



Winter condition of Atlantic salmon parr and pre-smolts experiencing variable stream flows.

Vue, S. ¹, K.D. Clarke ², and R.A. Cunjak ¹

¹University of New Brunswick

²Department of Fisheries and Oceans



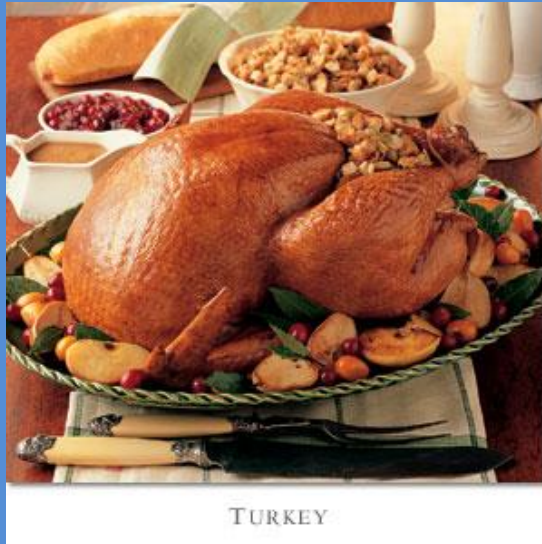
Winter for Humans

Increased metabolism



<http://englishchopsticks.files.wordpress.com/>

Creation of fat reserves
(energy)



TURKEY

<http://1.bp.blogspot.com/>



<http://upload.wikimedia.org/>

Winter for Fish



Picture by Paula Thoms

< 4 °C Temperatures

Limited Food Assimilation

Reduced Activity

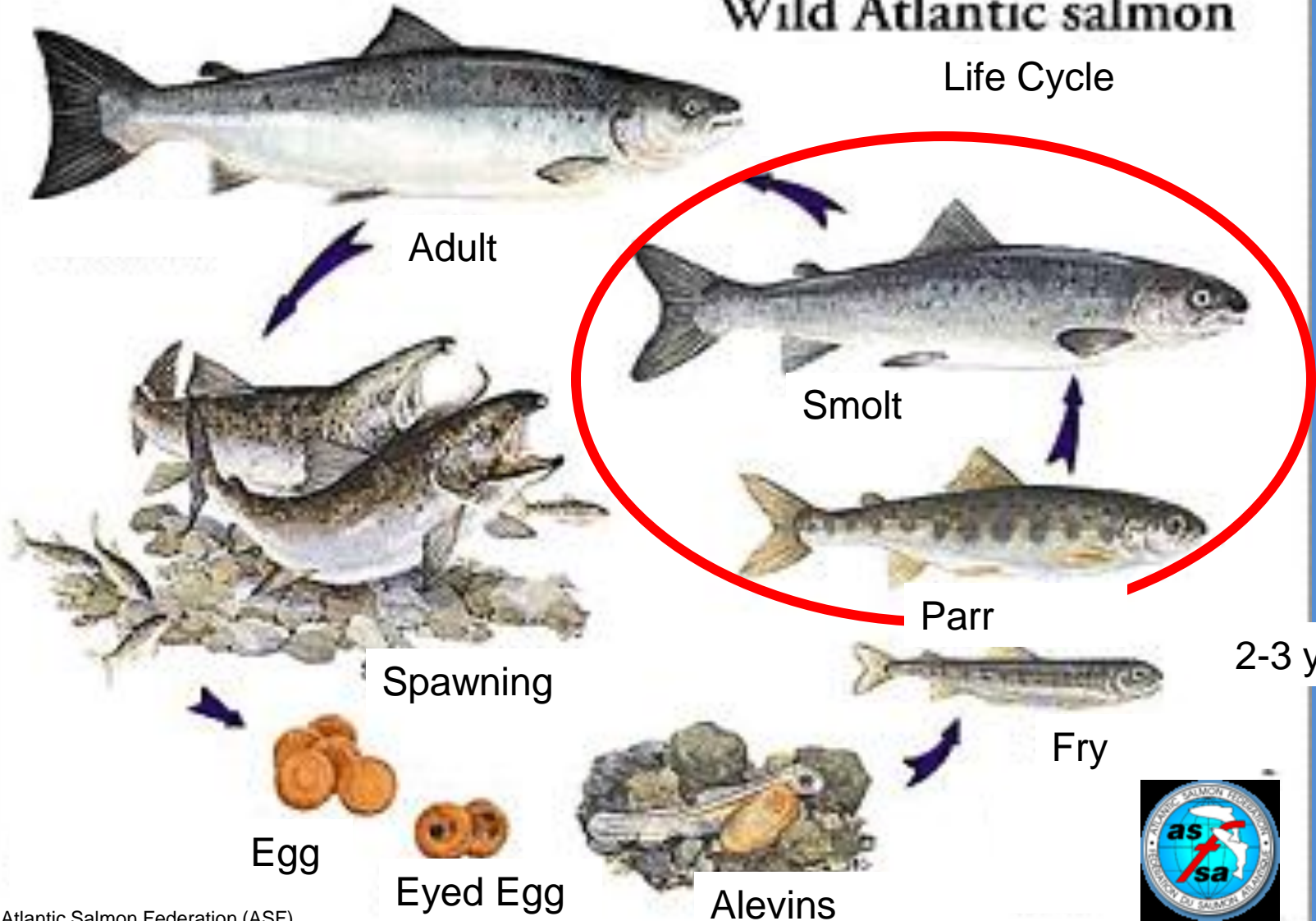
Decreased metabolism



Reliance on fat reserves
(energy)

Wild Atlantic salmon

Life Cycle



Atlantic Salmon Federation (ASF)



Atlantic salmon

- Winter condition
 - Period with the lowest fat content
- Smolting
 - Parr --> Smolts
 - Change occurs in early spring
 - Requires energy



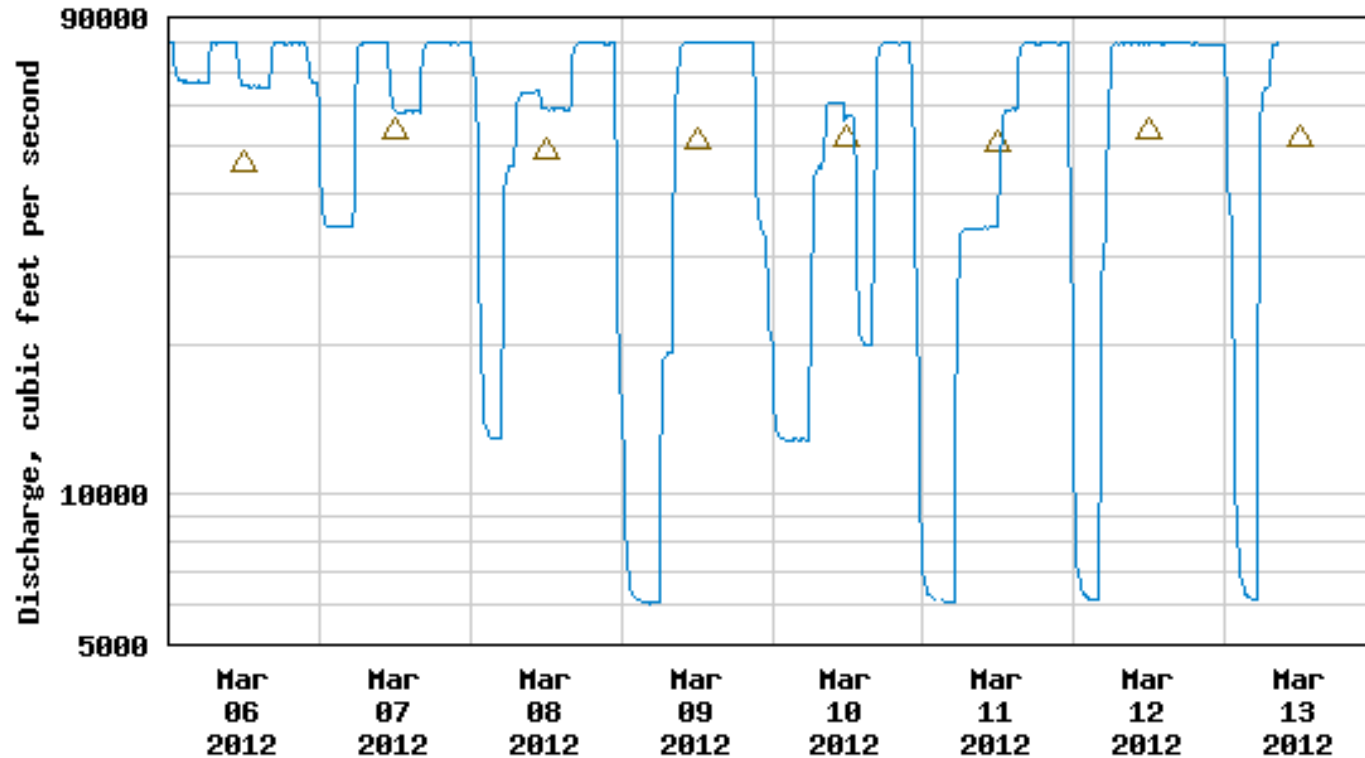
Regulated rivers

- Added environmental stressor
- Some hydrodams have variable flow regimes (Hydropeaking)
 - Peak flows coincide with electrical demand
 - High flows during the day
 - Low flows during the night
- Increased flow & velocities
 - Increased swimming rates
 - Energy cost

Hydropeaking Flows



USGS 01578310 SUSQUEHANNA RIVER AT CONOWINGO, MD



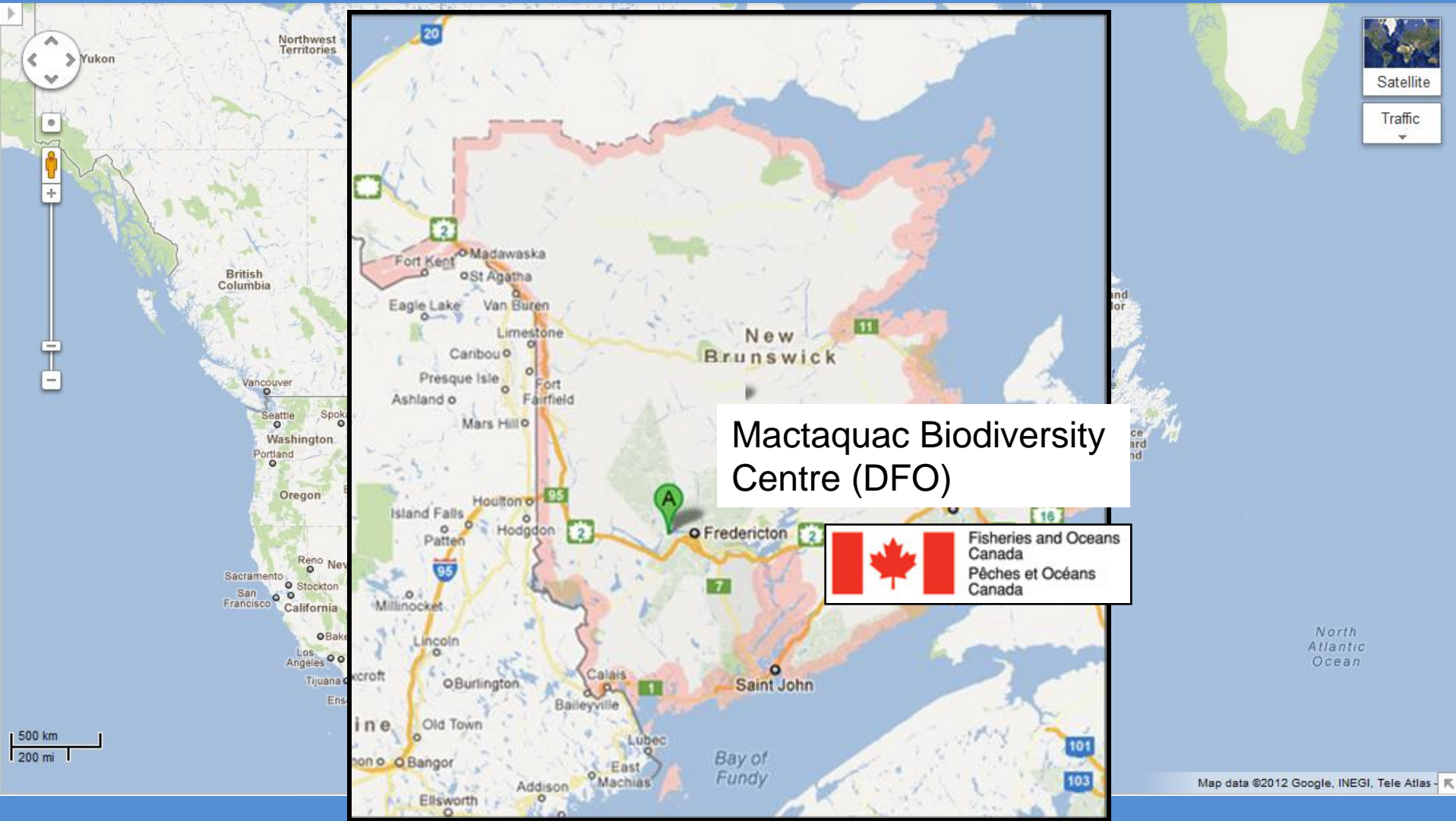
----- Provisional Data Subject to Revision -----

△ Median daily statistic (44 years) — Discharge

Objectives

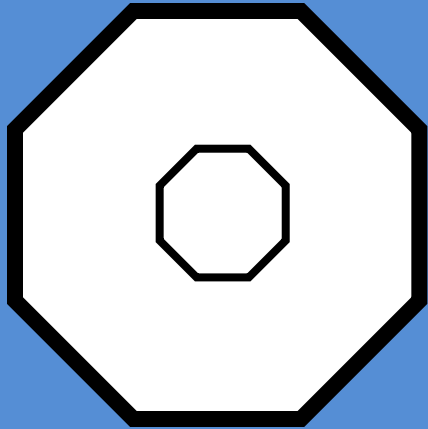
- Determine if hydropeaking flows affect the **overwintering condition** of Atlantic salmon parr.
- Determine if **smoltification** is affected by hydropeaking flows.

New Brunswick

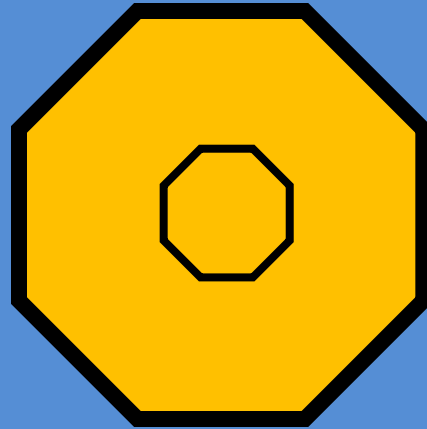
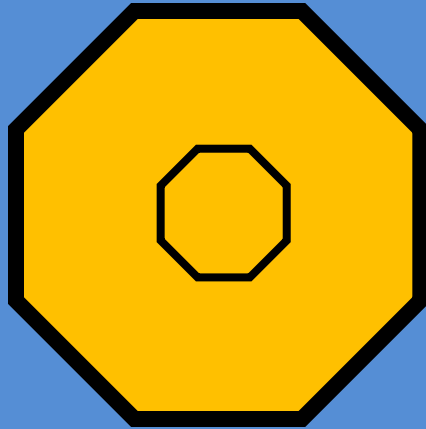
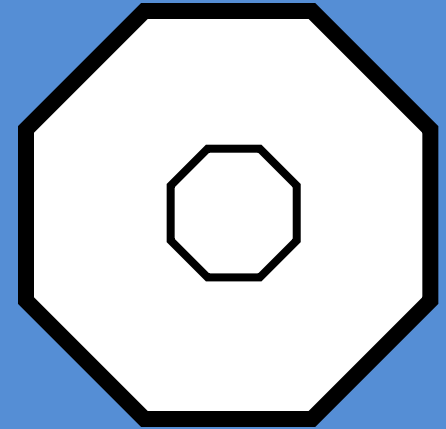


Experimental Setup

Control



Control



Hydropeaking
Flows

Hydropeaking
Flows

10 x 10 meters

24 spawning adult salmon

Outdoor Tanks

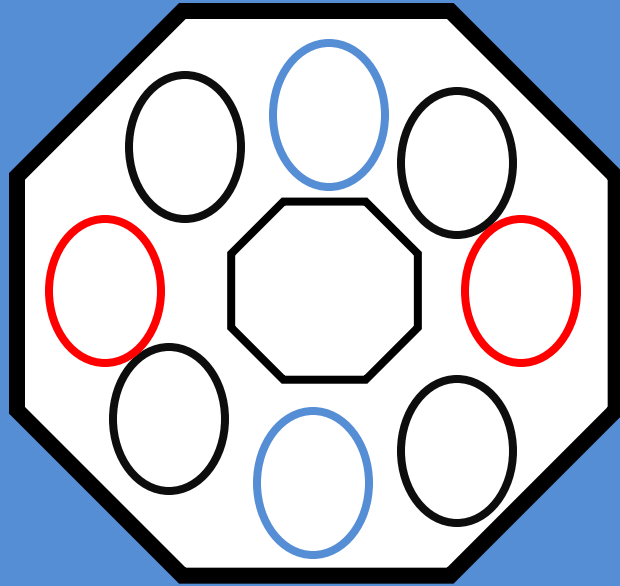
-Snow/Ice

-Winter temperatures

-Natural light regimes



Picture by Kurt Samways



Riffles



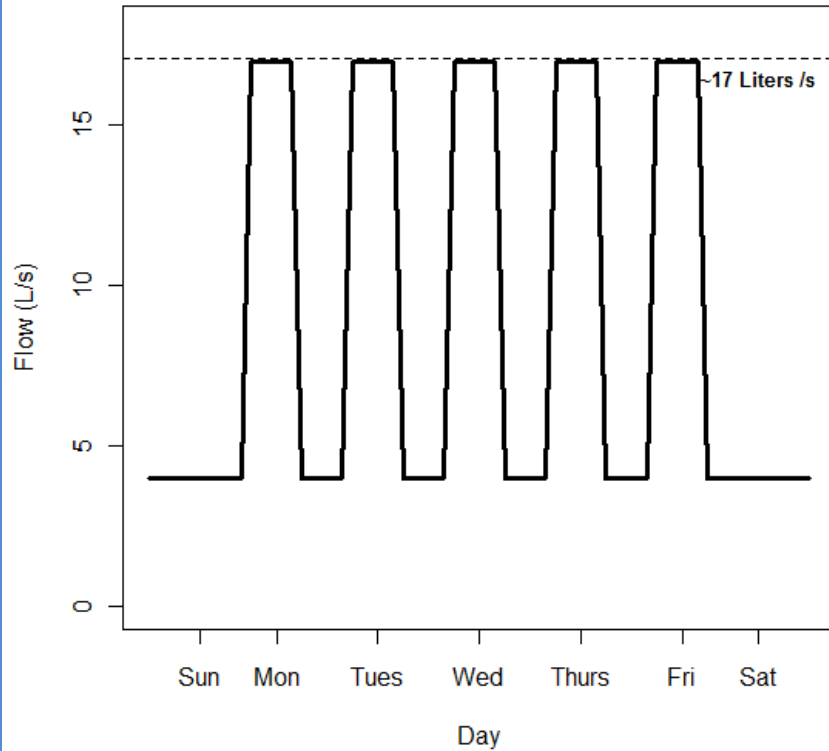
Pools



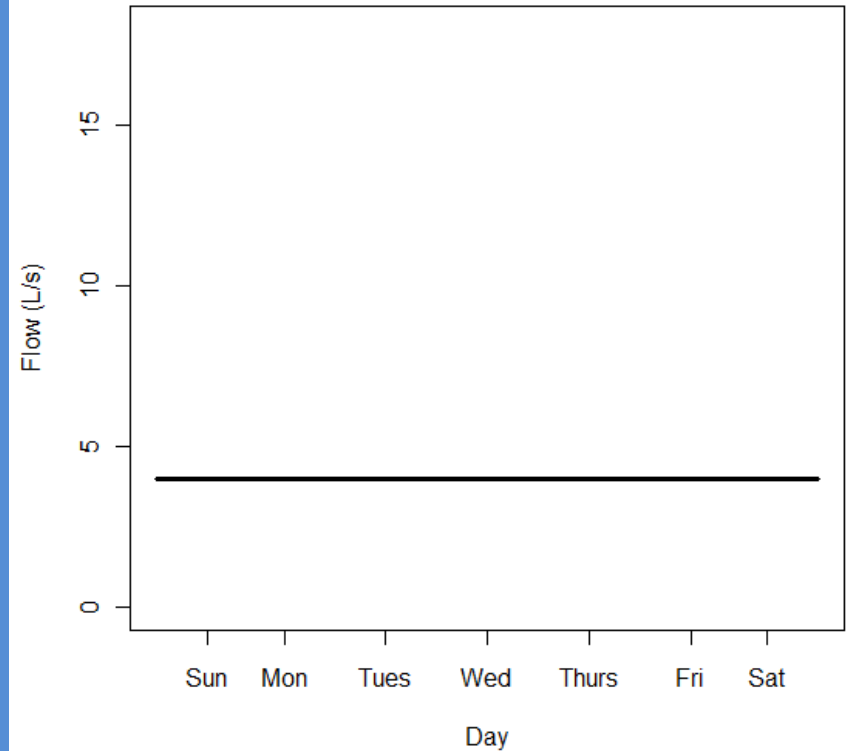
Runs

Weekly Flow Regime

Hydropeaking



Control



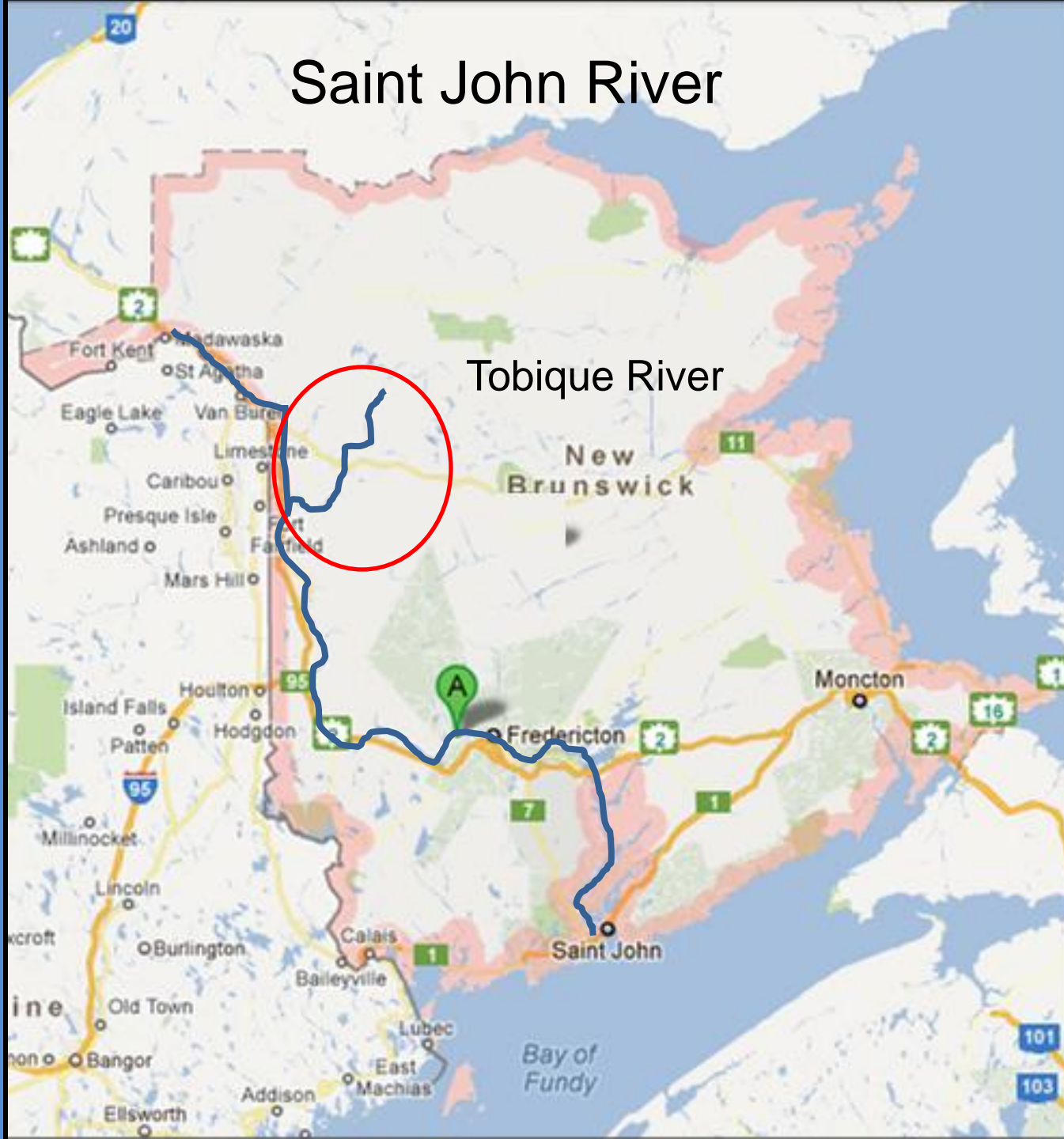
February-May

	Flow (L/s)	X	Velocity (m/s)	X
Hydropeaking	16.79	4	0.14	2
Control	4.24		0.069	

-Tobique head waters x2

-Typical range 2-50x

Saint John River



Tobique River

Googlemaps

Fish

- Fish
 - 60 wild Atlantic salmon parr (Tobique River) per tank
 - 0.70 parr/m²
 - 3 age classes
 - Young of year, Age 1 & 2
 - 41 – 168 mm
 - Individually tagged
 - (PIT tags)
- Food resources
 - Naturally occurring macroinvertebrates



Methods

- To assess overwintering conditions we examine the differences in:
 - Condition Factor (K)
 - $\frac{W*10^n}{L^3}$
 - Fat content
 - Bioimpedance analysis (BIA)
 - Cox & Hartman 200
 - Allison Krimmer and Joseph Rasmussen (ULETH)
 - Smoltification
 - Na^+, K^+ - ATPase Activity

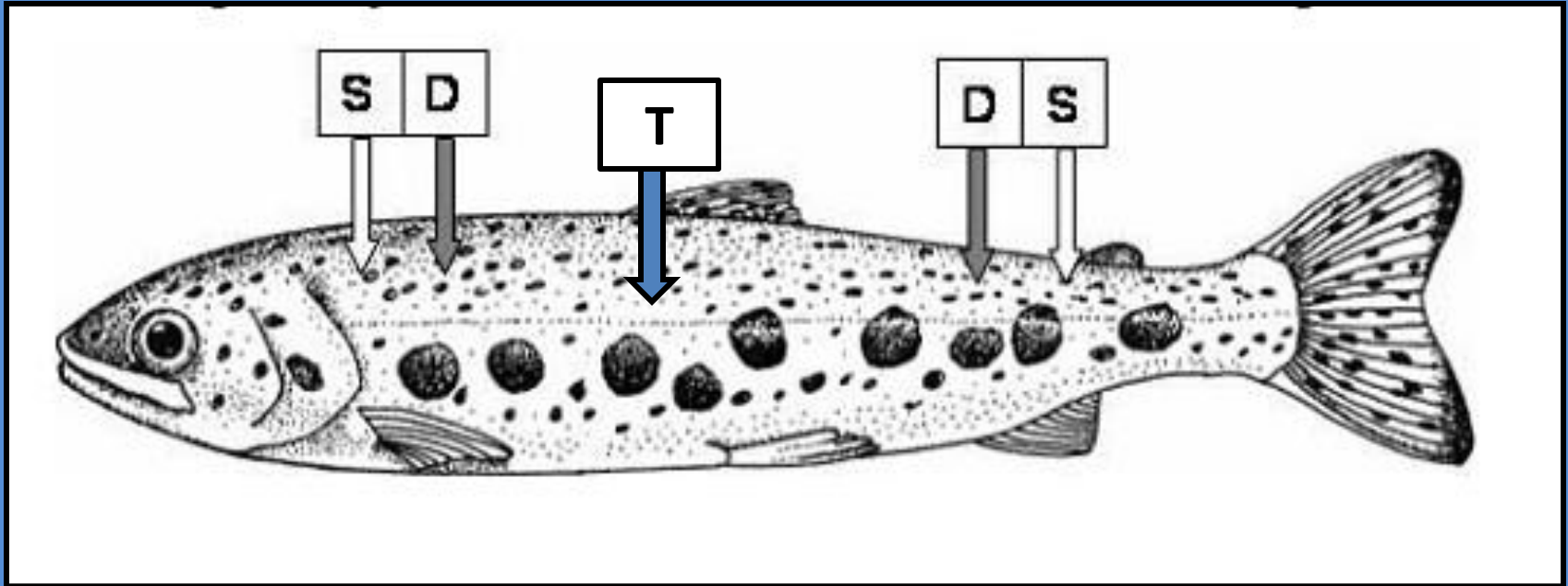
Methods

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Measuring Fat Content

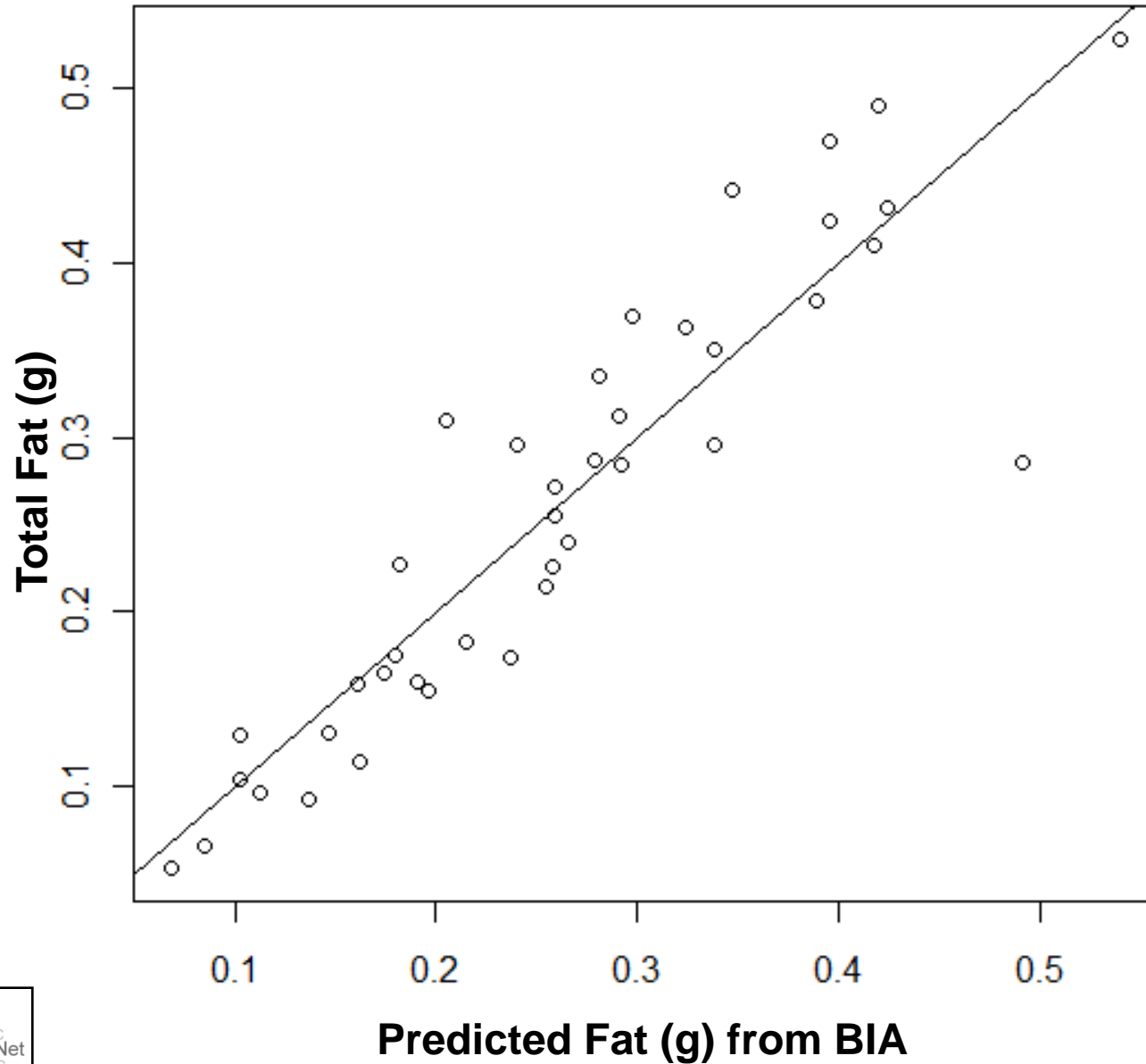
- **Bioimpedance analysis(BIA)**
 - Correlates electrical values with fat content
 - Non-leathal measurement of fat content
 - Temporal assessment of individual fish

Bioimpedance analysis (BIA)



(Cox & Hartman 2005)

Predicted Fat vs. Total Fat



mm<100

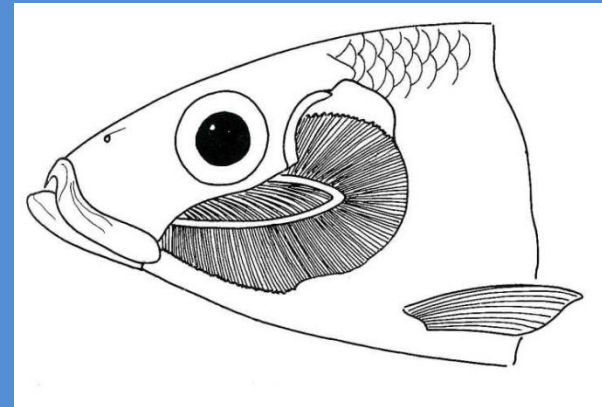
$r^2 = 0.825$

Methods

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 - Smoltification
 - Na⁺,K⁺ - ATPase Activity

Smoltification

- Na^+, K^+ - ATPase Activity
 - Smolts have increased Na^+, K^+ - ATPase Activity
- Gill Biopsy
 - McCormick 1993
 - Non-lethal method

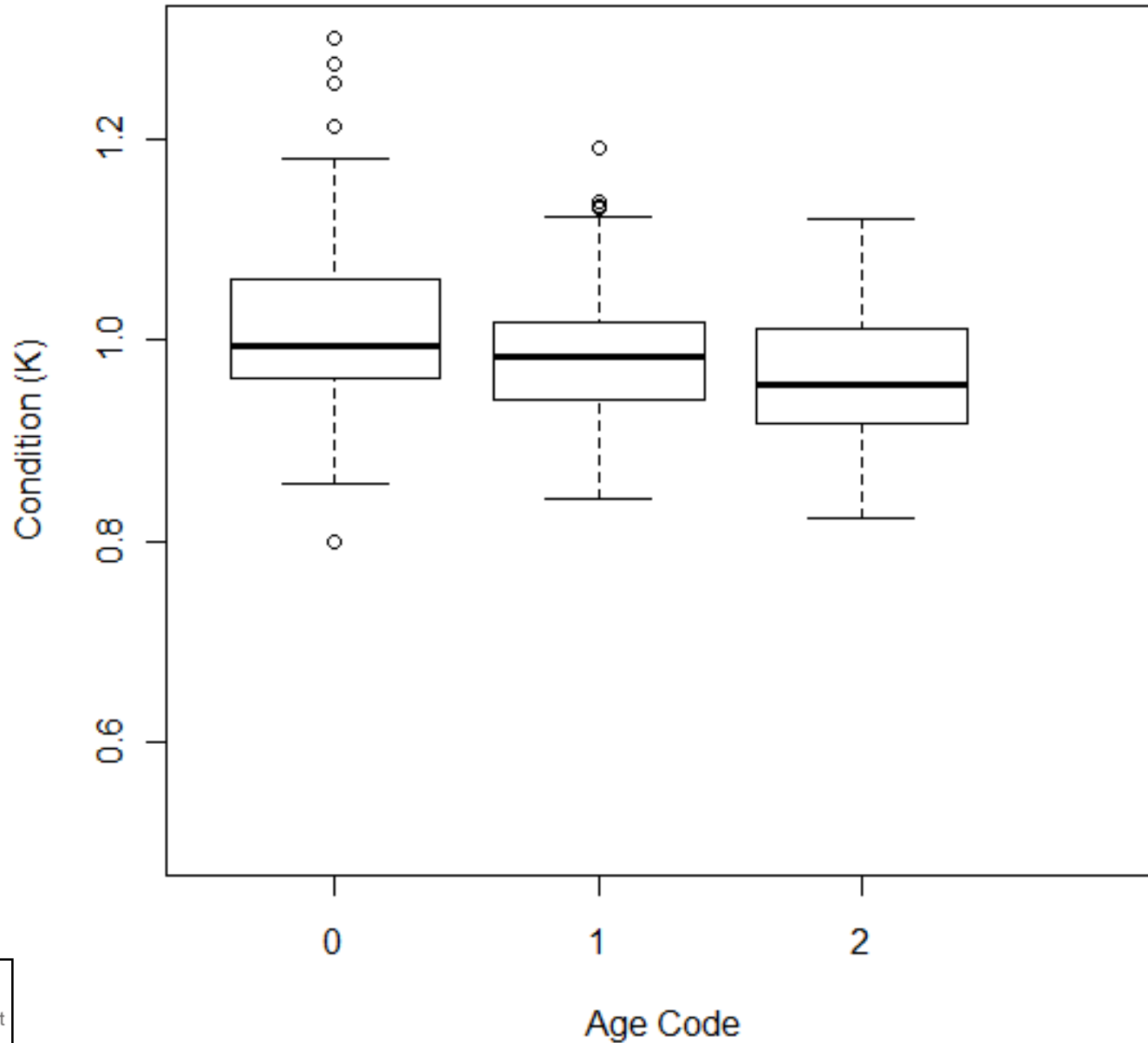


<http://petcaregt.com>

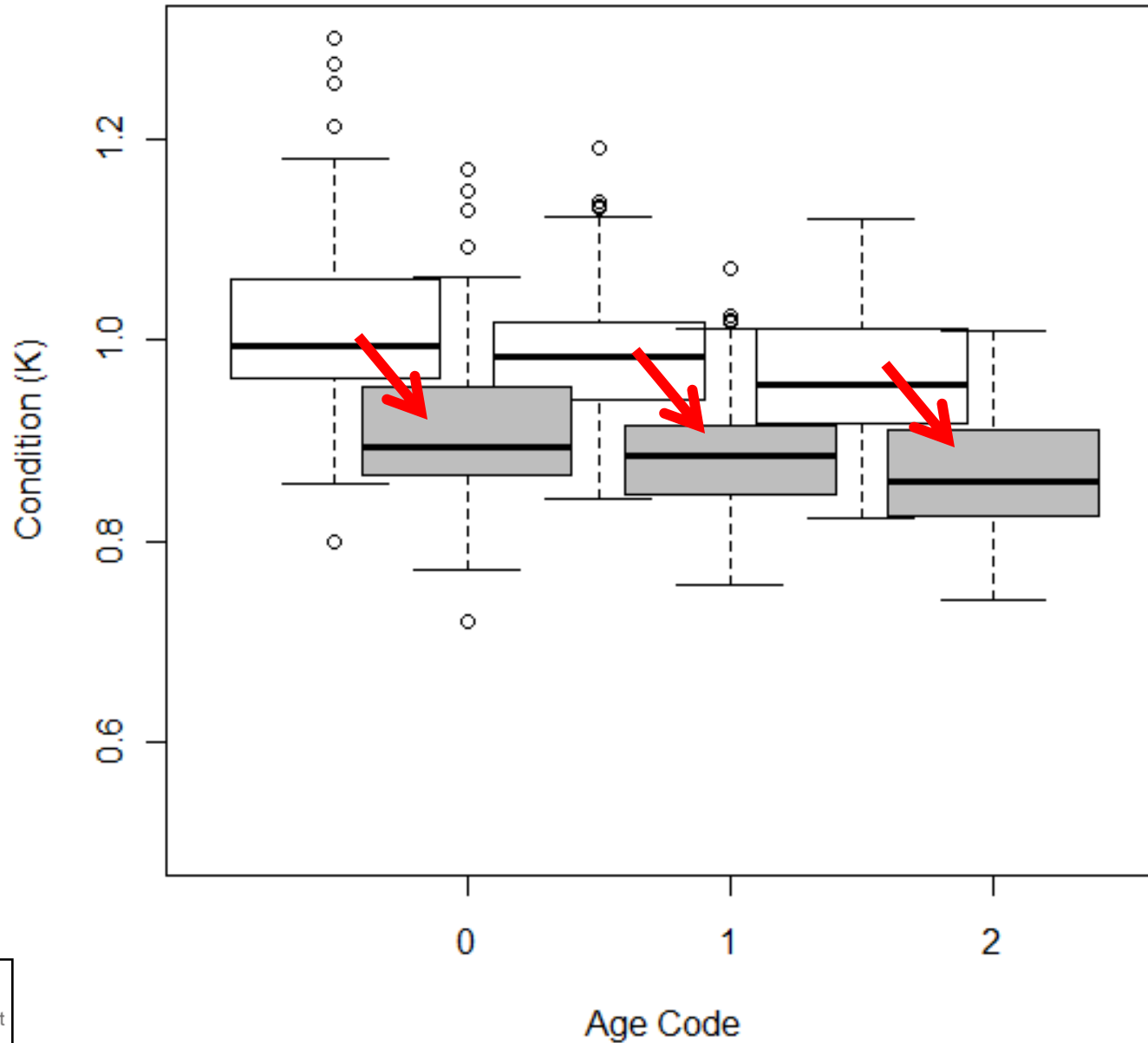
Predicted Results

- Condition Factor (K)
- Fat content
- Smoltification
 - **Reduced** amount of parr capable of smolting

Condition (K) of Atlantic Salmon



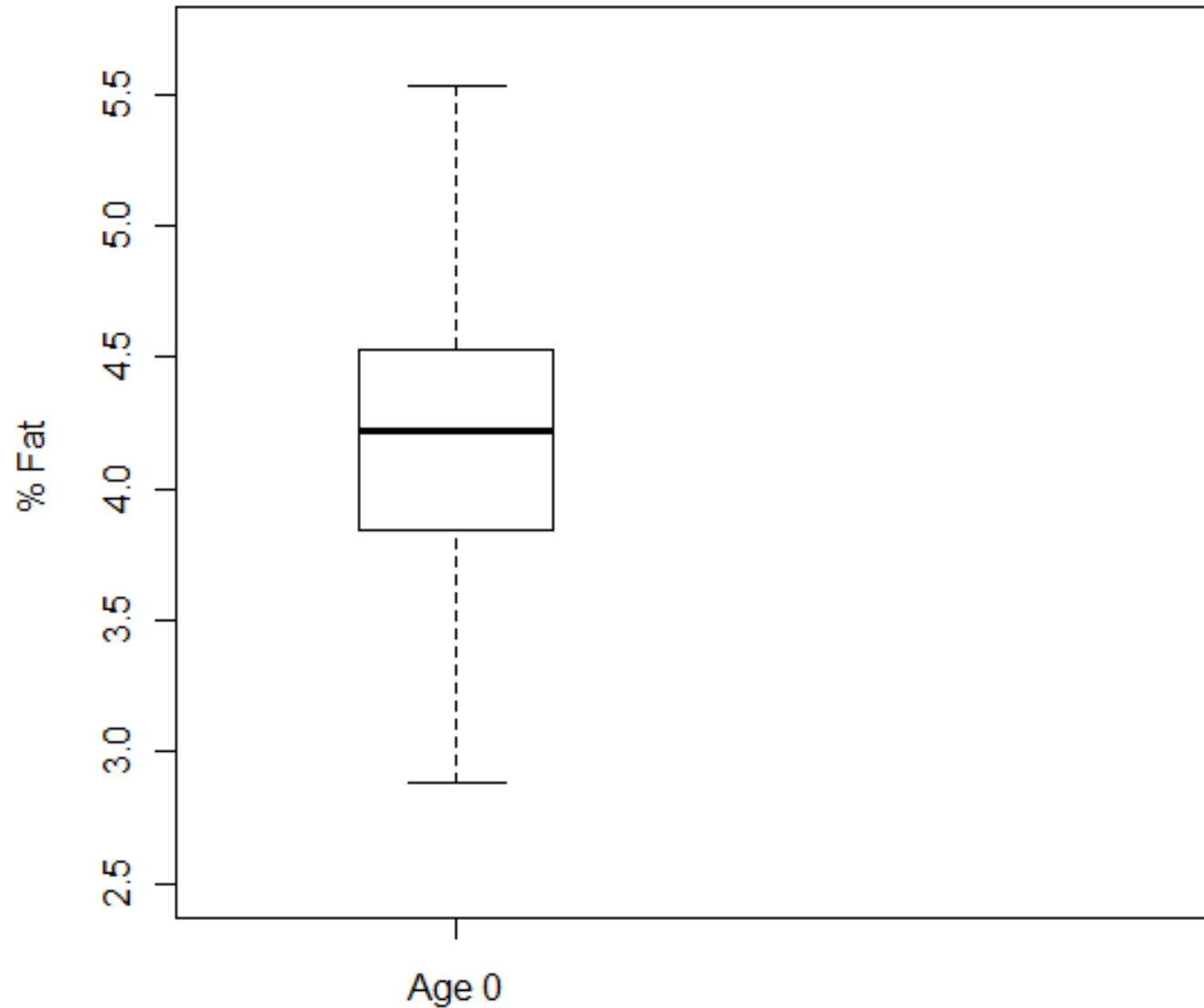
Predicted condition with hydropeaking flows



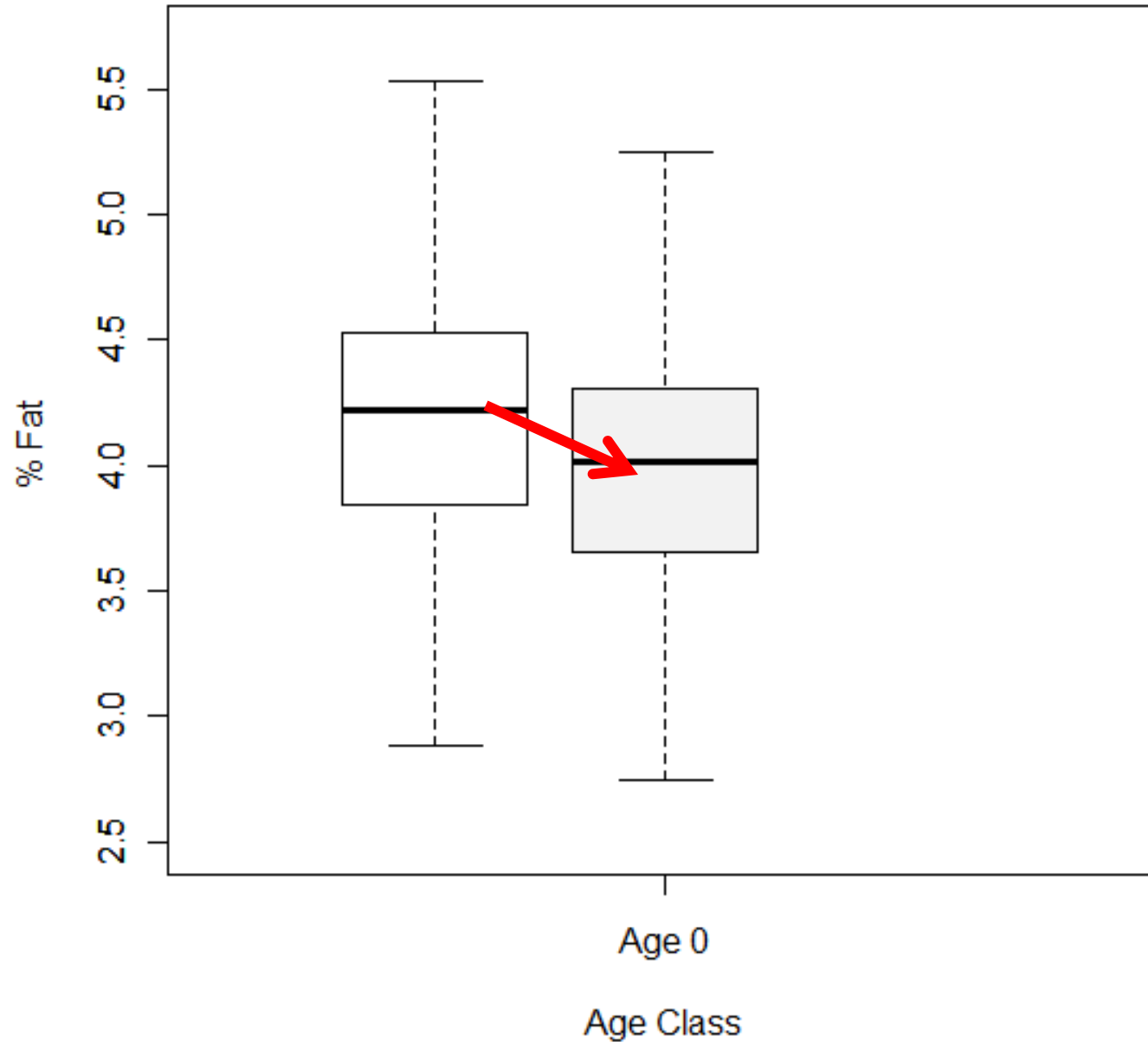
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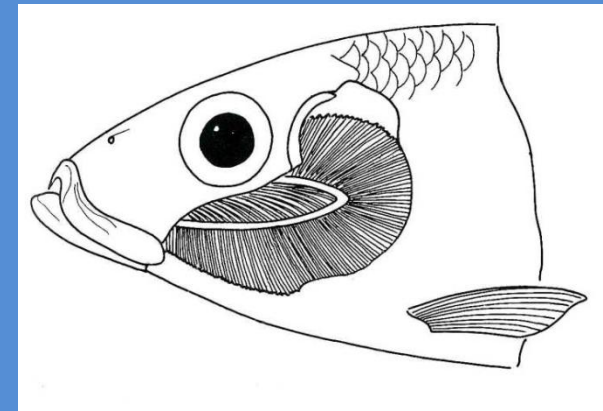
Fat Content (g)



Predicted Fat Content (g)



Predicted Results



<http://petcaregt.com>

– Condition Factor (K)

- Decrease in condition factor in parr experiencing hydropeaking flows

– Fat content

- **Decrease in fat content** in parr experiencing hydropeaking flows

– Smoltification

- **Reduced** amount of parr capable of smolting

Summary

- Provide new knowledge on the effects of hydropeaking flows on overwintering Atlantic salmon by assessing changes in:
 - Condition factor (K)
 - Fat content
 - Smoltification

Future

- Adapt experimental setup
 - Earlier start
- Improve bioimpedance analysis
- Tracking habitat usage within tanks

Acknowledgements

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Questions?

