SCIENTIFIC OPINION

efsa JOURNAL

ADOPTED: 29 March 2023

doi: 10.2903/j.efsa.2023.7992

Welfare of ducks, geese and quail on farm

EFSA Panel on Animal Health and Animal Welfare (AHAW Panel), Søren Saxmose Nielsen, Julio Alvarez, Dominique Joseph Bicout, Paolo Calistri, Elisabetta Canali, Julian Ashley Drewe, Bruno Garin-Bastuji, Jose Luis Gonzales Rojas, Christian Gortázar Schmidt, Mette Herskin, Virginie Michel, Miguel Ángel Miranda Chueca, Barbara Padalino, Helen Clare Roberts, Hans Spoolder, Karl Stahl, Arvo Viltrop, Christoph Winckler, Charlotte Berg, Sandra Edwards, Ute Knierim, Anja Riber, Attila Salamon, Inga Tiemann, Chiara Fabris, Aikaterini Manakidou, Olaf Mosbach-Schulz, Yves Van der Stede, Marika Vitali and Antonio Velarde

Abstract

This Scientific Opinion concerns the welfare of Domestic ducks (*Anas platyrhynchos domesticus*), Muscovy ducks (*Cairina moschata domesticus*) and their hybrids (Mule ducks), Domestic geese (*Anser anser f. domesticus*) and Japanese quail (*Coturnix japonica*) in relation to the rearing of breeders, birds for meat, Muscovy and Mule ducks and Domestic geese for foie gras and layer Japanese quail for egg production. The most common husbandry systems (HSs) in the European Union are described for each animal species and category. The following welfare consequences are described and assessed for each species: restriction of movement, injuries (bone lesions including fractures and dislocations, soft tissue lesions and integument damage and locomotory disorders including lameness), group stress, inability to perform comfort behaviour, inability to perform exploratory or foraging behaviour and inability to express maternal behaviour (related to prelaying and nesting behaviours). Animal-based measures relevant for the assessment of these welfare consequences were identified and described. The relevant hazards leading to the welfare consequences in the different HSs were identified. Specific factors such as space allowance (including minimum enclosure area and height) per bird, group size, floor quality, characteristics of nesting facilities and enrichment provided (including access to water to fulfil biological needs) were assessed in relation to the welfare consequences and, recommendations on how to prevent the welfare consequences were provided in a quantitative or qualitative way.

Keywords: On-farm animal welfare, ducks, geese, quail, foie gras, welfare consequences, end the cage age

Requestor: European Commission

Question number: EFSA-Q-2021-00395

Correspondence: ahaw@efsa.europa.eu

Panel members: Søren Saxmose Nielsen, Julio Alvarez, Dominique Joseph Bicout, Paolo Calistri, Elisabetta Canali, Julian Ashley Drewe, Bruno Garin-Bastuji, Jose Luis Gonzales Rojas, Christian Gortázar Schmidt, Mette Herskin, Virginie Michel, Miguel Ángel Miranda Chueca, Barbara Padalino, Paolo Pasquali, Helen Clare Roberts, Hans Spoolder, Karl Stahl, Antonio Velarde, Arvo Viltrop and Christoph Winckler.

Declarations of interest: If you wish to access the declaration of interests of any expert contributing to an EFSA scientific assessment, please contact interestmanagement@efsa.europa.eu.

Acknowledgements: The AHAW Panel wishes to thank the following hearing experts for the support and scientific evidence provided to this scientific output: Magali Blanchet, Ana Chapatte Granados, Daniel Guémené, Joanna Litt and Gaelle Pauthier. The AHAW Panel wishes to thank the following for the support provided to this scientific output: the Seconded National Expert Maria V Veggeland, the trainee Gizella Aboagye and the visiting scientist Elea Bailly-Caumette. The AHAW Panel wishes to acknowledge all European competent institutions, Member State bodies and umbrella stakeholders organisations (European Forum of Farm Animal Breeders, European Poultry Breeders, Euro Foie Gras and European Rural Poultry Association) that provided data for this scientific output.

Waiver: In accordance with Article 21 of the Decision of the Executive Director on Competing Interest Management a waiver was granted to Sandra Edwards, an expert of the Working Group WG/P/AHAW/2020/05 - AHAW Welfare Farm to Fork. Pursuant to Article 21(6) of the aforementioned Decision, the concerned expert was allowed to take part in the drafting and in the discussion of the scientific output but was not allowed to take up the role of, or act as, chairman, vice-chairman or rapporteur of the Working Group. Any competing interests are recorded in the respective minutes of the meetings of the Working Group WG/P/AHAW/2020/05 - AHAW Welfare Farm to Fork.

Suggested citation: EFSA AHAW Panel (EFSA Panel on Animal Health and Animal Welfare), Nielsen SS, Alvarez J, Bicout DJ, Calistri P, Canali E, Drewe JA, Garin-Bastuji B, Gonzales Rojas JL, Schmidt CG, Herskin M, Michel V, Miranda Chueca MA, Padalino B, Roberts HC, Spoolder H, Stahl K, Viltrop A, Winckler C, Berg C, Edwards S, Knierim U, Riber A, Salamon A, Tiemann I, Fabris C, Manakidou A, Mosbach-Schulz O, Van der Stede Y, Vitali M and Velarde A, 2023. Scientific Opinion on the welfare of ducks, geese and quail on farm. EFSA Journal 2023;21(5):7992, 157 pp. https://doi.org/10.2903/j.efsa.2023.7992

ISSN: 1831-4732

The EFSA Journal is a publication of the European Food Safety Authority, a European agency funded by the European Union.

Summary

In the framework of its Farm to Fork (F2F) strategy, the European Commission is undertaking a comprehensive evaluation of the animal welfare legislation, including Council Directive 98/58/EC of 20 July 1998 on the protection of animals kept for farming purposes. Furthermore, the European Commission published the European Citizen Initiative (ECI) 'End the Cage Age' which calls on the EU to prohibit the use of cages, among others for ducks, geese and quail.

Currently, there is no specific EU legislation for the protection of ducks, geese and quail. However, there are recommendations of the Council of Europe concerning Domestic ducks, Muscovy ducks and their hybrids and Domestic geese and their crossbreeds. These recommendations were adopted more than 20 years ago and do not consider the latest scientific findings on the welfare of these species. Against this background, the European Commission requested the European Food Safety Authority (EFSA) to provide the scientific basis for future legislative proposals on the welfare of ducks, geese and quail.

This Scientific Opinion (SO) includes the assessment of welfare of Domestic ducks (*Anas platyrhynchos domesticus*), Muscovy ducks (*Cairina moschata domesticus*) and their hybrids (Mule ducks), Domestic geese (*Anser anser f. domesticus*) and Japanese quail *(Coturnix japonica)* commercially produced in the European Union. Birds for breeding and meat were considered for all the species. In addition, foie-gras production was considered for Muscovy ducks, Mule ducks and Domestic geese, and egg production was considered for Japanese quail. The process of collecting feathers and down, the process of force-feeding for foie gras production, transport and the killing of these animals were not part of this mandate.

In this opinion, EFSA was requested to describe, for each of the species, the main husbandry systems (HSs) with a focus on the accommodation currently used for keeping these birds (ToR-1). EFSA was also asked to describe the relevant welfare consequences with regard to restriction of movement, injuries (bone lesions including fractures and dislocations, soft tissue lesions and integument damage, and locomotory disorders including lameness), group stress and inability to perform comfort behaviour in relation to the HSs described (ToR-2). The welfare consequences 'inability to perform exploratory or foraging behaviour' and 'inability to express maternal behaviour' (in relation to prelaying and nesting behaviours) were also considered. EFSA was also requested to provide qualitative or quantitative recommendations to prevent the negative welfare consequences in relation to the following specific factors (ToR-3): space allowance per bird, size of the group, floor quality, availability, design and size of nesting facilities and enrichment provided (including access to water to fulfil biological needs).

For all species, birds for breeding were categorised as immature (young birds reared for future breeding purposes) and mature breeders that include pedigree, great grandparents, grandparents and parental breeders kept for reproduction. For non-breeding birds kept for meat production, the starting period and growing period were considered in the assessment. In addition, for foie gras production (Muscovy and Mule ducks and Domestic geese), a third period known as the 'overfeeding period' has been taken into account. Japanese quail, intended for egg production, were categorised into immature layers (i.e. young quail that have not reached the laying age) and layers (mature birds kept for egg production).

To carry out this assessment, the scientific literature was reviewed and an ad hoc expert working group was established. Additionally, a joint questionnaire prepared by the European Commission and EFSA was sent to EU Member States and a second questionnaire was sent by EFSA to stakeholder umbrella organisations to retrieve information on the most prevalent HSs used for ducks, geese and quail. For the description of the relevance of the welfare consequences in relation to the HSs, experts initially identified the relevant hazards. Subsequently, expert elicitations were carried out to determine the prevalence of these hazards in relation to each HS(ToR-2). Another elicitation exercise was done to determine space allowance for birds (behavioural model: see ToR-3). Sources of uncertainty related to the data collection and the assessment methodology were described and their overall impact on the conclusions quantified.

As a starting point to assess the welfare of ducks, geese and quail, the Opinion described the biology, genetic selection and production cycle (Section 3.1–3.3). Currently used HSs are described in Section 3.4. Individual cages are mainly used for pedigree duck breeders and male Muscovy ducks for the production of Mule ducks. Collective cages are used for quail breeders (including couple cages) and layer quail during commercial egg production, and in Mule ducks during the overfeeding phase for foie gras production. Other breeder categories and birds for meat production are kept in indoor floor

systems (with or without outdoor access) and outdoor systems depending on the age. For meat and foie gras production during the starting and growing phases, the most common HSs are indoor floor systems (with or without outdoor access) and outdoor systems. For foie gras production during the overfeeding phase, Mule ducks and Domestic geese can be kept in pen systems indoors (elevated or not).

The relevant welfare consequences are described and assessed by taking into account their species-specific characteristics. In addition, the opinion identified animal-based measures (ABMs) relevant to each species and specifically applicable to the welfare consequence under consideration. For each ABM, a definition and interpretation have been provided. ABMs that were related to several welfare consequences were also taken into consideration during the assessment. The relevant hazards were identified for the different welfare consequences and the currently used HSs. The prevalence of the hazards in a given HS was evaluated (highly prevalent hazards: present in > 66% of the farms, moderately prevalent: 33–66% and low prevalence: < 33%). Outcome tables giving an overview of the link between the welfare consequences, husbandry systems and hazards in the four species were prepared. Finally, under the assumption that these hazards contribute equally to the risk that a welfare consequence occurs, the relevance of the welfare consequences in the described HSs was assessed on the basis of the estimated prevalence of the hazards.

For breeders of ducks and quail, the following welfare consequences were identified as more relevant for birds kept in cages than in indoor floor systems: restriction of movement, group stress, inability to perform comfort behaviour, bone lesions, soft tissue lesions and integument damage, locomotory disorder, inability to perform exploratory or foraging behaviour and inability to perform prelaying and nesting behaviour. In the case of geese, these welfare consequences are more relevant for birds in indoor floor systems than in floor systems with outdoor access and in outdoor systems.

For all the species under consideration (during the starting and growing periods), these welfare consequences were more relevant for birds in indoor floor systems than in indoor floor systems with outdoor access and in outdoor systems.

The above-mentioned welfare consequences are more relevant for Muscovy and Mule ducks housed in elevated collective cages and elevated indoor pen systems than in indoor floor pen systems during the overfeeding phase for foie gras production.

All the considered welfare consequences are more relevant for layer quail housed in collective cages than in indoor floor systems.

To reduce the risk of the birds experiencing the welfare consequences listed in the SO, preventive measures were described in ToR-3 in relation to specific factors listed in the mandate.

The potential impact of space allowance (including minimum enclosure area and height) was assessed by a behavioural space model to ascertain the space required by the birds to perform their species-specific behaviour, categorised as stationary, dynamic, bathing, wing flapping and other comfort behaviours. In addition, expert knowledge elicitation was also applied for the assessment of the space allowance. Four different scenarios were described which correspond to different likelihoods to improve animal welfare. These include the space that allows the birds to perform (i) stationary behaviours (with an appropriate inter-individual distance), (ii) all species-specific behavioural categories expressed as the median of the proportion of birds performing each of the selected behavioural categories at any random point in time, (iii) space required for dynamic behaviours considering also functional areas (waterfowl: for bathing, quail: for dust bathing) and (iv) space required for allowing all the birds to perform the dynamic behaviours at the same time.

It is concluded that there is not enough scientific evidence to provide recommendations on the minimum total floor space per enclosure (besides the above-mentioned individual space requirements) that will prevent the welfare consequences of restriction of movement, group stress, locomotory disorders, soft tissue lesions, inability to perform exploratory or foraging behaviour. However, for all the species, a minimum height of enclosure should be provided to allow the animals to adopt their natural posture when standing and wing flapping. These are 66 cm for Domestic ducks; 96 cm for Muscovy and Mule ducks; 127 cm for Domestic geese. In the case of Japanese quail, the minimum height of 150 cm is recommended to permit jump and flight.

Limited information is available on optimal group size. However, birds should not be kept individually as it results in isolation stress. In the case of groups of immature or female birds, a minimum group size of two is recommended for all the species. Considering their social behaviour, a bigger group size may be advantageous. In the presence of a mature male bird, the minimum group size should be based on the adequate sex ratio. However, further research is needed to investigate the welfare consequences at different group sizes, also considering sex ratio.

Birds in indoor systems should be provided with solid and littered floors. The litter material should be dry and friable.

In waterfowl (ducks and geese), additionally floor areas under and around water sources should ensure sufficient drainage (e.g. perforated floor in indoor floor systems). With regard to design and size of nesting facilities, soft and manipulable nesting material should be provided for all birds to facilitate nest building behaviour. For ducks, an enclosed nest (opaque top, sides and back) should be provided. Individual nests for birds kept in groups should allow non-competitive use of nests over time and indications of space and height to allow nesting behaviour are provided. For Domestic ducks, Domestic geese and Japanese quail, a floor level nest is preferred.

For ducks and geese, open water sources should be provided that allow at least head dipping (e.g. open deep bell drinker) and preferably full body contact and incomplete bathing (e.g. shallow bathing trough and showers), or full bathing, swimming and diving (e.g. deep bathing trough) besides the performance of wet preening and dabbling/sieving. In addition, drinking water should be available via separate drinkers. In the case of quail, fine material (e.g. sand) should be provided in specific areas to allow dust bathing behaviour, as well as structures to allow resting under cover. For all birds, additional forage-related enrichment such as silage (waterfowl) or pecking blocks (quail) should be offered. Easily reachable elevated structures such as perches are recommended for Muscovy ducks. For all the species, the use of a covered veranda is recommended when outdoor access is precluded.

Due to the scarce scientific evidence available for the species considered in this opinion, further research is recommended regarding the welfare of the different categories in the identified husbandry systems. Further research is recommended also on the welfare consequences derived from the rearing practices (e.g. overfeeding) which are not covered from the current mandate.

Table of contents

1. Introduction

1.1. Background and terms of reference as provided by the requestor

1.1.1. Background

In the framework of its Farm to Fork strategy, the Commission started a comprehensive evaluation of the animal welfare legislation. This includes the following acts:

- Council Directive 98/58/EC of 20 July 1998 concerning the protection of animals kept for farming purposes[1];
- Council Directive 1999/74/EC of 19 July 1999 laying down minimum standards for the protection of laying hens[2];
- Council Directive 2008/119/EC of 18 December 2008 laying down minimum standards for the protection of calves (Codified version)[3];
- Council Directive 2008/120/EC of 18 December 2008 laying down minimum standards for the protection of pigs (Codified version)[4];
- Council Directive 2007/43/EC of 28 June 2007 laying down minimum rules for the protection of chickens kept for meat production[5];
- Council Regulation (EC) No 1/2005 of 22 December 2004 on the protection of animals during transport and related operations and amending Directives 64/432/EEC and 93/119/EC and Regulation (EC) No 1255/97[6];
- Council Regulation (EC) No 1099/2009 of 24 September 2009 on the protection of animals at the time of killing.[7]

These acts are based on scientific opinions that are outdated. In the context of this evaluation, and possible drafting of legislative proposals, the Commission needs new opinions that reflect the most recent scientific knowledge.

Furthermore, a successful EU Citizen Initiative (ECI) 'End the Cage Age' was published by the Commission on 2 October 2020. The ECI calls for banning the use of cages among others for ducks, geese and quail.

The concept of 'cage' is not precisely defined in the legislation. In its common meaning 'cage' means a box or enclosure having some open work (e.g. wires, bars) for confining or carrying animals. It can cover either individually confined animals or animals kept in groups in a limited space. A cage may also prohibit the confined animal to perform its species-specific natural behaviours. The ECI organisers defined as a cage an enclosure that does not allow the concerned animal to fulfil its natural needs and express its natural behaviour.

- There exists no specific EU legislation for the welfare of ducks, geese, and quail but the Recommendation of the Council of EU concerning Domestic ducks.[8]
- Recommendation of the Council of EU concerning Muscovy ducks and hybrids Muscovy and Domestic ducks.[9]
- Recommendations of the Council of EU concerning Domestic geese and their crossbreeds.[10]

---

[1] OJ L 221 , 8.8.1998, p. 23.
[2] OJ L 203, 3.8.1999, p. 53.
[3] OJ L 10, 15.1.2009, p. 7.
[4] OJ L 47, 18.2.2009, p. 5.
[5] OJ L 182, 12.7.2007, p. 19.
[6] OJ L 3, 5.1.2005, p. 1.
[7] OJ L 303, 18.11.2009, p. 1.
[8] Standing Committee of the European Convention for the Protection of animals kept for farming purposes (T-AP) – Recommendation concerning Domestic ducks (*Anas platyrhynchos*) adopted by the Standing Committee on 22 June 1999; https://www.coe.int/t/e/legal_affairs/legal_co-operation/biological_safety_and_use_of_animals/farming/Rec%20ducks.asp#TopOfPage
[9] Standing Committee of the European Convention for the Protection of animals kept for farming purposes (T-AP) – Recommendation concerning Muscovy ducks (*Cairina moschata*) and hybrids muscovy and Domestic ducks (*Anas platyrhynchos*) adopted by the Standing Committee on 22 June 1999; https://www.coe.int/t/e/legal_affairs/legal_co-operation/biological_safety_and_use_of_animals/farming/Rec%20Muscovy%20ducks%20E%201999.asp#TopOfPage
[10] Standing Committee of the European Convention for the Protection of animals kept for farming purposes (T-AP) – Recommendation concerning Domestic geese (*Anser anser f. domesticus, Anser cygnoides f. domesticus*) and their crossbreeds adopted by the Standing Committee on 22 June 1999 https://www.coe.int/t/e/legal_affairs/legal_co-operation/biological_safety_and_use_of_animals/farming/Rec%20geese.asp#TopOfPage

serve as a baseline to take for the implementation of Council Directive 98/58/EC. These recommendations were adopted more than 20 years ago and do not consider the latest scientific findings.

Against this background, the Commission would like to request EFSA to review the available scientific publications and possibly other sources to provide a sound scientific basis for future legislative proposals.

This request is about the protection of ducks, geese and quail related to the production of meat (including foie gras), to the production of eggs and to breeding.

1.1.2. Terms of references

EFSA is requested to provide a scientific opinion on the impact of caged -systems on the welfare of

- Domestic ducks (species *Anas platyrhynchos*),
- Muscovy ducks (species *Cairina moschata*) and hybrids of Domestic and Muscovy ducks,
- Geese (*Anser anser f. domesticus*, *Anser cygnoides f. domesticus*) and their crossbreeds,
- Commonly farmed quail (family Phasianidae, e.g. species Common quail (*Coturnix coturnix*) and Japanese quail (*Coturnix japonica*), and family Odontophoridae)

related to the production of meat (including foie gras), to the production of eggs and to breeding. The request refers to:

- The keeping of breeders;
- The keeping of ducklings/ chicks and pullets before they start laying eggs;
- The keeping of layers, including breeders, during the production of eggs;
- The keeping of animals for meat production;

The process of collecting feathers and down, the process of force-feeding for fatty liver production, the transport and the killing of the animals are not part of this request.

For this purpose, the EFSA is asked, for each species (or group of species where comparable in view of their welfare) and category of animals as listed above, to describe the welfare of the animals and the associated risks by:

a) Describing the **main husbandry systems** with a focus on the accommodation currently used in the EU for keeping these animals (**ToR-1**);
b) Describing the relevant **welfare consequences** concerning restriction of movement, injuries, group stress and inability to perform comfort behaviour related to these husbandry systems (**ToR-2**);

Relevance will not need to be based on a comprehensive risk assessment, but on EFSA's expert opinion regarding the severity, duration and occurrence of each welfare consequence;

c) Providing recommendations on qualitative or quantitative criteria to prevent the negative welfare consequences listed in point b for the concerned species in relation to (**ToR-3**):
    - space allowance (three-dimensional) per animal,
    - maximum size of the group,
    - floor quality,
    - availability, design and size of nesting facilities,
    - enrichment provided (including access to water to fulfil biological needs).

1.1.3. Interpretation of the terms of reference

In the framework of its Farm to Fork strategy, the European Commission (EC) started a comprehensive evaluation of the animal welfare legislation and has asked EFSA to review the available scientific publications and possibly other sources to provide a sound scientific basis for future legislative proposals on the protection of ducks, geese and quail.

This Scientific Opinion (SO) concerns the welfare assessment of ducks, geese and quail on farm, in relation to the production of meat (including foie gras), to the production of eggs and to breeding.

A welfare assessment may consist of two components, i.e.: the risk assessment, with identification of the negative welfare consequences (adverse effects) that occur to an animal in response to a hazard, and the benefit assessment, with identification of positive welfare consequences; however, in the current document EFSA addressed the EC mandate by focusing on certain adverse effects only. In the context of this SO, the adverse effects are called 'welfare consequences'.

Four species are considered in this SO and are: (i) *Anas platyrhynchos domesticus* (Domestic ducks), (ii) *Cairina moschata domesticus* (Muscovy ducks) and hybrids between a female Domestic duck and a male Muscovy duck (Mule ducks), (iii) *Anser anser f. domesticus* (Domestic geese) *and* (iv) *Coturnix japonica* (Japanese quail).

Hybrids between female Domestic duck and male Muscovy duck are called 'Mule' or 'Mulard' ducks. These two terms are synonyms and, in this SO, 'Mule ducks' is used. The reverse hybrid (female Muscovy duck and male Domestic duck) is called 'Hinny' and is not used for the same purposes as Mule ducks; therefore, the welfare of hinnys is not considered in this SO. Although some breeding farms of 'Mallard duck' exist, this species has been excluded from the current assessment, because mallards are wild representatives of the *Anas platyrhynchos* species and, thus, out of the scope of the mandate.

In contrast to the request in the mandate, the species *Anser cygnoides f. domesticus* and its hybrids with Domestic geese*, Coturnix coturnix,* the family *Odontophoridae* and quail hybrids have not been included in the current assessment because these species/families are not farmed for any significant meat or egg production in the EU and are not likely to be raised for those purposes in the future. Similarly, ducks, geese and quail kept for gaming, hunting or hobby purposes are not in the scope of the mandate, and therefore will not be assessed in this SO.

Diverse descriptive categories pertain to each species; Table 1 shows the animal species and descriptive categories assessed in this SO with indication of the relevant production purposes (meat, meat and foie gras, eggs for human consumption or breeding).

In all species, **breeders** are raised in different husbandry systems during the immature and mature physiological stages. Immature breeders will be considered as the first descriptive category.

'Immature breeders' are young birds during their growing period that are reared for breeding purposes.

Mature breeders will be subdivided into four descriptive categories: pedigree (pure line selection nucleus, with known pedigree); great-grandparents and grandparents (both pure lines but generally with unknown pedigree), and parental breeders (intercross-hybrid strain, with unknown pedigree). Each category can be raised in different husbandry systems at different periods of breeding.

'Pedigree breeders' are reproducers from the pure selected lines (selection nucleus). 'Great-grandparent breeders' are reproducers from the pure selected line with known or unknown pedigree records. 'Grandparent breeders' are, as for great-grandparents, reproducers from pure selected lines deriving from the pedigree selected lines (selection nucleus) that have known or unknown pedigree. 'Parental breeders' are reproducers of unknown pedigree, each sex being either an inter-cross of 2 pure lines or from a pure line. Their offspring are intended for production of meat, meat and foie gras or eggs for human consumption and will not be kept as breeders themselves.

All the four species and hybrids considered in this SO are kept for **meat production**. In this SO, the rearing phase has been subdivided in two periods: (i) the 'starting period' and (ii) the 'growing period'. In quail, these two periods have been combined because the birds are mostly kept in the same husbandry system.

In the case of Muscovy and Mule ducks, and Domestic geese reared for the production of **foie gras**, a third period called the 'overfeeding period' has also been considered in addition to the starting and growing periods. However, the use of Muscovy ducks for foie gras production is currently limited.

For the **production of eggs for human consumption**, only the Japanese quail is assessed in this SO. Although limited production of table eggs from ducks and geese exists, in the knowledge of the EFSA experts these represent niche productions and will not be included in the current assessment. In this context, Japanese quail are categorised as (i) 'immature layers', which are quail reared for laying purposes, but which have not yet reached the laying age, and (ii) 'layers', covering birds in the egg production phase. For detailed information on the production cycles see Section 3.3.

Table 1: Summary of species and descriptive categories assessed in this Scientific Opinion, with indication of the production purposes

Animal species	Descriptive categories depending on the production purposes			
	Breeding	**Production of meat**	**Production of meat and foie gras**	**Production of eggs**
Domestic ducks	(Including females for Mule duck production) – Immature breeders – Pedigree breeders – Great-grandparent breeders – Grandparent breeders – Parental breeders	– Starting period – Growing period	na	(a)
Muscovy and Mule ducks	(Including males for Mule duck production) – Immature breeders – Pedigree breeders – Great-grandparent breeders – Grandparent breeders – Parental breeders	– Starting period – Growing period	– Starting period – Growing period – Overfeeding period	na
Domestic geese	– Immature breeders – Pedigree breeders – Great-grandparent breeders – Grandparent breeders – Parental breeders	– Starting period – Growing period	– Starting period – Growing period – Overfeeding period	(a)
Japanese quail	– Immature breeders – Pedigree breeders – Great-grandparent breeders – Grandparent breeders – Parental breeders	– Starting and growing period(b)	na	Immature layers Layers

(a): In some EU MSs, there is limited production of eggs for human consumption; however, in the knowledge of the EFSA experts, these represent only niche production; na = not applicable.
(b): In quail, these two periods have been combined because the animals are mostly kept in the same system.

This is the first EFSA SO addressing the welfare of ducks, geese and quail. Each species is reviewed in terms of general biology, particularly in relation to behaviour and physiology (see Sections 3.2), and the domestication from the ancestors. This information is intended as a background for the discussion of the welfare consequences in ToR-2 of this SO.

ToR-1, Section 3.4, **describes the husbandry systems for each animal species under consideration** with a focus on the most common types of housing that are currently used in the EU for keeping these animals, including cage and non-cage systems. EFSA experts consider the ECI organisers' definition of cages to be ambiguous and include different husbandry systems, some of which are currently considered 'non-caged systems'. In this regard, it is important to highlight that when the term 'cage' is used in this SO, it refers to the terminology commercially or practically used for a specific husbandry system.

The EC provided further clarification on the mandate with indications to describe and assess the most common husbandry systems without focusing only on those called, in the common usage, 'cage'.

EFSA was also requested to describe the following **welfare consequences** related to the husbandry systems described under ToR-1: restriction of movement, injuries, group stress and inability to perform comfort behaviour (**ToR-2**; Section 3.5). These welfare consequences can lead to negative affective states such as fear, pain and/or distress. All the welfare consequences listed in the mandate are included in the EFSA guidance except for injuries (EFSA AHAW Panel, 2022a; see also Section 2.2.3.2). Injuries were interpreted as a combination of several welfare consequences that include 'bone lesions (including fractures and dislocations)', 'soft tissue lesions and integument damage', and 'locomotory disorders (including lameness)'. Although not specifically requested in the mandate, the EFSA experts included two additional welfare consequences in the current assessment: 'inability to perform exploratory or foraging behaviour' and 'inability to express maternal behaviour', but limiting the latter assessment to 'prelaying and nesting behaviours'. These welfare consequences are considered relevant to cages and for assessing some of the factors listed in ToR-3, in relation to e.g. 'floor quality', 'enrichment' and 'nesting facilities', respectively (Section 3.6). This led to a list of eight welfare consequences described in this SO.

As reported in previous EFSA opinions (EFSA AHAW Panel, 2023a,b), the scientific literature on birds' welfare often references to birds' behavioural needs and preferences. These terms have been defined by (Rowe and Mullan, 2022) and are used as such in this SO. A behavioural need is related to behaviours, which are part of the natural repertoire and are primarily motivated by internal causal factors (Weeks and Nicol, 2006). Animals will attempt to perform these behaviours even in the absence of an optimum environment or the necessary resource. For example, the performance of 'sham' dust bathing on a wire floor, in the absence of a preferred substrate, is a good example of a 'behavioural need'. A behavioural preference indicates the relative outcome when a bird has been provided a choice (e.g. the choice between different foraging, nesting or dust bathing substrates).

Each welfare consequence is described considering species-specific issues. A list of animal-based measures (ABMs) to assess the welfare consequences is provided and species-specificities are highlighted. Definition and interpretation of the ABMs are reported. ABMs that are not exclusively linked to a specific welfare consequence but might be associated with several welfare consequences are also considered. The main hazards leading to the welfare consequences in the diverse husbandry systems were identified and assessed. For the purpose of this mandate, only those hazards related to the husbandry systems (i.e. structure-related) and to the factors requested in ToR-3 were assessed. The assessment of the risk that a welfare consequence occurs (called 'the relevance of a welfare consequence' in this SO) in a husbandry system was based on the prevalence of the hazards in each husbandry system.

ToR-3 explores (Section 3.6) the **relationship between specific factors requested in the mandate and the welfare consequences**. The specific factors are the space allowance and enclosure height per animal, maximum group size, floor quality and the availability, design and size of nesting facilities, as well as the enrichment provided (including access to water to fulfil biological needs). For the assessment, 'maximum group size', was addressed as 'size of the group' because it included both minimum and maximum group sizes, to better respond to the request of the mandate in relation to the ECI initiative.

When possible, for these factors, quantitative or qualitative recommendations allowing the prevention of the welfare consequences were provided. It should be noted that the effect of each factor on animal welfare will be considered separately. However, quantification given is subject to considerable uncertainty because it does not consider the interaction between factors and confounding in study designs. Therefore, the recommendations consider the other factors as following good practice or according to the other recommendations made in this opinion.

2. Data and methodologies

2.1. Data

2.1.1. Data from literature

Information from the papers selected as relevant from the literature search (LS) described in Section 2.2.1 and from additional literature identified by the EFSA experts was used for a narrative description and assessment to address ToRs 1, 2, 3 (see relevant Sections in the Assessment).

2.1.2. Data from Member States and stakeholder umbrella organisations

Due to the scarcity of information in the literature on the most common husbandry systems used for ducks, geese and quail in the EU (ToR-1), information on the description of husbandry systems was requested by EFSA via ad hoc questionnaires to Member State (MS) representatives (see Section 2.2.2.1) and stakeholder umbrella organisations (Section 2.2.2.2).

2.2. Methodologies

This SO follows the protocol detailed in the methodological guidance that was developed by the EFSA AHAW Panel to deal with all the mandates in the context of the Farm to Fork strategy revision (EFSA AHAW Panel, 2022a).

According to the protocol, EFSA translated the assessment questions listed in the mandate (ToRs 1, 2 and 3) into more specific subquestions. These are interrelated, meaning that the outcome of each subquestion is necessary to proceed to the next subquestion.

The translation of the assessment questions into subquestions is mapped in Table 2.

Three main approaches were used to develop the subquestions: (i) literature search, (ii) consultation with MSs and Stakeholder umbrella organisation representatives, followed by (iii) expert opinion through WG discussion. These methodologies were used to address the mandate extensively (see relevant sections in the Assessment, Section 3).

The general principle adopted in the preparation of this SO was that relevant reference(s) would be cited in the text when published scientific literature is available, and when no references are provided, it is intended as expert opinion.

Table 2: Overview of translation of the mandate assessment questions into subquestions

Assessment questions		Subquestions	
Translation of the mandate ToRs			
i.	**Describe the current husbandry systems**	***1.*** *Identify the most common husbandry systems for Domestic ducks, Muscovy and Mule ducks, Domestic geese and Japanese quail for each descriptive category.*	***2.*** *Describe the husbandry systems.*
		Aim: Husbandry systems to be considered in the assessment are identified and selected to be representative of the currently used systems in the EU. Approach: literature review, consultation with MSs and Stakeholders umbrella organisations representatives, and expert opinion via group discussion. Relationship with assessment question: This subquestion is necessary for the overall assessment question requiring the description of the husbandry systems.	Aim: All the husbandry systems for each descriptive category identified and selected from subquestion 1 are described narratively. Approach: literature review and MSs and Stakeholders' consultation complemented by expert opinion via group discussion. Relationship with assessment question: This corresponds to the assessment question and is necessary for the next assessment question.
ii.	**Describe the relevant welfare consequences concerning restriction of movement, injuries, group stress and inability to perform comfort behaviour related to these husbandry systems**	***3.*** *Identify the welfare consequences to assess, and the related ABMs.*	***4.*** *Describe the welfare consequences and the related ABMs.*
		Aim: To translate the welfare consequences of the mandate into the welfare consequences of the guidance, and identify other welfare consequences that are relevant for the assessment of subquestions 7 and 8. To identify the related ABMs. EFSA generated a list of welfare consequences common for all F2F mandates, which was used as a basis for this identification (EFSA AHAW Panel, 2022a). Approach: Literature review and expert opinion via group discussion (see focus and full resulting list in Section 3.5). Relationship with assessment question: The identification of the welfare consequences to take into consideration is necessary for the assessment of their relevance in relation to the husbandry systems (subquestion 5) and for the assessment of the husbandry systems in relation to the specific factors (subquestions 7 and 8). The identification of the related ABMs is functional to the description of the welfare consequences (subquestion 4).	Aim: To define the welfare consequences in accordance to the guidance and highlighting species specificities for Domestic ducks, Muscovy and Mule ducks, geese and quail; to describe the welfare consequences, and to define and interpret the related ABMs. Approach: Literature review and expert opinion via group discussion. Relationship with assessment question: This corresponds to the assessment question and is necessary for the next assessment question.

Assessment questions		Subquestions	
		5. *To identify the hazards leading to the welfare consequences and the relation with the husbandry systems.*	**6.** *Assess the relevance of the welfare consequences in relation to the husbandry systems.*
		Aim: To identify the hazards leading to the welfare consequences and relate them to the husbandry systems described in subquestion 2. Approach: expert opinion via group discussion. Relationship with assessment question: The link of the hazards, husbandry systems and welfare consequences is functional for assessing the relevance of the welfare consequences in relation to the husbandry systems (subquestion 6).	Aim: To assess the prevalence of the hazards in the husbandry systems and assess the relevance of the welfare consequences on the basis of the number of highly prevalent hazards. Approach: Literature review and expert opinion via EKE linking the hazards, husbandry systems and welfare consequences. Relationship with assessment question: This corresponds to the assessment question and is necessary for the next assessment question.
iii.	**Provide recommendations on qualitative or quantitative criteria to prevent the negative welfare consequences listed in point ii. for the concerned species in relation to a list of factors**	**7.** *Describe the factors listed in the mandate in relation to the species: space allowance (three-dimensional) per animal, maximum size of the group, floor quality, availability, design and size of nesting facilities, enrichment provided (including access to water to fulfil biological needs).*	**8.** *Describe the measures to prevent the negative welfare consequences described in subquestion 3.*
		Aim: To interpret and describe the factors listed in the mandate in relation to the welfare consequences identified in subquestion 3 Approach: EKE for the factor space allowance; expert opinion via group discussion for the other factors; Relationship with assessment question: This corresponds to the assessment question.	Aim: To identify measures to prevent the welfare consequences identified in subquestion 3 Approach: Literature review and expert opinion via group discussion Relationship with assessment question: The preventive measures are identified in relation the welfare consequences of subsection 7

2.2.1. Literature search

A broad literature search was performed to identify studies providing information on ducks, geese and quail and in particular to address the subquestions requiring the description of husbandry systems, welfare consequences, ABMs, hazards and preventive measures.

The search was restricted to records published in the last 20 years. The retrieved information was saved in Web of Science and relevant results (records) appearing at a later stage were screened and added to the pool of papers available to the experts.

In addition, relevant articles, review articles, websites and key reports were checked, irrespective of the year of publication, and included if considered relevant.

Details of the literature search strategy and number of the records that supported the process are provided in Appendix A.

2.2.2. Consultation of stakeholders

2.2.2.1. Member States

Due to the scarcity of information about the most common husbandry systems used for ducks, geese and quail (ToR-1) in the EU, the European Commission and EFSA prepared a joint questionnaire that was sent to EU MS representatives dealing with animal welfare. Main questions focused on information on the existing population of ducks, geese and quail in each MS (e.g. on the number of animals and number of farms) and on the most common husbandry systems and practices that are used for keeping these animals (a template of the questionnaire is reported in Annex A).

2.2.2.2. Stakeholder umbrella organisations

With specific focus on the husbandry systems for keeping breeders of Domestic ducks, Muscovy ducks, Domestic geese and Japanese quail, a specific questionnaire was prepared by EFSA experts and sent to stakeholder organisations covering these species. Main questions focused on information on the breeder categories, main husbandry systems and features that are currently used in the EU (a template of the questionnaire is reported in Annex B). Data were provided by the following organisations: European Forum of Farm Animal Breeders (EFFAB), European Poultry Breeders, Euro Foie Gras and European Rural Poultry Association. In addition, three EFFAB representatives joined a working group meeting of the EFSA experts to answer follow-up questions as hearing experts.

2.2.3. Experts opinion through group discussion

To address ToR-1, ToR-2 and ToR-3, as explained in Table 2, expert opinion was mainly elicited via group discussion on the basis of experts' own knowledge and the information retrieved from the available literature and the consultation of stakeholders (see Section 2.2.1). In some cases, specific exercises were carried out on the basis of the expert opinion:

1) Assessment of the likelihood that a hazard is present in a given husbandry system and development of outcome tables (ToR-2, Section 2.2.3.2),
2) Assessment of the welfare in relation to 'space allowance' (ToR-3, Section 2.2.3.4).

2.2.3.1. Describing husbandry systems (ToR-1)

To address subquestions 1 and 2 (**ToR-1**), the data on the husbandry systems and current practices to keep ducks, geese and quail obtained from the literature were complemented by information provided by stakeholders (see Sections 2.1.2 and 2.2.2) and further reviewed and complemented by the EFSA experts. It needs to be noted that each husbandry system is described considering the factors that may be associated with an impact on animal welfare that are listed in ToR-3 of the mandate (see Section 3.4).

2.2.3.2. Describing animal welfare (ToR-2)

The list of welfare consequences common for all F2F mandates that was generated by the EFSA AHAW Panel was the basis of the expert group discussion to address subquestion 3 on the identification of the welfare consequences that are relevant for addressing ToR-2 in the species under consideration. The eight welfare consequences have been described by the EFSA experts in relation to the species under assessment.

For the assessment of the relevance of the welfare consequences (see Section 3.5), based on the occurrence, severity and duration, the EFSA experts have identified related ABMs and associated the relevant hazards leading to the welfare consequences according to the husbandry systems where the hazards are considered most likely to occur.

ABMs linked to the welfare consequences are listed and their definition and interpretation are the outcomes of group discussion on the basis of the available literature considered most relevant for the specific animal species or from scientific sources on other poultry species (e.g. EFSA AHAW Panel, 2023a,b). In general, the ABMs are applicable across all the species considered, although scientific literature for most of them is scarce. Where species-specific references are missing, the ABMs have been included based on expert opinion, taking account of practical experience and extrapolation from other bird species (e.g. EFSA AHAW Panel, 2023a,b). Subsequently, an assessment of the hazards leading to the welfare consequences and their relationship with the husbandry systems is provided. One hazard may lead to more than one welfare consequence (EFSA AHAW Panel, 2012) and welfare consequences may lead directly to other welfare consequences.

There are ABMs that can be used to assess more than one welfare consequences (so-called 'iceberg indicators', see Appendix B). In some cases, these indicators were only used in the literature to assess the effect of the factors listed in ToR-3 of the mandate (see Section 3.6). Many welfare consequences (also in addition to the ones assessed in Section 3.5) can affect these iceberg indicators but they are not specific for any of them.

Once the relevant hazards for each welfare consequence were identified, the next step was to assess the prevalence of these hazards in the different husbandry systems. To answer the term of reference on the description of the welfare consequences in the relevant husbandry systems, a semi-quantitative EKE exercise was carried out.

The EKE exercise was done separately for each husbandry system and production type (breeders, meat, foie gras, table eggs) resulting from subquestion 1 (Table 2) and included the assessment of hazards in these systems. For each combination, EFSA experts were asked to assess the proportion of farms in a given husbandry system for Domestic ducks, Muscovy and Mule ducks, Domestic geese and Japanese quail, in which the hazard is present (as described in ToR-1).

Expert opinion was elicited in four phases:

- **First phase**: EFSA experts **identified the relevant hazards** for each welfare consequence under assessment. The relevance of these hazards was qualitatively estimated based on expert opinion with consideration of their impact on the magnitude of the welfare consequence (severity, duration and occurrence).
- **Second phase:** Eight experts evaluated the list of relevant hazards and assigned individually, for each bird category, the **proportion of farms in which the hazard is present** in a given husbandry system (described in ToR-1) to one of three categories (highly prevalent: present in > 66% of the farms, moderately prevalent: 33–66% and low prevalence: < 33%).
- **Third phase:** The assigned category of each expert was transformed into numbers (highly prevalent = 3, moderately prevalent = 2, low prevalence = 1). The classical median values among the experts were calculated. For each welfare consequence and husbandry system, the hazards with a median > 2 were classified as highly prevalent, hazards with a median of between 1.5 and 2 as moderately prevalent and hazards with median below or equal to 1 as low prevalence. The results, including the welfare consequences associated with these hazards, were included in **outcome tables** (Tables 26–29) where highly prevalent hazards were marked in red, prevalent hazards in orange and low prevalence hazards in green.
- **Fourth phase:** For each of the eight welfare consequences, the proportion of hazards scored as highly prevalent in each husbandry system was calculated for each welfare consequence and visualised in Tables 30–33. With the assumption that all hazards contribute equally to a welfare consequence, the **relevance of the welfare consequences** in each husbandry system was assessed on the basis of the number of highly prevalent hazards.

2.2.3.3. Assessment of the welfare in relation to the factors (ToR-3)

The space requirements were assessed by considering three factors: space allowance, minimum enclosure area, and height. Space allowance was assessed by EKE using a behavioural space model. Minimum enclosure area and height were addressed narratively.

The other factors listed in ToR-3, i.e. maximum size of the group, floor quality, availability, design and size of nesting facilities, enrichment provided (including access to water to fulfil biological needs), were assessed narratively using the available literature and by expert opinion through group discussion.

Due to the lack of data, Muscovy and Mule ducks are considered together.

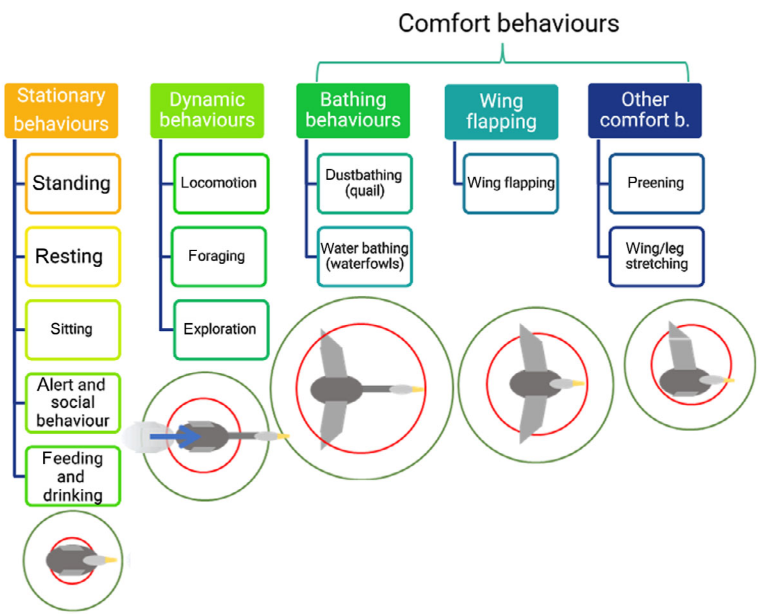
2.2.3.4. Space allowance

2.2.3.4.1. Behavioural space model for determining space allowance

A quantitative modelling approach was applied to calculate the space allowance that would allow Domestic, Muscovy and Mule ducks, Domestic geese and Japanese quail to express their behavioural repertoire. Therefore, a version of the 'behavioural model to estimate space allowance requirements' for domestic fowls (EFSA AHAW Panel, 2023b) was used to estimate the space required for different behaviours to be performed by the four different species studied in this scientific opinion. Five behavioural categories (see Figure 1) were estimated reflecting the behavioural needs of the birds: (i) stationary behaviour (standing, resting, sitting, alert and social behaviour, feeding, drinking), (ii) dynamic behaviour (locomotion, foraging, exploration) and the comfort behaviours, (iii) wing flapping, (iv) preening and wing/leg stretching, and specifically, (v) bathing behaviour (water bathing in waterfowl and dust bathing in quail).

These behavioural categories reflect major parts of a typical ethogram of the bird species in focus, presuming that allowing sufficient space for these behaviours enables the animal to achieve a higher welfare state. The behaviours of swimming for waterfowl and flying for quail were excluded from the model because these require space and facilities (e.g. open water and height) not present in most reported studies or in commercial systems. Space for these behaviours is considered separately in narrative text (see Sections 3.6.1.2 and 3.6.1.3 and 3.6.5.1).

Space needed to perform each of the behaviours in the above categories and available data on the proportion of birds performing each of these behaviours in a typical scan sampling situation in a non-cage environment were used to calculate space requirements (see for more detail Section 2).



Red circle: Space occupied by the bird expressing the behaviour. Green circle: Space occupied by the bird expressing the behaviour taking into account the inter-individual distance as part of social behaviour.

Figure 1: Behavioural categories and behaviours considered in the model with a graphical representation of the required space

2.2.3.4.2. Outline of behavioural space model for ducks, geese and quail

The space allowance (SA) is represented in Equation 1 as weighted average of the different behaviours, where A_c represents the area required by a bird to perform each of the specific behavioural categories c, and PB_c represents the proportion of birds performing each of the behavioural categories:

$$SA = \sum_{c}^{N} (A_c \times PB_c) \tag{1}$$

$$c = 1\text{–}5$$

c = 1) stationary behaviours, 2) dynamic behaviours, 3) bathing behaviours, 4) wing flapping, 5) preening and leg/wing stretching.

Area A_c is composed of three elements. First, the surface area of the birds was calculated and then expressed in the form of a circle (yellow area 'a' in Figure 2) for subsequent calculation. Secondly, the inter-individual distances between the birds were added for each behavioural category.

Inter-individual distances are defined by the average distance between two individual animals. These distances are influenced by various factors, including the behaviour expressed at that moment by each animal, the context and their previous experience. Maintaining inter-individual distances is a part of social behaviour and a way to create an area free of conspecifics around an individual. The distance is driven by the tension between avoidance of social conflict and maintenance of social cohesion. An appropriate inter-individual distance therefore also functions to reduce negative aggressive interactions and to promote positive behaviour and behavioural diversity. To maintain an appropriate inter-individual distance, each animal needs sufficient space. In selecting an appropriate space allowance, i.e. stocking density and pen size, it is important to know the preferred inter-individual distances of individuals in the context under consideration.

For waterfowl, inter-individual distance was calculated based on morphometric data of the distance from the base of the neck to the bill. For quail, the inter-individual distance was calculated based on an allometric scaling originating from estimates for broilers (EFSA AHAW Panel, 2023b).

The model includes a minimal distance 'D' between animals performing the same behaviour. This inter-individual distance is interpreted as an additional band of the radius around the circle (Equation 2).

$$R = \frac{D}{2} \tag{2}$$

The area A required to perform behaviours subsumed in each behavioural category is expressed in Equation 3 below.

$$A_c = \pi \times (r_c + R_c)^2 \tag{3}$$

$$c = 1\text{–}5$$

c = 1) stationary behaviours, 2) dynamic behaviours, 3) bathing behaviours, 4) wing flapping, 5) preening and leg/wing stretching.

A is the total space (area), being the space covered by the bird, with r being the radius representing the animal and R being the additional radius to reflect the inter-individual distance D/2 since values for inter-individual distances were divided by two birds.

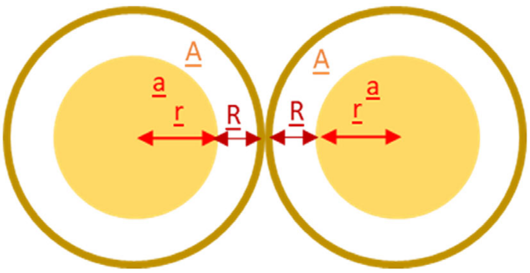


Figure 2: The space A occupied by two animals depicted as two circles in yellow (a1 and a2) with the inter-individual space (R1 and R2)

Assuming that the animals will optimally and equally distribute in an area (Figure 3), we observe a small part, which is not covered by circles. This area is called ω and is calculated with equation 4 (Equation 4) (Steinhaus, 1999).

$$\omega = \frac{A}{0.9069} \quad (4)$$

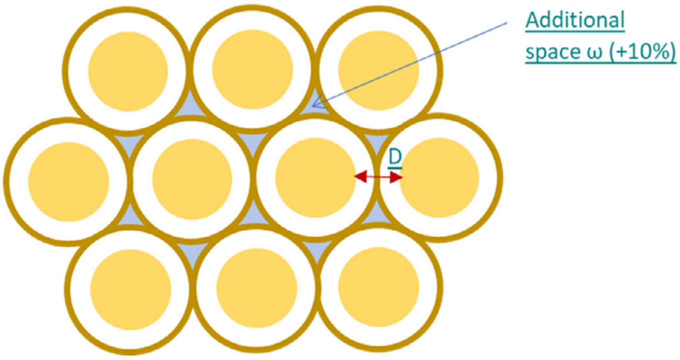


Figure 3: Depiction of the entire flock (yellow circles) with the additional space ω between animals and the inter-individual distance D

Theoretically, assuming that all birds are fully synchronised in performing specific behaviours, the necessary space allowance would be the maximum of the required areas Ac, which corresponds to area required for bathing behaviours.

2.2.3.4.3. Data collection

Data on the behavioural categories were extracted from the available literature. Only papers considering meat birds close to slaughtering or sexually mature layer quail (general assumptions are reported in Table 3), all of them in non-cage systems, were used for the data extraction. For the stationary behaviours, the space occupied was assessed with planimetric data that were only available for Domestic and Muscovy ducks. For these two species, the maximum space covered when a stationary behaviour is performed (standing, sitting) was considered. Data for geese and quail needed extrapolation from morphological data retrieved from available scientific and commercial literature. This extrapolation was based on data given for body length, body width and weight predominantly. The outcome of this calculation was the start for the Expert Knowledge Elicitation focusing on the space covered by a goose and quail while performing a stationary behaviour.

Table 3: General assumptions

	Domestic ducks	**Muscovy and Mule ducks[(a)]**	**Domestic geese**	**Japanese quail**
Weight	3.0 kg	4.4 kg	6.7 kg	0.3 kg
Age	Before slaughtering	Muscovy ducks: Before slaughtering Mule ducks: end of growing period, before the overfeeding phase	Before slaughtering or before the overfeeding phase in case of geese for foie gras production	Sexually mature layers and broilers before slaughtering (7 weeks of age)

(a): Due to lacking data, Muscovy and Mule ducks are considered together.

2.2.3.4.4. Assessment of space for combined behavioural categories

The assessment of space for combined behavioural categories was based on two aspects:

1) Determination of the space needed for the bird to perform each behavioural category
2) Assessment of % of birds performing each behavioural category at any random point in time

Since specific data on space needed for different behavioural categories were not available, the approach was based on the question: What is the relative factor to adjust the morphological space of stationary behaviour to other categories of behaviour?

Therefore, the body dimensions of ducks, geese and quail were considered, paying attention to the prolonged neck/head/bill in waterfowl compared to domestic fowl. Since specific behavioural categories include stretched or flapped wings, wing length including feathers was taken into consideration based on the morphological data available (see Section 3.6.1.1.1 for the results).

The % of animals performing each behavioural category in an instantaneous scan was extracted from the literature. Only studies that had used comparable definitions for the behaviours were considered. Data on stationary behaviour (standing, resting, sitting, alert and social behaviour, feeding, drinking), active behaviour (locomotion, foraging, exploration) and the comfort behaviours wing flapping, preening and wing/leg stretching, and specifically bathing behaviour (water bathing in waterfowl and dust bathing in quail) were extracted as far as available from the literature.

The number of studies per behaviour is shown in Table 4.

Table 4: Total number of extracted values per category and species and the total number of studies selected for the behavioural categories considered in this opinion

Behavioural category	Domestic ducks	Muscovy and Mule ducks	Domestic geese	Japanese quail
Stationary	25	9	47	14
Dynamic	13	6	29	6
Comfort	9	3	17	3
Wing flapping	1	1	1	1
Bathing	3	2	1	3
Studies in total	6	2	5	4

The total number of extracted values/data points (N, Table 5) as well as their minimum, median and maximum of proportion of birds showing the behaviours were calculated (Table 5).

Table 5: Data on the proportion of birds expressing each of the five selected behavioural categories at any given point in time for ducks, geese and quail, extracted from the literature and given as Median (min; max)

Behavioural category	Domestic ducks	Muscovy and Mule ducks	Domestic geese	Japanese quail
Stationary	68.5%	64.0%	49.7%	36.5%
	(52.1%; 85.0%)	(56.4%; 68.9%)	(16.4; 75.3%)	(29.1%; 70.9%)
Dynamic	13.8%	15.1%	23.0%	29.3%
	(5.3%; 21.2%)	(4.8%; 15.1)	(6.7%; 39.6%)	(18.5%; 31.7%)
Comfort	12.4%	16.2%	14.9%	11.6%
	(8.4%; 19.2%)	(14.9%; 25.2%)	(5.9%; 28.7%)	(3.5%; 24.8%)
Wing flapping	1.3%	0.2%	0.3%	0.1%
	(1.3%; 1.3%)	(0.2%; 0.2%)	(0.3%; 0.3%)	(0.1%; 0.1%)
Bathing	2.1%	1.5%	4.2%	2.2%
	(2.0%; 2.8%)	(1.5%; 1.5%)	(4.2%; 4.2%)	(1.0%; 9.5%)

2.2.3.4.5. Standardisation of the proportion of the behaviours

At the beginning, when necessary, the studies' results were harmonised to a common unit, the proportion in time of a specific behaviour. The total for the mean/median proportion of all behaviours found did not add up to 100% per reference due to (i) sum of behaviours in ethogram did not sum up to 100% in the original study and/or (ii) not all data were extracted from the original study, only those that referred to the selected five behavioural categories. Therefore, in the final model, the proportions for each behaviour were standardised to a total of 100%. This standardisation step was conducted to create a behaviour profile that corresponds to an 'estimated behaviour profile' for Domestic, Muscovy and Mule ducks, Domestic geese, Japanese quail, respectively.

2.2.3.4.6. Limitations of the behavioural model

Not all definitions of the different behaviours are the same across the 17 studies used for data extraction. As there is no standardised and uniformly used ethogram, a minimal range of deviations was allowed, if the core of the behaviour was covered. The extracted data were used and recalculated in order to compose a hypothetical but data-driven ethogram of a typical duck, geese and quail, respectively.

The extracted values might be biased towards certain housing systems and not fully reflect behaviour in completely unrestricted circumstances. Although cage systems were excluded, other parameters of commercial housing systems used in some reports might have biased the outcome.

The extracted data on behaviours did not add up to 100% in each study, which was due to different reasons, e.g. because only a subset that fitted the predefined categories/definitions of the selected behaviours was extracted from the study. Therefore, behavioural categories might be under- or overestimated since not all behaviours of the birds are reflected in the model.

In most studies, only specific behaviours and not complete time budgets/ethograms were produced. In addition, the method of scan sampling could differ regarding time of the day, frequency and interval, introducing additional variability into the data set.

The model might not reflect the circadian rhythm of the birds or socially facilitated behaviour, e.g. dust bathing which is preferably shown by several birds simultaneously. The modelling approach does not allow every bird to perform every behaviour at the same time but reflects the proportions of birds showing the range of behaviours selected at a certain time, according to the values extracted from the selected studies.

Due to missing information on inter-individual distances, in waterfowl, these parameters were approximated with morphometric data from base of neck to bill (see Section 2.2.3.4.4).

2.2.4. Uncertainty analysis

The overall methodology to assess uncertainty in this SO followed the approach described in Sections 3.2.1 and 3.2.2 of EFSA AHAW Panel (2022a).

The uncertainty in the assessment performed was investigated in a qualitative manner following the procedure described in the EFSA guidance on uncertainty analysis in scientific assessments (EFSA Scientific Committee, 2018a,b) for case-specific assessments with some modifications.

The sources of uncertainty and their potential impact on the conclusions are presented in Appendix C.

Regarding the overall impact of uncertainties on the developed conclusions of the SO, it was agreed to perform an assessment only for a subset of key conclusions in which a first screening revealed there might be a higher uncertainty.

For the conclusions that derived from the EKEs (i.e. ToR-3 – on the space allowance; see Section 3.6.1.1), the output from the behavioural model already expressed the uncertainty on the space allowance needs for the different bird categories (as described in EFSA AHAW Panel, 2022a).

All conclusions on ToR-2 and the ones on ToR-3 that derived from a narrative assessment (e.g. on the factors height and floor type) were rephrased in order to refer to well-defined questions of interest (so-called 'statements', see Appendix D). These questions related to an animal species and category (e.g. breeders of Domestic ducks) and a husbandry system (e.g. individual cages) in the case of the conclusions on ToR-2, or to an animal species and category and a factor (e.g. environmental enrichment) in the case of ToR-3.

The 90% threshold was selected to ensure that conclusions were referring to situations in which a large proportion (≥ 90%) of the animals for each target animal species/category would experience/not experience the welfare consequence due to the presence/absence of the hazard/factor. Experts were asked to provide their individual judgement on the certainty for each conclusion according to three predefined agreed certainty ranges (see Table 6), which are derived from the approximate probability scale of the guidance on uncertainty (EFSA, 2019). Experts were first asked to identify the probability range best reflecting their degree of certainty for each conclusion. Individual answers were then subjected to group discussion during which experts had the opportunity to explain the rationale behind their judgement, and a consensus on which category best reflected the overall certainty was reached. A qualitative translation of the outcome of the uncertainty assessment was also derived (e.g. 'more likely than not' for a certainty range of >50–100%) (see Table 6).

For further details and the results of the uncertainty analysis on the conclusions, see Section 3.7 and Appendix D.

Table 6: Three ranges used to express agreed (consensus) certainty around conclusions (adapted from EFSA, 2019)

Quantitative assessment	**Certainty range**		
	> 50–100%	**66–100%**	**90–100%**
Qualitative translation	More likely than not	From likely to almost certain	From very likely to almost certain

3. Assessment

3.1. General biology, of the wild and domestic species

3.1.1. General biology of domestic ducks

Most of the present commercial Domestic ducks (*Anas platyrhynchos domesticus*) originate from China, and for this reason are mainly named Pekin or Peking ducks, while some breeds of local Domestic ducks (e.g. Rouen, Duclair, Aylesbury) derive from the green-headed wild Mallard (*Anas platyrhynchos*). Some studies reported that the domestication of the Domestic duck in the European continent was initiated by the Romans, who described the primitive farming of captive wild ducks (Harper, 1972; Bogenfürst, 1999; Albarella, 2005; Kear, 2005).

A study on whole genome sequencing on a group of Domestic and Mallard ducks in China (Zhang et al., 2018) showed that Domestic ducks differentiate from Mallards as a consequence of selection. This was particularly evident for the expression of genes related to plumage, fat metabolism and neurological function. In fact, Domestic ducks are more docile, less vigilant and show important differences in brain morphology. Furthermore, Guo et al. (2021) have recently suggested, on the bases of whole genome study, that Domestic duck may not have originated from the present-day wild duck species but from a currently unidentified ancestor. However, some information on the behaviour of Mallard ducks can be of interest also for Domestic ducks.

Mallards are dabbling ducks that obtain much of their feed by sieving particles of food from surface water through their bill (Cherry and Morris, 2008). However, the Mallard duck is highly flexible with regard to foraging behaviour, and makes use of multiple foraging methods (Thomas, 1982). Domestic ducks also show foraging behaviour (Reiter and Bessei, 1995; Reiter et al., 1997). Dabbling can be considered as foraging behaviour and ducks perform a high proportion of foraging behaviours in water (Rodenburg et al., 2005). While dabbling, they may go deep with the head covered by the water or they may be grubbing in mud or shallow water with the eyes above the surface, allowing for predator surveillance. They may also dive for food under water and forage on land. Being omnivorous, they feed on seeds, plants and invertebrates, e.g. insects and worms (Combs and Fredrickson, 1996; Tidwell et al., 2013). On land, they occasionally graze, dig or hunt (Breuer, 1991).

Mallards are particularly active in foraging during the morning and afternoon (Thomas, 1982). When the Domestic duck is kept under commercial conditions with access to bedding material, foraging in the bedding material has been reported to take up 15% of the daily 24-h time budget during the rearing period (Reiter and Bessei, 1995). In experimental studies, when adding time spent on performing dabbling behaviour in drinking water and in feed troughs to time spent foraging in the bedding material, then foraging behaviour may take up to 30% of the time budget of a Domestic duck. For comparison, the female mallard has been observed to spend 42% and males 22% of the daily 24 h foraging during the pre-breeding season in Norway where light is present 24 h/day (Arzel and Elmberg, 2015). Bouts of general activity occur throughout the 24 h of a day in the Domestic duck (Reiter, 1997), so, unlike the domestic fowl, light intensity appears to have less influence on the activity level and distribution between activity and rest over the 24 h of a day.

Mallards fly well. They are facultative migratory birds living in the Northern Hemisphere, although not all individuals migrate. The mallard spends the winter living in mixed sex groups where males compete over access to females during pair formation (Poisbleau et al., 2005a). In small groups (n = 30) under experimental conditions, it has been shown that male mallard ducks form a clear linear hierarchy (Poisbleau et al., 2005a,b). In spring, the male and female pair up before migrating north towards the breeding location.

Mallards are ground nesters. When kept in captivity, nest boxes are provided just off the litter and, in a study involving 12 birds, the majority of them (7 of 12) worked for access to a nest box, indicating that motivation to get access to nest boxes can be high (Barrett et al., 2021). This is supported by other studies demonstrating increasing competition between ducks, based on measures of aggression and prevalence of floor laying, with decreasing nest:duck ratio (Makagon and Mench, 2011; Barrett et al., 2019). Both mallards living under natural conditions and Domestic ducks kept in captivity seem to prefer nests offering a high level of concealment (Bjärvall, 1970; Makagon et al., 2011). When a clutch of about 10–11 eggs has been laid and the female has started incubation, the male abandons her. Incubation takes 28 days (Cherry and Morris, 2008). The ducklings are precocial, meaning that they search and find feed independently from the day they hatch, although in nature under the guidance of the mother duck. The mother duck will also brood the ducklings during the first few weeks (Pingel, 2000; Boos et al., 2007), when the ducklings are incapable of maintaining thermal comfort without an external heat source. According to Pingel (2000), the development of the plumage of ducklings allows them to cope with temperatures around 0°C from 4 weeks of age.

Limited research is available on the thermal requirements of Domestic ducks after they have gained the capacity to regulate their own body temperature. It has been suggested that the thermoneutral zone of adult Domestic ducks lies between 5°C and 20°C (Pingel, 2000). To get rid of excess heat, Domestic ducks thermoregulate mainly through panting, heat exchange in water via bill, legs and feet (Pingel, 2000) and spreading of the wings.

Brooding may facilitate transfer of oil from the feathers of the mother to the down of the ducklings, aiding waterproofing, which is important as they enter water for foraging purposes already within the first 1–2 days after hatch. However, Bakken et al. (2006) argued that it is the level of cleanliness that keeps the ducklings' down water-repellent, i.e. the presence of hydrophilic hatching fluid residues in the down causes water to penetrate. Thus, incubator-hatched ducklings can swim and keep the down dry as long as they are well cleaned and dried (Bakken et al., 2006).

One characteristic of the Domestic duck is the elaborate preening behaviour (Reiter et al., 1997). Part of the preening includes the distribution of oil from the uropygial gland to maintain flawless feather structure and prevent water from penetrating the feathers to the down and skin of the duck, i.e. it plays an important part in thermoregulation (Moreno-Rueda, 2017). Maintenance of the plumage also involves wet preening. If ducks have access to an open water source, then flapping with their wings, tilting back and forth and tossing water with the head is part of the behavioural repertoire (Reiter et al., 1997; Makagon and Riber, 2022). Similar behavioural elements can be observed in ducks only having access to water from drinking sources such as water cups or water nipples (Jones et al., 2009; Waitt et al., 2009). Cleaning of the bill, nostrils and eyes in water is important for the health of the Domestic duck (O'Driscoll and Broom, 2011).

Despite the long domestication process, distinct fear responses remain a characteristic for the Domestic duck, with significant vigilance behaviour and flight distances to humans or non-human objects (e.g. herding robots, vehicles, model of a fox or cylinders) being reported (Henderson et al., 2000, 2001a). Being part of a flock reduces the flight distance to humans (Henderson et al., 2001b).

3.1.2. General biology of Muscovy and mule ducks

In 1999, the Standing Committee of the European Convention for the Protection of Animals kept for Farming Purposes[11] adopted the Recommendation concerning Muscovy ducks (*Cairina moschata*) and hybrids of Muscovy and Domestic ducks (*Anas platyrhynchos*). The following description of the biological characteristics of Muscovy ducks and hybrids with Domestic ducks is taken from this recommendation and complemented with references and additional information where relevant.

The Muscovy duck (*Cairina moschata*) or musk duck or mute duck originated in South America. They were domesticated by the native Colombians and Peruvians and then introduced to Europe by Spanish and Portuguese people in the 16th century. Domesticated Muscovy ducks were also present in Central America and in the southern part of North America. The Muscovy duck has been domesticated in many parts of the world. Female Muscovy ducks were used in the past as natural incubators for hatching Domestic duck eggs.

Even if under natural conditions the Muscovy duck is a tropical bird and lives in marshy forests, its robustness has enabled it to adapt to different climates and habitats. It has both relatively sharp claws which facilitate perching and webbed feet which facilitate locomotion (swimming and diving) on and in water.

Muscovy ducks are omnivorous, feeding on plants, worms, insects, fish, amphibians and reptiles. Muscovy ducks are sexually dimorphic, the male being almost twice the weight of the female. Aggressive and sexual displays are simple and not well differentiated. In the male, these may take the form of feather-crest-raising, tail-shaking and moving the head backwards and forwards. Muscovy ducks, especially the males, are more aggressive than mallard breeds. Mostly, wild Muscovy ducks can be found in small groups of separate sexes (Rodenburg et al., 2005).

[11] Standing Committee of the European Convention for the Protection of animals kept for farming purposes (T-AP) – Recommendation concerning Muscovy ducks (*Cairina moschata*) and hybrids muscovy and Domestic ducks (*Anas platyrhynchos*) adopted by the Standing Committee on 22 June 1999.

In the wild, copulation occurs on water during the rainy season. According to Clayton (1984), mating can occur successfully on dry land or in water. After copulation, the female selects a nest site, usually in a tree hollow or sometimes in rushes, and lays 8–15 eggs, which she incubates for about 35 days. Nest building by the female is little sophisticated, comparable to nest building by the jungle fowl. The male is polygamous and does not participate in nest-site selection or incubation. The female rears the young until they can fly, and the ducklings learn from the mother's actions. Domesticated Muscovy ducks were also found to prefer elevated, sheltered and low-lighted nest sites (Bilsing et al., 1991).

When compared with Domestic duck, the embryonic development of Muscovy ducks is longer (around 35 days vs. 32–33 and 27–28 days for the Mule and Domestic ducks, respectively), and the ducklings take longer to reach sexual maturity.

Different from the Domestic duck, the Muscovy duck has an area of bare skin from the bill to just above and behind the eye with the male having a well-developed caruncle at the base of the bill which is even more prominent during the mating season (Clayton, 1984). The bill is richly innervated and very well supplied with sensory receptors. Moreover, the Muscovy duck can be recognised by the red skin on its head, from the base of the bill to the neck, especially in the male.

Bilsing et al. (1991) report that wild Muscovy ducks preferably roost and perch in trees. Muscovy ducks fly, swim and walk efficiently. Birds presently used for meat and foie gras, due to selection for heavy birds, may be unable to fly, perch at high level, have difficulty in walking and be subject to leg disorders. Water-related behaviour in domesticated Muscovy ducks comprises drinking, sieving, head dipping, bathing, swimming, diving and wet preening (Bulheller et al., 2004).

Muscovy ducks in both domestic and wild conditions carry out complex preening behaviours which take up a substantial amount of their time. After bathing, ducks perform a range of vigorous shaking movements to eliminate the excess water, followed by cleaning movements to remove foreign bodies. An elaborate sequence is then performed to distribute oil to the feathers from the uropygial gland above the tail. This is necessary to regulate the body temperature and waterproofs the feathers. A short period of sleeping often follows preening. Ducks can repeat this sequence of behaviours (feeding, bathing, preening and sleeping) several times in a day (see also Section 3.5.4).

It is not known for how long the domesticated Muscovy has been separated from its wild ancestor, but Clayton (1984) supposes that it might be 600–700 years ago and reported differences from the wild type being limited to a larger body and greater variation in plumage colour. Farmed Muscovy ducks have retained many anti-predator responses such as freezing, alarm calling, attempts to take off or run rapidly away from danger, and vigorous struggling if caught. Such behavioural responses may be associated with immediate physiological responses. Male Muscovy ducks and hybrids fight frequently using their claws, wings and bills, particularly for chasing off intruders.

Feral Muscovy ducks observed in Florida spent between 18% and 33% of the daytime (considering different day times and sexes) on water or at the shoreline, 13–42% in tree or shrub cover, 31–49% on open grass and 4–12% in other areas. They mostly roosted at night at pond and wetland shorelines. Reiter et al. (1997) observed mixed species groups of Domestic, Muscovy and Mule ducks during the first 7 weeks of life during eight daylight hours under varying housing conditions (deep litter pen or free range from 5 weeks of age onwards, each with or without water bath, group size 102, later 51 ducks), and recorded mean time budgets for Muscovy and Mule ducks for feeding of 2–4%, drinking of about 7%, sieving in litter or grass about 11%, preening 15–16%, sitting 56–59%, walking about 4% and bathing 2%.

Muscovy ducks have slightly higher temperature requirements than Domestic ducks (Grashorn and Brehme, 2018). They cite the Lower Saxony guidelines for the keeping of ducks (ML, 2013) setting minimum temperatures of 15°C in the final stage of growing, Pingel (2000) recommends minimum temperatures at this point of 18–20°C. These figures are probably more related to optimal food conversion rather than animal welfare issues. In any case escaped or intentionally introduced Muscovy ducks did survive and became feral in many areas, also in EU (Downs et al., 2017).

The Muscovy and Domestic duck hybrid (Mule duck) is obtained by crossing a female Domestic duck and a male Muscovy. It is a sterile hybrid because of the difference in the numbers of chromosomes between the two parents. It shows little sexual dimorphism and can flourish in cooler conditions than the Muscovy duck. Significant differences were found between the Domestic and Muscovy ducks, especially with respect to their biology, physiology and behaviour. Depending on the character considered, the mule duck can:

- Be quite similar to one of the parents: Reiter and Bessei (1995) reported that the behaviour of the Mule duck is, for example, more comparable to that of the Muscovy duck than to that of the Domestic duck.
- Be midway between the parents, for example, in terms of growth (Baéza et al., 2005).
- Benefit from an heterosis effect for some factors as feed ingestion capacity and fatty liver weight (Baéza et al., 2005) or fear response (Faure et al., 2003).

3.1.3. General biology of domestic geese

Domestic geese (*Anser anser domesticus*) kept in EU originate from the Greylag goose (*Anser anser*). Although the goose was one of the first birds to be domesticated (Kear, 2005; Eda et al., 2022), they have retained some aspects of behavioural and physiological biology of their wild ancestor (especially, for the reproduction in terms of their response to photoperiod duration).

Geese are diurnal terrestrial feeders, spending the night in a roost location on water, mudflats or small islands. At dawn, they fly to a nearby foraging ground and spend most of the day there (Owen and Black, 1990).

The Greylag geese are predominantly herbivorous, mainly feeding on growing grass found in pastures (Scheiber et al., 2013; Strong et al., 2021); however, they also consume agricultural and horticultural crops (Bogenfürst, 2017; Olsson et al., 2017), as well as small fish, amphibians and molluscs (Guémené et al., 2012; Bogenfürst, 2017).

Greylag geese are facultative migratory birds; they may temporarily or permanently cease migration if the mild winter affords sufficient food supply for them (Kear, 2010). Upon returning from the wintering grounds, the flocks split into pairs. Breeding females form loose breeding colonies, while non-breeders aggregate for moulting (Kotrschal et al., 2010). They are seasonal breeders, which their domesticated counterparts also retained (Shi et al., 2008). Greylag geese, especially females, are philopatric, meaning that they return to the breeding area where they were born and build their nests on the ground and close to water (Nilsson and Persson, 2001). The females lay up to 12 eggs and incubate them alone (Kozák, 2019); however, the gander remains close in need of protecting the nest and the female (Kotrschal et al., 2010). Goslings hatch synchronously and leave the nest within 1–2 days afterwards (Nyland, 2005), from which point they forage individually. Goslings are capable of flying from around 8 weeks of age (Kozák, 2019).

Greylag geese are socially complex birds (Kotrschal et al., 2010) displaying a wide range of social interactions (Lorenz, 1992; Scheiber et al., 2013) and being capable of identifying their kin and other individuals (Scheiber et al., 2011). Communication with a wide variety of vocalisations is an important part of their social behaviour (Greylag goose: Lorenz, 1992; Domestic goose: Guémené et al., 2012; Bogenfürst, 2017). Greylag geese are monogamous with long-term pair bonds but tend to form larger flocks most of the year (Kotrschal et al., 2010). However, within the larger flock smaller groups of birds can be identified, i.e. a breeding pair and their offspring in close proximity to other such families. The young stay with their parents for an entire year and sometimes join for a second year, as they reach sexual maturity at around 2 years of age. Domestic geese are also social, but through domestication, they have become polygynous and reach sexual maturity earlier (Bogenfürst, 2017).

Geese only have certain innate behaviours (e.g. migration, nest building, imprinting, stretching the neck for greeting, rolling an egg back to the nest if it rolled out) and learn important foraging and social skills from their parents (Black et al., 2007; Kotrschal et al., 2010). Geese have been shown to have exceptional memory and are known to be vigilant and prone to fearfulness (Bogenfürst, 2017).

Being a member of a social group has its advantages. Greylag goslings increase their participation in agonistic encounters with group members as they grow and they may even win these encounters with the help of their father, but generally lose such encounters without support (Kotrschal et al., 2010). Studies with Barnacle geese (*Branta leucopsis*) showed that goslings living in a family group were attacked less by other geese, were more vigilant and were heavier compared to lone goslings (Black and Owen, 1989a,b). In contrast to this, naturally hatched Domestic geese were lighter from 6–18 weeks of age than artificially hatched Domestic geese (Boz et al., 2017a, 2021). Without parents, during artificial rearing of the geese, the social structure is compromised and humans have attempted to manage social development by adapting the environmental factors and the husbandry system. Naturally hatched Domestic geese foraged, preened and flapped their wings more, were less fearful, but showed higher level of feather pecking compared to artificially hatched Domestic geese (Boz et al., 2021). These results show that goslings reared by their parents (similar to goslings in the wild) have more developed social skills (i.e. not being fearful, but also know when to flee to avoid injuries during agonistic encounters) compared to goslings not reared by their parents.

Mating happens in a sequence of discernible steps (Gillette, 1977) and two-thirds of the copulations occur before noon (Gillette, 1977; Gumułka and Rozenboim, 2015). Wild geese almost exclusively mate on deep open water (Guémené et al., 2012). Domestic geese can mate on land; however, the presence of water in the environment has been shown to improve reproductive performance (Gillette, 1977; Guémené et al., 2012). In fact, in intensive systems, the lack of water has been reported, in rare cases, to cause hygiene problems and pecking of the phallus of ganders (Bogenfürst, 2017).

It has been shown that in Embden and Toulouse geese, the egg production was severely affected when the birds were kept at temperatures below 1.8°C (Gillette, 1976). Bogenfürst (2017) found temperatures up to 28°C did not affect egg production negatively. Recent studies with White Sichuan geese aged 14–28 days showed that the upper critical level of ambient temperature for 28-day-old body weight and weight gain were around 26°C (Liu et al., 2022a), while the upper critical levels of ambient temperature from 28 to 49 days of age for weight gain and feed intake were 25.19°C and 23.97°C, respectively (Liu et al., 2022b). To get rid of the excess heat, Domestic geese may thermoregulate through panting, heat exchange in water via the beak, legs and feet or spreading of the wings.

There is no time budget information on Greylag geese during the breeding season, however on the wintering grounds – based on a 9 h/day observation period – they spend around 50–66% feeding, 15–40% resting and 8–12% with other activities (Amat, 1986; Käßmann and Woog, 2007). In 2- to 7-week-old domestic goslings, the average share of the behaviours was the following, based on a 1 h/day observation period: 4% feeding, 4% drinking, 84% resting, 9% playing, 0.2% social behaviour and 0.7% preening (Molnár et al., 1998). In adult white Landes geese, based on a 5 h/day observation period, the average share of the behaviours was 4% feeding, 3% drinking, 64% resting, 17% playing, 3% performing social behaviour and 9% preening, while in grey Landes geese, it was 4% feeding, 3% drinking, 66% resting, 18% playing, 3% performing social behaviour and 7% preening (Molnár et al., 2004). Eating, drinking, grooming (preening with or without water, oiling, washing) and resting made up 66.3% of non-breeding activity of adult Domestic geese (Gillette, 1977). The remaining 33.7% was spent by giving alarm calls, fluffing feathers, beak washing, spreading wings, stretching wings and legs, pecking, pulling feathers and other not specified behaviours (Gillette, 1977). Swimming and playing with water are integral components of comfort and play behaviour in Domestic geese, thus these are expected to be more common in systems with access to free range (Abd-El-Gawad et al., 1993) and water. Domestic geese do a considerable amount of pecking due to exploration, stimuli-seeking, hunger or aggressiveness (Gillette, 1977; Molnár et al., 2004; Salamon, 2019). Aggressive pecking is more prevalent in intensive production systems than in free range systems (Boz et al., 2021), still it is rare (~ 1%) and not injurious (Gillette, 1977; Boz et al., 2021).

3.1.4. General biology of Japanese quail

As in the wild Japanese quail, the domestic Japanese quail is slightly sexually dimorphic, as females are somewhat larger than males and differ slightly in plumage pattern (Mills et al., 1997; Dixon and Lambton, 2021). The wild quail's plumage is cinnamon brown, and in the domestic quail, a larger variation of colours, including white (but use of this phenotype is avoided in commercial flocks, to avoid aggression from the flock-mates) or buff-coloured birds, can be seen. As in many other bird species, the domesticated birds are larger and produce more eggs (Mills et al., 1997).

It has been shown that the thermal comfort zone of Japanese laying quail lies between 22°C and 24°C, and that the birds show signs of cold stress already at temperatures around 20°C (Castro et al., 2017). Japanese quail dustbathe in a way similar to that of laying hens (for full description, see EFSA AHAW Panel (2023a)), and there is substantial variation between individual birds with respect to the amount of dust bathing shown (Gerken et al., 1987). In hot conditions, quail disseminate heat mainly through panting and spreading of the wings.

According to Formanek et al. (2008), the social organisation of the wild Japanese quail is largely unknown. According to the same authors, the young wild Japanese quail live in family groups, but there is limited information on social interaction and organisation among adult birds. Japanese quail are known to establish hierarchies within small social groups by frequent aggressive interactions (Alcala et al., 2019). It has been shown that the presence of a dominant individual will influence the behaviour of the subordinate individuals in a group, by affecting both their behaviour repertoire and the temporal pattern of their behaviours. It is assumed that this can influence the level of social stress and limit the opportunities of utilising various environmental resources by the subordinate individuals (Alcala et al., 2019).

Vocalisation was identified as one sign of social motivation in chicks but not in adult birds (Formanek et al., 2008). Male birds are, especially during the breeding season, aggressive towards each other, and also adult females can show aggression towards males (Mills et al., 1997). Aggressive pecking in quail can lead to severe head injuries, sometimes serious enough to lead to affected birds being euthanised (Wechsler and Schmid, 1998). Domestic Japanese quail can be selected on higher or lower levels of fear (tonic immobility) or sociability, but the observed response can be influenced also by environmental components (Mills and Faure, 1991).

Regarding nest building, the literature is not detailed. Wild Japanese quail nest on the ground, like other related species, and spend a limited amount of time on nest construction, with the female, preferably using a grass clump as nesting site with gathering of some dry grass around laying. The female is also the one incubating the eggs (Orcutt Jr and Orcutt, 1976). Although, evidence on nest preferences is limited, all authors agree that wild as well as domesticated quail prefer secluded and concealed nest sites as well as manipulable material, such as hay or chaff (Schmid and Wechsler, 1997) It has been suggested that quail are reluctant to nest in captivity and will not do so unless provided with relevant environmental conditions to trigger this behaviour (Dixon and Lambton, 2021) as well as the possibility of isolation. However, quail do express prelaying restlessness when housed without access to suitable nesting areas and providing the quail with suitable areas and material for nesting would reduce stress and enhance the birds' natural behaviour (Dixon and Lambton, 2021). It is possible that, despite the presence of an adequate nesting area, the different strains exhibit different prelaying behaviour, as already demonstrated, e.g. in laying hens (Mills and Wood-Gush, 1985).

3.2. Process of genetic selection in ducks, geese and quail

This section describes the common process of genetic selection in ducks, geese and quail. The commercial process might differ in detail between the different companies and selected lines.

Nowadays, poultry sector production schemes show a general pyramidal organisation based on the implication of different actors between the selection and production levels, with an intermediate one of multiplication (Figure 4). It is common that the breeders also exert the multiplier activities, especially for species of limited worldwide or local production or integrated production (e.g. Domestic geese and Japanese quail).

Selection practices can be either empirical or resulting from the implementation of rigorous approaches (e.g. pedigree genetic selection or genomic selection). The empirical method, so-called mass selection, consists in choosing the reproducers from a set of animals according to their own performance on one or a few chosen traits (Guémené et al., 2011). Other more effective genetic selection methods, based on Mendel's laws, have since been developed for commercial production, as well as local breeds (Restoux et al., 2022). These methods are currently the most used in the species considered in this opinion. At the present time, this method of genetic selection can be associated with the genomic selection method whenever appropriate genomic tools are available for the species of interest (Wolc et al., 2011a,b; Le Roy et al., 2014). Genomic evaluation of an individual is based on the identification of a set of thousands of DNA markers on the genome, whose presence is associated with desired performance evolution (positively or negatively) for a specific trait measured on a large representative reference population. In theory, individual character measurements on the candidate, and either ancestries, collaterals or descendants are not needed at each generation. However, in practice, for different technical and practical reasons, one of which being the insufficient size of the necessary reference population in poultry species, it is important to keep the individual measurements on all animals, or at least the selected ones, as well as the pedigree records, in order to increase the precision of the genomic evaluation (Le Roy et al., 2014). For the evaluation of the genetic or genomic value of each breeding candidate and establishing an appropriate specific individual mating scheme, breeders are currently mainly housed in individual cages (Wolc et al., 2011a,b).

In the present SO, **immature breeders** are considered as a first unique category as they are usually kept in the same husbandry systems until they reach maturity. Within the poults of known pedigree produced in pure lines for each population of the breeding company selection nucleus, some immature breeders will be selected as candidates for pedigree breeders for the next generation of the selected line. Depending on the commercial product market size, other immature individuals will be used to set up the populations of future great-grandparent or grandparent breeders, or even directly as parental breeders.

Pedigree breeders are reared in closed populations or lines throughout the generations, having a limited number of reproducers. They have known pedigree and individual performance records that allow their individual genetic and/or genomic evaluation. The numerous selection traits measured can be quantitative and qualitative such as those related to reproduction and production traits, but also to disease resistance, behaviour, resilience, as well as phenotypic traits such as plumage or skin colour, etc.

Great-grandparent breeders are reproducers from the pure selected line with unknown or known pedigree records. In this later case, they can play the role of a mirror population of the selected line. Their offspring are primarily used as grandparental breeders for the production of parental breeders. This stage will only be needed in the production scheme if the commercial product market size is very important, as it is a way to multiply the number of offspring at the following stages.

Similarly, **grandparent breeders** are reproducers from pure selected lines. Males or females from one line are crossed with the reciprocal of another line, at the first stage of the female and male paths for production of the parental breeders. Only the offspring of one sex, depending on if they are from the female and male paths, respectively, will be kept as parental breeders and the offspring of the other sex will not be kept as breeders themselves.

Parental breeders are reproducers of unknown pedigree resulting from the male and female paths, respectively. Their offspring are intended for production of meat, meat and foie gras or eggs for human consumption and will not be kept as breeders themselves.

Therefore, **birds** (broilers, pullets and layers) **kept for the production** of meat, foie gras or eggs for human consumption result from the inter-cross of reproducers from two different parental breeder strains, that themselves most often result each from two different grandparent strains.

The length of the genetic improvement process will depend on the trait heritability and the number of traits considered for a single line. In addition, the process of intercrossing and multiplication takes time and results in a delay lasting between 3 and 5 years for expecting an initial first effect of genetic selection of the closed pure lines on commercial production.

The importance of the improvement differs greatly from one strain to another for the same species, depending on whether the lines are from the female or the male path, or the production purposes of the commercial products that can be slaughtered at various ages and/or live body weights (light, medium and/or heavy). Nevertheless, overall, the increase in body weight which has been achieved can be estimated at around twofolds for the geese, 2–3.5 folds for the quail and 3–5 for the Domestic duck and the Muscovy duck. Similarly, the laying performance of breeders has been greatly increased (Grimaud frères, online[12]; Orvia, online[13]; Cailles-robin, online[14]). Thus, they can easily reach over 200 eggs in one productive period of 52 weeks for the Domestic duck and the Quail, even if for the latter, the productive period is generally interrupted after only 20 weeks of lay. It also reaches 200 eggs for the Muscovy duck, but in two shorter successive reproductive periods, while Geese will lay a maximum of 30–40 eggs per yearly reproductive period.

The crossing of several lines or even two different species (e.g. Mule duck production) is an alternative that is performed because of interest in production. The offspring produced have generally an advantage, called hybrid vigour or heterosis effect, i.e. performance significantly better than average of their parents on many traits, or even super-heterosis effects, i.e. performance significantly better than the best of their parents. On a practical point of view, one of the advantages is that, if a line is identified as being the major cause of a specific problem in the intercross, the breeders can substitute this parental line with another in the mating scheme to rapidly overcome the situation. The same strategy can be used also to better adapt the commercial product to different rearing environments worldwide.

[12] Grimaud Fréres, online. https://grimaudfreres.com/ [Accessed: 8 January 2023].
[13] Orvia, online. https://www.orvia.fr/ [Accessed: 8 January 2023].
[14] Cailles-robin, online. https://www.cailles-robin.fr/ [Accessed: 8 January 2023].

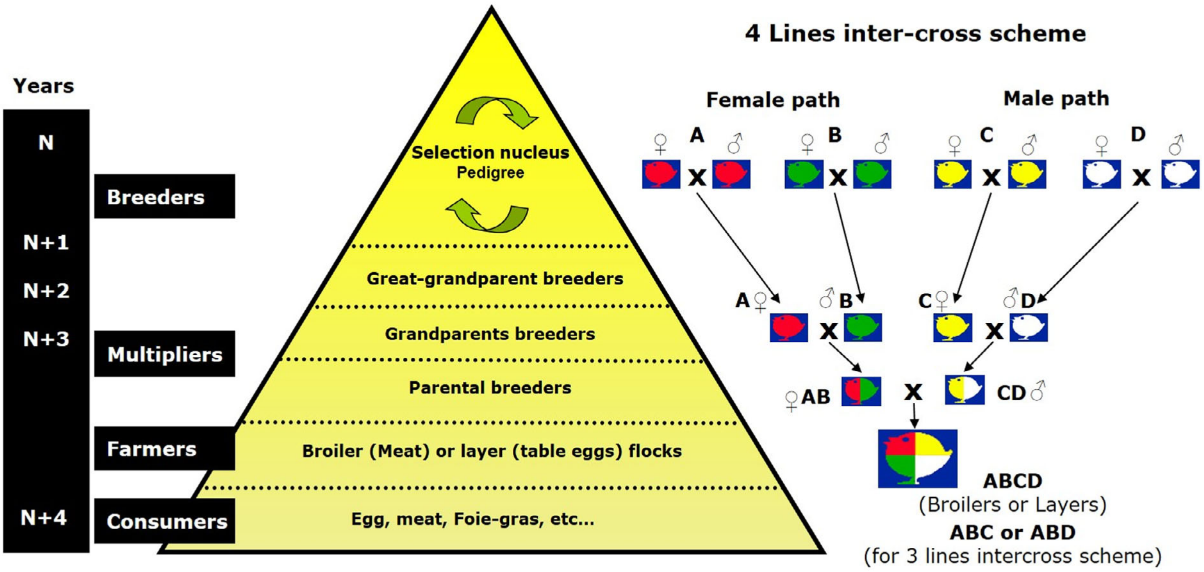


Figure 4: Illustration of nowadays general commercial poultry production schemes. Adapted from © Guémené, 2015

3.3. Production cycle

3.3.1. Production cycle of domestic ducks

The production cycle of Domestic duck can be divided into different phases and can vary depending on the purpose (breeding or meat production).

3.3.1.1. Production cycle for breeders

Genetic selection in Domestic ducks is performed using individual genetic evaluation of the candidates and pedigree reproduction at the level of the selection nucleus. At hatch, in the case of immature pedigree breeders, identified hatchable eggs are pedigree hatched, i.e. individually identified and separated from each other, and the ducklings are tagged and sexed, either by inspection of the cloaca, feather colour or eye colour. The sex can also be identified earlier during incubation in some lines. Depending on the selection pressure and selection objectives, a sufficient number of candidate ducklings of both sexes are then kept together at this stage (immature breeders) and sorted out afterwards through the selection process. Surplus ducklings are reared for meat production.

In the case of immature great-grandparent breeders, the ducklings are sexed and a certain number, depending on need, are kept as future breeders, while the surplus are reared for meat production.

In the case of future grandparent and parental breeders, the ducklings are sexed but only those of one sex, male or female depending on the line or path, will be kept as future breeders, while those of the other sex and surplus are reared for meat production or discarded during incubation.

During the rearing period, females and male are mixed at a ratio of 4–7:1 (females: male), depending on the strain and local practices.

Usually, the immature breeder ducks spend the first 23 weeks in a rearing barn where heating is supplied during the first 10–21 days of life. From 0 to 12 weeks of age, the rearing of young breeders is similar to ducklings reared for meat production (Section 3.4.1.2). To avoid excess body fat that may negatively affect fertility and health, the immature breeders are feed restricted from 7 weeks of age onwards. Then, they are moved to the production barn where laying starts at around 24 weeks of age and continues until approximately 75 weeks of age.

During the laying period, males and females can be either separated in individual cages, where reproduction is carried out by artificial insemination (case of selection in pedigree breeders and for the male Muscovy duck parental breeders for intercross Mule duck production) or mixed in indoor floor systems, where reproduction is then carried out by natural breeding (case of multiplication of grandparents and parental breeders). Individual cages are used in selection for individual measurement of some selected traits (reproductive traits, feed consumption, etc.) and to enable parentage assignment for pedigree establishment.

3.3.1.2. Production cycle for meat

During the starting period, lasting about 10–21 days, the mixed-sex flocks of day-old ducklings are placed on litter in a heated building (starting period). This period is followed by a growing period, with the commercial slaughter being between 5 and 8 weeks of age, except for a minor production of heavy ducks, where the slaughter age is around 14 weeks. In general, the slaughter ages are determined by the ages at which Domestic ducks moult, i.e. between 9 and 13 weeks and again between 15 and 19 weeks of age. These moulting periods are excluded from slaughtering as complete de-feathering at slaughter is impossible during moult. At slaughter, the liveweight is 3.0–4.3 kg, depending on husbandry system and duck strain used (Steczny et al., 2017; Grashorn and Brehme, 2018; Avicultura, online[15]; Cherry Valley, online[16]). Regardless of the husbandry system, the Domestic duck is reared with an intact bill, i.e. bill trimming is not performed in EU at any stage.

3.3.2. Production cycle of Muscovy and mule ducks

3.3.2.1. Production cycle for breeders

3.3.2.1.1. Muscovy ducks

At hatch, the breeder ducklings are sexed, either by inspection of the cloaca or feather colour, and ducklings destined for breeding are mixed at a ratio of 3–5:1 (females: male), depending on the hybrid and local practices. Surplus males are reared for meat production.

The Muscovy ducks generally have the bill and the claws trimmed at hatch. Bill trimming is carried out by applying an infrared (IR) treatment to the hooked tip of the bill. The ducklings are held in a headband for about 15 s. The IR penetrates the stratum corneum, damaging the epidermis and dermis. The device is calibrated to reach a certain beak length with an intensity that can also be adjusted according to the age of the breeding flock, the strain and species, factors that influence the size of the beak and the level of keratin in the beak. The beak is not cut, but the cauterisation of the epithelium, indicated by a white spot at the tip of the beak, will result in the slowing of its growth. About 2 weeks after the procedure, the damaged areas have healed and the tip of the treated beak softens and falls off (Gentle and McKeegan, 2007; Marchant-Forde and Cheng, 2010), thus avoiding the risk of wounding and infection. Beaks treated in this way are more uniform in length and have fewer abnormalities than hot-bladed beaks (Carruthers et al., 2012). Trimming by scissors between 15 and 20 days of age Gustafson et al. (2007a) may still occur, but is currently rarely practised.

Shortening of the claws can be carried out by different methods: (1) at hatch by thermo-cautery, i.e. by applying a hot blade against the nails or more recently by applying an infrared treatment, (2) in farms manually using scissors or mechanically using a system of blades rotating under a grid, around the age of 15 days (at the same time of possible bill trimming when using scissors).

Usually, the immature breeder ducks spend the first 24 weeks in a rearing barn where heating is supplied during the first 10–21 days. From 0 to 12 weeks of age, the rearing of young breeders is like that practised for ducklings reared for meat production (see Section 3.3.2.2). To avoid excess body fat that may negatively affect fertility and health, the animals are feed restricted from 7 weeks of age onwards (Pingel et al., 2012).

Then, they are moved to the production barn where photoperiod and light intensity are modulated in order to control the onset of lay. Depending on the practices, males and females can be separated in individual cages, reproduction is then carried out by artificial insemination (case of selection in pedigree breeders) or mixed on the ground, reproduction is then carried out by natural mating (case of multiplication). Individual cages are used in selection in order to individually control the laying of eggs, to assign parentage followed by pedigree and to measure productive and reproductive traits.

Laying starts at around 24 weeks of age and continues until approximately 55 weeks of age. This period can be extended up to 82 weeks in the case of using the same breeders for two successive laying cycles of about 24 weeks each, interrupted by a moult of around 10 weeks, with the first laying period lasting generally longer than the second. Synchronisation of laying cycle among layers is performed.

[15] Avicultura, online. Un-rara-avis-una-explotacion-de-patos-para-carne. Available online: https://avicultura.com/un-rara-avis-una-explotacion-de-patos-para-carne/ [Accessed: 8 January 2023].

[16] Cherry Valley, online. SM3 production specification. Available online: https://bb162a23-e952-48d3-b1f8-8428182b8f6c.filesusr.com/ugd/949670_45e8451249894c97ac1fae0879aaf6dd.pdf [Accessed 7 January 2023].

3.3.2.1.2. Mule ducks

Specific Domestic duck and Muscovy duck lines are selected for production of Mule ducks. Breeding of future females (Domestic duck) and males (Muscovy duck) is similar to that described for the production of Domestic (see Section 3.3.1.1) or Muscovy (Section 3.3.2.1) ducks, respectively. At hatch, the breeder ducklings are sexed, either by inspection of the cloaca, feather colour or eye colour.

Since the Parental breeders are from two different species, natural mating will lead to low fertility, thus artificial insemination is required to obtain hybrids of Mule ducks. For semen collection, a female is required to stimulate ejaculation (so-called Boute-en-train). Depending on the practices, Domestic ducks are reared in individual cages (for pedigree selection) or on the floor on litter (female parental breeders) in a laying building, whereas male Muscovy ducks are systematically reared in individual enclosure (males and females for selection and male parental breeders).

Bill and occasionally claw trimming is performed in Mule ducks as described for Muscovy ducks (Section 3.3.2.1).

3.3.2.2. Production cycle for meat and foie gras

Muscovy ducks are kept for meat, and in a few MSs for foie gras production, although for the latter predominantly male hybrids (Mule ducks) are used.

Muscovy ducks can be reared in mixed-sexes or single sex flocks for meat production. However, it is more common to keep the sexes separately due to the large sex dimorphism and different age at slaughter.

In Mule ducks, due to the differences in liver quality between males and females (smaller and more veined livers in females; Marie-Etancelin et al., 2015), only males are reared usually for foie gras production. Females may occasionally be reared in some non-EU countries for meat production, or more recently in the EU for foie gras production due to difficulties in the supply of ducklings because of the culling of breeding flocks due to avian influenza outbreaks. The selection of males and elimination of females is commonly done post-hatching: Mule ducks are sexed at the hatchery, either by inspection of the cloaca, feather colour or eye colour. In lines characterised by albinism, this method is being gradually replaced by a recently available method of pre-hatching sexing (*in ovo* sexing), based on a spectrometer inspection of the eye colour in the egg at 10 days of incubation (Filières-avicoles, online[17]; Poultry world, online[18]).

The production cycle of both Muscovy ducks and Mule ducks can be divided into different production periods, their number depending on the production considered (production of meat exclusively, or of meat and foie gras).

Starting period: For meat and foie gras production, the starting period lasts between 2 and 4 weeks. During this period, they are fed protein-rich feed (18–22%) ad libitum and achieve a live weight at the end of this period between 0.7 and 1.6 kg depending on its duration and the species (Baéza et al., 2005).

Growing period: In meat production, the starting period is followed by a growing period (duration 6–10 weeks) during which a lower protein feed (16–18%) is offered ad libitum. Indoor rearing can be continued in the same building as the one used for starting or in another structure that has no heating system (see Section 3.4.2.2). The Muscovy ducks are usually fattened in single sex groups due to their pronounced sexual dimorphism, but often in the same house. In intensive fattening, the female birds are slaughtered at about 10 weeks with a live weight of 2.5–3.5 kg, the male birds at about 12 weeks with a weight of 4.5–5.5 kg (Pingel, 2000; Arias-Sosa and Rojas, 2021).

For foie gras production (mostly in Mule ducks), a growing period of 3–5 weeks is followed by a preparation for overfeeding period lasting 4–8 weeks. During the preparation for overfeeding, feed is distributed in meals. The amount of feed provided at each meal is kept at a modest level for 3–7 weeks and then gradually increased in the last week. This strategy prepares the birds for high feed intake by inducing progressive distension of the distal part of the oesophagus (or pseudo-gullet), as well as the onset of hepatic steatosis. The live weight at the end of this period is 3.8–4.6 kg depending on its duration and the feed restriction strategy applied (Baéza et al., 2005). As the husbandry system is the same, for the purpose of this opinion, the preparation for overfeeding is considered part of the growing period.

[17] Filieres-avicoles, online. Le sexage dans l'œuf du canard mulard, une innovation signée Orvia. Available online: https://www.filieres-avicoles.com/technique/le-sexage-dans-l-aeuf-du-canard-mulard-une-innovation-signee-orvia#:~:text=En%20effet%20l%27identification%20du,les%20m%C3%A2les%20des%20yeux%20noirs [Accessed: 8 January 2023].

[18] Poultry world, online. In-ovo sexing of Muscovy and Mule duck eggs. Available online: https://www.poultryworld.net/poultry/in-ovo-sexing-of-muscovy-and-mule-duck-eggs/ [Accessed: 8 January 2023].

In case an outdoor run is used during the growing period, a rest period is required between successive batches by legislation for sanitary reasons. It lasts 12 weeks so that the use of a run allows the rearing of approximately 2.5 flocks per year (Pingel et al., 2012).

Overfeeding period: The overfeeding period (usually lasting 9–12 days) starts between 10 and 14 weeks of age with 4–4.5 kg body weight. The birds are then transferred to collective cages or pens (see Section 3.4.2.3) in buildings that fulfil specific requirements regarding controlled ventilation and cooling. The birds are force-fed two times a day. The act of force-feeding consists of introducing a tube (force-feeding funnel; 'embuc') into the oesophagus, in order to place food in increasing quantities. The amounts of feed administered vary from 250 g per meal at the beginning of gavage to 450 g per meal at the end. If necessary, for example when the duck's oesophagus is not yet fully empty, it can be adjusted to smaller amounts of feed. The commercial live weight at the end of this period is 5.7–6.4 kg and 560 g of liver weight (Baéza et al., 2005), even if some variability exists depending on the genetic line and on the time of overfeeding, as well as on production under specific quality scheme.

3.3.3. Production cycle of domestic geese

Domestic goose breeds can be categorised based on their weight (that can be achieved by the end of the production) into heavy-, middle- and lightweight geese. Heavyweight geese, such as the Embden, Pomeranian, Toulouse, can weigh 7–10 kg (females 7–9 kg, males 8–10 kg). Middleweight geese, such as the Landes, Italian, Hungarian and Diepholz, can weigh 5.5–7.5 kg (females 5.5–6.5 kg, males 6.5–7.5 kg). Lightweight geese, such as the Czech, Alsatian can weigh 4–5.5 kg (females 4–4.5 kg, males 4.5–5.5 kg) (Ashton, 2015; Bogenfürst, 2017; Salamon, 2020).

Domestic goose hybrids can be categorised in the above way as well. These hybrids usually originate from Domestic goose breeds, through a long pedigree selection process that created the lines, which are used for the crossing to create the final product (see Section 3.2). Parallel to commercial lines which offer typically hybrids to the producing farmer, purebred breeds might be locally used for production. Meat type geese, such as the Embden and Pomeranian, have exceptional growth rate and meat quality, but their reproductive traits are medium or weak. Liver type geese, such as the Toulouse and Landes, are heavy- or middleweight geese with great fattening ability. They can produce livers up to 1,500 g; however, their reproductive traits are medium or weak.

The production cycle of Domestic geese for meat is divided into starting period and growing period. When the Domestic geese are reared for foie gras, the growing period includes the preparation for overfeeding and the pre-overfeeding (see Section 3.4.3.2). An additional period, the overfeeding, is also considered.

3.3.3.1. Production cycle for breeders

At hatch, a sufficient number of goslings of both sexes are kept as candidates for the production of the next generation and only some will be finally selected based on their genetic value. Goslings are sexed by inspection of the cloaca and future breeder goslings are placed to a rearing house in a sex ratio of 3–7:1 (female:male).

For pedigree lines, all the good goslings irrespective of the sex are kept and selected at a later stage. Surplus goslings will be sold for meat production or, as the number of necessary candidates per population remains low, the pedigree breeders can be used during part of the laying period as grandparent or even parental breeders. Nowadays, pedigree breeders are raised collectively in floor pens with the use of natural mating. Thus, in order to keep track of the pedigree, parental DNA assignment is put in place in order to manage population genetic diversity (e.g. Andres and Kapkowska, 2011) as well as the evolution of the consanguinity rate. A limitation of this practice is that several traits cannot be selected, such as individual laying performance or feed intake.

The immature breeder goslings require heating in the first 2 weeks and are kept only indoors up to 5–6 weeks of age. For their growing period (between week 5–6 to week 25–30), they are either kept in the same building or moved to another one, with or without access to outdoors, in which they will remain until the preparation for their first laying period. Preparation begins 2–3 months before the laying is expected. The laying period is about 20 weeks long. After the first laying period, the parental breeders have a resting period of 2–3 months before the preparation for the next laying period begins. Parental geese are kept in production for three to five laying periods (Bogenfürst, 2017).

3.3.3.2. Production cycle for meat

During the starting period, the 1-day-old goslings are placed on straw litter in a heated building and remain there for up to 4 weeks. The growing period, beginning from week 5, can differ in length depending on the intensity of the production and what type of goose is produced. It can last up to 8–9 weeks in intensive production when geese can be slaughtered before their first moult. The geese are fed with concentrated feed (protein content and amount depending on the final product) and corn and have unlimited access to drinking water via nipple drinkers or water troughs. In extensive production, the growing period lasts up to 16 weeks with intensive grazing or ~ 23 weeks with extensive grazing, when a heavier goose is produced with a higher meat yield (Pingel, 2000; Kozák, 2021). There may be an intensive fattening period (not force feeding) in the last 3–4 weeks of the growing period (in intensive or extensive grazing) in order to get an extra weight boost by fat deposition (Pingel, 2000; Bogenfürst, 2017). During this period, the feed is corn (e.g. in Hungary), but in Poland and Germany, oats are used for this purpose, and hence, their product is called 'oat goose' (Buzała et al., 2014; Kozák, 2021; Kucharska-Gaca et al., 2022).

3.3.3.3. Production cycle of geese kept for foie gras production

The production cycle for foie gras production up to 8–9 weeks is the same as the production cycle for geese intended for meat production in intensive systems (Guémené and Guy, 2004; Bogenfürst, 2017). As described in Section 3.3.3.2, the 1-day-old goslings are kept on straw litter in the starting period and then may or may not have access to an outdoor run depending on the intensity of the production. Both young (8–9 weeks old) and older geese (~ 12–25 weeks old) can be used for foie gras production (Bogenfürst, 2017; Kozák, 2021). In some countries, older geese are used also for feather harvesting once or twice during the production period. The preparation for the overfeeding period lasts 3–5 weeks during which feeding is restricted (Guémené and Guy, 2004) and prepares the birds for force feeding (or cramming). During the preparation, the geese need to achieve good condition and need to be healthy. They need to have a dilated oesophagus (by being fed with high protein diet and high-quality green fodder) in order to be able to take in the large amount of feed (Bogenfürst, 2017). This is achieved by limiting the amount of feed available and the feeders are accessible for only a few hours a day (Guémené and Guy, 2004). Before force feeding (during the last week of preparation), there is a pre-overfeeding period lasting for 3–10 days, when the hourly and quantitative feed restriction is lifted to achieve consumption levels above the regular ad libitum levels (Guémené and Guy, 2004).

When the preparation is complete, the geese are transferred to pens (either floor pens or elevated pens, see Sections 3.4.3.3.1 and 3.4.3.3.2) for the overfeeding (Buckland and Guy, 2002; Bogenfürst, 2017). The geese are overfed with whole corn (soaked or cooked) and have ad libitum access to drinking water. The overfeeding now is only done with a feed dispenser, as manual overfeeding is labour intensive. During this period, the pseudocrop of the geese can never be empty, but the specific parameters of the cramming depend on several factors (sex, age, health and condition of the geese, type of feed dispenser, season, feed quality). The intensity of the overfeeding is considered adequate (from a productive point of view) if 1–1.2 kg of feed is given to each goose every day. However, the amount of feed given to the geese is gradually increased during the overfeeding period. In the starting period (day 1–4), the first ration is 270 g which is increased to 560–670 g in the next days. In the second period (day 5–10), the ration is gradually increased from 740 to 1,000 g. During the first 10 days, the 2–3 overfeeding meals can be increased, in some countries, to 5 meals. From day 11, the ration is above 1,000 g, but the number of meals may vary due to the digestive system's capacity (Bogenfürst, 2017).

3.3.4. Production cycle of Japanese quail

The commercial genetic selection in quail has been focused mainly on body weight and egg production rate (Minvielle, 2004; Cheng et al., 2010). The species, *Coturnix japonica,* is the same for both meat and eggs production. However, the genetic line of layers is lighter (< 200 g) than broilers (> 300 g). Japanese quail for meat production are said to respond rapidly to genetic selection for body weight (Anthony et al., 1991; Marks, 1996; Vali, 2008) and studies have also been made on carcass composition (Lotfi et al., 2011), food conversion ratio (Varkoohi et al., 2010) and meat quality (Oguz et al., 2004; Genchev et al., 2008; Gevrekci et al., 2009; Narinc et al., 2013).

The two main behavioural traits used in the experimental selection of domestic Japanese quail are social behaviour and fear (Mills and Faure, 1991), respectively, and this study can be of interest as a model for poultry species, on ways to model group stress and tolerance for conspecifics and adaptability for group living in commercial husbandry systems, that would hence be beneficial for bird welfare (Formanek et al., 2008; Guzmán et al., 2013).

3.3.4.1. Production cycle for breeders

Genetic selection programs are performed for Japanese quail for both eggs and meat production, just as broilers using individual genetic evaluation of the candidates and pedigree reproduction at the level of the selection nucleus. As for other species, the great-grandparent and/or grandparent, and parental breeders allow an exponential increase of poult number at each level of the scheme, in a fold range that will depend on the market size and make it possible to disseminate the genetic progress. It is reinforced by the effects of heterosis resulting from the intercross between lines selected on complementary traits. There are also mass selection programs conducted by minor actors for niche markets, especially for egg production.

At hatch, in the case of future pedigree breeders, identified hatchable eggs are pedigree hatched and the newly hatched quail are identified with a tag. Depending on the selection pressure and selection objectives, a sufficient number of candidates of both sexes (immature breeders) are then kept together and sorted out afterwards through the selection process based on their genetic value for a combination of traits. They will be initially put in collective floor pens during the 5–6 first weeks and after sexing, placed in cages in couples (female–male) following a pre-established mating scheme in order to keep the pedigree. Surplus poults can be either kept as future Grandparent or parental breeders and/or as layers for the female lines or reared for meat production.

In the case of future Grandparent or parental breeders, the poults are similarly placed in floor pens at hatching in mixed-sex groups and placed in collective cages (20–30 birds) after sexing. Males and females will be used for inter-crossing purposes and mixed at a ratio of 5–6:1 (females: male). Surplus birds are reared for meat production.

The domesticated female Japanese quail can reach adult weight at 5–6 weeks after hatching (Ionità et al., 2010), and become sexually mature at around 44–56 days of age (El-Sheikh, 2016) or even before (around 35–40 days of age) with commercial lines. This can be linked to management factors such as housing system and stocking density, with feed and light management being incongruently changed as applied in laying hens e.g. increase in photoperiod towards sexual maturity (El-Sheikh, 2016). Male domestic Japanese quail begin mating attempts at around 35 days of age, although complete copulation cannot be seen until a few days later (Ottinger and Brinkley, 1979). The sexual maturation can be influenced by social factors. Currently, routine artificial insemination is not practised, since the techniques for sperm collection and inseminations are not well mastered, even in experimental conditions. Domestic Japanese quail are not inclined to brood, and eggs are hence mechanically incubated. Nest building and nest acceptance might show lower correlations to the egg laying itself, with females showing nest building but do not lay in the nest or might not start to incubate, and other females not laying into a nest. Especially in the quail, this variation is more pronounced compared to other domestic bird species (Orcutt Jr and Orcutt, 1976; Michel, 1989). The incubation period is 18 days of the brooding eggs with poults weighing around 11–13 g (Hegab and Hanafy, 2019).

3.3.4.2. Production cycle for meat

Age at slaughter is often 4–5 weeks (Narinc et al., 2014; Priti and Satish, 2014) but also 5–6 weeks have been reported (Walita et al., 2017), and will vary depending on the strain used and the local market requirements. Reported slaughter weight ranges between 140 g and 300 g. The proportion of dressed meat from the slaughtered bird is ~ 70–73% (Priti and Satish, 2014).

3.3.4.3. Production cycle for commercial eggs

The standard Japanese quail hen used for egg production will weigh ~ 150–250 g (Priti and Satish, 2014), but this is dependent on the line chosen, as commercial and published information indicates up to 290–300 g (Ghayas et al., 2017). Egg weights between 9 and 12 g can be expected and can be affected by the age of the female, which may also influence hatchability (Zita et al., 2013; Hrnčár et al., 2014). Also here, lines might differ in production traits (e.g. with larger egg size), as the variety of genotypes is higher and more locally distributed than in other poultry species (Shimma and Tadano, 2019). The males might be slaughtered for meat production (Gontijo et al., 2016). The females start laying at around 6 weeks of age and will produce almost one egg a day, resulting in a 1-year production of approximately 290 eggs (Minvielle, 1998). Typically, a production cycle lasts 6 months (Lukanov et al., 2018). If kept for longer, the production during the second year can be expected to achieve 150–170 eggs. In literature, Quail are reported to reach peak performance in laying at 13–14 weeks (Ratriyanto et al., 2018) and continue at considerable level until 24 weeks of age (Priti and Satish, 2014) with a decline to about 50% by 40 weeks of age (Kaye et al., 2017). However, commercial factsheets report an earlier egg laying peak and much better persistency of egg production with current genotypes. Although, Japanese quail can be kept in commercial production until 3 or 4 years of age, this is not a current commercial practice in EU. Colour-sexing is practised within some commercial quail lines, but not for all (Minvielle, 2004). The interest in quail farming for egg production purposes is increasing (Lukanov, 2019).

3.4. Description of husbandry systems (ToR-1)

3.4.1. Husbandry systems of domestic ducks

The immature, great-grandparents, grandparents and parental breeders of Domestic ducks are kept in indoor floor systems, whereas the pedigree breeders are kept in individual cages.

Meat ducks are kept during the starting period in indoor floor systems only. Around 10–21 days of age, some, but not all, ducks are moved to the grower barn (indoor floor systems) or the outdoor keeping. The majority of the ducks remain in the starter barn during the growing period. If moved within farm, the movement may be done by herding the ducks to walk from the starter barn to the grower barn or outdoor keeping. Alternatively, the ducks are either encouraged to walk up into a truck or another means of transport or caught, placed in transport crates and loaded on a truck that takes them to the grower barn or outdoor keeping.

During the growing period, Domestic ducks can be kept in indoor floor systems, in indoor floor systems with outdoor access or only in outdoor keeping. In a few cases, a veranda might be added to indoor floor systems either with or without outdoor access. In general, there is quite some variation between farms with respect to husbandry system, though some are more common than others. An overview of the different types of husbandry systems for Domestic ducks kept for breeding or meat purposes and at different ages is provided in Table 7.

Table 7: Overview of husbandry systems for Domestic ducks

Production	Descriptive category	Husbandry system
BREEDERS (Including females for Mule duck production)	Immature	Indoor floor systems
	Pedigree	Individual cages
	Great-grandparents	Indoor floor systems
	Grandparents	Indoor floor systems
	Parental	Indoor floor systems
MEAT	Starting period	Indoor floor systems
	Growing period	Indoor floor systems
		Indoor floor systems with outdoor access
		Outdoor system

3.4.1.1. Husbandry systems for breeders

Main characteristics of the husbandry systems for breeders are reported in Table 8.

3.4.1.1.1. Indoor floor systems

This system is used for all strains of immature, great-grandparent, grandparent and parental breeders. In all these categories, artificial insemination is never used, except for the production of mule ducks.

For the reproductive period, males and females are moved into dedicated collective indoor floor systems with reproduction based on spontaneous mating for Domestic duck breeders, with the exception of females for Mule duck production and pedigree breeders. The former being also raised in collective indoor floor systems but inseminated weekly with mixed Muscovy drake semen, while the Pedigree breeders are placed in individual cages and inseminated with individually identified semen of Domestic drakes, following a pre-established mating scheme.

The types of drinkers that are used in indoor floor systems are the bell drinkers and sometimes nipple drinkers, the latter being also used in cages. All these breeders use regular feeders, while for immature breeders, the feed can also be provided dispersed on any support (cardboard, plastic, etc...) placed on the floor to be easily accessible to the ducklings during the first days.

The floor for i**mmature** breeders is usually fully covered with litter. Some other enrichment materials can be present, such as minerals and hanging ropes.

In **great-grandparents,** the floor is covered with litter (80–100% of the area). **Grandparent breeders** have also the floor covered with litter and can be provided enrichment such as minerals and hanging ropes for playing.

For parental breeders, the enrichments provided, and the size of the nests used are the same as for the grandparent breeders. The roof of the nest is usually covered to avoid light to enter. Stocking density is ~ 20 ducklings/m^2 in week 1 which is gradually reduced to ~ 5 birds/m^2 by week 3, and then, 3.5–4 ducks/m^2 can be used. Litter is present and is usually of wood shavings in the first 5–6 weeks, and then usually straw pellets.

3.4.1.1.2. Individual cages

This system is used for pedigree breeders.

Individual cages are nowadays used to collect and record individual data such as egg laying performance, feed consumption to evaluate feed efficiency and to collect faeces to evaluate feed digestibility, even if this practice is not the routine.

Pedigree breeders of Domestic ducks are usually kept in individual cages.

The usual dimensions of individual cages are 33 length × 51 width × 51 height cm or, depending on the company, dimensions can be different according to the sex: 58 × 45 × 50 cm female and 58 × 50 × 58 cm for male. Cages have wire floor and may be furnished with perforated rubber matting providing leg support and comfort to the birds (systematically for males and sometimes for females), and nests with litter and a large open entrance on the side of the cage. The roof of the nest is usually covered to avoid light to enter. No other features (e.g. enrichments) are provided. The cages are neighbouring with another three cages, which allows the animals to see and to have limited interaction with each other. For the watering and feeding equipment, nipples and individual feeders are used, respectively. Artificial insemination is performed.

Table 8: Husbandry system for Domestic Duck breeders. Information provided by Stakeholder umbrella organisations reflecting current practices (see Section 2.2.2.2). When cells are empty, the information is not applicable or has not been provided

Descriptive category	Husbandry system	Strains and sexes	Duration	Stocking density (birds/ m^2)	No of animals (ducks/building)[(a)]	Dimensions (l × w × h)[(b)]	Total m^2	Sex ratio (female: male)	Nest provision and dimensions (l × w × h)[(b)]
Immature breeders	Indoor floor systems	All	6 months	5	1,000–4,000	–	–	3.5–5: 1 Separate rearing	–
Pedigree breeders	Individual cages	All	Can vary from 25 weeks to 1.5 years	–	–	33 × 51 × 51 cm	0.17 m^2	–	Yes, dimension not provided
Great-grandparents breeders	Indoor floor systems	All	–	4	4,000	–	–	6:1	Yes, dimension not provided
Grandparents breeders	Indoor floor systems	All	From 45 weeks to 2 years of life	3.5–4	2,000–4,000	–	–	3.5–5: 1	Yes, one nest 45 × 33 × 32 cm
Parental breeders	Indoor floor systems	All	From 45 weeks to 2 years of life	3.5–4	4,000–5,000	–	–	3.5–6: 1	Yes, one nest 45 × 33 × 32 cm

(a): The number indicates the number of animals on the building; however, it might not correspond to the group size because the presence of pens inside the building has not been provided.
(b): l = length, w = width, h = height.

3.4.1.2. Husbandry systems for meat production

3.4.1.2.1. Indoor floor systems

These systems are used for Domestic ducks during the starting and growing period. Domestic ducks in indoor floor housing systems are mostly kept in large-scale buildings that usually do not have structural elements other than feeders and drinkers.

Starting period: The day-old ducklings are delivered in mixed-sex flocks to the rearing farms. They are placed in a full-house heated starter barn where the temperature is kept at 30°C or higher depending on the humidity on the day of placement and gradually lowered to 26°C or 23°C on day 8 until the end of the starting period (between 10 and 21 days) where temperature can go down to 15°C. The decrease in temperature may be steeper in barns where ducklings destined for systems with free-range in the growing period are kept. During the first 3 days, feed and water are typically provided in feed trays on the floor to ease the access for the ducklings. Open water sources may be also provided already during the starting period, but this is not the standard.

Common for the starting and growing period: The floor is usually solid (concrete or ground soil floor) and littered, except for locations under the water sources where perforated floor is used, but variation exists in how large a proportion of the flooring is taken up by slats and litter, respectively. In Germany, the Lower Saxony guidelines (ML, 2015) require that at least 75% of the floor is littered and recommend placing open water sources over perforated floors for hygienic reasons. Straw or wood-shavings is typically used as litter, and new material is provided daily/regularly on the entire surface of the solid floor, even though pine or wood shavings, rice hulls or sawdust can be seen (Babington and Campbell, 2022).

The floor is usually solid and littered, but some ducklings are also kept on elevated wire floor during the first week and plastic slats for the following 2 weeks of the starting period and the growing period. In this husbandry system, the stocking density reported is 37 ducklings/m^2 the first week, 15 ducks/m^2 the second week, 7.7 ducks/m^2 the third week and 3.6 ducks/m^2 from the fifth to seventh week.

Feeder and water lines are evenly distributed within the house. The feeding and drinking systems can be different types of automated or manually operated feeders and nipple or round drinkers (Table 9). Water is mostly supplied from nipple drinkers (6–10 birds/nipple drinker) of which some (e.g. every tenth) may have a cup underneath from which it is expected that the ducks can cleanse their nostrils and eyes. Open water sources (see under growing period) may be already provided during the starting period, but this is not the standard. The most common type of feeders is linear with a space per bird ranging between 1.8 and 12 cm.

The flock size varies between 400 and more than 30,000 ducks per house (Grashorn and Brehme, 2018). The maximum stocking density typically ranges between 20 and 25 kg/m^2 at any stage, but both lower and higher stocking are reported by EU MSs (Annex 1). Commonly the light programme used for the ducklings is constant light for the first 3 days of life, after which 16 h/8 h (light/darkness) is provided, but often there is also natural light entering the house.

Table 9: Minimum drinker and feeder reported for Domestic ducks' provision (ML, 2015)

Age (days)	Ducks/nipple drinker	Rim of round or long drinkers cm/kg liveweight	Feeder space cm/kg liveweight
1–5	25	3.3	0.8
6–21	15	1.6	0.8
> **21**	10	0.5	0.4

Growing period: The grower barns used for duck production in the EU vary greatly in design and material used. Barns may be open-sided or with completely closed walls (called Louisiana barns). Furthermore, they may be built with solid bricks or a less insulating material, such as polytunnels. Artificial lighting is a requirement in some MSs (e.g. Germany), whereas in others, it is usually not used due to the influx of natural light from the areas covered just by netting (e.g. parts of the sidewalls and endwall; e.g. Denmark). Depending on MS/region and degree of intensification, forced ventilation or natural ventilation is used.

The Council of EU recommendation[19] concerning Domestic ducks requires: 'ducks must be provided with water facilities sufficient in number and so designed to allow water to cover the head and be taken up by the bill so that the duck can shake water over the body without difficulty'. The ducks should be allowed to dip their heads under water. In addition to the cups under a proportion of the nipple drinkers (described under 'Common for starting and growing period'), this may be allowed for by providing open water sources. For example, in Lower Saxony, this is implemented by requiring provision of open water from 22 days of age onwards up to 24 h before bringing the ducks to slaughter. For this, the use of nipple drinkers with pendulum and deep cup (see Table 46, No. 4) is widespread.

As a niche production, some indoor floor systems do provide covered verandas during the growing period as a supplement to the indoor facility. Covered verandas provide the ducks with natural light, variation in the climatic conditions and additional space, not only to the birds venturing out into the veranda, but also for the birds staying indoor which will benefit from the reduced stocking density. The area may be littered (usually with the same substrate as the indoor house) with a concrete foundation underneath. The covered veranda is protected against predators and wild birds or other animals and usually also against extreme weather conditions by a roof; however, it is not heated. Roughage and open water sources can beneficially be provided in the covered verandas without the risk of increasing dust or moisture level in the indoor litter. As access to covered verandas is a rare practice in the production of Domestic ducks, detailed information on the system cannot be provided.

3.4.1.2.2. Indoor floor systems with outdoor access

During the **growing period**, ducks in the floor system with outdoor access are housed in barns similar to those described under indoor floor systems (Section 3.4.1.2.1). However, outdoor access is provided typically from days 10–12 of age or older depending on the outdoor climatic conditions. The type of outdoor range provided varies considerably. It may be an outdoor run with concrete floor or an outdoor area varying in space allowance per duck and resources available, e.g. types of vegetation, shelter, open water sources, etc. The marketing standards for poultry meat sets 2 m^2/duck of outdoor area mainly covered with vegetation as the minimum requirement for ducks to be classified as free-range ducks (Commission Regulation (EC) 543/2008)[20], whereas the organic regulations state that an outdoor area of minimum 4.5 m^2/duck must be provided (Commission Implementing Regulation (EU) 2020/464)[21]. The structuring of the outdoor range is highly variable. Tall vegetation in terms of trees or bushes may be present, but often the range is plain pasture with patches of bare ground, or even a concrete pad. Feed and drinking water may be provided in the outdoor range, although this is discouraged due to avian flu precautions. Different types of open water sources for wet preening or bathing may be present. These can range from automatic water troughs, allowing dipping of the head, to swimming pools, allowing full body bathing and in some cases even diving (Section 3.6.5.1). Water hygiene is either maintained by frequent change of the water or by filtering. Ponds may also be present, but the water quality may be poor if filtering of the water is not done. Resources placed in the free range (i.e. feed, drinking water and open water sources) have to be placed under a cover to prevent contact with wild birds/droppings. Roughage, such as cut grass or alfalfa, may be provided. In addition, a simple shelter may be present where the ducks can find shade or seek shelter under poor weather conditions. As the Domestic duck is poor at flying due to its heavy body weight, no wing clipping or other measures are done to prevent them from escaping the outdoor enclosure.

One major challenge in the free range is predators, including gulls, foxes, ravens, crows and humans. In addition to an electric fence surrounding the outdoor area, several protective measures may be applied. Lines of string closely together may be placed at the height of ~ 2 m, but gulls quickly learn how to pass through the strings. Gas cannons and flare guns (or signal pistols) may be fired at irregular intervals to deter predators but can be also a source of stress for ducks. More sophisticated, a specific speaker device can be used to detect sounds in the area and emit an adapted deterring sound, when sounds of potential predators are recognised. Predators (e.g. common gull, lesser black-backed gull and foxes) can be regulated by hunting or other non-invasive methods (e.g. handheld laser).

---

[19] Standing Committee of the European Convention for the Protection of animals kept for farming purposes (T-AP) – Recommendation concerning Domestic ducks (Anas platyrhynchos) adopted by the Standing Committee on 22 June 1999.

[20] Commission Regulation (EC) No 543/2008 of 16 June 2008 laying down detailed rules for the application of Council Regulation (EC) No 1234/2007 as regards the marketing standards for poultry meat. OJ L 157, 17.6.2008, pp. 46–87.

[21] Commission Implementing Regulation (EU) 2020/464 of 26 March 2020 laying down certain rules for the application of Regulation (EU) 2018/848 of the European Parliament and of the Council as regards the documents needed for the retroactive recognition of periods for the purpose of conversion, the production of organic products and information to be provided by Member States. OJ L 98, 31.3.2020, pp. 2–25.

3.4.1.2.3. Outdoor systems

Ducks may be moved directly from the starter barn to the outdoor area with no access to a grower barn or other indoor facilities, despite the presence of shelter. This is typically practised in extensive systems such as in organic production (e.g. in Denmark) or in niche production. The flock size is therefore often considerably smaller (e.g. 3,600 in Denmark) than in indoor systems. During the warm season, the ducks will be moved to the outdoors permanently as early as 13–14 days of age, whereas they may be 3–4 weeks old during winter season.

The structuring and furnishing of the outdoor keeping are as described in Section 3.4.1.2.2 'Floor system with outdoor access' with the difference that in the case of outdoor keeping essential resources, i.e. feed and water, and shelter are always provided outdoors. Feed and water are placed under a cover to minimise/avoid contact with wild birds/droppings.

3.4.2. Husbandry systems of Muscovy and Mule ducks

The husbandry systems generally used for Muscovy and Mule ducks comprise individual cages, indoor floor systems, indoor floor systems with outdoor access and only outdoor keeping systems with some shelter, but no barn. For foie gras production, in addition, elevated collective cages or pen systems indoor are in use. An overview of the different types of husbandry systems for the different production purposes and ages is provided in Table 10. However, there is quite some variation between farms within husbandry systems which is described below.

Table 10: Overview of husbandry systems for Muscovy and Mule ducks

Production	Descriptive category	Husbandry system
BREEDERS (Including males for Mule duck production)	Immature	Indoor floor systems
	Pedigree	Individual cages
	Great-grandparents	Indoor floor systems
	Grandparents	Indoor floor systems
	Parental	Indoor floor systems
		Individual cages[(a)]
MEAT AND FOIE GRAS	Starting period (for heating, 1–3/4 weeks – Phase 1)	Indoor floor systems
	Growing period (4–12 weeks – Phase 2 for meat production; Phase 2 and 3 for foie gras production)	Indoor floor systems
		Indoor floor systems with outdoor access
		Outdoor system
	Overfeeding period (last 10–12 days- Phase 4)	Elevated collective cages indoor
		Elevated pen systems indoor
		Floor pen systems indoor

(a): Males for Mule duck production.

3.4.2.1. Husbandry systems for breeders

Husbandry systems are visualised in Table 10 and are in common with Domestic ducks (e.g. indoor floor systems and individual cages; see Section 3.4.1.1). Differences compared to Domestic ducks are described below. Main characteristics of the husbandry systems for breeders are reported in Table 11.

3.4.2.1.1. Indoor floor systems

This system is used for all strains and both sexes of **immature,** and most of **great-grandparent and grandparent breeders** with the exception of a limited number of offspring with known pedigree whose performances are used for pedigree breeder candidates' genetic evaluation.

All the categories mentioned are raised in floor pens with litter (80–100% of the surface).

Parental breeders may also stay in indoor floor systems, except for mule production, in which artificial insemination is performed. Floor is with litter (80–100% of the surface) and there is provision of nests. Artificial insemination is only used in parental breeders for the production of Mule ducks, and rarely in great-grandparent and grandparent breeders. Male parental breeders for the production of Mule ducks are housed either in indoor floor systems (in pens) or individual cages.

The types of drinkers that are used are bell drinkers and nipples together. All these breeders use the feeders, while the immature breeders can also provide feed for the birds on the floor.

3.4.2.1.2. Individual cages

This system is used for pedigree breeders and for male parental breeders for the production of Mule ducks.

Pedigree breeders are kept in individual cages. This system is currently used to collect individual traits data and pedigree to perform a genetic selection program. It is also used to carry out artificial insemination with individual's sperm; to keep track of the pedigree in order to monitor the selection program and both the genetic diversity of the population and the rate of inbreeding (i.e. consanguinity) low.

These cages are designed to house only one bird and have wire mesh floor, equipped with a nipple drinker, a feeding trough and a nest. Part of the floor area might be covered by a perforated plastic mat (commercially called 'leg support') to improve the animals' comfort. Their sizes vary according to the sex of the animals. Cages for females range between the following values: Length × Width × Height: 60 cm × 39–45 cm × 50–51 cm and are extended by a nest containing wood shavings. These are square and covered with a roof that allows the light to enter. Cages for males are slightly larger (60 × 50 × 60 cm) and may have a wooden perch on the floor to allow this species to express its perching behaviour. Cages are disposed in a group of three or more to allow the birds to have visual and limited physical contact with each other. For the watering and feeding equipment, nipples and individual feeders are used, respectively.

Parental male breeders for mule production, i.e. Muscovy drakes, are placed in individual cages during the reproductive period. They are raised separate from the female Domestic ducks because of the use of artificial insemination. They are kept in individual cages for 6 months to collect sperm. For the watering and feeding equipment, nipples and individual feeders are used, respectively.

Table 11: Husbandry system for Muscovy and Mule Duck breeders. Information provided by Stakeholder umbrella organisations reflecting current practices (see Section 2.2.2.2). When cells are empty, the information is not applicable or has not been provided

Descriptive category	Husbandry system	Strains and sexes	Duration	Stocking density (birds/m^2)	No of animals (birds/ building)[(a)]	Dimensions (l × w × h)[(b)]	Total m^2	Sex ratio (female: male)	Nest provision and dimensions (l × w × h)[(b)]
Immature breeders	Indoor floor systems	All	6 months	5.5	10,000	–	–	– Separated in rearing	–
Pedigree breeders	Individual cages	All	1.5 year	–	–	Female: 60 × 39–45 × 50–51 cm Male: 60 × 50 × 60 cm	0.23 m^2	–	Yes, 30 × 45 × 30–40 cm
Great-grandparents breeders	Indoor floor systems	All	2 years	5	5,000	–	–	6:1 always kept together, except for mule production	Yes, number and dimension not provided
Grandparents breeders	Indoor floor systems	All	2 years	5	5,000	–	–	6:1 always kept together, except for mule production	Yes, number and dimension not provided
Parental breeders	Indoor floor systems	Females	2 years	5	5,000	–	–	6:1 always kept together, except for mule production	Yes, number and dimension not provided
	Individual cages	Males intended for mule production	6 months	–	–	58 × 50 × 58 cm or 51 × 62 × 52 cm	0.29 m^2 or 0.32 m^2	–	–

(a): The number indicates the number of animals on the building; however, it might not correspond to the group size because the presence of pens inside the building has not been provided.
(b): l = length, w = width, h = height.

3.4.2.2. Husbandry systems for meat production

3.4.2.2.1. Indoor floor systems

These systems are used for Muscovy and Mule ducks during the **starting and growing period**.

Buildings used for the starting and growing period of Muscovy ducks kept for fattening can vary from old buildings with smaller pens (e.g. formerly pens for fattening pigs) to new large buildings. According to Grashorn and Brehme (2018), these buildings can house more than 10,000 ducks and are similar to those described for Domestic ducks (Section 3.4.1.2.1). Likewise, for Mule ducks in the starting and growing period, flock sizes vary from a few hundred animals to nearly 15,000.

Indoor systems for Muscovy ducks are often barren with perforated floors made of wood, metal or plastic material without litter, and water provision only through nipple or round drinkers (Knierim et al., 2005; Guémené et al., 2012). The more frequent use of perforated floor for Muscovy ducks compared to Domestic ducks (Rodenburg et al., 2005) is sometimes explained by a tendency of the Muscovy duck to 'waste' water (Grashorn and Brehme, 2018) and a higher susceptibility to adverse influences from moist litter.

However, moisture of the litter depends also on litter management and stocking density, and in practice, Muscovy ducks can successfully be fattened on littered floor. Some farms are also floor littered with the exception of the areas under the water sources that are perforated. The German Federal State Lower Saxony, where a large proportion of the Muscovy duck is kept, requires that at the latest from an age of 5 weeks onwards a minimum of 20% of the floor needs to be littered (ML, 2013). This implements the Council of EU Recommendation,[22] stipulating that the 'floor shall include an area sufficient to enable all birds to rest simultaneously and covered with an appropriate bedding material.' However, as this Recommendation has largely not been transcribed into EU or national regulation, it can be expected that often Muscovy ducks are still kept on fully perforated floors. When indoor flooring systems with litter or combinations of litter and slatted floors are used, drinkers are mostly located over slatted plastic or wire flooring for hygienic reasons (Merlet et al., 2010).

Mule ducks are mostly kept during the starting period on solid and littered floors, with possible exceptions of perforated areas under the water sources. Different types of substrates are used of which straw is most common. The material might be renewed periodically in some farms.

Feeder and water lines are evenly distributed within the house. The feeding and drinking systems can be different types of automated or manually operated feeders and nipples or round drinkers (see Annex B), for Mule ducks mostly nipple drinkers. Common recommendations on feeder and drinker space are given in Table 12. Regarding the provision of open water, the same applies as reported for the Domestic duck. During the first days of life of the ducklings, feed is typically provided in feed trays on the floor, as in Domestic Ducks, and constant light is provided to ease access for the ducklings. In general, light regime in terms of photoperiod is similar to the one applied in Domestic ducks, but light is often kept at low levels (< 30 Lux; (Grashorn and Brehme, 2018)) without any natural light in order to decrease the extent of feather pecking and cannibalism (Knierim et al., 2005). For Mule ducks during the starting period access to natural light is more common.

Table 12: Recommendation on drinker and feeder provision for Muscovy ducks during starting and growing period according to Grashorn and Brehme (2018)

Age (days)	Ducks/nipple drinker	Rim of round drinkers; cm/kg liveweight	Rim of round/long feeders; cm/kg liveweight
1–15	25	3.1	1.1/1.3
> 15	10	0.5	0.26/0.3

Regarding temperature management, the day-old ducklings are either placed in a full-house heated starter barn or in a barn with zone heating (brooders) with a temperature of about 34°C in the area around the duckling which is gradually decreased to 18°C at 4 weeks of age and later down to 15°C (Grashorn and Brehme, 2018). Temperature management for Mule ducks is similar to that for Domestic ducks.

[22] Council of Europe Standing Committee of the European convention for the protection of animals kept for farming purposes. Recommendations concerning Muscovy Ducks (*Cairina moschata*) and hybrids of Muscovy and Domestic ducks (*Anas platyrhynchos*), adopted by the Standing Committee of the European Convention for the Protection of Animals kept for Farming Purposes (T-AP) on 22 June 1999.

In Muscovy ducks raised on perforated floor, stocking density can vary from 16 to 52 kg/m^2 (4–13 birds/m^2 at the final stage of the growing period (Rodenburg et al., 2005). ML (2013) limits stocking density to a maximum of 35 kg/m^2. Grashorn and Brehme (2018) provide a table with common stocking densities expressed in kg live weight/m^2 (Table 13) and birds/m^2.

For Mule ducks during the starting period, stocking density usually is between 5 ducks/m^2 and 15 ducks/m^2. In the first case (5 ducks/m^2), ducks can remain in the same house during the starting, growing and preparation for over-feeding periods (indoor density of 20 kg/m^2 at 12 weeks of age). In the second case (15 ducks/m^2), 50–66% of the animals are transferred to another house after the starting period (indoor density comprised between 20 and 30 kg/m^2 at 12 weeks of age).

Table 13: Stocking densities for Muscovy ducks at different ages reported by Grashorn and Brehme (2018)

Age (weeks)	Live weight (kg)	Males (up to 11 weeks)/m^2	Females (up to 10 weeks)/m^2
1	8	80.0	96.4
2	17	68.0	77.3
3	23	41.8	52.3
4	27	27.0	36.3
5	27	16.9	27.9
≥ 6	25–35	4.7–6.5	7.8–11.0

For Mule ducks, it is reported from Hungary that about 20 ducklings/m^2 are kept in week 1, which is gradually reduced to 4 ducks/m^2 by week 4 and maintained afterwards.

Some indoor floor systems do provide a covered veranda as a supplement to the indoor facility, without affecting the stocking density per m^2 (the available surface area considers the surface area of the veranda, always available to the ducks).

3.4.2.2.2. Indoor floor systems with outdoor access

The growing of Muscovy ducks with outdoor access can mainly be found in organic or Label Rouge production. In organic production, the ducks are kept in stocking densities of up to 21 kg/m^2 and with access to a minimum of 4.5 m^2 free range per bird. At least one-third of the floor indoors is solid and littered. Although no statistics differentiating Domestic and Muscovy ducks are available, it is estimated that numbers of Muscovy ducks in organic production are low, among other reasons because of the risk of feather pecking and cannibalism.

Mule ducks kept for later foie gras production, during the growing period are largely reared in indoor floor systems with outdoor access, in accordance with the EU charter on breeding adopted by Euro Foie Gras.[23] These systems are barns like those described under indoor floor systems (see Section 3.4.2.2.1) with access provided to outdoor areas, typically from the end of the starting period, or earlier depending on the outdoor climatic conditions. When climatic conditions are unfavourable (e.g. during the winter), or in the case of limited access to outdoor decided by a ministerial order for sanitary reason, ducks can be kept indoors during the growing and preparation for overfeeding periods. These periods can then take place in the same house as the starting period or in another house which may be open-sided (netting on one side) or with completely closed walls. Stocking density is between 3 and 6 ducks per m^2 (12–24 kg/m^2), depending on house type and the farmer's ability to manage ducks reared exclusively indoor.

The outdoor range may be a non-concrete run including a grassed area, a thatched area or a wooded area. The marketing standards for ducks kept for later foie gras production set at least 3–5 m^2/duck of outdoor area as the minimum requirement to be classified as Protected Geographical Identification (PGI/06/95) or Label Rouge (LA/16/89[24], LA/12/89[25], LA/19/02[26]) ducks, depending on the stocking density in the indoor area (10 or 7.5 ducks/m^2 maximum in the house, respectively). Outdoor access is required at 43 days of age, at the latest. As for Domestic ducks, feed and drinking water may be provided in the outdoor range, although this is discouraged due to

[23] Eurofoiegras, online. European charter on breeding of waterfowl for foie gras. Available online: https://www.eurofoiegras.com/wp-content/uploads/2019/05/EN-EUROFOIEGRAS_CHARTE-1.pdf [Accessed: (January 2023].

[24] Foie gras cru et produits de découpe de canard mulard gavé (LA/16/89).

[25] Canard mulard gavé entier, foie gras cru et produits de découpes crus frais et magrets surgelés (LA/12/89).

[26] Produits transformés de canards mulards gavés (LA/19/02).

avian flu. Resources placed in the free range (i.e. feed, drinking water and open water sources) have to be placed under a cover to prevent contact with wild birds/droppings. For the outdoor run, a period of rest is required between successive batches by legislation for sanitary reasons. It lasts 12 weeks so that the use of a run allows the rearing of approximately 2.5 flocks per year (Pingel et al., 2012).

3.4.2.2.3. Outdoor systems

Some Mule ducks kept later for foie gras production, especially during the summer in extensive systems with a flock size of 100 to a maximum of 2,000 animals, may go directly from the husbandry system of the starting period to the outdoor area with no access to a grower barn or other indoor facilities. The structuring and furnishing of the free range are as described in Section 3.4.2.2.2 'Floor system with outdoor access'. Feed and water are then placed outdoor, under a cover to prevent contact with wild birds/droppings. Protecting nettings covering the outdoor range may be required in the case of limited access to outdoor determined by a ministerial order for sanitary reason.[27]

3.4.2.3. Husbandry systems for foie gras production

In accordance with the Council of EU Recommendation of 22 June 1999, individual cages used during the overfeeding period (9–12 days, or more in some traditional systems) have been banned for all new installations since 1 January 2011, and for all installations since 1 January 2016 according to an additional delay of 5 years to upgrade them towards group housing.

Since that date, Mule ducks kept for foie gras production are placed either in elevated collective cages (most common system), generally designed for 4–5 ducks, or elevated collective pens (designed for 6–10 ducks) or, more rarely, in floor pens (designed for groups of 15–25 ducks, older system) (see descriptions below).

Three main types of housing systems can be distinguished during the overfeeding period (see Sections 3.4.2.3.1–3.4.2.3.3). These systems are the same in the different MSs.

At present day, the minimum technical characteristics of commercial housing for ducks in the overfeeding period are detailed in the Council of EU's recommendation concerning Muscovy and Mule ducks, and are specified in a report from the General Direction for Food (DGAL)[28] in France. This report details the following requirements:

- a minimum of three ducks per housing unit;
- a minimum total area of 4,000 cm^2 for three ducks, 5,000 cm^2 for four ducks and 1,200 cm^2/duck for five or more ducks;
- a minimum width of 80 cm;
- the furniture of longitudinal troughs;
- a slatted floor without protruding elements, made of plastic or metal;
- a sufficient lighting to allow all ducks to see each other, to be seen clearly, to examine their surroundings and to have normal activity levels;
- a restraint time should not exceed the feeding time for a row of cages.

For all these husbandry systems (Sections 3.4.2.3.1–3.4.2.3.3), no enrichment is currently provided.

3.4.2.3.1. Elevated collective cage systems indoor

Collective cage rearing systems during the limited fattening period represent most of the duck foie gras production (Figure 5).

Elevated cages are mostly designed to house four to five birds, in an area comprised between 0.6 and 0.8 m^2 (80–120 cm wide × 60–75 cm long) depending on the number of animals housed (around 1,250 cm^2/animal). They are made of wire and have a flat wire mesh floor. Mainly depending on the company, it may be further covered with some soft material (e.g. a rubber coating, a rubber mat or a plastic or metallic flat plate). The wire mesh walls are about 70–80 cm high, and the front of the cage is made of vertical bars to allow access to the water trough placed in front, or more rarely in back, of the cage. They have no roof, but those cages are equipped with a mobile sloping front wall that can partly close the top of them. This wall is lowered at feeding time to limit animals' movement and facilitate the intervention of the personnel feeding the animals. In these systems, a person cannot enter, and the restraint is mechanical.

[27] (Arrêté du 8 février 2016 relatif aux mesures de biosécurité applicables dans les exploitations de volailles et d'autres oiseaux captifs dans le cadre de la prévention contre l'influenza aviaire).

[28] Canard à foie gras du Sud-Ouest (Chalosse, Gascogne, Gers, Landes, Périgord, Quercy (IG/06/95)).

Figure 5: Illustration of elevated collective caged systems indoor used for Mule ducks during the overfeeding period (© Joanna Litt, ITAVI, France)

3.4.2.3.2. Elevated collective pen systems indoor

These systems are designed to house 6–10 animals, in an area comprised between 1.2 and 1.8 m^2 (1,250–1,500 cm^2/animal). They are made of wire and have a flat wire mesh floor. The wire mesh walls are about 80 cm high and the front of the cage is made of bars to allow access to the water trough placed in front or in back of the enclosure. The main difference of these systems with the ones described in Section 3.4.2.3.1 is that pen systems have no roof. These enclosures (Figure 6) are rectangular and can be:

- wider than long: during feeding, the feeder stands in front of the middle of the pen and separates the fed animals from the non-fed animals manually, by moving the ducks from one side of the pen to the other. In these systems, a person cannot enter, and the restraint is manual.
- longer than wide: to facilitate the intervention of the person feeding the animals at feeding time, those cages are equipped with mobile walls at the front and the back of the pen that can, respectively, be lowered and be pulled towards the front of the pen to limit animals' movement and to bring the ducks closer to the person feeding them. In these systems, a person cannot enter and the restraint is mechanical.

Figure 6: Illustration of two elevated collective pen systems indoor used for Mule ducks during the overfeeding period. (A) Wider than long pen; (B) longer than wide pen (© Joanna Litt, ITAVI, France)

3.4.2.3.3. Floor collective pen systems indoor

Floor pens are usually 3 m^2 (1×3 m) for 15–25 animals (1,200–2,000 cm^2/animal) (Figure 7). They are made of wire mesh walls and slatted floor. In some rare cases, animals may be provided with straw litter. Water is available from a trough placed in the pen. The restraint of animals at feeding time is carried out directly by the person feeding the animals, who, unlike the other systems described, enters the pen. In these systems, animals are restrained manually.

Figure 7: Illustration of floor collective pen systems indoor used for Mule ducks during the overfeeding period (© Joanna Litt, ITAVI, France)

3.4.3. Husbandry systems of domestic geese

In the EU, Domestic geese are kept for breeding purposes, and for meat and foie gras production. The immature and parental breeder geese are kept in indoor systems with or without outdoor access, whereas the selection breeders are kept in indoor floor system. Geese for meat and foie gras are kept in indoor floor systems only (with various floor types), or with access to an outdoor range, but from a certain age, geese kept for meat production may be kept in a free range (outdoor only) system. There is also an overfeeding period in geese for foie gras production, in which geese are kept indoor only in pens. An overview of the different types of husbandry systems for Domestic geese kept for different purposes at different ages is provided in Table 14.

Table 14: Overview of husbandry systems for Domestic geese

Production	Descriptive category	Husbandry system
BREEDERS	Immature	Indoor floor systems
		Indoor floor systems with outdoor access
	Pedigree	Indoor floor systems
	Great-grandparents	Indoor floor systems
	Grandparents	Indoor floor systems
		Indoor floor systems with outdoor access
	Parental	Indoor floor systems
		Indoor floor systems with outdoor access
MEAT and FOIE GRAS	Starting period	Indoor floor systems
	Growing period	Indoor floor systems
		Indoor floor systems with outdoor access
		Outdoor keeping
	Overfeeding period (only Foie Gras production)	Elevated pen systems indoor
		Indoor floor pen systems

3.4.3.1. Husbandry systems for breeders

As visualised in Table 14, the husbandry systems are similar to those of Domestic, Muscovy and Mule ducks (see Sections 3.4.1 and 3.4.2). Main characteristics of the husbandry systems for breeders are reported in Table 15.

The use of cage systems is not in use anymore for geese under selection and reproduction.

3.4.3.1.1. Indoor floor systems

Indoor floor systems are exclusively used for all strains and both sexes of pedigree and great-grandparent breeders. Immature, grandparent and parental breeders may also use this system. The types of drinkers that are used are the bell drinkers and the nipples. All these breeders use the regular feeders, while in immature and pedigree breeders feed can be also provided on the floor.

Immature breeders: The 1-day-old immature breeder goslings are placed on litter (straw or wood shavings) in a heated building and fed a protein-rich feed (20–22%) ad libitum in round or long feeders and have unlimited access to water from drinkers (round or bell, and later nipple drinkers) in the first 4–5 weeks. Fresh litter is spread every 1–2 days on top of the old litter. Initially goslings are kept together, but as they grow and because they like to huddle, pens are formed in the building to separate them to groups of 200–300 goslings (8–10 goslings/m^2) ranging between 1,000 and 4,000 goslings per building. From week 3, the goslings can get green fodder to fulfil their needs for fibre and to prevent feather pecking (Bogenfürst, 2017).

Between week 4–5 and week 25–30, indoor rearing can continue in the same building as the one used from the beginning or in another building that may or may not have outdoor access (see Section 3.4.3.1.2). Artificial lighting system (although the building may have windows on one to two sides) is provided but no heating system. As the goslings grow, the number of birds is constantly reduced until 1–2 geese/m^2 is reached, in order not to increase too drastically the stocking density. Feeding is carefully portioned (max. 18% protein) in long feeders and green fodder may be given in hay racks.

Preparation for the first laying period begins around 25–30 weeks of age. During preparation, the ganders and geese are kept in a separate building (or in separate pens of the same building) for a few weeks, because they need different amounts of feed and different light regimes to induce reproductive activity. Flocks of breeding geese are created in a sex ratio of 3–4:1 (females: male) about 2–3 months before laying is expected. Between 50% and 80% of the total number of immature breeders are kept in indoor floor systems from 25 to 40 weeks, in a proportion variable due to avian influenza (the rest of immature breeders are kept in barns with outdoor access, Section 3.4.3.1.2).

From 40 weeks to 2 years of age, **pedigree breeders** are kept in indoor floor systems. The males and females are kept either together during the reproductive period for natural mating in a sex ratio of 2–3:1 (females: male) or separately during rearing. Generally adult males and females are kept together during egg laying. They are also kept together when they are not laying. However, there is a 10- to 12-week preparation period, when the needs (mainly in feeding and light) of males and females differ and then they are kept separate in different houses. In some cases, multiple small groups of 15–20 (3–5 females: 1 male) are kept, with two to three males in the group to avoid problems of mating or infertile males.

Great-grandparent breeders are raised in floor pens with straw litter. Wide drinkers are provided. Other features reported are natural light and nests. Please see Table 10 for further information.

Grandparent breeders are kept in indoor floor systems. Some of them can be kept also in barns with outdoor access (see Section 3.4.3.1.2) outside the reproductive period, depending on avian influenza conditions. The floor has straw litter. Wide drinkers are provided. Enrichment reported is natural light and nests.

Around 50% of **parental breeders** are kept in indoor floor systems. However, in case of a larger number of birds, extending the space allowance and separation of flocks should be considered, otherwise production may decline (Bogenfürst, 2017). Thus, the building may be divided into pens depending on the size with 150–200 geese/pen. During preparation and over the laying period, parental breeders are kept constantly indoor in a light proof building (concrete building, polytunnel or other material) with artificial light system. The floor may be litter (usually straw) or a mixture of litter and slatted floors. Fresh litter is spread every 1–2 days on top of the old litter. The geese are fed with feed containing ~16% protein from long feeders, but they have limited access (both in terms of time and quantity) to it. Water is accessible from nipple drinkers for a part of the day, including the time of feeding. One nest, made of wood (0.5 × 0.5 × 0.5 m), can be calculated for about 5–6 geese and additional nest material (straw) is provided every second day to keep eggs clean and prevent egg breaking (Bogenfürst, 2017). In addition to artificial light, the birds might be provided with natural light (if the building has windows), grass, alfalfa and straw, as enrichment.

Artificial insemination is a decreasing practice, but when in use, it has the purpose of boosting fertility in parental breeders (but not in pedigree breeders). In this case, some of the ganders may be moved from the collective pen and temporarily housed in individual pens (0.6 × 0.6 × 0.8 m) in one end of the same building (usually for the last 6–8 weeks of the laying season). Fresh litter is spread every day on top of the old litter. Feed (from a small feeder) and water (from nipple drinkers or bucket) can be provided individually for them (Bogenfürst, 2017). No enrichment is provided in these pens.

3.4.3.1.2. Floor systems with outdoor access

Immature, grandparent and parental breeders may use for all strains and sexes of Domestic geese the indoor floor systems with outdoor access. Indoor floor system with outdoor access is defined as 'animals kept inside a barn, with possibility to go outside'. They keep them in a sex ratio of 3–5:1 (females: male). The types of drinkers that are used by all these three types of breeders are the bell and the nipple drinkers, while the types of feeding used are the classic feeders and feeding on floor/ litter.

Immature breeders: The building floor and setup, and animal density can be the same as in the indoor system up to week 4–5 (see Section 3.4.3.1.1). From week 3, the goslings can have access to an outdoor area (if it is available) and they get green fodder to fulfil their needs for fibre and to keep their beaks busy in order to prevent feather pecking (Bogenfürst, 2017). Between week 4–5 and week 25–30, indoor rearing with outdoor access differs from indoor rearing in the amount of feed given (green fodder is calculated in the feed portion) and in the animal density, which can be a bit higher irrespective of the housing (4–10 geese/m^2), and maybe in the type of housing, which could be a lighter structure and may have windows (though usually the housing is the same with or without outdoor access). The building floor is the same as in the indoor system (see Section 3.4.3.1.1). Further, the geese may have access to open water outdoors (1 m^2 open water/15 geese) (Bogenfürst, 2017).

Grandparent: 50–100% of grandparent breeders are kept in indoor floor systems with outdoor access for 2 years for easy management of egg production and reproduction performance, and to stimulate reproduction. The proportion is variable because some grandparents can be reared also in indoor systems without outdoor access (see Section 3.4.3.1.1), but this proportion varies also according to avian influenza. Group size is between 600 and 1,000 birds per house with a usual stocking density of 1.2–2 geese/m^2. The types of enrichment materials are natural light, grass, trees, grass/alfalfa and straw. Nests are square with dimensions of $0.5 \times 0.5 \times 0.5$ m. Artificial insemination may be used, but it varies from farm to farm.

Parental breeders: When parental breeders are not laying eggs, they can be kept in an indoor system with outdoor access. In this case, the housing can be a concrete building, polytunnel or other material, but also a light structure with a roof covered from maybe 1–2 sides. The building floor and setup, and animal density can be the same as in the indoor system (see Section 3.4.3.1.1). In order to prevent carrying in mud and manure from the outdoor range, the area in front of the building should have concrete or slatted floor. If there is a grazing area, then it should be utilised gradually, in order to continuously have fresh vegetation for the geese. Feed is portioned accordingly, water is accessible most of the day, especially if there is an open water source (Bogenfürst, 2017).

It can happen that geese have outdoor access during the laying season. In this case, the animal density can be 4–10 geese/m^2 with a sex ratio of 3–4:1 (females/male) (Bogenfürst, 2017). The floor indoors can be slatted or litter (straw or sawdust) or a mixture of both. Nests made of wood ($0.5 \times 0.5 \times 0.5$ m) should be placed indoors and one nest can be calculated for about five to six geese. Additional nest material (straw) is provided every second day to keep eggs clean and prevent egg breaking (Bogenfürst, 2017). The birds can have access to certain vegetation (such as orchard or vineyard; see Mancinelli et al., 2022), hiding places, watering holes, as a form of enrichment.

Table 15: Husbandry system for Domestic geese breeders. Information provided by stakeholder umbrella organisations reflecting current practices (see Section 2.2.2.2). When cells are empty, the information is not applicable or has not been provided

Descriptive category	Husbandry system	Strains and sexes	Duration	Stocking density (birds/m^2)	No of animals (geese/barn)[(a)]	Sex ratio (female/:male)	Nest provision and dimensions (l × w × h)[(b)]
Immature breeders	Indoor floor systems	All	25–36 weeks	2	1,000 – 4,000	5:1 Separated in rearing	–
	Indoor floor systems with outdoor access	All	25–36 weeks	2–2.5	1,000–1,200	3–5:1	–
Pedigree breeders	Indoor floor systems	All	From 40 weeks to 2 years	0.8–1	300–1,000	2–3:1 Kept either together or separate in rearing	50 × 50 × 50 cm
Great-grandparents breeders	Indoor floor systems	All	2.5 years	1	1,000	3:1 Always kept together	–
Grandparents breeders	Indoor floor systems	All	From 40 weeks to 2 years	1	1,000	3:1 Always kept together	–
	Indoor floor systems with outdoor access	All	2 years	1.2–2	600–1,000	3–5: 1	50 × 50 × 50 cm
Parental breeders	Indoor floor systems	All	3.5 years	1	2,000	3:1 Always kept together	–
	Indoor floor systems with outdoor access	All	3–3.5 years	1.2–2	600–1,000	3–5: 1	50 × 50 × 50 cm

(a): The number indicates the number of animals in the building; however, it might not correspond to the group size because the presence of pens inside the building has not been provided.
(b): l = length, w = width, h = height.

3.4.3.2. Husbandry systems for meat production

As shown in Table 14, to produce meat, Domestic geese in the starting period are kept in indoor floor systems, whereas in the growing period, they can be kept in several husbandry systems: indoors (with or without veranda), indoors with outdoor access and free range. The conditions in these systems are similar to those of Domestic ducks (see Section 3.4.1.2) and breeder Domestic geese (see Section 3.4.3.1), but there are specific differences that are mentioned in the sections below.

3.4.3.2.1. Indoor floor systems

The indoor system is similar in all of the husbandry systems although the type of flooring might vary. During the **starting period,** the 1-day-old goslings are placed on litter (straw or wood shavings) in a heated building, fed a protein-rich feed (20–22%) ad libitum (in round or long feeders) and have unlimited access to water from drinkers (round or bell, and later nipple drinkers). The building may have partly slatted floor which enables higher animal density (up to 10–15 birds/m^2) compared to litter only floor (7–8 goslings/m^2) up to week 4. Fresh litter is spread every 1–2 days on top of the old litter. From week 3, the goslings should get green fodder to fulfil their needs for fibre and to prevent feather pecking.

In the **growing period**, the indoor systems may have litter (straw) floor or slatted floor, or a mixture of these two. Fresh litter is spread every day on top of the old litter. The geese may be fed from feeders (preferably metallic) or on litter. Green fodder can be provided in hay racks. Water is available from nipple drinkers for some part of the day. The stocking density indoors is max 3 geese/m^2. There is no information about the maximum group size (Bogenfürst, 2017). There is little information on enrichment, but geese may have access to watering holes.

The indoor systems may have a veranda that may be used during the growing period to supplement the indoor facility, as it provides natural light, variation in the climatic conditions and additional space. Roughage and open water can beneficially be provided in the covered verandas without the risk of increasing dust or moisture level in the indoor litter. Detailed information on the system cannot be provided, however, because access to covered verandas is a rare practice in the production of Domestic geese.

3.4.3.2.2. Floor systems with outdoor access

The specifics of the indoor floor systems in the **growing period** are the same as described in Section 3.4.3.2.1, while the outdoor area is similar to that described in Section 3.4.3.2.3. It is important to note that if goslings will have access to open water (e.g. lake or deep channel) in the growing period, then from 3 weeks of age the goslings should have access to shallow open water (only a few hours/day at this stage) to learn how to oil their feathers (Bogenfürst, 2017). The birds can have access to certain vegetation (such as orchard or vineyard; see Mancinelli et al., 2022) or hiding places, as a form of enrichment. In the last 3–4 weeks of the growing period, there may be an intensive fattening period (not overfeeding), when the birds are closed back indoors (see growing period details in Section 3.4.3.2.1), into smaller floor pens (30–40 geese/pen, 4–5 geese/m^2, about 7–8 m^2/pen; Bogenfürst, 2017).

3.4.3.2.3. Outdoor systems

The free-range may or may not contain a channel or lake; density on water can be about 1 m^2 open water/15 geese. In free range systems, the geese have no access to a building; however, they need a roof or light shelter (1 m^2 of roof for 7–10 geese) from the elements (sun, rain, hail, wind). The flock size can be up to 2,500, but the flocks need to have a separation distance for health reasons, possibly divided by a movable fence or separated by a section not used by geese. If there is not enough grass on the pasture, then it must be provided for the birds in hay racks, as well as the concentrated feed in large capacity feeders (Bogenfürst, 2017). The birds can have access to certain vegetation (such as orchard or vineyard; see Mancinelli et al., 2022) or hiding places as well.

3.4.3.3. Husbandry systems for foie gras production

Husbandry systems are listed in Table 14. Up to the point of foie gras production, the husbandry systems are the same as those for Domestic geese intended for meat production (see Section 3.4.3.2). The husbandry systems for foie gras production are similar to those of Muscovy and Mule ducks, i.e. elevated pen systems indoors and floor pen systems indoor (see Sections 3.4.2.3.2 and 3.4.2.3.3, respectively) with some differences described below.

3.4.3.3.1. Elevated pen systems indoor

Indoor systems with elevated pens are similar to the indoor systems with floor pens (see Section 3.4.3.3.2), except in the elevated pens, the floor is slatted or wire mesh and without litter. There is a difference in the elevation of the pens from the floor, which can vary between 0.4 and 1 m. The elevation enables easier access for the manual restraint and that can result in lower stress for the birds. Further, the size of the elevated pens may differ slightly (0.75–1 m wide, 0.6 m long and 0.6 m high; Bogenfürst, 2017).

3.4.3.3.2. Floor pen systems indoor

Geese for foie gras production are kept in houses that are built for such purpose with pens with plastic slatted or wire mesh floors (or maybe litter) and have a maximum capacity of 1,500–2,000 geese per building (Bogenfürst, 2017). The pens are ~1.5–3 m^2 in size (1.1–1.2 m wide, 1.5–3 m long and 0.7 m high) and house a maximum of 10 geese, so stocking density is ~3.3–6.6 birds/m^2 (Bogenfürst, 2017). There is no enrichment in the pens.

3.4.4. Husbandry systems of Japanese quail

In the EU, domestic quail for commercial production of eggs and meat are kept in cages, or in indoor floor systems with litter. The production focus is eggs, meat or, in case of small-scale producers, a combination of these using different genotypes, e.g. dual purpose. The method of animal husbandry appears to be highly variable, depending on the size of the flock and the degree of commercialisation. Some flocks can probably best be described as 'semi-commercial', but there are also reasonably large quail farms with a clear focus on production.

The breeding companies and multipliers, as well as most of the farmers producing table eggs, are rearing and keeping quail in collective cages. The number of laying quail farms on floor systems (single tier) is still low. In the EU broiler quail are reared in indoor floor systems without outdoor access. Cage-rearing systems are, to the knowledge of EFSA experts, not in use for meat production in EU but might be used in other countries. Those cages are comparable with those of quail layers. Overview of husbandry systems for Japanese quail is provided in Table 16.

Table 16: Overview of husbandry systems for Japanese quail

Production	Descriptive category	Husbandry system
BREEDERS	Immature	Indoor floor systems
	Pedigree	Couple cages
	Great-grandparent	Collective cages
	Grandparent	Collective cages
	Parental	Collective cages
MEAT	Starting and growing period	Indoor floor systems
COMMERCIAL EGGS	Immature layers	Collective cages
		Indoor floor systems
	Layers quail	Collective cages
		Indoor floor systems

Some countries have specific legislative requirements for quail husbandry systems. For example, in Switzerland, for all categories of quail from the third week of life onwards the housing on 100% grid floor (any type of perforated floor without litter) is forbidden (BLV, 2020).[29] However, the grid during the first 2 weeks of age must be partially covered with a material that is not slippery for the chicks, and on which feed can be scattered. Later, the pens (of a minimum height of 50 cm) require a minimum of 50% floor area being littered. Quail must be kept in groups of at least two birds. The minimum area must be 5,000 cm^2 for both adults and young animals which allows a maximum of six quail (from 6 weeks of age onwards) on this area, and for each additional bird at least further 450 cm^2. Up to 2 weeks of age, 50 birds and from 14 to 41 days 16 birds can be kept on 5,000 cm^2. Raised areas can be included in the minimum area if they provide at least 50 cm of free space overhead. If

[29] (BLV (Bundesamt für Lebensmittelsicherheit und Veterinärwesen, Swiss Confederation) (2020): Fachinformation Tierschutz 4.3, Tiergerechte Haltung von Wachteln (*Coturnix japonica*).).

efsa JOURNAL

the raised areas are higher than 50 cm from the ground, e.g. ramps should be installed so that they are easily accessible for the quail. At the same time, the enclosure must be equipped with enough hiding places for all birds to be able to retreat simultaneously. Retreat areas can be created by various means, e.g. with shelters, bushes, branches, boxes, etc. From the second week of life, a dust bath must be available, e.g. a box with dry earth, sand or bedding material suitable for bathing (e.g. spelt chaff, but not wood chips, bark or straw). For layers, nests (at least 16 cm high and with a surface area of 20 by 20 cm) must be available from 6 weeks of age onwards which must be partially covered and littered with suitable material.

In Austria, the keeping of domestic quail in cages is forbidden from 2023 onwards (and for existing holdings from 2031 onwards (THVO, 2022).[30] At least 45% of the floor area must be enclosed and with bedding (e.g. chaff, sawdust). The enclosures must have at least 5,000 cm^2 of accessible area, with an area of at least 450 cm^2 available to each animal from the age of 6 weeks. It must be at least 40 cm high on each level (except under ramps leading to the upper level) and contain feeders and drinkers, dust bathing facilities, a shelter, pecking stones and, for laying hens, the possibility of undisturbed egg-laying.

3.4.4.1. Husbandry systems for breeders

Main characteristics of the husbandry systems for breeders are summarised in Table 17.

3.4.4.1.1. Indoor floor systems

Immature breeders: The indoor floor systems are currently used for all strains and sexes for reasons of biosecurity, protection and best preparation for laying. Litter is provided. The types of drinkers and feeders that are used are nozzles and classic and round feeders, respectively, with ad libitum water and feed.

3.4.4.1.2. Collective cages

Great-grandparents, grandparents and parental breeders of all strains and both sexes are housed in collective group cages during the reproductive period. The laying period can be extended to more than 40 weeks, with still egg laying rate over 60% depending on needs. No enrichment is provided, but the provision of picking stone is currently tested in cages for parental breeders. The types of drinkers and feeders that are used are nozzles and normal feeders, respectively, with ad libitum water and feed. Artificial insemination is not used.

Typically, space allowance is ~130 cm^2 per bird as stated in the questionnaire based on data provided by several member states. Nesting facilities are typically not provided. Group sizes might vary depending on the breeding management and can be expected to range from 20 to 40 animals. The sex ratio females: male is comparable across all systems with 3–4:1 being the most applied. The flooring is typically a stable wire mesh with a sloping gradient towards to the cage front for egg collection. Litter is, as in all cage systems, missing. In contrast to common chicken cage systems, also manure belts are not frequently installed instead, cages are arranged A-shaped to minimise the soiling of the birds at lower levels or might have trays underneath that can be cleaned manually. Food is provided in troughs along the front side, nipple drinkers are often installed along the back side. Enrichment is not provided.

3.4.4.1.3. Couple cages

Pedigree breeders of all strains and both sexes are currently kept in couple cages, in a proportion of 70% of the total number of breeding birds, for pedigree traceability reasons. Two quail, one female and one male, are kept per couple, always together. The types of drinkers and feeders that are used are nozzles and normal feeders, respectively, with ad libitum water and feed. Artificial insemination technique, being not mastered, is not used.

Space allowance in couple cages, or also called pair or selection cages, varies with the floor space, as always one female is mated to one male. No nesting, no litter and no enrichment is given. The floor consists of stable wire mesh with a sloping gradient to the front to collect eggs. As in the collective cage, drinker nipples are in the back, and the food trough along the front.

[30] THVO (2022): Verordnung des Bundesministers für Soziales, Gesundheit, Pflege und Konsumentenschutz, mit der die 1. Tierhaltungsverordnung geändert wird.

3.4.4.2. Husbandry systems for meat production

3.4.4.2.1. Indoor floor systems

Quail for meat production are mainly kept in deep litter indoor floor systems. The space allowance varies between 89 and 147 cm^2 per bird (average 113.80 cm^2). A review based on different country reports states up to 600 cm^2 per bird in organic production but also concludes that research on the effect of stocking densities is needed (Damme, 2011; Bergmann et al., 2020). Floor systems are usually 2–3 m in height to allow the caretaking human to enter the pen and for the birds to perform short flights. Nesting facilities are not necessary as meat quail will be slaughtered before reaching sexual maturity. Group sizes varies between 30,713 and 118,721 birds per building (Damme, 2011). As specialised meat lines will be used for meat production, both sexes are reared with females being slaughtered at 35 and males at 42 days of age. Panels might offer additional coverage to the birds. Usually, artificial light is provided 14–16 h per day and the room temperature is around 18–20°C (DLG, Kompakt 6/2021).[31] Feed is provided in (round) troughs and water typically in nipple drinkers with a range between 30 and 52 quail per drinker. Drinkers are adjusted to the quail's size. As newly hatched quail can easily drown in a 1-cm^2 deep drinker, special quail chick drinkers are provided until 7–10 days of age before drinkers can be replaced by regular water troughs or nipple drinkers. In addition, local heat supply (e.g. dark brooders) may not only be beneficial during rearing but also when quail are mature as they prefer increased temperature for comfort behaviours. Separate dust baths might be offered to enable the birds to fulfil their behavioural needs. The floor systems might partly consist of perforated floors and might also have elevated structures which are accessible via ramps. Enrichment material is usually not provided.

[31] (DLG kompakt Nr. 6/2021: Haltung von Spezialgeflügel Wachteln).

Table 17: Husbandry system for Japanese quail breeders. Information provided by Stakeholder umbrella organisations reflecting current practices (see Section 2.2.2.2). When cells are empty, the information is not applicable or has not been provided

Descriptive category	Husbandry system	Strains and sexes	Duration	Stocking density	Birds/ cage	Dimensions (l × w × h)[(a)]	Total m^2	Sex ratio (female: male)	Nest provision and dimensions (l × w × h)[(a)]
Immature breeders	Indoor floor systems	All	From 1st day to 6th week of life	60 birds/m^2	–	–	–	1:1 Always kept together	
Pedigree breeders	Collective (couple) cages	All	From 6th to 30th week of life	14 kg/m^2	2	10 × 50 × 30 cm	0.05	1:1 Always kept together	No
Great-grandparents breeders	Collective cages	All	From 6th to 30th week of life	25 kg/m^2	27	60 × 60 × 30 cm	0.36	4:1 Always kept together	No
Grandparents breeders	Collective cages	All	From 6th to 30th week of life	25 kg/m^2	27	60 × 60 × 30 cm	0.36	5:1 Always kept together	No
Parental breeders	Collective cages	All	From 6th to 30th week of life	25 kg/m^2	27	60 × 60 × 30 cm	0.36	5:1 Always kept together	No

(a): l = length, w = width, h = height.

3.4.4.3. Husbandry systems for commercial eggs production

Quail immature layers and mature layers can be reared in collective cages and floor systems indoor.

3.4.4.3.1. Collective cages

It is the most common husbandry system for **immature layers** and **layer quail**. No information was found on the dimension of cages for immature layers. In layer quail, cages might be up to six tiers high and are typically called 'flat decks'. In general, flat decks for layer quail are not basically different from breeder quail. Examples of cage sizes are wide × length: 60 × 100 cm, 80 × 120 or 55 × 60 cm. The height of the system might be 20–30 cm. Space allowance per bird is ~ 126.25 cm^2 ranging from 107.5 to 155 cm^2 up to 200 cm^2 as stated in the questionnaire based on data provided by several member states. The flooring is typically a stable wire mesh or perforated plastic flooring with a sloping gradient towards to the cage front for egg collection. Litter is, as in all cage systems, missing. Nipple drinkers are often installed along the back side. The number of birds per drinker ranges between 11 and 18. Food is provided in troughs along the front or lateral side of the cage. A grid horizontally on the feed might prevent spilling. Usually, no nests or enrichment material are provided.

Group sizes might vary depending on the system used and can be expected to range from 20 to 90 birds. Only females are housed. Light management is comparable to laying hens being increased up to 16/17 h photoperiod per day. Decks are either stacked vertically on each other, in which manure trays prevent droppings on the lower tier. Alternatively, tiers are stacked in an A-shape without manure trays.

3.4.4.3.2. Indoor floor systems

Immature layers are normally reared in indoor floor systems until 42 days of age and around 160 g of live weight. The system is like those for broiler quail (see Section 3.4.4.2.1), with difference in the stocking density and feeding regime.

The stocking density is about 80 birds/m^2, with a maximum stocking density of 12.8 kg /m^2. The height normally is higher than 2 m. As immature quail do not lay eggs, the facilities are not provided with nests.

When the newly hatched quail arrive, the room temperature is around 37°C. This temperature will progressively decrease to 34°C after the first week, 30°C the second week, 28°C after the third week and 24°C afterwards. The humidity is constant between 55% and 65%.

Layer quail can be also raised in indoor floor systems. The space allowance can range between 123 and 160 cm^2 per bird. Floor systems are usually 2–3 m height to allow the caretaking human to enter the pen and the quail to perform short flights. Layer quail will be offered nests. These nests are usually on the ground and open to the front and offer a cover during egg laying. Nests might also be littered to prevent eggs from cracking. Nests should be 400–600 cm^2 for up to eight layers. Quail might use single nests as well as group nests. Group sizes might vary between 19,000 and 25,000 birds and will only consist of females. The floor is usually littered although combinations with perforated compartments might be in use. The litter provides the material for exploratory and foraging behaviour and should therefore be dry and friable, e.g. the often-used wood shavings. Often dust baths are provided which, especially if filled with materials of small particle size, are extensively used by the quail. Feed is provided in (round or linear) troughs. A grid placed horizontally on the feed might prevent spilling. After special chick drinkers have been used during rearing, water is typically provided in nipple drinkers with a cup underneath. The number of birds per drinker ranges between 14 and 17. The floor of the area with the feeder and drinkers is wire mesh. Local heat supply might be offered which is used by the quail for comfort behaviour and/or resting periods. As quail do not roost, despite extensive play behaviour or in panic situations, more than an additional elevated platform might not contribute to the welfare of the birds. The floor systems might partly consist of slatted floors and might also have elevated structures which are accessible via ramps. Enrichment material is usually not provided. Further validation on optimal husbandry and management procedures are ongoing.

A covered veranda might be available, particularly in organic production, only accessible for several hours per day. The floor is covered with sand that can be considered enrichment material for sand bathing. If temperature increases, there is the possibility of misting, but it can impair the sand quality with puddles. There is natural light.

There are some commercial initiatives going on, involving the keeping of quail in aviary systems, also outdoor. This type of system is used for small-scale production. However, such housing systems may not be fully developed and ready for a wider commercial market yet. Aspects such as mortality must be closely monitored.

3.5. Describing welfare consequences related to husbandry systems (ToR-2)

3.5.1. Introduction

This section describes the relevant welfare consequences concerning restriction of movement, group stress, inability to perform comfort behaviour, bone lesions (including fractures and dislocations), soft tissue lesions and integument damage, locomotory disorders (including lameness), inability to perform exploratory or foraging behaviour and inability to express maternal (prelaying and nesting) behaviours, related to husbandry systems identified in Section 3.4.

Although not specifically requested in the mandate, for these eight welfare consequences, the related ABMs have been identified and interpreted. The identification of the ABMs is functional to describe and assess the relevance of the welfare consequences and to assess quantitatively (some of) the factors in ToR-3. Birds experiencing one welfare consequence can be subjected to a secondary one. The latter can be assessed by diverse (secondary) ABMs. In this opinion, these ABMs are described in relation to their 'primary' welfare consequence.

In addition, some welfare consequences (e.g. restriction of movement, group stress) can also be indicated by changes in so-called iceberg indicators, such as growth and mortality rates; these are commonly used as indicators in controlled experiments in the available literature on housing conditions, but cannot be reliably attributed to any specific welfare consequence in commercial observations (see Section 2.2.3.2 and Appendix B).

Only the direct ABMs for assessing each welfare consequence are listed in the following Tables 18–24.

3.5.2. Restriction of movement

3.5.2.1. Description

The bird experiences stress and/or negative affective states such as pain, fear, discomfort and/or frustration because it is unable to move freely, or is unable to walk, fly, swim or dive comfortably (e.g. due to overcrowding, unsuitable floors, gates, barriers).

Restriction of movement is, for all the species covered, highly relevant when kept in cages that do not allow for ranging within a larger space. Restriction of movement is also present when kept in high stocking densities with limited space allowed for movement due to the density of birds per m^2. Other factors such as inappropriate flooring, locomotory disorders or synchronicity in movement patterns might add to the severity of the welfare consequence. Space allowance per bird integrates both the space the animals can use for stationary and active behaviours, and the inter-individual distance among birds.

3.5.2.2. Species-specific issues

In waterfowl, locomotion includes grazing and swimming. Prosser et al. (2015) showed that free-ranging domestic ducks covered an area of 1 km^2 and spent on average 50% of daytime foraging (locomotion behaviour in the context of searching for food). Also, for geese in an experimental setup, locomotion and foraging took up to 35% of their time budget (Ramseyer et al., 2009). Although quail express flying behaviour only in 0.43% of their time budget (Nordi et al., 2012, see also Section 3.6.1.3), it is still an integral part of their natural behaviour and space should be sufficient to allow for all species-specific behaviours.

The level of restriction of movement is dependent on the species and production system.

In Muscovy ducks, restriction of movement includes also perching because they may be impeded in reaching elevated structures (Brügesch et al., 2011). Therefore, Muscovy ducks not only need two-dimensional but also additional three-dimensional, vertical structures which in turn will require an additional height of the enclosure.

Domestic geese show extensive grazing and locomotor behaviour utilising large outdoor areas (Liu and Zhou, 2013; Massaccesi et al., 2019). The same papers reported that geese can use different grazing areas ranging from pastures to agroforests and vineyards.

Japanese quail show flying behaviour especially during escape attempts. To prevent this, cage heights are often limited to 20–25 cm, thereby preventing injuries or trauma from hitting the system ceiling at high velocity (Dixon and Lambton, 2021), but also preventing any other type of flying behaviour.

3.5.2.3. Animal-based measures

ABMs for restriction of movement are shown in Table 18. There are many cases where this welfare consequence can be associated with secondary ABMs (e.g. Section 3.5.4 for inability to perform comfort behaviour).

Table 18: ABMs for assessing 'restriction of movement', definition, interpretation and sources of evidence (scientific literature or expert opinion) for each species

ABM	Definition and Interpretation	Sources of evidence for each species
Bird disturbance	A bird makes physical contact with another thereby forcing the latter to change its original position or behaviour. Interpretation: A greater amount of bird disturbance indicates increased restriction of movement.	– Domestic ducks: Waitt et al. (2009) Liste et al. (2012a) – Muscovy ducks: Baéza et al. (2017) – Mule ducks: Litt (2020) – Domestic geese: Liao et al. (2022) – Japanese quail: expert opinion
Locomotor behaviours	Self-propelled capacity to move from one place to another using leg and/or wing assisted movements that results in walking, running, jumping and flying activities. This includes swimming in all waterfowl and diving in ducks. Interpretation: Attempts to show locomotor behaviour and interrupted bouts or sudden end of locomotion are indicative of restriction of movement.	– Domestic ducks: Jones and Dawkins (2010b) – Muscovy and Mule ducks: Knierim et al. (2005) – Domestic geese: Boz et al. (2021), Mancinelli et al. (2022) – Japanese quail: Schmid and Wechsler (1997), Mohammed et al. (2017), Muhammad and Mirza (2019), El Sabry et al. (2022)
Perching	Birds sitting or standing on an elevated structure. For Muscovy ducks only. Interpretation: Restriction of movement in the vertical dimension is indicated by no or little perching, but it may also relate to the inability of heavy birds to fly up to high elevated structures.	– Muscovy ducks: Brügesch et al. (2011)
Swimming or diving attempts	The bird moves on breast and belly in water, with the legs providing propulsion, with either raised head or submerged head and body as deep as possible. Not for quail. 'Swimming attempts' is relevant for all waterfowl and 'diving attempts' only for ducks. Interpretation: Low occurrence or lack of swimming or diving attempts, indicates restriction of movement.	– Domestic ducks and Mule ducks: expert opinion – Muscovy ducks: Knierim et al. (2005) – Domestic geese: Liao et al. (2022)
Wing flapping	Bilateral rapid upward and downward movement of the wings while stretching to the bird's full height and typically while standing still Interpretation: Restriction of movement is indicated by reduced wing flapping compared to unrestricted conditions	– Domestic ducks: Liste et al. (2012a) – Muscovy ducks: Knierim et al. (2005), Abdel-Hamid and Abdelfattah (2020) – Mule ducks: Mohamed et al. (2016) – Domestic geese: Gillette (1977), Yin et al. (2017a), Boz et al. (2021), Mancinelli et al. (2022) – Japanese quail: Nol et al. (1996), Muhammad and Mirza (2019).
Wounds	Wounds comprise all lesions to the skin ranging from minor superficial punctiform spots to scratches, to large open wounds that go deeper than the skin.	– Domestic, and Mule ducks and Domestic geese: experts' opinion – Muscovy ducks: Knierim et al. (2005) – Japanese quail: Burns et al. (2003)

ABM	Definition and Interpretation	Sources of evidence for each species
	Interpretation: Restriction of movement increases the risk for scratches caused by other birds walking across (lying) birds in a floor housing system, and/or in too small enclosures with/without sharp edges leading to technopathies.	

3.5.2.4. Main hazards and relationship with husbandry systems

Insufficient space allowance per bird (i.e. high stocking density, animals/m^2, see Section 3.6.1) is a major hazard impacting the freedom of movement of the animal. The stocking density drives the space that is allocated to a single individual. If the space is not adequately increased during the course of bird development, the welfare is increasingly impaired towards the end of the rearing period, either before slaughter or from the onset of lay. This is due to the growing body size of the individual bird, and the increasing preferred inter-individual distance, which is related to the sexual maturation and the establishment of a dominance order (Guhl, 1968).

Stocking density also influences the quality of the litter, as more excrement is added to the litter with more birds per m^2. High stocking density leads to insufficient space allowance and restriction of movement in all the examined husbandry systems.

Another important driver of restriction of movement is **insufficient total floor space**: The risk of this hazard is relevant in cages or pens due to the confined space. The small circle of action, as well as the often-unsuitable floor, contributes to the restriction of movement. In couple cages, the dominant animal or mating partner may influence the movement range of the other bird (see Section 3.5.3 on group stress for more details). Collective cages are also generally highly confining husbandry systems that restrict movement, even vertically (see Section 3.4).

Floor housing systems are typically occupied by larger numbers of birds, so a larger total area is available. The risk of restriction of movement is further reduced in floor housing provided with access to outdoor area. The outdoor area may be provided with open water to allow waterfowl to bath. In quail, outdoor areas allow them to jump or fly to a certain distance.

If the birds are kept in outdoor systems, larger areas are usually available, increasing still more the movement possibility for birds.

In most of the cages (see description in Section 3.4), there might be **insufficient height** to show behaviours the birds are motivated to express. In the case of quail, which typically jump or try to fly suddenly when disturbed, birds may injure their heads while jumping against the top of the cage. The height in cages of 20–30 cm does not allow flight responses and prevents quail from expressing wing flapping as part of their general arousal and comfort behaviour. In ducks housed in cages, insufficient height might prevent wing flapping.

Lack of elevated structures: Muscovy ducks perch and to do so they use elevated structures such as platforms. The absence of three-dimensional space restricts the birds to the floor and, therefore, restricts possible vertical movements.

Lack or impaired access to open water: Refers to facilities without open water with sufficient surface area and depth, where waterfowl will not be able to swim and dive.

3.5.3. Group stress

3.5.3.1. Description

The animal experiences stress and/or negative affective states such as pain, fear and/or frustration resulting from a high incidence of agonistic and other types of negative interactions, often due to hierarchy formation and competition for resources or mates.

Birds which are housed in single cages might still be subjected to group stress as a result of interactions across the cage partitions and the enforced close proximity between neighbouring birds. They may also experience 'isolation stress', as defined by EFSA AHAW Panel (2022a), because although birds in individual cages typically have visual and auditory contact with those in neighbouring cages, they cannot perform normal physical interactions with other birds. At the time of placement into an individual cage, they may also experience 'separation stress', as defined by EFSA (EFSA AHAW Panel, 2022a). This has been demonstrated under experimental circumstances when individual birds have been removed from any contact with familiar conspecifics (see Mills et al., 1993 for quail; Gaioni and Ross, 1982 for ducks; Ludwig et al., 2017 for Greylag geese). These welfare consequences are not listed under TOR-2 but are relevant for consideration in addition to group stress, as they are all affected by the access to conspecifics.

Group stress induced by aggressive behaviours is more likely to be caused by mature male birds, particularly during the breeding season (see Muscovy ducks: Rodenburg et al., 2005; Japanese quail: Wechsler and Schmid, 1998; Domestic geese: Weiß et al., 2011).

3.5.3.2. Species-specific issues

Group stress applies to all bird species considered in this opinion. Intra-species aggression is shown in all species due to the establishment of social hierarchies (see Section 3.1). Muscovy ducks are said to be more aggressive than Domestic ducks (Rodenburg et al., 2005).

3.5.3.3. Animal-based measures

The ABMs of this welfare consequence are shown in Table 19. Additionally, birds subjected to group stress can experience secondary welfare consequences as result of negative interactions within the group; these are in particular 'Soft tissue lesions and integument damage' from injurious pecking. For example, aggressive pecking is one of the most common causes of skin or eyelid lesions, head injuries and eye loss in quail (Kiani, 2022), and pecking also causes serious injury in ducks (Rodenburg et al., 2005). These ABMs are therefore discussed in the appropriate sections (e.g. Section 3.5.6 for 'Soft tissue lesions and integument damage').

In general, the ABMs in Table 19 are applicable across all the species considered, although scientific literature is sparse. Thus, in some cases, their inclusion is based on expert opinion, taking account of practical experience and extrapolation from other bird species. This applies to bird disturbance, which is an ABM documented in other poultry species (EFSA AHAW Panel, 2023b) but not reported in Domestic ducks and Japanese quail. Similarly, flock activity has only been reported as an ABM for Domestic ducks (Li et al., 2018) and suggested for Domestic geese (Tremolada et al., 2020), but has also been used through measurement of optical flow in laying hens and broilers (Lee et al., 2011; Dawkins et al., 2013). Piling behaviour has been reported only in Muscovy ducks (Rodenburg et al., 2005) and Domestic ducks (Chen et al., 2021) but, by analogy to these, this latter behaviour is likely to occur sometimes in the other species under consideration.

Table 19: ABMs for assessing 'group stress', definition, interpretation and sources of evidence (scientific literature or expert opinion) for each species

ABM	Definition and interpretation	Sources of evidence for each species
Agonistic interactions	Interaction between birds including pecks to the head area, grasps towards the neck, threats, chases and fights. Interpretation: Group stress is indicated by agonistic interactions	– Domestic ducks: Barrett et al. (2019) – Muscovy ducks Knierim et al. (2005) – Mule ducks: Litt et al. (2019) – Domestic geese: Mancinelli et al. (2022) – Japanese quail: Miller and Mench (2006), Muhammad and Mirza (2019), Kiani (2022), Mathkari (2022)
Bird disturbance	A bird makes physical contact with another in such a way that forces the latter to change its original position or behaviour. Interpretation: Group stress is indicated by the presence of bird disturbance	– Domestic ducks and Japanese quail: expert opinion – Muscovy ducks: Baéza et al. (2017) – Mule ducks: Litt (2020) – Domestic geese: Liao et al. (2022)
Injurious pecking	Injurious pecking refers to damaging bird-to-bird pecking whereby pecks to the feathers or tissue of another bird cause plumage damage, skin wounds or tissue damage. Interpretation: Group stress is indicated by injurious pecking. This may result from different motivations including aggressive pecking, feather pecking and cannibalism.	– Domestic ducks: Leipoldt (1992), Colton and Fraley (2014), Dong et al. (2021) – Muscovy ducks: Knierim et al. (2005) – Mule ducks: Mahmoud et al. (2021) – Domestic geese: Gillette (1977), Yin et al. (2017a), Boz et al. (2021) – Japanese quail: Wechsler and Schmid (1998), Miller and Mench (2006)

ABM	Definition and interpretation	Sources of evidence for each species
Piling behaviour	The dense clustering of birds, whereby some birds position themselves on top of others, increasing the risk of smothering (death by suffocation) and/or the risk of injuries. Interpretation: Group stress is indicated by piling behaviour.	– Domestic ducks: Chen et al. (2021) – Muscovy ducks: Rodenburg et al. (2005) – Mule ducks and Japanese quail: expert opinion – Domestic geese: Bogenfürst (2017))
Flock activity	The level of activity within a flock, evaluated by movement of group(s) or individuals and by the prevalence of (ab)normal activity patterns. Interpretation: Activity includes predominantly locomotion but might also reflect other movements e.g. disturbance of one bird causing another bird to stand up and sit down again (often after a short walking distance). Group stress is indicated by an increased mean activity, indicating restlessness of the flock as a whole, or by increased variation in flock activity influenced by individual birds	– Domestic ducks: Li et al. (2018) – Muscovy and Mule ducks and Domestic geese: expert opinion – Japanese quail: Jones et al. (1982)

3.5.3.4. Main hazards and relationship with husbandry systems

The most important hazards for group stress are those which give rise to competitive agonistic interactions (such as when unfamiliar social companions are introduced and/or competition for resources), enforced proximity to aggressors and hinder attempts to avoid or escape such interactions, and those which induce undesirable redirected behaviours as a result of inadequacies in an environment which fails to meet the behavioural needs of the birds.

Unfamiliar or inappropriate social companions may be introduced when groups are (re)formed, or when group composition in terms of age or sex distribution differs from the species-specific norm (for more details, see Section 3.6.2). The hazards are therefore **mixing unfamiliar birds** (Japanese quail: Edens et al. (1983), Gerken and Mills, 1993; Domestic geese: Kotrschal et al., 2010) and **inappropriate group sex composition** (Japanese quail: Wechsler and Schmid, 1998; Domestic geese: Weiß et al., 2011)**.** The effect of sex ratio will depend on the sexual maturity of the birds, since sexual aggression is highest in mature males (Rodenburg et al., 2005, for Muscovy ducks; Wechsler and Schmid, 1998, for Japanese quail; Weiß et al., 2011, for Domestic geese). Male mule ducks are not concerned by this problem, these animals being sterile interspecific hybrids. When mature breeders of Domestic ducks, Muscovy ducks and Domestic geese are housed in indoor floor systems, the dynamics of male–male antagonistic interactions will determine the optimal sex ratio to maximise reproductive outcomes while minimising social stress in mixed sex groups (Domestic geese: Gumułka and Rozenboim, 2017). If too few females are assigned to a male, this can cause stress for the females and, if more than one male is in the group, aggressive competition between the males. The optimal sex ratio in terms of animal welfare depends on the species, the space available, the number of males in a group and the sexual activity.

While mixing and group sex composition are management issues, the **size of group** is influenced by housing type, since typical commercial group sizes differ widely between intensive and extensive housing. Cage systems and some indoor floor systems house relatively small groups, whereas deep litter systems and those with outdoor access commonly utilise large group sizes, but there is no evidence in the species under consideration that group size per se represents a major hazard for group stress. See Section 3.6.2 for a more detailed discussion of the hazards of group size and references for each species.

Group stress in the context of individual cages (i.e. in ducks) is considered as the lack of physical contact with conspecifics and the occurrence of agonistic interactions across the partitions between adjacent birds. When housed in individual cages, breeders are in close proximity to other individuals, despite the physical separation between cages. Such proximity allows visual contact but provides no room for hiding or keeping a distance from animals that are perceived as threatening. Similarly, for breeders neighbouring other individuals of similar rank, there is no effective way of establishing the hierarchy and tension between individuals may be sustained. This might cause group stress in breeders kept in individual cages, but no scientific study has been found to describe this.

Competition for resources may relate to feeding, drinking or other provisions particular to the species and reproductive stage of the birds, such as water-bathing facilities for waterfowl, dust bathing facilities for quail and nest boxes for laying females. Thus, the hazards will include **insufficient feeder space**, **insufficient drinker space, lack of litter, lack or impaired access to open water, insufficient provision of enrichment**[32] (e.g. forage or pecking objects for waterfowl, or sand for dust bathing in quail) **and inadequate provision of nesting facilities**. While the details of some equipment provision, such as feeding, drinking and nesting space, may apply similarly to all housing systems, other types of facility, such as water bathing or dust bathing provision, might be limited by the housing system as a consequence of available space or floor type. See Section 3.6.5 for a more detailed discussion of the hazard of environmental enrichment provision and references for each species.

The inability of birds to avoid or escape from aggressive interactions will be influenced by the quantity and design of available space. This is highly dependent on the housing system. The available space has two components when considering housing: the space per bird, depending on the stocking density, and the total space available to the group, depending on the pen dimensions (see Section 3.6.1.2). These will in turn, together with bird aggregation behaviour, determine the inter-individual distance between the birds. An **insufficient space allowance per bird** can give rise to chronic social stress and fearfulness, reflected in stress physiological responses and reduced growth, and leading to greater frequency of overt aggressive interactions when social distancing between individual pairs is compromised. At the same stocking density, a larger group size will offer greater total pen area and hence potentially greater free space and choice of location for avoidance and escape for an individual bird. **Insufficient total floor space** is therefore also a hazard for group stress. In this respect, collective and couple cages and small pens in indoor floor systems, which typically have small group sizes and higher stocking density, represent a greater hazard. **Inappropriate pen design**, with a poorly designed layout where obstacles reduce the available space or prevent easy movement for escape and avoidance, is also a hazard. See Section 3.6.1.1 for a more detailed discussion of the hazard of space allowance and references for each species.

The final set of hazards for group stress are those which contribute to an increased risk of injurious behaviours such as feather pecking and cannibalism, since birds maintained in groups where this is occurring will experience disturbance, fear and pain. These behaviours are less well studied in the species of this opinion than in other domestic bird species where there is extensive knowledge (EFSA AHAW Panel, 2023a,b). These behaviours have a secondary welfare consequence of 'soft tissue lesions and integument damage', both as a direct effect of the behaviour and an indirect effect from associated management actions, such as bill trimming in Muscovy and Mule ducks, done to reduce their risk of occurrence or severity of consequences (see Section 3.5.6). While the development of injurious behaviours has many known causal factors in chickens (EFSA AHAW Panel, 2023a), in the species considered in this SO only **insufficient provision of enrichment** (Karcher et al., 2013, for Domestic ducks; Klemm et al., 1992, and Knierim et al., 2005, for Muscovy ducks), **high stocking density** (i.e. insufficient space allowance per bird) (Rodenburg et al., 2005, for ducks; Yin et al., 2017b, for geese) and **perforated floor** (Leipoldt, 1992, for Domestic ducks) have been scientifically documented. Of these, **high stocking density, perforated floor and insufficient provision of enrichment** are more likely to occur in collective cages and indoor floor pens than in outdoor systems.

3.5.4. Inability to perform comfort behaviour

3.5.4.1. Description

This welfare consequence is described as: the animal experiences stress and/or negative affective states such as discomfort and/or frustration resulting from the thwarting of the motivation to (fully) perform comfort behaviour in order to maintain the function and integrity of the integument.

Comfort behaviour involves behaviours performed to maintain the feathers and in waterfowl also eyes (e.g. Jones et al., 2009 for Domestic ducks; Liao et al., 2022 for Domestic geese) and nostrils (e.g. O'Driscoll and Broom, 2011, review by Nicol et al., 2017 for Domestic ducks) clean and in a good condition. It includes also preening, scratching, bathing and in waterfowl head dipping and wet preening. Impaired plumage, eye or nostril condition because of insufficient ability to perform comfort behaviour can further lead to discomfort, pain and/or increased disease or injury risks.

[32] Excluding water and litter in waterfowl, and only litter in Japanese quail.

In addition, wing and leg stretching and wing flapping (see also EFSA AHAW Panel, 2023a,b) are brief comfort behaviours that serve the ordering of plumage and relaxation of muscles and only take up a small fraction of the time budget (Gillette, 1977; Barber et al., 2004; Campbell et al., 2022). Therefore, in most investigations, these behaviours are grouped together, sometimes also with other comfort behaviour (e.g. for Domestic geese: Gillette, 1977; for Domestic ducks: Barber et al., 2004, Campbell et al., 2022; Mule ducks: Litt, 2020).

The need to perform comfort behaviour depends on environmental conditions (e.g. air temperature, soiling, ectoparasites) but also on animal-related factors. These may include age effects, but study results are heterogenous and too few considering the multitude of further factors influencing comfort behaviours (see review on water-related comfort behaviour by Babington and Campbell, 2022). The factors can partly relate to the different temperature requirements of birds of different ages (see Sections 3.3 and 3.4). It is also possible that the different phases of feather growth and development affect the need for and magnitude of comfort behaviours, but scientific evidence on this is largely lacking.

Eye, nostril, body and plumage conditions are not solely affected by the possible extent of performing comfort behaviour but can also be influenced by litter condition and cleanliness of the environment in general, as well as air quality (ammonia content). Eye or nostril disorders can also be a sign of an infectious systemic or respiratory disease. However, in the context of this opinion with a focus on 'housing', this ABM has been considered with respect to the opportunity to perform water bathing as a comfort behaviour.

3.5.4.2. Species-specific issues

In waterfowl, preening includes rubbing the back of the head or the sides of the head against the plumage or grasping individual feathers of different body parts with the bill and letting them slide through the bill from the shaft to the tip. Furthermore, they nibble the shafts of regrowing feathers and partly remove small fragments. This is repeatedly interrupted by vigilant attention to the surroundings. Preening is a long-lasting behaviour, particularly if, in waterfowl, bathing water is present, thereby allowing wet preening. Wet preening is shown more on land after bathing than on the water (Knierim et al., 2005 for Muscovy ducks).

Water bathing not only serves to keep the plumage in good order, but is partly also for thermoregulation (e.g. Farghly et al., 2017). On water, the behavioural sequence is initiated by lateral shaking of the tail, the bird then dips the head or beak into the water with a forward, downward movement, lifts the head and pours water over the neck and body. Then, lateral shaking movements of the body with spread wings are performed. Finally, the bird rises, flaps the wings and shakes the body. If only shallow water is available, or open water that cannot be entered, incomplete bathing sequences will take place. Only the head or, at most, the tips of the wings are immersed and no or less water can be moved under the wings. The movements of (incomplete) bathing sequences are usually interrupted by preening (Knierim et al., 2005 for Muscovy ducks). Although the amount of bathing in a typical time budget of Domestic ducks might vary, bathing is still a behavioural need of the birds (see Section 3.1.1), indicated by sham bathing when no substrate allowing water bathing is available (Jones and Dawkins, 2010b; Makagon and Riber, 2022). Geese may stretch the neck on the ground and move it in a snake-like manner while fluffing their neck feathers. The result is that the ventral part of the neck, in particular near the chest, becomes dirty and feather worn. Subsequently, the bird throws the head back over the shoulders, allowing the head and neck to flop onto the back and starts again a snake-like movement of the neck and head among the body feathers. Gillette (1977) called this cleaning process 'dry-washing'.

In Japanese quail, the comfort behaviours are dust bathing and preening, scratching, wing and leg stretching and wing flapping. Preening can be described as fluffing, separating, smoothing and oiling of the feathers (Statkiewicz and Schein, 1980; Schmid and Wechsler, 1997). The reported time that quail preen ranges from 10% to 12% of the time budget during the photoperiod. The behaviour seems to be independent of the diurnal rhythm and is closely related to dust bathing. Dust bathing movements are similar to those performed by Domestic fowl (Statkiewicz and Schein, 1980; EFSA AHAW Panel, 2023a,b). If there is no substrate for dust bathing, still the movements can be carried out in a modified way which is called sham or vacuum bathing (Gerken and Petersen, 1992).

3.5.4.3. Animal-based measures

The ABMs which indicate this welfare consequence are shown in Table 20.

Table 20: ABMs for assessing 'inability to perform comfort behaviour', definition, interpretation and sources of evidence (scientific literature or expert opinion) for each species

ABM	Definition and Interpretation	Sources of evidence for each species
Wing and leg stretching	Unilateral backward and downward stretch of wing and leg together. <u>Interpretation</u>: Inability to perform comfort behaviour is indicated by a reduced frequency of wing and leg stretching which impairs the possibility for the animal to relax muscles.	– Domestic ducks: Liste et al. (2012a) – Muscovy ducks: Abdel-Hamid and Abdelfattah (2020) – Mule ducks: Guémené et al. (2006) – Domestic geese: Gillette (1977); Mancinelli et al. (2022) – Japanese quail: Nasr et al. (2019), Mohammed et al. (2019b)
Wing flapping	Bilateral rapid upward and downward movement of the wings while stretching to the bird's full height while standing still. <u>Interpretation:</u> Inability to perform comfort behaviour is indicated by a reduced frequency of wing flapping.	– Domestic ducks: Liste et al. (2012a) – Muscovy ducks: Knierim et al. (2005), Abdel-Hamid and Abdelfattah (2020), Abdel-Hamid et al. (2020) – Mule ducks: Mohammed et al. (2016) – Domestic geese: Gillette (1977), Yin et al. (2017a), Boz et al. (2021), Mancinelli et al. (2022) – Japanese quail: Nol et al. (1996), Muhammad and Mirza (2019)
Dry preening	Manipulation of feathers using the beak or through rubbing with the head with no water involved. <u>Interpretation</u>: Inability to perform comfort behaviour is indicated by reduced preening.	– Domestic ducks: Jones and Dawkins (2010b), Jones et al. (2009) – Muscovy ducks: Knierim et al. (2005) – Mule ducks: Guémené et al. (2006) – Domestic geese: Gillette (1977), Yin et al. (2017a), Boz et al. (2021), Mancinelli et al. (2022), Molnár et al. (2006) – Japanese quail: Laurence et al. (2015), Mohammed et al. (2017), Nasr et al. (2019)
Wet preening	Manipulation of feathers using the beak or through rubbing with the head after the application of water. Water is applied either from a shower, by taking water into the bill followed by preening, or the head is ducked into an open water source followed by tossing water over the body and then preening. Wet preening can be limited by how much of the body can be reached with water. Not relevant for quail. <u>Interpretation</u>: Inability to perform comfort behaviour is indicated by reduced wet preening.	– Domestic ducks: Waitt et al. (2009), Jones and Dawkins (2010b) – Muscovy and Mule ducks and Domestic geese: expert opinion
Water bathing	Complete bathing: Typical shaking, forward-downward and wing spreading movements on a water surface by which water is moved under the wings and over the body, followed by wing flapping and body shaking (a front and back sidewards movement along the whole body by which water is expelled). The bathing sequences are usually interrupted and followed by preening. Incomplete bathing: Bathing movements with, at most, the tips of the wings being immersed in water, and only a small amount of water can be moved under the wings and over the body. Sham (or vacuum or dry) bathing: bathing movements without contact to water. Not relevant for quail.	– Domestic ducks: Waitt et al. (2009), Jones et al. (2009) – Muscovy ducks: Knierim et al. (2005) – Mule ducks: expert opinion – Domestic geese: Gillette (1977), Lin et al. (2016), Liao et al. (2022)

ABM	Definition and Interpretation	Sources of evidence for each species
	Interpretation: Inability to perform comfort behaviour is indicated by reduced water bathing and by incomplete instead of complete water bathing, and sham instead of incomplete or complete bathing	
Dust bathing	Complete dust bathing: A sequence of movements that starts by a bird lying down and tossing loose material onto and between the feathers. Other activities may occur in variable sequence during a dust bathing bout, including side lying, scratching, bill raking, head and body rubbing. A dust bathing bout usually ends with head and body shaking, which is characterised by body parts (head, tail, whole body) that are moved in quick alternating movements of the right and left side of the body. This is typically performed at the end of dust bathing to get rid of the particles of the dust and to get the plumage in order again. Incomplete dust bathing: performance of only part of the dust bathing movements Sham (or vacuum) dust bathing: bathing movements performed in the (apparent) absence of bathing substrate Only in quail. Interpretation: Inability to perform comfort behaviour is indicated by reduced or incomplete or sham dust bathing	– Japanese quail: Statkiewicz and Schein (1980)
Head dipping	The bird immerses its head in the water at the drinking trough or bathing opportunity. The eyes are covered by water. Not in quail. Interpretation: Inability to perform comfort behaviour is indicated by reduced head dipping.	– Domestic ducks: Waitt et al. (2009), Jones and Dawkins (2010b) – Muscovy ducks: Knierim et al. (2005) – Mule ducks: expert opinion – Domestic geese: Gillette, 1977
Nostril cleaning	The bird immerses the bill in water, covering the nostrils and expels air through the nostrils. Interpretation: Inability to appropriately perform comfort behaviour is indicated by reduced or lacking nostril cleaning	– Domestic ducks: Heyn et al. (2009) – Muscovy and Mule ducks and Domestic geese: expert opinion
Nostril condition	The condition of the nostrils varies from clear to blocked. Dirtiness of nostrils can be assessed separately or in combination with assessment of blockage. Interpretation: Inability to appropriately perform comfort behaviour is indicated by dirty and/or blocked nostrils with blocked nostrils being a worse stage than merely dirty nostrils.	– Domestic ducks: Heyn et al. (2009), O'Driscoll and Broom (2011), Karcher et al. (2013), Abdelfattah et al. (2020) – Muscovy ducks: expert opinion – Mule ducks: Mohammed et al. (2019a) – Domestic geese: Lierz and Heffels-Redmann (2019), Liao et al. (2022) Dirty or blocked nostrils have not been reported in quail.
Eye condition	The condition of the eyes of the bird, varying from clear and bright to closed, half-closed permanently or showing conjunctivitis, discharge and swelling. Eye discharge may result in the presence of a caseous mass that is difficult to remove and thereby obstruct vision. Crusts or	– Domestic ducks: Jones et al. (2009), Jones and Dawkins (2010a), O'Driscoll and Broom (2011), Abdelfattah et al. (2020); – Muscovy ducks: Knierim et al. (2005); – Mule ducks: Mohammed et al. (2019a), Litt et al. (2020)

ABM	Definition and Interpretation	Sources of evidence for each species
	dirt may be found around the eye(s) together with loss of feathers. Dirtiness or lack of feathers around the eyes can be assessed separately or in combination with assessment of the eye disorders described. Interpretation: Inability to appropriately perform comfort behaviour is indicated by signs of conjunctivitis, sinusitis, swelling, discharge, occlusion or alteration around the eyes or of the eye structure itself with higher severity of disorders being worse stages	– Domestic geese: Williams (2019), Liao et al. (2022) Eye disorders have not been reported in quail
Plumage and body condition	Degree of dirtiness of the plumage and body (particularly the ventral part) with litter, faeces or dirt. Interpretation: Inability to perform comfort behaviour results in poor plumage and body condition.	– Domestic ducks: Jones and Dawkins (2010a) – Muscovy ducks: Knierim et al. (2005) – Mule ducks: Litt et al. (2015c) and – Domestic geese: Yin et al. (2017a), Wang et al. (2019), Tremolada et al. (2020), Liao et al. (2022) – Japanese quail: expert opinion

3.5.4.4. Main hazards and relationship with husbandry systems

The main hazards for 'Inability to perform comfort behaviour' are lack of or impaired access to open water, poor litter quality, lack or insufficient provision of litter, insufficient total floor space and insufficient height.

Lack of open water or impaired access to open water: In waterfowl, water in general facilitates preening behaviour leading to clean and protective plumage. Regardless of husbandry system, water provision can be differently designed, allowing different degrees of access to open water, i.e. smaller or larger water surfaces of different depths that allow the bird more water contact than just for drinking, but to different degrees (see Table 46; Knierim et al., 2005; Liste et al., 2012a). However, more open water provision is technically more challenging in space-restricted environments, such as individual cages, and easier in floor systems with outdoor access or in outdoor keeping. The extent to which all comfort behaviours can be performed depends on the degree of the available surface and depth of the water provision, although showers or mists do also allow wet preening and bathing to some degree. Otherwise, (incomplete) bathing (Table 20) is only possible if the birds can at least dip their heads into water and toss water over the body (Knierim et al., 2005). Dirty water is less used for water bathing (for Domestic ducks: Liste et al., 2012a), so that the efficiency of cleaning or exchanging bathing water will also affect its use. Apart from the design and management of water provision, the animal to drinker or bath area ratio and possible time restrictions of water provision will affect the accessibility of open water, although to date no scientific evidence on minimum requirements in this regard is available (reviewed by Babington and Campbell, 2022). This factor is discussed in more detail in Section 3.6.5.

For quail, substrate on the floor that is friable, dry and fine facilitates dust bathing and preening behaviour (Schmid and Wechsler, 1997), leading to clean and protective plumage. **Poor litter quality or lack of litter** is present when no or only very low quantities of such material are available. This is typically the case in cages with wire floors and will lead to inability to perform comfort behaviour which may impair plumage and body condition. However, in quail, it is also possible and recommendable to provide separate dust bathing sites as **enrichment** (see Section 3.6.5.4). In waterfowl, especially around the water facilities, the litter is often moist or wet (e.g. O'Driscoll and Broom, 2011), and poor litter quality in floor systems can lead to poor plumage and body condition (Jones and Dawkins, 2010a). Depending on the humidity in the barn, also the litter in the rest of the barn may become moist and clump (Jones and Dawkins, 2010a). The risk of this is increased in barns with outdoor access under humid outdoor conditions, particularly due to birds carrying moisture inside by their feet and/or plumage when entering from outside.

Cages or husbandry systems used during the overfeeding phase may provide, in addition to lack of litter due to the use of fully perforated floors, **insufficient total floor space** or **insufficient height**, so that space-consuming activities such as wing stretching, or wing flapping are not possible or reduced. These hazards are discussed in more detail in Section 3.6.1.

3.5.5. Bone lesions (including fractures and dislocations)

3.5.5.1. Description

Bone lesions can be described as: the animal experiences negative affective states such as pain, discomfort and/or distress due to fractures or dislocations of the bones (excluding fractures leading to locomotory disorders). This welfare consequence may occur after animal–animal, animal–environment and animal–handler interactions.

In hatcheries, 1-day-old waterfowl (Domestic, Muscovy and Mule ducks, Domestic geese) hatchlings that seem present leg problem (developmental problem, dislocation, broken leg, spraddle leg and other deformities) are culled and will not get into the production chain.

3.5.5.2. Species-specific issues

The welfare consequences of limb fractures and dislocations are applicable to all the species. In the case of domestic breeder ducks and geese, it can occur during the egg laying period in breeders when male–male agonistic interactions escalate. Furthermore, it can also occur as a result of damaging impacts with environmental features (or other animals) due to fearful response of the animals (e.g. because of sudden movement, noise or light change). Finally, the welfare consequence may happen during handling of the animals (e.g. vaccination, artificial insemination, data recording such as weighing, transferring to fattening house or slaughter).

Keel bone damage may occur in layer quail; however, it is understudied. By extrapolating from laying hens, fractures and damage of the keel bone are caused by several possible factors that include the genetic effect on bone health, high egg laying performance, depletion of calcium from the bones and collisions within the housing system (Fleming et al., 2004; Wilkins et al., 2011; Regmi et al., 2015; Riber et al., 2018; Baur et al., 2020).

3.5.5.3. Animal-based measures

The ABMs which can indicate this welfare consequence are shown in Table 21. Limb fractures and dislocations are applicable across all the species considered, while keel bone damage is only considered in quail. The scientific literature is sparse, and in most species, the ABMs have been selected based on expert opinion, taking practical experience and extrapolation from other bird species into account (EFSA AHAW Panel, 2023a,b).

Table 21: ABM for assessing 'bone lesions (including fractures and dislocations)', definition, interpretation and sources of evidence (scientific literature or expert opinion) for each species

ABM	Definition and Interpretation	Sources of evidence for each species
Limb fractures and dislocations	Fractures of one or both wings or legs including sharp bends, shearing and/or fragmented sections of the bone, and injuries in which the ends of bones are forced from their normal positions in the joint. Interpretation: Bone lesions can be indicated by the presence of fractures and dislocations	– Domestic ducks, Muscovy ducks, Mule ducks and Japanese quail: expert opinion – Domestic geese: Tremolada et al. (2020) (broken wings)
Keel bone damage	Keel bone fractures include sharp bends, shearing, and/or fragmented sections of the keel bone. Indentations along the ventral surface or deviations from a straight line may indicate fractures. For layer quail only. Interpretation: Bone lesions can be indicated by the presence of keel bone damage	– Layer quail: expert opinion

3.5.5.4. Main hazards and relationship with husbandry system

The main hazards for 'bone lesions (including fractures and dislocations)' are related to mixing unfamiliar birds, inappropriate sex composition of groups, insufficient space allowance per bird and inappropriate pen design. Studies have investigated bone quality characteristics in relation to these hazards but did not directly compare the presence of bone fractures or dislocations to the bone quality.

Mixing unfamiliar birds (Japanese quail: Gerken and Mills, 1993; Domestic geese: Kotrschal et al., 2010) and **inappropriate group sex ratio** (Japanese quail: Wechsler and Schmid, 1998; Domestic geese: Weiß et al., 2011) may lead to agonistic interactions between males that may ultimately result in bone fractures and dislocations. The hazards may occur when groups are reformed, when group composition in terms of age or sex distribution or group size is inadequate (for more information see Section 3.6.2). The effect of sex ratio will depend on the sexual maturity of the birds, since sexual aggression is highest in mature males (Muscovy ducks: Rodenburg et al., 2005; Japanese quail: Wechsler and Schmid, 1998; Domestic geese: Weiß et al., 2011). Studies examining the effect of agonistic interactions on bone fractures and lesions are lacking.

Insufficient space allowance per bird has been shown to influence bone quality characteristics in Domestic ducks (Zhang et al., 2018). The calcium and phosphorus content of the tibia was significantly lower in high stocking density group (11 ducks/m^2) compared to medium (8 ducks/m^2) and low (5 ducks/m^2) stocking density groups. This might increase the risk of bone lesions.

Yang et al. (2022) found in Nonghua ducks that the breaking strength, the cortical bone thickness and the percentage of cortical bone area of tibia, femur and humerus, as well as the mineral density and the calcium content of humerus in cage-reared ducks was significantly lower than those of floor-reared ducks probably due to higher stocking density and less opportunity to perform locomotory behaviour. Bone quality deterioration in the cage-rearing system was related to perturbed amino acid, lipid and energy metabolism. However, the relationship of bone quality and the presence of fractures in the two husbandry systems were not investigated in the study. The findings of this study may to some extent be applicable to breeder ducks (both Domestic and Muscovy).

Inappropriate pen design: Krunt et al. (2022) found no difference in bone quality characteristics (length, width, weight and fracture toughness of tibia and femur) of Muscovy ducks kept in deep litter only and deep litter with swimming pond husbandry systems. According to a welfare assessment in Japanese quail, on average 0.53% of birds kept in cages had keel bone damage compared to the average 2.6% found in indoor floor systems (Antoni Dalmau, IRTA, personal communication, 2023). Falls and collisions seem more common in non-cage systems, and they are the main cause of keel bone damage.

The hazards associated with bone lesions (including fractures and dislocations) might be common but, in the opinion of EFSA experts, this welfare consequence is of low prevalence. For this reason, definitive conclusions regarding the effect of housing systems on this welfare consequence cannot be derived.

3.5.6. Soft tissue lesions and integument damage

3.5.6.1. Description

The animal experiences negative affective states such as pain, discomfort and/or distress due to physical damage to the integument or underlying tissues, e.g. foot-pad dermatitis, multiple scratches, open or scabbed wounds, bruises, ulcers, abscesses and feather loss. This welfare consequence may result from negative social interactions such as aggression, or from feather pecking from another bird or self-pecking, from handling or from damaging environmental features or from mutilation practices (e.g. bill trimming or beak reduction, claw trimming).

3.5.6.2. Species-specific issues

The welfare consequence 'soft tissue lesions and integument damage' applies to all bird species considered in this opinion. However, it may be more severe when the species has a greater propensity to behaviours in which the birds will impact with environmental features, such as fearful panic in quail (Gerken and Mills, 1993). Ducks and geese can also panic easily (Nicol et al., 2017) but generally do not take flight due to their heavier body weight. Domestic and Muscovy ducks differ in their response to fearful stimuli. Muscovy ducks generally showed reduced fear and stress responses compared with the Domestic genotype across a range of behavioural tests, whereas Mule ducks showed similar (as average of the two parents) or higher responses than the parental lines (e.g. more fearful than the two parents for fear of man at 10 weeks of age) (Faure et al., 2003). Other studies suggested that Domestic ducks respond to fear and stress with a general increase in behavioural activity and physiological responses, while Muscovy ducks showed increased avoidance behaviour (Arnaud et al., 2008, 2010).

This welfare consequence will also be more severe where the species has anatomical features capable of inflicting more serious wounds on conspecifics, such as a sharp point to the beak (Japanese quail: Gerken and Mills, 1993) or bill (Muscovy duck: Rauch et al., 1993; Gustafson et al., 2007a) or sharp claws (Muscovy duck:Rauch et al., 1993 ; Widowski and Rentsch, 2022). Management measures to remove such damaging features may, in themselves, involve soft tissue lesions and integument damage (Muscovy duck: Gustafson et al., 2007a; Japanese quail: Gerken and Mills, 1993).

Plumage damage and wounds to the skin due to feather pecking and cannibalistic pecking in Muscovy ducks may start at specific time when feather growth and replacement take place. First damage can occur around the third week of life (Knierim et al., 2005; Riber and Mench, 2008). Riber and Mench (2008) described that, following the pattern of feather development, damage was first observed around the preen gland (a gland located dorsally at the base of the bird's tail, producing oil which is then distributed through the plumage by the bird's preening behaviour), followed by the area where the tail feathers emerge, then shifting to the shoulders and wings at the time of the appearance of the primaries. Therefore, depending on the onset of feather pecking, different body parts can predominantly be affected (Knierim et al., 2005). Presumably the newly emerging feather shafts are particularly attractive, but also unrest due to itching or nutritional deficiencies during the feather development may play a role in plumage damage.

In adult breeding birds kept in groups, Bilsing et al. (1992a) reported that unmated females may disturb the mating process by pecking the cloacal area of females or the exposed penis of male birds while mating.

In the EU, routine bill trimming occurs in Muscovy and Mule ducks only, and not in the other species; references to trimming in Domestic ducks (Mohammed et al., 2022) and Japanese quail (Pizzolante et al., 2006; Abdelfattah, 2018; Cruvinel et al., 2022) from outside the EU have been found, whereas there are no references of bill trimming in geese. This indicates that injurious pecking may be less common in Domestic ducks, Domestic geese and in Japanese quail than in Muscovy and Mule ducks, when kept in husbandry systems used in the EU. It also indicates that in Domestic ducks and Japanese quail, the risk of injurious pecking has been effectively managed by preventive measures and/or by genetic selection.

Similarly, toe/claw trimming is carried out only in Muscovy and Mule ducks (Rauch et al., 1993; Widowski and Rentsch, 2022) and is not applicable to Domestic ducks, Domestic geese or Japanese quail. As this intervention is not regulated within the EU (except for national legislation in some MSs, e.g. Sweden), this indicates that the industry has only identified toe/claw trimming as relevant and needed in Muscovy and Mule ducks. Hence, injuries that are believed to be caused by claw scratches are most likely not that common in the other species, or have been solved by preventive measures and/or genetic factors, while it is difficult to evaluate if those solutions are applicable also to Muscovy and Mule ducks.

3.5.6.3. Animal-based measures

The ABMs which can indicate this welfare consequences are shown in Table 22. In general, these ABMs are applicable across all the species considered, although scientific literature is sparse.

Table 22: ABMs for assessing 'soft tissue lesions and integument damage', definition, interpretation and sources of evidence (scientific literature or expert opinion) for each species

ABM	Definition and Interpretation	Sources of evidence for each species
Bruises	A bruise is a superficial injury caused by trauma. It results from a haematoma and is often without rupture of the skin. It appears as discoloured skin on the body with fresh bruises usually being reddish while older bruises can appear yellow, blue and greenish. Interpretation: The presence of bruises is indicative of the welfare consequence 'soft tissue lesions and integument damage'.	– Domestic ducks: Valkova et al. (2021) – Muscovy ducks: expert opinion – Mule ducks: Litt et al. (2015c), Litt et al. (2020) – Domestic geese: Valkova et al. (2021) – Japanese quail: Buchwalder and Wechsler (1997)
Trimmed bill (beak)	An intact bill comprises an upper mandible curving over the straighter and shorter lower mandible. The tips of both mandibles are naturally sharp. Trimmed bills are identified by blunt mandible tips, a reduction of the upper mandible overhang and shortening of both mandibles. The extent of shortening depends on	– Domestic ducks: Gustafson et al. (2007b), Mohammed et al. (2022) – Muscovy ducks: Gustafson et al. (2007a) – Mule ducks: Ahmed (2022) – Japanese quail: Abdelfattah (2018), Aguiar et al. (2021), Cruvinel et al. (2022)

ABM	Definition and Interpretation	Sources of evidence for each species
	the trimming method employed and the age of the birds when trimmed. Interpretation: The presence of trimmed bill/beak is indicative of the welfare consequence 'soft tissue lesions and integument damage'.	There are no references on bill trimming in Domestic geese
Trimmed claw/toe	The practice of cutting claws or part of the toes to avoid injuries by the sharp claws when birds pile up in panic reactions. Only in Muscovy and Mule ducks. Interpretation: The presence of trimmed claw/toe is indicative of the welfare consequence 'soft tissue lesions and integument damage'.	– Muscovy ducks: Widowski and Rentsch (2022) – Mule ducks: Guémené et al. (2012)
Plumage damage	Deterioration or loss of plumage; it includes damaged feathers or feather loss. Interpretation: The presence of plumage damage is indicative of the welfare consequence 'soft tissue lesions and integument damage'.	– Domestic ducks: Jones and Dawkins (2010a), Karcher et al. (2013), Colton and Fraley (2014). – Muscovy ducks: Knierim et al. (2005), Farghly et al. (2017) – Mule ducks: Litt et al. (2019) – Domestic geese: Yin et al. (2017a,b), Wang et al. (2019), Tremolada et al. (2020), Boz et al. (2021), Liu et al. (2021), Liao et al. (2022) – Japanese quail: Mohammed et al. (2017)
Foot-pad dermatitis	A type of contact dermatitis affecting the foot and toe pads. Contact dermatitis reflects an inflammatory state in the subcutaneous tissue leading to hyperkeratosis, necrosis and ulceration in the extreme cases. Interpretation: The presence of foot-pad dermatitis is indicative of the welfare consequence 'soft tissue lesions and integument damage'	– Domestic ducks: Jones and Dawkins (2010a), O'Driscoll and Broom (2011), Karcher et al. (2013), Da Costa et al. (2015), Klambeck et al. (2017), Klambeck et al. (2019) – Muscovy ducks: Knierim et al. (2005), Farghly et al. (2017) – Mule ducks: Litt et al. (2015a) – Domestic geese: Boz et al. (2017a), Liao et al. (2021) – Japanese quail: Mohammed et al. (2017)
Wounds	Wounds comprise all lesions to the skin ranging from minor superficial punctiform spots to scratches to large open wounds that go deeper than the skin. Interpretation: The presence of wounds is indicative of the welfare consequence 'soft tissue lesions and integument damage'	– Domestic ducks: Valkova et al. (2021) – Muscovy ducks: Knierim et al. (2005) – Mule ducks: Litt et al. (2015b) (scratches) – Domestic geese: Boz et al. (2017b) – Japanese quail: Gerken and Mills (1993) – Pellegrini et al. (2019)
Breast ulceration	Presence of a crust or open lesion on the breast which can be accompanied by the presence of fibrin and/or of a peripheral inflammation. Interpretation: The presence of breast ulceration is indicative of the welfare consequence 'soft tissue lesions and integument damage'.	– Muscovy ducks: Farghly et al. (2017, 2018) – Mule ducks: Litt et al. (2015c) – Domestic geese: Liao et al. (2022) It has not been reported in Domestic ducks or Japanese quail
Hock burn	Hock burns are a type of contact dermatitis affecting the caudal part of the hock joint. Interpretation: The presence of hock burn is indicative of the welfare consequence 'soft tissue lesions and integument damage'.	– Domestic ducks: Park et al. (2018) – Muscovy ducks: Farghly et al. (2017) – Mule ducks: Litt et al. (2015c) It has not been reported in Domestic geese or Japanese quail
Twisted (angel) wing(s)	A musculoskeletal disorder in which the flight feathers of one or both wings of a bird twist away from the body.	– Domestic ducks: Sun et al. (2023) – Muscovy ducks: Chavarro-Tulcán et al. (2021) – Mule ducks: expert opinion.

ABM	Definition and Interpretation	Sources of evidence for each species
	Interpretation: The presence of twisted (angel) wing(s) is indicative of the welfare consequence 'soft tissue lesions and integument damage'	– Domestic geese: Tremolada et al. (2020), Lin et al. (2016), Zhu et al. (2021), Chang et al. (2022) It has not been reported in Japanese quail.

3.5.6.4. Main hazards and relationship with husbandry systems

The most important hazards for 'Soft tissue lesions and integument damage' can be categorised as those arising from injurious contact with environmental features such as flooring or enclosure partitions, those arising from injurious behaviours of conspecifics such as aggression or feather pecking and those arising from management actions such as mutilations.

If birds are unable to avoid aggression from others due to **insufficient total floor space** or **inappropriate pen design**, the prevalence or severity of soft tissue damage will increase (see also Section 3.5.3 on group stress for hazards increasing risk of injurious pecking). Furthermore, birds may injure themselves trying to carry out flight behaviours in too small areas. Excessive mating attempts, which can be common in commercial quail breeding farms, can cause injuries to female birds (Schmid and Wechsler, 1997; Galef Jr et al., 2006). If males, due to **insufficient total floor space**, cannot perform appropriate courtship behaviours, repeated, forced, mating attempts can result in head wounds, eye damage or body damage to the females (Cheng et al., 2010).

Insufficient space allowance per bird restricts the bird's movement and increases the risk of dermatitis and other welfare consequences such as locomotory disorders, including lameness. Feather damage, possibly reflecting feather pecking, was worse when Pekin ducks were kept at high stocking density of 8 birds/m^2 compared with 5, 6 and 7 birds/m^2 (De Buisonjé, 2001). Muscovy ducks with intact beaks on perforated floors showed no feather pecking up to 28 days of age when kept at lower density (6.3 birds/m^2), whereas at a higher stocking density (11.6 birds/m^2) feather pecking and injuries occurred, although this occurred also at both stocking densities when mash instead of pellets was fed (Bilsing et al., 1992b). Baeza et al. (2003) compared feather pecking in Barbary duck at a stocking density of 7, 9 or 11 birds/m^2 and found the highest level of feather pecking in older birds at a stocking density of 11 birds/m^2.

Insufficient height of enclosure is a hazard for birds kept in cages. If the height of the cage is too low, birds may experience plumage damage or skin lesions through abrasion or impact with the ceiling when trying to stand-up or/and wing flap. In the case of quail, which typically jump or try to fly vertically when startled, insufficient height of the enclosure may result in injuries to the head due to impact with the ceiling of the cage. Cages of an intermediate height (e.g. 26 cm) which encourage flying attempts but do not allow controlled flying, will increase the risk of soft tissue lesions (Gerken and Mills, 1993). Nordi et al. (2012) reported 15.6% of birds with head feather damage and injuries to the skin of the head and back when housed in cages of 26.5 cm height, whereas no injuries were observed in birds in an aviary of 162 cm height which permitted flying behaviour.

The soft tissue lesion of foot-pad dermatitis may result from **poor litter quality** with high moisture content from excreta or from spilled water. In a study on 46 Domestic duck farms, the quality of straw litter was found to influence the condition of the feet (Jones and Dawkins, 2010a), with high relative humidity and ammonia levels associated with increased incidences of foot-pad dermatitis. Floor drainage is an important factor and an improvement in foot condition was seen in birds reared on plastic slats and litter (Karcher et al., 2013). The drinker system can influence water spillage and the litter humidity. Water spillage and increase litter humidity are more frequent in houses with nipple drinkers rather than troughs or bell drinkers (Jones and Dawkins, 2010a). When comparing three different sized water troughs (narrow: 15 cm wide and 8 cm deep; intermediate: 20 cm wide and 12 cm deep; wide: 50 cm wide and 8 cm deep) for groups of ducks housed in commercial systems, foot condition was poorer when ducks were given wider troughs (Liste et al., 2012b). Other studies have found that levels of pododermatitis were generally low when birds were housed with open water sources (Jones and Dawkins, 2010a; O'Driscoll and Broom, 2011).

Quail kept on five different substrates: sand, dried mud, sawdust, wheat straw and rice straw, showed different behavioural responses, with no impact on a range of physical indicators including foot health (Mohammed et al., 2017).

If birds are housed on poor quality **perforated floors**, injury to the feet or claws may be caused by cuts from sharp edges or by trapping of the claws in void areas of inappropriate size. Other injuries including joint deformation have also been reported (Muscovy duck: Rauch et al., 1993).

Lack of litter can be another environmental hazard for soft tissue lesions and integument damage as a result of feather pecking or self-pecking. Feather pecking in Domestic ducks has been shown to be more prevalent on 100% slatted floor than on a 50% slatted floor in combination with 50% floor covered by straw, and a floor fully covered by litter (straw, wood shavings, sawdust or chopped straw; Leipoldt, 1992), suggesting that damaging behaviour will be more prevalent when there are **perforated floors** with **lack of litter**. **Insufficient provision of enrichment** is also a relevant hazard, since provision of environmental enrichment devices (coloured balls and zip-ties) has been shown to reduce the prevalence of plumage damage and skin lesions from self-pecking and conspecific-pecking in Pekin ducks (Colton and Fraley, 2014). Similarly, quail in an enriched aviary engaged in lower occurrence of agonistic behaviours, which might cause soft tissue lesions, than those in cages (Nordi et al., 2012). **Inappropriate pen design:** All species might be sensible to technopathies, meaning that sharp edges in the enclosure lead to abrasion of the feathers and thus plumage damage (EFSA AHAW Panel, 2022b). Incorrect spacing of cage bars may trap body parts and cause injuries (EFSA AHAW Panel, 2022b).

In quail, aggressive pecking is mainly directed towards heads and necks, and can be related to group composition and size, housing system, genetics and stocking density (Wechsler and Schmid, 1998; Gerken and Mills, 1993; Guzman et al., 2013; El Sabry et al., 2022). Severe pecking ('cannibalism') can lead to feather loss, serious head injuries and increased mortality (Wechsler and Schmid, 1998; Taskin and Camci, 2017; Abdelfattah, 2018). **Mixing of unfamiliar birds** can trigger aggressive pecking, although the behaviour can also be seen among familiar birds.

Inappropriate group sex composition: Female quail are larger than males and may injure them during aggressive encounters especially in situations where the males are unable to escape, such as in cages (Gerken and Mills, 1993). The prevalence of aggressive pecking is higher in male quail, but the presence of only one male in the group reduces serious injuries. Therefore, it is recommended to avoid using multi-male breeding groups (Wechsler and Schmid, 1998).

Sudden movements, noise or changes in light, may induce panic response in birds and result in soft tissue lesions when they run or fly into solid partitions of the enclosure, roof or furniture, or from collision with other birds (e.g. in ducks: Rodenburg et al., 2005). In natural conditions, quail tend to stay in dense vegetation and respond to threats by freezing and flying up vertically for a short distance before taking cover (Buchwalder and Wechsler, 1997). However, injuries may occur during the high velocity flight.

Invasive husbandry procedures. Management practices carried out to reduce the risk of injury from behavioural problems may themselves inflict soft tissue damage. Bill trimming, which involves tissue damage, is widely carried out in Muscovy and Mule ducks (Gustafson et al., 2007a). It is carried out especially in housing systems with no litter provision, but has also been reported from systems with outdoor access (Rodenburg et al., 2005), although in organic production, it will only be done in exceptional cases by legislation (Commission Implementing Regulation (EU)2020/464). The practice is also reported experimentally in Domestic duck (Gustafson et al., 2007b) although it is not normal commercial practice in Europe in this species. Bill trimming involves the removal of a portion of the bill using one of the following methods: cold cutting with scissors; tip-searing the bill against a cautery blade for several seconds; or cutting the bill with a hot blade to cauterise the stump (Gustafson et al., 2007a,b). Both trimming methods result in connective tissue proliferation in the bill, but the hot-blade method caused thicker scar tissue and fewer nerve fibres remained in the stump than with the tip-searing method. In general, ducks engage in fewer bill-related activities in the week after trimming and rest more than non-trimmed ducks, indicating acute pain but in the longer term, no chronic change has been reported (Gustafson et al., 2007a,b).

Beak trimming of quail may be undertaken in commercial systems to reduce welfare problems (Nicol et al., 2017), though is currently uncommon in the EU.

Claw trimming is used in Muscovy ducks to avoid injuries by the sharp claws when birds pile up in panic reactions. If claw trimming is carried out manually using scissors (at around 15 days of life), it frequently leads to bleeding or even amputation of toes as it is routinely done with one cut per foot (Knierim, personal communication in Rodenburg et al., 2005) (for further details, see Section 3.3.2). It is carried out in both indoor and free-range housing systems (Rodenburg et al., 2005).

However, it is important to bear in mind that sudden movement, noise or light change and invasive husbandry procedures are hazards that, unlike the others, are not the result of a specific husbandry system.

3.5.7. Locomotory disorders (including lameness)

3.5.7.1. Description

Locomotory disorders are when the animal experiences negative affective states such as pain or discomfort due to impaired locomotion induced by e.g. bone, joint, skin or muscle damage.

The prevalence of impaired locomotion, i.e. gait abnormalities, was reported in a study of 46 flocks of commercial ducks to be 14% at 23 days of age and 21% at 41 days of age (Jones and Dawkins, 2010a). These proportions are significantly higher than those reported by Abdelfattah et al. (2020), who found 0.63% of the Domestic ducks in six flocks to have gait abnormalities at 30 days of age when using the transect walk method. In an experimental study of Mule ducks, the prevalence of gait abnormalities was reported to increase from 3 to 5 weeks of age, while it decreased again from weeks 5 to 7 of age (Ahmed, 2022). It is known on individual level that the worse the gait score, the shorter distance the bird will walk on a treadmill (Domestic ducks: Byrd et al., 2016). Within age category, the body weight decreases as walking impairment measured as gait score increases, which may be due to reduced mobility, hindering the birds to access the feeder and waterer as much as otherwise wanted (Domestic ducks: Robison et al., 2015; Makagon et al., 2015).

3.5.7.2. Species-specific issues

The welfare consequence 'locomotory disorders' is relevant for all husbandry systems and animal categories in the case of waterfowl (breeders – Domestic ducks: Duggan et al., 2017; production of meat – Domestic ducks: Jones and Dawkins, 2010a; production of meat – Domestic geese: Charuta et al., 2012; production of foie gras –Mule ducks and Domestic geese: SCAHAW, 1998).

Very few publications report on 'locomotory disorders' in Japanese quail. Geerken and Mills et al. (1993) noted that leg and foot problems occur in caged breeders, particularly in old females of heavier meat strains. They reported that swellings of the tibiometatarsal and metatarsal joints, with abscesses around the joints, were the most common leg problems. Furthermore, they reported that swelling of the joints (arthritis-synovitis) was also a common problem when heavy strains were kept in mixed sex groups in cages and the suggested cause was slight skin lesions, which subsequently became inflamed, resulting from the increased load on the legs when females were mounted by males. The prevalence of these leg problems was lower in quail housed in floor systems, but floor-housed quail may experience plaques of dirt (e.g. food, litter, faeces) adhering to the toes, restricting the growth of the toes when the dirt dries up. However, the authors did not cite scientific studies as evidence for these postulates. In quail reared for meat production in indoor floor systems, an average of 3.62% (range from 0.8 to 6.8) of birds with moderate lameness and 1.23% (0–3.6%) with severe lameness has been reported (Antoni Dalmau, IRTA, personal communication, 2023).

3.5.7.3. Animal-based measures

The ABMs which can indicate locomotory disorders are shown in Table 23. Additionally, birds subject to this welfare consequence can experience other welfare consequences because of negative interactions, including inability to perform comfort, exploratory and foraging behaviours and soft tissue lesions and integument damage. ABMs for these secondary welfare consequences are discussed in the relevant sections.

Table 23: ABMs for assessing 'locomotory disorders (including lameness)', definition, interpretation and sources of evidence (scientific literature or expert opinion) for each species

ABM	Definition and interpretation	Sources of evidence for each species
Leg deformation	Abnormality of the cartilage growth resulting in deformed bones and, at least in severe cases, causing walking impairment. Interpretation: The higher the proportion of leg deformation in a flock the more the birds experience locomotory disorders.	– Domestic ducks: Charuta et al. (2011), Robison et al. (2015) – Muscovy and Mule ducks: expert opinion – Domestic geese: Charuta et al. (2012, 2014) – Japanese quail: Takahashi et al. (1983), Charuta et al. (2013)

ABM	Definition and interpretation	Sources of evidence for each species
Walking impairment/ lameness	The extent to which the bird is able to walk, varying from unaffected gait to slight changes in gait to obvious lameness or even lack of mobility. Interpretation: Studies on the relationships between walking ability and leg pathologies and between gait scores and pain in ducks, geese and quail are lacking, but it is possible that the worse the walking impairment, the higher is the risk that the birds experience locomotory disorders, which may be associated with pain.	– Domestic ducks: Jones and Dawkins (2010a), Makagon et al. (2015) – Muscovy ducks: Knierim et al. (2005) – Mule ducks: Litt et al. (2019), Litt et al. 2020) – Domestic geese: Yin et al. (2017a), Tremolada et al. (2020) – Japanese quail: expert opinion
Flock activity	The level of activity within a flock, evaluated by the sum of all individuals' movement and the prevalence of (ab)normal activity patterns. Activity includes predominantly locomotion which can be impaired, e.g. by lameness, but may also reflect other movements. Interpretation: Flock activity indicates mobile birds which are considered to be healthy and in a good welfare status. Inactivity may be caused by locomotory disorders and will result in additional reduction of welfare when the bird experiences pain or discomfort, including inability to cover its needs such as reaching feed and water. In flocks where a proportion of the birds is affected from locomotory disorders, the overall level of flock activity is reduced.	– Domestic ducks: Li et al. (2018) – Muscovy and Mule ducks and Domestic geese: expert opinion – Japanese quail: Wada (1986)

3.5.7.4. Main hazards and relationship with husbandry systems

In general, little is known from ducks, geese and quail about the impacts of the different hazards on locomotory disorders as there is a major research gap on this topic. Knowledge from broiler research can give, with reservations, some indications of the relationships between the identified hazards and locomotory disorders and is therefore included below, when literature from ducks, geese and quail is lacking.

The most important hazards for locomotory disorders are **insufficient space allowance per bird** (e.g. Li et al., 2018), **poor litter quality** (e.g. Jones and Dawkins, 2010a) and **genetic selection for rapid growth** (e.g. Bentley et al., 2020). However, the latter is not as such specific for any husbandry system, although there may be a tendency for hybrids growing faster in the more intensive systems, such as indoor floor systems. Interactions between these hazards may occur, increasing the negative impact on the locomotory disorders. In addition, the occurrence of locomotory disorders increases with age in Domestic duck (Jones and Dawkins, 2010a).

Limited research has focused on the effect of **insufficient space allowance per bird** on locomotory disorders in ducks, geese and quail, but it is well known from broilers that increasing stocking density is associated with increasing walking impairment (e.g. Dawkins et al., 2004). The high stocking density restricts the bird's movement and also increases the risk of dermatitis and locomotory disorders, including lameness.

Similarly, Yin et al. (2017a) observed a decline in the proportion of domestic geese with a normal gait with increasing stocking density (assessing 2, 3, 4, 5, 6 geese/m^2). Direct investigations of the effect of stocking density on walking ability have not been done in Domestic ducks, Muscovy ducks or quail. Li et al. (2018) investigated the effect of stocking density on flock activity in Domestic ducks using an automatic image monitoring system and found the flock activity levels in low stocking densities to be higher than those in high stocking densities. The authors speculated whether this was an indication of poorer walking ability in high stocking density flocks as compared to flocks kept at low stocking density. This is supported by research in broilers showing that flocks with a high percentage of individuals with impaired walking have a lower mean flow rate than flocks consisting of individuals with limited walking impairment (Dawkins et al., 2009). On the other hand, the optical flow measures of skewness and kurtosis did not differ among different stocking densities, suggesting that flocks kept at the different stocking densities had similar walking behaviour, i.e. the observed difference in flow rate may have been due to other active behaviours than walking (Li et al., 2018).

The ABMs growth rate and body weight may indicatethe presence of locomotory disorders in flocks of ducks, geese and quail; however, these ABMs may assess also other welfare consequences (see Appendix B). Multiple studies have shown that, irrespective of housing system, high stocking densities result in growth depression, i.e. reduced growth rate and body weight (Osman, 1993; de Buisonjé, 2001; Xie et al., 2014; Li et al., 2018; Zhang et al., 2018; Abo Ghanima et al., 2020). The causes of this association have not been determined, but it may (partly) be due to decreased walking ability with increasing stocking densities (as outlined above from broiler research), which negatively affects the ability of the birds to access feed and water. Another explanation could be heat stress at high stocking densities, as increased panting, which is performed to get rid of excessive heat, has been related to higher stocking densities on commercial farms (Jones and Dawkins, 2010a). Based on the effect of stocking density on performance parameters, Li et al. (2018) suggested a maximum stocking density of 7 Domestic ducks per m^2, corresponding to 22.5 kg/m^2. For Domestic geese, Yin et al. (2017a) proposed that to ensure good walking ability, the maximum stocking density should be 5 geese per m^2 (body weight not specified, slaughter age 70 days, hybrid: Yangzhou goslings, China). However, already at 5 birds per m^2, 14.5% of the geese showed some degree of walking impairment, whereas very few of the geese showed walking impairment at 2, 3 and 4 geese per m^2. Regarding the underlying causes of impaired locomotion, little is known in relation to stocking density. Foot-pad dermatitis has been reported not to be affected by stocking density (5, 6, 7, 8 and 9 ducks/m^2; Xie et al., 2014), which has also been demonstrated in broilers (Dawkins et al., 2004).

Poor litter quality is a hazard for impaired locomotion due to the association between litter quality and prevalence of contact dermatitis, i.e. foot-pad dermatitis and hock burns (see Section 3.5.6, Soft tissue lesions and integument damage). In Domestic ducks, Jones and Dawkins (2010a) showed that walking ability decreased, and foot-pad dermatitis increased with increasing litter moisture and ammonia concentrations. Although research on the topic within ducks, geese and quail is scarce, it has been stressed repeatedly that maintaining good litter quality is essential for avoiding contact dermatitis (Raud and Faure, 1994; Chen et al., 2021).

Genetic selection for rapid growth in broiler chickens has been linked to walking impairment in terms of worse gait scores in fast-growing hybrids compared to slower growing hybrids (Dixon, 2020); Rayner et al., 2020). No such direct comparison of growth rate and walking ability has been made in ducks, geese or quail, despite the growth rate of the Domestic duck being the fastest among all poultry species. Instead, studies have focused on skeletal development as a measure of locomotory disorder. Reducing the growth of Domestic ducks by restricting the feed during early age (5–14 days of age) to 85% of what is voluntarily ingested when having ad libitum access has been shown to result in less variability of metatarsal adduction at days 10 and 35 of age (Bentley et al., 2020). Metatarsal adduction is associated with the degree of inward pointing of the feet, with severe cases causing the ducks to walk on their own feet (Campbell et al., 2014; van Blois et al., 2019). Therefore, less variability in metatarsal adduction is suggested to indicate less gait abnormalities. Robison et al. (2015) found that tibia and femur ash content decreased as the gait scores worsened, and linked this to rapid growth rate, as this has previously been suggested to be the main contributor to inadequate bone quality in meat poultry (Williams et al., 2004). However, it is important to bear in mind that this hazard, unlike the others, is not a result of a specific husbandry system.

3.5.8. Inability to perform exploratory or foraging behaviour

3.5.8.1. Description

This welfare consequence is characterised by stress and/or negative affective states such as frustration and/or boredom resulting from the thwarting of the motivation to investigate the environment or to seek for food (i.e. extrinsically and intrinsically motivated exploration).

Foraging behaviour comprises an appetitive phase of searching for food sources, handling time required to catch, extract and process food into a form that can be swallowed, and the consummatory phase with the ingestion of the prepared food (Estévez et al., 2017). However, in commercial poultry, the accessibility of abundant, nutritious, well-balanced feed has reduced the foraging sequence to the consummatory phase. Despite this, Japanese quail in commercial facilities can be seen foraging in the litter even if no edible items are available and in the nearby presence of feeders (Schmid and

efsa JOURNAL

Wechsler, 1997), suggesting that foraging can be considered a behavioural need, also in the presence of adequate nutrition.

Exploration is closely linked to the search for food and other resources, such as mating possibilities or areas free of predation. In practice, foraging and exploratory behaviours cannot be distinguished. Animals explore their environment to, e.g. find food or water and avoid predators and environmental hazards, which makes this behaviour essential for survival under natural conditions (Wood-Gush and Vestergaard, 1989). Under rearing condition, domestic fowls will perform exploratory behaviour for a restricted period each day (Newberry, 1999) and may engage playfully with small objects found in the litter (Cloutier et al., 2000). However, exploratory behaviour might increase in case the birds are subjected to novel exploration opportunity.

3.5.8.2. Species-specific issues

When the Domestic duck is kept under commercial conditions with access to bedding material, foraging in the bedding material has been reported to take up 15% of the daily 24 h time budget during the rearing period (Reiter and Bessei, 1995). Under experimental conditions, foraging time is even greater when time spent performing dabbling behaviour in drinking water and in feed troughs is added to the time spent foraging in the bedding material (Riber and Mench, 2008). Bouts of general activity occurs throughout the 24 h of a day in the Domestic duck (Reiter, 1997), so light intensity appears to have less influence on the activity level and distribution between activity and rest.

Reiter et al. (1997) compared the different behaviours of Domestic, Muscovy and Mule ducks reared in the same systems (deep litter, windowless pens up to 5 weeks and with/without outdoor access after that). Time spent sieving in the litter or grass ranged from 11% to 13.2% with the higher values in the Domestic ducks.

Domestic ducks make use of water for foraging, feeding, drinking, exploration, even without prior experience (Donkin, 1989; Heyn et al., 2006; Liste et al., 2012a; Downs et al., 2017), just like their wild ancestors (see Section 3.1.1). West et al. (2022) described a significant difference in foraging behaviour between waterfowl species with Domestic ducks almost exclusively using a ‘deep dabbling’ behaviour when foraging, that involved fully submerging the bill and vigorously churning the water around them, whereas Muscovy ducks shifted to a ‘surface dabbling’ behaviour, skimming the surface of the water and producing very little water movement. Muscovy ducks are performing much less foraging by dabbling compared to grazing (West et al., 2022). As an example, Downs et al. (2017) described that Muscovy ducks were spending only 1.4% of their time foraging by dabbling or probing in soil compared to 25% foraging by grazing or gleaning from the ground.

Geese were shown to spend 55.4% of observations with foraging, preening and resting (14.5%, 26.5% and 14.5%, respectively) in an intensive system, while they did 81.2% of these same behaviours (36.0%, 19.4% and 25.8%, respectively) in an outdoor system (Boz et al., 2021). The time spent in foraging is doubled, illustrating the importance of space and substrate to fulfil foraging motivation. Mancinelli et al. (2022) described a foraging behaviour in geese which corresponds to grazing. Boz et al. (2021) described geese pecking or scratching on the ground. These behaviours were regrouped with consuming feed and water, respectively, at the feeder and drinkers, during the observations and cannot be separated in this study.

In quail, chicks are also precocial. The behaviour of precocial chicks consists of foraging bouts during which they may cool, alternated with brooding bouts during which they are rewarmed by a parent (Krijgsveld et al., 2003). During the rearing phase and when adult, quail are foraging in dry and friable litter. Schmid and Wechsler (1997), in a time budget analysis in a semi-natural aviary with natural soil and coverage, showed that the quail spent 35% of the observation time on passive behaviour, 24% on locomotory behaviour and 8% on exploratory/foraging behaviour.

3.5.8.3. Animal-based measures

Several ABMs can be used to assess inability to perform exploration and foraging behaviour e.g. dabbling, sieving and rooting on a substrate (all waterfowl), up-ending (all ducks) and ‘walking scratching and pecking’ in quail and waterfowl, including grazing (Muscovy ducks and Domestic geese) (see Table 24).

Table 24: ABMs for assessing 'inability to perform exploratory or foraging behaviour', definition, interpretation and sources of evidence (scientific literature or expert opinion) for each species

ABM	Definition and Interpretation	Sources of evidence for each species
Walking, scratching and pecking	The birds move slowly forward, exposes particles in the ground by rapid forward and backward movements of one or two legs consecutively and makes contact with them with the beak. This action is often repeated several times in a row. The pecking can also be expressed alone, directed towards the available materials. It considers also plucking and biting off vegetation using the beak (grazing). Scratching not present in waterfowl. Grazing present in Domestic geese and, to a lesser degree, in Domestic, Muscovy and Mule ducks. Interpretation: Inability to explore and forage is indicated by reduction in the number of birds and time spent walking, scratching and pecking.	– Domestic ducks: Pingel (2000), West et al. (2022) – Muscovy ducks: Downs et al. (2017), West et al. (2022) – Mule ducks: Pingel (1999) – Domestic geese: Boz et al. (2021), Cartoni Mancinelli et al., 2022 – Japanese quail: Krijgsveld et al. (2003)
Injurious pecking	Injurious pecking refers to damaging bird-to-bird pecking whereby pecks to or pulling the feathers or tissue of another bird cause plumage damage, skin wounds or damage to other tissues. Interpretation: The injurious pecking increases with inability to perform exploratory and foraging behaviour, as a redirected behaviour	– Domestic ducks: Leipoldt (1992), Colton and Fraley (2014), Dong et al. (2021) – Muscovy ducks: Knierim et al. (2005) – Mule ducks: Mahmoud et al. (2021) – Domestic geese: Gillette (1977), Yin et al. (2017a), Boz et al. (2021) – Japanese quail: Wechsler and Schmid (1998), Miller and Mench (2006)
Plumage damage	Deterioration or loss of plumage; it includes damaged feathers or feather loss. Interpretation: The welfare consequence 'inability to perform exploratory or foraging behaviour' is indicated if plumage damage is present.	– Domestic ducks: Jones and Dawkins (2010a) – Muscovy ducks: Knierim et al. (2005), Farghly et al. (2017) – Mule ducks: Mahmoud et al. (2021) – Domestic geese: Yin et al. (2017a), Wang et al. (2019), Tremolada et al. (2020), Liao et al. (2022) – Japanese quail: Mohammed et al. (2017)
Dabbling	Rapid beak-dipping movements either at water surface or deeper (including head immersions). Not in quail Interpretation: The less dabbling, the more severe the welfare consequence.	– Domestic ducks: Liste et al. (2012a), Babington and Campbell (2022), West et al. (2022) – Muscovy ducks: Riber and Mench (2008), West et al. (2022) – Mule ducks and Domestic geese: expert opinion
Sieving in water and on a substrate	The mandibulate bill is immersed in water and moved back and forth in the water. Sieving can also be seen in litter and vegetation; in this case, it can be also named rooting or foraging. Not in quail. Interpretation: The less sieving, the more severe the welfare consequence.	– Domestic ducks: Clayton (1976)), Reiter et al. (1997), Babington and Campbell (2022) – Muscovy and Mule ducks: Reiter et al. (1997) – Domestic geese: expert opinion
Up-ending	The head, breast and nape are immersed while the remainder of the body is above water and oriented vertically.	– Domestic, Muscovy and Mule ducks: expert opinion based on Collier and Wakelin (1996)

ABM	Definition and Interpretation	Sources of evidence for each species
	Not in geese, not in quail. Interpretation: The less up-ending, the more severe the welfare consequence.	

3.5.8.4. Hazards and relationship with husbandry systems

This welfare consequence is considered relevant, principally in cages where there is **insufficient space allowance per bird** and **insufficient provision of enrichment** to fulfil behavioural needs of the species under assessment (e.g. lack of water for ducks/geese and lack of dry and friable substrate for all species), preventing the birds from being able to explore and forage (see Section 1.1.3). The welfare consequence can also be seen in indoor systems with no outdoor access because litter is absent (slatted floor) or because litter is humid and caked.

Insufficient space allowance per bird: Under high stocking density, the birds might have difficulties walking around, exploring and performing foraging, even in the presence of adequate substrate. High stocking densities can be encountered in cages but also in indoor floor systems, when no outdoor access is allowed. Depending on space allowance and enrichment, the behaviour might not be completely restricted, some walking, object pecking and water exploration may still be possible.

Insufficient total floor space: As in the laying hens (see EFSA AHAW Panel, 2023a) also the species of this opinion require a minimum total floor space to perform the active behaviours that include all actions that birds perform in their normal daily routines for body maintenance, thermoregulation, social contact, exploration of feeding sources or in the search for mates. The spatial area where these daily activities take place is defined as the home range, and includes short- and long-distance movements and sporadic movements (e.g. exploring the edges of the home range). When the total space available is too low, this might prevent the birds from being able to fulfil their exploratory and foraging behaviour (see Section 3.6.1.2).

Poor litter quality or lack of litter: Appropriate litter (dry and friable) is important for Domestic ducks for thermoregulation, to perform foraging and rooting (Reiter et al., 1997; Rodenburg et al., 2005; Nicol et al., 2017). When the litter is lacking/insufficient, humid or caked litter can prevent birds from performing foraging behaviour (Mohammed et al., 2017). For more details, see Sections 3.6.3 and 3.6.5.

A **perforated floor** that does not allow the provision of litter will also impede birds exploring and foraging. Other foraging opportunities may be given to birds housed on slatted flooring; however, Makagon and Riber (2022) reported that for ducks, it is still unclear what type of substrate should be given, of which quality and how it should be provided (for further details, see also Section 3.6.5.3). The optimal proportion of perforated versus solid floor in a barn, that would allow both drainage of moist and exploring and foraging behaviour in substrate (i.e. rooting) is also unknown (for further details, see also Section 3.6.3).

Laying quail and breeders are kept in cages where no litter is available; therefore, they are not able to forage by performing the sequence of walking, scratching and pecking. The only opportunity for quail in collective cages to perform foraging is by using spilt feed particles on the wire floor, which will rapidly fall through the mesh and so not provide sustained foraging opportunity. Nordi et al. (2012) compared battery cages vs. enriched aviaries and showed that quail exhibited a richer behavioural repertoire in the aviary, including an increase in highly motivated activities such as pecking. The author did not measure foraging and exploratory ABMs per se, but pecking is part of these, showing more exploration and foraging activity in the presence of litter.

Lack or impaired access to open water: Cooper et al. (2002) found that ducks performed more dabbling and head dipping at bell drinkers and troughs, while nipple drinkers were used just for drinking and some wet-preening. Liste et al. (2012a) showed that ducks spent more time in a shallow pool (10 cm), which they used primarily for dabbling, than in a deep pool (30 cm), where they swam. Reiter et al. (1997) studied Domestic, Muscovy and Mule ducks in deep litter pens and outdoor range, with and without open water access. Sieving was promoted in pens with open water provision (from 8.8% to 10.3%) but even more promoted by outdoor access irrespective of open water provision (16.4% and 14.1% without and with outdoor access, respectively). Jones et al. (2009) reported that showers were used for dabbling and pools were preferred for bathing. Makagon and Riber (2022) concluded that more research is needed to determine whether the different watering system options and designs stimulate exploratory and foraging behaviour of ducks, or whether different waterer types may satisfy different motivations.

Insufficient provision of enrichment (excluding water and litter in waterfowl and litter only in Japanese quail): Domestic geese, which are adapted to consume and digest fibre-rich food, can consume up to 1.2 kg of grass per day from 13 to 18 weeks (Leprettre et al., 2000). The foraging and exploration behaviours can be redirected and expressed as feather pecking or cannibalism towards other birds in the absence of foraging material (Blokhuis, 1986; Dixon, 2008). These findings can likely be extrapolated to Japanese quail. For further info on the provision of enrichment, see Section 3.6.5.

3.5.9. Inability to express prelaying and nesting (maternal) behaviours

3.5.9.1. Description

The animal experiences stress and/or negative affective states such as frustration resulting from the thwarting of the motivation to lay eggs in a nest.

Prelaying and nesting behaviours are considered among the highest motivated behaviours in laying hens and they are both regarded as behavioural needs (Weeks and Nicol, 2006). Prelaying behaviour consists in pacing, while searching for a suitable nest site, and sitting in the chosen site. Prelaying behaviour is followed by laying of an egg (oviposition) after which laying hens will stay in the nest for resting for a while (Cooper and Appleby, 1996, 2003; EFSA AHAW Panel, 2023a). Although scientific evidence is scarce, these behaviours could be extended also to breeders of waterfowl; in the case of Domestic ducks, if prelaying/nest access somehow is hindered, the ducks exhibit frustration resulting in floor laying, increased aggression and stress-induced hypothermia, showing that they are highly motivated to lay in a nest (Makagon et al., 2011; Barrett et al., 2019, 2021). Orcutt Jr and Orcutt (1976) reported prelaying activities also in quail.

3.5.9.2. Species-specific issues

Prelaying and nesting behaviours are applicable to mature breeders and layer quail; however, they have not been extensively investigated in ducks, geese or quail.

Most Domestic and Muscovy duck and Domestic geese breeders will use individual or collective nest boxes when provided and, for this reason, most if not all waterfowl commercial egg production operations are equipped with nests nowadays (see Tables 8, 11 and 15). However, Arboleda and Kharel (1985) found that Muscovy ducks laid eggs more frequently on the ground than in two different nest types, although they concluded that the provision of nests reduces the number of floor eggs. Also for Domestic ducks, very high rates of floor eggs have been reported (Barrett et al., 2019). These authors suggested that competition for the nest might be one of the causes, without excluding a role of nest design, possibly in interaction with specific individual motivation. In fact, according to Barrett et al. (2021), Domestic ducks (50% of the tested ones) would be inclined to work, illustrating a motivation, by pushing a door to gain access to nesting facilities in an operant conditioning test.

Muscovy ducks show a clear preference for sheltered nests compared to open nests (Arboleda and Kharel, 1985; Bilsing et al., 1991).

During nest building, Domestic geese bend low while moving slowly, and pick up material in the periphery of their reach that they toss or drop near their body (Gillette, 1977).

Domestic strains of Japanese quail do not build a nest *per se* as a prelaying behaviour (Orcutt Jr and Orcutt, 1976), but when nests are provided, they use these for up to 70–80% of eggs (see Section 3.6.4). Schmid and Wechsler (1997) reported that Japanese quail in a semi-natural environment showed a preference for laying the eggs in cover. Orcutt Jr and Orcutt (1976) reported that the female generally chose a secluded site in a grass clump or tussock, or at least with dried grass plucked by the female within her reach as she sat on the nest site.

Moreover, regular egg collection should prevent nest building activity as such, as it is well known that removal of eggs will prevent incubation behaviour expression in birds (Bédécarrats et al., 1997; (Guémené et al., 2001). On the other hand, commercial initiatives have shown that quail raised in aviaries do, to a certain extent, lay in nesting facilities if appropriate nests are available (Aida Xercavins, IRTA, personal communication, 2023).

3.5.9.3. Animal-based measure(s)

It is known that the presence of eggs on the floor, can result from a mismatch between the nest requirements and what is offered to the layers. Therefore, the main ABM to assess the capability to express maternal behaviour in relation to prelaying and nesting behaviours, is 'eggs laid outside the nest' (see Table 25). Indeed, when the nests are not accessible, or not fulfilling the birds' expectation, a higher proportion of eggs will be laid outside the nest.

Table 25: ABMs for assessing 'inability to perform prelaying and nesting behaviour', definition, interpretation and sources of evidence (scientific literature or expert opinion) for each species

ABM	Definition and interpretation	Sources of evidence for each species
Eggs outside the nest	Number of eggs laid outside the nest out of the total number of eggs produced. Interpretation: Inability to perform nesting behaviour is indicated by increased percentage of eggs laid on the floor.	– Domestic ducks: Makagon and Mench (2011), Makagon et al. (2011), Barrett et al. (2019) – Muscovy ducks: Arboleda and Kharel (1985) – Domestic geese: Merritt (1962), Merritt and Lemay (1963) – Japanese quail: Schmid and Wechsler (1997)

3.5.9.4. Main hazard(s) and relationship with husbandry systems

In Domestic ducks, the motivation to lay eggs in an enclosed nest site (Barrett et al., 2021), that provides a high level of concealment (Makagon et al., 2011) is very high and similar to the nesting behaviour observed in Mallards. They prefer to nest in boxes, rather than laying the eggs on the floor, even if they had previously established floor laying behaviour due to lack of nest boxes (Barrett et al., 2019). According to Barrett et al. (2019, 2021) the absence of a suitable nest site may lead to psychological stress and poor welfare.

Barrett et al. (2019) identified a small percentage (5%) of Domestic ducks as persistent floor-laying birds (> 70% of floor eggs), suggesting that some ducks are less motivated to use nest boxes. However, the reason for the different motivation to use nest boxes in this species is still unclear.

From field experience in European farms, nests size and design, seem to fulfil the need of breeder ducks, geese and breeder and laying quail as they lay in the nest when all nests are equally accessible.

The vast majority of layer quail (for both table eggs and breeding purpose) are raised in cage systems without access to nesting facilities, while most (if not all) Domestic and Muscovy duck layers, as well as Domestic geese layers, benefit from nest access (see Section 3.4 on husbandry systems).

The hazard **inadequate provision of nesting facilities** includes inappropriate number/presence of nests, number of birds per nest (sometimes expressed by ratio nest/birds), position, design (material) and size of the nest.

When no nest is provided, this will prevent birds from fulfilling their prelaying and nesting behaviours.

When the number of ducks is too high for one nest, this might increase competition (see Section 3.6.4) and some birds will be prevented from accessing the nests. This maybe be also valid for geese and quail, but no research is available (recommendations for Domestic geese exist, see ToR-3).

Waterfowl and quail lay in an individual nest and do not need space for more than one bird to fit in the nest. Therefore, a nest that does not have a surface allowing one bird to enter and sit comfortably to realise the prelaying behaviour is not suitable. Having nests which are too small (in surface and/or height) is a hazard for this welfare consequence.

A nest that is not at ground level is a hazard that will compromise nest accessibility for Domestic ducks, Domestic geese and Japanese quail, since they prefer a ground level nest (see Section 3.6.4). The preference for Muscovy ducks is unclear; Muscovy duck ancestors were laying in an elevated location, but limited scientific evidence is available (Bilsing et al., 1991, see Section 3.1.2) on the currently used genotypes.

Lack of manipulable litter in sufficient quantity is a hazard that reduce attractivity of the nest.

3.5.10. Welfare consequences in relation to husbandry systems

In the following sections, the relation between welfare consequences and husbandry systems (described in ToR-1) has been assessed using the results of the exercise on the prevalence of the hazards in each husbandry system (see Section 2.2.3.2).

3.5.10.1. Outcome tables

In the following outcome tables (Tables 26–29), an overview of the link between the welfare consequences, husbandry systems and hazards in the four species is presented.

In the outcome tables, the hazards that were scored as highly prevalent (estimated to be present in > 66% of farms with a given husbandry system) are highlighted in red; hazards scored as moderately prevalent (estimated to be present in 33–66% of farms with a given husbandry system) are identified in orange, and hazards that were scored as low prevalence (hazards estimated to be in a given husbandry system in < 33% of farms) are highlighted in green.

efsa JOURNAL

Table 26: Overview of the hazards affecting the welfare consequences in the diverse husbandry systems used for keeping Domestic ducks. The values reported are the median of the scores estimated by eight experts on the proportion of farms with a given husbandry system for Domestic ducks (as described in ToR-1), in which a hazard is present (for detailed information, see Section 2.2.3.2). Red colour = highly prevalent hazard (2.5–3); orange = moderately prevalent hazard (1.5–2); green = low prevalence hazard (0–1). White cells = hazards not applicable in a specific husbandry system or production purpose

Domestic ducks	Breeders		Meat			
Hazards	**Individual cages**	**Indoor floor systems**	**Indoor floor systems**	**Indoor floor systems with outdoor access**	**Outdoor systems**	**Welfare consequences**
Inadequate provision of nesting facilities[(a)]	3.0	2.0				• group stress • inability to perform prelaying and nesting (maternal) behaviours
Inappropriate group sex composition	1.0	2.0	1.0	1.0	1.0	• group stress • bone lesions (including fractures and dislocations) • soft tissue lesions and integument damage
Inappropriate group size	3.0	1.0	1.0	1.0	1.0	• group stress[(b)]
Inappropriate pen design	3.0	1.5	1.5	1.0	1.0	• group stress • bone lesions (including fractures and dislocations) • soft tissue lesions and integument damage
Insufficient feeder space	1.0	2.0	2.0	1.5	1.0	• group stress
Insufficient height	3.0	1.0	1.0	1.0	1.0	• restriction of movement • inability to perform comfort behaviour • soft tissue lesions and integument damage
Insufficient provision of enrichment (excluding water and litter)	3.0	2.5	2.5	1.0	1.0	• group stress • soft tissue lesions and integument damage • inability to perform exploratory or foraging behaviour
Insufficient space allowance per bird	2.5	3.0	3.0	1.5	1.0	• restriction of movement • group stress • bone lesions (including fractures and dislocations) • soft tissue lesions and integument damage • locomotory disorders (including lameness) • inability to perform exploratory or foraging behaviour

Domestic ducks	Breeders		Meat			
Hazards	**Individual cages**	**Indoor floor systems**	**Indoor floor systems**	**Indoor floor systems with outdoor access**	**Outdoor systems**	**Welfare consequences**
Insufficient drinker space	1.0	2.0	2.5	2.0	1.5	• group stress
Insufficient total floor space	3.0	2.0	2.0	1.0	1.0	• restriction of movement • group stress • inability to perform comfort behaviour • soft tissue lesions and integument damage • inability to perform exploratory or foraging behaviour
Lack or impaired access to open water	3.0	3.0	3.0	2.0	2.0	• group stress • restriction of movement • inability to perform comfort behaviour • inability to perform exploratory or foraging behaviour
Mixing unfamiliar birds	1.0	1.0	1.0	1.0	1.0	• group stress • bone lesions (including fractures and dislocations) • soft tissue lesions and integument damage
Perforated floor	3.0	2.0	1.5	1.0	1.0	• group stress • soft tissue lesions and integument damage • inability to perform exploratory or foraging behaviour
Poor litter quality or lack of litter	3.0	2.0	2.0	2.0	1.0	• group stress • inability to perform comfort behaviour • soft tissue lesions and integument damage • locomotory disorders (including lameness) • inability to perform exploratory or foraging behaviour

(a): The hazard 'Inadequate provision of nesting facilities' is applicable for mature breeders only.
(b): Group stress in the context of individual cages is considered as the lack of physical contact with conspecifics and agonistic interaction between adjacent birds.

Table 27: Overview of the hazards affecting the welfare consequences in the diverse husbandry systems used for keeping Muscovy ducks and Mule ducks. The values reported are the median of the scores estimated by eight experts on the proportion of farms with a given husbandry system for Muscovy ducks and Mule ducks (as described in ToR-1), in which a hazard is present (for detailed information, see Section 2.2.3.2). Red colour = highly prevalent hazard (2.5–3); orange = moderately prevalent hazard (1.5–2); green = low prevalence hazard (0–1). White cells = hazards not applicable in a specific husbandry system or production purpose

Muscovy and Mule ducks	Breeders (Muscovy ducks only)		Meat and Foie gras (starting and growing phases)			Foie gras (overfeeding phase)			Welfare consequences
Hazards	**Individual cages**	**Indoor floor systems**	**Indoor floor systems**	**Indoor floor systems with outdoor access**	**Outdoor systems**	**Elevated collective cages indoor**	**Elevated pen systems indoor**	**Floor pen systems indoor**	
Inadequate provision of nesting facilities[(a)]	2.5	2.0							• group stress • inability to perform prelaying and nesting (maternal) behaviours
Inappropriate group sex composition	1.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	• group stress • bone lesions (including fractures and dislocations) • soft tissue lesions and integument damage
Inappropriate group size	3.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	• group stress[(b)]
Inappropriate pen design	3.0	1.5	1.5	1.5	1.0	2.5	2.5	2.0	• group stress • bone lesions (including fractures and dislocations) • soft tissue lesions and integument damage
Insufficient feeder space	1.0	2.0	2.0	2.0	2.0	1.0	1.0	1.0	• group stress
Insufficient height	3.0	1.0	1.0	1.0	1.0	3.0	2.0	1.0	• restriction of movement • inability to perform comfort behaviour • soft tissue lesions and integument damage

Muscovy and Mule ducks	Breeders (Muscovy ducks only)		Meat and Foie gras (starting and growing phases)			Foie gras (overfeeding phase)			
Hazards	**Individual cages**	**Indoor floor systems**	**Indoor floor systems**	**Indoor floor systems with outdoor access**	**Outdoor systems**	**Elevated collective cages indoor**	**Elevated pen systems indoor**	**Floor pen systems indoor**	**Welfare consequences**
Insufficient provision of enrichment (excluding water and litter)	3.0	2.0	2.5	1.0	1.0	3.0	3.0	3.0	• group stress • soft tissue lesions and integument damage • inability to perform exploratory or foraging behaviour
Insufficient space allowance per bird	3.0	2.0	2.0	1.0	1.0	3.0	3.0	3.0	• restriction of movement • group stress • bone lesions (including fractures and dislocations) • soft tissue lesions and integument damage • locomotory disorders (including lameness) • inability to perform exploratory or foraging behaviour
Insufficient drinker space	1.0	2.0	2.0	1.5	1.0	2.5	2.0	2.0	• group stress
Insufficient total floor space	3.0	2.0	2.0	1.0	1.0	3.0	3.0[c]	3.0[c]	• restriction of movement • group stress • inability to perform comfort behaviour • soft tissue lesions and integument damage • inability to perform exploratory or foraging behaviour
Lack of elevated structures (for Muscovy ducks)[d]	3.0	3.0	3.0	3.0	3.0				• restriction of movement

Muscovy and Mule ducks	Breeders (Muscovy ducks only)		Meat and Foie gras (starting and growing phases)			Foie gras (overfeeding phase)			
Hazards	Individual cages	Indoor floor systems	Indoor floor systems	Indoor floor systems with outdoor access	Outdoor systems	Elevated collective cages indoor	Elevated pen systems indoor	Floor pen systems indoor	Welfare consequences
Lack or impaired access to open water	3.0	3.0	3.0	2.0	2.0	3.0	3.0	3.0	• group stress • restriction of movement • inability to perform comfort behaviour • inability to perform exploratory or foraging behaviour
Mixing unfamiliar birds	1.0	1.0	1.0	1.0	1.0	1.5	1.5	1.5	• group stress • bone lesions (including fractures and dislocations) • soft tissue lesions and integument damage
Perforated floor	3.0	2.0	1.5	1.0	1.0	3.0	3.0	3.0	• group stress • soft tissue lesions and integument damage • inability to perform exploratory or foraging behaviour
Poor litter quality or lack of litter	3.0	2.0	2.0	2.0	1.0	3.0	3.0	3.0	• group stress • inability to perform comfort behaviour • soft tissue lesions and integument damage • locomotory disorders (including lameness) • inability to perform exploratory or foraging behaviour

(a): The hazard 'Inadequate provision of nesting facilities' is applicable for mature breeders only.
(b): Group stress in the context of individual cages is considered as the lack of physical contact with conspecifics and agonistic interaction between adjacent birds.
(c): In both elevated and floor collective pen systems indoors, birds can perform wing flapping; however, score 3 was given to the hazard 'Insufficient total floor space' in all three husbandry systems as result of the overall assessment of the five welfare consequences affected by this hazard.
(d): Lack of elevated structures is a hazard specific for Muscovy ducks only (i.e. not scored for foie gras which predominantly uses Mule ducks).

Table 28: Overview of the hazards affecting the welfare consequences in the diverse husbandry systems used for keeping Domestic geese. The values reported are the median of the scores estimated by eight experts on the proportion of farms with a given husbandry system for Domestic geese (as described in ToR-1), in which a hazard is present (for detailed information, see Section 2.2.3.2). Red colour = highly prevalent hazard (2.5–3); orange = moderately prevalent hazard (1.5–2); green = low prevalence hazard (0–1). White cells = hazards not applicable in a specific husbandry system or production purpose

Domestic geese	**Breeders**		**Meat and Foie gras (starting and growing phases)**			**Foie gras (overfeeding phase)**		
Hazards	**Indoor floor systems**	**Indoor floor systems with outdoor access**	**Indoor floor systems**	**Indoor floor systems with outdoor access**	**Outdoor systems**	**Elevated pen systems indoor**	**Floor pen systems indoor**	**Welfare consequences**
Inadequate provision of nesting facilities[(a)]	2.0	2.0						• group stress • inability to perform prelaying and nesting (maternal) behaviours
Inappropriate group sex composition	2.0	2.0	1.0	1.0	1.0	1.0	1.0	• group stress • bone lesions (including fractures and dislocations) • soft tissue lesions and integument damage
Inappropriate group size	1.0	1.0	1.5	1.0	1.0	1.5	1.5	• group stress
Inappropriate pen design	1.0	1.0	1.0	1.0	1.0	2.0	2.0	• group stress • bone lesions (including fractures and dislocations) • soft tissue lesions and integument damage
Insufficient feeder space	2.0	2.0	1.0	1.0	1.0	1.0	1.0	• group stress
Insufficient height	1.0	1.0	1.0	1.0	1.0	2.0	2.0	• restriction of movement • inability to perform comfort behaviour • soft tissue lesions and integument damage
Insufficient provision of enrichment (excluding water and litter)	3.0	2.0	3.0	1.0	1.0	3.0	3.0	• group stress • soft tissue lesions and integument damage • inability to perform exploratory or foraging behaviour

Domestic geese	Breeders		Meat and Foie gras (starting and growing phases)			Foie gras (overfeeding phase)		
Hazards	Indoor floor systems	Indoor floor systems with outdoor access	Indoor floor systems	Indoor floor systems with outdoor access	Outdoor systems	Elevated pen systems indoor	Floor pen systems indoor	Welfare consequences
Insufficient space allowance per bird	3.0	1.0	3.0	1.0	1.0	3.0	3.0	• restriction of movement • group stress • bone lesions (including fractures and dislocations) • soft tissue lesions and integument damage • locomotory disorders (including lameness) • inability to perform exploratory or foraging behaviour
Insufficient drinker space	2.0	2.0	2.0	2.0	2.0	3.0	3.0	• group stress
Insufficient total floor space	2.0	1.0	2.0	1.0	1.0	3.0	3.0	• restriction of movement • group stress • inability to perform comfort behaviour • soft tissue lesions and integument damage • inability to perform exploratory or foraging behaviour
Lack or impaired access to open water	3.0	2.0	3.0	2.0	2.0	3.0	3.0	• group stress • restriction of movement • inability to perform comfort behaviour • inability to perform exploratory or foraging behaviour
Mixing unfamiliar birds	1.0	1.0	1.0	1.0	1.0	1.0	1.0	• group stress • bone lesions (including fractures and dislocations) • soft tissue lesions and integument damage
Perforated floor	2.0	2.0	2.0	1.0	1.0	3.0	3.0	• group stress • soft tissue lesions and integument damage • inability to perform exploratory or foraging behaviour

Domestic geese	Breeders		Meat and Foie gras (starting and growing phases)			Foie gras (overfeeding phase)		
Hazards	Indoor floor systems	Indoor floor systems with outdoor access	Indoor floor systems	Indoor floor systems with outdoor access	Outdoor systems	Elevated pen systems indoor	Floor pen systems indoor	Welfare consequences
Poor litter quality or lack of litter	2.0	2.0	2.0	2.0	1.0	3.0	3.0	• group stress • inability to perform comfort behaviour • soft tissue lesions and integument damage • locomotory disorders (including lameness) • inability to perform exploratory or foraging behaviour

(a): The hazard 'Inadequate provision of nesting facilities' is applicable for mature breeders only.

Table 29: Overview of the hazards affecting the welfare consequences in the diverse husbandry systems used for keeping Japanese quail. The values reported are the median of the scores estimated by eight experts on the proportion of farms with a given husbandry system for Japanese quail (as described in ToR-1), in which a hazard is present (for detailed information, see Section 2.2.3.2). Red colour = highly prevalent hazard (2.5–3); orange = moderately prevalent hazard (1.5–2); green = low prevalence hazard (0–1). White cells = hazards not applicable in a specific husbandry system or production purpose

Japanese quail	Breeders			Meat	Eggs		
Hazards	Couple cages	Collective cages	Indoor floor systems[(a)]	Indoor floor systems	Collective cages	Indoor floor systems	Welfare consequence
Inadequate provision of nesting facilities[(b)]	3.0	3.0			3.0	2.0	• group stress • inability to perform prelaying and nesting (maternal) behaviours
Inappropriate group sex composition	2.0	3.0	3.0	1.0	1.0	1.0	• group stress • bone lesions (including fractures and dislocations) • soft tissue lesions and integument damage
Inappropriate group size	2.5	1.5	2.0	2.0	1.5	2.0	• group stress
Inappropriate pen design	3.0	3.0	1.0	1.0	3.0	1.0	• group stress • bone lesions (including fractures and dislocations) • soft tissue lesions and integument damage

efsa JOURNAL

Japanese quail	Breeders			Meat	Eggs		
Hazards	Couple cages	Collective cages	Indoor floor systems[a]	Indoor floor systems	Collective cages	Indoor floor systems	Welfare consequence
Insufficient feeder space	1.0	1.0	2.0	1.0	1.0	2.0	• group stress
Insufficient height	3.0	3.0	1.0	1.0	3.0	1.0	• restriction of movement • inability to perform comfort behaviour • soft tissue lesions and integument damage
Insufficient provision of enrichment (excluding litter)	3.0	3.0	2.0	2.0	3.0	2.0	• group stress • inability to perform comfort behaviour • soft tissue lesions and integument damage • inability to perform exploratory or foraging behaviour
Insufficient space allowance per bird	3.0	3.0	3.0	3.0	3.0	2.0	• restriction of movement • group stress • bone lesions (including fractures and dislocations) • soft tissue lesions and integument damage • locomotory disorders • inability to perform exploratory or foraging behaviour
Insufficient drinker space	1.0	1.0	1.0	1.0	1.0	1.0	• group stress
Insufficient total floor space	3.0	3.0	1.0	1.0	3.0	1.0	• restriction of movement • group stress • inability to perform comfort behaviour • soft tissue lesions and integument damage • inability to perform exploratory or foraging behaviour
Mixing unfamiliar birds	3.0	2.0	1.0	1.0	1.0	1.0	• group stress • bone lesions (including fractures and dislocations) • soft tissue lesions and integument damage
Perforated floor	3.0	3.0	1.0	1.0	3.0	1.0	• group stress • soft tissue lesions and integument damage, inability to perform exploratory or foraging behaviour

Japanese quail	Breeders			Meat	Eggs		
Hazards	**Couple cages**	**Collective cages**	**Indoor floor systems[(a)]**	**Indoor floor systems**	**Collective cages**	**Indoor floor systems**	**Welfare consequence**
Poor litter quality or lack of litter	3.0	3.0	2.0	2.0	3.0	2.0	• group stress • inability to perform comfort behaviour • soft tissue lesions and integument damage • locomotory disorders (including lameness) • inability to perform exploratory or foraging behaviour

(a): Indoor floor systems are used for immature breeders only.
(b): Inadequate provision of nesting facilities' is applicable for mature breeders and layer quail only.

3.5.10.2. Relevance of the welfare consequences in each husbandry systems

The relevance of the welfare consequences (i.e. risk that a welfare consequence occurs) was assessed on the basis of the associated highly prevalent hazards in each husbandry system and is visualised in the following tables (Tables 30–33). It needs to be noted that the welfare consequence 'Bone lesions (including fractures and dislocations)' has not been evaluated due to the low prevalence of this welfare consequence in all systems.

The Conclusions listed in Section 3.7 to answer to ToR-2 were derived from the results visualised in Tables 30–33.

Table 30: Domestic ducks: proportion of hazards scored as highly prevalent in the different husbandry systems out of the total number of hazards leading to a given welfare consequence. In brackets are reported the number of highly prevalent hazards out of the total number of hazards identified (na = not applicable)

Domestic ducks	Breeders		Meat		
Welfare consequences[(a)]	**Individual cages**	**Indoor floor systems**	**Indoor floor systems**	**Indoor floor systems with outdoor access**	**Outdoor systems**
Restriction of movement	100% (4/4)	50% (2/4)	50% (2/4)	0% (0/4)	0% (0/4)
Group stress	69% (9/13)	23% (3/13)	33% (4/12)	0% (0/12)	0% (0/12)
Inability to perform comfort behaviour	100% (4/4)	25% (1/4)	25% (1/4)	0% (0/4)	0% (0/4)
Soft tissue lesions and integument damage	67% (6/9)	22% (2/9)	22% (2/9)	0% (0/9)	0% (0/9)
Locomotory disorders (including lameness)	100% (2/2)	50% (1/2)	50% (1/2)	0% (0/2)	0% (0/2)
Inability to perform exploratory or foraging behaviour	86% (6/7)	43% (3/7)	43% (3/7)	0% (0/7)	0% (0/7)
Inability to express prelaying and nesting (maternal) behaviours[(b)]	100% (1/1)	0% (0/1)	na	na	na

(a): Bone lesions (including fractures and dislocations) have not been evaluated due to the low prevalence of this welfare consequence in all systems.
(b): Inability to express prelaying and nesting (maternal) behaviours is applicable for mature breeders only.

Table 31: Muscovy and Mule ducks: proportion of hazards scored as highly prevalent in the different husbandry systems out of the total number of hazards leading to a given welfare consequence. In brackets are reported the number of very prevalent hazards out of the total number of hazards identified (na = not applicable)

Muscovy and Mule ducks	Breeders (Muscovy ducks only)		Meat and Foie gras (starting and growing phases)			Foie gras (overfeeding phase)		
Welfare consequences[(a)]	**Individual cages**	**Indoor floor systems**	**Indoor floor systems**	**Indoor floor systems with outdoor access**	**Outdoor systems**	**Elevated collective cage systems indoor**	**Elevated collective pen systems indoor**	**Floor collective pen systems indoor**
Restriction of movement[(b)]	100% (5/5)*	40% (2/5)*	40% (2/5)*	25% (1/5)*	25% (1/5)*	100% (4/4)	75% (3/4)	75% (3/4)
Group stress	69% (9/13)	8% (1/13)	17% (2/12)	0% (0/12)	0% (0/12)	67% (8/12)	58% (7/12)	50% (6/12)
Inability to perform comfort behaviour	100% (4/4)	25% (1/4)	25% (1/4)	0% (0/4)	0% (0/4)	100% (4/4)	75% (3/4)	75% (3/4)

Muscovy and Mule ducks	Breeders (Muscovy ducks only)		Meat and Foie gras (starting and growing phases)			Foie gras (overfeeding phase)		
Welfare consequences[(a)]	**Individual cages**	**Indoor floor systems**	**Indoor floor systems**	**Indoor floor systems with outdoor access**	**Outdoor systems**	**Elevated collective cage systems indoor**	**Elevated collective pen systems indoor**	**Floor collective pen systems indoor**
Soft tissue lesions and integument damage	78% (7/9)	0% (0/9)	11% (1/9)	0% (0/9)	0% (0/9)	78% (7/9)	67% (6/9)	56% (5/9)
Locomotory disorders (including lameness)	100% (2/2)	0% (0/2)	0% (0/2)	0% (0/2)	0% (0/2)	100% (2/2)	100% (2/2)	100% (2/2)
Inability to perform exploratory or foraging behaviour	100% (6/6)	17% (1/6)	33% (2/6)	0% (0/6)	0% (0/6)	100% (6/6)	100% (6/6)	100% (6/6)
Inability to express prelaying and nesting (maternal) behaviours[(c)]	100% (1/1)	0% (0/1)	na	na	na	na	na	na

(a): Bone lesions (including fractures and dislocations) have not been evaluated due to the low prevalence of this welfare consequence in all systems.
(b): Lack of elevated structures is a hazard specific for Muscovy ducks only (i.e. not scored for foie gras which predominantly uses Mule ducks); a star (*) is added when this hazard has been scored as highly relevant.
(c): Inability to express prelaying and nesting (maternal) behaviours is applicable for mature breeders only.

Table 32: Domestic geese: proportion of hazards scored as highly prevalent in the different husbandry systems out of the total number of hazards leading to a given welfare consequence. In brackets are reported the number of highly prevalent hazards out of the total number of hazards identified (na = not applicable)

Domestic geese	Breeders		Meat and Foie gras (starting and growing phases)			Foie gras (overfeeding phase)	
Welfare consequences[(a)]	**Indoor floor systems**	**Indoor floor systems with outdoor access**	**Indoor floor systems**	**Indoor floor systems with outdoor access**	**Outdoor systems**	**Elevated collective pen systems indoor**	**Floor collective pen systems indoor**
Restriction of movement	50% (2/4)	0% (0/4)	50% (2/4)	0% (0/4)	0% (0/4)	75% (3/4)	75% (3/4)
Group stress	23% (3/13)	0% (0/13)	23% (3/12)	0% (0/12)	0% (0/12)	58% (7/12)	58% (7/12)
Inability to perform comfort behaviour	25% (1/4)	0% (0/4)	25% (1/4)	0% (0/4)	0% (0/4)	75% (3/4)	75% (3/4)
Soft tissue lesions and integument damage	22% (2/9)	0% (0/9)	22% (2/9)	0% (0/9)	0% (0/9)	56% (5/9)	56% (5/9)

Domestic geese	Breeders		Meat and Foie gras (starting and growing phases)			Foie gras (overfeeding phase)	
Welfare consequences[(a)]	**Indoor floor systems**	**Indoor floor systems with outdoor access**	**Indoor floor systems**	**Indoor floor systems with outdoor access**	**Outdoor systems**	**Elevated collective pen systems indoor**	**Floor collective pen systems indoor**
Locomotory disorders (including lameness)	50% (1/2)	0% (0/2)	50% (1/2)	0% (0/2)	0% (0/2)	100% (2/2)	100% (2/2)
Inability to perform exploratory or foraging behaviour	50% (3/6)	0% (0/6)	50% (3/6)	0% (0/6)	0% (0/6)	100% (6/6)	100% (6/6)
Inability to express prelaying and nesting (maternal) behaviours	0% (0/1)	0% (0/1)	na	na	na	na	na

(a): Bone lesions have not been evaluated due to the low prevalence of this welfare consequence in all systems.

Table 33: Japanese quail: proportion of hazards scored as highly prevalent in the different husbandry systems out of the total number of hazards leading to a given welfare consequence. In brackets are reported the number of highly prevalent hazards out of the total number of hazards identified (na = not applicable)

Japanese quail	Breeders			Meat	Eggs	
Welfare consequences[(a)]	**Couple cages**	**Collective cages**	**Indoor floor systems[(b)]**	**Indoor floor systems**	**Collective cages**	**Indoor floor systems**
Restriction of movement	100% (3/3)	100% (3/3)	33% (1/3)	33% (1/3)	100% (3/3)	0% (0/3)
Group stress	75% (9/12)	67% (8/12)	18% (2/11)	9% (1/11)	58% (7/12)	0% (0/12)
Inability to perform comfort behaviour	100% (4/4)	100% (4/4)	0% (0/4)	0% (0/4)	100% (4/4)	0% (0/4)
Soft tissue lesions and integument damage	89% (8/9)	89% (8/9)	22% (2/9)	11% (1/9)	78% (7/9)	0% (0/9)
Locomotory disorders (including lameness)	100% (2/2)	100% (2/2)	50% (1/2)	50% (1/2)	100% (2/2)	0% (0/2)
Inability to perform exploratory or foraging behaviour	100% (5/5)	100% (5/5)	20% (1/5)	20% (1/5)	100% (5/5)	0% (0/5)
Inability to express prelaying and nesting (maternal) behaviours[(c)]	100% (1/1)	100% (1/1)	na	na	100% (1/1)	0% (0/)

(a): Bone lesions have not been evaluated due to the low prevalence of this welfare consequence in all systems.
(b): Indoor floor systems are used for immature breeders only.
(c): Inability to express prelaying and nesting (maternal) behaviours is applicable for mature breeders and layers only.

3.6. Welfare assessment of the specific factors (ToR-3)

3.6.1. Space allowance (three-dimensional) per animal

3.6.1.1. Behavioural space model

A semi-quantitative exercise was carried out to determine the space allowance for Domestic, Muscovy and Mule ducks, Domestic geese and Japanese quail (see Section 2.2.3.4 for methodology).

3.6.1.1.1. The space occupied during performance of different behavioural categories

Table 34 shows the estimated area covered by a bird of each species when showing stationary behaviour.

Table 34: Space needed for stationary behaviour

Species[(a)]	Space	90% certainty interval
Domestic ducks	626 cm^2	613–640 cm^2
Muscovy and Mule ducks	873 cm^2	857–888 cm^2
Domestic geese	996 cm^2	771–1135 cm^2
Japanese quail	102 cm^2	86–109 cm^2

(a): The area was estimated based on the following bird weight: Domestic ducks – 3.0 kg, Muscovy and Mule ducks – 4.4 kg, Domestic geese – 6.7 kg and Japanese quail – 0.3 kg.

Table 35 reports the estimate of the inter-individual distance between two birds.

Table 35: Estimated values for inter-individual distance

Species[(a)]	Inter-individual distance (cm)
Domestic ducks	34.00
Muscovy and Mule ducks	26.00
Domestic geese	40.05
Japanese quail	10.91

(a): The value of inter-individual distance was estimated based on the following bird weight: Domestic ducks – –3.0 kg, Muscovy and Mule ducks – 4.4 kg, Domestic geese – 6.7 kg and Japanese quail – 0.3 kg.

Table 36 reports the relative factor to adjust the morphological space of stationary behaviour to other categories of behaviour (see Section 2.2.3.4.4 for methodology).

Table 36: The factor for each behavioural category is given as calculated from the morphological dimensions of the bird performing the behaviour and set in relation to the space needed for stationary behaviours (which is the reference behavioural category)

Behavioural category[(a)]	Domestic duck	Muscovy and Mule duck	Domestic geese	Quail
Stationary	1.0	1.0	1.0	1.0
Dynamic	2.8	2.6	2.8	2.0
Other comfort behaviours	2.4	2.9	4.1	3.0
Wing flapping	3.8	4.9	7.2	5.1
Bathing	7.0	7.6	13.1	5.1

(a): The space required for each behavioural category was estimated based on the following bird weight: Domestic ducks – 3.0 kg, Muscovy and Mule ducks – 4.4 kg, Domestic geese – 6.7 kg and Japanese quail – 0.3 kg.

3.6.1.1.2. Outcomes of the behavioural space model

The behavioural space model for Domestic, Muscovy and Mule ducks, Domestic geese, Japanese quail is based on the area estimated for performance of each behavioural category (Section 3.6.1.1.1) and the median of the proportion of birds performing each of the selected behavioural categories at any random point in time. Calculations for the model are shown in Annex 3. The main outcome of the model is provided in Table 37, with the frequency of behavioural categories shown per species and the resulting total area for a median bird. The number of birds per m^2, as well as the calculated kg of birds per m^2 based on the assumption of the mean weight of an individual bird (see Table 37), are also shown.

Table 37: Data for the median of standardised % of birds performing each of the five selected behavioural categories at any given point in time for ducks, geese and quail. From this, the area required per bird, as well as the number of birds and the corresponding information on kg/m^2 are calculated.

Behavioural category[(a)]	Domestic ducks	Muscovy and Mule duck	Domestic geese	Japanese quail
Stationary	69.9%	66.0%	53.9%	45.7%
Dynamic	14.1%	15.6%	25.0%	36.8%
Comfort	12.6%	16.7%	16.2%	14.6%
Wing flapping	1.3%	0.2%	0.3%	0.1%
Bathing	2.1%	1.5%	4.6%	2.8%
Total area per bird (cm^2)	**4,122**	**4,061**	**7,776**	**581**
Number of birds per m^2	**2.43**	**2.46**	**1.29**	**17.2**
Kg birds per m^2	7.3	10.8	8.6	5.2

(a): The space required for each behavioural category was estimated based on the following bird weight: Domestic ducks – 3.0 kg, Muscovy and Mule ducks – 4.4 kg, Domestic geese – 6.7 kg and Japanese quail – 0.3 kg.

To interpret the possible application of the outcomes from the behavioural model (see Section 2.2.3.4), the following Tables 38–41 show, for each species, the space which is typically provided in current commercial practice and the space needed for four additional scenarios:

- Space allowance derived from the model which would allow all birds in a group to perform any of the behavioural categories in a fully synchronised way (i.e. any behavioural category performed by all birds at the same time). While this would be a very unlikely occurrence it represents the situation of maximum possible space requirement from the behavioural model.
- Space allowance derived from the model which would allow all birds in a group to perform any behavioural category if exhibited randomly over time, with the addition of a minimum separate functional area for bathing (waterfowl) or dust bathing (quail).
- Space allowance derived from the model which would allow all birds in a group to perform any behavioural category if exhibited randomly in time (i.e. space is time shared for different behaviours without any social facilitation).
- Space allowance per bird derived from the model which would allow all birds in a group to simultaneously perform stationary behaviours (standing on both or one leg, resting, sitting, feeding and drinking) with inclusion of appropriate inter-individual distance.
- Information on typical current space allowance provided in commercial systems, as retrieved in ToR-1 (Section 3.4).

Table 38: Domestic duck scenarios for space allowance per bird (and stocking density). These values were estimated based on a bird weight of 3.0 kg. The first row (highlighted in light grey) reports the values derived from the model which would allow all birds in a group to perform any of the behavioural categories in a fully synchronised way. The following rows (scenarios) are reflecting outcome of the model with behaviours that can be expressed with decrease of space allowance. The assumption is that all the other influencing factors are at the level of good practice. The value in dark grey (last row) refers to current situation (Section 3.4.1)

Scenarios	Space allowance (Stocking density)
All birds performing the species-specific behaviour wing flapping on dry land and bathing in water • Values allowing that 100% of birds can perform the same species-specific behavioural categories at the same time (wing flapping on littered floor and bathing on water), and maintain inter-individual distances among birds	**6,868 cm^2/bird** (1.5 birds/m^2) on littered floor + **Additional 10,188 cm^2/bird in the open water** for bathing (1.0 bird/m^2)

Scenarios	Space allowance (Stocking density)
All species-specific behavioural categories on dry land and <u>bathing on water</u>, if exhibited randomly in time • Values allowing birds to perform all species-specific behavioural categories if exhibited randomly in time, with average inter-individual distance • Allowing water bathing behaviours (considering 2.1% of time budget for performing the behaviour on open water). In small groups, there should be space in the water for at least one duck.	**4,139 cm^2/bird** on the dry land (2.4 birds/m^2) + **Additional minimum 5.3%** of this space should be **open water** (219 cm^2/bird, or in any case not less than of 10,188 cm^2 per enclosure)
All species-specific behavioural categories on dry land and <u>head dipping on water</u>, if exhibited randomly in time • Values allowing birds to perform all species-specific behavioural categories if exhibited randomly in time and to maintain inter-individual distances among birds • Allowing only head dipping[(a)] not bathing	**4,139 cm^2/bird** (2.4 birds/m^2)
Stationary behaviours • Values allowing birds to perform stationary behaviours and maintain inter-individual distances among birds. • Not allowing dynamic and comfort species-specific behaviours	**3,355 cm^2/bird** (3.0 birds/m^2)
Current situation in commercial systems • Values obtained from Section 3.4.1 Space on water not included	– Breeders: **2,000–2,900 cm^2/bird** (3.5–5 birds/m^2) – Growing birds: **2,800 cm^2/bird** at 7 weeks (3.6 birds/m^2)

(a): Head dipping leads to incomplete bathing behaviour; however, EFSA experts considered that this behaviour requires similar space to that of swimming and bathing, but on dry land.

Published experiments about the effect of different space allowances on ABMs in Domestic duck are sparse. Moreover, in the studies confounding factors such as group size were found. However, the systematic review of Domestic duck welfare research by Makagon and Riber (2022) identified seven papers in which stocking density was studied, with the majority reporting only production outcomes and a negative correlation between high stocking density and growth, irrespective of housing system. This has generally led to a recommendation of no more than 7–8 ducks/m^2 at slaughter age (e.g. De Buisonjé, 2001; Xie et al., 2014; Li et al., 2018). Regarding the effect of stocking density on other ABMs, De Buisonje (2001) showed increased feather damage in Domestic ducks kept at 8 ducks/m^2 as compared with those housed at 5, 6 or 7 ducks/m^2. Li et al. (2018) used optical flow monitoring to compare stocking densities of 5, 6, 7, 8 or 9 ducks/m^2 and suggested that the observed reduced mean activity might indicate an increasing percentage of individuals with abnormal walking behaviour as density increased. However, Xie et al. (2014) reported that foot-pad dermatitis was not affected by stocking density (5, 6, 7, 8 or 9 ducks/m^2).

Table 39: Muscovy and Mule duck scenarios for space allowance (and stocking density). These values were estimated based on a bird weight of 4.4 kg. The first row (highlighted in light grey) reports the values derived from the model which would allow all birds in a group to perform any of the behavioural categories in a fully synchronised way. The following rows (scenarios) are reflecting outcome of the model with behaviours that can be expressed with decrease of space allowance. The assumption is that all the other influencing factors are at the level of good practice. The value in dark grey (last row) refers to current situation (Section 3.4.2)

Scenarios	Space allowance (Stocking density)
All birds performing any of the species-specific behavioural categories on dry land and water • Values allowing that 100% of birds can perform the same species-specific behavioural category at the same time (wing flapping on littered floor and bathing on water), and maintain inter-individual distances among birds	**8,562 cm^2/bird** (1.2 birds/m^2) on littered floor + **Additional 12,010 cm^2/bird in the open water** for bathing (0.8 bird/m^2)
All species-specific behavioural categories on dry land and bathing on water, if exhibited randomly in time • Values allowing birds to perform all species-specific behavioural categories if exhibited randomly in time, with average inter-individual distance • Allowing bathing behaviours (considering 1.5% of time budget for performing the behaviour on water). In small groups, there should be space in the water for at least one duck.	**4,061 cm^2/bird** on the dry land (2.5 birds/m^2) + **Additional minimum 4.6%** of this space should be **open water** (187 cm^2/bird, or in any case not less than 12,010 cm^2 per enclosure)
All species-specific behavioural categories on dry land and head dipping on water, if exhibited randomly in time • Values allowing birds to perform all species-specific behavioural categories if exhibited randomly in time and to maintain inter-individual distances among birds. • Allowing only head dipping[(a)] not bathing.	**4,061 cm^2/bird** (2.5 birds/m^2)
Stationary behaviours • Values allowing birds to perform stationary behaviours and maintain inter-individual distances among birds. • Not allowing dynamic and comfort species-specific behaviours.	**3,049 cm^2/bird** (3.3 birds/m^2)
Current situation • Values obtained from Section 3.4.2 Space on open water not included	– Breeders: **1,800–3,200 cm^2/bird** (3–5.5 birds/m^2) – Growing birds of more than 6 weeks of age: **1,500–2,500 cm^2/bird** (males: 4–6.5 birds/m^2; females: 7.8–11.0 birds/m^2) – Overfeeding phase = **1,200–1,300 cm^2/bird** (7.5–8.3 ducks/m^2)

(a): Head dipping leads to incomplete bathing behaviour; however, EFSA experts considered that this behaviour requires similar space to that of swimming and bathing, but on dry land.

Published experiments about the effect of different space allowances on ABMs are rare for both Muscovy and Mule ducks. Moreover, in the studies confounding factors such as group size were found. Baeza et al. (2003) studied changes in welfare, performance and carcass quality of Muscovy ducks kept at three stocking densities (7, 9 and 11 male ducks/m^2) and found that a stocking density of 9 birds/m^2 gave best results for behaviour, walking ability and feather quality. They found the highest level of feather pecking in older birds at a stocking density of 11 birds/m^2. Similarly, Muscovy ducks with intact bills on perforated floors showed no feather pecking and cannibalism up to 28 days of life when kept at a lower density (6.3 birds/m^2), whereas at a higher stocking density (11.6 birds/m^2)

feather pecking and injuries occurred, although this was also the case at both stocking densities when mash instead of pellets was fed (Bilsing et al., 1992b).

Rufino et al. (2017) reported significantly better weight gain in Muscovy ducks housed at 2 than at 3 birds/m^2, while Nasr et al. (2022) reported progressively better weight gain when comparing 5, 7 and 9 birds/m^2.

In Mule ducks, body weight gain over a 10-week fattening period was lower when reared at a stocking density of 7 birds/m^2 than at 6 or 5 birds/m^2 (Taboosha, 2014).

Table 40: Domestic geese scenarios for space allowance (and stocking density). These values were estimated based on a bird weight of 6.7 kg. The first row (highlighted in light grey) reports the values derived from the model which would allow all birds in a group to perform any of the behavioural categories in a fully synchronised way. The following rows (scenarios) are reflecting outcome of the model with behaviours that can be expressed with a decrease of space allowance. The assumption is that all the other influencing factors are at the level of good practice. The value in dark grey (last row) refers to current situation (Section 3.4.3)

Scenarios	Space allowance (Stocking density)
All birds performing any of the species-specific behavioural categories on dry land and water • Values allowing that 100% of birds can perform the same species-specific behavioural categories at the same time (wing flapping on littered floor and bathing on water), and maintain inter-individual distance among birds	**15,861 cm^2/bird** (0.6 birds/m^2) on littered floor + **Additional 24,728 cm^2/bird in the open water** for bathing (0.4 bird/m^2)
All species-specific behavioural categories on dry land and bathing on water, if exhibited randomly in time • Values allowing birds to perform all species-specific behavioural categories if exhibited randomly in time, with average inter-individual distance. • Allowing bathing behaviours (considering 4.6% of time budget for performing the behaviour on water). In small groups, there should be space in the water for at least one goose.	**7,776 cm^2/bird** on the dry land (1.3 birds/m^2) + **Additional minimum 15%** of this space should be **open water** (1,166 cm^2/bird, or in any case not less than of 24,728 cm^2 per enclosure)
All species-specific behavioural categories on dry land and head dipping on water, if exhibited randomly in time • Values allowing birds to perform all species-specific behavioural categories if exhibited randomly in time and to maintain inter-individual distances among birds. • Allowing only head dipping[(a)] not bathing.	**7,776 cm^2/bird** (1.3 birds/m^2)
Stationary behaviours • Values allowing birds to perform stationary behaviours and maintain inter-individual distances among birds. • Not allowing dynamic and comfort species-specific behaviours.	**4,958 cm^2/bird** (2.0 birds/m^2)
Current situation • Values obtained from Section 3.4.3 Space on open water not included	• Breeders: **4,000–12,500 cm^2/bird** (0.8–2.5 birds/m^2) • Growing systems indoor: **3,300 cm^2/bird** (3 birds/m^2) • Growing systems indoor with outdoor access: **2,000–2,500 cm^2/bird** (4–5 birds/m^2) • Overfeeding phase**: 1,700–3,600 cm^2/bird** (2.8–6.06 birds/m^2).

(a): Head dipping leads to incomplete bathing behaviour; however, EFSA experts considered that this behaviour requires similar space to that of swimming and bathing, but on dry land.

Published experiments about the effect of different space allowances on ABMs in Domestic geese have generally looked at lower space ranges than the ones resulting from the behavioural model and also most of the studies confounded space allowance with group size. Yin et al. (2017a,b) compared the outcomes for groups of 6–17 Yangzhou goslings stocked at 2, 3, 4, 5 and 6 birds/m^2 over the period from 4 to 10 weeks of age (final weight of 3.5–3.9 kg). They reported that body weight gain and feather cleanliness decreased progressively as stocking density increased, while feather pecking increased and, at the higher densities of 5 or 6 birds/m^2, resting behaviour and walking ability were impaired. Similarly, Wang et al. (2019) compared stocking densities of 2.5, 3.5, 4.5, 5.5, 6.5 and 7.5 birds/m^2 for groups of 5–15 Sichuan white geese from 7 to 10 weeks of age. Increasing stocking density quadratically impaired growth rate, feather cleanliness and feather damage. Based on a broken-line linear regression analysis, they suggested 3.5 geese/m^2 as the point beyond which stocking density affected growth rate. In accordance with this Lin et al. (2016), studying larger groups of 24–40 White Roman geese suggested that birds were more sensitive to overstocking at younger ages and found no effect on growth rate when comparing densities of 1.2, 1.5 and 1.8 birds/m^2 from 9 to 14 weeks of age (final weight (4.6–5.1 kg). All these experiments were carried out in Asia, and no recent studies under European conditions were found.

Table 41: Japanese quail scenarios for space allowance (and stocking density). These values were estimated based on a bird weight of 0.3 kg). The first row (highlighted in light grey) reports the values derived from the model which would allow all birds in a group to perform any of the behavioural categories in a fully synchronised way. The following rows (scenarios) are reflecting outcome of the model with behaviours that can be expressed with a decrease of space allowance. The assumption is that all the other influencing factors are at the level of good practice. The value in dark grey (last row) refers to current situation (Section 3.4.4)

Scenarios	Space allowance (Stocking density)
All birds performing any of the species-specific behavioural categories on litter and in the dust bathing area • Values allowing that 100% of birds can perform the same species-specific behavioural categories at the same time (wing flapping on littered floor and dust bathing in functional area), and maintain inter-individual distance among birds	**1,155 cm^2/bird** (8.7 birds/m^2) + **Additional 1,155 cm^2/bird in the dust bathing area** (8.7 birds/m^2)
All species-specific behavioural categories if exhibited randomly in time and specific functional area for dust bathing • Values allowing birds to perform all species-specific behavioural categories if exhibited randomly in time, with average inter-individual distance • Allowing dust bathing behaviour (considering 2.8% of time budget for performing the behaviour in separate area with preferred substrate e.g. sand). In small groups, there should be space in the dust bathing area for at least one quail.	**581 cm^2/bird** (17.2 birds/m^2) Including 5.5% (32 cm^2/bird) of this space which should be dust bathing area with preferred substrate, but with a minimum of 1,155 cm^2 per enclosure.
All species-specific behavioural categories if exhibited randomly in time • Values allowing birds to perform all species-specific behavioural categories if exhibited randomly in time and to maintain inter-individual distances among birds. • No separate functional area for dust bathing (dustbathing performed in the litter).	**581 cm^2/bird** (17.2 birds/m^2)
Stationary behaviours • Values allowing birds to perform stationary behaviours and maintain inter-individual distances among birds. • Not allowing dynamic and comfort species-specific behaviours.	**430 cm^2/bird** (23.3 birds/m^2)

Scenarios	Space allowance (Stocking density)
Current situation in commercial systems • Values obtained from Section 3.4.4	– Breeders: **133–250 cm^2/bird (40–75 birds/m^2)** – Meat quail: **114 cm^2/bird (88 birds/m^2)** – Layer quail: **127 cm^2/bird (79 birds/m^2)**

Published experiments about the effect of different space allowances on ABMs in Japanese quail can be difficult to interpret, due to confounds with group size and housing system, as highlighted in the review of El Sabri et al. (2022). In growing birds, Cicek et al. (2004) reported reduced growth rate at lower space allowance when comparing 80, 100 and 125 cm^2/bird, as did Camci and Erensayin (2004) when comparing 45, 60 and 90 cm^2/bird, and Ozbey et al. (2004) when comparing 72, 90 and 120 cm^2/bird. However, Ayoola et al. (2014) reported no effect on growth rate when comparing stocking densities of 40, 50 and 60 birds/m^2 (equivalent to 250, 200 or 167 cm^2/bird). Mortality rate was also significantly increased in the low space treatments of Wilson et al. (1978) and Abdel-Azeem (2010), (232 and 143 cm^2/bird, respectively).

In laying quail, Nagarajan et al. (1991) reported that both egg production and mortality rate were significantly improved with an increase in space per bird (150, 180, 210 and 240 cm^2/bird), while better egg production with more space was also reported by Sharaf (1996) comparing 100, 150 and 300 cm^2/bird. Faitarone et al. (2005) reported higher laying rate at space allowances of 211 and 264 cm^2 per bird compared to 176 and 151 cm^2 per bird. Other aspects of egg quality can also be improved with increased space allowance as reviewed by El Sabri et al. (2022).

Following their detailed review, El Sabri et al. (2022) suggested that the best balance between economics and welfare was achieved by providing 100–150 cm^2/bird for growing broiler quail and 200–230 cm^2/bird for laying quail.

3.6.1.2. Minimum floor area of the enclosure

In addition to a minimum area per bird, also a minimum total floor area within an enclosure is considered. For laying hens in commercial flocks, the minimum total enclosure area was suggested to be around 80 m^2, based on published data on space use (EFSA AHAW Panel, 2023a). However, no such studies have been reported for any of the species under consideration in this Opinion and there is not enough scientific evidence to estimate the minimum total size of the floor area that will prevent the welfare consequences of restriction of movement, group stress, locomotory disorders, soft tissue lesions, inability to perform exploratory or foraging behaviour.

Horizontal space is needed for several behavioural activities, as described in Section 3.5.1. Active behaviours include all actions that birds perform such as body maintenance, thermoregulation, social interaction, exploration of food sources or in the search for mates (EFSA AHAW Panel, 2023a). Wild relatives of the species under consideration perform these behavioural activities in an area that is defined as the home range, which is substantial in size to meet their feed requirements from foraging. Domestic birds can also range widely if the possibility exists; for example, Prosser et al. (2015) showed that free-ranging domestic ducks cover an area of 1 km^2, while domestic geese may range for a distance of up to 5 km (Buckland and Guy, 2002). In general, domestic birds in larger enclosures will perform more locomotory and foraging/exploratory behaviour, but there are often confounds of group size and enrichment provision (Domestic ducks: Reiter et al., 1997; Domestic geese: Boz et al., 2021). If the total floor space is too small, various welfare consequences might occur, such as restriction of movement and locomotory disorders that may result from impaired development of the skeleton and musculature. No information to determine thresholds for these welfare consequences was found. If there is insufficient space to avoid and escape from aggressive behaviours of other birds, group stress and soft tissue lesions and integument damage may be increased. No ethogram describing the flight distance (i.e. the escape distance) in the species of interest during agonistic interactions was found. If the space is insufficient, there may be the inability to perform species-specific exploratory or foraging behaviours. Even when feed is provided for ad libitum intake, foraging behaviours still occupy a substantial part of the time budget (Domestic duck: 15% of the daily 24 h time budget (Reiter and Bessei (1995); Domestic goose: > 30% of daytime observations (Boz et al., 2021); Japanese quail: 8.3% of time (Schmid and Wechsler, 1997)).

Finally, discrete functional areas within the enclosure are needed for water-bathing (waterfowl) or dust bathing (quail) (see Section 3.6.5).

In the case of quail, although they most often run and hide in cover when threatened, they may respond by rapid take-off and a brief burst of forward flight (Earls, 2000). It is therefore necessary to provide adequate height and horizontal space, with precautions to avoid trauma from crashes with elements of husbandry systems including walls in case of flight responses. The distance which quail typically cover in flight is poorly documented. Anecdotal information in outdoor conditions suggests a distance of up to 91 m (birdfact.com). Expert opinion indicated that they were 70% certain that quail, both broilers and layers, can jump or fly further than 2 m when startled, 90% certain of more than 150 cm and 100% certain of more than 100 cm (Aida Xercavins, IRTA, personal communication, 2023).

In summary, no study has been reported for any of the species under consideration in this Opinion about minimal total floor space and there is not enough scientific evidence to estimate the minimum total size of the floor area that will prevent the welfare consequences of restriction of movement, group stress, locomotory disorders, soft tissue lesions and inability to perform exploratory or foraging behaviour.

3.6.1.3. Minimum height of the enclosure

The minimum height of a bird enclosure is considered the vertical distance from the floor or the surface of the litter (if the floor is littered, bearing in mind that litter height might increase over time) to the lower point of the ceiling of the enclosure. In the case of Muscovy ducks, where the natural behaviour includes perching, the minimum height should be measured as the distance above any perch or elevated structure which is provided. The height of the perch itself is discussed in Section 3.6.5. No evidence of a requirement for perching in Mule ducks has been identified.

To avoid the welfare consequence of restriction of movement the minimum height of an enclosure should allow the birds to adopt their natural posture when standing. If the enclosure height is too low, birds may experience the welfare consequence of soft tissue lesions and integument damage as a result of impact or abrasion injuries on the head and the wings towards the furniture of the enclosure. If the birds are unable to fully extend their wings, they may experience the welfare consequence of inability to perform comfort behaviour since wing flapping is considered a component of this. Depending on the reproductive stage and species, other natural behaviours which must be considered to avoid restriction of movement from inadequate enclosure height are mating in breeders and flying attempts in quail.

The first requirement to avoid welfare consequences is to be able to stand erect with the neck extended. This represents the sum of the length of leg, depth of chest and length of head and neck. The second requirement is to be able to wing flap. This is the length of leg, depth of chest and length of wing, including feathers. Tables 42–45 show the evidence on the space required for these activities for each species. The data sources within each species relate to diverse genetic lines and liveweights, and give different types of information on morphology, but the calculated outcomes generally show reasonable agreement. The final proposal following each table is based on the data sources deemed closest to current European genotypes.

Table 42: Morphometric data for Domestic ducks

Measure	Height (cm)	Explanation	Reference
Standing	32–45	Mallard duck 0.7–1.6 kg: whole body measurement	Dimensions (online)[(a)]
Standing	9.4 + 23.7 + (4.6/3.142) + 6.42 = 41	Pekin duck male and female 2.5 kg: chest depth + neck length + head diameter + metatarsus	Sari et al. (2013)
Standing	(37.0/3.142) + (46.3–27.6) + 9.3 + 2 = 42	Pekin duck SM3 hybrid male 3.5 kg: chest diameter + (body length-trunk length) + shank (+ 2 cm for head)	Steczny et al. (2017)
Standing	(29.4/3.142) + (43.9–25.6) + 9.0 + 2 = 39	Pekin duck mean of P8, P9 and P33 lines male 2.0 kg: chest diameter + (body length-trunk length) + shank (+ 2 cm for head)	Kokoszyński et al. (2019)
Standing	44	Mature female 3.5–4.5 kg: whole body measurement	Unpublished data (Daniel Guéméne, personal communication, 2023)
Wing length	0.5 (99–23) = 38	Mallard 1.6 kg (incl. feather length): 0.5 (wingspan-body width)	Dimensions, online[(a)]
Wing length	0.5 (89–25) = 32	Mature female 3.5–4.5 kg (incl. feather length): 0.5 (wingspan-body width)	Unpublished data (Daniel Guéméne, personal communication, 2023)

Measure	Height (cm)	Explanation	Reference
Wing flapping	9.4 + 6.4 + 33.2 + 20 = 69.0	Pekin duck male and female 2.5 kg: chest depth + metatarsus + wing length (+ 20 cm for feathers)	Sari et al. (2013)

(a): Dimensions, online. Mallard (Anas platyrhnchos), Available online. https://www.dimensions.com/element/mallard-anas-platyrhynchos [Accessed: 5 January 2023].

Considering the data in Table 42, the morphometric estimates used in further calculations for Domestic duck are 44 cm for standing, based on data in breeder birds under commercial condition (Daniel Guémené, personal communication, 2023), and 55 cm for wing flapping, based on the sum of wing length data for commercial genotypes (Daniel Guémené, personal communication, 2023 plus the average of chest depth and leg length data from two relevant sources (Steczny et al., 2017 and Daniel Guémené, personal communication, 2023).

Table 43: Morphometric data for Muscovy ducks

Measure	Height (cm)	Explanation	Reference
Standing	36–46	Muscovy: 2.7–6.8 kg: whole body measurement	Dimensions, online[33]
Standing	(40.4/3.142) + 18.3 + (16.4 /3.142) + 6.90 = 43.3	Lombok Muscovy Male 3.6 kg: chest diameter + neck length + head diameter + metatarsus	Tamzil et al. (2018)
Standing	(45.4/3.142) + 8.8 + 23.5 = 46.7	Egyptian Muscovy Male 4.0 kg: chest diameter + metatarsus (+23.5 cm for head+ neck)	Makram et al. (2021)
Standing	50	Male Muscovy 5.5–6.5 kg: whole body measurement	Unpublished data (Daniel Guéméne, personal communication, 2023)
Wing length	0.5 (152–24) = 64	Muscovy: 6.8 kg (incl. feather length): 0.5 (wingspan-body width)	Dimensions, online[34]
Wing length	0.5 (120–22) = 49	Male Muscovy 5.5–6.5 kg (incl. feather length): 0.5 (wingspan-body width)	Unpublished data (Daniel Guéméne, personal communication, 2023)
Wing flapping	(40.4/3.142) + 6.90 + 82.8 + 20 = 123	Lombok Muscovy Male 3.6 kg: chest diameter + metatarsus + wing length (+ 20 cm for feathers) (not incl. tibia 11.8)	Tamzil et al. (2018)

(a): Dimensions, online. Mallard (Anas platyrhnchos), Available online: https://www.dimensions.com/element/mallard-anasplatyrhynchos [Accessed: 5 January 2023].

Considering the data in Table 43, the morphometric estimates used in further calculations for Muscovy and Mule ducks are 50 cm for standing, unpublished data on male breeder birds under commercial condition (Daniel Guémené, personal communication, 2023), and 80 cm for wing flapping, based on the sum of wing length data for commercial genotypes (Daniel Guémené, personal communication, 2023) plus the chest depth and leg length data from Tamzil et al. (2018). The wing length for the breed reported by Tamzil et al. (2018) seems to be atypical. Due to the lack of data on Mule ducks' dimensions, Muscovy duck data were considered also for Mule ducks.

Table 44: Morphometric data for Domestic goose

Measure	Height (cm)	Explanation	Reference
Standing	62–76	Domestic goose 2.2–4.6 kg: whole body measurement	Dimension (online)[(a)]
Standing	60.6 + 8.3 = 68.9	White Kołuda male and female 6.7 kg: length of body (with neck) + shank	Lukaszewicz et al. (2011)

Measure	Height (cm)	Explanation	Reference
Wing length	0.5 (147 to 165–27) = 60–69	Domestic goose 2.2–4.6 kg (including feather length): 0.5 (wingspan-body width)	Dimensions (online)[(a)]
Wing flapping	15.3 + 8.3 + (19.0 * 3) + 25 = 105.6	White Kołuda male and female 6.7 kg: chest depth + shank + (forearm*3) (+ 25 cm for feathers)	Lukaszewicz et al. (2011)
Wing flapping	11.8 + 8.8 + 50.8 + 25 = 112.4	Native Turkish goose male 4.2 kg: breast depth + metatarsus + wing (+ 25 cm for feathers)	Saatci and Tilki (2007)

(a): Dimensions, online. Domestic Goose (Anser anser domesticus), Available online. https://www.dimensions.com/element/domestic-goose-anser-anser-domesticus [Accessed: 5 January 2023].

Considering the data in Table 44, the morphometric estimates used in further calculations for Domestic geese are 69 cm for standing and 106 cm for wing flapping, based on the data from Łukaszewicz et al. (2011) which appear most relevant for European breeds.

Table 45: Morphometric data for Japanese quail

Measure	Height (cm)	Explanation	Reference
Upright body posture	19	Heavy lines: 230 g (males), 290 g (females)	Gerken and Mills (1993)
Standing	6.7 + 7.0 + 1.9 = 15.6	Layer line 270–290 g: leg length + body depth + head depth	Industry Factsheet (Caillor Genetics, online)[(a)]
Standing	7.3 + 7.2 + 2 = 16.5	Female layer 314–358 g: waist size + leg length (+ 2 cm head + neck)	Unpublished data (Daniel Guéméne, personal communication, 2023)
Standing	19	At slaughter 300 g: whole body measurement	Unpublished data (Daniel Guéméne, personal communication, 2023)
Wing flapping	6.7 + 7.0 + 0.5 (32.2–6.4) = 26.6	Layer line 270–290 g: leg + body + 0.5 (wingspan-body width)	Industry Factsheet (Caillor Genetics, online)[(b)]
Wing flapping	7.3 + 7.2 + 0.5 (35.2–6.5) = 28.9	Female layer 314–358 g: waist size + leg length + 0.5 (wingspan-body width)	Unpublished data (Daniel Guéméne, personal communication, 2023)

(a): Calillor-Genetics, online. Line C55 physical description, reproduction/egg laying, Available online: https://caillor-genetics.com/files/caillor-genetics/souches-fiches/c55-fichetech-en.pdf.

(b): Dimensions, online. Mallard (Anas platyrhnchos), Available online: https://www.dimensions.com/element/mallard-anas-platyrhynchos [Accessed: 5 January 2023].

Considering the data in Table 45, the morphometric estimates used in further calculations for Japanese quail are 19 cm for standing and 29 cm for wing flapping, unpublished data on breeder birds under commercial condition (Daniel Guémené, personal communication, 2023).

In addition to the height physically occupied by an average bird, an additional height allowance should be added to take account of the variation between genotypes and between individuals within genotype, and to leave some clear space between the top of the head and the ceiling surface. For this purpose, EFSA expert opinion is that 20% should be added. **This gives a final minimum height to accommodate both standing and wing flapping of 66 cm for Domestic duck, 96 cm for Muscovy and Mule duck, 127 cm for Domestic geese and 35 cm for Japanese quail (but see further considerations for the latter species).**

For enclosures containing breeding birds where natural mating will occur, additional height will be required for this activity. This can be taken to be the standing height of the female plus the wing flapping height of the male. This will allow adequate height for the initial mounting, although the female bird may then crouch during copulation.

In the case of quail, it is appropriate to consider the additional height necessary to allow jumping and flight. When startled, quail will jump vertically to a considerable height and fly to escape a potential threat (Buchwalder and Wechsler, 1997). When the ceiling is of an intermediate height there is a high risk of collisions causing the welfare consequences of soft tissue lesion and integument damage, and also bone lesions. A low ceiling will deter vertical jumping and, as momentum increases with vertical distance, a height of 20 cm was suggested to be adequate for allowing standing but minimising injury from jumping

(Gerken and Mills, 1993). A flexible or cushioned ceiling has also been suggested to mitigate risk of injury (Dixon and Lambton, 2021). However, such a low height will cause the welfare consequence of restriction of movement by not allowing to fulfil the behavioural need of wing flapping or flying. To avoid this welfare consequence, enclosures should be high enough to exceed the normal jumping height and to allow flight, but information on the height required for this is sparse. Earls (2000) reported a vertical height approaching 3 m for flight take-off in Common quail (*Coturnix coturnix*). In Japanese quail, Nordi et al. (2012) reported that 15.6% of birds had head feather damage and injuries to the skin of the head and back when housed in cages of 26.5 cm height, whereas no injuries were observed in birds in an aviary of 162 cm height which permitted flying behaviour (0.4% of time budget). Muhammad and Mirza (2019) reported that an enclosure of 140 cm height allowed quail to fly (showing this behaviour 6.7 times per bird per day) but gave no information on the prevalence of soft tissue lesions in this or in more restrictive housing types of 30 cm height. Expert opinion suggests that jumping events in commercial quail are not very frequent, being 60% certain that quail, both broilers and layers, jump (or fly) higher than 1 m, 80% certain that this would be more than 80 cm and 100% certain that it would be more than 60 cm (Aida Xercavins, IRTA, personal communication, 2023). Regarding the maximum height of the jump or flight, expert opinion indicated 100% certainty that it is less than 2 m. In a large aviary, combining different functional areas for the birds, it may not be necessary to provide over the total area a height which accommodates flying, because also lower areas providing cover can be beneficial in reducing fearfulness and facilitating nesting (see Sections 3.6.4 and 3.6.5).

However, following the recommendation of the EFSA AHAW Panel (2023a,b) any bird enclosure with minimum of 2 m height will allow the stockperson to inspect the birds and consequently prevent or mitigate potential welfare consequences.

3.6.2. Size of the group

This section includes the assessment of minimum and maximum group sizes. Regarding the impact of group size on the welfare of ducks, geese and quail, there is very limited scientific evidence. Studies on greylag geese (Ludwig et al., 2017) and quail (Mills et al., 1993) have shown that social isolation influences animal health and welfare, depending on the general sociality of the species (see Section 3.5.3). Studies on the impact of maximum group size have not been found. In general, studies have focused on stocking densities and controlled for group size accordingly, so that the impact of the variable group size itself, even more in a commercially relevant setup, has not been shown so far.

A factor that (additionally) drives group stress in relation to group size is the sex ratio, especially in groups with sexually mature birds such as breeding groups. If too few females are assigned to a male, this can cause stress for the females and, if more than one male is in the group, aggressive competition between the males. The optimal sex ratio in terms of animal welfare depends on the species, the space available, the number of males in a group and the sexual activity.

EFSA experts assumed that an individual bird would experience isolation stress if kept without a conspecific, independently of enclosure size. Observable agonistic or aggressive interactions with neighbours might counteract isolation stress but do not lead to an improved welfare situation. There is no evidence for affiliative behaviours from one cage to another. Therefore, the recommended minimum group size for Domestic ducks, Muscovy and Mule ducks, Domestic geese and Quail is two for immature birds or female birds only. Considering the complex social behaviour, a bigger group size may be advantageous. However, the minimum number of birds required to allow the expression of complex social behaviours cannot be derived from the literature.

In presence of a mature male bird, the minimum group size should be based on the sex ratio that aims to prevent female birds from experiencing an increased amount of unwanted sexual behaviour and aggression among males. Wechsler and Schmid (1998) reported that a sex ratio of 8 females:1 male to 12 females: 1 male reduced the rate of aggressive pecking in Japanese quail, as compared to multi-male groups.

Housing birds in a group is the first preventive measure to avoid isolation stress. If, for selection reasons, individual parameters like feed efficiency, egg parameters, etc., are needed, precision livestock farming methods are promising method to allow the measurement of individual birds even when they are kept in groups (see review by Rowe et al., 2019). Promising technologies and strategies supporting the rearing and keeping of breeders in a group are presently under development and, to a limited extent, already in practice (e.g. RFID: Desnoues et al., 2015, Mika et al., 2021; genomic assignment: Rouger et al., 2019).

Radio-frequency identification (RFID) tagging technology for individual bird identification has been developed for most poultry species (Desnoues et al., 2015) and can be associated with the use of automated nests. However, the technology cannot allow individual identification of eggs for birds that are not laying in the nest (floor eggs), or when multiple birds lay simultaneously in the same nest. Also, the RFID identification and labelling of the eggs can be challenging, especially with very small birds (e.g. quail).

The use of RFID technologies can also be associated with feeders that allow collection of individual data in a collective rearing environment. Such devices have been developed experimentally but also by some breeding companies for use in practice in the last 15 years for different poultry species, such as Gallus (Mika et al., 2021), turkeys and ducks (Basso et al., 2012) but not for quail or geese to our knowledge. They allow collection of data on feed consumption, but also on feeding activity rhythms as well as behavioural responses, which are not easily accessible in individual cages. Such a device can also be associated with automatic scaling for assessing body weight simultaneously. However, the number of such automatic devices is still low and/or under development, mainly due to the cost. They also still need to be improved in order to be applicable in all contexts, especially at younger ages and/or for small species (i.e. quail) (Johnston et al., 2022).

The use of specific genomic arrays is another technique that, through DNA parental assignment, has been developed for all poultry species, and is available at least to the major breeding companies, which can permit to re-establish the genealogy *a posteriori*. In this way, reproduction can be based on group rearing associated with spontaneous mating instead of artificial insemination (Rouger et al., 2019). However, this approach excludes the possibility of controlling individual mating schemes, which would limit the effectiveness of selection programs. Moreover, optimal group size and ratio of female:male for each species/line would have to be carefully determined and considered in practice, in order to avoid a dominant male to have a higher representation in the progeny, which would result in a detrimental genetic diversity impoverishment.

In larger groups it can be more problematic to ensure that all birds have access to all resources. First, to reach such resources can get too long (e.g. for weaker animals), or second, resources are arranged in such a way that they can be locally occupied by dominant animals (e.g. in the case of unfavourably distributed food sources). These factors are dependent on the husbandry system and design. Any restriction in resource access will increase risk of group stress.

3.6.3. Floor quality

Floor quality is a key factor for welfare of ducks, geese and quail as it influences the risk of multiple welfare consequences, including **soft tissue lesions and integument damage, inability to perform comfort behaviour, inability to perform exploratory or foraging behaviour, restriction of movement and locomotory disorder**. Floor quality may be split into three components; flooring material (e.g. wire, plastic, slatted, concrete, dirt), litter characteristics (e.g. presence/absence, humidity, degree of soiling, type of litter) and litter management (e.g. initial amount, ventilation settings, allocation of extra material, appropriate litter treatment). Below these three components are reviewed.

3.6.3.1. Flooring material

Perforated floor is an umbrella term that includes slatted floors (generally made of concrete, but wooden and plastic slats are also used), wire mesh floors and perforated plastic floors, all of which may be used for housing of ducks, geese and quail. Perforated plastic floors are produced in different qualities, where some are softer than others. For waterfowl, perforated floor is often used under and around open water sources to ensure that water spilled in connection with bathing behaviour is drained from the floor. This may be the case both indoors and outdoors. The other main type of flooring material is solid floors that are usually covered with litter. Solid floors are typically made of concrete but can also be comprised of hard-packed dirt.

3.6.3.2. Litter characteristics

Several bedding materials have been examined for suitability as litter, including sawdust, wood shavings, rice straw, wheat straw, rice husk, ground corn cobs, sand, clay and gypsum (Benabdeljelil and Ayachi, 1996; Munir et al., 2019; Gerber et al., 2020; Diarra et al., 2021). Littered solid floors are characterised by deteriorating litter quality as the birds age, because the litter material progressively becomes mixed with faeces and moisture stemming from either water spillage during drinking or wet preening behaviour (only ducks and geese).

Several measures can be applied to counteract the deterioration of litter quality. A properly constructed drainage area under the water lines or any other source of water reduces the risk of moist litter (O'Driscoll and Broom, 2011). To keep the litter in good condition, the bedding material needs to be very absorbent and have a reasonable drying time, in addition to being free of physical, chemical and microbiological hazards (see Gerber et al., 2020). Often chopped straw is used as litter material in duck and goose barns. As long as the straw is chopped into small enough pieces (< 2.5 cm) it has nearly as good a water-holding capacity as peat moss (Shepherd et al., 2017). Rape-seed straw pellets are also reported to have a high water absorption capacity. Jones and Dawkins (2010a) emphasised the importance of the quality of straw used as litter, as they found that poor quality straw (due to a wet harvest) had a negative impact on a range of ABMs measured in Domestic ducks, including feather cleanliness, foot-pad dermatitis, mortality and the percent carcass downgrades.

3.6.3.3. Litter management

Maintaining good litter quality, i.e. to keep it dry and friable, also requires appropriate litter management, which is particularly important in the housing of ducks as their faeces are rather moist. The litter depth needs to be sufficient to insulate birds from the floor, retain faeces and allow birds to forage and explore, while not being too deep, as this will obstruct moisture evaporation. For Domestic geese, Bogenfürst (2017) recommended a 20–25 cm deep straw or wood shaving bedding on a concrete floor as a start when goslings arrive from the hatchery. No scientific evidence is available for the optimum litter depth for Domestic, Muscovy and Mule ducks, but a depth of 10 cm or much less is used in commercial production. Other litter management interventions are the frequency of new litter supply, litter turning, removal of soiled or moist litter, adjustment of ventilation and water source (Raud and Faure, 1994; Jones and Dawkins, 2010a) and litter treatment with acidifiers (Shepherd et al., 2017; de Toledo et al., 2020) or with fermenting microorganisms (Han et al., 2022). Acidifiers reduce the pH, the moisture and ammonia content of the litter (de Toledo et al., 2020), while fermenting microorganisms increase the temperature in the house and reduce the emission of ammonia, carbon-dioxide, hydrogen-sulphide and dust particles (Han et al., 2022).

3.6.3.4. Effect of floor quality on welfare consequences

Floor quality has an impact on **soft tissue lesions and integument damage, inability to perform comfort behaviour, inability to perform foraging behaviour, restriction of movement and locomotory disorder** in ducks, geese and quail. However, research on the topic is rather limited. The available research studies are also highly variable in terms of the stocking densities used and the type of flooring material, litter characteristics and litter management applied, which limits the possibility of drawing clear conclusions. To date, no comparisons of the effect of the different perforated floor types on the risk of the mentioned welfare consequences have been reported. Likewise, there are major gaps of knowledge on the effect of litter type and litter management interventions on several ABMs, including foraging behaviour, cannibalistic wounds, foot-pad dermatitis, feather cleanliness or eye disorders. Basic knowledge on bird preference for the different types of perforated floors, for different litter types or for either perforated or littered solid floors is also lacking. A review of the existing scientific literature is provided below.

The inability to keep clean and dust bathe **(Inability to perform comfort behaviour)** is affected by floor quality. Wet/moist floors may reduce the cleanliness of the plumage. At 7 days of age, a higher percentage of Domestic ducks kept on fully littered solid floors as compared to fully slatted floors have been reported to have a higher degree of feather cleanliness (Fraley et al., 2013; Karcher et al., 2013). By 21 and 32 days of age (the latter only during summer), this difference had disappeared, whereas during winter, the 32 days old ducks kept on litter had a reduced plumage cleanliness compared to ducks kept on slatted floor. In another study, Domestic ducks kept on a perforated plastic net system had better plumage condition than birds kept in a deep litter system or deep litter system with enrichment (perches, coloured balloons and ribbons) (Chen et al., 2015). This seemed to be related to bathing behaviour, as the Domestic ducks kept on the perforated plastic net system water-bathed more than the birds kept in the deep litter system or deep litter system with enrichment (Chen et al., 2015). Domestic geese kept on dirt floors without litter had reduced feather cleanliness at 56 and 84 days of age compared to birds kept on perforated plastic floors (Liao et al., 2022). However, in Mule ducks, housing without access to bathing water on plastic slats or solid floors with one of two types of litter (sand and wood shavings), or no litter, did not influence feather cleanliness (Mohammed et al., 2019a).

In the case of quail, good quality litter, i.e. dry, friable and free of physical, chemical and microbiological hazards, is important as dust bathing material to meet the behavioural needs of dust bathing behaviour **(Inability to perform comfort behaviour)**. Although sham dust bathing is performed in cages where litter is not available (Gerken and Petersen, 1992), research from laying hens has shown that sham dust bathing cannot substitute the need for normal dust bathing behaviour

(Olsson et al., 2002). Quail kept on littered solid floors (free range, not specified further) expressed a higher frequency of dust bathing and ground pecking than those kept on littered solid floors (smaller pens with sawdust bedding), whereas these behaviours did not occur in quail kept on perforated floor in battery cages (Muhammad and Mirza, 2019). Mohammed et al. (2017) reported a higher occurrence of dust bathing in quail kept on solid floors that were littered than on solid floors (dried dirt) without litter. When comparing different types of litter, dust bathing occurred most frequently in sand, followed by rice straw, sawdust and wheat straw in decreasing order (Mohammed et al., 2017).

Floor quality may also influence eye disorders in Domestic ducks depending on season **(Inability to perform comfort behaviour)**. During summer, Domestic ducks housed on slatted floors had more eye disorders than ducks housed on littered floors (Fraley et al., 2013), whereas no difference between flooring systems was found during winter (Karcher et al., 2013). In 84-day old Domestic geese, eye condition was worse in birds kept on dirt floors without litter compared to birds kept on perforated plastic floors (Liao et al., 2022). In a study of Mule ducks, neither flooring material (plastic slats vs. solid) nor litter type (sand, wood shavings) or absence of litter affected eye condition (Mohammed et al., 2019a).

Presence of good quality litter, i.e. dry, friable and free of physical, chemical and microbiological hazards (e.g. contamination from faeces), on the floor provides ducks, geese and quails with the opportunity to forage and explore (and thus prevents **Inability to perform foraging and exploratory behaviour)**. Mohammed et al. (2017) examined the effect of different litter types (sand, wheat straw, saw dust and rice straw) on behaviour in quail and found more foraging in quail housed on rice straw, followed by sawdust, sand and wheat straw in decreasing order. Litter of good quality is particularly important in waterfowl that are housed without access to open water sources, where the behavioural need for dabbling/sieving in water to some extent is redirected towards the litter on the floor, which is sometimes referred to as playing behaviour (Molnár et al., 1998, 2004; Molnár and Bogenfürst, 1999). Abdel-Hamid et al. (2020) showed that Muscovy ducks foraged more when kept on littered solid floor than on perforated floor.

Domestic ducks housed on slatted floors may redirect their foraging behaviour towards the feathers of conspecifics, i.e. perform feather pecking (Leipoldt, 1992), causing plumage damage (Karcher et al., 2013) **(Soft tissue lesions and integument damage)**. By use of scan sampling of Domestic ducks in a barn, Dong et al. (2021) observed a higher frequency of injurious pecking (severe feather pecking, aggressive pecking and self-directed pecking) at 27–29 and 34–36 days of age compared to 20–22 days of age, but the frequencies were generally low (performed by 0.02% of total observed birds). Neither the time of the day nor the area of the barn (slatted vs. littered) affected the frequency of injurious pecking. Chen et al. (2015) observed more feather pecking in Domestic ducks kept on a perforated plastic net system than birds kept in a deep litter system or deep litter system with enrichment. In contrast, Mule ducks housed on either plastic slats, solid floor without litter or solid floor with litter (sand or wood shavings) did not differ in feather quality (Mohammed et al., 2019a), whereas feather quality in 56-day-old Domestic geese was worse for birds kept on dirt floors without litter compared to birds kept on perforated plastic floors (Liao et al., 2022). Increased occurrence of feather pecking and aggressive behaviour have been found when quail are housed on dried dirt floor without litter as compared to solid floors with litter (sand, wheat straw, sawdust or rice straw) (Mohammed et al., 2017). When comparing the effect of the different litter types, feather pecking was least common in quail kept on either sand or sawdust. No difference in plumage damage was found in Mule ducks kept on solid floors with either sand or wood shavings (Mohammed et al., 2019a). In Muscovy ducks kept either in a deep litter system or on perforated floor in a cage system, no difference was found in plumage damage (Abdel-Hamid et al., 2020).

From broiler research, it is known that the floor quality also is a key factor in regard to presence of contact dermatitis, i.e. foot-pad dermatitis, hock burns and breast ulcerations, where the former is the most commonly reported in ducks, geese and quail **(Soft tissue lesions and integument damage)**. Moisture is an important characteristic of litter quality that affects the incidence of foot-pad dermatitis. Poultry faeces and water leaking/splashing from drinkers is the main cause of wet litter and birds constantly standing/sitting on wet litter will have softened foot-pad/breast that will become more prone to lesions (Shepherd and Fairchild, 2010). The incidence of foot-pad dermatitis has been reported to be positively correlated with increasing relative humidity and ammonia in the litter in Domestic ducks (Jones and Dawkins, 2010a). Foot-pad dermatitis has been reported in ducks, geese and quail kept on perforated floors, solid floors without litter and on littered solid floors (Dayen and Fiedler, 1990; Knierim et al., 2005; Fraley et al., 2013; Karcher et al., 2013; Mohammed et al., 2017; Boz et al., 2017b; Liao et al., 2021). In two studies, occurrence of foot-pad dermatitis was investigated in Domestic ducks kept either on fully slatted floors or on fully littered solid floors during winter (Karcher et al., 2013) and summer (Fraley et al., 2013). A difference was only found at 7 days of age during the summer, where a higher percentage of ducks kept on littered solid floors had foot-pad dermatitis than on slatted floors. In Domestic geese, foot-pad dermatitis was found to be worse at 70 and 84 days of age when birds were kept on perforated plastic floors compared to birds kept on dirt floor without litter, while there was no difference at 56 days of age (Liao et al., 2021). In a study of Mule ducks, neither flooring material (plastic slats vs. solid), litter type (sand, wood shavings) or absence of litter on solid floor affected foot-pad dermatitis (Mohammed et al., 2019a). Muscovy ducks kept in a cage system had a higher prevalence of foot-pad dermatitis than in a deep litter system (Abdel-Hamid et al., 2020). In quail, Mohammed et al. (2017) did not find a difference in foot problems (i.e. hyperkeratosis and lesions of feet and toes) when comparing five types of litter (sand, dried mud, wheat straw, sawdust and rice straw). Breast ulcerations were found to be worse at 56 and 84 days of age when Domestic geese were kept on a dirt floor without litter compared to perforated plastic floors (Liao et al., 2022).

Perforated floors have been proposed to lead to difficulties in balancing, slipping and falling due to being slippery (Raud and Faure, 1994; Rodenburg et al., 2005), implicating difficulties in walking comfortably (**Restriction of movement**) or risk of damage leading to walking difficulties (**Locomotory disorders)**. Chen et al. (2015) found better gait scores in Domestic ducks kept on a perforated plastic net system than in birds kept in a system with deep litter floor or deep litter floor with enrichment. However, Karcher et al. (2013) reported that the flooring type, i.e. slatted floor or littered solid floor, did not affect the prevalence of ducks having walking difficulties or being culled due to leg problems, although the authors themselves questioned the validity of the results on walking ability due to uncertainty about the method used during data collection. Likewise, no difference in walking ability, measured as gait score, was found in Mule ducks housed either on plastic slats or on solid floors (Mohammed et al., 2019a), nor did the absence or type of litter (sand, wood shavings) on solid floors have any influence on walking ability. In Domestic ducks, Jones and Dawkins (2010a) showed that walking ability decreased with increasing litter moisture, which may have been linked to an increase in foot-pad dermatitis as the litter moisture increased.

Finally, the ability to rest comfortably may be affected by floor quality, including both flooring material and litter characteristics. On one hand, the presence of dry litter may increase comfort while in resting position and may aid in thermoregulation of young birds, but on the other hand, perforated floors allow airflow under the body while resting, which reduces the risk of heat stress, particularly during the later part of the growing period. However, resting problems and cold/heat stress have not been assessed in the context of this SO and the impact of floor quality on these welfare consequences is therefore not addressed further.

3.6.4. Availability, design and size of nesting facilities

Birds housed for egg production and breeders lay eggs in a nest (see Sections 3.1 and 3.5.9). The absence of a nest leads to the welfare consequence inability to perform prelaying and nesting behaviour. In birds housed individually or as a couple (1 female: 1 male) the nest serves only one female, while in birds kept in a group the same nest can be successively used by several females. However, these species like to nest individually, therefore the nest is still an 'individual nest' and the number and size are established to allow only one bird to lay in the nest at the same time. When nests for birds kept in a group are present but inadequate, it may lead to the welfare consequence inability to perform prelaying and nesting behaviour in the case that the nests do not meet the expectation of the birds. Moreover, if the number of nest per bird is insufficient, the welfare consequence of group stress could also occur, because of competition to access this resource if insufficiently provided for birds which are in a group.

Factors impacting these welfare consequences are:

- Presence of nest
- Number of nest boxes provided (or ratio of nest boxes: birds)
- Size of nest
- Design of the nest (roof, light/dark, nesting material, entrance, material of the nest box)
- Location of the nest

Any of these factors, by promoting the access to the nest when correctly provided, will lead to:

- Ability (or at least stimulation) to perform prelaying and nesting behaviour if the nest conforms to the birds' expectations (Barrett et al., 2019, 2023).

- Prevention (or reduction) of group stress, by decreasing competition and possibly aggression when trying to access the nest (Barrett et al., 2019).

There is very little knowledge about the optimal number (ratio), design, location of nests available for ducks, geese and quail, to avoid the two welfare consequences.

3.6.4.1. Nesting facilities for domestic ducks and Muscovy ducks

It has been reported that Domestic ducks raised in a group are commonly provided in commercial conditions with individual nests, with a ratio of 1 nest box for 5 females, and that the presence of a roof enhances nest attractiveness (Harun et al., 1998; Makagon et al., 2011). Moreover, ducks use the nests more when placed at floor level than when placed at a higher level. These practices are also the most common under commercial conditions with individual nests placed at floor level and only on one level. These practices are also in use for Muscovy ducks and Domestic geese. In order to avoid competition between layers for nest access, the ratio of females: nests needs attention, taking into account the overall duration of flock daily laying period (this covers a higher proportion of the day in ducks than in laying hens), the duration of the individual nesting period in case of nests provided for birds kept in group, flock size and the fact that not all nests will be used to the same extent.

Domestic ducks are motivated to lay in a nest and Barrett et al. (2021) showed that ducks are ready to work (pushing doors) to have access to their nest. In their experiment, Barrett et al. (2019) showed that among the Domestic ducks not laying in nests, some were not attracted by the nests offered (not visiting them) and others were visiting the nests but laying on the floor. The different factors which might explain why ducks did not access the nest are (for more details, see Barrett et al., 2019):

- Competition (avoiding the nest is avoiding aggression taking place there). Aggression is seen especially in the case of multiple birds in the nest, and floor eggs were higher when increasing the number of females per nest from 1 to 4 in Domestic ducks (Makagon and Mench, 2011). It has to be noted that floor laying in this study was very high at the beginning of the laying period in both cases, but it was nearly doubled when a ratio of 4 females per nest was used instead of 1/1 (these results obtained in experimental small groups were not representative of nest laying in commercial conditions). Barrett et al. (2019) hypothesised that Domestic duck are gregarious nesters and that in a small group (e.g. 8 birds), it is not leading to aggression, but that it might be the case in bigger groups. While gregarious nesting is observed in Domestic ducks, it may have been derived from brood parasitism behaviour observed in Mallard ducks nesting at high densities (Harun et al., 1998). Although gregarious nesting is seen when each female has her own nest, the behaviour is more frequent when four females need to share a nest. This finding suggests that Domestic ducks competing for nest sites may result in aggression.
- Social factors and nest design may influence bird's interest of the nest: for example, it was shown that Domestic ducks prefer nests with a higher level of concealment (e.g. with curtains and closed top) than open boxes (Makagon et al., 2011). However, no differences in floor-laid eggs were found between a nest with and without a top (Makagon and Mench, 2011). The same authors hypothesised that 'the birds did not regard the level of concealment provided by the nest boxes as sufficient and found no benefit to using them'.
- The nesting substrate could also affect the motivation of the prelaying birds. In a study of Barrett et al. (2019) sawdust was provided in the nest boxes and on the floor, and some birds laid on the floor. It might be that ducks do not prefer sawdust as nesting substrate or, alternatively that the attraction of the nest box was reduced by the lack of contrast between the floor and the nest substrate.
- Lack of motivation to enter the nest: nest-layers are likely to be more dominant than floor layers, and thus, in small groups of ducks, to have priority access to a nest box. This may not be easily applicable to commercial farms. The process of domestication may have also reduced the motivation to enter nest boxes, since the behaviour is no longer essential for the survival of an animal.
- In addition, factors such as prior experience with the nest site, and nest adaptation (Makagon et al., 2011) are found very important to enhance nest acceptance.

Nest dimensions have been reported for Domestic and Muscovy ducks from the questionnaire to umbrella stakeholder organisations (see Sections 3.4.1.1.2 and 3.4.2.1.2). Similarly, in literature, the nest boxes currently used commercially vary from 40 × 40 cm for Domestic ducks (1,600 cm^2, with a ratio 1 nest: 2 females and height 40 cm; Barrett et al., 2019) to 35 × 47 cm in experimental breeding facilities for Muscovy ducks (1,645 cm^2, ratio 1 nest: 6 females and height 61–87 cm (Virginie Michel, ANSES, personal communication, 2023).

Other important elements for expressing prelaying behaviours are the provision of dry and friable litter, like wood shavings or straw, in sufficient quantity (e.g. enough litter so that the floor is not visible) and the provision of a nest at floor level (Domestic ducks, see ToR-2). A recent study by Barrett et al. (2023) found that Pekin ducks preferred manipulable substrates (such as sawdust) as nesting material.

When given a choice between sheltered nests nearer to the ground and unsheltered higher nests, Muscovy ducks showed a clear preference to lay in the lower, but sheltered nests (Bilsing et al., 1991). Bilsing et al. (1991) also found that Muscovy ducks motivated for egg laying preferred rooms with lower illumination (15 Lux) compared to higher illumination (80 Lux) to lay. Similarly, Arboleda and Kharel (1985) found preferences for a covered nest type compared to an open nest type. Nevertheless, the Muscovy ducks laid eggs more frequently on the ground than in either of the two nest types.

3.6.4.2. Nesting facilities for domestic geese

Nest dimensions are reported for Domestic geese from the questionnaire to umbrella stakeholder organisations (see section 3.4.3.1.2). In literature, Buckland and Guy (2002) recommended a nest size of 50 × 70 cm (3,500 cm^2, with a ratio 1 nest/3–6 geese and height 70 cm) placed at ground level to optimise the proportion of eggs laid in nest and optimise egg cleanliness and hatchability.

Bogenfürst (2017) recommended a nest size of 60 × 60 cm (3,600 cm^2, with a ratio of 1 nest/max. 5 geese) to avoid floor laying and optimise egg cleanliness. The nests generally do not have separating walls. In the case that separating walls are used, the height of these should be 75 cm. These 'nest boxes' do not have a top. The nests need to have a retainer to keep the nesting material inside.

The size of nest recommended by these authors are very similar: 3,500–3,600 cm^2/bird.

The nesting material is usually straw or wood shavings, which needs to be refreshed daily. Perforated floors can be placed in front of the nests to prevent the geese carrying dirt into the nests. Geese do not choose nests that are too brightly lit (if natural light comes through the window and lights that nest), close to the entrance of the building or pen, or those located in a draft.

3.6.4.3. Nesting facilities for Japanese quail

Quail prefer to lay in cover (Schmid and Wechsler, 1997).

Experimental nest-acceptance for quail of 70% has been reported for a nest of 20 cm × 20 cm × 20 cm (400 cm^2) (Inga Tiemann, University of Bonn, personal communication, 2023). In a commercial indoor floor system, offering a nest providing 30 cm^2/per bird, 80% of eggs were reported to be laid in the nest (Aida Xercavins, IRTA, personal communication, 2023). Such percentages of nest acceptance demonstrate the motivation of quail to lay in nest. This rate of nest laying varies depending on the genetic line and husbandry systems.

3.6.5. Environmental enrichment

Environmental enrichment is the modification of the environment of captive animals with the goal to improve animal welfare (Newberry, 1995) by 'providing them sensory and motor stimulation, through structures and resources that facilitate the expression of species-specific behaviour and promote psychological well-being through physical exercise, manipulative activities, and cognitive challenges according to species-specific characteristics' (NRC, 2011). As a rule, enrichment increases the complexity of the environment, but the extent can differ. While the increased complexity can mean an increased management challenge, for the animal it increases opportunities to interact with the environment in an adaptive way. Young (2003) summarised that the goal of environmental enrichment is to increase the number of species-specific behaviour patterns and of behavioural diversity, to reduce frequencies of abnormal behaviour and to enhance the animal's ability to cope with challenges.

Therefore, adequate enrichment may prevent or mitigate a wide range of welfare consequences, namely the **restriction of movement**, **inability to perform comfort behaviour, to perform exploratory or foraging behaviour**, and the occurrence of **soft tissue lesions and integument damage**, and **locomotory disorders** as well as **group stress**.

Following Xu et al. (2022), environmental enrichment can be categorised into provision of manipulable material (e.g. substrate for foraging or dust bathing, or water for comfort behaviour and foraging), structural equipment (e.g. elevated areas for perching or cover for hiding) and outdoor access.

Environmental enrichments that are considered in the following sections are:

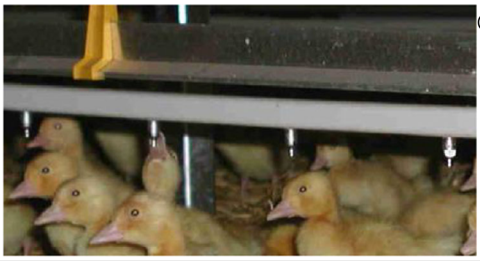
- Open water provision (for other purposes than drinking) in waterfowl.
- Enrichment allowing dust bathing in quail.
- Foraging-related enrichments.
- Elevated areas and cover.
- Outdoor access.

3.6.5.1. Open water provision

In waterfowl, different options to provide open water with regards to shape, surface area and depth of the water facility (see Table 46) allow different degrees of diving, swimming, bathing, head dipping, wet preening, nostril cleaning and dabbling/sieving (e.g. Bulheller et al., 2004). The differences in design of the equipment and degree of accessibility of (open) water have not only effects on the freedom to perform species-specific behaviour, but also on necessary hygiene measures and water usage.

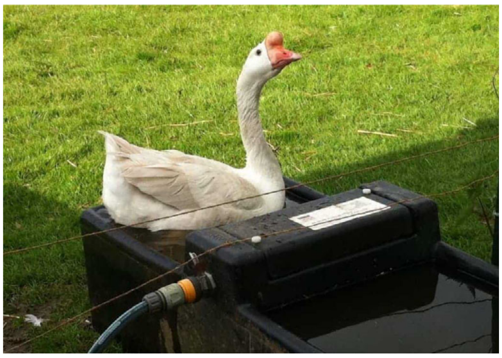
There is almost no research on the strength of **motivation** to reach and use open water (for ducks reviewed by Babington and Campbell, 2022). For Domestic ducks, Cooper et al. (2002) tested preferences towards different water resources where the birds had to overcome barriers of different heights, and found that the highest barrier was passed most often to reach a water trough with the largest surface area and depth. Another indication of high motivation is redirected or sham behaviour in the absence of the resources. Where open water is not available, waterfowl may redirect their need for dabbling/sieving in water to some extent towards the litter on the floor (Molnár et al., 1998, 2004; Bogenfürst, 1999; Abdel-Hamid et al., 2020) or show sham bathing (Gillette, 1977; Jones and Dawkins, 2010b; Makagon and Riber, 2022).

Table 46: Different types of water provision for ducks and geese, with indications of the behaviours that the birds can express

Type of water provision	**Exemplary image**	**Behaviours that can be expressed by animals using this water source:**
1) Nipple drinker without drip tray	 © Ute Knierim	• Drinking • Limited wet preening
2) Nipple drinker with drip tray	 © LUBING Maschinenfabrik, Germany	• Drinking • dabbling/sieving • Limited wet preening

Type of water provision	Exemplary image	Behaviours that can be expressed by animals using this water source:
3) Nipple drinker with pendulum and cup	 © Ute Knierim	• Drinking • Dabbling/sieving • Limited wet preening
4) Nipple drinker with pendulum and deep cup	 © LUBING Maschinenfabrik, Germany	• Drinking • Dabbling/sieving • Nostril cleaning • Limited wet preening
5) Round drinker with narrow rim	 © Ute Knierim	• Drinking • Dabbling/sieving • Nostril cleaning • Limited wet preening
6) Round drinker with wider rim	 © Ute Knierim	• Drinking • Dabbling/sieving • Nostril cleaning • Limited wet preening
7) Deep bell drinker (only usable from about 3 weeks of age onwards)	 © Ute Knierim	• Drinking • Dabbling/sieving • Nostril cleaning • Head dipping • Limited wet preening

Type of water provision	Exemplary image	Behaviours that can be expressed by animals using this water source:
8) Deep open bell drinker (only usable from about 3 weeks of age onwards)	 Küster (2007)	• Drinking • Dabbling/sieving • Nostril cleaning • Head dipping • Limited wet preening
9) Drinker trough ***(from commercial website – needs permission)***	 © Courtesy of Osprey/BEC	• Drinking • Dabbling/sieving • Nostril cleaning • Head dipping • Limited wet preening
10) Shower	 © Ute Knierim	• Wet preening
11) Shallow bathing trough with daily water exchange	  © Ute Knierim	• Drinking • Dabbling/sieving • Nostril cleaning • Head dipping • Wet preening • Incomplete bathing • Swimming and diving attempts

Type of water provision	Exemplary image	Behaviours that can be expressed by animals using this water source:
12) Cattle trough ***(from BWA website – needs permission)***	 © Morag Jones	• Drinking • Dabbling/sieving • Nostril cleaning • Head dipping • Wet preening • Bathing
13) Deep bathing trough with filtering of water	 © Ute Knierim	• Drinking • Dabbling/sieving • Nostril cleaning • Head dipping • Wet preening • Incomplete bathing • Bathing • Swimming • Diving
14) Pool		• Drinking • Dabbling/sieving • Nostril cleaning • Head dipping • Wet preening • Incomplete bathing • Bathing • Swimming • Diving

Apart from allowing the performance of species-specific behaviour as such, a further positive welfare effect of open water accessibility, with or without further foraging-related enrichment, may relate to the prevention of **feather pecking and cannibalism**. These are serious problems in Muscovy ducks (Gustafson et al., 2007a) and to a lesser degree (feather pecking reported, but not cannibalism) in Mule ducks (Mahmoud et al., 2021). Feather pecking is sometimes even reported in Domestic ducks when they are housed without litter (Leipoldt, 1992; Gustafson et al., 2007b; Karcher et al., 2013). Feather pecking was also observed in geese, particularly when housed indoors (Boz et al., 2021), but with low frequencies. Only little research has been done on the effect of enrichment on these abnormal behaviours or the consequences on plumage and skin, with heterogenous results in Muscovy ducks (Klemm et al., 1995; Knierim et al., 2005; Riber and Mench, 2008; Mohammed et al., 2015). Klemm et al. (1995) found a reducing effect of open water (shallow bathing trough, 15 cm deep) provided in an outdoor run (veranda) on feather pecking, but only if bathing water was already provided early in life (from day 3 of life onwards). Furthermore, keeping the Muscovy ducks in a mixed group with Domestic ducks increased the effect (Klemm et al., 1995). Riber and Mench (2008) studied the provision of open water (shallow trough, 10 cm deep with or without mostly non-edible enrichment material) in small groups (17 ducks) of bill-intact Muscovy ducks from day 6 of age onwards, and only found a general interaction between treatment and age. In the control groups (without open water and any other enrichment), frequency of feather pecking was significantly higher than in groups that were water-enriched or feed-enriched (with different edible enrichment material) at 14 days of age, and higher than in feed-enriched groups at 18 days of age, with no differences between the water- and feed-enriched groups. Although cannibalistic behaviour was not observed as such (likely due to the applied scan sampling method), a total of 56.4% of the ducks were injured, with no significant differences between treatments. Also, Knierim et al. (2005) found feather pecking and cannibalism in all treatment groups, each including 400 female bill-trimmed Muscovy ducks that were provided with either bell drinkers, a shower, a shallow bathing trough or deep bathing trough and were kept on perforated plastic floors. No consistent differences regarding injuries could be found between treatments, but the plumage was in general less intact with restricted water access. Mohammed et al. (2015) observed lower frequencies of feather pecking in small groups (6 Muscovy ducks) from day 37 to 70 of age with a water bath provided (no further details given) compared to no water bath (n = 2). Overall, it appears that preventive effects of enrichment are more likely on feather pecking than on cannibalism, although in Muscovy ducks, Knierim et al. (2005) observed that cannibalism exclusively developed as a consequence of feather pecking. In any case, despite beneficial effects of availability of litter, open water, foraging material and outdoor access, enrichment alone is often not sufficient to prevent the occurrence of feather pecking and cannibalism. It is likely that, similar to laying hens, further factors (e.g. reviewed by Jung and Knierim, 2018) also play an important role.

In breeding geese, provision of open water may also mitigate pecking of the gander’s phallus which was observed in intensive systems without open water access (Bogenfürst, 2017).

Furthermore, an open water trough in Muscovy ducks (Knierim et al., 2005) or swimming pool in Domestic geese (Liao et al., 2021) was found to positively affect **foot-pad health**. Further positive effects of the use of open water for preening, head dipping or (incomplete) bathing relate to the condition of **nostrils** (Heyn et al., 2009; Jones et al., 2009; O’Driscoll and Broom, 2011; Bogenfürst, 2017), **eyes** (Knierim et al., 2005; Jones et al., 2009; Jones and Dawkins, 2009, Jones and Dawkins, 2010a; Bogenfürst, 2017; Liao et al., 2022) and **plumage** in terms of cleanliness and completeness (Knierim et al., 2005; Bogenfürst, 2017; Liao et al., 2022). The latter is not only due to a possible reduction of feather pecking, as discussed above, but also to better body care through preening and bathing. There are indications that bathing opportunities lead to significantly longer durations of preening (Raud and Faure, 1994; Ruis et al., 2003; Knierim et al., 2005), although not all investigations confirmed this (e.g. Reiter et al., 1997, but with very small sample size). Specifically, wet preening depends on water accessibility; with oiling of the feathers being a very important part (Babington and Campbell, 2022). This helps to maintain the fine feather structures, sustaining their water-repellent characteristics (Bezzel, 1977). The well-groomed oily feathers are also likely more dirt-repellent (Knierim et al., 2005). Not all studies did find similar positive effects of open water on all ABMs alike. For instance, eye condition was worse in Domestic geese kept without access to a swimming pool at 84 days of age, and feather cleanliness decreased (at 56 and 84 days) compared to birds kept with access to a swimming pool, but nostril condition was not affected (Liao et al., 2022). O’Driscoll and Broom (2011) found decreasingly dirty and blocked nostrils and dirty plumage (but not eye disorders) in Domestic ducks in the order from access to only a nipple drinker, over a bell drinker to a water trough and bath. An exception were the groups where water was provided via a bell drinker in a littered area. Here, plumage was dirtier compared to nipple drinkers in a littered area. Thus, further factors such as water quality, air quality and cleanliness of the surroundings also play an important role. For example, Jones and Dawkins (2010a) reported higher incidences of eye disorders (eyes closed or half closed permanently, or conjunctivitis) from houses with nipple drinkers only when they simultaneously had poor ventilation leading to higher air temperatures and ammonia contents. On the other hand, as mentioned above, if open water is not provided in a well-drained area, it may lead to deteriorated litter conditions and consequently impair bird welfare (see also Section 3.6.3). High levels of ammonia can develop, which promote eye disorders (for broiler chickens: Miles et al., 2006). No data specific to ducks or geese exist, but it can be considered that similarly to broiler chickens, longer term exposure to high ammonia concentrations is detrimental. Negative effects of water troughs (ca. 13 cm deep) compared to nipple drinkers under commercial US management conditions on eyes, nostrils, feathers, foot pads and **mortality** have been reported by Schenk et al. (2016), in ducks under commercial US management conditions, although nostril condition at 33 days of age is inconsistently reported as worse and better. Here, ammonia content in the air was higher in the water trough treatment during the last three study weeks when duck condition deteriorated. Probably one reason was that litter management was aligned to the treatment with nipple drinkers and not to the pens with open water where water spillage likely increased the need for topping up or exchange of litter. In line with Liste et al. (2013), physical and microbiological water quality in the troughs were found to be problematic despite twice daily water exchange. However, while Liste et al. (2012a) evaluated feather cleanliness, foot condition and mortality rates as 'good standard overall' compared with industry norms (though not compared with a control without open water), Schenk et al. (2016) evaluated the outcomes in ducks with open water access as reflecting impaired welfare. The water surface provided to the ducks was very small in both studies. Schenk et al. (2016) provided two troughs that were each 1.8 m long and 0.2 m wide for 1,000 ducks which amounts to a water surface of 0.00073 m^2/duck. In comparison, the space allowance calculations presented in Section 3.6.1 result in a minimum water surface of 0.022/duck. Furthermore, drinking water was only provided in troughs, which might be problematic not only for sanitary reasons, but also because ducks use bell drinkers more when the quality of bathing water decreases (Liste et al., 2012b). Therefore, part of the problems that Schenk et al. (2016) encountered may be due to the high stocking density at the troughs, deteriorated floor and air quality and lack of additional drinkers. In general, it indicates that, besides high water usage, providing open water sources may present some management challenges.

As yet, no scientific investigations are available on the effect of different numbers of water facilities and their space allowances on frequencies and durations of water-related behaviours and hygienic conditions. Such investigations would be complex, because many aspects relating to type of water facility, possible combination of different facilities, bird type and environmental conditions will affect the results. In the absence of specific scientific evidence, for ducks, the practice-derived recommendations presented in Tables 9 and 12 on minimum drinker numbers or space may serve as a guideline. With respect to water facilities that allow full body contact, some guiding figures can be derived from the space allowance calculations presented in Section 3.6.1 (Tables 38–40).

In hot environments, open water access may facilitate **thermoregulation** (reviewed for ducks by Babington and Campbell, 2022). For instance, Farghly et al. (2017) found beneficial effects on growth performance, heterophils/lymphocytes ratio, body temperature and mortality rates in Muscovy ducks particularly when the ducks had (2 hours) access to swimming water during midday.

Water depth (10 cm vs. 20 cm and 30 cm) did not affect the percentage of time Domestic ducks spent inside or outside a pool nor the extent of preening, particularly the time spent head and body dipping and the frequency of shaking, stretching and wing flapping (Liste et al., 2012a). However, other **frequencies of water-related behaviours** were influenced. The ducks showed more locomotion, but also stayed more inactive on the deeper pools, while they performed more dabbling (a form of foraging behaviour) in the shallow pool which in total was used more often. Liste et al. (2012a) noted that different water depths were used in different ways. Concordantly, Knierim et al. (2005) found that Muscovy ducks showed swimming and diving in a deep bathing trough (25 cm at deepest point), while (after 2 weeks of age) they only showed swimming attempts and diving attempts in a shallow trough (6 cm deep). Also, complete bathing behaviour sequences were not performed in the shallow trough after 5 weeks of age, whereas all other water-related behaviours (incomplete bathing sequences, head dipping, dabbling, catching water drops, drinking) were observed at both trough depths. In contrast, at the rim of bell drinkers, ducks older than 3 weeks only showed drinking and dabbling (Knierim et al., 2005). In deep open bell drinkers (44 cm diameter, 10 cm deep, see Annex B), Heyn et al. (2009) observed head dipping in Domestic ducks. No studies were found on water depth to allow swimming in geese. However, based on morphometric calculation (tibia and metatarsus length: Saatci and Tilki, 2007; femur length: Dogan and Takci, 2021), EFSA experts estimated a depth of 40 cm.

Open water sources can be combined with material stimulating foraging behaviour such as plastic strings (Riber and Mench, 2008) or outdoor access (e.g. Klemm et al., 1995; Abo Ghanima et al., 2020). Water-based enrichment has been found to increase foraging behaviour of Muscovy ducklings (Riber and Mench, 2008).

3.6.5.2. Enrichment allowing dust bathing in quail

In quail, sham dust bathing is performed in cages where litter is not available (Geerken and Petersen, 1992). Furthermore, Schein and Statkiewicz (1983) found high levels of dust bathing when deprivation of a dust bathing substrate was terminated, indicating the presence of built-up motivation. In addition, monopolisation of the dust bath by one bird in couple cages, as reported by Miller and Mench (2006), may indicate that the birds regard it a valuable resource. There is no reason to expect that quail differ from domestic fowl in their need to perform dust bathing, for which ample evidence is present (EFSA AHAW Panel, 2023a).

Regarding suitable substrate for dust bathing in quail, not much information is available. Schmid and Wechsler (1997) observed quail in semi-natural outdoor aviaries with mainly natural soil and a central smaller area with a mixture of wood chips and humus. The birds predominantly dustbathed in the soil (91% of 271 events) and only sometimes in the wood chips. The authors also reported that certain dust bathing sites were regularly used by the birds. Although other factors (such as location) may have influenced the quails' choices, it is likely that, comparable to laying hens (EFSA AHAW Panel, 2023a), quail prefer fine and friable material for dust bathing. For instance, Miller and Mench (2006) provided separate sand-filled dust bathing areas and found that they were well accepted by the quail. Guiding figures on the size of separate dust bathing areas can be derived from the space allowance calculations presented in Section 3.6.1 (Table 41).

3.6.5.3. Foraging-related enrichments

The provision of litter on the floor, instead of fully perforated floors without litter as frequently used for Muscovy and Mule ducks, or cage floors (quail and breeders), can be regarded as part of enrichment, as the provision of litter material can stimulate foraging behaviour and, in quail, dust bathing (Schmid and Wechsler, 1997; Nordi et al., 2012). However, in addition, foraging-related enrichment can include attractive forage such as fresh plant material, silage or hay/straw, balls of straw or alfalfa or even mealworms in troughs, racks or on astroturf mats (Bierschenk et al., 1992; Knierim et al., 2005; Riber and Mench, 2008).

Provision of roughage, fresh or dried fodder, or silage is particularly important for geese without access to pasture, because geese are adapted to grazing and can consume up to 1.2 kg of grass per day from 13 to 18 weeks (Leprettre et al., 2000). When access to a grazing area cannot be provided, for instance, maize can be offered in racks, and can reach a consumption of 0.4–0.6 kg per day from 13 to 18 weeks (Leprettre et al., 2000).

Effects of enrichment unrelated to water on feather pecking and cannibalism in Muscovy ducks has seldomly been investigated (Bierschenk et al., 1992; Riber and Mench, 2008). However, it is likely that it is one further contributory factor to the mitigation of this abnormal behaviour like in laying hens (reviewed by Jung and Knierim, 2018; van Staaveren et al., 2021).

Feather pecking, and additionally aggressive pecking, is also reported for quail in cages (Miller and Mench, 2006; Taskin and Camci, 2017). Taskin and Camci (2017) found that the provision of pecking blocks significantly lowered injury numbers and feather damage, most likely due to a considerable abrasion of the beak. The growth of overlong beaks can furthermore hinder preening or even feeding (Bergmann et al., 2020). Also pecking and scratching as part of foraging behaviour in soil or litter (Schmid and Wechsler, 1997) can be important to prevent beaks and claws from becoming too long and presenting a welfare problem (Bergmann et al., 2020).

3.6.5.4. Structural equipment (elevated areas and cover)

The structural complexity of an enclosure can be enhanced by perches or elevated areas for Muscovy ducks. Although the flying ability of Muscovy ducks is largely reduced due to selection for heavier birds, Knierim et al. (2005) reported that structures such as frames with AstroTurf mats with silage (Figure 8) have also been used by female Muscovy ducks (from the eighth week of life onwards) for perching, but also for rest under or in close contact to these structures. Similarly, ramps leading to water facilities appeared to be attractive resting places, which can also be due to the nearby water, because feral Muscovy ducks were found to often rest at the shoreline (Downs et al., 2017).

Structural equipment such as perches for Muscovy ducks mainly allow the performance of the species-specific **perching** behaviour, although, as discussed above, the heavy birds commercially used are not able to fly up high. Brügesch et al. (2011) found that male Muscovy ducks from 32 to 74 days of age used perches intensively during the day, with a considerably higher use of perches that were only 4 cm high compared to a height of 18 cm.

Figure 8: Frames with AstroTurf mats on which silage can be distributed (Knierim et al., 2005)

Elevated areas with ramps for quail may be used to increase space provision (BLV, 2020), although it has been reported that quail show only a limited interest in utilising such elevated structures (Schmid and Wechsler, 1997). Quail are ground-living birds and do not perch. At the same time, they show a clear preference for staying under natural or artificial cover (Schmid and Wechsler, 1997). The provision of cover appears to be important to limit their typical **flight behaviour**, the flying up vertically, that may result in head injuries and mortality. Buchwalder and Wechsler (1997) performed preference tests with different types of cover and found that quail preferred to stay in cover types that were partially or fully open to the sides compared with cover types that were partially or fully open to the top. When confronting the birds individually with a flight inducing stimulus, the birds showed significantly less flight behaviour if they were in cover. Cover may be provided by wooden boxes or similar sheltering structures, or by natural vegetation, which additionally may stimulate exploratory and foraging behaviour (Laurence et al., 2015).

3.6.5.5. Outdoor access

The highest degree of complexity and variability of stimuli is likely reached in outdoor environments with variable vegetation, structures and animal inhabitants such as insects, molluscs, worms or small vertebrates. For geese especially, the opportunity to graze is important and grass intake can be considerable (Leprettre et al., 2000). In addition, in indoor systems with outdoor access, retreat from conspecifics is facilitated, thereby lowering the stocking density indoors and providing the choice between different microclimatic areas.

Outdoor access can also be provided by a veranda with a concrete floor. This allows the birds to retreat from conspecifics, experience outdoor climatic conditions and unfiltered natural light with higher shares of UV radiation. The latter allows recognition of certain colour-mediated information (e.g. in the plumage of other birds), as birds are sensitive to wavelengths as low as 340 nm (Prescott et al., 2003; for mallards: Parrish et al., 1984). In addition, the provision of enrichment in natural light may stimulate stronger activity than enrichment alone, as has been found for broilers (de Jong and Gunnink, 2019). Many of the stimuli mentioned above for outdoors are lacking when a veranda with concrete floor is provided, but a veranda offers protection from adverse weather conditions and from contact with wild animals to differing degrees, depending on its design.

Outdoor areas combine the different elements of enrichment, presented in the sections above, to differing degrees, together with unfiltered light, air quality differing from indoor conditions and increased space allowances. Thus, outdoor areas have great potential to contribute to improved welfare by allowing and stimulating species-specific behaviour to greater extent (EFSA AHAW Panel, 2023a), although risks due to predation, infection and adverse weather effects need to be taken into account as well as challenges to maintain favourable range conditions.

3.7. ToR-2, welfare consequences related to husbandry systems: conclusions and recommendations

In this SO, the assessment of the relevance of the welfare consequence (i.e. the risk that a welfare consequence occurs) in a husbandry system is based on the prevalence of the hazards in each husbandry system (see Section 2.2.3.2).

efsa JOURNAL

The following conclusions are derived from the results showed in Tables 30–33, referring to the highly prevalent hazards and considering the following seven welfare consequences: restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness), inability to perform exploratory or foraging behaviour and inability to express prelaying and nesting (maternal) behaviours (for more details, see Section 3.5.10.2). Welfare consequences that were considered not applicable for a certain category were not mentioned in the conclusions.

3.7.1. Conclusions on domestic ducks (see Table 30)

3.7.1.1. Domestic duck breeders

1) All the assessed welfare consequences (restriction of movement, group stress,[33] inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness), inability to perform exploratory or foraging behaviour as well as inability to express prelaying and nesting behaviours) are more relevant for Domestic duck breeders housed in individual cages than in indoor floor systems (90–100% certainty).

3.7.1.2. Domestic ducks for the production of meat

1) All the assessed welfare consequences (restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness) and inability to perform exploratory or foraging behaviour) are more relevant in the case of Domestic ducks for the production of meat housed in indoor floor systems than in indoor floor systems with outdoor access or in outdoor systems (90–100% certainty).

3.7.2. Conclusions on Muscovy and mule ducks (see Table 31)

3.7.2.1. Muscovy duck breeders

1) All the assessed welfare consequences (restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness), inability to perform exploratory or foraging behaviour and inability to express prelaying and nesting behaviours) are more relevant for Muscovy duck breeders housed in individual cages rather than in indoor floor systems (90–100% certainty).

3.7.2.2. Muscovy and mule ducks for meat and foie gras production (starting and growing phases)

1) Five of the assessed welfare consequences (restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage and inability to perform exploratory or foraging behaviour) are more relevant for Muscovy and Mule ducks during the starting and growing phases of meat and foie gras production housed in indoor floor systems than in indoor floor systems with outdoor access or in outdoor systems (66–100% certainty).
2) The welfare consequence 'Locomotory disorders (including lameness)' resulted not to be relevant in any of the three systems considered.

3.7.2.3. Muscovy and mule ducks for foie gras production during overfeeding phase

1) All the hazards leading to the welfare consequences 'locomotory disorders (including lameness)' and 'inability to perform exploratory or foraging behaviour' are highly prevalent in all three husbandry systems (elevated collective cage systems indoor, elevated pen systems indoor and floor pen systems indoor). (66–100% certainty).
2) The welfare consequences restriction of movement, group stress, inability to perform comfort behaviour, and soft tissue lesions and integument damage are more relevant for Muscovy and Mule ducks during the overfeeding phase housed in elevated collective cage

[33] Group stress in the context of individual cages is considered as the lack of physical contact with conspecifics and agonistic interaction between adjacent birds (see Section 3.5.3.1).

systems indoor rather than in elevated pen systems indoor or floor pen systems indoor (66–100% certainty).

3) The welfare consequences group stress and soft tissue lesions and integument damage are more relevant for Muscovy and Mule ducks during the overfeeding phase when housed in elevated pen systems indoor rather than in floor pen systems indoor (66–100% certainty).

3.7.3. Conclusions on domestic geese (see Table 32)

3.7.3.1. Domestic geese breeders

1) Six of the assessed welfare consequences (restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness) and inability to perform exploratory or foraging behaviour) are more relevant for Domestic geese breeders housed in indoor floor systems than in indoor floor systems with outdoor access (66–100% certainty).
2) The welfare consequence 'Inability to express prelaying and nesting (maternal) behaviours' resulted not to be relevant in any of the three systems considered.

3.7.3.2. Domestic geese for meat and foie gras production (starting and growing phases)

1) All the assessed welfare consequences (restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness) and inability to perform exploratory or foraging behaviour) are more relevant for Domestic geese during the starting and growing phases of meat and foie gras production housed in indoor floor systems than in indoor floor systems with outdoor access or in outdoor systems (66–100% certainty).

3.7.3.3. Domestic geese during for foie gras production during overfeeding phase

1) All hazards leading to the assessed welfare consequences (restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness) and inability to perform exploratory or foraging behaviour) are equally prevalent in the two husbandry systems (elevated pen systems indoor and floor pen systems indoor)(66–100% certainty).

3.7.4. Conclusions on Japanese quail (see Table 33)

3.7.4.1. Japanese quail breeders

1) Six of the assessed welfare consequences (restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness) and inability to perform exploratory or foraging behaviour) are more relevant for Japanese quail breeders housed in couple or collective cages than in indoor floor systems (66–100% certainty).
2) The hazard leading to the welfare consequence inability to express prelaying and nesting behaviours' is highly prevalent in both couple and collective cages.

3.7.4.2. Japanese quail for the production of meat (broiler quail)

1) For five of the assessed welfare consequences (restriction of movement, group stress, soft tissue lesions and integument damage, locomotory disorders (including lameness) and inability to perform exploratory or foraging behaviour), all hazards except 'insufficient space allowance per bird' are generally of low prevalence in broiler quail housed in indoor floor systems (50–100% certainty).
2) The welfare consequence inability to perform comfort behaviour resulted not to be relevant for broiler quail housed in indoor floor systems.

3.7.4.3. Japanese quail for the production of eggs (layer quail)

All the assessed welfare consequences (restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness), inability to perform exploratory or foraging behaviour and inability to express prelaying and nesting behaviours) are more relevant for layer quail housed in collective cages than in indoor floor systems (66–100% certainty).

3.7.5. ToR-2: overall recommendations

1) The currently used husbandry systems as described in this SO and called cages (individual, couple or collective) and the systems currently used during the overfeeding phase for foie gras production as described in this SO, should be avoided as they lead to high risk of occurrence of the welfare consequences considered in this SO (see Tables 30–33).
2) To reduce the risk of the birds experiencing the welfare consequences considered in this opinion (restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness), inability to perform exploratory or foraging behaviour and inability to express prelaying and nesting (maternal) behaviours), the preventive measures described in ToR-3 should be applied in all husbandry systems.
3) Further research is recommended on the welfare consequences of rearing practices (e.g. overfeeding) which are not covered from the current mandate.

3.8. ToR-3: conclusions and recommendations in relation to specific factors

3.8.1. Space allowance

3.8.1.1. Space allowance (behavioural space model)

3.8.1.1.1. Conclusions on space allowance

Domestic ducks (based on an average weight of 3.0 kg)

1) The space allowance required to prevent restriction of movement, inability to perform comfort behaviour and inability to perform exploratory or foraging behaviour is 4,139 cm^2/bird (90% certainty interval 0.38–0.45) corresponding to 7.2 kg/m^2 (90% certainty interval 6.74–7.82 kg/m^2). However, this space will not allow complete water bathing.
2) To allow domestic ducks to exhibit complete water bathing (with full body contact with the water surface) an additional minimum 5.3% of this space should be open water (219 cm^2/bird and at least a minimum surface area of 10,188 cm^2 per enclosure).
3) The minimum space allowance per bird to perform only stationary behaviours is 3,355 cm^2/bird, (0.30 ducks/m^2). This space will not prevent restriction of movement, inability to perform comfort behaviour and inability to perform exploratory or foraging behaviour.

Muscovy and Mule ducks (based on an average weight of 4.4 kg)

1) The space allowance required to prevent restriction of movement, inability to perform comfort behaviour and inability to perform exploratory or foraging behaviour is 4,061 cm^2/bird (90% certainty 0.38–0.43) corresponding to 10.8 kg/m^2 (90% certainty interval 10.20–11.47 kg/m^2). However, this space will not allow complete water bathing.
2) To allow Muscovy and Mule ducks to exhibit complete water bathing (with full body contact with the water surface) an additional minimum 4.6% of this space should be open water (187 cm^2/bird and at least a minimum surface area of 12,010 cm^2 per enclosure).
3) The minimum space allowance per bird to perform only stationary behaviours is 3,049 cm^2/bird, (3.3 ducks/m^2). This space will not prevent restriction of movement, inability to perform comfort behaviour and inability to perform exploratory or foraging behaviour.

Domestic geese (based on an average weight of 6.7 kg)

1) The space allowance required to prevent restriction of movement, inability to perform comfort behaviour and inability to perform exploratory or foraging behaviour is 7,776 cm^2/bird (90% certainty interval 0.71–0.89) corresponding to 8.5 kg/m^2 (90% certainty interval 7.53–9.44 kg/m^2). However, this space will not allow complete water bathing.
2) To allow Domestic geese to exhibit complete water bathing (with full body contact with the water surface) an additional minimum 15% of this space should be open water (1,166 cm^2/bird, minimum surface area of 24,728 cm^2 per enclosure).
3) The minimum space allowance per bird to perform only stationary behaviours is 4958 cm^2/bird, (2 geese/m^2). This space will not prevent restriction of movement, inability to perform comfort behaviour and inability to perform exploratory or foraging behaviour.

Japanese quail (based on an average weight of 0.3 kg)

1) The space allowance required to prevent restriction of movement, inability to perform comfort behaviour and inability to perform exploratory or foraging behaviour is 581 cm^2/bird (90% certainty interval 529–633 cm^2/bird) corresponding to 5.2 kg/m^2 (90% certainty interval 4.74–6.67 kg/m^2). However, a minimum length of the enclosure is necessary to allow the Japanese quail to fly and jump. The minimum length has been estimated in 2 m (Section 3.6.1.2).
2) Of this space allowance, a minimum area of 5.5% with preferred substrate (32 cm^2/bird, minimum of 1,155 cm^2) will allow Japanese quail to exhibit complete dust bathing.
3) The minimum space allowance per bird to perform only stationary behaviours is 429 cm^2/bird, (23.3 quail/m^2). This space will not prevent restriction of movement, inability to perform comfort behaviour and inability to perform exploratory or foraging behaviour.

3.8.1.1.2. Recommendations on space allowance

Domestic ducks (based on an average weight of 3.0 kg)

1) Space allowance of minimum 4,139 cm^2/bird on dry land should be provided to prevent restriction of movement, inability to perform comfort behaviour and inability to perform exploratory or foraging behaviour in husbandry system where water provision allows only head dipping.
2) An additional area as open water of at least 219 cm^2/bird should be provided to allow birds to exhibit complete water bathing, or in any case not less than of 10,188 cm^2 per enclosure.

Muscovy and Mule ducks (based on an average weight of 4.4 kg)

1) Space allowance of minimum 4,061 cm^2/bird on dry land should be provided to prevent restriction of movement, inability to perform comfort behaviour and inability to perform exploratory or foraging behaviour in situations where water provision allows head dipping.
2) An additional area as open water of at least 187 cm^2/bird should be provided to allow birds to exhibit complete water bathing, or in any case not less than of 12,010 cm^2 per enclosure.

Domestic geese (based on an average weight of 6.7 kg)

1) Space allowance to prevent restriction of movement, inability to perform comfort behaviour and inability to perform exploratory or foraging behaviour in situations where water provision allows head dipping only should be at least 7,776 cm^2/bird.
2) An additional area as open water of at least 1,166 cm^2/bird should be provided to allow birds to exhibit complete water bathing, or in any case not less than 24,728 cm^2 per enclosure.

Japanese quail (based on an average weight of 0.3 kg)

1) Space allowance to prevent restriction of movement, inability to perform comfort behaviour and inability to perform exploratory or foraging behaviour should be at least 581 cm^2/bird.
2) To allow birds to exhibit complete dust bathing a minimum area of 32 cm^2/bird should be provided with preferred substrate, or it any case not less than 1,155 cm^2 per enclosure.
3) Further studies should be carried out on the minimum enclosure length to allow quail to fly and jump.

3.8.1.2. Minimum enclosure

3.8.1.2.1. Conclusion on minimum floor area of the enclosure

1) Birds require a minimum total floor area in their enclosure to prevent the welfare consequences of restriction of movement, group stress, locomotory disorders, soft tissue lesions and integument damage, inability to perform exploratory and foraging behaviour. Adequate information to define the area required for this purpose in any of the species considered in this Opinion is currently unavailable.

3.8.1.2.2. Recommendation on minimum floor area of the enclosure

1) Research should be carried out to define the minimum total floor area of an enclosure required to prevent the welfare consequences of restriction of movement, group stress, locomotory disorders, soft tissue lesions, inability to perform exploratory and foraging behaviour, for all the species considered in this Opinion.

3.8.1.3. Minimum height of the enclosure

3.8.1.3.1. Conclusions on minimum height of the enclosure

1) To prevent the welfare consequences of restriction of movement and inability to perform comfort behaviour, and to minimise the risk of soft tissue lesions and integument damage and bone lesions (including fractures and dislocations), enclosure height must allow a bird to adopt a normal standing posture and to perform wing flapping. This height should be measured from the surface of the floor, or any additional litter which might increase in depth over time or, in the case of Muscovy ducks only, from the top of any perch or elevated structure which is provided, to the lower part of the ceiling.
2) For the relevant species, the minimum height allowing the prevention of the above-mentioned welfare consequence is: 66 cm in Domestic duck; 96 cm in Muscovy and Mule duck; 127 cm Domestic goose (66–100% certainty).
3) The minimum height required for Japanese quail to exhibit vertical jumping and flying when startled, without high risk of incurring soft tissue lesions and integument damage and bone lesions (including fractures and dislocations) is 150 cm (66–100% certainty).
4) However, a minimum height of 2 m will allow the stockperson to inspect the birds.

3.8.1.3.2. Recommendations on height of the enclosure

1) The minimum height for enclosures should be: 66 cm for Domestic duck, 96 cm for Muscovy and Mule ducks and 127 cm for Domestic goose.
2) For Japanese quail, the minimum estimated height of the enclosure to prevent injuries when flying or jumping vertically should be 150 cm, however further research is needed to confirm this estimation.
3) To allow stockperson to enter the husbandry system for inspection, the minimum height, from floor to ceiling should be 2 m.

3.8.2. Size of the group

3.8.2.1. Conclusions on size of the group

1) There is no scientific evidence to conclude on any maximum group size.
2) The minimal group size preventing isolation is two birds for immature birds and adult females. However, in the case of mature birds of mixed sex, adequate sex ratio is an important consideration to avoid unwanted sexual behaviour as well as aggression between males.
3) There are developing technologies, at different levels of readiness, that will allow to collect the type of data that requires birds currently kept in individual enclosures, to avoid isolation. Options may include using precision livestock farming techniques when animals are kept in groups and/or alternative selection strategies based on keeping genetically related individuals together.

3.8.2.2. Recommendations on size of the group

1) Birds should not be kept individually.
2) The recommended minimum group size for Domestic ducks, Muscovy and Mule ducks, Domestic geese and Japanese quail is two for immature birds and females only.
3) In case of one or more mature males in the group, the recommended sex ratio defines the minimum group composition. More research is needed to identify the optimal sex ratio.
4) Further research is needed to investigate the maximum group size.
5) It is recommended to further develop and implement alternative methods to collect the type of data that requires birds currently to be kept in isolation in individual cages, to allow keep the birds in group all the time. Options may include using precision livestock farming techniques when animals are kept in groups and/or alternative selection strategies based on keeping genetically related individuals together, to avoid isolation.

3.8.3. Floor quality

3.8.3.1. Conclusions on flooring material

1) Littered solid floors provide, in comparison to perforated floors, improved opportunities for ducks, geese and quail to perform exploratory and foraging behaviour. This requires that the litter is of a good quality, i.e. dry, friable and free of physical, chemical and microbiological hazards.
2) Provision of littered solid floors to ducks, geese and quail will prevent or reduce injurious pecking and group stress as compared to floor with lack of litter (66–100% certainty).
3) Littered floors will, in comparison to perforated floors, increase the risk of feather dirtiness in waterfowl if litter quality is poor. This risk is particularly high at the part of the floor close to water sources.
4) Littered solid floors will, in comparison to perforated floors, reduce the risk of soft tissue lesions and integument damage, particularly foot-pad dermatitis, in waterfowl.
5) The flooring material, either perforated or littered solid floors, does not affect locomotory disorders in waterfowl (50–100% certainty).

3.8.3.2. Conclusions on litter characteristics

1) Litter material with high water absorption and drying capacity maintains high litter quality, which stimulates exploratory, foraging and comfort behaviour and prevents or mitigates group stress (due to injurious pecking), as well as soft tissue lesions and integument damage, and locomotory disorders.

3.8.3.3. Conclusions on litter management

1) Litter management is important to maintain good quality litter, i.e. dry, friable and free of physical, chemical and microbiological hazards, in duck, goose and quail barns to stimulate exploratory, foraging and comfort behaviour and prevent or mitigate group stress (due to injurious pecking), as well as soft tissue lesions and integument damage and locomotory disorders.

3.8.3.4. Recommendations on flooring material

1) In ducks and geese, the flooring material in any indoor housing should be solid and littered, except for the area under and around any type of water source, where drainage should be ensured by some type of perforated floor.
2) More research should be carried out to determine the optimum proportion of littered and perforated floors indoor for ducks and geese.
3) In ducks and geese, drainage under and around any type of water source should be ensured in the outdoor area to maintain a dry surface.
4) For quail, the flooring material should be solid and littered.

3.8.3.5. Recommendations on litter characteristics

1) Litter for ducks, geese and quail should always be dry and friable.
2) If straw is used as litter, it should be chopped to ensure sufficient water absorption and drying capacity.

3.8.3.6. Recommendations on litter management

1) The quantity and replenishment frequency of new litter should ensure dry and friable condition, and presence of uncontaminated bedding material that facilitates foraging, exploratory and comfort behaviours.
2) More research is needed on how to optimise different types of litter management in duck and goose barns.

3.8.4. Availability, design and size of nesting facilities

3.8.4.1. Conclusions on nesting facilities for domestic and Muscovy ducks and domestic geese

From field experience in Europe, nests as they are implemented, seem to fulfil the needs of the female birds in terms of laying behaviour when all nests are accessible. However, there is scientific evidence that availability and quality of nests is important for the welfare of birds. The following characteristics were identified as sufficient to allow layer birds to perform prelaying and nesting behaviours:

1) A nest with soft and manipulable material (e.g. straw, wood shavings) at least fully covering the floor, will facilitate nesting behaviour (66–100% certainty).
2) Floor level nests are preferred by Domestic ducks and Domestic geese, whereas the preference of current genotypes of Muscovy ducks is less clear.
3) An enclosed nest (opaque top, sides and back) provides a secluded, safe environment for nesting behaviour in ducks (66–100% certainty).
4) Individual nests with enough space will allow nesting behaviour (approximately 1,600 cm^2/nest for ducks (shortest side of at least 40 cm) and 3,500 cm^2/nest for geese (shortest side of at least 50 cm), and enough height will allow the bird to enter easily and arrange the nesting material (40 cm minimum for ducks and 70 cm for geese) (66–100% certainty).
5) In birds kept in a group, sharing of a nest over time (but not in simultaneous occupation) is possible. Commercial practice is to provide 1 nest for 5 ducks or 6 geese maximum. There is evidence of a greater risk of floor laying of eggs, possibly as a result of competition, with increasing number of birds per nest or due to other factors (e.g. rearing practices, social factors) (66–100% certainty).

3.8.4.2. Conclusions on nesting facilities for Japanese quail

1) Japanese quail show a preference to lay eggs in cover, and the majority use a nest box when it is provided (66–100% certainty).
2) Japanese quail prefer to lay in dry and friable material (66–100% certainty). There is no scientific evidence to allow description of the optimal nest characteristics.

3.8.4.3. Recommendations on nesting facilities for Domestic and Muscovy ducks and Domestic geese

1) Any enclosure where adult female breeders are kept should contain one or more separate areas destined for egg laying.
2) The floor should not be of wire mesh, and it should contain manipulable material deep enough for nest building. Nests should be dimensioned to allow a single bird to show nesting behaviour.
3) A nest with sides, back and opaque top protection is recommended for ducks.
4) For Domestic geese the nest should not be placed under direct sunlight.
5) Further research is suggested to optimise nest design and nest ratio (nest: female) for Domestic and Muscovy ducks, and Domestic geese.

3.8.4.4. Recommendations on nesting facilities for Japanese quail

1) Nests providing cover, should be available for all laying quail and quail breeders, and should contain dry and friable material which is attractive for the species of interest.
2) Further research is necessary to optimise nest design for Japanese quail.

3.8.5. Environmental enrichment

3.8.5.1. Conclusions on water provision for Domestic ducks, Muscovy and Mule ducks and Domestic geese

1) Providing open water helps to prevent or mitigate the welfare consequences soft tissue lesions and integument damage, group stress, inability to perform comfort behaviour and inability to perform exploratory or foraging behaviour.
2) Depending on the surface area and depth of the water facilities, different possibilities for foraging, locomotion and comfort behaviour exist. From minimal (e.g. deep open bell drinkers) to maximal open water provision (e.g. pond), increasingly water-related behaviours, from dabbling/sieving, head dipping, incomplete bathing, complete bathing, resting on water to swimming and diving can be carried out. Common bell drinkers only allow drinking and dabbling/sieving. In drinkers with sufficient depth (e.g. 10 cm) head dipping is possible; troughs and ponds allowing water contact with the whole body allow bathing and swimming or diving depending on water depth.

3) Providing open water that allows swimming and diving helps to prevent restriction of movement.
4) The water-related behaviours also help the birds to keep their eyes, nostrils and plumage clean and intact. Moreover, under hot conditions open water access facilitates thermoregulation.
5) Minimum water depth for head dipping and incomplete bathing would be 10 cm for ducks and 15 cm for geese (66–100% certainty); the surface area of one device must allow at least one bird at any age to put the head inside.
6) Minimum depth for swimming would be 20 cm for ducks. For geese a minimum depth of 40 cm is proposed for swimming (66–100% certainty). The surface area of water provided for swimming should allow unimpeded movement, however there is a lack of knowledge on the minimum surface to achieve this.
7) Inappropriate design and management of the open water provision leads to sanitary problems and deterioration of floor and air quality.

3.8.5.2. Conclusions on dust bathing for Japanese quail

1) Quail prefer fine, friable substrate for dust bathing. Provisiofn of such material minimises the welfare consequences inability to perform comfort behaviour and also the inability to perform exploratory or foraging behaviour.

3.8.5.3. Conclusions on foraging-related enrichments

1) In waterfowl, inability to perform exploratory or foraging behaviour can be prevented or mitigated by providing litter on parts of the floor and by providing additional forage-related enrichment material such as silage or hay.
2) Stimulation of foraging contributes to reduced risks of feather and cannibalistic pecking in ducks and therefore can help to reduce integument damage (90–100% certainty).
3) In quail, inability to perform exploratory or foraging behaviour can be prevented or mitigated by providing litter on the floor and additional enrichment material such as pecking blocks which help to mitigate welfare problems due to sharp or long beaks.

3.8.5.4. Conclusions on structural equipment

1) In Muscovy ducks, insufficient scientific evidence is available on effects of easily reachable elevated structures and effects of shelter on resting behaviour.
2) In Japanese quail, provision of artificial or natural horizontal cover or shelter can reduce flight responses and thus lower the risk of soft tissue lesions. More research is needed on the effects of differently designed structures on quail welfare.

3.8.5.5. Conclusions on outdoor access

1) Outdoor access can provide the highest richness of stimuli and in indoor systems with outdoor access, additionally retreat from conspecifics is possible, thereby lowering the stocking density indoors. It furthermore allows a choice between different microclimatic areas facilitating locomotion. For geese, the opportunity to graze is especially important.
2) Outdoor access can also pose management challenges with regard to protection of the birds from predation, infection and adverse weather conditions and with regard to maintenance of favourable range conditions. A covered veranda is an intermediate solution providing some of the benefits of outdoors, but lower management challenges and more protection from outdoor hazards.
3) Although outdoor access can provide a high richness of stimuli, there are no scientific studies of the welfare costs and benefits for quail with and without outdoor access.

3.8.5.6. Recommendations on water provision for Domestic ducks, Muscovy and Mule ducks and Domestic geese

1) Open water facilities that allow at least head dipping, but preferably full body contact with the water surface, should be provided throughout the birds' life. These water facilities should be placed on well-drained areas and deterioration of water quality should be prevented by water exchange and cleaning of the facility or filtering of the water. Separate drinkers should be provided in addition to bathing water.

2) Minimum space requirements at water facilities to allow the bird to exhibit water bathing should be as reported in Section 3.8.1.1.2.

3.8.5.7. Recommendation on dust bathing for Japanese quail

1) Fine, friable material suitable for dust bathing (such as sand or other fine-grained material) should be provided, e.g. in specific dust bathing sites which should have a minimum area of 32 cm^2/bird to allow complete dust bathing.

3.8.5.8. Recommendations on foraging-related enrichments

1) In all species, permanent access to manipulable enrichment should be provided not only in the form of dry, friable litter on at least part of the floor, but also in the form of additional, preferably edible, material (such as silage, fresh fodder or pecking blocks) suitable to stimulate foraging and further exploration.

3.8.5.9. Recommendations on structural equipment

1) For Muscovy ducks, provision of structures that allow perching, as well as resting under or adjacent to cover, are recommended, but further research should be carried out to understand their necessary characteristics, including height and length per bird.
2) For Japanese quail, horizontal structures providing cover for the birds should be made available, but further research should be carried out to determine their necessary characteristics and space needed per bird.

3.8.5.10. Recommendations on outdoor access

1) Outdoor access should be provided after the starting phase to allow ducks and geese to choose between different temperatures, light conditions and substrate quality and to promote foraging, exploratory and comfort behaviours. For this, the ground should be mainly covered by vegetation. Areas around water facilities should be managed to avoid muddy conditions. They can for instance have concrete or gravel floors. If circumstances, such as disease risk, preclude outdoor access, covered verandas should be provided.
2) Covered verandas should be provided to allow quail to choose between different temperatures, light conditions and substrate qualities and to promote foraging, exploratory and comfort behaviours by the natural light, outdoor climate and additional enrichment material (see above). Further research on the implementation of veranda systems in commercial conditions should be carried out.

References

Abdel-Azeem FAA, 2010. The influence of different stocking density and sex on productive performance and some physiological traits of Japanese quail. Egyptian Poultry Science, 30, 203–227.

Abdelfattah MG, 2018. Physiological and productive impacts of beak trimming and feed form in Japanese quail. Egyptian Journal of Animal Production, 55, 171–185.

Abdelfattah E, Vezzoli G and Makagon M, 2020. On-farm welfare assessment of commercial Pekin ducks: a comparison of methods. Poultry Science, 99, 689–697. https://doi.org/10.1016/j.psj.2019.10.006

Abd-El-Gawad E, El-Esssawy G and Kamel M, 1993. Some studies on behavioural, physiological and productive aspects in Egyptian goslings kept under two systems of management. Veterinary Medical Journal, 41, 77–82.

Abdel-Hamid SE and Abdelfattah EM, 2020. Effect of different dietary protein levels on some behavioral patterns and productive performance of Muscovy duck. Advances in Animal and Veterinary Sciences, 6, 661–667. https://doi.org/10.17582/journal.aavs/2020/8.6.661.667

Abdel-Hamid SE, Saleem A-SY, Youssef MI, Mohammed HH and Abdelaty AI, 2020. Influence of housing systems on duck behavior and welfare. Journal of Advanced Veterinary and Animal Research, 7, 407–413. https://doi.org/10.5455/javar.2020.g435

Abo Ghanima MM, Abd El-Hack ME, Taha AE, Tufarelli V, Laudadio V and Naiel MA, 2020. Assessment of stocking rate and housing system on performance, carcass traits, blood indices, and meat quality of French Pekin ducks. Agriculture, 10, 273. https://doi.org/10.3390/agriculture10070273

Aguiar DP, Valentim JK, Lima HJDÁ, Bittencourt TM, Andreoti LZ, Pereira IDB, Velarde JMDS and Zanella J, 2021. Beak trimming and stocking densities for laying and performance traits and behavioral patterns in Japanese quails. Revista de Investigaciones Veterinarias del Perú, 32, e19248. https://doi.org/10.15381/rivep.v32i5.19248

Ahmed FAM, 2022. Early feed restriction can affect the behavior and welfare of mule ducks. PSM Veterinary Research, 7, 43–54.
Albarella U, 2005. Alternate fortunes? The role of domestic ducks and geese from Roman to Medieval times in Britain. Documenta Archaeobiologiae, 3, 249–258.
Alcala RS, Caliva JM, Flesia AG, Marin RH and Kembro JM, 2019. Aggressive dominance can decrease behavioral complexity on subordinates through synchronization of locomotor activities. Communications Biology, 2, 1–14. https://doi.org/10.1038/s42003-019-0710-1
Amat JA, 1986. Numerical trends, habitat use, and activity of Greylag Geese wintering in southwestern Spain. Wildfowl, 37, 35–45.
Andres K and Kapkowska E, 2011. Applicability of anatid and galliform microsatellite markers to the genetic diversity studies of domestic geese (Anser anser domesticus) through the genotyping of the endangered zatorska breed. BMC Research Notes, 4, 1–10. https://doi.org/10.1186/1756-0500-4-65
Anthony NB, Emmerson DA, Nestor KE, Bacon WL, Sigel PB and Dunnington EA, 1991. Comparison of growth curves of weight selected populations of turkeys, quail, and chickens. Poultry Science, 70, 13–19. https://doi.org/10.3382/ps.0700013
Arboleda C and Kharel M, 1985. Breeding and management of ducks for meat and egg production; study 3: nesting preference of Muscovy ducks.
Arias-Sosa LA and Rojas AL, 2021. A review on the productive potential of the Muscovy Duck. World's Poultry Science Journal, 77, 565–588. https://doi.org/10.1080/00439339.2021.1921668
Arnaud I, Gardin E, Sauvage E, Bernadet M-D, Couty M, Guy G and Guemene D, 2010. Behavioral and adrenal responses to various stressors in mule ducks from different commercial genetic selection schemes and their respective parental genotypes. Poultry Science, 89, 1097–1109. https://doi.org/10.3382/ps.2009-00553
Arnaud I, Mignon-Grasteau S, Larzul C, Guy G, Faure J-M and Guemene D, 2008. Behavioural and physiological fear responses in ducks: genetic cross effects. Animal, 2, 1518–1525. https://doi.org/10.1017/S1751731108002784
Arzel C and Elmberg J, 2015. Time use and foraging behaviour in pre-breeding dabbling ducks Anas spp. in sub-arctic Norway. Journal of Ornithology, 156, 499–513.
Ashton C, 2015. Keeping geese: Breeds and management. Crowood Press Ltd, Ramsbury Marlborough. 192 pp.
Ayoola AA, Adeyemi OA, Egbeyale LT, Sogunle OM and Ekunseitan DA, 2014. Effects of sex and stocking density on growth performance and some physiological traits of Japanese quails (Coturnix coturnix japonica). Malaysian Journal of Animal Science, 17, 43–53.
Babington S and Campbell DL, 2022. Water for domestic ducks: the benefits and challenges in commercial production. Frontiers in Animal Science, 3, 2. https://doi.org/10.3389/fanim.2022.782507
Badawi YK, 2017. Effect of housing system on Japanese quail performance. Journal of Animal and Poultry Production, 8, 483–490. https://doi.org/10.21608/JAPPMU.2017.46068
Baeza E, Chartrin P and Arnould C, 2003. Effects of stocking density on welfare, growth performance and carcass quality in Muscovy ducks. Science Technology Avi, 45, 4–8.
Baéza E, Chartrin P, Bordeau T, Lessire M, Thoby J, Gigaud V, Blanchet M, Alinier A and Leterrier C, 2017. Omega-3 polyunsaturated fatty acids provided during embryonic development improve the growth performance and welfare of Muscovy ducks (Cairina moschata). Poultry Science, 96, 3176–3187. https://doi.org/10.3382/ps/pex147
Baéza E, Rideau N, Chartrin P, Davail S, Hoo-Paris R, Mourot J, Guy G, Bernadet M, Juin H, Meteau K and Hermier D, 2005. The fattening ability of Muscovy, Pekin and their hybrids, hinny and mule ducks. Productions Animales, 18, 131–141.
Bakken GS, Banta MR, Higginbotham CM and Lynott AJ, 2006. It's just ducky to be clean: the water repellency and water penetration resistance of swimming mallard Anas platyrhynchos ducklings. Journal of Avian Biology, 37, 561–571. https://doi.org/10.1111/j.0908-8857.2006.03685.x
Barber CL, Prescott NB, Wathes CM, Le Sueur C and Perry GC, 2004. Preferences of growing ducklings and Turkey poults for illuminance. Animal Welfare, 13, 211–224. https://doi.org/10.1017/S0962728600026956
Barrett L, Malecki I and Blache D, 2019. Differences in pre-laying behavior between floor-laying and nest-laying Pekin ducks. Animals, 9, 40. https://doi.org/10.3390/ani9020040
Barrett L, Maloney SK and Blache D, 2021. Pekin ducks are motivated to access their nest site and exhibit a stress-induced hyperthermia when unable to do so. Animal, 15, 100067. https://doi.org/10.1016/j.animal.2020.100067
Barrett L, Maloney SK and Blache D, 2023. Pekin ducks are motivated to lay in their preferred nest substrate. Animal Welfare, 32, e28. https://doi.org/10.1017/awf.2023.19
Basso B, Bordas A, Dubos F, Morganx P and Marie-Etancelin C, 2012. Feed efficiency in the laying duck: appropriate measurements and genetic parameters. Poultry Science, 91, 1065–1073. https://doi.org/10.3382/ps.2011-02008
Baur S, Rufener C, Toscano MJ and Geissbühler U, 2020. Radiographic evaluation of keel bone damage in laying hens—morphologic and temporal observations in a longitudinal study. Frontiers in Veterinary Science, 7, 129. https://doi.org/10.3389/fvets.2020.00129

Bédécarrats G, Guémené D and Richard-Yris MA, 1997. Effects of environmental and social factors on incubation behavior, endocrinological parameters, and production traits in Turkey hens (Meleagris gallopavo). Poultry Science, 76, 1307–1314. https://doi.org/10.1093/ps/76.9.1307
Benabdeljelil K and Ayachi A, 1996. Evaluation of alternative litter materials for poultry. Journal of Applied Poultry Research, 5, 203–209. https://doi.org/10.1093/japr/5.3.203
Bentley A, Porter L, Van Blois L, Van Wyk B, Vuong CN, Tellez-Isaias G, Shafer D, Tucker Z, Fraley SM, Hargis BM and Fraley GS, 2020. A feed restriction milieu for Pekin meat ducks that may improve gait characteristics but also affects gut leakiness. Poultry Science, 99, 39–47. https://doi.org/10.3382/ps/pez551
Bergmann S, Moritz J, Kronthaler F, Damme K, Erhard M and Knoll-Sauer M, 2020. Die Haltung von Japanwachteln unter Tierschutzgesichtspunkten und Beurteilung der Tiergerechtheit anhand tierbezogener Indikatoren. Berliner und Münchener Tierärztliche Wochenschrift, 133. https://doi.org/10.2376/1439-0299-2020-7
Bezzel E, 1977. Ornithologie. Eugen Ulmer Verlag, Stuttgart. 51 pp.
Bierschenk F, Rauch H, Matthes S, Ellendorff F, Klemm R, Reiter K, Pingel H and Schneider K, 1992. Probleme der Intensivhaltung von Moschusenten-Untersuchungen zur Vermeidung des Schnabelstutzens. Abschlußbericht zum BML-Forschungsvorhaben. Institut für Kleintierzucht der FAL, Celle und der Universität Leipzig.
Bilsing A, Becker I and Nichelmann M, 1992b. Verhaltensstörungen bei der Moschusente. Aktuelle Arbeiten zur artgemäßen Tierhaltung. KTBL-Schrift, 351, 69–76.
Bilsing A, Holub H, Fussy M and Nichelmann M, 1992a. Sexualverhalten der Moschusenten unter Bedingungen der intensiven Elterntierhaltung: Partnerbeziehung, Territorialverhalten. Störungen der Tretaktivität. Arch. Geflügelk, 56, 171–176.
Bilsing A, Nichelmann M and Holub H, 1991. Einfluβ der Domestikation auf das Verhalten der weiβen Zuchtform von Cairina moschata. Proceedings of the Verhandlungen der Deutschen Zoologischen Gesellschaft, 84, 316.
Bjärvall A, 1970. Nest-site selection by the mallard (Anas platyrhynchos). A questionnaire with special reference to the significance of artificial nests. Viltrevy (Stockh), Svenska Jägareförbundet, 151–179.
Black JM and Owen M, 1989a. Parent-offspring relationships in wintering barnacle geese. Animal Behaviour, 37, 187–198. https://doi.org/10.1016/0003-3472(89)90109-7
Black JM and Owen M, 1989b. Agonistic behaviour in barnacle goose flocks: assessment, investment and reproductive success. Animal Behaviour, 37, 199–209. https://doi.org/10.1016/0003-3472(89)90110-3
Black JM, Prop J and Larsson K, 2007. Wild goose dilemmas: population consequences of individual decisions in barnacle geese. Branta Press, Groningen. 254 pp.
Blokhuis HJ, 1986. Feather-pecking in poultry: its relation with ground-pecking. Applied Animal. Behaviour Science, 16, 63–67. https://doi.org/10.1016/0168-1591(86)90040-7
Bogenfürst F, 1999. Kacsák–Házikacsák, pézsmarécék, mulardkacsák, díszrécék. Gazda Kiadó, Budapest. 340 pp.
Bogenfürst F, 2017. Lúdtenyésztők kézikönyve. Forum, Udine.
Boos M, Zimmer C, Carriere A, Robin JP and Petit O, 2007. Post-hatching parental care behaviour and hormonal status in a precocial bird. Behavioural Processes, 76, 206–214. https://doi.org/10.1016/j.beproc.2007.05.003
Boz MA, Sarica M and Yamak US, 2017a. Effect of production system on foot pad dermatitis (FPD) and plumage quality of geese. European Poultry Science, 81, 1–10.
Boz MA, Sarica M and Yamak US, 2017b. Production traits of artificially and naturally hatched geese in intensive and free-range systems: I Growth traits. British Poultry Science, 58, 132–138. https://doi.org/10.1080/00071668.2016.1261997
Boz MA, Sarıca M, Yamak US and Erensoy K, 2021. Behavioral traits of artificially and naturally hatched geese in intensive and free-range production systems. Applied Animal Behaviour Science, 236, 105273. https://doi.org/10.1016/j.applanim.2021.105273
Breuer U, 1991. Zu Abstammung, Verhalten und Haltung der Moschusente (Cairina moschata, L., 1758): eine bewertende Literaturübersicht, na.
Brügesch F, Spindler B and Hartung J, 2011. Practical experience with the use of perches as environmental enrichment for Muscovy ducks. Proceedings of the Animal hygiene and sustainable livestock production. Proceedings of the XVth International Congress of the International Society for Animal Hygiene, Vienna, Austria. pp. 1073–1075.
Buchwalder T and Wechsler B, 1997. The effect of cover on the behaviour of Japanese quail (Coturnix japonica). Applied Animal Behaviour Science, 54, 335–343. https://doi.org/10.1016/S0168-1591(97)00031-2
Buckland R and Guy G, 2002. Goose production (No. 154). Food Agriculture Org.
Bulheller M, Kuhnt K, Hartung J and Knierim U, 2004. Effects of different types of water provision on the behaviour and cleanliness of the plumage of muscovy ducks (Cairina Moschata). Proceedings of the Proceedings of the 38th International Congress of the ISAE. Helsinki, Finland. pp. 212.
Burns KE, Otalora R, Glisson JR and Hofacre CL, 2003. Cellulitis in Japanese quail (Coturnix coturnix japonica). Avian Diseases, 47, 211–214. https://doi.org/10.1637/0005-2086(2003)047[0211:CIJQCC]2.0.CO;2
Buzała M, Adamski M and Janicki B, 2014. Characteristics of performance traits and the quality of meat and fat in Polish oat geese. World's Poultry Science Journal, 70, 531–542. https://doi.org/10.1017/S0043933914000580
Byrd CJ, Main RP and Makagon MM, 2016. Evaluating Pekin duck walking ability using a treadmill performance test. Poultry Science, 95, 2244–2249. https://doi.org/10.3382/ps/pew207

Camci O and Erensayin C, 2004. Effect of stocking density during the early growth phase on fattening performance of Japanese quails (Coturnix Coturnix japonica). Archiv fur Geflugelkunde, 68.
Campbell DL, Belson S, Erasmus MA and Lea JM, 2022. Behavior and welfare impacts of water provision via misting in commercial Pekin ducks. Journal of Animal Science, 100, skac341. https://doi.org/10.1093/jas/skac341
Campbell CL, Colton S, Porter A, Haas R, Gerometta E, Lindberg A, Fraley SM and Fraley SG, 2014. Descriptive analyses of gait characteristics in Pekin Ducks from hatch to market weight. Journal of Applied Poultry Research, 23, 146–155. https://doi.org/10.3382/japr.2013-00819
Carruthers CR, Gabrush T, Schwean-Lardner KV, Knezacek TD, Classen HL and Bennett CD, 2012. On-farm survey of beak characteristics in White Leghorns as a result of hot blade trimming or infrared beak treatment. Journal of Applied Poultry Research, 21, 645–650. https://doi.org/10.3382/japr.2011-00433
Castro JDO, Junior TY, Ferraz PFP and Fassani ÉJ, 2017. Comportamento de codornas japonesas submetidas a diferentes temperaturas. Energia Na Agricultura, 32, 141–147. https://doi.org/10.17224/EnergAgric.2017v32n2p141-147
Chang SC, Lin MJ, Lee CH, Lin LJ, Liao JW and Lee TT, 2022. Effects of angel wings on morphological and histological characteristics of White Roman geese. Poultry Science, 102, 102389. https://doi.org/10.1016/j.psj.2022.10238
Charuta A, Dzierzęcka M, Czerwiński E, Cooper RG and Horbańczuk JO, 2012. Sex-and age-related changes of trabecular bone of tibia in growing domestic geese (Anser domesticus). Folia Biologica (Kraków), 60, 205–212. https://doi.org/10.3409/fb60_3-4.205-212
Charuta A, Dzierzecka M, Komosa M, Biesiada- Drzazga B, Dzialaszczepanczyk E and Cooper RG, 2013. Age-and sex-related changes in mineral density and mineral content of the tibiotarsal bone in quails during post-hatching development. Kafkas Üniversitesi Veteriner Fakültesi Dergisi, 19. https://doi.org/10.9775/kvfd.2012.7055
Charuta A, Dzierzęcka M, Majchrzak T, Czerwiński E and Cooper RG, 2011. Computer-generated radiological imagery of the structure of the spongious substance in the postnatal development of the tibiotarsal bones of the Peking domestic duck (Anas platyrhynchos var. domestica). Poultry Science, 90, 830–835. https://doi.org/10.3382/ps.2010-01031
Charuta A, Tatara MR, Gruzewsk AA, Pierzchala M, Kalinowski Ł, Trusewicz M and Łuszczewska-Sierakowska I, 2014. Morphological and densitometric research of the tibial bone in the post-natal development in domestic geese. Animal Science Papers and Reports, 32, 251–260.
Chavarro-Tulcán I, Arias-Sosa LA and Rojas AL, 2021. Evaluation of metabolic syndromes and parasitic infection in Muscovy ducks under different management conditions. Tropical Animal Health and Production, 53, 1–10. https://doi.org/10.1007/s11250-021-02944-4
Chen Y, Aorigele C, Yan F, Li Y, Cheng P and Qi Z, 2015. Effect of production system on welfare traits, growth performance and meat quality of ducks. South African Journal of Animal Science, 45, 173–179. https://doi.org/10.4314/sajas.v45i2.8
Chen X, Shafer D, Sifri M, Lilburn M, Karcher D, Cherry P, Wakenell P, Fraley S, Turk M and Fraley G, 2021. Centennial Review: History and husbandry recommendations for raising Pekin ducks in research or commercial production. Poultry Science, 100, 101241. https://doi.org/10.1016/j.psj.2021.101241
Cheng KM, Bennett DC and Mills AD, 2010. The Japanese Quail. The Japanese quail. The UFAW handbook on the care and management of laboratory and other research animals. 8th edn. Wiley-Blackwell, Oxford. pp. 655–673.
Cherry P and Morris TR, 2008. Genetic improvement. Domestic duck production: science and practice. CABi, Wallingford, UK. pp. 229.
Cicek T, Kilic S, Calilar S, Karaman M and Gurbuz Y, 2004. Effect of cage and floor housing in different stocking density on performance and some carcass characteristics of Japanese quails. Proceedings of the XXII World Poultry Congress Istanbul, Turkey.
Clayton D, 1976. The effects of pre-test conditions on social facilitation of drinking in ducks. Animal Behaviour, 24, 125–134. https://doi.org/10.1016/S0003-3472(76)80105-4
Clayton GA, 1984. Muscovy Duck. In: IL Mason (ed). Evolution of domesticated animals. Longman, London. pp. 340–344.
Cloutier S, Newberry RC, Forster CT and Girsberger KM, 2000. Does pecking at inanimate stimuli predict cannibalistic behaviour in domestic fowl? Applied Animal Behaviour Science, 66, 119–133. https://doi.org/10.1016/S0168-1591(99)00068-4
Collier K and Wakelin M, 1996. Instream habitat use by blue duck (Hymenolaimus malacorhynchos) in a New Zealand River. Freshwater Biology, 35, 277–287. https://doi.org/10.1046/j.1365-2427.1996.00499.x
Colton S and Fraley G, 2014. The effects of environmental enrichment devices on feather picking in commercially housed Pekin ducks. Poultry Science, 93, 2143–2150. https://doi.org/10.3382/ps.2014-03885
Combs DL and Fredrickson LH, 1996. Foods used by male mallards wintering in southeastern Missouri. The Journal of Wildlife Management, 60, 603–610. https://doi.org/10.2307/3802078
Cooper J and Appleby M, 1996. Individual variation in prelaying behaviour and the incidence of floor eggs. British Poultry Science, 37, 245–253. https://doi.org/10.1080/00071669608417856

Cooper JJ and Appleby MC, 2003. The value of environmental resources to domestic hens: a comparison of the work-rate for food and for nests as a function of time. Animal Welfare, 12, 39–52. https://doi.org/10.1017/S0962728600025367

Cooper J, McAfee L and Skinn H, 2002. Behavioural responses of domestic ducks to nipple drinkers, bell drinkers and water troughs. British Poultry Science, 43, S17–S18.

Cruvinel JM, Montenegro AT, Ouros CCD, Alves KDS, Ribeiro GC, Santos TSD, Molino ADB and Garcia EA, 2022. Beak trimming in japanese quails at initial phase is an alternative to reduce the negative effects of feather pecking. Acta Scientiarum. Animal Sciences, 44, e54129. https://doi.org/10.4025/actascianimsci.v44i1.54129

Da Costa MJ, Oviedo-Rondón EO, Wineland M and Jeffrey D, 2015. Effects of eggshell conductance and incubation temperatures on duck footpad development. Journal of Applied Poultry Research, 24, 536–546. https://doi.org/10.3382/japr/pfv056

Dalmau A, 2023. Personal Communication, 15th March 2023. e-mail.

Damme DK, 2011. Wachteln: Zucht und Haltung. Verlag Eugen Ulmer.

Dawkins MS, Cain R, Merelie K and Roberts SJ, 2013. In search of the behavioural correlates of optical flow patterns in the automated assessment of broiler chicken welfare. Applied Animal Behaviour Science, 145, 44–50. https://doi.org/10.1016/j.applanim.2013.02.001

Dawkins MS, Donnelly CA and Jones TA, 2004. Chicken welfare is influenced more by housing conditions than by stocking density. Nature, 427, 342–344. https://doi.org/10.1038/nature02226

Dawkins MS, Lee HJ, Waitt CD and Roberts SJ, 2009. Optical flow patterns in broiler chicken flocks as automated measures of behaviour and gait. Applied Animal Behaviour Science, 119, 203–209. https://doi.org/10.1016/j.applanim.2009.04.009

Dayen M and Fiedler H, 1990. Intensive raising of Muscovy ducks. DTW. Deutsche Tierarztliche Wochenschrift, 97, 149–151.

De Buisonjé F, 2001. Bezettingsdichtheid bij vleeseenden. Praktijkonderzoek. Pluimvee, 15, 36–38.

de Jong I and Gunnink H, 2019. Effects of a commercial broiler enrichment programme with or without natural light on behaviour and other welfare indicators. Animal, 13, 384–391. https://doi.org/10.1017/S1751731118001805

de Toledo TDS, Roll AAP, Rutz F, Dallmann HM, Dai Pra MA, Leite FPL and Roll VFB, 2020. An assessment of the impacts of litter treatments on the litter quality and broiler performance: a systematic review and meta-analysis. PLoS One, 15, e0232853. https://doi.org/10.1371/journal.pone.0232853

Desnoues B, Chabault M, Baumard Y, Couty M, Delaveau J, Gourichon D, Grasseau I, Mills M, Mercerand F and Rat C, 2015. L'identification électronique par RFID chez les volailles.

Diarra S, Lameta S, Amosa F and Anand S, 2021. Alternative bedding materials for poultry: availability, efficacy, and major constraints. Frontiers in Veterinary Science, 8, 669504. https://doi.org/10.3389/fvets.2021.669504

Dixon LM, 2008. Feather pecking behaviour and associated welfare issues in laying hens. Avian Biology Research, 1, 73–87. https://doi.org/10.3184/175815508X363251

Dixon LM, 2020. Slow and steady wins the race: the behaviour and welfare of commercial faster growing broiler breeds compared to a commercial slower growing breed. PLoS One, 15, e0231006. https://doi.org/10.1371/journal.pone.0231006

Dixon L and Lambton S, 2021. Behavioral Biology of Chickens and Quail. In: K Coleman and SJ Schapiro (eds). Behavioral Biology of Laboratory Animals. 1st edn. CRC Press. pp. 560.

Dogan GK and Takci İ, 2021. A macroanatomic, morphometric and comparative investigation on skeletal system of the geese growing in Kars region II; Skeleton appendiculare. Black Sea. Journal of Health Science, 4, 6–16. https://doi.org/10.19127/bshealthscience.800479

Dong Y, Karcher DM and Erasmus MA, 2021. Self-and conspecific-directed pecking behavior of commercial Pekin ducks. Applied Animal Behaviour Science, 235, 105223. https://doi.org/10.1016/j.applanim.2021.105223

Donkin RA, 1989. The Muscovy Duck: cairina moschata domestica: origins, dispersal, and associated aspects of the geography of domestication. AA Balkema.

Downs J, Loraamm R, Anderson JH Jr, Perry J and Bullock J, 2017. Habitat use and behaviours of introduced muscovy ducks (Cairina moschata) in urban and suburban environments. Suburban Sustainability, 5, 1. https://doi.org/10.5038/2164-0866.5.1.1028

Duggan BM, Rae AM, Clements DN and Hocking PM, 2017. Higher heritabilities for gait components than for overall gait scores may improve mobility in ducks. Genetics Selection Evolution, 49, 1–7. https://doi.org/10.1186/s12711-017-0317-2

Earls KD, 2000. Kinematics and mechanics of ground take-off in the starling Sturnis vulgaris and the quail Coturnix coturnix. Journal of Experimental Biology, 203, 725–739. https://doi.org/10.1242/jeb.203.4.725

Eda M, Itahashi Y, Kikuchi H, Sun G, Hsu K-h, Gakuhari T, Yoneda M, Jiang L, Yang G and Nakamura S, 2022. Multiple lines of evidence of early goose domestication in a 7,000-y-old rice cultivation village in the lower Yangtze River, China. Proceedings of the National Academy of Sciences, 119, e2117064119. https://doi.org/10.1073/pnas.2117064119

Edens F, Bursian S and Holladay S, 1983. Grouping in Japanese quail: 1. Agonistic behavior during feeding. Poultry Scence, 62, 1647–1651. https://doi.org/10.3382/ps.0621647

EFSA (European Food Safety Authority), Hart A, Maxim L, Siegrist M, Von Goetz N, da Cruz C, Merten C, Mosbach-Schulz O, Lahaniatis M, Smith A and Hardy A, 2019. Guidance on Communication of Uncertainty in Scientific Assessments. EFSA Journal 2019;17(1):5520, 73 pp. https://doi.org/10.2903/j.efsa.2019.5520

EFSA AHAW Panel (EFSA Panel on Animal Health and Welfare), 2012. Guidance on risk assessment for animal welfare. EFSA Journal 2012;10(1):2513, 30 pp. https://doi.org/10.2903/j.efsa.2012.2513

EFSA AHAW Panel (EFSA Panel on Animal Health and Welfare), Nielsen SS, Alvarez J, Bicout DJ, Calistri P, Canali E, Drewe JA, Garin-Bastuji B, Gonzales Rojas JL, Gortázar Schmidt C, Herskin M, Michel V, Miranda Chueca MA, Padalino B, Roberts HC, Spoolder H, Stahl K, Viltrop A, Winckler C, Mitchell M, Vinco LJ, Voslarova E, Candiani D, Mosbach-Schulz O, Van der Stede Y and Velarde A, 2022a. Scientific Opinion on the welfare of domestic birds and rabbits transported in containers. EFSA Journal 2022;20(9):7441, 188 pp. https://doi.org/10.2903/j.efsa.2022.7441

EFSA AHAW Panel (EFSA Panel on Animal Health and Welfare), Nielsen SS, Alvarez J, Bicout DJ, Calistri P, Canali E, Drewe JA, Garin-Bastuji B, Gonzales Rojas JL, Gortázar Schmidt C, Herskin M, Miranda Chueca MA, Michel V, Padalino B, Pasquali P, Roberts HC, Spoolder H, Stahl K, Velarde A, Viltrop A, Edwards S, Ashe S, Candiani D, Fabris C, Lima E, Mosbach-Schulz O, Gimeno CR, Van der Stede Y, Vitali M and Winckler C, 2022b. Scientific Opinion on the methodological guidance for the development of animal welfare mandates in the context of the Farm to Fork Strategy. EFSA Journal 2022;20(7):7403, 29 pp. https://doi.org/10.2903/j.efsa.2022.7403

EFSA AHAW Panel (EFSA Panel on Animal Health and Welfare), Nielsen SS, Alvarez J, Bicout DJ, Calistri P, Canali E, Drewe JA, Garin-Bastuji B, Gonzales Rojas JL, Schmidt CG, Herskin M, Miranda Chueca MA, Padalino B, Pasquali P, Roberts HC, Spoolder H, Stahl K, Velarde A, Viltrop A, Winckler C, Estevez I, Guinebretiere M, Rodenburg B, Schrader L, Tiemann I, Van Niekerk T, Ardizzone M, Ashe S, Hempen M, Mosbach-Schulz O, Rojo Gimeno C, Van der Stede Y, Vitali M and Michel V, 2023a. Scientific Opinion on the welfare of laying hens on farm. EFSA Journal 2023;21(2):7789, 188 pp. https://doi.org/10.2903/j.efsa.2023.7789

EFSA AHAW Panel (EFSA Panel on Animal Health and Welfare), Nielsen SS, Alvarez J, Bicout DJ, Calistri P, Canali E, Drewe JA, Garin-Bastuji B, Gonzales Rojas JL, Schmidt CG, Herskin M, Miranda Chueca MA, Padalino B, Pasquali P, Roberts HC, Spoolder H, Stahl K, Velarde A, Viltrop A, Winckler C, Tiemann I, de Jong I, Gebhardt-Henrich SG, Keeling L, Riber AB, Ashe S, Candiani D, Garc'ıa Matas R, Hempen M, Mosbach-Schulz O, Rojo Gimeno C, Van der Stede Y, Vitali M, Bailly-Caumette E and Michel V, 2023b. Scientific Opinion on the welfare of broilers on farm. EFSA Journal, 2023;21(2):7788, 236 pp. https://doi.org/10.2903/j.efsa.2023.7788

EFSA Scientific Committee, Benford D, Halldorsson T, Jeger MJ, Knutsen HK, More S, Naegeli H, Noteborn H, Ockleford C, Ricci A, Rychen G, Schlatter JR, Silano V, Solecki R, Turck D, Younes M, Craig P, Hart A, Von Goetz N, Koutsoumanis K, Mortensen A, Ossendorp B, Germini A, Martino L, Merten C, Mosbach-Schulz O, Smith A and Hardy A, 2018a. Scientific Opinion on the principles and methods behind EFSA's Guidance on Uncertainty Analysis in Scientific Assessment. EFSA Journal 2018;16(1):5122, 235 pp. https://doi.org/10.2903/j.efsa.2018.5122

EFSA Scientific Committee, Benford D, Halldorsson T, Jeger MJ, Knutsen HK, More S, Naegeli H, Noteborn H, Ockleford C, Ricci A, Rychen G, Schlatter JR, Silano V, Solecki R, Turck D, Younes M, Craig P, Hart A, Von Goetz N, Koutsoumanis K, Mortensen A, Ossendorp B, Martino L, Merten C, Mosbach-Schulz O and Hardy A, 2018b. Guidance on Uncertainty Analysis in Scientific Assessments. EFSA Journal 2018;16(1):5123, 39 pp. https://doi.org/10.2903/j.efsa.2018.5123

El Sabry MI, Hassan SS, Zaki MM and Stino FK, 2022. Stocking density: a clue for improving social behavior, welfare, health indices along with productivity performances of quail (Coturnix coturnix)—a review. Tropical Animal Health and Production, 54, 1–9. https://doi.org/10.1007/s11250-022-03083-0

El-Sheikh TM, 2016. Evaluation of productive and reproductive performance of Japanese quails in floor pens and conventional cages with different stocking densities. Egyptian Poultry Science Journal, 36, 669–683. https://doi.org/10.21608/epsj.2016.168800

Eratalar SA, 2021. The effects of plastic slatted floor and a deep-litter system on the growth performance of hybrid Pekin ducks. Archives Animal Breeding, 64, 1–6. https://doi.org/10.5194/aab-64-1-2021

Estévez I, Newberry RC and Applegate T, 2017. The contribution of environmental enrichment to sustainable poultry production. Achieving Sustainable Production of Poultry Meat, 3, 247–271.

Faitarone ABG, Pavan AC, Mori C, Batista L, Oliveira R, Garcia EA, Pizzolante C, Mendes A and Sherer M, 2005. Economic traits and performance of Italian quails reared at different cage stocking densities. Brazilian Journal of Poultry Science, 7, 19–22. https://doi.org/10.1590/S1516-635X2005000100003

Farghly MFA and Mahmoud UT, 2018. Access to outdoor swimming pond during summer season improved Muscovy ducks performance and health status. Livestock Science, 211, 98–103. https://doi.org/10.1016/j.livsci.2018.03.008

Farghly MFA, Mahrose KM, Ullah Z, Rehman ZU and Ding C, 2017. Influence of swimming time in alleviating the deleterious effects of hot summer on growing Muscovy duck performance. Poultry Science, 96, 3912–3919. https://doi.org/10.3382/ps/pex207

Faure J, Val-Laillet D, Guy G, Bernadet M-D and Guemene D, 2003. Fear and stress reactions in two species of duck and their hybrid. Hormones and Behavior, 43, 568–572. https://doi.org/10.1016/S0018-506X(03)00062-X

FAWC, 2009. Farm animal welfare in Great Britain: Past, present and future. Council, Farm Animal Welfare.

Fleming RH, McCormack HA, McTeir L and Whitehead CC, 2004. Incidence, pathology and prevention of keel bone deformities in the laying hen. British Poultry Science, 45, 320–330. https://doi.org/10.1080/00071660410001730815

Formanek L, Houdelier C, Lumineau S, Bertin A, Cabanès G and Richard-Yris M-A, 2008. Selection of social traits in juvenile Japanese quail affects adults' behaviour. Applied Animal Behaviour Science, 112, 174–186. https://doi.org/10.1016/j.applanim.2007.07.004

Fraley SM, Fraley GS, Karcher DM, Makagon MM and Lilburn MS, 2013. Influence of plastic slatted floors compared with pine shaving litter on Pekin Duck condition during the summer months. Poultry Science, 92, 1706–1711. https://doi.org/10.3382/ps.2012-02992

Gaioni SJ and Ross LE, 1982. Distress calling induced by reductions in group size in ducklings reared with conspecifics or imprinting stimuli. Animal Learning and Behavior, 10, 521–529. https://doi.org/10.3758/BF03212294

Galef BG Jr, Watkins SJ and Salehi P, 2006. Effects of enclosure size on sexual behavior of Japanese quail (Coturnix japonica). Journal of Comparative Psychology, 120, 433–437. https://doi.org/10.1037/0735-7036.120.4.433

Genchev A, Mihaylova G, Ribarski S, Pavlov A and Kabakchiev M, 2008. Meat quality and composition in Japanese quails. Trakia Journal of Sciences, 6, 72–82.

Gentle MJ and McKeegan DEF, 2007. Evaluation of the effects of infrared beak trimming in broiler breeder chicks. Veterinary Record, 160, 145–148. https://doi.org/10.1136/vr.160.5.145

Gerber PF, Gould N and McGahan E, 2020. Potential contaminants and hazards in alternative chicken bedding materials and proposed guidance levels: a review. Poultry Science, 99, 6664–6684. https://doi.org/10.1016/j.psj.2020.09.047

Gerken M, Bamberg H and Petersen J, 1987. Studies on the relationship between fearfulness and egg quality traits in Japanese quail. Applied Animal Behaviour Science, 18, 389–390.

Gerken M and Mills A, 1993. Welfare of domestic quail. Proceedings of the Proceedings of the 4th European Symposium on Poultry Welfare, 158–176.

Gerken M and Petersen J, 1992. Heritabilities for behavioral and production traits in Japanese quail (Coturnix coturnix japonica) bidirectionally selected for dustbathing activity. Poultry Science, 71, 779–788. https://doi.org/10.3382/ps.0710779

Gevrekci Y, Oğuz I, AKŞİT M, Oenenc A, Oezdemir D and Altan O, 2009. Heritability and variance component estimates of meat quality in Japanese quail (Coturnix coturnix japonica). Turkish Journal of Veterinary & Animal Sciences, 33, 89–94. https://doi.org/10.3906/vet-0603-30

Ghayas A, Hussain J, Mahmud A, Javed K, Rehman A, Ahmad S, Mehmood S, Usman M and Ishaq H, 2017. Productive performance, egg quality, and hatching traits of Japanese quail reared under different levels of glycerin. Poultry Science, 96, 2226–2232. https://doi.org/10.3382/ps/pex007

Gillette DD, 1976. Effects of temperature and wind upon egg laying by geese. Poultry Science, 55, 1744–1749. https://doi.org/10.3382/ps.0551744

Gillette DD, 1977. Mating and other behavior of domestic geese. Applied Animal Ethology, 3, 305–319. https://doi.org/10.1016/0304-3762(77)90056-6

Gontijo RP, Boari CA, Pires AV, Silva MA, Abreu LR and Martins PG, 2016. Carcass traits and meat quality of quails from both sexes and eight distinct strains. Animal Production Science, 57, 2141–2147. https://doi.org/10.1071/AN15854

Grashorn M and Brehme G, 2018. DLG-Merkblatt, 436.

Guémené D, 2015. Welfare problems in broilers caused by the genetic factors and the resistance of stress in commercial broilers. In "Animal Welfare in broiler production" Better Training for Safer Food – SANCO Training Course. Desenzano del Garda, Brescia, Italy.

Guémené D, 2023. Personal Communication, 2nd February 2023. Working group meeting of the European Food and Safety Authority.

Guémené D, Boulay M, Chapuis H, Desnoues B, Rault P and Seigneurin F, 2011. Sélection Génétique des espèces avicoles et productions biologiques. Agricultures Alternatives, 105, 11–12.

Guémené D and Guy G, 2004. The past, present and future of force-feeding and "foie gras" production. World's Poultry Science Journal, 60, 210–222. https://doi.org/10.1079/WPS200314

Guémené D, Guy G, Noirault J, Destombes N and Faure J-M, 2006. Rearing conditions during the force-feeding period in male mule ducks and their impact upon stress and welfare. Animal Research, 55, 443–458. https://doi.org/10.1051/animres:2006028

Guémené D, Kansaku N and Zadworny D, 2001. L'expression du comportement d'incubation chez la dinde et sa maîtrise en élevage. INRAE Productions Animales, 14, 147–160. https://doi.org/10.20870/productions-animales.2001.14.3.3735

Guémené D, Shi ZD and Guy G, 2012. Production systems for waterfowl. Alternative systems for poultry: health, welfare and productivity. CABI, Wallingford, UK. pp. 128–154.

Guhl AM, 1968. Social behavior of the domestic fowl. Transactions of the Kansas Academy of Science, 71, 379–384. https://doi.org/10.2307/3627156

Gumułka M and Rozenboim I, 2015. Mating activity and sperm penetration assay in prediction of the reproduction potential of domestic goose ganders in a harem system. Animal Reproduction Science, 161, 138–145. https://doi.org/10.1016/j.anireprosci.2015.08.016
Gumułka M and Rozenboim I, 2017. Effect of the age of ganders on reproductive behavior and fertility in a competitive mating structure. Annals of Animal Science, 17, 733–746. https://doi.org/10.1515/aoas-2016-0071
Guo X, He X-X, Chen H, Wang Z-C, Li H-F, Wang J-X, Wang M-S and Jiang R-S, 2021. Revisiting the evolutionary history of domestic and wild ducks based on genomic analyses. Zoological Research, 42, 43–50. https://doi.org/10.24272/j.issn.2095-8137.2020.133
Gustafson LA, Cheng H-W, Garner JP, Pajor EA and Mench JA, 2007a. Effects of bill-trimming Muscovy ducks on behavior, body weight gain, and bill morphopathology. Applied Animal Behaviour Science, 103, 59–74. https://doi.org/10.1016/j.applanim.2006.04.003
Gustafson L, Cheng H-W, Garner J, Pajor E and Mench J, 2007b. The effects of different bill-trimming methods on the well-being of Pekin ducks. Poultry Science, 86, 1831–1839. https://doi.org/10.1093/ps/86.9.1831
Guzmán DA, Pellegrini S, Kembro JM and Marin RH, 2013. Social interaction of juvenile Japanese quail classified by their permanence in proximity to a high or low density of conspecifics. Poultry Science, 92, 2567–2575. https://doi.org/10.3382/ps.2013-03206
Han T, Wang T, Wang Z, Xiao T, Wang M, Zhang Y, Zhang J and Liu D, 2022. Evaluation of gaseous and solid waste in fermentation bedding system and its impact on animal performance: a study of breeder ducks in winter. Science of The Total Environment, 836, 155672. https://doi.org/10.1016/j.scitotenv.2022.155672
Harper J, 1972. The tardy domestication of the duck. Agricultural History, 46, 385–389.
Harun M, Veeneklaas R, Van Kampen M and Mabasso M, 1998. Breeding biology of Muscovy duck Cairina moschata in natural incubation: the effect of nesting behavior on hatchability. Poultry Science, 77, 1280–1286. https://doi.org/10.1093/ps/77.9.1280
Hegab I and Hanafy A, 2019. Effect of egg weight on external and internal qualities, physiological and hatching success of Japanese quail eggs (Coturnix coturnix japonica). Brazilian Journal of Poultry Science, 21. https://doi.org/10.1590/1806-9061-2018-0777
Henderson JV, Lines JA, Wathes CM, White RP and Nicol CJ, 2001a. Behaviour of domestic ducks exposed to mobile predator stimuli. 2. The association of individual duckling attributes with relative position in a flock. British Poultry Science, 42, 439–448. https://doi.org/10.1080/00071660120070659
Henderson JV, Nicol CJ, Lines JA, White RP and Wathes CM, 2001b. Behaviour of domestic ducks exposed to mobile predator stimuli. 1 Flock responses. British Poultry Science, 42, 433–438. https://doi.org/10.1080/00071660120070668
Henderson JV, Wathes CM, Nicol CJ, White RP and Lines JA, 2000. Threat assessment by domestic ducklings using visual signals: implications for animal–machine interactions. Applied Animal Behaviour Science, 69, 241–253. https://doi.org/10.1016/S0168-1591(00)00132-5
Heyn E, Damme K, Bergmann S, Remy F, Küster Y and Erhard M, 2009. Open water systems for species-appropriate housing of Peking ducks--effects on behaviour, feather quality and plugged up nostrils. Berliner und Münchener Tierärztliche Wochenschrift, 122, 292–301.
Heyn E, Damme K, Manz M, Remy F and Erhard M, 2006. Impact of open water systems on behavior and health of peking ducks during fattening. EPC 2006-12th European Poultry Conference, World's Poultry Science Association (WPSA), Verona, Italy.
Hong E, Kang BS, Kang HK, Jeon JJ, Kim HS, Son J and Kim CH, 2019. Effect of different stocking densities in plastic wired-floor house on performance and uniformity of Korean native commercial ducks. Korean Journal of Poultry Science, 46, 215–221. https://doi.org/10.5536/KJPS.2019.46.4.215
House GM, Sobotik EB, Nelson JR and Archer GS, 2020. Effects of ultraviolet light supplementation on pekin duck production, behavior, and welfare. Animals, 10, 833. https://doi.org/10.3390/ani10050833
Hrnčár C, Hanusova E, Hanus A and Bujko J, 2014. Effect of genotype on egg quality characteristics of Japanese quail (Coturnix japonica). Slovak Journal of Animal Science, 47, 6–11.
Ionità L, Panà CO, Stanca C and Marin M, 2010. Researches regarding the influence of compound feed on growth replacement of young quails. Scientific Papers: Series D, Animal Science-The International Session of Scientific Communications of the Faculty of Animal Science. pp. 131–137.
Johnston A, Bishop V, Simonot M, Tobari Y, Son Y, Tsutsui K, Leng G and Meddle S, 2022. Short-term fasting enhances food seeking behaviour and increases hypothalamic neuropeptide Y mRNA expression in Japanese quail (Coturnix japonica) chicks. Proceedings of the Avian Research Symposium 2022.
Jones RB, Bessei W and Faure JM, 1982. Aspects of "fear" in Japanese quail chicks (Coturnix coturnix japonica) genetically selected for different levels of locomotor activity. Behavioural Processes, 7, 201–210. https://doi.org/10.1016/0376-6357(82)90035-3
Jones T and Dawkins M, 2010a. Environment and management factors affecting Pekin duck production and welfare on commercial farms in the UK. British Poultry Science, 51, 12–21. https://doi.org/10.1080/00071660903421159
Jones T and Dawkins M, 2010b. Effect of environment on Pekin duck behaviour and its correlation with body condition on commercial farms in the UK. British Poultry Science, 51, 319–325. https://doi.org/10.1080/00071668.2010.499143

Jones TA, Waitt CD and Dawkins MS, 2009. Water off a duck's back: showers and troughs match ponds for improving duck welfare. Applied Animal Behaviour Science, 116, 52–57. https://doi.org/10.1016/j.applanim.2008.07.008

Jung L and Knierim U, 2018. Are practice recommendations for the prevention of feather pecking in laying hens in non-cage systems in line with the results of experimental and epidemiological studies? Applied Animal Behaviour Science, 200, 1–12. https://doi.org/10.1016/j.applanim.2017.10.005

Karcher DM, Makagon MM, Fraley GS, Fraley S and Lilburn M, 2013. Influence of raised plastic floors compared with pine shaving litter on environment and Pekin duck condition. Poultry Science, 92, 583–590. https://doi.org/10.3382/ps.2012-02215

Käßmann S and Woog F, 2007. How to cope with snow and ice: winter ecology of feral Greylag Geese Anser anser. Wildfowl, 57, 29–39.

Kaye J, Luka S, Akpa G and Adeyinka I, 2017. Egg production pattern of Japanese quail (Coturnix coturnix japonica) in Northern Guinea Savannah Zone of Nigeria. International Journal of Innovative Research and Advanced Studies (IJIRAS), 4, 93–97. http://hdl.handle.net/123456789/1536

Kear J, 2005. Introduction. In: J Kear and M Hulme (eds). Ducks. New York, Oxford University Press, Geese and Swans. pp. 313.

Kear J, 2010. Man and Wildfowl. A&C Black Publishers Ltd., London. 273 pp.

Ketaren PP, Sinurat AP, Prasetyo LH, Raharjo YC and Purba M, 2011. Effect of lysine and metabolizable energy levels on productive performance of Mule ducks. SAADC 2011 strategies and challenges for sustainable animal agriculture-crop systems, Volume III: full papers. Proceedings of the 3rd International Conference on sustainable animal agriculture for developing countries, Nakhon Ratchasima, Thailand. pp. 367–371.

Kiani A, 2022. Effects of group sizing on behavior, welfare, and productivity of poultry. Journal of World's Poultry Research, 12, 52–68. https://doi.org/10.36380/jwpr.2022.7

Klambeck L, Kaufmann F, Kämmerling J, Kemper N and Andersson R, 2017. Effect of two different additional water sources on health and welfare parameters in farmed Pekin ducks (Anas platyrhynchos fd). Berliner und Münchener Tierärztliche Wochenschrift, 130, 273–280.

Klambeck L, Stracke J, Spindler B, Klotz D, Wohlsein P, Schön H, Kaufmann F, Kemper N and Andersson R, 2019. First approach to validate a scoring system to assess footpad dermatitis in Pekin ducks. European Poultry Science, 83(10), 1399. https://doi.org/10.1399/eps.2019.262

Klemm, R, Pingel LH, Reiter K, Bierschenk F, and Rauch W, 1992. Investigations on feather pecking in Muscovy ducks. World's Poultry Congress, Amsterdam, The Netherlands, pp. 390–393.

Klemm R, Reiter J and Pingel H, 1995. Untersuchungen zum Federpicken bei Moschusenten. Archiv fur Geflugelkunde, 59, 99–102.

Knierim U, Bulheller M, Kuhnt K, Briese A and Hartung J, 2005. Mindestanforderungen an die Haltung von Moschusenten (Cairina moschata dom.). Schlussbericht des Forschungsauftrags 01HS039 der Bundesanstalt für Landwirtschaft und Ernährung (BLE).

Kokoszyński D, Wasilewski R, Saleh M, Piwczyński D, Arpášová H, Hrnčar C and Fik M, 2019. Growth performance, body measurements, carcass and some internal organs characteristics of Pekin ducks. Animals, 9, 963. https://doi.org/10.3390/ani9110963

Kotrschal K, Scheiber IB and Hirschenhauser K, 2010. Individual performance in complex social systems: the greylag goose example. Animal behaviour: Evolution and mechanisms. Springer, Berlin, Heidelberg. pp. 121–148.

Kozák J, 2019. Variations of geese under domestication. World's Poultry Science Journal, 75, 247–260. https://doi.org/10.1017/S0043933919000023

Kozák J, 2021. Goose production and goose products. World's Poultry Science Journal, 77, 403–414. https://doi.org/10.1080/00439339.2021.1885002

Krijgsveld KL, Visser GH and Daan S, 2003. Foraging behavior and physiological changes in precocial quail chicks in response to low temperatures. Physiology and Behavior, 79, 311–319. https://doi.org/10.1016/S0031-9384(03)00117-3

Krunt O, Kraus A, Zita L, Machová K, Chmelíková E, Petrásek S and Novák P, 2022. The effect of housing system and gender on relative brain weight, body temperature, hematological traits, and bone quality in muscovy ducks. Animals, 12, 370. https://doi.org/10.3390/ani12030370

Kucharska-Gaca J, Adamski M and Biesek J, 2022. Effect of parent flock age on hatching, growth rate, and features of both sexes goose carcasses. Poultry Science, 101, 101920. https://doi.org/10.1016/j.psj.2022.101920

Küster Y, 2007. Tierfreundliche Haltungsumwelt für Pekingenten: Untersuchungen zu Rundtränken, Duschen und Ausläufen unter Berücksichtigung des Verhaltens, der Tiergesundheit und der Wirtschaftlichkeit. PhD Thesis. University of München, Germany. 170 p..

Laurence A, Houdelier C, Calandreau L, Arnould C, Favreau-Peigné A, Leterrier C, Boissy A and Lumineau S, 2015. Environmental enrichment reduces behavioural alterations induced by chronic stress in Japanese quail. Animal, 9, 331–338. https://doi.org/10.1017/S1751731114002523

Lavigne F, Molette C, Bouillier-Oudot M, Arroyo J and Bonnefont C, 2017. Feed transition effects on mule duck performances during the rearing and over-feeding periods [Conference poster]. 12e Journées de la Recherche Avicole et Palmipèdes à Foie Gras (JRA-JRPFG 2017), 5 & 6 avril 2017. Tours, France. pp. 1000–1004.

Le Roy P, Chapuis H and Guemene D, 2014. Sélection génomique: quelles perspectives pour les filières avicoles? INRA Productions Animales, 27, 331–336.
Lee H-J, Roberts SJ, Drake KA and Dawkins MS, 2011. Prediction of feather damage in laying hens using optical flows and Markov models. Journal of the Royal Society Interface, 8, 489–499. https://doi.org/10.1098/rsif.2010.0268
Leipoldt AL (Praktijkonderzoek Pluimveehouderij), 1992. Gedrag van pekingeenden met variatie in drinkwatersysteem en bodembedekking. 0928-2076.
Leprettre S, Auvergne A, Dubois J, Babilé R, and Lavigne F, 2000. Systeme d'élevage des oies et performances de croissance. In 4èmes journées de la recherche sur les palmipèdes à foie gras Arcachon, 4–5 October 2000, pp. 105–108.
Li W, Yuan J, Ji Z, Wang L, Sun C and Yang X, 2018. Correlation search between growth performance and flock activity in automated assessment of Pekin duck stocking density. Computers and Electronics in Agriculture, 152, 26–31. https://doi.org/10.1016/j.compag.2018.06.053
Liao S-C, Lu P-X, Shen S-Y, Hsiao C-C, Lien C-Y, Wang S-D, Lin T-Y and Tu P-A, 2021. Effects of different swimming pool conditions and floor types on growth performance and footpad dermatitis in indoor-reared white roman geese. Animals, 11, 1705. https://doi.org/10.3390/ani11061705
Liao S-C, Lyu P-X, Shen S-Y, Hsiao C-C, Lien C-Y, Wang S-D, Lin T-Y and Tu P-A, 2022. Effects of swimming pool conditions and floor types on white roman geese's physical condition scores and behaviors in an indoor rearing system. Animals, 12, 3273. https://doi.org/10.3390/ani12233273
Lierz M and Heffels-Redmann U, 2019. Respiratory disorders. BSAVA Manual of Backyard Poultry Medicine and Surgery. BSAVA Library, 160–177.
Lin MJ, Chang SC, Lin TY, Cheng YS, Lee YP and Fan YK, 2016. Factors affecting the incidence of angel wing in white roman geese: stocking density and genetic selection. Asian-Australasian Journal of Animal Sciences, 29, 901–907. https://doi.org/10.5713/ajas.15.0456
Liste G, Kirkden RD and Broom DM, 2012a. Effect of water depth on pool choice and bathing behaviour in commercial Pekin ducks. Applied Animal Behaviour Science, 139, 123–133. https://doi.org/10.1016/j.applanim.2012.03.005
Liste G, Kirkden R and Broom D, 2012b. A commercial trial evaluating three open water sources for farmed ducks: effects on health and production. British Poultry Science, 53, 576–584. https://doi.org/10.1080/00071668.2012.736613
Liste G, Kirkden RD and Broom DM, 2013. A commercial trial evaluating three open water sources for farmed ducks: effects on water usage and water quality. British Poultry Science, 54, 24–32. https://doi.org/10.1080/00071668.2013.763900
Litt JM-J, 2020. Mise au point et validation d'indicateurs pour une évaluation multicritère de l'état des canards pendant la période de gavage. PhD Thesis. INPT, Toulouse.
Litt J, Chaumier J, Bernadet MD, Laborde M, Vogelaer J, Albaric O, Huguet JM and Guerin JL, 2015. Histological validation of a footpad dermatitis scoring system appropriate for mule duck [Conference poster]. Actes des 11èmes Journées de la Recherche Avicole et Palmipèdes à Foie Gras, Tours, France. pp. 247–252.
Litt J, Chaumier J, Laborde M, Bernadet MD, Vogelaer J, Boucher M and Bignon L, 2015b. Evaluation of the physical integrity of mule duck in commercial farms: inventory. Actes des 11èmes Journées de la Recherche Avicole et Palmipèdes à Foie Gras, Tours, France. pp. 876–880.
Litt J, Chaumier J, Laborde M, Bernadet M, Vogelaer J, Boucher M and Bignon L, 2015c. Establishment of an animal-based indicators grid for the assessment of physical integrity of mule duck [Conference poster]. Actes des 11èmes Journées de la Recherche Avicole et Palmipèdes à Foie Gras, Tours, France, les 25 et 26 mars 2015. pp. 1012–1018.
Litt J, Laborde M, Lavigne F, Bijja M, Bernardet M, Robin P, Amand G, Pertusa M, Labussière E and Cadudal F, 2019. Ecofog-Gagner en compétitivité et réduire les impacts environnementaux de la filière foie gras. Innovations Agronomiques, 71, 51–66. https://doi.org/10.15454/kjfmtn
Litt J, Leterrier C, Savietto D and Fortun-Lamothe L, 2020. Influence of dietary strategy on progression of health and behaviour in mule ducks reared for fatty liver production. Animal, 14, 1258–1269. https://doi.org/10.1017/S1751731119003367
Liu ZL, Chen Y, Xue JJ, Huang XF, Chen ZP, Wang QG and Wang C, 2022b. Effects of ambient temperature on the growth performance, fat deposition, and intestinal morphology of geese from 28 to 49 days of age. Poultry Science, 101, 101814. https://doi.org/10.1016/j.psj.2022.101814
Liu ZZ, Chen ZP, Xue JJ, Huang XF, Chen Y, Wang BW, Wang QG and Wang C, 2022a. Effects of ambient temperature on growth performance, blood parameter, and fat deposition of geese from 14 to 28 days of age. Poultry Science, 101, 101758. https://doi.org/10.1016/j.psj.2022.101758
Liu ZZ, Xue JJ, Huang XF, Chen Y, Wang QG, Zhang S and Wang C, 2021. Effect of stocking density on growth performance, feather quality, serum hormone, and intestinal development of geese from 1 to 14 days of age. Poultry Science, 100, 101417. https://doi.org/10.1016/j.psj.2021.101417
Liu HW and Zhou DW, 2013. Influence of pasture intake on meat quality, lipid oxidation, and fatty acid composition of geese. Journal of Animal Science, 91, 764–771. https://doi.org/10.2527/jas.2012-5854

Lorenz K, 1992. Here am i-where are you?: the behavior of the greylag goose. Harper Collins Publishers, London. 270 pp.
Lotfi E, Zerehdaran S and Ahani Azari M, 2011. Genetic evaluation of carcass composition and fat deposition in Japanese quail. Poult Science, 90, 2202–2208. https://doi.org/10.3382/ps.2011-01570
Ludwig SC, Kapetanopoulos K, Kotrschal K and Wascher CA, 2017. Effects of mate separation in female and social isolation in male free-living Greylag geese on behavioural and physiological measures. Behavioural Processes, 138, 134–141. https://doi.org/10.1016/j.beproc.2017.03.002
Lukanov H, 2019. Domestic quail (Coturnix japonica domestica), is there such farm animal? World's Poultry Science Journal, 75, 547–558. https://doi.org/10.1017/S0043933919000631
Lukanov H, Genchev A and Kolev P, 2018. Comparative investigation of egg production in WG, GG and GL Japanese quail populations. Trakia Journal of Sciences, 4, 334–343. https://doi.org/10.15547/tjs.2018.04.011
Lukaszewicz E, Kowalczyk A and Jerysz A, 2011. The effect of sex and feed supplementation with organic selenium and vitamin E on the growth rate and zoometrical body measurements of oat-fattened White Kołuda® geese. Turkish Journal of Veterinary & Animal Sciences, 35, 435–442. https://doi.org/10.3906/vet-1008-420
Mahmoud UT, Mahmoud MA, Abd-Elkareem M, Ahmed FA and Khalil NSA, 2021. Prebiotics reduce feather pecking behavior, and improve trace element profile and redox balance in Mule ducks. Journal of Veterinary Behavior, 43, 28–38. https://doi.org/10.1016/j.jveb.2021.03.001
Makagon MM and Mench JA, 2011. Floor laying by Pekin ducks: effects of nest box ratio and design. Poultry Science, 9o, 1179–1184. https://doi.org/10.3382/ps.2010-01287
Makagon MM and Riber AB, 2022. Setting research driven duck-welfare standards: a systematic review of Pekin duck welfare research. Poultry Science, 101, 101614. https://doi.org/10.1016/j.psj.2021.101614
Makagon MM, Tucker CB and Mench JA, 2011. Factors affecting nest choice by Pekin ducks. Applied Animal Behaviour Science, 129, 121–128. https://doi.org/10.1016/j.applanim.2010.10.008
Makagon MM, Woolley R and Karcher DM, 2015. Assessing the waddle: an evaluation of a 3-point gait score system for ducks. Poultry Science, 94, 1729–1734. https://doi.org/10.3382/ps/pev151
Makram A, Galal AA and El-Attar AA, 2021. A comparison of three duck strains (Pekin, Muscovy & Sudani) in Egypt for sexual dimorphism with regard to body weight, body measurements and carcass traits. Journal of Genetic and Environmental Resources Conservation, 9, 50–57.
Mancinelli AC, Mattioli S, Menchetti L, Dal Bosco A, Chiattelli D, Angelucci E and Castellini C, 2022. Validation of a behavior observation form for geese reared in agroforestry systems. Scientific Reports, 12, 1–13. https://doi.org/10.1038/s41598-022-18070-6
Marchant-Forde RM and Cheng HW, 2010. Different effects of infrared and one-half hot blade beak trimming on beak topography and growth. Poultry Science, 89, 2559–2564. https://doi.org/10.3382/ps.2010-00890
Marie-Etancelin C, Retailleau B, Alinier A and Vitezica Z-G, 2015. Sex impact on the quality of fatty liver and its genetic determinism in mule ducks. Journal of Animal Science, 93, 4252–4257. https://doi.org/10.2527/jas.2015-9121
Marks HL, 1996. Long-term selection for body weight in Japanese quail under different environments. Poultry Science, 75, 1198–1203. https://doi.org/10.3382/ps.0751198
Massaccesi L, Cartoni Mancinelli A, Mattioli S, De Feudis M, Castellini C, Dal Bosco A, Marongiu ML and Agnelli A, 2019. Geese reared in vineyard: soil, grass and animals interaction. Animals, 9, 179. https://doi.org/10.3390/ani9040179
Mathkari CV, 2022. Effects of Environmental enrichments on well-being measures in colony-caged Japanese quail (Coturnix Japonica). PhD thesis. University of Maryland, College Park. 169 p..
Merlet F, Rousset N, Ponchant P and Corson MS, 2010. Evaluation de l'impact Carbone en production de canards à rôtir: une approche de terrain des systèmes d'élevage sur caillebotis et sur litière. TeMA, 13, 31–38.
Merritt E, 1962. Selection for egg production in geese. Proceedings of the Proc. XII World's Poultry Congress, Sydney. Section Papers, 83–87.
Merritt ES and Lemay JA, 1963. Age and performance in Geese1. World's Poultry Science Journal, 19, 191–201. https://doi.org/10.1079/WPS19630019
Michel R, 1989. Influence of experience and visual stimulation in Japanese quail laying site selection under experimental condition. Behavioural Processes, 18, 155–171. https://doi.org/10.1016/S0376-6357(89)80013-0
Michel V, 2023. Personal Communication, 10th March 2023. Working group meeting of the European Food and Safety Authority.
Mika A, Guettier E, Berger Q, Le Bihan-Duval E, Jrm B, Pampouille E, Bouvarel I, Mignon-Grasteau S and Bihan-Duval L, 2021. Eva-HD-Mise au point d'un automate de consommation alimentaire pour volaillesnommè BIRD-e: Bird Individual Ration Dispenser-electronic. Innovations Agronomiques, 82, 137–149.
Miles DM, Miller WW, Branton SL, Maslin WR and Lott BD, 2006. Ocular responses to ammonia in broiler chickens. Avian Diseases, 50, 45–49. https://doi.org/10.1637/7386-052405R.1
Miller KA and Mench JA, 2006. Differential effects of 4 types of environmental enrichment on aggressive pecking, feather pecking, feather loss, food wastage and productivity in Japanese quail. British Poultry Science, 47, 646–658. https://doi.org/10.1080/00071660601084333

Mills AD, Crawford LL, Domjan M and Faure JM, 1997. The behavior of the Japanese or domestic quail Coturnix japonica. Neuroscience and Biobehavioral Reviews, 21, 261–281. https://doi.org/10.1016/S0149-7634(96)00028-0

Mills AD and Faure J-M, 1991. Divergent selection for duration of tonic immobility and social reinstatement behavior in Japanese quail (Coturnix coturnix japonica) chicks. Journal of Comparative Psychology, 105, 25–38. https://doi.org/10.1037/0735-7036.105.1.25

Mills AD, Jones RB, Faure J-M and Williams JB, 1993. Responses to isolation in Japanese quail genetically selected for high or low sociality. Physiology and Behavior, 53, 183–189. https://doi.org/10.1016/0031-9384(93)90029-F

Mills A and Wood-Gush D, 1985. Pre-laying behaviour in battery cages. British Poultry Science, 26, 247–352. https://doi.org/10.1080/00071668508416810

Minvielle F, 1998. Genetics and breeding of Japanese quail for production around the world. Proceedings of the 6th Asian Pacific Poultry Congress, Nagoya, Japan, 122–127.

Minvielle F, 2004. The future of Japanese quail for research and production. World's Poultry Science Journal, 60, 500–507. https://doi.org/10.1079/WPS200433

ML, 2013. Vereinbarung des Niedersächsischen Ministeriums für Ernährung, Landwirtschaft und Verbraucherschutz (ML) und der Niedersächsischen Geflügelwirtschaft, Landesverband e. V. (NGW) zur Weiterentwicklung der Mindestanforderungen an die Haltung von Moschusenten.

ML, 2015. Vereinbarung des Niedersächsischen Ministeriums für Ernährung, Landwirtschaft und Verbraucherschutz (ML) und der Niedersächsischen Geflügelwirtschaft, Landesverband e. V. (NGW) über die Weiterentwicklung der Mindestanforderungen an die Haltung von Pekingmastenten.

Mohammed A, Matouq S, Negm E and Darwish M, 2022. Impact of bill trimming on duck health and welfare-a review. Indiana Journal of Agriculture and Life Sciences, 2, 17–26. https://doi.org/10.5281/zenodo.7139301

Mohammed AAA, Abdel-Rahman MAM and Darwish MH, 2015. Influence of swimming deprivation on behavior, performance and some blood parameters of Muscovy ducks. Journal of Advanced Veterinary Research, 5, 53–59.

Mohammed HH, Abdelaty AI, Saleem A-SY, Youssef MI and Abdel-Hamid SE, 2019a. Effect of bedding materials on duck's welfare and growth performance. Slovenian Veterinary Research, 56, 149–156.

Mohammed HH, Rehan IF, Abou-Elnaga AF and Mohamed RA, 2019b. Effects of feeder shape on behavioral patterns, performance and egg quality traits of Japanese quail. Slovenian Veterinary Research, 56, 139–148. https://doi.org/10.26873/SVR-751-2019

Mohammed HH, Said EN and Abdel-Hamid S, 2017. Impact of different litter materials on behaviour, growth performance, feet health and plumage score of Japanese quail (Coturnix japonica). European Poultry Science, 81, 719–727. https://doi.org/10.1399/eps.2017.172

Mohammed RA, Abou-Ismail UA and Shukry M, 2016. Effects of different monochromatic LED light colours on fear reactions and physiological responses in Mulard ducks. Animal Production Science, 57, 1128–1136. https://doi.org/10.1071/AN15249

Molnár M and Bogenfürst F, 1999. Effects of two different watering tray types on the behaviour of geese. Acta Agraria Kaposváriensis, 3, 221–228.

Molnár M, Molnár T and Bogenfürst F, 1998. A lúd néhány viselkedési formájának változása 2-7 hetes korig, intenzív tartási viszonyok között. Acta Agraria Kaposváriensis, 2, 49–56.

Molnár M, Molnár T and Bogenfürst F, 2004. Comparative study on the behaviour of two goose genotypes selected for cramming during the Preconditioning for laying. Acta Agriculturae Slovenica, 216.

Molnár M, Nagy I, Molnár T and Bogenfürst F, 2006. Animal welfare aspects of goose liver production without force feeding: selection possibilities for behaviour forms. Acta Agraria Kaposváriensis, 10, 223–227.

Moreno-Rueda G, 2017. Preen oil and bird fitness: a critical review of the evidence. Biological Reviews, 92, 2131–2143. https://doi.org/10.1111/brv.12324

Muhammad SD and Mirza RA, 2019. Effect of rearing system on performance, meat quality and welfare in local quails. Zanco Journal of Pure and Applied Sciences, 31, 116–120. https://doi.org/10.21271/zjpas.31.s4.18

Munir M, Belloncle C, Irle M and Federighi M, 2019. Wood-based litter in poultry production: a review. World's Poultry Science Journal, 75, 5–16. https://doi.org/10.1017/S0043933918000909

Nagarajan S, Narahari D, Alfred Jayaprasad I and Thyagarajan D, 1991. Influence of stocking density and layer age on production traits and egg quality in Japanese quail. British Poultry Science, 32, 243–248. https://doi.org/10.1080/00071669108417347

Narinc D, Aksoy T, Karaman E, Aygun A, Firat MZ and Uslu MK, 2013. Japanese quail meat quality: characteristics, heritabilities, and genetic correlations with some slaughter traits. Poultry Science, 92, 1735–1744. https://doi.org/10.3382/ps.2013-03075

Narinc D, Karaman E and Aksoy T, 2014. Effects of slaughter age and mass selection on slaughter and carcass characteristics in 2 lines of Japanese quail. Poultry Science, 93, 762–769. https://doi.org/10.3382/ps.2013-03506

Nasr MA, Alkhedaide AQ, Radwan MM, Abd-El Salam EH, Hussein MA and El Bayomi RM, 2022. Growth, carcass parameters, biochemical and oxidative stress indices, and meat traits of duck breeds under different stocking densities. Poultry Science, 101, 101992. https://doi.org/10.1016/j.psj.2022.101992

Nasr MA, Mohammed H, Hassan RA, Swelum AA and Saadeldin IM, 2019. Does light intensity affect the behavior, welfare, performance, meat quality, amino acid profile, and egg quality of Japanese quails? Poultry Science, 98, 3093–3102. https://doi.org/10.3382/ps/pez089

Newberry RC, 1995. Environmental enrichment: Increasing the biological relevance of captive environments. Applied Animal Behaviour Science, 44, 229–243. https://doi.org/10.1016/0168-1591(95)00616-Z

Newberry RC, 1999. Exploratory behaviour of young domestic fowl. Applied Animal Behaviour Science, 63, 311–321. https://doi.org/10.1016/S0168-1591(99)00016-7

Nicol CJ, Bouwsema J, Caplen G, Davies AC, Hockenhull J, Lambton SL, Lines JA, Mullan S and Weeks CA, 2017. Farmed bird welfare science review. Department of Economic Development, Jobs, Transport and Resources, Melbourne. 321 pp.

Nilsson L and Persson H, 2001. Natal and breeding dispersal in the Baltic Greylag Goose Anser anser. Wildfowl, 52, 21–30.

Nol E, Cheng K and Nicholas C, 1996. Heritability and phenotypic correlations of behaviour and dominance rank of Japanese quail. Animal behaviour, 52, 813–820. https://doi.org/10.1006/anbe.1996.0226

Nordi WM, Yamashiro KC, Klank M, Locatelli-Dittrich R, Morais RN, Reghelin AI and Molento CFM, 2012. Quail (Coturnixcoturnix japonica) welfare in two confinement systems. Arquivo Brasileiro de Medicina Veterinária e Zootecnia, 64, 1001–1008. https://doi.org/10.1590/S0102-09352012000400029

NRC (National Research Council (US) Committee for the Update of the Guide for the Care and Use of Laboratory Animals), 2011. Guide for the Care and Use of Laboratory Animals. 8th edn. National Academies Press, Washington, Washington (DC). 220 pp.

Nyland J, 2005. Greylag Goose Anser Anser. In: J Kear and M Hulme (eds). Ducks, Geese and Swans. Oxford University Press, New York. pp. 276–280.

O'Driscoll KKM and Broom DM, 2011. Does access to open water affect the health of Pekin ducks (Anas platyrhynchos)? Poultry Science, 90, 299–307. https://doi.org/10.3382/ps.2010-00883

Oguz I, Aksit M, Onenc A, Gevrekci Y, Ozdemir D and Altan O, 2004. Genetic variability of meat quality characteristics in Japanese quail (Coturnix coturnix japonica). Archiv fur Geflugelkunde, 68, 176–180.

Olsson C, Gunnarsson G and Elmberg J, 2017. Field preference of Greylag geese Anser anser during the breeding season. European Journal of Wildlife Research, 63, 1–12. https://doi.org/10.1007/s10344-017-1086-5

Olsson IAS, Keeling LJ and Duncan IJ, 2002. Why do hens sham dustbathe when they have litter? Applied Animal Behaviour Science, 76, 53–64. https://doi.org/10.1016/S0168-1591(01)00181-2

Orcutt FS Jr and Orcutt AB, 1976. Nesting and parental behavior in domestic common quail. The Auk, 135–141.

Osman AMA, 1993. Effect of the stocking rate on growth performance, carcass traits and meat quality of male Peking ducks. Der Tropenlandwirt-Journal of Agriculture in the Tropics and Subtropics, 94, 147–156.

Ottinger MA and Brinkley HJ, 1979. Testosterone and sex related physical characteristics during the maturation of the male Japanese quail (Coturnix coturnix japonica). Biology of Reproduction, 20, 905–909. https://doi.org/10.1095/biolreprod20.4.905

Owen M and Black JM, 1990. Waterfowl ecology. Blackie and Son, Ltd., London. 105 p..

Ozbey O, Erisir Z, Aysondu MH and Ozmen O, 2004. The effect of high temperatures on breeding and survival of Japanese quails that are bred under different temperatures. International Journal of Poultry Science, 3, 463–467. https://doi.org/10.3923/ijps.2004.463.467

Park B-S, Um K-H, Park S-O and Zammit VA, 2018. Effect of stocking density on behavioral traits, blood biochemical parameters and immune responses in meat ducks exposed to heat stress. Archives Animal Breeding, 61, 425–432. https://doi.org/10.5194/aab-61-425-2018

Parrish JW, Ptacek JA and Will KL, 1984. The detection of near-ultraviolet light by nonmigratory and migratory birds. The Auk, 101, 53–58. https://doi.org/10.1093/auk/101.1.53

Pellegrini S, Condat L, Caliva JM, Marin RH and Guzman DA, 2019. Can Japanese quail male aggressions toward a female cagemate predict aggressiveness toward unknown conspecifics? Livestock Science, 222, 65–70. https://doi.org/10.1016/j.livsci.2019.02.013

Pingel H, 1999. Influence of breeding and management on the efficiency of duck production. Lohmann Information, 22, 7–13.

Pingel H, 2000. Enten und Gänse, Stuttgart, Eugen Ulmer. 104–125 pp.

Pingel H, Guy G and Baéza E, 2012. Production de Canards.

Pizzolante CC, Garcia EA, Saldanha EAPB, Laganá C, Batista L, Deodato AP and Souza ALP, 2006. Beak-trimming methods and their effect on the performance of Japanese quail pullets (Coturnix japonica). Brazilian Journal of Poultry Science, 8, 213–216. https://doi.org/10.1590/S1516-635X2006000400002

Poisbleau M, Fritz H, Guillemain M and Lacroix A, 2005a. Testosterone and linear social dominance status in captive male dabbling ducks in winter. Ethology, 111, 493–509. https://doi.org/10.1111/brv.12324doi.org/10.1111/j.1439-0310.2005.01092.x

Poisbleau M, Fritz H, Guillon N and Chastel O, 2005b. Linear social dominance hierarchy and corticosterone responses in male mallards and pintails. Hormones and Behavior, 47, 485–492. https://doi.org/10.1016/j.yhbeh.2005.01.001

Prescott N, Wathes CM and Jarvis J, 2003. Light, vision and the welfare of poultry. Animal Welfare, 12, 269–288. https://doi.org/10.1017/S0962728600025689

Priti M and Satish S, 2014. Quail farming: an introduction. International Journal of Life Sciences, 2, 190–193.
Prosser DJ, Palm EC, Takekawa JY, Zhao D, Xiao X, Li P, Liu Y and Newman SH, 2015. Movement analysis of free-grazing domestic ducks in Poyang Lake, China: a disease connection. International Journal of Geographical Information Science, 30, 869–880. https://doi.org/10.1080/13658816.2015.1065496
Ramankevich A, Wengerska K, Rokicka K, Drabik K, Kasperek K, Ziemiańska A and Batkowska J, 2022. Environmental enrichment as part of the improvement of the welfare of Japanese Quails. Animals, 12, 1963. https://doi.org/10.3390/ani12151963
Ramseyer A, Petit O and Thierry B, 2009. Patterns of group movements in juvenile domestic geese. Journal of Ethology, 27, 369–375. https://doi.org/10.1007/s10164-008-0128-6
Ratriyanto A, Nuhriawangsa AMP, Masykur A, Prastowo S and Widyas N, 2018. Egg production pattern of quails given diets containing different energy and protein contents. Proceedings of the AIP Conference Proceedings, 020011.
Rauch HW, Pingel H and Bilsing A, 1993. Welfare of Waterfowl. Proceedings of the 4th European Symposium on Poultry Welfare. Animal and Food Research Council. Roslin Research Station, Edinburgh, Scotland. pp. 139–147.
Raud H and Faure J, 1994. Welfare of ducks in intensive units. Revue Scientifique et Technique de l'Office International des Epizooties, 13, 125–142.
Rayner AC, Newberry RC, Vas J and Mullan S, 2020. Slow-growing broilers are healthier and express more behavioural indicators of positive welfare. Scientific reports, 10, 1–14. https://doi.org/10.1038/s41598-020-72198-x
Regmi P, Deland T, Steibel J, Robison SC, Haut R, Orth M and Karcher D, 2015. Effect of rearing environment on bone growth of pullets. Poultry Science, 94, 502–511. https://doi.org/10.3382/ps/peu041
Reiter K, 1997. Das Verhalten von Enten (Anas platyrhynchos f. domestica). Arch Geflügelk, 61, 149–161.
Reiter K and Bessei W, 1995. A behavioural comparison of pekin, muscovy and mulard duck in the fattening period. Proceedings of the 10th European Symposium on Waterfowl, Halle, 118–121.
Reiter K, Zernig F and Bessei W, 1997. Effect of water bath and free range on behaviour and feathering in Pekin, Muscovy, and Mulard duck. Proceedings of the Proceedings of the 11th European Symposium on Waterfowl, Nantes, France, 224–229.
Restoux G, Rognon X, Vieaud A, Guémené D, Petitjean F, Rouger R, Brard-Fudulea S, Lubac-Paye S, Chiron G and Tixier-Boichard M, 2022. Managing genetic diversity in breeding programs of small populations: the case of French local chicken breeds. Genetics Selection Evolution, 54, 1–17. https://doi.org/10.1186/s12711-022-00746-2
Riber AB, Casey-Trott TM and Herskin MS, 2018. The influence of keel bone damage on welfare of laying hens. Frontiers in Veterinary Science, 5, 6. https://doi.org/10.3389/fvets.2018.00006
Riber AB and Mench JA, 2008. Effects of feed-and water-based enrichment on activity and cannibalism in Muscovy ducklings. Applied Animal Behaviour Science, 114, 429–440. https://doi.org/10.1016/j.applanim.2008.03.005
Robison CI, Rice M, Makagon MM and Karcher DM, 2015. Duck gait: relationship to hip angle, bone ash, bone density, and morphology. Poultry Science, 94, 1060–1067. https://doi.org/10.3382/ps/pev050
Rodenburg TB, Bracke MBM, Berk J, Cooper J, Faure JM, Guémené D, Guy G, Harlander A, Jones T, Knierim U, Kuhnt K, Pingel H, Reiter K, Serviére J and Ruis MAW, 2005. Welfare of ducks in European duck husbandry systems. World's Poultry Science Journal, 61, 633–646. https://doi.org/10.1079/WPS200575
Rouger R, Teissier M, Brard-Fudulea S, Thébault N, Riquet J, Leroux S, Vignal A, Bed'Hom B, Rognon XX and Lumineau S, 2019. Practical applications of genomic assignment methods in the avian breeding industry. Proceedings of the XIth European symposium on poultry genetics (ESPG), pp. np.
Rowe E, Dawkins MS and Gebhardt-Henrich SG, 2019. A systematic review of precision livestock farming in the poultry sector: is technology focussed on improving bird welfare? Animals, 9, 614. https://doi.org/10.3390/ani9090614
Rowe E and Mullan S, 2022. Advancing a "Good Life" for farm animals: development of resource tier frameworks for on-farm assessment of positive welfare for beef cattle, broiler chicken and pigs. Animals, 12, 565. https://doi.org/10.3390/ani12050565
Rufino JPF, Cruz FGG, Melo RD, Feijó JC, Damasceno JL and Costa APG, 2017. Performance, carcass traits and economic availability of Muscovy ducks fed on different nutritional plans in different housing densities. Brazilian Journal of Poultry Science, 19, 689–694. https://doi.org/10.1590/1806-9061-2017-0471
Ruis MAW, Lenskens P and Coenen E, 2003. Welfare of Pekin-ducks increases when freely accessible open water is provided. The Second World Waterfowl Conference, Alexandria, Egypt. pp. 17.
Saatci M and Tilki M, 2007. Zoometrical body measurements and their relation with liveweight in native Turkish geese. Turkish Journal of Veterinary and Animal Sciences, 31, 47–53.
Salamon A, 2019. Keeping Breeder Geese Indoors: Problems and Mistakes. Proceedings of the Congress book. pp. 5.
Salamon A, 2020. Fertility and hatchability in goose eggs: A review. International Journal Poultry Science, 19, 51–65. https://doi.org/10.3923/ijps.2020.51.65
Sari M, Tilki M, Onk K and Isik S, 2013. Effects of production system and gender on live weight and body measurements in Pekin ducks. Ataturk University Journal of Veterinary Science, 8, 112–121.

SCAHAW (Scientific Committee on Animal Health and Animal Welfare), 1998. Report on welfare aspects of the production of foie gras in ducks and geese. Available online: https://food.ec.europa.eu/system/files/2020-12/sci-com_scah_out17_en.pdf

Scheiber IB, Hohnstein A, Kotrschal K and Weiß BM, 2011. Juvenile greylag geese (Anser anser) discriminate between individual siblings. PLoS One, 6, e22853. https://doi.org/10.1371/journal.pone.0022853

Scheiber IB, Weiß BM, Kotrschal K and Hemetsberger J, 2013. References. The social life of greylag geese: patterns, mechanisms and evolutionary function in an avian model system. Cambridge University Press, United Kingdom. pp. 202.

Schein MW and Statkiewicz WR, 1983. Satiation and cyclic performance of dust-bathing by Japanese quail (Coturnix coturnix japonica). Applied Animal Ethology, 10, 375–383. https://doi.org/10.1016/0304-3762(83)90186-4

Schenk A, Porter AL, Alenciks E, Frazier K, Best AA, Fraley SM and Fraley GS, 2016. Increased water contamination and grow-out Pekin duck mortality when raised with water troughs compared to pin-metered water lines using a United States management system. Poultry science, 95, 736–748. https://doi.org/10.3382/ps/pev381

Schmid I and Wechsler B, 1997. Behaviour of Japanese quail (Coturnix japonica) kept in semi-natural aviaries. Applied Animal Behaviour Science, 55, 103–112. https://doi.org/10.1016/S0168-1591(97)00039-7

Sharaf MM, 1996. Cage versus floor rearing of Japanese quails as affected by sex, age and bird density. Egyptian Poultry Science, 16, 725–738.

Shepherd E and Fairchild BD, 2010. Footpad dermatitis in poultry. Poultry science, 89, 2043–2051. https://doi.org/10.3382/ps.2010-00770

Shepherd E, Fairchild B and Ritz C, 2017. Alternative bedding materials and litter depth impact litter moisture and footpad dermatitis. Journal of Applied Poultry Research, 26, 518–528. https://doi.org/10.3382/japr/pfx024

Shi Z, Tian Y, Wu W and Wang Z, 2008. Controlling reproductive seasonality in the geese: a review. World's Poultry Science Journal, 64, 343–355. https://doi.org/10.1017/S0043933908000081

Shimma K and Tadano R, 2019. Genetic differentiation among commercial lines of laying-type Japanese quail. The Journal of Poultry Science, 56, 12–19. https://doi.org/10.2141/jpsa.0170213

Statkiewicz WR and Schein MW, 1980. Variability and periodicity of dustbathing behaviour in Japanese quail (Coturnix coturnix japonica). Animal Behaviour, 28, 462–467. https://doi.org/10.1016/S0003-3472(80)80053-4

Steczny K, Kokoszynski D, Bernacki Z, Wasilewski R and Saleh M, 2017. Growth performance, body measurements, carcass composition and some internal organ characteristics in young Pekin ducks. South African Journal of Animal Science, 47, 399–406. https://doi.org/10.4314/sajas.v47i3.16

Steinhaus H, 1999. Mathematical snapshots. Courier Corporation, Dover, New York. 300 pp.

Strong EA, Redpath S, Montras Janer T, Elmberg J and Månsson J, 2021. Seeking greener pastures: crop selection by Greylag Geese (Anser anser) during the moulting season. Ornis Fennica, 98, 16–32.

Sultana S, Hassan MR, Choe HS and Ryu KS, 2013. Impact of different monochromatic LED light colours and bird age on the behavioural output and fear response in ducks. Italian Journal of Animal Science, 12, e9.

Sun Y-X, Sang Q-Q, Yin ZT, Zhang F, Zhu F and Hou ZC, 2023. Genome-wide association study identified the candidate genes associated with angel wing trait in Pekin duck. Animal Genetics., 54, 211–215. https://doi.org/10.1111/age.13289

Taboosha MF, 2014. Effect of stocking density and slaughter age on growth performance and carcass traits of female mule ducks (cross-bred of Muscovy Drake and Pekin Ducks) during summer season in Egypt. Middle East Journal of Applied Sciences., 4, 1023–1033.

Tag EI-D, Ali MA, Ismail FS, Gad HA and EI-Shahat AM, 2004. Effect of feed restriction during the rearing period on subsequent performance of Campbell and Domyati ducks. Journal of Animal and Poultry Production, 29, 6809–6828.

Takahashi N, Shinki T, Abe E, Horiuchi N, Yamaguchi A, Yoshiki S and Suda T, 1983. The role of vitamin D in the medullary bone formation in egg-laying Japanese quail and in immature male chicks treated with sex hormones. Calcified Tissue International, 35, 465–471. https://doi.org/10.1007/BF02405078

Tamzil MH, Lestari L and Indarsih B, 2018. Measurement of several qualitative traits and body size of Lombok Muscovy Ducks (Cairina moshcata) in semi-intensive rearing. Journal of the Indonesian Tropical Animal. Agriculture, 43. https://doi.org/10.14710/jitaa.43.4.333-342

Taskin A and Camci O, 2017. Pumice as an instrument for beak blunting in quail. European Poultry Science, 81. https://doi.org/10.1399/eps.2017.170

Thomas GJ, 1982. Autumn and winter-feeding ecology of waterfowl at the Ouse Washes, England. Journal of Zoology, 197, 131–172. https://doi.org/10.1111/jzo.1982.197.1.131

Tidwell PR, Webb EB, Vrtiska MP and Bishop AA, 2013. Diets and food selection of female mallards and blue-winged teal during spring migration. Journal of Fish and Wildlife Management, 4, 63–74. https://doi.org/10.3996/072012-JFWM-062

Tiemann I, 2023. Personal Communication, 10th March 2023. Working group meeting of the European Food and Safety Authority.

Tremolada C, Bielińska H, Minero M, Ferrante V, Canali E and Barbieri S, 2020. Animal-based measures for the on-farm welfare assessment of geese. Animals, 10, 890. https://doi.org/10.3390/ani10050890

Vali N, 2008. The Japanese quail: A review. International Journal of Poultry Science, 7, 925–931. https://doi.org/10.3923/ijps.2008.925.931

Valkova L, Voslarova E, Vecerek V, Dolezelova P, Zavrelova V and Weeks C, 2021. Traumatic injuries detected during Post-Mortem slaughterhouse inspection as welfare indicators in poultry and rabbits. Animals, 11, 2610. https://doi.org/10.3390/ani11092610

van Blois L, Bentley A, Porter L, Prihoda N, Potter H, Van Wyk B, Shafer D, Fraley S and Fraley G, 2019. Feed restriction can alter gait but does not reduce welfare in meat ducks. Journal of Applied Poultry Research, 28, 858–866. https://doi.org/10.3382/japr/pfz044

van Staaveren N, Ellis J, Baes CF and Harlander-Matauschek A, 2021. A meta-analysis on the effect of environmental enrichment on feather pecking and feather damage in laying hens. Poultry Science, 100, 397–411. https://doi.org/10.1016/j.psj.2020.11.006

Varkoohi S, Babak MMS, Pakdel A, Javaremi AN, Zaghari M and Kause A, 2010. Response to selection for feed conversion ratio in Japanese quail. Poultry Science, 89, 1590–1598. https://doi.org/10.3382/ps.2010-00744

Wada M, 1986. Circadian rhythms of testosterone-dependent behaviors, crowing and locomotor activity, in male Japanese quail. Journal of Comparative Physiology A, 158, 17–25. https://doi.org/10.1007/BF00614516

Waitt C, Jones T and Dawkins MS, 2009. Behaviour, synchrony and welfare of Pekin ducks in relation to water use. Applied Animal Behaviour Science, 121, 184–189. https://doi.org/10.1016/j.applanim.2009.09.009

Walita KZ, Tanganyika J and Mussah SR, 2017. Effect of sex, type of feed and age at slaughter on carcass yield characteristics of Japanese quails (Cortunix Japonica) in Malawi. International Journal of Avian & Wildlife Biology, 2, 50–53. https://doi.org/10.15406/ijawb.2017.02.00015

Wang C, Liu Z, Xue J, Wang Y, Huang X and Wang Q, 2019. Effect of stocking density on growth performance, feather quality, carcass traits, and muscle chemical component of geese from 49 to 70 days of age. Journal of Applied Poultry Research, 28, 1297–1304. https://doi.org/10.3382/japr/pfz097

Wechsler B and Schmid I, 1998. Aggressive pecking by males in breeding groups of Japanese quail (Coturnix japonica). British Poultry Science, 39, 333–339. https://doi.org/10.1080/00071669888863

Weeks CA and Nicol CJ, 2006. Behavioural needs, priorities and preferences of laying hens. World's Poultry Science Journal, 62, 296–307. https://doi.org/10.1079/WPS200598

Weiß BM, Kotrschal K and Foerster K, 2011. A longitudinal study of dominance and aggression in greylag geese (Anser anser). Behavioral Ecology, 22, 616–624. https://doi.org/10.1093/beheco/arr020

West AK, Xu EM, Nelson MD, Hart TR, Stricker EM, Cones AG, Martin GM, Strickland K, Lambert DL, Burman L, Zhu DH and Schneider ER, 2022. Quantitative Evaluation of Tactile Foraging Behavior in Pekin and Muscovy Ducks. Frontiers in Physiology, 13, 1209. https://doi.org/10.3389/fphys.2022.921657

Widowski TM and Rentsch AK, 2022. Farming poultry. Routledge Handbook of Animal Welfare. Taylor and Francis, New York. pp. 493.

Wilkins L, McKinstry J, Avery N, Knowles T, Brown S, Tarlton J and Nicol C, 2011. Influence of housing system and design on bone strength and keel bone fractures in laying hens. Veterinary Record, 169, 414. https://doi.org/10.1136/vr.d4831

Williams DL, 2019. Ophthalmological and otic disorders. In: G Poland and A Raftery (eds). BSAVA Manual of Backyard Poultry Medicine and Surgery. John Wiley & Sons, Chichester, UK. pp. 160–177.

Williams B, Waddington D, Murray DH and Farquharson C, 2004. Bone strength during growth: influence of growth rate on cortical porosity and mineralization. Calcified Tissue International, 74, 236–245.

Wilson HR, Douglas CR, Nesbeth WG and Miller ER, 1978. Floor space for brooding bobwhite quail. Poultry Science, 57, 1499–1502. https://doi.org/10.3382/ps.0571499

Wolc A, Arango J, Settar P, Fulton JE, O'Sullivan NP, Preisinger R, Habier D, Fernando R, Garrick DJ and Dekkers J, 2011b. Persistence of accuracy of genomic estimated breeding values over generations in layer chickens. Genetics Selection Evolution, 43, 1–8. https://doi.org/10.1186/1297-9686-43-23

Wolc A, Stricker C, Arango J, Settar P, Fulton JE, O'Sullivan NP, Preisinger R, Habier D, Fernando R and Garrick DJ, 2011a. Breeding value prediction for production traits in layer chickens using pedigree or genomic relationships in a reduced animal model. Genetics Selection Evolution, 43, 1–9. https://doi.org/10.1186/1297-9686-43-5

Wood-Gush DGM and Vestergaard K, 1989. Exploratory behavior and the welfare of intensively kept animals. Journal of Agricultural Ethics, 2, 161–169. https://doi.org/10.1007/BF01826929

Xercavins AS, 2023. Personal Communication 15th March 2023. e-mail.

Xie M, Jiang Y, Tang J, Wen Z, Huang W and Hou S, 2014. Effects of stocking density on growth performance, carcass traits, and foot pad lesions of White Pekin ducks. Poultry Science, 93, 1644–1648. https://doi.org/10.3382/ps.2013-03741

Xu D, Shu G, Liu Y, Qin P, Zheng Y, Tian Y, Zhao X and Du X, 2022. Farm environmental enrichments improve the welfare of layer chicks and pullets: a comprehensive review. Animals, 12, 2610. https://doi.org/10.3390/ani12192610

Yang Q, Liu H, Wang L, Wei B, Wu Q, Xu Q, Tang Q, Qi J, Li J and Wang J, 2022. Untargeted metabolomics study on the effects of rearing ducks in cages on bone quality. Poultry Science, 101, 101604. https://doi.org/10.1016/j.psj.2021.101604

Yin L, Wang Z, Yang H, Xu L, Zhang J and Xing H, 2017a. Effects of stocking density on growth performance, feather growth, intestinal development, and serum parameters of geese. Poultry Science, 96, 3163–3168. https://doi.org/10.3382/ps/pex136

Yin L, Yang H, Xu L, Zhang J, Xing H and Wang Z, 2017b. Feather performance, walking ability, and behavioral changes of geese in response to different stocking densities. Applied Animal Behaviour Science, 196, 108–112. https://doi.org/10.1016/j.applanim.2017.06.017

Young RJ, 2003. Environmental enrichment: an historical perspective. Environmental Enrichment for Captive Animals. 1–19

Zhang YR, Zhang LS, Wang Z, Liu Y, Li FH, Yuan JM and Xia ZF, 2018. Effects of stocking density on growth performance, meat quality and tibia development of Pekin ducks. Animal Science Journal, 89, 925–930. https://doi.org/10.1111/asj.12997

Zhu X, Shao B, Guo Y, Gao L, Zhang H, Chen W, Wang Y, Gao G and Huang Y, 2021. Incidence rate of angel wing and its effect on wing bone development and serum biochemical parameters in geese. Poultry Science, 100, 101450. https://doi.org/10.1016/j.psj.2021.101450

Zita L, Ledvinka Z and Klesalová L, 2013. The effect of the age of Japanese quails on certain egg quality traits and their relationships. Veterinarski arhiv, 83, 223–232.

Zulkifli I, Rasedee A, Syaadoh O and Norma M, 1998. Daylength effects on stress and fear responses in broiler chickens. Asian-Australasian Journal of Animal Sciences, 11, 751–754. https://doi.org/10.5713/ajas.1998.751

Abbreviations

ABM	Animal-based measure
AHAW	Animal Health and Animal Welfare
ANSES	Agence nationale de sécurité sanitaire de l’alimentation, de l’environnement et du travail
BLV	Bundesamt für Lebensmittelsicherheit und Veterinärwesen
DGAL	General Direction for Food
ECI	European Citizen Initiative
EKE	Expert Knowledge Elicitation
F2F	Farm to Fork
HS	Husbandry System
IRTA	Institute of Agrifood Research and Technology
ITAVI	Institut Technique de l’Aviculture
LA	Label Rouge
MS	Member State
NRC	National Research Council (US) Committee for the Update of the Guide for the Care and Use of Laboratory Animals
PGI	Protected Geographical Identification
SCAHAW	Scientific Committee on Animal Health and Animal Welfare
SO	Scientific Opinion
ToR	Term of Reference

Appendix A – Literature Search

A broad literature search was carried out to identify literature providing information for the species mentioned in the mandate. The search was restricted to the date of publication, considering only records published in the last 20 years. Ducks and geese were considered together, and quail was considered separately. Language restrictions aimed at identifying only publications with an English abstract and full texts of a language covered in the expertise of EFSA experts. No document type restrictions were applied in the search string.

The records retrieved from Web of Science were exported to EndNote libraries/Excel files together with the relevant metadata (e.g. title, authors, abstract). Titles and abstracts were screened for relevance. Duplicates were removed when two or more records were identical. Full text publications were screened if title and abstract did not allow assessing the relevance of a paper.

Literature search – Domestic ducks, Muscovy and Mule ducks and Domestic geese.

Date: 12th August 2021. Web of Science (WoS core collection, BCI, CABI, Medline Advanced search. timespan: 2000–2021. Language = English.

Search string: (TI = (Farm* OR "Housing" OR Husbandr* OR Onfarm*)) OR (AB = ("Housing" OR Farm* OR Husbandr* OR Onfarm*)) AND

(TI = ("Restriction of movement*" OR Comfort OR Behav* OR Enrichment* OR Pain* OR Welfare* OR Stress* OR Wellbeing OR "well being" OR confinement OR density OR floor OR "access to water")) OR (AB = ("Restriction of movement*" OR Comfort OR Behav* OR Enrichment* OR Pain* OR Welfare* OR Stress* OR Wellbeing OR "well being" OR confinement OR density OR floor OR "access to water")) AND

TS = (duck OR ducks OR Anatidae OR anas OR "a plantyrhynchos" OR "a. plantyrhynchos" OR "carina moschata" OR "c moschata" OR "c. moscata" OR Muscovy OR Goose OR Gooses OR Geese OR Anser OR Anseriform* OR "a cygnoides" OR "a. cygnoides").

OR

TI = ((Farm* OR "Housing" OR Husbandr* OR Onfarm*) AND (system OR systems OR condition OR conditions))) OR (AB = (("Housing" OR Farm* OR Husbandr* OR Onfarm*) AND (system OR systems OR condition OR conditions))) AND

TS = (duck OR ducks OR Anatidae OR anas OR "a plantyrhynchos" OR "a. plantyrhynchos" OR "carina moschata" OR "c moschata" OR "c. moscata" OR Muscovy OR Goose OR Gooses OR Geese OR Anser OR Anseriform* OR "a cygnoides" OR "a. cygnoides")

Results = 1163. Result after screening for relevance: 350 for ducks and 90 for geese.

Literature search – Quail

Date: 12th August 2021. Web of Science (WoS core collection, BCI, CABI, Medline). Advanced search. timespan: 2000–2021. English.

Search string: (TI = (Farm* OR "Housing" OR Husbandr* OR Onfarm*)) OR (AB = ("Housing" OR Farm* OR Husbandr* OR Onfarm*)) AND

(TI = ("Restriction of movement*" OR Comfort OR Behav* OR Enrichment* OR Pain* OR Welfare* OR Stress* OR Wellbeing OR "well being" OR confinement OR density OR floor OR "access to water")) OR (AB = ("Restriction of movement*" OR Comfort OR Behav* OR Enrichment* OR Pain* OR Welfare* OR Stress* OR Wellbeing OR "well being" OR confinement OR density OR floor OR "access to water")) AND

(TS = (quail OR quail OR coturnix OR "c japonica" OR "c. japonica")) OR TI = (phasianidae OR odontophoridae) OR AB = (phasianidae OR odontophoridae) OR

(TI = ((Farm* OR "Housing" OR Husbandr* OR Onfarm*) AND (system OR systems OR condition OR conditions))) OR (AB = (("Housing" OR Farm* OR Husbandr* OR Onfarm*) AND (system OR systems OR condition OR conditions))) AND

(TS = (quail OR quail OR coturnix OR "c japonica" OR "c. japonica")) OR TI = (phasianidae OR odontophoridae) OR AB = (phasianidae OR odontophoridae)

Results = 252. Result after screening for relevance: 108.

Appendix B – Iceberg indicators

Iceberg indicators are indicators that can be used to obtain a quick overview on possible welfare problems, as they may reflect several welfare consequences in an integrative manner. Iceberg indicators provide an overall assessment of welfare, just as the protruding tip of an iceberg signals its submerged bulk beneath the surface of the water (FAWC, 2009; EFSA AHAW Panel, 2022b). Iceberg indicators are not exclusively linked to a specific welfare consequence but may be associated with the additive consequence of several welfare consequences (Table B.1).

Table B.1: Iceberg indicators, definition, interpretation, sources of evidence (scientific literature or expert opinion) for each species as well as the main welfare consequences (out of the eight assessed in Section 3.5) they might indicate

ABM	Definition and interpretation	Sources of evidence for each species	Welfare consequences
Fear response	Fear responses are behavioural or physiological reactions of animals towards sudden, threatening and/or novel stimuli. Tonic immobility is an experimental measure of fearfulness. Interpretation: Fear responses may be shown in situations of group stress, but this ABM can also be affected by different welfare consequences.	– Domestic ducks: Zulkifli et al. (1998), Sultana et al. (2013), House et al. (2020). – Muscovy ducks: Abdel-Hamid et al. (2020) – Mule ducks: Faure et al. (2003), Arnaud et al. (2008)), Arnaud et al. (2010)) – Domestic geese: Boz et al. (2021) – Japanese quail: Ramankevich et al. (2022)	Group stress
Body weight heterogeneity	The variability in body weight within a flock resulting in reduced uniformity Interpretation: An increased body weight heterogeneity may be shown in situations of group stress and/or locomotory disorders, but this ABM can also be affected by other welfare consequences.	– Domestic ducks: Tag et al. (2004), Hong et al. (2019) – Muscovy ducks, Mule ducks and Japanese quail: expert opinion – Domestic geese: Lin et al. (2016)	– Group stress – Locomotory disorders
Impaired growth rate	A reduction in growth rate. Interpretation: A reduced growth rate may be shown in situations of restriction of movement and/or group stress, but this ABM can also be affected by other welfare consequences.	– Domestic ducks: Jones et al. (2009), Jones and Dawkins (2010a), O'Driscoll and Broom (2011), Abo Ghanima et al. (2020), Eratalar (2021); – Muscovy: Taboosha (2014), Nasr et al. (2022) – Mule ducks: Lavigne et al. (2017) – Domestic geese: Yin et al. (2017a, b), Wang et al. (2019), Liu et al. (2021) – Japanese quail: El Sabry et al. (2022)	– Restriction of movement – Group stress – Locomotory disorders
Mortality rate	The sum of the number of birds found dead and culled in relation to the total number of birds housed and present for a certain timespan. Interpretation: An increased mortality rate may be shown in situations of restriction of movement, group stress and/or locomotory disorders, but this ABM can also be affected by other welfare consequences.	– Domestic ducks: Jones et al. (2009), Jones and Dawkins (2010a), O'Driscoll and Broom (2011), Fraley et al. (2013), Karcher et al. (2013), Abo Ghanima et al. (2020), Eratalar (2021) – Muscovy ducks: Knierim et al. (2005), Farghly et al. (2017) – Mule ducks: Ketaren et al. (2011) – Domestic geese: experts' opinion – Japanese quail: Badawi (2017)	– Restriction of movement – Group stress – Locomotory disorders – Soft tissue lesions and integument damage

efsa JOURNAL

Appendix C – Sources of Uncertainty

Table C.1: Sources of uncertainty associated with the assessment methodology and inputs (broad literature search, expert opinions) for the identification and assessment of husbandry systems, welfare consequences, related ABMs and assessment of factors listed in ToR-3

Source of uncertainty	Nature or cause of the uncertainty	Impact of the uncertainty on the assessment
Literature search – Language	The search was performed exclusively in English (at least the abstract for other languages). More studies could have been identified by including references with abstracts in languages other than English. Experts have also consulted publications written on their mother languages (e.g. German, Hungarian, French).	The description and type of husbandry systems, relevant welfare consequences, ABMs and/or factors may have been underestimated.
Literature search – Publication type	Studies considered included primary research studies identified through the extensive literature search and grey literature (factsheets, guidelines, conference papers, EU reports, book chapters, etc.) known to the EFSA Experts, but an extensive search of the grey literature was not conducted. Therefore, there may be reports and other guidance documents on animal welfare of which the EFSA Experts were not aware off.	Underestimation of the published relevant papers. The description and type of husbandry systems, number of relevant welfare consequences, ABMs and/or hazards may have been underestimated.
Broad literature search – inclusion and exclusion criteria	The screening phase might have led to the exclusion of certain studies that could have included relevant information. The experts mainly used literature (with certain exceptions) that involved breeds that are kept/relevant in the EU.	Underestimation of the published relevant papers. The description and type of husbandry systems, number of relevant welfare consequence, ABMs and/or hazards may have been underestimated.
Limited information available on specific factors	The lack of published information on the species of interest reflect lack of knowledge on many aspect of these birds that may be of relevance for the welfare assessment.	Under or overestimation of the effect of specific factors and husbandry systems on welfare consequences.
Lack of data on hazards	Although some information on the hazards leading to the welfare consequences considered in the assessment were retrieved in the scientific literature, for many hazards the knowlege regards the prevalence in the husbandry systems is too limited to draw quantitative conclusions; conclusions relied largely on expert opinion.	Under or overestimation of the prevalence of the hazards that affected the estimation of the relevance of the welfare consequences
Expert group – number and type of experts	A limited number (7–10) of experts were selected based on their knowledge on animal welfare in the different waterfowl and quail categories and related husbandry systems. They also had to show they had no conflict of interest. This may have resulted in a reduced level of technical knowledge derived from the field practice.	The description and type of husbandry systems, relevant welfare consequences, ABMs and/or factors may have been underestimated.

efsa JOURNAL

Source of uncertainty	Nature or cause of the uncertainty	Impact of the uncertainty on the assessment
Bird categories considered	Though the experts focused on collecting information relevant to the EU, the birds used in the information retrieved might not be the breeds/strains or categories currently used in the EU to study welfare consequences and ABMs, thus requiring an extrapolation exercise from the experts.	Under or overestimation of the effect of specific factors, husbandry systems and welfare consequences on the species/ categories under assessment.
Farming conditions and practices considered	The information retrieved could have been performed anywhere in the world, and thus may consider poultry farming conditions different from those currently allowed in the EU. Experts had to extrapolate findings to the EU relevant conditions in some cases.	Under or overestimation of the prevalence of the hazards that affected the estimation of the relevance of the welfare consequences on the husbandry systems considered.
Time allocation	The time allocated to this opinion was limited and additional time for reflection would have facilitated better organisation of activities and a call for data.	The description and type of husbandry systems, relevant welfare consequences, ABMs and/or factors may have been underestimated.
Approach/Type of assessment	The approach used to assess the exposure variables of specific ToRs (EKE or narrative) might have led to different representation of the results, enhancing or limiting the understanding of findings.	Under or overestimation of the effect of specific factors, husbandry systems and welfare consequences.

Appendix D – Uncertainty analysis results

Tables D.1 and D.2 report the results of the uncertainty analysis on the conclusions formulated on ToR-2 and the ones on ToR-3 that derived from a narrative assessment, respectively.

For each conclusion, it is visualised the statement with the well-defined question of interest that was formulated and for which experts were asked to provide their individual judgements, along with the consensus certainty range reflecting their collective uncertainty about the statement. To formulate the appropriate statement in the case of ToR-3, each conclusion has been subdivided by animal species. For all conclusions, the number of the section where the associated conclusion(s) can be found is also reported.

No uncertainty analysis was carried out for conclusions which are factual information. ToR-3 conclusions derived from EKE exercises already had a certainty range estimated as part of the EKE process (see Section 3.8.1.1).

Table D.1: Uncertainty assessment results for the ToR-2 conclusions on the welfare consequences related to husbandry systems (in brackets the section number where the associated conclusion(s) are presented)

Conclusion	Statement	Certainty range
Domestic duck breeders (Section 3.7.1.1)		
Restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness), inability to perform exploratory or foraging behaviour and inability to express prelaying and nesting (maternal) behaviours are more relevant welfare consequences for Domestic duck breeders housed in individual cages than in indoor floor systems.	The proportion of Domestic duck breeders farms in which animals are exposed to restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness), inability to perform exploratory or foraging behaviour and inability to express prelaying and nesting (maternal) behaviours is higher in individual cages than in indoor floor systems	90–100%
Domestic ducks for the production of meat (Section 3.7.1.2)		
Restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness) and inability to perform exploratory or foraging behaviour are more relevant welfare consequences in Domestic ducks for the production of meat housed in indoor floor systems than in indoor floor systems with outdoor access or in outdoor systems.	The proportion of Domestic duck farms for production of meat in which animals are exposed to restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness) and inability to perform exploratory or foraging behaviour is higher in indoor floor systems than in indoor floor systems with outdoor access and outdoor systems.	90–100%
Muscovy ducks breeders (Section 3.7.2.1)		
Restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness), inability to perform exploratory or foraging behaviour and inability to express prelaying and nesting (maternal) behaviours are more relevant welfare consequences for Muscovy duck breeders housed in individual cages rather than in indoor floor systems.	The proportion of Muscovy duck breeders farms in which animals are exposed to restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness), inability to perform exploratory or foraging behaviour and inability to express prelaying and nesting (maternal) behaviours is higher in individual cages than in indoor floor systems.	90–100%
Muscovy and Mule ducks for meat and foie gras production (starting and growing phases) (Section 3.7.2.2)		
Restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage and inability to perform exploratory or foraging behaviour are more relevant welfare consequences for Muscovy and	The proportion of Muscovy and Mule duck farms (starting and growing phases) in which animals are exposed to restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and	66–100%

Conclusion	Statement	Certainty range
Mule ducks during the starting and growing phases of meat and foie gras production housed in indoor floor systems than in indoor floor systems with outdoor access or in outdoor systems.	integument damage and inability to perform exploratory or foraging behaviour is higher in indoor floor systems than in indoor floor systems with outdoor access and outdoor systems.	
Muscovy and Mule ducks for foie gras production during overfeeding phase (Section 3.7.2.3)		
Locomotory disorders (including lameness) and inability to perform exploratory or foraging behaviour are relevant welfare consequences for Muscovy and Mule ducks during the overfeeding phase housed in all three husbandry systems (elevated collective cage systems indoor, elevated pen systems indoor and floor pen systems indoor), as the hazards leading to these welfare consequences are highly prevalent.	In more than 66% of the farms with the three systems of the overfeeding phase (elevated collective cage systems indoor, elevated pen systems indoor and floor pen systems indoor) Mule and Muscovy ducks are exposed to locomotory disorders (including lameness) and inability to perform exploratory or foraging behaviour.	66–100%
The welfare consequences group stress and soft tissue lesions and integument damage are more relevant for Muscovy and Mule ducks during the overfeeding phase when housed in elevated pen systems indoor rather than in floor pen systems.	The proportion of Mule and Muscovy ducks (overfeeding phase) in which animals are exposed to restriction of movement, group stress, inability to perform comfort behaviour and soft tissue lesions and integument damage is higher in elevated collective cages indoor and elevated pen systems indoor than in floor pen systems indoor.	66–100%
The welfare consequences group stress, and soft tissue lesions and integument damage are more relevant for Muscovy and Mule ducks during the overfeeding phase when housed in elevated collective pen systems indoor rather than in floor collective pen systems indoor.	The proportion of Muscovy and Mule ducks (overfeeding phase) in which animals are exposed to group stress and soft tissue lesions and integument damage is higher in elevated pen systems indoor than in floor pen systems.	66–100%
Domestic geese breeders (Section 3.7.3.1)		
Restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness) and inability to perform exploratory or foraging behaviour are more relevant welfare consequences in Domestic geese breeders housed in indoor floor systems than in indoor floor systems with outdoor access.	The proportion of domestic geese breeders farms in which animals are exposed to restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness) and inability to perform exploratory or foraging behaviour is higher in indoor floor systems than in indoor floor systems with outdoor access.	66–100%
Domestic geese for meat and foie gras production (starting and growing phase) (Section 3.7.3.2)		
Restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness) and inability to perform exploratory or foraging behaviour are more relevant welfare consequences in Domestic geese during the starting and growing phases of meat and foie gras production housed in indoor floor systems than indoor floor systems with outdoor access or in outdoor systems.	The proportion of domestic geese farms for meat and foie production (starting and growing phase) in which animals are exposed to restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness) and inability to perform exploratory or foraging behaviour is higher in indoor floor systems than in indoor floor systems with outdoor access or outdoor systems.	66–100%
Domestic geese for foie gras production during overfeeding phase (Section 3.7.3.3)		
Restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness) and inability to perform	In more than 66% of the farms with elevated pen systems indoor and indoor floor pen systems during overfeeding phase, Domestic geese are exposed to restriction of movement,	66–100%

Conclusion	Statement	Certainty range
exploratory or foraging behaviour are relevant welfare consequences for Domestic geese during the overfeeding phase housed in the two husbandry systems (elevated pen systems indoor and floor pen systems indoor), as the hazards leading to these welfare consequences are highly prevalent.	group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness) and inability to perform exploratory or foraging behaviour.	
Japanese quails breeders (Section 3.7.4.1)		
Restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness) and inability to perform exploratory or foraging behaviour are more relevant welfare consequences in breeders housed in couple or collective cages than in indoor floor systems.	The proportion of Japanese quail breeder farms in which animals are exposed to restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness) and inability to perform exploratory or foraging behaviour is higher in in couple and collective cages than in indoor floor systems.	66–100%
Japanese quails for the production of meat (broiler quail) (Section 3.7.4.2)		
Restriction of movement, group stress, soft tissue lesions and integument damage, locomotory disorders (including lameness) and inability to perform exploratory or foraging behaviour, are welfare consequences for which all hazards except 'insufficient space allowance per bird' are generally of low prevalence in broiler quail housed in indoor floor systems.	In more than 66% of the farms with indoor floor systems for meat production, Japanese quail are exposed to restriction of movement, group stress, soft tissue lesions and integument damage, locomotory disorders (including lameness) and inability to perform exploratory or foraging behaviour.	50–100%
Japanese quails for the production of eggs (layer quail) (Section 3.7.4.3)		
Restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness), inability to perform exploratory or foraging behaviour and inability to express prelaying and nesting (maternal) behaviours are more relevant welfare consequences in layer quail housed in collective cages than in indoor floor systems.	The proportion of Japanese quails farms for production of eggs in which animals are exposed to restriction of movement, group stress, inability to perform comfort behaviour, soft tissue lesions and integument damage, locomotory disorders (including lameness), inability to perform exploratory or foraging behaviour and inability to express prelaying and nesting (maternal) behaviours is higher in layer quail housed in collective cages than in indoor floor systems.	66–100%

Table D.2: Uncertainty assessment results for the ToR-3 conclusions on specific factors that were assessed narratively. Each conclusion has been subdivided by animal species (in brackets the section number where the associated conclusion(s) are presented)

Animal species	Conclusion	Statement	Certainty range
Height of the enclosure (Section 3.8.1.3.1)			
Domestic duck	The minimum height required to prevent restriction of movement and inability to perform comfort behaviour, and to minimise the risk of soft tissue and integument damage and bone lesions (including fractures and dislocations) in Domestic ducks is 66 cm.	At a minimum enclosure height of 66 cm, at least 90% of the Domestic ducks will not experience the restriction of movement and inability to perform comfort behaviour and the risk of soft tissue and integument damage and bone lesions (including fractures and dislocations) will be minimised.	66–100%

Animal species	Conclusion	Statement	Certainty range
Muscovy and Mule ducks	The minimum height required to prevent restriction of movement and inability to perform comfort behaviour and to minimise the risk of soft tissue lesions and integument damage and bone lesions (including fractures and dislocations) in Muscovy and Mule ducks is 96 cm.	At a minimum enclosure height of 96 cm, 90% or more of all Muscovy and Mule ducks will not experience restriction of movement and inability to perform comfort behaviour, and the risk of soft tissue and integument damage and bone lesions (including fractures and dislocations) will be minimised.	66–100%
Domestic goose	The minimum height required to prevent restriction of movement and inability to perform comfort behaviour and to minimise the risk of soft tissue lesions and integument damage and bone lesions (including fractures and dislocations) in Domestic geese is 127 cm.	At a minimum enclosure height of 127 cm, 90% or more of all Domestic geese will not experience restriction of movement and inability to perform comfort behaviour, and the risk of soft tissue and integument damage and bone lesions (including fractures and dislocations) will be minimised.	66–100%
Japanese quail	The minimum height required to exhibit vertical jumping and flying when startled, without high risk of incurring soft tissue lesions and integument damage and bone lesions (including fractures and dislocations) in Japanese quail is 150 cm.	At a minimum enclosure height of 150 cm, 90% or more for all Japanese quails the risk of incurring soft tissue lesions and integument damage and bone lesions (including fractures and dislocations) will be minimised.	66–100%
Floor quality - Flooring material (Section 3.8.3.1)			
All species	Provision of littered solid floors to ducks, geese and quail will prevent or reduce injurious pecking and group stress.	Providing ducks, geese and quail with littered solid floors will lead to a decrease in the proportion of birds exposed to injurious pecking and group stress compared with absence of litter	66–100%
Waterfowl	The flooring material, either perforated or littered solid floors, does not affect locomotor disorders (including lameness) in waterfowl.	There will be no difference in the proportion of waterfowl experiencing locomotor disorders (including lameness) when kept in perforated or littered solid floors.	50–100%
Availability design and size of nesting facilities – Nesting facilities (Section 3.8.4.1)			
Domestic and Muscovy ducks and Domestic goose	A nest with soft and manipulable material (e.g. straw, wood shavings) at least fully covering the floor will facilitate nesting behaviour.	90% or more of female breeders of Domestic and Muscovy ducks and Domestic geese will perform nesting behaviour when provided with soft and manipulable material at least fully covering the floor.	66–100%
Domestic and Muscovy ducks	An enclosed nest (opaque top, sides and back) provides a secluded, safe atmosphere for nesting behaviour in ducks.	A higher proportion of ducks will lay eggs in the nest when provided with enclosed nests (opaque top, sides and back) compared with open nests.	66–100%
Domestic and Muscovy ducks and Domestic goose	Individual nests with enough space will allow nesting behaviour (approximately 1,600 cm^2/nest for ducks (shortest side of at least 40 cm) and 3,500 cm^2/nest for geese (shortest side of at least 50 cm), and enough height will allow the bird to enter easily and arrange the nesting	A higher proportion of Domestic ducks and Muscovy ducks and Domestic geese will lay eggs in the nest when provided with nests with a space and height of 1,600 cm^2/nest and 40 cm (ducks) or 3,500 cm^2/nest and 70 cm (geese) compared with	66–100%

Animal species	Conclusion	Statement	Certainty range
	material (40 cm minimum for ducks and 70 cm for geese).	smaller nests (provided that no other female is using it simultaneously).	
Domestic and Muscovy ducks and Domestic goose	In birds kept in a group, sharing of a nest over time (but not in simultaneous occupation) is possible. Commercial practice is to provide 1 nest for 4 ducks or 6 geese maximum. There is evidence of a greater risk of floor laying of eggs, possibly as a result of competition, with increasing number of birds per nest or due to other factors (e.g. rearing practices, social factors).	There will be a higher proportion of birds laying eggs on the floor when nests are shared by more than four (ducks) or six (geese) individuals.	66–100%
Japanese quail	Japanese quail show a preference to lay eggs in cover, and the majority use a nest box when it is provided.	There will be a higher proportion of quail laying eggs in a covered nest or nest box compared with no covered nests.	66–100%
Japanese quail	Japanese quail prefer to lay in dry and friable material.	There will be a higher proportion of quail laying eggs in the nest when the nest is provided with dry and friable material compared with no material.	66–100%
Environmental enrichment – Water provision (Section 3.8.5.1)			
Domestic, Muscovy and Mule ducks	Minimum water depth for head dipping and incomplete bathing would be 10 cm for ducks; the surface area of one device must allow at least one bird at any age to put the head inside.	At a minimum water depth of 10 cm, 90% or more ducks will perform head dipping and incomplete bathing, if the surface area of the device allows at least one bird at any age to put the head inside.	66–100%
Domestic goose	Minimum water depth for head dipping and incomplete bathing would be 15 cm for geese; the surface area of one device must allow at least one bird at any age to put the head inside.	At a minimum water depth of 15 cm, 90% or more geese will perform head dipping and incomplete bathing, if the surface area of the device allow at least one bird at any age to put the head inside.	66–100%
Domestic, Muscovy and Mule ducks	Minimum depth for swimming would be 20 cm for ducks. The surface area of water provided for swimming should allow unimpeded movement, however there is a lack of knowledge on the minimum surface to achieve this.	At a minimum water depth of 20 cm, 90% or more ducks will perform swimming, if provided with adequate surface area.	66–100%
Domestic goose	For geese a minimum depth of 40 cm is proposed for swimming. The surface area of water provided for swimming should allow unimpeded movement, however there is a lack of knowledge on the minimum surface to achieve this.	At a minimum water depth of 40 cm, 90% or more geese will perform swimming, if provided with adequate surface area.	66–100%
Environmental enrichment – Foraging-related enrichments (Section 3.8.5.3)			
Domestic and Muscovy and Mule ducks	Stimulation of foraging contributes to reduced risks of feather and cannibalistic pecking in ducks and therefore can help to reduce integument damage.	There will be a lower proportion of birds performing feather pecking and cannibalism when foraging is stimulated by providing litter on parts of the floor and additional enrichment material such as silage or hay.	90–100%

Annex A – Questionnaire to the Member States

The annex is a document containing a questionnaire submitted to the Member States and can be found in the 'Supporting information' section.

Annex B – Feedback from stakeholder umbrella organisation

The annex is a document containing feedback from stakeholder umbrella organisation and can be found in the 'Supporting information' section.

Annex C – Farm to fork ducks, geese and quail: Behavioural space model

The annex is a document containing supporting documents on the behavioural space model and can be found in the 'Supporting information' section.