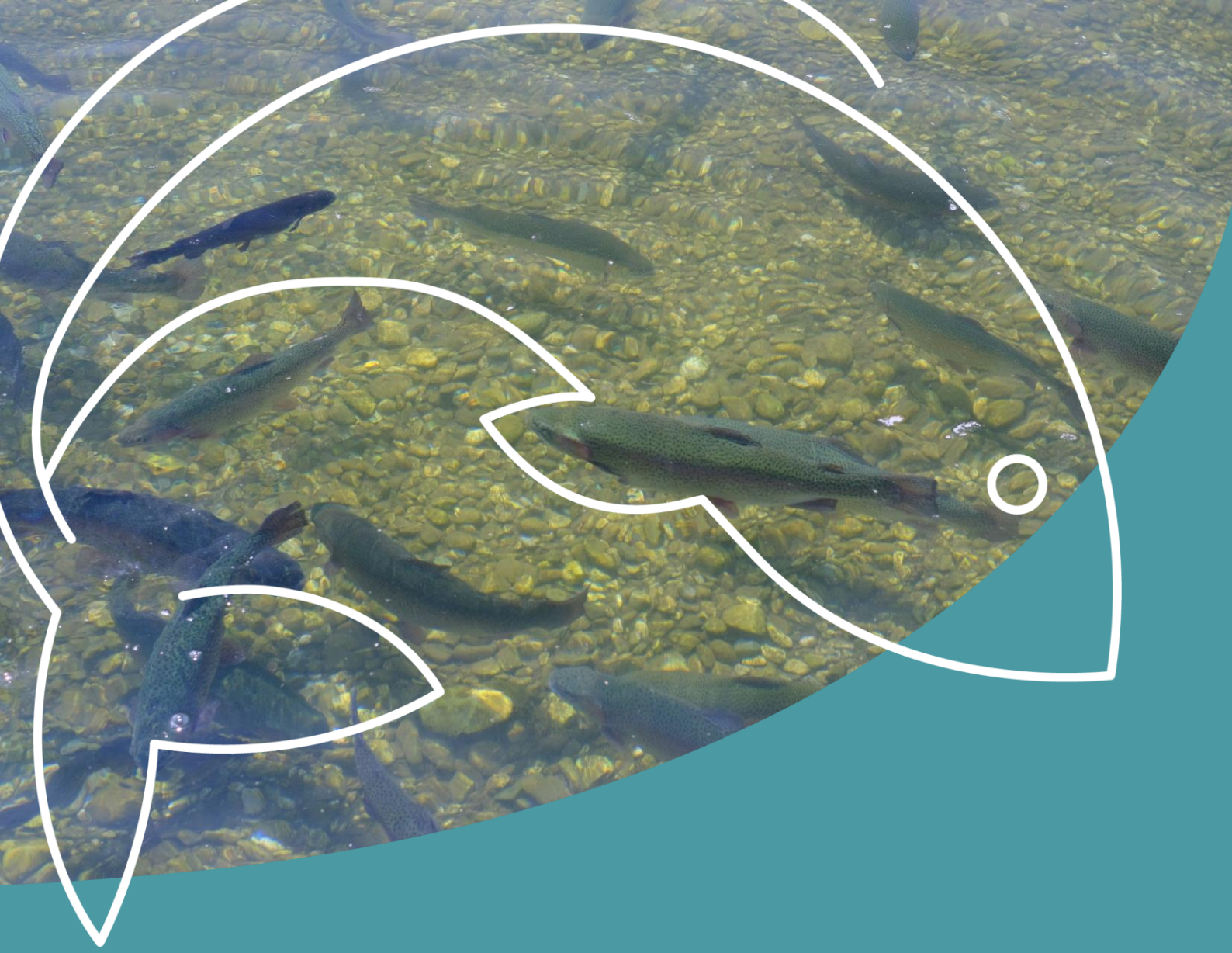

Code of Good Practices on Fish Welfare among Aquaculture Producers

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Background

The Strategic Guidelines for a more sustainable and competitive aquaculture for the period 2021 to 2030[1] supports the development of code of good practice on fish welfare based on scientific research and evidence, covering farming, transport and killing.

The purpose of this paper is to advise on scope and content of this code and to recommend a wide range of reference material, including guidelines from other bodies such as WHOA, that should be studied in the process of developing the code.

Animal welfare, including fish welfare, has been described in a variety of different but generally compatible ways which are outlined in detail in the AAC publication *Using Ethology to Improve Farmed Fish Welfare and Production*[2]. To simplify one of the approaches, fish welfare has three dimensions, depending firstly on good *functional* welfare such that the fish are in good health, free from disease and injury and generally in a good physical state. Secondly, the fish are able to perform a range of motivated *natural* behaviours such that where possible they are free from fear and frustration and generally able to make choices that are instinctively driven. Thirdly, achieving these two dimensions may ensure *mental* welfare and a good quality of life, though this may be harder to measure. The assessment of welfare depends on the development of indicators which are more advanced in some areas than others.

These three animal welfare strands are interconnected. Any code of practice should aim to achieve good welfare in all three dimensions. It should aim to protect fish from pain, anxiety and distress, to minimise suffering and to promote positive welfare. Good fish welfare should be seen as part of a One *Health/ One Welfare approach* which takes account of the needs of animals, the environment and society. *It can* be beneficial for production, for meeting the aspirations of consumers and for making the work of the fish farmer more satisfying. Better welfare can also improve productivity and quality, including welfare quality. The benefits of higher welfare production for the producer and the production economy should be assessed. Meanwhile, support for aquaculture from Member States and the European Union could include grants for capital expenditure for fish welfare projects and support for additional costs incurred by the adoption of higher welfare practices.

Good welfare practices can also improve fish health. Where this reduces the need for anti-microbial drugs, it can reduce the risk of developing anti-microbial resistance. Where this reduces the need to use anti-parasitic drugs it reduces the risk of environmental contamination affecting marine invertebrates as well as reducing the risk of anti-parasitic resistance. There is also a potential benefit in relation to food safety.

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:236:FIN
[2] https://aac-europe.org/images/AAC_ethology_and_welfare_final.pdf

The AAC has published recommendations on fish health[3], slaughter[4][5] transport[6] and small scale aquaculture[7] which should be read in combination with this document.

Recommendations

General

In developing guidelines, we recommend the guidelines should:

1. Include relevant principles which apply to all species and systems.
2. Be written so they allow for variation between species, life stages, scales and systems of production and the intended market (eg for food or for restocking).
3. Be based both on the best available science and practical experience.
4. Take into account the precautionary principle, in the absence of science and practical experience, where there are reasonable concerns about the potential adverse effects of a practice.
5. Include recommendations about training & knowledge sharing.
6. Apply to all fish reared in a system including cleaner fish.
7. Recommend the use input and environmental indicators combined with animal-based outcome indicators in order to measure welfare.
8. Take a holistic approach which is designed to meet welfare objectives fully whilst accommodating factors such as legislation, worker safety, food safety, administrative burden and economic practicality for small as well as large producers.
9. Incorporate the principle that fish should be protected from avoidable pain, anxiety and distress; also that fish farming and holding practices should aim towards providing positive welfare.
10. Ensure that responsibilities are assigned regarding welfare aspects.

We recommend that all the references listed at the end, cross-referenced by subject, are studied during the development of these guidelines.

In particular, the provisions of the Council of Europe Recommendations, the WOAH Aquatic Animal Health Code, EFSA scientific opinions and the EU Platform on Animal Welfare guidelines should be incorporated.

[3] AAC, 2023. Recommendation on Fish Health Good Management Practices - https://aac-europe.org/wp-content/uploads/2023/10/AAC-Recommendation-on-Fish-Health-Good-Management-Practices-2.pdf
[4] Aquaculture Advisory Council, 2017. Report on farmed fish welfare during slaughter. https://aac-europe.org/en/publication/report-on-farmed-fish-welfare-during-slaughter/.
[5] Aquaculture Advisory Council, 2019. Fish welfare at slaughter. https://aac-europe.org/en/publication/fish-welfare-at-slaughter/.
[6] Aquaculture Advisory Council, 2022. Recommendation on Fish Welfare in Live Fish Transport. https://aac-europe.org/en/recommendations/position-papers/373-aac-recommendation-on-fish-welfare-in-live-fish-transport.
[7] AAC, 2022. Recommendation on the definition and realities of smallscale aquaculture. https://aac-europe.org/en/publication/aac-recommendation-on-the-definition-and-realities-of-small-scale-aquaculture/

Feeding

Feeding strategies should respect natural feeding rhythms, in some species and systems allowing fish to eat at the time of their choice. Feeding strategies that result in poor body condition, fin damage, hunger, frustration, aggression, or contamination of water with excess feed must be avoided.

Guidelines should include recommendations for periods of feed withdrawal. Withdrawal of feed is carried out for several husbandry reasons, such as preparation for handling and transport, some of which carry inherent welfare benefits. There are also a range of welfare risks associated[8]. Many fish can be adapted to long periods without feed, in certain circumstances, but it should not be assumed that withdrawing feed does not have negative welfare consequences. Periods of extended fasting can result in poor welfare and should be minimised and kept as short as possible. Effects of feed withdrawal vary according to species, their natural feeding habits, life stage, condition and with environmental variables such as temperature.

Feeding regime elements should include species and lifestage-appropriate requirements for health and welfare:

- Frequency of feeding (regular or self-feeding, environment-appropriate or temperature-appropriate)
- Quantity and composition of feed (physical quality, nutrition, palatability, digestibility)
- Distribution of feed
- Feed withdrawal (procedures that should be followed by feed withdrawal, minimum time necessary to clear the gut, species/life-stage/temperature specific maximum feed withdrawal times)
- Suitable equipment
- Indicators and record keeping
- Reference to sustainabilty and traceability

The impacts of feeding strategies on water quality and other husbandry aspects must also be planned for and managed.

Physical environment

Water quality

Good water quality is essential to meeting the physiological and behavioural needs of fish. Water currents provide occupation and facilitate exercise which can be beneficial for the physical and mental health of many species, but can be harmful if fish are subject to overly intense currents for too long a time, cannot obtain shelter from unwanted current, or currents otherwise cause physical exhaustion.

Water quality parameters are species and life stage specific and can also vary between systems and feeding practices. Some water quality management aspects are system specific, for example ammonia is not normally critical in cage systems, and RAS systems require more frequent monitoring of more parameters. Monitoring systems can also be system specific or appropriate.

[8] Noble, C., Gismervik, K., Iversen, M. H., Kolarevic, J., Nilsson, J., Stien, L. H. & Turnbull, J. F. (Eds.) (2018). Welfare Indicators for farmed Atlantic salmon: tools for assessing fish welfare 351pp.

The AAC endorses the best practices in the 'Guidelines on Water Quality and Handling for the Welfare of Farmed Vertebrate Fish' produced in the EU Platform on Animal Welfare[9]. Water quality elements appropriate for the species should include:

- Water supply and availability
- Suitable water flow, exchange and treatment
- Water quality monitoring (key parameters where relevant: oxygen, ammonia, carbon dioxide, pH, temperature)
- Optimal water quality parameters and acceptable ranges
- Current / water velocity / water flow as appropriate for the farmed species
- Monitoring procedures and remedial actions that should be implemented immediately if any parameters deviate from the optimal conditions
- Give examples of operational welfare indicators used to assess animal welfare as it relates to water quality

Stocking density

Stocking density is a clear and measurable indicator that is closely related to many input and outcome factors relevant to welfare. Stocking densities above certain thresholds can cause poor welfare due to its effects on:

- Fear and anxiety, increased levels of aggression and physical effects such as fin damage, in turn causing pain
- Inhibiting the expression of a range of normal behaviours
- Water quality including key parameters

Low stocking density in intensive systems may cause poor welfare in some species and life-stages where it permits some dominant individuals to perform territorial behaviour, resulting in aggression towards others. Low stocking density in extensive systems may not be a problem provided that there is space for fish to establish territories. In addition to densities, the total dimensions of the system, vertically and especially horizontally, are also very important in determining welfare and ensuring freedom of movement. The impact of stocking density on water quality varies with species, with system, with a range of key parameters (see section on water quality), and with management practices such as feeding.

Stocking densities can be impacted by factors such as light or the perceived presence of predators which can cause aggregation, locally increasing stocking densities.

Guidelines should state the principles by which higher and lower stocking densities should be determined. Space requirements will vary by species, with average weight or age and with system. Space allowances should be sufficient to maintain good water quality where this cannot be fully controlled. Maximum stocking densities should be set in any system to meet behavioural and water quality needs, and minimum stocking densities may be needed to prevent territorial behaviour. Stocking density should be adjusted when necessary and closely monitored in relation to other affecting factors of production.

[9] https://food.ec.europa.eu/system/files/2022-07/aw_platform_plat-conc_guide_farmed-fish_en.pdf

Lighting

Fish have natural diurnal cycles according to species that should be respected. They can seek light by swimming to the surface and avoid it by swimming deeper or by seeking shelter. The provision of light enables fish to be observed to ensure their welfare and for welfare indicators to be measured. Atlantic salmon avoid bright surface light during the day, but are attracted by lights at night which encourages schooling behaviour. Providing lights just at the surface can result in localised high stocking density[10].

Other species, perhaps nocturnal species, may avoid the light. It should be assumed that a period of dark is needed at night for all species. Fish, especially juveniles, may also need to be protected from ultraviolet light.

Guidelines should consider:

- Requirements for observation of the fish
- Any benefits for the behaviour of the species in providing light at different depths during the day and/or night
- The need of any species for periods of dark
- Use of covers and shades to protect fish from light including u.v. or to enable them to avoid it

Excluding wildlife interactions (parasites, predators, disease, genetics fitness, pollution)

Fish farms should be designed and operated to prevent impacts of wildlife on the welfare of farmed animals, and allow for coexistence between farming and wildlife conservation.

Guidelines should address the need to protect finfish from predators, using non-lethal means as far as possible. Some members of the AAC consider that lethal means should not be used. Guidelines should also address the need to prevent escapes and explore solutions to reach this goal.

Guidelines should also address the need to protect finfish from parasites such as sea lice and to prevent these from building up and escaping back into the environment.

Environmental enrichment

Some aquaculture environments are environmentally barren for economic and sanitary reasons, but there is evidence that enrichment is beneficial for learning and cognitive development in species that evolved in and are adapted to complex environments. There is evidence for this in seabream[11] and also that increasing environmental complexity can benefit salmonids and carp. Failure to provide for behavioural needs may lead to poor welfare. For example, there is evidence that a lack of substrate provision may cause frustration in tilapia[12].

The behavioural needs of fish can be better met through the addition of forms of environmental enrichment which are tailored to the natural behaviour of the species.

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[10] Stien *et al*, 2013, *op cit*

[11] Arechavala-Lopez, P., Caballero-Froilán, J.C., Jiménez-García, M., Capó, X., Tejada, S., Saraiva, J.L., Sureda, A. and Moranta, D., 2020. Enriched environments enhance cognition, exploratory behaviour and brain physiological functions of Sparus aurata. *Scientific Reports*, *10*(1), p.11252.

[12] Galhardo, L., Correia, J. and Oliveira, R.F., 2008. The effect of substrate availability on behavioural and physiological indicators of welfare in the African cichlid (Oreochromis mossambicus). *Animal Welfare*, *17*(3), pp.239-254.

Physical enrichment can provide shelter, substrate and complexity in a rearing environment.

All the species commonly farmed in the EU seek shelter, and most use bottom substrate, at some point in their lives. Where possible, the addition of structures such as hanging ropes, plastic tubes and shredding can provide structure. The addition of stones, sand and gravel can provide for the needs of benthic species. Adding hatching mats for breeding animals has proved to be beneficial for salmonid species.

Sensory stimuli may also be beneficial through increasing the complexity of experience. These include visual, auditory, chemical and tactile stimuli. However, fish should also be protected from excessive noise or continuous light – some species are active in the dark, not the light.

Occupational stimuli such as the provision of currents can also keep the fish active. Air bubbles can also provide interest and perhaps cause fish to exhibit positive play behaviour.

Social interaction can be positive or negative for fish. Schooling can provide protection, but solitary fish can become aggressive towards each other when exhibiting territoriality.

Foraging is a strongly motivated behaviour, so dietary enrichment is another means of increasing positive welfare in fish.

Different species have different behavioural requirements, so environmental enrichment should always be species-specific. It needs to be designed to be practicable and to avoid biosecurity and hygiene issues. Additional structures must be such as to avoid damage to netting which would risk fish escaping. Results of enrichment need to be validated to ensure that the intended benefits are achieved.

The AAC report *Using Ethology to Improve Farmed Fish Welfare and Production* which this recommendation is based on has a much more detailed account of the benefits of environmental enrichment. See also Arechavala-Lopez et al (2022a) for a much more detailed and fully-referenced account.

The Guidelines should address the provision of environmental enrichment which provides for the behavioural needs of individual species in a practical way without risking health or biosecurity.

Health

Good health is essential for physical and mental welfare and to facilitate natural behaviours in fish. In turn, all three facets of good welfare are required to ensure good health. Good health is essential for maintaining fishes' large array of coping mechanisms and responses to environmental challenges[13]. All physiological systems including the basic senses including sight and hearing should function properly.

[13] Madaro, A., Kristianses, T. S., & Pavlidis, A. (2020). How Fish Cope with Stress?, in Kristiansen, T. S., Fernö, A., Pavlidis, M. A., & van de Vis, H. (Eds.), The Welfare of Fish. Springer.

The immune systems[14] and appetites[15] of fish are especially vulnerable to stress. A short period of stress may bring long lasting effects including increased incidence of disease, increased mortality, reduced appetite, impaired development, and deformities[16]. Common aquaculture practices that are inherently stressful should be carried out with the minimum suffering, stress, injury, and time to return to feeding.

Guidance on disease control should focus on the prevention of diseases through b breeding, biosecurity and husbandry practices. The guidance should recommend a holistic approach to health based on natural disease resistance based on breeding for robustness, avoiding high levels of stress and maintaining welfare in all its forms. Guidance should also promote routine monitoring and recording of fish health and welfare conditions, where possible during scheduled handling to avoid additional instances of handling.

Guidelines should also address the need to protect finfish from parasites and to prevent these from building up.

The AAC has developed a detailed position on best management practices for fish health here[17].

Treatments

Animals which are sick or in poor health should always be treated where this is possible without causing poor welfare and humanely euthanised (see section on emergency killing) where this is not.

Any treatments will be made in line with EU legislation that minimise the risk of developing antimicrobial resistance. Disease should be avoided through enhancing the natural resistance of fish to disease by a variety of means including breeding, good management, the avoidance of stress and the use of suitable vaccinations and immunostimulants.

Treatments which cause poor welfare, for example aversive mechanical and chemical treatments for parasites and/or infectious diseases, should be avoided as should treatments which damage other marine organisms, for example some anti-parasitics.

Painful procedures shall be avoided to the greatest extent possible (see section on health in relation to mutilations and surgical procedures). Pain management should be provided when painful procedures are administered.

Breeding

Breeding programmes must follow the principles of responsible and balanced breeding that ensure that enough weight is given to fish health and welfare traits; including resistance to fish disease and

[14] Gino Nardocci, Cristina Navarro, Paula P. Cortés, Mónica Imarai, Margarita Montoya, Beatriz Valenzuela, Pablo Jara, Claudio Acuña-Castillo, Ricardo Fernández. (2014) Neuroendocrine mechanisms for immune system regulation during stress in fish. Fish & Shellfish Immunology. 40(2). https://www.sciencedirect.com/science/article/abs/pii/S1050464814002861

[15] M. Conde-Sieira, M. Chivite, J. M. Miguez, J. L. Soengas. (2018) Stress Effects on the Mechanisms Regulating Appetite in Teleost Fish. Frontiers in Endocronology. 9:631. https://www.frontiersin.org/articles/10.3389/fendo.2018.00631/full

[16] EUPAW, Guidelines on Water Quality and Handling for the Welfare of Farmed Vertebrate Fish, EU Platform on Animal Welfare Voluntary Initiative on Fish Welfare, 2020. https://food.ec.europa.eu/animals/animal-welfare/eu-platform-animal-welfare/platform-conclusions_en

[17] AAC, 2023. Recommendation on Fish Health Good Management Practices - https://aac-europe.org/wp-content/uploads/2023/10/AAC-Recommendation-on-Fish-Health-Good-Management-Practices-2.pdf

individual fishes robustness. Improved health and welfare are based on the natural defence mechanisms of farmed species[18].

Responsible and balanced breeding means that breeding strategies pay attention to animal health and welfare, as well as production and flesh quality traits, better use of resources and improved genetic diversity. Inbreeding is controlled under 1%, as recommended by FAO,as it drives lower robustness too. At least as much attention should be paid to criteria conducive to the improvement of fishes' welfare and health as to production criteria. Natural breeding procedures should be encouraged where practicable.

Guidance should cover:

- the selection of traits which impact positively or negatively on the welfare of fish
- Natural or artificial breeding procedures which cause poor welfare
- Genetic manipulations such as triploidy whenever causing negative effects on health and welfare
- Barren housing environments of juveniles failing to provoke fish to develop robustness

Handling

The immune systems[19] and appetites[20] of fish are especially vulnerable to stress. A short period of stress may bring long lasting effects including increased incidence of disease, increased mortality, reduced appetite, impaired development, and deformities[21]. Reducing instances of handling, and making them more gentle, is critical to providing good welfare and health.

The AAC endorses the best practices in the 'Guidelines on Water Quality and Handling for the Welfare of Farmed Vertebrate Fish' produced in the EU Platform on Animal Welfare[22]. Handling elements should include:

- Preparatory actions, eg fasting, acclimatisation, fitness inspection etc.
- Crowding
- Noise and other vibrations
- Time out of water
- Design and operation of pumping systems and nets
- Correct design and maintenance of equipment
- Backup/emergency plans
- Designation of personnel responsible for fish health during handling

[18] H. M. Nielsen, I. Olesen, S. Navrud, K. Kolstad, P. Amer. (2011) How to Consider the Value of Farm Animals in Breeding Goals. A Review of Current Status and Future Challenges. J Agric Environ Ethics. 24.

[19] Gino Nardocci, Cristina Navarro, Paula P. Cortés, Mónica Imarai, Margarita Montoya, Beatriz Valenzuela, Pablo Jara, Claudio Acuña-Castillo, Ricardo Fernández. (2014) Neuroendocrine mechanisms for immune system regulation during stress in fish. Fish & Shellfish Immunology. 40(2). https://www.sciencedirect.com/science/article/abs/pii/S1050464814002861

[20] M. Conde-Sieira, M. Chivite, J. M. Miguez, J. L. Soengas. (2018) Stress Effects on the Mechanisms Regulating Appetite in Teleost Fish. Frontiers in Endocronology. 9:631. https://www.frontiersin.org/articles/10.3389/fendo.2018.00631/full

[21] EUPAW, Guidelines on Water Quality and Handling for the Welfare of Farmed Vertebrate Fish, EU Platform on Animal Welfare Voluntary Initiative on Fish Welfare, 2020. https://food.ec.europa.eu/animals/animal-welfare/eu-platform-animal-welfare/platform-conclusions_en

[22] https://food.ec.europa.eu/system/files/2022-07/aw_platform_plat-conc_guide_farmed-fish_en.pdf

- Adequate monitoring

Transport

The period before, during and after transport carries a high risk for both fish welfare and production.

Guidance should include:

- Pre-Transport Planning and Preparations
- Journey Preparations
- Loading and Unloading
- The Journey
- Post-Journey

The AAC has developed a detailed position on best practices during transport here[23].

Slaughter

The EU Slaughter Regulation states that "Animals shall be spared any avoidable pain, distress or suffering during their killing and related operations" (Article 3(1)). There a very high risk of poor fish welfare period before and up to the point of slaughter.

Welfare guidelines for farmed fish at slaughter should incorporate WHOA (formerly OIE) recommendations which includes advice for all stages of the slaughter process including;

- Design of holding facilities
- Fish handling including loading, transferring and unloading
- Fasting periods
- Methods of stunning and killing
- Effective operation and maintenance of stunning equipment
- Verification of the effectiveness of stunning

Advice should take into account the suitability of available stunning and killing systems for different species, systems and scales of operation. Advice in relation to slaughter must include requirements for workers' safety including electrical safety.

There should be guidance on the testing and licensing of stunning machines to ensure that they are safe to use, that they deliver the required parameters, whether electrical or percussive, and that they effectively stun fish in practice.

The choice of stunning and killing method should take account of species-specific information when available.

This should take account of:

- The availability of parameters shown to prevent brain activity in that species

[23] Aquaculture Advisory Council, 2022. Recommendation on Fish Welfare in Live Fish Transport. https://aac-europe.org/en/recommendations/position-papers/373-aac-recommendation-on-fish-welfare-in-live-fish-transport.

- The availability of behavioural measures of consciousness
- The availability of stunning machines shown to be able to deliver those parameters and to achieve a humane kill in practice
- The need for methods and/or systems that are suitable for small and micro-enterprises and that are practical for the size of production and in a range of locations and conditions.

WHOA lists methods that enable humane killing for certain fish groups. This list should be updated; for example, electrical stunning is now commercially available for some European Seabass and Gilthead Seabream systems. The list should also be expanded to recommend combinations of stunning and slaughter suitable for each species.

The AAC has developed detailed positions on best practices during slaughter here[24] and here[25]. Council of Europe[26] and EFSA recommendations[27] should also be followed.

Emergency killing

Guidance should include protocols for emergency killing of fish, either individuals which are suffering or for emergency killing of large batches of fish. There should be contingency planning to deal with large-scale events.

As for methods of killing, similar principles should be applied to emergency killing. Fish must be rendered immediately unconscious and remains so until death. In addition to methods recommended for slaughter of fish, some additional killing methods which achieve the same objectives, such as the use of anaesthetic overdoses, can be considered with appropriate safeguards.

The recommendations of WOAH's Aquatic Animal Health Code on emergency killing should be incorporated into the recommendations.

We suggest that if fish are ill or injured to such an extent that suffering is chronic and treatment is no longer feasible and transport would cause additional suffering, they must be killed on the spot and without delay by a person properly trained and experienced in the effective techniques of humane killing.

Horizontal Measures

Indicators

A judicious combination of good input rules backed by measurements of the environment and the animals is required to ensure and assure that good fish welfare is achieved. This applies to all other

[24] Aquaculture Advisory Council, 2017. Report on farmed fish welfare during slaughter. https://aac-europe.org/en/publication/report-on-farmed-fish-welfare-during-slaughter/.
[25] Aquaculture Advisory Council, 2019. Fish welfare at slaughter. https://aac-europe.org/en/publication/fish-welfare-at-slaughter/.
[26] Standing committee of the European convention for the protection of animals kept for farming purposes, 2005. Recommendation concerning farmed fish. https://www.coe.int/t/e/legal_affairs/legal_co-operation/biological_safety_and_use_of_animals/Farming/Rec%20fish%20E.asp#:~:text=All%20fish%20species%20kept%20for,their%20biological%20characteristics%2C%20the%20scientific
[27] EFSA, 2009. Various recommendations on the slaughter of individual species are listed at https://www.efsa.europa.eu/en/topics/topic/fish-welfare.

headings in this document. Indicators can be used to assess welfare during rearing, transport and slaughter.

Welfare indicators may rely on observations made:

- on the animals themselves (animal-based or group-based)
- on the aquatic environment they are reared in (resource-based)
- or on the routines and protocols performed on-site (management-based).

These three types of data source provide complementary information about the welfare state of the fish. Indicators observed on the animals are also called *Direct* or *Output* indicators, while the other two types are also called *Indirect* indicators.

Detailed accounts of the use of indicators for Atlantic salmon and rainbow trout, and the science behind them, can be found in the *Fishwell* guides for these two species at https://nofima.com/press-release/download-the-fishwell-handbooks/.

When something is wrong, farmers can often quickly tell from the behaviour of the fish. Behaviours observed or measured included swimming and feeding behaviours and any behaviour that is abnormal in addition to physical measures such as injuries or skin and fin condition.

Frenetic behaviour at the surface could be a response to fear, lack of oxygen or other aspects of poor water quality. Failure to feed is commonly a sign of poor welfare. Conversely, exploratory behaviour, feeding and normal swimming behaviour can be a sign of positive welfare.

Assessing welfare through behaviour has several potential advantages if the right indicator is chosen. Behavioural observations are accessible and offer direct indications on the state of the animal that may be observed on site and in real time. The evidence that supports the adequacy of behavioural observations as welfare indicators when joined by deep ethological knowledge of the species has been in fact mounting in recent years.

There are general behavioural patterns associated with poor welfare states (including diseases, infections, fear, pain or negative cognitive states) that are transversal to several taxa (Kent et al., 1992; Sneddon, 2020; Sneddon et al., 2014). The neural networks underpinning these behaviours have even been recently identified (Ilanges et al., 2022). The use of behavioural variables as operational indicators of negative welfare is therefore increasingly rooted on solid neurophysiological evidence, which provides ever growing reliability for their use in industry context. Although far less is known about them, positive welfare states are a goal worth pursuing and therefore should be able to be identified and assessed.

The measurement of Operational Welfare Indicators (OWIs) formalises an experienced stockperson's observation and intuition. An OWI describes a behaviour which can be easily and effectively measured on the farm as a welfare assessment tool.

To qualify as an OWI, a behavioural measurement has to be:

1. Valid. It must clearly measure a behaviour that relates to welfare. Behavioural requirements vary with species and lifestage, so OWIs need to be species and lifestage-specific.
2. Reliable. You should get the same result whoever measures it and however they measure it.
3. Repeatable. It should be possible to get a consistent result if the measure is taken several times.
4. Comparable. It should be possible to compare the behaviour in different contexts, eg to determine the impacts of management, husbandry practices or systems

5. Suitable. It must be practicable for use in the system or during the husbandry practice being observed.

A list of OWIs which can be used during the rearing of the five main European species (Atlantic salmon, rainbow trout, gilthead seabream, European seabass or common carp) is shown in Table III of the AAC publication *Using Ethology to Improve Farmed Fish Welfare and Production* (accessible from https://aac-europe.org/en/recommendations/reports/459-using-ethology-to-improve-farmed-fish-welfare-and-production), published in 2022. Table IV from the same document, which follows it, explains how the indicators can be interpreted.

These indicators can be based on observations of both individuals and groups. Other group-based animal-based indicators include mortality, growth rates, disease and parasite levels and the appearance of scales or blood in the water.

Contingency planning

Aquaculture systems can be subject to a combination of bad weather, poor water quality, disease outbreaks and accidents. Fish may need to be handled and/or emergency slaughter carried out at short notice.

Systems should be designed and managed for robustness and the avoidance of such problems. Contingency plans should be in place for all farm management procedures and especially for handling procedures, including foreseen and unforeseen problems.

Training

All those involved in aquaculture need appropriate competence in matters that affect fish health and welfare. This includes Competent Authority personnel and veterinarians as well all farm personnel, managers and owners.

This should include an understanding of:

1. Natural needs, behaviour and physiology of the farmed species, including how fish respond to pain, stress and disease
2. Welfare indicators including normal behaviour, environmental factors, signs of disease and poor welfare
3. Methods for inspection of fish
4. Production conditions that are important for fish welfare
5. Best handling practices
6. Operation and maintenance of equipment
7. Environmental enrichment
8. Systems for management of water supply and quality control
9. Methods for the management of situations frequently encountered during the containment of fish
10. Methods for the management of unforeseen events including the design and implementation of contingency plans
11. Legal requirements for fish health and welfare

All farm personnel, managers and owners should receive training, refresher training, and role specific training regularly.

Planning

Guidance should include requirements for welfare management plans, approved by a veterinarian and regularly updated.

Record keeping

1. Guidance should include requirements for record keeping including allocation of responsibilities. Records will allow traceability of batches of fish including back to the production of the eggs. Records should include: Aquaculture animals and animal products taken in and out of the aquaculture facility, including place of origin and place of receptions.
2. Number of fish.
3. Weight of fish.
4. Stocking density.
5. Water quality measures.
6. Feeding times, methods and quantities.
7. Instances of use of medications.
8. Instances of use of mechanical treatments.
9. Instances of handling.
10. Mortality per unit of production relevant to the form of production, including the cause of mortality and any diseases diagnosed.
11. Results of completed health checks: number of completed health checks, sampling, examinations performed, diagnoses and completed treatments.
12. Methods of slaughter used, where carried out on-farm, and other measures including mis-stun rate and indicators of consciousness used

Record keeping requirements should balance such needs as fish health and welfare and biosecurity against the need to limit administrative burdens, especially for small enterprises. Different requirements for reporting should be rationalised to avoid repetition of recording, since much of this is already recorded at Member State level.

Inspections

Guidance should include responsibilities for, frequency of and requirements of regular inspections of the fish.

Annex: Existing Guidelines for Reference

Document	Source	Relevant to					
		Fee.	Env.	Hea.	Han.	Tra.	Sla.
Expert / Consensus / Policy Guidelines							
Atlantic Salmon Welfare Handbook	FISHWELL	Y	Y	Y	Y	Y	Y
Welfare Indicators for farmed rainbow trout: tools for assessing fish welfare	FISHWELL	Y	Y	Y	Y	Y	Y
Recommendation Concerning Farmed Fish	Council of Europe	Y	Y	Y	Y	Y	Y
Norwegian Regulation	Norway	Y	Y	Y	Y	Y	Y
EU Platform Guidelines on water quality & handling	EU Platform on Animal Welfare	Y	Y		Y	Y	Y
Farmed Salmonid Handbook	Ireland	Y	Y	Y	Y	Y	
Certified Quality Aquaculture Standards	Ireland	Y	Y	Y	Y	Y	
Aquatic Animal Health Code	WOAH	Y			Y	Y	Y
Research for ANIT Committee: Particular welfare needs in animal transport: aquatic animals	European Parliament research services					Y	
AAC Slaughter Positions 1 & 2	AAC						Y
AAC Transport Position	AAC					Y	
Fish Health and Welfare During Transport	Italy					Y	
Fish Welfare During Transport	Bavaria					Y	
Fish Welfare Guidelines	Spain, APROMAR, Equalia, CIWF	Y	Y	Y	Y	Y	Y
Fish Slaughter Best Practice Guidelines	AENOR						Y
Stakeholder Guidelines							

Farming White Paper	Eurogroup for Animals	Y	Y	Y	Y		
Transport White Paper	Eurogroup for Animals					Y	
Food Business Resources	Compassion in World Farming	Y	Y	Y	Y	Y	Y
Key Aquatic Animal Welfare Recommendations for Aquaculture	Aquatic Life Institute	Y	Y	Y	Y	Y	Y
Environmental Enrichment in Aquaculture	Aquatic Life Institute		Y				
Code EFABAR	EFFAB	Y	Y	Y	Y		
Mediterranean Fish Welfare: Guide to good practices and assessment indicators	HAPO						
Guide to good practices. Welfare in fish farm, breeding and transport.	CIPA	Y	Y	Y	Y	Y	
Stunning and Slaughter: Best Practices for Animal Welfare in Aquaculture	Aquatic Life Institute						Y

Aquaculture Advisory Council (AAC)
Rue Montoyer 31, 1000 Brussels, Belgium

Tel: +32 (0) 2 720 00 73
E-mail: secretariat@aac-europe.org
Twitter: @aac_europe
www.aac-europe.org