CCAC guidelines: Nonhuman primates
(facilities, facility management, and husbandry)
ACKNOWLEDGEMENTS

The Canadian Council on Animal Care (CCAC) Board of Directors is grateful for the expertise contributed by the members of the CCAC Nonhuman Primates Subcommittee and for their engagement throughout the guidelines development process. In addition, the Board is grateful to Mr. Shawn Eccles who contributed to the final stages of the development of this guidelines document, and to all those who provided critical input during the two review periods. We would also like to acknowledge the contributions of both the CCAC Standards Committee and the CCAC Assessment and Certification Committee members, who provided important guidance to the subcommittee. Finally, we would like to thank the CCAC Secretariat project team for its excellent work throughout this process.

The CCAC also acknowledges its funders, the Canadian Institutes of Health Research (CIHR) and the Natural Science and Engineering Research Council of Canada (NSERC). The CCAC could not continue to deliver on its current mandate without their generous support.

Dr. Eileen Denovan-Wright
Chair, CCAC Board of Directors

Mr. Pierre Verreault
CCAC Executive Director

CCAC NONHUMAN PRIMATES SUBCOMMITTEE

Dr. Martin Paré, Queen’s University (Chair)
Dr. Stefan Everling, University of Western Ontario
Dr. Stéphane Goulet, Primus Bio-Resources Inc.
Dr. Jim Gourdon, McGill University
Dr. Julio Martinez-Trujillo, University of Western Ontario
Dr. Andrew Winterborn, Queen’s University

EXTERNAL REVIEWERS

The document incorporates comments received during two review periods. Nineteen reviewers from eleven different academic, government, and private sector organizations across Canada and five international reviewers participated in the first review, and nineteen reviewers from twelve different institutions across Canada and three internationals reviewers participated in the second review. Three individuals participated in both reviews.
CCAC STANDARDS COMMITTEE
Dr. Philip Byrne, Fisheries and Oceans Canada (Chair)
Dr. Stan Boutin, University of Alberta
Ms. Barbara Cartwright, Humane Canada™
Dr. Eileen Denovan-Wright, Dalhousie University
Dr. Nicolas Devillers, Agriculture and Agri-Food Canada
Mr. Dan Fryer, Rural Animal Management Services
Mr. Darren Grandel, Ontario Society for the Prevention of Cruelty to Animals
Ms. Lesley Howes, Environment and Climate Change Canada
Dr. Christopher Kennedy, University of Ottawa
Dr. Lyne Létourneau, Université Laval
Dr. Scott MacDougall-Shackleton, University of Western Ontario
Dr. Joanna Makowska, University of British Columbia
Dr. Gordon Mitchell, Canadian Food Inspection Agency
Dr. Elisabeth Ormandy, University of British Columbia
Dr. Toolika Rastogi, Humane Canada™
Dr. Albrecht Schulte-Hostedde, Laurentian University
Dr. Keith Sharkey, University of Calgary
Dr. James Sherry, Environment and Climate Change Canada
Dr. Patricia Turner, University of Guelph
Dr. Andrew Winterborn, Queen’s University

CCAC ASSESSMENT AND CERTIFICATION COMMITTEE
Dr. Martha Navarro, Health Canada (Chair)
Dr. Mejid Ayroud, University of Calgary
Dr. Craig Bihun, National Research Council of Canada
Dr. Catherine Breault, Charles River Laboratories Preclinical Services Sherbrooke Inc.
Mr. Shawn Eccles, British Columbia Society for the Prevention of Cruelty to Animals
Ms. Karen Gourlay, McMaster University
Mr. Darren Grandel, Ontario Society for the Prevention of Cruelty to Animals
Ms. Simmone Kerswell, University of Alberta
Dr. Jean Lavallée, Aquatic Science & Health Services
Dr. Pierre Moffatt, Shriners Hospitals for Children
Dr. Tom Moon, University of Ottawa
Dr. Doug Morck, University of Calgary
Mrs. Jennifer Smith-Beaudoin, Lennoxville & District Women’s Centre
Dr. Jonathan Spears, University of Prince Edward Island
Dr. René St-Arnaud, Shriners Hospitals for Children
Dr. Mark Torchia, University of Manitoba
CCAC SECRETARIAT PROJECT TEAM

Standards Team
Ms. Julie Dale, Guidelines Development Director (Project Lead)
Ms. Wendy Clarence, Research Analyst
Dr. Gilly Griffin, Director of Standards

Additional Assistance
Ms. Felicetta Celenza, Project Manager and Events Coordinator
Dr. Sylvie Cloutier, Associate Director of Assessment
Ms. Sandra MacInnis, Director of Public Affairs and Communications
Ms. Charlotte Tellier, Scientific Translator
Ms. Emily Verlinden, Graphic Design and Editing Coordinator
# TABLE OF CONTENTS

**PREFACE** .......................................................................................................................... 1

**SUMMARY OF THE GUIDELINES LISTED IN THIS DOCUMENT** ........................................... 2

1. **INTRODUCTION** .................................................................................................................. 3

2. **FACILITIES** .......................................................................................................................... 4

   2.1 Animal Rooms and Procedure Rooms ................................................................................. 4
   2.2 Primary Enclosure .................................................................................................................. 4
       2.2.1 Spatial Requirements ....................................................................................................... 4
       2.2.2 Cage Design .................................................................................................................... 5
   2.3 Outdoor Facilities .................................................................................................................. 6

3. **FACILITY MANAGEMENT** .................................................................................................... 7

   3.1 Light ........................................................................................................................................ 7
   3.2 Temperature and Relative Humidity of Indoor Facilities ...................................................... 7
   3.3 Sound and Vibration ................................................................................................................ 8

4. **HUSBANDRY** ....................................................................................................................... 9

   4.1 Identification .......................................................................................................................... 9
   4.2 Record Keeping ...................................................................................................................... 9
   4.3 Animal Monitoring ............................................................................................................... 9
   4.4 Housing Management ........................................................................................................... 9
       4.4.1 Social Interaction ............................................................................................................ 10
       4.4.2 Feeding Habits .............................................................................................................. 12
       4.4.3 Space Requirements ..................................................................................................... 12
       4.4.4 Use of Objects and Control of Their Environment ......................................................... 12
   4.5 Nutrition, Feeding, and Water ............................................................................................. 13
       4.5.1 Foraging ........................................................................................................................ 13
   4.6 Environmental Enrichment ................................................................................................. 14
       4.6.1 Addressing the Animal’s Physical Environment ............................................................ 14
       4.6.2 Addressing the Animal’s Sensory Environment ............................................................ 15
       4.6.3 Stimulating the Animal’s Cognitive Capability ............................................................. 15
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.7 Physical Activity</td>
<td>16</td>
</tr>
<tr>
<td>4.8 Cleaning and Sanitation</td>
<td>16</td>
</tr>
<tr>
<td>4.9 Human Contact and Handling</td>
<td>17</td>
</tr>
</tbody>
</table>

**REFERENCES** | 18 |

**APPENDIX 1 – NONHUMAN PRIMATE HOUSING SYSTEM ASSESSMENT TOOL** | 23 |

**GLOSSARY** | 25 |
The Canadian Council on Animal Care (CCAC) is the national peer review organization responsible for setting and maintaining standards for the ethics and care of animals in science throughout Canada.

CCAC guidelines are intended to provide assistance in the implementation of Russell and Burch’s Three Rs (replacement, reduction and refinement) (Russell and Burch, 1959). The guidelines are based on expert peer advice and current interpretation of scientific evidence. They are intended to provide a framework for the implementation of evidence-based practices, which are constantly evolving. Implementation of evidence-based practices should result in continual improvement in animal welfare.

In developing the CCAC guidelines: Nonhuman primates, a number of issues arose, which proved challenging to resolve, in particular, the capture of nonhuman primates from the wild, the involvement of nonhuman primates in protocols at category of invasiveness level E, and genetically modified nonhuman primates. The CCAC will continue to work with the relevant expert subcommittees to develop guidance on these matters. In the interim, to assist institutions when designing or renovating nonhuman primate facilities and to ensure good care for these animals held in Canadian institutions, this abridged version of the intended full guidelines document has been released.

The CCAC guidelines: Nonhuman primates (facilities, facility management, and husbandry) provides information for investigators, animal care committees, facility managers, veterinarians, and animal care staff to help facilitate improvement in the care given to nonhuman primates. In addition, those involved with nonhuman primates should keep abreast of the current literature.

For studies outside of Canada, Canadian investigators are subject to these guidelines as well as the relevant legislation and regulations pertaining to animal ethics and care in the country where the study is conducted.
SUMMARY OF THE GUIDELINES LISTED IN THIS DOCUMENT

2. FACILITIES

Guideline 1
Consideration must be given to providing the animals a complex environment with sufficient horizontal and vertical space for unhindered species-specific behaviours suited to the age and health status of the animals.

Subsection 2.2.1 Spatial Requirements, p.4

Guideline 2
Nonhuman primates must be provided with perching or elevated areas and other opportunities for species-typical behaviours, while avoiding harmful cage materials.

Subsection 2.2.2 Cage Design, p.5

4. HUSBANDRY

Guideline 3
Any nonhuman primate injured as a result of the housing environment must be reported to the veterinarian and the animal care committee so that measures can be taken to address housing deficiencies and prevent recurrence of injury.

Subsection 4.4 Housing Management, p.10

Guideline 4
All animals of social species should be pair or group housed in conditions that allow full contact with compatible animals.

Subsection 4.4.1 Social Interaction, p.10

Guideline 5
Nonhuman primates should be provided with the opportunity to express foraging behaviour on a daily basis.

Subsection 4.5.1 Foraging, p.13
INTRODUCTION

Throughout this document, the term ‘must’ is used for mandatory requirements. The term ‘should’ is used to indicate an obligation, for which any exceptions must be justified to, and approved by, an animal care committee.

As with any animal-based science, application of the Three Rs (replacement, reduction and refinement) should guide decisions concerning the validity of scientific studies and the care of the nonhuman primates (Burm et al., 2014).

This abridged version of the CCAC guidelines: Nonhuman primates focuses primarily on implementation of refinement, in terms of the housing and the care of animals in a facility. Animals living in an environment where facilities and practices are oriented toward the promotion of good animal welfare are likely to be less stressed and exhibit normal behaviours and physiology (Poole, 1997).

This document focuses on applying refinement strategies to enable the expression of behaviours important to the welfare of nonhuman primates. These strategies are generally applicable to all nonhuman primates commonly housed in scientific institutions; however, those caring for or working with nonhuman primates should be aware of any additional requirements for the particular species or the individual animal involved.
For general guidance on laboratory animal facilities, please see the CCAC guidelines on: laboratory animal facilities – characteristics, design, and development (CCAC, 2003) and the Canadian Biosafety Standards (Government of Canada, 2015a). Additional guidelines and information of particular concern for nonhuman primates are presented in this section.

Facilities housing nonhuman primates must be secure and unauthorized access must be prevented.

2.1 ANIMAL ROOMS AND PROCEDURE ROOMS

Facilities should be designed to provide separation of groups in quarantine from established colonies, and separation of animals of different species, different health status, etc. following quarantine. Nonhuman primate rooms should be maintained under negative pressure. Ideally, there should be an anteroom, which helps to maintain pressure gradients.

Surfaces within the animal room must be easily sanitized (Government of Canada, 2015b). Drains and gutters are recommended for animal rooms.

Measures must be in place to prevent animals from accessing potentially hazardous equipment or furniture (including light fixtures, ventilation ducts, electrical wires and outlets, and sprinklers).

2.2 PRIMARY ENCLOSURE

Primary enclosures include cages, pens, corrals, etc. In facilities where the room is the primary enclosure, an anteroom is required.

2.2.1 Spatial Requirements

Guideline 1

Consideration must be given to providing the animals a complex environment with sufficient horizontal and vertical space for unhindered species-specific behaviours suited to the age and health status of the animals.

Cages must be designed for pair or group housing of animals, such that normal affiliative behaviour and avoidance behaviour can be expressed, and negative interactions reduced (see Section 4.4, “Housing Management”). Cages must provide sufficient space, both horizontally and vertically, to allow adequate freedom of movement for the animals to perform physical and social behaviours important to their welfare.
(e.g., grooming, resting, foraging, play, normal locomotor repertoire, etc.), while reducing the incidence of behaviours detrimental to their welfare.

Species-specific needs and the size and age of the animals should dictate the cage size and complexity required to address the animal’s physical, psychological, and behavioural well-being (Buchanan-Smith et al., 2004). Other factors to be considered include group size and the health status of the animals. There is currently little consensus on appropriate minimum enclosure sizes internationally, and space requirements can be influenced by the quality of the animal's environment. Standards for cage size cannot be based solely on the body weight of an animal (Buchanan-Smith et al., 2004). In-house experience, the experiences of other institutions, and behaviours that have been shown to be important to nonhuman primates in the wild should be considered in determining the best designs to meet the animals’ needs.

Appendix 1 provides an assessment tool to assist with rating behaviours and elements that must be evaluated when determining the appropriate cage size. The assessment should be a team approach involving the veterinarian, trainer, facility manager, investigators, and research and animal care staff, who have knowledge of the unique characteristics and behaviour of the particular animals, in order to assess the animals’ quality of life (Lambeth et al., 2013). The animal’s needs should be met regardless of the length of time it will be held.

Cages should be of sufficient dimensions to allow the addition of furnishings that promote positive behaviours and can maximize use of the available space for the animals. Larger cages with complex features may stimulate locomotor activity, while eliminating unwanted abnormal behaviours including stereotypies (Kitchen and Martin, 1996), and contribute to optimal growth patterns in young animals (Faucheux et al., 1978). Housing animals in groups in larger cages provides each animal with greater space to utilize and may help to stabilize social relationships, while also making efficient use of the room.

2.2.2 Cage Design

**Guideline 2**

Nonhuman primates must be provided with perching or elevated areas and other opportunities for species-typical behaviours, while avoiding harmful cage materials.

Perches or elevated areas are required for all nonhuman primates. Cage design should favour vertical space over horizontal space and include elevated resting areas and climbing structures so that the animals can fully utilize the vertical space, unless such features are detrimental to the animals (e.g., animals recovering from anesthesia or having a cognitive or physical impairment that would make these features unsafe). See Section 4.6, ”Environmental Enrichment".

Cages should provide the ability to temporarily separate animals for procedures, treatments, feeding, training, safe introduction of new animals to a pair or group, and temporary incompatibility issues, and be flexible such that they can be combined to allow animals greater space or to accommodate larger groups. Cages should also be designed to offer structural barriers that allow some privacy and multiple escape routes to avoid attacks and intimidation from dominant individuals.

Cage materials should be easily cleaned and sanitized. Any nuts and bolts should not be accessible to animals and there should be no sharp surfaces or small openings to prevent injuries and entrapment.
2.3 OUTDOOR FACILITIES

If nonhuman primates are housed outdoors, there must be a secondary enclosure to prevent escapes and intrusions. Shelter from the elements must be provided for each animal at all times. During cold weather, the animals must have free access to climate-controlled indoor housing.

Health problems can arise in some species exposed to low temperatures. For example, cynomolgus monkeys held at temperatures below 12°C can experience health problems, depending on the duration of exposure and age of the animal, and animals with access to outdoor housing can experience frostbite from perching on metal in cold weather.
The CCAC guidelines on laboratory animal facilities – characteristics, design and development (CCAC, 2003) should be consulted for general guidelines on managing laboratory animal facilities that are applicable to all species. This section provides additional considerations particular to nonhuman primates.

Procedures for managing the environment will depend on the room layout and type of enclosure. Particular attention should be paid to maintaining an appropriate environment within each nonhuman primate’s enclosure.

### 3.1 Light

It is preferable to use natural light in combination with artificial light and the use of shutters, as necessary, to maintain the photoperiod for animals housed indoors. A 12 hour light/12 hour dark cycle is adequate for nonhuman primates and reduces changes in physiological variables associated with seasonality (Qin et al., 2015; Lemos et al., 2009). A dusk/dawn transition may be beneficial and can be accomplished through a gradual change in light intensity or, where that is not possible, signaled through a visual or auditory cue that lets the animals know about the upcoming light transition (e.g., a radio or a small light going off/on a few minutes before the lights change).

### 3.2 Temperature and Relative Humidity of Indoor Facilities

Consideration should be given to the combined effects of temperature and humidity, and the impact on evaporative heat loss (Walters et al., 2004). Many nonhuman primate species originate from tropical or subtropical climates and prefer high temperatures and relative humidity. Temperature requirements are species specific and facilities should balance consideration of the climate where the species originates with the health and safety of the staff.

Variation in temperature must be avoided; however, nonhuman primates will adapt to a range of temperatures if given sufficient time (i.e. no rapid, abrupt fluctuations) and if provided with physical structures to facilitate thermoregulation (e.g., a nest box, a thermoneutral resting structure, contact bedding, or a heat lamp/heated area). The degree of body contact between individuals can be an indicator of whether the temperature is affecting their welfare (Schino and Troisi, 1990).

Relative humidity is commonly kept at 40-70%. Nonhuman primates are more susceptible to low relative humidity than other species. Bloody nose syndrome (associated with Moraxella catarrhalis, found in the normal flora of the nasopharynx) is linked to a lack of humidity in the room (Sasseville and Diters, 2008). It spreads among animals easily and is difficult to eradicate. Therefore, all measures must be taken to prevent its introduction in the colony by maintaining an adequate humidity level. If detected, it should be reported to the veterinarian so that mitigation measures can be taken.
3.3 SOUND AND VIBRATION

While nonhuman primates can generate a lot of noise, consideration should be given to housing them where they will not be exposed to excessive sound levels, including ultrasound (Heffner, 2004; Coleman, 2009) and vibration. Additionally, incorporation of wood and plastics in conventional metal cages can help reduce noise levels.
4.1 IDENTIFICATION

All nonhuman primates should be uniquely identified, using the least invasive method appropriate for the housing situation and intended studies. The advantages and disadvantages of various methods for identifying nonhuman primates are reviewed by the Joint Working Group on Refinement (2009).

For invasive procedures, the use of local or topical anesthetic or general anesthesia must be considered.

4.2 RECORD KEEPING

All animals must be clearly identified, with the protocol number to which they have been assigned, the name of the principal investigator, emergency contacts, and any other relevant information (including a brief summary of any experimental procedures) on sheets or cards posted on, or near, the enclosures.

Individual animal records must be kept, indicating such information as birth date, sex, origin, physical measurements, reproduction information, health information, medical history and nutritional history. Records of research activities must be kept, including complete records of all scientific/experimental procedures, as treatment in one study may influence the animals’ response in a second study. A record of cagemates may also be useful to ensure the animal will be socially housed with animals that were confirmed to be compatible; however, these animals will still require monitoring (see Section 4.4.1, “Social Interaction”).

Information gathered through welfare assessments, including details of health, behaviour, and physiology must be documented and retained in the animal’s records.

4.3 ANIMAL OBSERVATION

All animals must be observed at least daily by competent staff1 and any abnormalities must be reported to the veterinarian. Observations should be made of the animal’s behaviour, attitude, and indirect measures of health, including feces, food intake, and urine output.

For animals undergoing experimental procedures, plans must be in place to monitor the animals based on the particular procedures involved and the potential risks to the welfare of the animals.

4.4 HOUSING MANAGEMENT

The goal of housing management is to provide rich and stimulating conditions that will render the animals capable of adapting or modifying their environment to increase their resiliency, improve their psychological

---

1 Competency is described in the CCAC guidelines on: training of personnel working with animals in science (CCAC, 2015).
wellbeing, and reduce fear, anxiety, and stress responses. This goal will be accomplished by providing opportunities for the animals to increase the time they spend in species-typical behaviours, while providing a safe environment to the animals and the people working with them.

Housing management requires development of a management plan based on knowledge of the animal's species-specific behavioural repertoire. Consideration must be given to such aspects as:

- social interactions and natural social groupings;
- control and complexity of their environment;
- feeding habits;
- space requirements; and
- use of physical objects.

Consideration must also be given to the effects of the position of the cage on the particular animals being housed in terms of social interaction, disturbance, etc. For example, some animals may benefit from having a view of activity in the corridor, while for others this may be a source of stress.

The effectiveness of the management program should be assessed regularly using quantitative measures to ensure species-typical behaviours are increased or sustained at a high level. There may also be a concurrent decrease in abnormal behaviours; however, this can be affected by other influences such as early social history. Examples of quantitative measures include time spent foraging and eating, incidence of stereotypic behaviours, and number and severity of incidents of aggression. Assessment of the housing management program should be a team approach, involving the veterinarian, behavioural specialists, facility manager, investigator, and research and animal care staff, as approved by the animal care committee.

Guideline 3
Any nonhuman primate injured as a result of the housing environment must be reported to the veterinarian and the animal care committee so that measures can be taken to address housing deficiencies and prevent recurrence of injury.

There should be an annual evaluation of the appropriateness of the housing system (including any environmental enrichment) by the veterinarian, as well as follow-up when incidents are reported.

4.4.1 Social Interaction

Guideline 4
All animals of social species should be pair or group housed in conditions that allow full contact with compatible animals.
In general, nonhuman primates are social animals, hence social housing is important for their welfare, and any other form of housing must be justified to, and approved by, the veterinarian and the animal care committee. When animals are removed from social housing for a particular component of an experimental protocol (e.g., behavioural testing), it should be for the minimum duration required and approved by the animal care committee, and the animals should be returned to their housing promptly following completion of the session.

While there may be potential risks associated with social housing (e.g., disease transmission or problematic aggression), the benefits of social housing outweigh the risks. There is substantial evidence that social housing of nonhuman primates positively affects their welfare, for example see Dettmer and Fragaszy (2000), Reinhardt and Hurwitz (1993), Reinhardt and Reinhardt (1991), Eaton et al. (1994), Boccia et al. (1989), Coelho et al. (1991), Watson et al. (1998), and Gonzalez et al. (1982). The benefits of social housing include the ability to cope effectively with stress, demonstration of species-typical behaviours, absence of abnormal behaviours including stereotypies, presence of a balanced temperament, and reduction of chronic stress (McNulty et al., 2004; Schapiro and Bushong 1994; Reinhardt V., 1990; and Seelig, 2007 as cited in DiVinci and Wyatt, 2011). Social housing can have a positive impact on scientific studies, such as improving the sensitivity of detecting drug-induced effects (Xing et al., 2015). Experience has shown that the risks can be managed effectively, for example, by careful selection of compatible animals and providing sufficient space and environmental complexity.

Housing strategies, in order of preference, are generally group/family housing; pair housing; side-by-side caging that allows grooming contact; and single housing with visual, auditory, and olfactory contact. Anxious behaviour has been found to be lower in paired rhesus macaques that are allowed full contact, compared to singly-housed controls (Baker et al., 2008). When full-time social housing is not possible, part-time social housing is preferred over single housing (Baker et al., 2014). Partial contact may provide some benefits of social housing, while allowing the animals choice and control (Lee et al., 2012). If animals are singly housed, they must not be housed in a room without conspecifics.

While social housing is very important to the welfare of nonhuman primates, it should be combined with additional housing management practices to further address the animals’ needs and reduce the incidence of stereotypic behaviours (Eaton et al., 1994).

**4.4.1.1 Establishing Compatible Pairs/Groups or Introducing a New Animal**

A detailed plan must be developed before creating a pair or group of nonhuman primates, or introducing an animal to an existing group, taking into account the natural social organization of the species and the characteristics of the individual animals (Capitanio et al., 2017; Truelove et al., 2017). In general, young animals (less than 3 years of age) will adapt to new cagemates, while older individuals may not accept new cagemates as easily.

For adults, the plan should include gradual introduction of the animals by housing them in close proximity with visual but no physical contact, and observation by staff for affiliative or aggressive behaviour. If the response is positive, the animals can be moved to a situation of protected physical contact (e.g., through wire mesh, grooming bars, perforated panels, etc.) with continued observation by staff. If the response remains positive, the animals can be introduced to full contact under direct observation by staff members who are ready to intervene and separate the animals if there are welfare concerns (minor displays of aggression should be monitored but may not require intervention). An animal should not be moved into the cage of an-
other animal, but rather the animals should be introduced in a neutral environment or by opening a divider between their adjoining cages. See the Joint Working Group on Refinement (2009) for more information on developing an introduction strategy.

Under exceptional circumstances to avoid single housing, compatible animals of the same genus but different species (e.g., *Macaca*) could be housed together (see DiVincenti et al., 2012; and Rehrig et al., 2014).

Social housing of adult males with females or with other males raises consideration of strategies to prevent breeding and/or aggression. Males have shown a preference for female partners and the benefits of social housing can be provided without allowing breeding by administering birth control (e.g., implants or monthly prostaglandin injections) or by housing a vasectomized male with a female or group of females. Strategies to minimize aggression among males when housing them together include housing an intact male with a castrated male or group of castrated males, or housing an adult male with a juvenile male. The practice of cutting, blunting, or filing canines must not be used as a means of addressing male aggression.

The location of animals held in separate cages within a room is important to limit the influence of dominant animals over more submissive animals. Visual barriers between certain animals may be helpful in minimizing this influence. Where nonhuman primates are group housed, they may require additional space per animal as well as multiple escape routes and structural barriers to allow opportunity to avoid any aggressive animals.

### 4.4.2 Feeding Habits

The housing management plan must accommodate the feeding habits of the animals and their health status. For example, if they normally forage on the ground, food should be provided in a manner that functionally simulates foraging on the ground (see Section 4.5.1, “Foraging”). The plan must also take into account the potential for dominance and competition among socially housed animals to ensure the needs of each animal are met.

### 4.4.3 Space Requirements

The management plan must also address the availability of space and furnishings to accommodate species-specific behaviours important to the animals. For example, appropriate space is provided for each animal to perform normal locomotor behaviour (e.g., walking, climbing, leaping, etc.) and sleep in a normal manner (e.g., animals that would normally sleep in trees should be provided with suitable perches).

### 4.4.4 Use of Objects and Control of Their Environment

The housing management plan should include the addition of objects for nonhuman primates to manipulate (e.g., puzzle feeders), suited to the species and age of the animals, as well as plans for rotation or replacement of objects to sustain interest (Lutz and Novak, 2005). Nonhuman primates respond favourably to objects that can be destroyed, such as pieces of wood (Lutz and Novak, 2005).

Any objects provided must be safe for the animals, and risks to the animals (e.g., injury, swallowing the object, and intestinal obstruction) must be assessed.

Nonhuman primates benefit from the ability to exercise some degree of control over their situation (see a review by Rennie and Buchanan-Smith, 2006). This includes control of their environment (e.g., noise), social interactions, and activities such as feeding.
4.5 NUTRITION, FEEDING, AND WATER

Nonhuman primates must be fed a quality diet that is appropriate for the species and obtained from a reputable supplier. The quantity fed should be controlled as per recommendations of the National Research Council (NRC, 2003) or other reliable source to ensure normal growth of young animals, maintenance of healthy body condition, and prevention of obesity. Additional information on food preferences can be found by reviewing recent literature (e.g., Laska, 2001; Visalberghi et al., 2003; Laska et al., 2009). Overweight animals are at greater risk of diabetes, cardiovascular diseases, muscle atrophy, and degenerative joint diseases (Schmidt, 2010). The use of feed should be based on manufacturer’s expiration and storage recommendations. Any change in diet should be done gradually.

Fresh fruits and vegetables must be given every day to supplement the basic ration, as appropriate for the species and age of the animals, unless they interfere with the scientific requirements. Nonhuman primates should be given a daily source of vitamin C. Fruit juices are effective rewards during positive reinforcement training for most nonhuman primates.

The goal of the feeding strategy should be to increase the amount of time animals spend foraging and eating, without increasing their caloric intake. Examples of such strategies include providing food that is difficult to access (e.g., feeding through bars, feeding treats frozen in ice, and using puzzle feeders), providing high fibre/low calorie forage items, and hiding small food items in the bedding substrate (Chamove et al., 1982; Joint Working Group on Refinement, 2009), in line with the health status, motor control, and dexterity of the animal.

Food is a powerful motivator and can be used as a reward to positively reinforce desirable behaviours. Even the daily feeding routine can be incorporated as a training tool (e.g., having the animals come to the front of the cage to obtain food in order to accustom them to human presence in close proximity). In general, high calorie, high sugar foods should be avoided as treats for positive reinforcement.

Nonhuman primates should be provided with water ad libitum through either an automated system or water bottles (NRC, 2003; Fortman et al., 2017).

Animals that are new to an automated system or that may be experiencing physical difficulties must be carefully observed to ensure they are sufficiently able to access the water (Fortman et al., 2017).

For group housing, the feeding and watering strategy must be adapted to the social group so that submissive animals are not prevented from accessing food and water by dominant animals. For small groups, the number of access points for food and water should be the same as the number of animals. Consideration should also be given to the hierarchy in a group or room and whether the feeding schedule and delivery of food may induce aggression. Feeding structures and devices should be designed and situated to minimize food contamination.

4.5.1 Foraging

Guideline 5

Nonhuman primates should be provided with the opportunity to express foraging behaviour on a daily basis.
Feeding strategies that encourage nonhuman primates to spend long periods of time searching for, gathering and processing food are desirable. Nonhuman primates will spend a significant amount of time foraging if provided with the opportunity (McNulty et al., 2004), and there is evidence that this has a positive effect on their welfare (Bayne et al., 1991; Chamove et al., 1982).

Bedding and other floor substrates seeded with small foods can promote foraging behaviour among nonhuman primates (Doane et al., 2013). Removable drain baskets can be used to prevent the substrate from blocking drains (see the Husbandry Section on the NC3Rs’ macaque website).

An animal's ability to forage may be influenced by its health status, and this should be considered in planning foraging opportunities. Additionally, any food consumed through foraging activities should be considered as part of the daily food allotment.

**4.6 ENVIRONMENTAL ENRICHMENT**

Environmental enrichment is a term used to refer to provision of stimulating and responsive environments (Shepherdson et al., 1998) above the basic conditions which meet the animal's physical, physiological, and psychological needs. Modifications to an animal's environment should focus first on the species-specific needs of each animal (i.e. those physical and behavioural needs for which some degree of distress would occur in their absence), as well as on identifying any further improvements to the animal's environment that may provide positive welfare benefits (enrichment) (Weary, 2012).

It is imperative to recognize and maintain standard conditions (i.e. the basic conditions that must be met for animals); however, further environmental enrichment must always be considered. Long-term housing should offer a variety of activities and resources for animals to explore.

An assessment must be made of the safety of any environmental enrichment in terms of the risk of injury, ingestion, etc. The animal's response to any initiatives should also be monitored to determine which initiatives the animal prefers, avoids, or ignores.

Information on addressing the physical and sensory environment and cognitive capabilities of nonhuman primates is presented below. For additional examples, see the Enrichment Section on the NC3Rs’ macaque website and Vernes and Louwerse (2010).

**4.6.1 Addressing the Animal’s Physical Environment**

There is substantial evidence that nonhuman primates prefer the use of perches and elevated areas in cages (Clarence et al., 2006; MacLean et al., 2009; Reinhardt, 1992), and that these features can have positive implications for the animals’ welfare (Neveu and Deputte, 1996). Sufficient perching space at different levels within the upper area of the housing unit must be provided to accommodate all of the animals (see Section 2.2.2, “Cage Design”).

Additional items that may improve the animal’s physical environment include:

- objects that can be manipulated and modified, mirrors, logs, branches, paper, and cardboard boxes;
- swings, ladders, play and resting structures, hammocks;
• pools;
• flooring substrate; and
• nest boxes.

Nonhuman primates have enhanced tactile sensitivity (see Hoffmann et al., 2004) and may benefit from objects and foraging opportunities that incorporate a variety of textures.

All objects must be safe and non-toxic. Natural substrates such as wood are preferred, and maple, beech and oak are all considered appropriate (Joint Working Group on Refinement, 2009). Any object or structure (e.g., perches) should be sanitized or replaced regularly to minimize risks associated with physical injury and microbiological burden, with consideration to their use for scent marking.

When providing such objects, the main goal should be to sustain the animal's interest. Novelty is important; over time, animals may lose interest in items for which they had initially shown a preference (Taylor et al., 1997). Sustained interest can be achieved by:

• using objects the animals can manipulate and modify (e.g., destructible items such as paper, cardboard boxes, or wood);
• introducing new objects regularly (rotation according to a schedule); and
• linking objects to naturally motivated behaviours, such as eating, foraging, grooming, or locomotion and postural movements.

### 4.6.2 Addressing the Animal’s Sensory Environment

At a minimum, the animals should be able to have visual, olfactory, and auditory interaction with conspecifics (as noted in Section 4.4, “Housing Management”). Animals should also have the capacity to remove themselves from visual contact when they want by way of barriers and/or privacy panels (see Section 4.4, “Housing Management”). Submissive animals may require some privacy to comfortably eat and drink.

New World species rely on olfactory cues more than Old World species. Natural material (e.g., wood) that will retain scent marks should be provided for New World species.

#### 4.6.2.1 Music and Videos

The value of music and videos for nonhuman primates should be carefully evaluated. Some studies have shown that videos do not provide relevant benefits (Harris et al., 1999; Lee et al., 2011), while others have shown the animals to be attracted to videos (Andrews and Rosenblum, 2002; Bloomsmith and Lambeth, 2000; O’Neill-Wagner, 2005; Platt and Novak, 1997; Swartz and Rosenblum, 1980). Among the criteria to be considered are the species, sex, age, and housing arrangement of the animals, as well as the type of video presented.

#### 4.6.3 Stimulating the Animal’s Cognitive Capability

Cognitive tasks are an integral part of the management program, whether part of the research study or part of training for husbandry and veterinary care. Further stimulating the cognitive capacities of nonhuman primates should be encouraged through tasks such as learning and memory tests and setting problems for animals to solve.


4.7 PHYSICAL ACTIVITY

Housing should offer the capability and stimulation for physical activity in the form of natural locomotor activities appropriate for the age of the animal and the animal model being studied. Cages should be of a sufficient size to allow exercise on an on-going basis (see Section 2.2.1, “Spatial Requirements”). When non-human primates are housed in cages with limited space for extended periods, other opportunities for natural locomotor behaviour should be provided.

A larger and more complex play area may provide physical benefits and other behavioural improvements (Griffis et al., 2013); however, its impact must be assessed in terms of the effect on all nonhuman primates (i.e. those being given access to the area and those who remain in their home cages if the area is within sight). The larger area should be monitored to ensure it provides benefit to the animals, with modifications to the furniture, etc. as necessary to encourage physical activity (Joint Working Group on Refinement, 2009). The exercise area and training of the animals should be designed to facilitate retrieval of the animals in a manner that is safe for the animals and personnel.

4.8 CLEANING AND SANITATION

All cages should be spot cleaned frequently and sanitized regularly to keep the environment dry and comfortable for the animals. The frequency of sanitizing will vary depending on factors such as the number, age, and type of animals, the type of bedding and the size of the enclosure; cages are commonly sanitized every two weeks and pens every four weeks. The period for sanitizing can be extended if justified (for instance during quarantine, or low housing density); however, it should not be extended on a regular basis, as doing so will make cages difficult to clean and sanitize.

Criteria for sanitizing pens depend on whether new animals will be introduced or the same animals will be returned to the pen. Thorough sanitization is required if pens will be used by different animals.

If it is necessary to have the animals present in the pens or cages during cleaning, the cleaning process (including the water temperature, cleaning agents, etc.) must not be harmful to the animals and care should be taken not to spray or otherwise disturb the animals. Precautions should be taken to minimize the creation of aerosols while spraying enclosures.

Objects within cages and pens should be sanitized with at least the same frequency as the enclosure. However, scent marking is an important component of the natural behaviour of some species (e.g., marmosets), and cleaning procedures should be designed to minimize stress associated with disturbance of scent marks (Joint Working Group on Refinement, 2009).

The sanitation process should be monitored to ensure the required level of sanitation is achieved. It should be validated and verified regularly.

Objects and equipment leaving a nonhuman primate area must first be sanitized or covered. The sanitation method should be in accordance with the clinical situation. It should be designed to eliminate common parasites, gram-negative and gram-positive bacteria, and tuberculosis.
4.9 HUMAN CONTACT AND HANDLING

Animals should be approached in a calm, respectful, non-challenging, and reassuring manner. This is particularly important when housing a new animal. Behaviour patterns in some nonhuman primates have been shown to vary in response to a direct or indirect gaze from people (Zou et al., 2015; Coleman and Pierre, 2014; Fox and Kalin, 2014; Capitanio, 1999).

It is important to understand affiliative and agonistic behaviours of the animals (e.g., lip smacking, avoiding direct eye contact, etc.) to encourage positive relationships between personnel and nonhuman primates. Examples of behaviours and facial expressions used by macaques in communication are available in the Behaviour Section of the NC3Rs’ macaque website.

Habituation and desensitization methods are encouraged to help primates overcome fear of people and to prepare them for research and other procedures where they may be in close contact with humans (Clay et al., 2009). For example, treats can be distributed in a manner that leads to animals coming to the front of the cage when people are present. The use of training techniques with positive reinforcement can facilitate housing management.
References


References


APPENDIX 1
NONHUMAN PRIMATE HOUSING SYSTEM
ASSESSMENT TOOL

The housing system must have the following features:

- allow for social housing;
- provide high perching space for each animal;
- contain sufficient and proper space for each animal to sleep in a normal manner;
- enable proper access to food and water;
- allow for proper sanitation; and
- be safe for the animals and for humans.

Outdoor housing must also have the following:

- secure perimeter to prevent escapes and intrusions;
- shelter from elements; and
- indoor access during cold weather.

An evaluation of the housing system also includes the elements listed in the table below. “Maximal use of the available room vertical space” is the most important element and is scored on a scale of 1-10 and other elements are rated on a scale of 1-5, where a score of “1” indicates the worst possible state. A total score is then calculated to determine if the housing system is optimal, acceptable or inadequate.
Table 1  Nonhuman Primate Housing System Assessment Tool

<table>
<thead>
<tr>
<th>Housing Elements</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>Maximal use of the available room vertical space</td>
<td></td>
</tr>
<tr>
<td>Provides privacy areas to hide</td>
<td></td>
</tr>
<tr>
<td>Allows escape from aggressor</td>
<td></td>
</tr>
<tr>
<td>Prevents the monopolizing of food, water, and resting areas by dominant individuals</td>
<td></td>
</tr>
<tr>
<td>Allows for foraging</td>
<td></td>
</tr>
<tr>
<td>Animals can walk/run, climb, leap, swing, hang</td>
<td></td>
</tr>
<tr>
<td>Optimal use of the 3 dimensional space by incorporating shelves, logs, ladders, climbing structures, branches, hammocks, swings, ropes, pool, etc.</td>
<td></td>
</tr>
<tr>
<td>Wooden structures are provided</td>
<td></td>
</tr>
<tr>
<td>Flooring substrate (bedding) is provided</td>
<td></td>
</tr>
<tr>
<td>Presence of objects such toys, mirrors, logs, branches, paper, cardboard boxes, etc.</td>
<td></td>
</tr>
<tr>
<td>Allows separation of animals for treatments, feeding, training, and the introduction of new animals to a pair or group</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Housing System Status</th>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimal</td>
<td>&gt;43</td>
</tr>
<tr>
<td>Acceptable</td>
<td>33-43</td>
</tr>
<tr>
<td>Inadequate</td>
<td>&lt;33</td>
</tr>
</tbody>
</table>
Glossary

Anesthesia – a state caused by an external agent, resulting in depression of the nervous system, leading to loss of sensation and motor function.

Basic conditions – conditions that are required to meet the essential needs of animals for good health and well-being (e.g., food, water, secure space, space to perform species-specific movements, social interaction, etc., appropriate for the species).

Conspecifics – animals belonging to the same species.

Distress – a state where the animal must devote substantial effort or resources to the adaptive response to challenges emanating from the environmental situation; it is associated with invasive or restrictive procedures conducted on an animal, or other conditions which significantly compromise the welfare of an animal, which may or may not be associated with pain.

Environmental enrichment – enhancements to an animal’s environment that go beyond meeting its basic species-specific needs and further improve overall quality of life.

Furnishings – temporary or permanent additions to an animal’s enclosure that address its needs or enrich the environment.

Genetically modified – a deliberate modification of the genome (the material responsible for inherited characteristics).

Homeostasis – the process of internal regulation by which biological systems tend to maintain stability while adjusting to conditions that are optimal for survival.

New World nonhuman primates – Central and South American species.

Old World nonhuman primates – African and Asian species.

Pain – an unpleasant sensory and emotional experience associated with actual or potential damage or described in terms of such damage.

Positive reinforcement training – animal training based on stimulus-response-reinforcement; the trainer asks for a behaviour using a signal (stimulus), the animal performs the requested behaviour (response), and then the animal gets something it wants (reinforcement).

Puzzle feeders – feeding devices which require some manipulation by the animal to gain access to food.

Quarantine – confinement of animals which may carry an infectious disease, for a specified period of time to allow for evaluation.

Quality of life – the welfare of the animal throughout its entire life-span.
Refinement – the modification of husbandry or experimental procedures to minimize pain and distress.

Stress – a state caused by factors external to an animal that displace homeostasis; stress can be beneficial (e.g., in triggering a flight response if the animal is threatened, thus helping it to cope with changes in its environment); however, prolonged stress can cause changes to an animal’s endocrine system, leaving it less able to cope with its environment.

Three Rs – Replacement, reduction and refinement in animal-based science, as first explained by W.M.S. Russell and R.L. Burch in 1959 in *Principles of Humane Experimental Technique*.

Welfare – the physical health and mental well-being of the animal.