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Water quality and fish welfare in closed floating cages for production of Atlantic salmon (*Salmo salar*)

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In Norwegian salmon farming, closed floating sea-cages have been introduced as a possible solution to the increasing problems with infestation of sea-lice and as a way to minimize the risk of fish escapes. Closed cages could also make it possible to remove and utilize a substantial part of the solid waste otherwise released directly to the marine environment. It is also expected that more controlled rearing conditions compared to in traditional open cages could lead to better survival and a more effective production. So far, little is known about how to safeguard and optimize the production of fish in such closed floating cages. A pilot project was initiated in spring 2012 stocking a closed cage of 1550 m^3 volume with 80 000, 1-year old salmon smolt. We concluded that the closed system was fit to eliminate the problems with sea-lice, and the fish stock demonstrated relatively high survival rate (97.1%), acceptable growth and welfare score. However, the water exchange rate was too low during the end of the cycle in autumn at a fish density of 20 – 25 kg/m^3 resulting in reduced water quality and fish welfare. From November 2012 to September 2014, on-growing of Atlantic salmon from sea-transfer to harvest size in closed cages of 3000 m^3 was studied and compared to parallel groups in open net-cages. Appearance of sea-lice, fish mortality and causes of mortality, water quality and other fish welfare parameters were frequently monitored. No infestation with sea-lice was detected during 28 months of trials. The survival rate varied between groups, but was generally higher than in the open reference cages. Growth and feed conversion rate was acceptable, but should be further improved. We established a first generation model for the interaction between specific water consumption (Q=l/kg fish/min), feeding intensity (L=g feed/m^3 water flow), important water quality parameters, such as pH, CO_2, TAN, suspended solids (SS), and fish welfare in closed cages.

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The gut-brain axis in fish

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Interest in the interactions between the gastrointestinal tract and the central nervous system has grown tremendously over the past decade. With the ever increasing number of pre- and pro-biotics being marketed to the aquaculture industry, there is renewed interest in the gut and the role intestinal microbiota play in fish health. It's commonly thought that gut microbiota modulate biochemical and neuro hormonal signaling pathways between the gut and the brain in vertebrates. Much of these interactions are assumed to be similar in fish; however, little research has been conducted to clearly demonstrate the bidirectional signaling of the gut-brain axis in fish. Much of the research to date has been conducted in goldfish (*Carassius auratus*). These studies have defined many gut peptides in goldfish as either anorexigenic (appetite suppressing) or orexigenic (appetite stimulating), as well as exploring their metabolic roles. The functional roles of these peptides in species important to aquaculture are less clear. In channel catfish, (*Ictalurus punctatus*) all gut peptides studied to date appear to be inhibitory or have no effect on feeding. Differences between goldfish and catfish demonstrate the need to establish gut-brain interactions in each species of interest. Defining the crosstalk of the gut-brainaxis is an essential step toward understanding how diet, stress, and shifts in gut microbiota affect fish performance.

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