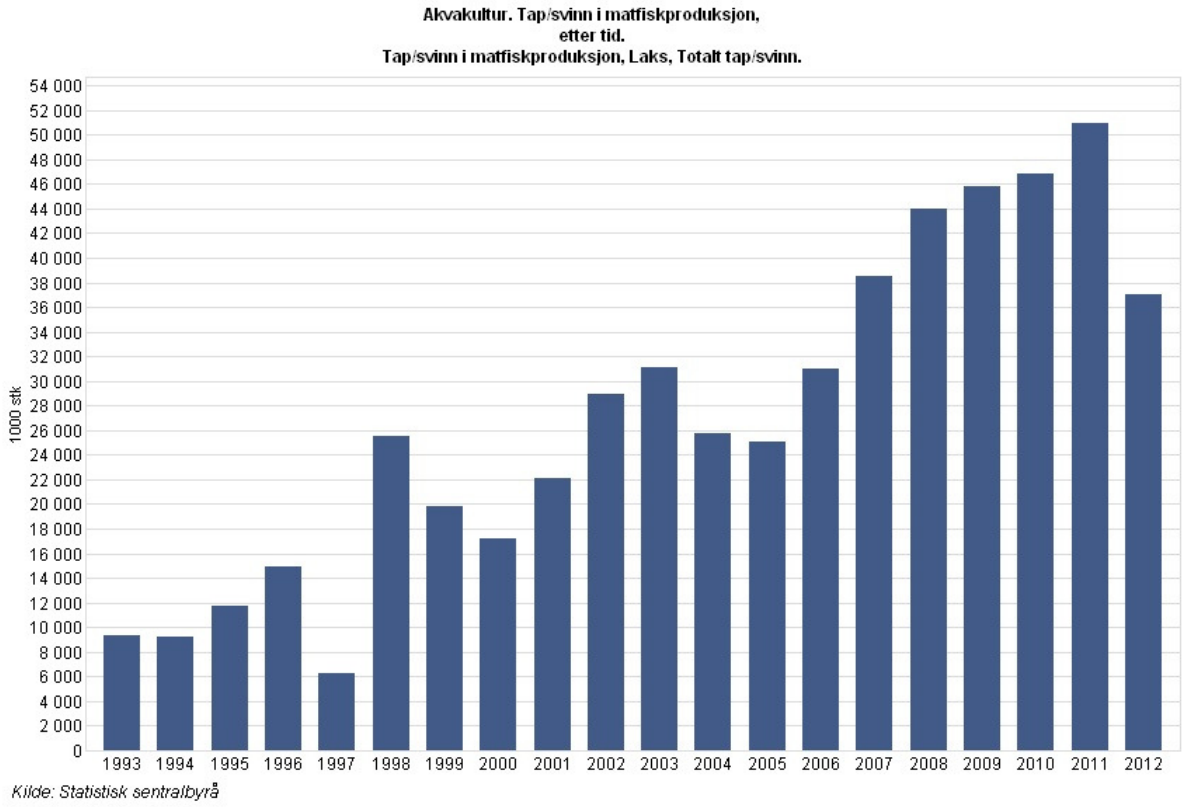
Repeated crowding and pumping impair Atlantic salmon smolt quality

Åsa Maria Espmark, Øyvind Aas-Hansen, Jelena Kolarevic, Kjell Midling (Nofima) and Jonatan Nilsson (IMR)

Background

- According to the Norwegian Directorate of Fisheries 15-20% of all smolt that are put in sea do not make it to slaughter – what is happening to these fish?



Background

- Most likely multifactorial causes between factors that fish are exposed to during freshwater phase
- Fish may become less robust and less resistant towards infections and diseases if they are roughly handled during the sensitive smolt stage
- During the freshwater stage and before sea transfer the fish are repeatedly handled during crowding, pumping, vaccination, transport, amongst others

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Objective

The aim of this study was to investigate long term effects of repeated crowding and pumping during fresh-water phase, and how the fish performed after being transferred to sea water

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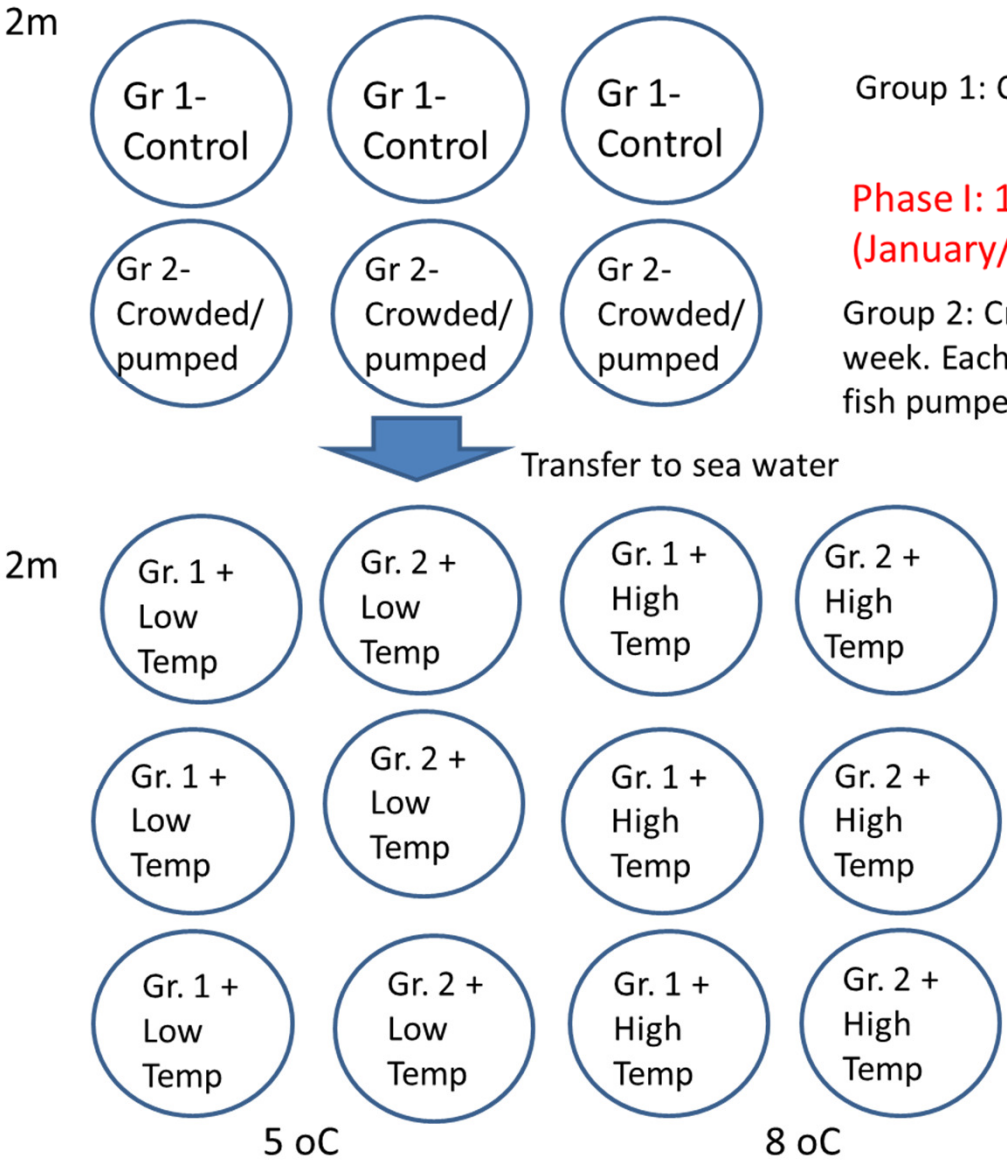
Material and Methods



Group 1: Control – no crowding/pumping

Phase I: 1 month in **fresh water** (January/February)

Group 2: Crowded/pumped 5 times; once a week. Each tank crowded for 3 hours; and fish pumped to a neighbor tank and back

Phase II: 84 days in **sea water**

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Material and Methods
Phase I (Fresh water)

- Acclimation: 5 weeks
- 500 fish per tank (triplicates; 2m ($3m^3$))
- Temp: 5.5 ± 0.2°C; light: 24h
- Start weight 1st crowding/pumping: 57.5 g
- Pump: Heathro impeller pump 6”
- Controls were not crowded/pumped
- Crowding/pumping procedure:
  - 5 weeks (once a week)
  - Immersion of water prior to crowding: 13.9 ±1.5 min
  - Crowding: 3 hours (after recommendations from farmers)
  - Pumping: 40.1 ±7.3 min

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Material and Methods
Transferring fish from phase I to phase II

- Phase I ➔ phase II
  - Fresh water ➔ sea water
- Sea challenge test:
  - 24 h
  - Salt water 34,5 ‰
  - 10 fish from each six phase I tanks
- Transfer to phase II
  - Fish in phase I tanks were divided between two tanks in phase II

Sea challenge test

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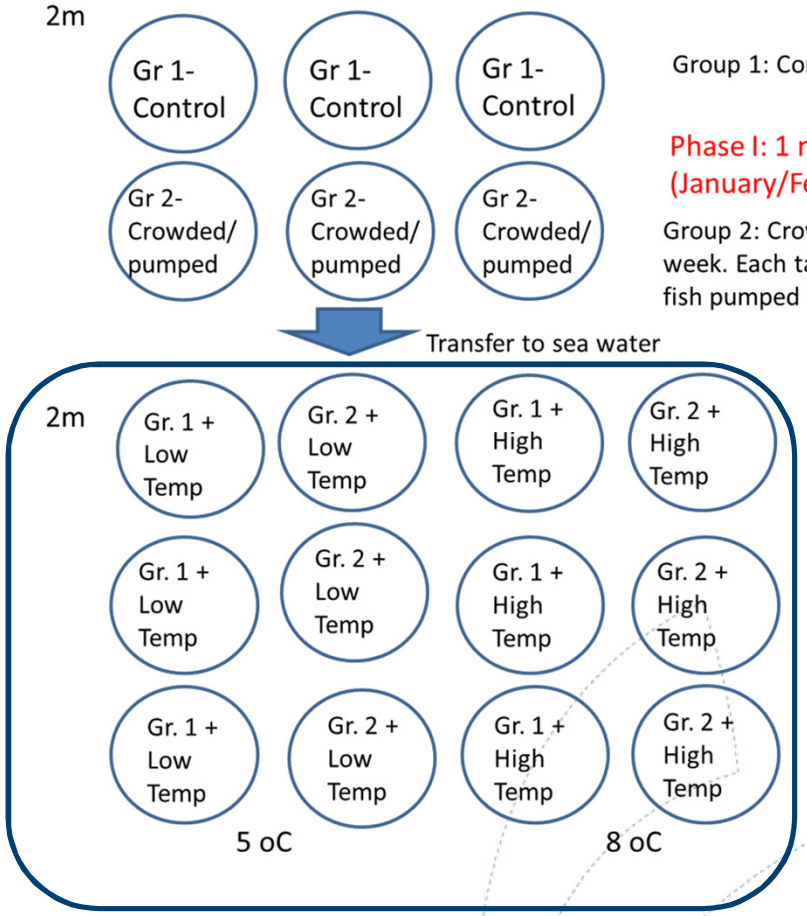
Material and Methods
Phase II (sea water)

- Duration: 84 days
- 224.1±3.9 fish per tank
- Tanks: 2m (3m^3; 12 tanks; triplicates)
- Temp: 8^{o}C and 5^{o}C
- Light: 24h
- "Sea transfer" to controllable tanks were chosen instead of transfer to sea cages, since the experiment was dependent on controllable conditions and two temperatures



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Material and Methods – sampling/monitoring

Phase I

- At four of five crowding/pumping occasions:
  - Individual weight and length
  - Blood samples for gasses and stress variables
  - Welfare score
- Cont. monitoring of O_2
- Weekly monitoring of CO_2
- Water flow (kept constant at 80 l/min in all tanks throughout phase I and II)
- Dead fish - weight/length

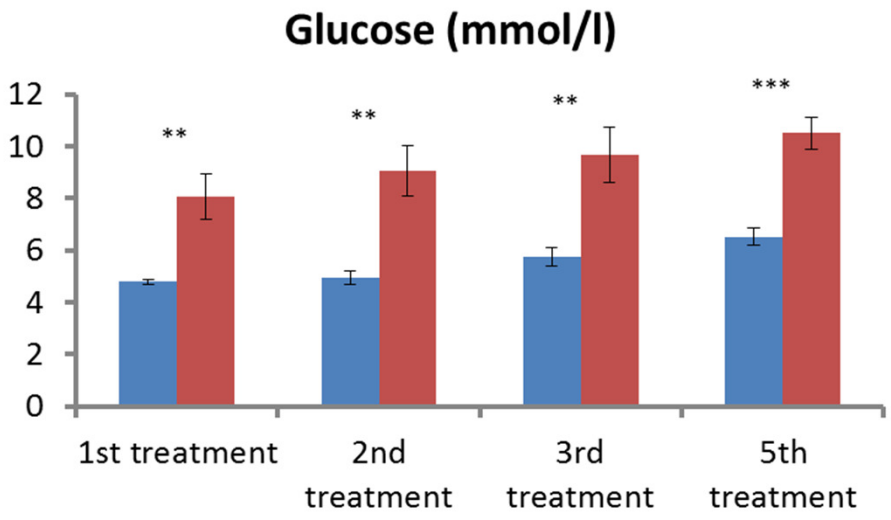
Sea challenge test

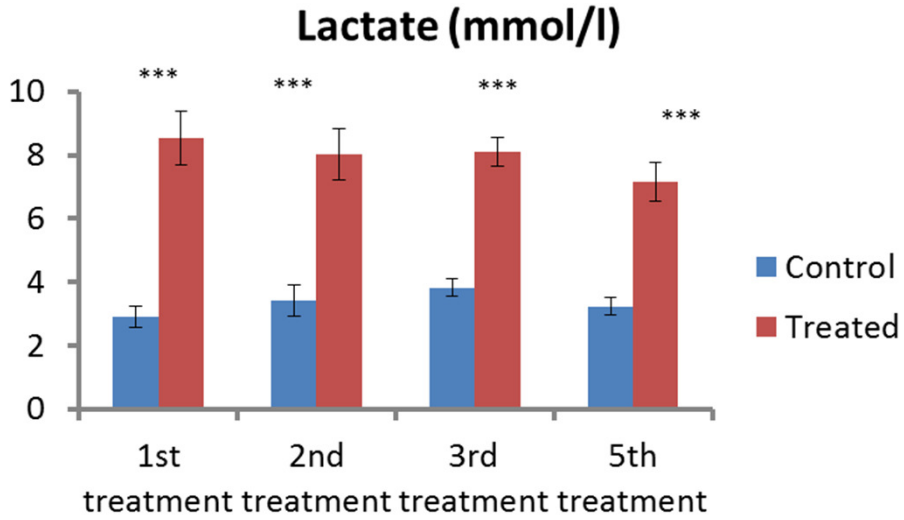
- Individual weight and length
- Blood samples for gasses and stress variables, chloride
- Welfare score
- Gills for Na/K ATPase activity

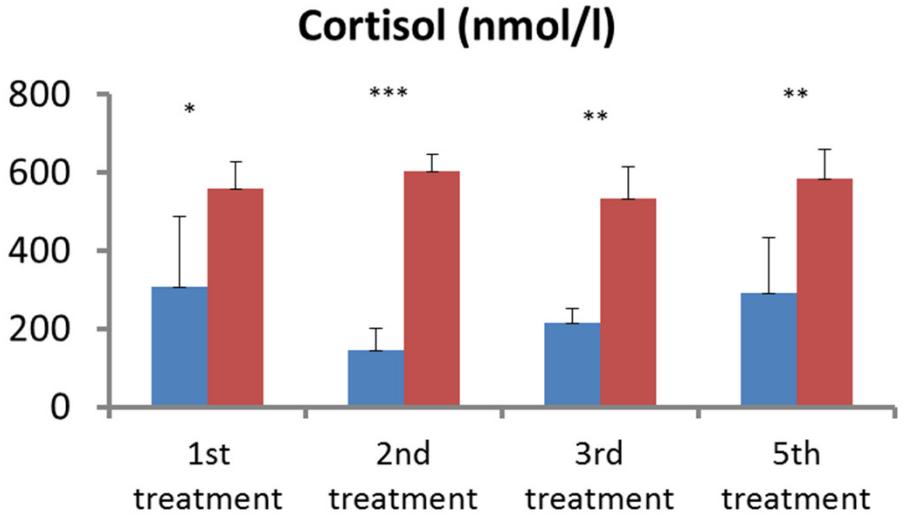
Phase II

- Feed spill 7 days a week
- Dead fish – weight, length, picture
- Cont. monitoring of O_2
- Weekly CO_2
- Termination of experiment:
  - Weight and length
  - Blood (gasses, stress, chloride)
  - Welfare score
  - Skin for histology

Results - Effects of treatment in phase I







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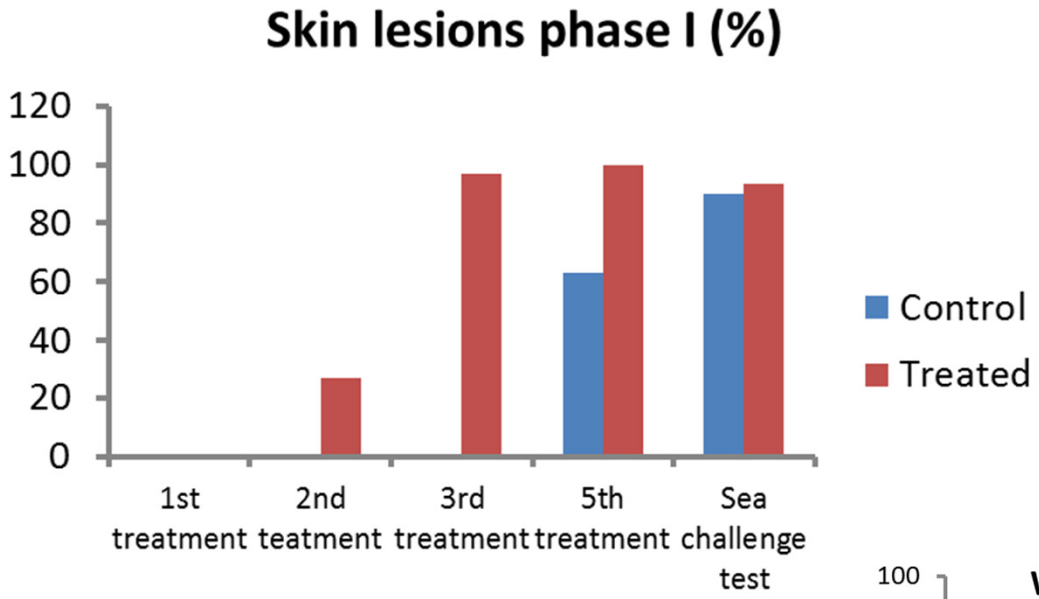
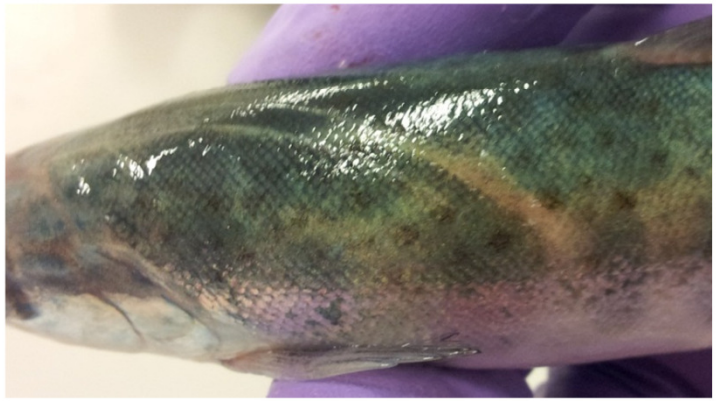
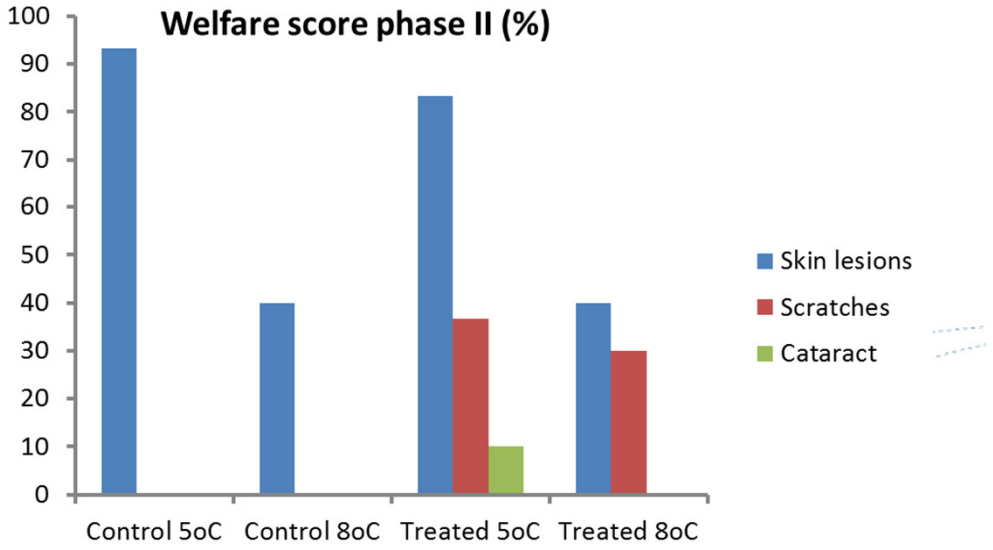
Results - Welfare score







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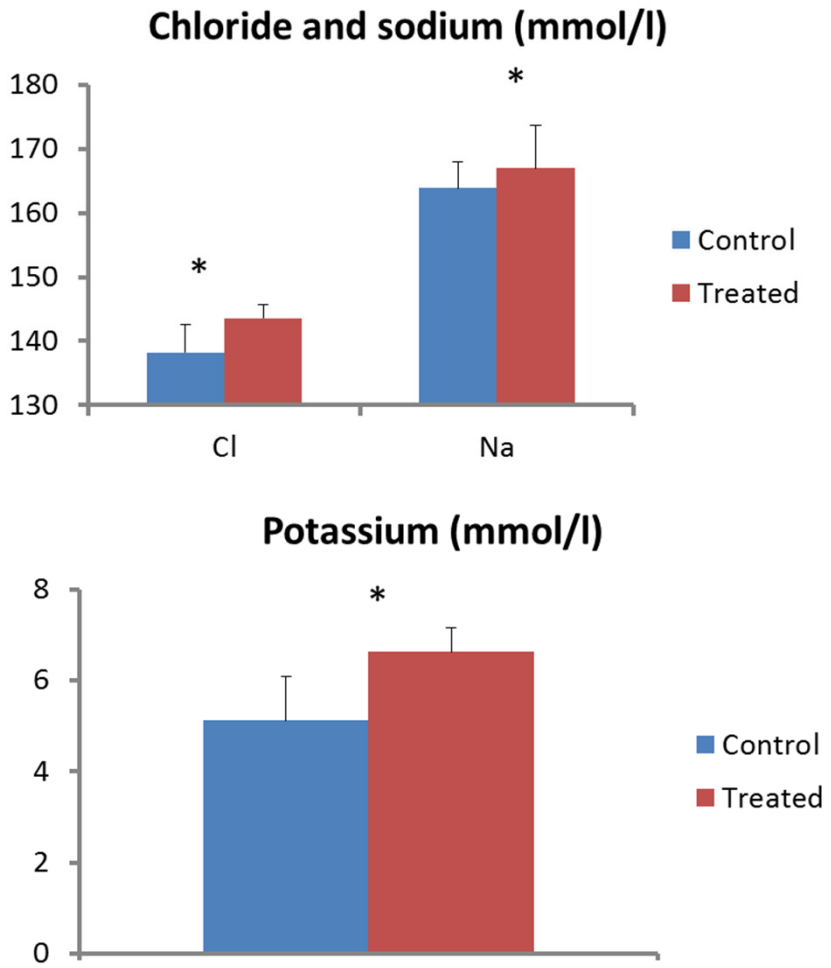
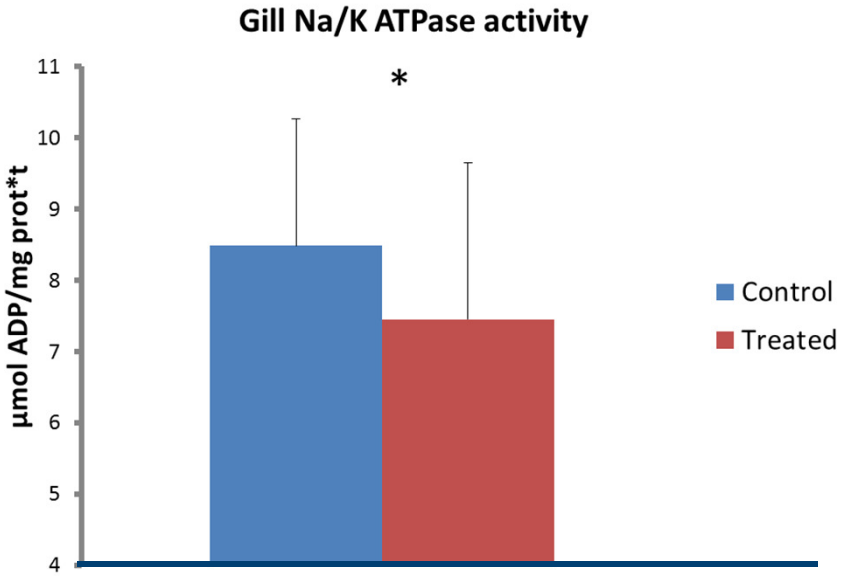
Results - Sea challenge test





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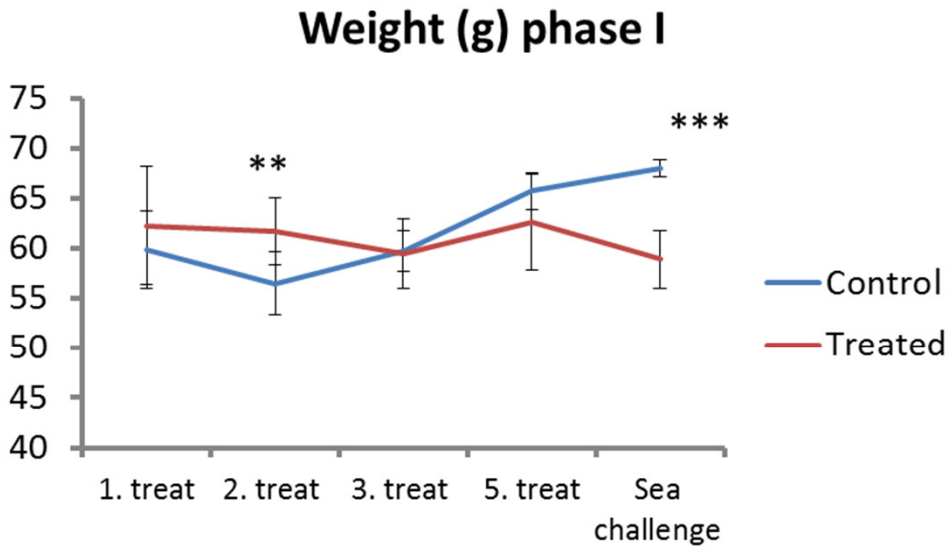
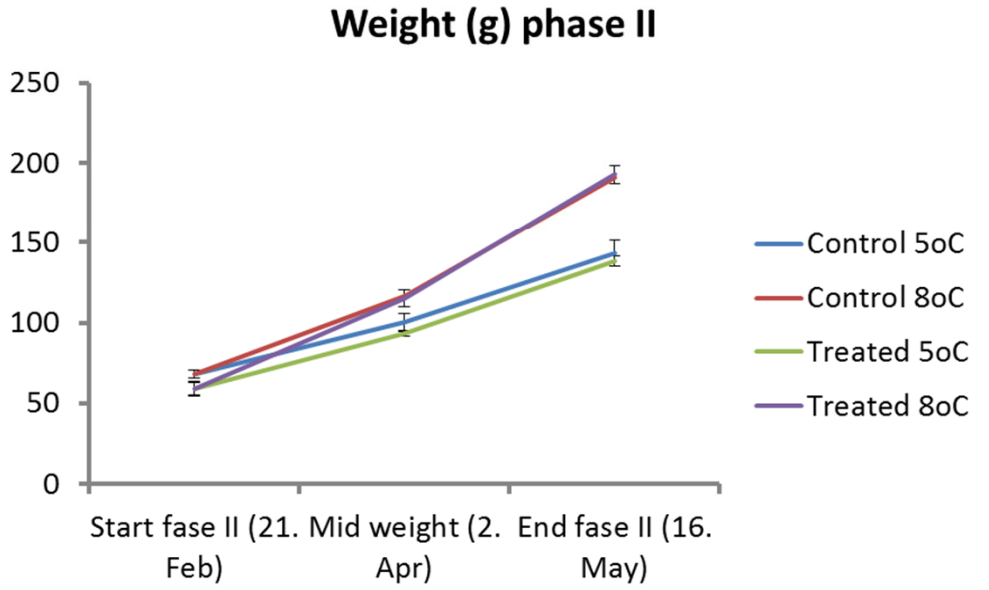
Results - Weight and growth



Significant effect of temperature



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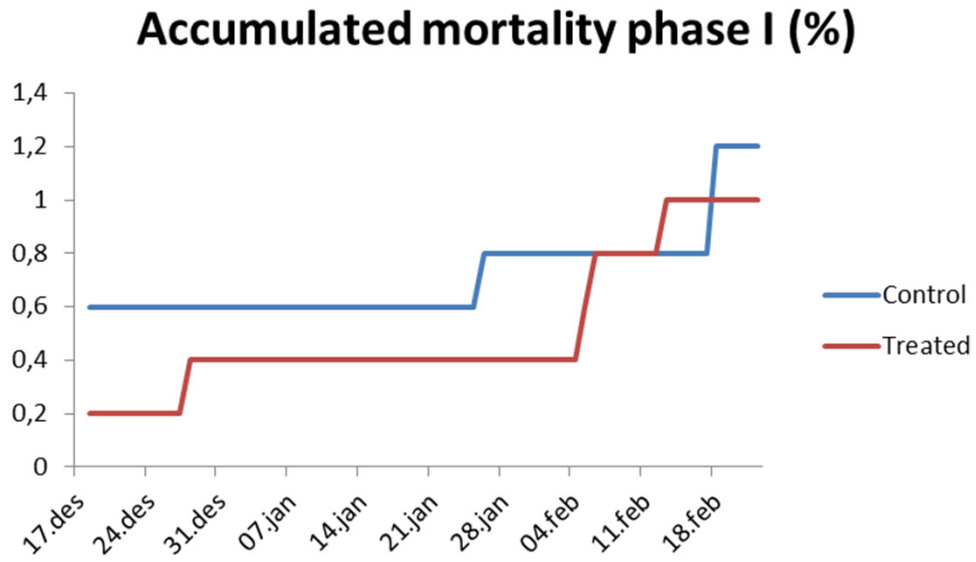
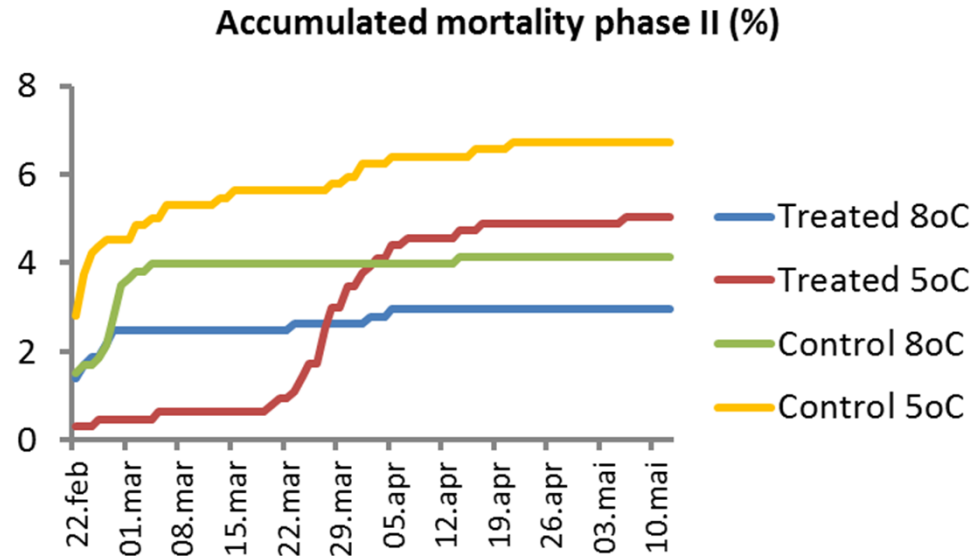
Results - Mortality





- Treated fish at low temp experienced increased mortality 1 month after transfer to sea
- Controls that have not been handled show low tolerance to transfer.
- Some handling may be advantageous and serve as training/adaptation towards coming handling

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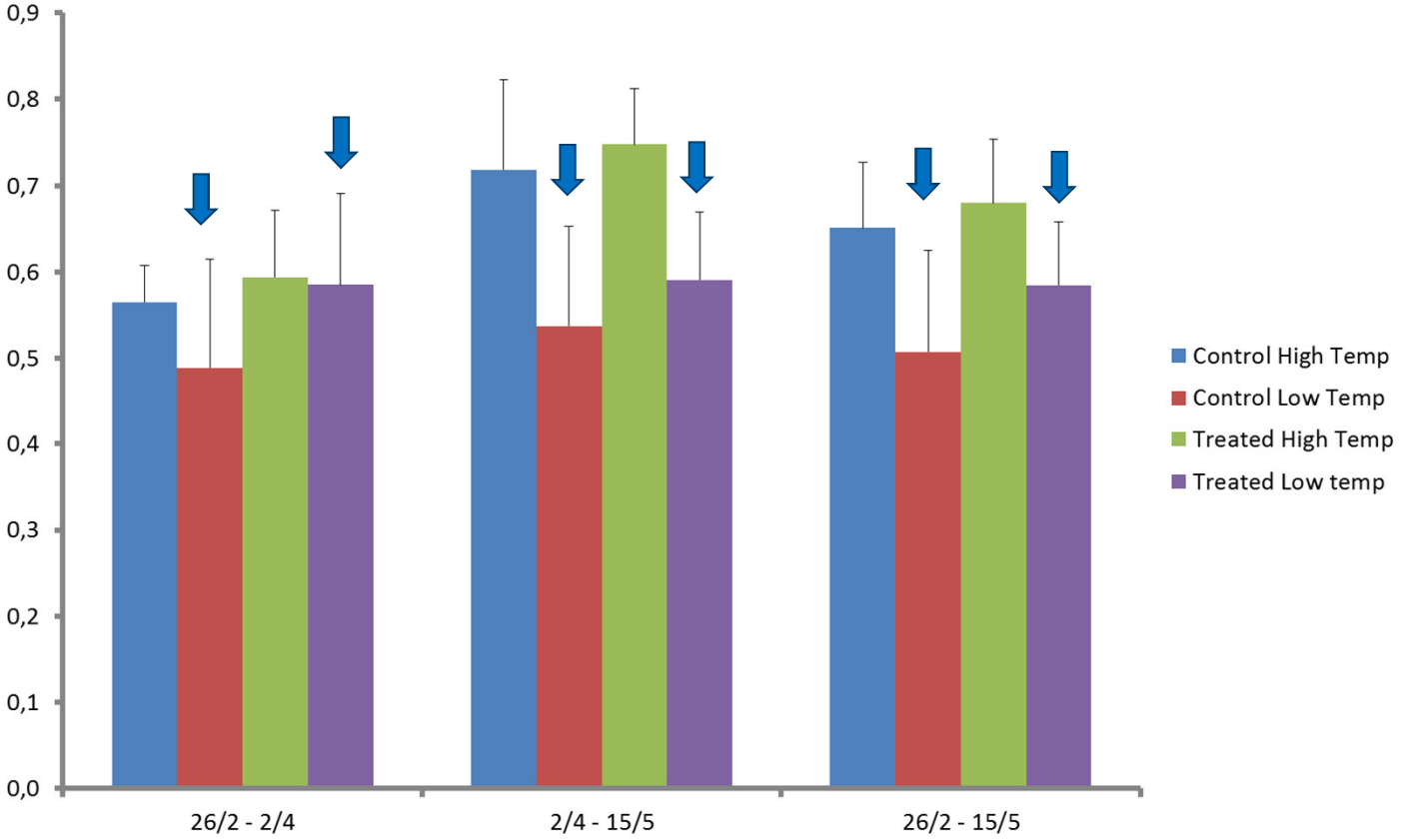
Results – FCR (feed convertion ratio)



Phase II
1st part

Phase II
2nd part

Phase II

A non-significant increase in FCR for Treated fish at low temperatures may indicate lower feed utilization

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Discussion and Conclusions

- Crowding and pumping were associated with increased stress among salmon smolt, showed by increased levels of glucose, lactate and cortisol in blood after each treatment
- Repeated crowding and pumping limited growth. However three months after treatment the differences in growth were not significant
- Smoltification was impaired by stress induced by repeated crowding and pumping
- Repeated crowding and pumping lead to skin lesions, mainly scale loss. One month after sea water transfer treated fish transferred to low temperatures showed a sudden increase in mortality
  - Scratches/scale loss caused by pumping may develop to wounds that kill the fish either directly or indirectly via infections

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Discussion and Conclusions

- As an acute response to sea transfer some control fish died. Some handling (but not rough) may serve as training and adaptation to the handling they will experience when moved/transported
- A non-significant increase in FCR for Treated fish at low temperatures may indicate lower feed utilization
- The fish in this experiment were transferred to sea water in controlled tanks instead of to sea cages. If these fish were transferred to sea cages with more infectious variables, one outcome could have been more infections to the treated fish as an effect of the skin lesions

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Acknowledgements

- We want to direct special thanks to the involved technical personnel at Nofima for their valuable knowledge and experience during the experiment
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