Assessment framework for a positive list for captive reptiles in the Netherlands

Part 1: Assessment framework for reptiles

Recent insights into the welfare of animals emphasise the fact that an animal's capacity to be aware of their situation is central to the concept of animal welfare. Welfare is based on the capacity to suffer, experience pleasure, feel pain, etc. (Duncan, 2006; Browning & Veit, 2022). Welfare is threatened if an animal species experiences restrictive conditions that, based on scientific evidence, are not conducive to certain biological characteristics of the animal species. This applies not only to mammals, but to all vertebrates including reptiles (Lambert, Carder & D'Cruze, 2019; Azevedo et al., 2021), birds (Marino, 2017) and fish (Brown, 2015; Mason & Lavery, 2022). Based on this general scientific literature, the Advisory Board has explored the possibility that the assessment framework for reptiles can build on the previously established assessment framework for mammals. As part of this process, the Advisory Board has replaced the biological features specific to mammals by those specific to reptiles (defined here as all non-avian reptiles). For reptiles, these kinds of features can also be considered to be risk factors in terms of the development of welfare problems. The Board realises that welfare problems in reptiles can manifest themselves differently than in mammals. For example, reptiles will very rapidly become passive and lower their metabolism if the environment does not meet the requirements. Although this may be an indication of welfare problems, it must be further substantiated by additional symptoms.

The assessment system uses a binary scale (yes/no) to identify risk factors in reptile species. Risk factors are related to the following two categories of injury and/or distress: 1) hazards to humans (zoonoses or personal injury) and 2) hazards to the animal (animal welfare/animal health). The justification for using these features draws on scientific insights that are general and non-species-specific, as outlined for each risk factor.

Further details of the assessment framework are given later in this chapter. These consist of (in order):

- Glossary of terms;
- Working procedure;
- Assessment framework and risk factors;
- Assessment and assessment chart.

1.1 Glossary of terms

The following definitions clarify the key terms used in this advisory report.

Risk factor: A risk factor is a species-specific trait that typically facilitates the survival of an animal in its natural habitat. If inadequately expressed, due to restrictive conditions, neglect, or excessive human contact, this has limited or significant harmful outcomes for the welfare and/or health of humans or animals. The phrase 'significant harmful outcomes' refers to behavioural abnormalities, health conditions and injuries that have a lasting, permanent, and/or severe impact on the welfare and health of humans or animals. The assessment framework focuses solely on those risk factors that are not applicable to all reptile species.

Risk category: a set of risk factors where the inherent features of an animal entail a variety of interlinked behaviours that serve a common purpose. The impact of risk factors belonging to the same risk category will result in the same type of pathology.

Risk class: the categorisation of animal species based on the number of risk categories in which risk factors have been identified.

1.2 Working procedure

The definitive assessment framework was developed over multiple rounds of iteration:

1. Generate ideas about the risk factors that determine the welfare and/or health of animals or humans;
2. Group related risk factors into risk categories;
3. Draw up a draft assessment framework with risk categories;
4. Perform a provisional test of the assessment framework, using thirty animal species (with a sufficient degree of variation in their biology and ecology);
5. Based on this test, make the assessment framework more rigorous, both in terms of content and language;
6. Carry out a more comprehensive definition of the risk categories and make the assessment framework more rigorous;
7. Submit the assessment framework for consultation[1];
8. Increase the rigour of the assessment framework by incorporating feedback from the experts that were consulted.

For each identified risk factor:

- A clear definition and explanatory notes have been produced. This ensures that the assessment will have a high level of reproducibility and clarity, regardless of which expert is involved.
- Scientific evidence for adverse effects on the health and welfare of humans and/or animals has been provided.

1.3 Assessment framework and risk factors

The assumption behind a risk-factor-based assessment framework is that every species is adapted to its natural habitat, in terms of behaviour, physiology, and morphology. To achieve optimum performance in their natural environment, animal species have developed species-specific traits to help ensure their survival and reproductive output. Scientific evidence for this can be found in the basic literature on evolutionary behavioural ecology (Davies et al*.*, 2012; Dugatkin, 2013; Alcock, 2013).

Certain conditions of captivity (further referred to as restrictions) are in conflict with these species-specific traits and their plasticity and pose a risk for the welfare and health of animal species. Not every restrictive condition represents a risk *per se*. Thus, whether or not a restriction will actually lead to health or welfare problems depends on the nature and scope of that restriction, as well as on the ability of the species to anticipate, manage, and adapt to it. For instance, it is conceivable that some aspects of the natural, species-specific behavioural repertoire are so important for an animal that it is driven to perform those behaviours, regardless of the functional result. Some snakes, such as racers, actively forage for food in their habitat. Because they live in open habitats, the animals have to cover large distances (Brown & Parker, 1976; Plummer & Congdon, 1994; Mitrovich et al., 2018). Even if they are regularly fed, these species continue to move and forage for food as part of their natural behaviour and regularly incur injuries to the head (rostral trauma) as they push against the walls of the terrarium (Mehler and Bennett, 2003).

The scientific evidence that underpins the assessment framework was drawn from the general literature on animal behaviour, the physiology of stress, and on plasticity and adaptation. In terms of risks to animal welfare, general stress theory (which applies to all vertebrates) indicates that uncontrollable/unpredictable conditions should be regarded as stressors that can severely impact health and welfare (Sapolsky, 2004). Unpredictable and uncontrollable conditions are powerful triggers for physiological stress systems, irrespective of the specific stressor involved (Koolhaas et al., 2014).

[1] https://www.internetconsultatie.nl/toetsingskader_huisdieren

The assessment framework is based on the screening of various risk factors that impact the welfare and/or health of animals or humans. These risk factors are clustered into the following categories:

1. Human injury/health;
2. Food consumption;
3. Use of space/safety;
4. Temperature;
5. Humidity;
6. Light spectrum;
7. Social behaviour.

1.3.1 Human injury/health

This category contains risk factors associated with an animal species that could pose a threat to human health. These features include risks of zoonoses and injuries with significant harmful outcomes for the welfare and/or health of humans. This risk factor includes chronic infections and/or fatigue, acute danger and mortality risk as a result of venomous animal bites, broken bones, brain injuries, wounds and bruises that may necessitate urgent medical treatment or hospitalisation. Such incidents may significantly impair an individual's ability to perform their normal work for an extended period or permanently, as a result of loss of function or death.

The severe outcomes of these risks on humans are vital considerations in the assessment. The presence of one or more risks in this risk category is sufficient reason to assign the animal species to the highest risk class (H) (see Chapter 2). The following risk factors have been identified:

1. *The animal species poses a risk of zoonoses*
   In its assessment of the risks of zoonoses in mammals, the Advisory Board considered non-alimentary zoonoses only. Accordingly, the system that has been developed does not include zoonoses that can be transmitted to humans or animals through the food chain, as the risks of alimentary zoonoses are managed by means of food safety legislation. In the almost complete absence of knowledge or information about the incidence of zoonoses transmitted by reptiles, the Advisory Board has opted to evaluate individual species based on the zoonotic infections that have been identified for them. Severe zoonoses (EMZO class 4; Havelaar, et al., 2010) that are transmitted along infection pathways that are almost impossible to control (e.g. airborne/aerogenous routes) are classified as a risk. With regard to the Netherlands' populations of domestic/production mammals, there are programmes to control and limit the risk of infection to acceptable levels, both from one animal to another and from animals to humans (zoonoses). These programmes concern the remaining zoonoses, whose dangers can be reduced to accepted reference levels by feasible control measures. For this reason, these other zoonoses play no part in the assessment. However, there are no programmes of this kind available for reptiles. This is why the Advisory Board has decided also to include the risk of zoonoses in its assessment. In general, very few severe zoonoses have been identified in the literature for reptiles, with the exception of West Nile virus, (Ebani et al., 2017; Mitchell, 2011; Mendoza-Roldan et al., 2020). However, reptiles can be affected by parasites and represent a risk through the transmission of Protozoa, Cestoda, Pentastomida, Nematoda, Trematoda and Ixodida (Mendoza-Roldan et al., 2020).

2. *The animal species poses a risk of personal injury*
   To survive in their natural habitats, animal species have developed traits to defend themselves against threats from other members of the same species or from predators,

including humans (the 'fight' response) as well as behaviours for evading threats (the 'flight' response). Their use of these traits (either actively or reactively) in conjunction with restrictive conditions and the confrontation with humans, can pose a risk of injury to humans. These risks are determined in part by the animal's size and its method and means of attack, potentially in combination with any (unpredictable) escape behaviours used by the species in question. Scores in this risk category are limited to situations that involve a risk of permanent damage to health, loss of function, or death. Any such incidents will generally require urgent medical treatment or hospitalisation (for broken bones, brain injury, internal trauma, poisoning, cardiac arrest, loss of tissue, etc.) resulting from constriction, scratches, bites, butting, stings or kicks. These incidents have a long-term impact on day-to-day life, and/or may result in long-term loss of function and/or death.

1.3.2 Food consumption

Food is essential for animal life. Evolutionary processes have produced animal species that can vary considerably in the range of food sources on which they are dependent, in their strategies for acquiring such food, and in the degree of specialisation involved. The wrong type of food or presenting food items in the wrong way are also key causes of both physical and psychological welfare problems. The wrong type of food does not only lead to stunted growth (growth abnormalities, deformities; Mehler and Bennett, 2003; Doneley et al., 2017), it also increases susceptibility to infection (Donoghue & McKeown, 1999; Mans & Braun, 2014) and can lead to severe behavioural problems later in life (Mehler and Bennett, 2003; Han & Dingemanse, 2015). The risk factors are based on the extent to which animal species are specialised in their diet and foraging behaviour.

1. <u>The animal species is an herbivorous browser</u>
   These animals are not only herbivorous, they also mainly eat leaves, young shoots and fruits of woody plants (e.g. *Uromastyx* or *Iguana*, some tortoises/terrestrial turtles). Herbivores can be classified on a continuous spectrum based on their dietary preferences and the morphological specialisation of their digestive systems. They range from grazers at one end of the spectrum, through intermediate grazers (species that both graze and browse), to exclusive browsers at the other (Donoghue and McKeown, 1999). Browsers, in particular, experience problems if they are unable to browse as much as they need to, if at all. An unbalanced diet due to incorrect levels of vitamins and minerals or poor composition in terms of digestion can lead to vitamin and mineral deficiencies, gastrointestinal problems, weakening, and ultimately death (Donoghue and McKeown, 1999; Raila et al., 2002). This biological feature should, therefore, be included as a risk factor for the animal species in question.
2. <u>The animal species has a keratinous beak (rhamphoteca) or no tooth replacement (acrodont dentition)</u>
   Various animal species whose natural plant-based diet is rich in fibre and minerals have a keratinous beak. The beak continues to grow throughout the animal's life to compensate for the mechanical abrasion (grinding, scraping) that occurs when chewing food. The most obvious examples of animal species with keratinous beaks are terrestrial tortoises and turtles (Vitt & Caldwell, 2013). If the food provided causes insufficient wear because it is too soft, then the normal movements of gnawing and chewing may not be adequately stimulated and may not be performed completely. As a result, there is insufficient wear on the surface of the keratinous beak. This leads to an overgrown beak (rhamphotheca overgrowth, Mans, 2013) resulting in inadequate food consumption. Another group of reptiles has an acrodont dentition where the teeth are not replaced (Vitt & Caldwell, 2013; Dosedelova et al., 2016). This group includes agamid lizards, chameleons and spiny-tailed lizards and related species (*Leiolepis*). In these

animals, inappropriate food can cause accelerated wear of the only pair of teeth, ultimately preventing food consumption and causing the animals to starve (Mans, 2013).

3. *The animal species has to engage in prolonged foraging*
   Animals living in the wild often spend a great deal of their time foraging for, locating, and consuming food. Insufficient stimulus for this foraging behaviour can lead to stress, boredom and stereotypic behaviour (especially locomotory stereotypies and pacing; Michaels et al., 2020). This foraging behaviour is often inextricably linked to food consumption. Many species are dependent on food that is widely dispersed and/or concealed. Each item or mouthful only provides a relatively small portion of their daily energy needs. If the animal species experiences conditions that make such foraging behaviour unnecessary or impossible, this can lead to boredom and abnormal behaviour. Boredom can lead to depression-like symptoms or damaging behaviours. The emergence of abnormal behaviour, such as stereotypies, is commonly considered to be a sign of significant deficiencies in the animals' housing or care (Burghardt, 2013).
4. *The animal species has an intermittent feeding pattern*
   Several species, such as boas or species of rattlesnakes, eat very infrequently in the wild, but consume very large prey (Campbell and Brodie, 1992; Schuett et al., 2002; Henderson and Powell, 2007). These species require careful feeding; if they are exclusively fed large prey (with a long interval between feeds), there is a risk of vitamin deficiencies (vitamins B and C used up within several days; Zwart, 2001). However, feeding prey that are too small can have severe consequences following a protracted period of fasting. The costs, in terms of energy, of digestive system upregulation are extremely high (Secor and Diamond, 1995; Goodrich et al., 2024). This can cause rapid weight loss and potentially even death of the animal.
5. *The animal species is reliant on a narrow range of specific foods*
   The diet of some species is so specialised that they are at great risk of being unable to fulfil their dietary needs, resulting in serious nutritional deficiencies. Two examples are *Moloch horridus* and lizards of the genus *Phrynosoma* that exclusively eat specific species of ants, primarily of a single genus (Pianka & Parker, 1975; Withers and Dickman, 1995). Geckos from New Caledonia (*Rhacodactylus spp*, *Correlophus ciliatus*) mainly consume rotting fruit, supplemented by insects, a diet that is difficult to achieve in captivity (Wilkinson, 2015). Some carnivorous reptiles are genuinely specialised feeders, and will only eat certain lizards, snakes, crabs, or slugs and snails. If this particular prey is absent, this can lead to weight loss, disease, and ultimately death (Donoghue and McKeown, 1999). Many farmed insects used for feeding reptiles in captivity contain too much fat, are deficient in calcium and contain insufficient vitamins (Finke, 2003; Boyer, 2006; van Zanten & Simpson 2021). If only limited species of insects are used as food, there is a risk of an unbalanced diet due to incorrect proportions of vitamins and minerals and insufficient composition can lead to vitamin and mineral deficiencies, unhealthy embryos, 'deterioration', and ultimately death (Laing and Fraser, 1999; Dierenfeld et al., 2002; Wilkinson, 2015).

1.3.3 Use of space/Safety

Animal species make demands on their environment. These demands can differ considerably from one species to another. If these demands are not adequately met, this can lead to severe behavioural problems, reproductive issues, or even physical harm to the animal.

The various demands that animals impose on their environment, as well as the potential problems that may arise for both animals and humans, are specified below.

1. *The animal species moves around in its home range and/or defends its territory*
   When the habitat of an animal is limited, this can inhibit natural patterns of behaviour and

promote stereotypic behaviour (especially locomotor stereotypies, such as pacing; see e.g. Mason & Mendl, 1997; Mason, 2006; Michaels et al., 2020). In reptiles this can promote stereotypic behaviour (especially locomotory stereotypies such as pacing) and lead to escape behaviour, resulting in self-inflicted injury and infections (Wilkinson, 2015; Rose et al., 2017).

2. *The animal species relies on a secluded breeding site or hibernation site*
   The species constructs a secluded, self-made breeding site for use as a resting place/shelter, or as a place in which to raise its young (altricial). If there is a lack of nest substrate or sufficient suitable places to lay eggs, this can lead to dystocia (egg binding) and death (Zwart, 2001) in some snakes, tortoises/turtles and lizards.
3. *The animal species uses flight as a primary survival strategy or exhibits voluntary tail loss*
   When exposed to danger, the animal species exhibits a strong flight response or voluntary tail loss (tail autonomy). Animals that resort to flight can also exhibit strong flight responses in captivity. In these cases, animals may crash into walls or obstacles at high speed, potentially resulting in physical trauma (such as broken bones) or death. Animals that resort to flight, such as water dragons and sail-fin dragons (*Physignatus*, *Basiliscus*, *Hydrosaurus*) or monitor lizards exhibit a strong flight response in the face of danger in order to escape predators. In captivity, these animals can exhibit flight responses when startled or if attempts to capture them are poorly executed. In these cases, animals may take flight at high speed or dive from upright structures, potentially resulting in physical trauma (such as broken bones) or death (Warwick, 1990; Garner and Jacobson, 2021). In the case of handling, extreme stress, or high density, other species of lizards and some snakes can shed their tails (Clause and Capaldi, 2006; Hoogmoed et al., 2011). Although the tail will partially regrow, the animal's locomotory capacity may be reduced and reserves of fat stored in the tail will be lost (Maginnin, 2006; Bateman and Flemming, 2009; Emberts et al., 2019).
4. *The animal species only uses self-constructed burrows/breeding sites*
   Species such as girdled lizards, some skinks, and spiny-tailed lizards use burrows they dig themselves and have a behavioural need to dig (Branch and Patterson, 1975; Milne and Bull, 2000; AlRashidi et al., 2021). When the ability to fulfil that need is restricted, this can result in overgrown claws, digging stereotypies, and foot injuries (Garner and Jacobson, 2021).
5. *The animal species is not strictly terrestrial (lives in trees, in water, in the air)*
   Some species make use of very specific elements of their environment. Some reptiles live mostly in trees, for example, while others live entirely or partially in the water. Their environments must accommodate these species-specific traits. For tree-dwelling species, the three-dimensional structure of their environment is of great importance. If this structure is inadequate, some large lizards may become trapped and lose their tail (Zwart, 2001). It is important that the structure of the enclosure/depth of the water are such that the animals cannot drown (turtles that drown in shallow water when they land on their back and cannot turn around; exhaustion if there is no land area, see Zwart, 2001).

Dependence on physical environment

All reptiles are dependent on different physical aspects of their environment. To achieve this, they exhibit strong behavioural regulation of the optimum environmental conditions. In other words, reptiles actively seek out the optimum environment in terms of temperature, humidity, and light. With respect to the physical aspects of an animal's environment, a degree of variation in terms of space and time is essential, allowing the animal to seek out the most suitable environmental conditions.

1.3.4. Temperature

All reptiles are poikilotherm and often use behavioural thermoregulation. As such, the metabolism and physiology is almost completely dependent on the ambient temperature. In order to maintain body temperature within certain limits, there may be behavioural thermoregulation and animals have a variety of morphological, physiological and behavioural adaptations (Bicego et al., 2007). If these limits are exceeded, however, and body temperature gets too high (hyperthermia) or too low (hypothermia), essential bodily functions will rapidly deteriorate (Seebacher and Franklin, 2005). Hyperthermia carries a high risk of organ damage. Hypothermia usually causes reduced organ function. Thermoregulatory adaptations differ vastly between species, and are dependent on the climate in which the animal lives and has evolved (Cossins & Bowler, 1987; McNab, 2002; Bicego et al., 2007; Gordon, 1990; Clarke & Rothery, 2008).

1. *The animal species is not adapted to the temperature in the Netherlands*
   Species whose home range is limited to regions such as tropical and/or subtropical climate zones, arctic climate zones, or extremely arid deserts need climate-controlled habitats if they are to survive in the temperate maritime climate of the Netherlands (Zhu et al., 2010). Obligatory tropical (or subtropical) species, such as large tortoises kept outdoors, do not easily tolerate low temperatures. If a heated indoor environment is lacking, this may result in the risk of hypothermia, increased susceptibility to illness, and possibly death (Zwart, 2001; Wilkinson, 2015).
2. *The animal species has active behavioural thermoregulation*
   For behavioural thermoregulation, species often need locations to cool off when the weather is too hot, or require warm spots (in the sun) to bask or keep warm. If an animal species is unable to fulfil these requirements, it will experience the same outcomes as described in section 1.3.4.1. A heated indoor environment for reptiles must enable a species to engage in natural behaviour to manage its body temperature. If (partial) temperature gradients (horizontal or vertical, depending on the ecology of the species) are lacking, or inappropriate sources of heat (wavelength, type of heat source) are used, this can result in reduced growth, behavioural problems, a reduced immune response, injury (burns), and death (van Zanten & Simpson, 2021; Warwick et al., 2023; Wilkinson, 2015; Zwart, 2001; Suedmeyer, 1995; Williams & Jackson, 2016; Nash, 2022).
3. *The animal species hibernates (non-facultative, not to be confused with a dormant winter period)*
   All animals are affected by the range of rhythmic changes in the outside world – such as day-night cycles, seasons and tides. In association with this, a periodicity or biological rhythm is present. This involves certain physiological and behavioural changes that occur at more-or-less regular intervals. To a greater or lesser extent (depending on the species) this adaptive temporal organisation in behaviour and physiology is driven by internal clocks in the animal's central nervous system that are synchronised to external stimuli known as 'zeitgebers' (Rusak, 1981; Takahashi, 2017). Whether being housed at high temperatures in the period when reptiles usually hibernate has a disruptive effect on the animal's physiology and behaviour depends on the species. In some species, being unable to hibernate can disrupt reproduction. Animals of these species require obligate hibernation in order to be able to reproduce the following season. However, in some other species, reproduction does not depend on hibernation. In these cases, hibernation is facultative. In the latter case, it is not known whether being unable to hibernate has a negative impact on survival.

1.3.5. Humidity

The animal species lives in a climate with a humidity that differs significantly from the climate in the Netherlands

Reptiles range from species that occur in extremely arid areas to species that live in or close to water. Even species that live in arid regions, such as desert tortoises (*Gopherus sp.*), make use of burrows in order to counteract the loss of water (Bulova, 2002). A lack of sufficient humidity during the hibernation of garter snakes (*Thamnophis sirtalis*) can significantly affect their further survival (Costanzo, 1989). Reptiles also actively seek out hiding places to prevent dehydration (Dezetter et al., 2023) and this has a direct impact on their temperature tolerance (Herrando-Pérez et al., 2020; Le Galliard et al., 2021). Excessive or insufficient humidity can also cause breathing problems and respiratory diseases (Schumacher, 1997). In conditions of low humidity, shedding problems can develop (Divers & Stahl 2019).

1.3.6. Light spectrum

The animal species lives in a range and habitat characterised by strong exposure to UV light (Ferguson zones 2, 3, 4)

Reptiles can vary significantly in their dependency on UV light in terms of its strength and spectrum (Baines et al., 2016). Many species need UV-B light in order to synthesise vitamin D (Karsten et al., 2009). If insufficient UV light is available, skeletal disorders, impaired fertility, problems in embryogenesis, etc. can occur (Zwart, 1980). Inappropriate UV lighting can also cause eye infections (Wunderlich et al., 2024). In addition, ultraviolet light also plays an important role in communication in some species, such as chameleons (Dollion et al., 2020). Behavioural regulation can also be a factor in this. According to need, species can actively seek out or avoid UV-B light and this need can even be stronger than temperature regulation (Conley and Lattanzio, 2022).

1.3.7. Social behaviour

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 & aggressive behaviour and sexual behaviour) and there are complex social structures governing members of the same species (ranging from egalitarianism (equality) to strictly despotic (dominant), hierarchical structures). The type of social structure exhibited by a species can determine whether any deviations from its typical conditions (such as highly territorial species being kept in groups) may lead to severe welfare problems due to persistent aggression. Animals that naturally exhibit solitary and territorial behaviour can undergo severe pathophysiological changes, including stomach ulcers, cardiovascular problems, and immunodeficiency (or even death) if individuals are forced to live socially without adequate opportunities to hide (Korzan & Summers, 2021).

1. The animal species has a linear or despotic dominance 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 (dominant) and there is little or no ranking among the other members. When several males are housed together or new individuals are introduced to a group, this increases the likelihood of fights, injuries, predation, and death (Warwick et al., 2023; Zwart, 2001). A dominance hierarchy can lead to competition for resources (food, water, heat sources), preventing or limiting subordinate animals' access to these and increasing the chance of pathologies and death (Warwick et al., 2023; Wilkinson, 2015).
2. The animal species (periodically) forms monogamous pairs
   Some species are highly selective in their choice of partner. This occurs in Australian skinks

(*Egernia* & *Tiliqua* sp.; Chapple, 2003), various species of lizards, and some crocodiles (Wittenberger & Tilson, 1980). This behaviour can increase the chance of intra-species aggression and even lead to death (Gardner et al., 2002; Chapple and Keogh, 2005).

1.3.8. Insufficient information about an animal species

In situations where insufficient information is available to assess a given animal species against some or all of the risk factors, a literature search is conducted to find details about closely related species within the same genus or family. Here, the term 'closely related' refers to animal species that share similar morphological and/or ecological traits. If literature on comparable species is available, its relevance to the animal species being assessed must be thoroughly justified and substantiated. If no literature is available for closely related species, a statement will be made to this effect.

Assessment and assessment chart

As individual components of the same risk category, risk factors cannot be compared to one another. Risk factors cannot be weighed (i.e. one risk factor is worse than another) or added up, for the following reasons:

- In order to determine the relative severity of different risk factors, it must be possible to assign weights to them. The process of assigning weights to risk factors cannot be scientifically substantiated. The scientific theory for indicating the gravity, severity, and duration of a risk factor is still in its infancy, so it is not yet usable for the assessment framework.
- The number of risk factors in a risk category that have check marks placed against them is immaterial, the physiological consequences for a species remain the same. Regardless of whether food is unavailable or of poor quality, or if there are dental issues that prevent consumption, the resulting impact in terms of the risk category remains unchanged. Thus, it is immaterial whether check marks have been placed against one or more risk factors within a risk category.

Nevertheless it is possible to add up risk categories, as the scientific literature shows that stress protocols in which several goals are compromised lead to more problems for the animal (welfare compromises). The categories are juxtaposed, since there is no established, objective unit of measurement that can be used to assign weights to risk categories, as the relevant theory is still in its infancy.

Scoring on multiple risk categories leads to an accumulated complex burden and, consequently, to an increased risk of health and welfare problems for a given animal species.

Further clarification of the assessment chart

As components of these risk categories, risk factors are not assigned individual weights. The total 'welfare costs' stemming from human-induced disturbances cannot be simply aggregated. In theory, it is possible to develop a unit of measurement based on an animal's stress response to human-induced disturbance. In practice, however, this is impossible, due to major discrepancies in the existing literature with respect to the type, duration, intensity and background involved (wild, captive, laboratory; Dickens and Romero, 2013). Work to create an 'Allostatic load index' for wild animals is still in its infancy (Edes et al*.*, 2018). Allostatic load is regarded as a metric for the overall toll of chronic exposure to heightened or fluctuating endocrine or neural responses resulting from persistent or recurring stress. Although the concept of 'Allostatic load' could theoretically be extended to include reptiles (Korte et al., 2005), there is currently insufficient scientific evidence to justify this. As a result, a thorough assessment of the various risk factors is not feasible, and the gravity of the severity and duration of animal distress cannot be established with complete scientific certainty.

It makes no difference to an animal species whether one or more risk factors apply within a given risk category[2], the physiological impacts it experiences remain comparable (Bicego et al., 2007). This is evident, for instance, in the case of the 'thermoregulation' goal, which involves maintaining body temperature within specific limits. This will be compromised if an animal species is insufficiently adapted to the temperate maritime climate of the Netherlands, and if they lack access to cooling facilities, for example, or are disturbed during hibernation. Analogous reasoning applies to the other risk categories, linked to other needs. Hence, it does not matter whether one or more risk factors apply to the animal species – the biological need cannot be achieved and the physiological impact on the species remains the same.

For the aforementioned reasons, the assessment of an animal species is predicated upon the scoring of risk categories rather than on individual risk factors.

In an animal species, if hazards are discovered in multiple risk categories, this precludes the simultaneous achievement of many needs, not just one. Scientific studies involving stress protocols in experimental animals show that when multiple needs are compromised, this causes greater harm to the health and welfare of the animal species in question. The scientific literature uses the concepts of 'Chronic Mild Stress Model' and 'resource allocation' to explain this. For example, studies that place many of an animal's needs under stress (e.g. nutrition, thermoregulation, and rest), also known as the Chronic Mild Stress Model, have proven to be extremely effective in eliciting the symptoms of depression, for example (Willner 2017). Other studies have shown that efforts by animals to adapt to restrictive conditions can adversely impact biological processes that are vital to the preservation of optimal health (Glazier, 2009b). This is also known as 'resource allocation'. Resource allocation describes how available energy and resources are distributed between various essential life processes, body structures, and tissues (Glazier, 2009a).

As in the case of risk factors, the Advisory Board has no established objective unit of measurement that can be used to assign weights to risk categories because the relevant theory is still in its infancy. To avoid that subjectivity, all risk categories are weighed equally and are considered to be juxtaposed. The Advisory Board concludes that the simultaneous exposure of an animal species to multiple risk categories leads to an accumulated complex burden and, consequently, to an increased risk of health and welfare problems for a given animal species.

Assessment chart

This leads to the following assessment chart and risk classes:

[2] a set of risk factors where the inherent features of animal species entail a variety of interlinked behaviours that serve a common purpose.

ANIMAL SPECIES:	In Dutch
English name:	
Genus:	
Subgenus:	
Species:	
Wild/Highly domesticated:	
A cross between the following parent species:	
HUMAN INJURY/HEALTH (LG)	
LG1	The animal species poses a risk of zoonoses, which in humans lead to death or chronic infections and/or fatigue, resulting in permanent impairment in daily life.
LG2	The animal species poses a risk of personal injury, necessitating prompt and/or prolonged medical care for injuries caused by biting, butting, kicking, stinging or scratching (such as broken bones, brain injury, internal trauma and bite wounds resulting in disfigurement), which can result in long lasting impairment in daily life or even death.
FOOD CONSUMPTION (V)	
V1	As an herbivorous browser, the animal species is at risk of failing to fulfil its essential nutritional requirements, which can lead to the development of vitamin and mineral deficiencies, gastrointestinal issues, physical deterioration (wear and tear) and, in the worst case scenario, death or comparable outcomes.
V2	The animal species has a keratinous beak (rhamphoteca) or no tooth replacement (acrodont dentition), leading to the danger of an overgrown rhamphoteca if the food is not properly abrasive or there is excessively rapid wear to the dentition. This results in reduced food consumption, loss of body condition and, in the worst case scenario, death or comparable outcomes.
V3	The animal species needs to engage in prolonged foraging each day, which involves seeking and/or burying food (digging). There is a risk of developing stereotypic or harmful behaviours or comparable outcomes if the foraging behaviour cannot be expressed sufficiently, if at all. Significant deviations in the size of prey offered can result in serious nutritional deficiencies.
V4	The animal species has an intermittent feeding pattern leading to the danger of nutritional deficiencies if the prey size does not match the natural choice of prey.
V5	The animal species is entirely reliant on a narrow bandwidth of specific foods (monophagous, extremely specialised feeder) with the risk of developing gastrointestinal disorders, nutritional deficiencies, cachexia (extreme thinness), and ultimately death if nutritional requirements are not met.
USE OF SPACE / SAFETY (R)	
R1	The animal species moves around in its home range and/or defends its territory, which can lead to the development of stereotypic behaviour or comparable outcomes if this behaviour cannot be sufficiently expressed, if at all.
R2	The animal species relies on a secluded breeding site for use as a resting place/shelter, without which there is a risk of aggressive or stereotypic behaviour, anxiety or comparable outcomes.
R3	The animal species uses flight as a primary survival strategy. If these animals are disturbed, there is a risk of capture myopathy (muscle damage as a result of extreme exertion, struggling or stress), trauma, broken bones, death or comparable outcomes.

R4	The animal species only uses self-dug burrows/home-made breeding sites, so there is a risk that the lack of an opportunity to dig will result in digging stereotypies or comparable outcomes.
R5	This animal species is not exclusively terrestrial (lives in trees, in water, or in the air). However, if there are insufficient opportunities to live in habitats other than on land, it is at risk of developing stereotypies or death.
TEMPERATURE	
T1	The animal species is not adapted to the average temperature in the Netherlands, so it is vulnerable to hypothermia, hyperthermia, respiratory illnesses, heightened susceptibility to disease, and death.
T2	The animal species has active behavioural thermoregulation. If there is no possibility for the animal to choose an optimal microclimate, there is a risk of hypothermia, hyperthermia, heightened susceptibility to disease, and death.
T3	The animal species hibernates (non-facultatively, not to be confused with winter dormancy) with the risk of metabolic disorders and death if disturbed.
HUMIDITY	
L1	The animal species has a habitat with a humidity that differs significantly from the climate in the Netherlands.
LIGHT SPECTRUM	
UV1	The animal species lives in a range and habitat characterised by strong exposure to UV light (Ferguson zones 2, 3, 4)
SOCIAL BEHAVIOUR (S)	
S1	The animal species has a (periodic) paired monogamous lifestyle and if this lifestyle is not respected, there is a risk of aggression, intra-species fighting, stress-related diseases and death or comparable outcomes.
S2	The animal species has a linear or despotic dominance hierarchy, and if this lifestyle is not respected, there is a risk of aggression, intra-species fighting, stress-related diseases and death or comparable outcomes.

Risk classes

Based on the risk category scores, an animal species will be placed in a higher risk class if it has a positive score in multiple risk categories. Classification into risk classes A to H is a scale that represents the level of difficulty of keeping the animal species in a safe and animal-friendly way.

For instance, risk class A indicates that risk factors were not identified in any of the seven risk categories. This means that keeping members of these species in the Netherlands is not hazardous to the welfare and/or health of humans or animals.

Risk class H comprises animal species for which one or more risk factors have been identified in the 'human health' risk category and/or in six 'animal welfare/animal health' risk categories. Keeping members of these species in the Netherlands poses a hazard to human health and/or involves a very large number of hazards to the welfare and/or health of animals.

The Advisory Board views the 'human injury/health' risk category (LG1, LG2 in the assessment table) as a vital consideration for society as a whole and recommends that the animal species that score in this risk category should be automatically assigned to the highest risk class (H).

Step-by-step assessment and classification into risk classes

This chapter shows how the assessment chart is used to perform a step-by-step assessment, after which the animals are categorised into different risk classes based on the outcome.

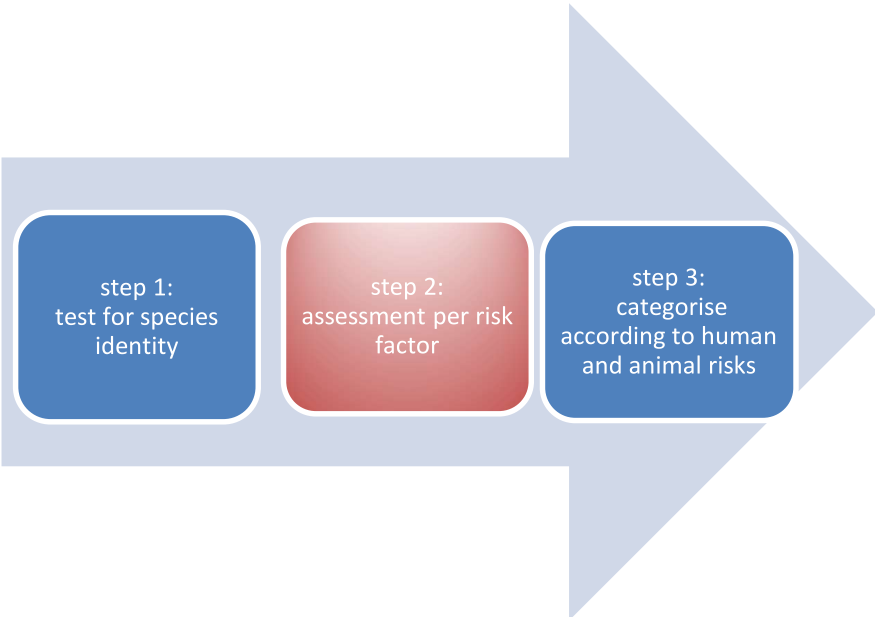
a. Advisory Board

The assessment will be carried out by the Advisory Board supported by several members of staff in identifying recent scientific source material. The availability of reliable and up-to-date scientific source material is essential, both for the assessment and for the discussion with the experts.

b. Step-by-step assessment

A step-by-step process is used to assess the risks and to classify the animal species by risk class.

The specified steps are as follows:



STEP 1.

First, two experts determine (independently of one another) whether the animal species under assessment can be considered highly domesticated and if there are highly domesticated populations within the species that justify using the 'forma domestica' as a reference for this particular population, rather than the original wild species (see Nijenhuis & Hopster, 2018). When crossbred with highly domestic animals, the risk class of the highest scoring parent species is retained for up to the fifth generation, regardless of whether that parent species was wild or highly domesticated. In doing so, the committee is complying with the European scientific consensus expressed in CITES, which states that crosses retain features from the parent species for five generations (EU Regulation No. 1320/2014). In situations where crosses between wild and highly domesticated animals have been conducted for six or more generations within a species, an assessment is made to determine if the cross in question can generally be regarded as highly domesticated and, if so, whether the 'forma domestica' should be used as a reference.

STEP 2.

Step 2 also involves two experts who (independently of one another) perform a screening based on risk factors that impact animal welfare/animal health and human and animal injury/health according to the chart, as shown in section 1.4. For the purposes of this screening, the Board members use reliable scientific sources (as outlined in Chapter 3), which provide a joint foundation for the assessment. Wherever screening for risk factors produces different results or raises questions, any differences in interpretation are specified, definition problems clarified, and arguments exchanged between the assessors. Afterwards, the animal species is reassessed using the assessment chart. This process is meticulously documented, to ensure that the final decisions are transparent and comprehensible.

STEP 3.

Step 3 specifies the allocation of the assessed species to one of eight risk classes (A-H). The categorisation into risk classes is determined by the number of risk categories that include one or more risk factors.

Reliable sources

Articles published in peer-reviewed journals (known as primary literature) are considered reliable sources (Nordell & Valone, 2017). These publications can be accessed through the bibliographic databases used by university libraries. The most relevant of these are Web of Science, CAB Abstracts, Biological Abstracts, Zoological Record and Google Scholar. Aside from this primary literature, other reliable sources include reference works, journal articles, and reports that contain references to primary literature, as well as dissertations. The prerequisite for this second category of sources is that autonomy must be ensured (in other words, there must be no affiliation with a company/interested party or financial gain).

Peer review is defined as "a process of subjecting an author's scholarly work, research or ideas to the critical scrutiny of others who are experts in the same field" (Kelly et al., 2014). Peer review primarily functions as a filter, ensuring that only sufficiently robust scientific research is published. This is achieved by assessing the validity, significance and originality of the study. Additionally, peer review is designed to enhance and ensure the quality of manuscripts that are deemed suitable for publication. Publications in peer-reviewed journals, by means of a systematic classification in which research and analysis methods are transparent and comprehensible, enabling others to reproduce the study.

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