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1 **An ethological approach to determining housing requirements of gamebirds in raised**
2 **laying units**

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Abstract

Each year, the UK rears around 20-30 million pheasants and 3-6 million red-legged partridges for shooting purposes. However, welfare organisations and some members of the gamebird industry itself have raised concerns about the use of raised laying units for breeding gamebirds. Although the proportion of breeding gamebirds kept in raised systems is relatively low there is some evidence that numbers may be increasing yet the incidence and severity of the challenges to gamebird welfare when housed in raised cages has never previously been assessed. Concern has also been raised over the ethics of confining semi-wild birds in barren cages as gamebirds are deliberately bred to retain their semi-wild behaviour which may be related to flying characteristics. The Farm Animal Welfare Committee and some sections of the gamebird industry have voiced concerns that such systems are incompatible with their ethical values, suggesting that the welfare of gamebirds in cages justifies rigorous assessment.

Currently, an assessment of whether cage-based breeding systems meet duty of care requirements is constrained by a lack of understanding regarding the needs of captive gamebirds. Identifying the birds' needs is a necessary step in defining what constitutes suitable enrichment for breeding gamebirds to optimise both welfare and animal production. Any caged-laying environment must therefore take into account the breeding ecology of the species in question and, importantly, allow the birds to display behaviours necessary to maintain health and welfare.

This is the first review to examine the behavioural ecology and, specifically, the breeding systems, of the ring-necked pheasant (*Phasianus colchicus*) and red-legged partridge (*Alectoris rufus*) with the aim of highlighting areas where a species-specific behaviour would indicate a requirement for a specific resource to be made available to the birds. This review highlighted possible behavioural needs for resources targeting foraging behaviours, foot and

75 claw function, suitable materials for dustbathing and privacy areas where birds can lay eggs
76 or escape social pressures. These behavioural needs may be met by furnishing cages with a
77 suitable type of solid floor and perching apparatus for enabling natural foot and claw function,
78 by provision of dustbathing material to satisfy both dustbathing and foraging behaviour and
79 by provision of privacy areas where birds can escape unwanted social encounters or lay eggs.

80
81 The outcomes of this paper form the basis with which to develop and assess the welfare
82 impacts of enrichment strategies and to provide an evidenced-based approach to inform
83 gamebird management, codes of practice or legislation.

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91 Key words: red-legged partridge; ring-necked pheasant; raised laying units; gamebird welfare;
92 behaviour-based needs
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1 Introduction

Each year, the UK rears around 20-30 million pheasants (*Phasianus colchicus*) and 3-6 million red-legged partridges (*Alectoris rufus*) for shooting purposes (ADAS, 2005) and other European countries also have large gamebird industries. Both pheasants and red-legged partridges are species of considerable economic importance in many countries (Cramp and Simmons, 1980; Dahlgren, 1988; Robertson et al., 1993b; Alonso et al., 2005) although wild populations have been declining over the last few decades (Robertson et al., 1993a; Aebischer and Potts, 1994; BirdLife, 2004). This has led to many shooting companies increasing their reliance on farmed birds in order to cover the short-fall. Breeding ring-necked pheasants are often housed either in large, multi-harem or smaller single-harem groups, both of which are housed in grass floor pens. However, raised cage systems similar to those used in the poultry industry are now common in mainland Europe while their use is increasing in the UK.

In general, commercial gamebird management practice for the two species differs only at the pairing/harem forming stage prior to the start of the laying season, whilst management throughout the season is essentially the same. The broad format for the year is: males and females are paired or put in to harem groups at the start of the breeding season (December to March), eggs are laid for approximately 8-12 weeks (April to June), and are collected to be either sold as eggs, day-old chicks or as 6 week old poults, or to be retained as breeding stock for the next laying season. Once the season has ended, the laying hens (spent hens) are usually sold to shoots, as is practise for pheasants, while a proportion of partridge hens are retained for the next laying season. Partridge hens are retained for two laying seasons whereas pheasant hens are only kept for one; anecdotally, partridges lay more eggs in their second year so stock is often split between one-season and two-season hens. The main species difference lies during the pairing up stage – ring-necked pheasants and red-legged partridges employ very different breeding strategies, harem-based and monogamous pairs, respectively. In the wild, partridges form monogamous pairs in the early winter while pheasant mate-choice does

not occur until late winter or early spring. Therefore, partridge-pairing in captivity occurs some time before pheasant harem-forming.

Gamebird breeding is under international market forces, forcing commercial breeding systems to evolve. However, the emergence of raised cages for breeding gamebirds potentially poses challenges to welfare which need to be understood. Raised cages improve production by reducing disease risks to the birds while, at the same time, facilitating egg collection (ADAS, 2005). In addition, data from chicken studies indicate that eggs laid in raised cages have a lower aerobic bacterial load than eggs laid in litter (Hannah et al., 2011), resulting in increased hatchability, chick growth and quality (Scott and Swetnam, 1993) and decreased embryo and chick mortality (Reid et al., 1961). Nevertheless, concern has been raised over the ethics of confining semi-wild birds in barren cages as gamebirds are deliberately bred to retain their semi-wild behaviour which may be related to flying characteristics (FAWC, 2008) and are released back into the wild after the breeding season. In consideration of this, the Farm Animal Welfare Council laid out recommendations for caged environments (FAWC, 2008), calling for a ban on the use of barren cages. Various sections of the gamebird industry in the UK have also voiced concerns that barren cage systems are incompatible with their ethical values, suggesting that the welfare of gamebirds in cages justifies rigorous assessment. This review seeks to address the question of what gamebirds need in a raised cage environment, using as a basis an understanding of the behavioural ecology of each species.

2 Raised laying units

Raised laying units were introduced into the laying hen/poultry industry during the 1930s, due to the increasing demand for cheap food and the industrialisation of animal agriculture (Whittle, 1998), while studies have examined the behavioural needs and priorities of laying hens in cage environments (Weeks and Nicol, 2006). The traditional methods for keeping

poultry (outside with movable huts or inside on the floor in barns) were not conducive to large-scale operations due to: (1) the inability to automate floor systems fully, thus requiring a large labour input, and (2) disease transmission and hygiene issues (Duncan, 2001). With regard to the latter, hens in cages are separated from their droppings, breaking the cycle of re-infection by pathogens transmissible via faeces. Intestinal parasites seldom occur in cages and the incidences of external parasites (lice, fleas and mites) are reduced (Fossum et al., 2009). Furthermore, ammonia and dust concentrations are lower in cages than in floor systems (Nimmermark et al., 2009), reducing respiratory pathologies and infections (Duncan, 2001). This is in contrast to the traditional grass-based pens, used for breeding pheasants in the UK, which are open to wind and weather, and are therefore susceptible to ‘poaching’ (when the ground structure breaks up and turns to mud) during periods of rain. To combat this, stockmen often add straw or sawdust in an effort to dry/firm up the ground; however, when litter gets wet, there is an increased build-up of infectious agents and bacterial and parasitic disease (Mazaheri et al., 2005; for a review see Lay et al., 2011).

Thus, these perceived advantages have led to the development of raised-units for breeding gamebirds. Indeed, unpublished data from on-farm records suggest that not only is egg production in cages higher than those in floor-based systems, possibly indicating increased breeding success, but also that hatchability in cage-laid eggs can reach 95% (G. Evans, pers. comm.). Raised units for pheasants are located outdoors (in contrast to poultry, which are housed indoors) and vary between a minimum of 2m x 1m and a maximum of 2m x 1.5m (x 0.5-0.6m high) in the UK, for a stocking density of 7-10 birds, although the minimum dimension cages (2m x 1m) are commonly used in other European countries. Partridge cages are also located outdoors but vary less in size at approximately 0.92m x 0.44m (x 0.27m height) for a pair of birds.

3 Gamebird welfare

195
196 Little evidence is available about the incidence and severity of the challenges to gamebird
197 welfare during captivity. Even mortality rates have rarely been published. Those estimated for
198 multi-harem pheasants housed in grass-floored pens range from 4.1% to 11.6% (Bates et al.,
199 1987; Pennycott, 2000). Anecdotally, mortality in laying pheasant hens in raised cages is
200 estimated at approximately 10% although it has been suggested that an overall recommended
201 figure of 5% mortality is about the average for breeding pheasants (Wise, 1993). There is a
202 lack of understanding regarding the needs of captive gamebirds and, as a result, little evidence
203 of how cage systems can be designed to meet such needs. Animal welfare and the appropriate
204 management of social behaviour are considered key components of reproductive success
205 (Swaigood, 2007). For these reasons, caged environments must take into account the
206 breeding ecology of each species and, importantly, allow the birds to display behaviours
207 important for their welfare and productivity. The two species of birds in question are very
208 different in their behavioural ecology and may require different furnishings or environments
209 in order to improve their welfare in cages.

212 **4 Behavioural ecology of ring-necked pheasants and red-legged partridge**

213
214 Ring-necked pheasants and red-legged partridges are classified in the order Galliforme. Both
215 species are rather stocky birds with small heads and short, broad wings (Cramp and Simmons,
216 1980). Galliformes, in general, are able to lay a large number of eggs within a breeding
217 season (Lack, 1968) which makes them suitable for intensive farming. Flight in this type of
218 bird is usually fast and low to the ground, however, this mode of flight is unsustainable for
219 long distances. As a result, the flight characteristics coupled with their territorial nature make
220 them appropriate species for shooting activities.

222 **4.1 Ring-necked pheasant**

223

224 The native range of ring-necked pheasants extends from Eastern Russia to the Japanese
225 Archipelago (Hill and Robertson, 1988a; Johnsgard, 1999). However, they are one of the
226 most widely introduced gamebirds (Hill and Robertson, 1988a), with introductions attempted
227 on every continent with the exception of Antarctica (Long, 1981). Their popularity results
228 from being highly adaptable and able to thrive in many different habitats, showing diverse
229 patterns of habitat use depending on local conditions (Whiteside and Guthery, 1983). This
230 implies that bird data from one habitat may not be applicable to birds from another habitat
231 (Gatti et al., 1989).

232

233 Ring-necked pheasants are a sexually dimorphic, medium sized bird where the male is larger
234 than the female (Long, 1981; Johnsgard, 1999; Tucak et al., 2008). Pheasants demonstrate a
235 harem defence polygamy breeding system where territorial males defend a harem of females
236 (Robertson et al., 1993b). This is a system where female self-clustering occurs with males
237 defending resources and females are asynchronous in ovulation (Göransson et al., 1990),
238 resulting in the male being able to inseminate all female members of the harem (Emlen and
239 Oring, 1977). During the spring, pheasants often roost in trees or dense shrub (Stokes, 1956);
240 territory establishment at an interface between woodland and arable land results in a higher
241 number of females in a harem, with female number related not only to protection from the
242 elements but also to the availability of food (Robertson et al., 1993b). In spring, the pheasant
243 diet consists mostly of young shoots and seeds which are most abundant in open habitats
244 (Genovesi et al., 1999), indicating that pheasants may require the opportunity to forage when
245 in captivity. In contrast to chickens, pheasants use beak digging or scratching to move soil
246 rather than leg digging (Hill, 1985; Wise, 1993), potentially increasing the importance of
247 movable substrate and foraging in captivity.

248

249 Prior to mating, females form into small flocks and visit the territories of many males before
250 they choose which harem to join (Robertson et al., 1993b). A result of female choice is that

some territorial males have few or no mating opportunities while others may have many (Hill and Robertson, 1988b). Harem size appears to vary greatly, with some studies reporting harem sizes of 1-5 females (Hill and Robertson, 1988a). A female's breeding range is larger than the male's territory e.g. 2.9 ± 0.8 ha vs 2.0 ± 0.5 ha (Hill and Robertson, 1988a; see also Smith et al., 1999), indicating that female mate choice is likely to be affected by factors in addition to male territory size. Pheasant hens are not monogamous, although they do become monogamous after reaching their breeding ranges and choosing a male (Ridley and Hill, 1987), and do not share the task of rearing young with the male, suggesting that the quality of the territory has a major influence on female mate choice. However, Ridley and Hill (1987) and Göransson et al. (1990) found no significant differences in harem size between males from different territory types (woodland edge, hedgerow or woodland clearing). Territorial males guard females from disturbance whether this is in the form of physical attack from another male, predation or excessive energy expenditure (Ridley and Hill, 1987; Hill and Robertson, 1988b).

During the breeding season, males fight to establish a territory at the woodland edge (Robertson et al., 1993a; Robertson, 1996), and, if unsuccessful, will either disperse to find another territory or remain non-territorial (Robertson et al., 1993b). Non-territorial males disperse further than territorial males (Leif, 2005), who are behaviourally restricted to a specific area (Smith et al., 1999). During the breeding season, male pheasants are very aggressive and actively defend their territories from other males with a variety of aggressive behaviours (see Taber (1949) and Ridley and Hill (1987) for details). Wattle size in males has been shown to be positively correlated with territory acquisition (Papeschi et al., 2003), with large wattle-size decreasing the aggressive behaviour of opponent males (Mateos and Carranza, 1997). Male territorial behaviour seems to be an outcome of female mate choice after the initiation of nesting behaviours rather than male competition (Grahm et al., 1993), with harem size dependent on female mate choice (Göransson et al., 1990).

Females distance themselves from the territorial male and search for a place to make a nest. A nest is quite frequently just a scrape amongst the leaves and residual vegetation, which may potentially facilitate foot function while also keeping claws functionally short. Studies following females throughout the breeding season have found that the structural mosaic of the habitat affects reproductive success (Dumke and Pils, 1973; Warner et al., 1987; Robertson, 1996) and it differs between countries. For instance, tall, herbaceous cover is preferable to woodland in Europe (Robertson, 1996), while grassland is preferred in the Midwestern United States (Dumke and Pils, 1973; Gates and Hale, 1974; Schmitz and Clark, 1999). Early nests are often found in woodland, changing to tall cereal crops later in the breeding season. Both woodland and grassland/cropland are dry areas, giving pheasants the opportunity for dustbathing. Damp or wet conditions are avoided, as is vigorous and profuse vegetation which can impede escape from a mammalian predator (Hill and Robertson, 1988b). There are physiological constraints associated with laying so many eggs as a clutch of eggs may represent 40% of the female's body weight (Hill and Robertson, 1988b). Female body condition determines her ability to incubate and care for her brood, with the added possibility of having to lay a second clutch if the first clutch fails for any reason. Indeed, nest attendance has been found to be dependent on female body condition, with females in better condition spending longer on the nest during the laying period (Persson and Göransson, 1999). Mean clutch size decreases throughout the breeding season and second clutches contain fewer eggs than first clutches (Hill and Robertson, 1988b; Robertson, 1991), although pheasants have little variation in the size and consistency of eggs (Kuźniacka et al., 2005). If a female suffers from undernutrition, she will lay fewer eggs rather than lay more eggs of poor quality (Hill and Robertson, 1988b), which would be less likely to hatch and survive (Kuźniacka et al., 2005).

4.2 Red-legged partridge (*Alectoris rufa*)

The native range of the red-legged partridge extends from South-Eastern France to North-West Italy, Portugal and Spain (Aebischer and Potts, 1994; Buenestado et al., 2009), with their core and optimal habitat in the agrarian pseudosteppes of Iberia (Vargas et al., 2006). The red-legged partridge is a very popular small gamebird (Alonso et al., 2005), however, this has led to a 95% decline in its original European range (Aebischer and Potts, 1994; Meriggi and Mazzoni della Stella, 2004) probably due to hunting and changes in agricultural practice (Vargas et al., 2006). Consequently, in Europe, the red-legged partridge is classified as SPEC category 2 (Species of European Conservation Concern) based on the decline in population numbers and limited distribution (BirdLife BirdLife, 2004).

There are three distinct stages in the annual biological cycle of red-legged partridges. At the beginning of autumn, partridges start to form coveys of three or more birds of both sexes (Tavares et al., 2001), with pair-bonds not maintained outwith the reproductive seasons (Mourao et al., 2010). During early winter males and females start to pair up, with all birds paired by early spring (Tavares et al., 2001). Adult distribution in late spring is related to the distribution of nesting habitat (Green, 1983; Rands, 1986) and to the structural diversity of the cover (Borrallho et al., 2000), although, in their native habitat, distribution of partridges during the breeding season is mainly due to the game management in operation in the region (Casas and Viñuela, 2010).

The red-legged partridge is primarily monogamous with high productivity, exhibiting double-nesting behaviour where a bonded pair will lay eggs in two nests, with the male and female incubating a nest each (Cramp and Simmons, 1980; Green, 1984). Simultaneous double nesting is an extremely unusual reproductive strategy (Skutch, 1957), and may be a result of complex trade-offs between male and female behaviour, such as mate quality, population density, body condition and time within the laying season (Green, 1984; Blomqvist et al., 2001; Owens, 2002; Cockburn, 2006). Females choose heavy males which display more frequent patterns of feeding and vigilance behaviours (Alonso et al., 2008), using body

condition as an indicator of higher male qualities (see Hamilton and Zuk, 1982). One suggestion for this type of female mate choice is that offspring from males with better secondary sexual characteristics may be more viable since the female can further improve the physical components of her offspring (von Schantz et al., 1989; von Schantz and Grahn, 1994). Male vigilance behaviour used as sexual selection criteria by the female increases the chance of survival and reproductive success of the female, by allowing an increased opportunity to feed in order to gain body condition for egg-laying and incubation (Dahlgren, 1990; Beani and Dessì-Fulgheri, 1995; Alonso et al., 2008). Also compelling is the suggestion that the complex plumage pattern, with bands of approximately equal length and width and spacing along the body, indicates a bird of superior quality (Bortolotti et al., 2006).

Red-legged partridges are most commonly associated with farm landscapes with crop fields delineated by hedgerows (in the UK and France) or open scrub areas (called *lindes*, in the Iberian Peninsula). These areas provide appropriate cover for nesting (Rands, 1986; Meriggi et al., 1991) and food is abundant (Thomas and Marshall, 1999), although other studies report that food quality is not the main driver of spatial behaviour (Buenestado et al., 2008). Such areas allow foraging, while also allowing dustbathing opportunities due to their dry nature. Anecdotally, red-legged partridge do not roost, although they do make use of high surfaces, such as rocky outcrops, for vigilance opportunities. The mean home range appears to vary significantly; between 7ha (Alonso et al., 2005) and 52.6ha (Buenestado et al., 2008) in Spain and 8ha (Green, 1983) in the UK. However, reported differences in home range area may result from differences between studies in their use of wild or re-stocked partridges, with Green (1983) and Alonso et al. (2005) both reporting on introduced birds. This difference in home range size may be one of the causes of the low success rates of restocking activities (Gortazar et al., 2000).

For partridges, the type of vegetation that the nest is situated in has great importance, with vegetation height and ground cover being critical factors affecting nesting success (Rands,

1988). The location of the nest seems to differ between areas, with some reporting a higher percentage of nests in hedgerows and natural vegetation (Ricci et al., 1990) and others reporting a preference for the edges of cultivated farmland with little disturbance. However, lindes are the preferred habitat over scrubland and cereal fields and nests in crops are usually within 5m of the field-edge (Casas and Viñuela, 2010). The male selects the nest site and builds the nest (Goodwin, 1953), the structure of which offers protection, good all-round vision and an easy route of escape (Ricci et al., 1990). Like for other ground-nesting birds in open areas, red-legged partridge nests are subject to a high nest-loss rate (Yanes and Suárez, 1995). Farming, and particularly harvesting, is the main cause of nest loss in some areas (Casas and Viñuela, 2010). Thus, cereal crops may be considered to be a sub-optimal habitat working as an ecological trap by reducing nest fitness (Battin, 2004). Under natural conditions, the breeding season lasts between 14-16 weeks (Gaudioso et al., 2002) with females laying one egg every 1-2 days, with a mean clutch size of 12 eggs (ranging from 10-24), although under commercial conditions females may lay between 40-55 eggs per year (Mourao et al., 2010).

5 Potential challenges to meeting bird needs in raised cages

5.1 Challenges from the physical environment

Raised laying units have several potential problems when applied to gamebirds, both physical and behavioural in nature. Both ring-necked pheasants and red-legged partridges are housed in cages in climates that differ from those in the countries in which they are native. This justifies concern about thermoregulation when in raised cages that offer little opportunity for selecting the best microenvironment. In northern latitudes, for instance, pheasants may be introduced into cages in December, when housed prior to the onset of the breeding season in March, experiencing challenges from cold stress during late winter months with no respite

from wire flooring. Conversely, cage housing could pose the risk of heat stress during summer months when shade and air flow may be limited. Additionally, the amount of light penetration into the cage may not be optimal for the birds. Anecdotally, commercial farmers have found that partridges lay more eggs in metal cages than in wooden cages, whereas pheasants seem to prefer wooden cages (O. Gronning, pers. comm.). This may be related to each species' native habitat, with partridges preferring high light levels of the open ground and pheasants preferring the lower light levels of shrubland and woodland.

Cages are constructed with solid sides and a sloping wire floor which may not provide a sufficiently varied foot surface in order to maintain foot and claw function. In the wild, pheasants utilize many and varied substrates, from roosting in trees and shrubs to open grassland and crop fields. Partridges may stand atop boulders and other tall structures in order to increase their field of vision when looking for predators. In poultry, long-term housing on a wire floor has been found to risk the development of hyperkeratosis and foot lesions (Abrahamsson and Tauson, 1993; Abrahamsson et al., 1996; Appleby et al., 2002), while bumblefoot is less prevalent in cages (Wang et al., 1998). While widely used in the poultry industry, wire flooring does not provide a suitable substrate for foraging nor perching and may result in frustration, redirected behaviours or a decrease in locomotion due to pain or discomfort (Leyendecker et al., 2005). For example, wire flooring does not allow ground pecking or beak digging associated with foraging behaviour in gamebirds. Unlike chickens, pheasants do not normally forage using the feet to move substrates during foraging, rather pheasants use the beak for digging. Thus, pheasants will constantly wear the beak surface and this inability may potentially result in overgrowth and a reduction in feeding efficiency and preening ability. In addition, although the cages used for gamebirds are meant to be high enough to allow pheasant cocks to crow, there is the potential for this behaviour to be inhibited by the lower height of the cage. In the wild, males crow as part of their territory defence. Males who are unable to crow may suffer an increase in social stress due to the inability to ritually defend their territory or reply in response to others' calls, although the

extent to which males may suffer social stress needs to be determined experimentally. Low cage height may also inhibit wing flapping behaviours, causing feather damage to the wings (Hughes and Black, 1976) important considerations if breeding birds are to be released into the wild after the breeding season. Wing flapping is used during courtship displays, both to highlight plumage patterns and to create sound, and is an important component of mate-choice, thus feather damage has the potential to reduce the male attractiveness to the female, potentially impacting on production. Feathers also provide warmth and some measure of physical protection from aggressive interactions. Exposed areas due to feather damage may provide a focal point for aggressive and feather pecking, thus impacting upon bird survival in the cage.

The wire floor of raised-units results in the inability to dust bathe. Dust bathing removes stale uropygial gland oil from the plumage, improving feather and down structure and as a result enhancing the insulation properties of the plumage (Borchelt and Duncan, 1974; Van Lier and Bokma, 1987). Currently, it is unclear whether the motivation to dust bathe is governed by internal (Vestergaard, 1982; Vestergaard and Bildsoe, 1999) or external mechanisms (Duncan et al., 1998), or indeed motivated by pleasure (Widowski and Duncan, 2000). Nevertheless, whether it is to alleviate suffering or to increase pleasure, the opportunity to dust bathe has a positive welfare advantage in laying poultry (Duncan, 2001). It is not unreasonable to suggest that the purely functional benefits of dust bathing in poultry are also met in gamebirds. Ultimately, whether dust bathing is pleasurable or not, this behaviour has evolved because it has a function and that function is probably the same in both types of bird.

5.2 Challenges from the social environment

Properly controlled studies into stocking density and colony size for wire-floor cages in laying hens have indicated that there is a lack of social space, with hens being more crowded

than they prefer (Duncan, 2001). This imposition on social space may be even more pronounced for gamebirds which have large breeding territories. For example, red-legged partridges have a mean home range which varies between 7-52 hectares (Green, 1983; Alonso et al., 2005; Buenestado et al., 2008), while the breeding range of ring-necked pheasants varies between 2-3 hectares (Hill and Robertson, 1988a; see also Smith et al., 1999). Harem size in ring-necked pheasants in the wild has been reported to be between 1 male:1-5 females (Hill and Robertson, 1988b), yet this ratio is typically between 1 male:6-10 females in raised cages and 1 male:8-12 females in multi-harem floor pens in the UK (Deeming and Wadland, 2002). Red-legged partridges form yearly breeding pair-bonds (Tavares et al., 2001) which are not maintained outwith the breeding season (Mourao et al., 2010), yet game farms routinely keep partridges housed together continuously in pairs for two breeding seasons (approximately 18 months). Therefore partridges may be exposed to an additional social stress by being forced to remain in pairs.

In captivity, partridges and pheasants are placed into their breeding units randomly – termed forced pairing. This practise does not appear to have great consequences for pheasants, although data is needed to determine this, but may be detrimental for partridges, where studies have shown that agonistic interactions and female mortality increases in forced-pairings (Nobilini et al., 1993; Gonzalez-Redondo, 2006; Prieto et al., 2012). Additionally, the forced pairing method often used in commercial partridge breeding farms has been highlighted for increasing the frequency of agonistic interactions and the frequency of ‘divorce’, where one or both birds becomes aggressive to the point of endangering survival (Nobilini et al., 1993). In some instances, it may be possible to re-pair the divorced couple with alternative birds, however, often it is too late in the season for any pair-bonds to form or one of the birds (usually the female) is too damaged to survive or lay successfully. Studies have shown that the increase in aggressions and divorce may be an artefact of the nature of commercial cage sizes; larger cages than those used commercially seem have lower incidences of agonistic interactions (Alonso et al., 2008). Gaudioso et al. (2002) also noted that pairs in larger pens

laid more eggs, possibly because females in smaller pens may or may not be able to avoid males who were too aggressive or sexual (Bortolotti et al., 2006). Free-pairing birds have the opportunity to choose their mate and the pair-bonding process goes through several stages (Choudhury, 1995) which are absent when birds are paired artificially. The difference in reproductive success of males and females free to choose mates emphasises the importance of sexual selection and active female choice, with both male and female requiring stimulation from each other to display nest-defence behaviour (Bottoni et al., 1993).

As these two species both have large territories and contact with neighbouring males is likely to be infrequent, there is also a risk of chronic stress from males being housed in close proximity in adjoined cages, although studies are needed to determine the extent of stress suffered, if any. Currently, the cages in use for pheasants and partridges do not allow birds to avoid unwanted social contact, thus the provision of partitions or areas of seclusion may decrease social stress, while also providing birds with cover from predators.

6 Conclusions

This review has highlighted the possible need for certain types of resources to be incorporated within raised cages and for a review of the commercial method of forced pairing of partridges. Larger scale commercial studies are needed to compare bird welfare and egg output in order to properly evaluate the impacts of the forced pairing method over the free-choice method. The partridge cages commonly used in industry do not allow for free-choice pairing, subsequently studies investigating alternative housing types are required to compare how well each cage type allows the expression of pairing behaviour. The resources suggested for incorporation into a cage are an alternative floor type to complement or replace wire, a perch for facilitating foot function and claw health or as an anti-predator response, materials to facilitate foraging behaviour, a suitable substrate for dustbathing, and an area of privacy to

function as both as a nesting area and a social/predator/weather escape area. Using the outcomes of the current study as a basis, there is a need to also confirm the importance of the short-listed resources for caged gamebirds and to evaluate the impacts of their provision on bird welfare and productivity. These issues will form the basis of subsequent reports.

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