Refining rabbit care
A resource for those working with rabbits in research

P Hawkins, R Hubrecht, A Buckwell, S Cubitt, B Howard, A Jackson, G M Poirier
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Contents

Introduction

1 Rabbits’ behavioural needs: How to optimise welfare
   1.1 Enclosure size and characteristics
   1.2 Social housing
   1.3 Solid flooring and substrate
   1.4 Raised areas
   1.5 Refuges
   1.6 Gnawing objects and dietary enrichment
   1.7 Positive interaction with humans
   1.8 Toys and objects to manipulate
   1.9 Special needs of breeding does

2 Monitoring refinements and record keeping

3 Rehoming rabbits

4 Rabbit-related resources

5 Feedback

6 Acknowledgements

Appendix: Rabbit ethogram

References
INTRODUCTION

This resource was produced by members of the UFAW/RSPCA Rabbit Behaviour and Welfare Group. It is intended for use by animal technicians, facility managers, veterinarians and scientists and provides guidance to help meet the needs of the laboratory rabbit and improve upon the husbandry standards set out by national guidelines or legislation. The recommendations, guidelines and case studies within this book are based on the expertise and practical experiences of people who use and care for laboratory rabbits, supported by reference to the current animal welfare science and laboratory animal science literature.

1 RABBITS' BEHAVIOURAL NEEDS: HOW TO OPTIMISE WELFARE

The first step towards providing good housing and care for any animal is to define the needs of the species (or strain!). We define the term 'need' in this document as an animal's requirements to ensure good welfare. There are a number of approaches to this, including considering (i) the animals' sensory world, biology and habitat in the wild, (ii) the results of applied animal behaviour and welfare science studies, and (iii) the results of other relevant studies, e.g. nutritional and epidemiological research. This resource is concerned with the first two of these approaches.

It is important to consider the behaviour and biology of rabbits in the wild when designing laboratory rabbit housing and care protocols, as domestic rabbits retain many wild-type behaviours and express these when they are given the opportunity. While some domestic animals have been selected for certain behaviours, such as tractability towards humans, rabbits have been selected primarily for their fur and meat. This means that, from a human-animal interaction point of view, the rabbit is not really very domesticated at all; in fact, the behaviour of rabbits is often referred to as 'wild' behaviour. Good communication with breeders will help to ensure that rabbits are brought up under suitable conditions (taking the eventual research environment into account, see below) and supplied in harmonious pairs or groups when appropriate.

In a research setting, it is also necessary to make sure that the housing and care system is compatible with achieving the aims of the research, otherwise the science will be flawed and animals' lives may be wasted. In addition, husbandry needs may arise from particular research protocols. This resource has taken account of these issues by suggesting alternative approaches for each refinement that can be used if the primary recommendations are not feasible.

Finally, it is essential that all those involved in implementing the refinements set out in this resource have discussed how any new measures will be introduced and how people feel about the changes that are planned. For example, there may be concerns in relation to staff health and safety, or the time that it will take to clean and monitor animals housed using new systems. Researchers should also be consulted about how the animals used in their projects are to be cared for, to ensure that refinements are compatible with the experimental needs and will not interfere with research data. However, all the husbandry systems and methods for implementing them described in this resource have been employed in care routines, including those associated with scientific studies. Considerable benefits are possible in terms of increased interest, satisfaction and morale for animal carers and researchers alike. It has also been found that housing in floor pens can result in savings on money and staff cleaning time.

Ultimately, any concerns should be addressed by effective communication and discussion between all involved, including the attending veterinarian and researchers, for example as part of regular reviews of husbandry refinements within the Ethical Review Process or other appropriate animal care and use committees.

2 ENCLOSURE SIZE AND CHARACTERISTICS

Rabbits move by crawling, hopping, running and jumping, often involving quick changes in direction. Sufficient space is needed for all these forms of exercise (and play in young animals) and appropriate social interactions. In the wild, home range sizes for individuals within rabbit social groups are approximately 50 square metres, yet the largest European standard size for a rabbit cage is 0.54 square metres. This represents around 1% of the rabbit's 'natural' range.

The need for exercise and space for social interaction is highly conserved in laboratory rabbits, for example, in studies on New Zealand White (NZW) rabbits housed in a semi-natural enclosure found that one-third of their active time was spent exploring, grooming, and performing intensive locomotion and sexual behaviour. If they do not have the freedom to exercise and take sequences of hopping steps, rabbits may be at higher risk of developing bone weakness and skeletal abnormalities.

Rabbits also need sufficient space so that they can use different resources within an area for specific behaviours. If they are able to, rabbits choose to use separate areas for feeding, resting and excretion. It appears to be especially important for rabbits to be able to disperse when they are active and for low-ranking does to be able to retreat to the periphery of the enclosure during aggressive episodes.

Rabbits frequently sit in an upright posture with their ears erect, so that they can scan their surroundings. Pens can allow rabbits to perform this behavior without their ears touching the roof and therefore may be better for the welfare of the rabbits.

Background

Providing sufficient, structured space will benefit any active and physically fit animals. One university found that some rabbits previously housed in small cages without adequate inclusions, developed leg injuries due to muscle wastage (or, more rarely, fractures) when placed in the pens. Adequate monitoring and appropriately designed equipped enclosures will help to prevent injuries, gradually increasing enclosure space to be a good idea in some circumstances.

The introduction of large areas of unstructured space may be limited benefit to the animals, because (i) large, barren areas are stressful, which is why ‘open field’ tests are used as a model of stress, and (ii) rabbits tend to use the natural behaviour of the rabbit to facilitate capture without resorting to chasing. Rabbits naturally tend to hide when people enter their enclosure and so they can often easily be caught by gently and smoothly removing them from their cage. Once rabbits are accustomed to being calmly caught in this way, they should usually stop hiding from familiar staff and allow themselves to be picked up. See section 2.7 of the NVER for more guidance on catching rabbits.

How to provide extra space and height

If rabbits must be housed in cages, Comfortable Quarters recommends that cages should measure at least 0.65m (27") wide, 0.8m (31") long and 0.75m (30") high. Rabbits could be housed singly if group housing is not appropriate (see section 1.2), or in pairs in cages of these dimensions, although cages of this size may not be easily available. More space can be provided by building larger pens, buying larger cages (e.g. housing small rabbits in the largest commercially available cages, rather than adhering rigidly to the weight-specific sizes in the European guidelines), adapting current cages or working with manufacturers to design larger cages. As health and safety is a consideration for larger and heavier cages, pens may be a more practical option.

Pens provide more space. An enclosure length of 1.5 to 2.0m (60 to 79") is recommended on the basis that a fully grown NZW will move forward this distance in just three hops. Additional space may be needed depending on group size. For example, Comfortable Quarters recommends a minimum floor area of 2m² (21.5²") for up to four adult rabbits weighing 4 to 8kg (9 to 18lb), with an increase of 0.5m² (5.4²") for each additional adult. In the authors’ experience, rabbits are commonly housed in pens measuring between 1.5 and 2.5m (6 to 27") wide, which are used to group rabbits of around three or four large rabbits (e.g. NZWs) or four to six of the smaller strains (e.g. dwarf lops).

A physically fit rabbit with strong bones can jump surprisingly high, so pen height should at least be 1.2m (48") to stop the rabbits jumping out or injuring themselves in the attempt (and solid items such as refuges should be positioned away from the sides so that they are not used as springboards to freedom). If a mesh cover is used instead, it should be at a height that allows the rabbits to sit up in the ‘hanging alert’ position without the tips of their ears touching the roof. Suitable materials for the mesh are stainless steel, which is relatively light and easy to clean, or plastic coated mesh, although this cannot be put through the cage washer. As an example, rabbits housed at the University of British Columbia are housed in pens originally designed for dogs, with indoor
and outdoor sections. The indoor areas are 1.5 by 1.7m (5ft by 5ft 7") and the outdoor areas are 5.5 by 1.7m (18ft by 5ft 7"). The rabbits are housed in groups of six to eight and are free to move from one area to another. They are provided with a range of other enrichment items, and are able to run and climb as well as use the indoor resting areas. These pens at Novo Nordisk (below) are purpose-built and measure 2.15m (6ft 6") by 0.81m (2ft 8") by 1.14m (3ft 9"). The pens are fixed to the wall at waist height to minimise bending and lifting by animal care staff and to facilitate catching the rabbits. Plastic-sheeting prevents the rabbits from escaping and reduces run-off and lift by a partition that has pop holes to allow the rabbits to run through. A purpose-built shelter is placed on each side of the partition, so that rabbits can hide or hop up on top. The floor is solid, non-slip and covered with a thick layer of litter. The housing system slopes toward the rear end, allowing urine and water spillages to be drained into an outlet. Natural light enters through the windows and is supplemented by an artificial light cycle of 12:12. These rabbits are used in immunisation and pharmacodynamic studies and are housed in groups of 10 for short-term or eight for long-term projects.

Troubleshooting

- If the rabbits are not using all the available space or are not carrying out different activities in different areas, review the number and position of blinds, partitions, platforms or shelters. By adding or removing some and/or rearranging them.
- If fractures or other injuries such as muscle strains occur, the rabbits may not have been strong enough to cope with the extra space and other resources. In such cases the housing protocol should be changed, for example by initially providing a smaller area and lower platforms, then gradually increasing the space available.

Alternative approaches

If sufficiently large, permanent accommodation cannot be provided, a shared exercise area is a useful alternative. This has been achieved at the University of Delaware by adapting a round, non-inflatable plastic children’s paddling pool, 0.61 (1ft 8") in diameter, into an exercise pen. The exercise pen is filled to half its depth with shavings and hay. Rigid walls with rails are placed inside and metal fencing is placed around the pen to contain the rabbits. Rabbits are put into the pen for an hour each day – singly at first, then in small groups after they have habituated to it. The pen is emptied and cleaned once a week with disinfectant (cage wash is unsuitable for the plastic) and the fence is also cleaned weekly. This arrangement allows the rabbits to rear on their hind legs, stretch and play, and also reported that the animals were more interested in enrichment items, calmer, less aggressive and easier to handle. They also reported that blood sampling time has been dramatically decreased and rabbits now come to the front of the cage instead of running to the back when visitors enter their room.

It is also possible to construct or adapt a pen, or adapt a room, to act as an exercise area (some establishments simply allow compatible rabbits to spend periods running free on the floor of the animal room) This is possible for rabbits on all types of systems, including regulatory technology. For example, NIZO does on reproductive technology studies at AstaZeneca are given access to pens equipped with platforms, tunnels and different floor materials (aspen chips and shredded paper). The rabbits are exercised in pairs or groups of three, for 10 to 20 minutes at least twice a week before blood sampling. Besides the usual benefits of decreased anxiety and improvements in physical condition, this also helps to warm the rabbits, promoting vasodilatation for blood sampling if required. The programme has had no effect on litter sizes or weights, or on abortion and embryo or fetus resorption rates.

If animals are incompatible, they can use the exercise area individually instead of with others. It is a good idea to allow each individual or group to use the area at the same time every day. It has been found that young, fasting rabbits given access to an area for an hour at the same time every day performed 65% of their rapid, locomotory play in the run and the remainder in the two hours before their daily exercise period. This suggests that it could be important to maintain a regular routine for access to the exercise area.

1.2 SOCIAL HOUSING

The rabbit is a naturally gregarious species and wild rabbits live in small, territorial breeding groups. The social unit comprises one dominant male, one to nine females, with juveniles, and sometimes several sub-dominant males. Studies of both wild rabbits and laboratory strains in semi-natural enclosures have shown that they maintain a strict rank order and that aggression is often defined by submissive behaviours and by animals having the ability to get away from one another.

Group housing represents a stimulating form of ‘enrichment’. Behavioural studies have found that pair- or group-housed rabbits spend significant amounts of time in close proximity to others. The quality of life of group-housed rabbits is significantly improved in comparison with singly housed animals, even for those individuals regarded as subordinate. Therefore, young rabbits and older female rabbits should be housed in harmonious pairs or social groups, unless group housing is precluded on veterinary advice or if it is incompatible with the study design. However, adult entire males should normally be singly housed because their territorial behaviour may lead to serious light wounds.

Group-housed rabbits need to be able to initiate or withdraw from social and visual contact at will; this is facilitated by providing plenty of space and structures such as referees and partitions. Partitions and other structures also provide the rabbits with additional places to scent mark. This is an important social behaviour that helps to reinforce hierarchies and maintain awareness of which animals are present. Rabbits possess scent glands in the anal region, in the groin, and under the chin. Both sexes use the chin gland in particular for marking out territory, although males do this more frequently than females. In free-ranging European rabbits, scent marks are concentrated at the centre of an area controlled by a social group and at the boundaries between adjacent social groups. It is a good idea to give captive rabbits the opportunity to scent mark in similar locations within the enclosure.

In summary, the key advantages of housing young rabbits and older female rabbits in one social group are to improve welfare resulting from the presence of social partners, the ability to express a broader range of natural behaviours, and calmer, more docile animals. There can also be advantages for humans, including scientific and possible economic benefits and greater job satisfaction.}

Background

Social housing works best for female rabbits, maintained in groups that were formed at weaning and allowed to remain stable. If female rabbits have been singly housed in cages for more than six months, they may be fearful and are often better off in pair housing rather than larger groups.

The principal concern for most people considering group housing is aggression, which will occur to some level. Compatibility depends on a number of factors, some of which can be controlled by good husbandry practice (such as pen size and structure, thoughtful grouping protocols, etc.) and some of which cannot (for example individual temperaments). Compatibility also correlates with sexual activity and stages of pregnancy and may show seasonal variation. Aggression can be minimised by providing visual barriers and refuges arranged so that animals can engage in contact by approaching others, as well as withdraw out of sight if they feel the need. It may also be possible to reduce aggression by using husbandry regimes that respect rabbits’ scent-marking behaviour. Cleaning out destroys most of all the marks that the rabbits have laid down and there has to be a balance between the need for acceptable hygiene standards and the need to avoid disrupting the animals’ olfactory environment, which is likely to be stressful for them. Disturbance can be reduced by regularly cleaning out latrines and replacing soiled substrate, so that total clean-out frequency is minimised. The cleaning frequency should be determined as a function of the rabbit shedding density, the substrate material and the experimental design. Transferring animals that have been scent marked when the enclosure undergoes a total clean out may also help to minimise disruption.

However, aggression can arise for reasons that are not apparent to humans and this is obviously much harder to prevent. Ultimately, each establishment should consider the potential harms and benefits of social housing and decide what level of aggression is acceptable. For example, it may be decided that rabbits should be housed together and
that occasional ‘scuffles’ are acceptable (especially when groups are first established), provided that no wounds occur that require surgical repair. The groups’ health is not impaired and no individuals are subjected to unacceptable aggression. If such aggression does occur, the answer may not be to stop group housing permanently but to address housing and husbandry, using the guidance in this book, and to keep it under continuous review.

Another concern is that subordinate rabbits may become stressed in group housing. However, the benefits of social housing outweigh stress that is solely due to being subordinate (which is a natural part of the experience of being a rabbit). Provided that levels of aggression are not exacerbated due to inappropriate housing. A study of female NZVI housed in non-territorial pairs in double cages found that enrichments such as nest boxes and ‘bunny blocks’ were not manipulated by dominant animals. However, with some double-cage designs there is a risk that the dominant rabbit can lie with half her body in each cage, restricting the movement of the other rabbit(s), in which case food and water should be available in both halves of the cage (Shirley Seaman, pers. comm.).

Socially housed rabbits should be individually identified, preferably in a way that means they can be identified from a distance without undue disturbance. Section 2.8 of the NVJCA offers guidance on identifying rabbits.

Sex and age

It is best to house rabbits in single-sex sibling groups that have been kept constant since birth; an alternative option is to form groups at weaning, i.e. at about six weeks of age. It is easiest to group house young female rabbits, although adult females of placid strains can be moved from individual to pair-housing, provided that cages are appropriately structured. While group members should always be the same age and sex, they do not necessarily have to be littermates. Intact mature females not used for breeding can usually be group housed indefinitively, but entire males over 50 to 60 days old should be individually housed, even if they are littermates, to prevent serious injuries from dominance fights. It may be better to house entire males individually from the time they are acquired, to prevent stress due to husbandry changes as they mature.

In the opinion of the authors, housing male and female rabbits so that they can sense one another’s presence should be avoided; even if they are housed in single sex groups (or females are group housed and males are singly housed). Groups of entire males kept close to females tend to fight and unilateral more frequently than males kept separate, so the males are clearly responding to the presence of females. Although there is no evidence that this is stressful for either sex, on the basis of current knowledge about rabbit behaviour it is possible that being able to sense, but not gain access to, the opposite sex is frustrating and stressful. More research into this is needed, but in the meantime different sexes should be housed in different rooms where possible.

Mature male rabbits will fight, with potentially serious consequences. The only way to group house mature males is to castrate them before they begin to become aggressive towards one another.

Strain

Most commonly used large strains are well suited to group housing – this includes the NZVI, Chinese, Russian, Belgian hare and Sandy (long). Some of the smaller strains, such as Dutch or Polish rabbits, may be more aggressive. If your establishment is using an aggressive strain, it is worth questioning whether there are sound scientific reasons for using that particular strain or whether it could be replaced with a more sociable strain without compromising the research.

Aggression frequently occurs at night. If it is available, low-lux CCTV can be used in conjunction with a time-lapse video recorder to monitor rabbits without disturbing them, including the use of infra-red light during the daytime cycle. This can be used to identify any aggressors and animals receiving aggression, as well as indicating whether there are issues with housing and enrichment that need to be addressed. A reverse light cycle is another option, so that animals can be monitored during the period when aggression is more likely.

In the authors’ experience, laboratory rabbits can be housed in large groups of 50 or more, provided that the animals have an appropriate quality and quantity of space and the groups have been established with care, according to the guidance below.

How to introduce social housing

When planning a change from individual to group housing, it is essential to consider:

- sex
- age
- strain
- how the group can be kept stable – how to deal with disruptions such as removal of individuals for procedures or introducing unfamiliar animals
- the housing and husbandry system
- experimental design

These issues are discussed below. It can be very difficult to form stable, harmonious groups of adult animals if they have not been group housed before. It is preferable to introduce the system by using it to group house new rabbits as they come into the facility. Whatever approach is taken, adequate time must be allowed to monitor newly formed groups, even if they comprise littermates transported together. Close monitoring is essential for the first week, especially during the first two days after the group has been formed (or re-formed). To facilitate this, it is advisable to group the animals early in the working day, so that they can be observed intermittently during the first few hours they are together. At this time, excessive group activity and frequent skirmishes, particularly if the same rabbit initiates them, could indicate that more serious aggression is likely. It is important to identify the most dominant and subordinate animals, and to monitor whether unacceptable aggression is occurring.

Making decisions about castration

There are a number of ethical and welfare issues associated with castration. It is summarised below, and there will need to be discussed by the relevant animal care and use or ethics committee (or local Ethical Review Process in the UK) in order to decide what is acceptable for each establishment. This assumes that (i) the experimental protocol does not require intact male animals and (ii) castration will be conducted by appropriately trained personnel, with effective pain management and supportive perioperative care.

Note that castration is a regulated veterinary procedure in many countries, for example, in the UK it may only be conducted by a qualified veterinarian. It is essential to check with the relevant national legislation before deciding on who will conduct the surgery.

Castration should be carried out three to four weeks after weaning and before the rabbits reach sexual maturity, which will be between 50 and 90 days of age, depending on their strain and nutritional status. Even after castration some aggression may occur, it is less frequent than in entire males, but probably commoner than in group-housed females. Also, sufficient time must be allowed after surgery for the concentration of sex hormones in the blood to decline – this can take one or two months and is essential if the males have reached sexual maturity.

- Castration involves surgery, which requires suitable facilities and the provision of appropriate analgesia and post-operative care.
- After castration, male rabbits generally become less aggressive and less active and can be housed together.
- No veterinary intervention should be performed unless it is in the best interests of the animal concerned.
- Some consider it morally wrong to mutilate animals so that they can live together (for the sake of human convenience).
- Some consider that the quality of life of harmoniously group housed male rabbits justifies castration.
- Using female rabbits instead generates another ethical problem as it leads to the wastage of male rabbits.

It may be the case that castrated males are group housed in pens, whereas intact males are housed singly in cages because space does not permit them to have a pen each. The authors of this report are opposed to surgically altering animals for reasons of economics or convenience, but we recognise that castrating male rabbits may make it possible to increase the living space for them in some circumstances. Whether or not this is acceptable for each establishment should be decided locally, for example by the relevant local committee(s).

Stability

Groups must be stable and harmonious to minimise the risk of aggression and injury. Introducing unfamiliar animals can be difficult once the animals are mature, which is normally over three or four months old (depending on the strain and feeding regime), but even then care must be taken when introducing such a rabbit to a pre-formed group. Even relationships between pair-housed rabbits are highly individual and pairs should not be swapped over, as this can lead to severe aggression.

Isolation for veterinary or scientific procedures

Wherever possible, house individuals separated for experimental or clinical reasons so that they can maintain olfactory and visual contact (at least) with the rest of the group. It is not normally necessary to isolate rabbits after they have recovered following surgery.

At the University of British Columbia, female rabbits were pen housed in groups of five and the groups were routinely re-formed immediately after surgical insertion of indwelling vascular access ports to the jugular or femoral veins. Items from the operating theatre, such as gauze with iodine, were placed in the rabbits’ pens before surgery took place to habituate them to the smell of the theatre. Care was taken with sound closure (using subcuticular stitches) and cleaning, then each rabbit was placed back into her pen to recover. It made no difference whether the pen had been cleaned or not while the rabbit was undergoing surgery, but the priority was to provide sufficient space so that the recovering rabbit could choose to be with other animals or to rest alone. In practice, the recovering rabbit would usually seek the company of the others, and rather than fighting or interfering with wounds, the rest of the group would lie down beside the animal recovering from surgery and provide warmth, comfort and stimulation, and this hastened recovery. This was the case with NZVI satenaze and Dutch belted strains (Mike Boyd, pers. comm.)
Introduction to unfamiliar adults

Unfamiliar rabbits have been successfully mixed by sedating them first using neuroleptanalgesics, drugs, with the underlying assumption that enough scent is transferred while the animals are sedated for them to recognise one another as cage mates. For example, mature NZW females to be regrouped were weighed and given Fentanyl/Droperidol early in the morning, then the rabbits were placed in a small pen where they were in close physical contact with one another. They began to recover after about four hours, when they were weighed and identified with coloured markers before transfer to a large pen. The rabbits were video-monitored for six hours. By the end of the six hours, the rabbits had completely recovered and some chasing and hair pulling was observed, but there were no injuries requiring treatment. The rabbits were then weighed at 24, 48, 72 and 168 hours. The authors made the point that minor amounts of scuffling can be tolerated for a short time. None of the rabbits was excluded from the food or water and none lost more than 25g over the total observation period.

Housing and husbandry systems

Floor (or wash height) pens are successfully used to group house rabbits in a variety of establishments. However, there are other ways of group or pair housing if pens cannot be provided. For example, good modular caging systems allow a number of large cages to be linked together to group house rabbits. Whatever the system, it is essential that sufficient space is provided for the rabbits to be able to withdraw from sight and contact in the case of aggression and this requires a well-structured environment including refuges and barriers or partitions. Husbandry tactics that can help to prevent aggression when establishing or re-forming groups are:

- scattering faceted pellets and urine-soaked litter from each rabbit into the pen for several days before mixing or re-grouping
- scattering food to encourage time-consuming foraging
- allowing visual and olfactory contact through wire mesh dividers, which are subsequently removed
- mixing the animals in a neutral pen area
- having their usual handles handle them together in small groups before mixing

Experimental design

Ocasional fighting may introduce increased variability or bias in some experimental designs, for example if stress hormones are being monitored in such cases, a decision will need to be made – in consultation with the researcher, attending veterinarian and relevant animal care and use committees – as to whether animals should be singly housed. This decision will need to balance the risks of fighting versus single housing, both as welfare issues and as stressors that may affect experimental outcomes.

Troubleshooting

- Aggression is a major concern when rabbits are group housed. There may be warning signs that an outbreak of serious aggression is imminent, such as increased scuffling or tufts of pulled out fur in the enclosure, but aggression is often completely unforeseen. If tufts appear, monitor the rabbits more frequently (e.g. six to eight times a day).
- Because most aggression occurs at night, rabbits should always be checked as early as possible in the morning in case individuals need to be separated or veterinary attention is necessary, if any warning signs are seen, review the husbandry protocol immediately (see below).
- If serious aggression occurs, resulting in open bite wounds, the aggressor or victim should be removed – temporarily or permanently. It may be possible subsequently to return the victim, even if s/he needed veterinary treatment. If the risk of further injury is considered unacceptable, the rabbit will have to be singly housed (and perhaps removed from the study as soon as possible). Persistent aggressors will probably have to be removed, but should not be housed in visual or olfactory contact with the group.
- It is also important to investigate the fundamental cause of the aggression. It may be necessary to review the housing, provide more dividers or refuges, or increase the available space. Increased monitoring will also be required, whether the aggression is addressed by removing animals, reviewing husbandry, or both.

Alternative approaches

There are veterinary and scientific justifications for single housing in a variety of circumstances, some of which are described here.

For example, persistent aggressors and their victims should not be housed together, entire adult males are usually singly housed because they are liable to fight and this can result in serious wounds. Metabolic studies and work with particular infectious agents are also incompatible with group housing. However, singly housed laboratory rabbits benefit from visual and minimal tactile contact with one another.

This kind of contact can be facilitated by incorporating perforated mesh panels into adjoining platforms/shelves or adjacent enclosure walls (making sure that they do not go down to the pen or cage floor), so that the rabbits can lie side by side. The rabbits must be able to avoid this contact if they want to, so a refuge should be provided. An appropriate gauge and thickness of mesh should be used. For example, bite wounds have been reported when using mesh with an aperture of 50 x 50mm (0.2 x 0.2") between pens but not with 25mm (1").

Observation ports or verandas fitted to cage fronts are another way of adding interest for singly housed rabbits. These increase visual contact by allowing rabbits to see more of the animal next door, including other rabbits, which is likely to reduce anxiety.

1.3 SOLID FLOORING AND SUBSTRATE

Studies in a range of species have shown that animals often prefer, and will work to gain access to, solid flooring. This may be because solid floors have various benefits compared to grid floors, such as being more comfortable to walk and rest on and allowing animals more control over their thermal environment. Solid flooring means that substrate can be provided, which facilitates and encourages natural behaviours such as digging, foraging and shredding activity.

Background

Solid flooring will benefit all sizes, strains and ages of rabbit, there are very few situations where it is not advisable on health or welfare grounds, provided that husbandry is adequate. Substrate should be regularly replaced to keep it clean and to prevent sore hocks.

How to introduce solid flooring with substrate

Pen flooring should be easy to clean, well-insulated and slip-proof. Examples of flooring that has worked well for the authors are concrete protected by epoxy resin paint or sealed vinyl, or securely fixed rubber matting over a concrete floor. Ribbed rubber sheeting cannot be kept clean and stainless steel was found to be too slippery. Sawdust or wood shavings, such as aspen, are suitable substrates that can be used with solid flooring, ideally with dust-free straw as enrichment on top. The straw can be installed if necessary.

Troubleshooting

- Sore hocks (pododermatitis) – seek veterinary advice immediately. Provide thick straw bedding and clean regularly until healed; ensure that all substrate is replaced more frequently.
- Coccidiosis – coccidia are common pathogens that are prevalent in wet conditions. In view of this, close attention should be paid to ensuring that the litter substrate remains dry, including using nipple drinkers above drain gratings. If coccidiosis occurs, more frequent cleaning schedules are required.

Alternative approaches

A solid resting area can be provided instead, which should account for one-third of the cage or pen area. This may be a solid shelf, roof of a refuge and/or a solid area of the floor. The animals usually choose to rest on it (this does not necessarily have to account for all the time they are at rest, the key aim is to provide them with a choice). If the rabbits are not resting on the solid area, check that it is large enough, that it is not placed in an area that the rabbit prefers to use as a latrine or, if it is raised above floor level, whether there is enough space above it.

If perforated flooring is being used, it should be comfortable and safe for the rabbits. Plastic flooring with recessed round holes is widely available, but wire grid floors should not be used – they are uncomfortable, can restrict the ability of animals to thermoregulate and have often been associated with pododermatitis.

1.4 RAISED AREAS

Access to at least one raised area, such as a platform that rabbits can jump on and off, provides important weight-bearing exercise and helps to build bone strength. Raised areas are also useful as look-out points; rabbits will jump on to them and rear alert when disturbed. Being able to scan their surroundings in this way is likely to reduce anxiety.

Troubleshooting

- Unused hocks (pododermatitis) – seek veterinary advice immediately. Provide thick straw bedding and clean regularly until healed; ensure that all substrate is replaced more frequently.
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If perforated flooring is being used, it should be comfortable and safe for the rabbits. Plastic flooring with recessed round holes is widely available, but wire grid floors should not be used – they are uncomfortable, can restrict the ability of animals to thermoregulate and have often been associated with pododermatitis.

Background

Raised areas benefit all physically fit rabbits past weaning age, whether they are housed in pens or cages – provided that cages have enough height and adequate floor area to accommodate other behaviours. However, rabbits housed for long periods in standard-size cages without a raised area may not have sufficient bone strength to jump on and off platforms without injury. One way to introduce platforms is to initially supply low ones, gradually increasing the height. Rabbits must be able to access the raised area(s) easily and, ideally, should be able to assume the ‘rearing alert’ posture while on top without their ears touching the roof. Avoid placing platforms or boxes in positions where they can be used to jump out of the enclosure, or make sure that the walls are high enough to prevent escape. Materials should be easy to clean and non-slip to avoid injuries when jumping on and off.

How to introduce raised areas

Raised areas may be provided in the form of bases that are sturdy enough to bear a rabbit’s weight, purpose-built platforms for pens, commercially available platforms for cages, or commercially available refuges that are an appropriate size and shape (see below). They should be rigid and remain in position when rabbits climb onto them. Suitable materials are wood or plastic. Straw bales are a very good way of providing raised areas and can also be an additional source of dietary enrichment. Rabbits generally make good use of raised areas that are about 250 to 300mm (10 to 12") high.
Troubleshooting

- Rabbits do not use raised areas – ensure that there is sufficient height above them for rabbits to sit up comfortably. Check that they are not made from materials that the rabbits could find uncomfortable or slippery or which change position easily when used.

- Injuries (other than by fighting) – check that platforms are stable, materials are non-slip and that rabbits are fit enough to jump up and off the raised areas. Consider lowering them temporarily or permanently.

Alternative approaches

In rare circumstances, for example some orthopaedic studies, it will not be possible to provide a raised area. In such cases sufficient space should be provided for appropriate exercise to help maintain bone strength and physical fitness.

1.5 REFUGES

In common with many other species, rabbits benefit from a refuge or ‘bolt-hole’ that they can retreat to if they feel afraid, stressed or unwell or simply wish to withdraw from social contact for a while. This is a natural escape response; so rabbits without access to some kind of ‘bolt-hole’ are likely to be stressed. Dominant animals may monopolise a refuge, so several should be provided – ideally at least one per rabbit.

Background

Rabbits benefit from the availability of shelters or refuges throughout their lives. These should be high enough to allow animals rapidly to move underneath, but low enough to provide feelings of security. As a guide, refuge height for an adult NZW should be about 300mm (12”).

Refuges should be large enough for rabbits to enter and turn around comfortably. Check that they are not made from materials that the rabbits could find uncomfortable or slippery; dustbins; sections of wide-bore plastic or fired-clay drain pipes made of a strong material that cannot be chewed by the rabbits.

Gnawing helps to maintain tooth sharpness and oral health, since rabbits’ teeth grow continuously, like those of mice and rats. Wild rabbits spend about 4-4% of their time eating36, and rabbits have been shown to prefer enrichment based on food items to enrichment based on non-food items37. Providing food that the rabbits have to search for or manipulate should therefore encourage natural behaviour; reduce boredom; and improve welfare.

The digestive system of the rabbit is adapted to deal with large amounts of low-quality food, which may be a mixture of coarse grasses, herbs, fruit, roots, leaves and bark. Standard pelleted diets are very different in that they have a higher calorific and nutrient density, are eaten in smaller amounts and may be perceived as monotonous and boring for rabbits. Rabbits are therefore likely to benefit from a more natural and interesting diet. Hay has been found to be particularly effective at reducing abnormal behaviours such as bar gnawing, excessive grooming and sham chewing38, 39.

Background

Rabbits benefit from dietary enrichment and gnawing objects and there are only occasionally veterinary or experimental reasons for withholding them. There is reduced scope for providing dietary enrichment for rabbits in certain circumstances, for example chew blocks supplied in regular veterinary studies should have a Certificate of Analysis. Remove leftover forage foods to prevent overeating and minimise disease risk. If animals are accustomed to eating standard pelleted diets only, they may take time to become accustomed to new foods. The original diet should always be available if the animal’s diet is changed, to ensure that they are getting enough to eat if they are slow to eat new foods.

How to introduce gnawing objects and dietary enrichment

Rabbits should be provided with dietary enrichment and gnawing objects from the time that they leave the nest. A wide range of gnawing objects is commercially available, including wooden (e.g. aspen) and synthetic chew blocks. Most come with a Certificate of Analysis and many can be cage washed, autoclaved or irradiated if necessary. Wood blocks with holes through the centre can be threaded onto a string and suspended from the enclosure wall for added interest. If chemical content is not an issue, then ‘logs’ of hardwood tree trimmings – 40 to 50mm (1.6 to 2”) in diameter and 150mm (6”) long with the bark attached – are often preferred by rabbits.

Loose or pressed hay, straw takes time to manipulate and provides additional dietary roughage. Straw also helps to prevent outbreaks of hair pulling40. To prolong handling time and interest, hay can be scattered on the cage or pen floor. Scattered on the roof of a cage to be pulled through, placed in a hay rack or nest or stuffed inside a dry water bottle. Putting vegetables or other dietary enrichment inside cardboard tubes and stuffing the ends with hay also can increase foraging time. Rabbits also make good use of alfalfa grass cubed and some dietary enrichment in the form of fresh fruit, vegetables or seeds (such as flaked maize, barley, oats and soy beans), cabbages, carrots, parsnips, turnips, mangolds, dandelion leaves, apples and hydroponic* grass. Commercially available foraging ingredients or mixes consist of dried fruits, beans and seeds, which can all be irradiated. All these supplementary foods can be scattered on the floor to encourage foraging behaviour, or some foods such as carrots can be stuffed into straw bales. It is vital to be aware of the risk of introducing pathogens or unbalancing the rabbits’ diet and to ensure that the attending veterinarian is aware of feeding protocols.

Consider feeding the rabbits in the afternoon rather than the morning as this corresponds better with their main period of foraging activity in the wild – that is, late afternoon and night time41. For example, research at Odense University compared the incidence of abnormal behaviour in groups of female SuvCPI rabbits housed with a light period from 04:00 to 16:00 and fed at either 08:00 or 14:00. The study found that afternoon feeding reduced abnormal activity such as bar biting or paw scraping during the dark period42.

Troubleshooting

- Not gnawing – try different gnawing objects and/or check that there are no dental problems.

- Competition for gnawing objects – ensure that several are available. Fix some to different areas of the pen so that dominant rabbits cannot monopolise them.

- Not foraging – it may simply be that animals are unused to foraging and need more time to become accustomed to the idea. It will help if animals are used to foraging from weaning – this may involve discussions with the breeder. It could also be that the rabbits would prefer different foods. If necessary, make small quantities of a treat available in

* Hydroponic: grown in nutrient solutions, without soil. This is a way of providing plants for laboratory animals without introducing soil pathogens.
Many people believe that turning rabbits upside down so that they are in a state of tonic immobility (TI) puts them into a ‘trance’ and that this is not unpleasant or stressful for the animals. However, this is not the case. During recovery from TI, heart rate, respiration and plasma corticosterone levels are significantly elevated and subsequent grooming and hiding behaviour also increase. Fear responses such as flattened ears, pupil dilation and struggling also occur while TI is being induced.

These responses are all similar to those that occur before and after other stressful events, which indicates that TI is disturbing and should not be induced without good reason. It may be acceptable to induce TI if it means that mild but potentially stressful veterinary procedures such as nail or tooth examinations will be carried out more quickly and thoroughly. It is not acceptable to use TI alone to facilitate any type of procedure that would normally require sedation, anaesthesia or analgesia.

**How to initiate a training and socialisation programme**

Although rabbits of any age can benefit from positive interaction with humans, the critical window for socialisation in rabbits is the first six weeks of life, so it is extremely helpful if the breeder can ensure that young animals are well socialised and habituated to human contact. Published studies on the effects of starting to handle rabbit pups from 10 days old or in the first week of life have found that handled pups were less fearful and approached humans more readily than unhandled controls. One study also reported an increased growth rate and reduced mortality rate.

However, nervous does may kill pups if they carry human scent, so it is probably best not to begin using the young are ten days old. Make sure that all the pups are handled during each session, to prevent one subsequently being ‘singly out’ by the mother.

Studies have found that rabbit pups exposed to even minimal contact with humans were significantly less fearful and more likely to approach people as adults, provided that the context occurred within half an hour after their daily suckling period. Contact comprised either weighing or briefly touching, which took less than three to five minutes for a whole litter. This level of contact may have been effective, despite being so brief, because the pups were still relatively unassured following feeding and were more sensitive to learning.

From the above, it appears that if it is only possible to handle pups for brief periods, the best time is within 30 minutes of them suckling. It requires careful monitoring of daily suckling times before the socialisation programme begins, as nursing is very quick (see section 1.9).

If more time is available for handling, then pups can be handled outside this 30-minute period. This may be a preferable option if nursing occurs late in the day (see section 1.9). In a study involving longer human contact, begun when rabbits were 10 days old, or in the first week of life, investigators reported that within two days, 80% of the rabbits voluntarily swallowed the solution from the syringe and the others did so with minimal encouragement.

After the five-day training period, the compound of choice can be dissolved in the methyl cellulose solution. Continue to coat the syringe tip with sugar and the rabbit will like the compound, unless it tastes particularly unpleasant.

**Training for cooperation with oral administration of substances**

This protocol is from the University of Texas, where researchers wanted to administer antibiotics to rabbits used to evaluate an oral therapy for Staphylococcus aureus without using gastric gavage. They found that the technique described below produced the desired serum and bone concentration of antibiotic and was time-efficient, required more than one technician and eliminated stress in the animal due to misplaced intubations.

Prepare a solution of 0.5% methyl cellulose, which tastes sweet. Draw this up into a fine tuberculin syringe and dip the tip in sugar. Four to five days before the study, offer the solution to each rabbit by placing the syringe into the animal’s mouth (there should be no need to enter the enclosure) then slowly injecting the solution so that the rabbit can taste and drink it three times a day. The investigators reported that within two days, 80% of the rabbits voluntarily swallowed the solution from the syringe and the others did so with minimal encouragement.

After the five-day training period, the compound of choice can be dissolved in the methyl cellulose solution. Continue to coat the syringe tip with sugar and the rabbit will like the compound, unless it tastes particularly unpleasant.

**Troubleshooting**

- A doe rejects or harms pups following handling – take care to ensure that she is not stressed while one or more pups are away, make sure that human scent is not left on the pups by wearing clean gloves and re-apply the dam’s odour via her soiled litter or nest materials.
- Rabbits may become over-enthusiastic and demanding about interactions with humans, evidence by dominance behaviours such as enurination or bar biting when carers enter the room – if this occurs, seek advice from a veterinarian or animal behaviourist.

**Alternative approaches**

Animal care staff should be knowledgeable about rabbit behaviour in order to appreciate how their own behaviour might affect the animals. If there is no opportunity for structured socialisation programmes, empathetic interactions with the rabbits during routine husbandry procedures will reduce stress and improve welfare.
How to introduce enrichment devices

When adding new enrichment devices, make sure that they do not significantly and/or persistently stress the animals. This can be achieved by placing the item so that the rabbit can retreat from it if possible and by making sure that animals are closely monitored when the object is first introduced.

Assessing whether the rabbits are benefiting from enrichment devices can be approached at a number of different levels, from simply seeing whether some or most of the rabbits appear to be using the device, to weighing chew blocks, to setting up a properly controlled behavioural test. Advice from animal behaviour scientists and veterinarians is essential to ensure that tests are scientifically sound and will not present any risks to the animals.

Troubleshooting

- Rabbits not using toys – try varying presentation (e.g. by suspending them), use alternative items, make sure that items are rotated regularly and frequently enough.
- Prolonged withdrawal from items – this could effectively reduce the enclosure space available to the rabbit, reducing welfare. In such cases, remove the item.
- Aggression over particular items – provide additional ones; ensure that there are sufficient refuges and/or barriers.
- If a rabbit is injured by a toy – veterinary attention should be sought (if appropriate) and the item should be removed immediately and checked to see whether it is faulty or unsuitable for some other reason. If the rabbit has a health problem such as overgrown incisors, or untrimmed claws becoming caught in an item, address this promptly. It may be possible to replace or modify the enrichment item, or substitute a different one.

Alternative approaches

Make sure that rabbits have a variety of other resources such as group housing, refuges and dietary enrichment so that they do not become bored.

Section 1.9: SPECIAL NEEDS OF BREEDING DOES

When addressing the particular needs of breeding does, it is pertinent to consider breeding behaviour in the wild in order to minimise stress to the mother and pups. Towards the end of pregnancy the doe will find a spot to construct a nest. This is usually within a nesting chamber, lined with grass and her own fur. The doe typically visits the nest to suckle her young for approximately three to five minutes in every 24 hours, usually after sunset. The pups can sense vibrations caused by their mother approaching and react with intense activity as they prepare to feed. This form of absentee parenting is an anti-predation strategy, if nursing does cannot withdraw from their young, they often show disturbed behaviour and may even become aggressive towards the pups. After about two weeks, the pups become mobile and try to suck at every opportunity. The mother does not allow them to nurse more frequently but escapes from the pups and takes refuge in areas that they cannot reach. Does (and especially bucks) will also sometimes kill and eat other does’ pups, and females with young will chase other rabbits away from their nests. The presence of other does – even if they are housed in separate cages – may be a stressor and can even lead to infanticide. The following are all therefore likely to be especially important for good mother and pup welfare.

- Nest box design and location – the nest box should be outside the cage so that the mother cannot use the roof for nesting. Vibrations that are not followed by nursing, such as those caused by the mother jumping onto the roof of the nest box, can distress the pups.
- Nesting material, such as long straw or hay, which the mother can use to build her own nest.
- Appropriate nursing frequency (normally once or twice a day in domestic rabbits).
- The ability to completely withdraw from the pups, e.g. by fitting a door that the doe can open or restricting access to the nest box for pups under two to three weeks old, providing a shelf for escape from older mobile pups.
- For the mother; the perception that her pups are safe from other does.

Background

The requirements below apply to all breeding does under all circumstances. The aim is to cater for the rabbit’s style of absentee parenting by enabling the doe to get away from her litter, provide a safe area, and to provide breeding animals with a good quality environment. It is based on the system devised by Strauchfer (1990), which has also been adapted for use as a prototype on commercial farms in the Netherlands (see diagram opposite). In addition to the special requirements set out below, all of the other husbandry refinements set out in this document apply equally to breeding does.

How to introduce housing refinements for breeding does

Ideally, a pen housing system should be constructed with five functional areas:

- a central area for exercise and rest – with a dry, non-slip, warm floor; structures for resting, refuges, and a good view of the rest of the enclosure.
- a feeding area – with several sources of food and water, hay, and other dietary enrichment and activity objects such as branches for gnawing and chin-marking.
- a nesting area – with at least one nest box per doe, tunnel-like entrances, partitions between nest areas and straw nesting material.
- a pups’ area with a darkened, straw-bedded area for resting, a well-lit feeding area, and small entrance passages (so that pups over weaning age cannot enter).
- a separate pen for the buck – to control reproduction rate when breeding is not required, the buck should be out of visual and olfactory contact with the does when he is not living with them or he will become stressed.

For a breeding group consisting of three to five compatible does, one buck and their offspring until weaning, the minimum total area for all of the above is 4.5 m² (48 square feet). The buck can be left in with the does, but careful monitoring is required because some bucks will kill their offspring. Otherwise, he can be temporarily separated from the group in the separate pen.

An evaluation of a prototype of this system found that the does were able to close the nest entrances with straw after daily nursing, after which they moved into the central area and only rarely had any other contact with the pups. The raised resting areas substantially reduced suckling attempts by older pups. These observations suggest that this system encourages more appropriate breeding and pup-rearing behaviour which is likely to improve welfare. If this improved system cannot be provided, then it may still be feasible to supply some of the most salient features. A key requirement for the mother is the ability to leave the pups, and, conversely, for the pups to be left alone and undisturbed while they are not being nursed. The minimum requirement for this is a separate nest box that the doe cannot jump on to, with a raised area in the main part of the cage or pen so that she can get away from the pups once she has left the nest. However, does with free access to the nest box tend to visit the nest more throughout the day, possibly because of the permanent and unnatural presence of the nest stimulus. These repeated nest visits increase the risk of injury and death to the pups.

Nursing activity has been found to decrease with increased cage size and the provision of a tunnel leading into the nest box. As another option, ‘cat-flaps’ are controlled by the animal and have been found to reduce pup mortality. However, neither of these solutions is ideal, as the mother needs to be able to close the nest with suitable materials herself, and to break olfactory contact with the pups.

Restricting nest box access, by closing the door or removing the nest box, may improve the welfare of both the doe and her pups as the ability of the mother to hear and smell the pups is reduced. A less labour-intensive solution is to use a screen to remove the nest box from the mother’s sight-line, although this will not remove the highly potent stimulus of the pups’ odour. The feasibility of any interventions controlled by humans is complicated by the fact that domestic rabbits usually nurse their pups during and within the first hour after dusk. Altering the animals’ lighting regime and introducing a ‘twilight’ period may make this more practicable.

**Troubleshooting**

- Does still approaching pups outside usual suckling time – this is probably in response to pup odour cues; consider ways of reducing these by separating the nest box more effectively.
- Does using nest box as a latrine – try providing the box later in the pregnancy, about seven days before parturition.
- Does rejecting the nesting box and littering outside – this may be because she feels insecure in the box; review its location and design.

**Alternative approaches**

Housing breeding does with no facility to withdraw from the pups is likely to cause stress to mother and pups alike and can significantly increase pup mortality. This should be avoided wherever possible for reasons of animal welfare.
Good record keeping is critically important when refining animal husbandry, both to ensure that animals are benefiting from the refinement and to help establish the cause of any problems that may occur. The rabbit husbandry refinement record sheet, below, is suitable for basic monitoring and assessment of most of the refinements recommended in this document. If rabbits are found to have behavioural problems following a particular husbandry refinement, refer back to the relevant troubleshooting section for guidance. Some behaviours, such as stereotypies, may reflect chronic underlying problems and further guidance from the veterinarian or an animal behaviour expert will be necessary.

Rabbit husbandry refinement record sheet

Interpret the refinement record sheet in conjunction with other routine health and husbandry data such as growth rates, results of health checks, any illnesses or physical injuries, diet, environmental data such as light levels and temperature, husbandry routines, and so on. Care staff’s impressions of the wellbeing of the group can also be useful, although these are necessarily subjective. For breeding rabbits, reproductive performance data should be analysed, including incidence of oestrus, dates when the buck was added and removed, number of young produced and weaned, and sex ratio.

Check the eyelids, nape, back, underbelly and testes especially carefully. Minor skin abrasions and small lacerations can usually be treated topically with antiseptic agents and most heal uneventfully. Even if no wounds are present, it is still necessary to weigh and monitor the health of each individual regularly e.g. weekly, to ensure that they are not being prevented from eating and drinking properly by dominant animals. If rabbits are killed at the end of a procedure, significant fight wounds should be relatively infrequent once the group has settled down. Animals should still be regularly checked for wounds, because they may be attached without removing grossly visible injuries.

Check the skin for scars and relate this to the husbandry programme and any changes that were made.

Advice on health checks for rabbits housed using any system, including pen or group housing, should always be sought from the attending veterinarian. For more information about rabbit health monitoring, see the NVGR section 2.107 and FELASA recommendations.

Guidance notes for the sheet: Normal behaviour: See the appendix (page 22) for a list of normal behaviours carried out by rabbits (an ethogram). It is quite a long list, so you will need to decide which behaviours are particularly meaningful for the refinement in question. For background information on the behavioural repertoire of group-housed female laboratory rabbits, see Held at al(49).

For example, relevant behaviours for most small enrichment objects such as mirrors or jingle bells are likely to be chin-marking, gnawing, olfactory investigation and play. If refuges are provided for the first time, likely behaviours are chin-marking, displacing, gnawing, jumping, olfactory investigation, rearing and resting.

Of course, not all ‘normal’ behaviour is desirable; some behaviours are normal yet undesirable because they are associated with stress or distress. Different behaviours will occur under different circumstances, so it is necessary for all relevant staff to discuss what would be a cause for concern, with additional expert input if appropriate. Also note that ethograms should be used with care, since even trained observers can be inconsistent. If different people will be making the observations, it is important that they are adequately trained, they have looked at the animals together and discussed what they have seen, and their results are regularly checked for consistency.

Health: When group housing rabbits in pens, health problems and significant light wounds should be relatively infrequent once the group has settled down. Animals should still be regularly checked for wounds, because they may be attached without removing grossly visible injuries.

Check the eyelids, nape, back, underbelly and testes especially carefully. Minor skin abrasions and small lacerations can usually be treated topically with antiseptic agents and most heal uneventfully. Even if no wounds are present, it is still necessary to weigh and monitor the health of each individual regularly e.g. weekly, to ensure that they are not being prevented from eating and drinking properly by dominant animals. If rabbits are killed at the end of a procedure, significant fight wounds should be relatively infrequent once the group has settled down. Animals should still be regularly checked for wounds, because they may be attached without removing grossly visible injuries.

Check the skin for scars and relate this to the husbandry programme and any changes that were made.

Advice on health checks for rabbits housed using any system, including pen or group housing, should always be sought from the attending veterinarian. For more information about rabbit health monitoring, see the NVGR section 2.107 and FELASA recommendations.

Using refinement: Is at least one animal using the refinement in an appropriate way, such as resting in contact with a refuge (inside or outside it)? Alternatively, are there traces of use (e.g. gnawing marks on wood blocks, a nest constructed inside a nest box)?

Abnormal or undesirable behaviours: Examples are hunching or sitting, which could signify boredom, under-grooming (which leads to a shiny or dull coat), over-grooming (which may lead to hair ball formation) and hair plucking or pulling (unless a doe is in heat). Hunching with the head in a corner is usually interpreted as boredom, depression or chronic pain. Other abnormal behaviours are under- or over-eating and restlessness, i.e. unrelenting bouts of activity with disconected elements of feeding, comfort, resting, alertness and withdrawal behaviour alternating with locomotion. Restlessness will upset normal behaviour patterns and time budgets and can make rabbits more likely to panic.

Examples of behaviours in rabbits that are considered stereotypic if persistent:
- rhythmic biting of water bottles and pulling out of stoppers
- biting, chewing or licking bars, food hoppers, walls or floor
- pawing or digging in the correct pawing the walls or the food hopper
- rapid circling, sometimes including kicking the walls
- head swaying or weaving, repeatedly sliding the nose between the bars
- pushing hoppers and drinkers with the head
- somersaulting

Aggressive behaviours: These are good examples of normal yet undesirable behaviours. They include biting, aggressive circling, aggressive competition over a limited resource, fighting that causes injuries or persistent emanation directed at a subordinate animal. All of these are features of dominance behaviours and may occur when groups are newly formed.

Stereotypic behaviours: A stereotypy is a repeated pattern of movements that shows little or no variation and has no obvious function. Stereotypic behaviours are often viewed as indicating that an animal is, or has been, unable to cope with his or her environment. They should always be taken seriously as an indicator of potential suffering – but note that they are not a reliable indicator of current welfare status as, they are not the sole indicator, and welfare may be poor in the absence of stereotypies.

Some common stereotypic behaviours in the rabbit are listed below. These may include remnants of escape movements (e.g. circling), inappropriate performance of normal behaviours (e.g. pawing the floor instead of digging) or frustration (e.g. prolonged pawing of the hopper). It is important to recognise that stereotypic behaviour may not occur when humans are present during the normal working day.

Using CCTV to monitor rabbits continuously including during the dark phase, can yield surprising results and provide a more accurate assessment of whether the animal’s environment is appropriate.

If stereotypic behaviours are observed in the laboratory rabbit, the appropriate course of action is to address their underlying causes, which might well be husbandry related. The first action should be an immediate review of housing and care according to the principles set out in this resource. In some cases stereotypies may take time to reduce, or may unresolve, even though welfare has improved. If this occurs, the refinement programme will not have been a failure as the animal’s ‘level of wellbeing should have increased even though the stereotypies remain. However, advice from an animal behaviourist should be sought in case there is another underlying cause that has not been addressed.
3 REHOMING RABBITS

Most experimental animals are euthanased following procedures, either because their tissues are required as part of the experiment or because their welfare might be compromised as a result of the procedures that had been carried out. However this is not always the case and some rabbits may be suitable candidates for rehoming. Examples are animals used in non- or minimally invasive studies, surplus breeding stock, antibody non-responders or animals acquired for a study to test a compound that was withdrawn before they were used.

At the time of writing, there are a few establishments in the UK (mainly universities) that rehome laboratory rabbits on a small scale. They do this because of ethical concerns about euthanasing healthy animals and the negative impact that this can have on staff morale. When deciding whether or not it is right to rehome a particular animal, it is necessary to carry out the following assessments on a case by case basis:

- Weigh the future quality and quantity of life that the rabbit will experience against the risk that they may suffer as a consequence of laboratory housing and use.
- Consult with the attending veterinarian when planning the rehoming strategy.
- Have the attending veterinarian certify that the rabbit is fit, neither suffering nor likely to suffer, and should go on to have an acceptable quality of life.
- In the UK, liaise with the Home Office Inspector and ensure, in good time (preferably when the project licence* is drawn up), that there is authorisation for release from the controls of the Animals (Scientific Procedures) Act 1986.
- Ensure that the prospective owner has sufficient knowledge about rabbits’ needs and will be able to provide them with appropriate care.
- If rabbits have been group housed, ensure that they will not be singly housed when rehomed.
- Ensure that the prospective owner is aware of the health and safety risks (e.g. allergy) associated with rabbits as companions.

The following resources provide background information on rabbit behaviour and practical examples of refinement.

Online resources
Animal Welfare Institute – Refined and environmental enrichment for all animals kept in laboratories, database by Viktor and Anne Reinhardt: www.awionline.org/SearchResultsSite?fulltext.aspx
National Centre for the Three Rs – www.nc3rs.org.uk, click on Information Portal and ‘Rabbits’
RSPCA Research Animals Department (Science Group) – information on housing and care; resources for ethics and animal care and use committees. See: www.rspca.org.uk/ethics/review

Behaviour


Housing guidelines
Comfortable quarters for rabbits in research institutions by K Boers and others (2002), in Comfortable Quarters for Laboratory Animals (9th edn), edited by Viktor and Anne Reinhardt, Animal Welfare Institute, Washington, DC, pp 45–49; can be downloaded at: www.awionline.org/hub/c2OcQ-rabbits.html
Guidelines for the housing of rabbits in scientific institutions by Lynette Chave (2000), Animal Research Review Panel Guideline 18, Animal Welfare Unit, NSW Agriculture, Australia.


Future principles for housing and care of laboratory rodents and rabbits: Report for the revision of the Council of Europe Convention ETS123, Appendix A for rodents and rabbits, part B by Staaflicher M and others (2002), Strasbourg, Council of Europe. This can be downloaded from www.coe.int by clicking on A-2 index, Animals used for experimental and other scientific purposes (laboratory animals), Tests and Documents, Other Documents, NEW Appendix A, and then scrolling down to the background information documents.

General reading


The rabbit: Good practice for housing and care by the RSPCA Research Animals Department (Science Group); download at: www.rspca.org.uk/rabbits/review and click on Housing and care and ‘Rabbits’.

4 RABBIT-RELATED RESOURCES

The following resources provide background information on rabbit behaviour and practical examples of refinement.

Online resources
Animal Welfare Institute – Refined and environmental enrichment for all animals kept in laboratories, database by Viktor and Anne Reinhardt: www.awionline.org/SearchResultsSite?fulltext.aspx
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Behaviour


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General reading


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5 FEEDBACK

The UFAW/RSPCA Rabbit Behaviour and Welfare Group would very much appreciate feedback on this book. Did you find it useful? Were there any suggestions that worked well, or did not work well? Did you have to adapt any of the recommendations? Please send feedback to rabbits@rspca.org.uk so that we can inform and improve future editions of this resource.

6 ACKNOWLEDGEMENTS

Many thanks to Helen UK, Merch Sharp & Dahme, Novo Nordisk and the Universities of Birmingham, Newcastle, Reading, Sheffield and Sussex for the very useful information on their rabbit housing protocols.

The authors would also like to thank Mike Boyd, Maggie Jennings and Shirley Seaman for their extremely helpful comments on the content and structure of this resource.

* The licence that permits a programme of research involving regulated procedures in the UK.
**APPENDIX: RABBIT ETHOGRAM**

This ethogram is a compilation of:

For a copy of this ethogram that can be edited, e-mail rabbits@rspca.org.uk.

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<tr>
<td>A</td>
<td>Air-boxing: Fast forward-flicking of forelimbs whilst rabbit sits upright on haunches. Usually precedes body grooming</td>
</tr>
<tr>
<td>B</td>
<td>Biting: Seen during intr- or intra-sexual chasing/fighting</td>
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<tr>
<td>C</td>
<td>Body-rolling: Rabbit throws self onto ground in a sideways roll, may lie immobile in outstretched position on side with eyes half closed for some seconds after roll. Often performed as dust-bathing in the wild</td>
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<tr>
<td>D</td>
<td>Boxing: Head lowered, neck outstretched (sometimes with eyes partly or fully closed) towards approaching rabbit</td>
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<tr>
<td>E</td>
<td>Chasing: Rabbit rapidly pursues another, often with tail erect</td>
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<tr>
<td>F</td>
<td>Chin-marking: Rubbing the chin over an object or conspecific, releasing secretion from the chin gland</td>
</tr>
<tr>
<td>G</td>
<td>Circling: Courtship circling — male runs semi-circles, alternating around stationary or slow-moving female. Also occurs between females in single sex groups. Aggressive circling — slow or rapid chasing around and around in one spot; participants may have rear end of opponent gripped between their teeth</td>
</tr>
<tr>
<td>H</td>
<td>Coprophagy/re-ingestion: Rabbit removes, chews and swallows soft, mucus-covered coprophagy pellets directly from anus</td>
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<tr>
<td>I</td>
<td>Copulation: Sexual mounting and thrusting followed by ejaculation. Successful ejaculation accompanied by male vocalisation as he falls backwards/sideways off the female</td>
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<tr>
<td>J</td>
<td>Crouching: A submissive behaviour; animal ‘freezes’ and presses head and shoulders against ground with ears flattened</td>
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<tr>
<td>K</td>
<td>Defaecation: Release of faecal pellets</td>
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<tr>
<td>L</td>
<td>Digging: Prolonged paw-scraping at deep substrate, usually associated with burrow excavation. The substrate is thrown forward or back and to the sides. The soil will then be patted down by alternate, downward thrusts of the forepaws and a small volume of the substrate passed over the head and ears, prior to licking/nibbling of fur over the rest of the body</td>
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<tr>
<td>M</td>
<td>Displacing: Rabbit approaches another and takes over his/her location</td>
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<td>N</td>
<td>Drinking: Lapping up water with tongue (not normally seen in wild rabbits; these appear to extract most of their water requirements from their diet)</td>
</tr>
<tr>
<td>O</td>
<td>Dozing: Lying or sitting with eyes slightly open to half open and one or both ears erect, aware of the environment and responsive to sound and movement</td>
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<tr>
<td>P</td>
<td>Feeding: Taking food material into mouth chewing and swallowing — from food dispenser or floor</td>
</tr>
<tr>
<td>Q</td>
<td>Fighting: Involves aggressive attack with limbs or teeth, often with combatants leaping into the air/past each other</td>
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</table>

**Fur-pulling**
- Only performed by females. Rabbit pulls mouthfuls of hair from her head in order to line her nest prior to parturition

**Gnawing**
- Gnawing wood or other solid material with teeth

**Grooming**
- Self-groom: A full body groom is usually preceded by air-boxing (see above). The forelimbs are licked and passed over the head and ears, prior to kicking/rolling of fur over the rest of the body
- Allogroom: Rabbits may also lick the fur of another rabbit (usually around the head, particularly the ears), typically of the opposite sex

**Locomotory**
- Hopping: forward movement achieved by alternate extension of fore and hindlimbs. Distinguished from running by its slower speed and shorter distance covered per forward jump
- Jumping – vertical movement by rabbit either onto an elevated surface or into the air. The latter may occur, for example: (a) when surprised by another rabbit; (b) during jump-fighting between same or mixed-sex pairs of rabbits (see above); or (c) during play gambolling (see below under ‘Play’)
- Parallel running – two rabbits run in parallel, with elevated gait, tail erect and at a slow pace along a mutual territorial boundary. May be interspersed with bouts of jump-fighting (see below) and/or parallel paw-scraping and scent-marking displays
- Running – rapid forward movement achieved by alternate, fully-stretched extension of fore and hindlimbs

**Locomotory**
- Courtship circling – male runs semi-circles, alternating around stationary or slow-moving female. Also occurs between females in single sex groups
- Aggressive circling – slow or rapid chasing around and around in one spot; participants may have rear end of opponent gripped between their teeth

**Locomotory**
- Nibbling litter: Picking up and nibbling litter, with or without ingestion
- Nose to nose approach: Two rabbits approach head on with necks outstretched to sniff nose to nose and/or nose to chin
- Nose to tail approach: One rabbit approaches another from the rear and sniffs under his/her tail (typically in the context of a male sniffing to determine the oestrous status of a female)
- Nudging: Rabbit pushes nose into body or rump of conspecific – may be in a sexual or non-sexual context
**Pawscraping**  
Rapid scratching at the ground with the forepaws in the context of: (a) foraging (typically for roots); (b) aggressive encounters between two rabbits; or (c) a scent-marking session by a rabbit alone. Scent products in the form of urine, faeces and/or chin-gland secretions are typically deposited during (b) and (c).

**Rearing**  
Sitting up on hindlimbs with both forepaws off the ground, ears partly or fully down.

**Rearing alert**  
As above but with ears erect.

**Resting**  
- Sitting – in upright stationary position, with rear end and forepaws on ground and ears down.
- Sitting alert – as above, but with ears up.
- Lying. Limbs tucked under – resting with trunk on ground, hindlimbs tucked under the forelimbs, which are lying under or forward stretched from the body.
- Lying. Limbs outstretched – resting with body trunk on ground, all four limbs outstretched and belly exposed. Rabbits often sunbathe in this position.
- Lying in physical contact with one or more conspecifics.

**Scrubbing**  
Scratching at own body with a hindfoot.

**Sexual following**  
Male approaches female from behind and she moves forward with male repeatedly following. He may snarl under her tail and put his chin on her rump as a prelude to mounting. When she moves away, an unreceptive female will usually tail-fall (see below) as he moves away. Also occurs between does in single-sex groups.

**Sexual submission**  
Female crouches with tail fully erect so that a male may mate with her (see also lordosis).

**Sleep**  
Lying or sitting with both eyes closed; ears usually flat against the back. Facial twitching and rapid eye movements may be seen.

**Submitting**  
Rabbit creases to move and drops nose below the nose of an approaching animal.

**Tail-flag**  
Rabbit has tail fully vertically erect (typically during aggressive/towishment interaction).

**Tail-wagging**  
Outstretched tail is flicked rapidly from side to side by female (typically in the context of a rear approach by a male).

**Thumping**  
Loud thumping of the ground with the hindfoot (feet), usually when alarmed but males may also foot-thump after mating.

**Urrination**  
- Squat urination – the hindquarters are lifted slightly and extended backwards and urine released in a continuous, downwards-directed flow.
- Urine squat – with hindlimbs typically extended and tail erect, the rabbit squats a short jet of urine out behind Urine spray (or excretion) – a short jet of urine is emitted during a fast/short action where either the whole body, or the hindquarters alone, are lifted and the hindquarters swang around in a semi-circle. Typically, this spray is directed at another rabbit, either during courtship or an aggressive encounter.

**Vocalisation**  
- Low-pitched grunting – heard in pursued doers, sexually aroused doers, sexually pursued but unreceptive doers.
- Screaming – very high pitched screeching when rabbit is injured or frightened.

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**REFERENCES**


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Courtship circling - male runs semi-circles, alternating around stationary or slow-moving female. Also occurs between females in single-sex groups.