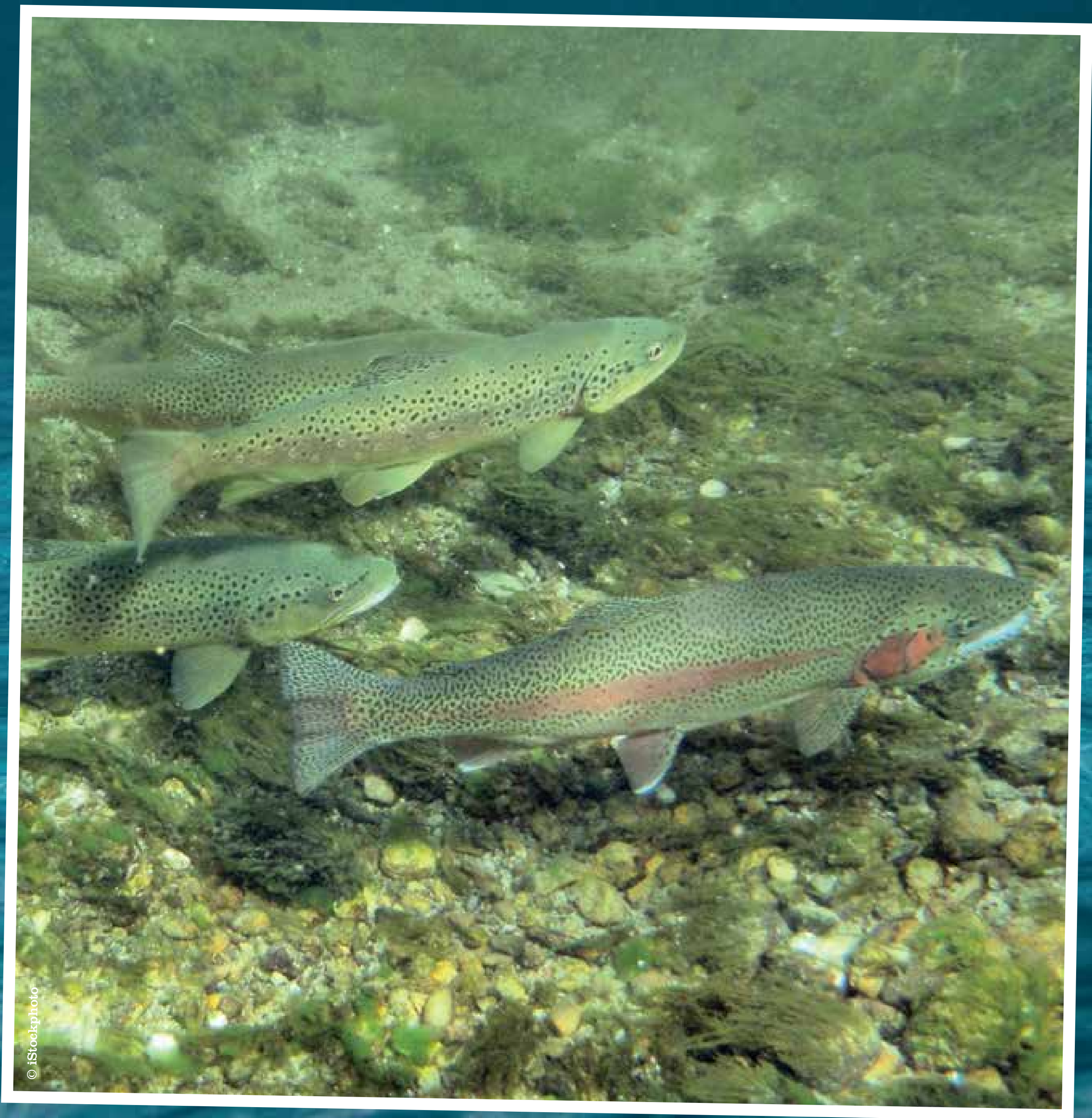
Improving the welfare of farmed rainbow trout



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Foreword

Rainbow trout are sentient beings and must be provided with a good quality of life in a farmed environment. This document focuses on the on-growing phase of rainbow trout production (100g to harvest size) by addressing the provision of good housing, good feeding, good health and opportunities to express appropriate behaviour in line with the adapted Five Freedoms model of Welfare Quality.

GOOD ENVIRONMENT

When considering good trout welfare in terms of housing/environment, two different types of rearing or on-growing system exist which affect how we look at factors such as stocking density and water quality. Trout reared in freshwater ponds, tanks or raceways usually receive water from a nearby river (although there may be partial water recirculation) (North *et al.*, 2006). In these type of rearing environments the water source affects factors such as water temperature and water flow and may limit the amount of fish that can be stocked. For example, as water temperatures rise during the summer months, less oxygen is able to dissolve in the water and be available to the fish. This effect is exacerbated when a large percentage of water is recirculated as this can further increase water temperatures. Higher stocking densities need faster water flow rates to remove waste products and replenish dissolved oxygen. Although river-fed systems often have environment agency-led monitoring of water quality this tends to be focussed on effluent rather than source water and so is more relevant to environmental aspects rather than to farmed rainbow trout welfare.

The second type of rearing system is in net cages (found in freshwater lakes or sea lochs) where factors such as temperature and salinity tend to fluctuate less because there isn't a point source but these factors may still vary spatially and should still be carefully monitored particularly with depth.

Enrichment

A barren environment leads to a chronic lack of cognitive, sensory and physical stimulation especially for migratory species such as salmonids with well-developed senses, particularly their sense of smell. Rainbow trout have been shown to have strong individual preferences and levels of motivation for access to different environmental conditions (Maia, Ferguson, Volpato, & Braithwaite, 2017). Enrichment is discussed further in the section, "Opportunities to express appropriate behaviour".

Perhaps a more immediate potential solution to improving farmed fish welfare is the use of a water current. The presence of a water current of 0.9 body lengths/second (<25% of maximum sustainable speed) was found to induce schooling behaviour and lower spontaneous or erratic swimming behaviour and fish visibly appeared much calmer (Larsen, Skov, McKenzie, & Jokumsen, 2012). The authors conclude that it is thereby likely that the presence of a current had a positive effect on welfare in addition to a positive effect on energy metabolism.

Stocking density

The concept of a minimum rearing space for fish is more complex than for terrestrial species as fish utilise a three dimensional medium (Ellis *et al.*, 2002, FSBI, 2002, Conte, 2004). Additionally, stocking density is not uniform at any point in time; it will increase as fish grow or decrease following grading and therefore, it is hard to measure precisely in the farm environment.

There are several studies clearly demonstrating that high density rearing (above 36 kg/m^3) of rainbow trout has negative effects both on production (reduced growth and feed conversion efficiency) and welfare parameters (Ewing & Ewing 1995; Ellis *et al.*, 2002; North *et al.*, 2006). Additionally there is some research demonstrating welfare benefits at much lower stocking densities (12 kg/m^3) than many current recommendations which needs further investigation (Zahedi, Akbarzadeh, Mehrzad, Noori, & Harsij, 2019). Enforced social contact that occurs between individual fish in crowded intensive systems can affect fish growth and lead to elevated physiological stress (Larsen *et al.*, 2012). Increased levels of fin bites, fin erosion, gill damage, plasma cortisol and reduced immune function are reported (Ellis *et al.*, 2002) and the energy costs of chronic stress lead to a higher susceptibility to disease (Wedemeyer, 1996).

Various causes of fin damage have been identified including infection, deterioration in water quality, bites from other fish and abrasion with the walls of the rearing unit or other fish, for example accidental contact during feeding although all these factors can result from higher stocking densities (Wall, 2000; Ellis *et al.*, 2002; Håstein, 2004). Fin lesions increase susceptibility to pathogen infection by breaking the physical barrier provided by the skin and mucus layer (Ellis *et al.*, 2002; Håstein, 2004) and in addition represent damage to live tissue which will cause pain (Ellis *et al.*, 2009). The initial injury makes the fish predisposed to infection by opportunistic pathogens, which in turn leads to further erosion and can reduce long-term survival (Winfree *et al.*, 1998). Fin damage is commonly considered a sign of unsuitable rearing conditions such as high stocking density (Alanärä & Brännäs, 1996).

Decreasing stocking density will have a positive effect on many aspects of welfare such as water quality, turbidity, social interaction, and fish contact with physical barriers (Ellis *et al.*, 2002) as well as potentially reducing the physical spread of disease (Bullock *et al.*, 1994). Additionally, reducing stocking densities reduces the risk of mass mortalities when there are system failures or management errors (Conte, 2004).

Examples of high stocking density welfare issues:

- Yarahmadi *et al* (2015) found that a stocking density of 45 kg/m^3 resulted in rainbow trout sub adults (65g) that were chronically stressed (decreased white cells and increased cortisol) when compared to a group reared at 10 kg/m^3. This study corrected for decreased water quality such as ammonia, pH and dissolved oxygen.

- Liu *et al* (2016) also noted significant changes in water quality in pen-reared rainbow trout (114g in weight) when stocking densities exceeded 40 kg/m^3. They also found growth was affected above 36 kg/m^3 and attributed this to chronic stress as seen by increased cortisol levels.

- Trenzado *et al* (2018) noted that both growth and digestion (protease activity) were impaired at stocking densities of 40 kg/m^3 compared to 15 and 30 kg/m^3.

- Yarahmadi *et al* (2016) looked at tank reared rainbow trout at 10, 40 and 80 kg/m^3 and found that chronic overcrowding seen at the two higher densities induces stress hormones which then impact expression of immune related genes and ultimately immunity.

Some of these effects of high stocking density relate to the deterioration of water condition, both in terms of oxygen supply and removal of waste products such as CO_2 and ammonia (Larson *et al.*, 2012), however, other effects of high stocking density are still not fully understood and occur even when water quality is maintained at high levels (MacKenzie *et al.*, 2012).

Overall the use of stocking density is a complex issue with many overlapping factors having differing levels of influence. Salmonid behaviour is reported to be more territorial at lower stocking densities whilst at moderate to high stocking densities shifts towards more dominance-based social hierarchies with occasional schooling behaviour (Alanärä, 1996; Larsen *et al.*, 2012). For example, trade-offs may exist to escape more dominant individuals, versus more space, depending on the social structure of the group housed (Laursen *et al.*, 2013). In other words when given the choice, trout may choose to be housed more densely and have less space if this means they are free from more dominant individuals. This is reflected in a wide variation between recommendations for rainbow trout stocking density, which varies from as little as 2 kg/m³ to 80 kg/m³ in North America and Europe although commercial farmers usually operate within a density range of 15 to 40 kg/m³, with 60 kg/m³ being seen as a maximum (Ellis *et al.*, 2002).

Compassion recommends that rainbow trout are given adequate space to meet their physiological and behavioural needs, and that all individual fish have access to adequate food and be able to avoid competition with other individuals. Stocking densities for on-growing (>100g) trout in freshwater and seawater lochs should follow RSPCA guidelines of a maximum of 15 kg/m³ across the site and no more than 17 kg/m³ in any one enclosure. There is some evidence of improved welfare in this species at densities below 15 kg/m³ but this requires further investigation to confirm before more specific recommendation can be outlined.

Water quality

Good water quality is essential for the health and welfare of farmed fish. Water is not only the source of oxygen, it also plays a vital role in disposing of waste products such as ammonia and carbon dioxide; it dilutes faeces and, if there is sufficient water flow, it removes faeces and uneaten feed.

Poor or inadequate key water quality parameters can lead to stress, impaired health and increased susceptibility to disease, organ damage and mortality for fish (Conte, 2004; MacIntyre *et al.*, 2008). For example, fish exposed to high carbon dioxide levels (and reduced pH) show reduced feed intake and poor growth (Toften H., Johansen L-H., Sommer A-I., 2006). Experimental evidence indicates that water quality is the key factor in relation to density affecting welfare in rainbow trout (Ellis *et al.*, 2002).

Water quality is determined by parameters including dissolved oxygen levels, carbon dioxide, ammonia, phosphorus, nitrite, salinity, and pH. Some parameters may be part of the local water chemistry and therefore less controllable; for example heavy metal concentration and water hardness. Additionally, other on-farm factors may infiltrate the water, including pollutants and pesticides. Levels of carbon dioxide, pH, nitrites and nitrates, turbidly and total suspended solids are relatively easy parameters to measure on farms and there are many commercially available instruments available. Correct calibration is important as are understanding that parameters are often linked e.g. increased turbidity due to organic material can increase water temperatures and decrease oxygen saturation (Chen, S., Stechey, D., Malone, 1994). Therefore, water quality parameters should be measured and interpreted with respect to other physical and biological parameters including fish behaviour.

Temperature

Water temperature is an essential component of effective thermoregulation and other physiological functioning for fish, including growth (Neuheimer & Taggart, 2007), if not within the correct optimal range it may affect numerous other factors as metabolic rate, respiration, blood pH imbalance, breakdown in osmoregulation or intolerance to handling and increased susceptibility to diseases (MacIntyre, 2008). For example, it has been calculated that raising the water temperature from 9°C to 15°C reduces the capacity of water to hold oxygen by 12.8%, while increasing the metabolic rate of a 100 g rainbow trout by 67.5% and increasing ammonia excretion by 98.6%, which leads to a 58.8% increase in environmental un-ionised ammonia (Klontz, 1993). Rainbow trout have a decreased tolerance to hypoxia (tissue oxygen deprivation) when water temperatures are too high (between 19-24°C); this becomes a problem particularly in warmer summer months and also as systems move towards more recirculated water to prevent environmental contamination for example such as in Danish "model farm" systems (Skov *et al.*, 2011). Preferred temperature for rainbow trout has been found to be 16°C although when oxygen is not limiting rainbow trout will occupy water between 13-19°C (Schurmann *et al.*, 1991). Other factors which influence temperature preferences are length of acclimation, dissolved oxygen and ion content of the water (Gary A. Wedemeyer, 1996).

Oxygen

Dissolved oxygen is one of the most fundamental water parameters for trout health and welfare. Sufficient levels are required to enable the oxygen from the water to reach the blood. As dissolved oxygen decreases, ventilation increases, alongside gasping behaviour (Gary A. Wedemeyer, 1996). Salmonids show a behavioural avoidance of low oxygen levels and there are observations that the distribution of individual fish changes, with fish moving towards the surface or water inflow where oxygen concentrations are higher (Gary A. Wedemeyer, 1996). Wedemeyer (1996) advises that oxygen requirements for trout should be well above 5-6mg/L to allow for temporary increases in oxygen requirements i.e. increased swimming. In their guide for rainbow trout welfare, the RSPCA recommends the level of dissolved oxygen to be 7mg/L (RSPCA, 2018). Additionally, in systems with primary production, e.g., earthen ponds with microalgae natural growth, oxygen should be monitored throughout each 24 hour period as oxygen levels may vary greatly from day (oxygen produced by photosynthesis) to dark (oxygen consumed by phototrophic organisms).

Compassion recommends for optimal welfare, ponds, raceways and tanks should use a spring water supply, or a river/lake water supply with as little pollution as possible. The pH should be between 6.8 and 8.0. Dissolved oxygen levels should always be above 7mg/L and water temperature should not rise above 160C. It is essential to continuously monitor oxygen levels at the input source and always provide supplemental oxygenation if the water oxygen levels fall below 7mg/L, especially if water is recirculated (Skov *et al.*, 2011). Recirculated water has the potential to reach much higher temperatures especially in summer months and thus have lower oxygen levels. Special care should be taken where fish have gill disease or are going to be exposed to stressors as their oxygen requirements will be greatly increased (MacIntyre, 2008). Other relevant water constituents (e.g. CO_2, ammonia, nitrite, carbon dioxide, suspended solids, salinity) should be regularly monitored and as more information is available regarding effects of mineral content these will be incorporated into the guidelines.

GOOD FEEDING

Feeding

Efficient feeding systems have not only to meet nutrient requirements of rainbow trout and minimise water pollution but also result in good trout welfare. The quantity of feed offered, and the feeding method used must ensure that all the fish have access to feed and they are satiated in order to remove the need for competition and aggression. Factors such as appetite, number, size variation of fish and how the feed is distributed must be taken into account, as well as natural feeding rhythms. Daily food intake is also affected by seasonal and environmental factors such as temperature and day length.

It is important that feed is provided using methods that minimise competition, aggression and stress during feeding and also ensure that all fish have access to sufficient feed. Systems that fail to distribute feed to all the fish tend to lead to increased aggression, due to a bigger disparity on sizes (Alanärä, 1996). There is some debate as to the most appropriate spatial and temporal feeding strategies. Self-feeding systems (known as 'demand feeders') have been used with trout especially to examine feeding preferences (da Silva, Kitagawa, & Sánchez Vázquez, 2016) (da Silva *et al.*, 2016) (Sánchez-Vázquez, Yamamoto, Akiyama, Madrid, & Tabata, 1999). The fish operate an electronic or mechanical device that releases pellets into the water. Farmers may either place in the hopper the quantity of feed they believe to be appropriate or the feed is provided *ad lib*. Such systems can reduce stress levels by spreading feeding across the daylight hours, although there is a substantial danger that a dominant group may prevent subordinate fish from getting sufficient access to the feeder (Alanärä & Brännäs, 1996). Fish are crepuscular feeders (i.e. they prefer to feed at dawn or dusk) and an advantage of such demand feeders is that they allow fish to feed at their preferred times.

Compassion recommends that food for rainbow trout must be of optimal quality for fish and the feeding method used must minimise competition and hence aggression and ensure that all the fish have access to feed.

Fishmeal

Along with the increasing feed demand for rearing and producing fish, there is a corresponding increase in fishmeal and fish oil. The content of rainbow trout feed has wide consequences regarding sustainability and animal welfare. Rainbow trout are a carnivorous species and their feed contains a proportion of animal protein and oil sourced from wild caught fish. The use of wild caught fish (so called reduction fisheries) for reduction to fishmeal and fish oil (FMFO) which is then added to farmed fish represents food wastage as a majority of these fish are, in fact, human edible and energy is inevitably lost during the process. For example, only 22% of protein fed to trout results in human-edible protein (Fry, Mailloux, Love, Milli, & Cao, 2018). The welfare of the fish caught by reduction fisheries is very poor during capture, landing and killing; there is no humane slaughter practised. Therefore the FMFO industry has substantial negative welfare consequences and should be addressed.

Compassion recommends that the amount of FMFO in rainbow trout feed be reduced as much as possible, while still providing for the nutrition needs of farmed trout. This can be done by replacing some of the FMFO with other ingredients that can meet nutritional requirements, e.g. fish trimmings (or waste from other agricultural processes where suitable, e.g. poultry), algal oils, etc.

Fasting

Farmed trout are often fasted before different husbandry procedures, including slaughter, in order to reduce their metabolic rate (and therefore lower the oxygen demand) and the physical activity of the fish (Salin *et al.*, 2018). It also serves to empty the digestive system prior to killing, which reduces water fouling (undigested feed, faeces and microorganisms) during transport, and aids hygienic processing post-slaughter (Wall, 2000). Unlike other animals, however, gut emptying times in fish are temperature dependent meaning that longer fasting periods are required when temperatures are lower, such as in winter (López-Luna, Vásquez, Torrent, & Villarroel, 2013).

Many studies of 'optimal' fasting times have focused on product quality parameters, rather than fish welfare, for example, flesh pH and onset of rigor mortis; although liver colour was used as a stress indicator (Rubén Bermejo-Poza *et al.*, 2017). From a fish welfare point of view, little information is available on the effect of the duration of the fasting period. Whilst fish in the wild may not feed for long periods, farmed fish receive feed at regular intervals therefore periods without food are likely to negatively impact welfare (Santurtun, Broom, & Phillips, 2018). This suggests that the period of feed withdrawal should be kept as short as possible.

In practice, it is not clear in many cases how long trout are starved before slaughter across the largest producers in the EU (France, Italy, and large trout in Poland), though in Denmark, standard practice is between 1-3 days (European Commission, 2017). Many in the industry measure fasting periods in 'degree days' (the temperature in centigrade multiplied by the number of days). RSPCA welfare standards for farmed rainbow trout recommends that the fasting period should not be over 54 degree days (RSPCA, 2014). The Soil Association's organic standards for aquaculture state that rainbow trout shouldn't be starved for longer than 40 degree days (Soil Association, 2017).

A much greater understanding of fasting periods in relation to fish welfare is needed. For example, it has been suggested that intermittent feed withdrawal (feeding every other day) for a period of one month prior to pre-slaughter fasting may help trout to better adapt to the fasting period than trout fed daily up until total feed withdrawal (R. Bermejo-Poza *et al.*, 2015). However, fin erosion is seen to increase when reducing the quantity of feed provided; the reduction in food is thought to strengthen social hierarchies, which then leads to increased fin damage during more aggressive encounters (Cvetkovikj *et al.*, 2015).

Compassion recommends that fasting periods should be no longer than is required for fish welfare benefits (i.e. to reduce oxygen requirements and waste accumulation in the water) and fasting periods should not exceed the period of time needed for the gut to empty. To effectively reduce salmonid metabolic rates, a fasting period of 2-3 days is required (G.A Wedemeyer, 1996). According to a study by Bermejo-Poza (2017), a pre-slaughter fasting period from 17.2 degree days to 22.3 degree days was enough to achieve a full emptying of the gut in rainbow trout. In any case, rainbow trout should not be fasted for longer than 72 hours at any one time for welfare reasons and fish should never be fasted for presumed flesh quality benefits. Procedures should be in place to ensure that this maximum time is adhered to for every fish in the pen. For example, where multiple harvests/days are required to slaughter all fish in a pen, the fish should be segregated so that fasting times can be adhered to. Records of the dates and duration of fasting should be kept.

GOOD HEALTH

Many production-related or husbandry diseases have emerged concurrently with the intensification of aquaculture husbandry practices in salmonids (Poppe, Barnes, & Midtlyng, 2002). These include various types of skeletal deformities, cataracts and soft tissue malformations. Wild fish have evolved patterns of behaviour designed to avoid or limit exposure to infective parasites. In the wild, fish can avoid habitats and other fish with high parasite densities; however, fish confined in cages are unable to do so (Barber, 2007).

There are several bacterial diseases that exist in rainbow trout aquaculture. The major concerns are flavobacteriosis (RTFS), red mark syndrome, puffy skin, enteric redmouth, and infectious pancreatic necrosis but also, lactococcosis, bacterial kidney disease, proliferative kidney disease, ichthyophtariasis, saprolegniosis, columnaris and furunculosis. For a more detailed overview of some of the diseases affecting rainbow trout in aquaculture see FAO document produced by the Fisheries and Aquaculture department[1].

Vaccines have proven effective against many of the bacterial pathogens of farmed fish but should be used in conjunction with good management practices. Both injectable and short-acting immersion vaccines have been used successfully however, therapeutic treatments themselves may be stressful to fish. In land-based trout-farms, both fish size and growth rate were negatively associated with the probability and frequency of treatments (Thorburn, Teare, Martin, & Moccia, 2001). Many of the therapeutic agents, vaccines or protective immunostimulants can be delivered in the feed without the need for handling and manipulation which has better implications in welfare terms. Feeding rainbow trout glucan in low doses several weeks prior to a stressor shows potential for reducing the immunosuppressive effects of stress (Meena *et al.*, 2013) but care must be taken that this does not mask poor production methods and all preventative treatment strategies need full welfare assessments.

Use of antibiotics

Antibiotics are used to treat infection and other pathogens in rainbow trout, as well as being used as a preventative or suppressive measure. Two previously licensed monovalent furunculosis vaccines have been lost to the industry in recent years[2], which has led to an increased need for antibiotic treatment in freshwater (Responsible Use of Antimicrobials Alliance[3]). However this is associated with risks, both to the fish species themselves as well as to the environment. Fish are often medicated through their feed, however there may be problems when antibiotics accumulate throughout the system in the water, sediment and fish biological tissue. Tissue damage, particularly to the gills, have been observed after acute exposure to OTC (Rodrigues *et al.*, 2017). Trout also show taste preferences for different antibiotics and varying aversion to these substances at different concentrations (Maklakova *et al.*, 2011). Autogenous vaccines (prepared directly from the infectious organism from an animal and then used to immunise the same animal against future challenges) represent a practical alternative to antibacterials in the face of new challenges. Antibiotic medication of sea-grown trout is very rarely done[6].

[1] (FAO, n.d) (http://www.eurl-fish.eu/Activities/survey_and_diagnosis
[2] https://www.ruma.org.uk/wp-content/uploads/2017/10/RUMA-Targets-Task-Force-Report-2017-FINAL.pdf
[3] https://www.ruma.org.uk/

Compassion recommends that all disease treatments should be recorded in the veterinary health and welfare plan and only when prescribed by a vet. Guidelines produced by RUMA regarding the Responsible Use of Antimicrobials in Fish Production[1] and the Responsible Use of Vaccines and Vaccination in Fish Production should be followed. Disease risk should be assessed on a site-by-site basis and prevention via vaccination should be prioritised. The veterinary health and welfare plan should outline planned husbandry procedures, risk assessments, disease monitoring and details of all treatments carried out. The continued development of cost-effective authorised vaccines should be supported by producers' organisations and the veterinary profession. High levels of antibiotic use in farming systems is indicative of health and welfare problems at a systemic level and should be immediately addressed.

OPPORTUNITIES TO EXPRESS APPROPRIATE BEHAVIOUR

A barren environment leads to a chronic lack of cognitive, sensory and physical stimulation. Rainbow trout have been shown to have strong individual preferences and levels of motivation for access to different environmental conditions such as shelter and access to different coloured habitats (Maia, Ferguson, Volpato, & Braithwaite, 2017). Provision of environmental choices in tanks, ponds and raceways (as opposed to net cages) has more potential to provide enrichment as there is a base/bottom area to place or anchor enrichment objects. The mainstay of research on enrichment for rainbow trout has been focussed on juvenile fish in hatchery units, for example, by provision of woody debris, stones or other substrates in rearing tanks (Kientz & Barnes, 2016) to improve post-release survival of salmonid fisheries (Brockmark, Neregård, Bohlin, Björnsson, & Johnsson, 2007; Fast *et al.*, 2008). Further research is needed to investigate the welfare benefits of environmental enrichment in on-growing facilities such as raceways and ponds especially under commercial rearing conditions. Studies have also focussed on the provision of enrichment that minimises any additional husbandry procedures, such as suspended enrichment (Kientz, Crank, & Barnes, 2018) or tank wall colours (Luchiari & Pirhonen, 2008). Any introduced object to an aquaculture facility has the potential to be a source of bacterial contamination, and should not only be practical and easy to install but simple to clean or sterilise.

Perhaps a more immediate potential solution to improving farmed fish welfare is the use of a water current. The presence of a water current of 0.9 body lengths/second (<25% of maximum sustainable speed) was found to induce schooling behaviour and lower spontaneous or erratic swimming behaviour and fish visibly appeared much calmer (Larsen, Skov, McKenzie, & Jokumsen, 2012). The authors conclude that it is thereby likely that the presence of a current had a positive effect on welfare in addition to a positive effect on energy metabolism.

Crowding, handling and transport occur at different stages of rearing and while some of these procedures, such as vaccination, extend the health and welfare of the fish, stress and injury are almost inevitable during these operations: scales, skin, snout, and eye damage being the most common damage found with handling stress. Handling, pumping and netting fish evokes a neuroendocrine stress response in many species of farmed fish (Pickering, 1998) and reduces disease resistance (Stangeland, Høie, & Taksdal, 1996). A study indicated that rainbow trout show vigorous swimming activity and elevated oxygen consumption during transport (Chandroo, Duncan, & Moccia, 2004). While activity levels returned to baseline within 48 hrs, swimming performance, measured as critical speed and endurance, was still affected after this period. The provision of a recovery period following transport is clearly important for welfare and subsequent survival (Iversen *et al.* 1998, Iversen and Eliassen 2009). See transport section of “Improving the welfare of farmed rainbow trout at slaughter - Recommendations”.

There is some evidence for different behavioural coping styles in rainbow trout. Behavioural styles are usually categorised into reactive and proactive; also referred to as bold (proactive) and shy (reactive), or high responding (reactive) and low responding (proactive). When challenged in novel environments, low responding and high responding rainbow trout have been shown to respond differently to one another (Schjolden *et al.*, 2005). Low responding trout have been shown to be more prone to following routines compared to high responding trout, taking longer times to alter their food seeking behaviour in a new environment (Ruiz-Gomez *et al.*, 2011). High responding trout have also consistently been shown to express higher levels of cortisol in response to stressors (Ruiz-Gomez *et al.*, 2008). Frost and colleagues (2007) suggest that social context is important for modulating coping styles in rainbow trout. In this study, the researchers found that bold individuals increase in shyness after observing another trout lose a fight. This suggests that behavioural styles have degrees of plasticity, and are dependent on external factors as well as consistent internal traits.

Compassion recommends that all the fish-handling practices should be planned and prepared in advance in order to have the appropriate equipment available). It should be done carefully in order to decrease the natural fish escaping reactions, which can lead to over excited swimming behaviour which promote fish injuries and fish exhaustion leading to stress and poor welfare. Meaningful environmental enrichment should be provided where at all possible, for example, utilisation of gentle (e.g. 0.9 body lengths per second) current be permitted where possible and where proven to be beneficial to trout welfare. Welfare outcomes should be measured and recorded for rainbow trout and include parameters such as swimming behaviour, feeding behaviour, skin and fin damage and skeletal deformities. Further work to develop more behavioural indicators of positive welfare for rainbow trout are required.

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