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Refining rabbit care

A resource for those working with rabbits in research

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A resource for those working with rabbits in research

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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^{1, 2}. 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)³. (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^{4, 5}. 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 wild and domestic rabbits has been found to be very similar indeed⁶. It is essential to bear this in mind when caring for and handling rabbits.

The rabbits' needs set out in sections 1.1 to 1.9 below are mainly based on two documents that have used both approaches (i) and (ii) mentioned above: the revision of the European Convention that sets out laboratory animal husbandry standards¹; and the BVA(AWF)*/FRAME/RSPCA/UFAW Joint Working Group on Refinement (JWGR)⁷. We have also used the Animal Welfare Institute publication *Comfortable Quarters*⁸, other recent papers on rabbit behaviour and welfare and the findings of the Pharmaceutical Housing and Husbandry Steering Committee project on rabbit husbandry⁹.

The guidance on how to meet the needs of the rabbit has been drawn up using current animal welfare science literature, the experience of the authors and practical information kindly made available to us by a number of universities, pharmaceutical companies and laboratory animal breeders. It includes factors to take into account when changing husbandry, how to introduce each refinement and what to do if the rabbits do not appear to be using a resource or if there are behaviours

that give cause for concern. In most cases, the best way to prevent behavioural problems is to consider the whole life experience of the rabbits and provide them with tailored husbandry refinements from as early an age as possible. 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, specific 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.

1.1 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, and for the provision of enrichment. In the wild, home range sizes for individuals within rabbit social groups are approximately 50 square metres¹⁰, yet the largest European standard size for a rabbit cage is 0.54 square metres¹. 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, a study on New Zealand White (NZW) rabbits housed in a semi-natural enclosure found that one-third of their active time was spent exploring, gnawing, and performing intensive locomotion and sexual behaviour¹¹. 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 abnormalities¹².

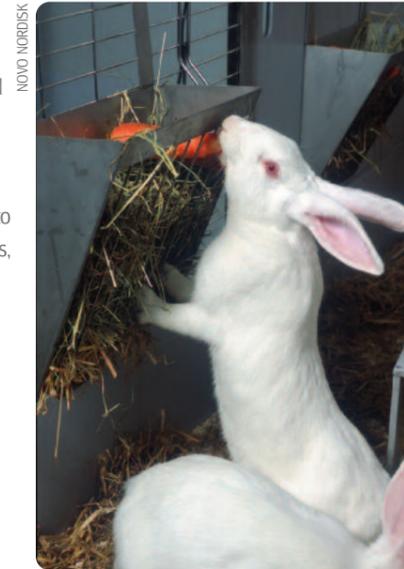
Rabbits also need sufficient space so that they can use different resources within an area for specific behaviours. If they are able to, rabbits choose to use separate areas for feeding, resting, nest making and excretion. It appears to be especially important for rabbits to be able to disperse when they are active and for low-ranking does to be able to retreat to the periphery of the enclosure during active periods¹³.

Rabbits frequently sit in an upright posture with their ears erect, so that they can scan their surroundings⁷. Pens can allow rabbits to perform this behaviour 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 animal. 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 and equipped enclosures will help to prevent injuries; gradually increasing enclosure size may be a good idea in some circumstances.

The introduction of large areas of unstructured space may be of 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 carry out distinct activities in different places. It is therefore good practice to subdivide the living space using partitions, platforms and shelters to encourage rabbits to use different areas for different activities. This also facilitates harmonious social housing (see below). Partitions can be constructed from sheet materials such as ply (e.g. 0.6 x 0.6m or 24 x 24") and suspended from the top of the pen so that they are 25 to 50mm



(1 to 2") above floor level. This provides a visual break between individuals, which can help to reduce aggression, and some rabbits spend much of their time resting behind them.

Concerns may be expressed that rabbits might be more difficult to capture if they occupy a larger, more complex space. However, staff can be trained 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 refuge. Once rabbits are accustomed

to being calmly caught in this way, they should usually stop hiding from familiar care staff and allow themselves to be picked up. See section 2.7 of the JWGR for more guidance on catching rabbits⁷.

How to provide extra space and height

If rabbits must be housed in cages, *Comfortable Quarters* recommends that cages should measure at least 0.68m (27") wide, 0.8m (31") long and 0.75m (30") high⁸. 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 hops¹⁴. Additional space may be needed depending on group size. For example, *Comfortable Quarters* recommends a minimum floor area of 2m² (21.5ft²) for up to four adult rabbits weighing 4 to 6kg (9 to 13lb), with an increase of 0.45m² (4.8ft²) for each additional adult. In the authors' experience, rabbits are commonly housed in pens measuring between 1.5 and 2.5m² (16 to 27ft²), which are used to house groups 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 be at least 1.2m (4ft) 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 'rearing 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 3.5 by 1.7m (11ft 6" 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 areas⁸.

These pens at Novo Nordisk (below) are purpose-built and measure 2 by 1.5m (6ft 6" by 5ft). 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 room allergen levels. Each pen is divided in two along its length 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 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.



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If floor pens are not a feasible option, an alternative way of providing extra space is to join cages together. Modular cage systems that are specially designed to be joined together are available commercially. Alternatively, it may be possible to adapt more conventional caging systems. Cages can be joined horizontally, or vertically using ramps, as reported by the UK National Institute for Biological Standards and Control¹⁵. This was found to be a practical way to provide more space for pair-housed NZW and Dutch rabbits.

However housing is modified, rabbits should adapt to using clearly defined areas for feeding, resting, exercise/foraging and excretion. Physiological improvements may be noticed, such as tending towards the ideal body weight and increased muscle tone, but the rabbits will still spend a significant amount of time resting, so do not expect them to be active in the extra space all the time. However, the authors' experience is that the rabbits' behaviour should be calmer; for example, animals should run away less often when visitors enter the room.

The input of care staff is essential when modifying cages, as they will have to handle, clean and maintain them. Pilot studies are a useful way of identifying and dealing with practical or health and safety issues.

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. Try 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, 6ft (1.8m) in diameter, into an exercise pen¹⁶. The exercise pen is filled to half its depth with shavings and hay, plastic balls with rattles 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 investigators 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 study, including regulatory toxicology. For example, NZW does on reproductive toxicology studies at AstraZeneca 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 rates¹⁷.

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, fattening rabbits given access to an area for half 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 period¹. 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 males⁶. 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 defused by submissive behaviours and by animals having the ability to get away from one another^{6, 18}.



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Group housing represents a stimulating form of 'enrichment'. Behavioural studies have found that pair- or group-housed rabbits spend significant amounts of their time in close proximity to others^{19, 20}. The quality of life of group-housed rabbits is significantly improved in comparison with singly housed animals, even for those individuals regarded as subordinate²¹. Therefore, young rabbits and older female rabbits should be housed in harmonious pairs²⁰ 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 fight 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 refuges and partitions. Partitions and other structures also provide the rabbits with additional places to scent mark. This is an important



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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 groups²². 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 harmonious social groups are: better 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^{7, 21, 23}.

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 or all of 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 stocking density, the substrate material and the experimental design. Transferring objects 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 group's health is not impaired and no individuals are subjected to unacceptable aggression. If such aggression does occur, the answer may be not 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 NZWs housed in non-littermate pairs in double cages found that enrichments such as nest boxes and 'bunny blocks' were not monopolised by dominant animals²⁰. 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 JWGR offers guidance on identifying rabbits⁷

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.

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 dark 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 30 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.

Sex and age

It is best to house rabbits in single-sex sibling groups that have been kept constant since birth, but 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 indefinitely, 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 urinate more frequently¹⁸, 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 another²⁴.

Strain

Most commonly used large strains are well suited to group housing – this includes the NZW, Chinchilla, Russian, Belgian hare and Sandy lop. 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.

Making decisions about castration

There are a number of ethical and welfare issues associated with castration, as summarised below, and these 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 80 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 (or 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

Whenever 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 vein. 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 wound closure (using subcuticular stitches) and cleaning, then each rabbit was placed back into her pen to recover. It made no difference whether the pens 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 NZW, watanabe and Dutch belted strains (Mike Boyd, pers. comm.).

Introducing unfamiliar adults

Unfamiliar rabbits have been successfully mixed by sedating them first using neuroleptoanalgesic* 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 reweighed 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 250g over the total observation period²⁵.

Housing and husbandry systems

Floor (or waist-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 faecal 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 handler handle them together in small groups before mixing⁷.

Experimental design

Occasional 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 the 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 rehoused 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 problem 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 another⁹. This kind of contact can be facilitated by incorporating perforated mesh panels into adjoining platforms/shelves or adjacent enclosure walls (making sure that they 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 30 x 30mm (1.2 x 1.2") 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 room, 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 sexes, 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 irradiated 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 siting nipple drinkers above drain gratings. If coccidiosis occurs, more frequent cleaning schedules are required.**

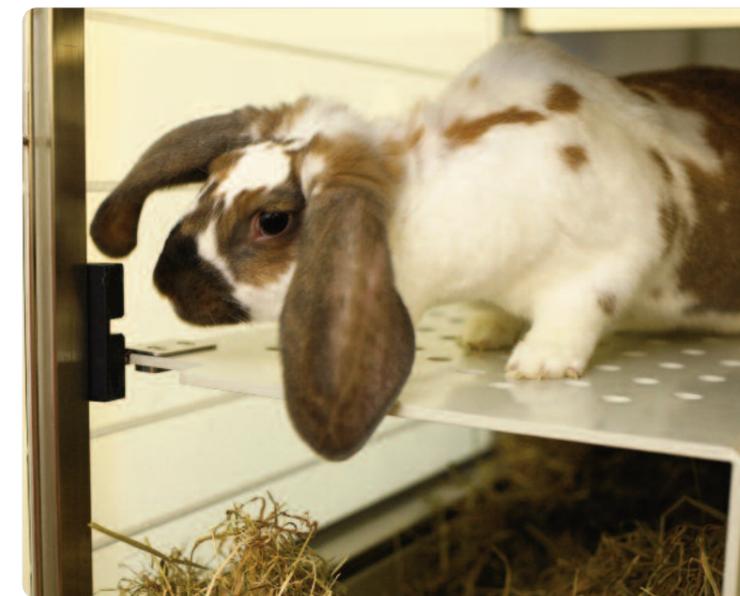
Alternative approaches

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.



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 boxes 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 on 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 are feeling 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 act as a secure refuge. (If animals can hop onto them as well, refuges will also fulfil the functions of a raised area, as above.) Group-housed rabbits should ideally be provided with at least one refuge each, regardless of whether they are platforms or shelves that also serve as refuges. This prevents monopolisation by dominant rabbits and so minimises competitive aggression. Refuges with two entry/exit holes for group-housed rabbits will provide an escape route in case of aggressive encounters. However, rabbits often share refuges, so some should be large enough to allow this.

How to introduce refuges

Suitable shelters include: commercially available rabbit refuges; boxes such as cardboard boxes; wooden boxes; paper sacks (e.g. sawdust bags); dustbins; sections of wide-bore plastic or fired-clay drain pipes (e.g. 450mm [18"] diameter PVC pipe); and shelves or planks that the animals can get under. Make sure that items such as cardboard boxes and sawdust bags have not been stored in areas where they may have become contaminated. Two plastic washing up bowls screwed together with entry and exit holes can also work well as a refuge. In the authors' experience, rabbits do not favour lighter plastic tubes or boxes and they will not use 300mm (12") clay drainage pipe bends. Cardboard boxes may not be compliant with Good Laboratory Practice (GLP)



requirements for toxicity studies. For GLP studies, raised areas are better, made of a strong material that cannot be chewed by the rabbits.

Refuges should be large enough for rabbits to enter and turn around in them, but small enough to provide feelings of security. As a guide, refuge height for an adult NZW should be about 300mm (12").

Troubleshooting

- Not using refuges – are there enough of them, are they of suitable construction, are they large enough? Are the entry and exit holes the right size?
- Aggressive competition for a particular shelter – supply more refuges; consider the use of visual barriers to reduce competition.
- Turning over purpose-built plastic refuges then ignoring them – make solid floors for the refuges that are 50 to 60mm (2 to 2.4") larger all round, and screw them on.
- Shredding cardboard boxes – this is generally regarded as an extra activity and is not viewed as a negative response. If this occurs, new boxes should be provided (staff can be asked to donate suitable boxes).



Alternative approaches

Rabbits should be provided with refuges – this is reflected in current European guidelines¹. If they are housed in cages that are too small for refuges to be added, then more space should be provided.

1.6 GNAWING OBJECTS AND DIETARY ENRICHMENT

Gnawing helps to maintain tooth sharpness and oral health, since rabbits' teeth grow continuously, like those of mice and rats. Wild rabbits spend about 44% of their time eating²⁶, and rabbits have been shown to prefer enrichment based on food items to enrichment based on non-food items²⁷. 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 grass, 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 chewing^{28, 29}.

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 regulatory toxicology studies should have a Certificate of Analysis.

Remove leftover forage feeds to prevent soiling 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 animals' 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, thin '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, or straw, takes time to manipulate and provides additional dietary roughage. (Straw also helps to prevent outbreaks of hair pulling³⁰.) 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 net or stuffed inside a dry water bottle. Putting vegetables or other dietary enrichment inside cardboard tubes and stuffing the ends with hay can also increase foraging time. Rabbits also make good use of alfalfa grass cubes and some

establishments are able to provide more natural chewing items such as cherry wood branches, which are good for chin marking. All chewing objects should be provided *ad libitum* to avoid conflict for access. Depending on the study circumstances, it may be possible to provide



dietary enrichment in the form of fresh fruit, vegetables or seeds (such as flaked maize, barley, oats, peas and soya 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 time³¹. For example, research at Odense University compared the incidence of abnormal behaviour in groups of female Ssc:CPH 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 period³².

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 solution, without soil. This is a way of providing plants for laboratory animals without introducing soil pathogens.

the substrate alongside the normal food in hoppers, then introduce increasing quantities of normal food to the floor.

- **Losing body weight** – this is unlikely to be a problem if the rabbits have become fitter because they are foraging and gnawing more, as opposed to overeating and not exercising. If rabbits weigh significantly less than the optimum weight for their strain, consult the veterinarian and ensure that sufficient standard diet is available to all animals.

Alternative approaches

There are some occasions (such as some dental studies or where animals have injuries to the mouth) when wooden or synthetic blocks, non-toxic plastic rods or strips or something similar cannot be provided for gnawing. Similarly, dietary enrichment may not be compatible with some metabolic studies. In this instance, consideration should be given to the possibility of providing the enrichment in-between study periods.

1.7 POSITIVE INTERACTION WITH HUMANS

Rabbits are easily frightened and need to be handled with great care³³. Human-rabbit interactions are less likely to cause stress during husbandry or scientific procedures if staff behave in a way that is compatible with the natural behaviour of the rabbit. Rabbits can recognise and discriminate between different humans³⁴, so positive contact with familiar humans in the form of handling (stroking and grooming), training and general habituation to human contact will provide interest for the animals and reduce stress when they are handled during the conduct of procedures. Not all rabbits respond positively to such manipulations, but studies have shown that gentle and frequent handling of young rabbits not only reduces their fear of humans but also has a positive effect on growth rate and reduces mortality³⁵.

Stroking and grooming rabbits, and regularly giving treats, helps to win the confidence and trust of the rabbits and can be combined with health monitoring, such as checking body weight or tooth condition. Unwell animals may interact differently with carers, which could be the first sign that health or welfare is compromised.

Background

An appropriate programme of positive interactions with humans benefits all rabbits, even if they have been housed in the laboratory for some time – it is never too late. Staff will need to have an adequate understanding of rabbit behaviour and, where applicable, may need to learn animal training techniques such as positive reinforcement. This will take time and resources and, in the case of training animals, will also require some commitment.

Rabbits can learn to cooperate during handling and during some procedures, but if they need to be restrained stress can be minimised by habituating the animals and keeping them calm, for example by gently wrapping them in a blanket. This should complement, not replace, the administration of sedatives and analgesics prior to the conduct of painful or stressful procedures.

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 behaviours also increase. Fear responses such as flattened ears, pupillary dilation and struggling also occur while TI is being induced³⁶. These responses are all similar to those that occur before and after other stressful events, which indicates that **TI is distressing 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 old³⁵ or in the first week of life^{37, 38}, 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 rate³⁵. However, nervous does may kill pups if they carry human scent, so it is probably best not to begin until the young are ten days old. Make sure that all the pups are handled during each session, to prevent one subsequently being 'singled 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 contact 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 aroused following feeding and were more sensitive to learning^{37, 38}. 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. This requires careful monitoring of daily suckling times before the socialisation programme begins, as nursing is over very quickly (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 old³⁵, up to three NZW pups at once were taken from their nests or cages each day, always by the same (female) person. Each group of pups were stroked and talked to "in a friendly way" for a period of 10 minutes between 9:00 and 12:00, then replaced into the nest or cage. Although some of these pups were handled more than 30 minutes after they had finished nursing, the

benefits with respect to reduced fearfulness and anxiety around humans were still realised, maybe because they were handled for longer³⁵.

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 gavage³⁹. They found that the technique below produced the desired serum and bone concentration of antibiotic and was time-efficient, never required more than one technician and eliminated stress and any risks to the animal due to misplaced intubation.

Prepare a solution of 0.5% methyl cellulose, which tastes sweet; draw this up into a 1ml 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 rabbits should take 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, evidenced 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.

1.8 TOYS AND OBJECTS TO MANIPULATE

There is a range of commercially available enrichment items that can be given to rabbits. These include mirrors⁴⁰, plastic or rubber objects, stainless steel rattles and balls. The authors could not come to a unanimous conclusion about the merits of these items for rabbits. Some were positive about enrichment devices because they can increase the rabbits' behavioural repertoire and reduce stereotypic behaviours, especially in cage-housed rabbits. Others were more sceptical, arguing that some items do not seem to be designed to meet the rabbits' needs or natural behaviour. These members did not believe that the welfare benefits had been proven or were concerned that some items could be aversive. It was agreed by all that items should be carefully researched, monitored and evaluated. It was also agreed that more research is needed into the welfare impact of different toys for rabbits.

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Background

Toys should be carefully evaluated to ensure that there is sufficient evidence of use, they are non-toxic and they will not cause injury. Items that animals can eat, chew or hide in seem to be preferred.

Group housed rabbits need to be provided with sufficient items to avoid aggressive competition. Individual animals may show preferences for particular items or may become accustomed to items and lose interest in them. In the experience of the authors, rabbits often have quite a low boredom threshold with respect to toys. A programme of rotating items, for example on a weekly or fortnightly basis, can help to prevent boredom⁴¹. The odour of other rabbits on an item may be stressful, so it is good practice to wash items before rotating them. Chews and other wooden objects are harder to clean so should remain with the same group or be discarded.

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 test³. 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.

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 sunset⁶. 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 resting. 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 rabbits⁴²).
- 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, more 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 sense that pups are safe from other does, and also to provide breeding animals with a good quality environment. It is based on the system devised by Stauffacher (1992)⁴, which has also been adapted for use as a prototype on commercial farms in the Netherlands⁴³ (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 against, 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.

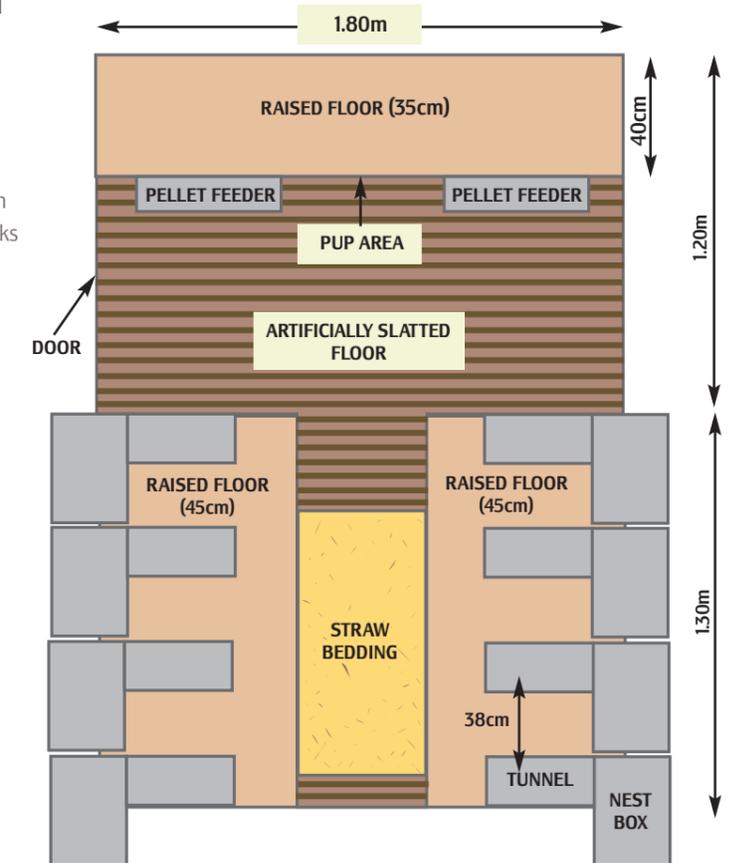
For a breeding group consisting of three to five compatible does*, one buck and their offspring until weaning, the minimum total area for all of the above is 4.5 m² (48 square feet). The buck can be left in with the does, but careful monitoring is required because some bucks will kill their offspring. 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 they have 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^{44,45}.

Nursing activity has been found to decrease with increased cage size and the provision of a tunnel leading into the nest box⁴². As another option, 'cat flaps' are controlled by the animal and have been found to reduce pup mortality⁴⁶. 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 pups⁴⁷.

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^{44,48}. (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' odour⁴⁷.) 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 dusk⁴². Altering the animals' lighting regime and introducing a 'twilight' period may make this more practicable.

Modified group housing system for breeding does*



*Reproduced with permission from Ruis & Coenen (2004)⁴³

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.
- Doe using nest box as a latrine – try providing the box later in the pregnancy, about seven days before parturition.
- Does rejecting the nest 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.

2 MONITORING REFINEMENTS AND RECORD KEEPING

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.

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

Room: _____
Cage/pen number: _____

CURRENT HOUSING AND HUSBANDRY				
STRAIN:	SEX:	AGE:	NUMBER OF ANIMALS IN GROUP:	
HOUSING TYPE:	PEN	CAGE/PEN ADDITIONS:	RAISED AREA/ SHELF	
	MODULAR CAGE		GNAWING OBJECTS (STATE TYPE)	
	STANDARD CAGE		SHELTER	
FLOORING:	SOLID (STATE SUBSTRATE TYPE, IF PRESENT)		FORAGE FEED (STATE TYPE)	
	PERFORATED		TOYS (STATE TYPE)	
	MIXED			
NESTING MATERIAL (STATE TYPE):				
DETAILS OF REFINEMENT				
WHEN INTRODUCED (DATE AND TIME): _____				
CHECK 1 (DATE AND TIME): _____				
NORMAL BEHAVIOURS	HEALTH	USING REFINEMENT?	ABNORMAL BEHAVIOUR/ STEREOTYPIES	ANY AGGRESSIVE BEHAVIOURS?
CHECK 2 (DATE AND TIME): _____				
NORMAL BEHAVIOURS	HEALTH	USING REFINEMENT?	ABNORMAL BEHAVIOUR/ STEREOTYPIES	ANY AGGRESSIVE BEHAVIOURS?

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 *et al*⁴⁹.) For example, relevant behaviours for most small enrichment objects such as mirrors or jingle balls 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 fight wounds should be relatively infrequent once the group has settled down. Animals should still be regularly checked for wounds, because they may be attacked without receiving grossly visible injuries. Check the eyelids, nape, back, underbelly and testes especially carefully. Minor skin abrasions and small lacerations can usually be treated topically 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, it can be very revealing to use fine blade clippers to remove the hair and inspect 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 JWGR section 2.10⁷ and FELASA recommendations⁵⁰.

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 inertia, which could signify boredom, under-grooming (which leads to a staring or dull coat), over-grooming (which may lead to hair ball formation) and hair plucking or pulling (unless a doe is building a nest). 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. afunctional bouts of activity, with disconnected elements of feeding, comfort, resting, alertness and withdrawal behaviour alternating with locomotion⁵¹. Restlessness will upset normal behaviour patterns and time budgets and can make rabbits more likely to panic⁸.

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^{52, 53}.

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)^{54, 55}.

It is important to recognise that stereotypic behaviour may not occur when humans are present during the normal working day³². Using CCTV to monitor rabbits continuously, including during the dark phase, can yield surprising results and provide a more accurate assessment of whether the animals' environment is appropriate.

If stereotypic behaviours are observed in the laboratory rabbit, the appropriate course of action is to address their underlying causes, which may 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 persevere, even though welfare has improved⁵². If this occurs, the refinement programme will not have been a failure as the animals' 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.

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 corner, 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 enurination directed at a subordinate animal. All of these are features of dominance behaviours and may occur when groups are newly formed.

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.

Most establishments that rehome animals find suitable homes for them via animal researchers and carers and their friends and contacts. The establishment checks that prospective owners have appropriate facilities; some universities offer a health care service for the rabbits once they have been adopted and will accept rabbits back if the new owners have problems with them. One university also has an arrangement with a local rabbit rescue organisation, in which the university castrates male rabbits for the rescue centre and the rescue centre rehomes rabbits for the university in exchange.

The UK Laboratory Animal Science Association has produced guidance on rehoming laboratory dogs, which includes practical advice and many useful principles that apply to other species including rabbits:

LASA guidance on the rehoming of laboratory dogs by the LASA Rehoming Guidance Working Party (edited by Maggy Jennings & Bryan Howard), LASA, Tamworth, UK. This publication can be downloaded at: www.lasa.co.uk; click on 'Position Papers & Publications – Texts' then 'LASA Publications'.

4 RABBIT-RELATED RESOURCES

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

Online resources

Animal Welfare Institute – Refinement and environmental enrichment for all animals kept in laboratories; database by Viktor and Annie Reinhardt: www.awionline.org/SearchResultsSite/laball.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 or animal care and use committees. See: www.rspca.org.uk/ethicalreview

Behaviour

Why does my rabbit...? by Anne McBride & Nina Bondarenko (2000), Souvenir Press, ISBN 0-2856355-0-6.

Behaviour of the pet rabbit: what is normal and why do problems develop? by Emma Magnus (2005), *In Practice* 27: 531–535.

The private life of the rabbit: an account of the history and social behaviour of the wild rabbit (2nd edn) by Robert Mathias Lockley (1985), Boydell & Brewer, ISBN 0-8511524-3-0 (out of print).

Stereotypic animal behaviour: Fundamental and applications to animal welfare (2nd edn) edited by Georgia Mason and Jeffrey Rushen (2006), CAB International, ISBN 1-84593-042-8. See also: www.aps.uoguelph.ca/~gmason/StereotypicAnimalBehaviour

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 Annie Reinhardt, Animal Welfare Institute, Washington, DC, pp 43–49; can be downloaded at: www.awionline.org/pubs/cq02/Cq-rabbits.html

Guidelines for the housing of rabbits in scientific institutions by Lynette Chave (2003), *Animal Research Review Panel Guideline* 18, Animal Welfare Unit, NSW Agriculture, Australia.

Housing for laboratory rats, mice, guinea pigs and rabbits by Ann L Hargreaves (2000), Australian and New Zealand Council for the Care of Animals in Research and Teaching: Adelaide, Australia, ISBN 0-9586821-3-5. See: www.adelaide.edu.au/ANZCCART/publications/

Refinements in rabbit husbandry by David Morton and others (2003), *Laboratory Animals* 27: 301–329; can be downloaded at: www.lal.org.uk/pdf/files/RABbit.PDF

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

Future principles for housing and care of laboratory rodents and rabbits: Report for the revision of the Council of Europe Convention ETSI23, Appendix A for rodents and rabbits, part B by Stauffacher M and others (2002), Strasbourg: Council of Europe; This can be downloaded from www.coe.int by clicking on: A–Z index; Animals used for experimental and other scientific purposes (Laboratory animals); Texts and Documents; Other Documents; NEW: Appendix A; and then scrolling down to the background information documents.

General reading

The laboratory rabbit by Gary R Batchelor (1999), chapter 25 in *The UFAW Handbook on the Care and Management of Laboratory Animals* (7th edn), edited by Trevor Poole and Pauline English, Blackwell Science, Oxford, pp 395–408.

The welfare of laboratory rabbits by Lena Lidfors, Therese Edström and Lennart Lindberg (2004), chapter 10 in *The Welfare of Laboratory Animals*, edited by Eila Kaliste, Kluwer Academic Publishers, The Netherlands, pp 211–243.

Rabbits and hares by Anne McBride (1994), Whittet Books Ltd, ISBN 0-9054836-7-7.

The domestic rabbit (5th edn) by J C Sandford (1996), Blackwell Science, ISBN 0-6320389-4-2.

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

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APPENDIX: RABBIT ETHOGRAM

This ethogram is a compilation of:

- Morton D B, Jennings M and others (2003) Refinements in rabbit husbandry. *Laboratory Animals* 27: 301–329 – see Appendix 1, pp 325–7.
 - Held S E, Turner R J & Wootton R J (2001) The behavioural repertoire of non-breeding group-housed female laboratory rabbits (*Oryctolagus cuniculus*). *Animal Welfare* 10: 437–443.
 - Gunn D & Morton D B (1995) Inventory of the behaviour of New Zealand White rabbits in laboratory cages. *Applied Animal Behaviour Science* 45: 277–92
- For a copy of this ethogram that can be edited, e-mail: rabbits@rspca.org.uk.

Air-boxing	Fast forward-flicking of forelimbs whilst rabbit sits upright on haunches. Usually precedes body grooming.
Biting	Seen during inter- or intra-sexual chasing/fighting.
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.
Bowing	Head lowered, neck outstretched (sometimes with eyes partly or fully closed) towards approaching rabbit.
Chasing	Rabbit rapidly pursues another, often with tail erect.
Chin-marking	Rubbing the chin over an object or conspecific, releasing secretion from the chin gland
Circling	<ul style="list-style-type: none"> ● 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.
Coprophagy/re-ingestion	Rabbit removes, chews and swallows soft, mucus-covered coprophagy pellets directly from anus.
Copulation	Sexual mounting and thrusting followed by ejaculation. Successful ejaculation accompanied by male vocalisation as he falls backwards/sideways off the female.
Crouching	A submissive behaviour; animal 'freezes' and presses head and shoulders against ground with ears flattened.
Defaecation	Release of faecal pellets.
Digging	Prolonged paw-scraping at deep substrate, usually associated with burrow excavation. The substrate is thrown under and behind the body and the rabbit may turn and push the displaced spoil further back with alternate forward thrusting movements of the forepaws.
Displacing	Rabbit approaches another and takes over his/her location.
Drinking	Lapping up water with tongue (not normally seen in wild rabbits; these appear to extract most of their water requirements from their diet).
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.
Feeding	Taking food material into mouth chewing and swallowing – from food dispenser or floor.
Fighting	Involves aggressive attack with limbs or teeth, often with combatants leaping into the air/past each other.

Fur-pulling	Only performed by females. Rabbit pulls mouthfuls of hair from her body in order to line her nest prior to parturition.
Gnawing	Gnawing wood or other solid material with teeth.
Grooming	<ul style="list-style-type: none"> ● 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 licking/nibbling 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	<ul style="list-style-type: none"> ● 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.
Lordosis	Female crouching still with curved, convex spine, tail elevated and vulva visible.
Mounting	Sexual mounting of hindquarters (or head) of conspecific. May see homosexual mounting by males or females grouped in the absence of opposite sex individuals in captivity.
Olfactory investigation	Close sniffing of object/conspecific.
Play	<ul style="list-style-type: none"> ● Head flicking – flicking head sideways. ● Play gambolling or 'frisky hop' – forward hopping/jumping accompanied by sideways tossing of the head/ears, shaking/twisting the body or kicking out with the feet. Young rabbits may also run back/forth at some speed during this activity.
Nest-building	Female gathers mouthfuls of nesting material, carries it to the nesting site and builds a nest which she then lines with fur plucked from her own body. If nesting in a purpose-built breeding-stop, the female emerges and then digs soil into the tunnel to close the entrance. The soil will then be patted down by alternate, downward thrusts of the forepaws and a small volume of urine and a few faecal pellets deposited on top. This same closing and patting-down action may be seen in domesticated rabbits at the entrance of their cage/pen nest box.
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	<ul style="list-style-type: none"> ● Sitting – in upright stationary position, with rear end and forepaws on ground and ears down. ● Sitting alert – as above, but with ears erect. ● 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 conspecific(s).
Scratching	Scratching at own body with a hindfoot.
Sexual following	Male approaches female from behind and she moves forward with male repeatedly following. He may sniff under her tail and put his chin on her rump as a prelude to mounting, before she moves away. An unreceptive female will usually tail-flag (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 ceases to move and drops nose below the nose of an approaching animal.
Tail-flag	Rabbit has tail fully vertically erect (typically during aggressive/courtship 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.
Urination	<ul style="list-style-type: none"> ● Squat urination – the hindquarters are lifted slightly and extended backwards and urine released in a continuous, downwards-directed flow. ● Urine squirt – with hindlimbs typically extended and tail erect, the rabbit squirts a short jet of urine out behind. ● Urine spray (or enurination) – a short jet of urine is emitted during a twist/jump action where either the whole body, or the hindlimbs alone, are lifted and the hindquarters swung around in a semi-circle. Typically, this spray is directed at another rabbit, either during courtship or an aggressive encounter.
Vocalisation	<ul style="list-style-type: none"> ● Low-pitched grunting – heard in pursued does, sexually aroused does, sexually pursued but unreceptive does. ● Screaming – very high pitched screeching when rabbit is injured or frightened.

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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.