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WORKING PARTY FOR THE PREPARATION OF THE FOURTH MULTILATERAL CONSULTATION OF PARTIES TO THE EUROPEAN CONVENTION FOR THE PROTECTION OF VERTEBRATE ANIMALS USED FOR EXPERIMENTAL AND OTHER SCIENTIFIC PURPOSES (ETS 123)

6th Meeting
Strasbourg, 25-27 March 2003

Species-specific provisions for birds

Background information for the proposals presented by the Group of Experts on birds

PART B

revised by the Group of Experts

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Future principles for housing and care of laboratory birds

Report for the revision of the Council of Europe Convention ETS123 Appendix A for birds

Issued by the Council's Working Group for Birds

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Part B

Background for the proposals of the Working Group

Preamble

Avian intelligence, behavioural complexity and capacity to suffer physical pain have often been regarded as inferior to those of mammals. There is a growing body of evidence that such assumptions are not justified (Elzanowski 1991, Gentle 1991, 1992, Ristau 1991, Marler 1996, Skutch 1996), but there is comparatively little information available on husbandry refinements including environmental stimulation for laboratory birds (Poole & Stamp Dawkins 1999). The literature largely relates to companion or zoo birds (Coulton *et al*. 1997, VanHoek & King 1997, but see King 1993) or to birds reared for meat or egg production (Bell & Adams 1998, Jones & Carmichael 1998).

The recommendations made by the Expert Working Group are thus based on published literature wherever possible, but where housing and husbandry refinements have not been scientifically evaluated, the Group has based its recommendations on members' own experience as experts in the field, current good practice and the recent expert Working Group report on *Laboratory birds: Refinements in husbandry and procedures* (Hawkins *et al.* 2001).

Species–specific sections – birds

1 Introduction

Birds are used for a broad range of purposes including fundamental research, applied veterinary medical studies and toxicology. Domestic fowl and turkeys are the most common laboratory birds and are often used in developmental studies and for the production of biological materials such as tissue and antibodies. Domestic poultry are also the most commonly used species in bird welfare research. Fowl are used for pharmaceutical safety and efficacy evaluation, whereas quail and other birds are more frequently the subjects of ecotoxicology studies. The other, less commonly used species such as the pigeon and wild birds are generally used in psychology and fundamental physiology or zoology research. Catching wild birds to use as experimental animals should be avoided unless it is necessary for the purposes of the experiment.

All birds are essentially built for flight and so share the same basic body plan despite their extremely diverse range of adaptations for locomotion and feeding. Most species are adapted to range over relatively large, three-dimensional areas by one or more means of locomotion including flying, walking, running, swimming or diving, both while foraging and during migration. Many species of bird are highly social and should be kept in stable groups wherever possible.

Additional details are provided for the commonly bred and used laboratory species. It is essential that the housing and care of less commonly used species not included below pay due regard to their behavioural, physiological and social requirements. Housing, husbandry and care protocols for such species should be researched before birds are obtained or used. Advice on requirements for other species (or if behavioural or breeding problems occur) should be sought from experts and care staff to ensure that any particular species needs are adequately addressed. Information and guidance on less commonly used species is available in the background information document.

Some research using domestic poultry needs to approximate 'farm' conditions for the purposes of the study, e.g*. poultry welfare projects or research into farm bird husbandry or pathologies. It may therefore be necessary to obtain strains with inherent welfare problems, or to house birds using the same space allowance that poultry in commercial units would be given. In such circumstances the project should be justified and directly applicable to commercial poultry production. The housing and husbandry standards should at least be equal to those set out in the standards laid out in the European Convention on the Protection of Animals kept for Farming Purposes and related Recommendations for farm animals..*

As stated in the Introduction, bird behaviour, ecology and physiology are diverse and both behavioural abnormalities and substantial suffering can be caused if housing and care are inappropriate. This is unacceptable for ethical and scientific reasons. All those concerned with the husbandry, care and use of laboratory birds should fully research their behavioural and physiological requirements and use the information gained to design experimental and husbandry protocols that will minimise stress. Best practice for a particular species or strain should be applied to all individuals, regardless of the conditions in which that species or strain may be housed for farming, unless the information obtained can be used to justify improving the lives of farmed birds (see Hawkins *et al.* 2001).

1.1 Potential welfare problems

Many of the potential welfare problems specific to birds are associated with inappropriate pecking behaviour. This can be divided into (i) aggressive pecking; (ii) feather pecking (where individuals either peck at other birds' feathers or pluck and pull at their own); and (iii) pecking at the skin of other birds, which can cause serious suffering and mortality if unchecked. There are a number of measures that should be employed to avoid outbreaks *of injurious pecking wherever possible and to reduce or prevent this behaviour should it occur. Prevention is especially important because fowl are attracted to damaged feathers, such that the presence of a few feather-pecked birds may lead to the rapid spread of injurious pecking.*

The cause of inappropriate pecking is not always clear, but it is often possible to avoid outbreaks by rearing chicks with access to substrate that enables them to forage and peck appropriately. Chicks of all species should therefore be housed on solid floors with litter.

There are a number of measures that can be employed to reduce the incidence of injurious pecking should it occur. These include (i) providing alternative pecking substrates such as foraging substrate, bunches of string, pecking blocks or straw, (ii) providing visual barriers, (iii) periodically or temporarily lowering the light intensity or using red light, and (iv) using light sources that emit UV. Anti-pecking sprays are commercially available and can be used to reduce the incidence of injurious pecking in the short term, but it will still be necessary to address the underlying causes of the behaviour. Some strains of domestic bird have been selectively bred so that inappropriate pecking is reduced and such strains should be researched and used wherever possible.

Methods which cause pain or distress, such as very low lighting (i.e. below 20 lux) for prolonged periods or physical modifications such as beak trimming should not be used.

Feather pecking in domestic fowl is thought to be mis-directed foraging behaviour (ground pecking) rather than aggression (Blokhuis 1986, Blokhuis *et al.* 2001, Anonymous 2001). Likely contributory factors are believed to be large group sizes, grid flooring and bright lighting (Duncan 1999, Bilcik & Keeling 2000). A recent epidemiological study in fowl (Green *et al.* 2000) has indicated an association between injurious pecking and factors that reduce opportunities to forage, such as high stocking density, compacted litter and agoraphobia (*e.g.* resulting in low use of the outdoor range in free-range systems). The birds' genetic background can also be a significant factor. Controlled studies where birds' feathers were artificially damaged indicate that fowl are highly attracted to damaged feathers and this can mediate the spread of feather pecking and cannibalism (McAdie & Keeling 2000).

It would therefore appear to be important to increase foraging opportunities and reduce competition and frustration when housing domestic birds. Early exposure to sufficient, suitable pecking substrates such as wood shavings or straw has been demonstrated to reduce the incidence of feather pecking in adulthood (Huber-Eicher & Sebö 2001, Nicol *et al.* 2001), and so it is essential to rear chicks on solid floors with litter and continue to provide it throughout birds' lives. Current research suggests that bunches of white string (*e.g.* polypropylene baling twine) are preferred to many other pecking items and that the interest is sustained in the long term (Jones *et al.* 1997, 2000, Jones & Rayner 2000, Jones 2001). Furthermore, the bunches of string have been shown to be more attractive to birds than damaged feathers (McAdie & Keeling 2000).

Although feather pecking is less likely in small groups with access to litter and other pecking substrates, it may still develop for seemingly reasons that are relatively poorly understood at the time of writing. There are a number of measures that have been reported as alleviating the problem in various circumstances and these should be researched and trialled as appropriate, with the emphasis on using a combination of techniques to provide an appropriate environment for the birds. Temporarily lowering the light intensity or changing the light colour to red, providing supplementary ultraviolet (UV) light, and providing alternative pecking substrates may reduce the incidence of feather pecking once it has developed (Sherwin *et al.* 1999a). Blood from peck wounds cannot be seen in red light, but housing birds under red light should be regarded as an emergency measure to prevent more serious injury. Using UV light, preferably from hatch, is a more constructive way or preventing or alleviating feather pecking. Many components of the avian diet, such as berries and seeds, are highly reflective of UV light and so it has been speculated that light sources that do not include UV might make the environment appear more barren than it really is to birds. This could result in foraging pecks becoming redirected to the feathers of other birds (Sherwin *et al.* 1999a, Lewis *et al.* 2000).

Visual barriers, *e.g.* free-standing, plywood boards, have also been trialled in studies aiming to help reduce injurious pecking. It is thought that barriers enable subordinate birds to retreat and also prevent other birds from seeing and copying injurious pecking behaviour, but results have been variable (Sherwin *et al.* 1999a, Wechsler & Schmid 1998, Lewis *et al.* 2000). It is advisable to use barriers in conjunction with other techniques such as providing UV light and pecking substrate. Commercially available anti-pecking sprays may be useful in the short term but, like low intensity or red light, should only be regarded as a temporary measure to prevent acute suffering. If animals are performing injurious behaviours, simply preventing the behaviours will not address their underlying causes and the welfare problems will remain. This will cause the animals avoidable suffering and is not an appropriate course of action.

If, for experimental reasons, birds are to be kept in an environment where severe feather pecking is likely to occur, it is advisable to use strains that have been selected to show little feather pecking (Craig & Muir 1993, Kjaer & Sorensen 1997, Duncan 1999; see also de Jong *et al.* 2001, Preisinger 2001). Some strains have also been demonstrated to show less cannibalism. It is therefore important to research each strain thoroughly when planning projects.

Commercially, some birds (*e.g.* turkeys) are usually housed under very low light intensities to reduce feather pecking, sometimes in conjunction with long (23 hours) or continuous photoperiods. However, such lighting conditions might cause great concern for welfare as they can result in retinal detachment, buphthalmia (distortions of the eye morphology) and subsequent blindness (Ashton *et al.* 1973, Siopes *et al.* 1984, Davis *et al.* 1986, Manser 1996). Behavioural studies have shown that turkeys prefer light intensities (*e.g.* 20 lux, RSPCA 1997) higher than those generally provided under commercial conditions (Sherwin 1998). In addition, very low intensities make it difficult for humans to detect colours, thus making it almost impossible to adequately inspect the birds. No birds should be housed in very low light intensities for prolonged periods.

Beak trimming or tipping are commonly used, or 'spectacles' fitted, if feather pecking or cannibalism become a problem in commercial situations. These procedures can cause both acute and chronic pain regardless of the age at which they are carried out (Duncan *et al.* 1989, Gentle *et al.* 1990) and should never be undertaken without compelling justification; appropriate anaesthesia and analgesia must also be administered (Hawkins *et al.* 2001). If pecking problems persist, beak trimming is preferable to debeaking (Hawkins *et al.* 2001).

Metal anti-pecking rings ('bits') pass through the nasal septum and between the mandibles so that birds cannot fully close their beaks. This inhibits normal behaviour more than debeaking, and neither method is desirable (Hawkins *et al.* 2001). In the case of quail, housing males and females together in appropriately composed groups before sexual maturity should render debeaking unnecessary (Gerken & Mills 1993), and providing sufficient space and environmental stimulation for the birds is also likely to reduce aggression. The beaks of ducks are richly innervated and very well supplied with sensory receptors such that beak trimming can cause acute and chronic pain (Gentle 1992, Hawkins *et al.* 2001). Inappropriate pecking in ducks should therefore be countered by reviewing husbandry and care.

> *Birds housed in a poor quality environment that does not permit them to forage, exercise or interact with conspecifics will experience chronic distress that may be indicated by stereotypic behaviour, for example autophagia (self-pecking), feather pecking, and pacing. Such behaviours should be regarded as indicative of serious welfare problems and should*

lead to an immediate review of housing, husbandry and care.

Chronic distress in birds is often indicated by stereotypic behaviour. A stereotypy has been defined as a repeated pattern of movements which shows little or no variation and has no obvious function (Mason 1991, Manser 1992), such as circling, pacing or pecking at one spot. Stereotypies are generally associated with poor welfare (inappropriate husbandry or environment) and are regarded as indicators of inability to cope with physiological or psychological stressors. Stereotypies may have different causes (Keiper 1969) but most can usually be greatly reduced or eliminated by improving animals' environments, for example by providing better quality and quantity space and companions where appropriate. Any abnormal behaviours should be taken seriously as indicative of a welfare problem and regarded as unacceptable (Hawkins *et al.* 2001).

2 The environment in the animal enclosures and its control.

2.1 Ventilation

Many species are especially susceptible to draughts. Measures should therefore be in place to ensure that individuals do not become chilled. Accumulation of dust and gases such as carbon dioxide and ammonia should be kept to a minimum.

See Kirkwood (1999a).

2.2 Temperature

Where appropriate, animals should be provided with a range of temperatures so that they can exercise a degree of choice over their thermal environment. All healthy adult quail, pigeon and domestic ducks, geese, fowl and turkeys should be housed at temperatures between 15 and 21 °C. It is essential to take account of the interaction between temperature and relative humidity, as some species will suffer from heat stress within the prescribed temperature range if relative humidity is too high. For species where there are no published guidelines on temperature and humidity, the climate experienced in the wild throughout the year should be researched and replicated as closely as possible. Higher room temperatures than those indicated or a localised source of supplementary heat such as a brooder lamp may be required for sick or juvenile birds (see Table below).

Recommended temperatures and relative humidities for juvenile domestic fowl and turkeys, G. gallus domesticus and Meleagris gallopavo

Age (days)	*Under lamp (°C)*	*Ambient temperature in room (°C)*	*Relative humidity (%)*
Up to 1	*35*	*25 to 30*	*70 ± 10*
1 to 7	*32*	*22 to 27*	*70 ± 10*
7 to 14	*29*	*19 to 24*	*40 to 80*
14 to 21	*26*	*18 to 21*	*40 to 80*
Over 21	*-*	*15 to 21*	*40 to 80*

The chicks' behaviour should be used as a guide when setting brooder lamp temperature. Chicks of all species should be evenly spread and making a moderate amount of noise; quiet chicks may be too hot and chicks making noisy distress calls may be too cold. Where brooder lamps are used, chicks will huddle directly under the lamp if they are cold, in which case the lamp should be lowered, or will form a circle around the periphery of the heated area if they are too hot, in which case the lamp should be raised.

If birds are subjected to the physiological stress of attempting to adapt to inappropriate climates, both welfare and experimental results are likely to be affected (Hawkins *et al.* 2001). The Group has therefore stressed the importance of researching the climate to which each species is adapted and providing a choice of temperatures wherever possible. The temperature requirements of hatchlings can be very different to those of adult birds and we strongly recommend that the new Appendix A draws attention to this.

Proposals for different temperature ranges for different species were initially based on Duncan (1999), Mills *et al.* (1999), Hutchison (1999) and Hawkins *et al.* (2001) and were consolidated in response to comments from the Netherlands (Document GT123 (2001) 32).

2.3 Humidity

Relative humidity should be maintained within the range of 50 to 70 % for healthy, adult, domestic birds.

2.4 Lighting

Light quality and quantity are critically important for some species at certain times of the year for normal physiological functioning. Appropriate light:dark regimes for each species, life stage and time of year should be researched before animals are acquired.

Lights should not be abruptly switched off, but should be dimmed and raised in a gradual fashion, and dim 'night lights' should be provided. This is especially important when housing birds capable of flight.

Normal fluorescent tubes, which flash at 100 Hz, may well be perceived as flickering to some birds. Although it is not known whether flickering is always aversive, high-frequency fluorescent tubes, or incandescent lighting, should be used wherever possible.

Light quality, levels and duration are all extremely important to birds. The eyes and optic region of the avian brain are highly developed, which reflects their adaptation for vision during flight. The avian retina is considerably more complex than that of mammals (Bowmaker *et al.* 1997) and so photoreception and vision in birds are very different from humans. Birds have excellent colour vision; the visual acuity of some species (*e.g.* raptors) exceeds that of old world primates, and some species also have specialised areas of the retina for different visual tasks.

It is essential to research appropriate light:dark regimes because photoperiod directly influences bird development and physiology. A photoreceptor within the thalamus co-ordinates photoperiodic responses to changing day lengths in birds, and is activated when light passes through the thin avian skull (Follett 1984). Consequently, light quality and quantity may be critically important for some species at certain times of the year for normal physiological functioning (*e.g.* CCAC 1984, Hutchison 1999, Mills *et al.* 1999). Life stages must also be taken into consideration because the requirements of juveniles may differ from those of more mature animals (Mills *et al.* 1999).

The welfare implications of other aspects of light quality are less well researched, but a logical case can be made from what is known of avian vision. The 'critical flicker fusion frequency', or frequency at which a strobe light is no longer perceived as flashing, is notably higher for birds than humans (reviewed by D'Eath 1998). It would seem likely that normal fluorescent tubes, which flash at 100 Hz, would be perceived as flickering to a bird such as a starling *Sturnus vulgaris*. High-frequency fluorescent tubes, or incandescent lighting, would therefore seem preferable on these grounds._Under some circumstances, however, birds do not find this flicker aversive, and may even prefer fluorescent light; possibly because of its spectral properties (Sherwin 1999, Widowski *et al* 1992).

- Further research is needed to study the impact of light quality (*i.e.* flicker frequency) on the behaviour and welfare of a range of bird species.

Most diurnal birds can also see ultraviolet (UV) light and many species have UV reflecting plumage (Bennett & Cuthill 1994); it has been hypothesised that such markings may be related to feather pecking among groups of turkeys (Sherwin & Devereux 1999). It has been suggested that UV colouration may turn out to be an important component of bird communication (Manning & Stamp Dawkins 1998).

Most commercially available artificial light sources have considerably less ultraviolet (UV) light than full daylight, so that their colour balance would be likely to appear unnatural to birds. There is experimental evidence that some species make different mate choice decisions when the UV waveband is not present, most probably because the plumage (which reflects UV as well as human-visible wavelengths) appears an odd colour to the bird (Bennett *et al.* 1997). There is evidence that birds prefer environments that contain a UV component in the lighting (Moinard & Sherwin 1999).

Thus, although birds can be, and have been, kept successfully under artificial lighting, it is possible that any visual tasks based on colour (social signals, displays, foraging) are rendered more difficult. Direct effects of light on stress and welfare in birds are, as yet, little researched. However, if outdoor housing, windows or skylights are not possible, use of special daylight-mimicking fluorescent lighting, running at high frequencies, would seem advisable (Hawkins *et al.* 2001).

- The effects of light sources with and without a UV component on bird behaviour, (including aggression and feather pecking) and welfare need further evaluation.

2.5 Noise

Some birds, e.g. *the pigeon, are thought to be able to hear very low frequency sounds. Although infrasound (sound below 16 - 20 Hz) is unlikely to cause distress, birds should be housed away from any equipment that emits low frequency vibrations whenever possible.*

Most birds can hear sounds between 1 and 5 kHz, with a high frequency hearing limit of about 10 kHz for passerines and 7.5 kHz for non-passerines (Dooling 1992, see also Heffner 1998). Birds do not utilise high frequencies for sound localisation (apart from owls (Strigiformes), who can hear up to 12 kHz) and none studied to date can equal even human high frequency hearing (Heffner 1998), so ultrasound is unlikely to cause welfare problems. Sensitivity decreases gradually below 1 kHz but some birds, *e.g.* the pigeon, are thought to be able to hear very low frequency sounds (Kreithen & Quine 1979). Although infrasound (sound below 16 - 20 Hz) is unlikely to cause distress, birds should be given the benefit of the doubt and housed away from any equipment that emits low frequency vibrations whenever possible (G Sales, pers. comm.).

- Research is needed into the impact of infrasound on birds.

3 Health

Captive bred birds should be used wherever possible. Wild birds may present special problems in terms of their behaviour and health when in a laboratory situation. A longer period of quarantine and habituation to captive conditions is generally required before they are used in scientific procedures.

Careful health monitoring and parasite control should minimise health risks in birds with outdoor access.

Captive bred birds of a suitable health status should be used wherever possible. Wild birds may present special problems in terms of their behaviour and health when in a laboratory situation. A period of 28 days quarantine should normally be allowed for wild caught birds where possible. During this time the birds can become adapted to the laboratory conditions and their health monitored prior to experimental work commencing. Monitoring should be agreed with a veterinary surgeon and may consist of faecal sampling and examination for the presence of parasites and bacteria, including potential zoonoses such as those caused by Salmonellae and *Campylobacter*. During this period birds may be treated for the presence of endo- and ectoparasites on advice from the attending veterinarian (Hawkins *et al.* 2001).

4 Housing and enrichment

Introduction

Birds should be housed in enclosures which facilitate and encourage a range of desirable natural behaviours, including social behaviour, exercise and foraging. Many birds will benefit from housing that allows them to go outdoors and the feasibility of this should be evaluated with respect to the potential to cause distress or to conflict with experimental aims. Some form of cover such as shrubs should always be provided outdoors to encourage birds to use all the available area.

A good standard of well-being and welfare cannot be achieved without appropriate housing, husbandry and care. In common with most other laboratory animals, birds spend the majority of their time in their holding cages or pens, not undergoing procedures. Good housing should make them feel safe, secure and able to exercise, to control their environment to a degree and to express a range of natural behaviours including interactions with conspecifics (Nicol 1995, see also FAWC 1993). Poor quality and quantity of space is likely to lead to boredom and frustration which may be expressed as stereotypic behaviour, which should be regarded as unacceptable and to be avoided (Hawkins *et al.* 2001).

In general, birds should be housed in pens or aviaries as opposed to cages (Coles 1991, also see Kirkwood 1999a). Domestic fowl, for example, can usually be provided with a better and more appropriate environment if they are group housed in large pens (Duncan 1999) and may also be less fearful (Hansen *et al.* 1993). While some birds, *e.g.* small passerines, can be provided with an acceptable quality of life by group housing them in large, enriched cages, larger species will require more space and should be housed in aviaries or pens (Hawkins *et al.* 2001). Many birds will benefit from access to outdoor runs and the feasibility of this should be evaluated case by case, with respect to the potential to cause physiological or psychological stress or to conflict with experimental aims. Cover, such as shrubs, is essential for feelings of safety (*e.g.* Cornetto & Estevez 1999, Newberry & Shackleton 1997) and to reduce aggression (Cornetto *et al* 2002). Birds able to go outdoors will be at some risk of contracting disease from wild populations, although this does not necessarily outweigh the advantages associated with access to the outside, such as experiencing a more stimulating environment and reduced fearfulness (Grigor *et al.* 1995). Careful health monitoring and regular worming should minimise health risks (Hawkins *et al.* 2001). For an example of an housing system for laboratory fowl incorporating an outdoor run, see Fölsch *et al.* (2002).

Standards of husbandry and care in the laboratory should exceed commercial conditions (Duncan 1999, Hawkins *et al.* 2001), unless the project in question has a direct application that aims to alleviate a welfare problem occurring in practice.

4.1 Social housing

Most species of bird are social for at least part of the year and highly sensitive to family relationships so the formation of appropriate, stable, harmonious groups should be given a high priority. Research into the optimal composition of groups and at what stage in the birds' lives these should be created is essential before groups are formed and studies are planned.

The social behaviour of birds and the importance of kin relationships has been reviewed in Marler (1996). The optimum timing and membership of groups should therefore be researched for each species and strain (Hawkins *et al.* 2001). Studies in a number of different fields indicates that interaction with conspecifics is important and meaningful to birds; some examples are set out below.

Birds have a great capacity for social learning, *i.e.* learning by watching the activities of others. It is generally considered that this is an 'advanced' form of learning and indicates higher cognitive capacity. Most social learning has been related to foraging or feeding activities learnt by watching parents (Hatch & Lefebvre 1997, Stokes 1971, Sherry 1977), siblings (Tolman 1964, Tolman & Wilson 1965, Johnston *et al.*1998, Nicol & Pope 1999) or models (Turner 1964, Tolman 1967, Fritz & Kotrschal 1999). This form of learning can lead to the rapid spread of novel behaviours such as the opening of milk bottle tops by blue tits *Parus caeruleus* (Fisher & Hinde 1949, Sherry & Galef 1990). Vocal learning has evolved (probably independently) in at least three avian orders; the Passeriformes, Psittacines and Apodiformes (*e.g.* swifts *Apus* spp. and hummingbirds) (Dooling 1992).

Teaching by an animal could indicate that it is aware of the consequences of the 'student' animal's behaviour and so may be capable of identifying with another animal's thought processes, *i.e.* possess a form of empathy. Nicol & Pope (1996) showed that when a hen saw her chicks eating food which she believed was distasteful (though in reality it was perfectly appetising) she increased her vocalisations and pecking activity, apparently attempting to direct her chicks to a dish containing more palatable food.

4.2 Environmental Enrichment

A stimulating environment is a very important contributor to good bird welfare. Perches, dust and water baths, suitable nest sites and nesting material, pecking objects and substrate for foraging must always be provided for species and individuals that will benefit from them unless there is compelling scientific or veterinary justification for withholding such items. Birds should be encouraged to use all three dimensions of their housing for foraging, exercise and social interactions including play wherever possible.

It is generally accepted that animals may suffer if prevented from carrying out actions that they are strongly motivated to perform, for example if laying hens are prevented from building nests (Duncan & Wood-Gush 1972, Cooper & Appleby 1994). Some behavioural studies using birds have suggested that they possess 'object permanence', *i.e.* they can remember objects that are no longer there, so that 'out of sight' is not 'out of mind'. This object permanence would warrant birds with the ability to suffer due to the absence of a valued resource, such as a nest box. Parrots have highly developed object permanence abilities that are comparable to those in 2-year-old humans, and can locate a goal by predicting its concealed movement and position (Pepperberg & Funk 1990). Pigeons (Neiworth & Rilling 1987), domestic fowl (Freire *et al.* 1997) and chicks (Vallortigara *et al.* 1998) are also able to mentally represent the hidden movement and position of objects and thus accurately locate a goal after it has been moved out of sight. This suggests that out of sight is not necessarily out of mind, and so birds' cognitive capacities should be considered along with behavioural and motivational studies when trying to predict whether frustration and suffering are likely to occur.

The range of cognitive skills now known to exist in birds indicates that birds have a higher mental capacity than has been previously thought. For example, tool use occurs amongst many bird species including thrushes (*Turdus* spp.), finches (Fringillidae), ravens (*Corvus corax*) and vultures (Cathartiformes) (McFarland 1993). Recently, Keas (*Nestor notabilis*) have been used in studies on imitation by giving them the opportunity to open artificial fruit puzzles (Huber *et al.* 1998) and the ability of birds to count has been investigated using an African grey parrot *Psittacus erithacus* (Pepperberg 1994). Locomotory, social and object play have also been observed in birds, particularly corvids (Skutch 1996).

There is thus considerable potential for birds to experience suffering and distress, and so preventative measures should be taken wherever possible. A stimulating environment is likely to be a very important contributor to good bird welfare and should always be provided. Whether birds are kept in cages, aviaries or pens, providing them with an adequate quantity of space is not enough. Good quality space is vital for good welfare. Space can be made more complex and interesting by providing separate areas for different activities such as dust bathing, bathing in water, perching and play as appropriate (Duncan 1999, Hawkins *et al.* 2001). Domestic fowl provided with such accommodation will occupy different areas and carry out a range of activities at different times of day (Channing *et al.* 2001) and the same is likely to be true of other species. Passerines require perches of varying diameters to exercise the feet (Coles 1991, Association of Avian Veterinarians 1999) and perches are also extremely important for sitting during the day and roosting at night for many non-passerines (CCAC 1984, Jacobs *et al.* 1995, Duncan 1999, Hutchison 1999, Kirkwood 1999a). Studies on domestic fowl have found that birds are less fearful when they are perching off the ground and that this is consistent with the retention of perching behaviour as an antipredation strategy (Keeling 1997, Newberry *et al.* 2001).

Furthermore, studies in domestic fowl with experimentally-induced sodium urate arthritis have found that birds subsequently housed in large pens with litter and companions exhibited less pain-related behaviour and lameness than those housed in standard cages (Gentle & Corr 1995, Gentle & Tilston 1999). This suggests that it is especially important to provide a complex environment for birds who may be experiencing discomfort or pain, as mental stimulation will help to divert attention and aid endogenous analgesia.

For further justification for the inclusion of dust and water baths, nesting material, pecking objects and substrate for foraging, see Table legends for individual species below.

- More research is needed objectively to evaluate appropriate environmental stimulation for a range of species of bird. This should examine the impact of enrichment items on both experimental birds and on the results of studies. Particular attention should be given to devising appropriate environmental stimulation for birds used in infectious disease studies.

4.3 Enclosures - dimensions and flooring

Guidelines for enclosure dimensions are set out in the species-specific provisions for domestic fowl, domestic turkeys, quail, ducks and geese, pigeons and zebra finches. All birds, especially species that spend a significant proportion of their time walking, such as quail or fowl, should be housed on solid floors with substrate rather than on grid floors. Birds can be prone to foot problems, e.g. overgrown claws, faecal accumulation and foot lesions such as foot pad dermatitis due to standing on wet litter, on any type of flooring and so frequent monitoring of foot condition is always necessary. In practice, it may be necessary to consider a compromise between solid and grid flooring for scientific purposes. In such cases, birds should be provided with solid floored resting areas occupying at least a third of the enclosure floor. Grid areas should be located under perches if faecal collection is required. To reduce the incidence of foot injuries, slats made of plastic should be used in preference to wire mesh wherever possible. If wire mesh must be used, it should be of a suitable grid size to adequately support the foot and the wire should have rounded edges and be plastic coated.

Wire flooring does not permit the provision of substrate for dust bathing, scratching and pecking and does not permit the scattering of food or treats on the floor to encourage natural foraging behaviour. It has been demonstrated that the foraging behaviour of domesticated Swedish bantams still corresponds to the optimal foraging strategies displayed by wild-type birds. Although the domesticated birds employed less costly behavioural strategies, which was interpreted by the authors as a possible passive adaptation to a domesticated life, they had retained the ability to respond in an adaptive manner to their environment (Andersson *et al.* 2001). Furthermore, domestic fowl have been shown strongly to prefer solid floors with litter rather than grid floors (FAWC 1997) and caged hens to have a high demand for a litter substrate (Gunnarsson *et al.* 2000). Grid floors are therefore unsuitable for housing birds and their use should be discontinued on animal welfare grounds.

Foot lesions can cause problems if species that spend a large proportion of their time walking are housed on unsuitable flooring or substrate. In general, these species (*e.g.* quail, fowl) should be housed on solid floors with appropriate substrate (see 4.6 for examples) to avoid lesionsHousing on solid floors may, however, lead to accumulation of faeces on the feet so monitoring and husbandry must be adequate to prevent this. It is especially important to maintain litter in a dry condition to avoid foot pad dermatitis

In practice, a compromise between solid and wire flooring may be required for scientific purposes. In this case, birds should be provided with solid floored resting areas occupying at least a third of the pen or cage floor (Hawkins *et al.* 2001). All wire mesh areas should be of a suitable size and construction, with rounded edges and plastic coating, as this has been found in practice to reduce the incidence of lesions. This is especially important where large areas of wire flooring are deemed necessary, for example in toxicology or metabolism studies (Hawkins *et al.* 2001).

- More research is needed to investigate optimum flooring for birds; in particular, ratios of solid: grid floor, appropriate mesh or grid sizes and flooring materials.

4.4 Feeding

Feeding patterns of wild birds vary widely and consideration should be given to the nature of the food, the way in which it is presented and the times at which it is made available. Diets that will meet the nutritional requirements of each species and promote natural foraging behaviour should be researched and formulated before any animals are obtained. Part of the diet or additional treats should be scattered on the enclosure floor to encourage foraging wherever appropriate. Dietary enrichment benefits birds, so additions such as fruit, vegetables, seeds or invertebrates should be considered where appropriate even if it is not possible to feed birds on their 'natural' diet. Where new foods are introduced, the previous diet should always be available so that birds will not go hungry if they are unwilling to eat new foods. Some species are more adaptable than others and advice should be sought on appropriate dietary regimes.

Some species, particularly granivores, require grit to digest their food. Appropriately-sized grit must be made available where required. Birds will select grit of the size they prefer if material of various sizes is provided. The grit should be replaced regularly. Dietary calcium and phosphorus should also be provided for birds in an appropriate form and at an appropriate level for each life stage, to prevent nutritional bone disease. Any such requirements should be thoroughly researched and catered for. Food should be supplied in troughs rather than circular feeders, as circular feeders occupy valuable floor area and can hinder effective cleaning and inspection of birds. Chicks of some species (e.g. domestic turkeys) may need to be taught to feed and drink in order to avoid dehydration and potential starvation. Food for all species should be clearly visible and provided at several points to help prevent feeding problems.

Food selection, feeding times and durations ultimately depend on a bird's species, age, the season and which food is currently available (Paulus 1988). Many species, *e.g.* waterfowl, often spend more time feeding than doing anything else (Goudie & Ankney 1986, Paulus 1988, Sedinger 1992) so it is very important to encourage appropriate foraging behaviour (see also Andersson *et al.* 2001). It is essential to ensure that lighting is adequate so that chicks can see their food; UV light may well help with this (see above). Many chicks will copy feeding behaviour, so tapping at their food with a finger or pencil will often encourage them to peck at the food for themselves. Alternatively, housing chicks of different ages together or so that they can see one another will enable younger chicks to copy older birds.

Birds have relatively few taste buds in comparison with mammals (*e.g.* blue tits have 24, fowl 340, mallard ducks *Anas platyrynchos* 375 and rats 1,265) but nevertheless appear to have an acute sense of taste (Welty & Baptista 1988). Taste is thus relevant to many birds (Lint & Lint 1981) and dietary enrichment should be considered (Association of Avian Veterinarians 1999); fowl can taste well (Gentle 1971) and the taste of food appears to be important to the pigeon (Zeigler 1975). Birds also learn to avoid unpalatable substances and chicks learn to associate the consequences of eating foods with their taste. While some species are specialist feeders that are adapted to eat a narrow range of food items, generalists may benefit from dietary enrichment (Hawkins *et al.* 2001). Diet preferences are shaped by early experience, however, so any new foods should be introduced gradually and as an extra option, especially where birds have previously been fed on bland or uniform diets. Some species or individuals may be unwilling to eat new foods as adults, so the diet to which they are accustomed should always be available as well (Association of Avian Veterinarians 1999).

Many species of granivorous and herbivorous birds ingest small pieces of insoluble grit which they retain in their gizzards and which assist in the process of degradation, grinding and breaking up of seeds and other fibrous plant matter prior to chemical digestion. It is essential that appropriately-sized grit is made available to species that require it (Kirkwood 1999a). Birds will select grit of the size they prefer if material of various sizes is provided (Hawkins *et al.* 2001).

Nutritional bone disease is a potential problem in many species of birds maintained in captivity (Kirkwood 1999b). Because of their very rapid rates of skeletal growth compared to mammals (Kirkwood *et al.* 1989) birds tend to have requirements for higher dietary calcium concentrations during growth and can develop skeletal pathology (including poorly mineralised bones and pathological fractures) very rapidly if calcium intake is inadequate. Although the dietary calcium concentrations of the main components of the diets of many species of birds are relatively low (*e.g.* many invertebrates, grains, fruits, and green plants), nutritional bone disease is rare in free-living birds. It is known that some species include calcium-rich items such as fragments of bone or snail shell in the diet they feed to their chicks (*e.g.* Seastedt & Maclean 1977, Kirkwood 1999a) and this behaviour may be more common among birds than has previously been realised. It is important to estimate dietary calcium concentrations carefully because both deficiencies and excesses can cause severe skeletal pathology. This is especially important in high egg production strains of domestic fowl, which are prone to osteoporosis. Where calcium supplementation in the feed is judged to be necessary, quantities should be calculated and administered with precision (Kirkwood 1996). Additional calcium may be offered in the form of crushed oyster shells in a separate container to be taken *ad libitum*.

4.5 Watering

One nipple or cup drinker should be provided for every 3 or 4 birds with a minimum of two in each enclosure. Care should be taken to ensure that chicks cannot become trapped in drinkers as they will become chilled and may drown. Water may also be given in birds' feed if appropriate.

All birds should have access to water at all times, even species that do not normally drink when in good health (Kirkwood 1999a). The number of drinkers is taken from Duncan (1999). Water in the feed has been shown to be a potent reinforcer in domestic fowl (Sherwin 1993). Water should be clearly visible, especially for young chicks. If juvenile birds are not drinking for themselves, they should be individually 'beak dipped' by placing the beak gently in cold water for 1 to 2 seconds.

4.6 Substrate, litter, bedding and nesting material

Suitable substrates for birds should be absorbent, unlikely to cause foot lesions and of an appropriate particle size to minimise dust and prevent excessive accumulation on the *birds' feet. Suitable substrates include chipped bark, white wood shavings, chopped straw or washed sand, but not sandpaper. Litter should be maintained in a dry, friable condition and be sufficiently deep to dilute and absorb faeces. Other suitable floor coverings include plastic artificial turf or deep pile rubber mats. A suitable pecking substrate such as pieces of straw should be scattered over the floor.*

Hatchlings and juvenile birds should be provided with a substrate that they can grip to avoid developmental problems such as splayed legs. Juvenile birds should also be encouraged if necessary, for instance by tapping with the fingers, to peck at the substrate to help prevent subsequent misdirected pecking.

Many species of birds have a high demand for substrate, especially those that spend much time walking and/or inhabit a forest floor habitat in the wild, e.g. domestic fowl, turkeys and quail (Schmid & Wechsler 1997, Gunnarsson *et al.* 2000, see Hawkins *et al.* 2001). All of the substrates listed above have been successfully provided in practice in the experience of Expert Group members. Sandpaper should not be used because it abrades the feet and may be ingested for the grit when faecally contaminated (Coles 1991). It is important to monitor birds' feet regularly for signs of lesions and faecal accumulation when using any type of substrate. Excessive accumulation of faeces mixed with substrate and lesions such as hock burns or pododermatitis can be caused by poor quality litter and/or inadequate husbandry. If problems of this nature occur, birds should not be denied substrate but the type of litter and animal care should both be reviewed.

4.7 Cleaning

See item 4.9 of the General Section of Appendix A.

4.8 Handling

Suitable equipment for catching and handling should be available, e.g. well maintained nets in appropriate sizes and darkened nets with padded rims for small birds.

If the experimental procedure requires adult birds to be handled regularly, it is recommended from a welfare and experimental perspective to handle chicks frequently during rearing as this reduces later fear of humans.

All birds are liable to find restraint and handling extremely stressful, perhaps because handling by humans may be interpreted as a close encounter with a predator. The bird's point of view must be considered at all times before and during handling. Competent handling is thus vital not only for the safety of the human handler but also because attacking birds may be dropped or mishandled, which could result in bruising or broken bones. Even if there is no physical damage, the psychological distress will lead to greater fear, anxiety and aggression the next time the bird has to be caught (Hawkins *et al.* 2001).

There are a number of essential factors that must be addressed during training. These include applying the correct amount and method of restraint and ensuring that respiration is not prevented by incompetent or inappropriate handling (Fowler 1995). Other important considerations are the potential for hyperthermia during handling and the likelihood that birds will employ antipredator strategies such as panting, gaping, closing the eyes or fluffing up the feathers (Redfern & Clark 2001). It is essential that bird handlers are properly trained to recognise signs of genuine distress that could indicate shock, wing sprain, leg or wing fractures, skin damage or heat stress and know the appropriate actions to take (Fowler 1995, Redfern & Clark 2001).

It may be possible to reduce handling stress by habituating birds to human contact and handling from hatch (if possible), using positive reinforcement and rewards (Jones 1994, see Laule 1999). However, this may not be as effective in particularly 'flighty' strains (Murphy &

Duncan 1978).

- More research is needed into the effect of handling chicks from hatch on subsequent handling stress in adult birds.

4.9 Humane killing

The preferred method of killing for juvenile and adult birds is an overdose of anaesthetic using an appropriate agent and route.

Euthanasia by an appropriate anaesthetic agent is preferable to CO_2 *inhalation for birds and embryonic birds, as* CO_2 *may be aversive. As diving birds and some others, e.g. mallard ducks, can slow their heart rates and hold their breath for long periods, care should be taken when killing such species using chemical agents by inhalation to ensure that they do not recover from anaesthesia. Ducks, diving birds and very young chicks should not be killed using carbon dioxide.*

According to the EC Working Party Report (Close *et al.* 1997), the most acceptable method for killing either embryonic or adult birds is an overdose of sodium pentobarbitone. The most commonly used method for killing bird embryos is cooling or freezing, and this was considered by the EC Working Party to be humane provided that death was confirmed by a suitable method afterwards. Disruption of the membranes and maceration (*NB* in a macerator designed for the purpose) were also considered to be acceptable for embryonic birds.

It is the opinion of the Working Party that chilling is likely to be aversive and that the stage in incubation at which it is no longer acceptable is difficult to define (one would not kill a day-old chick by chilling and a chick one day before hatching is little different). Chilling should therefore not be carried out before killing using mechanical means as this may cause avoidable suffering.

For adult birds, an overdose of an appropriate anaesthetic agent was considered to be most acceptable and humane by the EC Working Party and the BVA(AWF)/FRAME/RSPCA/UFAW Joint Working Group on Refinement (Close *et al.* 1997, Hawkins *et al.* 2001).

Diving birds and some other species (*e.g.* the mallard duck *Anas platyrhynchos*) possess physiological mechanisms that enable them to withstand long periods of hypoxia and hypercapnia (reviews in Jones 1976, Butler 1982, see also Butler & Taylor 1983). Ducks and diving birds should therefore not be killed using carbon dioxide (Hawkins *et al.* 2001). Very young chicks are resilient to CO_2 because it accumulates in the air space before hatching (Jaksch 1981) and can take a long time to die (M Raj, unpubl. obs. on domestic fowl and turkey chicks). There is an increasing body of evidence to suggest that a range of species find CO_2 aversive (*e.g.* Leach *et al.* 2002), and there have been a number of behavioural studies of turkeys and domestic fowl exposed to CO_2 and to gas mixtures including CO_2. These describe behavioural responses to such gases including gasping and head shaking, which are interpreted as indicating or causing distress (Raj 1996, Lambooij *et al.* 1999, Webster & Fletcher 2001). On this basis, birds should be given the benefit of the doubt and carbon dioxide euthanasia avoided where possible.

- Further studies are needed to evaluate at which levels and in which proportions in gas mixes CO_2 is aversive to birds.

4.10 Records

See item 4.12 of the General Section of Appendix A.

4.11 Identification

Non-invasive or minimally invasive methods such as noting physical differences, ringing with either closed or split rings and staining or dyeing the feathers are preferable to more invasive techniques such as electronic tagging or wing tagging. Combinations of coloured leg rings minimise handling for identification, although due regard should be paid to any potential impact of colours on behaviour If the use of transponders is required to log how frequently birds are present at different locations, it may be possible to fix them to rings rather than to implant them. When using rings as temporary marking for rapidly growing chicks, regular checking is essential to ensure that the ring is not impeding the growth of the leg.

Highly invasive marking methods such as toe clipping or web punching cause suffering and should not be used.

Birds are commonly identified by several methods, including (from least to most invasive):

- Noting physical differences, *e.g.* plumage colours and patterns, morphological differences.
- Ringing with either closed or split rings. Care must be taken to ensure that leg ring colours and symmetry will not affect behaviour (*e.g.* Swaddle & Cuthill 1994) and that the correct size of ring is fitted for each species and age group. Particular care is needed for young animals that can quickly out-grow rings, *e.g.* domestic turkey chicks.
- Staining or dyeing the feathers. The potential impact of the chosen colour on behaviour must be researched and groups closely monitored following marking. All staining agents must be non-toxic and non-irritant.
- Electronic tagging. The left pectoral muscle is commonly used as an insertion site in birds, although this may not be appropriate for small birds likely to spend a significant amount of time flying. If it is considered that intramuscular implantation could cause pain or impair movement, transponders should be implanted subcutaneously at the base of the neck.

- Wing tagging. Even small wing tags are likely to interfere with normal behaviour to a greater extent than the alternative methods outlined above (provided that they are competently employed), so markers should not be fixed to the wings unnecessarily. Wing badges must be competently fitted, must not impede flight and must always be as small as possible.

The list of identification methods and guidance for using them is taken from Hawkins *et al.* (2001); see also Redfern & Clark (2001). The practical or legal need to mark animals at all should always be questioned. If it is necessary to identify individual birds, the technique that is least invasive, causes least suffering and is compatible with experimental aims should always be used.

II. Species-specific enclosure dimensions and husbandry guidelines

The pen and cage dimensions and husbandry guidelines in this section were based on those in Hawkins *et al.* (2001). These, in turn, were set out according to current good practice and the experience of the JWGR Working Party members.

Guidelines for caging birds in stock and during procedures in user establishments

The Group proposes that there should be separate Tables for domestic fowl, domestic turkeys, quail, ducks and geese, pigeons and zebra finches, with legends as follows:

A standard pen size of $2m^2$ (with the exception of pens for turkeys over 20 kg) was agreed by the Working Group because:

- $2m^2$ is an easily manageable pen size that is already in use at some establishments;
- it provides the flexibility to house a range of different species by altering the number of animals in each pen;
- it provides sufficient space for environmental enrichment to encourage a range of behaviours and also allows for behaviours such as pre-laying pacing, social attraction and repulsion and so on;
- $2m^2$ permits easy access for cleaning, catching and monitoring animals.

Guidelines for housing the domestic fowl, *Gallus gallus domesticus*, in stock and during procedures

Domestic fowl retain much of the biology and behaviour of the Jungle fowl from which they were domesticated. Behaviours that are most important to the species are nesting (in females), perching and using litter for foraging, scratching, pecking and dustbathing. Fowl are social and should be housed in groups of around 5 to 20 birds, with fewer males than females in mixed groups, e.g. a ratio of 1:5. Attempts have been made to select strains of fowl for reduced feather pecking or agonistic behaviour. The existence of appropriate strains of this type, and the feasibility of acquiring them, should be evaluated for each project.

Laying hens should have access to nest boxes from at least 16 weeks of age so that they can investigate them before they come into lay at 18 weeks. Nest boxes should be enclosed and large enough to allow one hen to turn around. A loose substrate such as wood-shavings or straw should be supplied within nestboxes to promote nesting behaviour. Substrate should be regularly replaced and kept clean.

Fowl should always be provided with the opportunity to perch, peck appropriate substrates, forage and dustbathe from one day old. Perches should be 3 to 4 cm in diameter and round with a flattened top. The optimum height above the floor varies for different breeds, ages and housing conditions but perches should initially be fixed at 5 to 10 cm and at 30 cm above the floor. Perch heights can then be adjusted in response to the birds' behaviour by seeing how easily birds can get on and off perches and move between them. Birds should also be briefly observed during dark periods; all individuals should be roosting unless the perches are too high. Each individual should be allowed 15 cm of perch at each level. Suitable materials for dustbathing include sand, soft wood shavings.

Fowl are highly motivated to perform 'comfort behaviours' such as wing flapping, feather ruffling and leg stretching, which help to maintain strong leg bones. Birds should therefore be housed in floor enclosures large enough to permit all of these behaviours whenever possible. Ideally, birds should be housed with outdoor access; appropriate cover such as bushes is essential to encourage fowl to go outside. Flooring for fowl should be solid, as this enables the provision of substrate to encourage foraging and possibly help to reduce

the incidence of feather pecking. If fowl need to be caged for scientific purposes, they should be housed in enclosures designed to address behavioural requirements. If there are scientific reasons for not providing a solid floor, a solid area with loose substrate and items such as bunches of string, pecking blocks, rope, turf or straw should be provided for pecking.
Fowl strains developed for rapid growth rates (broilers) are highly susceptible to lameness and their use should be avoided wherever possible. If broilers are used, individuals should be assessed for lameness at least weekly and grown more slowly than commercially unless growth rate is essential for the study.

The minimum enclosure size for group housed domestic fowl is 1m² for birds less than 600g bodyweight and 2m² for birds greater than 600g.

Body mass (g)	Area per bird – pair housed (m^2)	Area per bird – group housed (m^2)	Minimum height (cm)	Minimum length of feed trough per bird (cm)
Up to 300	0.5	0.15	30	3
300 to 600	0.5	0.2	40	7
600 to 1200	1	0.3	50	15
1200 to 1800	1	0.4	50	15
1800 to 2400	1.5	0.5	55	15
Over 2400	1.5	0.6	75	15
Male birds	1.5	0.6	75	15

Behaviour
The domestic fowl is derived from the Burmese Red Jungle fowl *Gallus gallus*. Domestication, probably for cockfighting and as a sacrificial bird, began more than 5000 years ago. Despite the lengthy domestication period, domestic fowl retain much of the biology and behaviour of Jungle fowl, although domestic birds employ more energy saving strategies (Schütz *et al.* 2001, Ito *et al.* 1999) and modern breeds have been successfully re-established in the wild (McBride *et al.* 1969, Anonymous 2001, Andersson *et al.* 2001). Consideration of the ecology and behaviour of Jungle fowl is therefore essential for predicting the requirements of the domestic fowl (Hawkins *et al.* 2001, Fölsch *et al.* 2002).

Jungle fowl are predominantly ground-living in tropical and temperate scrub, forest or jungle habitats with ample overhead cover. The provision of appropriate cover is also very important for domesticated birds (Cornetto & Estevez 1999, Cornetto *et al.* 2002), and studies have suggested that visually discontinuous cover provides the greatest feelings of security (Newberry & Shackleton 1997). The most common social organisation in Jungle fowl is one male with up to four females, though they form larger groups of around 20 birds in more open environments. Other males either are solitary or form unisexual groups of 2 or 3 birds. Mixed groups have a well-defined home range with a regular roosting location. Jungle fowl spend the majority of their time foraging for seeds, fruits and insects (Duncan 1999), while domestic hens provided with concentrated food *ad libitum* may spend around 35 % of their day ground pecking and scratching (Anonymous 2001, Fölsch *et al.* 2002). It is therefore very important that husbandry systems should encourage this foraging behaviour. Maintaining the condition of the plumage through preening and dustbathing is also a time-consuming daily activity which becomes more important to fowl as they mature (Duncan 1999, Anonymous 2001).

Fowl are highly social and will form groups with stable hierarchies under appropriate conditions (see Anonymous 2001). Hens prefer to be with conspecifics (Lindberg & Nicol 1996), prefer familiar birds to an empty cage and should not be housed in isolation (Hawkins *et al.* 2001). There is probably no optimum group size, though it has been suggested that small groups of around 5 to 20 birds are generally favourable as there is less aggression and stress than in larger sized groups (Duncan 1999). Conversely, subordinate hens have been shown to prefer larger groups, possibly because this provides more opportunities to escape dominant birds (Lindberg & Nicol 1996). Mixed sex groups should contain few males to avoid excessive competition between them. Female groups with a small number of males may have lower aggression than groups of females only. However, the addition of males to a group of females may increase social stress if there is insufficient space (Duncan 1999).

Behaviours that are most important to fowl are nesting, perching and using litter for scratching, pecking and dustbathing (FAWC 1997, Duncan 1999, Olsson & Keeling 2000, Widowski & Duncan 2000, Anonymous 2001), so fowl should therefore be housed in floor pens large enough to permit all of these behaviours (Duncan 1999, Fölsch *et al.* 2002). Fowl are also highly motivated to perform 'comfort behaviours' such as wing flapping, feather ruffling and leg stretching, which help to ensure strong leg bones (Knowles & Broom 1990). It is also important to recognise that fowl will synchronise their activities and prefer to carry out specific behaviours together as a flock, so any facilities provided for them should enable them to do this (Duncan 1999, Anonymous 2001, Channing *et al.* 2001).

Domestic fowl in commercial flocks are often housed in extremely barren environments that seriously limit their ability to exercise and to express a range of natural behaviours (Anonymous 2001). The Group believes that this does not justify inadequate housing and husbandry in the laboratory and that fowl should be provided with good quality and quantity space wherever they are kept. (see also Höfner *et al.* 1997, Hawkins *et al.* 2001)*,* Table (i) on page 45 sets out fowl welfare criteria according to the animals' main needs, summarised from Anonymous *et al.* (2001). The third column has been added by the Expert Group.

Flooring

When kept on loose substrate, fowl spend a great deal of time performing foraging behaviour, *i.e.* pecking and scratching the ground (Duncan 1999, Anonymous 2001). Motivation for this behaviour appears to be high, as hens will forage for feed rather than eat identical feed that is freely available (Duncan & Hughes 1972) and, when given the choice, strongly prefer litter to a wire floor (FAWC 1997). Fowl kept on a wire floor or without appropriate pecking substrate may express their motivation to forage by excessive food manipulation with the beak and by feather pecking, a severe welfare problem (Green *et al.* 2000, Anonymous 2001). The incidence of feather pecking is significantly lower when litter is provided (Blokhuis 1989) and fowl have a high demand for a litter substrate (Gunnarrson *et al.* 2000), so fowl should be kept in pens with a loose substrate such as sand or soft wood-shavings (Hughes & Channing 1998). In these conditions it is important to replace the litter frequently to remove droppings and reduce the risk of disease.

Dustbathing is an especially important behaviour for hens (e.g. Zimmerman *et al.* 2000), but is thwarted by many housing systems (Anonymous 2001). 'Sham' or 'vacuum' dustbathing is often performed by fowl housed on wire floors, where animals are strongly motivated to dust bathe but unable to do so. Performing this vacuum dustbathing behaviour does not affect a bird's motivation to dustbathe in a suitable substrate (Lindberg 1999), so is not a substitute for 'real' dustbathing, which is likely to be pleasurable to hens (Widowski & Duncan 2000) and also appears to remove excess feather lipids and help to maintain plumage. Activities such as dust bathing require a considerable amount of space, as birds tend to roam some distance when foraging and bathing, but are important to the birds and so should always be possible (Duncan 1999, Fölsch *et al.* 2002).

A cage is not an appropriate housing environment for fowl (Fölsch *et al.* 2002, see also Hansen *et al.* 1993). If fowl must be kept in cages, it is advisable to provide a solid area with loose substrate covering at least one third of the floor area to allow some expression of foraging behaviour (Hawkins *et al.* 2001). Several cage designs have been developed that incorporate such an area (see Sherwin 1994, Fölsch *et al.* 2002). Many modified cages also provide a perch and nest box that allow much of the natural behavioural diversity of the species and provide an alternative method of housing if very hygienic conditions are required. However, measures that reduce feather pecking may be necessary (see below), such as providing objects for pecking or temporarily lowering the light intensity. It is advisable to use systems that have been extensively developed and tested, as deaths due to trapping are common in many early designs. If there are sound scientific reasons for not providing a solid area with loose substrate, toys or other items such as pecking blocks (*e.g.* Pecka-blocks, Breckland International Ltd, UK), rope, turf or straw should be provided for pecking, as fowl are attracted towards novel stimuli such as pecking items and sustain interest in them provided that they are selected with care (Newberry 1999). Plain bunches of white string are particularly effective (Jones *et al.* 1997, 2000, Jones & Carmichael 1998, Jones & Rayner 2000, Jones 2001).

Table (i) overview of fowl welfare

Need	**Natural behaviour and welfare issues**	**Potential welfare problems in standard cages with no enrichment and grid floors?**
Food, foraging	Pecking, ground scratching, needs litter and variety of food items	YES
Water	Frequent drinking, generally not at night	NO
Rest	Perching close together, usually at night	YES
Thermoregulation	Panting, raising feathers or wings	NO (in general)
Health	*E. coli*, coccidiosis, bone fractures	NO (parasites)/ YES (fractures)
Social contact	Peck order, communication, social recognition, possibility of escape	YES
Nesting	Nesting behaviour	YES
Maternal	Brooding, raising chicks	YES
Exploration	Pecking, scratching, visual investigation	YES
Safety	Fear, hysteria, need cover in open spaces, neophobia, frustration	YES/NO
Movement	Lack of movement, bone atrophy	YES
Body care/comfort	Preening, dust bathing, wing flapping, stretching, raising feathers	YES

Perches

Fowl have feet that are anatomically adapted to close around a perch when they roost, and feral and wild fowl spend a large amount of time perching on branches. In captive environments with limited perch space, hens struggle vigorously to obtain and keep perching space despite severe crowding, which indicates a high motivation to do so. Recent studies indicate that hens will push through heavy doors to gain access to perches at lights-off (Olsson & Keeling 2001) and become frustrated when they cannot perch at lights-off, such that the welfare of hens who cannot perch is reduced (Olsson & Keeling 2000). Providing perches reduces bird density on the floor, allows subordinate birds to escape dominant individuals by day and reduces agonistic interactions (Cordiner & Savory 2001, Pettit-Riley & Estevez 2001). Additional welfare benefits include feelings of safety (Keeling 1997), enhanced spatial awareness (Gunnarsson *et al.* 1999), improved foot and plumage condition and increased leg bone strength. Any deleterious effects of perching, such as bumblefoot or keel deformation, are due to poor perch design or positioning (Baxter 1994).

Fowl should therefore always be provided with the opportunity to perch and so at least 15 cm should be available to each bird (Duncan 1999, RSPCA 1999b). Perches should have a flat top about 3 to 4 cm wide, as round perches can increase the incidence of keel deformation (Duncan *et al.* 1992). The optimum height above the floor varies for different breeds and housing conditions (see also Lambe & Scott 1998), although layers can generally reach higher perches than broilers.

Nest boxes

Pre-laying behaviour occurs between 20 and 120 minutes before oviposition and starts with searching behaviour that leads to selection of a nest site and nest building. Hens are strongly motivated to obtain a suitable nest site (Cooper & Appleby 1994, Freire *et al.* 1997, Fölsch *et al.* 2002) and become frustrated and develop stereotypic pacing if deprived of access to one (Duncan & Wood-Gush 1972). Competition for preferred nest boxes may be a problem so a sufficient number should always be provided to allow subordinate birds access to nesting areas. Physiological stress arising from the failure to find a suitable nest site can lead to the egg being retained and 'dropped' later in the day without pre-laying behaviour. These eggs have a dusted or banded appearance, arising from extended calcification, and are a good indicator of stress during the pre-laying period. Laying hens should therefore have access to nest boxes from at least 16 weeks of age (Rietveld-Piepers *et al.* 1985, Hawkins *et al.* 2001). Although the exact nest site requirements of individual hens vary considerably, an enclosed individual nest box is satisfactory and highly preferable to most hens. Nest boxes should preferably be littered, enclosed and allow one hen to turn around. Hens are motivated to examine nest sites in the weeks before they come in to lay and allowing them to do so increases later use of the nest box (Rietveld-Piepers *et al.* 1985, Sherwin & Nicol 1993). A loose substrate such as wood-shavings or clean straw is also important and allows complete expression of nest building activities. An astroturf floor is also suitable though less preferable to the hens.

Broilers

Lameness is highly prevalent in all broilers grown on commercial (or approximately commercial programmes (Kestin *et al.* 1999; Sanotra 2000) and this is known to be painful (McGeown *et al.* 1999; Danbury *et al.* 2000; Weeks *et al.* 2000). The majority of the lameness is due to the excessively fast growth rates that occur in modern broiler strains. Growth can be influenced by decreasing the day length so that birds have less time to feed and this is the preferred method (Classen 1992). Alternatively, altering the level of protein and energy content or restricting feed, will reduce the incidence of lameness and its attendant welfare problems (Su *et al.* 1999). However, feed restriction can lead to aggressive behaviour, feather pecking and increased competition at around the time when food is delivered. Close observation and adequate management are therefore essential. See also Anonymous *et al.* (2001) for a summary of welfare issues relating to broilers.

Cage and pen sizes

The current European Convention and Directive guidelines for caging fowl (Council of Europe 1986) allow 650 cm^2 per bird for groups of three birds or more with body mass 1800-2400g. Six large fowl could therefore legally be kept in an area approximately 50 cm x 80 cm. This would not be sufficient to permit a range of normal behaviours or the provision of a good quality environment and the minimum pen area and area per bird both therefore need to be increased.

If birds must be caged, *e.g.* where a study requires the collection of faeces, they should be housed in modified cages designed to address behavioural requirements (Sherwin 1994) rather than standard size or ‘battery’ cages (see also Duncan 1999). Standard cages with a height of 40 cm prevent many comfort behaviours, and so cage heights that prevent full extension of the head and wings should not be used. Adult birds will take at least 2000cm^2 for the expression of comfort behaviours (Dawkins & Hardie 1989, Duncan 1999) and male birds require at least 2,500 cm^2 (Duncan 1999). Clearly, exercise, foraging and the inclusion of environmental enrichment will require yet more space.

The requirement for an extensive area appears to be important in two contexts. First, in the early stages of pre-laying behaviour, hens with access to a suitable nest site show increased walking and exploration in larger rather than smaller areas. If access to the nest is denied, hens develop stereotypic pacing suggesting that locomotory motivation is thwarted (Duncan & Wood-Gush 1972). These findings suggest that hens may be motivated to walk and explore the environment during the early stages of pre-laying behaviour. If so, then a confined area such as a cage will not meet these requirements and may account for the unusually high number of nest entries sometimes observed in cages with nest sites. Second, studies on spacing suggest that there are social attraction and repulsion forces and that when hens are given sufficient space, their chosen stocking density can vary considerably (*e.g.* Keeling & Duncan 1989, Channing *et al.* 2001). In small pens, birds may be motivated to achieve appropriate spacing, but be physically prevented from doing so. It is likely that the failure to express this motivation gives rise to social stress (Hawkins *et al.* 2001).

Fowl will walk up to 2.5 km a day and fly to and from elevated places if they have the opportunity to do so (Keppler & Fölsch 2000). They prefer large spaces and appear to find small spaces aversive if they have the opportunity to avoid them (Lindberg & Nicol 1996). Furthermore, in a survey of welfare scientists, summarised in Table (ii) below, space was rated as the most important welfare criterion to domestic fowl (Anonymous 2001).

Table (ii) design criteria for welfare in domestic fowl, ranked in order of importance (1 = most important)

Rank	Design criteria	Consequences if design is not appropriate
1	Space	Bone weakness, restricted or abnormal behaviour, fear
2	Substrate	Restricted or disturbed behaviour
2	Laying nest	Disturbed behaviour, gakel calls
4	Genetic background (strain)	Feather pecking, need to beak trim, fearfulness
5	Social contact (group size)	Abnormal or disturbed behaviour; social stress, aggression, feather pecking
6	Light	Eye abnormalities, reproductive depression
7	Perches	Behavioural restriction

Feeding

Fowl show diurnal rhythms in feeding behaviour with peaks in feeding usually at the beginning and end of the light period. Additionally, the sight and sound of a feeding bird triggers feeding behaviour in others, and so it is likely that at certain times of the day all birds are motivated to feed. The provision of insufficient feeder space for all birds to feed synchronously is likely to be deleterious to the well-being of displaced birds; the resulting competition and feelings of frustration could also lead to outbreaks of feather pecking (see Green *et al.* 2000). A minimum of 15cm of feeder length per bird should thus be provided to allow birds of any strain to feed synchronously (Duncan 1999).

Guidelines for housing the domestic turkey, *Meleagris gallopavo*, in stock and during procedures

Wild turkeys regularly utilise a diverse range of environments and perform a variety of behaviours including dustbathing, foraging and hunting. The social behaviour of the wild turkey is complex, particularly during the breeding season. Domestic turkeys retain many of the characteristics of wild birds but there are some fundamental differences, e.g. domestic turkeys are unable to fly but have retained the ability to run quickly, jump and glide, especially at younger ages.

Domestic turkeys are highly social and should not be singly housed. Stable groups should be formed as soon as birds are acquired and adequate monitoring is essential as injurious feather pecking and head pecking can occur from the first day of life.

Lameness is a common problem and needs to be carefully monitored. A policy for dealing with lameness should be agreed with the attending veterinarian.( )

Turkeys should be provided with perches placed at a height where birds on the ground are not able easily to peck and tug at the feathers of perching birds. However, if birds are older and less agile, the access to perches should be facilitated by special equipment such as ramps. Where this is not possible, perches should be placed at a low height (e.g. 5 cm). The shape and size of the perch should be in accordance with the rapidly growing claws of the birds. Perches should be ovoid or rectangular with smoothed corners and made of wood or plastic.

Substrate for dustbathing should always be provided. Suitable materials are fresh sawdust or sand. Straw bales may be used for enrichment and to provide a refuge from dominant birds, but will need to be frequently replaced and older, heavier birds may need ramps to gain access to them.

The minimum enclosure size for group housed domestic turkeys is 2 m^2. For birds over 20 kg, the minimum enclosure size is 3 m^2 and all enclosure sides should be at least 1.5 m long.

Body mass (kg)	Area per bird – group housed (m^2)	Minimum height (m)	Minimum length of feed trough per bird (cm)
1	0.3	1	15
4	0.35	1	15
8	0.4	1	15
12	0.5	1.5	20
16	0.55	1.5	20
20	0.6	1.5	20
Over 20	1	1.5	20

Behaviour

The domestic turkey is derived from the native wild turkey of North America. The natural habitat used by wild turkeys varies considerably according to the season, climatic conditions and behaviour being performed. Turkeys regularly utilise environments as diverse as open plains, dense woodland, thick scrub, treetops, and can sometimes even be seen wading in lakes. The walking speed of the wild turkey is approximately 5 km/h but birds can run with great manoeuvrability at speeds up to 30 km/h. Although their endurance is not great, wild turkeys are capable of flight - in stark contrast to the domesticated strains. Wild turkeys are not true migrants but will move up to 80 km between winter and summer sites. Typically, daily movement is 2-3 km and the home range covers from 200 to 1,000 acres (Bent 1963, Schorger 1966, Williams 1981).

The social behaviour of the wild turkey is complex. During the breeding season, males congregate in large groups to display to each other, emitting their characteristic 'gobbling' call. In domestic birds this display is readily elicited by the presence of humans. After hatching, the family is a basic social unit with the young firmly imprinted on the hen. The mother apparently teaches the young about the suitability of various foods with a series of displays and distinctive 'clucks'. Several broods usually join together in the spring to form a larger flock with the males leaving in the winter such that during this season there are 4 types of flock; (i) old hens without broods, (ii) brood hens with female offspring, (iii) young males recently separated from mothers and (iv) older males (Schorger 1966, Watts and Stokes 1971).

Wild turkeys perform a wide variety of other behaviours such as dustbathing, anting, foraging, hunting and fighting (which may sometimes last for hours). They are a highly vocal animal with a wide diversity of calls; eight are recognised and used routinely during hunting (Williams 1981).

Social housing
Domestic turkeys are highly social and become very distressed when isolated. Handling or housing birds as individuals should be avoided as this generally makes the birds considerably less tractable. However, turkeys are capable of recognising one another and placing any 'strange' turkey into an established group will almost certainly result in that individual being attacked by several others and possibly killed. Group housed turkeys can be highly aggressive to one another. Intense sparring fights can occur as the birds mature. During such fights, the opponents become almost oblivious of extraneous stimuli - handlers must be cautious if trying to intervene in a fight. The most extreme form of injurious pecking is head pecking in which one individual is incessantly targeted and pecked, sometimes with great force, by several other birds. It tends to become more frequent when the turkeys reach sexual maturity, especially if there is a significant difference in size between birds (Hawkins *et al.* 2001).

Feather pecking and aggression
Injurious feather pecking can occur from the first day of life. Recent evidence (Sherwin *et al.* 1999a) indicates that, at least in relatively small groups (of between 50 and 100 birds), this can be considerably reduced by providing supplementary ultraviolet radiation (turkeys can see in the UV spectrum), pecking substrates (*e.g.* straw) and visual barriers to reduce social transmission of this behaviour. Other pecking substrates which might be used are chains or twine (both at head height to ensure the birds do not become entangled), vegetable matter such as cabbages or scattering food in the substrate.

Environmental stimulation
Like the domestic fowl, the turkey is often housed in extremely barren conditions when kept in a commercial flock. Less has been published on environmental stimulation for turkeys than fowl (see Sherwin *et al*. 1999a and b), but it is equally important to provide sufficient quality space to allow turkeys to express a range of natural behaviours (Berk 1999, Hawkins *et al.* 2001). Enrichment, in conjunction with low stocking density, has also been found to reduce mortality in the BUT Big6 strain (Berk 1999).

As noted above, scattering food such as grain in pecking substrates such as straw promotes foraging behaviour and other vegetable matter, such as brassicas (*e.g.* cabbage leaves) or scattered grain (Crowe & Forbes 1999), can also be provided on the floor of the pen (Sherwin *et al*. 1999b). Straw bales also make the birds' environment more interesting and can provide a refuge from dominant birds, but will need to be frequently replaced (Hawkins *et al* 2001). While enrichment improves walking ability, older, heavier birds may need ramps if they are still to gain access to and benefit from perches and ramps (Berk 1999). Turkeys are particularly attracted to peck at string-like objects or those that are easily manipulated by the beak (Crowe & Forbes 1999).

Space allowances

Turkeys are the largest domesticated gallinaceous bird. They show a variety of 'comfort' behaviours such as wing-flapping, feather ruffling and leg stretching. In addition, they show spontaneous vigorous locomotion ('frolicking') which has all the appearance of 'play' and which decreases in frequency as the birds get older (Sherwin & Kelland 1998). All these activities, particularly locomotion, require a considerable amount of space. The UK Farm Animal Welfare Council noted that a maximum stocking density of 38.5kg/m^2 had been recommended, but provided their own formula which suggested a maximum permissible stocking density of 59.1kg/m^2 (FAWC 1995). This higher density approximates to 3 adult birds each weighing 20 kg being provided with 1 m^2, which is clearly limiting for birds wishing to perform behaviours that require considerable space such as dustbathing and wing-flapping. Good practice would suggest a considerably lower density is maintained to allow comfort behaviours, exercise and environmental enrichment. Fully grown stags may have a wing span of 1.5 m and should at least be able to extend their wings.

Perching and dustbathing

Recommendations on the provision of perches and substrate for dust baths are taken from Hawkins *et al.* (2001).

Guidelines for housing quail (*Coturnix spp.; Colinus virginianis; Lophortyx californica; Excalfactoria chinensis*) in stock and during procedures

Wild quail live in small social groups and devote much of their time to scratching and foraging for seeds and invertebrates on the ground. The preferred habitat of many species is dense vegetation such as grasslands, bushes alongside rivers and cereal fields. Domestication does not appear substantially to have altered quail behaviour, so it is essential to design housing systems that respect this and allow the provision of substrate for scratching, pecking and dustbathing, nestboxes and cover wherever possible. The housing of quail in aviaries or pens as opposed to cages is therefore strongly recommended.

Quail should be group housed in either all female or mixed sex groups. Where the sexes are mixed, the ratio of males to females should be low (e.g. 1:4) to reduce aggression between males and injuries to females. It may be possible to pair house males if stable pairs are formed during rearing. The likelihood of aggressive pecking leading to skin lesions and feather loss is reduced if quail are not kept under intensive conditions and established groups are not mixed.

Quail are capable of extremely rapid, upward escape flights, which can lead to head injuries in captivity. Staff should therefore always approach birds slowly and calmly and quail should be provided with cover and environmental enrichment, especially early in life, in order to reduce fear. Quail chicks should have access to coloured objects such as balls, tubing and cubes to alleviate fear of both human beings and novel stimuli in adult birds. Adult birds should be given pecking objects such as stones, pine cones, balls and branches of vegetation. Sand, wood shaving or straw substrate for foraging and a place to which the birds can withdraw should be provided, with additional dust baths of sand or sawdust if the foraging substrate is not suitable for dust bathing. Laying hens should have access to nest boxes and nesting material, such as hay.

If quail must be housed in cages, consideration should be given to combining enclosures, adding enrichment items and providing a minimum enclosure height of 30 cm (with a roof made of pliant material) to reduce the risk of head injury. Solid enclosure roofs may make birds feel safer, although this could result in unacceptably low light levels in lower enclosures if birds are housed in racks. Birds should be cage housed for the minimum possible period because many welfare problems become more severe with age, especially in birds kept for one year or more.

The minimum enclosure size for group housed quail is 1 m^2.

Body mass (g)	Area per bird – pair housed (m^2)	Area per additional bird-group housed (m^2)	Minimum height (cm)	Minimum length of trough per bird (cm)
Up to 150	0.5	0.1	30	4
150-250	0.6	0.15	30	4

Behaviour

Quail are adapted to inhabit grasslands with a degree of cover (Mills *et al.* 1999, Hawkins *et al.* 2001). The Japanese quail *Coturnix japonica* is omnivorous and the diet of wild birds comprises small seeds, insects and spiders (Kawahara 1967). Although European and Japanese quail are migratory, quail generally only perform short flights to escape predators during the breeding season. Most have short, rounded wings and are capable of extremely rapid, upward flight that enables them to escape from danger.

Domestication does not appear to have substantially altered quail behaviour, so it is essential to design housing systems that respect this. Substrate for scratching, pecking and dustbathing, nestboxes and cover are all important for quail welfare (Johnson & Guthery 1988, Schmid & Wechsler 1997, see Mills *et al.* 1997).

Group composition

Male quail should be housed in stable pairs because (i) aggression and homosexual copulation attempts are frequent in larger all-male groups and (ii) males are aggressive towards unfamiliar males (see Mills *et al.* 1999). In general, the literature recommends low male:female ratios for the quail (Mills *et al.* 1999, Wechsler & Schmidt 1998). A ratio of one male to four females is suggested in Mills *et al.* (1999), and a previous study evaluating a range of sex ratios found that fertility was satisfactory in breeding groups with sex ratios of 1:8 or 1:12 (Wechsler & Schmidt 1998).

Birds introduced into established groups are likely to be attacked, especially where strange birds are introduced into the home cages of groups with established hierarchies. Groups should therefore never be mixed or birds replaced with others (Mills *et al.* 1999).

Aviaries and floor pens

Quail are generally housed in outdoor aviaries, floor pens with deep litter or smaller battery type caging. Aviaries with outdoor access are to be preferred, but where birds must be housed wholly indoors, serious consideration should be given to housing in pens as opposed to cages (Hawkins *et al.* 2001). Current standard size quail cages do not permit environmental enrichment or a range of behaviours and so their use should be discontinued on animal welfare grounds.

Groups of eight Japanese quail housed in semi-natural outdoor aviaries of 19 m^2 containing a substrate of soil and wood chips, herbs, shrubs and artificial shelters have been reported to display a range of natural behaviours including exercise, foraging, flight and dustbathing. These birds had been reared in battery cages up to 5 weeks of age (Schmid & Wechsler 1997). Aviary-housed female Japanese quail have been found to have a strong preference for artificial cover, especially while egg laying, and also to show flight behaviour in response to a frightening stimulus significantly less when under cover (Buchwalder & Wechsler 1997). Cover (either natural or artificial) should therefore be provided to encourage natural behaviour and reduce stress. Quail are thus able to express a range of natural behaviours in aviary housing, so should be housed in pens or aviaries wherever possible (Hawkins *et al.* 2001).

Floor pens are an adaptation of agricultural practice and commonly suggested stocking densities range between 40 to 200 birds/m^2 (Home Office 1989, Hodgetts 1999, Mills *et al.* 1999). Suitable substrates include sand, wood shavings or straw. Higher levels of fertility and hatchability are achieved in floor pens at low stocking densities (Ernst & Coleman 1966). Some welfare problems may still occur when birds are housed in floor pens, however. Quail housed in floor pens are often found to have hardened balls of food, litter and faeces adhering to their feet (Gerken & Mills 1993), which can lead to increased pecking at the toes, injuries and possibly cannibalism. Good husbandry and regular monitoring of birds' feet are therefore essential, whichever type of flooring is used.

Cages

Standard laboratory battery cages are extremely small and in no way allow birds to exercise adequately or permit the provision of environmental stimulation. For example, quail housed in semi-natural aviaries (with cover) were found to spend 24 % of their time walking, running or flying and 8 % pecking and scratching away from their feeder, despite having *ad libitum* access to food (Schmid & Wechsler 1997); neither of these activities are possible in standard size cages. Breeding female quail housed in cages also exhibit pre-laying restlessness

(Gerken & Mills 1993). The justification for housing quail in standard size 'battery' cages should therefore always be questioned, and birds housed in aviaries or pens wherever possible.

If there are compelling scientific or veterinary reasons for keeping quail in cages, serious consideration should be given to modifying them to provide better quality and quantity of space and thereby improving welfare. The typical quail flight response is vertical and this can result in serious injuries when birds are housed in standard cages. Quail are therefore typically kept in cages with insufficient headroom to permit high jumps. However, the welfare of caged quail can be significantly improved by combining cages to give birds more space for exercise, adding enrichment items and by providing a minimum cage height of 30 cm. Although it has been suggested that injuries will be worse if cage height exceeds 20 cm (Mills *et al.* 1999, Gerken & Mills 1993), it is the experience of BVA(AWF)/FRAME/RSPCA/UFAW JWGR members that cages 30 cm high significantly reduce or even eliminate the problem. Consideration could also be given to providing solid cage roofs, as this may make birds feel safer, although this could result in unacceptably low light levels in lower cages if birds are housed in racks (Hawkins *et al.* 2001).

If large areas of wire flooring are deemed to be necessary, *e.g.* for some toxicology studies, a solid resting area should be provided and the wire should be coated with soft plastic to reduce damage to the feet of the birds (Hawkins *et al.* 2001). The duration of studies where birds are housed in cages should be kept to a minimum because many welfare problems become more severe with age, especially if studies last for a year or more (Gerken & Mills 1993).

Environmental stimulation

Providing environmental stimulation for chicks in the form of coloured objects (balls (Sherwin 1995), tubing, cylinders and cubes) alleviates fear of both human beings and novel stimuli in adult birds, perhaps by reducing underlying fearfulness (Jones *et al.* 1991, review in Mills *et al.* 1997). Toys in the form of stones and pine cones may reduce aggression in groups of adult birds (Ottinger & Rattner 1999). Other commonly provided items are balls, tubes, mirrors and branches of vegetation (K Miller, pers. comm.).

Nest boxes

Laying hens will benefit from nest boxes, which can be clipped on to the sides of their cages, and nesting materials. Nest boxes filled with chaff were preferred over those containing hay or turf in a study using Japanese quail (Schmid & Wechsler 1998).

Perches

A study involving continuous observation of Japanese quail in a semi-natural aviary at twilight found that the birds did not roost on perches at night, unlike fowl. They also spent very little time (0.5 %) on elevated structures, *e.g.* on top of shelters (Schmid & Wechsler 1997). It is not currently considered to be necessary to provide perches.

Dustbathing

Dustbathing is important to quail (Schmid & Wechsler 1997); Japanese quail use litter for dustbathing (Mills *et al.* 1999) and exhibit vacuum dustbathing behaviour in its absence (Gerken 1983, Mills *et al.* 1997). Dust baths should therefore always be provided, with suitable substrates such as sand or sawdust.

Guidelines for housing ducks and geese in stock and during procedures

Domestic ducks and geese commonly used in research and testing include Anas platyrhynchos, Anser anser domesticus and Cairana moschata. All waterfowl are primarily adapted for locomotion and feeding in water, which is also very important for 'comfort' behaviours such as bathing and preening. Ducks and geese should be provided with a pond with a mixture of stones and grit on the bottom, both to increase the birds' behavioural repertoire and to encourage adequate maintenance of the feathers. The very minimum that waterfowl should be able to do is immerse their heads under water and shake water over the body. Drinkers and ponds for waterfowl should be located over grid areas with drains beneath to reduce flooding.

Water to a depth of around 1 cm should be provided in a shallow bowl for bathing within 24 hours of hatching. After the first week, a shallow pond (dimensions as in table) with large stones on the bottom should be provided with food or grit scattered among the stones to encourage dabbling or diving as appropriate. Access to ponds for juvenile birds should only be under supervision to ensure that they can leave the water and do not become chilled. This should continue until they are clearly capable of leaving the water unaided and their feathers have begun to emerge. It is not necessary to control the temperature of the water.

Ducks and geese should be housed on solid floors and have sufficient space to permit foraging, walking, running and wing flapping. Grazing geese should be provided with natural plant cover (either in outdoor runs or using potted shrubs indoors) or boxes and straw bales. Ducks and geese should always be kept outdoors or have access to outdoor runs unless there is scientific or veterinary justification for keeping them indoors. Birds housed with outside access should be kept secure from predators and should be supplied with a dry shelter to enable them to rest. They should also have a pond and vegetation for cover and/or grazing as applicable. Serious consideration should be given to supplying other features of the habitat that are likely to be important to each species whether birds are housed indoors or outdoors. This includes shallow water with vegetation for dabbling ducks, turf for geese and deeper water with large stones for species that live along rocky coasts.

Ducks and geese should be housed in appropriately sized groups wherever possible and the amount of time when any individual is left alone should be minimised. Many species of waterfowl become territorial during the breeding season, however, so it may be necessary to reduce group sizes and ensure that there is sufficient enclosure space to reduce the risk of injury, particularly to female birds.

Domestic geese and ducks have been selected for meat and egg production, but all breeds retain most of their 'wild type' behaviour and are generally more nervous and easily upset than other domestic fowl, especially when they are moulting.

The minimum enclosure size for group housed ducks and geese is 2 m^2.

	Area per bird – pair housed (m^2)*	**Area per bird – group housed (m^2)***	**Minimum height (cm)**
Ducks up to 1.2 kg	1	0.33	200
Ducks over 1.2 kg	1.5	0.5	200
Geese	1.5	0.5	200

*This should include a pond (see table below).

- Minimum pond sizes and depths for ducks and geese

	Pair housed[a]		Group housed[a]	
	Area (m^2)	**Depth (cm)**	**Area (m^2)**	**Depth (cm)**
Ducks	0.15	30	0.5	30
Geese	0.15	10 to 30	0.5	10 to 30

[a] Pond sizes are per 2 m^2 enclosure. The pond may contribute up to 50% of the minimum enclosure size.

Water

Ducks, geese and swans belong to the family Anatidae, which includes over 140 species distributed world-wide. All are wetland specialists, so are primarily adapted to locomotion and feeding in water and have varying abilities to walk and feed on land. Most species live on or near fresh water ponds, rivers and lakes, although many inhabit or feed at brackish estuaries and some are marine (see *e.g.* Owen & Black 1990). Ponds and lakes are used by ducks and geese for feeding, mating (in large bodied domestic birds) and as a refuge, particularly at night. Water is also very important for 'comfort' behaviours such as bathing and preening (Hawkins *et al.* 2001).

The opportunity to replicate natural wildfowl habitats is limited in the laboratory, but consideration should be given to supplying features of the habitat that are likely to be important to the birds, for example shallow water with vegetation for dabbling ducks, turf for geese and deeper water with large stones for species that live along rocky coasts (Forbes & Richardson 1996). Regular access to water is also important for the integrity of the feet and to help prevent cloacal infections (usually *Pseudomonas* spp) caused by the birds being unable to defecate naturally into water while swimming (Redig 1996). All waterfowl should therefore have a pond with a mixture of stones and grit on the bottom, both to increase the birds' behavioural repertoire and to encourage adequate maintenance of the feathers. The very minimum that waterfowl should be able to do is immerse their heads under water and shake water over the body (RSPCA 1999a). Many species may be nocturnal and rest during the day but still make good use of the pond during the night, especially if they are fed in or under the water (Hawkins *et al.* 2001).

Ducklings and goslings are capable of walking, eating, swimming and diving almost immediately after hatching. They can be introduced to water 1 cm deep for bathing in a shallow bowl within 24 hours of hatching (Forbes & Richardson 1996), but it is important to note that hand-reared chicks can become soaked and chilled if they spend too long in the water and may also have difficulty leaving the water (Hawkins *et al.* 2001). Naturally-reared chicks are brooded by their parents, which keeps them clean and dry (Robinson 1996). It is advisable to allow hand-reared ducklings and goslings two or three short (*e.g.* 15 minutes), supervised swims a day to provide exercise and encourage preening for the first 2 to 3 weeks. A shallow pond with large stones on the bottom will provide extra interest and exercise after the first week; food or grit can be scattered among the stones to encourage dabbling. All bowls and ponds should be emptied or closed to the birds when unsupervised until they are larger and feathers have begun to replace their juvenile 'down', which occurs at 3 to 6 weeks of age, depending on the species (Hawkins *et al.* 2001).

Space and environmental stimulation

Ducks and geese should be able to exercise by walking and running, and should also have sufficient space to flap their wings without obstruction (Hawkins *et al.* 2001). Geese are adapted to walk while grazing and so will require a greater proportion of walking and grazing land than dabbling and diving ducks. Swimming exercise is more important for ducks and diving ducks need sufficient depth of water to dive in. Some diving ducks, *e.g.* stifftails such as the ruddy duck *Oxyura jamaicensis*, are very poorly adapted for walking and rarely leave the water so will need large ponds (Hawkins *et al.* 2001).

Although sufficient space to exercise is of primary importance for waterfowl, a stimulating environment is also necessary to encourage them to forage, play and use all three dimensions of their pond (Hawkins 1998). Features of their natural environment can be reproduced to an extent in the laboratory, and a variety of natural and synthetic objects should be used to provide environmental stimulation in pens and ponds (Hawkins *et al.* 2001).

Aggression may be associated with the provision of environmental stimulation if animals are competing for an insufficient number of objects or the space allowance is inadequate, but this can be reduced or prevented by allowing sufficient objects and space and observing the birds. Occasional competition for items accompanied by single pecks, rather than sustained attacks, should be regarded as normal social interaction and are no reason to stop providing environmental stimulation (Hawkins 1998).

Social housing and behaviour

Waterfowl are extremely gregarious and form strong attachments to one another. Geese in particular form long term, stable bonds, especially within family groups (Owen & Black 1990, Ely 1993). Some ducks such as the European teal *Anas crecca* and common eider *Somateria mollissima* do especially well in groups and display behaviour that may not be observed in single pairs, but others should be kept in single pairs only, *e.g.* shelducks *Tadorna tadorna* (Forbes & Richardson 1996). Group housing ducks and geese is vital for an acceptable standard of welfare in the majority of cases and the amount of time when any individual is left alone should be minimised (Hawkins *et al.* 2001). Ducks and geese generally become distressed if they cannot see conspecifics, so it may be necessary to provide a bird undergoing procedures with a companion who they can see (*e.g.* Stephenson 1994).

Many species of waterfowl become territorial during the breeding season. Male ducks and geese will defend females against other males until incubation has begun, and geese will defend their mate and her feeding resources throughout incubation. Some geese drive other families of geese away while rearing young. In most dabbling ducks, stifftails and some diving ducks, lone males will attempt to forcibly mate with other females. Many broods of mallards have mixed parentage as a result (Owen & Black 1990) but this extra pair forced copulation can also result in the death of the female. It may be necessary to reduce group sizes and ensure that there is sufficient space to reduce the risk of injury.

All geese and some ducks shed all the flight feathers simultaneously during moulting and are flightless until the new feathers have grown. This is often associated with ‘moult migrations’, where birds move to safer areas during the flightless period. This lasts for between 3 and 5 weeks and is often accompanied by a decrease in flight muscle mass (Owen & Black 1990, Saunders & Fedde 1994). The behaviour patterns of some species may also alter while their mobility is restricted, including changes in feeding times and stronger responses to stimuli interpreted as predators (Kahlert *et al.* 1996). Moulting birds may therefore require extra consideration, *i.e.* they should always have a refuge where they can feel secure and disturbance should be minimised.

Guidelines for housing the pigeon, *Columba livia*, in stock and during procedures

The various strains of domestic pigeon are believed to derive from the rock dove Columbia livia. Rock doves nest and roost on cliffs or within caves, and feral pigeons will utilise sheltered ledges on man-made structures in the same way. In their natural habitat pigeons usually occur in pairs to large flocks, feeding and roosting together, but will defend roosting spaces and nesting areas. Pigeons can be housed in mixed groups, and may lay eggs but will not incubate them if nest boxes are not provided.

Care must be taken when choosing a breed for laboratory use, as some strains may show abnormal or undesirable behaviours and should therefore be avoided. Pigeons are primarily seed eaters but are omnivorous, so food containing animal protein, such as commercially available turkey starter crumbs or chick rearing meal, should be offered regularly.

Pigeons should be allowed an area sufficient for flight wherever possible, with a separate perching area for each bird along at least one wall of the enclosure. Box perches approximately 30 cm square and 15 cm deep located in blocks should be provided. Branches hung from the roof and scaffolding can also be used for perching. Toys hung from chains should be provided, e.g. bird bells, mirrors and commercially available toys designed for companion animals. Each enclosure should have shallow water baths. Where pigeons must be handled frequently, 'nesting areas' or chambers can be provided so that birds can be trained to retreat to them for capture.

If enclosures large enough to permit flight are not feasible, access to 'flight rooms' with perches for exercise and social interaction (e.g. a modified animal room) should be considered, provided that birds are carefully monitored to ensure that subordinate birds are not bullied.

Larger, enriched enclosures with shelving, perches and toys should be used wherever possible rather than 'standard' pigeon enclosures. Pigeons benefit from being able to forage and should not be kept on grid floors without strong scientific justification.

The minimum enclosure size for group housed pigeons is 2 m^2, with a minimum height of 2 m. Enclosures should be long and narrow (e.g. 2 m by 1 m) rather than square so that birds are able to perform short flights.

Number of birds	Minimum area (m^2)	Minimum height (m)	Minimum length of food trough per bird (cm)	Minimum length of perch per bird (cm)
2 to 6	2	2	5	30
Up to 12	3	2	5	30
Each additional bird	0.15		5	30

Behaviour

The most commonly used Columbiform in the laboratory is the domestic pigeon, which is believed to derive from the rock dove *Columbia livia* (Hawes 1984). Rock doves nest and roost on cliffs or gorges or within potholes and caves, and so feral pigeons will utilise sheltered ledges on man-made structures (such as box perches) in the same way.

Wild and feral birds usually occur in large, mixed flocks and are usually housed in mixed groups in the laboratory, which helps to prevent aggression during the breeding season (Hutchison 1999). If breeding is not required, it can be prevented by withholding nesting places, as females may lay eggs but will not incubate them without a nesting site.

Pigeons are primarily seed eaters but will take a very wide range of grains, fruits, berries and vegetation and also small snails and other molluscs (Hutchison 1999). A variety of foods should be presented such as legumes and cereals with some smaller seeds (Harper 1996). Vegetable proteins alone do not provide an adequate diet for pigeons (Hutchinson 1999) and so foods containing animal protein should be offered regularly (Harper 1996, Hutchinson 1999). Pigeons fed *ad libitum* are liable to become obese, particularly females, and so regular monitoring of body weight and condition is essential (CCAC 1984, Hawkins *et al.* 2001). Obesity can be largely prevented by restricting feed to 28.5 g per bird per day and including low-palatability grains such as barley (FDW Harper, pers. comm.).

Domestic pigeons are kept in a variety of forms and over two hundred fancy breeds now exist, including strains that have been developed for appearance, endurance flying, racing and for meat production. Care must be taken when choosing a breed for laboratory use, as some strains may show abnormal or undesirable behaviours and should be avoided (Hutchison 1999).

Housing
If birds must be housed indoors, consideration must be given to providing sufficient quality and quantity space to allow a range of behaviours. This should include flight wherever possible (CCAC 1984, Hawkins *et al.* 2001), not least because pigeons have been demonstrated to express a strong preference for aviaries that are large enough for them to fly (Schmorrow & Ulrich 1991). Despite this, laboratory pigeons are often housed singly in small cages that do not permit them to extend their wings. This does not permit exercise or the provision of environmental stimulation. Furthermore, pigeons housed in 'standard' cages for long periods undergo a substantial loss in muscle tone and are not physiologically normal (Clarkson *et al.* 1963). Small cages are therefore not appropriate for long-term housing (CCAC 1984, Hawkins *et al.* 2001).

Modified cages
If pigeons must be housed in cages for scientific or veterinary reasons, large, modified cages with shelving, perches and toys should be used wherever possible (Nepote 1999, see also CCAC 1984) rather than 'standard' pigeon cages. Access to 'flight rooms' with perches for exercise and social interaction (*e.g.* a modified animal room) should also be seriously considered, provided that birds are carefully monitored to ensure that subordinate birds are not bullied (CCAC 1984, Nepote 1999).

Catching birds
If pigeons must be handled frequently, 'nesting areas' can be provided and birds trained to retreat to them for capture. It is possible to house pigeons in aviaries with outside access and with conspecifics even where they are required for training in small test chambers (*e.g.* Skinner boxes), by constructing connecting channels directly from the aviary and training the birds to enter the chambers for food. Following a habituation period of several days, a sliding door can be used to shut the pigeons in the experimental chamber, eliminating the need for stressful manual capture (see Huber 1994).

Perches
Flights and aviaries should allow a separate perching area for each bird, as sufficient box perches will allow birds to establish their own territories, reducing fighting and facilitating easy capture (CCAC 1984). Box perches approximately 30 cm square and 15 cm deep located in blocks on one wall simulate a 'natural' type of environment and also help to deposit faeces in one area. Each bird should have at least 30 cm of perching space (Hutchison 1999). Pens should have covered food, grit and water hoppers, with additional water baths (CCAC 1984, Hutchison 1999). It may be necessary to supply large waterproof

trays in which smaller baths can be placed, as pigeons splash considerably when they bathe and will soak the surrounding area (Hawkins *et al.* 2001).

Environmental stimulation
Pigeons are often housed in barren conditions in the laboratory, but they will benefit from and make good use of large pens or aviaries supplied with enrichment items (Hawkins *et al.* 2001). Nesting facilities, nesting material and perches should be provided when birds are paired or housed in aviaries (Hutchison 1999). Birds housed in the laboratory have been found to benefit from toys such as bird bells, mirrors and rubber toys designed for cats, hung from chains. Foliage can be attached to the sides of aviaries using thick gardening wire to provide additional perching and shelter. Branches hung from the roof and scaffolding can also be used for perching (J Archer, pers. comm.).

Flooring
Pigeons should not be housed on grid floors, as this prevents foraging. Birds housed on solid floors should be cleaned out regularly, the frequency depending on the degree of confinement. Smaller cages will require daily cleaning, but in larger flights it will only be necessary to clean heavily soiled areas beneath perching areas daily (Hawkins *et al.* 2001).

Guidelines for housing the zebra finch,* Taeniopygia guttata*, in stock and during procedures

Zebra finches occur across most of Australia and its neighbouring islands. They are highly mobile, ranging over wide areas in search of food, and live in flocks of up to several hundred individuals. The species is monogamous and sexually dimorphic, as the male's plumage is more ornate than that of the female. The breeding season is not fixed, but is triggered by the availability of ripening grass seeds. Zebra finches use nests for roosting as well as breeding; roosting nests may be old breeding nests or purpose-built. Nests can be provided for captive birds in the form of wicker or plastic baskets with dried grass for nesting material, but birds will defend these and it is important to monitor behaviour to ensure that sufficient nests are provided.

Zebra finches are social and non-breeding birds should be housed in groups. Mixed-sex groups are possible and breeding can be suppressed by feeding a diet of dry seeds supplemented with fresh greens, but never soaked or sprouted seeds. Sprays of Panicum millet should be continually available as dietary enrichment. As Zebra finches feed extensively on the ground, birds should be housed on solid floors to facilitate natural foraging behaviour.

Toys, perches and swings designed for companion birds will benefit zebra finches and these should be provided wherever possible. Perches are particularly important for wellbeing and should be provided at a range of heights to facilitate normal feeding and roosting behaviour. Water for bathing should be provided at least once a week in trays 0.5 to 1 cm deep.

Fitting zebra finches with coloured leg bands for identification can have significant effects on their social and reproductive behaviour (e.g. red can enhance dominance and green or blue reduce it). Colours and patterns that have minimum impact on social interactions should be researched before fitting leg bands.

Minimum enclosure sizes for zebra finches are set out below. Enclosures should be long and narrow (e.g. 2 m by 1 m) to enable birds to perform short flights. Zebra finches thrive in outdoor enclosures provided they have access to shelter and heating is provided in cold conditions.

Number of birds	***Minimum area (m^2)***	***Minimum height (m)***	***Minimum number of feeders***
Up to 6	*1*	*1*	*2*
Up to 12	*1.5*	*2*	*2*
12 to 20	*2*	*2*	*3*
Each additional bird	*0.05*	*2*	*1 per 6 birds*

Natural habitat and social behaviour

Zebra finches are found across most of Australia, as well as neighbouring islands (Zann 1996). They are a highly sociable species and usually live in flocks numbering a few dozen to a few hundred, often mixed with other species of small birds (Jones & Slater 1999, Hawkins *et al.* 2001). The zebra finch ranges over a wide area in search of food and local populations can be highly mobile, deserting an area if conditions are unfavourable. Perhaps as an adaptation for the need to be able to fly large distances at short notice, there is no synchronous moult and the feathers are shed gradually throughout the year (Zann 1996). The birds will use nests as roost sites even outside the breeding season, a habit which allows them to survive in areas where the temperature is low at night. Roosting nests are either old breeding nests or purpose-built (Zann 1996).

Housing and space requirements
As it is a sociable species, communal housing should always be provided for the zebra finch. The minimum enclosure dimensions presented in the table in Part A of this document are based on the experience of Expert Group members. It is best to optimise vertical height and length, to permit free flight. Steel or treated wood can be used to construct the framework of finch enclosures and plastic-coated wire mesh, of no greater than 1 cm width, is suitable for the walls of the enclosure and is also preferable to plastic aviary netting. The floor should be solid, as this encourages natural foraging behaviour when seeds are spilt or deliberately placed on the floor. Suitable substrates include bark chips, wood shavings or sand (Hawkins *et al.* 2001).

The range of the zebra finch is widespread within Australia, and it can sometimes be exposed to sub-zero temperatures over winter (Meijer *et al.* 1996). Zebra finches seem to thrive in outdoor accommodation, provided that some indoor shelter and/or heating is provided for particularly harsh conditions (Bates & Busenbark 1970).

Breeding and rearing
Zebra finches are monogamous and sexually dimorphic. The breeding season is not fixed, but is triggered by the arrival of rains. In a long-term population study, Zann *et al.* (1995) showed that there was a time-lag of one or 2 months between the start of the rains and breeding, such that hatching of the eggs coincided with the first availability of ripening grass seeds. Dry seed alone, however abundant, did not stimulate breeding.

Presumably so that they can take advantage of unpredictable breeding conditions without the delay imposed by courtship, zebra finches form long-term monogamous pair bonds in the wild. Once paired, much of the social behaviour of the male and female is directed towards maintaining this bond. The surest sign of pair-bonding is allopreening, where the male and female sit close to and preen each other. Young birds are capable of breeding at quite an early age, probably another adaptation for opportunistic breeding when conditions are unpredictable. The median age of first breeding is about 90 days in both sexes in wild birds (Zann 1996) and birds can breed even earlier in aviary conditions. The modal clutch size is five, both sexes incubating during the day and the female at night (Zann 1996). The average length of incubation is 14 days.

The zebra finch is amongst the easiest of birds to breed in captivity, due to its opportunistic breeding in response to the arrival of rains (Zann *et al.* 1995). If breeding is desired, it is important to stock birds at a lower density than for standard housing, provide an excess of nest sites, and maintain an equal sex ratio. This reduces sexual conflict and aggression between pairs. Zebra finches seem to breed best when a small number of pairs are housed together in a medium-sized aviary with sufficient breeding sites. Whenever pairs of birds are provided with a nesting site and with a supply of greens, live insects, and softened seeds, they are liable to attempt breeding. The ‘ideal’ conditions of captive housing can lead to over-production of young, or unhatched eggs (Bates & Busenbark 1970).

Dried grass and/or coconut fibre should be provided for nest-lining, although not in great excess as under the ‘cost free’ conditions of captivity some birds may overfill their nests with lining, constricting the space available to the nestlings. Suitable commercially produced nests are either a completely enclosed pear-drop-shaped wicker basket (or its more easily cleaned plastic equivalent), or a cubic wooden box of side about 12 cm and with either an entrance hole of about 4 cm or the top half of the front cut away. Dried grass for nest lining can be hung in a basket of wide-mesh chicken-wire within the aviary; this keeps it unsoiled by faeces and the aviary tidy. Some birds continue to add nesting material over clutches and then lay another clutch on top. Nesting material should therefore be removed after clutches have been laid. For further information on breeding and rearing, see Jones & Slater (1999) and Hawkins *et al.* (2001).

Diet
In the wild, zebra finches subsist on an almost exclusive diet of dry grass seeds. The basic diet for captive zebra finch consists of commercially available foreign finch seed mix (largely millet and canary seed). Finches also like both soaked and sprouted seeds and fresh greens, but these should not be provided to mixed flocks unless the birds are required to breed. Soaked seeds are produced by soaking the normal finch mix for a day, then rinsing the hydrated seeds before they are given to the birds. If soaked seeds are stored in a warm, dark place and kept moist, they will sprout; sprouted seeds should also be rinsed before they are given to the birds. Suitable greens for zebra finches include the darker outer leaves of lettuce or dandelion, water-cress, and spinach; pet shops also sell dehydrated greens which often have vitamin supplements added. It is best to give the birds a small amount of greens and protein-rich foods regularly, because an infrequent supply encourages them to overeat, which can result in diarrhoea (see Jones & Slater 1999, Hawkins *et al.* 2001).

Live insect prey, most conveniently mealworms or cricket nymphs, provide essential protein, but these should be limited to two or three a day, in order to prevent overeating. If birds are in a communal aviary where there is a risk of subordinate individuals having reduced access to these preferred foods, they are best supplied in several small, separated dishes, so that no one bird can monopolize the resource. Millet (*e.g. Panicum*) in spray form encourages natural foraging behaviour; fruit such as apple, and the yolk of hard- boiled eggs, are also recommended additions to the diet (Bates & Busenbark 1970).

Attempts should be made to carefully assess the nutrient balance of the diet and to correct any potential deficits with supplements (Kirkwood 1996). Supplements can be added to the birds' water in liquid form or to the food or grit as powder. Grit is best provided in a small dish separate from the seed mix, so that the bird can control its intake as necessary. Cuttlebone is the most convenient means of providing finches with calcium. Whole cuttlebone should be attached to the side of the bird's cage with the softer side outermost; alternatively, crushed cuttlebone can be added to the grit mix (Jones & Slater 1999).

Environmental stimulation
Toys: A range of toys designed for finches is commercially available. Birds are likely to benefit from these, provided that care is taken to ensure that all cage additions are well used, promote a range of desirable behaviours and are supplied in sufficient numbers to avoid competition (Hawkins *et al.* 2001).

Perches: Zebra finches are essentially perching birds, so are likely to feel most secure when they are able to rest above human head level. The most convenient perching materials are 0.5 cm doweling rods which should be easy to remove and clean regularly. Natural branches provide birds with extra interest and a range of different diameters and shapes to exercise the feet, and should be provided where possible. Swings may also help birds to exercise as their movement necessitates use of the wings for balance. Plentiful perching space, at several different levels with some high up (within 15 cm of the roof) for roosting, provides the birds with alternative perching heights. Like most birds, zebra finches feel safest on branches near the roof of the aviary, but prefer to approach feeders or the ground by moving to progressively closer perches. The aviary should not, however, be so crowded with perches as to make free flight or capture of the birds difficult. Perches should not be placed over food or water containers, so as to avoid fouling (Jones & Slater 1999, Hawkins *et al.* 2001).

Baths and water: As one might expect for a species that can persist in arid conditions, zebra finches can do without water for long periods, their needs being met by metabolic water from carbohydrate breakdown. However, in captivity it is essential to provide them with drinking water and also bathing water at least once a week (Jones & Slater 1999, Hawkins *et al.* 2001).

Coloured leg rings

An aspect of husbandry which may be unexpected and is of welfare significance, is that banding the birds with colour rings for identification can have profound effects on their social behaviour. The colour of rings which a bird wears can affect their attractiveness to mates, their breeding success, longevity and even the sex ratio of their broods (Burley 1985, 1986 a,b,c, 1988, Zann 1994). Females appear to prefer males with red leg rings, perhaps a redirected preference for the redness of the male's bill, and dislike green rings; females also find black-ringed males attractive and blue-ringed males unattractive (Burley *et al.* 1982). More recently, this pattern has been shown to be mirrored in intrasexual dominance interactions, with red-ringed males being dominant over green-ringed males (Cuthill *et al.* 1997). The important lesson for keeping zebra finches in captivity, is that colour-banding for identification is far from neutral in its effect on behaviour. Even banding a male with asymmetrical arrangements of multiple colours (*e.g.* orange over green on the left leg, green over orange on the right) will reduce his attractiveness to potential sexual partners (Swaddle & Cuthill 1994). If birds have to be banded for identification, it is best to use colours which have less impact on social interactions (see Burley *et al.* 1982, Burley 1986a) and/or to provide multiple food sources so that dominant birds cannot monopolize the resource (see Cuthill *et al.* 1997).

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[1] This paper used the 'Delphi' method to define a framework for the assessment of farm animal welfare, making the assumption that welfare problems arise when animals are housed in environments to which they have difficulty adapting. A total of 22 welfare scientists from the Netherlands, Canada, Denmark, Italy, Sweden, the UK and France contributed to the finished article.

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