POSITION PAPER

Lack of knowledge does not justify a lack of action: the case for animal welfare in farmed fish

Vincent Lugert[1], Dieter Steinhagen[2], and Stefan Reiser[1]

Received: September 19, 2019
Revised: November 4, 2019
Accepted: November 26, 2019


© Thünen Institute/Nicole Stollberg

Vincent Lugert


© Sabine Steinhagen

Dieter Steinhagen

KEYWORDS **animal welfare, fish, stress response, sentience, consciousness, aquaculture, regulatory actions, public demands, ethics**

1 Description of the problem

Nowadays, 50 % of the world's fish for consumption already originate from aquaculture farms. Predictions indicate that this number will increase to approximately 65 % (Monaco and Prouzet, 2015), which is equivalent to 90 to 100 million metric tons per year by 2030 (World Bank, 2013). Rising production levels are often associated with increased intensification and larger environmental footprints, putting aquaculture at the centre of public debates regarding sustainability and animal welfare. Welfare debates about fish are often focused around one specific question: Whether fish are capable of suffering or experiencing pain, and if so, to what extent. This question addresses the cognitive and mental capacities of fish, which are currently topics of intensive scientific debates (Key, 2016; Browman et al., 2019). Hence, the number of studies and peer-reviewed publications about animal welfare specifically related to aquaculture-reared species has increased significantly over the last decade, indicating the political and public awareness of the topic (Huntingford et al., 2012). However, the scientific study of welfare in farmed fish is still at an early stage compared to that of terrestrial livestock (Huntingford et al., 2006).

It should be noted, that the group of organisms named 'fish' is often treated as a group of animals from the same species. 'Fish', however, comprise organisms from various taxonomic groups and a large number of species, which account for around 60 % of all vertebrate species (Nelson et al., 2016). They inhabit all aquatic ecosystems and each species has developed particular adaptations to living in their particular habitat. Therefore, anatomical structures, physiological traits and behavioral patterns vary greatly between different fish species according to their taxonomic group, and as a perfect adaptation to the conditions of a particular habitat. This enormous diversity has to be regarded when drawing conclusions about 'fish' and each respective species grown in aquaculture.

Whether or not pain perception in fish should remain unproven, and even if it proves to be unexperienceable in fish, there is sufficient assignable evidence to justify the same level of animal welfare in farmed fish as in terrestrial livestock. Recent studies have been able to demonstrate that some fish are capable of solving problems (Balcombe, 2016), using tools (Bernardi, 2012) and learning and deploying avoidance behaviour (Yue et al., 2004; Dunlop and Laming, 2006). Certain specimens have even passed self-awareness tests (Kohda et al., 2019). Fish show physiological and behavioral stress responses that are in some way similar to those in mammals. Accordingly, the European general public expects animal welfare to be generally safeguarded during the rearing and slaughtering of fish.

This article aims to provide an overview by summarising the prevailing scientific opinion from the field of welfare research in aquaculture within the framework of this issue.

[1] Thünen Institute of Fisheries Ecology, Bremerhaven, Germany
[2] The University of Veterinary Medicine Hannover, Germany
CONTACT: vincent.lugert@thuenen.de

2 Possible solutions

2.1 Evaluating physiological and nutritional demands of farmed fish

Living in water largely determines the body structure, physiology and behaviour of fish. Water is in intimate contact with their gills and skin, therefore its physical and chemical properties directly influence fish physiology. In particular, water temperature, oxygen, carbon dioxide, ammonium and nitrate concentrations may have a direct effect on fish physiology.

In general, fish can adapt to a range of water parameters, however, when their capacity for adaptation is exceeded, fish may suffer from physiological or pathological disorders, which may result in a stress response. The level at which abiotic parameters exceed the adaptive capacity of fish depends on the species and life stage of the fish. When tolerance levels are defined, interactions with water parameters must also be taken into account. Hence, during rearing, water parameters should be monitored and matched to the specific requirements of the fish species being raised. Feeding rates and feed composition must be determined in relation to fish size and species requirements to optimise dietary intake, health, growth, feed conversion and fecundity. The nutritional requirements of the fish species must be properly addressed.

In particular, when new feed ingredients are introduced, such as proteins or lipids of plant or insect origin, the bioavailability of micronutrients and the absence of anti-nutritional factors must be ensured. In general, feed should be provided daily and adapted to the system used in order to reduce the aggressive behaviour of fish when competing for feed. Since feed availability is sometimes limited in the wild, fish have developed various behavioural and physiological adaptations to reduce metabolism during feed deprivation. During routine production procedures such as transport, sorting, stocking and slaughter, short periods of feed deprivation allow clearance of the gut. This reduces fecal contamination of the water, thus improving sanitary conditions. It also reduces the oxygen demand, CO_2 and ammonia excretion of the fish, which helps to maintain water quality during the management procedures.

2.2 Evaluating the ecological and behavioural demands of farmed fish

As mentioned previously, fish cannot simply be compared across species and taxonomic groups. Each species has different ecological and behavioural demands, and varying physiological capacities. Some fish live singularly or territorially for most of the year, while others form large schools. Certain species live in benthic habitats or seek shelter in caves, rocks, corals and aquatic plants, while others inhabit and seek their prey in the open water column. All of these characteristics may alternate depending on the life stage of the fish (juvenile, subadult and adult specimens).

Accordingly, husbandry methods, rearing conditions and stocking density should reflect these specific demands. In general, each fish species should be kept in accordance with their natural behaviours and within a beneficial social structure. The level of domestication in fish species is also known to enhance general husbandry practices, species-appropriate breeding and animal welfare. Trait-specific breeding programmes can enhance growth characteristics and feed conversion, but also immune competence and stress resilience, making fish more adaptive to husbandry methods. When rearing different species in polyculture, care must be taken to ensure that these are compatible in terms of water quality and parameters, as well as social and predatory behaviour. This also holds true for species reared communally for management reasons such as the control of sea lice (e.g. cleaner fish in salmon cages).

2.3 Evaluating rearing systems and husbandry techniques

As highlighted previously, different species of fish have different ecological needs and have adapted to a wide range of conditions and habitats throughout evolution. The types of rearing systems currently applied are limited, and can be classified roughly as ponds, tanks, troughs and net cages of various sizes and materials. With the exception of earthen ponds, these systems are all artificial and barren rearing environments.

The heterogeneity of fish certainly creates the need for further adaptions of rearing systems to fulfill specific natural demands. Environmental enrichment, though critically debated among the aquaculture community, might help to adapt aquaculture rearing systems to species-specific requirements (Näslund and Johnsson, 2016). Feasibility of added substrates and enrichment strategies have yet to be studied more thoroughly, but there are promising initial results regarding their effects on welfare (e.g. Batzina and Karakatsouli, 2012; Batzina et al., 2014). Indeed, enrichment goes beyond the addition of substrates or structures; it also includes the presence or alteration of flow, shade, cover, shelter and hideouts. Naturally, these measures must be incorporated while taking into account hygiene management and the practicability of daily working routines.

In addition to rearing systems, many common aquaculture working routines also have scope for improvement. While natural adaptations and physiological capacities enable some species to do well, even under rough husbandry conditions, others are much more delicate and require special measures. Behavioural abnormalities detected visually or by means of automated alarm systems may indicate suboptimal husbandry conditions way before welfare is put at risk. This also holds true for altered behavioural patterns following certain hatchery techniques, which would indicate that these measures should be evaluated and potentially improved. With regard to evaluation and improvement, staff carrying out daily working routines must be involved in the process first and foremost, so that it may be continuously developed and refined.

2.4 Evaluating staff training, competence and performance

Many of the current cases of poor animal welfare and even animal cruelty in terrestrial farm animals have resulted from poor staff competence, performance and motivation. Staff competence can easily be assured through vocational training, and can be permanently maintained at a high level

through continuing education, training and qualification programmes. Such programmes are offered by a variety of different organisations, from government bodies and chambers of agriculture to private consultants.

Staff involved in fish rearing and production must be aware of welfare-related objectives and should receive additional training on welfare-related issues (Segner et al., 2019). Motivation is often closely related to salary, general work atmosphere and a feeling of appreciation. All three are known to increase employee performance and engagement, which directly affect animal welfare. Owners and staff must possess fundamental knowledge about the species-specific needs (see points 2.1, 2.2, 2.3 of this article) of the fish under their care (Council of Europe, 2005).

Without experienced and well-trained staff, cases of poor fish welfare may remain undetected or may be detected too late (Segner et al., 2019).

2.5 Evaluating and monitoring the state of welfare in farmed fish

The public debate surrounding the extent to which animal welfare is safeguarded in livestock farming is extremely controversial. The available information on the state of welfare of reared fish is minimal, especially in aquaculture operations. In order to make reliable statements about the state of animal welfare in fish, a regularly scheduled monitoring system should be established. The system should be based on reliable, valid and practically feasible indicators. The indicators should be specified for each monitored species and surveyed by trained staff at regular intervals. Data on animal-related, resource-related and management-related indicators must be systematically collected. Arlinghaus et al. (2009) suggest that such welfare indicators should focus on objectively measurable items such as behaviour, physiology, growth, fecundity, health and stress. Finally, the collected data on animal welfare in farmed fish should be made publicly available.

Using such data, positive and/or negative trends on the state of welfare in farmed fish can be monitored in the long term. Furthermore, the results of measures and activities initiated for the improvement of fish welfare can be evaluated.

2.6 If in doubt: actions should reflect the code of best knowledge and practice!

In order to safeguard fish welfare, any aquaculture practices or measures should – as a minimum – reflect the possibility that some fish could be capable of experiencing emotions and suffering, just as terrestrial livestock animals (Braithwaite, 2010), and be in accordance with ethical standards (Mackensen, 2011). All welfare-related work and tasks should reflect this and be performed in accordance with the code of best knowledge and practice.

3 Conclusion

Animal welfare is a fundamental societal choice, which commences well before suffering or pain. The welfare of animals under human care starts with the most basic aspects: feed, care and husbandry methods. Accordingly, the debate about whether fish are capable of experiencing suffering or pain should not be considered the pivotal issue in a welfare context. Although understanding the pain perception and suffering capacity of fish is important, it must be considered independently. Welfare should extend beyond this point and include the entire quality of life of the fish. Husbandry and production methods should be led by the biological requirements of fish in addition to public demands, rather than solely economic principles or scientific debates.

Additionally, the growing body of recent scientific findings indicates that fish in aquaculture facilities should be given the same protection as currently afforded to terrestrial livestock. They are all animals under human care. It must be ensured that aquaculture operations follow public ethical opinion and demands in addition to incorporating the necessary regulatory measures and legal frameworks. All participants will ultimately benefit, since good standards in fish welfare will safeguard product quality and healthy foods, which generate maximum revenue and consumer acceptance.

Acknowledgements

We would like to thank the two unknown reviewers for their professional comments on an earlier version of the manuscript. Their suggestions and references have greatly helped to improve the overall quality of the article. This work was funded by the German Federal Ministry of Food and Agriculture (BMEL) through the Federal Office for Agriculture and Food (BLE), grant number 28N1800008.

REFERENCES

Arlinghaus R, Schwab A, Cooke SJ, Cowx IG (2009) Contrasting pragmatic and suffering-centred approaches to fish welfare in recreational angling. J Fish Biol 75(10):2448–2463, doi:10.1111/j.1095-8649.2009.02466.x

Balcome J (2016) Fishes use problem solving and invent tools. New discoveries show that fishes are capable of complex mental calculus, reshaping our ideas about animal intelligence underwater. Sci Am 314(6): 66–69, doi:10.1038/scientificamerican0616-66

Batzina A, Karakatsouli N (2012) The presence of substrate as a means of environmental enrichment in intensively reared gilthead seabream *Sparus aurata*: Growth and behavioral effects. Aquaculture 370–371: 54–60, doi:10.1016/j.aquaculture.2012.10.005

Batzina A, Dalla C, Papadopoulou-Daifotib Z, Karakatsoulia, N (2014) Effects of environmental enrichment on growth, aggressive behaviour and brain monoamines of gilthead seabream Sparus aurata reared under different social conditions. Comp Biochem Physiol Part A Mol Integr Physiol 169:25–32, doi:10.1016/j.cbpa.2013.12.001

Bernardi G (2012) The use of tools by wrasses (Labridae). Coral Reefs 31(1):39, doi:10.1007/s00338-011-0823-6

Braithwaite VA (2010) Do fish feel pain? Oxford: Oxford University Press, 194 p

Browman HI, Cooke SJ, Cowx IG, Derbyshire SWG, Kasumyan A, Key B, Rose JD, Schwab A, Skiftesvik AB, Stevens ED, Watson CA, Arlinghaus R (2019) Welfare of aquatic animals: where things are, where they are going, and what it means for research, aquaculture, recreational angling, and commercial fishing. ICES J MarSci 76(1): 82–92, doi:10.1093/icesjms/fsy067

Council of Europe (2005) Standing committee of the European convention for the protection of animals kept for farming purposes (T–AP) Recommendation concerning farmed fish [online]. Retrieved from <https://www.coe.int/t/e/legal_affairs/legal_co-operation/biological_safety_and_use_of_animals/Farming/Rec%20fish%20E.asp> [at 16 September 2019]

Dunlop R, Millsopp S, Laming P (2006) Avoidance learning in goldfish (*Carassius auratus*) and trout (*Oncorhynchus mykiss*) and implications for pain perception. Appl Anim Behav Sci 97(2):255–271, doi:10.1016/j.applanim.2005.06.018

Huntingford FA, Adams C, Braithwaite VA, Kadri S, Pottinger TG, Sandøe P, Turnbull JF (2006) Current issues in fish welfare. J Fish Biol 68(2):332–372, doi:10.1111/j.0022-1112.2006.001046.x

Huntingford FA, Jobling M, Kadri S (2012) Aquaculture and behaviour. Oxford: Wiley-Blackwell, 358 p

Key B (2016) Why fish do not feel pain [online]. Animal Sentience 3(1)1–33. Retrieved from <https://animalstudiesrepository.org/animsent/vol1/iss3/1/> [at 15 Jun 2020]

Kohda M, Hotta T, Takeyama T, Awata S, Tanaka H, Asai J-y, Jordan AL (2019) If a fish can pass the mark test, what are the implications for consciousness and self-awareness testing in animals? PLoS Biology 17(2):-e3000021, doi:10.1371/journal.pbio.3000021

Mackensen H (2011) Aquakulturen – ein vernachlässigtes Tierschutzthema. Die Probleme der Massenzucht von Fischen [online]. In: AgrarBündnis e.V. (ed) Der kritische Agrarbericht 2011, Chapter8, 227–232. Retrieved from <https://www.kritischer-agrarbericht.de/fileadmin/Daten-KAB/KAB-2011/Mackensen.pdf> [at 15 Jun 2020]

Monaco A, Prouzet P (2015) Governance of seas and oceans. Hoboken: John Wiley & Sons, 318 p

Näslund J, Johnsson JI (2016) Environmental enrichment for fish in captive environments: effects of physical structures and substrates. Fish Fish 17(1):1–30, doi:10.1111/faf.12088

Nelson JS, Grande TC, Wilson MVH (2016) Fishes of the world. 4th Edition. Hoboken: John Wiley & Sons, 624 p

Segner H, Reiser S, Ruane N, Rösch R, Steinhagen D, Vehanen T (2019) Welfare of fishes in aquaculture [online]. FAO Fisheries and Aquaculture Circular 1189. Budapest: FAO, 18 p. Retrieved from <http://www.fao.org/3/ca5621en/CA5621EN.pdf> [at 15 Jun 2020]

World Bank (2013). Fish to 2030: prospects for fisheries and aquaculture [online]. AES Agriculture and Environmental Services. Washington, DC: World Bank, 102 p, World Bank Report 83177-GLB. Retrieved from <http://documents.worldbank.org/curated/en/458631468152376668/pdf/831770WP0P11260ES003000Fish0to02030.pdf> [at 15 Jun 2020]

Yue S, Moccia RD, Duncan IJH (2004): Investigating fear in domestic rainbow trout, Oncorhynchus mykiss, using an avoidance learning task. Appl Anim Behav Sci 87(3):343–354, doi:10.1016/j.applanim.2004.01.004