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A non-intrusive method of assessing plumage condition in commercial flocks of laying hens

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Abstract

Standard techniques for assessing plumage damage to hens from feather pecking typically require capture and handling. Handling of individual birds for plumage assessment is relatively easy in experimental studies; however, close inspection of individual birds in commercial flocks is less feasible because catching birds is difficult, may compromise bird welfare and affect egg production. The aim of this study was to assess a non-intrusive method for scoring plumage damage in a commercial free-ranging flock of laying hens. Plumage damage was scored within a 2 m distance of the birds, without capture or handling, using a 5-point scale for 5 body regions. The feather scores, recorded at a distance, by two independent scorers were compared (distance scores), and were then compared with feather scores recorded by a scorer who caught and handled the birds to examine the plumage damage closely (capture scores). There was a significant and positive correlation between the distance scores and the capture scores, and the mean correlation coefficient for all plumage score traits was 0.89. There was also a significant and positive correlation between scorers, and the mean correlation coefficient for all plumage score traits was 0.84. The standard deviation of the residual mean difference between scorers and between methods was less than 1 point for individual body regions and less than 1.5 points for the total body score. Large variation in feather damage within a flock and small sample size increased the standard error of the mean total feather score. When feather damage variation within flocks is low (ie little observed feather damage), the current industry standard of scoring a sample of 100 birds is likely to provide a reliable estimate of flock feather damage; however, when there is large variation within birds of a flock (ie considerable observed feather damage) ≥ 200 birds should be inspected to accurately monitor changes in plumage condition. The non-intrusive method of feather scoring described in this paper may be useful for commercial-scale feather pecking studies or for farmers who need to assess the plumage damage of their flocks reliably, quickly and with minimal disturbance or stress to the birds.

Keywords: *animal welfare, feather pecking, feather score, non-intrusive technique, plumage damage, sample size*

Introduction

The behaviour known as feather pecking is when one hen pecks at or plucks the feathers from another bird. Feather pecking can be defined in different ways with distinctions between different types of pecking (Savory 1995), and may result in poor quality plumage, patches of feather loss and damage to the skin. In addition, birds experience pain when feathers are removed (Gentle *et al* 1990), and damaged birds have poor thermoregulation and consequently greater energy demands than unaffected birds (Leeson & Morrison 1978; Tauson & Svensson 1980; Tullett *et al* 1980; Peguri & Coon 1993). Egg production can also decrease (Johnsen *et al* 1998; El-Lethey *et al* 2000) and damaged birds may be cannibalised (Allen & Perry 1975). Because feather pecking is one of the most serious welfare issues facing the egg industry, understanding its causal basis is a major priority (Jones *et al* 2004; Rodenburg *et al* 2004).

When investigating the effects of housing, environmental or other factors on feather pecking, the assessment of plumage condition using feather scoring is often used as an alternative method to direct behavioural observations (Bilcik & Keeling 1999). This is because it may be difficult to observe pecking behaviour, and actual feather damage is more relevant to bird welfare. However, as this method of assessment involves catching and handling the birds, it is potentially stressful as well as being both difficult and time consuming. A reliable method of assessing feather damage that did not involve handling would be a major advantage both for research and flock management. The first requirement of a non-intrusive visual inspection method would be for it to provide as much, and as reliable, information as methods that involve catching the birds (eg Hughes & Duncan 1972; Allen & Perry 1975; Tauson *et al* 1984; Norgaard-Nielsen *et al* 1993; Vestergaard *et al* 1993; Hansen & Braastad 1994; Kjaer & Sorensen 1997; Johnsen *et al* 1998; Bilcik & Keeling 1999; Nicol *et al* 1999; Albentosa *et al* 2003). Various scales for plumage condition are currently used; for example, Hughes and Duncan (1972) estimated feather pecking damage by assigning a single score (0–4, best–worst, respectively) for the whole body. The same

5-point scale, but assigned separately for 4 body parts, was used by Allen and Perry (1975). Bilcik and Keeling (1999) used a similar 5-point scale but for 11 body parts, and Tauson *et al* (1984) used a 4-point scale (1–4, worst–best, respectively) for 5 body parts. Flight feathers (tail and primaries) are sometimes scored slightly differently to body feathers (Wechsler & Huber-Eicher 1998; Bilcik & Keeling 1999; Aerni *et al* 2000). The fewer the points included in the scale, the wider the range of plumage condition for each score. Conversely, a very detailed scale makes it more difficult for different observers to give the same score when independently scoring the same bird. One advantage of using a method where individual scores are given for different parts of the hen's body is that more detailed information is obtained on where the plumage is damaged and to what extent the plumage is damaged.

A second requirement for a valid visual inspection method is that it should be usable on a commercial scale with large flocks of birds. The handling of individual birds for plumage assessment is relatively easy in experimental studies in which groups of < 200 individually marked birds housed in small pens are involved (eg Hughes & Duncan 1972; Norgaard-Nielsen *et al* 1993; Vestergaard *et al* 1993). Close inspection of individuals in commercial flocks of > 2000 birds is less feasible (particularly for free-range and barn/aviary systems) because catching birds is difficult, may compromise bird welfare and/or affect egg production. Catching and handling of birds is therefore discouraged by farmers (L Craig, Deans Foods Ltd, UK, personal communication). To overcome this problem researchers either score plumage condition of individual birds less frequently (Gunnarsson *et al* 1999; Green *et al* 2000) and possibly miss important information on the development of feather pecking within a flock, or score plumage condition from a distance. For example, Huber-Eicher and Sebo (2001a,b) estimated the percentage of birds in commercial laying hen flocks with damaged tail feathers. Starting from the nearest bird, all tails in view were judged until 10% of the total number of birds in the pen was reached. Bestman and Wagenaar (2003) scored plumage condition of organically reared laying hens on a 9-point scale and for 9 body parts (maximum 40 birds per flock). Birds were scored within a distance of 2 m from the observer. In the first studies (Huber-Eicher & Sebo 2001a,b), tail damage may not have been representative of total feather damage (see Norgaard-Nielsen *et al* 1993), and no detail on the degree of feather damage or other body regions affected was obtained. In the second study (Bestman & Wagenaar 2003), the large scoring range and number of body regions would have been time consuming and difficult to replicate between independent scorers (Tauson *et al* 1984). Assessing the plumage condition of 40 birds per flock is well below the industry standard of ≥ 100 birds per flock (ADAS Gleadthorpe, UK) and finally, the researchers did not state whether scoring from a distance was a good approximation of scoring by handling the bird.

Finally, the current industry standard of scoring ≥ 100 birds per flock is determined on the basis of convenience rather than statistical error (ADAS Gleadthorpe, UK). A valid inspection method requires that the feather score determined from the sample is a reliable estimate of feather score for the entire flock.

This study describes a method of plumage assessment in laying hens in which the area and degree of plumage damage of birds in commercial flocks can be reliably determined using a visual inspection method at a distance from the birds without the need for capture, and therefore with the minimum of disturbance or stress to the birds themselves. The aims of this study were to determine: (1) whether the visual inspection method correlated positively with feather scores recorded when a bird was caught and closely examined for plumage damage (ie the current standard technique for assessing plumage damage); (2) whether there was good inter-scorer reliability using this distance visual inspection method; and (3) how sample size and feather damage variation within a flock influenced error estimates of feather damage for an entire flock.

Materials and methods

Non-intrusive method validation

In order to validate a distance visual inspection method of plumage assessment, an experiment was carried out on a commercial free-range flock of 4200 Oakham Blue hens (the current laying flock at the time of the experiment) at the Food Animal Initiative (FAI) farm Wytham, Oxford, UK. The FAI is a commercial farm that can be used for research purposes. The birds were 73 weeks old at the time of the experiment and many had extensive plumage damage (A Bright, personal observation), although there was large inter-bird variation in plumage condition. The birds were housed in four mobile arks (126.84 m^2 each), with daily access to 1 hectare of wood chip on which to range between 0900h and approximately 2100h (summer dusk); during the day, birds were free to move between the four houses. Commercial grade layer mash was provided *ad libitum* in pan feeders (4.6 cm per hen) and water by nipple drinkers (146 per house). Lighting to each house was supplied by natural light and 12 Sollatek Lumina 12 V compact fluorescent bulbs (Tafelberg Marina Ltd) on a 15 h:9 h light:dark cycle (light: 0700h–2200h).

We inspected the plumage condition of birds within a single house each day, for four days (June 2004), between 0700h–0900h, before the birds were let out onto the range. For all birds, the body was divided into 5 different regions: neck, back, rump, tail and wing (Bilcik & Keeling 1999). The neck, back and rump were scored on a 0–4 (best–worst) scale adapted from Allen and Perry (1975) (Table 1). Slightly different criteria were used for scoring flight feathers (tail and wing primaries) because of the different types of feathers and damage (Table 1). The underside of the neck or the breast was not scored because feather damage in these regions may be attributable to abrasion from the feeders and unrelated to pecking damage from other birds (Bilcik & Keeling 1999).

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Table 1 A description of the scoring method used to evaluate feather condition (adapted from Allen & Perry 1975); a slightly different scale was used for flight feathers compared with feathers on the rest of the body.

Score	Body	Flight feathers
0 (best)	Well-feathered body part with no or very little damage	Intact feathers
1	Slight damage with feathers ruffled but where the body is completely or almost completely covered	A few feathers separated and/or broken or missing
2	Severe damage to feathers but localised naked area (< 5 cm^2 naked)	All feathers separated and several broken or missing
3	Severe damage to feathers and large naked areas (> 5 cm^2 naked)	Most feathers missing or broken
4 (worst)	Severe damage to feathers, > 5 cm^2 naked area and haemorrhage by broken skin	All feathers missing or broken and/or haemorrhage by broken skin

A catching frame (three wooden panels of 1 × 0.7 m [length × height]) holding up to 10 birds was placed, where space allowed, within a house and birds were slowly flushed towards the frame by two scorers and enclosed within the frame. The frame was moved after several 'catches' and the scorers attempted to flush birds from all parts of the house to prevent birds being caught repeatedly.

For the assessment of plumage condition, a focal bird within the catching frame was chosen by the two scorers; the colour (Oakham Blue hens are black, white or grey) of the focal bird was recorded.

Method 1 — distance method: the first scorer (M1a) examined the focal bird from behind the catching frame (ie within 2 m of the bird) and scored the feather damage on the 5 body regions (total number of focal birds scored per house: n = 58, 82, 95, 80 in house 1–4 respectively, total n = 315). The second scorer (M1b) scored the feather damage of approximately 40% of the total focal birds inspected in each house (n = 24, 33, 38, 32 in house 1–4 respectively, total n = 127). This score was always kept blind from, but matched to, the first scorer. M1b scored only 40% of the focal birds to restrict the capture/scoring period to 2 h and to ensure that the birds weren't kept inside past 0900h (ie the time birds were normally let out onto the range).

Method 2 — capture method: the scorer (M2) picked up the same focal bird as scored by M1a, and carefully examined and scored the plumage for damaged, broken or missing feathers (M2: n = 58, 82, 95, 80 in house 1–4 respectively, total n = 315). Each body region was scored in a randomly different order to that in Method 1.

Statistical analysis

For M1a, M1b and M2 a total feather score for each bird was calculated by summing the scores for each body region. Hence this score could reach a maximum of 20 (4 × 5) or a minimum of 0 (0 × 5). The data are presented as means ± standard deviation (SD) as a measure of the maximum difference between scorers and methods for all 5 body regions as well as the total feather score.

To establish whether house or bird colour influenced the scorers, house number (ie 1–4) and bird colour effects were tested on the residual difference between total feather score for each scorer and method by fitting the General Linear Model, Residual difference total feather score = House + Colour (Minitab for Windows, Release 14, MINITAB® Inc). No effects of time or bird colour were found on the residual differences between total feather scores for each scorer or method; therefore, a Pearson's correlation was used to test the reliability between the two scorers and between Method 1 and Method 2. Analyses were carried out on all 5 body regions as well as the total feather score.

Sample size error estimates

To examine the effects of sample size and feather damage variation within a flock on the error estimates of mean flock feather scores, six flocks from four commercial free-range laying farms (Dean's Food Ltd) were feather scored using the distance visual inspection method described above. The flocks were aged between 22 and 73 weeks at the time of the plumage assessment and were made up of a variety of commercial free-range laying breeds (Lohman Traditional: two flocks; Lohman B: one flock; Hyline: one flock; Oakham Blue: two flocks); flock size varied between 2500 and 4200 birds (all flocks were considered medium sized on a commercial scale). Four-hundred birds were scored from five flocks and 300 birds from one flock.

Flocks were coded with a '1' if the range of total feather scores was ≤ 5 points (three flocks) and a '2' if the range of total feather scores was > 5 points (three flocks). The standard error of the mean total feather score was calculated for the first 50, 100, 200, 300 and 400 birds sampled in a flock.

Results

Non-intrusive method validation

The rump of the birds was found to have the greatest plumage damage, followed by the tail; damage to the neck, back and wings was comparatively low with most birds scoring a 1 or 0 in these regions (Figure 1).

The mean residual difference between Method 1 (M1a, M1b) and Method 2 (M2) scores for all body regions ranged from 0.04 ± 0.29 to 0.13 ± 0.58 (Table 2) Overall, scores tended to be slightly higher (ie more damage noticed) after picking up a bird to inspect the feather damage. However, the residual mean difference between M2 and M1a for total feather score was 0.43 ± 1.16 and

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Table 2 Mean residual difference in feather score ± standard deviation between scorers (M1a–M1b) and between methods (M2–M1a, M2–M1b) for individual body regions and total feather score; M1 = distance, M2 = capture method.

Residual difference	Neck	Back	Rump	Tail	Wing	Total	Total n
M1a–M1b	0.02 ± 0.50	0.01 ± 0.53	0.06 ± 0.38	–0.04 ± 0.54	0.05 ± 0.60	0.08 ± 1.19	127
M2–M1a	0.10 ± 0.37	0.08 ± 0.34	0.04 ± 0.29	0.13 ± 0.38	0.06 ± 0.34	0.43 ± 1.16	315
M2–M1b	0.12 ± 0.56	0.06 ± 0.51	0.09 ± 0.40	0.05 ± 0.55	0.13 ± 0.58	0.40 ± 0.82	127

Table 3 Pearson's correlation coefficients and the level of significance for feather score comparisons between scorers (M1a and M1b) and between methods (M1a and M2, M1b and M2) for individual body regions and total feather score; M1 = distance, M2 = capture method.

Correlation	Neck	Back	Rump	Tail	Wing	Total	Total n
M1a and M1b	0.83***	0.81***	0.92***	0.88***	0.71***	0.91***	127
M1a and M2	0.91***	0.92***	0.96***	0.94***	0.91***	0.97***	315
M1b and M2	0.79***	0.83***	0.91***	0.88***	0.74***	0.92***	127

*** indicates significance at 99.9% level ($P < 0.001$)

between M2 and M1b 0.40 ± 0.82 (Table 2), indicating that there was a good correlation between scores obtained using the distance and capture methods.

The mean residual difference between M1a and M1b scores for all body regions ranged from –0.04 ± 0.38 to 0.06 ± 0.54 (Table 2). Although M1a tended to score slightly higher overall than M1b, the mean residual difference for total feather score was 0.08 ± 1.19 (Table 2), further confirming that there was very good inter-scorer reliability using this distance method.

There were strong positive correlations between scores using Method 1 and Method 2, and between scores given by M1a and M1b (Table 3). This was found for all body regions as well as the total feather score. Correlation coefficients between M1a and M2 (ie Method 1 and 2) varied between 0.91 (neck) and 0.97 (total; Table 3). Correlation coefficients between M1a and M1b varied between 0.71 (wing) and 0.91 (rump; Table 3). Finally, M1b and M2 were compared to eliminate any effect of scoring bias by the first scorer; correlation coefficients varied between 0.74 (wing) and 0.91 (rump; Table 3). Correlations between scorers tended to be lower for scoring feather damage on wing primaries (Table 3); however, all correlations were significant at the 99.9% level ($P < 0.001$).

Sample size error estimates

Large variation in feather damage within a flock increased the standard error of the mean total feather score compared with flocks with low variation in plumage damage (Figure 2). Sample size also influenced the standard error when there was large variation in feather damage within flocks, but only when sample size was ≤ 100 birds (Figure 2).

Discussion

This study used a non-intrusive method for assessing plumage damage from feather pecking in a commercial flock of laying hens. Plumage damage was scored using a 5-point scale on 5 body regions within a 2 m distance from the bird but without capture or handling.

The majority of plumage damage in this flock was to the rump, followed by the tail (Figure 1). Damage to the neck, back and wings was low. These results are similar to those of other studies where the back/rump region and tail received the majority of damage from feather pecking (Tauson *et al* 1984; Norgaard-Nielsen *et al* 1993; Bilcik & Keeling 1999). The high total body score indicated that the birds had quite extensive plumage damage, which is not unusual for end of lay birds (Hughes & Duncan 1972; Bilcik & Keeling 1999).

There was a significant and positive correlation between the distance scores (M1a and M1b) and the capture scores (M2). The mean correlation coefficient for all plumage score traits was 0.89 (Table 3). Birds tended to be scored slightly higher when caught and closely examined because plumage damage and bare patches were sometimes covered by overlying feathers. However, overall the residual difference between methods was low (Table 2) and the standard deviation was less than 1 point for individual body regions and less than 1.5 points for total feather score.

There was also a significant and positive correlation between scorers (M1a and M1b) using the distance method, although the correlation between scorers tended to be lower when scoring feather damage of the wing primaries (Table 3). Damage to the wing primaries, attributable to feather pecking, may be harder to determine because the area of damage cannot be quantified as on the body regions and broken feathers are not as visible as on the tail. The mean correlation coefficient for all plumage score traits was 0.84 (Table 2). These results are in accordance with other studies that have compared inter-scorer reliability for feather damage in laying hens (eg Adams *et al* 1978; Tauson *et al* 1984). Furthermore, the residual difference between scorers using the distance method was very low (Table 3),

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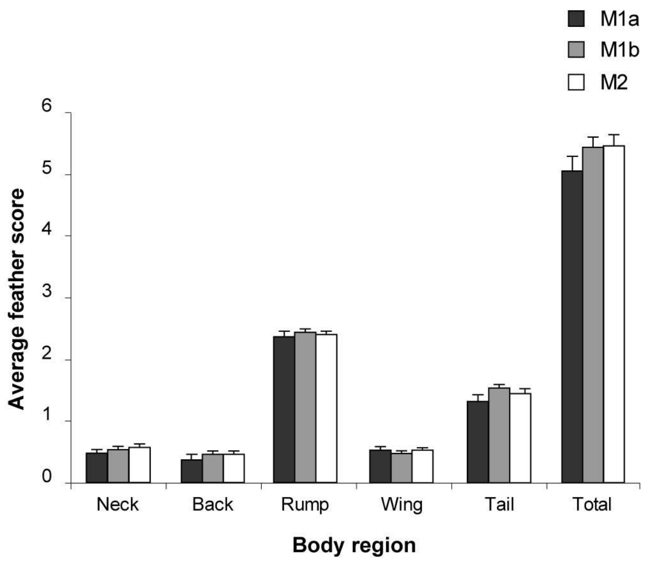
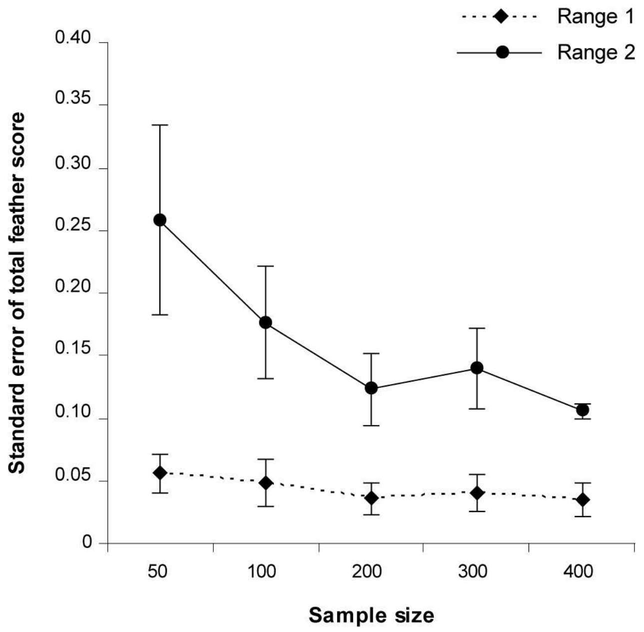
Figure 1



Average feather score for neck, back, rump, wing, tail and total for scorers M1a (Method 1 = distance, Scorer 1: total n = 315), M1b (Method 1, Scorer 2: total n = 127) and M2 (Method 2 = capture: total n = 315). Error bars are standard errors.

Figure 2



Standard errors of total feather score as affected by sample size and feather damage variation; Range 1 = range of total feather scores ≤ 5 points, Range 2 = range of total feather scores > 5.

with the standard deviation less than 1 point for individual body regions and less than 1.5 points for total feather score.

When there was low variation (ie ≤ 5 points) in feather damage within a flock, sample size had little influence on the standard error estimates of mean total feather score (Figure 2). In flocks with high variation (ie > 5 points) in feather damage within a flock, there was larger variation in standard error estimates of mean total feather score at low sample sizes (ie 50 birds, 100 birds); however, above a sample size of 200 birds the standard error variation was reduced (Figure 2). The results from this study are similar to those of Kestin and Knowles (2004) who estimated the number of broiler birds that needed to be sampled in order to determine the prevalence of lameness. Kestin and Knowles (2004) concluded that when the proportion of lame birds within a flock was low, examining smaller numbers of birds was adequate to have reliable (± 0.05) estimates of the prevalence of flock lameness; as the proportion of lameness increased, larger numbers of birds would need to be examined. However, regardless of the proportion of lameness, estimate precision was not significantly improved by increasing sample sizes above approximately 300 birds (Kestin & Knowles 2004). The results of this study demonstrate that when feather damage variation within flocks is low (ie little observed feather damage), the current industry standard of scoring a sample of 100 birds is likely to provide reliable estimates of flock feather damage; however, when there is large variation within birds of a flock (ie considerable observed feather damage) ≥ 200 birds should be inspected to accurately monitor changes in plumage condition.

Once a scorer was familiar with the method, a distance plumage assessment for an individual bird could be completed within 10 s (on the basis of this study). Using a randomly marked transect, and moving slowly between and around birds to ensure all body regions are visible, 100 birds in a commercial flock can be scored in less than 1 h.

Animal welfare implications

Provided scorers regularly re-assess the feather damage scale they are using between and within flocks, the method described in this study may be useful for other commercial-scale feather pecking studies where birds need to be assessed for plumage damage with minimal disturbance, particularly longitudinal studies where flocks are assessed regularly throughout the rear and lay period. The reliable assessment of plumage damage can also assist commercial farmers in improving the health and welfare of their laying hens. The method of feather scoring described in this study may prove useful to commercial farmers who previously did not carry out regular quantitative plumage assessment of their laying flocks because catching birds was time consuming and disruptive. Finally and most importantly, this method can be carried out with minimal disturbance or stress to individual birds or the flock.

Conclusions

This study has demonstrated that our method of feather scoring birds from a within 2 m distance, using a 5 point scale for 5 body regions, correlates well with feathers scores obtained by capturing and handling the birds, has a high inter-scorer reliability and can be carried out quickly while providing adequate detail on degree of plumage deterioration to different body regions.

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