

WP 2 - Social enrichment and requirements for the tank rearing of Atlantic salmon

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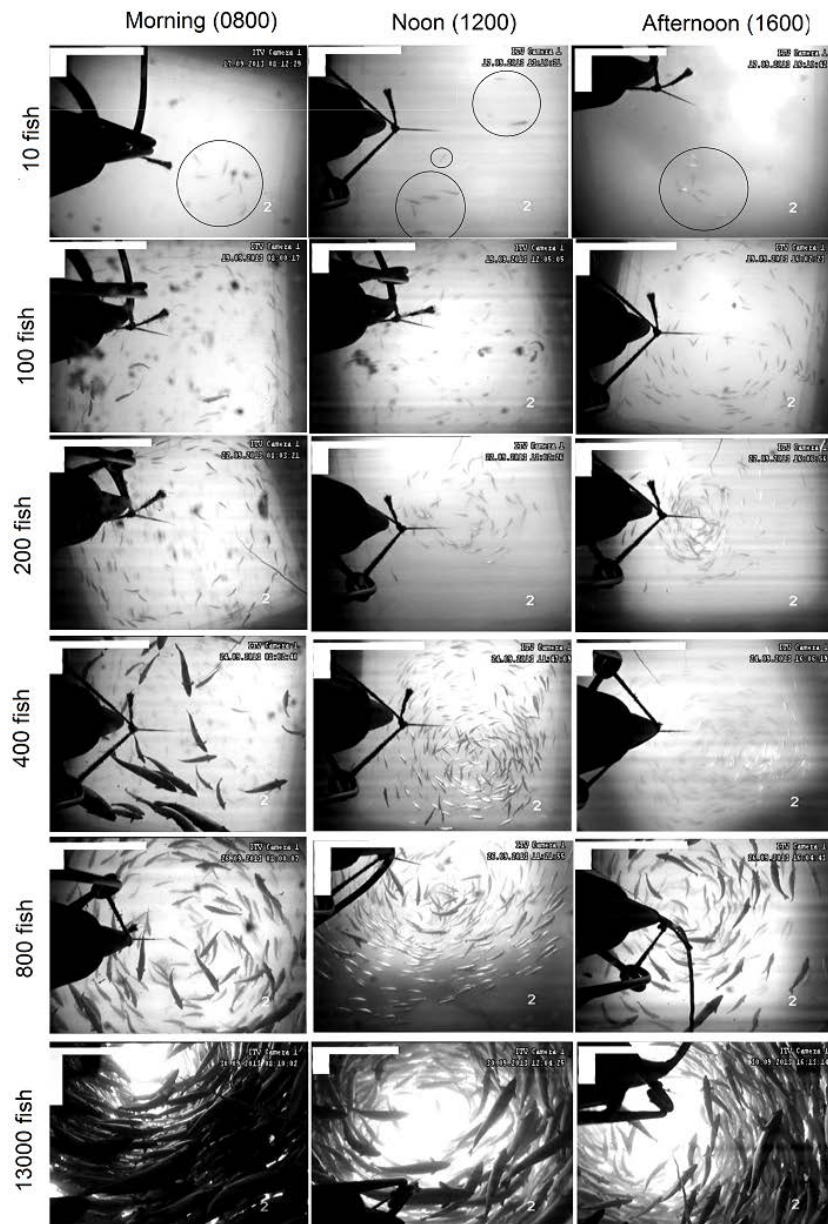
Institute of Marine Research

Task 2.1

Optimization of group size for animal experimentation with group-living salmon

3 Rs

- Reduction: As few fish as possible
- Refinement: Optimal environment
- Is few fish optimal?
 - Welfare
 - Relevance (a 4th R)



In sea cage, 3-kg salmon

Group size increased every
2nd day by adding fish

Folkedal et al., unpublished

Welfare aspects of group size

- Salmon are territorial in small groups, but schooling in large groups
- Small groups should give more damages and higher stress levels, at least for subdominant fish
- Which group size/density is large enough?

Relevance aspects of group size

- In experiments where results should be comparable to commercial aquaculture fish should **behave and perform as at commercial densities**
- Fish at densities with low aggression may still deviate behaviourally from commercial densities, with results being irrelevant for aquaculture

Three experiments

- Different behaviour at different stages
- Therefore the experiment must be made with all stages

- Pre-smolts (50 g)



- Smolts (100 g)



- Post-smolts (1000 g)



Pre-smolts

Matre Research Station



Pre-smolts

From 3 m circular tanks to 1 m squared tanks
21 days duration

- Fish: Salmon pre-smolts, 48.8 ± 6.9 g
- Tanks: 1 × 1 m (350 L)
- Flow: 18 L/min
- Current direction : clockwise
- Duplicates

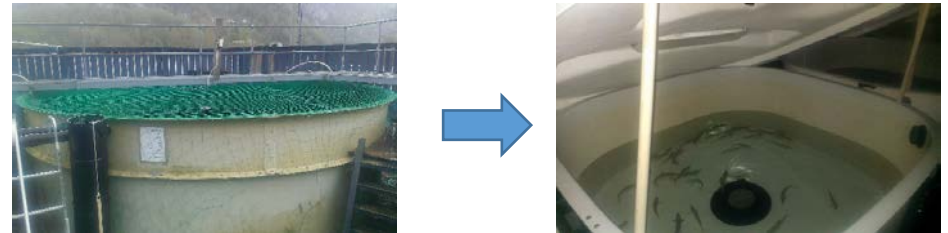


Group size	Stocking density (kg/m ³)
10	1.4
15	2.1
23	3.2
34	4.8
51	7.2
76	10.8
114	16.3
171	24.4

Smolts

- Fish: Salmon smolts, 78.1 ± 22.1 g
- Tanks: 1.5×1.5 m (775 L)
- Flow: 30 L/min
- Current direction : clockwise
- Triplicates

Start at sea water transfer
42 days duration



Group size	Stocking density (kg/m ³)
12	1.4
25	2.6
50	4.9
100	11.2
200	21.1

Post-smolts

Transferred from 12×12 m cages to 3 m tanks
28 days duration

- Post-smolts, 941 ± 306 g
- Tanks: 3 m circular (5600 L)
- Flow: 200 L/min
- Current direction : clockwise
- Triplicates

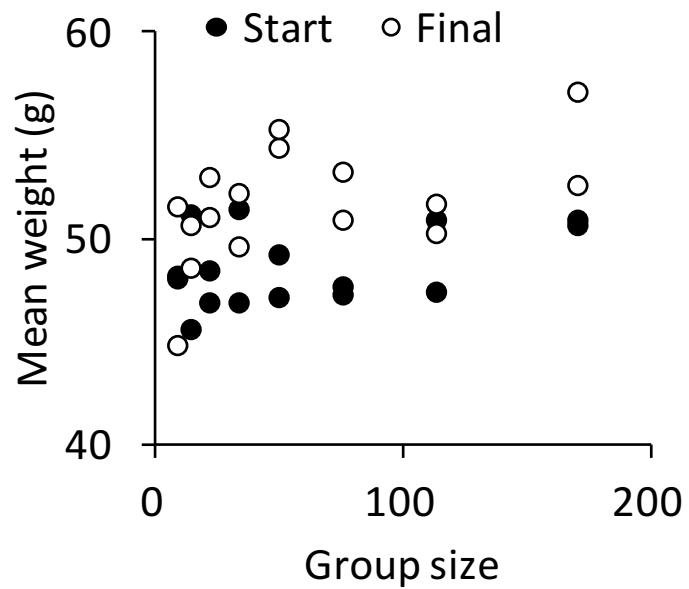


Group size	Stocking density (kg/m ³)
10	1.7
30	5.0
70	11.7
150	25.0

Weight

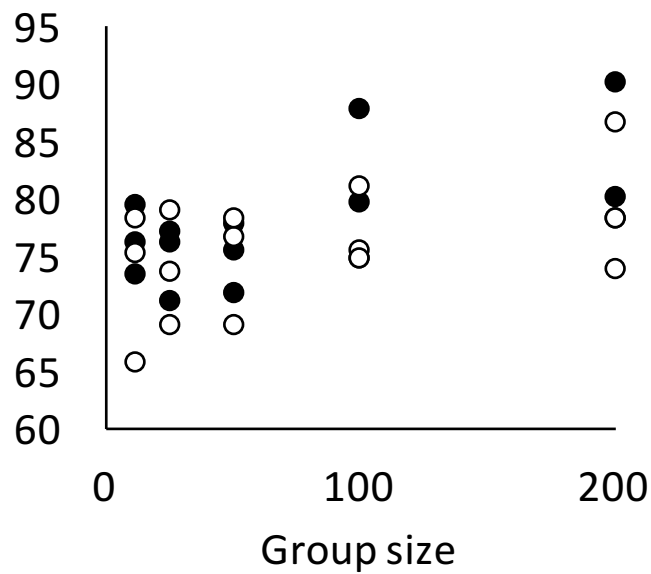
21 days

Pre-smolts



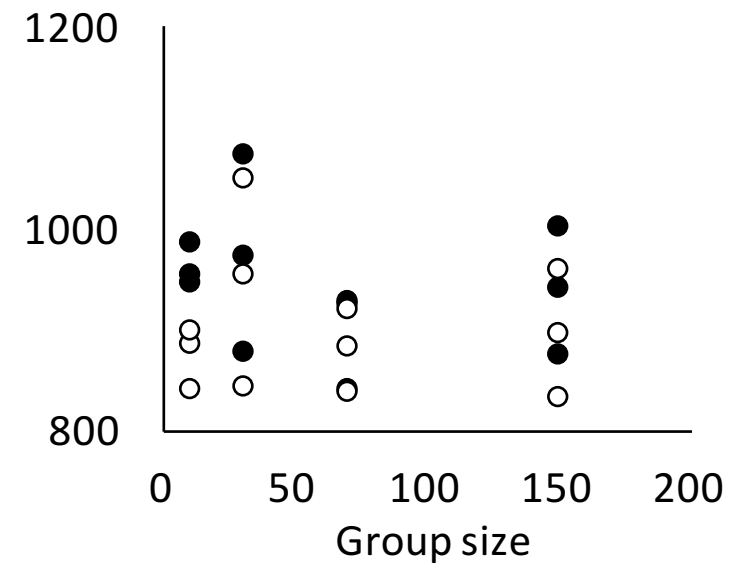
42 days

Smolts



28 days

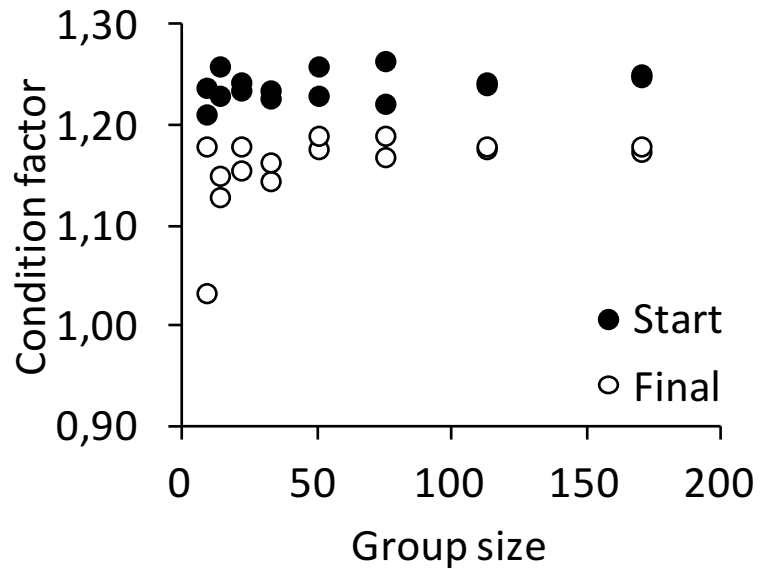
Post-smolts



Condition factor

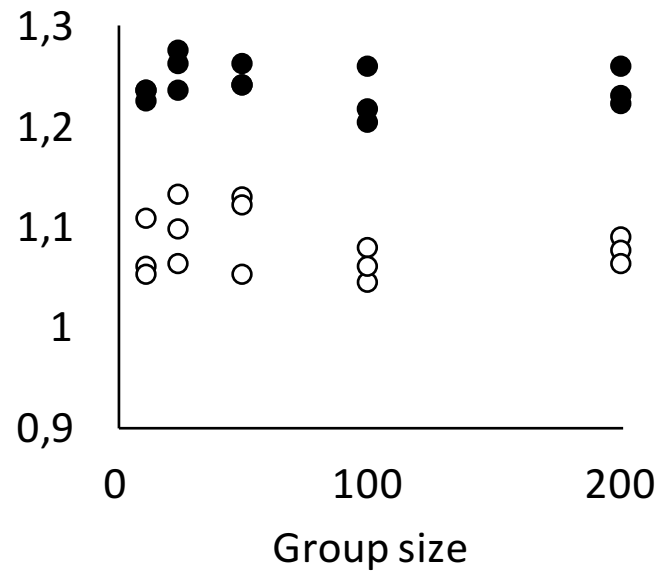
21 days

Pre-smolts



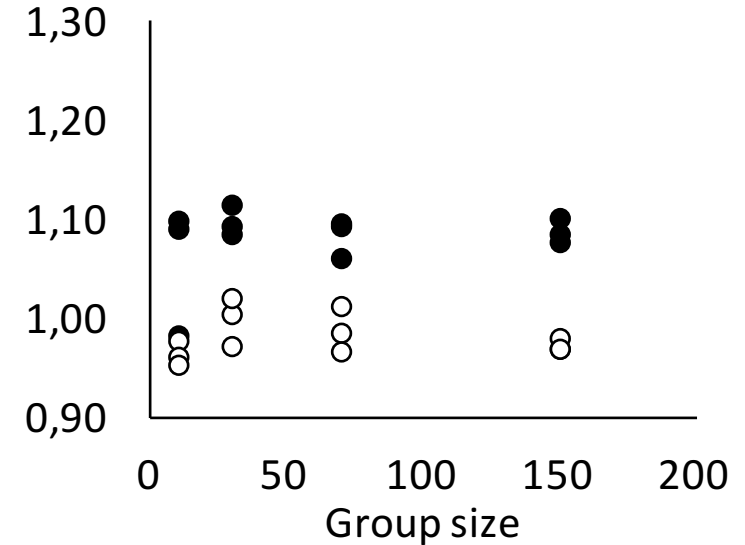
42 days

Smolts



28 days

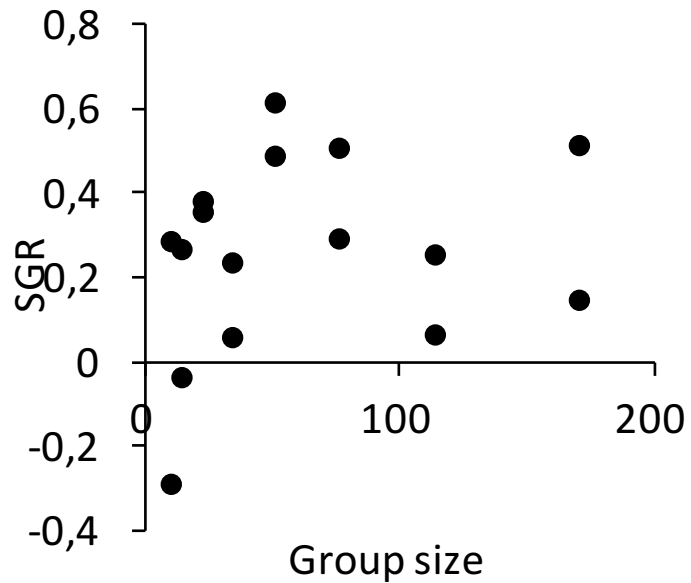
Post-smolts



Growth rate

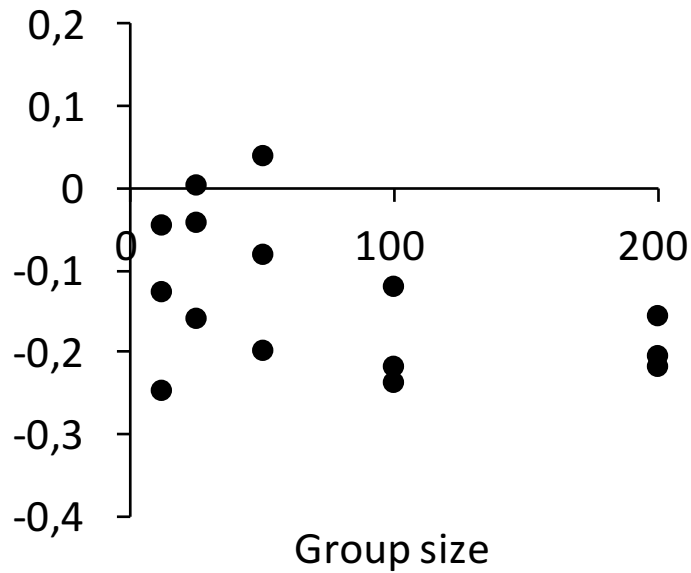
21 days

Pre-smolts



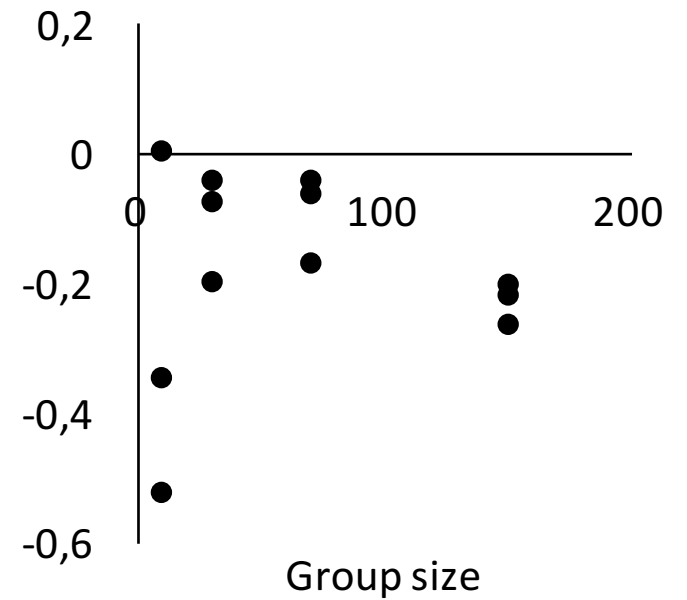
42 days

Smolts



28 days

Post-smolts

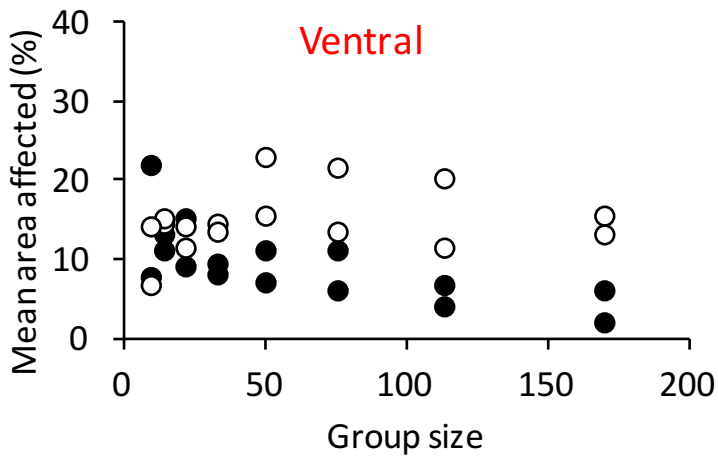
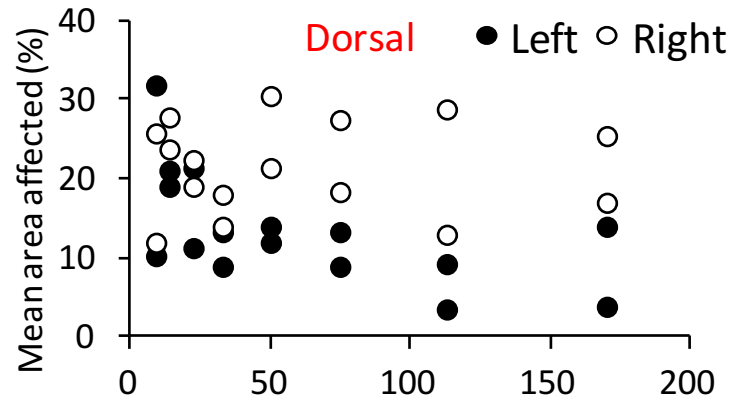


The image shows two fish, likely salmon, positioned horizontally. The fish on top is slightly above the fish on the bottom. Both fish have a silvery, iridescent scales that appear damaged or missing in several areas, particularly along the dorsal and lateral regions, revealing a darker, more textured skin underneath. A ruler is placed below the fish, showing measurements in centimeters. The ruler is marked with numbers 18, 19, 20, 21, 22, 23, and 24. The fish on the bottom is positioned over the 18 to 24 cm range. The fish on the top is positioned over the 19 to 24 cm range. The text "Scale loss" is overlaid in the center of the image, in a white, sans-serif font.

Scale loss

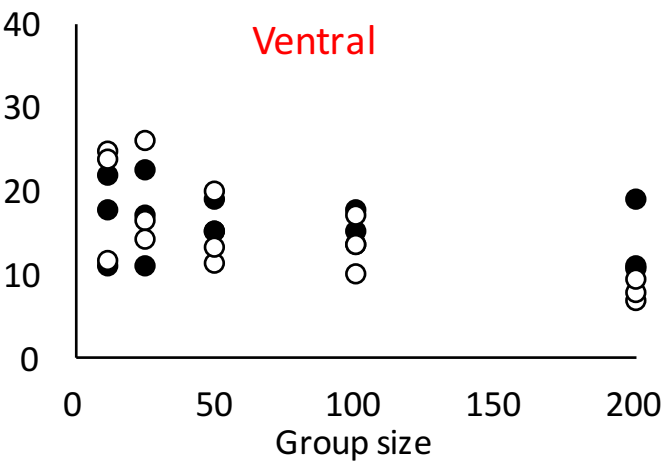
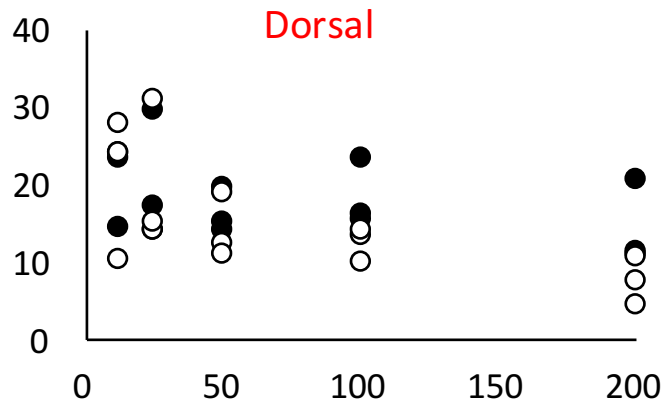
21 days

Pre-smolts



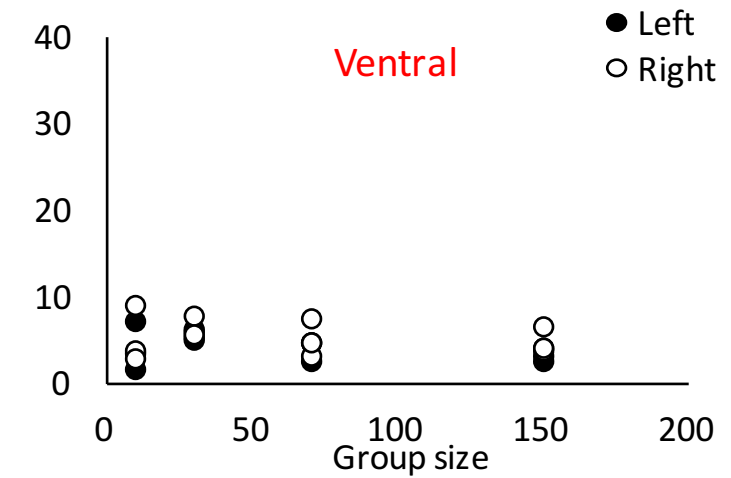
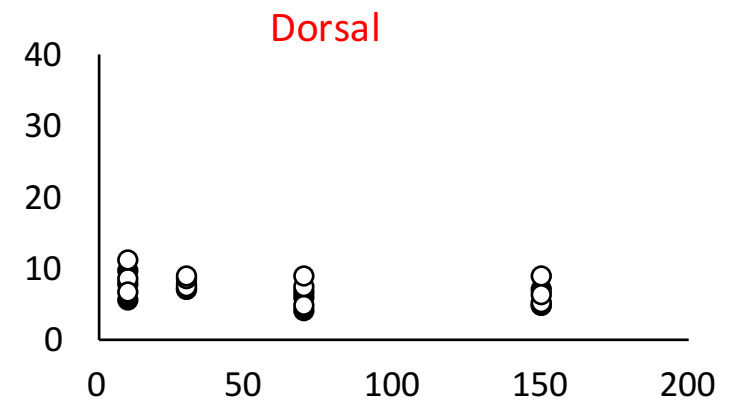
42 days

Smolts



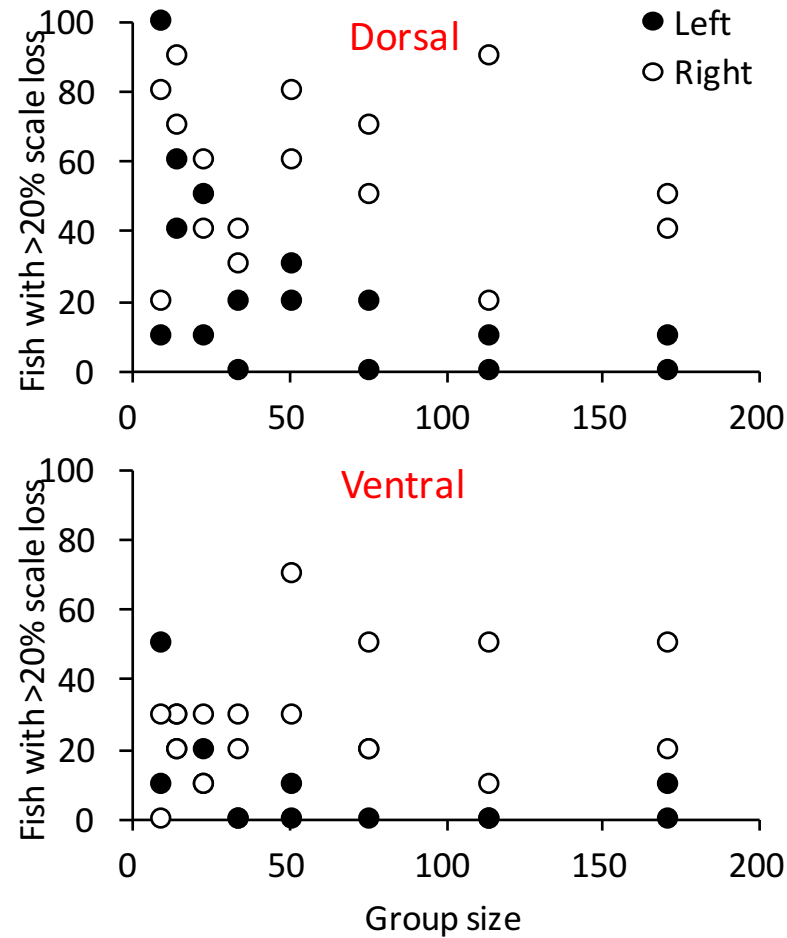
28 days

Post-smolts



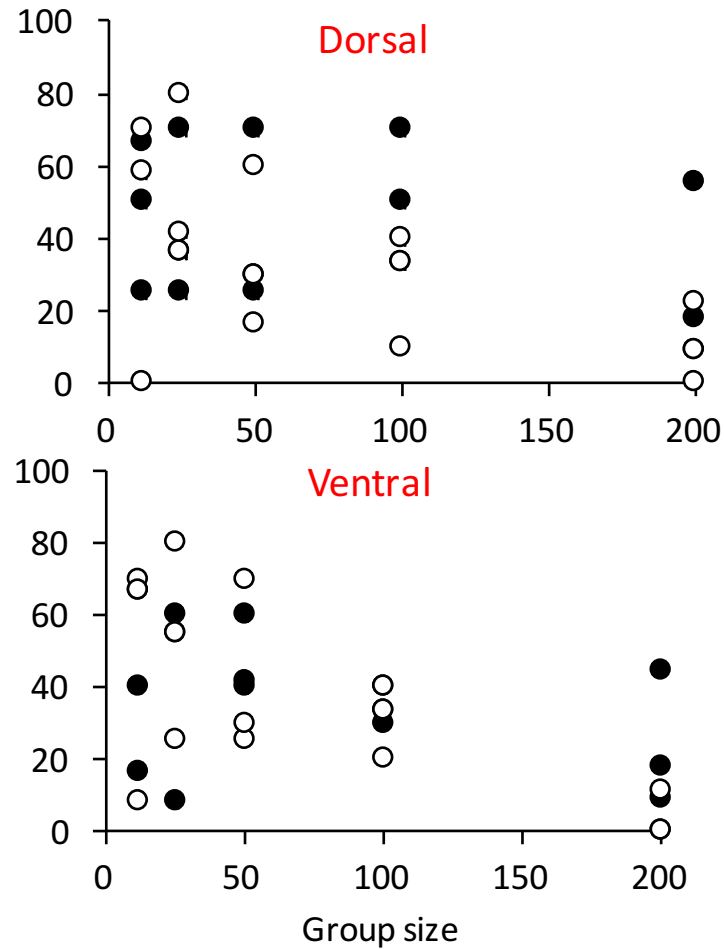
21 days

Pre-smolts



42 days

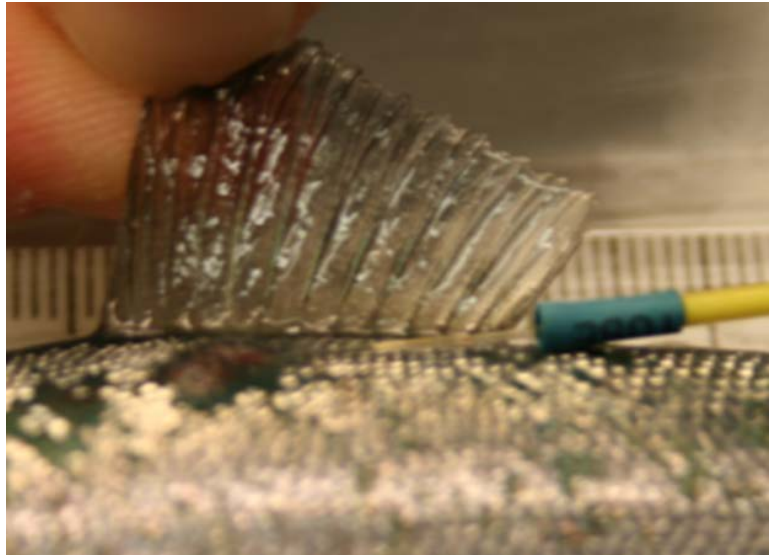
Smolts



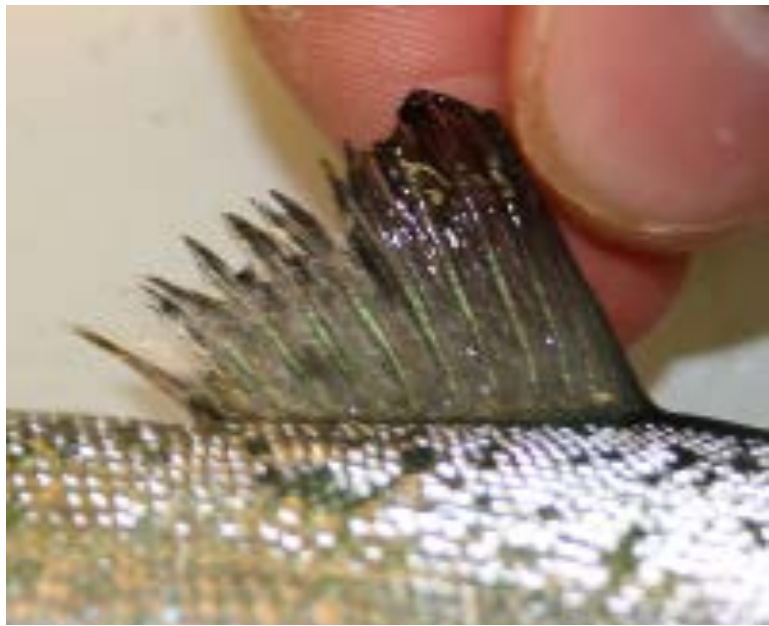
28 days

Post-smolts

Very few fish
with >20% scale
loss

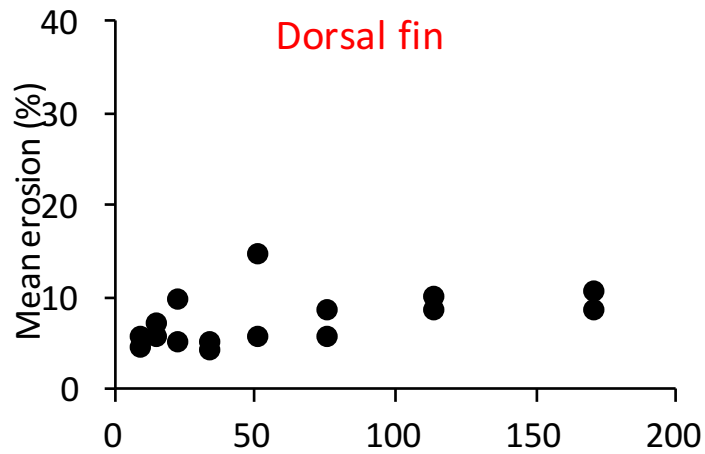


Fin
erosion



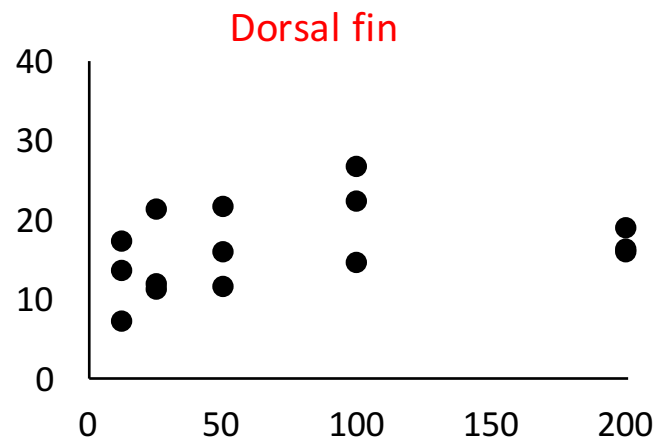
21 days

Pre-smolts



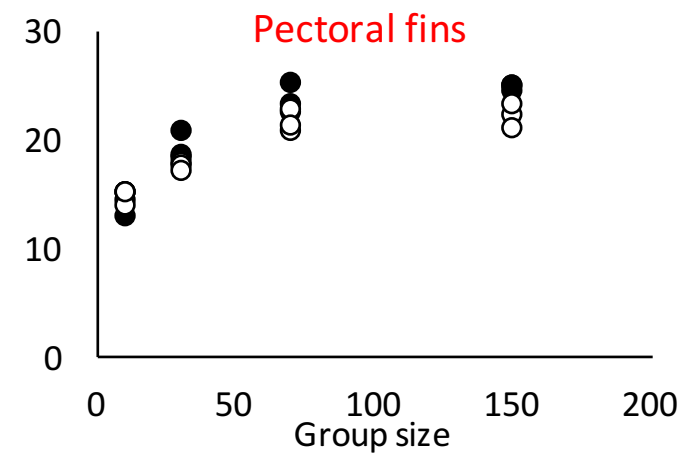
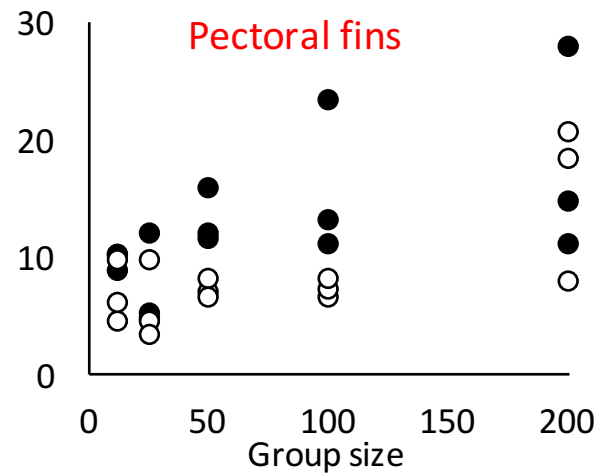
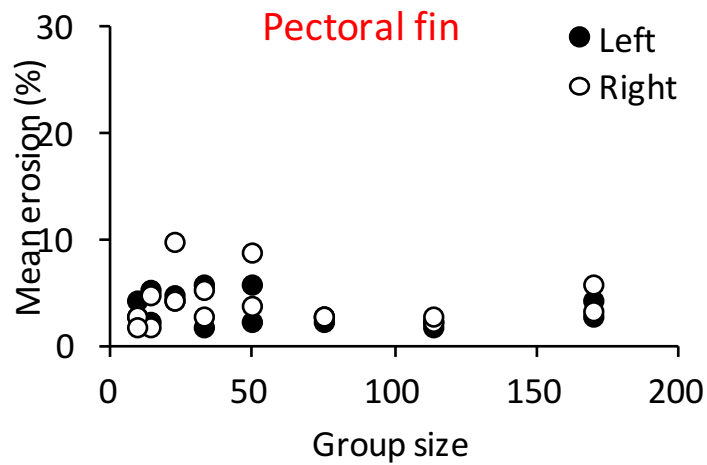
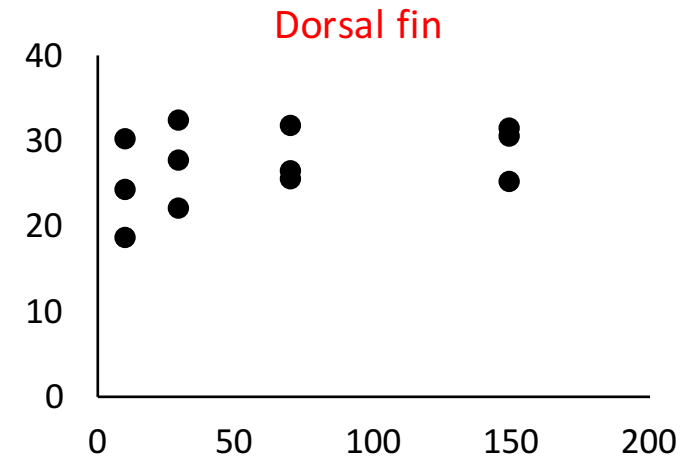
42 days

Smolts



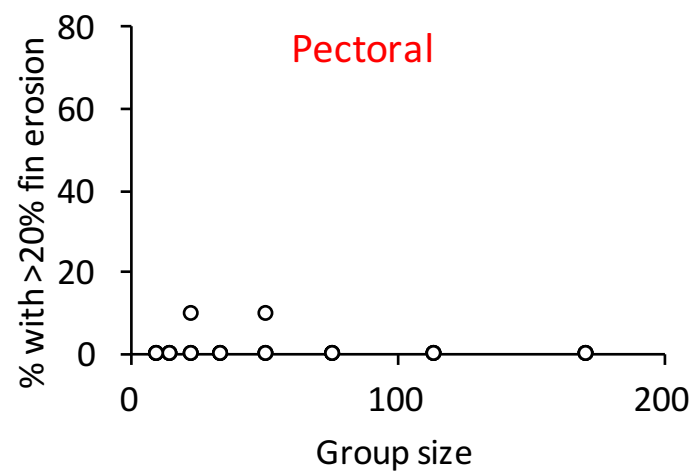
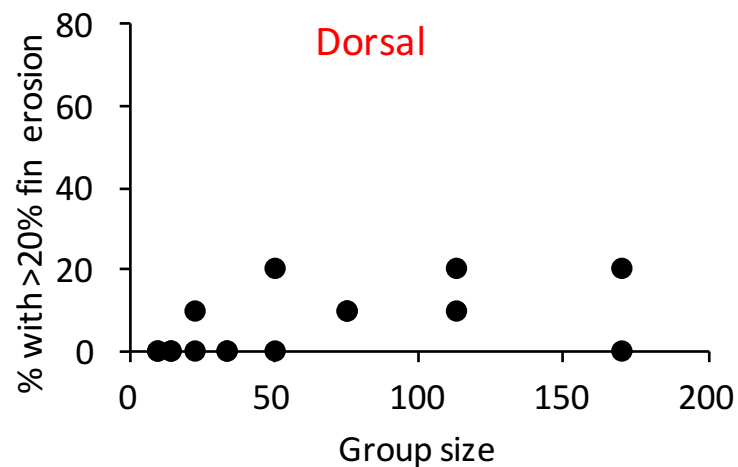
28 days

Post-smolts



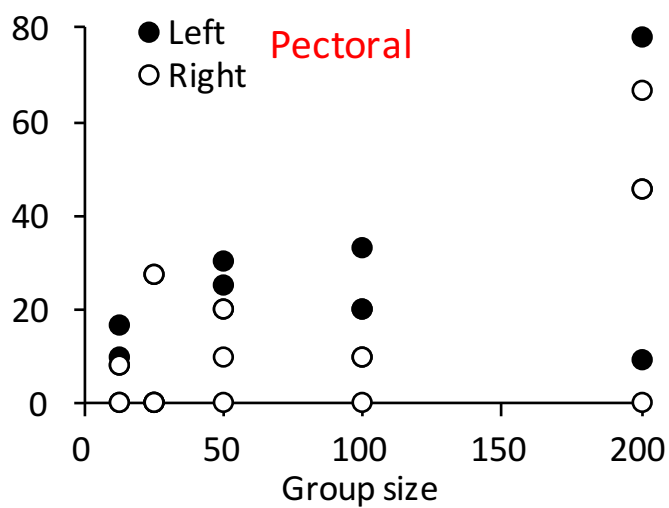
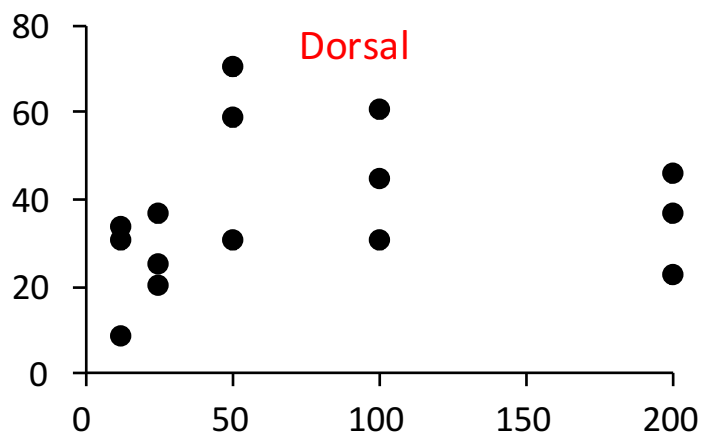
21 days

Pre-smolts



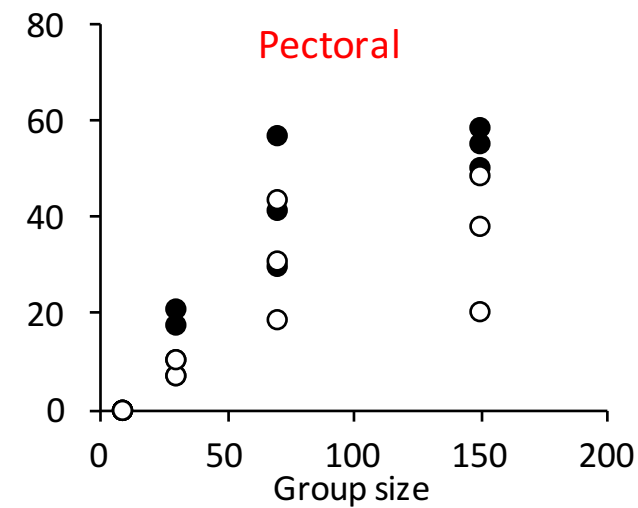
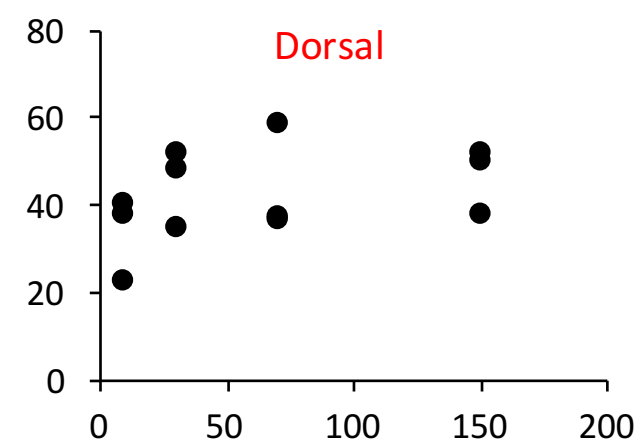
42 days

Smolts



28 days

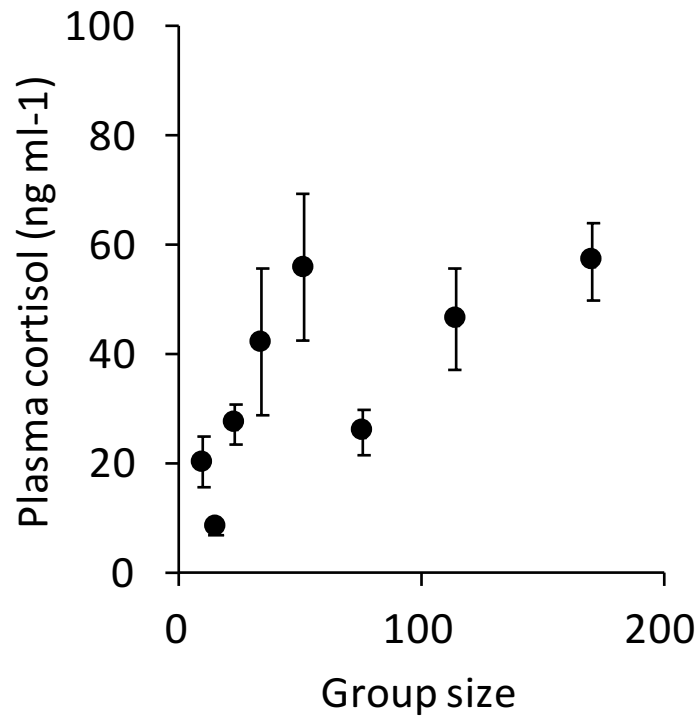
Post-smolts



Baseline plasma cortisol

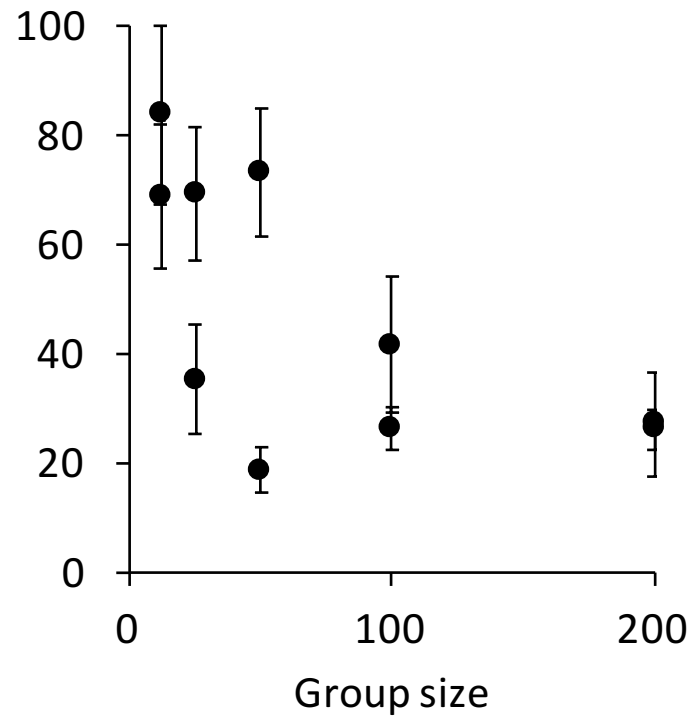
21 days

Pre-smolts



42 days

Smolts



28 days

Post-smolts

To be analyzed

Aggression

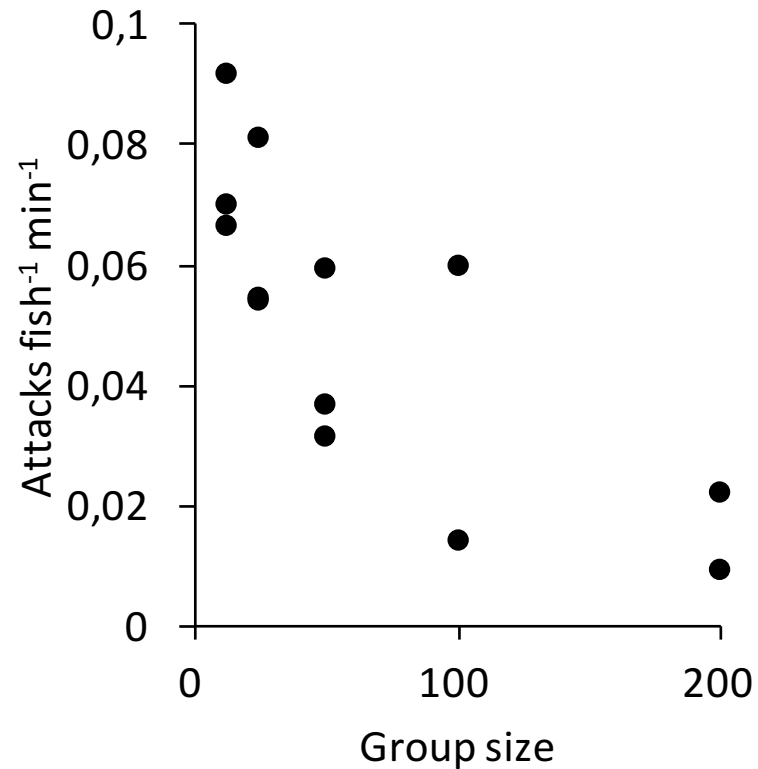
21 days

Pre-smolts

To be analyzed

42 days

Smolts



28 days

Post-smolts

To be analyzed

Summary Task 2.1.

- Scale loss decreased with group size
- Erosion of pectoral fins increase with group size (smolts and post-smolts)
- Baseline plasma cortisol increases with group size in pre-smolts, but decreases with group size in smolts
- Aggression level decreases with group size (in smolts)
- Generally less between-tank variation in the larger groups

Task 2.2

Effect of changing rearing unit volume on acclimation and behaviour of salmon pre-smolts.

- How long acclimation period is needed?
- Acclimation period before the experiment starts varies extensively between conductors, but the true acclimation status is seldom documented
- Too short acclimation periods may give false results, too long periods extend the total time of the experiment

Examples:

- Trout showed a cortisol acclimation time **over one month** (Pottinger & Pickering, 1992)
- Salmon post-smolt transferred to smaller tanks and group size showed a marked drop in daily food intake (>50%) followed by a steady increment towards normal levels **over 6 weeks** (Folkeadal et al., unpublished)
- (and Task 2.1 suggests long acclimation periods)

- A rule of thumb amongst salmon farmers for the fish to thrive is to avoid transfer of fish to smaller group sizes or rearing units than their current ones
- The opposite is more or less standard in aquaculture research
 - Sufficient replicates and statistical power
- How does change in rearing unit size affect acclimation time?

Acclimation for 8 weeks

Planned to spring 2016

Original tank size (m)	Original volume (L)	New tank size (m)	New volume (L)	New group size
1	350	0.5	100	20
1	350	1	400	80
1	350	1.5	900	180

- Smaller tanks
- Similar tanks
- Larger tanks

Pre-smolts of ca 50 g

Stocking density 10 kg/m³ in
all tanks

Triplicates

Measures

- Appetite (feed collection 3 days/week)
- Water cortisol once per week
- Growth
- Welfare scores/fin erosion and scale loss
- Behaviour