EUROGROUP FOR ANIMALS

Looking Beneath the Surface:

Fish Welfare in European Aquaculture

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‘Welfare in seafood production is going to play an ever more relevant role.’

Paolo Bray,
Founder and Director
Friend of the Sea

Executive summary

Fish represent over 60% of all known vertebrate species on Earth. As sentient species they have the capacity to suffer, including the ability to experience pain. Fish are one of the most populous and diverse animal groups on the planet and, importantly, the most exploited for human use and consumption. Despite this, the welfare of fish has remained a relatively unexplored concept, in both scientific terms and in public and political spheres. The fact that their living environment is innately hostile to humans distances fish from us and makes them difficult to observe.
Historically, very little was known about fish behaviours, and it was widely believed that they did not have the capacity to feel pain. This perhaps goes some way towards explaining the historic lack of concern for fish welfare.
With the publication of groundbreaking work by researchers in 2003 proving categorically that fish *can* and *do* suffer, the debate surrounding the extent to which they require legal protection has gained momentum.

While legislation on the protection of animal welfare is increasingly implemented in countries around the world, fish have remained largely ignored and are, at times, expressly excluded from the legal protections afforded to mammals, birds and other vertebrates[1]. The few pieces of legislation that apply to fish welfare are insufficient in their scope, poorly implemented and poorly enforced.

In 2017, the European Commission published a report on the welfare of fish during transport and at the time of slaughter in European aquaculture. The report showed systematic weaknesses in aquaculture processes, which undoubtedly had a negative impact on fish welfare. However, rather than recommend formal remedial action, the Commission stated its confidence in the industry itself to address the issues and make the necessary welfare improvements. Eurogroup for Animals strongly opposes this view and believes that there is no evidence to support the idea that the industry is moving to standardise welfare practices at slaughter.

If legal protection of fish welfare is to have any meaningful application, a proper understanding of aquaculture is necessary. It is important to recognise that fish in farms will likely spend their entire lives in captivity, thus the potential welfare impact of aquaculture practices is not limited to end-of-life capture and slaughter. Welfare concerns extend across the entire lifecycle of the fish, including housing, transport, handling, health and monitoring systems.

This report provides an overview of the extent to which fish welfare might be impacted within the aquaculture industry, by describing the main processes of fish farming and their associated welfare implications. The report then outlines how these welfare issues can be addressed, by considering the current regulatory framework in relation to the welfare of farmed fish, including a critique of the Commission's 2017 report and recommendations. Finally, this report sets out some recommendations for formal remedial action. Eurogroup for Animals believes that swift action is vital if fish are to be protected from further harm; application of the recommendations in this report would significantly improve the welfare of fish in the aquaculture industry.

[1] Council Directive 98/58/EC of 20 July 1998 concerning the protection of animals kept for farming purposes.

1. Fish welfare

1.1 The concept

Fish represent over 60% of all known vertebrate species on Earth. Many animals inhabit aquatic environments, and it should be noted that throughout this report 'fish' refers only to vertebrate finfish. This large group captures the bony fish (a group which comprises the vast majority of fish species, including cod, salmon and goldfish) and cartilaginous fish (a group which includes sharks and rays). The report therefore excludes aquatic mammals such as whales and dolphins, and all of the invertebrates, including crustaceans (e.g. lobsters and crabs), shellfish (e.g. mussels and oysters), cephalopods (e.g. octopuses and squid), and echinoderms (e.g. starfish and sea urchins). The most recent assessment of fish diversity documented 33,249 species, 564 families and 64 orders. Of these, over 31,000 species are classified as bony fish[2].

One of the most populous and diverse animals on the planet, fish are routinely exploited for human use and consumption. Meanwhile fish welfare remains a relatively unexplored area, both scientifically and politically. Indeed, while legislation on the protection of animal welfare has been increasingly implemented in countries around the world, since the introduction of 'Martin's Act' in England in 1822[3], fish remain largely ignored or are expressly excluded from the legal protections afforded to mammals, birds and other vertebrates[4].

The few pieces of legislation that apply to fish welfare, such as Council Regulation (EC) No 1/2005[5], on welfare during transport, and Council Regulation (EC) 1099/2009[6], on welfare at the time of slaughter, are insufficient in their scope, as well as being poorly implemented and enforced.

The tendency to exclude fish from welfare considerations is, in part, because debates that were largely laid to rest with regard to the sentience of mammals and birds continued to rumble on until recently in the case of fish. There has long been global acceptance that mammals and birds are sentient (i.e. they have the capacity to suffer and can experience both pleasure and pain) and it is this fact that gives rise to our moral obligation towards them. In short, these animals are understood to possess welfare needs which should be met. This, in turn, gives rise to the ever-expanding global body of legislation which seeks to protect animal welfare and prevent unnecessary suffering.

Despite fish possessing similar neurochemistry and physiology to mammals and birds, their capacity to suffer was ignored, avoided or actively rejected until very recently.

Those who argued that fish are not sentient based their position on the fact that fish do not possess a neocortex, the part of the mammalian brain that deals with emotion, sensory perception and cognition. This argument is Cartesian[7] in its foundation, asserting that while it can be recognised that fish may react physically to injury or damage, this reaction is merely an unconscious response to external stimuli (known as nociception). For an animal to be considered capable of experiencing pain (and associated suffering), the argument goes, response to injury or damage must be more complex than mere unconscious reaction and must include a conscious awareness of the painful experience.

Based on the absence of a neocortex in fish, Rose et al, in the 2012 paper, 'Can Fish Really Feel Pain?'[8], concluded that: 'overall, the behavioral and neurobiological evidence reviewed shows fish responses to nociceptive stimuli are limited and fish are unlikely to experience pain'. As Balcombe notes, however, birds do not possess a neocortex either[9] and yet have long been afforded legal protection based on indisputable evidence of their sentience. Notwithstanding the dubious view that a neocortex is required for an individual to experience suffering, thorough research published almost a decade prior to Rose et al had already explored the specific issue of fish sentience, and drawn compelling conclusions.

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[2] Balcombe, J. (2016). What a fish knows - the inner lives of our underwater cousins. 1st ed. London: Oneworld Publications, p.11.
[3] The Cruel Treatment of Cattle Act 1822 ('Martin's Act') was the world's first animal welfare law and was introduced in England in 1822. Its aim was to prevent the cruel treatment of farmed and working animals.
[4] For example, the EU's General Farming Directive and Slaughter Regulation exclude fish from key sections.
[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] Rene Descartes was a 17th century philosopher whose theory of animals as automata asserted that animals were unfeeling, unthinking and machine-like. Descartes compared the screaming of a dog during a live vivisection demonstration as a mechanical response, similar to the screeching of a rusty machine in operation.
[8] Rose, J., Arlinghaus, R., Cooke, S., Diggles, B., Sawynok, W., Stevens, E. & Wynne, C. (2012). Can fish really feel pain? Fish and Fisheries, 15(1), pp.97-133.
[9] Balcombe, J. (2016). What a fish knows - the inner lives of our underwater cousins. 1st ed. London: Oneworld Publications, p.75.

In 2003, the publication of a paper by Lynne Sneddon et al[10] caused waves in the scientific community. Their research sought to prove whether or not fish could feel pain and, if so, whether their experience was merely an unconscious reaction to injurious stimuli or could be truly indicative of the conscious experience required for the capacity to suffer.

Sneddon et. al.'s research corroborated earlier findings by Russian scientist, Chervova[11], demonstrating that fish have the requisite physical anatomy to feel pain, react consciously to painful stimuli and demonstrate evidence of suffering as a result of pain being inflicted. This evidence of the high cognitive functioning required to demonstrate sentience, coupled with the proof of conscious, prolonged reactions to painful stimuli, effectively debunked the assertion that a neocortex was necessary to experience pain. It also provided clear evidence that fish certainly do have the capacity to suffer. Much research has followed into physiological and behavioural evidence of phenomenal consciousness in fish.

By proving that fish can and do suffer, Sneddon et al's work opened up discussion in both public and political spheres on the putative human obligation to protect fish from suffering.

Since the publication of Sneddon et al's work, an increasing body of evidence has shown that fish are not just sentient but that some species demonstrate tool use[12] and cooperation with others[13], including interspecies cooperative hunting (previously attributed to very few animals, all of which were considered far more cognitively advanced than fish, such as dolphins and false killer whales[14]). They also exhibit complex social skills[15] and even self-awareness[16], a high-functioning cognitive trait previously only attributed to humans, great apes and some cetaceans (dolphin and whale species).

Although slow, progress is nonetheless being made, with the plight of fish gradually becoming the subject of both political and public interest. Research carried out by the European Food Safety Authority (EFSA) and published as a series of reports in 2008 and 2009, considered the need for welfare provision for fish, not just in the interests of the fish themselves but also for food safety reasons. This research resulted in a series of detailed, species-specific reports, which considered inter alia, welfare during husbandry and at the time of slaughter. The work highlighted the higher occurrence of potentially dangerous pathogens in fish not afforded adequate welfare provision, explored the impact of stress on farmed fish, and reviewed the range of factors in aquaculture that can impact on welfare[17].

EFSA's research in turn triggered the publication of a 2009 statement by the European Commission, acknowledging that: 'there is now sufficient scientific evidence indicating that fish are sentient beings and that they are subject to pain and suffering'[18].

Despite burgeoning evidence that fish have welfare needs, and some moves in the political sphere to recognise that fact, legal protection for fish remains far behind that of other animals. This is of significant concern, not just from an ethical perspective but because fish are by far the most exploited animal group on earth.

Evidence of the extent to which fish may suffer is still limited, albeit expanding, and the research that does exist focuses on very few species. Caution must be exercised, therefore, when speculating as to how that suffering may be experienced (for example, its intensity in comparison to mammal or bird suffering), or the specific preferences and needs of different fish species. However, Eurogroup for Animals believes that, given the compelling evidence of suffering among those fish species examined (including many who are commonly bred and captured for human consumption), a range of specific protections are well-founded and clearly justified. Eurogroup for Animals also argues that a precautionary principle should be employed to ensure that fish are adequately protected by law from unnecessary suffering in the aquaculture and fisheries industries.

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[10] Sneddon, L., Braithwaite, V. & Gentle, M. (2003). Do fishes have nociceptors? Evidence for the evolution of a vertebrate sensory system. Proceedings of the Royal Society B: Biological Sciences, 270(1520), pp.1115-1121.
[11] Chervova, L.S. (1997). Pain Sensitivity and Behaviour of Fishes. Journal of Ichthyology, 37, pp.106-111.
[12] Balcombe, J. (2016). What a fish knows - the inner lives of our underwater cousins. 1st ed. London: Oneworld Publications, pp. 118-123.
[13] Ibid, pp. 166-169.
[14] Schultz, C. (2013). Dolphins Have Interspecies Hunting Parties. [online] Smithsonian. Available at: https://www.smithsonianmag.com/smart-news/dolphins-have-interspecies-hunting-parties-1861912/ [Accessed 8 May 2018].
[15] Balcombe, J. (2016). What a fish knows - the inner lives of our underwater cousins. 1st ed. London: Oneworld Publications, pp. 133-177.
[16] Smith, L. (2018). Mirrors have revealed something new about manta rays and it reflects badly on us. The Guardian. Available at: https://www.theguardian.com/science/blog/2018/feb/27/mirrors-have-revealed-something-new-about-manta-rays-and-it-reflects-badly-on-us
[17] EFSA. (2008f). Food Safety considerations of animal welfare aspects of husbandry systems, pp. 1–24.
[18] Vassiliou. (2009). Response to written question E-1140/09 European Commission.

1.2 The context

Fish killed for human consumption are so numerous and so poorly documented that it is impossible to place an exact figure on the number of deaths. The best estimate is that between 40.000.000.000 and 140.000.000.000 fish per year are killed in commercial fish farms, while between 830.000.000.000 – 2.400.000.000.000 fish per year are wild-caught globally[19].

In his book, *What a Fish Knows*, Jonathan Balcombe attempts to put these figures into context. He states that if all fish killed annually in commercial fishing operations were placed nose to tail, the line of bodies would reach further than the distance from the earth to the sun and back (186 million miles)[20]. Fish are unique among animals farmed for human consumption in that their deaths are recorded in collective weight rather than number of animals. When we consider that each is an individual, with welfare needs, social lives, families and minds (however different those minds might be to ours), the need to address the welfare concerns inherent in farming and capturing fish for human consumption is both indisputable and urgent.

Given the lack of regulation or historical concern for fish, the way in which fish are treated in the process of production, capture and slaughter for human consumption shows an extraordinary lack of regard for their welfare and unquestionably causes immense suffering. Wild-caught fish may die by decompression when hauled from their ocean home. This is a process whereby the 'sudden change in pressure can cause parts of the gut to be forced out through the mouth and anus, eyes to bulge from their sockets and the swim bladder to burst'[21]. Large fish may be hauled on board by one or more gaffer hooks impaled into their head or body. Fish may have their gills sliced open and be left to bleed out while still conscious, be left to starve for days on the end of a long line where they are vulnerable to attacks from predators, or be crushed to death in the pressure of being caught up in a large commercial fishing net with thousands of others. Most frequently, they are left to suffocate over a period of hours. The non-selective nature of many fishing methods, in particular trawling methods, means that 'non-target' animals, such as other fish, marine mammals and other living creatures, can also be caught up in large numbers. These animals are considered 'bycatch', with no commercial value, and are often simply cast back into the sea, dead or dying[22].

Fish for human consumption reach consumers from one of two major processes: wild-capture or farming. While fish farming (known as 'aquaculture') is the predominant focus of this report, aquaculture commonly uses wild-caught fish and fish oil as feed and, as such, the two systems are inextricably linked. With this in mind, a brief summary of the processes relating to wild-capture fishing will be provided below, before focusing more narrowly on welfare issues related to fish farming. There is a general trend towards significant reductions in the wild fish content of aquaculture feeds, as better technology is applied to feed formulations and trimmings are increasingly used. However, species new to aquaculture continue to use significant amounts of wild fish. New species continue to come into European aquaculture, and aquaculture production in Europe and globally is expected to continue to increase.

[19] Communication between researcher and Mood from Fishcount, 2016.
[20] Balcombe, J. (2016). What a fish knows - the inner lives of our underwater cousins. 1st ed. London: Oneworld Publications, p.7.
[21] Mood, A. (2010). 'Worse things happen at sea: the welfare of wild caught fish', Fishcount, p.25.
[22] Numbers of deaths listed above do not include animals considered 'bycatch'.

1.3 Consumer concern for fish welfare

Research suggests that consumers are concerned with sustainability, environmental impact and fish welfare. According to studies conducted in the EU, the main concerns for consumers when buying seafood products are freshness and health benefits, closely followed by environmental impact and overfishing. All of these areas of concern are linked to fish welfare. Good welfare in fish farming reduces the need for medications, lowers stress, creates less –environmental impact and improves product quality.

Consumers want welfare guarantees for fish they are consuming. The few studies to explore attitudes and buying behaviours have consistently found concern among consumers, a willingness to pay extra, and a desire for more information. In the first survey on fish welfare attitudes to be carried out across Europe (detail on next page), it was seen that the majority of people know that fish are sentient and want their welfare to be protected. Respondents demonstrated a good understanding of what factors impact on fish welfare. Respondents also made it clear that they want welfare guarantees for the benefit of the fish, but also because it indicates to the consumer that the product is high quality and environmentally sustainable.

In Europe, consumer preference for high welfare fish is strengthening[23]. Several studies[24] demonstrate a significant willingness to pay for improved fish welfare, either as a characteristic in and of itself, as part of an organic regime, or as a means of improving product quality.

[23] FAO. (2016). The State of World Fisheries and Aquaculture, p.23.
[24] EUMOFA. (2017b). The EU Fish Market 2017.

Just 4% of the world's aquaculture operates in Europe, with the vast majority located in Asia (88.9%)[25]. Competition for European operations is from countries with lower labour and land costs, lower production standards, and greater water resources. The EU is the most valuable international market for fisheries and aquaculture products, and 68% of its consumption is imported[26]. It is clear that Europe cannot compete with Asia on price, thus European production needs to compete based on having the highest standards. This means leading on quality and ensuring that consumer expectations are met.

The total number of aquaculture enterprises in the EU is estimated at 14,000-15,000. Almost 90% of these are micro-enterprises employing fewer than 10 employees. The total number of employees reported under the European Data Collection Framework (DCF) reached 70,000 in 2014. Profitability for the EU aquaculture sector was positive in 2014, and the Gross Value Added of the sector increased by 16% compared to 2013.

Shellfish is the most profitable of Europe's aquaculture sectors, with a market value of EUR 165 million, followed by the marine fish sector, which generates EUR 99 million in EBIT, and the freshwater fish sector, at EUR 87 million. EU aquaculture production is concentrated mainly in five countries: Spain, the United Kingdom, France, Italy and Greece, whose combined output makes up 76% in weight and 75% in value of EU totals.

Nearly one hundred species of fish are listed in FAO statistics as farmed in the EU (see Table 1 below for main species). Notably, all but carp are entirely or largely carnivorous species, making EU aquaculture dependent on the inhumane and unsustainable capture of wild fish for fishmeal and fish oil, which are used as feed.

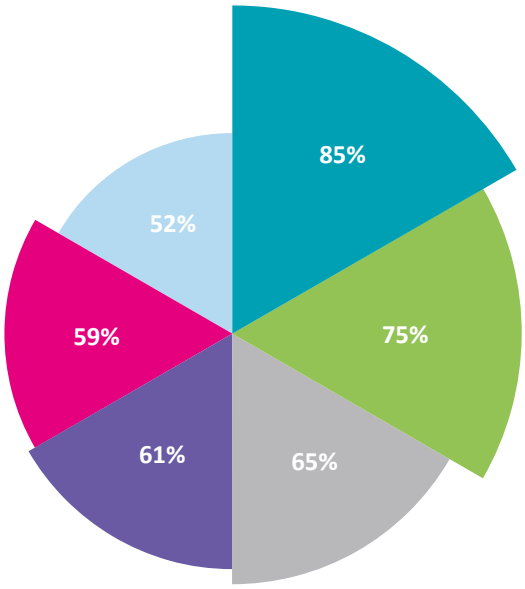
[25] European Commission. (2017). Welfare of farmed fish: Common practices during transport and at slaughter.
[26] For example, Solgaard, H. S., & Yang, Y. (2011). Consumers' perception of farmed fish and willingness to pay for fish welfare. British Food Journal; Grimsrud, K. M., Nielsen, H. M., Navrud, S., & Olesen, I. (2013). Households' willingness-to-pay for improved fish welfare in breeding programmes for farmed Atlantic salmon. Aquaculture, 372–375, 19–27; Altintzoglou, T., Honkanen, P., Winter, M. van H., & Olesen, I. (2013). Consumer aspects: Report on consumer aspects related to European organic aquaculture. OrAqua.

Herring in net

Consumer concern for fish welfare

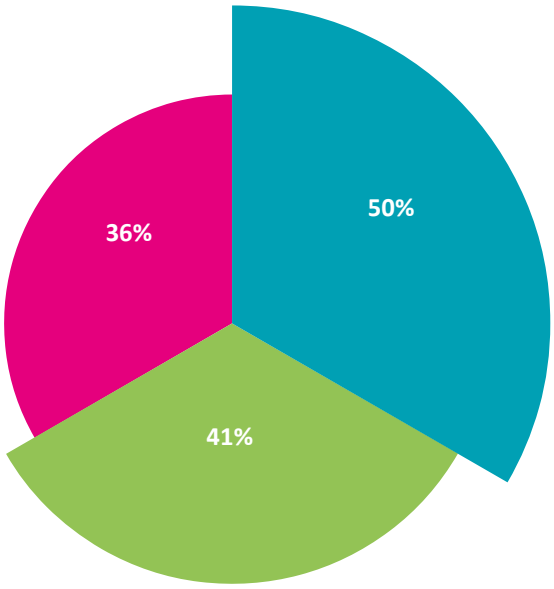
People are looking for welfare when they look for fish products, and welfare ranks higher than labour conditions and bycatch. They are looking for welfare because it is an indicator of the most important product attributes, product quality and sustainability. People want welfare guarantees on the label.

The following factors impact on the choice of which fish to buy for the following percentages of people:

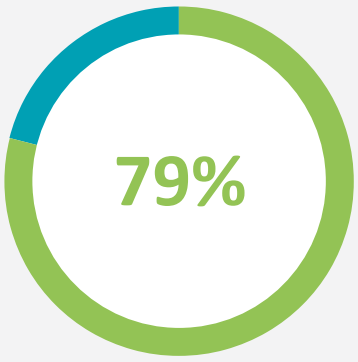


Quality and freshness
Cost
Environmental impact
Welfare of the fish
Bycatch
Labour conditions

The following percentages of people think the benefits of choosing higher welfare fish products are:



High product quality
Caught or farmed sustainably
Fish was well treated



... of people believe that the welfare of salmon should be **better protected** than it is now.

... of people think that the welfare of fish should be protected to the same extent as the welfare of **other animals** we eat.

... of people would like to see **information** about the fish's welfare on the **product label**, with preferences evenly split between a standalone welfare label and as part of other labels.

45% **of the people think clean water is most important factor of fish welfare.**

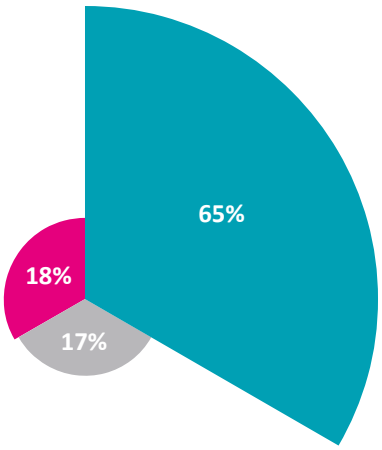
People recognise that they don't know the details, but have a holistic view of what fish welfare is.

Thinking the following essential or important for fish welfare are:

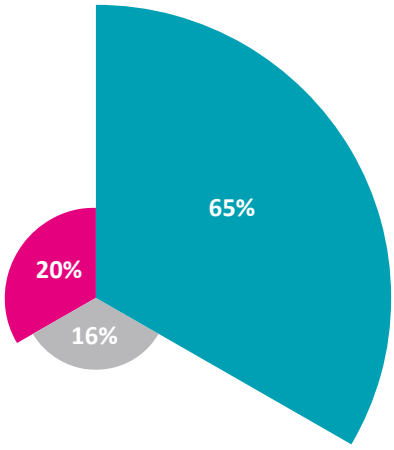
- Clean water **95%**
- Fish health **94%**
- Natural behaviours **93%**
- Minimum suffering **89%**
- Humane slaughter **89%**
- Enjoying life **82%**

People know that fish are sentient and that they feel pain. People think that the welfare of fish should be protected to the same extent as the welfare of other animals we eat, and believe that it's important to protect the welfare of fish better than it is protected now.

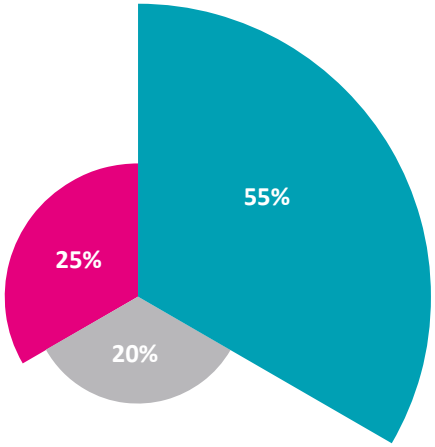
Fish are sentient



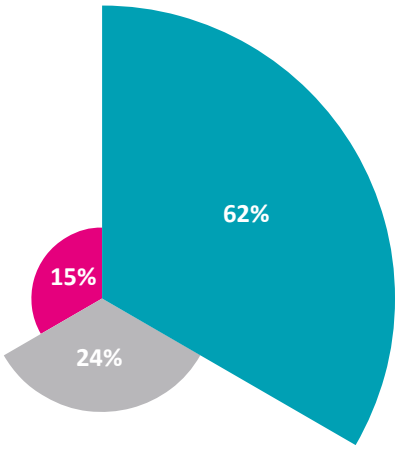
Fish feel negative emotions



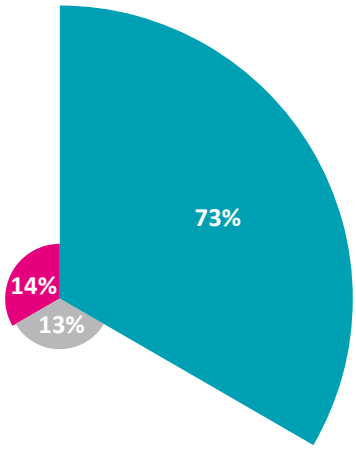
Fish feel positive emotions



Fish are intelligent



Fish feel pain



Agree
Disagree
Don't know

Research carried out by ComRes on behalf of Eurogroup for Animals and Compassion in World Farming between 30th April and 8th May 2018 using internet polling. 9,047 adults across the UK, Germany, France, Italy, Spain, Poland, Sweden, The Netherlands, and Czechia responded. Data tables can be viewed at www.comresglobal.com.

Welfare is firmly rooted in people's understanding of what 'sustainable' fish is and they think it is a more central part of what 'sustainability' should indicate to the consumer than are issues such as slave labour and working conditions.

what is sustain-able?

59% Farmed fish, kept in conditions that allow natural behaviours.

59% The species is not currently over-fished.

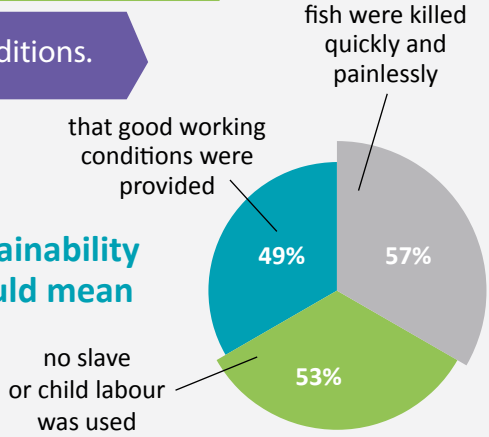
44% The fish was killed quickly and painlessly.

37% Employees had good working conditions.

70%

More people (70%) indicated that sustainability should mean fish farm conditions allowing for **natural behaviours**, than indicated the same for other welfare, environmental, and social aspects of sustainability.

sustainability should mean



2. Wild-capture fisheries

Wild-capture fisheries employ numerous methods in their operations. The main techniques, together with the associated welfare concerns are summarised below[27]. The categories used here are those required by EU regulations on the labels of wild fish products sold in Europe.

Seines

Seining uses a long net (up to 1km in length) dropped to surround a school of fish. The net is then drawn together with the fish held inside. Welfare concerns for seining are injury and stress to fish as they try to escape the net, and stress or death as the net is drawn in and the volume of bodies in a small space increases. Fish may then be injured as they are brought on deck, suffering stress, abrasions and scale loss. Fish captured using this technique are likely to be killed by asphyxiation or gutted alive.

Trawls

Trawling involves dropping a net (all the way to the seabed in the case of dredges) and dragging it along, sometimes for hours. Fish and other animals who find themselves in the trawler net's path attempt to 'outrun' the net but eventually succumb to exhaustion, at which stage they are enveloped by the net and captured. Those captured early in the trawling session may thus spend hours being dragged along, increasingly crushed by the bodies of other unfortunate animals caught. Some fish will die of suffocation while still underwater, as the crowd of bodies prevents them from opening their gills to breathe. Others die from circulatory failure as the pressure stops their blood circulation. Many more die from decompression when the net is brought from depths onto the ship. Those who are alive when the net is hauled to the surface may die from suffocation on the deck of the ship or, if they survive long enough, are gutted alive.

Gill nets (and similar nets)

Gill nets are effectively marine snares, with the nets hung in the water and invisible to fish. When a fish swims into a net, their gills become caught and they are unable to free themselves. Tangle and trammel nets serve a similar function but rely on the body of the fish becoming entangled, rather than the gills specifically. Fish may be left for hours or days before they are hauled up to the ship, where they are removed from the net by hand and slaughtered. Gill nets not only cause stress and injury to the fish, but also leave trapped fish vulnerable to predators and pose a risk to other 'non-target' animals, who may also be ensnared.

Hooks and lines

Hook and line fishing takes a number of forms, from a single fish being caught on a rod to 'long-lining', where lines hooked at intervals are spread along huge lengths of ocean (often between 50-100km in length). Variations on hook and line fishing include 'trolling', where hooks and lines on multiple rods are attached to a ship and dragged through the water to lure fish.

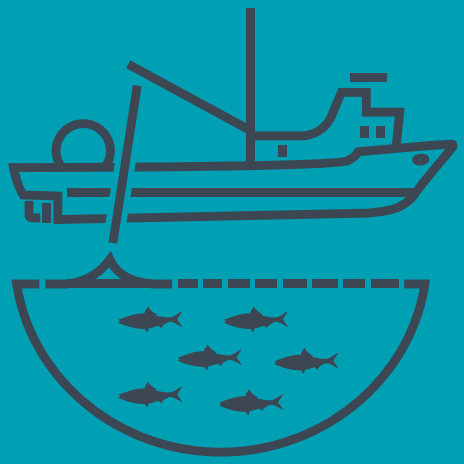
The primary welfare concern in hook and line fishing is the injury, pain and stress to the fish caused by being pierced through the face with a metal hook and subsequently dragged by that hook, resulting in an alarm response and struggle[28]. This is of particular concern in long-line fishing, where lines may be left for hours or even days until the fishing gear is hauled in. This can result in further injury to the fish, which continue to struggle to the point of exhaustion, as well as leaving them vulnerable to attacks by predators.

An associated welfare issue with long-line fishing is the accidental capture of 'non-target' marine animals or sea birds, such as albatross, who may be injured or drown as a result of being caught on the lines after being drawn by the bait or the fish already hooked. Finally, some line fishing employs live bait, either with hooks baited with live bait or the use of a technique called 'chumming', which involves throwing live bait overboard to attract fish during line and pole fishing. The use of live animals as bait increases the negative welfare impact significantly, as many small fish are captured in shallow water, kept captive in small containers, and then released into unfamiliar open waters teeming with predators.

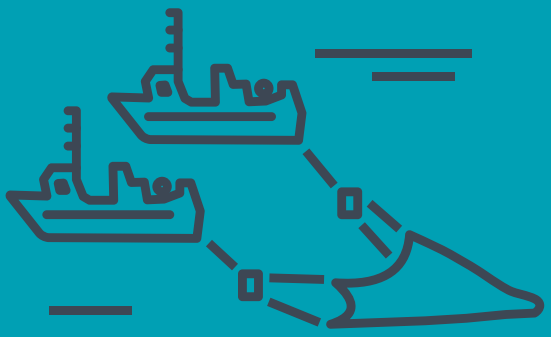
Traps

Trapping is a technique where fish are trapped when they swim into baited cages. Theoretically, this technique does not physically injure the fish, although fish may be attacked by a predator when entering the cage, or may become stressed when predators subsequently approach the trap and they cannot escape.

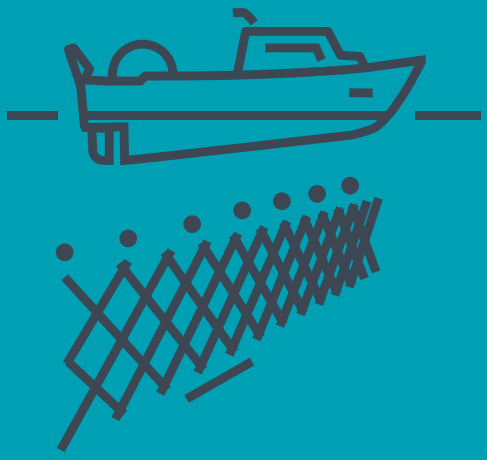
[27] These categories have been taken from the European Union guidance on fish and aquaculture labelling.
[28] Mood, A. (2010). 'Worse things happen at sea: the welfare of wild-caught fish', Fishcount., p. 44



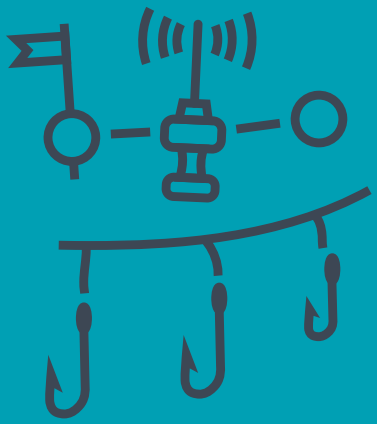
Seine



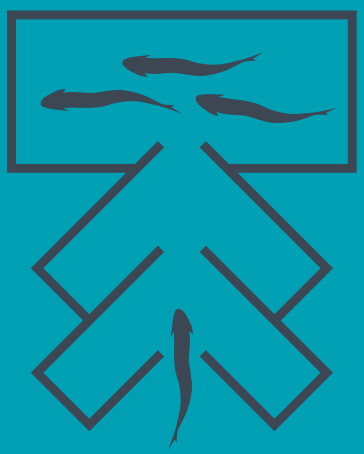
Trawl



Gill net



Long line



Trap

'Fish welfare is not something that is apart or unique; it is something that a good farmer takes care of anyway because proper welfare for animals, including fish, means basically that they get less trouble in the farming process.'

Michiel Fransen,
Head of Standards & Science,
Aquaculture Stewardship Council

3. Size and scope of European aquaculture

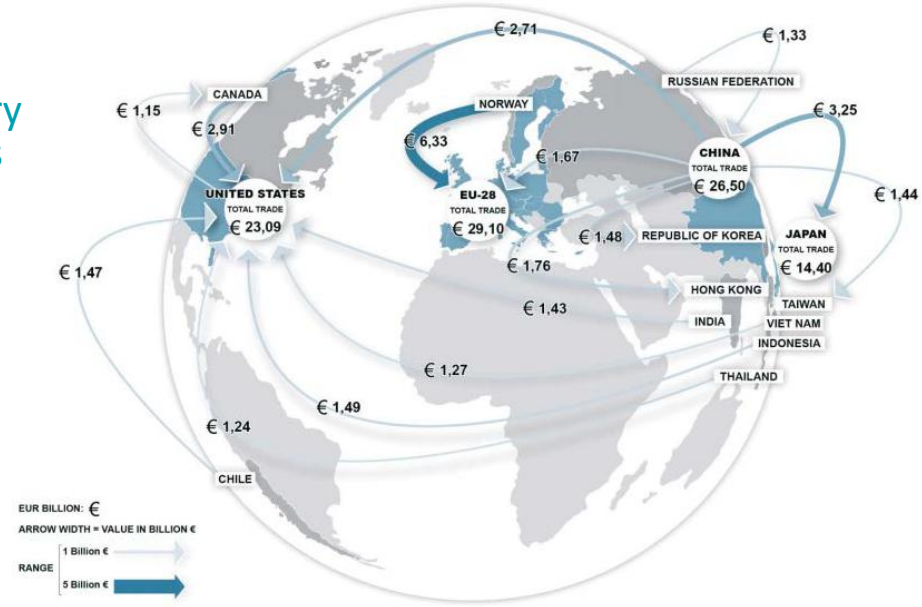
In aquaculture, fish are raised in captivity for most or all of their life. Farmed fish make up 26% of all fish consumed in the EU[29] and 44% globally[30]. According to statistics from the Food and Agriculture Organization of the United Nations (FAO), several hundred species of fish are farmed for food. Production is greatest in Asia, including in China whose carp farming sector produces more farmed fish than the rest of the world's aquaculture combined.

World capture fisheries production has remained relatively static since the late 1980s. Aquaculture, by contrast, has grown substantially and, in 2014, produced 73.8 million tonnes of fish, with an estimated value of USD 160.2 billion (EUR 135 billion)[31]. According to the FAO, fish farming production increased 5.8% each year in the decade to 2014[32]. Estimates suggest that by 2030 more than 60% of fish for human consumption will come from aquaculture. China has played a major role in this growth, as it represents more than 60% of world aquaculture production[33]. Indonesia, India, Vietnam, the Philippines and Bangladesh follow China as the next top producers of farmed fish. Indeed, China, India, Vietnam and Bangladesh are among 35 countries in the world which produce more farmed fish than they capture from the wild[34].

[29] EUMOFA. (2017b). The EU Fish Market 2017.
[30] FAO. (2016). The State of World Fisheries and Aquaculture, p.191.
[31] FAO. (2016). The State of World Fisheries and Aquaculture, p.17.
[32] Ibid., p. 34.
[33] Ibid., p.14.
[34] Ibid., p.29.

Main trade flows of fishery and aquaculture products in the world (2016)

Source: EUROSTAT (for EU trade flows) and GTA (for bilateral trade between extra-EU contries)

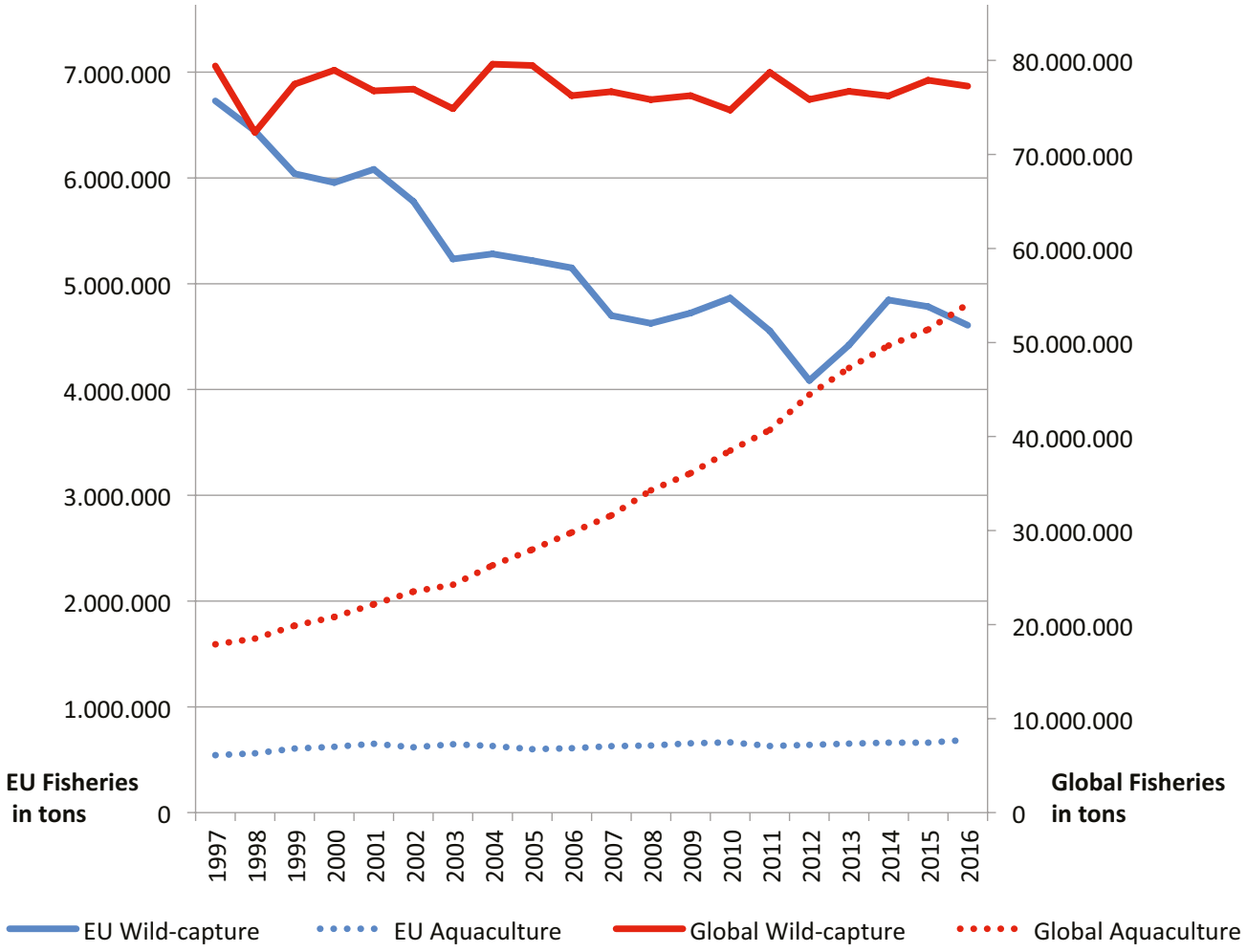


EU farmed fish production 2014[35]

FAO species category	Production (t)	Estimated numbers lower (millions)	Estimated numbers upper (millions)
Rainbow trout	194.080	39	924[36]
Atlantic salmon	175.090	21	48
Gilthead sea bream	85.483	213	284
Common carp	70.937	28	141
European sea bass	63.965	128	159
Turbot	11.849	5	17
North African catfish	4.986	3	10
European eel	4.570	3	12

[35] Estimates provided by Fishcount, (unpublished), 2016.
[36] The large range of estimated numbers for rainbow trout is based on the fact that in some markets they are harvested at portion size (a few hundred grams) and in others as large fish of several kilos. The true number will fall somewhere in between.

EU and Global Fisheries and Finfish aquaculture production in the last 20 years

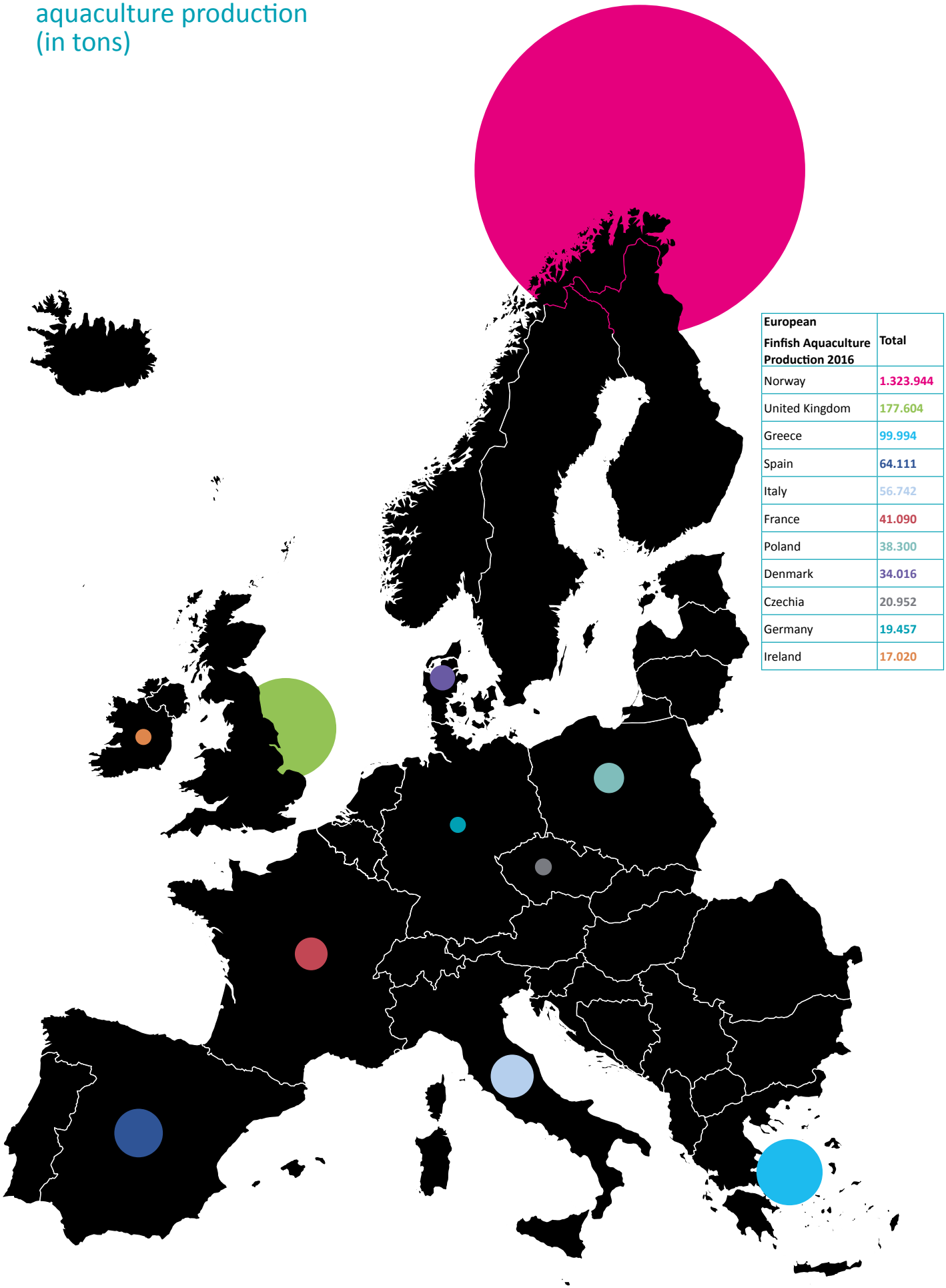


Source: FAO (2017) FishStat Plus

European Aquaculture Production 2016

Country	Species	Tonnes
Austria	Total 17 species	3.483
	Rainbow trout	1.220
Belgium	Total unspecified species	44
Bulgaria	Total 30 species	11.770
	Rainbow trout	4.667
	Common carp	3.174
Croatia	Total 17 species	15.042
	European seabass	5.310
	Gilthead seabream	4.101
Cyprus	Total 7 species	6.600
	Gilthead seabream	5.039
	European seabass	1.517
Czechia	Total 14 species	20.952
	Common carp	18.354
Denmark	Total 9 species	34.016
	Rainbow trout	31.087
Estonia	Total 4 species	867
	Rainbow trout	680
	3 other species	187
Finland	Total 4 species	14.412
	Rainbow trout	13.376
France	Total 17 species	41.090
	Rainbow trout	26.100
Germany	Total 13 species	19.457
	Rainbow trout	8.640
	Common carp	5.238
Greece	Total 14 species	99.994
	Gilthead seabream	49.265
	European seabass	42.557
Hungary	Total 12 species	16.248
	Common carp	10.036
Iceland	Total 5 species	15.061
	Atlantic salmon	8.420
Ireland	Total 3 species	17.020
	Atlantic salmon	16.300
Italy	Total 27 species	56.742
	Rainbow trout	35.000
	Gilthead seabream	7.600
	European seabass	6.800
Latvia	Total 18 species	788
	Common carp	569
Lithuania	Total 13 species	4.393
	Common carp	3.474
	Rainbow trout	332
Malta	Total 4 species	6.073
	Atlantic bluefin tuna	3.709
	Gilthead seabream	2.221
Netherlands	Total 8 species	5.690
	North African catfish	2.900
	European eel	2.300
Norway	Total 7 species	1.323.944
	Atlantic salmon	1.233.619
	Rainbow trout	87.775
Poland	Total 12 species	38.300
	Common carp	18.549
	Rainbow trout	14.415
Portugal	Total 13 species	4.851
	Turbot	2.388
	Gilthead seabream	1.162
Romania	Total 20 species	12.548
	Common carp	4.841
	Other carp	4.485
Slovakia	Total 14 species	2.169
	Rainbow trout	1.115
Slovenia	Total 6 species	1.232
	Rainbow trout	833
Spain	Total 20 species	64.111
	European seabass	22.956
	Rainbow trout	17.354
	Gilthead seabream	12.397
Sweden	Total 5 species	13.429
	Rainbow trout	11.547
United Kingdom	Total 17 species	177.604
	Atlantic salmon	163.135
	Rainbow trout	13.851

2016 European top ten aquaculture production (in tons)



European Finfish Aquaculture Production 2016	Total
Norway	1.323.944
United Kingdom	177.604
Greece	99.994
Spain	64.111
Italy	56.742
France	41.090
Poland	38.300
Denmark	34.016
Czechia	20.952
Germany	19.457
Ireland	17.020

Fish hatchery

Salmon hatchery

4. Fish welfare in European aquaculture

This section describes the major welfare concerns relating to fish farming at each stage of the farming process. These processes differ depending on the location of the fish farm, whether it is intensive, semi-intensive or extensive, and the species of fish being farmed. The specific processes and welfare concerns associated with fish farming will now be described.

Given that fish welfare has been ignored or even denied until very recently, detailed scientific research on aspects of welfare during fish farming is limited. The information below has been taken from existing scientific evidence and expert opinion. In practice, however, welfare issues are likely to be more numerous than those already identified.

4.1 Rearing systems

4.1.1 Types of hatchery systems and processes

As the name suggests, hatcheries are the part of the process in which eggs are harvested and raised from egg through to juvenile fish. This period differs depending on species and individual growth. Fish are then transferred to a 'growing on' system, where they remain until they are slaughtered (or transported to slaughter).

The following presents a broad overview of hatchery systems, based on information available on the most commonly farmed species in Europe (salmon, trout, sea bream, carp and sea bass).

Broodstock

The term 'broodstock' refers to the mature fish used to provide the eggs for the farm. These fish may be wildcaught, as is the case with sea bass and sea bream, or taken from the population of fish bred at the farm itself (after an initial broodstock has been established). Sea bass and sea bream taken from the wild to become broodstock are highly stressed by their removal from their natural habitat and, as a result, have a six-month recovery period before being used for breeding37. The aquaculture industry generally prefers wild-caught broodstock in order to maintain genetic diversity.

Egg collection/stripping

The eggs are collected from broodstock by taking the fish out of water and pushing the eggs out. This is normally done by hand. For some species, including sturgeon, eggs can only be removed by surgical procedure.

Incubation

Bucket, silo and tank containers with a capacity of between 5 and 200 litres can be used to incubate eggs. Water is circulated around the eggs, and dead or non-viable eggs are removed to prevent contamination and fungal infection. Tank design, water temperature, salinity, water flow and other parameters will differ, depending on the species and whether the fish eggs are marine or freshwater.

Basket incubators are alternatives to bucket or silo systems. These are comprised of shallow trays or baskets, stacked in a tier system. Cascading water is used to keep water circulating around the eggs.

Hatching trays/troughs

Hatching trays are shallow trays with (either fresh or salt) water flowing through them. Eggs are transferred into baskets with perforated sides and placed in the trays. The hatching trays are kept indoors and away from direct sunlight. Once hatched, the fry (juvenile fish) will move through the perforation and onto the substrate in the hatching tray.

First feed tanks

First feed tanks are where the newly hatched fry become accustomed to feeding (usually commercial dry fish food). Prior to this stage, the fry are reliant on the remains of the egg sac from which they hatched. First feed tanks will vary in size and design, depending on the species. Light may be used to encourage faster development, much in the same way that artificial light is used in factory farming of chickens to encourage laying and moult activities.

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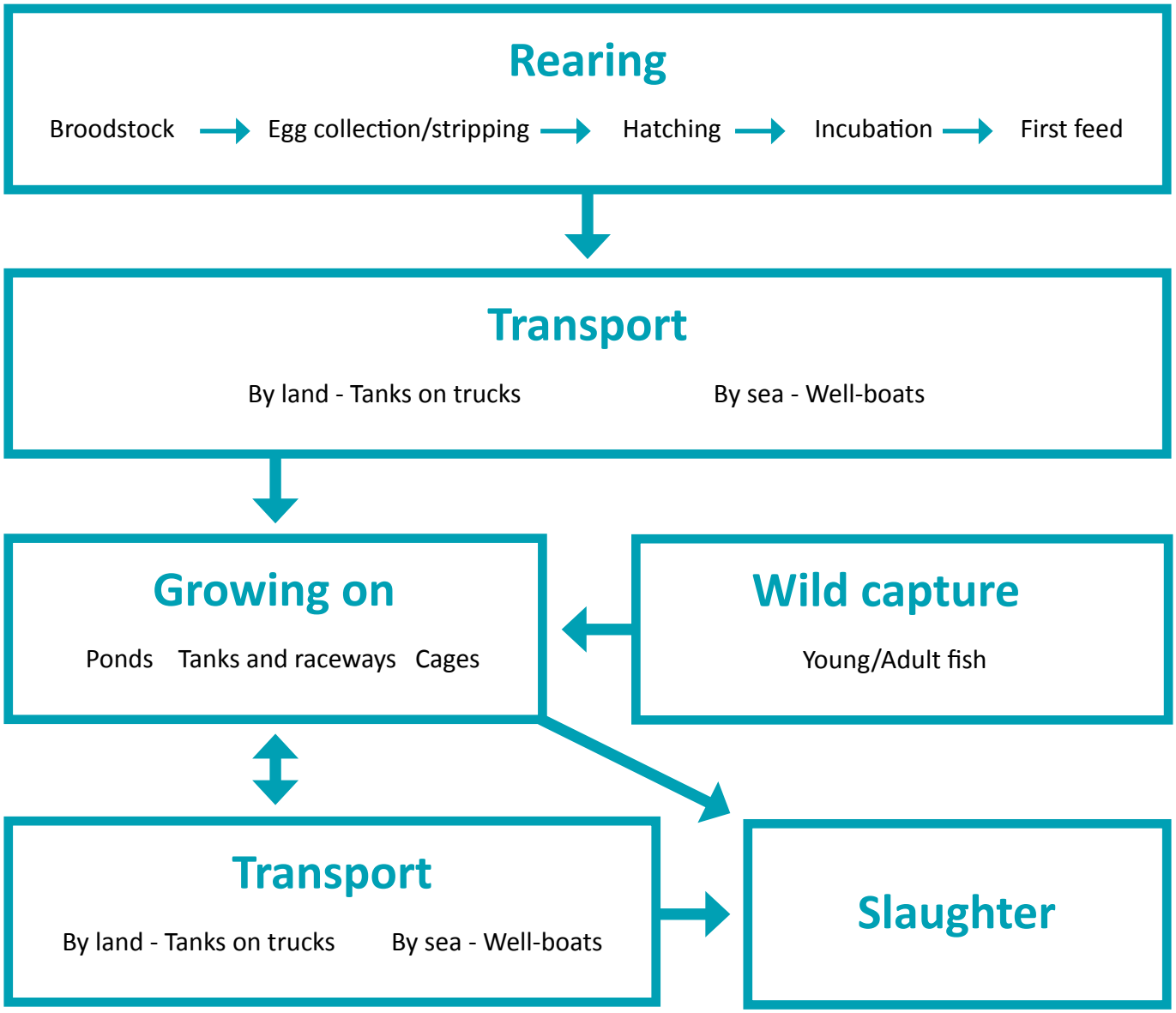
[37] EFSA. (2008c). Animal welfare aspects of husbandry systems for farmed European sea bass and gilthead sea bream, p.37.

The aquaculture journey of a fish



4.1.2 Welfare concerns in rearing

Hatchery stages

There are significant welfare concerns for the broodfish at the hatchery stage. For instance, broodfish are usually kept captive for much longer periods than other fish used in aquaculture, and are likely to be subjected to handling and treatments (e.g. hormone treatment and light manipulation to bring on ovulation) throughout their lives. Perhaps one of the greatest welfare issues for broodfish is the process of 'stripping'.

'Stripping' fish is one of the hatchery-stage processes by which eggs are extracted from the female broodfish and seminal fluid (known as 'milt') is extracted from the male. This process requires the fish to be manually handled, as the eggs and seminal fluid are, literally, squeezed from their bodies and combined to encourage fertilisation.

Prior to stripping, the farmer will check whether the female fish is close to ovulation. This may be done by sight, manual handling or by taking a sample via the insertion of a catheter into the fish's genital opening. During ovulation, the fish is taken from the water and pressure applied to her abdomen to release the eggs into a dry bowl. In some cases, such as the sturgeon, the anatomy of the female fish does not lend itself to this process and so the fish will be anaesthetised and the eggs surgically removed. In many cases, the female will then be euthanised[38].

The process of extracting the milt from the males is similar to that used with females. The males will be taken from the water, wiped down to prevent the eggs getting wet and held over the egg pan. The fish's abdomen will be massaged to trigger the release of the seminal fluid, which will then be spread over the eggs.

Some fish farming allows fish to spawn in a more natural manner, with males and females being kept in the same 'spawning tank' and the males fertilising the female's eggs directly as they would in the wild. This method is not free from stressful handling processes, however, as both male and female are injected with hormones to regulate the timing of the spawning. Fish subjected to stripping are also injected so that the farmer can control timing and ensure the best yield.

All stages of the stripping and spawning processes raise major welfare concerns for the fish, with risks of stress or injury at all stages of the process.

In addition to welfare concerns for broodfish, there are also implications for the juvenile fish at the early stage of the farming process, as negative management at this stage can have a significant impact on future health and welfare of the fish. For example, stress in the mother can be passed to the eggs and juveniles[39], which has been shown to manifest as poor immunity to disease in later life[40].

The later hatchery stage and the growing on period presents welfare concerns across a large number of areas. These are highlighted in broad terms below.

[38] Rottman, R., Shireman, J. & Chapman, F. (1991). Techniques for Taking and Fertilising the Spawn of Fish. SRAC Publications. [online] Southern Regional Aquaculture Center. Available at: http://agrilifecdn.tamu.edu/fisheries/files/2013/09/SRAC-Publication-No.-426-Techniques-for-Taking-and-Fertilizing-the-Spawn-of-Fish.pdf [accessed 8 May 2018].

[39] For example, McCormick, M. (1999). Experimental test of the effect of maternal hormones on larval quality of a coral reef fish. Oecologia, 118(4), pp.412-422; Sopinka, N., Hinch, S., Middleton, C., Hills, J. & Patterson, D. (2014). Mother knows best, even when stressed? Effects of maternal exposure to a stressor on offspring performance at different life stages in a wild semelparous fish. Oecologia, 175(2), pp.493-500.

[40] Auperin, B. & Geslin, M. (2008). Plasma cortisol response to stress in juvenile rainbow trout is influenced by their life history during early development and by egg cortisol content. General and Comparative Endocrinology, 158(3), pp.234-239.

4.2 Growing on systems

4.2.1 Types of growing on systems and processes

After the hatchery stage, fish are transported to the 'growing on' stage. Growing on systems will differ depending on the species and geography and may comprise multiple stages. For example, the growing on system for salmon has various stages, as salmon 'smoltify' after hatching, i.e. they go through a series of physiological adaptations to be able to move from fresh-water to salt water. This must be accommodated in the farming process (and, in itself, may present welfare problems). Examples of different growing on systems are described below.

Ponds

Ponds are man-made water bodies widely used in aquaculture. In extensive and semi-intensive systems, ponds have lower stocking densities and natural feeds occurring in the water. In intensive systems, stocking densities are high, all feed must be provided to the fish, and the pond may be lined with plastic or another material.

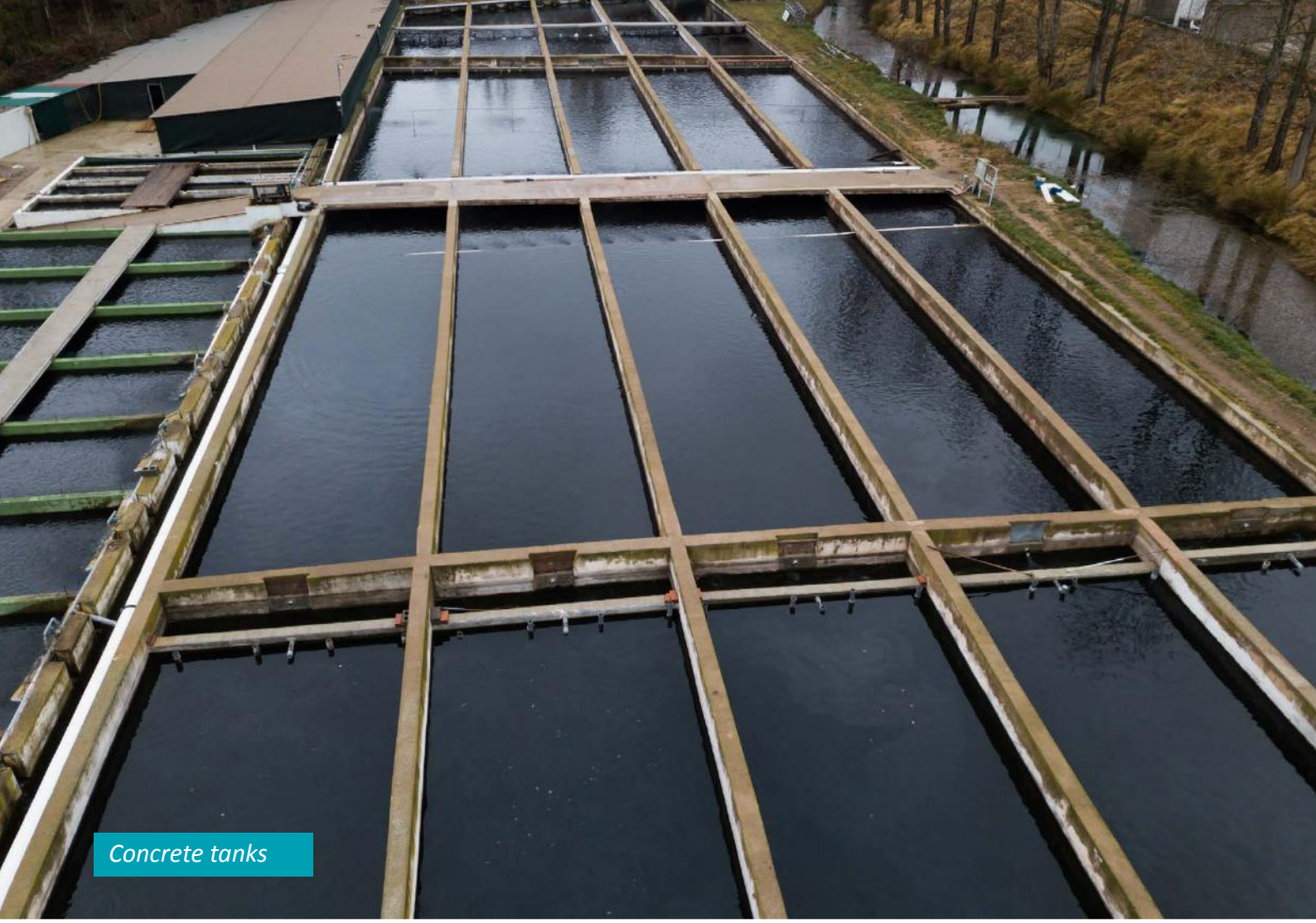
Pond culture is used in semi-intensive sea bream fish farming, with various parameters managed carefully (e.g. water inlet and outlet, vegetation and food availability). Ponds were traditionally used to farm a number of species (such as sea bream and trout) but have become less common as new technologies have been developed. Traditionally, trout have been farmed using interconnected pond systems with water flowing through them.

Pond culture continues to dominate carp aquaculture in Europe, where extensive production systems using earth ponds and an element of natural feeds constitute the most natural, and probably the most innately high welfare, aquaculture system.

Tanks and raceways

Tanks and raceways are concrete or earth constructions used to farm fish on land. Using water flow-through or recirculation (see below), these systems are used in intensive fish farming with high stocking densities.

Recirculation systems can be used at either the hatchery or the growing on stage but are more expensive at the latter stage, due to the large amount of water required. Once operating, recirculation is a largely closed system, although it does require topping up with small amounts of clean water periodically. The system treats and cleans the water in order to recycle it continuously through the system. This is a far more complex and expensive process than the flow-through water and cage systems, which do not include elements of water treatment and recycling.



Concrete tanks

Rainbow trout in raceway

It has been argued that recirculation systems may be better for fish welfare and the environment than flow-through or cage farming because of the degree of control that the farmer can have over the system, as well as the lack of discharge into the local environment. However, the environment in a recirculation system is typically extremely barren and so far removed from their natural home that fish farmed in recirculation systems may not be classified as 'organic'.

Cages

Species such as salmon, trout, sea bream and sea bass can be kept in sea cages during the growing on stage. Sea cages have floating frames from which closed-bottom nets are hung to house the fish. The cages are fixed, to prevent them moving with tidal changes, and can be up to 160 metres in diameter. Depending on the location and specific system used, the net can extend to a depth of between 5 and 50 metres. 'Anti-fouling' cage chemicals might be used to treat the water in some cases. These are pesticides and require prior agreement from the relevant authorities before they can be employed[41]. Predator nets are often employed to prevent the fish from being attacked and eaten. These are placed around and under the cages at a suitable distance from the fish.

Specific welfare issues relating to cages include concerns about keeping fish captive in a space much smaller than their teritorry or range in the wild, and restrictions on the behaviour of bottom dwelling fish, such as turbot, which are unable to engage in this behaviour in a cage system.

[41] Ibid., p.43.

4.2.2 Welfare concerns in the growing on phase

Poor water quality

Lack of oxygen, excess carbon dioxide, excess ammonia, wrong salinity levels, wrong temperatures and high or low pH can all cause illness and high mortality rates in fish farms. Their impact otherwise on the quality of life of fish remains difficult to understand or measure.

Diseases and parasites

Diseases and parasites impact fish similarly to humans and other animals. Their susceptibility to disease is greatly increased by stress, which reduces their immune performance significantly and often reduces their appetite. Treatments for diseases and parasites can also affect welfare. This may include stressful overcrowding, or involve the use of chemicals (for example, hydrogen peroxide), pesticides or heat treatment. Parasites such as sea lice in salmon farming spread easily to wild populations, causing mortalities and other welfare issues.

Some alternative treatments for parasites are considered to be somewhat kinder to the fish affected, although these, too, carry inherent welfare problems. For example, using wrasse and lumpfish as cleaners uses their natural behavior to 'clean' parasites from the skin of salmon. This spares the salmon the stressful and potentially injurious need to be treated for parasites but also brings the wrasse and lumpfish into captivity, which is likely to impact their welfare, and normally results in an early death for the cleaner fish in the salmon cage or at harvest.

High stocking densities

High stocking densities can lead to aggression between fish and result in injury. It also encourages disease spread (both within the farm and, possibly, in the local environment) while the resulting stress further lowers resistance to disease. Highdensity stocking affects all aspects of water quality which, in turn, may impact upon the local environment and prevent fish from performing the behaviours that would be natural in the wild. Interestingly, it is not just high stocking density that can threaten fish welfare. Research has shown that low stocking densities can also cause problems, including increased aggression. This issue has not been noted in European aquaculture systems but serves to indicate the complexities in meeting fishes' needs.

Handling

In addition to the stripping process described above, fish in farms are handled at different stages of the process, causing stress and injury. Fish may be taken out of water for handling or grading, or to administer vaccinations. Grading (i.e. sorting fish according to size) may require handling, and occur numerous times for each individual fish.

Moving fish for grading, medical treatments or at harvest often involves crowding them to a very high density. They are then either lifted in a net or pumped in water. Pumping is considered less stressful but requires specialist equipment to minimise the risk of injury. Fish may also be transported at various stages of the aquaculture process.

When the time comes for fish to be taken for sale, vacuum pumps are used to transfer marketable salmon and trout between cages, tanks, and vehicles. Fish are sucked, in water, into a pipe and up to a pump chamber before compressed air pushes them out of the chamber into a new pipe. Pumps are used to transfer fry and fingerlings. Such pumping systems are believed to be better for fish welfare than dry netting them in large batches.

Predators

On a fish farm, fish are likely to be at such density that they present a great attraction to predators such as birds, otters and seals. In addition, their enclosure likely leaves them unable to hide or escape, causing stress if not their depredation. There are further welfare issues for the predators, who may be killed by farmers in order to protect the fish stock, or they may be caught in 'anti-predator' nets, causing injury or death.

Ability to perform natural behaviours

Fish farms restrict many, if not most, natural fish behaviours. Preventing fish from foraging, migrating, hunting, mating, rearing young and developing social bonds is likely to have a significant impact on their welfare.

Tuna fattening

From the wild to the farm – capture-based aquaculture

Some species of fish are not raised from eggs in fish farms but are captured in the wild and placed directly into a growing on system. Examples of this practice are outlined below.

Wild-caught European eels

Eels are unusual in aquaculture as they cannot be raised from eggs in captivity and, thus, juveniles (glass eels) are captured in the wild and put straight into a 'growing on' system. Aside from the welfare problems associated with wild capture (see earlier sections of this report), this removes the juvenile populations of eels before they have reached sexual maturity (between 6 and 16 years of age, depending on factors such as water temperature[42]), thus before they contribute to population growth.

As recently as 30 years ago, European eels were abundant. Since 2014, however, the European eel has been classified as Critically Endangered[43], partly due to overfishing.

Tuna ranching

Smaller tuna are captured in the wild and transferred to cages where they are grown on for several months, primarily to increase their fat content or size.

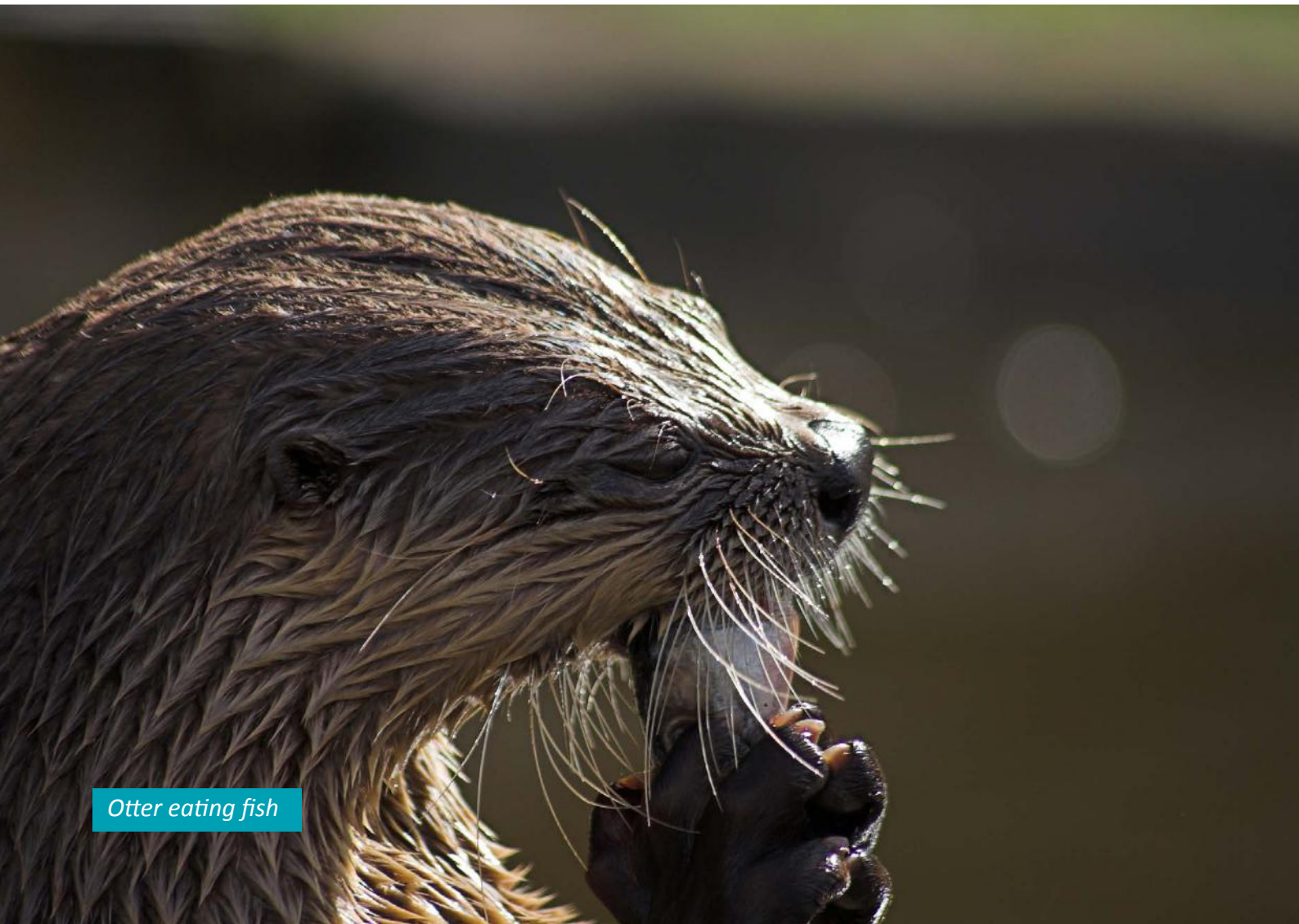
This practice has various welfare implications, including the fact that tuna, normally predators with a large home range, are, in aquaculture, held captive in a very small area. The slaughter of tuna is carried out in situ meaning that other tuna are in the same cage while the killing is carried out. This likely causes stress and fear in those tuna that witness slaughter of their conspecifics. Finally, due to the sheer amount of food a tuna must consume to reach the desired condition, huge numbers of fish must be captured in order to feed them. For each kg of weight gain in these tuna, between 15 and 40 kg of feed (normally fish flesh) is given[44].

Cod hotels

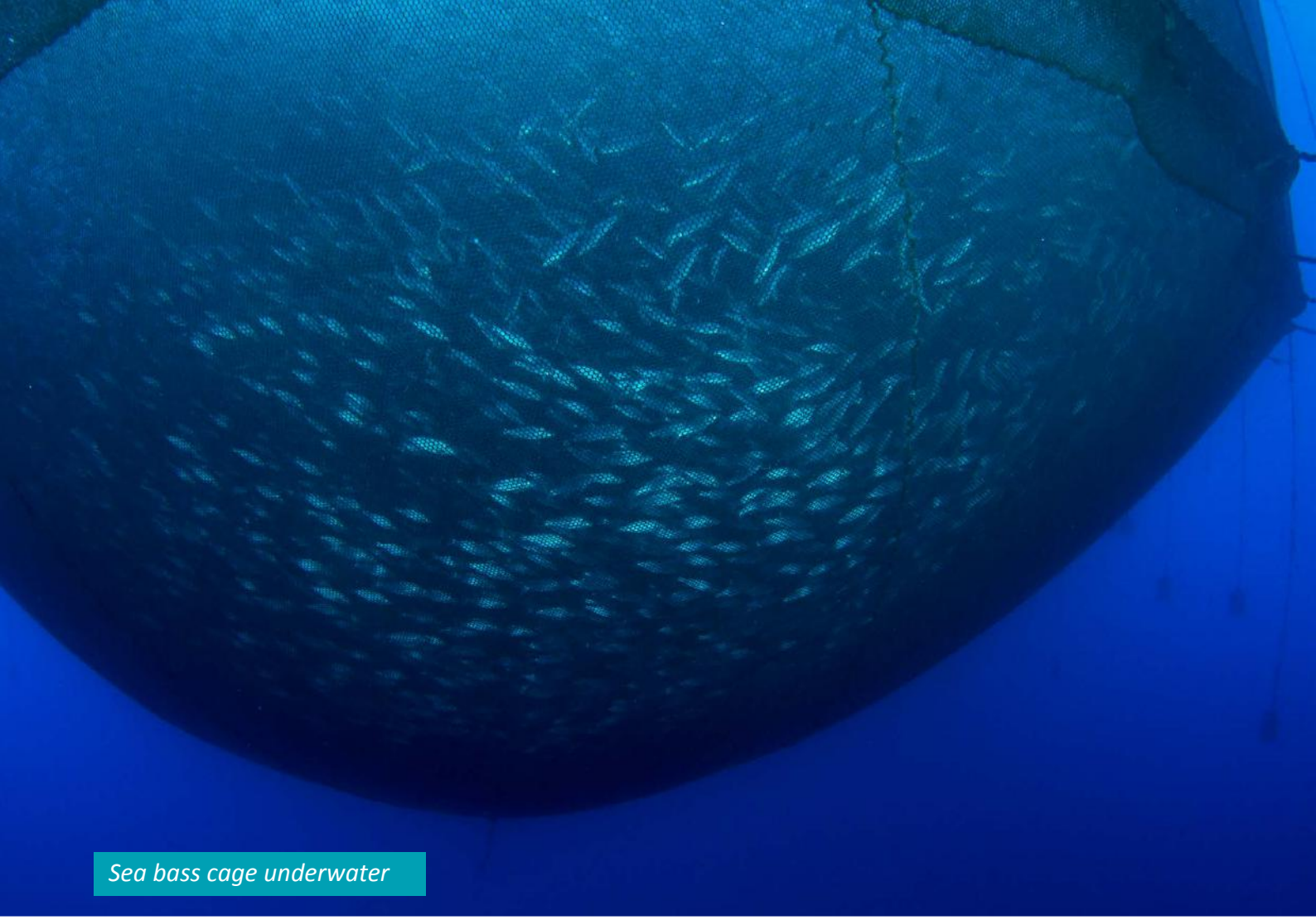
Mature cod are captured and held in cages for a period of weeks or months while farmers wait for prices to rise in the market so that they can be sold for the highest profit. This practice has been made possible only recently by the provision of appropriately shaped cages to house the cod. It remains somewhat experimental, however, with many associated instances of mass mortalities[45].

[42] Kirkegaard, E. (2010). European Eel and Aquaculture. DTU Aqua Report. National Institute of Aquatic Resources.
[43] IUCN Redlist Anguilla Anguilla.
[44] See: http://www.fao.org/fishery/culturedspecies/Thunnus_thynnus/en
[45] See: https://nofima.no/en/forskningsomrade/capture-based-aquaculture/?lang=en

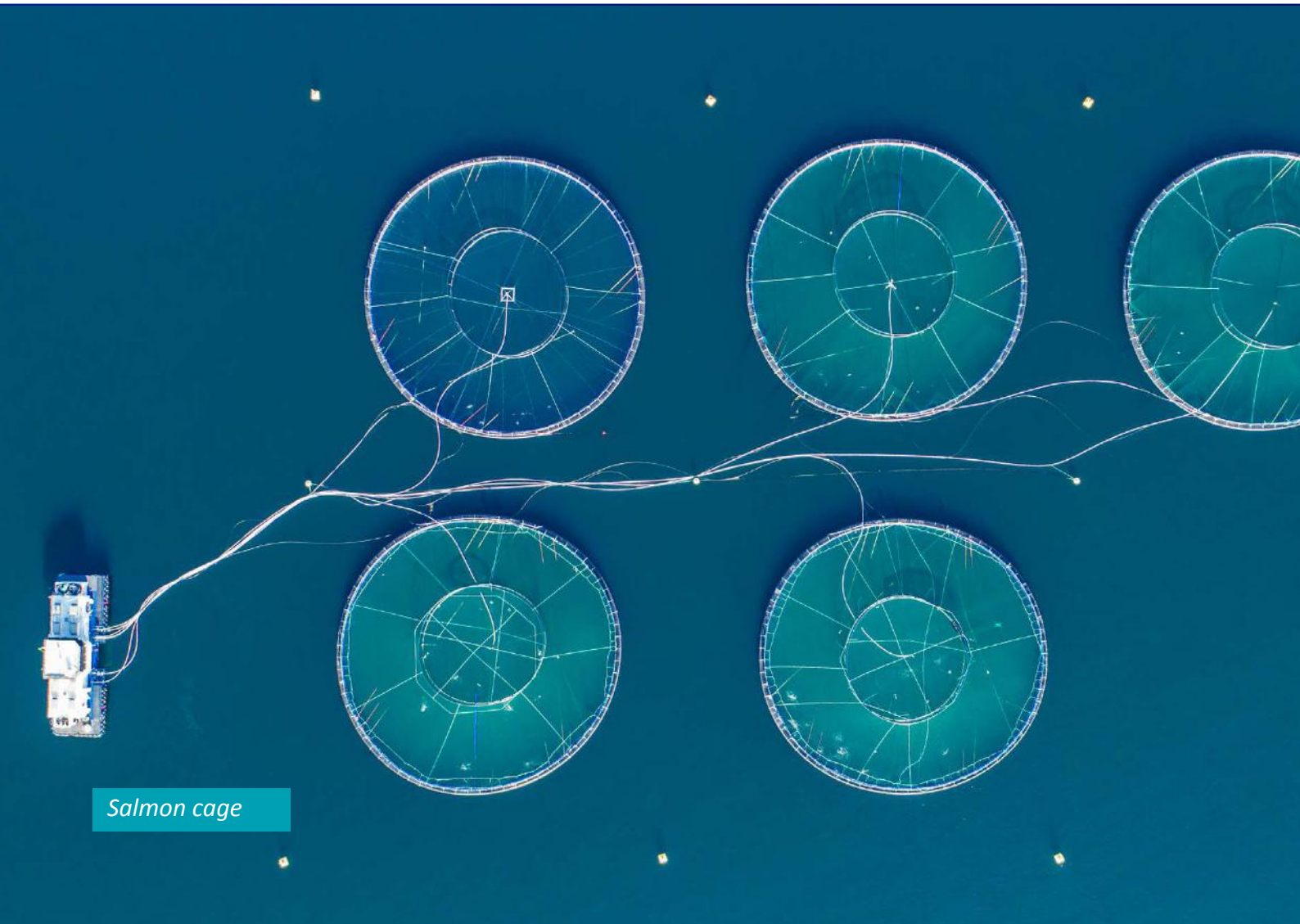
Handling: Sorting juvenile sea bream
(N.B. fish on their side is normally a sign of physiological problems, often resulting from poor breeding programmes)



Otter eating fish



Sea bass cage underwater



Salmon cage

4.3 Transport

4.3.1 Transport systems and processes

Transport beyond the farm is normally juveniles being brought to a growing on farm, mature fish to a new growing on farm, or marketable fish to a slaughter and processing facility. The processes involved in these stages are outlined briefly below, with a summary of the core welfare concerns relating to the transport of farmed fish.

Depending on their geographical location, countries use different methods and combinations of transport. For example, in the UK and Ireland, trucks deliver juvenile salmon (smolts) to a well-boat (see below), while in Spain they deliver juvenile sea bass and sea bream to well-boats. In Greece, Spain and Italy, trucks transport juveniles (fry/fingerling and juveniles) to container ferries. In Denmark, France, Italy and Poland, marketable rainbow trout are transported by truck to a slaughterhouse. In Germany, Poland and Czech Republic, marketable carp are transported by truck to a slaughterhouse or to retailers for live sale.

Transport practices include preparation of the fish for transport, crowding at the farm, loading the vehicle, monitoring during transport, and unloading at a slaughter or growing on facility. Methods and common transport practices can be broadly summarised as follows:

Road transport

Normally for overland transport, tanks are mounted on a truck. These tanks are usually fibreglass, with a sealable hatch and a valve/pipe discharge point. Sensors measure the temperature and oxygen levels in the water and are monitored from the cab of the vehicle. Water in the tank is oxygenated or aerated to control the levels of oxygen in the water and may be refreshed, depending on the length of the journey. Tanks used for road transport are always closed systems.

Sea transport

Well-boats are boats or ships which have built-in tanks to transport fish. They may either be open systems with a single pass flow-through system, or closed systems. The choice of an open or closed system depends on whether or not there are bio-security issues associated with the fish itself, local regulations, or risks of contamination with fish pathogens along the transport route.

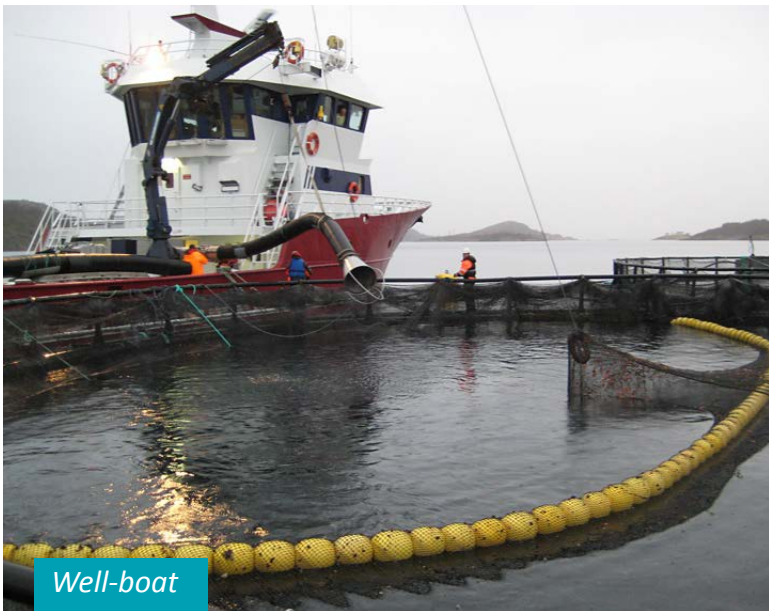
Well-boats are used in Norway, the UK and Ireland for smolts and marketable salmon, and in Greece, Spain and Italy to transfer juvenile sea bass and sea bream to grow on cages.

4.3.2 Welfare concerns in the transport phase

Transport can cause stress and impair welfare through changes in stocking density, handling, water movement, noise and vibrations, and poor water quality.
The overriding factor in density is the maintenance of water quality throughout the journey. Different fish species have varying requirements regarding oxygen, pH, salinity and temperature, and they cope differently with variance in these parameters. In a closed system, carbon dioxide and ammonia (both excreted by fish) increase during transport. Oxygen needs to be administered to avoid hypoxia.

Exposure to these types of stressors, simultaneously or in rapid succession, may induce severe physiological stress. Such stress should be minimised as it may result in a higher metabolic rate and induce shedding of mucus by the fish, leading to a deterioration of the quality of the water and, in particular, increased ammonia and CO^2 levels.
Poorly-managed loading or unloading, in addition to crowding of fish, may also lead to severe injuries, increase aggression or result in higher mortalities. The process of transport may itself create pain and fear in fish. It is not possible to give an exact limit for the maximum transportation time in a closed system, as this depends on fish species, density, temperature and water treatment in the transport unit. Close monitoring of the fish and their environment is required.

Where netting is used as part of the transport stage additional risk is created, as it exposes fish to air and crushing pressure from the volume of conspecifics in the net.



Well-boat

Atlantic salmon on ice

4.4 Slaughter

4.4.1 Practices and techniques

Slaughter activities for fish include handling for transfer to equipment for stunning and slaughter (e.g. crowding, pumping, time out of water, holding in tanks/pens), stunning and slaughter.

Stunning methods

Electrical stunning

Fish may only be stunned by the use of electricity but not killed, so an electrical stun must be immediately followed by an effective killing method. When a stun does not immediately kill, it can be painful and cause suffering. Mis-stuns may occur due to size and weight variations between fish, as well as the position of fish in relation to the stunning device when the current is discharged.

Electrical stunning in water

This method is used for smaller fish such as rainbow trout and carp, and involves fish being exposed to an electrical field. For trout, the field is created by using two plate electrodes in a water tank, or ring or plate electrodes in a pipe through which water is pumped. For carp, two plate electrodes cover the whole area of two opposite walls of the tank or two rod electrodes are mounted on a manual device and inserted into the water to administer the stun.

Electrical stunning out of water

This process is used for Atlantic salmon in Norway. The fish are placed in a device (for example, a conveyor belt) which acts as the negative electrode, with steel flaps suspended above, which the fish come into contact with as they pass under. The rows of steel flaps act as the positive electrodes. A waveform consisting of a combination of a direct and alternating electrical current results in a very low incidence of injuries[46]. The fish must be oriented head-first for the stun to be immediate and they must not be exposed to pre-shocks.

Exposing the fish to air during electrical stunning out of water may be more stressful than the electrical stunning itself.

Percussion

Percussion refers to the use of blunt force to render a fish unconscious prior to slaughter. It cannot be utilised effectively with all fish species, but is used for larger fish including Atlantic salmon, rainbow trout and carp.

For Atlantic salmon, fish are removed from water before an automatic device, using a non-penetrating bolt driven by air pressure, renders them unconscious. Swim-in percussive stunners, for which the salmon do not have to be dewatered prior to entering the stunner, have been developed but are not yet widely used. Stunning should be immediately followed by decapitation or percussion as a killing method. For carp and rainbow trout, a blow or repeated blows to the head are delivered with a priest (a handheld club).

It is vital that experienced personnel administer manual percussive stunning, as a blow to the head is painful when incorrectly applied and does not result in an immediate stun. Manual percussive stunning must be carried out by trained personnel. Automated stunners should be adjusted by experienced staff according to the size of the fish. Percussed Atlantic salmon can die of cerebral haemorrhage, meaning that percussion is an irreversible stunning method. High air pressure can result in carcass damage, which creates an economic issue for famers who wish to sell fish intact. The main hazard for automated stunning is a mis-stun caused by variation in the size of fish.

In addition to serious welfare concerns linked to the failure to properly stun fish before slaughter, using effective stunning methods brings quality improvements to the consumer and economic benefits to the farmer, including:

- flesh quality is improved when the stress levels at time of slaughter are reduced. Pumping and stunning both contributing to this;
- the time to rigor mortis is increased, making it easier for the processor to achieve pre-rigor filleting, resulting in gains in product quality and yield;
- higher quality product has a longer shelf life;
- automation of the process reduces personnel costs; and
- rendering fish immobile improves the throughput rate of processing lines.

[46] This is a quality issue, not a welfare issue, as fish are immediately unconscious.

Killing without stunning methods

Live chilling with CO2

This is a recently developed slaughter method whereby salmon are exposed to water at 0.5-3°C with added CO^2 at low and moderate levels and O^2 at close to saturation levels. This practice does not protect fish welfare, as its application is unlikely to result in loss of consciousness, with salmon showing aversive reactions when subjected to this process. Salmon are subsequently killed by gill cutting and bleeding in chilled seawater. This method is not widely used and is being phased out in some countries.

Asphyxia in air, in ice, or in ice slurry

Sea bass and sea bream are transferred from a seawater cage or tank to ice flakes or ice with seawater slurry, kept at temperatures between 0-2°C. For rainbow trout, ice slurry and fresh water is used. In both cases, the fish are likely to be conscious as they suffocate to death. In the case of asphyxia in air, the fish are placed in free-draining bins or boxes. Unsurprisingly, this is stressful, and aversive responses have been documented in fish subjected to these practices.

Beheading

Conscious carp are sometimes simply beheaded, which does not meet World Organisation for Animal Health (OIE) guidelines and is likely to cause pain and suffering, depending on the speed with which the procedure is carried out.

Salt

Eels may be placed in salt without prior stunning, causing significant suffering and a prolonged death.

Coring/spiking

Smaller tuna may be killed by coring or spiking. Here, the fish are crowded together before being individually captured, sometimes by use of a 'gaffer' hook. A coring device or spike is then pushed into the brain. This is sometimes performed in water, in which case it is possible for it to be done humanely[47].

4.4.2 Welfare concerns in slaughter

Detailed evaluation of species-specific stunning and slaughter was carried out by the EFSA in 2009[48]. Reports were subsequently published, outlining concerns with regard to fish welfare at the time of slaughter. Key concerns are outlined below:

- the OIE advises the use of electrical or mechanical stunning and killing methods for farmed fish. Killing by a manual blow to the head is acceptable when carried out correctly and instantaneously after exposure of fish to air. Other slaughter methods, including live chilling with CO^2, CO^2 saturation, chilling in ice water followed by electrical stunning, and asphyxia in ice, do not meet OIE standards and are considered to cause unacceptable suffering;

- despite OIE guidelines advising that slaughter should not be carried out without pre-stunning, most farmed fish are slaughtered without stunning. This causes significant, and often prolonged, pain and suffering;

- fish must be oriented appropriately for electrical stunning to be effective. When not appropriately oriented, the electrical charge may not be applied directly to the head;

- automated percussive stunning machines will mis-stun fish some of the time, as the bolt does not strike the correct point on the head. The fish is then injured but not stunned, resulting in suffering;

- fish may recover from a stun if a killing method is not applied in time. A study confirmed that one in three salmon recover from electric stunning and are thus conscious when slaughtered[49];

- The parameters for effective electrical stunning have been established for very few species. Where this technology is used with other species, the welfare consequences are uncertain.

- percussive stunning by hand is only effective if the person is trained and well-practised. Many carp are sold live to consumers in Eastern Europe at Christmas, and it is very unlikely that they are stunned effectively prior to slaughter; and

- when coring or spiking fish, the wrong area of the brain may be penetrated, increasing the time to lose consciousness and causing painful bleeding.

[47] EFSA opinion on the welfare of tuna at time of killing, available at: https://www.efsa.europa.eu/en/topics/topic/fish-welfare
[48] Reports were published in relation to Atlantic salmon, carp, sea bass and sea bream, tuna and turbot, and are available at: https://www.efsa.europa.eu/en/topics/topic/fish-welfare
[49] Erikson, U. (2011). Assessment of different stunning methods and recovery of farmed Atlantic salmon (Salmo salar): isoeugenol, nitrogen and three levels of carbon dioxide. Animal welfare, 20, pp. 365-375.

5. Regulatory framework

Several pieces of EU legislation cover different aspects of the welfare of farmed fish. The requirement to safeguard fish welfare when making EU law concerning fish comes from Article 13 of the Treaty on the Functioning of the European Union. This Article states: *'In formulating and implementing the Union's … fisheries … policies, the Union and the Member States shall, since animals are sentient beings, pay full regard to the welfare requirements of animals …'.*

In addition to the legislation itself, the EFSA has issued a series of opinions on fish welfare, at the request of the European Commission. These include an opinion on a general approach to fish welfare and sentience, a series of opinions on husbandry, a series on stunning and killing of different species, and an opinion on food safety aspects of animal welfare husbandry for farmed fish. While not legally binding on either the EU or Member States, these opinions can be used as a reference to inform the implementation and enforcement of EU and domestic legislation.

The standards laid down in the OIE Aquatic Animal Health Code also guide Member States in interpreting and enforcing EU legislation. All EU Member States are members of the OIE and subscribe to its standards. In most cases, OIE standards are the international baseline in any given area, and fish welfare is unfortunately unique in being the only area in which pieces of EU animal welfare legislation are weaker than the equivalent OIE standards.

Legislation with some provision for fish welfare is outlined below.

5.1 Health and welfare

The General Farming Directive (98/58) applies to fish, which are covered by the general requirements of this Directive. This includes Article 3, which states that 'Member States shall make provision to ensure that the owners or keepers take all reasonable steps to ensure the welfare of animals under their care and to ensure that those animals are not caused any unnecessary pain, suffering or injury'. However, there is no specific Directive or Regulation for fish welfare at European level to buttress this, such as those that exist for farmed pigs and chickens. It is also worth noting that, as a Directive, this requires Member State implementation, and there are yet very few examples of fish-relevant welfare regulations at national level.

Regulation EU 2016/429 (Animal Health Law)[50] aims to control transmissible diseases in animals including fish, in farmed and other contexts.

While not governing animal welfare directly, it acknowledges that 'better animal health promotes better animal welfare, and vice versa'. Many areas of importance to the welfare of farmed fish are covered by this Regulation, including:

- preventing the spread of disease
- accreditation and registration of aquaculture establishments
- record-keeping and traceability by aquaculture establishments and transporters
- general and disease prevention requirements for the movement of aquatic animals
- responses to disease symptoms and mortalities.

5.2 Transport

Council Regulation (EC) No 1/2005 (Transport Regulation)[51] aims to protect the welfare of animals being transported live, in farms and other contexts. It applies to all vertebrates and, while it thus applies to fish, there are, in practice, few requirements that address the specific welfare requirements of fish. The regulation covers areas including:

- checks, authorisations, and notifications to be carried out by officials
- checks to be carried out by transporters
- training and competence of transporters, handlers, and officials
- design, construction, maintenance and operation of equipment and facilities
- documentation
- planning obligations.

The European Commission's own 2011 study [53] noted concerns with regard to the efficacy of enforcement and implementation of welfare measures for fish during transport. This resulted in the commissioning of a further study to better understand the issues surrounding welfare during transport and at the time of slaughter. The outcome of this process is explored in the next section.

[50] Regulation (EU) 2016/429 of the European Parliament and of the Council of 9 March 2016 on transmissible animal diseases and amending and repealing certain acts in the area of animal health ('Animal Health Law').
[51] 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.
[52] European Commission. (2011). Report from the Commission to the European Parliament and The Council on the impact of Council Regulation (EC) No 1/2005 on the protection of animals during transport.

5.3 Slaughter

Council Regulation (EC) No 1099/2009 (Slaughter Regulation)[53] aims to protect the welfare of animals at the time of killing. It explicitly requires that 'fish … shall be spared any avoidable pain, distress or suffering during their killing and related operations'. It does not, however, contain any of the detailed provisions made for other animal groups and which are detailed in the EFSA opinions.

The regulation recognises both its obligations and shortcomings with respect to fish. For this reason, it requires a study of current practices, together with an exploration of possible regulatory changes to better protect fish.
The outcome of this process is explored in the next section.

5.4 Data and transparency

The Commission Implementing Decision 2016/1251 on data collection governs the collection, management and use of data in aquaculture and requires the reporting of such data, including the type of farming system used.

5.5 Controls and audits

Regulation EU 2017/625 (Official Controls Regulation)[54] aims to ensure the application of animal health and welfare rules. The regulation covers areas including:

- responsibilities of national competent authorities
- responsibilities of the European Commission
- financing of official controls
- cooperation between Member States.

5.6 Organic aquaculture

Commission Regulation (EC) No 710/2009 (Organic Aquaculture Regulation)[55] lays down detailed rules governing practices in the production of aquaculture products which can be labelled as organic. This regulation contains the most stringent fish welfare requirements of any EU regulation. This is for two reasons: firstly, consumers expect organic production to better cater to the wellbeing of animals than standard production systems; secondly, consumers expect organic production to use fewer chemicals and therapeutic treatments than standard production systems, and this can best be achieved by providing higher welfare to the fish.

EU logo for 'organic product'

The regulation covers areas including:

- predator control
- stocking densities and space
- lighting conditions
- housing environment
- minimising handling of fish
- pre-slaughter stunning
- sustainability of feed sources
- live transport

At the time of publication, the text for a new and updated organic regulation had recently been adopted by the European Parliament and Council. The text places a greater emphasis on welfare and contains a range of stricter and more specific welfare requirements.

The new text, in force from 2021 onwards, is more stringent in certain areas, such as:

- requiring that disease prevention be based on keeping animals in optimal conditions through several welfare criteria;
- requiring that disease treatment be immediate to avoid suffering;
- introducing welfare as an objective of breeding programmes;
- introducing welfare as an objective of feeding regimes;
- requiring that all persons involved in keeping fish have the necessary skills to maintain fish welfare; and
- avoiding injury and suffering during pre-slaughter handling.

[53] Council Regulation (EC) No 1099/2009 of 24 September 2009 on the protection of animals at the time of killing.
[54] Regulation (EU) 2017/625 of the European Parliament and of the Council of 15 March 2017 on official controls and other official activities performed to ensure the application of food and feed law, rules on animal health and welfare, plant health and plant protection products, amending Regulations (EC) No 999/2001, (EC) No 396/2005, (EC) No 1069/2009, (EC) No 1107/2009, (EU) No 1151/2012, (EU) No 652/2014, (EU) 2016/429 and (EU) 2016/2031 of the European Parliament and of the Council, Council Regulations (EC) No 1/2005 and (EC) No 1099/2009 and Council Directives 98/58/EC, 1999/74/EC, 2007/43/EC, 2008/119/EC and 2008/120/EC, and repealing Regulations (EC) No 854/2004 and (EC) No 882/2004 of the European Parliament and of the Council, Council Directives 89/608/EEC, 89/662/EEC, 90/425/EEC, 91/496/EEC, 96/23/EC, 96/93/EC and 97/78/EC and Council Decision 92/438/EEC (Official Controls Regulation).
[55] Commission Regulation (EC) No 710/2009 of 5 August 2009 amending Regulation (EC) No 889/2008 laying down detailed rules for the implementation of Council Regulation (EC) No 834/2007, as regards laying down detailed rules on organic aquaculture animal and seaweed production.

'Upon slaughtering the fish, fish should be inspected for, for instance, bites, which are a sign of aggression, parasites, other disease symptoms, for instance deformities or discolourations'

Mark Nijhof,
Vice-Chair Technical Committee Aquaculture,
GlobalGAP

6. European Commission report and outcomes

In November 2017, the European Commission published its long awaited study report: "Welfare of farmed fish: *Common practices during transport and at slaughter."*

While the Slaughter Regulation included fish, the preamble to this legislation states that: 'fish are physiologically different to terrestrial animals, slaughtered in different contexts, and research is less developed' and so 'provisions applicable to fish should, for now, be restricted to the basic principle'. Article 27(1) of that regulation mandates the production of 'a report on the possibility of introducing certain requirements regarding the protection of fish … taking into account animal welfare aspects as well as the socio- economic and environmental impacts'.

The European Commission's 2011 report into the implementation of the Transport Regulation recognised concerns that the regulation did not protect fish effectively. It called for 'a study on the welfare of fish during transport, with a view to determining the appropriateness of a revision of the provisions of the Regulation to improve the clarity of the legal framework on the transport of live fish for aquaculture operators'.

These actions were incorporated into the EU's animal welfare strategy 2012-2015 and were combined into a single study.

The aims of that European Commission study were as follows:

- to gather information on current animal welfare practices prevailing in European aquaculture as regards the transport and slaughter of farmed fish;
- to gather information on national rules and use of international standards, best practices, or voluntary assurance schemes;
- to analyse collected data to illustrate the extent to which fish welfare issues are addressed or remain unresolved;
- to assess factors which may influence the use of animal welfare principles, such as the economic situation of the industry, trade issues and available knowledge among business operators; and
- the study assessed current practice against standards in the OIE Aquatic Animal Health Code;

The headline findings for slaughter were as follows:

- implementing the use of stunning practices would in most cases result in economic savings or only very minor increases to production costs;
- the vast majority of sea bass and sea bream in Greece, Spain and Italy are slaughtered by asphyxia in ice, and OIE standards at slaughter are therefore not achieved for these species;
- OIE standards are met for percussion of Atlantic salmon, with some practices that do not adhere to OIE standards still in use; and
- stunning technologies are sometimes used with trout and carp, although their efficacy is often unknown.

The headline findings for transport were as follows:

- regarding transport to growing on facilities, it was found that OIE standards are likely to be met for the three species examined in the case study countries (salmon, sea bass and sea bream); and
- for transport of marketable fish for slaughter, OIE standards are met for salmon and trout. For common carp, transport fails to meet OIE standards (except in Czechia) but meets the aforementioned Transport Regulation.

7. A laissez-faire approach

The European Commission's study and subsequent report on the welfare of fish during transport and slaughter highlighted a number of concerns with regard to fish welfare in European aquaculture. Despite the findings, the Commission concluded that no specific action was required at this stage. Instead, it stated its confidence that welfare standards would improve via voluntary measures implemented by the aquaculture industry. The report's conclusion stated that:

'At this stage, the Commission considers that the evidence suggests that it is not appropriate to propose specific requirements on the protection of fish at the time of killing, taking into account that the objectives of the Regulation may equally be achieved by voluntary measures, as evidenced by the improvements introduced by industry in recent years. … If further guidance is required this would be best achieved at Member State level'… 'Improvements are still needed in order to increase welfare of some fish species, such as the European sea bass and Gilthead sea bream'

Eurogroup for Animals is deeply concerned at this laissez-faire approach and the Commission's belief that the aquaculture industry should be charged with self-regulation when it comes to fish welfare, given the serious and widespread welfare issues identified during the review, and which negatively impact millions of individual fish each year.

Several findings from the study demonstrate the need for urgent remedial action at EU level, including:

- the use of effective and humane stunning methods in European aquaculture is the exception rather than the rule. This is unacceptable and will cause serious and widespread suffering to millions of individual fish;
- industry-led, welfare-specific accreditation schemes, which may have the potential to augment legal standards, were only in operation in one country (the United Kingdom). Other accreditation schemes not focused specifically upon animal welfare are more widely subscribed to across Europe but, within those schemes, effective stunning was not evidenced as being widely achieved. As such, and regardless of any potential for welfare improvement via accreditation schemes, these are not currently an adequate vehicle to ensure high welfare standards;
- despite ample evidence to demonstrate that asphyxiation without stunning causes suffering, advice advocating this as an acceptable slaughter method continues to be issued at Member State level;
- with the exception of Germany and the Netherlands[56], effective stunning prior to slaughter is not being adequately enforced;
- the study's conclusion contained a major flaw, in that, despite the EU's Organic Aquaculture Regulation mandating pre-slaughter stunning and the statement that it was being effectively enforced, the study also reports that this technology is not used commercially in those countries producing organic sea bass. It is thus impossible to conclude that the Organic Regulation is being effectively implemented and enforced with regard to stunning; and
- Market demand has been shown to drive up welfare standards in third countries, while Member States appear to be falling behind.

Despite the study data demonstrating widespread failure to protect fish welfare, the Commission justified its decision to take no remedial action based on the assertion that: 'the industry as a whole is gradually but continuously improving fish welfare as evidenced by the increasing use of more humane methods such as electrical stunning, the phasing out of others such as CO2 stunning, and the adoption of private standards'. While this may be true for some operations in some countries, overall, the study data simply did not support either the conclusion or its justification.

[56] The Netherlands was not part of the Commission study but has legislation in progress and has made subsidies available for the purchase of stunning equipment.

Sea bass and sea bream

The inadequacy and lack of foundation of the Commission's conclusions are most starkly demonstrated in the sea bass and sea bream sectors.

The European Commission study confirmed that: 'Asphyxia in ice of sea bass and sea bream is still the main practiced slaughter technique', with no other slaughter method identified as common practice. 'Organic' sea bass is produced and marketed in Europe which, in and of itself, likely demonstrates widespread and systemic non-compliance with the Organic Aquaculture Regulation (710/2009), which requires effective stunning in the slaughter of these fish.

Multiple research papers explore the stunning of sea bass and sea bream, dating as far back as 2000 and, in 2009, EFSA called for stunning practices to be developed. Despite this now ageing data supporting the need for stunning to be properly developed and implemented, the Commission study found that the stunning of these species existed only 'on an experimental basis' in the EU. Without sufficient motivation, this disappointing rate of progress can be expected to continue.

The majority of sea bass and sea bream farms in the biggest producing countries are GlobalGAP certified. This is the only international private standard (alongside the tiny organic sector) that requires pre-slaughter stunning. This report identifies that the European producers of these species do not use stunning, showing the ineffectiveness of the private standard. Only two farms in Greece use stunning on an experimental basis, while five or six in Turkey have integrated commercial stunners into their harvest boats.

Despite evidence that asphyxiation causes prolonged suffering in fish, in November 2016 the *Asociación Española de Normalización y Certificación* (AENOR), the Spanish statutory body for technical standards, issued guidelines stating that asphyxiation of sea bass and sea bream is permitted. Eurogroup for Animals firmly believes that the self-regulatory approach advocated by the Commission is, at best, optimistic yet naïve.

Since the sentience of fish was accepted by scientific consensus, and EFSA issued relevant detailed opinions, the EU has acknowledged that the evidence is sufficient to demonstrate that fish experience pain and suffering. While the European Commission responded to enquiries and concerns by commissioning its study into transport and slaughter and publishing the results in 2017, it has failed to translate either current knowledge or its own findings into decisive action.

The Commission's study clearly demonstrates that fish welfare standards are being widely failed across European aquaculture and yet it proposes to take no action. Meanwhile, the OIE has established standards that are significantly more stringent than those of the EU, European retailers are requiring welfare standards from their non-EU suppliers, and the large international aquaculture certification bodies are increasingly incorporating welfare specific aspects. As the EU exhibits complacency, its aquaculture sector is at risk of losing its claim as the quality leader.

8. The way forward: a vision for animal welfare in European aquaculture

Article 13 of the Treaty on the Functioning of the European Union mandates that: 'the Union and the Member States shall, since animals are sentient beings, pay full regard to the welfare requirements of animals'. The General Farming Directive places direct responsibility on farmers to protect the welfare of the animals under their care, stating that: 'Member States shall make provision to ensure that the owners or keepers take all reasonable steps to ensure the welfare of animals under their care and to ensure that those animals are not caused any unnecessary pain, suffering or injury'[57].

More individuals are farmed in aquaculture than in any other form of livestock agriculture in Europe, and all of those individuals are sentient, that is, they have the capacity to suffer. This report has explored the size and scope of the European aquaculture industry, together with its operating processes.

Despite the 2017 European Commission study demonstrating significant gaps in the implementation of legal standards for fish, and highlighting that legal standards designed to protect fish are generally far fewer and less stringent than those designed to protect other animals farmed for human consumption, the Commission has confirmed that it does not intend to take action to improve fish welfare standards. Eurogroup for Animals is calling for this decision to be urgently reconsidered.

We believe that European regulations on fish welfare should, as a minimum, be equivalent to standards in the OIE Aquatic Animal Health Code. In line with the European sector's position as a leader in quality and technology, standards should be as high as the knowledge base allows. Normalising best practice and continuous improvement is essential if European aquaculture is to compete against the vast offerings from Asian aquaculture.

We believe that the European Union is best placed to harmonise best practice and drive continuous improvements, ensuring that there is a level playing field in Europe and safeguarding the position of European production as the quality leader. The Organic Aquaculture Regulation sets the bar above standard practice and exhibits a focus oncontinuous improvement, a model which the basic farm animal welfare regulations should follow.

The EU legislative framework protecting animal welfare and governing the aquaculture sector provides many opportunities to take advantage of the current knowledge base and deliver on specific objectives for fish welfare. As the knowledge base around fish welfare continues to grow and produce better species-specific understanding, research agendas must deepen our understanding of fish welfare. The regulatory framework must remain flexible and integrate new knowledge in the future.

Eurogroup for Animals recommends that the following specific improvements be implemented, as the first steps in meeting the legal and moral obligations to the fish farmed in European aquaculture.

8.1 Rearing

- Fish should be included in the requirements of Article 4 of the General Farming Directive to *'ensure that the conditions under which animals … are bred or kept, having regard to their species and to their degree of development, adaptation and domestication, and to their physiological and ethological needs in accordance with established experience and scientific knowledge'.* Fish farmers should comply with the provisions laid out regarding staffing, inspection, record-keeping, freedom of movement, housing, equipment, substance provision, mutilation and breeding procedures.
- Provisions in the Animal Health Law seeking to reduce the spread of transmissible diseases should explicitly recognise that stressed fish have significantly reduced immune performance. Specific provisions should be introduced to reduce the spread of disease by keeping fish in optimal and low-stress conditions.
- The handling of fish, particularly handling out of water, should be minimised. Handling methods such as dry netting of fish (for transport, slaughter, application of treatments, movement on farm, or other) should be avoided. The correct use of a fish pump should be mandatory.
- Housing should cater to the welfare needs of fish, facilitating their natural behaviours to the greatest extent possible. Substrate and shelter appropriate to different species should be provided.
- EFSA should be mandated to carry out risk assessments on the welfare aspects of specific husbandry practices, including housing and handling, as well as the application of treatments for disease and parasites.
- EFSA or Animal Welfare Reference Centres should be mandated to develop species-specific sets of welfare indicators for the main aquaculture species in Europe.

[57] Article 3, 98/58/EC General Farming Directive

8.2 Transport

- Water quality parameters and monitoring practices adequate for maintaining the welfare of fish in transport should be a legal requirement.
- Systems to maintain water quality should be required, such as degassers for water, carbon dioxide and nitrogen, as well as protein skimmers and temperature control systems.
- The requirement that terrestrial animals have food and water for a journey of twice the anticipated length should be extended to water quality provisions necessary in fish transport, e.g. oxygen provision.
- Contingency plans should be required in case of poor welfare conditions occurring during transport. The current requirement that animals not fit to complete their journey be unloaded, watered, fed and rested is not appropriate for fish.
- Maximum species specific stocking densities during transport should be established.
- Competent authorities should keep all records of water quality and welfare parameters for each journey, with an abridged form made publicly available.

8.3 Slaughter

- Legislative amendments should be made so that slaughter techniques render fish immediately unconscious and insensible to pain. Species-specific parameters should be prescribed in the appropriate Annex.
- A mechanism should be established for certifying effective stunning and slaughter equipment, in accordance with the EFSA guidelines[58].
- Locations where fish are slaughtered should be incorporated in the definition of 'slaughterhouse' and have a designated animal welfare officer.
- Monitoring procedures should be put in place at slaughter to:

    - Identify any pre-existing welfare issues the fish have been suffering, such as health problems or injuries, including those resulting from aggression.

    - Monitor and confirm the efficacy of stunning and slaughtering operations.

- Killing and related operations should only be carried out by persons with relevant animal welfare training and appropriate competence.
- Periods of holding fish prior to slaughter should be minimised, and the holding conditions appropriately designed and monitored.
- Periods out of water prior to stunning should be avoided or minimised.
- Procedures should be established providing for welfare during slaughter for public health, animal health, animal welfare or environmental reasons.

8.4 Data transparency

- The number of fish in aquaculture production should be reported as number of individuals, not by tonnage.
- Competent authorities should be compelled to collect and publish data on welfare indicators, including health issues and mortality rates.

8.5 Trade

- While maintaining higher standards within European production, the EU should also require OIE standards to be in place for aquaculture fish imported into Europe, as part of the animal welfare chapters in trade agreements.

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[58] EFSA. (2013). Guidance on the assessment criteria for studies evaluating the effectiveness of stunning interventions regarding animal protection at the time of killing (Vol. 11). https://doi.org/10.2903/j.efsa.2013.3486

'These are sentient animals, there is a responsibility on the farmer to practice good husbandry and to keep the welfare of the animals in mind.
... Because we are farming them and responsible for their whole life cycle, we have a responsibility there.
... We count animal welfare as critical to delivering responsibly produced, modern products.'

Dan Lee
Standards Co-ordinator
Global Aquaculture Alliance

9. Conclusion

Settling the question of whether fish feel pain was a pivotal moment in mainstreaming the recognition of fish welfare as an issue. Those that continue to doubt the pain experience of fish are an isolated minority in academia, while the questions of behaviour and cognitive function exposed in the study of pain have driven the fish welfare debate beyond pain and into specifics of fish needs and preferences. In some respects, farmers already pay significant regard to the welfare of the animals they keep, but as new knowledge emerges and regulations lag behind, there are significant opportunities to address fish welfare.

Sub-sectors of European aquaculture that have adopted higher welfare practices have clearly stated the production efficiencies and product quality gains they have achieved. In addition, the role of providing for welfare in avoiding the spread of disease is increasingly recognised. The European Commission's recent study shows that more sub-sectors of European aquaculture could adopt established international standards without threatening their profits. Political action is required to standardise these best practices across Europe.

There is already a substantial and overlapping framework of regulations protecting the welfare of fish, especially farmed fish. These regulations could achieve considerably more if they were amended to take account of the latest available knowledge. Indeed, in many cases, the necessary protections would require the revision of existing regulations. In this context, and with fish presenting such diverse and distinct physiological, farming and welfare systems, a directive specific to fish welfare would best draw together and underpin the regulatory framework.

Welfare offers the European aquaculture sector both the route to high quality, environmentally friendly, ethical production, and the means by which to communicate these attributes to customers. As the largest private aquaculture certification bodies mainstream welfare in their global schemes, now is the time for Europe to act and cement its position as the quality leader.

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