Advisory Report: Mammalian Positive List Assessment Framework

Scientific Advisory Committee on the Positive List (WAP - *Wetenschappelijke Adviescommissie Positieflijst*)

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Table of Contents

Foreword

The Ministry of Agriculture, Nature and Food Quality (LNV: *Ministry of Landbouw, Natuur en Voedselkwaliteit*) wishes to create a list of animal species that are officially allowed to be kept domestically (the Positive List).

To this end, in autumn 2017 the LNV invited a group of independent scientific experts to participate under their individual titles in a Scientific Advisory Committee on the Approval List (WAP: Wetenschappelijke Adviescommissie Positieflijst).

LNV asked the WAP for recommendations on producing a simplified, scientifically valid assessment framework for the Domestic Animals Positive List. Criteria for the framework included practical feasibility (simple, time-efficient and cost-efficient), compliance with both Dutch and European laws, and scientific validity.

The committee's duties consisted of:

- developing an assessment framework
- drawing up concrete criteria for classification purposes in the framework
- providing scientific evidence for these criteria
- weighting the criteria relative to one another.

The result was a recommended assessment framework that is both practicable and scientifically sound, and which can be used to identify and categorise species according to potential risk factors. Although the system was designed to be applied to mammals, it can also serve as the basis for assessing potential risks in birds, reptiles and amphibians.

LNV asked the WAP to take animals' intrinsic value (as described in the Animals Act) as the starting point when developing the assessment framework. In addition to animal health, the concept of welfare in the framework also allows for consideration of aspects such as natural behaviour and physical integrity.

Assessment according to the framework produces a list of animal species classified according to potential risks to animal welfare and health, as well as potential dangers (zoonoses, injury) to humans and animals.

A list of committee members and supporting experts is given on the front page.

Dr Ludo Hellebrekers,

WAP Chair

1 Assessment framework and risk factors

The assessment framework is based on risks that can affect the health and welfare of humans and animals when certain species are kept in captivity. The WAP limited its scope to risk factors that have been scientifically proven potentially to cause substantial harm to health and welfare.

Definition of a risk factor:
A risk factor is a specific characteristic of a species that serves to aid its survival in its natural habitat, and which – if inadequately expressed due to restrictions in captivity or intensive contact with humans – will substantially affect the health and/or welfare of animals or humans.

The assessment relies primarily on a screening process using binary risk factors (yes/no) that reveal across species which biological characteristics could impede the problem-free husbandry of specimens of a species under consideration. All risk factors are examined in connection with the following three categories of harm and/or discomfort: 1) zoonoses; 2) animal health/welfare and 3) physical injury to humans and animals. The justification for use of these features draws from scientific insights that are generic and non-species-specific, as outlined for each risk factor.

This section then further details the assessment framework, listing (in order):

- the method used by the WAP to draw up the framework
- the over-arching assessment framework and risk factors
- the assessment scheme with weighing factors
- notes on the assessment framework and scientific underpinnings.

1.1 WAP working method

The WAP worked with multiple iterative rounds to produce the final framework.

1. Work started by drawing up the first rough draft of the assessment framework and formulating risk categories, including risk factors for animal health/welfare and dangers to humans and/or animals.
2. Next, a provisional test of the assessment framework was carried out on a limited number of species of sufficient variety.
3. Form and content were edited in preparation for formulation of the final assessment framework.
4. Experts were asked for feedback on the draft.
5. Final testing was carried out on mammals, and risk factors further defined.
6. Form and content was edited in preparation for formulation of the final assessment framework.

For each risk factor, the WAP:

- produced a clear definition and explanatory notes with a view to ensuring a high level of reproducibility and compliance, regardless of who is using the framework (i.e. to ensure a clear definition of each relevant risk factor); and
- provided scientific evidence for the adverse effects to the health and welfare of humans and/or animals.

The assessment framework was drawn up to ensure that it can both be used on mammals and also serve as a basis for assessing potential risks in birds, reptiles and amphibians. The scientific validity of the system is currently based on mammalian research. We recommend having a number of bird and herpetofauna experts look at whether the screening process and/or the grounds for the associated risk factors require modification for these animal classes, and whether such modification is possible while retaining scientific validity.

1.2 Step-by-step assessment

A step-by-step process is used to assess risks and classify the animal species accordingly. The committee operates under the basic assumption that legally prohibited species (see Article 1.4 1b2 of the Animal Husbandry Decree (*Besluit houders van dieren*)) are a priori excluded from the assessment procedure.[1]

[1] Examples of such species include those prohibited due to risk of invasion.

These steps are as follows:

STEP 1.

To allow the use of the proper reference framework in qualitative species assessments, three experts are asked independently of one another to investigate the extent to which the species in question (or population group within the species) differs from the original species as the result of domestication or cross-breeding (species integrity). The experts then determine whether the species under examination can generally be considered to be domesticated, and whether domesticated populations exist within the species that justify using the 'forma domestica' as a reference instead of the original wild species. In the case of cross-breeds, the risk category of the highest-scoring parent species is applied through to the fifth generation, regardless of whether the parent species is wild or domesticated. In doing so, the committee acts in compliance with the European scientific consensus expressed in CITES, which states that cross-breeds retain characteristics from the parent species for five generations (EU Regulation No. 1320/2014).

The scientific literature lists species that are deemed by substantial scientific consensus to be domesticated (Fuller, 2010; Larssen & Fuller, 2014; Zeder, 2015; MacHugh et al., 2017; Nijenhuis & Hopster, 2018). Domesticated populations differ from wild populations, as they are (genetically) tamer by nature, suffer less anxiety, are less aggressive, and less prone to stress than their non-domesticated counterparts (Nijenhuis & Hopster, 2018). The species *Sus scrofa*, for example, has both a wild variant (wild boar) and a domesticated variant (domestic pig). Domesticated populations and cross-breeds are assessed separately from wild populations.

STEP 2.

Step 2 also involves three experts who, independently of one another, perform a screening based on established risk factors that affect animal health/welfare and constitute a danger to humans and animals (as shown in the chart below). These factors belong to the seven pre-established risk categories: extremely high risk, consumption of food, safety/concealment, climate, habitat, activity/periodicity and hierarchy/reproduction. The committee has scientific sources at its disposal to perform this screening (scientific papers, handbooks, encyclopaedias) that serve as a common basis. Wherever the screening of a risk factor produces different results, the differences in interpretation are identified, definition problems clarified and arguments exchanged. The experts also look at the extent to which the information available for screening risk factors is insufficient for a full evaluation. For each species, the screening results in a number of risk factors, spread across the seven predefined risk categories.

A report is issued on this assessment process and used to set out protocols, definitions and interpretations in writing, organise them and make them available to assessors.

STEP 3.

Step 3 covers the joint evaluation of the screening results by the three experts based on the total number of identified risks, and lastly the allocation of species to risk classes.

The following system is applied during this process:

1. *Extremely high risk.* If, during the screening, one or more risks are identified in the 'extremely high risk' category, the species is automatically placed in the highest risk class.
2. *Classification according to number of risk categories.* The species are classified according to the number of risk categories they score in (extremely high risks, food consumption, safety/concealment, climate, habitat, activity/periodicity and hierarchy/reproduction). As species receive risk-factor scores in more and more categories, they are assumed to be more complex and therefore to require a more diverse range of husbandry measures.
3. *Allocation to risk classes*. In this step, the risk classification is interpreted and the species is allocated to one of five classes based on the number of risk categories it has scored in. The use of five different classes is evidence of the differentiating power of the framework, and reflects the degree of accuracy of the assessment. The results are interpreted as follows: 0 = class A; 1 = class B; 2-3 = class C; 4-5 = class D; 6 and/or extremely high risk = class E. For a definition of the risk classes, please see Appendix 2.
4. *Number of risks per risk category.* If a species scores on more than two factors within a certain risk category, the complexity of the animal is deemed to have increased enough to justify moving it to a higher/more severe risk class.

5. *Animal size*. Depending on the size of an average adult animal (as defined by Article 1.4 of the Animal Husbandry Decree, subsection 1(a)1°–ii), species with an identified risk under 'climate' may be re-evaluated and potentially moved to a higher/more severe risk class. Among other reasons, this is because larger animals require more living space and therefore more complex accommodations, which entail considerable risks. The surface area required for living/sleeping space, including the facilities necessary to ensure the proper climate, are then determined by the three experts based on 'expert judgement' and drawing a distinction between the following three categories:
   - Indoor accommodations of 2 m^2 or less (no re-evaluation necessary);
   - Accommodation > 2 m^2 or other indoor (potentially climate-controlled) space of up to 10 m^2 or outdoor (potentially climate-controlled) day/night accommodation of up to 5 m^2 (re-evaluation);
   - Climate-controlled space > 10 m^2 or climate-controlled sleeping space > 5 m^2 (re-evaluation).
6. Lastly, the assessors decide whether it has become apparent during the screening or the assessment (a) that insufficient information is available to adequately assess the species fully/exhaustively/on all factors, and (b) whether strong enough indications have been found in the existing literature to warrant seriously considering placing the animal in a high risk class. This joint procedure is of crucial importance in establishing risk factors that are both clear and practicable for species during the screening stage, and to allow a coherent and critical assessment of the results. The importance of effective reporting and written instructions has already been discussed above (see Appendix 3 for further elaboration on this point).

The decision to allocate species to risk classes according to the number of identified risk categories is based on the complexity of the species. If a species presents one or more risks in six categories (food consumption, safety/concealment, climate, habitat, activity/periodicity and hierarchy/reproduction), then it can be reasonably assumed that meeting the ethological and physiological needs of such animals will place extremely high demands on the keeper. The same applies if the species scores one or more risks in the 'extremely high risk' category. The fewer risk categories a species scores in, the more reasonable the assumption that keeping specimen of the species/category – in a manner that reduces the likelihood of substantial harm to their health and well-being – will place relatively fewer demands on the keeper.

1.3 Screening chart

X=YES / Empy=NO / ? =insufficient information for a full evaluation

	SPECIES	ASSESSOR:	species 1	species 2	species 3	species 4	species 5	species 6	species 7	species 8	species 9
	Dutch/ English name										
	Genus										
	Subgenus										
	Species										
	Subspecies										
	Reference (Wild or Domesticated)										
	Cross-breeding of following parent-species										
UITZONDERLIJK	**EXTREMELY HIGH RISK**										
	1	The species presents an extremely high risk of zoonoses that can lead to chronic health problems or death in humans									
	2	The species presents an extremely high risk of physical injury to humans and/or animals that will lead to chronic health problems, loss of function or death									
	3	The species completely depends on a narrow range of specific foods (monophagous, extreme food specialist) or environmental conditions (extreme habitat speci									
	4	The species requires elective surgical procedures other than spaying									
	5	Maintaining captive animal populations requires ongoing supply of wild animals									
RISKS TO ANIMAL WELFARE/ ANIMAL HEALTH	**RISKS TO ANIMAL WELFARE AND ANIMAL HEALTH**										
	FOOD CONSUMTION										
	1	The species is a herbivorous browser									
	2	The species is a herbivore with hypsodont or polyphyodont teeth									
	3	The species must forage for long periods daily, including searching for and/or hiding food in the ground (digging)									
	SAFETY/CONCEALMENT										
	1	The species exhibits specific behaviour aimed at securing its home range/territory									
	2	The species uses a secluded nesting site (altricial)									
	3	The species uses flight as a primary survival strategy									
	4	The species must dig its own burrow/make its own nest									
	CLIMATE										
	1	The species is not adapted to a mild ocean climate, and cannot be kept without climate-control facilities									
	2	The species needs places to cool off or bask/stay warm									
	HABITAT										
	1	The species is not strictly terrestrial (lives in trees, water or the air)									
	2	The species uses a specific substrate to care for itself									
	ACTIVITY / PRIODICITY										
	1	The species hibernate (not optional, not to be confused with winter rest)									
	HIERARCHIE / REPRODUCTION										
	1	The species live their lives as monogamous couples									
	2	The species have a linear or despotic dominant hierarchy									
	3	The species breeds quickly (overpopulation)									
OPTIONAL	RE-EVALUATION										
	SIZE	Indoor accommodations of 2 m2 or less (no re-evaluation necessary)									
		Accommodation > 2 m2 or other indoor (potentially climate-controlled) space of up to 10 m2 or outdoor (potentially climate-controlled) day/night accommodation of up to 5 m2 (re-evaluation)									
		Climate-controlled space > 10 m2 or climate-controlled sleeping space > 5 m2 (re-evaluation)									

2 Notes and scientific basis

The assessment relies primarily on a screening process using binary risk factors (yes/no) that reveal across species which biological characteristics could impede the problem-free husbandry of specimens of a species under consideration. All risk factors are examined in relation to the following three categories of harm and/or discomfort: 1) zoonoses; 2) animal health/welfare; and 3) physical injury to humans and animals. The justification for use of these features draws from scientific insights that are generic and non-species-specific, as outlined for each risk factor.

The purpose of the screening is to reveal whether the relevant risk under each factor is of concern or not. The screening chart includes risk factors that have been proven scientifically to potentially cause substantial harm to the health and welfare of humans and/or animals. Risk factors have also been selected that are species-specific, as all species have social, climate, nutrition (etc.) requirements that cannot be covered by general factors and that cannot be used to draw distinctions in the complexity of keeping the species in question. Any problems will also depend on the available options for, and the difficulty of, creating the most suitable conditions for the animal in question in the Netherlands, as well as the knowledge and skills required of the keeper. Another aim of this recommendation is ensure that the nature and scope of the potential health and welfare risks to humans and animals is reflected in the number of risk factors and categories applicable to a species, and that this information forms an effective basis for decisions regarding inclusion in the Positive List.

2.1 Screening of extremely high risks

This category includes animal characteristics (and combinations thereof) that present an extremely high risk of serious harm to animal health/welfare and/or serious danger to humans and animals. These factors are a crucial part of the assessment, and the presence of one or more risks in this category constitutes sufficient cause to allocate the animal to the highest risk class (E). The committee has designated the following factors as presenting an extremely high risk:

1. <u>The species presents an extremely high risk of zoonoses that can lead to chronic health problems or death in humans</u>
   The WAP limited its evaluation of the risks of (mammalian) zoonoses to the non-alimentary zoonoses identified previously by the Office for Risk Assessment & Research (BuRO: *Bureau Risicobeoordeling & onderzoek*), part of the Netherlands Food and Consumer Product Safety Authority (NVWA: *Nederlandse Voedsel en Warenautoriteit*). Foodborne zoonoses are therefore not included in the system that has been developed here, as the risks pertaining to alimentary zoonoses are controlled by food safety legislation. Because there is virtually no knowledge or information available regarding the *prevalence* of zoonoses spread by the species under evaluation, the WAP opted to assess the species based on the *observed* zoonoses per species. The basis for evaluating mammalian zoonosis risks is given in Section 2, which includes an overview of zoonoses, their impact and the feasibility of the control measures to be put in place. Section 2 was drawn up by zoonosis experts, and is based on the emerging zoonoses (EMZO) list (Havelaar et al., 2010). Serious zoonoses (EMZO class 4), whose contagion routes are almost impossible to control (such as airborne/aerogenous, or via human-to-human contact following transmission from animals) are classified as an extremely high risk. Dutch domestic/production animal populations are subject to programmes aimed at controlling and limiting the risk of infection to acceptable levels, both between animals and from animals to humans (zoonoses). These programmes concern other zoonoses whose dangers can be reduced to accepted reference levels by feasible control measures, and which are therefore not included in the assessment.

2. <u>The species presents an extremely high risk of physical injury to humans and/or animals that will lead to chronic health problems, loss of function or death</u>
   To survive in their natural habitats, animal species have developed characteristics for defending themselves against threats from other members of the same species or predators, including humans (the 'fight' response) as well as behaviours for evading threats (the 'flight' response). The active or reactive expression of these characteristics in a confined space creates the risk of potential injury to humans. These risks are determined in part by the animal's size and the method and means of attack, potentially in combination with any (unpredictable) escape behaviours to which members of the species are prone. A high risk of physical injury to humans or members of the species under consideration is only recorded in this category if there is a danger of chronic health problems, loss of function or death. These are species whose behaviour, size and methods/means of attack are designed to actively or reactively inflict serious injury on humans, even if the

animal is treated properly. Any such incidents will generally require urgent medical treatment (for broken bones, brain injury, internal trauma, loss of tissue, etc.) resulting from scratches, bites, collisions, stings or kicks. These incidents will affect day-to-day life for a long period, and/or may result in long-term loss of function and/or death.

3. The species completely depends on a narrow range of specific foods (monophagous, extreme food specialist) or environmental conditions (extreme habitat specialist)
   The diet of some species is so specialised that there is a major risk of being unable to fulfil it's dietary needs. Two examples are the giant panda (*Ailuropoda melanoleuca*) and the anteater, which have an exclusive need for specific types of bamboo and termites respectively. Extreme habitat specialists have a narrow range of specific habitat requirements relating to elements such as the composition and/or climate of their environment.

4. The species requires elective surgical procedures other than spaying
   These are species requiring physical interventions (such as skunks, which are virtually impossible to keep without the removal of the scent glands), which will generally cause the animal some discomfort. The skunk example raises another welfare issue that may be present if the procedure is not deemed necessary: failing to remove the scent gland significantly increases the likelihood that at some point, the intact skunk will generate so much odour that it may be given up or released by the keeper, implying a relevant risk to the health and welfare of the animal.

5. Maintaining captive animal populations requires ongoing supply of wild animals
   Supplementary wild animals are often necessary to maintain populations of species that reproduce poorly in captivity. Although the members of certain species are capable of reproduction, in such cases the rate is too low to cover the demand for replacement. Wild animals are not accustomed to life in captivity, nor have they begun or undergone the process of domestication. Compared to animals bred in captivity, wild animals are generally more delicate, reactive and sensitive to stress. Wild animals also present a far greater risk in terms of emerging zoonoses[2] than exotic species that have already been bred in captivity for some time. This warning applies to new, as yet unknown zoonoses that emerge via human-wildlife contact (potentially via domesticated pets) with serious consequences for humans. Over 60% of new zoonoses identified over the past 30 years have come from wildlife. Catching and introducing wild animals is therefore classified as a high risk, from both an animal-welfare and human-health perspective.

2.2 Screening risks to animal welfare and animal health

'Animal welfare is the quality of life as it is perceived by the animal itself' (Bracke et al., 1999). An animal will experience a positive state of well-being if it has the freedom to exhibit normal, species-specific behaviour patterns and is able to respond adequately to the challenges presented by the prevailing circumstances (Council on Animal Affairs, 2018).

One basic assumption of an assessment framework based on risk factors is that, to a greater or lesser extent, the behaviour and physiology of all species is optimally suited to specific natural habitat. To survive in their natural environment, species have developed unique characteristics to help ensure their survival, scientific support for which can be found in the basic literature on evolutionary behavioural ecology (Davies et al., 2012; Dugatkin, 2013; Alcock, 2013).

Imposed domestic conditions place demands on a species' ability to adapt, posing a potential risk to the health and welfare of animals in captivity. Domestic conditions generally differ greatly from an animal's natural environment. Not all differences necessarily present a risk, however – the permanent availability of food, water and veterinary care, and the absence of predators also offers advantages, after all. Whether any deviations from an animal's natural habitat will actually lead to health or welfare problems therefore depends on the nature and scope of the changes, as well as on the ability of the species to anticipate and adapt to these. For example, it is conceivable that certain elements of an animal's natural, species-specific behavioural repertoire are so important to its 'evolutionary fitness' that expression of the behaviour is important to the animal in and of itself, regardless of its functional purpose. Polar bears, for example, evolved in surroundings where sources of food are few and far between. If polar bears only go in search of food when they are hungry, they run a major risk of not finding any

[2] Infectious diseases transmissible from animals to humans and that are becoming more prevalent, e.g. in animals caught in the wild and due to the increased number of vectors as a result of global warming.

prey in time. Hunger alone is therefore insufficient as a stimulus for acquiring food. Walking is, however, and well-fed polar bears remain intrinsically motivated to keep on the move (Hopster et al., 2009). Such species-specific characteristics are included in the assessment as potential risks.

The scientific underpinnings of the assessment framework draw from the general literature on animal behaviour and the physiology of stress and adaptation. In terms of risks to animal welfare, general stress theory (which applies to mammals) teaches that uncontrollable/unpredictable conditions should be regarded as stressors that can severely affect health and welfare (Sapolsky, 2004). Unmanageable/unpredictable conditions lead to the strong activation of physiological stress systems, regardless of the exact nature of the stressor (Koolhaas et al., 2011). Compound stressors (i.e. risk factors) therefore imply an increased risk to health and welfare (Korte et al., 2005). The committee has designated the following aspects as risk factors.

2.2.1. Food consumption

Food is essential for life. Evolutionary processes have produced species that can vary considerably in the food sources on which they are dependent, their strategies for acquiring it and their degree of specialisation. The wrong food, or food offered in the wrong way, are also key sources of both physical and psychological welfare problems. Incorrect feed not only leads to stunted growth (McCance & Widdowson, 1974), but also increases susceptibility to disease (Keusch, 2003; Franca et al., 2009) and behavioural problems later in life (Laus et al., 2011). The risk factors are based on the extent to which animals are specialised in their diet and food-seeking behaviour.

1. *Herbivorous browsers*
   These animals are not only herbivorous, but eat mainly leaves, young shoots and fruits from woody plants. Herbivores can be classified on a continuous spectrum based on their dietary preferences and the morphological specialisation of their digestive systems, ranging from grazers at one end, through intermediate grazers (species that both graze and browse) to exclusive browsers (concentrate selectors) at the other (Hofmann, 1989; Clauss et al., 2003). Browsers in particular experience problems if they cannot browse according to their needs. Herbivorous browsers/concentrate selectors are characterised by a digestive system adapted to the consumption of easily digestible, energy-rich food with a thin cell wall, high ligneous content and containing natural repellents. Over the course of a day, they consume small amounts of food consisting of a broad spectrum of browsing material (parts of dicotyledons; herbs, bushes and trees). For this reason, species such as deer, white-tailed deer, dik-dik, muntjac and elk require a special diet that is difficult to reproduce, as it requires providing sufficient browsing material (Müller et al., 2010; BMEL, 2014; Clauss et al., 2002; Shochat et al., 1997; Gussek et al., 2017). In many cases, the life expectancy of animals in captivity is therefore lower than for animals in the wild (Müller et al., 2011; Chapman et al., 2010). An unbalanced diet due to incorrect proportions of vitamins and minerals and insufficient composition for digestion can lead to vitamin and mineral deficiencies, gastrointestinal problems, 'deterioration' and ultimately death (Müller et al., 2010;, McCusker et al., 2011; Chapman et al., 2010; Haigh, 1991a; Clauss et al., 2013; Gussek et al., 2017). For this reason, no species of concentrate selectors have yet been domesticated (Hofmann, 1989).

2. *The species is a herbivore with hypsodont or polyphyodont teeth*
   The species has incisors and/or molars that emerge gradually from the tooth socket, and whose surface must either wear away by grinding food, or be replaced by a new, underlying dental element (other than milk teeth). Various vegetarian animal species whose natural diet is rich in fibre and minerals have what are called 'hypsodont' teeth. Teeth of this type continue to grow throughout the animal's lifetime, to compensate for the mechanical abrasion (grinding, scraping) that occurs when chewing food. Examples of hypsodonts include equine and deer species, rabbits and rodents (see e.g. Walker, 1981). If food causes too little abrasion (due either to not enough roughage, or roughage with inadequate texture/fibre length) the animal's normal mastication patterns/behaviours are understimulated or incompletely performed (especially when pellets are used as feed, see Wolff & Kamphues, 1996; Crabhill & Schumacher, 1998; Reiter, 2008, among others). This results in too little abrasion of the chewing surface of the teeth, resulting in overgrown crowns, spurs, infected gums and roots, and associated problems with eating, weight loss and other problems (see e.g. Crossley, 1995; Crabhill & Schumacher, 1998; Reiter, 2008). Having manifested once, these problems often recur, requiring repeated treatment and/or extraction of the affected dental elements (see e.g. Legendre, 2002; Dixon & Dacre, 2005). Given the relatively high frequency of observed dental problems in hypsodont species held in captivity (including *Oryctolagus cuniculus*, various *Muridae* and *Equidae*; see e.g. Okuda et al., 2007; Capello, 2008; Jekl et al., 2008; Jekl & Redrobe, 2013; Anthony et al., 2010; O'Neill et al., 2010) and the correlation with 'errors' in accommodation and feed, this biological feature should be included as a potential

risk factor when keeping these species.

3. *The species must forage for long periods daily, including searching for and/or hiding food in the ground (digging)*
   Animals living in the wild often spend a great deal of their time searching for, finding and consuming food. One example is carnivores (e.g. mustelids, felines, bears and canine species) that hunt prey either alone or in groups. Insufficient stimulus for this foraging behaviour may lead to stress, boredom and stereotypy (especially locomotive stereotypy and pacing) (Club & Mason, 2007; AZA Small Carnivore TAG, 2010; Vinke & Schoemaker, 2012; Kistler et al., 2009; Maslak et al., 2016; Roberton et al., 2002; Burgener et al., 2008; Rose et al., 2017). This searching behaviour is intrinsically linked to food consumption. Many species are dependent on food sources that are widely dispersed out and/or hidden, and each item or mouthful of which only covers a relatively small portion of their daily energy needs. Examples include wild forest boars that eat acorns, grass and chestnuts, or buried tubers, roots, earthworms and insect larvae; elephants that mostly eat tree bark; browsers that consume mainly foliage and young buds; and polar bears that must travel for kilometres before finding any prey. Circumstances in captivity that make this searching behaviour unnecessary or impossible can lead to boredom and abnormal behaviours (Poirier & Bateson, 2017; Lambert, 2006; Sarrafchi & Blokhuis, 2013; Studnitz et al., 2007).

2.2.2. Safety/concealment

1. The species exhibits specific behaviour aimed at securing its home range/territory
   The living space available to animals in captivity is often limited, which in turn can inhibit natural patterns of behaviour and cause stereotypy to emerge (especially locomotive stereotypy such as pacing; see e.g. Mason & Mendl, 1997; Mason, 2006). Research on wild carnivores (including feline and bear species) by Clubb & Mason (2003, 2007) and Kroshko et al. (2016) has shown that an animal’s natural home range and daily distance travelled are significant predictors of locomotive and other stereotypy (especially pacing). Although no factor analysis has been carried out among other species, a comparative study among primates suggests a comparable correlation between home range/daily distance travelled and the propensity for locomotive stereotypy (Prescott & Buchanan-Smith, 2004). It has also been established that the size of the animal’s enclosure significantly influences locomotive stereotypy in other species that naturally travel large distances or have a large home range, such as giraffes and equine species (see Veasey et al., 1996; Luescher et al., 1998, among others). Based on this information, it would seem reasonable to suppose that the home range/daily distance travelled can constitute a risk factor for the development of locomotive stereotypy in other species.

2. *The species uses a secluded nesting site (altricial)*
   The species makes its own secluded nesting site for use as concealment/shelter, or to raise its young. Species such as boars, rodents, otters, hedgehogs, small bears (*Procyonidae*) and civets (*Viverridae*) require a secluded nesting site for resting, shelter/concealment or raising their young (Somers et al., 1995; Sørensen et al., 2005; Heap et al., 2008; Roberton et al., 2002). The absence of sufficient nesting materials and/or suitable resting/hiding places can result in the death of the young through hypothermia or infanticide, as well as aggression and stereotypy in animals (Sutherland-Smith, 2015; Vercammen & Habets, 2006; Evans, 2006; Heap et al., 2008; Labate et al., 2001; Tynes, 2010; Aquilar & Superina, 2014).

3. *The species uses flight as a primary survival strategy*
   When exposed to danger, the species’ main response is a strong urge to flee. Flight animals such as deer, impala, antelopes, lagomorphs (hares, rabbits and pikas) and gazelles exhibit a strong urge to flee to escape predators (see e.g. Kurauwone et al., 2013; Moran, n.d.; Harcourt-Brown & Whitwell, 2003; Nowak & Walker, 1991; Poelarends & Leenstra, 2009; Thompson-Olais, 1998; Haigh, 1991b; Wallach et al., 2007). In captivity, these animals can exhibit a major flight response if startled or if efforts to catch them are not properly carried out. In such cases, animals may crash into fencing at high speed, potentially resulting in physical trauma (such as broken bones) or death. If being caught, there is also the possibility of ‘capture myopathy’, a non-infectious condition involving muscle damage due to extreme strain, struggle or stress (BMEL, 2014; Masters & Flach, 2015; Moran, n.d; Wolfe, 2015; Aubery, 2001; Kessler et al., 2009; Batard et al., 2009). Both in the wild and in captivity, habituation to aversive stimuli and the animal’s home (space, shelter) play a significant part in inhibiting flight behaviour (Kurauwone et al., 2013; Borkowski, 2001; Poelarends & Leenstra, 2009; Wallach et al., 2007). A typical result of domestication is a substantial reduction in flight responses (Nijenhuis & Hopster, 2018), allowing these animals (such as horses) to be kept in domestic surroundings nonetheless.

4. *The species must dig its own burrow/make its own nest*
   Species such as ground squirrels, mongooses, marmots, armadillos and cactus mice make exclusive use of burrows they have dug themselves, and have an intrinsic need to dig (BMEL, 2014; Superina, 2003; Weber & Hoekstra, 2009; Keaney, 2015; Wissink-Argilaga & Pellett, 2015). Inadequate opportunities to dig can lead to overgrown nails, digging stereotypy and paw injuries (Michener, 2016; Superina, 2003; Mason et al., 2007; BMEL, 2014; Aquilar & Superina, 2014; Bolgan et al., 2009).

2.2.3. Climate

Virtually all mammals regulate their body temperature within a narrow range independently of the ambient temperature. To remain within this range, animals have developed a variety of morphological, physiological and behavioural adaptations. If these limits are exceeded, however, and body temperature gets too high (hyperthermia) or too low (hypothermia), essential bodily functions will rapidly deteriorate. Hyperthermia carries a large risk of organ damage, and hypothermia usually causes reduced organ function. Thermoregulatory adaptations differ vastly between species, and are dependent on the climate in which the animal has evolved (Cossins & Bowler, 1987; McNab, 2002; Bicego et al., 2007; Gordon, 1990; Clarke & Rothery, 2008).

1. *The species is not adapted to a mild ocean climate, and cannot be kept without climate-control facilities*
   Species that cannot survive in the Netherlands' mild ocean climate without climate-controlled spaces are those whose natural territory is limited to regions such as low-lying tropical and/or subtropical climates, Arctic climate zones or extremely arid deserts. Obligatory sub-tropical species such as the kinkajou, northern treeshrew, South American tapir and the two/three-toed sloth cannot tolerate low temperatures. A non-heated environment may result in the risk of hypothermia, increased susceptibility to illness, and possibly death (NIEA, 2004; Gillespie, 2003; Shoemaker et al., 2003; BMEL, 2014; Zhu et al., 2010).

   Obligatory Arctic species (such as polar bears) run the risk of hyperthermia in the absence of sufficient shade, swimming/other water or other ways to cool down (AZA Bear TAG, 2007). Obligatory high-elevation species (such as Dall sheep and bighorn sheep) cannot tolerate the humidity of the Dutch climate, resulting in a high risk of respiratory infections (Weber, 2012; Foreyt et al., 1996; Ruske & Molch 2010). Obligatory arid species such as the white-tailed gnu, hartebeest, common tsessebe and lesser Egyptian gerboa cannot tolerate low temperatures. Without a dry, warm environment free from draughts, they are at risk of hypothermia, other symptoms of chilling/freezing (frostbite, loss of ear tips) and immune system impairment (Wolfe, 2015; Aubery, 2001; BMEL, 2014).

2. *The species needs places to cool off or bask/stay warm*
   The species need locations to cool off when the weather is too hot, or requires warm spots (in the sun) to bask or keep warm. For notes, see the section on thermoregulation above.

2.2.4. Habitat

1. *The species is not strictly terrestrial (lives in trees, water or the air)*
   Some species make use of very specific elements of their environment. Members of the squirrel family (*Sciuridae*) live mostly in trees, for example; other animal species live entirely or partially in the water, while bats or flying squirrels spend part of their lives in the air. Their habitats must accommodate these species-specific characteristics. For tree-dwelling and flying species, the three-dimensional structure of their habitat is of great importance. The scientific reasoning behind this can be found in the more general literature on the importance of enclosure enrichment (Sampedro-Piquero & Begega, 2017; Mason et al., 2007).

2. *The species uses a specific substrate to care for itself*
   Species use a specific substrate, such as water, sand and mud, or scraping/scratching sites for their toilet needs (Garcia et al., 2012; Pukazhenthi et al., 2013). If tapirs have no water to swim in, for example, they can suffer from persistent constipation resulting in rectal prolapse (Shoemaker et al., 2003; Fowler, 1986).

2.2.5. Activity/periodicity

All animals are affected by the range of rhythmic changes in the outside world – such as day-night cycles, seasons and tides – with which an observable periodicity or biological rhythm can be associated. These rhythms are expressed in both physiological and behavioural changes that occur at more-or-less regular intervals. This adaptive temporal organisation in behaviour and physiology is driven to a greater or lesser extent (depending on the species) by internal clocks in the animal's central nervous system that are synchronised by 'zeitgebers' (Rusak, 1981; Takahashi, 2017). Depending on the rigidity of these internal clocks, the physiological processes and behaviours they govern can be at odds with the external environment in which the animal lives (relative to its normal habitat), potentially resulting in disorders to behaviour and physiology.

1. *The species hibernate (not optional, not to be confused with winter rest)*
   Species such as the edible dormouse and marmot have a fixed period of hibernation, which is characterised by an extreme drop in body temperature interspersed with short periods of normal temperature (Fietz et al., 2005; Exner et al., 2003). These animals have developed physiological adaptations, and put on fat before the winter which they then shed during hibernation. The length of hibernation (approx. 8 months) in wild edible dormice is not due to unfavourable climatic conditions, but most likely serves to increase chances of survival (reducing the risk of predation) (Bieber et al., 2014). Edible dormice housed in high temperatures do not hibernate for long enough which, combined with the available diet, leads to the risk of obesity; permitting a full-length hibernation potentially lowers reproduction and survival rates (Long & West, 2012; Fietz et al., 2005).

2.2.6. Hierarchy/reproduction

Virtually all animal species exhibit some degree of social behaviour (social interactions between members of the same species, such as mother-young interactions, play, territorial behaviour, dominance & aggression, and sexual behaviour) complex social structures among the members (ranging from egalitarianism to strictly despotic, hierarchical structures). Depending on the social structure typical of a species, atypical circumstances (e.g. social isolation in herd/pack animals) can cause serious welfare problems. Animals that naturally exhibit solitary and territorial behaviour can undergo severe pathophysiological changes (or even die) if individuals are forced to live socially without adequate opportunities to withdraw (Raab, 1971; Von Holst, 1972; 1998). Pathophysiological and behavioural signs of stress manifest whenever very social animals are placed into solitary or isolated confinement (Heidbreder et al., 2000), or if strictly hierarchical animals are kept in dense populations, leading to social instability and stress (Calhoun, 1962; Barnett, 1988; Sapolsky, 2005; Bartolomucci, 2007). These forms of social stress are one of the most common causes of various stress-related conditions in captive animals (Proudfoot & Habing, 2015).

1. *The species live their lives as monogamous couples*
   These species are incredibly selective in their choice of partner.

2. *The species have a linear or despotic dominant hierarchy*
   Either the dominance hierarchy or social ranking covers all members of the group (linear), or all members of the group are subordinate to the alpha member (despot) and there is little or no ranking among the other members.

3. *The species breeds quickly (overpopulation)*
   A generation interval of less than 2 months in a social species can create the danger of overpopulation and the resulting associated social stress (Calhoun, 1962, 1973; Burger & Kaiser, 1996).

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Appendix 1: LNV assignment to the Positive List Advisory Committee

Description of assignment

Assignment

The Ministry of Agriculture, Nature and Food Quality (LNV) has asked the Scientific Advisory Committee on the Positive List for Domestic and Hobby Animals (WAP) for recommendations on producing a simplified assessment framework for the Domestic Animals Positive List. The system should allow experts to achieve cost-effectiveness in assessing animal species as regards the risks associated with keeping the species based on single criteria. Pursuant to the Animals Act, this process involves risks relating to animal welfare as well as dangers to humans and animals. The scientific validity of the system and the assessment remain equally important here. The Committee's duties consist of developing the method, specific criteria, weighting of the criteria and a scientific substantiation of the system. LNV will use the advisory report to determine policy rules for the assessment of animal species, after which these rules will be submitted for consultation, with the Committee's recommendation enclosed. In so far as the opinions are partly related to the Committee's final report, LNV may ask the Committee for advice.

Outcome

The outcome of the assignment is an advisory report with a scientifically substantiated assessment framework that can be used to classify mammalian species based on risks within the context of the Positive List. The system must also be suitable for assessing bird species and herpetofauna. Should the Advisory Committee come to the interim conclusion that it is unable to develop a scientifically sound recommendation within the policy and legal framework set, the outcome shall be for the Advisory Committee to explain which issues it is facing and what will be required to complete the assignment successfully after all.

Agreements for this assignment

Options for support

- The Advisory Committee can ask LNV to expand the Committee via a list of names and specific expertise.
- The Advisory Committee can ask LNV to provide organisational, administrative and research-related support for the Committee. LNV will assess this request and then decide what will be done in consultation with the Committee. The work will be allocated on the basis of consultations between the project manager and the chair of the Advisory Committee, within the arrangements made for this purpose with LNV.
- At the Advisory Committee's request, LNV can attend the meetings to support the Committee through contributions based on the policy and legal framework of the assignment. This process is to maximise effectiveness and efficiency.

Working method of WAP Committee members

- LNV has pointed out that the independence of all members should be guaranteed. The same applies to the current members. To this end, LNV has asked the Committee first of all to assess the independence of its members itself. Following this assessment, LNV will make a final decision as the awarding authority. For this purpose, it will ask the Advisory Committee to prepare a list of ancillary activities as well as memberships relevant to this assignment and to send it to LNV.
- The remuneration of Committee members is contracted out to WUR. Members of the Committee will not automatically become members of the Committee that will eventually assess the species.

Planning

- The Committee must provide the final recommendation on the system to be used as quickly as possible. This entire process depends on the availability of the Advisory Committee's members and the time required for allowing the Advisory Committee to arrive at a well-considered recommendation.
- The agreed planning is that the Advisory Committee provides the final report to LNV no later than on 1 November 2018. The final report of the Advisory Committee will be submitted for consultation with explanatory notes provided by LNV.

- After considering the opinions and specifying the policy framework for the Positive List, the assessment framework will be laid down in a policy rule. This policy rule will be resubmitted for consultation together with the draft Decree on the Designation of Species of Mammal.

<u>Preconditions and criteria</u>

As part of its assignment, the Committee is asked to:

- Provide a highly simplified assessment framework in the recommendation, which is well substantiated from a scientific point of view.
- Develop a system that allows a risk assessment to be made for an animal species. It is subsequently up to the Minister to determine what risk level she considers to be socially acceptable.
- Avoid the use of exclusion and inclusion criteria where possible, because the choice whether or not the risk to be taken is acceptable rests with the Minister. The Committee is asked to limit itself to indicating a ranking order in terms of risks.
- Work on a system that can also serve as a basis for the assessment of birds, reptiles and amphibians in addition to mammals. If the Committee comes to the conclusion that this aim is undesirable or impossible, the Committee will be asked to substantiate this opinion. The Committee is asked to indicate what will be required nonetheless to develop a system that can be used in order to create a Positive List for birds and reptiles as well.
- Ensure that the recommendation matches the legal framework laid down in the Animals Act as well as current legislation and relevant case law. The criteria stated in Article 1.4 of the Animal Keepers Decree make up the framework for the assessment. In terms of case law, especially the Andibel judgment as well as the court (Trade and Industry Appeals Tribunal) decisions on the 2015 system (CBB:2017:70) and on the release of the long-eared jerboa (CBB:2017:107) are important.
- Take the intrinsic value described in the Animals Act as the starting point when developing the assessment framework. Additionally, the concept of welfare in the assessment framework must be broader than animal health. This matter is also about being able to exhibit natural behaviour, for example.
- Indicate in the recommendation how domestication is handled in the assessment. If domestication is included, the Committee will be asked to indicate how it has been included in the assessment framework. If domestication is not included, a substantiation of this fact will also be requested.
- Include in its working method the considerations prepared by LNV for the legal feasibility of the system with regard to European requirements for scientific validation.
- Take as a starting point that the assessment framework performs assessments at species level rather than at sub-population level, for example.
- Indicate in the recommendation whether and (if so) under what conditions or criteria an assessment at sub-species level is required, because an assessment at species level will not be sufficient.
- Indicate in the recommendation and substantiate whether and (if so) under what conditions or criteria a species may be assessed on the basis of scientific knowledge of or together with a related species (same genotype) (clustering).
- Provide recommendations on how crossbreeds should be handled.
- Include on an equal basis in the assessment framework not only risks relating to welfare but also risks to the safety of humans and other animals. These issues can be classified as a risk of:
    - zoonosis;
    - injury.
- Use single criteria in the assessment framework, which are defined in a clear and concrete manner. The relationship between the criterion on the one hand and the welfare as well as safety risks on the other should be described and validated here.
- Allow LNV to apply the precautionary principle. This principle relates to situations in which there are indications for risks but not enough information is available. The recommendation must state what information should at least be available to assess the animal. It should also be indicated how the risks in cases where information is insufficient can still be mapped out in the best possible manner on the basis of the scientific information that is available.
- Assess the risks, ignoring the actual motivation, resources, knowledge and expertise of a keeper. A higher risk means that keeping a species in a responsible manner requires more from a keeper in terms of welfare and danger, as there will be major consequences if the species is not kept correctly.

- Validate the assessment framework not on the basis of the practical situation in which the animals are kept but on the basis of a demonstrable link between a single criterion and a risk to animal welfare as well as danger to humans or animals.
- Provide a scientific substantiation for the risk assessment. Here, the Committee should explain in the recommendation what requirements it has set for the reliability of scientific source material.
- Indicate in the recommendation to what extent the assessment of a species based on this system provides sufficient insight into the risks to be mitigated for an exemption application.
- Test the initial system by performing a rough assessment of a number of species. This process has two goals: it could serve as a criterion for the quality of the system for the Committee, while it could serve as an indication of a possible field of tension between the scientific and the social perspective for LNV – are many species being kept that will end up in higher risk categories?
- Take into account the fact, in so far as important, that there already are regulations which prohibit various animal species from being kept: for the assessment of mammalian or other species for the Positive List, this fact applies to:
    - animal species that are prohibited in the EU due to a risk of invasion. These species do not have to be assessed;
    - primates and many felines that are prohibited pursuant to the Nature Conservation Act (Section 3.20). These species do not have to be assessed.
- Make sure that its members can indeed operate in a private capacity, independently and without being bound by any instructions.
- Be aware that the names of all the Committee members will be included in the Committee's final recommendation.

Appendix 2 – Definition of the risk classes

It is key that step 2 in the risk classification of species only considers those risk factors that have the potential of causing substantial harm to the health and welfare of the relevant species in the event that the requirements associated with the risk factor are exceeded. The more risk categories a species embodies, the more reasonable the assumption that there is a greater likelihood of substantial health or welfare problems and that meeting the ethological as well as physiological needs of members of the species will place higher demands on their keeping and management. If a species scores risks in multiple categories, this fact usually means an increase in the complexity of keeping the relevant species as well as an imposition of higher demands on their keeping and management. In view of the above considerations, the WAP proposes that species are classified into five risk classes.

Risk class A: Keeping members of these species in the Netherlands poses no demonstrable risk of substantial harm to the well-being and/or health of individuals. This category includes species in respect of which no risks have been identified. The precautionary measures to be put in place are typically very restricted and general in nature.

Risk class B: Keeping members of these species in the Netherlands poses one or two clear risks of substantial harm to the well-being and/or health of individuals. This category includes species for which a maximum of two risks have been identified in a single risk category. The measures to be put in place are typically singular in number and only require a limited amount of knowledge as well as experience on the part of the keeper.

Risk class C: Keeping members of these species in the Netherlands poses a limited number of clear risks of substantial harm to the well-being and/or health of individuals. This situation is deemed to be the case if a limited number of risks have identified across two or three risk categories. As a result, although the measures to be put in place will typically be limited in number, scope and/or complexity, they will impose specific requirements on the knowledge as well as experience on the part of the keeper.

Risk class D: Keeping members of these species in the Netherlands poses a significant number of clear risks of substantial harm to the well-being and/or health of individuals. This situation is deemed to be the case if risks have been identified across four or five risk categories. As a result, the measures to be put in place typically increase in number, variability and/or complexity and they require the keeper to have a high level of knowledge as well as skills.

Risk class E: Keeping members of these species in the Netherlands poses one or more demonstrable, exceptionally high risks of substantial harm to the well-being and/or health of animals and/or human health. This group includes species that have scored on one or more risks from the exceptionally high risk category, along with species for which clear risks have been identified in all six risk categories.

Appendix 3 – Risk assessment trials

First trial assessment
The four experts all scored the twenty species using the screening chart made available to them. Each expert then scored a further ten different species, three of which concerned commonly kept species (such as dogs, cats, horses, rabbits and similar) and seven of which were selected by the experts themselves based on their expertise in relation to the relevant species. In this manner, individual scores were produced for a total of sixty species. The final scores were then determined jointly, after which the outcomes were assessed and placed into the five risk classes. The species that were scored together constituted a representative sample of mammalian species kept in the Netherlands.

Outcome
It was noted that the individual scores corresponded very closely if the risk factor scoring was negative. In the case of positive scores, the individual scores varied widely between the assessors and correlations between the individual rankings were found to be weak or absent in rank correlation tests. In the subsequent discussion of the scores between the experts, it was established that the variations could principally be attributed to differences in the interpretation of the risk factors and the precision with which sources were consulted. Differences of opinion on the application of the risk factors and the placement into the classification categories were resolved through reflection as well as discussion, resulting in refinement of the risk factor descriptions and of the manner in which those factors can best be applied, as well as in refinement and fine-tuning of the arguments that underpin the classification into risk categories. A concerted effort was made in this regard to distinguish between scientific arguments on the one hand and the normative boundaries and arguments involved on the other. The classification results were distributed fairly evenly across the risk categories, with the exception of the exclusion category, for which the number of scores was substantially lower.

Adjustment
The first trial, which involved 60 species, resulted in amendments to the assessment framework and changes to tighten the risk factors further.

Second trial assessment
The amended assessment framework was subsequently used by two experts, who were given the same scientific sources with which to work, in order to conduct a second screening and assessment for a further twenty different mammalian species.

Outcome
The variation in the screening results as revealed in the first trial did not disappear, even though the same sources had been used and the assessment framework had been tightened.

Conclusion
Based on this exercise, the WAP concludes that the screening by individual experts as well as the subsequent score-setting and assessment of the results must be based on identical scientific source materials, while the discussion as well as any fine-tuning of the screening results forming the basis for the assessment and placement into risk classes must necessarily be carried out in consultation between the experts. Joint score-setting and assessment is essential to the learning process, the critical reflection as well as the tightening and fine-tuning of the risk factors, whereas it is also needed to ensure a coherent assessment system that delivers reproducible, consistent, objective and defensible outcomes. The WAP has concluded that the variations in the individual scores of the assessors will narrow over the course of the process but will not disappear entirely. The classification categories were amended and simplified on the basis of the above trials.