Monitoring of light intensity in salmon farming tanks

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Introduction

Artificial lighting is commonly practised to increase growth and control biological processes, such as smoltification, in tank-based production of salmon parr and smolt. At present, many large land-based farms for production of post-smolt and even further grow-out to harvest size are being built that are depending on light programs to control sexual maturation. Such new farms are mainly intensive recirculating water systems (RAS) characterised by high fish density in large and deep tanks. The combination large, deep tanks with high biomass often causes low light intensity, especially in the deeper part of the water column.

Surprisingly few reported studies that describes effective lighting in RAS tanks are available (Nofima, 2020). For example, light dispersion in tanks stocked salmon parr seems not well documented. The continuously moving fish stock entails shading and changes the light dispersion in the water. Sufficient light intensity in all parts of the tank's water volume should be ensured by the right combination of number and power of the lamps.

At several Norwegian smolt farms, light conditions in tanks applied different lighting managements (lamps above the surface and underwater, number and power) have been monitored. This brief review describes the outcome of the study performed by Bio Marine and The Norwegian University of Life Sciences.

Light conditions and salmon

In salmon, both the eyes and the pineal organ on the upper side of the head perceive light. Production of melatonin, a hormone that controls physiological processes such as smoltification and sexual maturation, mostly occurs in the pineal organ and the level of melatonin is affected by the light conditions. A light intensity below 10 lux has only a minor effect on the melatonin production (Migaud et al., 2006). Spinal abnormities and a reduced number of silver coloured smolt are observed at 10 lux compared to at increasing light intensity to 650 lux (Handeland et al. 2013). In the same study, low light intensity also demonstrated reduced size of the dorsal fins. The authors suggested that a minimum intensity of 43 lux is needed to secure optimal smolt quality, development, welfare and growth in Atlantic salmon.

Lighting in fish tanks

The lighting systems in commercial salmon tanks can vary a lot. LED-lamps mounted 5 – 10 m from each other above the tank surface are commonly applied. Circular tanks with 25 m circumference use from one to five Aqualux ® lamps of 300 W (Svein Kr. Svengaard, pers.com.). Lamps are frequently mounted on the crossing walkway of the tank.

Light sampling and comments

At a smolt farm in Mid-Norway, light intensity was monitored in the water column of a circular tank with 10 m diameter and 3 m depth (Figure 1). The fish stock's density was c. 15 kg/m^3, i. e. 765 individuals of 20 g per m^3. As indicated (Figure 2), sampling was conducted both horizontally and vertically from the surface to the bottom (1 m distance, altogether 35 sampling points).

Three different lighting alternatives were assessed:

Alt. I: Only lamps above the surface (4 lamps á 300 W mounted 2 m above surface 3 m from each other), total power: 1200 W

Alt. II: Only underwater lamps (2 lamps á 600 W mounted at 2 m depth along the walkway, 6 m distance from each other), total power: 1200 W

Alt. III: Combining lamps above surface and underwater (4 lamps above surface and 2 underwater lamps, 300 W/lamp), total power: 2400 W

Use of above surface lamps only demonstrated high light intensity at the central surface and gradually reduced intensity towards the deeper part of the tank (Figure 3). Beneath 1.5 - 2 m depth the intensity was below the recommended minimum level of 43 lux.

Underwater lamps (alternative II) resulted in low light intensity (< 43 lux) in the main part of the tank's volume except the upper m towards the surface and at 2 m depth close to the lamps. Satisfying light conditions at the surface was probably due to the lighting mounted at the roof of the hall.

Double light power combining above surface and underwater lamps indicated favourable light conditions from the surface to 2 m depth. In the deepest part above the tank bottom the light intensity was only sufficient in the vicinity of the lamps.

Conclusions

Based on these preliminary tests, favourable light conditions in tanks with high fish density require lighting which combines use of lamps above the surface and underwater lamps. A recommended total light power of 2500 W for a circular tank of 10 m diameter and 3 m depth seems appropriate. Further tests for optimization of lighting of tanks as regards number, power and positioning of the lamps should be conducted.

References

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