Stress and cultured rainbow trout (Oncorhynchus mykiss)

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Introduction

Aquaculture is not only a growing production industry worldwide, it is also a means of raising fish for restocking depleted ecosystems (Soutar, 2004). Accordingly, the success of this activity is important both economically and for preserving biodiversity. In intensive fish farming, the effect of stressors can result in reduced performance and welfare for the fish and thus lower overall profitability (Conte, 2004). Stressors regularly found in aquaculture reflect handling, water quality and conditions, and stocking density (Bennison, 2004). Therefore, understanding and monitoring the ways in which stress may be experienced and exhibited in fish culture can enhance the welfare of the animals while minimising associated health problems. The following studies have assessed stressors. Current research into welfare work has focused on rainbow trout and other salmonids, since they are the most frequently farmed fish (Soutar, 2004). However, welfare research has the potential to influence all areas of aquaculture, once species-specific differences are identified (Chandroo et al., 2004).

Discussion

Stress-induced physiological changes are well-known, and include adrenalin secretion and increases in respiration, heart rate and blood pressure. A non-invasive measurement of stress has the potential to be a useful tool for aquaculture management. Ellis et al. (2004) planned to establish whether the free corticosteroids released into the water via the gills were measurable and if the change in their concentration in tank water was comparable to plasma concentrations. Ruane and Komen (2003) had not found a correlation between plasma and water concentrations, but they had not isolated the active, free corticosteroids. Ellis et al. (2004) compared plasma and water-free corticosteroid concentrations for three groups of fish (n=300) that experienced either no stressor, a single stressor or repeated stressors. Despite successfully correlating plasma and water concentrations with significant differences between all three groups at 1-2 hours post stress, the procedure was complicated and did not appear to be readily transferable to practical application. That said, this could offer a relevant method for stress surveillance in any fish culture system, though there are some limitations as the measurement is only a relative measure for groups of fish, the current arrangement does not transfer to static water systems, and there is a lag time of approximately 30 minutes before changes are detected. However, this system is an improvement on currently available methods, as the fish are not disturbed and no additional stressors are applied to the fish in terms of handling, sedation, venipuncture or whole body extracts (Ellis et al., 2004). The success of this research allows for future stress, pain and welfare research of fish to be improved with more accurate results. It promises to enhance production systems by allowing monitoring of the fish within their environment.

Physiological changes are not the only indicators of stressors in animals. Several fish behaviours are known to be affected by stressors, including swimming behaviour, thermoregulation and orientation. So, familiarity with both normal and abnormal species-specific behaviours is critical for effective welfare and stress management (Conte, 2004) (Schreck et al., 1997). Anras and Lagardere (2004) studied the changes to swimming behaviour due to stress, by acoustic telemetry, which tracked nine implanted fish within three different stocking densities (low, medium and high). The results showed the diurnal rhythms of the fish were lost in the high stocking density, adversely affecting the production and welfare of the fish by increasing energy demands, activity, oxygen consumption, fin abrasion, aggression, social flux and the fragility of social hierarchies (Anras and Lagardere, 2004).

This study required specific equipment and implants, which may not be adaptable to most production systems. However, similar tracking of behaviour could be achieved via video monitoring and/or tagging, but under conditions of chronic stress, normal appearance and behaviour may be displayed and so critical underlying changes would be missed if this method is used alone (Rottmann et al., 1992). This study could have utilised some quantitative stress measure (i.e., plasma corticosteroid concentrations) to establish a relationship between the stressors encountered by the fish and the associated behavioural changes. Aquaculture employs several practices that may affect fish welfare, including high-density cultures, feeding strategies and handling methods. Currently many governments, including NSW, are drafting codes of practice for aquaculture, and research such as this can be helpful for determining optimal standards (Chandroo et al., 2004) (Bennison, 2004).

Fear is a stressful state that adversely affects any production animal's welfare, performance and profitability (Jones, 1997). Shuttle boxes and avoidance behaviour have been used on many species to assess fear. Yue et al. (2004) developed a variation for fish. Their "shuttle tank" was designed to assess true fear as distinct from reflexive response in rainbow trout (n=13), using a plunging net for the frightening stimulus and a light as the neutral stimulus. The results included a statistically significant increase in avoidance responses over the course of the trials, (from 25% success on day 1 to 65% on day 5). The average responses to the neutral stimulus were almost doubled for the frightening stimulus (3.2s to 6.3s). This latency of response was attributed to the time taken to make the cognitive picture of the association and respond appropriately. Yue et al. (2004) claim to have found results comparable to those from traditional experimental subjects used in psychology - rats, pigeons and dogs. However, this research could have been more comprehensive if it had included more trials and more subjects. Given the existing level of contradictory research over the capacity for fear, pain & cognition in fish (Chandroo et al, 2004), the results need to be backed-up with further studies. Despite the current debate about how stress may be experienced by fish, its effects in terms of health, welfare, performance, production and profitability are undeniable, so additional understanding can only enhance our ability to improve aquaculture.

Conclusion

This research suggests that improved understanding and monitoring of stressors in aquaculture systems will result in enhanced welfare, performance and production. Further investigation may be necessary into the fear and cognitive abilities of fish, but this will prove pivotal in making positive changes to current production systems.

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