Winter condition of Atlantic salmon parr and pre-smolts experiencing hydropeaking flow regimes.

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Winter for Fish

Picture by Paula Thoms

< 4 °C Temperatures

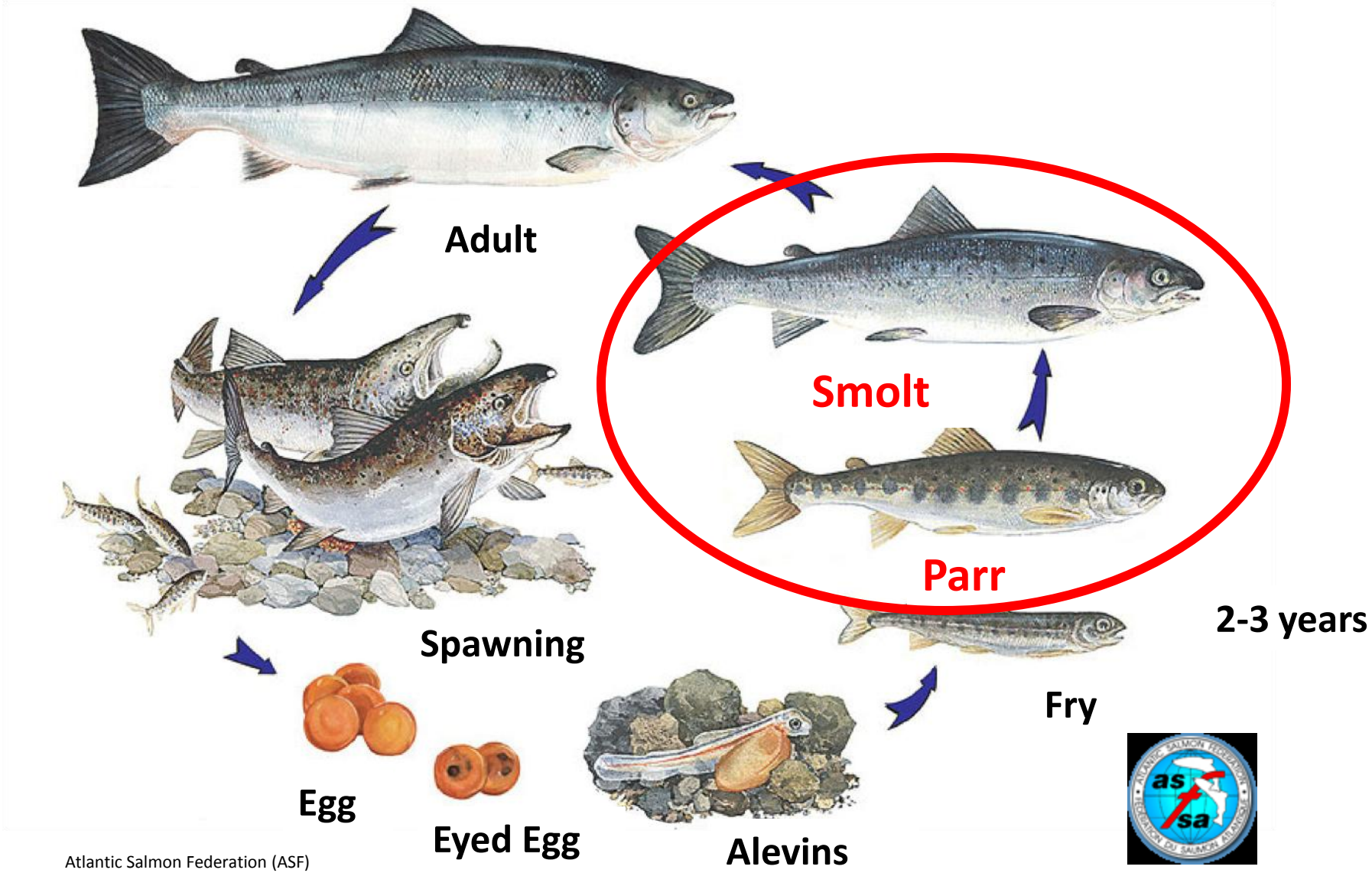
Decreased metabolism

Limited Food Assimilation

Reliance on lipid reserves (energy)

Period with rapid lipid depletion

Atlantic Salmon Lifecycle



Atlantic Salmon Federation (ASF)

Atlantic Salmon Smolts

- Physiological changes (>120 mm)
  - Occurs in late winter (April-May)
  - Silver color tone
  - Increase in Na^+,K^+ - ATPase activity

- Requires energy

- Reduced lipid levels and condition factor during late winter

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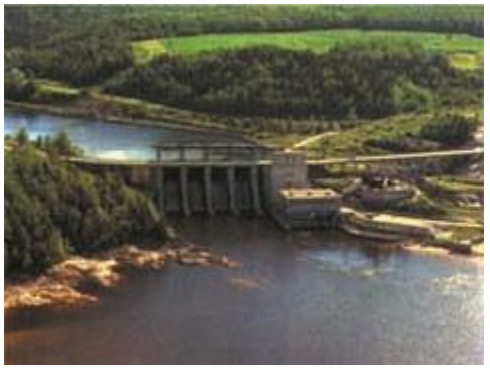
Regulated Rivers

- Hydropeaking flow regimes

- Regulated flow regime for electrical production
  - High flows during the day
  - Low flows at night



- 2-50 x increase in flow on a daily basis
  - Increased velocity

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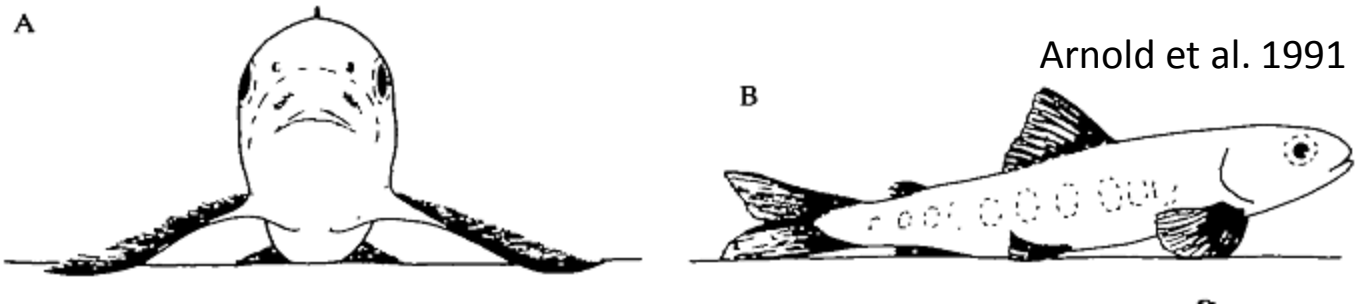
Adaptations to High Velocity

- Large pectoral fins for station holding (summer)



Arnold et al. 1991

- Inhabiting interstitial space where velocity is reduced (winter)

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Hypotheses

- Hydropeaking flows would **negatively** affect the **overwintering condition** of Atlantic salmon parr.

- Smoltification will **decrease** in fish exposed to hydropeaking flows

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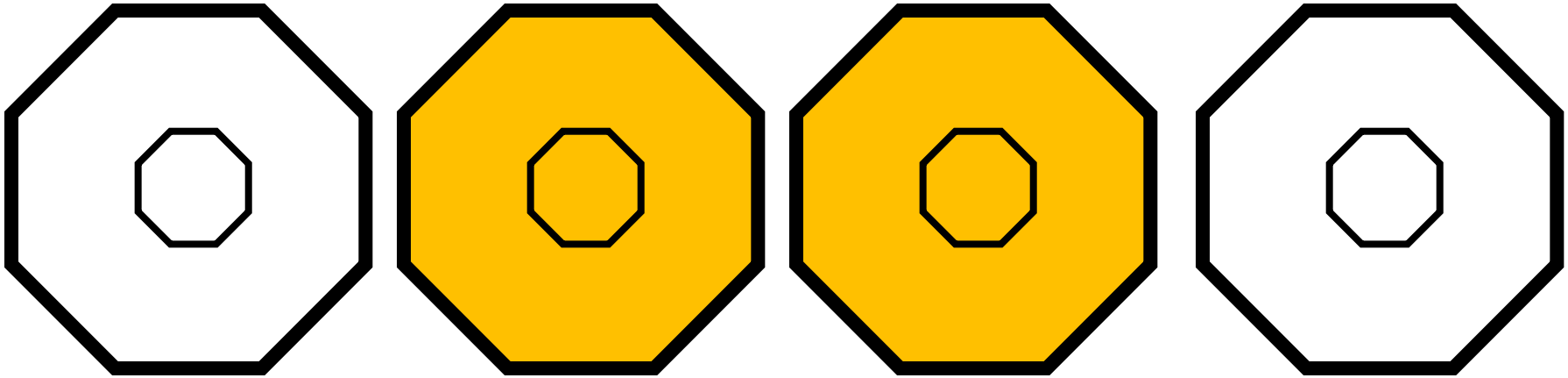
Experimental Setup

Mactaquac Biodiversity Centre (DFO)

Fisheries and Oceans Canada
Pêches et Océans Canada

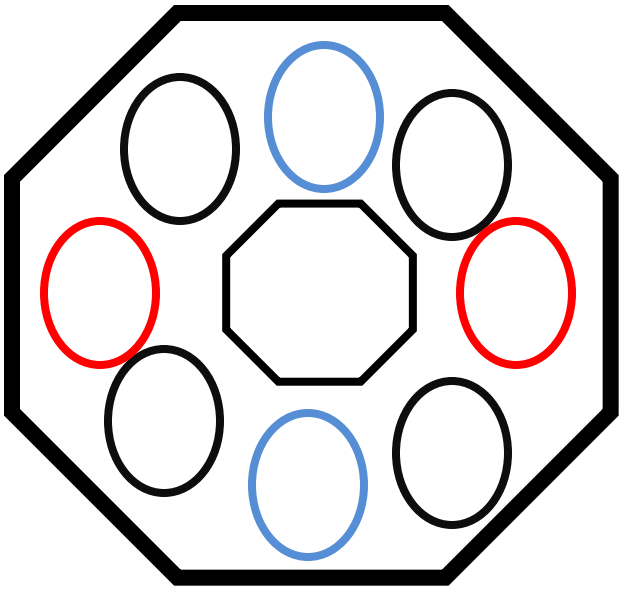
Control | Hydropeaking Flows | Hydropeaking Flows | Control



10 x 10 metres

Natural substrate and various habitat

Outdoor Mesocosms
- **-Snow/Ice**
- **-Winter temperatures**
- **-Natural light regimes**



Riffles

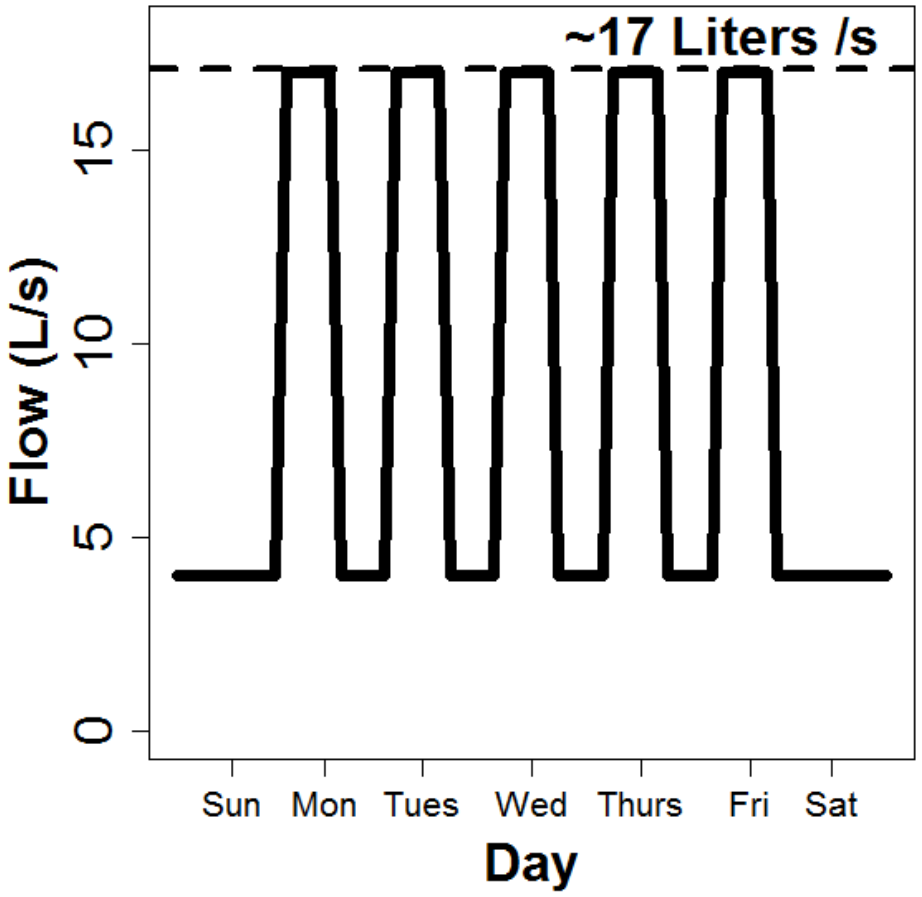
Pools

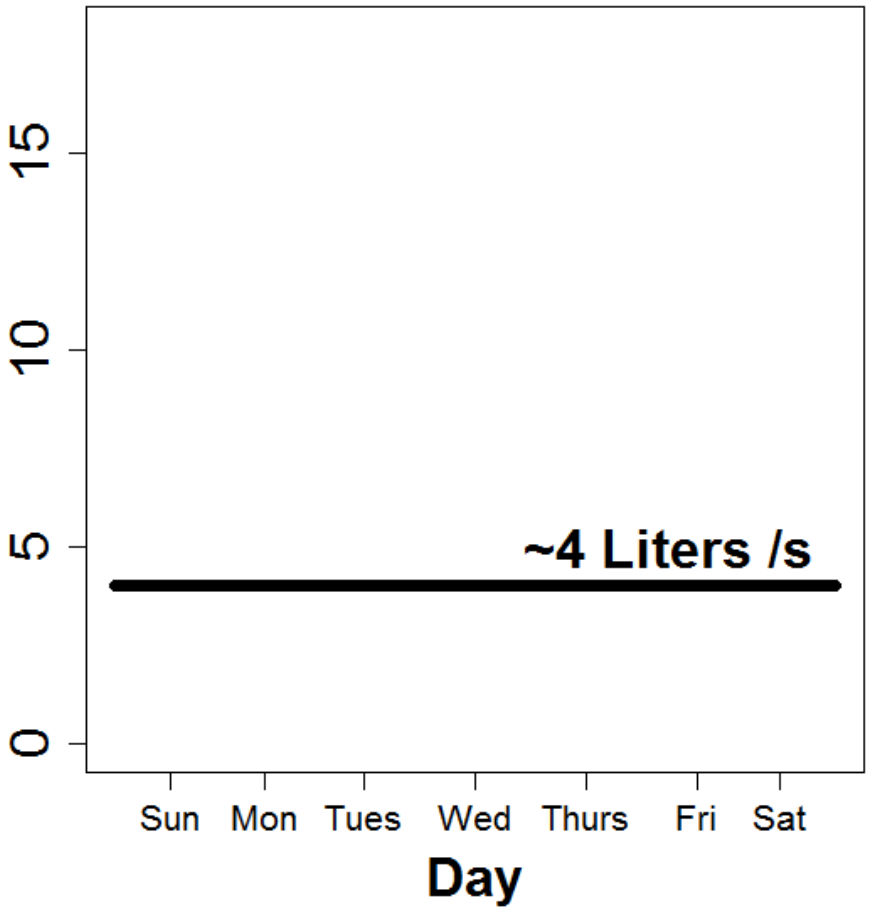
Runs

Pictures by Kurt Samways


Picture by Kurt Samways

Flow Regime

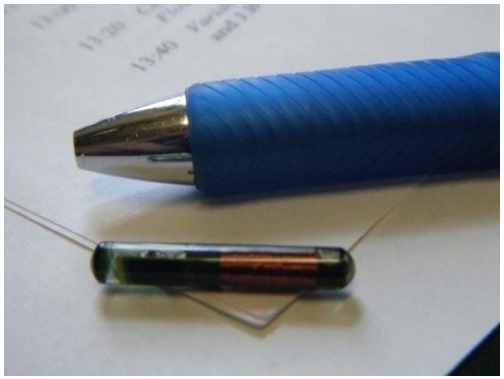




4 X flow increase
2X velocity increases

No change in water level during flow changes

Fish



~0.60 wild parr/m²

Collected from the Tobique River, NB

Year 1

- 62 Parr per tank
- 3 age classes
  - Young of year, Age 1 & 2
- ~40 – 170 mm

Individually tagged

PIT tags (>2 g)

VIE tags (<2 g)

Food resources

Feed *ad libitum* on naturally occurring macroinvertebrates

Sampling

- Monthly from February to May (Year 1)
- Collect fish via electrofishing

- Measurements (Condition):
  - Length & weight (condition factor and weight gain)
  - Total Lipids (Bioimpedance Analysis (BIA))
    - Correlates electrical values with total lipid content
  - Smoltification status (May)
    - Na^+,K^+ - ATPase Activity

Results

Year 1 (2x velocity increase) 2012

– Data suggest low velocity fluctuations do not affect overwinter condition or Na^+, K^+ ATPase activity.

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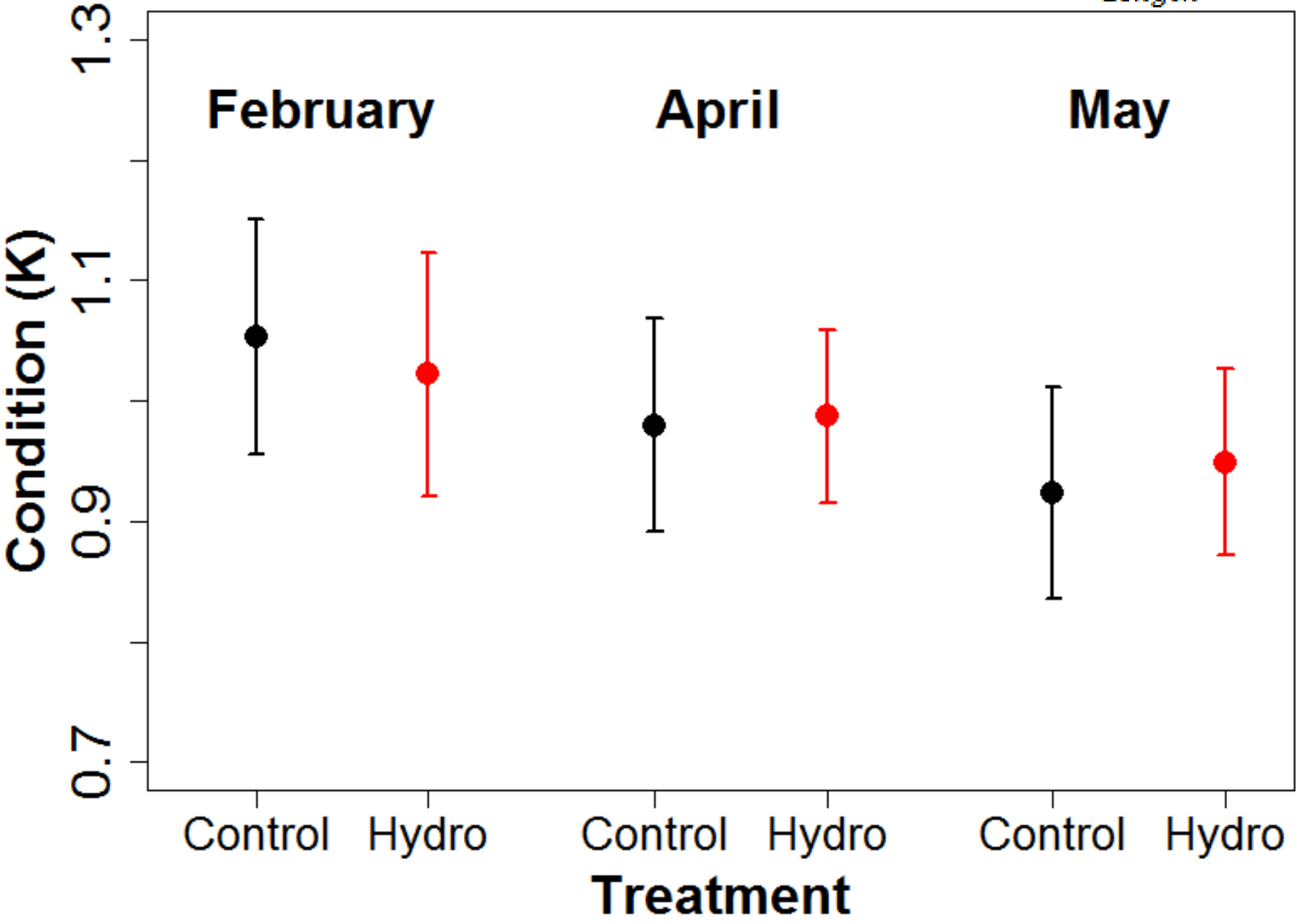
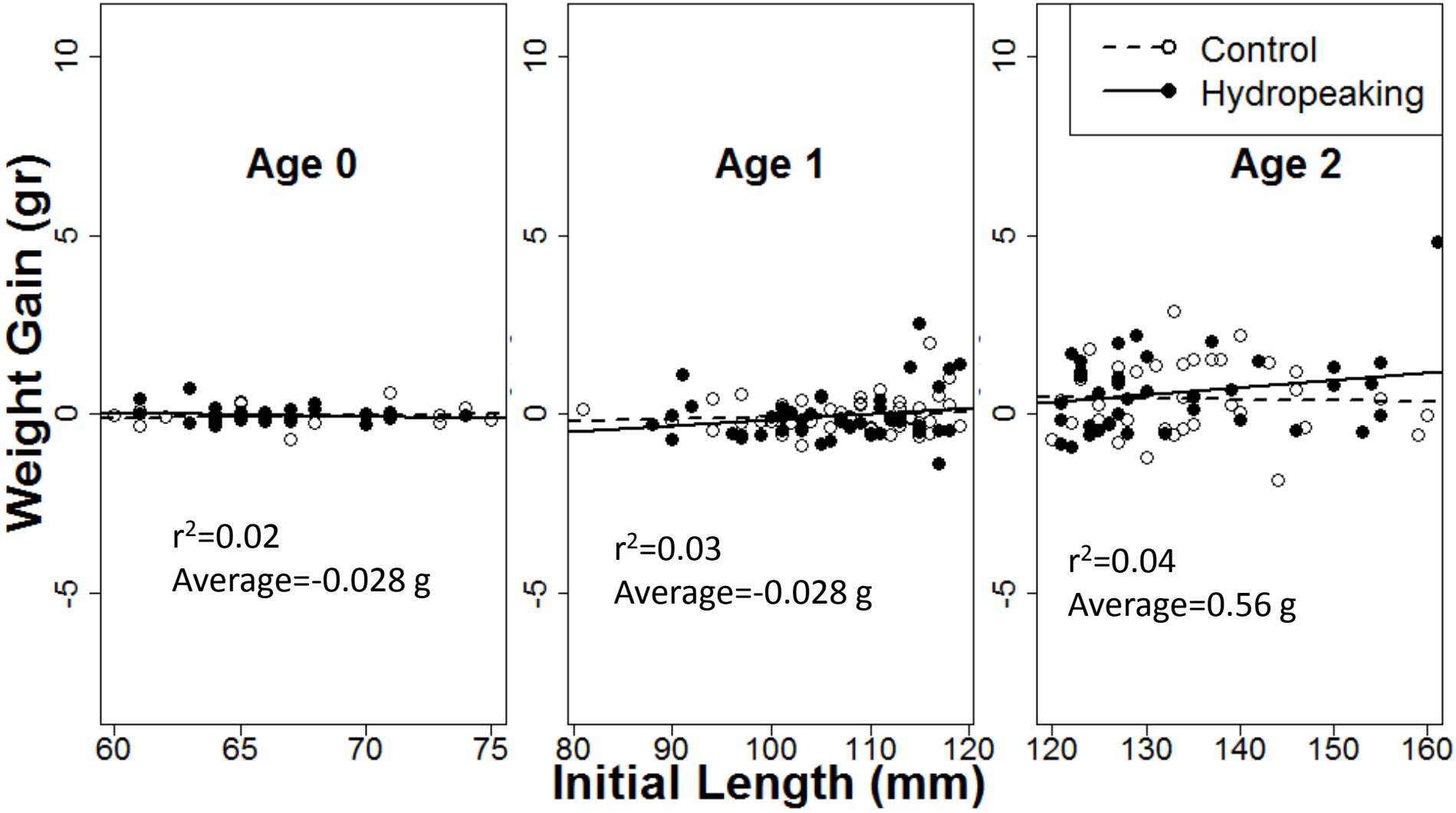
$$Condition\ Factor(K) = \frac{Weight \times 10^2}{Length^3}$$



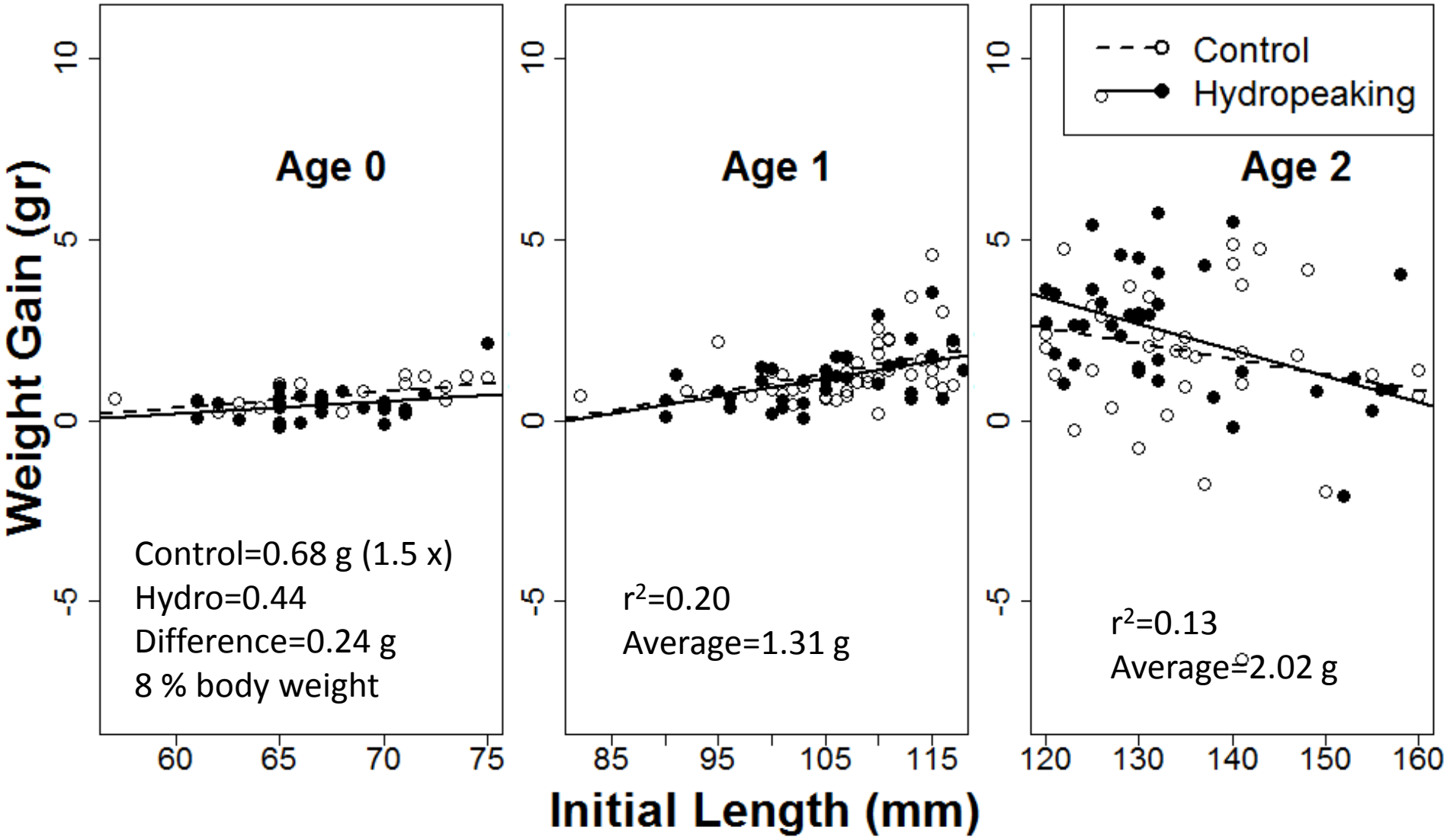
Weight gain during winter

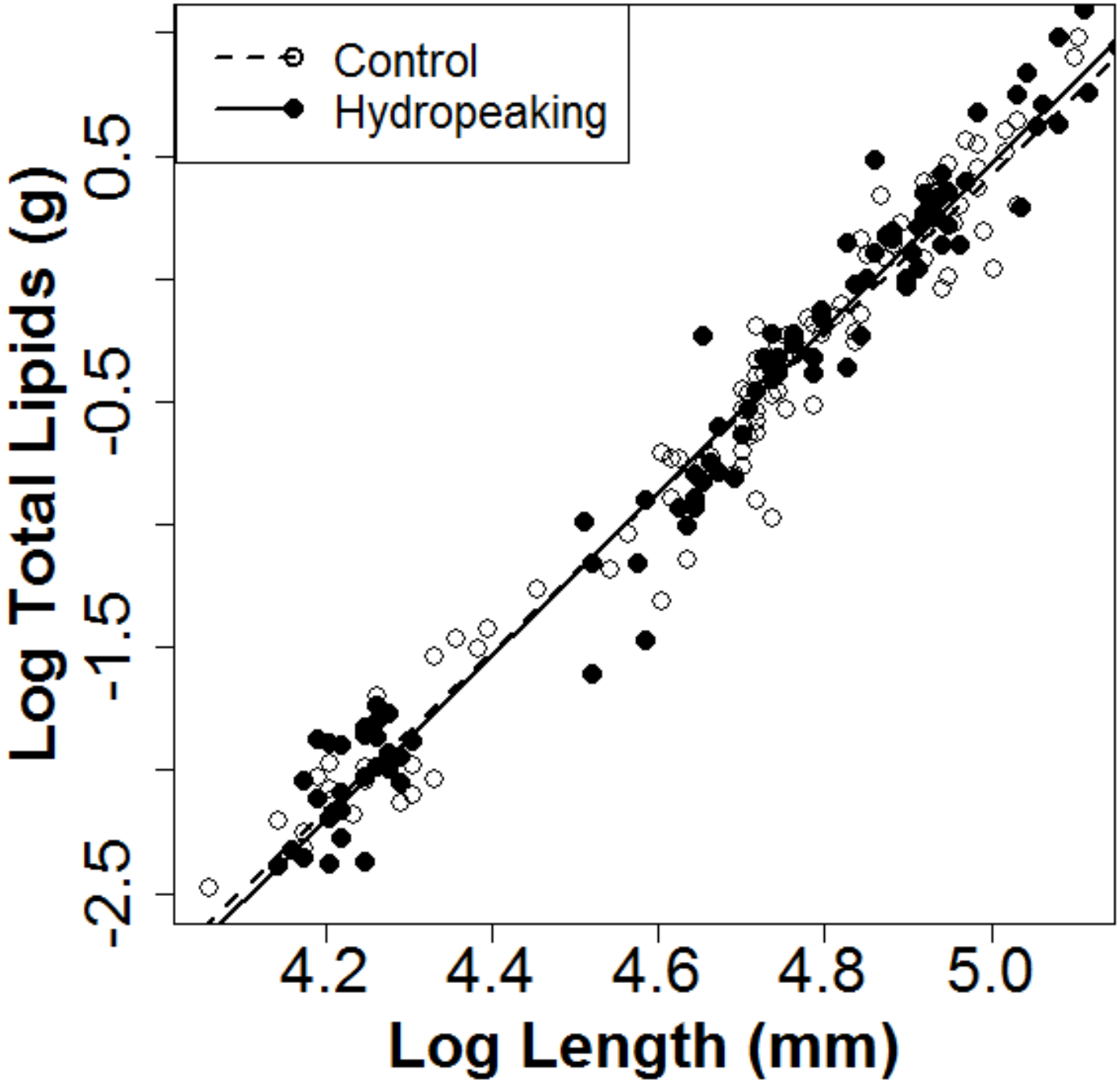
Feb-April

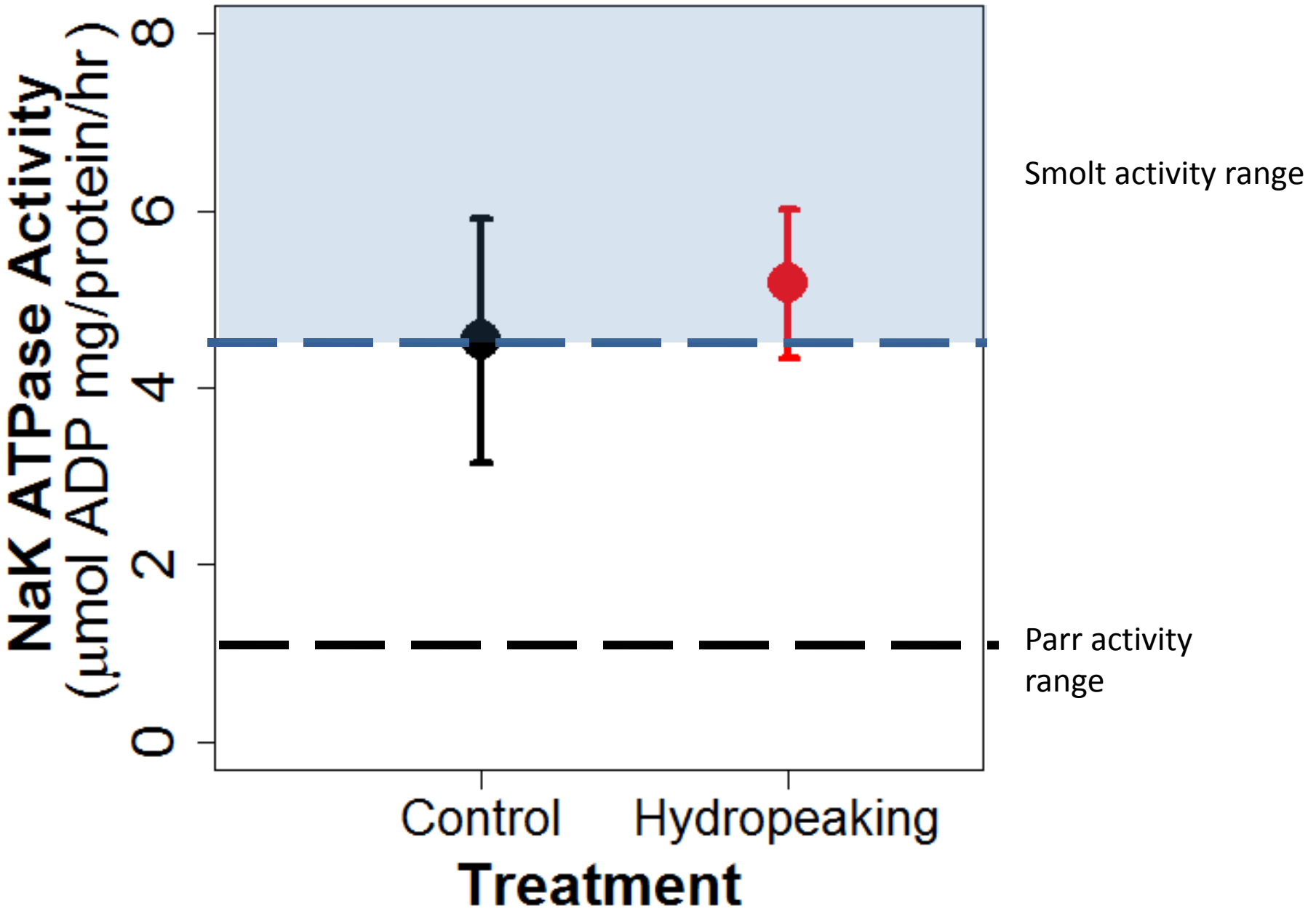


Weight gain during spring

April-May




Control
Hydropeaking
Log Total Lipids (g)
0.5
-0.5
-1.5
-2.5
4.2
4.4
4.6
4.8
5.0
Log Length (mm)


NaK ATPase Activity
(µmol ADP mg/protein/hr)
0
2
4
6
8
Control
Hydropeaking
Treatment
Smolt activity range
Parr activity range

Results

Year 1 (2x velocity increase)

– Data suggest low hydropeaking fluctuations do not affect overwinter condition or smotification

Year 2 (4 x velocity increase)

– In progress

- Preliminary data suggest no differences in condition between treatments

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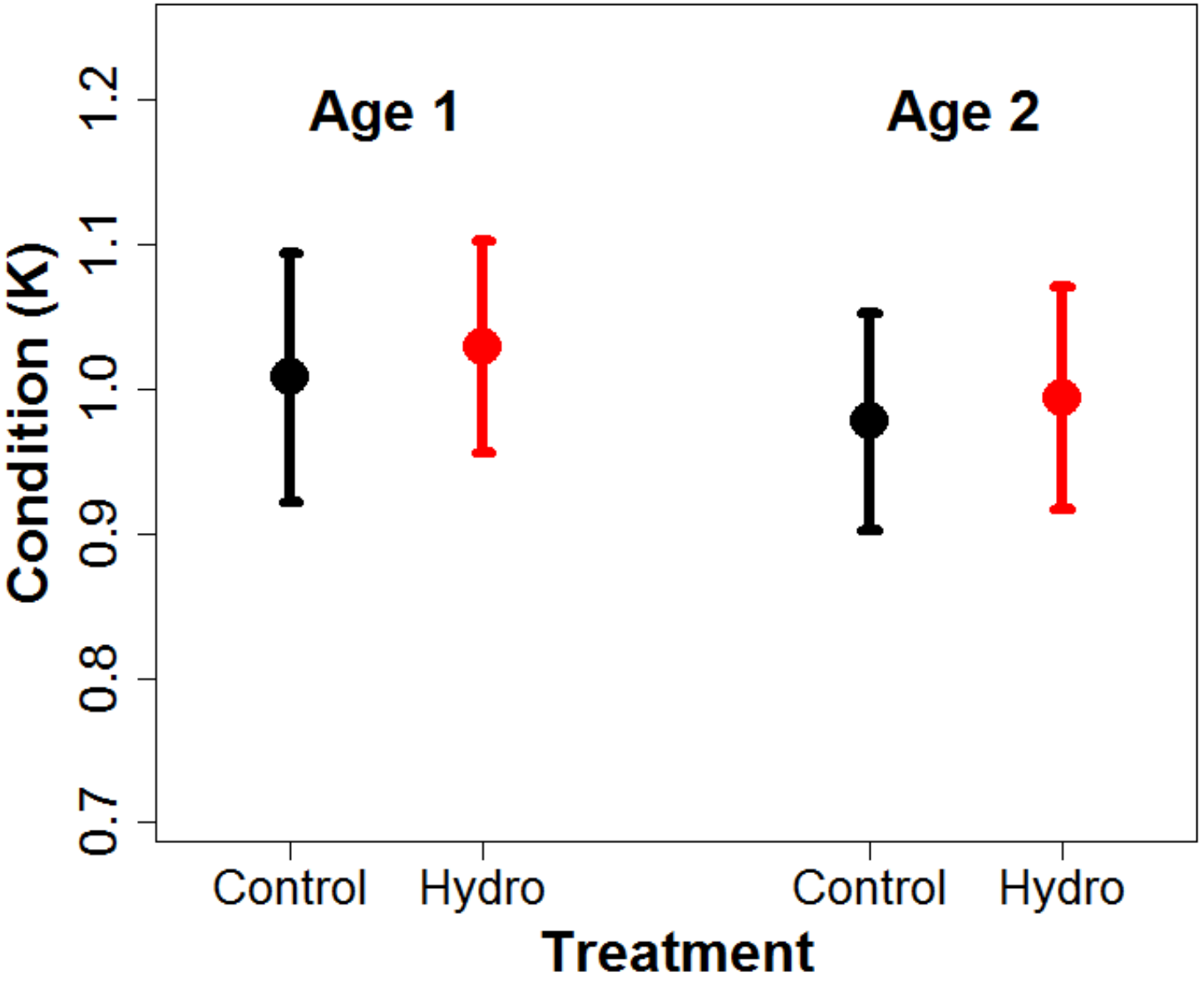
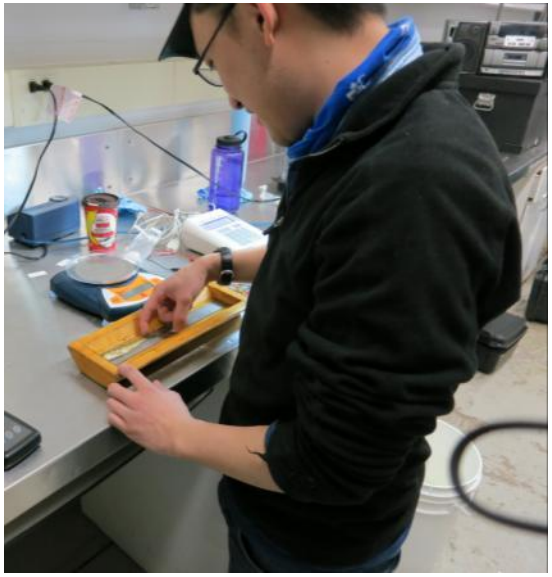
Condition during February 2013



Summary

- Data suggest low velocity fluctuations do not affect overwinter condition or Na^+, K^+ ATPase activity.
  - No differences in:
    - Condition
    - Weight Gain
    - Total lipids
    - Na^+,K^+ - ATPase activity



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Implications

- Atlantic salmon are able to cope with low-moderate velocity changes during winter months
  - Inhabiting interstitial space

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Year 2 2012/13

- Increased velocity (4x)
- Growth Hormones
- Na^+,K^+ - ATPase activity during April and May

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- NSERC HydroNet

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Questions?
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