AQUATIC LIFE INSTITUTE

Recommendations for Aquaculture Certification Schemes to Improve Animal Welfare Standards

November 2022

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Here we have included our recommendations for aquaculture standard improvement as it directly relates to aquatic animal health and welfare. We have based these recommendations on the 5 primary pillars of welfare identified in our Aquatic Welfare Guide.

General Notes:

For the first edition of this benchmark, we did not look at additional documents such as independent feed, facility, or hatchery standards. We are solely looking at the "health and welfare" section of the main certification standard requirements. We recognize that in most current standards, feed content (particularly FIFO, insects, and general composition) was out of scope as they only focused on the welfare of the farmed fish. However, it's important for us to emphasize the significance of this aquafeed topic as it relates to the welfare of *all* fish. We would like to promote the recognition of feed composition and welfare in principal certification standard requirements and are keeping this topic in mind for future versions of the benchmark.

For each of the 5 pillars of welfare analyzed in this benchmark, the overarching goal is to have species-specific requirements according to the best available scientific evidence. Therefore, vague or general language regarding each criteria for animal welfare in aquaculture standards were not granted full points, however, the presence of welfare language was acknowledged where appropriate. With that being said, areas where language leaves room for misinterpretation were also not awarded full points. For example, we believe "industry best practices regarding health and welfare" could translate to preventing the worst kind of farming practices, however, it does not encourage or require optimal welfare practices

At present, several aquaculture certification schemes only certify a narrow range of fin-fish species, while others who certify a wider range of species do not adequately address specific welfare provisions which leaves a large portion of the market without strong fish welfare protections. Therefore we encourage certifications to extend their species specific guidelines to all major farmed species including Grass, Silver and Common Carp, Nile tilapia, and Catla.

Benchmark criteria points are in black.
Certifier language is in blue.
ALI feedback is in red.

Global Animal Partnership (GAP):

GAP provides some of the strongest protections for aquatic animal welfare in their newly released Atlantic salmon welfare standards. The biggest concern we have at present relates to potential confusion surrounding their current Step Level system (1,3, and 5). Having a 3-tiered system instead of a 2-tiered system could perhaps resolve some questions or discrepancies that could arise. We have listed several recommendations for improvement below:

Step Level 1:

1. Water Quality (1.8)
    a. *There is a range of acceptable measures provided for a wider variety of water quality parameters.*
        i. 5.2.3 For salmon reared in tanks, water quality must adhere to the following limits: ■ Oxygen Saturation: 80-100% ■ Temperature: 8-16°C (46-60°F) 7 ■ Maximum Free Ammonia: .025 mg/L ■ Maximum Carbon dioxide (CO2): 15 mg/L-1 ■ pH: 6.2-7.8 ■ Maximum Nitrate: 100 mg/L-1 ■ Maximum Nitrite: .1 mg/L-1
        ii. Numerical limits for suspended solids/turbidity could be added.
2. Space Requirements and Stocking Density (2)
    a. (No comment)
3. Environmental Enrichment (1.1)
    a. *Animals experience the correct amount and type of contact with conspecifics.*
        i. N/A
        ii. Stocking densities must be set, monitored, and adjusted according to species' natural hierarchy structure and reproductive habits.
    b. *Physical and psychological stimulation allows for the expression of behaviors that promote psychological well-being.*
    c. *Holding environment modifications to include structural complexity, shelter, and visual stimulation.*
    d. *Introducing a diversity of visual, auditory, olfactory, tactile and taste stimuli.*
        i. 5.4.1 Enrichment must be provided by the time fry are ready for first feeding at 1 month old.
        ii. 5.4.2 Fry and parr must be provided with at least 1 Type A enrichment (See Appendix VII) per pen/tank.
        iii. 5.4.5 Smolts must be provided with environmental enrichments which alter either the direction or velocity of the current in their pen/tank (See Appendix VII).

iv. 5.4.6 Adult salmon must be provided with 1 Type A enrichment (See Appendix VII) per pen/tank.
v. 5.4.8 Enrichments must be evenly distributed throughout the tank or pen.
vi. Type A includes Substrate, Submerged hides (only for freshwater production), Hanging curtain and Moving Light Array.
vii. Refer to Step Level 3 requirements for recommendations.

e. *The use of feed enhanced with appropriate nutrients, the amount and variety of food available, feeding frequency, and/or delivery system.*
i. N/A
ii. Introducing a combination of self-feeding through the use of an automatic system, coupled with hand feeding to observe fish behavior and make any adjustments where necessary.

4. Feed Composition (1.175)
a. *Limits the amount of fishmeal and fish oil (FMFO) used in aquafeed.*
i. 7.4.1 The average annual FIFO ratio must be recorded.
ii. 7.4.2 The average annual FIFO ratio must not exceed 1.5:1
iii. FIFO should be calculated according to each production cycle.
b. *Encourages feed compositions that contain as much plant-based content as possible, including algae and emerging new technologies (mycelium. etc).*
i. N/A
ii. The proportion of animal feed components must be replaced by plant-based/alternative fishmeal and fish oil products wherever nutritionally possible.
c. *Requires FMFO to be sourced from offcuts and byproducts of human animal consumption.*
i. N/A
ii. If aquatic animal feed components are used, then they must be sourced using fishmeal/fish oil from trimmings of wild fish processed for human consumption, and fishmeal/fish oil from by-catches of captures for human consumption according to applicable regulations and initiatives.
d. *Consider fish's ability to access and digest food.*
i. 7.1.3 Feed must be distributed over at least 75% of the surface of the tank or pen to allow all salmon to access food.
ii. Feeding behavior should be monitored to ensure all fish have access to food, and adjustments should be made when necessary. Feed can be dispensed from various sources to limit resource aggression.

5. Stunning and Slaughter (1.9)

a. *Fish should be regularly assessed for signs of consciousness after stunning.*
b. *Slaughter workers should be trained in a well-defined way and mistakes should be rare.*
    i. 1.1.5 The auditor will assess at least 500 salmon based on appendix III.
    ii. Slaughter operations must provide training to all staff (whether full-time, part-time, seasonal or contractual) and/or managers that: is written and/or hands-on; is presented in all necessary languages; describes all aspects of the individual's responsibilities; describes emergency procedures; is provided prior to the individual's handling of any fish on the operation; is on-going as necessary and, at a minimum, when any changes affecting the slaughter of salmon are implemented.
    iii. Workers should be trained in assessing signs of consciousness after stunning and throughout the slaughter process in accordance with appendix III.

Step Level 3:

1. Water Quality (1.8)
    a. *There is a range of acceptable measures provided for a wider variety of water quality parameters.*
        i. 5.2.3 For salmon reared in tanks, water quality must adhere to the following limits: ▪ Oxygen Saturation: 80-100% ▪ Temperature: 8-16°C (46-60°F) 7 ▪ Maximum Free Ammonia: .025 mg/L ▪ Maximum Carbon dioxide (CO_2): 15 mg/L-1 ▪ pH: 6.2-7.8 ▪ Maximum Nitrate: 100 mg/L-1 ▪ Maximum Nitrite: .1 mg/L-1
        ii. Numerical limits for suspended solids/turbidity could be added.
2. Space Requirements and Stocking Density (2)
    a. (No comment)
3. Environmental Enrichment (1.325)
    a. *Animals experience the correct amount and type of contact with conspecifics.*
        i. N/A
        ii. Stocking densities must be set, monitored, and adjusted according to species' natural hierarchy structure and reproductive habits.
    b. *Physical and psychological stimulation allows for the expression of behaviors that promote psychological well-being.*
    c. *Holding environment modifications to include structural complexity, shelter, and visual stimulation.*

d. *Introducing a diversity of visual, auditory, olfactory, tactile and taste stimuli.*
e. *The use of feed enhanced with appropriate nutrients, the amount and variety of food available, feeding frequency, and/or delivery system.*
    i. 5.4.1 Enrichment must be provided by the time fry are ready for first feeding at 1 month old.
    ii. 5.4.3 Fry and parr must be provided with at least 1 Type A enrichment (See Appendix VII) per pen/tank.
    iii. 5.4.7 Adult salmon must be provided with 2 types of enrichment (See Appendix VII) per pen/tank.
    iv. 5.4.8 Enrichments must be evenly distributed throughout the tank or pen.
    v. Type A includes Substrate, Submerged hides (only for freshwater production), Hanging curtain and Moving Light Array.
    vi. Type B also includes Overhanging or over tank/pen cover, Alternating water current velocity (only for freshwater production), Bubble Curtain, Simultaneous feed distributed at different depths (only for marine production).
    vii. The combination of enrichment types A and B should be increased to the extent that other areas of welfare are not impaired.

4. <u>Feed Composition (1.3)</u>
    a. *Encourages feed compositions that contain as much plant-based content as possible, including algae and emerging new technologies (mycelium. etc).*
        i. N/A
        ii. The proportion of animal feed components must be replaced by plant-based/alternative fishmeal and fish oil products wherever nutritionally possible.
    b. *Requires FMFO to be sourced from offcuts and byproducts of human animal consumption.*
        i. N/A
        ii. If aquatic animal feed components are used, then they must be sourced using fishmeal/fish oil from trimmings of wild fish processed for human consumption, and fishmeal/fish oil from by-catches of captures for human consumption according to applicable regulations and initiatives.
    c. *Consider fish's ability to access and digest food.*
        i. 7.1.3 Feed must be distributed over at least 75% of the surface of the tank or pen to allow all salmon to access food.
        ii. Feeding behavior should be monitored to ensure all fish have access to food, and adjustments should be made when necessary.

Feed can be dispensed from various sources to limit resource aggression.

5. Stunning and Slaughter (1.9)
    a. *Fish should be regularly assessed for signs of consciousness after stunning.*
    b. *Slaughter workers should be trained in a well-defined way and mistakes should be rare.*
        i. 1.1.5 The auditor will assess at least 500 salmon based on appendix III.
        ii. Slaughter operations must provide training to all staff (whether full-time, part-time, seasonal or contractual) and/or managers that: is written and/or hands-on; is presented in all necessary languages; describes all aspects of the individual's responsibilities; describes emergency procedures; is provided prior to the individual's handling of any fish on the operation; is on-going as necessary and, at a minimum, when any changes affecting the slaughter of salmon are implemented.
        iii. Workers should be trained in assessing signs of consciousness after stunning and throughout the slaughter process in accordance with appendix III.

Step Level 5:

1. Water Quality (1.8)
    a. *There is a range of acceptable measures provided for a wider variety of water quality parameters.*
        i. 5.2.3 For salmon reared in tanks, water quality must adhere to the following limits: ▪ Oxygen Saturation: 80-100% ▪ Temperature: 8-16°C (46-60°F) 7 ▪ Maximum Free Ammonia: .025 mg/L ▪ Maximum Carbon dioxide (CO_2): 15 mg/L-1 ▪ pH: 6.2-7.8 ▪ Maximum Nitrate: 100 mg/L-1 ▪ Maximum Nitrite: .1 mg/L-1
        ii. Numerical limits for suspended solids/turbidity could be added.
2. Space Requirements and Stocking Density (2)
    a. (No comment)
3. Environmental Enrichment (1.415)
    a. *Animals experience the correct amount and type of contact with conspecifics.*
        i. N/A
        ii. Stocking densities must be set, monitored, and adjusted according to species' natural hierarchy structure and reproductive habits.
    b. *Physical and psychological stimulation allows for the expression of behaviors that promote psychological well-being.*

c. *Holding environment modifications to include structural complexity, shelter, and visual stimulation.*
d. *Introducing a diversity of visual, auditory, olfactory, tactile and taste stimuli.*
e. *The use of feed enhanced with appropriate nutrients, the amount and variety of food available, feeding frequency, and/or delivery system.*
    i. 5.4.1 Enrichment must be provided by the time fry are ready for first feeding at 1 month old.
    ii. 5.4.4 Fry and parr must be provided with at least two (2) Type A and one (1) Type B enrichments (See Appendix VII) per pen/tank.
    iii. 5.4.5 Smolts must be provided with environmental enrichments which alter either the direction or velocity of the current in their pen/tank (See Appendix VII).
    iv. 5.4.6 Adult salmon must be provided with 1 Type A enrichment (See Appendix VII) per pen/tank.
    v. 5.4.8 Enrichments must be evenly distributed throughout the tank or pen.
    vi. Type A includes Substrate, Submerged hides (only for freshwater production), Hanging curtain and Moving Light Array
    vii. Type B also includes Overhanging or over tank/pen cover, Alternating water current velocity (only for freshwater production), Bubble Curtain, Simultaneous feed distributed at different depths (only for marine production).
    viii. Novel innovations for various types of enrichments are required at this step level. Producers should be encouraged to develop trial enrichments in partnership with fish welfare specialists and aquatic animal veterinarians in order to contribute to the existing enrichment knowledge base. Areas that could be considered for future study include: combinations of a variety of heterogeneous structures in the same enclosure, auditory stimuli such as noise and music, the correct amount of environmental predictability, and chemical stimuli related to olfaction, taste, or chemosensing. For example, food chemical signals may serve as enrichments in the form of chemical attraction and feeding stimulation. Attractants result in faster detection which could reduce energy expenditure for the fish while reducing waste, which has positive effects on water quality and feed cost. Feeding stimulants have an effect on satiation and modulate food ingestion with relevant effects on growth, and there is potential to use these chemicals to

stimulate and enrich the farm environment while reducing the ecological impacts of forage fisheries.[1]

4. Feed Composition (1.3)
    a. *Encourages feed compositions that contain as much plant-based content as possible, including algae and emerging new technologies (mycelium. etc).*
        i. N/A
        ii. The proportion of animal feed components must be replaced by plant-based/alternative fishmeal and fish oil products wherever nutritionally possible.
    b. *Requires FMFO to be sourced from offcuts and byproducts of human animal consumption.*
        i. N/A
        ii. If aquatic animal feed components are used, then they must be sourced using fishmeal/fish oil from trimmings of wild fish processed for human consumption, and fishmeal/fish oil from by-catches of captures for human consumption according to applicable regulations and initiatives.
    c. *Consider fish's ability to access and digest food.*
        i. 7.1.3 Feed must be distributed over at least 75% of the surface of the tank or pen to allow all salmon to access food.
        ii. Feeding behavior should be monitored to ensure all fish have access to food, and adjustments should be made when necessary. Feed can be dispensed from various sources to limit resource aggression.
5. Stunning and Slaughter (1.9)
    a. *Fish should be regularly assessed for signs of consciousness after stunning.*
    b. *Slaughter workers should be trained in a well-defined way and mistakes should be rare.*
        i. 1.1.5 The auditor will assess at least 500 salmon based on appendix III.
        ii. Slaughter operations must provide training to all staff (whether full-time, part-time, seasonal or contractual) and/or managers that: is written and/or hands-on; is presented in all necessary languages; describes all aspects of the individual's responsibilities; describes emergency procedures; is provided prior to the individual's handling of any fish on the operation; is on-going as

[1]Arechavala-Lopez, Pablo, et al. "Environmental Enrichment in Fish Aquaculture: A Review of Fundamental and Practical Aspects." Reviews in Aquaculture, vol. 14, no. 2, 10 Oct. 2021, pp. 704–728, 10.1111/raq.12620

necessary and, at a minimum, when any changes affecting the slaughter of salmon are implemented.

iii. Workers should be trained in assessing signs of consciousness after stunning and throughout the slaughter process in accordance with appendix III.

RSPCA Assured:

The RSPCA Atlantic salmon and Rainbow trout standards also incorporate strong animal welfare considerations.

The areas with the most room for improvement are within environmental enrichment and feed composition. Throughout their standards, the RSPCA does not directly address environmental enrichment as a necessity for farmed fish, and only provides holding environment modification requirements for cleaner fish being used. They fail to set standards for feed composition and monitoring to ensure the minimal amount of FMFO is used. As their standards cover salmon and trout, two predominantly carnivorous species, this is of particular importance. Recommendations can be found below:

1. Water Quality (2)
    a. (No comment)
2. Space Requirements and Stocking Density (2)
    a. (No comment)
3. Environmental Enrichment (0.4)
    a. *Animals experience the correct amount and type of contact with conspecifics.*
        i. N/A
        ii. Stocking densities and the space provided per individual must be set, monitored, and adjusted according to the species' natural hierarchy structure, behaviors in their natural environment versus in captivity, reproductive habits, familiarity and personality.
    b. *Physical and psychological stimulation allows for the expression of behaviors that promote psychological well-being.*
        i. The units in which fish are kept should be designed with full consideration of their welfare needs, and should protect them from physical or physiological discomfort, distress and injury, and allow them to perform natural behaviors. The stock-keeper is responsible for providing the life support system for farmed fish

and should maintain the highest environmental quality at all times.

ii. Whichever net design is being used, the proportion of the cone which is included in stocking density calculations must permit a minimum of a 5m diameter swim circle.

iii. Adequate husbandry does not necessarily constitute an enriched environment. Therefore, interventions using substrate (real or artificial), submerged structures, hanging curtains, light arrays, tank/pen cover, alternating water current velocities, and bubble curtains can be used as active enrichment methods to promote psychological well-being in farmed fish.

c. *Holding environment modifications to include structural complexity, shelter, and visual stimulation.*

i. For wrasse over 10 grams, suitable environmental enrichment, such as artificial kelp and hides, must be provided.

ii. Sea pen environment/enrichment: lumpfish. Pens must have suitable structures and substrates to provide the lumpfish with adequate refuges and places to rest.

iii. Artificial kelp, hides, structures, and substrates for adequate refuges and places to rest should be provided to *all* fish within the enclosure. These modifications would establish a level of complexity to the environment to increase stimulation, promote positive interactions between animals, decrease stress and susceptibility to disease, and increase welfare for all fish being farmed. Species-specific adjustments would need to be made and closely monitored (i.e. aggression and territoriality in salmonids).

d. *Introducing a diversity of visual, auditory, olfactory, tactile and taste stimuli.*

i. N/A

ii. Animals must be provided with sensory stimulation. This can incorporate several different components, however, the area with the most readily available knowledge is related to lighting variations.

iii. Natural or artificial lighting, using suitable intensities and colors, strategically placed to provide day/night simulations, or strategically placing lamps at lower depths within the enclosure to encourage deeper swimming behavior are forms of visual enrichments in aquatic environments.

e. *The use of feed enhanced with appropriate nutrients, the amount and variety of food available, feeding frequency, and/or delivery system.*

i. N/A

ii. Introducing a combination of self-feeding through the use of an automatic system, coupled with hand feeding to observe fish behavior and make any adjustments where necessary.

f. *The scheme should have a commitment to update their standards for enrichment as new research on the motivations and needs of fish emerge.*

i. The RSPCA are aware of trials examining the introduction of environmental enrichment to tanks to reduce fin damage. The results from such trials would be greatly appreciated by the RSPCA Farm Animals Department in order to inform future standards.

ii. Environmental enrichment can indeed be used as a method to reduce fin damage. However, there are many additional benefits to incorporating enrichment interventions throughout the production cycle. A commitment to actively participate in and update enrichment requirements according to the best available science in a timely manner would have a far greater impact on certified aquatic animal welfare.

4. <u>Feed Composition (0.3)</u>

a. *Limits the amount of fishmeal and fish oil (FMFO) used in aquafeed.*

i. N/A

ii. The fish used to feed salmonids have similar welfare needs, thus creating a 'welfare pyramid' effect, as each farmed salmon must eat the biomass equivalent of 9 herring, or 120 anchovies, to be brought to harvest weight. The farming of these carnivorous species contributes to the existing strain on wild fisheries. In order to alleviate pressure on wild, "reduction" fisheries used for fishmeal and fish oil, it's imperative that farms calculate fish-in-fish-out (FIFO) ratios for each production cycle, and place limits accordingly on the amount of fishmeal and fish oil being used.

b. *Prohibits the use of insects in feed.*

i. N/A

ii. Industry uptake of farming insects for use in animal feed poses a series of risks. Considering the availability of plant-based alternatives, insect agriculture for fish feed does not bear out on a risk-benefit analysis. An analysis of the best available evidence shows that, despite insect meal's market potential, it embodies or enhances each of the risks already present in finfish farming, in a new domain. There is also the uniquely high levels of processing cost required for this feed. Arable coproducts are farmed and processed, and then fed to insects, which are farmed and

processed, to be fed to fish, which are farmed and processed, to be fed to humans. As salmonids represent the only infraclass of obligate finfish carnivores that we farm, this is a trophic pyramid without precedent, where the direct human consumption product will require multiple levels of processing. The introduction of an extra trophic level to the farming system has the potential to outweigh any costs saved by utilizing insects as feed.

c. *Encourages feed compositions that contain as much plant-based content as possible, including algae and emerging new technologies (mycelium. etc).*
    i. N/A
    ii. The proportion of animal feed components must be replaced by plant-based/alternative fishmeal and fish oil products wherever nutritionally possible.
d. *Requires FMFO to be sourced from offcuts and byproducts of human animal consumption.*
    i. N/A
    ii. If aquatic animal feed components are used, then they must be sourced using fishmeal/fish oil from trimmings of wild fish processed for human consumption, and fishmeal/fish oil from by-catches of captures for human consumption according to applicable regulations and initiatives.
e. *Consider fish's ability to access and digest food.*
    i. Fish should have freedom from hunger and malnutrition by ready access to a high quality diet that is appropriate to their species, and allows full health to be maintained.
    ii. Feeding must be such that the quality, quantity and frequency are optimal for the fish's stage of development.
    iii. All feed must be manufactured from constituents that are free from active parasites and known fish pathogens and contamination.
    iv. All feeds used must be produced strictly to the standards laid down by all the relevant UK and EU legislation.
    v. Food must be dispensed and distributed in such a way that fish can eat without undue competition.
    vi. Fish must be observed at least once a day during feeding.
    vii. The person feeding must check that fish on the periphery of the tank or enclosure receive adequate amounts of food.
    viii. Overfeeding must be avoided.
    ix. Feed can be dispensed from various sources to limit resource aggression, increase equal access to food, and decrease adverse behavioral habits.

5. Stunning and Slaughter (1.8)
    a. *Explicitly bans the use of ice slurry, CO2, ammonia bath, salt, and other inhumane methods of slaughter.*
        i. All fish must be humanely stunned/killed.
        ii. S 1.4 The method of stunning/killing used must rapidly, and without pain and distress, render the fish insensible, until death supervenes.
        iii. S 1.4.1 Permitted stunning/killing methods for marine sourced trout are: a) an effectively applied percussive blow b) electronarcosis followed by bleeding or, c) electrocution.
        iv. In order to avoid any clarification issues related to what can be characterized as “humane” versus “inhumane” methods of stunning and slaughter, explicit wording must be used.

Naturland:

Naturland imposes water quality standards that are more focused on the pollution of surrounding waters rather than measuring and maintaining optimal (not just adequate) conditions within actual enclosures. Naturland has somewhat adequate environmental enrichment, although this is largely due to their requirements for natural vegetation in ponds as an organic aquaculture label, which is not necessarily motivated by the welfare of the fish. This could be improved by acknowledgment of the direct benefits of environmental enrichment and a commitment to update standards based on future research. The other major weaknesses are the lack of any standards for slaughterhouse worker training on welfare. Although slaughter is a relatively short time at the end of a fish's life, these are intensely stressful experiences. The lack of any recommendations here reflects the broader trend with Naturlands standards, a concern for the environment rather than the fish.

1. Water Quality (0.8)
    a. *There is a range of acceptable measures provided for a wider variety of water quality parameters.*
    b. *These measures consider species and life stage and are based on best available science evidence.*
        i. The water quality (e.g. temperature, pH, salinity, oxygen, ammonium and nitrate concentrations) must conform to the natural requirements of the species in question.
        ii. More specific water quality requirements given by species in the appendices. However many of these focus on pollution levels rather than other important parameters for welfare.

2. Space Requirements and Stocking Density (2)
    a. (No comment)
3. Environmental Enrichment (0.9375)
    a. *Animals experience the correct amount and type of contact with conspecifics.*
    b. *Physical and psychological stimulation allows for the expression of behaviors that promote psychological well-being.*
        i. 4.1 The husbandry conditions must enable the animal to behave in a way natural to the species; this refers, in particular, to behavioral needs regarding movement, resting and feeding as well as social and reproduction habits. The husbandry systems shall be designed keeping all this in view, e.g. in respect of stocking density, soil, shelter, shade and flow conditions.
        ii. Enrichment provisions should be actively pursued for improved welfare of the animals being farmed and should extend beyond "natural" husbandry techniques. Behaviors should be closely monitored and adjustments should be made accordingly.
    c. *Holding environment modifications to include structural complexity, shelter, and visual stimulation.*
        i. Various provisions for different species:
        ii. Carp: On average, at least 30% of embankment line shall represent the natural biotope structure to at least 2 m depth in the form of a helophytic zone, reed and/or overhanging trees/shrubs.
        iii. Tropical Fish: In pond farms, on at least 10% of production area, the natural vegetation shall be allowed to develop undisturbed (as a refuge for native animal species).
        iv. Native ecosystem health, wild animal welfare, and farmed animal welfare are of equal importance. Naturland's provisions take into account the significance of preserving the natural environment to the extent physically possible, and the significance of minimizing negative impacts on wild animal populations, however, fail to address the benefits that intentional enrichments could have on farmed animal quality of life. Explicitly and consciously modifying the farmed animal enclosures could help producers, other certification schemes, and the aquaculture industry appreciate the value of environmental enrichments and organic standards could emerge as a leader in this field as new innovations are explored.
    d. *Introducing a diversity of visual, auditory, olfactory, tactile and taste stimuli.*
        i. 4.1 If there is sufficient evidence that artificial illumination is necessary, then the simulated day length shall not exceed 14

hours, unless longer periods are required to induce reproductive effects (e. g. to prevent cod from spawning and salmon from smoltification).

ii. Natural or artificial illumination, using suitable intensities and colors, should be strategically placed to provide appropriate day/night simulations. Many species depend on natural lighting cycles for normal development, growth, and reproduction. Adequate light is crucial, as each species must be reared in a specific range according to their life stage and surrounding environment. Swimming behavior of aquatic animals can be greatly affected by both natural and artificial lighting. Strategically placing lamps at lower depths within the enclosure can encourage fish to swim deeper. As fish utilize more of the available space provided, crowding and chances of aggression are reduced, and water quality and the physical experience of each fish are improved.

e. *The use of feed enhanced with appropriate nutrients, the amount and variety of food available, feeding frequency, and/or delivery system*.

i. Depending on the species, ecological modifications through organic production leads to natural feed availability and natural habitat structure.

ii. Submerged dispensing machines could promote self-feeding, ultimately allowing fish more reliable access to food. Fish could learn about the machines and explore risk, as well as choose between several different machines containing varying feed formulations to self-regulate nutritional intake. If these machines are not used or available, adjusting the feeding schedule/area where feed is dispersed to allow some level of variation could also have beneficial effects on welfare, so long as fish do not display competitive/aggressive behavior.

f. The scheme should have a commitment to update their standards for enrichment as new research on the motivations and needs of fish emerge.

i. Naturland's holistic approach encourages extensive to semi-intensive production and inclusion of biodiversity promoting modifications.

ii. We recognize that an organic or holistic approach to production results in the inevitable incorporation of more natural elements in the farming system. However, in order to encourage an industry-wide push for more robust aquatic animal welfare considerations across the board, it's imperative to explicitly state the importance of and intention behind the use of a more

"natural" farming system. For example, producers should actively pursue novel environmental enrichment opportunities on a species-specific basis, instead of merely allowing a more natural farming system to function independently without acknowledging the physical and psychological benefits for aquatic animals and without exploring areas of improvement.

4. Feed Composition (1.3)
    a. *Prohibits the use of insects in feed.*
        i. N/A
        ii. Industry uptake of farming insects for use in animal feed poses a series of risks. Considering the availability of plant-based alternatives, insect agriculture for fish feed does not bear out on a risk-benefit analysis. An analysis of the best available evidence shows that, despite insect meal's market potential, it embodies or enhances each of the risks already present in finfish farming, in a new domain. There is also the uniquely high levels of processing cost required for this feed. Arable coproducts are farmed and processed, and then fed to insects, which are farmed and processed, to be fed to fish, which are farmed and processed, to be fed to humans. As salmonids represent the only infraclass of obligate finfish carnivores that we farm, this is a trophic pyramid without precedent, where the direct human consumption product will require multiple levels of processing. The introduction of an extra trophic level to the farming system has the potential to outweigh any costs saved by utilizing insects as feed.
    b. *Requires FMFO to be sourced from offcuts and byproducts of human animal consumption.*
        i. 8.4 Special requirements are made as to the origin of fish meal/oil (ref. Appendix 1)
        ii. The following sources are permissible: products from organic aquaculture, fishmeal/-oil from trimmings of wild fish processed for human consumption, fishmeal/-oil from by-catches of captures for human consumption in line with corresponding regulations and initiatives.
        iii. Establishing usage limits and transparent process explanations in order to encourage additional use of fishmeal and fish oil alternatives should be considered.
    c. *Consider fish's ability to access and digest food.*
        i. 2.7 Unsatisfactory feed conversion is an indication of increased nutrient outflow, which is why the feed conversion ratio must be measured several times during the life cycle and adapted where necessary.

ii. 8.7 For certain farming systems, an upper limit for the quantities of feed introduced may be determined (ref. B.Supplementary Regulations for specific farming systems and animal species).
iii. The entire population of farmed fish should have reliable access to food and every attempt should be made by the farmer to avoid resource aggression during feeding. Behaviors should be monitored during the entire feeding process and adjustments should be made where necessary.

5. Stunning and Slaughter (1.45)
   a. *Explicitly bans the use of ice slurry, CO2, ammonia bath, salt, and other inhumane methods of slaughter.*
      i. N/A
      ii. In order to avoid any clarification issues related to what can be characterized as “humane” versus “inhumane” methods of stunning and slaughter, explicit wording must be used.
   b. *There should be a backup slaughter method to stun and then humanely kill any fish that are alive and conscious after the initial stunning or slaughter method.*
   c. *Fish should be regularly assessed for signs of consciousness after stunning.*
   d. *Slaughter workers should be trained in a well-defined way and mistakes should be rare.*
      i. 9 A reporting protocol for slaughter which governs the proceedings adopted in connection with catching, sorting, caging, stunning and killing in detail is to be submitted prior to initial certification and co-ordinated with Naturland and must be brought up to date as required. It must include the following details: responsibilities, proof of expertise of those carrying out the procedures, the timing of all processes and the place where they are performed, from catch to slaughter, equipment and substances used stunning (e. g. type of procedure, type of facility, setting, and maintenance of apparatuses), monitoring of success of stunning, measures to be taken in the case of unsuccessful stunning, repeat stunning, kill (e. g. cutting line), and environmentally sound disposal of slaughtering waste.
      ii. A back-up method of stunning must be available at all times to humanely stun fish that display signs of consciousness during the stunning and slaughter process.
      iii. Fish must be carefully observed throughout the process to ensure that none of them are showing any signs of recovery before any further handling of them. Trained slaughter workers should monitor and record the presence or absence of:

1. eye movement
2. rhythmic opercular movement
3. involuntary muscular twitches
4. fish turn over
5. signs of fish attempting to swim

iv. Slaughter workers should be trained in a universal and well-defined way so that mistakes are rare. All workers involved in the stunning and slaughter process must be able to identify when fish have been stunned properly and intervene where improper stunning has occurred. A designated fish welfare management personnel should be identified, present, and actively participate in all stunning and slaughter operations.

e. Culling of fish should use an effective stunning method and respect animal welfare.
   i. N/A
   ii. Any ill or injured fish incapable of recovery must be immediately and humanely killed. Emergency killing methods such as a non-recoverable, percussive blow to render the animal immediately insensible, must be performed by trained personnel.

f. Minimize time between stunning and slaughter in order to minimize risk of consciousness being recovered.
   i. N/A
   ii. Example of an acceptable provision: automated percussive stunning or electrical stunning followed by exsanguination within 10 seconds.

Friend of the Sea:

Their species-specific standards have added broad provisions that are intended to protect the welfare of many species of farmed fish. The main strengths of these new standards are the strong requirements for employee training and good standards for slaughter. Listing more specific information for each species related to stocking density, environmental enrichment, and feed composition would help improve their standard requirements.

1. <u>Water Quality (1.2)</u>
   a. *There is a range of acceptable measures provided for a wider variety of water quality parameters.*

b. *These measures consider species and life stage and are based on the best available evidence.*
    i. 2.1 A contingency plan must exist to correct water quality parameters when they deviate from reference values.
        1. 2.2 Temperature should be verifiable at all times and must fall between 'X - X' (depending on species).
        2. Oxygen levels must be verifiable at all times and must be > 70% oxygen saturation (certain requirements dependent on species).
    ii. While it's imperative to continuously monitor and correct water temperature and dissolved oxygen, these water quality parameters do not necessarily address improving welfare conditions or providing optimal water quality within the enclosures because these are the two parameters that are essential simply for survival. Depending on the species being farmed, numerical values, ranges, or limits should be listed for additional water quality parameters such as: free ammonia, carbon dioxide, pH, suspended solids, nitrate, nitrite, etc.

2. <u>Space Requirements and Stocking Density (1)</u>
    a. *Stocking density requirements should be based on the best available scientific evidence for the species and life stage.*
    b. *Include specific numerical limits.*
        i. 1.1 Production units should provide horizontal and vertical withdrawal space, optimizing fish welfare conditions regarding spatial constraints.
        ii. 13.2 Stocking density should be monitored in relation to fish health and behavior indicators (Section 3 Animal Health and Welfare; Section 12 Welfare Assessment).
        iii. Stocking densities are highly dependent on species, however, the numbers that are provided include extremely large ranges with no example calculation or guidance as to how densities should be calculated. Production units should have more conservative stocking densities to ensure optimal welfare, and must provide substantial justification for any increases that may occur.
3. <u>Environmental Enrichment (0.3)</u>
    a. *Animals experience the correct amount and type of contact with conspecifics.*
    b. *Physical and psychological stimulation allows for the expression of behaviors that promote psychological well-being.*
    c. *Holding environment modifications to include structural complexity, shelter, and visual stimulation.*

d. *Introducing a diversity of visual, auditory, olfactory, tactile and taste stimuli.*
e. *The use of feed enhanced with appropriate nutrients, the amount and variety of food available, feeding frequency, and/or delivery system.*
f. *The scheme should have a commitment to update their standards for enrichment as new research on the motivations and needs of fish emerge.*
    i. 1.8 Structural enrichment should be provided. If deemed impossible or harmful, other types of enrichment should be implemented (occupational, dietary, social, sensorial).
    ii. 1.5 Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research, and welfare specialist advice.
    iii. Recognizing the fields of enrichment that can be achieved in aquaculture is an important step towards shifting to more enriched production methods (social, occupational, physical/structural, sensory, dietary). In order to help develop more tangible enrichment interventions for a variety of farmed species, a certification scheme should incorporate a public commitment to update requirements as new recommendations emerge, and establish a timeline for new incorporations to demonstrate a feasible plan for pursuing positive animal welfare in aquaculture. There are existing enrichment methods that have been scientifically proven for several of the most commercially relevant species such as Atlantic salmon, Rainbow trout, and Nile tilapia that require minimal capital investment and disruption in the production process. We have included several enrichment areas to consider below:
        1. Enclosure coloration
        2. Substrate provision
        3. Lighting
        4. Water complexity
        5. Structures
        6. Shelter
        7. Feeding system

        More detailed information and examples can be found in the Aquatic Life Institute's *An Industry Shift Towards Environmental Enrichment* report published in August 2022.

4. Feed Composition (0.3)
    a. *Limits the amount of fishmeal and fish oil (FMFO) used in aquafeed.*
        i. N/A

ii. The fish used to feed salmonids have similar welfare needs, thus creating a 'welfare pyramid' effect, as each farmed salmon must eat the biomass equivalent of 9 herring, or 120 anchovies, to be brought to harvest weight. The farming of these carnivorous species contributes to the existing strain on wild fisheries. In order to alleviate pressure on wild, "reduction" fisheries used for fishmeal and fish oil, it's imperative that farms calculate fish-in-fish-out (FIFO) ratios for each production cycle, and place limits accordingly on the amount of fishmeal and fish oil being used.

b. *Prohibits the use of insects in feed.*
   i. N/A
   ii. Industry uptake of farming insects for use in animal feed poses a series of risks. Considering the availability of plant-based alternatives, insect agriculture for fish feed does not bear out on a risk-benefit analysis. An analysis of the best available evidence shows that, despite insect meal's market potential, it embodies or enhances each of the risks already present in finfish farming, in a new domain. There is also the uniquely high levels of processing cost required for this feed. Arable coproducts are farmed and processed, and then fed to insects, which are farmed and processed, to be fed to fish, which are farmed and processed, to be fed to humans. As salmonids represent the only infraclass of obligate finfish carnivores that we farm, this is a trophic pyramid without precedent, where the direct human consumption product will require multiple levels of processing. The introduction of an extra trophic level to the farming system has the potential to outweigh any costs saved by utilizing insects as feed.

c. *Encourages feed compositions that contain as much plant-based content as possible, including algae and emerging new technologies (mycelium. etc).*
   i. N/A
   ii. The proportion of animal feed components must be replaced by plant-based/alternative fishmeal and fish oil products wherever nutritionally possible.

d. *Requires FMFO to be sourced from offcuts and byproducts of human animal consumption.*
   i. N/A
   ii. If aquatic animal feed components are used, then they must be sourced using fishmeal/fish oil from trimmings of wild fish processed for human consumption, and fishmeal/fish oil from

by-catches of captures for human consumption according to applicable regulations and initiatives.

e. *Requires diets to contain sufficient energy and nutrients for the particular species and age group.*
    i. 4.2 The farm must ensure that feeding regimes are according to manufacturer's guidelines, farmer experience, and feeding behavior. Adjustments of feeding regimes should be based on fish behavior, appetite, expected biomass, and minimisation of feed waste.
    ii. This feeding regime could differ according to each production cycle, and should be monitored by an aquatic animal veterinarian or fish welfare specialist to ensure the animals are being fed an appropriate and nutritious diet.

5. Stunning and Slaughter (1.675)
    a. *Fish should be regularly assessed for signs of consciousness after stunning.*
        i. N/A
        ii. Fish must be carefully observed throughout the process to ensure that none of them are showing any signs of recovery before any further handling of them. Trained slaughter workers should monitor and record the presence or absence of:
            1. eye movement
            2. rhythmic opercular movement
            3. involuntary muscular twitches
            4. fish turn over
            5. signs of fish attempting to swim
    b. *Minimize time between stunning and slaughter in order to minimize risk of consciousness being recovered.*
        i. N/A
        ii. Example of an acceptable provision: automated percussive stunning or electrical stunning followed by exsanguination within 10 seconds.

GLOBALG.A.P:

The standards address most of the sub criteria but there are several significant weaknesses. There are many areas for improvement with the most important being water quality and stocking density, which serve as minimum standards to ensure fish health and welfare. The existing provisions for water quality outline a wide variety of relevant factors that should be controlled; however there are no specific requirements

for water quality parameters. Instead water quality must be controlled to 'ensure the health and welfare'. Although on the face of it this seems like a useful requirement, the lack of specific recommendations leaves this largely open to interpretation and we worry that, in practice, this will serve as a weak protection. The same issue occurs for stocking density. Here, GLOBALG.A.P requires producers to set densities 'based on scientific evidence or industry best practice regarding health and welfare'. Again this would niaivly appear to be a strong recommendation. However without firm guidance, and with the inclusion of industry best practices, it's unlikely that this provides any meaningful protection.

1. Water Quality (0.9)
    a. *There is a range of acceptable measures provided for a wider variety of water quality parameters.*
    b. *These measures consider species and life stages and are based on the best available scientific evidence.*
        i. AQ 20.2.17 A risk assessment is undertaken to demonstrate that water quality does not compromise food safety and animal health and welfare.
        ii. AQ 20.2.20 The farm shall have in place a risk-based monitoring and control system for water quality to ensure the health and welfare of the farmed aquatic species is not compromised. The risk assessment (refer to AQ 20.2.17) shall include relevant water quality parameters, fluctuations, and sampling points (at farm or production unit level), such as temperature, dissolved oxygen, carbon dioxide, dissolved nitrogen (over-saturation), pH, ammonia, nitrate, nitrite, and suspended solids and microbiological parameters (e.g. fecal indicators), among others identified in the risk assessment as necessary. Records for each site shall be in place. Frequency shall be related to the aquaculture system used and is established by the risk assessment. Laboratory testing occurs in a manner consistent with industry requirements and prevailing regulations.
        iii. Numerical limits and optimal ranges, not simply survivable ranges, for the different species that are currently covered by this certification must be provided for a variety of water quality parameters such as temperature, dissolved oxygen, carbon dioxide, dissolved nitrogen (over-saturation), pH, ammonia, nitrate, nitrite, and suspended solids and microbiological parameters (e.g. fecal indicators), among others identified in the risk assessment as necessary.
    c. *Water quality should be monitored at least once a day, ideally there are requirements for continuous monitoring of water quality and the*

formulation of effective management plans to quickly rectify issues that arise.

i. AQ 20.9.4 Where farmed aquatic species welfare is dependent upon automatic systems/equipment (e.g. oxygen level, pump pressure), the systems are equipped with alarms and backup systems.
ii. AQ 20.9.5 Where risk assessments show that oxygen levels could drop below the minimum for species welfare, oxygen supplementation systems are available and maintained in good repair.
iii. Alarms, backups, and contingency plans should not only be put in place and mandated for automatic systems/equipment, and adequate mitigation plans such as those used to supplement dissolved oxygen or correct fluctuations in other crucial parameters should be a management plan requirement for all farming systems.

2. Space Requirements and Stocking Density (0.75)
    a. *Stocking density requirements should be based on the best available scientific evidence for the species and life stage.*
    b. *Include specific numerical limits.*
        i. AQ 20.2.14 The farm/hatchery/transport operates according to set densities.
        ii. A density shall be established in relation to farmed aquatic species, size, production stage, environment and production system. Where no legislative requirements exist, the farm shall show that limits are based on scientific evidence or industry best practice regarding health and welfare and food safety. Density limits shall not be set as an average for the system, or as a production cycle average. Set densities shall not be exceeded. Stocking densities shall be calculated, and records shall be in place.
        iii. Values or ranges for the aforementioned set densities must be listed according to species.
3. Environmental Enrichment (0.5)
    a. *Animals experience the correct amount and type of contact with conspecifics.*
    b. *Physical and psychological stimulation allows for the expression of behaviors that promote psychological well-being.*
    c. *Holding environment modifications to include structural complexity, shelter, and visual stimulation.*
    d. *Introducing a diversity of visual, auditory, olfactory, tactile and taste stimuli.*

e. *The use of feed enhanced with appropriate nutrients, the amount and variety of food available, feeding frequency, and/or delivery system.*
    i. N/A
    ii. Recognizing and incorporating a public commitment to update requirements as new recommendations emerge, and establishing a timeline for new incorporations demonstrates a feasible plan for pursuing positive animal welfare in aquaculture which is a crucial component to sustainable seafood development. There are existing enrichment methods that have been scientifically proven for several of the most commercially relevant species such as Atlantic salmon, Rainbow trout, and Nile tilapia that require minimal capital investment and disruption in the production process. We have included several enrichment areas to consider below:
        1. Enclosure coloration
        2. Substrate provision
        3. Lighting
        4. Water complexity
        5. Structures
        6. Shelter
        7. Feeding system

        More detailed information and examples can be found in the Aquatic Life Institute's *An Industry Shift Towards Environmental Enrichment* report published in August 2022.

4. Feed Composition (0.575)
    a. *Limits the amount of fishmeal and fish oil (FMFO) used in aquafeed.*
        i. AQ 20.2.3 The compound feed supplier shall provide information of the fishmeal composition upon request, including fish meal percentage and when possible, origin (wild catch, industrial by-products, other). Farms shall have in place Fish In vs Fish Out information.
        ii. The Fish In vs Fish Out information that is available must have maximum limits according to the species being farmed.
    b. *Prohibits the use of insects in feed.*
        i. N/A
        ii. Industry uptake of farming insects for use in animal feed poses a series of risks. Considering the availability of plant-based alternatives, insect agriculture for fish feed does not bear out on a risk-benefit analysis. An analysis of the best available evidence shows that, despite insect meal's market potential, it embodies or enhances each of the risks already present in finfish farming, in a new domain. There is also the uniquely high levels of processing

cost required for this feed. Arable coproducts are farmed and processed, and then fed to insects, which are farmed and processed, to be fed to fish, which are farmed and processed, to be fed to humans. As salmonids represent the only infraclass of obligate finfish carnivores that we farm, this is a trophic pyramid without precedent, where the direct human consumption product will require multiple levels of processing. The introduction of an extra trophic level to the farming system has the potential to outweigh any costs saved by utilizing insects as feed.

c. *Requires FMFO to be sourced from offcuts and byproducts of human animal consumption.*
    i. N/A
    ii. If aquatic animal feed components are used, then they must be sourced using fishmeal/fish oil from trimmings of wild fish processed for human consumption, and fishmeal/fish oil from by-catches of captures for human consumption according to applicable regulations and initiatives.
d. *Consider fish's ability to access and digest food.*
    i. AQ 20.2.13 The farm shall have a system in place to ensure that feeding levels are in accordance with needs based on e.g. feed manufacturer's guidelines or farming experience. The system shall ensure an evenly distribution of the feed to the population, and have a mechanism for the adjustment of feeding levels depending on appetite and expected biomass and to minimize feed waste, avoid competition and aggression. Feeding records shall be present and shall demonstrate monitoring of feed efficiency.
    ii. The entire population of farmed fish should have reliable access to food and every attempt should be made by the farmer to avoid resource aggression during feeding. Behaviors should be monitored during the entire feeding process and adjustments should be made where necessary.

5. <u>Stunning and Slaughter (1.15)</u>
    a. *Explicitly bans the use of ice slurry, CO2, ammonia bath, salt, and other inhumane methods of slaughter.*
        i. N/A
        ii. In order to avoid any clarification issues related to what can be characterized as "humane" versus "inhumane" methods of stunning and slaughter, explicit wording must be used.
    b. *There should be a backup slaughter method to stun and then humanely kill any fish that are alive and conscious after the initial stunning or slaughter method.*

i. N/A
ii. A back-up method of stunning must be available at all times to humanely stun fish that display signs of consciousness during the stunning and slaughter process.

c. *Slaughter workers should be trained in a well-defined way and mistakes should be rare.*
   i. Slaughter workers should be trained in a universal and well-defined way so that mistakes are rare. All workers involved in the stunning and slaughter process must be able to identify when fish have been stunned properly and intervene where improper stunning has occurred. A designated fish welfare management personnel should be identified, present, and actively participate in all stunning and slaughter operations.

d. *Minimize time between stunning and slaughter in order to minimize risk of consciousness being recovered.*
   i. N/A
   ii. Example of an acceptable provision: automated percussive stunning or electrical stunning followed by exsanguination within 10 seconds.

Best Aquaculture Practices (BAP):

For BAP to provide meaningful protections for fish, we recommend a variety of improvements. Provisions for environmental enrichment currently do not exist. BAP could better promote fish welfare by requiring companies to provide fish with enrichments, whether social, occupational, physical, sensory, or dietary. These requirements would ideally consider the best available science and be updated regularly. Similarly, the scheme is currently inadequate in the areas of stunning and slaughter. We recognize that BAP requires a humane method of slaughter. This requirement could be strengthened by using more specific language, as well as providing training in slaughter, monitoring, and a backup slaughter method. Lastly, the BAP scheme can improve in the area of feed composition. It would be beneficial for BAP to include provisions that reduce the demand for FMFO, which can be achieved by reducing the proportion of FMFO in fish diets, favoring the culture of herbivorous species, and using feeds based on by-products or plant-based products where feasible. The welfare of cultured fish could also be improved by requiring diets to consider the needs of a given species and age-group, as well as fish's ability to access food.

1. Water Quality (1.1)
    a. *There is a range of acceptable measures provided for a wider variety of water quality parameters.*
    b. *These measures consider species and life stage and are based on best available science evidence.*
        i. Aquaculture Facility Certification: Finfish and Crustacean Farms Appendix A has some values for water quality that apply to both the water body and the effluent.
        ii. It's not clear how the values are derived, e.g. from literature review or some other process and they are not species specific.
        iii. Numerical limits and optimal ranges, not simply survivable ranges, for the different species that are currently covered by this certification must be provided for a variety of water quality parameters such as temperature, dissolved oxygen, carbon dioxide, dissolved nitrogen (over-saturation), pH, ammonia, nitrate, nitrite, and suspended solids and microbiological parameters (e.g. fecal indicators), among others identified in the risk assessment as necessary.
    c. *Water quality should be monitored at least once a day, ideally there are requirements for continuous monitoring of water quality and the formulation of effective management plans to quickly rectify issues which arise.*
        i. Facility staff shall make regular inspections of the culture facility, water quality, and behavior and condition of crustaceans or fish.
        ii. Appendix A in Aquaculture Facility Certification: Finfish and Crustacean Farms states monthly or quarterly for frequency of data collection.
        iii. Frequent or continuous monitoring of dissolved oxygen concentration and at least daily monitoring of water temperature and salinity (salmon standards).
        iv. Where weather conditions allow, trained staff shall make at least daily inspections and reports on the culture facility, water quality, and behavior and condition of fish.
        v. For established farms, the applicant shall provide three years of monitoring data to show that the farm meets or exceeds sediment and water quality criteria specified in 4.1, its operating permits and/or its own monitoring plan at current operating levels.
        vi. Continuous monitoring should be required for all species and farming systems.
2. Space Requirements and Stocking Density (0.5)

a. *Stocking density requirements should be based on the best available scientific evidence for the species and life stage.*
b. *Include specific numerical limits.*
    i. 14.1: The applicant's facility shall apply a maximum biomass limit based on performance measures for aquatic animal health and survival records, and any applicable national regulations.
    ii. 2.7: The AWS shall explain, set and keep under review stocking density limits appropriate to the species and size of animals being reared. Documents shall be available to verify these limits are observed.
    iii. 9.9: The applicant shall apply stocking density criteria based on local conditions, which shall normally be at or below an average 25 kilograms per cubic meter, but may rise higher than this for 5 percent of the production cycle if the fish show other good welfare indicators, and water quality is good (salmon standards).
    iv. Numerical values or ranges for densities must be listed according to the species that are certified.
    v. There should be no provision for allowing an increase in stocking density for any part of the salmon production cycle regardless of what constitutes "good" welfare indicators or "good" water quality. If living conditions are optimal, management practices should remain the same, and unnecessary changes should not occur to try and increase profits while risking a decline in welfare as a result of an increase in density. Production units should have more conservative stocking densities to ensure optimal welfare.

3. <u>Environmental Enrichment (0)</u>
    a. *Animals experience the correct amount and type of contact with conspecifics.*
    b. *Physical and psychological stimulation allows for the expression of behaviors that promote psychological well-being.*
    c. *Holding environment modifications to include structural complexity, shelter, and visual stimulation.*
    d. *Introducing a diversity of visual, auditory, olfactory, tactile and taste stimuli.*
    e. *The use of feed enhanced with appropriate nutrients, the amount and variety of food available, feeding frequency, and/or delivery system.*
    f. *The scheme should have a commitment to update their standards for enrichment as new research on the motivations and needs of fish emerge.*
        i. N/A
        ii. BAP makes no mention of the benefits of environmental enrichment in aquaculture. Many substantial improvements must

be made. Recognizing and incorporating a public commitment to update requirements as new recommendations emerge, and establishing a timeline for new incorporations demonstrates a feasible plan for pursuing positive animal welfare in aquaculture which is a crucial component to sustainable seafood development. There are existing enrichment methods that have been scientifically proven for several of the most commercially relevant species such as Atlantic salmon, Rainbow trout, and Nile tilapia that require minimal capital investment and disruption in the production process. We have included several enrichment areas to consider below:

1. Enclosure coloration
2. Substrate provision
3. Lighting
4. Water complexity
5. Structures
6. Shelter
7. Feeding system

More detailed information and examples can be found in the Aquatic Life Institute's *An Industry Shift Towards Environmental Enrichment* report published in August 2022.

4. Feed Composition (0.625)
    a. *Limits the amount of fishmeal and fish oil (FMFO) used in aquafeed.*
        i. 9.1: The applicant's facility shall use feed for which the manufacturer has provided data on the wild fishmeal and fish oil content or feed fish inclusion factor.
        ii. 9.2: The facility shall record the characteristics of all feeds used, the total amounts of each feed used each year and the total annual crustacean or fish production.
        iii. 9.3: The facility shall calculate and record a yearly feed-conversion ratio for completed crops.
        iv. 9.4: The facility shall calculate and record a final yearly fish in:fish out ratio for completed crops.
        v. 9.5: The fish in:fish out ratio shall not exceed the following values: Litopenaeus vannamei – 1.2, Penaeus monodon –1.7, tilapia – 0.7, Pangasius – 0.5. Limits have not yet been fixed for other species, and will be added once adequate data has been accumulated. For other species the values shall be recorded.
        vi. Limits must be established for other species as ample information currently exists.
    b. *Prohibits the use of insects in feed.*
        i. N/A

ii. Industry uptake of farming insects for use in animal feed poses a series of risks. Considering the availability of plant-based alternatives, insect agriculture for fish feed does not bear out on a risk-benefit analysis. An analysis of the best available evidence shows that, despite insect meal's market potential, it embodies or enhances each of the risks already present in finfish farming, in a new domain. There is also the uniquely high levels of processing cost required for this feed. Arable coproducts are farmed and processed, and then fed to insects, which are farmed and processed, to be fed to fish, which are farmed and processed, to be fed to humans. As salmonids represent the only infraclass of obligate finfish carnivores that we farm, this is a trophic pyramid without precedent, where the direct human consumption product will require multiple levels of processing. The introduction of an extra trophic level to the farming system has the potential to outweigh any costs saved by utilizing insects as feed.

c. *Encourages feed compositions that contain as much plant-based content as possible, including algae and emerging new technologies (mycelium. etc).*
   i. N/A
   ii. The proportion of animal feed components must be replaced by plant-based/alternative fishmeal and fish oil products wherever nutritionally possible.
d. *Requires FMFO to be sourced from offcuts and byproducts of human animal consumption.*
   i. Fishery-based ingredients from wild sources should come from responsibly managed fisheries.
   ii. If aquatic animal feed components are used, then they must be sourced using fishmeal/fish oil from trimmings of wild fish processed for human consumption, and fishmeal/fish oil from by-catches of captures for human consumption according to applicable regulations and initiatives.
e. *Requires diets to contain sufficient energy and nutrients for the particular species and age group.*
   i. The Area Plan shall cover minimum nutritional specifications and specialist hatchery diets, as required.
   ii. This feeding regime could differ according to each production cycle, and should be monitored by an aquatic animal veterinarian or fish welfare specialist to ensure the animals are being fed an appropriate and nutritious diet.
f. *Consider fish's ability to access and digest food.*

i. Feeding shall be managed to avoid stress caused by under- or overfeeding.
ii. The entire population of farmed fish should have reliable access to food and every attempt should be made by the farmer to avoid resource aggression during feeding. Behaviors should be monitored during the entire feeding process and adjustments should be made where necessary.

5. Stunning and Slaughter (0.95)
   a. *There should be a backup slaughter method to stun and then humanely kill any fish that are alive and conscious after the initial stunning or slaughter method.*
      i. N/A
      ii. A back-up method of stunning must be available at all times to humanely stun fish that display signs of consciousness during the stunning and slaughter process.
   b. *Fish should be regularly assessed for signs of consciousness after stunning.*
      i. Stunning should be sufficient to render fish unconscious rapidly, as indicated by lack of opercular movement or other indicators.
      ii. Indicators must be explicitly listed. Trained slaughter workers should monitor and record the presence or absence of:
         1. eye movement
         2. rhythmic opercular movement
         3. involuntary muscular twitches
         4. fish turn over
         5. signs of fish attempting to swim
   c. *Slaughter workers should be trained in a well-defined way and mistakes should be rare.*
      i. Pg 59 Farm workers shall be trained in their roles and responsibilities in maintaining the welfare of farmed aquatic animals. Farm managers are responsible for providing training to workers about 1) evaluation of welfare indicators, including normal and abnormal behavior, signs of poor welfare and expected diseases, 2) water quality management and aquatic animal husbandry, 3) aquatic animal handling procedures (crowding, disease treatment, transfers, loading for transport), and 4) humane euthanasia methods. Training logs should be maintained by the farm to indicate worker training activities.
      ii. All workers involved in the stunning and slaughter process must be able to identify when fish have been stunned properly and intervene where improper stunning has occurred. A designated

fish welfare management personnel should be identified, present, and actively participate in all stunning and slaughter operations.

d. *Culling of fish should use an effective stunning method and respect animal welfare.*
    i. N/A
    ii. Any ill or injured fish incapable of recovery must be immediately and humanely killed. Emergency killing methods such as a non-recoverable, percussive blow to render the animal immediately insensible, must be performed by trained personnel.
e. *Minimize time between stunning and slaughter in order to minimize risk of consciousness being recovered.*
    i. N/A
    ii. Example of an acceptable provision: automated percussive stunning or electrical stunning followed by exsanguination within 10 seconds.
