PROJECT: BENCHMARK
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Responses in osmoregulatory capacity in gills, intestine and kidney before seawater transfer

HYPOTHESIS:

Effect of fish size and length of winter signal in freshwater (RAS) on osmoregulatory capacity in gills intestine and kidney

DURATION: August 2022-January 2023

FISH SIZE TESTED:
- 160 grams, figure 1a: *Early winter signal, EW, 6 weeks winter signal starting at 40 g*
- 350 grams, figure 1b: *Late winter signal, LW, 6 weeks winter signal starting at 120 g*
- 850 grams, figure 1c: *Late long winter signal, LLW, 18 weeks winter signal starting at 120 g*

SALINITY TESTED: Freshwater

HIGHLIGHTS (see illustration):

Early winter signal (Group 2, EW) gives strong response:
- Significant increase in gill Nka enzyme activity was after 260 dd, peaking at 350 dd. Gills loose seawater tolerance if not given increased salinity.
- Intestinal and kidney Nka activity peak at 720 dd, indicating later seawater readiness than in gills.
- De-smoltification in gills occurred already after 720 dd while intestine and kidney lost sweater tolerance between 720 and 1836 dd.

Late winter signal (Group 3, LW) gives strong response:
- Peak Nka enzyme activity levels were found at 350 dd for all tissues indicating a more synchronized smoltification compared to the Early Winter group (EW).
- Desmoltfication was observed between 350 dd and 1430 dd in all tissues.

Late long winter signal (Group 4, LLW) gives weak response:
- The spring signal (24 h light) appears have to no effect on the Nka enzyme activity in gills and kidney while an increase was observed in the intestine. This indicate that the spring signal have a limited stimulatory effect in larger fish (>350 grams), or if the winter signal is too long. Tissue-specific differences (e.g intestine) and unsynchronized development of Nka enzyme activity.

RECOMMENDATIONS for photoperiod treatments and development of seawater tolerance:

- **SW transfer at 150 grams:** A traditional winter signal (Early winter protocol) should be used if the producer aims to transfer fish between 100-150 grams as all tissues have sufficient osmoregulatory capacity at 350 dd (150 grams). Transfer at 720 dd is possible if 12 ppt BW is used to keep gill Nka enzyme activity elevated until seawater transfer around approximately 720 dd.
- **SW transfer at 350 grams:** A delayed winter signal of 6-8 weeks (Late winter protocol)

may be beneficial if the aim to transfer fish at 350 grams as this will secure optimal osmoregulatory capacity in all three organs. Reduction in Nka enzyme activity likely occurs shortly after between 500 - 720 dd so it's not recommended to delay SW transfer after 720 dd using 12 ppt (+/- 1 week). Continues light (No winter protocol) is not recommended.

- **SW transfer at 820 grams:** In Benchmark II we found no optimal rearing protocols to obtain sufficient osmoregulatory capacity at time of SW transfer. Extending the winter signal for 18 weeks or trying to stimulate smolt development by photoperiod in 7-800 grams is not recommended as it they do not respond sufficiently to the photoperiod treatment. Use of higher salinity ranges (>20 ppt) should be considered to maintain high Nka enzyme activity levels high in all organs after smoltification to delay loss of osmoregulatory capacity.

The factsheet is ready for implementation, but with the note that the testing has not been done for all industrial relevant conditions.

READ MORE:

The reader is referred to Benchmark I (Ytrestøyl et al., 2022), review articles (any published on production protocols) and methodological consideration for the Nka enzyme activity in production settings (Takvam et al., 2023; Submitted, Reviews in Aquaculture). The reader is also referred to other related factsheets in Benchmark II trial related to growth, performance, nephroscore and maturation in RAS and SW phase (SW tanks and open net pens; Gifas).

Ytrestøyl et al., 2022. https://doi.org/10.1111/jwas.12880.