French Reference Centre for Animal Welfare

OPINION

Opinion of the FRCAW on the impact of housing dimensions on cat welfare

Original title in French

Avis du CNR BEA sur les conséquences de la surface d'hébergement des chats sur leur bien-être

SEPTEMBER 2025

French Reference Centre for Animal Welfare

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Avis du CNR BEA sur les conséquences de la surface d'hébergement des chats sur leur bien-être

Requested by
Animal Welfare Office (BBEA) of the General Directorate for Food (DGAL), French Ministry of Agriculture and Food Sovereignty

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Summary

To assist in its revision of the Order of 3 April 2014 laying down the animal health and protection rules that must be complied with in the course of activities related to domestic species companion animals, the Animal Welfare Office (BBEA) has asked the FRCAW to report on the consequences for cat welfare of the provision of accommodation, for both long-term occupation and short stays of 15 days or fewer, where the housing surface area is restricted to less than 2 m^2 per cat, in comparison with the provision of a surface area of 2 m^2 or more per cat.

The report summarises the relevant fundamental features of cat ethology and addresses the BBEA's question through five sub-questions that enable distinctions to be made between cats housed alone or in groups and between different lengths of stay. They also allow consideration of the effects of the provision of environmental features other than floor area, and of differences between the characteristics of individual cats.

Increasing surface area, including vertical provision, contributes to a reduction in the stress experienced by cats in different contexts, particularly through the increased control it gives them over their surroundings, and the expression of greater behavioural variety it encourages. The report makes clear that it should be combined with other environmental factors (hiding places, complex three-dimensional spaces, access to the outdoors, regular interaction with humans). Although the findings in the literature do not offer an answer to the question precisely as posed, they all point to the same conclusion: reducing floor area to less than 2 m^2 per cat reduces cat welfare in both the short and long term.

Keywords

cats / welfare / housing / surface area / shelters / pounds

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Context as defined by the client

'The Decree of 3 April 2014 requires a minimum surface area of 2 m^2 per animal for the accommodation of cats in pounds and shelters. The calculation of this minimum surface area includes the surface area of the platforms provided in the accommodation.

The same document requires that: 'Cats must be able to move freely, without hindrance or interference. They must be able to exercise and play as required, on a daily basis. (Annex to the Decree, Section 1, Chapter II).

The decree provides for exceptions to this minimum surface area requirement:

- for the duration of treatment in isolation of a sick animal;
- in shelters and pounds, in the event of overcrowding where this does not compromise animal welfare. This period may not exceed 2 months per year in shelters.

Shelter and pound representatives are seeking to extend these exemptions to include cases where cats' health status is unknown and requires monitoring (unidentified cats entering the pound), and where cats are awaiting vaccination and/or screening before being released into the community. This additional derogation would be limited to 15 days and would be subject to the inclusion of a description in the facility's health rules of arrangements regarding the organisation and layout of the housing provided in the above cases.

The Opinion of the FRCAW may be used to help revise the Order of 3 April 2014, which lays down the animal health and protection rules with which activities related to pets belonging to the domestic species covered by Articles L. 214-6-1, L. 214-6-2 and L. 214-6-3 of the French Rural and Maritime Fishing Code must comply.'

Request

'The FRCAW's expert opinion is required on the conditions under which cats are housed in pounds and shelters for pets. The question put to the FRCAW is: what are the effects on cat welfare in shelters and pounds of a housing surface area of less than 2 m^2 per cat, by comparison with the provision of a surface area of 2 m^2 or more per cat, in the case of:

1. long-term accommodation?
2. accommodation for a maximum period of 15 days?

The FRCAW is asked to address this issue in respect of housing arrangements and treatment of litter mates under two headings: cats housed alone, and cats housed in groups'.

Reference document

Order of 3 April 2014 laying down the animal health and protection rules with which activities related to domestic species companion animals covered by Article L. 214-6-4 of the Rural and Maritime Fishing Code must comply.

Table of contents

Glossary 1

Abbreviations and Acronyms 3

Figures and Tables 4

1 Methodology 5

1.1 Opinion timetable 5

1.2 Creation of the reference corpus 7

1.3 Analysis of the literature and development of recommendations 7

1.4 Uncertainty assessment method 9

2 Cat ethology 10

2.1 General characteristics and physiological needs of cats 10

2.1.1 Domestication 10
2.1.2 Kitten reproduction and development 10
2.1.3 Feeding and watering 11
2.1.4 Need for and use of space 12

2.2 Sensory perceptions 12

2.2.1 Vision 12
2.2.2 Hearing 13
2.2.3 Odorat 13
2.2.4 Touch 13
2.2.5 Taste 14

2.3 Emotional sensitivity: expressing and measuring stress 14

2.4 Inter- and intra-specific interactions 15

2.4.1 Sociability in cats 15
2.4.2 Human/cat relationship 17

2.5 Adapting a cat's environment to its needs 17

2.5.1 Pillar 1 - A safe place 18
2.5.2 Pillar 2 - Free access to key resources in a cat's environment 18
2.5.3 Pillar 3 - Opportunity for play and predatory behaviour 19
2.5.4 Pillar 4 - Positive, regular and predictable human-cat social interaction 19
2.5.5 Pillar 5 - A varied and appropriate sensory environment, but avoiding overload 19

3 Answer to the question 21

3.1 Group accommodation for cats 21

3.1.1 Results of the literature review 21
3.1.2 Conclusion and recommendation of the FRCAW 23
3.2 Accommodation for single-housed cats 24
3.2.1 Results of the literature review 24
3.2.2 Conclusion and recommendation of the FRCAW 25
3.3 Link between impact on welfare and length of time spent in confined conditions 26
3.3.1 Results of the literature review 26
3.3.2 Conclusion and recommendation of the FRCAW 28
3.4 Other housing parameters 28
3.4.1 Results of the literature review 28
3.4.2 Conclusion and recommendation of the FRCAW 32
3.5 Factors inherent in cats 33
3.5.1 Results of the literature review 33
3.5.2 Conclusion and recommendation of the FRCAW 36
4 General conclusion 38
Bibliography 39
Appendix 44

Glossary

Home range

The home range can be considered to be determined by the sum of the movements of an animal living in a location for a given period of time. This effectively defines the home range as an emergent structure – it is an epiphenomenon – generated by movement behaviour. For practical reasons (to simplify the study), the home range can also be understood as the portion of space where an animal expresses its habitual activities over a certain period of time (according to Benhamou, 1998). (Benhamou, 1998)

'Chat haret' (no direct English equivalent, domestic cat that has become feral)

In the original French version of this Opinion, this term referred specifically to a domestic cat that has returned to a 'wild state', establishing populations that are independent of humans, particularly in terms of food availability (Savouré-Soubelet et al., 2024). In the English version, alternative terms have been used according to context.

Familiarisation

Process by which an animal, through repeated interactions with no negative consequences, learns to recognise and accept individuals of other species as non-threatening. This process gradually reduces the animal's fear or stress responses when encountering new individuals of these species.

Frustration

Negative emotional state experienced by an animal when it is prevented from performing a behaviour it is motivated to carry out. This feeling can be caused by the presence of physical or social obstacles, by the impossibility of satisfying its needs, or by the disruption of routines and can lead to a state of stress (according to Fraser & Broom, 1990).

Habituation

Process by which an animal, through repeated interactions with no negative consequences, learns to recognise and accept specific stimuli and environments as non-threatening. This process progressively reduces the animal's fear or stress reactions to the new or unfamiliar elements.

Socialisation

This term was not used in the original French Opinion, as it has a more restricted sense in French than in English (see Manning & Dawkins, 2012). In French, use of the term is limited to the acquisition of social behaviour through various learning

processes during the behavioural development of an individual of a social species. Given that *Felis catus* is considered to be an 'optionally social' species by some authors, the term was excluded from the original report in French, but appears here in reference to the work of certain English-language authors.

Floor area

Floor area refers to the total floor space available for an animal in its environment, generally measured in square metres (m^2). This measure is used to assess the physical space required for the animal's welfare, taking into account the specific needs linked to its natural behaviours, such as movement, resting and feeding.

Stress

Change in an animal's state of balance (homeostasis) in response to an environmental stimulus that could cause it harm. The stressed individual then carries out a series of more or less instantaneous physiological and behavioural responses to ensure its survival. This physiological reaction is triggered by the activation of the sympathetic nervous system (via catecholamines: noradrenaline, adrenaline), followed by the activation of the corticotropic axis (glucocorticoids). These adaptive responses can be negative or positive, depending on the situation in which individuals find themselves and how they perceive it. If the individual is unable to re-establish homeostasis quickly, stress can become chronic and cause a general deterioration in the individual's condition (see White Paper, Le Bien-être de l'animal de compagnie, Welfare of Companion Animals, 2019).

Abbreviations and Acronyms

ANSES

French Agency for Food, Environmental and Occupational Health & Safety

BBEA

Animal Welfare Office (Bureau du Bien-Être Animal) of the French General Directorate for Food

CSS

Cat-Stress-Score, Kessler and Turner, 1997

CNR BEA

Centre National de Référence pour le Bien-Être Animal. Referred to as the FRCAW in the present document, except in bibliographical references and titles.

DGAL

French General Directorate for Food

EFSA

European Food Safety Agency

FRCAW

French Reference Centre for Animal Welfare (Centre National de Référence pour le Bien-Être Animal)

Figures and Tables

Figures

Figure 1. Expertise schedule of actions 6

Tables

Table 1. The development of domestic kittens (after Weiss, 2015, data from Beaver 2003) 11

1 Methodology

1.1 Opinion timetable

The Opinion was produced over a period of 9 months. An initial phase, in which the methodology was framed and constructed was followed by a second phase in which reference materials were collected and analysed. On the basis of this analysis of the selected corpus and of discussion among the experts, a draft of the report was produced by the FRCAW's expertise coordinator. It was then revised by the expert committee and the FRCAW's steering committee, in accordance with the FRCAW's procedure for the production of expert reports (*Figure 1*).

In this report, the following terms are used to refer to the various groups consulted:

- expert panel (also expert group, experts): all three terms refer interchangeably to the experts called upon by the FRCAW to provide materials and views during the various phases of discussion and work on the expertise,
- working group: refers to the expert panel and the expertise coordinator,
- the FRCAW: refers to all those who reviewed and validated the report, i.e. the working group and the steering committee.

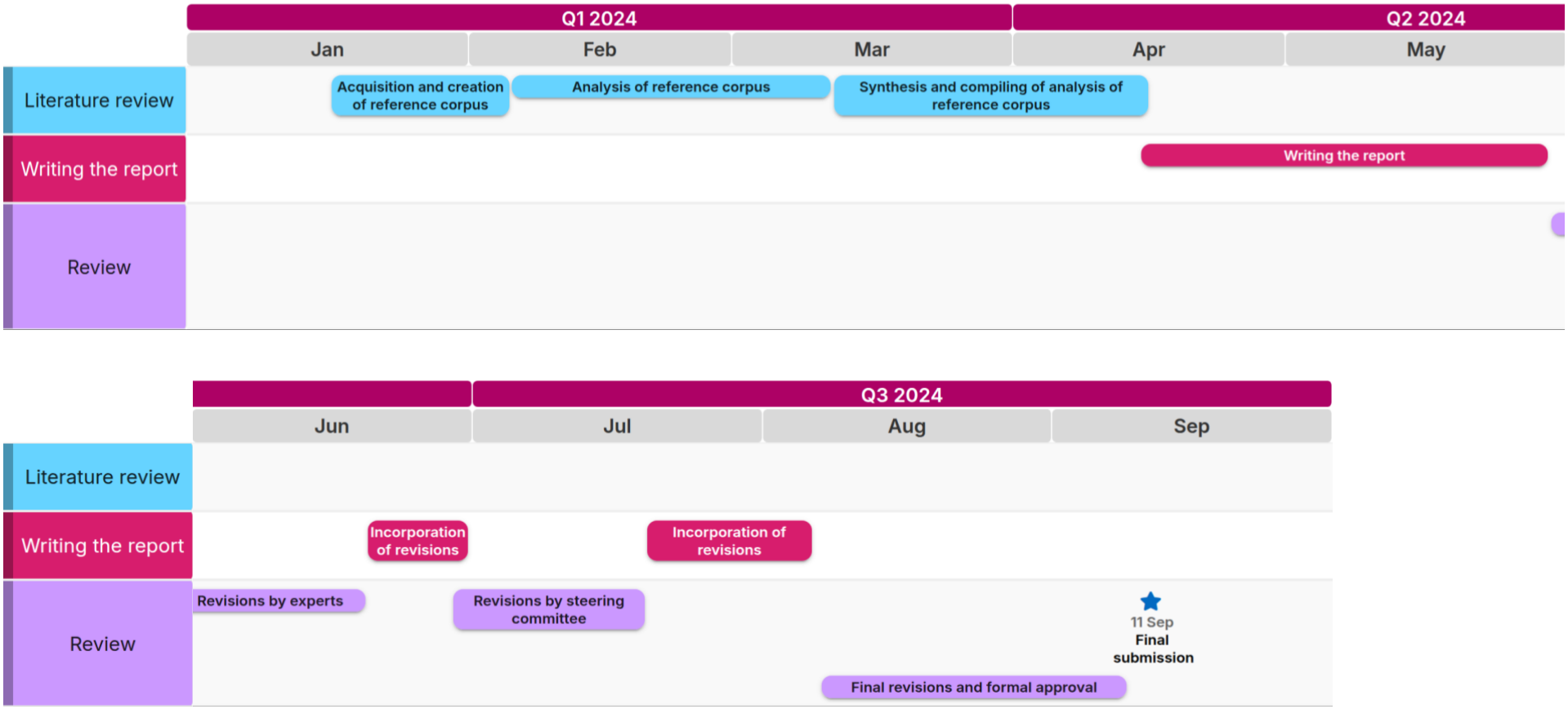

Figure 1. Expertise schedule of actions

1.2 Creation of the reference corpus

Given the limited time available to produce the report, the working group, formed of the FRCAW expertise coordinator and 5 experts in ethology, veterinary science, behavioural ecology and cat welfare, decided to create the reference corpus in relation to three areas of research: housing conditions for cats, available space and density of occupancy.

The reference corpus was compiled on the basis of a Web of Science (WOS) search, supplemented where necessary by contributions from invited specialists in the field.

The following equation was applied for the WOS subject search: (cats OR cat) AND (welfare OR stress OR wellbeing OR impacts OR health OR behavior OR behaviour) AND (space OR housing OR density).

This first search generated 4,397 documents and was then refined by selecting disciplines of interest (veterinary sciences, zoology, ecology, environmental sciences, behavioural sciences, multidisciplinary sciences, biology), followed by document types of interest (review articles and scientific articles) and, finally, titles of interest. A list of 30 documents was thus produced, including 19 scientific articles and 11 review articles. To this initial corpus, a further 7 review articles and 3 scientific articles were added by the experts, giving a total of 40 documents at this stage.

Following analysis of the literature by the expert panel (see Section *1.3*), 6 scientific articles and 1 review article were discarded because they either did nothing to answer the question under consideration or were judged to be of insufficient quality.

Analysis of regulatory documents allowed a further 4 documents to be added to the evidence base, along with 21 other texts from the scientific literature, chosen in particular for their usefulness to the production of the glossary and the background section on cat ethology (cf. *2*).

The final version of the reference corpus thus contains 58 documents in total.

1.3 Analysis of the literature and development of recommendations

The evidence base was analysed by the working group using two tabular templates: one for review articles and another for scientific articles (see *Appendices 1 and 2*).

Given the great variation between the publications selected in terms of their experimental design (enclosure size in m^2, available heights in metres, presence or absence of enrichment, number of individuals in the groups, individuals observed, shelter operation, etc.), and protocols (variables observed, study duration, presence or absence of a

habituation phase, etc.), and given the paucity of publications directly addressing the question put to the FRCAW (specifically, comparison of cats in long-term accommodation measuring under 2 m^2 with those in long-term accommodation measuring over 2 m^2), the working group decided to unpack the question put by the BBEA into more limited sub-questions, based on the methodology used by the EFSA (2023).

The question asked by the BBEA has thus been broken down into 5 sub-questions.

Original question (BBEA):

'What are the effects on cat welfare in shelters and pounds of a housing surface area of less than 2 m^2 per cat, by comparison with the provision of a surface area of 2 m^2 or more per cat, in the case of:

1. long-term accommodation?
2. Accommodation for a maximum period of 15 days?

The FRCAW is asked to address this issue in respect of housing arrangements and treatment of litter mates under two headings: cats housed alone, and cats housed in groups.'

Sub-questions drawn up by the FRCAW, based on the EFSA formulation:

In view of the impact on their welfare, is there any scientific evidence to suggest that:

1. Cats should not be housed in **groups** in a space providing less than 2 m^2 of ground-level floor space per cat, **even for two weeks or less**?
2. Cats should not be kept **alone** in enclosures measuring less than 2 m^2 at ground level, **even for two weeks or less**?
3. Does the welfare impact of accommodation measuring less than 2 m^2 at ground level per cat **increase with the length of time spent under these conditions**?
4. **Are there any housing parameters other than floor area** that could affect the welfare of cats in enclosures?
5. **Could particular factors inherent in cats** affect their ability to adapt to a restricted space?

Responses were formulated systematically by providing:

+ the information contained in the evidence base that could help in answering the original question put to the FRCAW,
+ additional information available from the literature,
+ the conclusions of the FRCAW in light of the above information,
+ the recommendations of the FRCAW in relation to each sub- question.

The conclusions and recommendations contained in the report were drawn up by the expert group based on their analysis of the literature (cf. *3*).

1.4 Uncertainty assessment method

To provide precise answers to the various sub-questions set out above (cf *1.3)*, despite the limited scientific literature available, the expert panel members provided uncertainty assessments for their responses to each question. For this purpose, two meetings were organised once the responses had been collated. Four of the five expert panel members participated in this work, one being unavailable.

Each sub-question (cf. *1.3*) was re-worded to ensure that all the experts had a similar understanding of the question. Sub-questions 4 and 5 were dealt with parameter by parameter. All questions asked, answers given by each expert and the consensus reached for each question are summarised in *Appendix 3*. For each question, the experts could choose one of three ranges of certainty:

- More likely than not: certainty between 50% and 100%
- From probable to almost certain: certainty between 66% and 100%
- From very probable to almost certain: certainty between 90% and 100%

Every question was considered in relation to a set of ideal circumstances for all parameters other than those detailed in the particular question. For example, to address the question 'Out of 100 cats housed in a group in a space providing less than 2 m^2 of ground-level floor space per cat for two weeks, what is the probability that there will be a negative impact on the welfare of 90 of the cats?', the experts visualised 100 cats in a space providing less than 2 m^2 per cat where all other environmental parameters were ideal. In view of the context of the assessment as set out by the requesting body, the expert panel defined the ideal reference situation as being the best possible conditions in a shelter.

The impact on cat welfare of the various parameters examined was systematically assessed with regard to the five pillars described in *Section 2.5* of this report.

Despite the care taken in the wording of the questions, it turned out that the experts had differing understandings of some of the questions. In these cases, the question was either re-worded to provide greater clarity, or elucidation of its context or implications emerged in the course of discussion, allowing consensus to be reached. Where appropriate, contexts or implications have been detailed in the results.

2 Cat ethology

To fully understand how a cat's environment affects its welfare, it is necessary to understand its behaviour, phylogeny, ontogeny and needs. The following section accordingly summarises several essential aspects of cat ethology.

Unless otherwise stated, the information in this section is based on Chapter 2 of Animal behavior for shelter veterinarians and staff *by Weiss et al. (2015). This chapter of the guide was written by Stephen Zawistowski.*

2.1 General characteristics and physiological needs of cats

2.1.1 Domestication

The domestication of *Felis catus*, the domestic cat as we know it, probably began around 10,000 years ago. It is descended from the African wild cat (*Felis silvestris lybica*), a solitary carnivore (Driscoll et al., 2007). To benefit from the surfeit of prey represented by the influx of rodents around early human farming settlements, wildcats needed to adapt their solitary behaviour. Cats more able to tolerate humans and other cats are likely to have exploited this opportunity, reproducing and passing on this (inter- and intra-specific) tolerance of other individuals to their descendants. This would have enabled the development of the species as we know it, with a social organisation that could adjust to different environmental conditions. Although, where resources are dispersed, stray and/or feral cats will lead largely solitary lives, they will also live in groups when food sources in a location are sufficient to meet the needs of multiple individuals.

2.1.2 Kitten reproduction and development

Cats reproduce seasonally. Females come into heat in spring, with the increase in daylight hours.

Several males may engage in intense fighting for access to a female in oestrus. Once fertilisation has taken place, the male rarely stays close to the female. She may then be fertilised again by one or more other males.

Gestation lasts between 60 and 68 days. A female can give birth to 1 to 6 kittens per litter. Up to two weeks old, the kittens are highly dependent on their mother, as they are born with their eyes closed and with poor hearing, are unable to eliminate on their own, and

cannot regulate their body temperature, despite being covered in downy fur. Their eyes open between 2 and 3 weeks of age. The kittens then respond to visual and auditory stimuli, start to walk and develop their first play behaviours. During the sensitive period for environmental learning, between 2 and 7 weeks of age, young kittens will ideally be exposed to the various stimuli (living creatures, objects, sounds, etc.) that they will encounter throughout their lives, in order to limit or even avoid possible stress from these stimuli in adulthood.

The different stages of a kitten's development are summarised in the *Table 1*.

Table 1. The development of domestic kittens (after Weiss, 2015, data from Beaver 2003)

Age (weeks)	Behavioural characteristics
0 - 2	Mainly suckling Temperature regulation develops
2 - 3	Eyes open Respond to sound and visual stimulation Crawling and walking First signs of play behaviour
3 - 4	Greater mobility Leave the sleeping area to eliminate Social play begins
5 - 6	Weaning begins Respond to threats with piloerection (puffing up fur)
6 - 8	Playing with an object Competition between litter mates Predatory learning

2.1.3 Feeding and watering

Wild cats eat several small meals a day, depending on the success of their predatory actions. To best meet the dietary needs of domestic cats, who have retained this characteristic, they need to be given access to small meals several times a day.

As food-seeking behaviour accounts for a significant proportion of a cat's activity time, it is recommended that domestic cats, particularly those without access to the outdoors, should have access to similar activities.

Cats must have access to fresh, clean water at all times.

2.1.4 Need for and use of space

The extent of the home ranges of stray or feral cats varies enormously between individuals, depending in particular on the availability of resources. As an indication, home ranges reported in the literature vary from 0.1 to 990 ha, depending on the study (Parker, 2018). Several studies have noted that the extent of home ranges varies according to the season or the individual. With regard to the variation between individuals, cats who are fed and supported by humans have smaller home ranges than those who are not, especially where weather conditions are unfavourable (Forin-Wiart, 2014). In general, home ranges are created around the point of food distribution (Parker, 2018). Most studies record larger average home ranges for male cats than females, although several studies find no significant difference. The size of male home ranges is thought to be influenced mainly by the distribution of receptive females and the availability of food resources, while that of female home ranges is thought to be influenced more by the availability of resources (Pillay et al., 2018).

Several cats may have overlapping home ranges. Areas of overlapping home ranges can vary from 0.7 to 15 ha (Parker, 2018).

Cats' home ranges need to be considered in three dimensions. Cats use vertical space for resting places or observation points for hunting. As predators, cats use their ability to climb and scale to observe their environment from high points where they are less easily detected by prey, potential predators and competitors.

In addition, the use of new technologies (e.g. trackers) makes it possible to establish the time budgets of a freely moving individual, tracking its activities (feeding, resting, travelling, etc.) across time and space. The spatio-temporal distribution of behaviours (or actio-spatiality) thus obtained enables the identification of zones that are specific to each behaviour and that vary (e.g. according to season) within a cat's home range (Forin-Wiart, 2019). These studies highlight the importance for cats of the use of specific places to express their behaviours.

2.2 Sensory perceptions

2.2.1 Vision

Cats' eyes are located at the front of their heads, giving them binocular vision and good depth perception. This ability is essential for targeting prey, climbing, jumping and walking edges. Their whiskers and vibrissae (see below) complement their sight by enabling them to spot targets at close range. They also have good peripheral vision, helping them to detect the motion of prey or possible danger moving in from the side.

Cats are able to adapt well to different light levels, with pupils that can contract or open very wide and a high density of rods in their retinas. They are particularly well-adapted to night vision thanks to the *tapetum lucidum* lying just behind the retina, which acts like a light-reflecting mirror and increases their sensitivity to low light levels (Walls, 1942), enabling them to hunt at dusk and at night. On the other hand, the low density of cones in their retinas limits their visual acuity and colour perception. Red, in particular, is not perceived by cats.

2.2.2 Hearing

Cats have a particularly wide hearing spectrum, being able to hear sounds between 20 and 80,000 Hz (by way of comparison, the human hearing spectrum is between 31 and 17,600 Hz). These frequencies extend to the ultrasonic vocalisations of rodents (above 20,000 Hz), making it easy for cats to hear their prey. They also have the ability to rotate their auricles independently of each other, making it easy to distinguish the origin of the sounds they perceive.

2.2.3 Odorat

Cats have numerous olfactory receptors in the olfactory mucosa of their nasal cavities, as well as a vomeronasal organ in the roof of their mouths, enabling them to capture odours and pheromones.

Cats are also thought to release odours via the sebaceous glands located on their faces, paws and ano-genital areas using the odours they give off to discriminate between other cats. They are also thought to mark conspecifics or humans with their own scent by rubbing their faces against the individuals in question (behaviour known as *allorubbing*), which would then enable them to discriminate between familiar and unfamiliar individuals.

2.2.4 Touch

A cat's whiskers, or vibrissae, are thought to play an important role in its sense of touch. Its facial whiskers may enable the cat to partially compensate for its less precise near vision, by detecting elements close to its face, particularly in dark and/or cluttered areas, thus protecting its eyes and other parts of its face. Meanwhile, the vibrissae on its forearms and paws may play a role in a cat's hunting behaviour, helping it to hold, bite and kill its prey, and could also help it to climb.

2.2.5 Taste

Cats do not perceive sweetness, they show an aversion to bitter and acidic tastes, and an attraction to umami (McGrane et al., 2023). When they are given the same food over a period of time, it has been observed that they may lose interest in it. This characteristic varies from one cat to another: some cats prefer a greater diversity of foods and flavours, while others are highly susceptible to neophobia and prefer a diet with little variation.

2.3 Emotional sensitivity: expressing and measuring stress

The most commonly-used system to indicate stress in cats is the Cat Stress Score (CSS) established by Kessler & Turner in 1997, itself based on McCune's Cat-Assessment-Score (1994). This system indicates 7 levels of stress ranging from 'fully relaxed' (Level 1) to 'terrified' (Level 7). Each level is assigned to an individual based on behavioural markers (posture, position of limbs, vocalisation, activity, etc.). The behavioural markers for each stress level are listed in *Appendix 4*.

Unless otherwise stated, the following discussion of the CSS is based on the contents of the review conducted by Vojtkovska et al. (2020).

Although the CSS is widely used to assess stress levels in the scientific literature because it is minimally invasive, inexpensive and easy to use, it has a number of limitations that need to be borne in mind if informed conclusions are to be reached concerning the results reported in *Section 3* of this report (*Answer to the question*).

A first common criticism of the CSS concerns **the reliability of the behaviours observed** for attributing stress levels to individuals. For example, low activity is associated with a low stress level, except at Level 7, when a cat produces all the fear signals. A cat showing a reduction in activity and a reduction in the expression of normal behaviours may be assessed as being calm and contented when it might equally be stressed, frustrated or resigned. Similarly, all sleeping cats will score low, despite their actual emotional state. Conversely, certain behaviours may be assigned high stress levels when the individual expressing them may not in fact be stressed. For example, cats in oestrus produce vocalisations that could be classified as stress vocalisations. CSS results can also be influenced by parameters other than stress (age, sex, sterilisation), and have been demonstrated to differ according to an animal's temperament: shy cats have a higher CSS than more adventurous cats (J. J. Ellis et al., 2021).

The CSS observation protocol is also subject to question. The test's authors indicate that it **cannot be used below 15°C** because the cats would be too cold to express the behaviours required to assign the 'fully relaxed' score. Further, the **recommended**

observation times are too brief (15 minutes) to obtain a true picture of the behaviours expressed by an individual. It is therefore recommended that CSS observations should be carried out over several days and at several different time points over the day. With regard to the latter, scores have been reported to be higher in the morning than in the afternoon. Finally, many people feel that the scoring scale lacks precision. There is no certainty, for example, that the differences in stress between the different scores are equivalent. Thus, a reduction in stress from level 2 to level 1 does not necessarily represent the same reduction as that from level 4 to level 3. Nor does the system allow an intermediate score to be assigned between two stress levels in cases where the individual exhibits behaviours associated with both levels. Last, the CSS does not allow a distinction to be made between a cat that is genuinely asleep and one that is feigning sleep, even though the latter behaviour indicates stress in this species.

A last problem lies in the fact that the CSS is a subjective test, the reproducibility of which has not been demonstrated. The test's authors have indicated 90% reproducibility between trained observers, falling to 75% between untrained observers. It is probable that a combination of these factors has contributed to the fact that no correlation has been found between the CSS and physiological indicators of stress, such as the urinary cortisol/creatinine ratio or faecal cortisol levels.

The experts called upon by the FRCAW also noted the time that has passed since the establishment of this stress scoring system, which would benefit from being updated in the light of current knowledge. In general, most behavioural tests must be combined with physiological tests to be considered reliable indicators, and this is not the case for the CSS. Furthermore, the treatment of vocalisations, which serve as important indicators of stress in cats, would benefit from further refinement. The relationship between cats and humans should also be taken into account, as this too has an impact on stress levels in cats. Last, those consulted questioned the acceptability, in welfare terms, of a stress score of less than 3, although this was considered acceptable by the authors of the CSS.

2.4 Inter- and intra-specific interactions

2.4.1 Sociability in cats

As noted in *Section 2.1.1. Domestication*, strictly speaking, domestic cats are not social animals, but they can tolerate the presence of conspecifics and express social behaviour when resources (such as food and space) allow proximity between several individuals. This behavioural flexibility, which is strongly influenced by their behavioural development at a young age and by their experience, makes them a 'facultatively social' species, according to certain authors (Croney et al., 2023).

Domestic cats are often considered to be solitary animals, and this goes some way towards explaining the paucity of studies into their social behaviour. However, observation has shown that cats have preferences for certain conspecifics, with some individuals who live in groups spending more time together than could be explained by chance. This preference is thought to be influenced by kinship or familiarity between individuals and varies greatly from one individual to another (Croney et al., 2023).

Some authors also describe groups of cats in which related females share the care of the young (Overall & Dyer, 2005).

2.4.1.1 Communication and affiliative behaviour

Among the affiliative behaviours developed between cats familiar to each other, we can note mutual rubbing and grooming, resting or sleeping side by side, nose-to-nose contact, and holding the tail in an erect position, potentially with the tip of the tail pointing forward, when the two individuals approach each other (Croney et al., 2023). This tail carriage is often associated, in this situation, with a forward position of the ears. It should be noted that the position of the ears is a more important signal for determining the outcome of an interaction between two cats than an erectly held tail, the latter being used more in interactions with other species (Deputte et al., 2021).

Interacting cats can also produce sounds to communicate satisfaction or a positive emotional state, such as purring or other sounds emitted with a closed mouth (Beaver, 2003).

2.4.1.2 Agonistic behaviour

Given the choice, cats generally prefer to flee rather than engage in conflict. Aggressive behaviour may nevertheless be observed in certain cases, such as:

- During play sessions, mainly among kittens,
- To defend or access a resource or an area of interest,
- Between several males for access to a female in oestrus,
- In a pregnant female or one who has just given birth, in defence her litter,
- When a cat cannot express its aggression towards its intended target aggression is transferred to an accessible object,
- For cats in pain and/or suffering from illness, etc.

Among the visual signals used to increase the distance between two individuals, we can note a low tail position, a flattened body, ears back, an averted gaze, or even flight. When these signals fail to achieve their goal, threat signals may be expressed, such as an arched back, flattened ears, dilated pupils, an erect tail or piloerection.

The sounds that signal of threat or aggression tend to be produced with an open mouth, hissing or growling for example.

It should be noted that agonistic interactions between cats are frequently observed in multi-cat households. Several studies based on surveys of owners of several cats have reported high rates of conflict between cats when a new cat is introduced into the household (50%) or as an everyday occurrence (44%) (Croney et al., 2023).

2.4.2 Human/cat relationship

Pet cats can form close and complex relationships with humans. It has been shown, for example, that cats are attentive to human cues such as gestures or glances towards a place to find hidden food. When given the choice, cats also spend more time with attentive humans than inattentive ones (Croney et al., 2023).

This particular attention paid to humans may be linked to the fact that a cat's behaviour directed towards humans influences the latter's understanding of its needs, creating a virtuous circle that can contribute to improved welfare (Croney et al., 2023). For example, it has been demonstrated that humans can distinguish between cat purrs made to obtain food and other types of purrs. Cats have therefore developed modes of communication specific to their interactions with humans. For example, cat meows are generally directed at humans, whereas they are very rarely directed at other cats. Other types of affiliative behaviour towards humans can also be observed, such as the rubbing of the body against the legs of humans, or the raising of the tail, for example (Deputte et al., 2021).

In short, people who are familiar with cats are better able to understand their needs by interpreting their signals than those who are not. Similarly, cats adjust their communication with humans according to their degree of familiarity with them.

Because of the close relationships that cats can form with humans, it has been shown that cats that are highly dependent on the presence of humans can experience anxiety in the absence of human interaction (Croney et al., 2023).

2.5 Adapting a cat's environment to its needs

The contents of the above sections highlight the behavioural flexibility of cats and their ability to adapt to different physical and social environments. However, certain environmental parameters are essential for cats, not only as an aid to adaptation, but also as the necessary conditions for them to express the behaviours typical of their species without constraint, and to experience positive emotions.

The guidelines provided by Ellis et al. (2013) for a cat's environmental needs in order to maximise its welfare in confined spaces are based on five pillars. The experts consulted by the FRCAW considered it appropriate for these pillars to be developed in respect of the question to be addressed in this report.

Accordingly, this report refers to the following, revised version of the 5 pillars proposed by Ellis to meet the environmental needs of every cat:

1. Provide a *safe place*, in which the cat is protected and cannot be disturbed;
2. Provide free access to *multiple and separated key environmental resources*, such as food, water, toileting areas, scratching areas, play areas and resting or sleeping areas;
3. Provide opportunity for play and predatory behaviour;
4. Provide positive, consistent and predictable human-cat social interaction;
5. Provide a varied and appropriate sensory environment, but avoiding overload.[1]

The different pillars, along with examples of what their provision might look like, are described and developed in the following sub-sections.

2.5.1 Pillar 1 - A safe place

The concept of a '*safe place*' focuses on the importance of providing cats with one or more havens or spaces to retreat to and feel secure. Such spaces allow them to relax, rest and hide if need be. In them, cats can feel protected and safe from potential threats. They may be either high perches (such as a shelf or cat tree) or ground-level hiding places (such as a box or space under a piece of furniture), providing that the space is easily accessible, comfortable and in a quiet location.

This type of space is particularly important in multi-cat households or in environments where the cat may feel threatened, such as catteries, veterinary practices or hospital cages, or more generally in any place that is unfamiliar.

2.5.2 Pillar 2 - Free access to key resources in a cat's environment

Ensuring safe, non-competitive access to key resources such as food, water, litter boxes, resting areas and scratching posts is essential for the physical and mental well-being of cats. In multi-cat households in particular, this helps to limit conflicts over resources that can lead to stress, frustration and/or anxiety.

The resources must be available in sufficient quantity for all the cats in the household, thus reducing competition. They must also be easily accessible and sufficiently far apart for each cat to be able to access them without being confronted by a fellow cat.

[1] This final pillar is a modified version of Ellis et al. (2013)'s fifth pillar, taking into account the suggestions of those consulted by the FRCAW. Here, the pillar as originally formulated: 'Provide an environment that respects the importance of the cat's sense of smell', was considered too restrictive.

2.5.3 Pillar 3 - Opportunity for play and predatory behaviour

This third pillar emphasises the importance of providing cats with stimulation and activities that allow them to express their natural hunting and play behaviours, particularly where the cats do not have free access to the outdoors. This helps prevent boredom and promotes good physical and mental health through exercise.

Activities should be varied to keep the cat's interest, and physically and mentally stimulating. Involving humans in this type of activity can also have a positive effect, as it can strengthen the bond between humans and cats.

This pillar can involve, for example, providing toys that mimic prey (mice, toys with feathers, etc.) and encourage chasing and catching behaviour, using fishing rods or pulling toys to stimulate interaction and physical activity, or providing structures such as cat trees, tunnels or runs offering opportunities to climb, hide and scratch.

2.5.4 Pillar 4 - Positive, regular and predictable human-cat social interaction

As explained in *section 2.4.2 0*of this report, cats can form strong relationships with humans. Accordingly, positive, regular and predictable inter-specific interactions contribute to the welfare of cats by strengthening their relationship with humans, on condition that such interactions are not imposed and respect the preferences of each individual.

If a cat shows signs of positive emotions and a willingness to interact with a human, petting, play and vocal communication can help maintain a good relationship between cat and human.

In multi-cat households, human-cat interactions must be considered as resources and provided to each cat in an equitable manner, respecting the preferences of each individual.

2.5.5 Pillar 5 - A varied and appropriate sensory environment, but avoiding overload

As explained in *section 2.2* of this report, cats' perception of their environment does not resemble that of humans. It depends in particular on the individual's sensory sensitivity, which therefore plays an important role in cat welfare (according to the definition of animal welfare provided by the Anses, 2018).

It is therefore essential to provide cats with a calm, stable living space, avoiding loud noises, sudden movements and strong smells that could disturb them. Finally, changes in

the cat's environment should, as far as possible, be gradual, so as not to overload them with new stimuli.

3 Answer to the question

Having followed the methodology described in *Section 1.3* of this report, the answers to the various sub-questions established by the FRCAW are detailed in the sub-sections below. For ease of reading, supplementary information concerning the experimental protocols used in the articles cited in this section is provided in *Appendix 5*.

3.1 Group accommodation for cats

Sub-question dealt with in this section:

In view of the impact on their welfare, is there any scientific evidence to suggest that cats should nout be housed in **groups** in a space providing less than 2 m^2 of ground-level floor space per cat, **even for two weeks or less**?

3.1.1 Results of the literature review

3.1.1.1 Publications in the corpus directly addressing this question

Within the corpus selected by the working group, only one publication examines the impact on cat welfare of group housing in less than 2 m^2 per cat **for two weeks and 3 days** (Loberg & Lundmark, 2016). The authors note the following consequences:

+ Cats expressed **more**[2] **behaviours associated with a positive emotional state** (licking of conspecifics, body-to-body contact with conspecifics, general activity) **in an available space of 4 m^2 per cat** than in an available space of 2 m^2 per cat. The authors attribute these differences in behaviour to the **better control of the environment and wider choice of activities** made possible by the floor area provision of 4 m^2 per cat.
+ The cats expressed **more individual play behaviours**[3] (behaviours associated by the authors with positive welfare) in **an available space of 4 m^2 per cat** than in an available space of 1 m^2 per cat.

No difference was found in the cats' stress scores (Cat-Stress-Score, CSS) between the different floor areas provided (1 m^2, 2 m^2, and 4 m^2 per cat); the CSS varied between 1 and 4, with a median of 2 for all areas. It should be noted that the same facilities and

[2] Difference observed to occur in the afternoon ($p < 0.05$)
[3] Difference observed to occur in the afternoon ($p < 0.05$)

resources were available to each test group (provision for 15 cats: 7 wall perches, 1 floor-level surface with 9 compartments, 3 cat trees with several perches and hiding places at different heights, 4 benches, 2 cat carriers on the ground, 1 space enclosed by wire mesh for the observer that the cats could climb and rest on, toys, 9 bowls of water, 15 bowls of food, 8 litter trays).

3.1.1.2 Additional information provided in the corpus

In a study that observed cats in shelters over periods of up to several months, **levels of stress in the cats were strongly and positively correlated with the space available per cat** ($n = 63$, $r = 0.80$, $p < 0.001$). The Cat-Stress-Score (CSS)[4] of 'weakly tense' (score of 3/7), considered acceptable by the authors, was achieved with a minimum accommodation size of 1.67 m^2 per cat (Kessler & Turner, 1999a).

A second study, also observing cats in groups in shelters and catteries, showed a **significant association between the available space per cat and faecal concentrations of cortisol metabolites** (FCM). It found that cats housed in pens with less than 1.67 m^2 of floor space per cat had a higher average faecal concentration of cortisol metabolites than cats housed in pens of 1.67 to 3 m^2 per cat, as well as those housed in pens of more than 3 m^2 per cat (44.71 ng/g, 34.687 ng/g, and 28.13 ng/g respectively; $K = 8.2$; $p = 0.0166$). Since the faecal concentration of cortisol metabolites is a stress indicator, the authors conclude that **increasing the floor area per cat reduces stress in individuals** (Blasco et al., 2021). The FRCAW notes, however, that the cats' FCM baselines were not provided in the publication, making it impossible to state with certainty that the recorded FCM levels corresponded to stress in the individual cats.

It should be noted that some practical guides for housing cats in confined spaces recommend providing more floor space per cat when housed in groups than when housed individually, to avoid conflict (Wagner et al., 2018). This could be to take account of the lack of separation in group housing to delimit individual spaces (Weiss, 2015). Some guides even recommend that, where several cats are housed, the enclosures should allow the cats to be separated by at least 3 metres from each other (Rochlitz, 2005; Weiss, 2015).

As a point of information, the Walloon Government Decree of 24 November 2022 (Belgium), containing the conditions for authorisation of animal establishments and the keeping and marketing animals in such establishments, stipulates a minimum floor area of 3 m^2 for one or two cats, and a minimum ceiling height of 1.8 m. The decree goes on to stipulate a minimum of 1.5 m^2 for each additional cat, requiring, for example. 6 m^2 for 4 cats.

Switzerland, through its Animal Protection Ordinance, goes a little further in its specifications, requiring a minimum height of 2 m for all cat accommodation and a

[4] Cf. 2.3 Emotional sensitivity: expressing and measuring stress

minimum floor space of 7 m^2 for 1 to 4 cats. For more than 4 cats, the minimum floor space is 1.7 m^2 for each additional cat. The Swiss regulations also stipulate that the length/width ratio of the floor area must not exceed 2:1.

In its Proposal for a Regulation of the European Parliament and of the Council on the Welfare of Dogs and Cats and their Traceability (2023), the European Commission stipulates a minimum floor area for a cat of 4 m^2, and a minimum height of 1.8 m. The proposed regulation then stipulates a minimum floor area of 2 m^2 for each additional cat.

The FRCAW notes that there is a strong probability that the above regulations have made use of the only available studies of the impact of floor area on the welfare of cats to establish their minimum areas per cat, i.e. those of Loberg & Lundmark (2016) (cited in particular by the EFSA (2023)) and Kessler & Turner (1999a).

3.1.2 Conclusion and recommendation of the FRCAW

With regard to Kessler and Turner's CSS (1997), which is used by several publications to assess cat stress levels, the experts consulted for the present report are of the view that it is likely that some of the behaviours giving a stress score of 3 may, in light of current knowledge, be associated with a state of deleterious stress. This score and the criteria for assigning it should be reviewed in the light of current knowledge (cf. *2.3*). Thus, whereas it would seem indisputable that housing cats in an available space of 1.67 m^2 or less induces stress in the animals, there is still no certainty that a slightly larger surface area will be sufficient in terms of its impact on cat welfare, especially since housing parameters other than floor area can influence this (cf. *3.4*).

In response to the sub-question at the beginning of this section, the FRCAW concludes that elements in the literature suggest that group housing cats in an available space of less than 2 m^2 of floor space per cat, even for two weeks or less, has a negative impact on their welfare, but they do not allow this to be stated with certainty. Despite this uncertainty, it is the view of the experts called upon by the FRCAW that such a limited floor area cannot allow cats to express the diversity of behaviours necessary for their welfare. Additionally, the proximity of congeners imposed by this floor area may restrict their access to resources and to a safe place (cf.*2.5.1*).

Recommendation

The committee of experts considers it to be highly probable to almost certain (degree of certainty estimated at over 90%) that housing cats in groups in an available floor space of less than 2 m^2 per cat at ground level, even for two weeks or less, has a negative impact on their welfare. They should therefore not be housed under such conditions, to ensure that their welfare is not negatively impacted.

3.2 Accommodation for single-housed cats

Sub-question dealt with in this section:

In the view of the impact on their welfare, is there any scientific evidence to suggest that cats should not be kept **alone** in enclosures measuring less than 2 m^2 at ground level, **even for two weeks or less**?

3.2.1 Results of the literature review

3.2.1.1 Publications in the corpus directly addressing this question

Within the selected bibliographical corpus, all publications reporting on the impact "of the size of individual housing on cat welfare focus on cats housed in cages with an area that ranges from 0.5 m^2 to 1.1 m^2, and heights generally between 0.5 and 0.8 m. No publication studies the impact on cat welfare of being housed alone with a ground area of between 1.1 m^2 and 2 m^2 for two weeks or less.

3.2.1.2 Additional information provided in the corpus

With regard to the housing of cats in individual cages, various studies suggest that this type of housing is detrimental to the cats' welfare in both the short and long term. In particular, the working group has noted the following information in the literature:

- After 1, 2 and 6 days in a cage, cats housed in a floor area of **1 m^2 had a significantly lower stress score (CSS) than those housed in an area of 0.7 m^2** (for the three periods respectively $z = -2.5$, $p < 0.05$; $z = -2.3$, $p < 0.05$; $z = -2.2$, $p < 0.05$). Throughout the observation period, the average CSS for both cats housed in an area of 0.7 m^2 and cats housed in an area of 1 m^2 was nevertheless **greater than 3** (Kessler & Turner, 1999a).

- The EFSA (2023) takes the view that keeping cats permanently in boxes, crates and cages (with an area of 1 m^2 or less and with a maximum height of 0.76 m) is detrimental to their welfare. The EFSA therefore recommends that cats should **not be kept permanently in boxes, crates or cages**, whether or not they have more than one level.
- One study reported that spending 10 minutes each day outside the individual cage (floor space = 0.58 m^2, height = 0.71 m) in a 4 m space^2 , combined with behavioural enrichment (clicker training) over the first 10 days in the shelter, improved the emotional state of the cats and significantly reduced ($p < 0.0001$) the risk of upper respiratory tract disease in cats that displayed frustration behaviours in a shelter (Gourkow & Phillips, 2016).

We may note that Switzerland, through its Animal Protection Ordinance, requires a minimum overall surface area of 1 m^2 for individual cages, with a minimum ground area of 0.5 m^2 and a maximum of 3 levels. Individual cages must also be at least 1 m high, with at least 35% of the surface area above the cage floor. In addition, the Swiss regulations stipulate that cats must not occupy this type of accommodation for more than 3 weeks, and that during any stay under these conditions, cats must be able to exercise outside the cage for at least 5 days a week. A space of **7 m^2** must be available for this purpose.

3.2.2 Conclusion and recommendation of the FRCAW

In answer to the above sub-question, there is consensus across all publications in the corpus that the housing of cats in restricted spaces of less than 1.1 m^2 (enclosures, cages, or transport crates) has a negative impact on their welfare (high stress score, restriction of movement, increased frustration, etc.), even during the first 10 days of any stay. Furthermore, the experts consulted for the present study are of the view that, given the ethological needs of cats, housing them in an area of less than 2 m^2, even for just two weeks, would reduce their welfare in a similar way to housing them in an area of 1.1 m^2 or less (restriction of movement, reduced behavioural diversity, frustration, etc.).

Recommendation

The committee of experts considers it to be probable to almost certain (degree of certainty estimated at more than 66%) that housing cats alone in a space with a ground area of 2 m^2, even for two weeks or less, has a negative impact on their welfare. They should therefore not be housed under such conditions, to ensure that their welfare is not negatively impacted.

3.3 Link between impact on welfare and length of time spent in confined conditions

Sub-question dealt with in this section:

Is there any scientific evidence to suggest that the welfare impact of accommodation measuring less than 2 m^2 at ground level per cat **increases with the length of time** spent under these conditions?

3.3.1 Results of the literature review

3.3.1.1 Publications in the corpus directly addressing this question

Within the body of literature studied, there is no publication that specifically studies the consequences over time on the welfare of cats housed in a ground area of less than 2 m^2 per cat. That said, several articles in the selected corpus investigate changes that occur over time in the general condition of cats in shelters (taking all parameters into account) or subsequent changes to the level of acute stress experienced by cats on admission to a shelter.

3.3.1.2 Additional information provided in the corpus

On the matter of **the habituation of cats to** shelter **conditions**, there is consensus in the literature that cats experience a reduction in acute stress in the days following their introduction to accommodation in a confined space (the length of time varies according to housing conditions and the cats tested). The working group notes the following, in particular:

+ In the study by Kessler and Turner (1997), cats that had recently arrived in shelters (with variable housing sizes: 0.9 m^2 + 2.25 m^2 (indoor + outdoor) for 1 or 2 cats, and 5.52 m^2 + 12.76 m^2 for 6 to 8 cats) had for the most part (around two thirds) become accustomed (significant drop in CSS) to the conditions in the shelter after **5 days for cats housed alone** and after **4 days for cats housed in pairs or groups.** However, the stress levels of these two groups of cats were **higher after two weeks than those of the control group of cats, who had spent longer at the shelter**. **For 4%** of the cats in these two groups, **no fall in CSS was observed in the two weeks following their introduction to the shelter**.
+ Similarly, in a study investigating the impact of the availability of hiding places on the stress levels of cats housed in cages, the authors observed a **significant reduction in CSS in all cats in the course of the time spent in a shelter**. However, this reduction occurred far more quickly in cats provided with hiding places (on

Day 2) compared with those without hiding places (on Day 9) (Van Der Leij et al., 2019).

+ A second study on cats housed alone in cages produced similar results: on average, the cats showed **less stress** (better diet ($p < 0.0001$), less immobility ($p < 0.0001$), more rest ($p < 0.0001$), more elimination within the litter box rather than outside it ($p < 0.0001$), etc.) **from their 2nd day in a confined space**. This was all the more rapid if the cage was enriched (addition of a 'Hide, Perch & Go' box consisting of a hiding place and an elevated space with bedding, and addition of 1.5 cm of depth to the litter) and the environment was 'well managed' (minimal disturbance by staff, absence of barking or other noise, constant and regular care routine) (J. L. Stella et al., 2017).
+ Last, a review of the impact of social and environmental factors on the welfare of indoor cats has also indicated a **consensus in the literature on a drop in CSS to a stable and, according to the authors, 'acceptable' level between 3 and 5 days after the introduction of the cats to a confined space**. The authors nevertheless point out that **chronic stress, developed over a long period of time in stressful conditions, may have more negative consequences for cat welfare than acute stress** (Foreman-Worsley & Farnworth, 2019).

Turning to **the long-term evolution** of cat welfare in confined spaces, several studies have observed a general deterioration in the condition of the cats the longer they spend in shelters. The working group has noted the following information in particular:

+ For a median length of stay of **40 days** (with lengths of stay ranging from 1 to 186 days), **signs of deterioration were observed with regard to at least one health indicator** in 41% of the cats studied, these being housed as a single large group in a shelter (Vojtkovská et al., 2021).
+ Similarly, another study assessing housing conditions and the state of cat welfare in 30 shelters (median space per cat = 3.3 m^2 and minimum space per cat = 1.7 m^2), found **a significant positive correlation between the percentage of cats whose coats were in poor condition and the average length of stay in the shelter** ($r_s = 0.46$, $p < 0.05$) (Arhant et al., 2015).
+ In a shelter where the various enclosures provided available spaces of between 1.29 m^2 and 2.29 m^2 per cat when full (i.e. at maximum accommodation capacity), individuals who had been **resident at the shelter for more than 7 years spent significantly more time in a state of inactivity** (compared with cats resident for 1 to 6 years only, $p = 0.01$) **and in agonistic interactions** ($p = 0.03$ and $p = 0.01$). Conversely, they spent significantly less time eating ($p = 0.019$ and $p = 0.041$) than cats having spent less time at the shelter (under a year and 1 to 6 years respectively) (Gouveia et al., 2011).

Last, in its Opinion on the welfare of dogs and cats, the EFSA (2023) states that accommodation in small spaces has the same negative consequences on cat welfare in both the short and long terms, particularly relating to fear, anxiety and boredom.

3.3.2 Conclusion and recommendation of the FRCAW

There is some evidence in the literature to suggest that the longer a cat stays in accommodation with less than 2 m^2 ground area per cat, the more its welfare is affected, although it is not possible to state this with certainty.

In particular, in the light of the literature studied, it appears that, whereas acute stress decreases in the majority of cats in the first few days after their introduction to accommodation with less than 2 m^2 available floor space per cat (on condition that the enrichment necessary for their adaptation is provided), some cats never become accustomed to these housing conditions. What is more, even cats that adapt to these living conditions and no longer express acute stress may tend to develop chronic stress, potentially caused by the limited available space, this being insufficient for them to express their full behavioural repertoire. This reduction in welfare can be observed in particular through the deterioration of an animal's health or coat, by learned helplessness (inactivity), or by agonistic interactions (aggression or avoidance) with conspecifics.

Recommendation

The expert panel considers it to be highly probable to almost certain (degree of certainty estimated at more than 90%) that the adverse effects on cat welfare of accommodation providing less than 2 m^2 ground area per cat (as noted in Sections 3.1.2 and 3.2.2, involving restriction of movement, reduced behavioural diversity, frustration, etc.) increase with the length of time spent under these conditions. Cats should therefore not be permanently housed in these conditions, whether alone or in groups, to ensure that their welfare is not negatively impacted.

3.4 Other housing parameters

Sub-question dealt with in this section:

Is there any scientific evidence to suggest that **housing parameters** other than floor space could affect the welfare of cats in enclosures?

3.4.1 Results of the literature review

Analysis of the scientific literature highlights the complexity of the potential interactions between housing factors and their impacts on cat welfare. Drawing on the reviews and articles studied, which mainly addressed shelter accommodation, the working group notes

that, in addition to the size of the accommodation, the parameters found in this section can have negative impacts on cat welfare.

3.4.1.1 Sensory and/or cognitive disruption

Over 2 days of observation of cats housed in cages with a floor area of 1.1 m^2 and a height of 1.5m, **more affiliative and maintenance behaviours and fewer avoidant behaviours** (suggesting a better emotional state) were observed in cats in a **'managed'** environment (minimal disturbance by staff, no barking or other noise, constant and regular care routine) compared with cats in an 'unmanaged' environment (significant differences observed in 4 of the 9 observation windows: 2 and 4pm on the first day and 11am and 3pm on the second). Furthermore, cats in 'managed' environments appeared to **adapt more quickly** (significantly fewer cats were concealed on the second day compared to the first, $p = 0.005$) than cats in 'unmanaged' environments. (J. L. Stella et al., 2017).

A review article examining ways to improve the welfare of cats in shelters recommends the **addition of sensory enrichments,** such as scents to encourage cats to detect or deposit olfactory cues (cf.*2.5.5*), auditory stimuli (music for example) to increase environmental observation and approach behaviour (important natural behaviours in cats), or **food enrichment** to increase foraging and exploration behaviour (Houser & Vitale, 2022). The beneficial effects of food enrichment on the welfare of cats is evidenced by several other publications (Ellis et al., 2013; Stella et al., 2017).

In particular, the expert committee notes that, of the various factors considered in this section, the provision of a **regular and consistent care routine** plays a fundamental role in cat welfare.

3.4.1.2 Physical enrichment (perches, hiding places, toys, etc.)

The literature is in agreement on the benefits for cat welfare of providing physical enrichment, when provided in sufficient quantity and quality (adequate size, position and access) (Foreman-Worsley & Farnworth, 2019).

Stella and colleagues (2017) observed more affiliative and maintenance behaviours (i.e. feeding, watering, grooming, resting, stretching, yawning, scratching, climbing) as well as fewer avoidant behaviours (suggesting a better emotional state) in cats housed in **enriched cages** (hiding place, perch, deeper litter) compared with cats in non-enriched environments (difference observed in 1 of the 9 observation windows, at 9am on the second day).

The CSS for cats housed alone in a **non-enriched cage** was observed to be **significantly higher** ($p < 0.001$) than for cats housed alone in **enriched cages** (provision of a platform with a towel to allow perching and hiding) between the 2nd and 9th days of observation (duration = 10 days) (Gourkow & Fraser, 2006).

A number of studies have stressed the benefits of **hiding places** for cat welfare (Lamon et al., 2023). The positive consequences include:

+ A **significant negative correlation between the proportion of very thin cats** (i.e. with a body condition score of 1, indicating poor welfare) **and the proportion of enclosures with hiding** and **resting areas** ($r = -0.54$, $p < 0.05$), for cats housed in shelters (Arhant et al., 2015).
+ **A significant reduction in the number of agonistic interactions** observed in a group of cats when a **visual barrier** is provided (screen separating two functional spaces from a perching shelf) (Desforges et al., 2016).
+ **Reduced stress** in cats (significant decrease in faecal glucocorticoid concentrations, significant increase in food intake and significant increase in weight gain) (Ellis et al., 2021).
+ **More rapid decline in cat CSS** over time (Foreman-Worsley & Farnworth, 2019).
+ **Faster adaptation** (significantly lower CSS from Day 2) to novel shelter conditions, and less pronounced (but not significant) weight loss than in cats without access to a hiding place (Van Der Leij et al., 2019).

Loberg and Lundmark (2016) recommend prioritising the **number of hiding places** over their size, since few cats use the hiding places simultaneously.

The benefits of **perching shelves, platforms and other raised structures** in providing cats with a complex and stimulating three-dimensional environment are also highlighted in the literature (Overall & Dyer, 2005; Jongman, 2007).

3.4.1.3 Access to outdoors

According to owners, **significantly more behavioural problems** were observed in cats with **no or partial access to the outdoors** than in those with free access to the outdoors, one study reports. The authors conclude that these behavioural problems could result from increased stress, insufficient mental stimulation and lack of physical activity (Sandøe et al., 2017).

The experts consulted for the present report noted that, while limited access to the outdoors (such as that generally provided in shelters) is very likely to be less beneficial for cat welfare than free access, it can still make a contribution to improving their welfare in confined spaces.

3.4.1.4 Enclosure design

Several reviews have pointed to the benefits of enlarging individual cat cages by installing a passage between two cages. This not only increases the space available for a given cat, but also creates separate its living spaces (water and food being separate from the litter tray, for example) (Janke et al., 2017; Wagner et al., 2018).

The experts consulted for the present report state that poorly designed enclosures are even more likely to have a negative impact on the welfare of cats housed in groups than on that of cats housed alone (over 90% and 66% certainty respectively). Indeed, the design of enclosures for groups of cats is particularly important to prevent some cats from blocking other cats' access to resources.

3.4.1.5 How cats interact with humans

Several reviews stress the importance of cats interacting with humans as a way to **reduce stress** in the cats and **increase their welfare** (Vitale & Udell, 2019; Houser & Vitale, 2022).

Lack of friendly human contact could be worse for cats abandoned by their owners than for strays and ferals (Rochlitz et al., 1998).

The working group also notes that this factor is taken into account by the Swiss regulations, which state that cats kept alone must have daily contact with humans or visual contact with other cats (Animal Protection Ordinance). The experts also point out that over and above the need for daily cat-human interactions, it is the quality of these interactions that is essential to improving cat welfare.

3.4.1.6 The presence of familiar or unfamiliar congeners

A **higher average CSS, more agonistic interactions, cats hiding more frequently**, and **less play and resting behaviour** were manifest to a significant degree in cats housed with **unfamiliar conspecifics** (approximately 4 m^2 available per cat) compared to cats housed alone or with familiar cats (between 1.5 and 4.5 m^2 per cat) (Ottway & Hawkins, 2003).

Cats housed in shelters in **related pairs** (same litter) express **significantly more affiliative behaviour** with each other than cats housed in unrelated pairs (Bradshaw & Hall, 1999).

3.4.1.7 Cat group size

Several scientific reviews note that there is no consensus in the literature on whether housing cats alone or in groups is more stressful (Finka et al., 2014; Foreman-Worsley & Farnworth, 2019).

With regard to group size, Finka and Foreman-Worsley's critical review (2022) concludes that studies dealing with the impact of group size on cat welfare use different experimental protocols, house cats under different conditions and carry out different forms of analysis. Indeed, no consistent relationship emerges between the size of the group of cats in confined housing and their state of welfare.

As an example, some authors recommend groups of 2 to 4 cats per enclosure (Weiss, 2015), while others recommend a limit of 4-6 individuals, with as few new introductions

as possible into the group (Finka et al., 2014). Still others set the maximum group size at 10 to 12 cats (Newbury et al., 2010).

3.4.2 Conclusion and recommendation of the FRCAW

There is a consensus in the scientific literature that the provision of physical enrichment (hiding places, perches and toys in particular) improves cat welfare. Although the impacts of the other housing parameters reviewed above (cf. *3.4.1*) are also recognised, the evidence available in the literature does not allow this to be stated with certainty.

On the basis of the information available in the literature, and on its knowledge of the physiology and ethology of the domestic cat, the expert committee considers it to be highly probable to almost certain (degree of certainty estimated at over 90%) that the **presence of sensory and/or cognitive disruptions**, **lack of physical enrichment**, **poorly designed enclosures** for **group-housed** cats, **poor-quality interactions with humans**, and/or **an excessively large group size** (greater than 12 **cats**) will have a negative impact on the welfare of cats in enclosures. Similarly, the experts consider that it is probable to almost certain (degree of certainty estimated at over 66%) that **lack of access to the outdoors**, **poorly designed enclosures** for **single-housed** cats, and the **presence of unfamiliar congeners** for group-housed cats, have a negative impact on the welfare of cats in enclosures.

Thus, while the provision of sufficient floor space to enable cats to express their entire behavioural repertoire is essential for their welfare, so is the proper management of the other environmental parameters mentioned in the above section. The complexity of the interactions between the factors inherent in enclosed housing makes it all the harder to assess the impact of available floor space in housing alone on cat welfare.

Provision of a minimum area of available floor space in cat accommodation must therefore be considered alongside other parameters. In particular, cats must be provided with hiding places, a complex and stimulating three-dimensional space, access to the outdoors if the layout permits, a well-designed and 'managed' enclosure and regular, positive interactions with humans. It is important that these elements should complement each other rather than be seen as alternatives, in light of the five pillars set out earlier in this report (cf. *2.5*).

Recommendation

On the basis of the information available in the literature and the knowledge of the experts consulted, the FRCAW recommends that, whatever the size of the accommodation and duration of stay, housing should include hiding places, a complex and stimulating three-dimensional space, access to the outdoors if the layout permits, good management (minimal disturbance, provision of a routine, etc.) and positive interactions with humans, so that the cats' welfare is not compromised. It should be noted that it is hard to envisage that all these features could be provided in a space with a floor area of less than 2 m^2. The FRCAW also recommends that more research be carried out solely on the consequences for cat welfare of the different floor areas available per cat for cat welfare.

3.5 Factors inherent in cats

Sub-question dealt with in this section:

Is there any scientific evidence to suggest that particular **factors inherent in cats** could affect their **ability to adapt to a restricted space**?

3.5.1 Results of the literature review

The scientific literature studied to answer the main question of the impact of housing conditions on cat welfare highlights the degree of individual variation in the ability of cats to adapt to a novel or confined environment. Based on the information available in the reviews and articles studied, the working group notes that the parameters listed in this section can affect a cat's ability to adapt to a confined space.

3.5.1.1 Tolerance of other cats (for group-housed cats)

The introduction into a group of cats of a cat that is unused to living in a group would be more stressful for all the individuals concerned than the introduction of a cat used to other cats. Indeed, when an individual with a low tolerance of other cats ('*unsocialized to conspecifics*') was introduced into a group of cats in a shelter, Kessler and Turner (1999b) recorded a significantly higher CSS for both the introduced cat and the other cats in the group when compared with the CSS when an individual accustomed to living in a group was introduced.

The ASPCA (American Society for the Prevention of Cruelty to Animals), for example, recommends that cats showing signs of social stress (e.g. aggressive cats, who hide

frequently, sit with their backs to the rest of the group, are not very active, or display litter box problems) should not be housed in groups, nor should unsocialised free-roaming cats (Weiss, 2015).

In line with the above information, the committee of experts considers that it is highly probable to almost certain (degree of certainty estimated at more than 90%) that an inability or limited ability to tolerate congeners has a negative impact on the ability of cats to adapt to a confined space, since the presence of congeners that are not tolerated, or only poorly so, acts as a stress factor for these animals.

3.5.1.2 Familiarisation with humans

Whether housed alone or in a group, **cats not familiar with humans were significantly more stressed** (higher CSS) than cats familiar with humans at the time of their introduction into confined housing (Kessler & Turner, 1999b). The committee of experts notes that cats housed in confinement have a high probability of interacting with humans. As a consequence, the experts consider it to be highly probable to almost certain (degree of certainty estimated at over 90%) that a lack of, or insufficient, familiarisation with humans impedes their ability to adapt to a confined space, with the presence of humans becoming a stress factor for these individuals.

3.5.1.3 Temperament[5]

Cats can **adapt to confinement in different ways depending on their temperament** (*personality traits*). In fact, in a study by Stella and Croney (2019), cats described by their owners as having a shy, calm and timid temperament hid more during the first 3 days of confinement (housed in a cage) and had longer latency to approach humans than cats described as active, playful and curious, who displayed more affiliative behaviour towards the experimenters, meowed and spent more time perching.

This same observation was made in another study carried out on cats housed in cages, in which cats assessed as shy using a *behavioural style* test spent significantly more time in their hiding box (on average 87.95% of their time compared with 75.95% of their time) and had a significantly higher CSS on the first 4 days than cats assessed as bold (Ellis et al., 2021).

The experts note that it is highly probable to almost certain (degree of certainty estimated at over 90%) that the temperament of cats has an impact on their ability to adapt to a confined space.

[5] Temperament is defined here as an individual's behavioural characteristics that are stable over time and across different situations.

3.5.1.4 Previous living conditions

In a study of cats housed in cages, **cats that had previously had an owner had a significantly higher CSS** during their first 3 days in the shelter than those found roaming (Dybdall et al., 2007). This higher CSS could be explained by a more intense state of stress, or by a more explicit expression of stress in these cats, due to their proximity to humans.

The experts believe that it is more likely than not (degree of certainty estimated at more than 50%) that cats' previous living conditions (whether or not they have been companion animals, and what space has been available to them) have an impact on their ability to adapt to a confined space. This greater uncertainty estimate is explained by the experts' view that, although a cat's ability to adapt varies according to its previous living conditions, it is difficult to attribute adaptability solely to this parameter. Temperament, lack of tolerance towards other cats and/or lack of familiarity with humans, for example, are confounding variables that may have a greater impact on a cat's ability to adapt to a restricted space.

3.5.1.5 Life stage

Based on the review by Wagner et al. (2018), **kittens are better able to live together in groups than adult cats**, especially if they are from the same litter.

It is, however, important that a cage should not be used to house kittens with their mother, as the latter would find it difficult to find the space needed to lie down comfortably to nurse her kittens. Moreover, the space in a cage is not sufficient for a mother and her kittens to exercise as much as is needed, nor is it enough for the mother to be able to withdraw from her kittens when she wishes, a situation that is detrimental to her welfare and to the proper development of the kittens (Weiss, 2015).

Last, cage housing appears to be particularly problematic for kitten development given the lack of opportunities to explore, play and socialise provided by this type of environment (Weiss, 2015).

The committee of experts believes that it is highly probable to almost certain (degree of certainty estimated at over 90%) that the ability of cats to adapt to a confined space varies according to their stage of life. This is explained in particular by a cat's need for stimulation and physical activity, these being generally less important to a 'senior' cat than to a young cat, for example.

3.5.1.6 Health status

Concerning the space requirements of cats as a function of their state of health, little information was found in the corpus selected.

For cats with osteoarthritis or orthopaedic injuries, however, the ASPCA recommends the addition of comfortable features to the accommodation rather than an increase in available space (Weiss, 2015).

The experts consulted in this report did not comment on the impact of poor health on a cat's ability to adapt to a restricted space. Nevertheless, they are of the view that it is highly probable to almost certain (degree of certainty estimated at over 90%) that a poor state of health (illness with symptoms) will affect the **need to adapt the space to the cat**. In fact, a cat in poor health should be able to be housed in particular accommodation that is adapted to its condition and may possibly have a smaller surface area than that for animals in good health. However, a sick cat will not necessarily adapt more easily to these housing conditions than a healthy cat.

3.5.1.7 Other parameters

The bibliographical evidence base established as detailed in Section *1.2* discussed no links between a cat's reproductive status or breed and its ability to adapt to a restricted space, since the focus of the works included was on the impact of density or available space on cat welfare. Nevertheless, almost all the articles consulted specified the breed and reproductive status of the cats studied in their research. Based on their experience and knowledge, the experts consulted believe that these parameters can have an impact on a cat's ability to adapt.

Indeed, the experts believe it to be probable to almost certain (degree of certainty estimated at over 66%) that a cat's breed influences its ability to adapt to a restricted space. Some breeds have temperament traits, a particular morphotype (smaller size, short legs, etc.), or a level of activity that makes it easier for them to adapt to restricted living conditions. Hence, while it is almost certain that the ability to adapt to a confined space is influenced by a cat's breed in some cases (such as Ragdoll, Bengal or Maine Coon), this is not as likely for all breeds, especially those that do not *a priori* have any particular space requirements (such as the European).

In the matter of reproductive status, the experts believe that it is very likely to almost certain (degree of certainty estimated at over 90%) that this affects a cat's ability to adapt to a confined space. In particular, uncastrated males, and females in heat are very likely to have greater difficulty adapting to a confined space than other cats.

3.5.2 Conclusion and recommendation of the FRCAW

The literature offers some evidence to suggest that several factors inherent in cats have an impact on their ability to adapt to a confined space, but it is not possible to state this with certainty.

On the basis of the information in the literature combined with their knowledge of the physiology and ethology of the domestic cat, the committee of experts considers that it is highly probable to almost certain (degree of certainty estimated at over 90%) that a cat's **inability or limited ability to tolerate other cats**, **lack of or inadequate familiarisation with humans**, **temperament**, **life stage** and **reproductive status** have an impact on its ability to adapt to a confined space. Similarly, the experts are of the view that it is probable to almost certain (degree of certainty estimated at over 66%) that a cat's **breed** has an impact on its ability to adapt to a restricted space. Last, the experts believe that it is more likely than not (degree of certainty estimated at over 50%) that a cat's **previous living conditions** (whether or not it has been a companion animal, previous space available) will affect its ability to adapt to a confined space. Regarding a cat's state of health, the experts consider that it is very likely to almost certain (degree of certainty estimated at over 90%) that a **poor state of health** (illness with symptoms) will require **adaptation of the space available to the cat**.

The FRCAW therefore concludes that a cat's individual characteristics (temperament, degree of tolerance towards other cats, degree of familiarity with humans, life stage, etc.) should ideally be considered before choosing the type of accommodation to be provided. In particular, in the case of group housing, the presence of cats with a low tolerance of other cats, unfamiliarity with humans and a fearful temperament all have the potential to increase the need for space and hiding places. To the best of the experts' knowledge, there is no agreed, single test for assessing a cat's temperament. However, Siegford et al. (2003), whose work focused exclusively on reactivity to humans, have provided a succinct characterisation of cat temperament. In the absence of a comprehensive and widely used temperament test, such a classification would appear difficult to carry out in practice. It is therefore preferable to provide floor space sufficient to accommodate inter-individual variability.

Kittens should also be given enough space to develop their behavioural repertoire, particularly during the sensitive period of their development (from 2 to 7 weeks of age).

Recommandation

On the basis of the information available in the literature and the knowledge of the experts consulted, the FRCAW recommends that the floor space provided for the housing of cats should take into account inter-individual variability, paying particular attention to the following individual traits – lack of or insufficient tolerance of other cats, the lack of or insufficient familiarisation with humans, temperament, life stage, reproductive status, breed, previous living conditions and state of health.

4 General conclusion

Interactions between the various environmental parameters and their impact on cat welfare are complex. It is therefore difficult to determine with any certainty which parameters most affect cat welfare, particularly given that the choice of environmental parameters varied from one study to another. Nevertheless, an increase in floor space is a good way to reduce stress in cats in a variety of contexts, not least because it allows them to increase their control over the environment. For example, the greater the available floor area, the easier it will be to provide enrichment elements (e.g. play equipment, hiding places, etc.) essential to the expression of the cats' specific behaviours, and the easier it will be for an individual to avoid conspecifics (in the case of for group-housed cats), to select its preferred areas where it can avoid other stressful stimuli, and to divide up the space. More generally, greater available space will encourage the expression of a wider variety of behaviours, including predominantly positive behaviours, which generate and indicate positive emotions.

Although the literature does not provide an answer precisely addressing the question posed, the results point towards the same conclusion: reducing floor area to less than 2 m^2 per cat negatively affects the cats' welfare in both the short and long term. However, an increase in floor space should not be seen as a guarantee in and of itself for the welfare of cats in captivity. Indeed, the literature also highlights the importance of providing hiding places, a complex and stimulating three-dimensional space, access to the outdoors, and regular interaction with humans. Factors inherent in cats, such as their temperament, tolerance of conspecifics and degree of familiarity with humans, should also be taken into account.

The FRCAW nevertheless recommends that further research be carried out to refine the recommendations on the amount of space required by cats in confinement, whether alone or in groups. This research should help achieve a better understanding of the interactions between the quantity and quality of the space provided for cats, and of the impact of these on their welfare. It should also clarify the evolution of these effects on a cat's welfare over time. In addition, the committee of experts noted, in particular, that vertical provision (i.e., the height the enclosures and their vertical layout), although important, was little discussed in the publications studied. As a consequence, this dimension is often not taken into account in the recommended minimum space requirements, whatever the type of accommodation. The FRCAW therefore recommends that vertical provision should be included when defining the minimum regulatory space requirements for cats. Further, raised areas and outdoor spaces are essential to cat welfare and should not therefore be used as a substitute for floor space when calculating and defining minimum areas for cats. Outdoor spaces in particular are beneficial for cats, provided that weather conditions allow comfortable use of the space, but this is not always the case. The minimum available surface area standards for cats should therefore relate solely to available area at ground level indoors.

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Appendix

Appendix 1. Pro forma completed by working group members for the analysis of scientific articles

Expert's Name	Publication reference	Cat alone or in a group	Size of group (where applicable)	Accommodation size in m^2 /cat	Total accommodation floor space in m^2	Attention to vertical space (and heights in meters where applicable)	Observed variable(s)	Results	Duration of study/observation (state which)	Behavioural changes over time (acclimatisation/habituation)	Factors that may affect space requirements (state of health, familiarity with humans, size of cat, age, temperament, sterilisation, other)

Appendix 2. Pro forma completed by the working group for the analysis of literature reviews

Expert's name	Journal reference	Impact of accommodation size on cat welfare	Specify any associated duration	Paper(s) source(s) of information noted in column C	Impact of the size of the group of cats on their welfare	Specify any associated duration	Paper(s) source(s) of information noted in column F	Impact of the height of the accommodation on the cats' welfare	Specify any associated duration	Paper(s) source(s) of information noted in column I	Concept of acclimatisation / habituation addressed? Consequences for cats, if any (length of adaptation time)	Specify any associated duration	Paper(s) source(s) of information noted in column L	Factors that may affect space requirements (state of health, familiarity with humans, size of cat, age, temperament, sterilisation, other)	Paper(s) source(s) of information noted in column O	Other items of interest

Appendix 3. Summary table of questions put to the experts to determine the uncertainty values associated with each answer

Sub-question	Question asked to assess uncertainty	Degree of certainty / expert				Consensus
		Expert 1	Expert 2	Expert 3	Expert 4	
In view of the impact on their welfare, is there any scientific evidence to suggest that cats should not be housed in **groups** in a space providing **less than 2 m^2 of ground-level floor space per cat, even for two weeks or less**?	Out of 100 cats housed in groups (optimum group size) in less than 2 m^2 of space per cat for two weeks, what is the probability that the welfare of 90 cats will be negatively impacted?	66-100	90-100	90-100	66-100	**90-100**
In view of the impact on their welfare, is there any scientific evidence to suggest that cats should not be kept **alone** in enclosures measuring **less than 2 m^2 at ground level, even for two weeks or less**?	Out of 100 cats housed alone in less than 2 m^2 of space per cat for two weeks, what is the probability that the welfare of 90 cats will be negatively impacted?	90-100	50-100	50-100	90-100	**66-100**
Is there any scientific evidence to suggest that the impact on cat welfare of accommodation measuring less than 2 m^2 at ground level per cat **increases with the length of time spent under these conditions**?	Out of 100 cats housed alone or in groups in less than 2 m^2 per cat, what is the probability that the welfare of 90 cats will deteriorate over time?	90-100	90-100	90-100	90-100	**90-100**
Is there any scientific evidence to suggest that **housing parameters other than floor area** could affect the welfare of cats in enclosures?	Out of 100 cats housed in a context of sensory and/or cognitive disruption (disturbances, surrounding barking and other loud noises, irregular and inconsistent care routine, no cognitive or sensory enrichment), what is the probability that the welfare of 90 cats will be negatively impacted?	90-100	50-100	90-100	90-100	**90-100**
	Out of 100 cats housed without physical enrichment (no perches, hiding places or toys), what is the probability that the welfare of 90 cats will be negatively impacted?	90-100	90-100	90-100	90-100	**90-100**

Sub-question	Question asked to assess uncertainty	Degree of certainty / expert				Consensus
		Expert 1	**Expert 2**	**Expert 3**	**Expert 4**	
Is there any scientific evidence to suggest that **housing parameters other than floor area** could affect the welfare of cats in enclosures?	Out of 100 cats housed without access to the outdoors ('catio' type enclosure, in a shelter), what is the probability that the welfare of 90 cats will be negatively impacted?	50-100	90-100	66-100	50-100	**66-100**
	Out of 100 cats housed in poorly designed enclosures, what is the probability that the welfare of 90 cats will be negatively impacted?	Alone: 50-100	66-100	66-100	66-100	**66-100**
		Group: 66-100	90-100	90-100	90-100	**90-100**
	Out of 100 cats housed in a way that produces poor quality interactions with humans, what is the probability that the welfare of 90 cats will be negatively impacted?	Alone: 90-100	90-100	90-100	90-100	**90-100**
		Group: 90-100	90-100	90-100	66-100	
	Out of 100 cats housed with unfamiliar congeners, what is the probability that the welfare of 90 cats will be negatively impacted?	66-100	90-100	66-100	66-100	**66-100**
	Out of 100 cats housed with too many other cats (more than 12), what is the probability that the welfare of 90 cats will be negatively impacted?	90-100	90-100	90-100	90-100	**90-100**
Is there any scientific evidence to suggest that particular **factors inherent in cats** could affect their **ability to adapt to a restricted space**?	Out of 100 cats, what is the probability that a lack of (or insufficient) tolerance towards other cats will have an impact on the ability of 90 cats to adapt to a confined space?	90-100	66-100	90-100	66-100	**90-100**
	Out of 100 cats, what is the probability that a lack of (or insufficient) familiarisation with humans will have an impact on the ability of 90 cats to adapt to a confined space?	90-100	50-100	66-100	90-100	**90-100**
	Out of 100 cats, what is the probability that temperament will have an impact on the ability of 90 cats to adapt to a confined space?	90-100	90-100	90-100	90-100	**90-100**

Sub-question	Question asked to assess uncertainty	Degree of certainty / expert				Consensus
		Expert 1	**Expert 2**	**Expert 3**	**Expert 4**	
Is there any scientific evidence to suggest that particular **factors inherent in cats** could affect their **ability to adapt to a restricted space**?	Out of 100 cats, what is the probability that previous living conditions (whether or not they have been a companion animal, amount of space previously available) will have an impact on the ability of 90 cats to adapt to a confined space?	50-100	66-100	90-100	90-100	**50-100**
	Out of 100 cats, what is the probability that their life stage will have an impact on the ability of 90 cats to adapt to a confined space?	90-100	66-100	90-100	90-100	**90-100**
	Out of 100 cats, what is the probability that a poor state of health (illness with symptoms) will have an impact on the need to adapt the space to the cat for 90 cats?	90-100	90-100	90-100	90-100	**90-100**
	Out of 100 cats, how likely is it that their breed will have an impact on the ability of 90 cats to adapt to a confined space?	50-100	90-100	66-100	50-100	**66-100**
	Out of 100 cats, what is the probability that their reproductive status will have an impact on the ability of 90 cats to adapt to a confined space?	90-100	90-100	66-100	66-100	**90-100**

Appendix 4. Summary table of behavioural indicators used to calculate the Cat Stress Score (based on Kessler and Turner, 1997)

i: inactive

a: active

Score	Body	Belly	Legs	Tail	Head	Eyes	Pupils	Ears	Whiskers	Vocalisation	Activity
1 - Fully relaxed	i: lying on side or back a: *not applicable*	exposed, slow ventilation	i: fully extended a: *not applicable*	i: extended or slightly curved a: *not applicable*	laid down (on surface), chin upward, or on surface	closed or half-open, may blink slowly	normal	very slightly back (normal position)	lateral (normal position)	none	sleeping/resting
2 - Weakly relaxed	i: lying on stomach, half on side, or sitting a: standing or moving, with back horizontal	exposed or not exposed, slow or normal ventilation	i: bent, hind legs may be laid out a: extended when standing	i: extended or slightly curved a: up or loosely downward	laid down (on surface) or over body, a little movement	closed, half-closed or normal (open)	normal	very slightly back (normal position) or erect to front	lateral (normal position) or forward (normal position)	none	sleeping/resting, awake/alert or active, may be playing
3 - Weakly tense	i: lying or sitting a: standing or moving, with back horizontal	not exposed, normal ventilation	i: bent a: extended when standing	i: on the body or curved backwards, may twitch a: up or tense downward, may twitch	over body, a little movement	normal (open)	normal	very slightly back (normal position) or erect to front or moving from back to front	lateral (normal position) or forward	meow or silent	resting, awake or actively prowling

Score	Body	Belly	Legs	Tail	Head	Eyes	Pupils	Ears	Whiskers	Vocalisation	Activity
4 - Very tense	i: lying on belly, curled up or sitting a: standing or moving, with the back of the body lower than the front	not exposed, normal ventilation	i: bent a: front legs extended and hind legs bent when standing	i: close to the body a: tense downwards or curled forwards, may twitch	over body or flattened against body, little or no movement	wide open or pressed together	normal or partially dilated	pricked to front or back, or moving from back to front	lateral (normal position) or forward	meow, plaintive meow, or silent	sleeping/resting curled up or alert, may be actively prowling, trying to escape
5 - Fearful, stiff	i: lying or sitting a: standing or moving, with the back of the body lower than the front	not exposed, normal or fast ventilation	i: bent a: bent near surface	i: close to body a: curled forward close to body	on plane of body, with little or no movement	wide open	dilated	partially flattened	lateral (normal position), forward or back	loud, plaintive meow, yowling or silent	alert, may be actively trying to escape
6 - Very fearful	i: lying on belly or crouched (all fours), may be trembling a: whole body close to the ground, crawling, may be shaking	not exposed, fast ventilation	i: bent a: bent near surface	i: close to body a: curled forward close to body	near surface, motionless	fully open	fully dilated	fully flattened	back	loud, plaintive meow, yowling or silent	motionless alert, or actively prowling
7 - Terrorized	i: crouched (all fours), shaking a: *not applicable*	not exposed, fast ventilation	i: bent a: *not applicable*	i: close to body a: *not applicable*	lower than body, crouched, motionless	fully open	fully dilated	fully flattened and back on head	back	loud, plaintive meow, yowling or silent	motionless alert

Appendix 5. Additional information on the experimental protocols employed in the articles cited in Part 3

Paper reference	Single- or group-housed cats	Number of cats in study	Number of cats per group, if applicable	Purpose of the study and experimental design	Variable(s) observed/recorded	Duration of study	Observation period(s), if applicable
Arhant et al., 2015	Single and group	30 shelters, median number of cats housed = 63	Variable	Relationship(s) between the different variables observed/recorded in questionnaire	Physical condition (body condition score, eye and nose discharge/infection, condition of coat and skin), behaviour (aggressive interactions, play behaviour, behaviour towards humans). Information obtained via questionnaire: information on individuals (sex, date of birth, date of admission, breed) and shelters (space available, access to the outdoors or not, equipment and facilities)	10 shelters received 2 visits, 20 shelters received a single visit	Variable
Blasco et al., 2021	Group	Not specified (10 participating organisations)	Not specified	Questionnaires completed by participating organisations and collection of cat stool faecal samples at each facility or feral colony. Relationships) between the different variables observed/recorded in questionnaire	FCM Information relating to the environment (space available per cat, exposure/non-exposure to dogs/barking, enrichment provision, frequent/infrequent turnover in group composition)	2 years, 5 months	-
Bradshaw & Hall, 1999	Group	50 (including 28 related pets and 22 unrelated pets)	2	Comparison of related and unrelated groups	Affiliative interactions (touching, mutual grooming, mutual rubbing, synchronous feeding)	5 days (including a 3-day phase of habituation to the environment)	Not specified
Desforges et al., 2016	Group	29	8, 7, 4, 7	Comparison of observed variables between the *baseline* control phase, the *removal* control phase and the test phase	Use of space and behaviour (affiliative and agonistic) before and after feeding	32 days (8 days for each of the 4 groups: 2 *baseline* control days - 4 test days - 2 *removal* control days)	8am – 4pm

Paper reference	Single- or group-housed cats	Number of cats in study	Number of cats per group, if applicable	Purpose of the study and experimental design	Variable(s) observed/recorded	Duration of study	Observation period(s), if applicable
Dybdall et al., 2007	Single	86 (35 OS and 51 S)	-	Comparison of an OS group (with a known owner prior to abandonment) and an S group (with no known owner prior to abandonment)	CSS, general information on cats	3 days	3pm – 7pm
Ellis et al., 2021	Single	72 (41 bold and 31 shy)	-	Comparison of 3 treatments (CTRL – standard cage with no hiding box or shelf; BOX - cage with hiding box added; SHELF – cage with shelf added)	Behaviour (general activity), posture, location in cage, food intake and weight, CSS, faecal glucocorticoid metabolite concentration (FGM)	10 days	7am - 11am and 11pm - 3am
Gourkow & Fraser, 2006	Single and group	165 cats	Maximum 8	Comparison of 4 treatments, (inconsistent handling + single housing; consistent handling + one of enriched single housing, basic group housing, or enriched group housing)	Outcomes following stay at the shelter (adoption, isolation, euthanasia, still at the shelter at the end of the experiment), CSS, information on adopters' criteria for choosing a cat via a questionnaire, etc.	21 days	Not specified
Gourkow & Phillips, 2016	Single	15 (7 test and 8 control)	-	Comparison of control group (no interaction with staff or experimenters and no treatment) and test group with cognitive enrichment	Mood (through behaviour), response to treatment, concentration of immunoglobulin A (s-IgA) in faeces, presence/absence of upper respiratory tract disease and/or injuries.	10 days	6am, 11am, 4pm, 8pm
Gouveia et al., 2011	Group	46	7, 8, 15 and 16	Correlations between time spent in observed variables and sex ratio, residence time in shelter and room density	Behaviour (grooming, inactivity, eating/drinking, friendly interactions, negative encounters, active behaviour, rest)	2 months	7am - 9am

Paper reference	Single- or group-housed cats	Number of cats in study	Number of cats per group, if applicable	Purpose of the study and experimental design	Variable(s) observed/recorded	Duration of study	Observation period(s), if applicable
Janke et al., 2017	Not specified	1945 initially. 1600 complete cases.	Not specified	Comparisons of variables recorded from cats before and after implementation of C4C (after 3 years and 8 months)	Data on the cats (identification number, date of admission, age, sex, neuter status at admission, reason for entry and exit, breed, etc.) Various C4C parameters (programme for more rapid adoption of cats): introduction of access points between cages, relinquishment by appointment, identification of rapidly adoptable cats, enrichment in cages and enclosures, etc.)	5 years, 7 months	-
Kessler & Turner, 1997	Single, pairs and groups	140 cats tested (40 in groups, 40 in pairs and 60 single) and 45 control cats, divided into 6 groups (together at the shelter for 2 to 16 weeks)	6 to 9	Observation of changes in CSS for each type of accommodation (groups, pairs or single) Comparison of test cats / control cats	Degree of tolerance to other cats (questionnaire for shelter staff and former owners) and CSS	14 days (10 days for 2 of the control groups)	10.30am and 4.30pm
Kessler & Turner, 1999a	Single and group	112 in groups (including 63 control cats and 49 cats divided into high- and low-density groups)	7 to 21	Control: different groups in spaces ranging from 1.15 m^2 / cat to 3.45 m^2 / cat	CSS	Control: 113 days	Inspection: 10am and 3pm
				Group housing: comparison of high-density groups (30 cats under 1.4 m^2 /cat) and low-density groups (19 cats over 1.67 m^2 /cat).		7 days	Group-house: 10am and 3pm
		44 single-housed cats		Single housing: comparison of cats housed in 1 m^2 cages (29 cats) and cats housed in 0.7 m^2 cages (15 cats)		7 days	Single-housed: 11am and 4.30pm

Paper reference	Single- or group-housed cats	Number of cats in study	Number of cats per group, if applicable	Purpose of the study and experimental design	Variable(s) observed/recorded	Duration of study	Observation period(s), if applicable
Kessler & Turner, 1999b	Single and group	114	Not specified, except for 5 in the control group	Comparison of 8 treatments: SP and n-SP (considered respectively as familiarised and unfamiliarised with humans using several preliminary tests), SC and n-SC (considered respectively as socialised and unsocialised with conspecifics using several preliminary tests), each category housed both alone and in a group	CSS, reaction to the approach of a human (HAT), reaction to the approach of a conspecific (CAT)	1 week (CSS) + 4 days for HAT and CAT	Single-housed: 10am and 4pm Group-housed: 10.30am and 4.30pm
Loberg & Lundmark, 2016	Group	89	15 (and a group of 14)	Each stable group tested under 3 treatments (1 m^2 /cat, 2 m^2 /cat, and 4 m^2 /cat, random order)	Behaviours (positive and negative activities, positive inactivity, positive and negative vocalisations and ambiguous behaviours), position of cats in the room, CSS	54 days (habituation = 14 days followed by experimentation = 3 days for each treatment)	8.30am-11am (after food distribution) 3.30pm-6pm (before food distribution)
Ottway & Hawkins, 2003	Single and group	72 (36 communal housing (i.e. with unfamiliar conspecifics) and 36 discrete housing (i.e. alone or with familiar conspecifics))	Communal housing: 33, 47 and 65 (not all cats were included in the study) Discrete housing: 1, 2 or 3	Comparison of the two housing-types (communal and discrete)	CSS, maintenance behaviours (eating, drinking, toilet use, grooming), play, hiding, affiliative and agonistic interactions, stereotypies	6 weeks	8.30am - 3.30pm

Paper reference	Single- or group-housed cats	Number of cats in study	Number of cats per group, if applicable	Purpose of the study and experimental design	Variable(s) observed/recorded	Duration of study	Observation period(s), if applicable
Sandøe et al., 2017	Single and groups (in owners' homes)	415 respondents who have or have had a cat	-	Questionnaires completed by 378 owners on their oldest cat Relationships(s) between the different variables collected	- General information about the cat (age, sex, breed, reproductive status, number of cats in the household, enrichments available, activities offered by the owner, etc.) - Prevalence of behavioural problems (destruction (scratching), fear of animals or people, soiling, boredom (vocalisation), aggression towards owner, visitors or animals) - Prevalence of health problems (overweight, arthritis, oral, renal, urinary, diabetes, metabolic problems)	1 month	-
Stella et al., 2017	Single	59	-	Comparison of 4 treatments: M+m+, M+m-, M-m+, M-m- (where M+ = managed room, M- = unmanaged room, m+ = enriched cage, and m- = unenriched cage) Changes in the various parameters observed between Day 1 and Day 2 for all conditions	Behaviours (maintenance, affiliative, avoidant), number of cats hiding, % of cats having eaten more than half the food, % of cats having urinated or defecated in the litter box, behaviours suggestive of disease, reaction to the approach of an unfamiliar person	2 days	8am - 4pm
Stella & Croney, 2019	Single	55	-	Comparison of single-housed cats divided into 2 groups on the basis of sickness behaviours and temperament as reported by their owners: Group 1 (shy, calm, mellow, timid) and Group 2 (active, playful, curious, easygoing)	Questionnaire for owners about their cat(s) (possible sickness behaviours and temperament). Observed: food intake, defecation, sickness behaviours, location in cage, vocalisations, behaviours (affiliative, aggressive, agonistic), latency to approach a familiar/unfamiliar person, response to approach of a familiar/unfamiliar person, faecal glucocorticoid metabolite (FGM) concentrations	3 days	8am - 4pm

Paper reference	Single- or group-housed cats	Number of cats in study	Number of cats per group, if applicable	Purpose of the study and experimental design	Variable(s) observed/recorded	Duration of study	Observation period(s), if applicable
Van der Leij et al., 2019	Single	23	-	Comparison of test cats (with hiding place) and control cats (without hiding place)	CSS, weight, adoption rate, and length of stay in the shelter	12 days	12.30pm - 5.15pm
Vitale & Udell, 2019	Single and groups (with owners and at the shelter)	46 (23 cats with owners and 23 shelter cats)	Not specified	Comparisons of cat interactions with humans according to the attentional state of the human and the origin of the cat (the latter in relation to behaviour with an unfamiliar human only)	For all cats: interactions with an attentive unfamiliar human and an inattentive unfamiliar human For cats with an owner: interactions with an attentive familiar human and an inattentive familiar human	Only 1 test per cat	Not specified
Vojtkovská et al., 2021	Group	220	Variable	Changes over time in the various indicators for cats at a shelter	Health indicators: body condition, third eyelid visibility, eye discharge, eye irritation, nasal discharge, presence of pathologically induced respiratory sounds, coat condition, lameness and abnormal postures	1 year	6 pm (every two weeks)

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