



The Welfare of Farmed Fish at the Time of Killing

Introduction

The UK has been progressive when it comes to animal welfare, but as of now, fish have been excluded from most of these welfare reforms. At a time when production continues to intensify, it is more important than ever that fish welfare be seriously considered. Without an official government code of practice, existing protections for fish rely on vague provision in legislation, certifications scheme or voluntary industry codes of practice. Moving forward, fish welfare must be officially recognised as a necessary part of building a sustainable, socially conscious, and ethical food sector. At its best, fish welfare is not only an innately valuable pursuit but also acts as a guide towards a better food sector overall.

Fish farming is the fastest-growing food sector in the world [1], and the UK faces a unique, time-sensitive opportunity to shape that growth. We believe that fish welfare should become an objective of the UK parliament, alongside the current objectives of sustainability and utilising scientific evidence. Strong standards for how to humanely slaughter is a necessary part of ensuring higher welfare. The recommendations set-forth in this report are built on the current scientific literature on fish welfare. If implemented, these improvements can provide millions of animals proper care during their final moments of life.

Background

Key Fish Species in British Aquaculture

The majority of British aquaculture is concentrated in the Scottish salmon industry, which made up ~94% of production by tonnage in 2019 [2] and slightly under two-thirds by number of individuals [3]. The next most prominent farmed species are rainbow trout and sea trout, which make up ~6% of production, then Atlantic halibut, common carp, Arctic char, Nile tilapia, and various other fresh or saltwater fish, which make up less than 0.2% of production.

However, these figures neglect another group of fish prominent in British aquaculture, cleaner fish. In 2016, the salmon farming industry reared approximately 1.5 million farmed cleaner fish (although it is likely that more were also harvested from the wild) [4]. One paper has predicted that the UK would use 10 million cleaner fish in 2020, although it is unclear whether this prediction was accurate [5]. This would make them the second or third most numerous group of fish in aquaculture. Extending protection to cleaner fish is not only important due to the large number of individuals affected, but also because of the large amount of suffering



caused by their current neglect by the industry. The Scottish Fish Health Inspectorate has documented multiple instances of extremely high mortality rates (up to 100%) among cleaner fish on salmon farms [6]. This showcases the neglect that cleaner fish face, often being treated as a disposable resource for increasing salmon productivity. This is a group that any guidance on the welfare of fish at slaughter must not ignore.

Current Industry Practices

Fish welfare within aquaculture is a complex and multifaceted issue. Fish farmers have a high degree of control over all aspects of a fish's life and, as such, have a responsibility to provide for their needs across their entire lives. However, there is a complete lack of detailed legal provisions on how fish should be treated. This means that, although farmed fish are protected under the Animal Welfare Act 2006 and The Welfare of Animals at the Time of Killing Regulations 2015 (WATOK) [7], most industry practices are unregulated, with no direction for specific guidance on implementation. In lieu of official government guidance, the Code of Good Practice for Scottish Finfish Aquaculture (CoGP) and existing certification schemes are the main guidance that governs UK aquaculture in practice.

The CoGP for Scottish Finfish Aquaculture covers handling, crowding, transport, and finally, slaughter [8]. For each, there is some acknowledgment of the welfare of the fish; however, the guidance is still generally quite weak. For example, although crowding should be kept to a 'minimum', no specific time durations are given as limits. Fish must also not be kept out of water 'so long as to produce signs of distress', but again, no time limit is given. Creating stronger legal requirements that provide these limits would mean standardized, high-level welfare protections that are enforceable rather than optional.

The CoGP lacks, among other things: a specific time limit on fasting length, detailed guidance on the procedures and machine parameters needed for effective stunning, detailed guidance on the monitoring of fish consciousness during slaughter, a requirement to record the number of unsuccessful stuns and fish regaining consciousness, a requirement for contingency plans to be made to humanely deal with unsuccessfully stunned fish, detailed guidance on the humane slaughter of cleaner fish, and a specified maximum length of time between the stunning and bleeding of fish.

The most prominent certifications scheme the RSPCA standards surpass the protections provided by the CoGP standards on many of the issues. However, undercover investigations from various animal protection organisations have shown that even on RSPCA farms, which theoretically have better protections, the farmer's duty of care to the fish in their farms is frequently ignored.

A recent investigation released by Animal Equality in February 2021 showed footage from a prominent slaughter facility [9]. The pioneering footage is the first of its kind to be released in



the UK. The investigation has revealed several extremely serious animal welfare abuses. These include:

- Numerous animals displaying consciousness after failure to stun, evidenced by flapping, wriggling, and gasping motions;
- Salmon's gills cut without prior stunning, causing pain, and/or salmon being re-stunned with a club after their gills were cut, causing blood to spray from their gills;
- Salmon being clubbed multiple times, in some instances as many as seven times per animal;
- Salmon's gills torn with workers' fingers, rather than a scalpel;
- Animals falling or being thrown to the floor and left to suffocate.

This reality stands in contrast to the industry figures that suggest that 95% of salmon in Scotland are slaughtered using percussive stunning followed by bleeding, and the remaining 5% by using electrical stunning before bleeding [10,11]. Even though the equipment may be available on these farms, the lack of a strong legal framework results in poor implementation in reality. Without official guidance and regulation on this issue from the government, a large number of fish will continue to unnecessarily suffer.

Some recommendations on aspects of aquaculture such as slaughter, handling, and crowding could also be applicable to the welfare of wild-caught fish. Although the Animal Welfare Act 2006 does not cover anything that takes place in the course of fishing, we would urge further investigation into how lab research and implementation in aquaculture can be generalised for use in wild fisheries. The number of wild-caught fish dwarfs the number of farmed fish in the UK by three to one by weight, and possibly several orders of magnitude by the number of individuals [3,12]. As such, the suffering of these fish is also a major welfare concern that deserves recognition in legislation concerning welfare at the time of killing.

Welfare at Harvesting

There are multiple welfare issues present during capture (harvesting) and transport to slaughter. It is important to recognise species specificity in any recommendations that are made.

Feed withdrawal

The first stage before capture (harvesting) for many fish is feed withdrawal. This is used to evacuate the gut and clean the digestive tract, as well as ensure good water quality and reduce physical activity and stress during transport [13,14]. However, concerns have been raised about the impact of feed withdrawal on the welfare of the fish. The Five Freedoms, a seminal theory of animal welfare, defines freedom from hunger and thirst as one of the main criteria for good welfare.



Existing research into this topic has largely focused on the effect of feed withdrawal on physiological indicators of welfare. Waagbø et al. (2017) [15] and Hvas et al. (2021) [16] examined the effect of a two- and four-week fast, respectively, on the welfare of Atlantic salmon. Both studies found that the general stress level was unaffected by the fast. Waagbø also found that there was no difference in the fish's ability to cope with handling stress. Even when exposed to exhaustive exercise, Hvas noted only minor effects on blood parameters between a fasted group and a control.

These findings have been replicated in rainbow trout, but usually over a much shorter period of time. Here, several studies have found that fasting between one to three days has no effect on physiological stress responses of rainbow trout as compared to a control [17][18][19]. Bermejo-Poza et al. (2017) examined the effect of a longer fast (3, 4, 5, 6, 7, and 9 days) on rainbow trout and, in fact, found that plasma concentrations of cortisol and glucose were lower with increased days of fasting, while the slaughter weight, relative growth, and hepatosomatic index (a measure of a fish's energy reserves) did not decrease until after 7 days of fasting.

However, we shouldn't confidently conclude from these studies that fasting has no effect on the welfare of salmon and trout, as they only evaluate physiological measures, which don't encompass all of welfare. For instance, it is reported that ten days of feed withdrawal increases aggressiveness and fin injuries [20]. Current evidence does suggest that short periods of fasting (less than three days) do not significantly affect welfare, though more research is needed before a strong conclusion can be reached.

It should also be noted that, as cold-blooded animals, fish modulate their metabolism by the temperature of their environment. This means that fish starve faster at higher temperatures e.g., at 20°C they would starve twice as fast as at 10°C.

Recommendations: Following a precautionary principle, given the lack of strong scientific evidence and considering thermal dependency, legislation should incorporate specific limits regarding the length of time that fish are starved. We encourage the adoption of Eurogroup for Animals' guidelines, which state that prior to transport, feed should be withdrawn for as short a period as necessary to clear the animal's gut. Specific limits should be set on starving for a maximum of 50 Celsius degree days or 48 hours[21]. In the case of lower temperatures such as 10 degrees Celsius or less, considerations should be made to increase the starvation period to a maximum of 72 hours.

Crowding

Crowding during capture is a highly stressful event for the fish involved. It often results in injuries from abrasion with other fish or the net, as well as a decrease in water quality, dissolved oxygen levels in particular [22]. In addition, greater exposure to light and the



effects of rapid depressurisation can cause stress for the fish. Many studies, including Erikson et al. (2016) [23], Ramsay et al. (2006) [24], and Trenzado et al. (2006) [25] have demonstrated these effects. These experiments showed that crowding led to considerably higher cortisol levels in fish, as well as several other negative welfare indicators, even in cases where the fish were already severely stressed. These findings were reiterated by Wall (2001) who stated that crowding is one of the main causes of compromised welfare during harvest [26], something that has been demonstrated by Gatica et al., who found that blood cortisol measures were highest in fish during capture and pumping [27].

However, as it is an inevitable part of the capture of large numbers of fish, crowding will always be present in aquaculture to some extent. Therefore, we should aim to minimise the suffering experienced during crowding by decreasing its duration and ensuring adequate water quality. The RSPCA guidelines stipulate that ‘fish must not be crowded for more than two hours’. However, they also state that ‘crowding and handling needs to be kept to an absolute minimum’, so in principle, crowding should be restricted to the shortest period of time viable for producers [28].

Recommendation: Any procedure that can lead to crowding stress should be replaced, if possible, by a less stressful procedure. There should be specified limits for crowding and time out of water, and a limit on other sources of stress such as poor water quality or extreme temperatures.

Handling and Manipulation

Handling, like crowding, is an innately stressful procedure for the fish, as it forces them into a completely unnatural environment where they have little control. Handling has been shown to cause elevations in physiological measures of stress, including cortisol [15,29–31]. As such, the frequency of handling should be minimised, and it should only be conducted by trained personnel who can treat fish with the proper level of care to avoid as much unnecessary suffering as possible. Methods for increasing the fish’s comfort include providing adequate support to the body, reducing the time kept out of water (never more than 15 seconds) [32], and making sure that handlers’ hands are wet before handling fish [33].

An alternative method of moving or handling the fish prior to transport is the use of pumps. These reduce the length of time the fish are exposed to the air, prevent crushing and injuring fish in nets, and avoid manual handling. However, there are still some potential welfare issues that need to be addressed, including the risk of injury through collisions with sharp corners or interior features in the pipe and maintaining good water quality even during blockages [22]. To avoid this, pumps should not have any sharp corners or protrusions that could injure the fish, water quality should be monitored, and the flow rate should be adjusted (neither too low nor too high) to avoid them being trapped within the pipe system, collide at high speed with pipe walls, and/or suffer from injuries, such as excessive scale loss. Lines and Spence comment that



fish should be inspected after pumping to ensure they are free of injury and have sufficient energy to maintain their equilibrium (upright orientation) [22].

Recommendations: The core issue is to emphasise the need to avoid any unnecessary handling as it can give rise to a range of negative welfare outcomes including poorer biosecurity, health problems, external injuries, degradation of the external environmental conditions. Any procedure that can lead to handling stress should be replaced, if possible, by a less stressful procedure such as LiftUp AS pumps to dispose of dead fish without rough handling within the cage [34]. To handle fishes the equipment (e.g. nets, pumping and brailing devices) should be designed, constructed, and operated to minimise physical injuries (pumping height, pressure and speed are important factors to consider); The time kept out of the water should not be higher than 15 seconds, and other sources of stress such as poor water quality or extreme temperatures should be limited - parameters should be kept within the optimal ranges during the process.

Transport

After fish have been captured, they are transported for slaughter and processing. There are several methods used for transport, including well-boats, roads, and helicopters. Even when there are no lapses in best practice, transport involves a great deal of stress for fish [35–37]. With all transport methods, the main concern is in minimising the duration and maintaining adequate environmental conditions throughout the journey.

Ideally, stocking density in transport would be maintained close to the stocking densities that have been established as appropriate for each species in their grow-out phases. For adult salmon, this is between 15 and 25kg/m³ [32,38,39]. However, likely due to the practical difficulties of maintaining this level, the RSPCA allows an increased stocking density of 125 kg/m³ on well-boats for salmon and trout at a live weight of 5kg [32,40]. As with stocking density, water quality should also be maintained within acceptable limits. Shabani et al. (2016) suggested that particular care should be taken to avoid exposing the fish to supersaturated or sub-optimal levels of dissolved oxygen [35]. Care should also be taken to ensure appropriate levels of ammonia, carbon dioxide, pH, and temperature. Long-term exposure or dramatic short-term deviations from acceptable ranges for these parameters can result in stress and high mortality for fish [41–43]. Rapid decreases or changes in temperature and pH should also be avoided, [22] as these can also cause death and distress. Overall, water quality, temperature, journey length, species, and transport system must be considered during the planning and stocking densities adjusted.

Recommendations: The European Parliament's Committee of Inquiry on the Protection of Animals during Transport (ANIT) has settled recommendations to mitigate the many welfare challenges associated with farmed fish transport and which we argue the UK should follow [44]. Nevertheless, transport prior to killing must be kept to an absolute minimum and shall be



done only when fish exhibit calm behaviour before starting this stage. Staff shall be certified to the different operations transport involved. Species-specific water quality tolerance limits and ranges shall be established e.g. dissolved oxygen, temperature, total ammonia, pH and CO₂. Within this framework, boat transport gears shall allow fresh water into the well, through opening valves. There must be sufficient natural or artificial lighting to enable continuous inspection/monitoring of the fish which shall be done without handling fish, instead making use of CCTV cameras. Whenever possible, humane slaughtering of the animals should be made pen-side to avoid stress injuries and mortalities from higher stocking densities during transport.

Welfare at killing for human consumption

Slaughter

The final stage of most farmed fish's lives is slaughter. Unfortunately, if the appropriate method for each species isn't used or is implemented poorly, this can cause high-intensity suffering for many minutes, or in some cases, for over an hour. Despite the purported use of stunning machines, many salmon experience highly stressful and painful deaths[40]. As per Compassion in World Farming's definition, any method of humane slaughter should ensure that two criteria are met [45]:

1. A killing method must be instant or preceded with a stunning method that causes instant unconsciousness. Alternatively, loss of consciousness can be gradual but the method must be non-aversive and painless.
2. Unconsciousness must last until death.

Percussive stunning

Percussive stunning can either be done manually or with an automated percussive stunning machine. Both methods involve striking the fish's head with a priest or rod to render them insensible. For this to be considered humane, each fish must be stunned immediately by a single blow [46]. The difficulty of achieving this depends on the method used (manual or automatic), the number of fish that will be stunned, and the species of fish.

Percussive stunning has been shown to be effective for salmon and trout in laboratory conditions. Lambooij et al. (2010) demonstrated that percussive stunning using an air pressure of 8.1 to 10 bars resulted in the appearance of slow waves and spikes, followed by a strong depression in electrical activity on an electroencephalogram (EEG) [47]. Roth et al. (2007) examined a similar range of pressures using a hammer strike calculated at between 4 and 6 bars [48]. They found that no fish regained behavioural signs of consciousness within one minute and 21% of fish regained minimal signs of consciousness within 10 minutes. These suggest that percussive stunning is an humane method of killing salmon and trout.

Given the large diversity between fish species, just because percussive stunning is an appropriate method for one species does not mean it is suitable for another. For example, for



tilapia, percussive stunning has been associated with higher cortisol concentrations, indicating that the fish experienced stress during the process [49]. Similar issues are found for common carp, which are also farmed in moderate numbers in the UK. In their case, the shape of their skulls means they are difficult to percussively stun effectively [50].

Additional difficulties arise in all species when a large number of fish must be stunned effectively. If this is done manually, worker fatigue will slowly reduce the force used in the strike and, therefore, the effectiveness of the stun. Santurtun et al. (2018) note that ‘the widely used methods of percussive stunning, manual or automatic, must be precise to effectively stun large numbers of fish’ [51], something that is hard to maintain after many hours of hard work. This problem has been found in Germany, where 28.1% of percussively stunned carp showed signs of consciousness at the time of slaughter [52], as well as for trout farms, where ~8% of stunned fish displayed behavioural signs of consciousness [53]

Electrical

Electrical stunning either stuns the fish and then requires an additional method for killing, or acts as a single-method killing device. This method can also be used in water prior to a percussive stun. This renders fish insensible by disrupting normal brain function and, if the current is used long enough, will kill the fish through anoxia [54].

This method of stunning has been shown to have good efficacy in the major farmed species in the UK. Several studies have found that electronarcosis produces immediate loss of consciousness or sensibility in rainbow trout and salmon [55–57], with higher currents generally having greater efficacy.

Interestingly, Concollato et al. (2016) found that trout asphyxiated with carbon monoxide (CO) had lower cortisol levels than those stunned with electricity [58], a finding they repeated in a second study in 2020 [59]. Although initial findings look promising, a more extensive review is probably needed before asphyxia with CO can be considered alongside the more well-established forms of stunning.

Nile tilapia are among the species farmed in the UK, and likewise respond to electrical stunning. Lambooij et al. (2008) concluded that they can be stunned almost instantaneously with certain settings [60]. This was also found by Filho (2015), as tilapia lost all visual indicators of consciousness 30 seconds after the current was shut off [61]. After stunning, the fish had plasma cortisol concentrations within the range of the cortisol levels typically found in unstressed fish. Bracke et al. (2014) also showed that a few flatfishes such as turbot and common sole remain unconscious after electrical stunning [62].

Inhumane Methods of Slaughter



Outside of these recommended stunning methods, there are a wide variety of methods used for slaughter that are now considered inhumane. Many of these are already well established as inhumane methods by the Farm Animal Welfare Committee, including carbon dioxide saturated water [63], live chilling + moderate CO₂ [64], exsanguination with no prior stunning, and asphyxia in air [58] or ice slurry.

As is made clear by the widespread recommendation of electrical and percussive stunning methods and the available supporting evidence, humane slaughter is possible for most of the farmed species in the UK. We believe that these humane slaughtering methods should be enshrined in an official code of practice. Even where these are available, the governing bodies must ensure that appropriate enforcement is in place, possibly with the inclusion of CCTV as suggested by Compassion in World Farming[65].

Recommendations: For both Atlantic salmon and rainbow trout (the most relevant farmed fish in the UK), specifications for stunning and slaughter are well-established. For other species, specifications for stunning and slaughter shall be set forth by fish welfare and slaughter experts through a consultation period. The use of a single method (i.e. automatic percussive blow or electrocution) to stuns (instantly) and kills is advocated and shall be enforced as standard practice. Nevertheless both stunning methods shall be followed by a separate kill method only when the fish do not show signal of regain consciousness; to ensure compliance, regular inspections must be carried out. The other methods such as carbon dioxide systems, live chilling in ice slurry, manual percussion, and leaving trout to asphyxiate in air, are unacceptable killing methods and must be made illegal. After stunning, control its effectiveness by checking the fishes for signs of consciousness, like rhythmic motion of the operculum, eye-roll-reflex, struggling, or other physical activities [22] shall be mandatory and records taken and kept to refine further killing procedures.

Conclusion

We support The Farmed Animal Welfare Committee's opinions on farmed fish welfare at the time of killing and believe that the UK should mandate ethical slaughter practices for fish, in addition to ensuring welfare at all key stages in the slaughter process. Whilst there are currently no specific legal provisions related to fish at the time of killing, including in regards to stunning, there is a legal obligation under WATOK to spare fish from any avoidable pain, distress, or suffering during their killing. Both FAWC's 1996 and 2014 reports recognise that the only way to avoid pain, distress, and suffering whilst killing a fish is to effectively stun them beforehand. Therefore, to satisfy the requirements under WATOK, appropriate stunning methods and parameters should be used for each species.

It is also clear that pre-stunning is currently the only firmly evidence-based, humane way to kill fish in aquaculture, as other slaughter methods fail to render the fish unconscious for many minutes or hours while they continue to suffer. As this can easily be avoided by using



appropriate stunning methods, failure to do so should fall under Section 4 of the Animal Welfare Act 2006 and Section 19 of the Animal Health and Welfare (Scotland) Act 2006, as stunning techniques are known and widely available throughout the industry.

The Scottish Government has said it is standard practice for all farmed salmon and large farmed trout in Scotland to be killed using a percussive stunning method that delivers irreversible instantaneous unconsciousness. Nevertheless, this has relied on the voluntary certification schemes, with no legal binding standards, and from which we can not hold to account for their actions. Without closer monitoring and enforcement this only continues to pass the message that stunning is voluntary. In contrast, by failing to install specific recommendations into legislation or official guidance, DEFRA has left the compulsory nature of stunning in the United Kingdom unclear. .

Recommendations

Up to date evidence of fish sentience is shaping the way consumers see fish. As such, there is a pressing need for the UK government to provide detailed legislation and/or official guidance on the welfare of finfish and aquatic animals. We ask DEFRA and other governmental bodies to afford the same level of protection to fish as given to terrestrial farmed animals. At the time of killing we make the following recommendations:

1. Set specific regulations with specific minimum welfare standards to detail fish pre-slaughter stages such as feed withdrawal, crowding, handling, and transportation to slaughter equipment. Establish legislation following the British Veterinary Association's recommendations with respect to each of these stages [66].
 - a. Establish operational welfare best practices and specific provisions for fish slaughterhouses and for any other facility that slaughters fish.
 - b. Make mandatory an effective contiguous stunning method to render unconsciousness until the animal dies.
 - c. Establish species-specific stunning parameters and discriminate the criteria to assess the stunning effectiveness.
2. This guidance should extend beyond the most commonly farmed species to other less commonly farmed species, such as carp and Nile tilapia, as well as cleaner fish or sick or injured animals.
3. Offshore farms should also be covered by this welfare legislation.
 - a. As mentioned above, the Animal Welfare Act does not apply to the sea, but these animals remain in our care and should be brought under its protection.
4. Extend protections at the time of killing to wild-caught fish



5. Staff should be required to be certified in order to perform any of the operations associated with slaughter.
6. Ensure appropriate channels of enforcement are established and undertaken. Conduct both announced and unannounced site inspections, with penalties for lack of compliance.
 - a. To ensure compliance with these protections, the devolved governments should oversee implementation in addition to updating legal standards and rules. The law should include official controls by competent authorities at slaughter establishments, as is the case in law for terrestrial animals. Official controls should include antemortem inspection carried out by an official veterinarian (OV) with proven expertise in the welfare of the species.
 - b. Given recent investigations, a review should take place to document the frequency of inspections and the welfare checks that are in place currently
7. Finally, we believe that welfare at the time of killing is only one aspect of the necessary standards that farmed fish should be covered by an official governmental codes of practice for finfish and other aquatic animals



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