

DELIVERABLE

2023-DL.3.2.3 – THE WELFARE IMPACTS OF THE DEPOPULATION METHODS USED IN THE EU IN THE CONTEXT OF AVIAN INFLUENZA

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1. Introduction

Many EU Member States (MSs) continue to report new outbreaks of Highly Pathogenic Avian Influenza (HPAI) (European Commission, 2023). In 2021/2022, the HPAI epidemic was the largest ever observed in the EU – both in terms of geographical spread and outbreak numbers (EFSA, 2023). HPAI is a highly contagious disease spreading from wild to domestic birds and in between farms. Upon detection of HPAI, the competent authorities must hence take the necessary actions to ensure its eradication or at least limit its diffusion. One of the key actions consists in the depopulation of the infected flock. To avoid the spread of the disease, depopulation must be conducted without delay and with strict biosecurity measures (Kanaujia et al., 2022). In practice, the sense of urgency surrounding the depopulation process and the potential logistic constraints (e.g., equipment availability) may jeopardize bird welfare. This issue is fully acknowledged by the different MSs, who expressed their desire during the Competent Authority meeting of the EURCAW-Poultry-SFA in 2022 to better integrate the animal welfare dimension into their depopulation operating procedures.

To meet this need, the EURCAW-Poultry-SFA has initiated in January 2023 an activity aiming at **making recommendations on the type of on-farm killing methods to deploy to ensure the most humane and effective depopulation**. These recommendations will be tailored to the characteristics of the farm (e.g., housing system) and birds (e.g., species) infected by the disease to ensure their relevance. Four specific objectives have been defined to achieve this overarching goal (**Figure 1**):

- The inventory of the depopulation methods (**O1a**) and procedures (**O1b**) used across the EU since 2018 (**O1**). Here, we use the term procedures to refer to existing variations, on site, in the implementation of a specific method. O1 will allow us to identify the most commonly-used methods in the EU, together with their most common procedures.
- The assessment of the effectiveness and welfare consequences of the most used methods and procedures in multiple depopulation contexts (farm characteristics x birds characteristics) (**O2**). O2 will allow us to determine:
 - a. The most humane and efficient procedure for each method in a specific context (**O2a: within-method comparison**)
 - b. In a specific context, the most suitable depopulation method and procedure to be used (**O2b: between-methods comparison**)
- The suggestion of existing or innovative practical solutions to tackle the welfare issues associated with each method (**O3**). O3 will allow us to propose “best-practices” for different depopulation methods, based on the procedures selected as most humane per depopulation context.

Concretely, this work will translate into two deliverables: 1) a guidance about the selection of the depopulation procedure according to the specific features of the targeted farm, and 2) suggestions for assessment methods of poultry welfare during depopulation procedures.

This document is a preliminary report of the first results obtained from this ongoing activity. In accordance with the work programme of 2023, it aims at listing the depopulation methods and procedures used in the EU the context of HPAI (O1a) with preliminary feedbacks on their effectiveness and animal welfare consequences (O2).

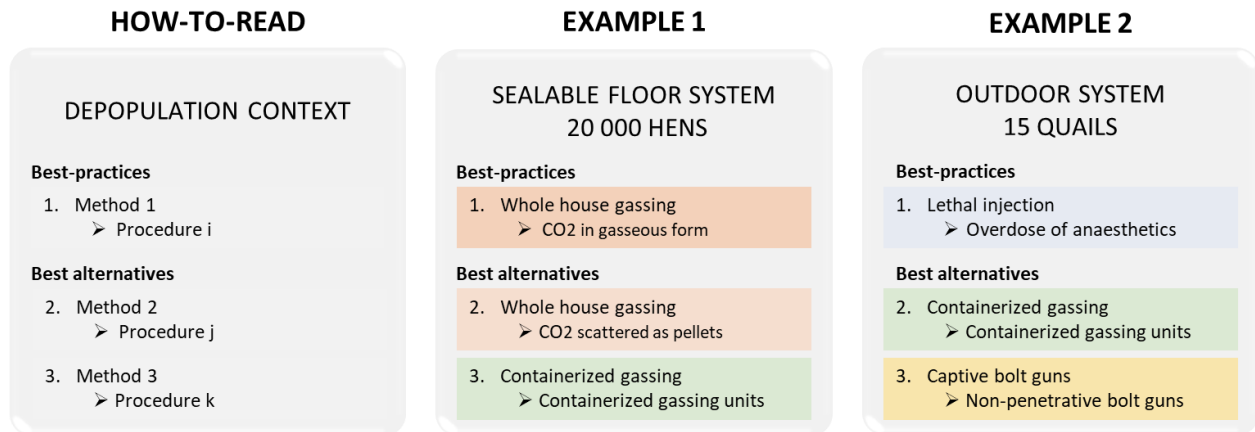


Figure 1. Classification example of depopulation methods and procedures according to their efficacy and welfare consequences in different depopulation contexts. These examples have not been validated by experts, they only have an illustrative purpose.

2. Materials and Methods

A **generic survey (Annexe 1)** was sent in March 2023 to the competent authority of all MSs. This survey was built using Sphinx iQ3 (version v8.2.2, Le Sphinx Développement). Respondents were asked to provide information relative to the choice of the depopulation methods (decision-makers and selection criteria) and to specify the depopulation methods used in their country since 2018 in case of HPAI outbreak (**O1a**). Respondents were also asked to provide official documents such as their national emergency plan for category A diseases (REGULATION (EU) 2016/429, Part III, Title I, Chapter I, Article 43) and their depopulation reports (COUNCIL REGULATION (EC) No 1099/2009 of 24 September 2009 on the protection of animals at the time of killing, article 18 (4)).

After analyzing the results obtained from the generic survey, a **four-hour workshop** was organized on the 12th of September 2023 by the EURCAW-Poultry-SFA. The objectives of the workshop sessions were to 1) identify the prevailing welfare issues associated with the five most used depopulation method (**O2**) and 2) highlight existing solutions to tackle the said issues (**O3**). This workshop was intended for the depopulation experts of each MS – who had to specify, once registered, the depopulation methods with which they were the most familiar. When experts did not give any specifications, we assumed that they were familiar with all the depopulation methods used in their country – an information that was derived from the answers obtained to the generic survey. During the workshop, experts were divided in four groups depending on their (assumed) level of expertise with different depopulation methods. The group work was divided in four sessions of 30 minutes: the first three sessions were focusing on a specific depopulation method each, and the fourth session consisted of an open discussion on any of the depopulation methods used in the EU. The objective of the fourth session was to promote information exchange between the EU experts on the depopulation methods of their choice – with no pre-defined themes of discussion.

After the workshop, for each of the ten most used depopulation method in the EU, a method-specific survey was also developed to collect (additional) information regarding its context of application (e.g., flock size), effectiveness (e.g., failure rate) and welfare consequences (e.g., cold stress). All surveys were built following the same structure under software Sphinx iQ3 (version v8.2.2,

Le Sphinx Développement), and a set of common questions was asked across surveys to ensure pairwise comparisons between methods (O2b). Within each survey, questions specific to the depopulation method in question were also asked to pinpoint existing variations of the depopulation process in order to eventually identify the most humane depopulation procedure of the method in question within a specific depopulation context (O2b). Each survey also gave respondents the opportunity to provide the following documents: the Standardized Operating Procedures, the training materials dispensed to depopulation operators, the technical feedback obtained regarding the depopulation interventions and existing guidance for animal welfare assessment within the context of depopulation. These documents will be used to refine the “best-practices” derived from the most humane depopulation procedure identified within a specific depopulation context (O3). All surveys were sent in October 2023 to the competent authority contact points of the different MSs and the experts who attended the workshop. Surveys will be closed in January 2024.

3. Preliminary results

Twenty out of 27 MSs answered the generic survey. A total of fourteen depopulation methods were identified. The number of MSs reporting using each depopulation method is given in **Figure 2**. The five depopulation methods that are most commonly used in the EU are: 1. Containerized gassing, 2. Cervical dislocation, 3. Lethal injection, 4. House gassing without foam, and 5. Captive bolts. Among the identified methods, ten are listed under the Regulation (EC) No 1099/2009 (Annex I, Chapter I). The four remaining methods, with unknown context of application, are ventilation shutdown, neck cutting, decapitation, house gassing with foam. Thirty-one depopulation experts from eighteen MSs attended the workshop and discussed the main welfare issues associated with these five mostly used methods. The sections below give, for each depopulation method, its general description, its legal framework (based on the Regulation (EC) No 1099/2009, if applicable), the existing variations of procedure and the **main issues encountered on field** leading to welfare problems during depopulation according to the experts – together with the **practical solutions** proposed by the experts to tackle them.

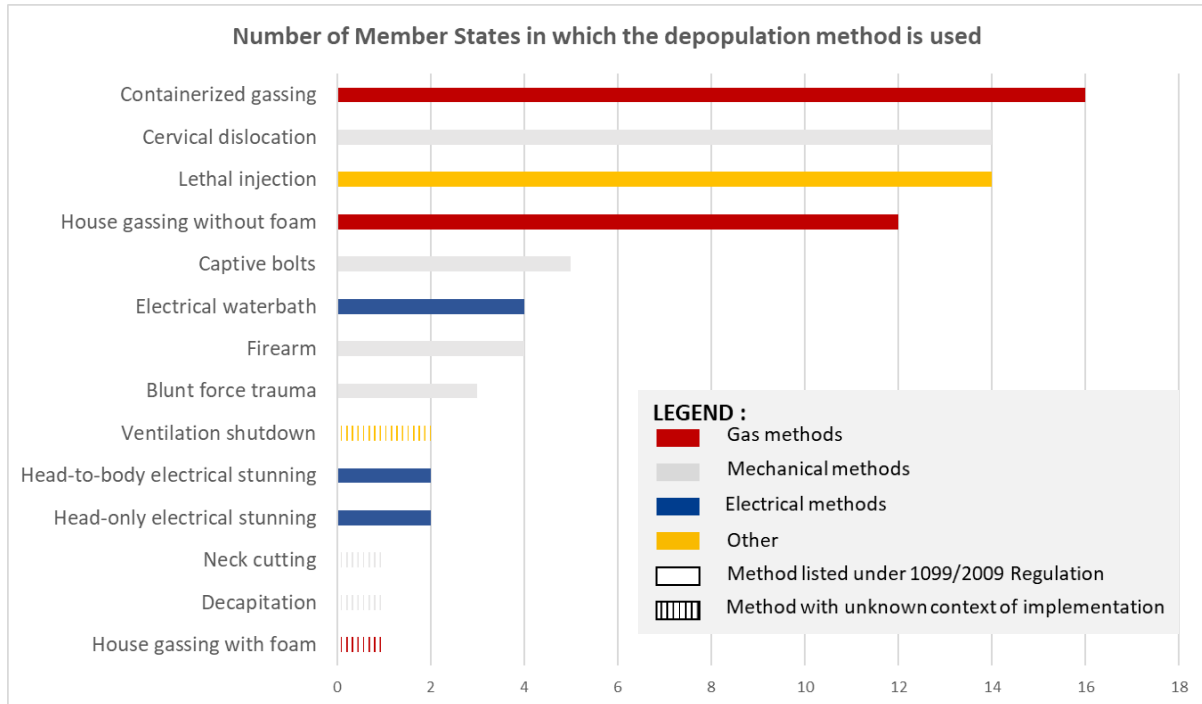


Figure 2. Number of Member States where each depopulation method is used.

Containerized gassing

General description

Administration of different gas or gas mixtures in containers at lethal levels, or to deplete the ambient gas mixture from oxygen (EFSA, 2019).

Legal framework as per Regulation (EC) No 1099/2009

Different gas can be used such as CO₂ (associated or not with inert gases), inert gases (Ar or N₂) or CO (associated or not with other gas). CO can only be administered if poultry can be kept under visual supervision at all times and if the birds are introduced individually in the container until dead. When CO₂ is used, the exposure of the birds to ambient gas mixtures with more than 40 % CO₂ can be direct or achieved gradually. The CO₂ method can be applied in two distinct phases, with an exposure of the birds to ambient gas mixture with more than 40 % CO₂ only once the birds have lost consciousness (with ambient mixture containing up to 40 % CO₂). CO₂-based method is considered as a simple stunning method if poultry are exposed to an ambient air with at least 30 % CO₂ for less than 3 minutes. CO₂-based method should not create burns or excitement by freezing or lack of humidity. Methods based on inert gases are considered as simple stunning methods if the exposure to anoxia lasts less than 3 minutes. When CO is used in a pure form, poultry must be exposed to an ambient gas mixture with more than 4 % CO. When CO is administered with other gases, the percentage of CO in ambient gas mixture is reduced to 1 %. Different equipment can be used as “containers” like pits or bags.

Variations of procedure

Birds may be sorted in parks prior to gassing, with varying stocking density within the parks. Variations also exist in ways of transporting the birds to the container: equipment exists that allows the birds to enter the container on their own, but most often birds must be carried – either manually or mechanically. The handling of the birds occurs under different lighting conditions. Birds can be inserted

within the containers inside a crate (e.g., in Containerized Gassing Units (CGU)) or loose. Stocking density inside the container varies. Regarding the gas mixture used, CO₂ alone appears to be mostly used but it is also sometimes mixed with Ar. Techniques to pre-heat the gas is sometimes used. Different filling techniques can be used: in practice, the CO₂ can be pre-filled, gradually filled, or filled in two successive phases.

Issues encountered on field leading to welfare problems during depopulation

- **Untrained operators:** the experts regretted that the depopulation operators are not always properly trained to carry birds in a way that would minimize their stress levels. **This issue is solved in certain countries by providing training to the operators.**
- **Operator's fatigue:** the experts insisted on the fact that even the most experienced and skilled operators are susceptible to fatigue when handling the birds over time, and thus more prone to making mistakes that can potentially be detrimental for animal welfare. **To prevent operator's fatigue, the experts suggested to opt for alternate depopulation methods in cases of large outbreaks or when heavy birds must be killed.**
- **Handling in daylight:** according to the experts, handling birds in bright daylight is stressful for the animals. **This welfare problem can be easily mitigated by installing curtains at the entrance door.**
- **Handling birds from high tiers:** experts reported experiencing difficulty when catching and transporting birds from high tiers. **To ease this procedure, they have promoted the use of slides from the tiers directly into the container.**
- **Piling birds in the container:** the experts have often witnessed birds smothering as a result of conscious birds being piled up on top of each other inside the container. **This issue can be avoided by putting birds into crates before inserting them into the container (or by using specific containers like "Containerized Gassing Units").**
- **Low gas temperature:** the birds can also suffer from cold stress when the gas filled in the container is at a low temperature. **To maintain the gas at an adequate temperature, some experts have been using heaters to pre-heat the gas before releasing it inside the containers. During cold times, experts also suggested to directly wrap the gas cylinder inside a fireproof blanket to help maintain the temperature inside the cylinder at a certain level.**
- **Inadequate [CO₂]:** the experts have faced situations where the CO₂ concentration inside the container is not sufficient to induce death. **To make sure that the appropriate concentration is reached, the experts emphasized the importance for farmers to communicate truthful data to the authorities and the appointed depopulation companies – for them to be able to calculate the appropriate volume of gas needed. Experts also suggested to monitor the CO₂ level in the container with a DRÄGER probe to ensure that the concentration that is aimed at is effectively reached and well-maintained.**
- **Direct exposure to [CO₂] above 40 %:** the experts reported instances where birds experienced pain due to direct contact with CO₂ concentrations above 40 %. **To avoid aversive reactions to high CO₂ concentrations, the experts consider that the birds should be exposed to gradual levels of CO₂ to render the birds unconscious before exposing them to high (and painful) CO₂ concentrations.**
- **Difficulty to assess the effective death of birds:** the experts shared their difficulty to assess the effective death of the birds once the latter have been gassed. **Certain experts advised to check for the absence of any movement within the container and to assess corneal reflex in a sample of birds - before gassing a new batch of birds.**

Cervical dislocation

General description

Stretching and twisting of birds' neck provoking cerebral ischemia (Regulation (EC) No 1099/2009, Annex I, Chapter I).

Legal framework as per Regulation (EC) No 1099/2009

Cervical dislocation can be done manually or mechanically, if 1) it is not used as a routine method and 2) no other stunning method are available. Maximum 70 birds must be killed per day by one person with this method. Manual cervical dislocation can only be applied on birds weighing maximum 3 kg. Mechanical dislocation can only be applied on birds weighing maximum 5 kg.

Variations of procedure

Both mechanical and manual cervical dislocation are used in the EU. One expert even reported systematically using a mechanical device following a manual cervical dislocation. In certain countries (e.g., Germany), national legislations require to stun the birds before performing cervical dislocation. Variation exists in the number of birds culled by one operator in one day.

Issues encountered on field leading to welfare problems during depopulation

- **Untrained operators:** cervical dislocation is a procedure which requires dexterity to be performed correctly, and the experts thus considered that only experienced and well-trained operators should be solicited to do it. **To make sure that the authorities only call upon trained operators when cervical dislocation is required, experts suggested the local or national keeping of a register tracking down the experienced operators.**
- **Operator's fatigue:** the experts insisted on the fact that even the most experienced and skilled operators are susceptible to fatigue when handling the birds over time, and thus more prone to making mistakes that can potentially be detrimental for animal welfare. **Some experts insisted on the fact that cervical dislocation should not be used on flocks with more than 20 birds to avoid operators' fatigue.**
- **Inconsistency in terms of unconsciousness induction:** the experts shared their struggle regarding the efficacy of the method at inducing stunning. **Therefore, they suggested to only use cervical dislocation on stunned birds.**
- **Difficulty to discriminate paralyzed from unconscious birds:** in practice, the experts are unable to identify if the birds are paralyzed or unconscious once the cervical dislocation has been applied. **Whenever possible, they hence advised using captive bolts rather than cervical dislocation on birds.**

Lethal injection

General description

Injections of veterinary medicines leading to loss of consciousness and sensibility followed by irreversible death (Regulation (EC) No 1099/2009, Annex I, Chapter I).

Legal framework as per Regulation (EC) No 1099/2009

No additional information provided.

Variations of procedures

Lethal injection may be used on birds rendered unconscious by another depopulation method.

Issues encountered on field leading to welfare problems during depopulation

- **Operator's fatigue:** the experts insisted on the fact that even the most experienced and skilled operators are susceptible to fatigue when handling the birds over time, and thus more prone

to making mistakes that can potentially be detrimental for animal welfare. **To facilitate the operator's work, the experts hence advised opting for an alternate method when it comes to killing heavy animals – and for veterinarians to use multi-injectors to ease their work.**

- **Painful procedure:** the experts reported that lethal injections could cause unnecessary pain to the birds. **To avoid such scenarios, they advised carefully following the route of administration recommended by the manufacturer when injecting the drugs.**

House gassing without foam

General description

Administration of CO₂ or gas mixtures of CO₂ with inert gases directly into the bird house at lethal levels or to create an anoxic situation (EFSA, 2019; Regulation (EC) No 1099/2009).

Legal framework as per Regulation (EC) No 1099/2009

Different gas can be used such as CO₂ (associated or not with inert gases) or inert gases (Ar or N₂). The CO₂ method can be applied in two distinct phases, with an exposure of the birds to ambient gas mixture with more than 40 % CO₂ only once the birds have lost consciousness (with ambient mixture containing up to 40 % CO₂). CO₂-based method is considered as a simple stunning method if poultry are exposed to an ambient air with at least 30 % CO₂ for less than 3 minutes. Methods based on inert gases are considered as simple stunning methods if the exposure to anoxia lasts less than 3 minutes.

Variations of procedure

The time between house sealing and the injection of gas may vary from one depopulation site to another. The number of injection points used can also vary according to the size of the house. On some occasions, a bird-free zone is built around the injection points. The use and position of sensors to monitor the gas concentration is also heterogeneous. CO₂ appears to be mostly used in practice, but N₂ is also used in some instances (e.g., in case of shortage in CO₂ storage). The whole house or part of the house may be gassed. When CO₂ is used, it can be inserted in the house in a gaseous form directly, or as pellets first – with birds being covered with tarpaulin or something alike to create an enclosed space where carbonic ice will vaporise in CO₂.

Issues encountered on field leading to welfare problems during depopulation

- **Shortage in gas storage:** The experts reported that the killing of sick birds had to be delayed due to shortage in gas storages at the national level. **In the experts' opinion, this situation could be avoided, if countries had better contingency plans in place.**
- **Insufficient gas supply:** the experts revealed witnessing situations where the gas was effectively supplied to the farm, but in insufficient quantities. **To avoid such an issue, the experts emphasized the importance of properly assessing the amount of gas required – based on the volume of the house.**
- **Low gas temperature:** the experts also reported issues related to the temperature of the gas used inside the house – which, if too low, can cause cold stress and frost bites for the birds. **Several strategies can be put into place to avoid this issue. For instance, the experts recommended to decrease the house temperature before injecting the gas into the house to avoid exposing the birds to large variations of temperature; and they suggested to place a fence around the gas inlets to prevent direct contacts between the birds and the gas. Some experts also suggested scattering CO₂ pellets on the floor while covering the birds underneath a tarpaulin rather than using CO₂ in a gaseous form. Experts who used this technique mentioned that it ensured a fast death of the animals, without causing frostbites.**

- **Inadequate [CO2]:** Experts also mentioned facing welfare issues related to inadequate gas concentration achieved within the house – as a result of operators’ mistakes, difficulty in sealing the house or difficulty in achieving even or optimal gas concentration within the house. **To avoid forgetting essential steps in the procedure, experts emphasized the need to work with a checklist, and they suggested using alternate depopulation methods for houses with many tiers, or for houses for which proper sealing is difficult. To achieve higher gas concentrations within the house, experts also suggested to remove the ammonia from the house before actually gassing.**
- **Difficulty to assess death:** certain experts also expressed their struggle to assess birds’ death. **To solve this problem, a fireman is sent into the house in certain countries to check for birds’ movement.**

Captive bolts

General description

Bolts can either be penetrative or non-penetrative. Penetrative captive bolt guns induce severe and irreversible damage with the shock and penetration of the bolt (Regulation (EC) No 1099/2009). Non-penetrative captive bolt induces severe damage with the shock of the bolt.

Legal framework as per Regulation (EC) No 1099/2009

Methods based on captive bolts are considered as simple stunning methods. When using non-penetrative captive bolts, the fracture of the skull should be avoided.

Variations of procedure

A cone is sometimes used to restrain the birds for the shot. Penetrative and non-penetrative bolts are commonly used.

Issues encountered on field leading to welfare problems during depopulation

- **Operator’s fatigue:** the experts insisted on the fact that even the most experienced and skilled operators are susceptible to fatigue when handling the birds over time, and thus more prone to making mistakes that can potentially be detrimental for animal welfare. **The experts suggested using an alternate method on large flocks to avoid operator’s fatigue.**
- **Low stunning efficiency:** the experts reported difficulty in effectively stunning the animals with spring-loaded penetrative captive bolt guns. **To successfully stun the animals, the experts hence insisted on the importance to select guns with sufficient power (that is cartridge or compress) that are adapted to the species and the size of the birds to kill.**

The methods below were not discussed in detail during the workshop. No information regarding existing variation of procedures or issues encountered on field leading to welfare problems are thus given for now.

Electrical waterbath

General description

Exposure of the entire body to a current generating a generalized epileptic form on the EEG and possibly the fibrillation or the stopping of the heart through a waterbath (Regulation (EC) No 1099/2009, Annex I, Chapter I).

Legal framework as per Regulation (EC) No 1099/2009

Electrical requirements (frequency of the current, and minimum average value of the current) vary according to the poultry in question (Annex I, Chapter II, Table 2) and can be found in **Table 1** below.

Table 1. Electrical requirements (frequency and minimum average value of the current) for poultry laid under Regulation (EC) No 1099/2009, Annex I, Chapter II, Table 2)

Frequency (Hz)	Chickens	Turkeys	Ducks and geese	Quails
< 200	100 mA	250 mA	130 mA	45 mA
From 200 to 400	150 mA	400 mA	Not permitted	Not permitted
From 400 to 1 500	200 mA	400 mA	Not permitted	Not permitted

Electrical waterbath is considered a stunning method except where frequency is equal or less to 50 Hz. Birds should not be shackled if they are too small for the waterbath, or if the shackles are likely to induce pain. Birds should be shackled by both legs and shackles should be wet before the birds are shackled. Birds must be exposed to the current for minimum four seconds.

Firearm

General description

Shock and penetration of one or several projectiles causing severe and irreversible damage in the brain of the animals (Regulation (EC) No 1099/2009, Annex I, Chapter I).

Legal framework as per Regulation (EC) No 1099/2009

No additional information provided.

Blunt force trauma

General description

Blow to the back of the head of the animal, which is positioned on a hard surface. Blow is delivered with a hard object (European Commission, 2018).

Legal framework as per Regulation (EC) No 1099/2009

Blunt force trauma can be used, if 1) it not used as a routine method and 2) no other stunning method are available. Maximum 70 birds must be killed per day by one person with this method. It can only be applied on birds weighing maximum 5 kg.

Ventilation shutdown

General description

Increase in heat and CO₂ levels within a sealed house to induce death by hyperthermia and hypoxia (Eberle-Krish et al., 2018)

Head-to-body electrical stunning

General description

Exposure of the body to a current generating a generalised epileptic form on the EEG and the fibrillation of the stopping of the heart (Regulation (EC) No 1099/2009, Annex I, Chapter I).

Legal framework as per Regulation (EC) No 1099/2009

No additional information provided in the context of depopulation.

Head-only electrical stunning

General description

Exposure of the brain to a current generating a generalised epileptic form on the EEG (Regulation (EC) No 1099/2009, Annex I, Chapter I).

Legal framework

This is considered a simple stunning method. Electrodes should span the brain of the birds and be adapted to its size. The minimum current to apply are 240 mA on chicken and 400 mA on turkeys.

Neck cutting

General description

Severance of both carotid arteries, leading to blood loss and death (EFSA, 2019).

Decapitation

General description

Death through anoxia of the central nervous system and blood loss by severing the neck close to the head (EFSA, 2019).

House gassing with foam

General description

Administration of gas-filled foam into the house to deplete the ambient gas mixture from oxygen (EFSA, 2019)

4. Next steps

Based on the responses obtained to the method-specific surveys and the documents retrieved, we will be able to make a more exhaustive list of the existing variation of procedures for each method, and to quantitatively assess their efficiency and welfare impacts in the most frequently-encountered depopulation contexts. This work will concretely translate into 1) a general guidance of the depopulation method to choose according to the depopulation context (2024), 2) best-practices for the main depopulation methods (2025) and 3) a suggestion for the assessment of bird welfare on depopulation site (2026). The deliverables will be presented, refined and validated by depopulation experts – either during workshops or through guided interviews. The suggested assessment for bird welfare, in particular, will be presented during a dedicated webinar.

5. References

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