Intensive handling of calves will reduce fear of humans, but hand-rearing should be avoided as animals can become highly aggressive. Current trials aim to provide a reliable means of assessing behavioural traits as a basis for selection or for comparison of taming techniques.

CONCLUSION

High standards of welfare in deer production systems are a realistic goal. There is economic motivation to develop them, there are no long-established traditions to adhere to, and a foundation of productive assessment techniques and results has been established. Ultimately, deer welfare will be *improved* by identification and elimination of unfavourable elements of husbandry, and *optimised* by identification and provision of favourable elements. Together with modification of animal temperament, these changes will ensure that the welfare of farmed deer is not compromised.

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