Humane Slaughter:

Gilthead sea bream and European sea bass

All animals killed for food should be slaughtered humanely. This means that they must be effectively stunned, rendered instantaneously insensible, and remain unconsciousness until death supervenes.

For gilthead sea bream and European sea bass:

- The use of a single method (i.e. electrocution) that both stuns (instantly) and kills is recommended above other methods where possible.
- Electrical stunning followed by chilling in ice slurry to kill is acceptable[1] provided that the stun is effective and lasts until death supervenes (i.e. the fish do not regain consciousness).
- Live chilling in ice slurry, and leaving sea bass and bream to asphyxiate in air, are unacceptable killing methods and must be phased out.

Introduction

Fish are sentient beings capable of feeling pain and suffering[2]. As such, they are entitled under animal welfare law to a humane slaughter that minimises suffering and renders them unconsciousness as quickly as possible, a state that must extend until death. Fish are supposed to be protected under the EU Slaughter Regulation, which requires that they be spared any avoidable pain, distress or suffering during their killing and related operations. According to the European Commission, compliance with this Regulation can be achieved by following the Guidelines of the World Organisation for Animal Health (OIE) on the stunning and killing of farmed fish to which all Member States have signed up[3]. A recent report by the Commission[1] concluded that most Member States surveyed are currently in breach of these guidelines. Many producers are using slaughter methods considered inhumane by the OIE. Subsequently, food companies are increasingly incorporating fish welfare into their corporate social responsibility policies and practices. This document provides information on the humane slaughter of gilthead sea bream and European sea bass, including:

- an overview of the welfare issues associated with pre-slaughter fasting and handling,
- an overview of the main methods of slaughter in use commercially,
- recommendations for corporate animal welfare policies and practices,
- methods to assess welfare at slaughter.

Information on gilthead sea bream and European sea bass are combined in one document as these are often farmed simultaneously and slaughtered using the same methods. However these are different species with different behavioural and physiological responses to stress[4], therefore specific information on each species is given where available.

Pre-slaughter procedures

Humane slaughter of fish can only be fully achieved by minimising stress and injury during the pre-slaughter phase as well as during the killing procedure itself. Crowding, and moving of fish from home/holding pens to the place where they will be slaughtered can be very stressful, and can take several hours.

Significant stress due to pre-slaughter handling may mask the quality benefits of a more humane slaughter. For example, a study that compared fish stunned by percussion (less stressful method) with those killed in ice slurry (considered a non-humane method leading to long periods of activity and stress before death supervenes) found no significant difference in the flesh quality of the fish killed by either method[5]. The researchers proposed that the stressful pre-slaughter period (fish were crowded and dragged in a net for 2 hours) outweighed the potential quality benefits that may otherwise have been achieved by humane slaughter[6]. This highlights the fact that pre-slaughter processes affect the commercial value of the fish as much as slaughter methods themselves.

Fasting

Farmed sea bass and sea bream are fasted before slaughter in order to reduce the metabolic rate (and therefore lower the oxygen demand) and the physical activity of the fish before handling and live transport. It also serves to empty the digestive system prior to killing, which reduces water fouling (undigested feed, faeces and microorganisms) during transport, and aids hygienic processing. Fish should never be fasted for presumed flesh quality benefits.

Gut emptying times of fish are dependent on water temperature (with gut emptying taking longer at lower temperatures). There is relatively little research evidence measuring how long sea bass and sea bream should be fasted for gut emptying and good welfare. Whilst fish in the wild may not feed for long periods, farmed fish receive feed at regular intervals therefore periods without food are likely to negatively impact welfare. Extended periods of starvation not only impact welfare but also product quality. In a study comparing these fasting periods on the product quality of sea bream, shelf-life was estimated at 16 days for fish fasted for 24 hours, 15 days for those fasted for 48 hours and 14 days for fish fasted for 72 hours[7], suggesting that 24 hours is most beneficial for product quality, compared with longer fasting periods.

A significant welfare problem with pre-slaughter fasting is that not all fish experience the same period of fasting. It may take days or even weeks from the start of fasting until the last fish in a cage is slaughtered[4]. The harvest process must be managed so that withdrawal of food prior to slaughter does not exceed 72 hours and all fish must be slaughtered within this timeframe.

Crowding

To begin the slaughter process, sea bass and sea bream are crowded in a pen, typically by use of a sweep net, so they can be more easily captured and moved to the slaughter site. Severe hazards for welfare during this phase include high stocking densities during crowding, long periods of crowding, and exposure to air. In commercial practice, sea bass and sea bream are typically crowded at a high stocking density of >700fish/m^3 [3] [4]. Welfare may be further impacted by poor water exchange, low oxygen levels, and fish waste accumulation (e.g. ammonia) in the water. Fish that are last to be caught and slaughtered will experience repeated attempts at catching and more prolonged periods of crowding and significant stress[4] (EFSA, 2009).

When crowding is poorly managed, sea bream and sea bass display vigorous escape behaviour, including rapid swimming and struggling, resulting in significant muscle use pre-slaughter[8]. This leads to an increase in lactic acid production, a lower muscle pH[9,10], and faster onset of rigor mortis[11], associated with lower product quality and changes in texture.

Severity and duration of crowding should be minimised as much as possible, and crowding should never occur for longer than 2 hours.

Moving fish

Ideally, sea bass and sea bream should be slaughtered as close to the rearing pens as possible so that they can be moved directly from the rearing pen to a cage side harvest boat. Moving fish causes stress, so should be limited as much as possible. In some cases fish maybe transported longer distances by well boat, or being dragged in nets behind a boat which can easily lead to fish becoming exhausted.

Sea bass and bream are moved from the crowding pen to the place of slaughter by braille nets (usually removed from water) or can be pumped through pipes (transferred in water). Braille nets should not be used as they involve removing fish from the water and also subject them to physical trauma due to pressure from other fish in the net and abrasion on the surface of the net. Pumping fish has a higher welfare potential dependant on the pump design and its operation. Pumping systems should be carefully designed to move the fish as gently and efficiently as possible.

Transport to offsite slaughter plants is typically via well boats, which can take several hours. These must be equipped with water quality monitoring and maintenance equipment to ensure that good conditions are maintained in transit. Well boats must not move too fast or fish will become exhausted when swimming to keep up with the boat.

A slaughter method that can be humane for European sea bass and gilthead sea bream

Currently, the vast majority of sea bass and sea bream are killed using the inhumane method of live chilling in ice slurry (see text box 1), or are left to asphyxiate in air (see text box 2). These methods are aversive, causing suffering for much extended periods (minutes to hours) before consciousness is lost. An alternative method is now commercially available which can provide a humane death when performed correctly – electrically stunning the fish before transferring them to an ice slurry.

Electrical stunning followed by live chilling in ice slurry

Electrical stunning is currently only used on a small number of sea bass and sea bream farms. Electrical stunning can be part of a humane slaughter system for these species, when performed correctly, as it can cause instant insensibility[6,12]. However, consciousness will be recovered after a period of time, and so in order for it to meet requirements of humane slaughter, electrical stunning must be followed by another method to kill[13]. For sea bass, live chilling in ice slurry can be used after an effective electrical stun and can lead to death without recovery of consciousness when stunning parameters are sufficient[12]. However, this is a relatively new method and further verification of machines and careful on-farm management and verification of stun effectiveness is needed. Research is urgently needed to thoroughly validate this method for sea bass and sea bream, however producers using this method commercially report its apparent effectiveness.

There are variations on the systems used to electrically stun fish (described below), but more generally, there are important factors to be aware of:

- The specific electrical parameters used are critical in ensuring that electrical stunning is effective. When the electrical current or voltage is too low, or the application duration too short, there may be ineffective stunning. This can be painful and cause injuries to conscious fish[6]. Alternatively it can mean fish regain consciousness during some stage of the killing or processing procedures, during which they may experience significant pain and suffering. When the electrical current or voltage is too high it can result in carcass damage such as haemorrhages, blood spotting, and spinal fractures [14,15].
- Ineffective electrical stunning can go unnoticed as it can lead to physical immobilisation only, whereby the body is motionless and unresponsive in reflex tests but the fish remains conscious (as shown by brain activity measures) and sensible to pain[16]. To prevent this it is important that the parameters used in electrical stunning systems are based on recommendations from research that has validated parameters using measurements of brain activity (via electroencephalograph (EEG) measurements) and not just based on behaviour signs.

There are in-water and dry electrical stunning machines available for sea bass and sea bream. Dry stunning is thought to reduce the amount of carcass damage and injuries sustained by the fish[17] when compared to in-water stunning. However, in-water stunning is preferable in terms of fish welfare as fish need not be restrained, handled, or removed from the water (all being stressors) before they are stunned[15,18].

a. **In-water electrical stunning**: Fish are exposed to an electric current in water, either within a water tank (batch system) or while pumped through a pipe (continuous flow system) which allows for faster processing. For in-water electric stunning, the voltage gradient in the water or electric field strength (measured as volts per meter) is the important parameter to consider rather than the total current.

   The electrical current passes not only through the fish but also through the water surrounding it so the current is dependent on the electrical conductivity of the water and also on the amount of water around the fish. The electrical conductivity of the water changes with its salinity and sea water is typically one hundred times more conductive than river water. The electric field required to stun a fish decreases slightly as the water conductivity increases, however because of the increased conductivity, the current and hence the electrical power increases almost in proportion to the conductivity. Stunning a fish in sea water can therefore require up to 50 times more power than stunning the same fish in fresh wate[19].

   It is difficult to provide general recommendations on the best electrical parameters to use in electrical stunning systems as so much depends on the individual set up of the system, the size and number of fish being slaughtered, as well as water conductivity, and other factors.

b. **Dry electrical stunning**: Fish are removed from water and passed over a conveyor belt which acts as one of the electrodes, with a chain of plate electrodes (steel flaps) hanging above acting as the other to complete the circuit. In some systems fish are sprayed with water between removing them from water and stunning, and this is referred to as semi-dry stunning.

   It is crucial that the fish enter dry stunning machines correctly - entering head-first and without excessive struggling. Incorrect orientation of fish brings a significant risk of pre-stun shocks and ineffective stunning, meaning that the process is inhumane because fish may feel the electricity for a few seconds before the electrodes reach the head. With correct orientation, dry electrical stunning can be humane, providing the follow-up killing method is suitable.

Text box 1

Live chilling in ice slurry *without* stunning – AN UNACCEPTABLE SLAUGHTER METHOD

Currently, sea bass and sea bream are commonly killed under commercial conditions by live chilling in ice slurry. Fish are pumped or netted from (ambient) holding water into ice slurry. This is a mixture of ice and water in a ratio ranging from 1:2 to 3:1, with typical temperatures of between 0 and 2°C (EFSA, 2009j). Fish eventually die from asphyxiation. This is a low cost method used to kill many fish species and is widespread globally[20]. However, the method results in "poor fish welfare" (OIE, 2010, p. 3) as it is highly aversive; there is a period of vigorous escape behaviour[21] followed by fish becoming immobilised. Although the sea bass and sea bream may slow or stop all behavioural activity after a few minutes of being placed in ice slurry, brain activity indicates the continuation of consciousness for considerably longer. Various studies report that sea bass and bream remain conscious in ice slurry for times ranging from 5 to 40 minutes[6,10,22–24].

Text box 2

Exposure to air – AN UNACCEPTABLE SLAUGHTER METHOD

Some sea bass and sea bream are killed by removal from water, however this is a very stressful killing method, with an extremely prolonged period to unconsciousness and death, and significant physical activity [4,8]. Typically, fish make violent attempts to escape and "maximal stress responses are initiated" (Robb & Kestin, 2002 in EFSA, 2009j). The time to loss of consciousness and death is temperature dependent, with higher ambient temperatures leading to faster death[4]. Sea bass asphyxiated in air struggle even longer (around + 65%) than those killed in ice water slurry (Bagni et al. 2002, in EFSA, 2009j). Likewise, sea bream also struggled longer (around + 25%) in air. Processing of fish should not begin until after they are dead. Death by asphyxia in air was reported to take 70±27.6 minutes by Poli et al. (2004)[23] and up to 128 minutes in a study by Acerete and colleagues (2009)[26].

Recommendations for corporate policies on humane slaughter of European sea bass and gilthead sea bream

1. All animals killed for food should be slaughtered humanely. This means that they must be stunned, rendered instantly insensible, and they should not regain consciousness before dying. For European sea bass and gilthead sea bream, the use of ice slurry without pre-stunning is unacceptable and should be phased out. Effective electrical stunning before immersion in ice slurry is instead recommended, as this can enable humane slaughter and there are commercial systems available. Percussive stunning or spiking, followed by a separate kill method where necessary, may also be acceptable, providing that fish do not regain consciousness after stunning. However these systems are unlikely to be commercially viable due to the relatively small size of sea bass and bream.

2. The killing of animals by bleeding without the use of pre-slaughter stunning is not considered a humane method of slaughter. Corporate animal welfare policies should stipulate that all fish products in the supply chain come from fish that have been subject to pre-slaughter stunning.

3. Fish removed from the production line (i.e. sick or injured fish, or those that do not fit market criteria) must be killed humanely.

4. All systems for killing animals should be effectively managed and monitored. This includes:
   - The development and use of Standard Operating Procedures (SOPs) for all live animal operations.
   - Effective training of all staff involved in live animal operations.
   - Designating a member of staff responsible for animal welfare in the slaughterhouse, an "Animal Welfare Officer", whose role it is to monitor operations to ensure SOPs are followed and to require remedial action be taken if non-compliance or other issues are found.
   - Use of CCTV in all live animal handling areas, with effective monitoring of the footage.
   - Effective measurement and proactive management of welfare outcomes at slaughter.
5. Pre-slaughter fasting periods should be no longer than is required for fish welfare benefits (i.e. to reduce oxygen requirements and waste accumulation in the water) and should not exceed 72 hours for each fish. Procedures should be in place to ensure that this maximum time is adhered to for every fish in the pen. For example, where multiple harvests/days are required to slaughter all fish in a pen, the fish should be segregated so that fasting times can be adhered to. Records of the dates and duration of fasting should be kept.

6. Crowding time and intensity should be minimised.

   - Narrow, deep nets should be used as they are more welfare-friendly than wide shallow nets for crowding fish.

- Crowding should be carefully monitored and managed so that the crowd remains calm, with very few fish showing signs of distress, such as leaping or thrashing. If this occurs it is a sign that the fish are too crowded.
- The fish should not be crowded for longer than 2 hours and repeated crowding should be avoided. Where unavoidable there should be a period of 24-48 hours between subsequent crowds.
- Oxygen levels in the water should be monitored throughout the crowding process and producers must ensure that oxygen saturation stays above 80%. If fish show behavioural signs of stress or oxygen levels fall below 80% then fish should be given more space by releasing the nets. Additional oxygen can be supplied to the water. Keeping nets clean also help as fouled nets can reduce the water flow.

7. Movement of fish to the point of slaughter should be carefully managed to minimize stress.
   - Only healthy fish should be transported so a health check should be done before transporting fish.
   - If hand-nets are used (e.g. to remove sick fish from the cage), they should be used to remove small numbers of fish only. Nets should have a smooth surface and should be used carefully, with fish being out of water for a maximum of 15 seconds.
   - Braille nets should not be used to move fish out of water. Instead, pumping systems should be used to move fish in-water, and these must be carefully designed and managed to ensure gentle movement of fish through pipes. The following points are important:
     - An even flow of fish should be achieved, rather than a pump which delivers fish in bursts.
     - Fish must move through the pipes at a suitable speed - fish should not be able to swim against the pumping current as this risks injury and exhaustion of fish and keeps them inside the pipe for longer than necessary. However, if the pumping current is too strong the fish may be at risk of injury either inside the pump or on exit.
     - Pipes should be dimensioned to accommodate the size of the fish and the number of fish being pumped, and should have a smooth surface on the inside, including at the point of any joins between pipes.
     - Pipes should be as short and straight as possible.
     - All fish should be cleared from the pipes/pumps before any break/stop in pumping, and fish should not spend any longer in the pipes than necessary. Oxygen is quickly depleted inside the pipes and fish will die quickly if stuck in the pipes.
     - If injuries occur (e.g. fin damage, scale damage, wounds on the snout, bruising etc.) inside the pipe, measures must be taken to investigate and correct any flaws in the system.

8. If fish are dewatered before slaughter this should be well designed so that fish are moved with the least impact and risk of injury. The time that fish are exposed to air should be kept to a minimum; 15 seconds should be the maximum.

9. If well boats are used to transport fish, the water conditions should be monitored and controlled, ensuring that oxygen levels do not fall too low, and the ammonia and other waste products are not accumulating to damaging levels.

10. Electrical stunning systems:
    - Compromises to the welfare of the fish should not be made for the sake of product quality. Electrical parameters should be chosen that result in an effective stun which lasts until death and that minimises the risk of electro-immobilisation (fish being paralysed but still conscious). The parameters should be appropriate for the size and number of fish being slaughtered, equipment set-up and water conductivity.
    - In dry and semi-dry systems, all fish must enter the machine head-first. Operators should be present to orient fish manually and check that every fish is correctly aligned.

- In dry and semi-dry systems, the time out of water should be kept to a minimum (the Humane Slaughter Association recommend a maximum of 15 seconds from dewatering to stunning)[27] to minimise stress and prevent aversive movements which may affect their smooth entry into the electric stunner.
- A kill method (immersion in ice slurry, decapitation, percussive blow or spiking) must be performed as soon as possible following stunning and must prevent recovery of consciousness before death occurs.
- For in-water systems it is important to clean and maintain electrodes daily as corrosion can build up quickly, especially in saltwater systems, which can affect the amount of current delivered to the fish and result in an ineffective stun.

11. Stunned fish can be killed by chilling in ice slurry but this should only be used for effectively stunned fish without risk of recovery of consciousness. The fish must be monitored to ensure they do not regain consciousness, and to ensure ice slurry conditions are optimal. The fish:ice:water ratio in an ice slurry tote should be approximately 2:1:1. Using cooled (to 0'C) rather than ambient water is preferable as this will ensure the ice slurry mixture has a lower overall temperature. All fish should be fully submerged in the ice slurry, and totes must not be overfilled.

12. All fish must be observed post-stun by a trained operator. If any fish show signs of recovery, such as opercular movement or eye roll, or in the case of stunner equipment failure, a contingency plan must be in place to immediately stun and kill the fish, e.g. with manual percussion and gill cutting, or spiking.

Welfare outcomes at slaughter

In order to proactively monitor and improve animal welfare at slaughter it is necessary to start by identifying appropriate measures of welfare. Whilst it is important (and in many cases mandatory) to record non-animal-based measures, such as electrical stunning parameter data, it is also important to look at the animal. Welfare outcomes are animal-based measures which give a more direct insight into the animal's experience than can be achieved by measuring 'inputs' such as husbandry resources. They are influenced by several factors and corrective action may require investigating a range of potential solutions.

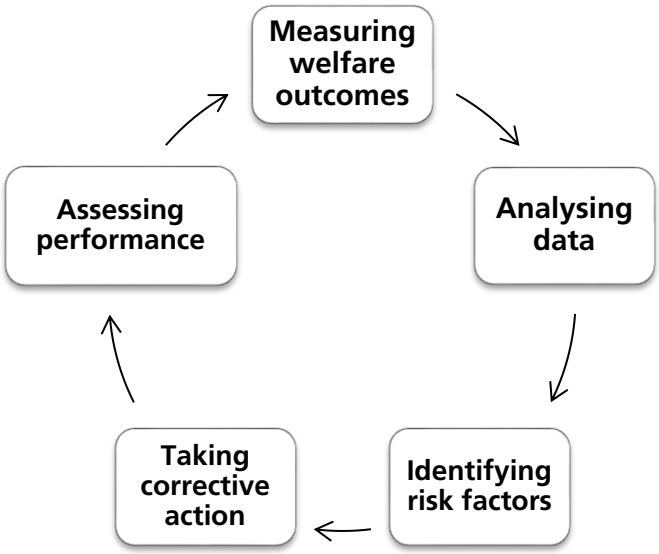
Corporate policies on animal welfare should stipulate that welfare outcome measures are used at slaughter. Recommended welfare outcome measures for European sea bass in slaughterhouses include the following:

Welfare Outcome	Detail
Activity during crowding	**WHAT:** A qualitative assessment of the activity of fish during crowding. **WHY:** The activity of the fish during crowding, as seen at the surface of the water, is an indicator of the stress experienced during this time. **HOW:** This measure should be continuously recorded. Their activity can be scored on a 5 point scale, described here: https://www.hsa.org.uk/downloads/publications/harvestingfishdownload-updated-with-2016-logo.pdf **TARGET:** 100% of the crowding procedures to be scored 1.
Indicators of consciousness	**WHAT:** An assessment of consciousness performed during the time interval between stunning and death. **WHY:** For slaughter to be considered humane, fish must be effectively stunned (rendered unconscious) so that they do not experience pain or stress during the process. **HOW:** This measure should be continuously recorded. Assess indicators of consciousness post electrical stun (see later table for a full list of potential indicators that can be used) and record the number and percentage of fish

	that show signs of recovering consciousness. Also record the action taken when fish showing signs of consciousness are detected. **TARGET:** 0% of fish to show signs of returning to consciousness[28]. *If signs of consciousness are seen, fish must be immediately re-stunned or stunned with an alternative, back-up method.*
Pre-stun shocks	**WHAT:** Fish may receive electric shocks upon entry to a dry electrical stunner, which are not sufficient to cause unconsciousness but which cause pain. These can be caused, for example, when a fish is moving vigorously and makes contact with one but not both of the electrodes, or due to tail-first entry to the stunner. **WHY:** The fish are still conscious and therefore these pre-stun shocks cause pain. Pre-stun shocks indicate that the stunning machine is poorly designed and/or operated. **HOW:** This measure should be continuously recorded. The incidence of fish entering the stunner head-first and calm (not thrashing) can be recorded. **TARGET:** 100% of fish to enter the stunner head-first and without thrashing movements.
Post-mortem flesh quality	**WHAT:** Time to rigor mortis and gaping of the muscle tissue. **WHY:** Post-mortem flesh quality can give a valuable insight into pre-slaughter treatment of the fish. When fish are stressed before (i.e. when crowded) and during slaughter they can become very active and use up their energy reserves, and causing an increase in lactic acid. This has a negative impact on flesh quality, i.e. time to rigor decreases (decreasing yield and shelf life) and flesh gaping increases (reducing yield and making it less appealing to consumers). **HOW:** Record time to rigor and gaping from a sample of carcasses.
Post-mortem haemorrhages	**WHAT:** Haemorrhages on the flesh of the fish. **WHY:** Physical damage post-mortem can give a valuable insight into pre-slaughter treatment of the fish. Haemorrhages are areas of flesh that have been damaged causing blood to leak into the area. Haemorrhages can occur if fish fall or are dropped from the dewaterer or braille, or if poorly maintained and operated pumps and pipes are used. They are also typically seen in the tail region if a fish has been lifted or held tightly by its tail prior to slaughter. Haemorrhages can also be caused by poorly-positioned manual percussive stunning and by electrical stunning if the correct parameters have not been used. **HOW:** Record incidence of haemorrhages from a sample of carcasses.
Post-mortem scale loss	**WHAT:** Scale loss or damage. **WHY:** Physical damage post-mortem can give a valuable insight into pre-slaughter treatment of the fish. Fish that are crowded and stressed can damage their scales due to rubbing against nets or each other. **HOW:** Record incidence of scale damage from a sample of carcasses.
Post-mortem eye damage	**WHAT:** Eye damage. **WHY:** Physical damage post-mortem can give a valuable insight into pre-slaughter treatment of the fish. Eye damage occurs during percussive stunning when the blow is position incorrectly and either hits the eye directly or close enough for the eye to rupture. Eyes can also be affected by poorly maintained nets. **HOW:** Record incidence of eye damage from a sample of carcasses.

Post-mortem snout damage	**WHAT:** Snout damage such as bleeding and/sore areas. **WHY:** Physical damage post-mortem can give a valuable insight into pre-slaughter treatment of the fish. Snout damage occurs when pre-slaughter crowding is not well managed and fish are swimming into the nets and each other. **HOW:** Record incidence and level of snout damage from a sample of carcasses.

Welfare outcome measures should be used as part of a proactive programme of measurement and continuous improvement, including target setting. A programme should involve a continuous cycle of:



Regular monitoring of welfare outcomes enables swift detection of problems, implementation of corrective action and continuous improvement to be achieved. Some measures should be continuously recorded (as indicated in the table above). For the other measures, it is recommended that they are recorded on a representative sample of a minimum of 50 fish per harvest. Target setting should be used for all measures, to drive improvement.

Indicators of consciousness

It is difficult to reliably determine *unconsciousness* of fish (and therefore that stunning is effective) at the slaughterhouse (EEG are required and this can only be measured in the lab) but it is important to ensure that there are no signs of consciousness after stunning. If any of the following signs of consciousness are observed then stunning is likely to have been ineffective. If in any doubt as to whether a fish is unconscious, do not hesitate to repeat the stun or use an alternative, back-up method.

Signs of an ineffective stun	Comment	Stunning methods applicable to
Breathing	Regular opercular movements indicate the fish is likely to be conscious	All
Eye roll	The vestibulo-ocular reflex (VOR), known as "eye roll", refers to the movement of the eyes in the head as the fish moves. In a conscious fish, the eye rotates dorso-ventrally when the fish is rocked from side to side.	All
Coordinated behaviour	Coordinated behaviour such as swimming or attempts to escape is a sign that fish is conscious.	All
Behavioural response to tail pinch	Behavioural response such as movement away from the stimulus indicates the fish is likely to be conscious.	All
Ability to achieve equilibrium	If a fish is able to achieve equilibrium after being inverted in water, then it is likely to be conscious.	All

Disclaimer

We will incorporate new scientific information regarding humane slaughter for fish into subsequent versions of these resources. Some of this research may alter our understanding of current established practice. Last update: November 2018

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