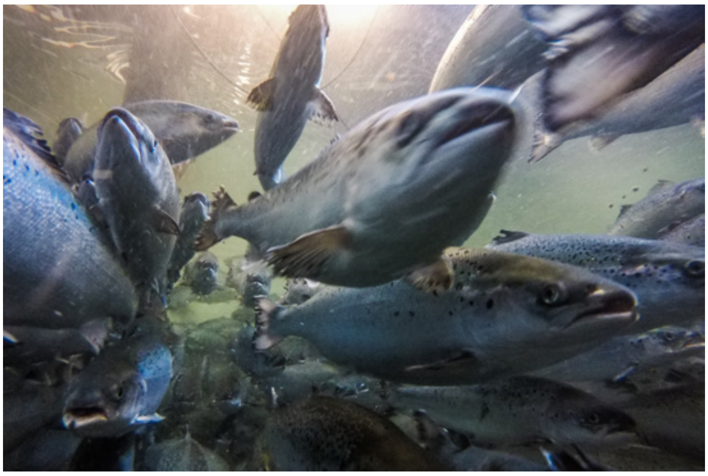
CtrlAQUA

A winter signal to induce smoltification versus 24 h light in RAS: effects on seawater performance in Atlantic salmon

In commercial recirculating aquaculture systems (RAS), brackish water are being used to induce seawater tolerance in salmon juveniles instead of traditional photoperiod manipulation. Effects of such protocols on fish performance and welfare were tested in a controlled experiment. In RAS, 24 h light and 12 ppt had a positive effect on growth. In seawater, 24 h light in RAS led to slightly reduced growth. However, due to larger size at sea transfer, fish on 24 h light in RAS were bigger at slaughter compared to fish given a winter signal in RAS.



Seawater tolerance, welfare, survival and growth performance was compared in salmon produced using 1) photoperiod induced smoltification (6 weeks of short days, 12:12 L:D, followed by 24 h light until sea transfer) or 2) using 24 light the entire RAS period. Both photoperiod treatments were replicated in freshwater (FW) RAS, or brackish water RAS (12 ppt) from 100g until seawater transfer at 200 g (Oct 6th) and 600g (Dec 8th) (Fig. 1)

Salinity / Photoperiod	Freshwater	Brackish
12:12 L:D 6 weeks	FW + ☾ 200 g 600 g	12ppt + ☾ 200 g 600 g
24 hous L	FW + ☀ 200 g 600 g	12ppt + ☀ 200 g 600 g

Figure 1: Experimental design

Seawater tolerance

During smoltification, salmonids develop ability to osmoregulate in seawater through increased activity of the enzyme Na+ K+ ATPase (NKA). In salmon given a 12:12 winter signal, NKA activity was lower at the end of the 12:12 period, but then increased rapidly when the fish was exposed to 24 h light in July (Fig. 2A). No differences in NKA activity between photoperiod treatments were found between August-October, but in November, there was a positive effect of a 12:12 winter signal. NKA exist in two distinct isoforms, one characteristic for freshwater adapted fish (NKAα1a) and the other, NKAα 1b, predominantly expressed in seawater adapted fish. A winter signal induced the expression of the SW isoform (Fig. 2B), and when brackish water was introduced from September, this further increased the expression of the SW isoform (Fig. 2B). Seawater tolerance tests (72 hours at 34 ppt) did not reveal any differences in serum concentrations of chloride (Cl), sodium (Na) and potassium (Mg), suggesting that fish in all treatments were able to regulate their osmolarity in seawater.

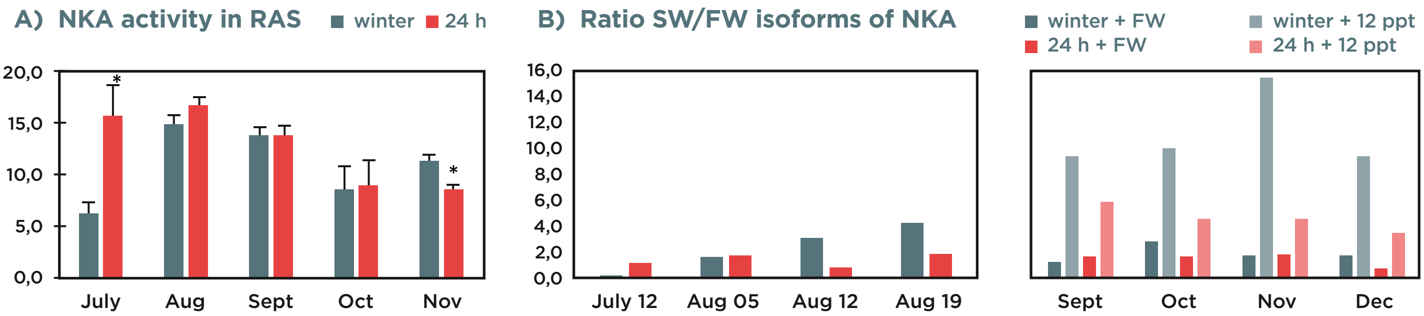


Figure 2: A) NKA values and B) ratio of the FW and SW isoform, in salmon given a winter signal with short days (12:12 LD) for 6 weeks and in salmon on continuous light (24 h light). The short day period ended in July.

Growth and survival

Survival in RAS was > 99% and not affected by treatment. Mortality peaked the first 5-8 weeks after seawater transfer in all treatments. Although fish exposed to 12 ppt in RAS had higher expression of the SW isoform of NKA at transfer, this did not improve survival in seawater after transfer. Overall, seawater survival was 93% and not affected by treatment in RAS. There was a positive effect of 24 h L and 12 ppt on growth rate (Fig. 3A) and condition factor (CF) in RAS. For salmon transferred at 200g, growth rate in seawater was slightly higher in salmon given a winter signal. There was no effect of salinity in RAS on growth in seawater (Fig. 3B). For fish transferred at 200g, final bodyweight was significantly higher in salmon given 24 h L in RAS compared to a 12:12 L:D winter signal (Fig. 3C), due to their larger size at sea transfer. Salmon given a winter signal would need 10 extra days in seawater to reach the same weight as the 24 h treatment. Timing of sea transfer had a larger impact on growth in seawater; fish transferred at 600g in December would need ~28 days to reach the same slaughter weight as fish transferred at 200g in October. However, the total number of days in seawater would be lower for salmon transferred at 600g, since they were transferred to sea 2 months later.

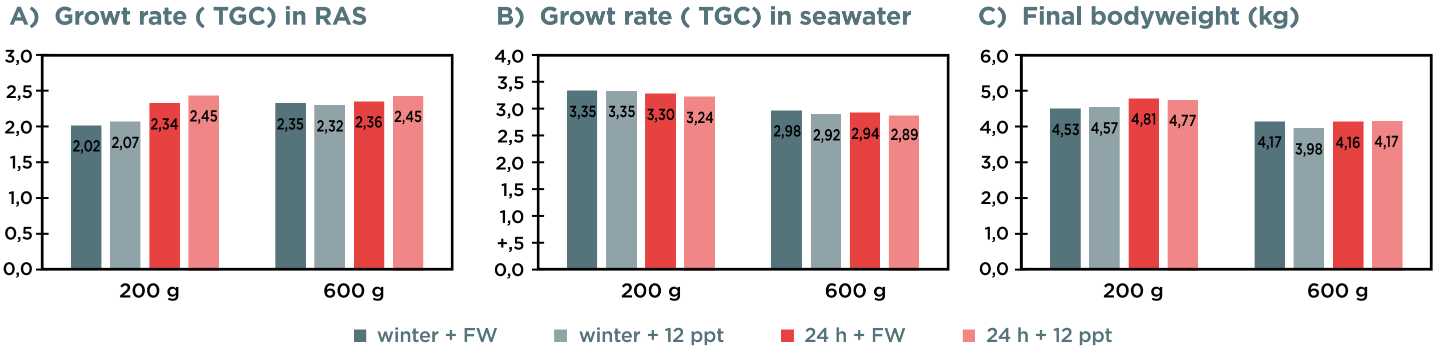


Figure 3: A) Growth in RAS, B) growth in seawater, C) bodyweight at slaughter for the 8 treatments.

The growth reduction in 24 h L treatment occurred the first weeks after sea transfer, salmon given a winter signal in RAS had higher growth the first weeks after sea transfer of the 200g fish (Fig. 4A). There was no effect of salinity in RAS on performance after transfer. For 600g fish, there were no effects of photoperiod or salinity in RAS on seawater growth, all treatments grew poorly shortly after transfer (Fig. 4B). Growth rate after transfer was negatively correlated with CF in RAS (Fig. 4C). Producing a leaner fish in RAS may improve growth performance after sea transfer.

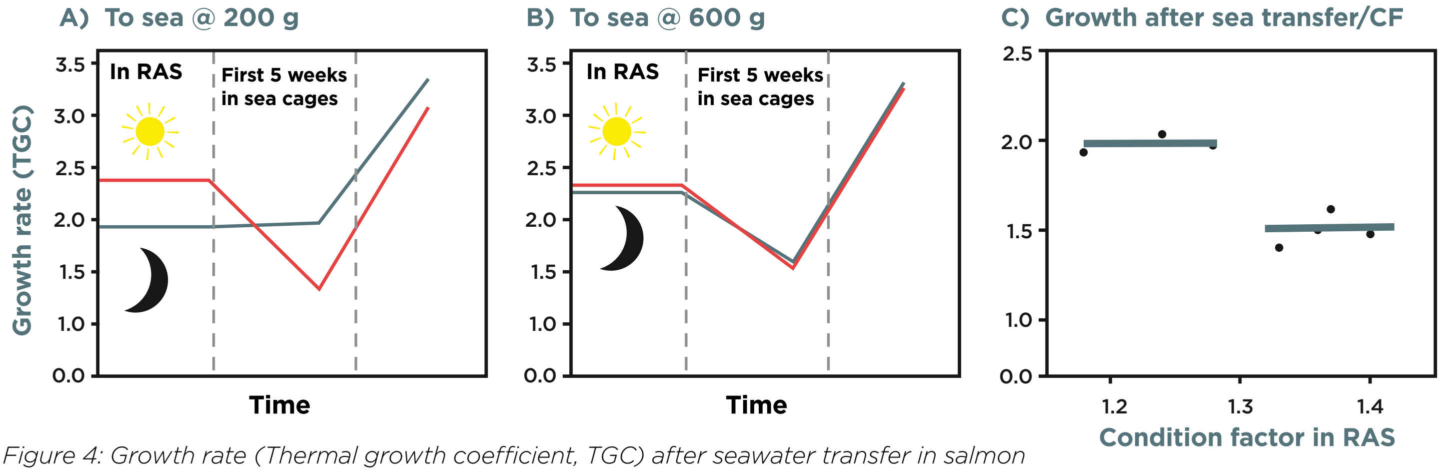


Figure 4: Growth rate (Thermal growth coefficient, TGC) after seawater transfer in salmon transferred at A) 200 g and B) at 600 g. C) Condition factor (CF) related to growth after transfer

About the research:

CtrlAQUA project BENCHMARK
Partners: Nofima, Cermaq and Pharmaq Analytiq
Fish: 100-600 grams
Water and system: Freshwater and 12 ppt brackish water in RAS, then cages in sea

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CtrlAQUA
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This is CtrlAQUA
CtrlAQUA is a centre for research-based innovation (SFI) doing research on closed-containment aquaculture systems on land and at sea. The main goal is to develop technological and biological innovations that will make closed systems a reliable and economically viable technology. Nofima AS is the host institution of CtrlAQUA, and is collaborating with several partners from research, the supplier industry and salmon farming companies

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