

# Using the biochemical and isotopic composition of fish scales to understand the marine phase of Atlantic salmon

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Technological  
University



# Atlantic salmon marine phase

- Marine mortality linked to declines
- Many threats:
  - Historical overfishing
  - Predation
  - Climate change
- Important to increase our understanding



# Scales

Scales incorporate isotopes and biochemical markers into collagen layers

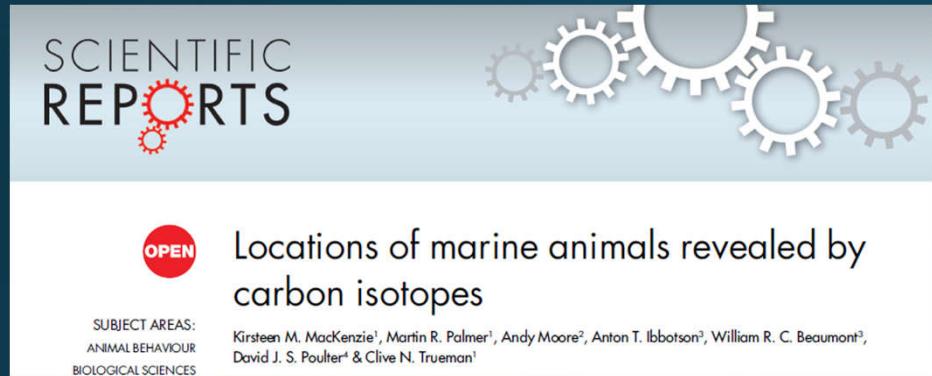
Many other tissues require the death of the fish or are stressful to obtain

- Muscle
- Blood
- Otoliths
- Stomach contents

Advantages of scales:

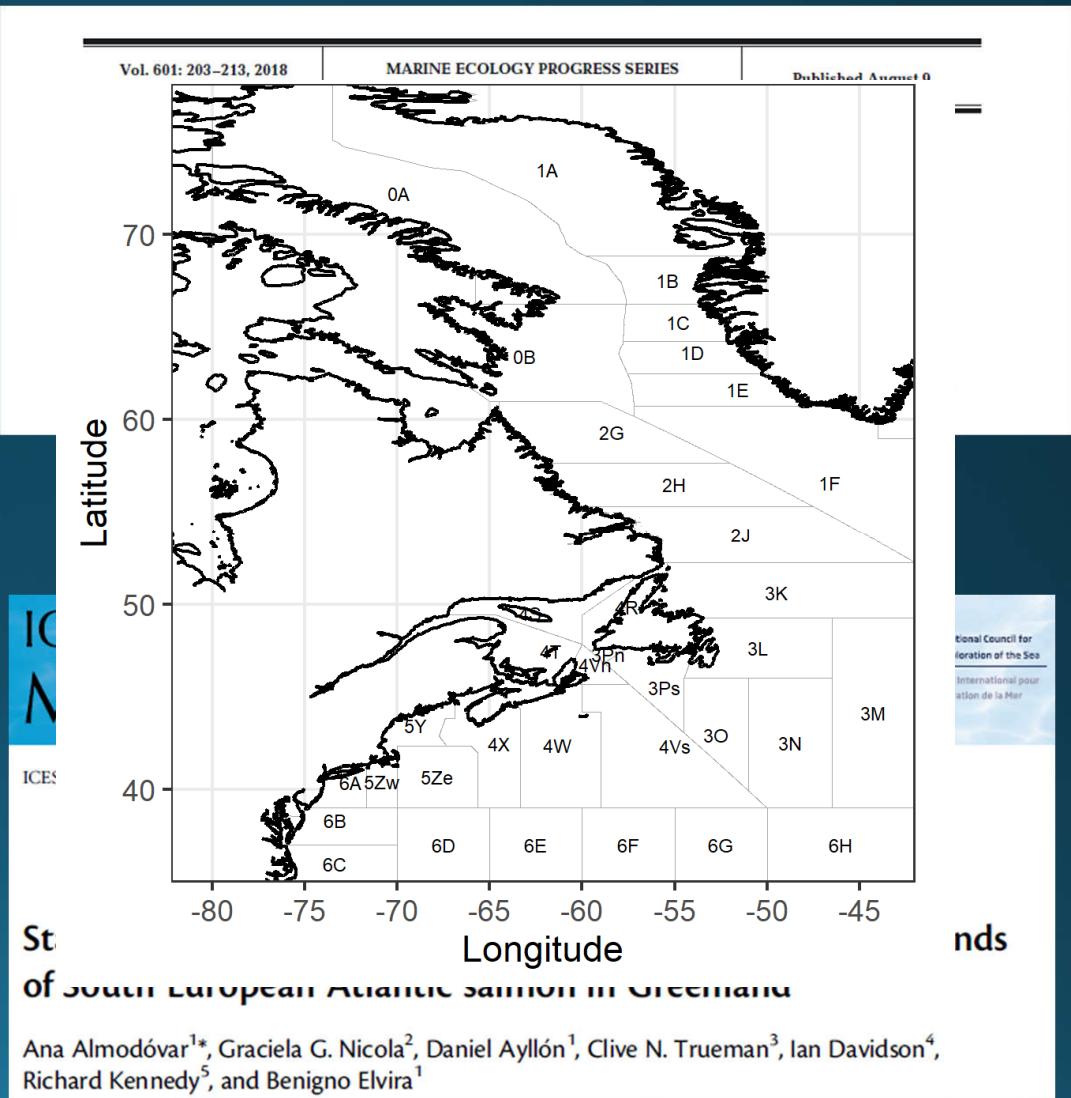
- \* Non-lethal
- \* Growth and age analysis
- \* Routinely taken
- \* Easy storage
- \* Vast archives

# Stable isotope analysis



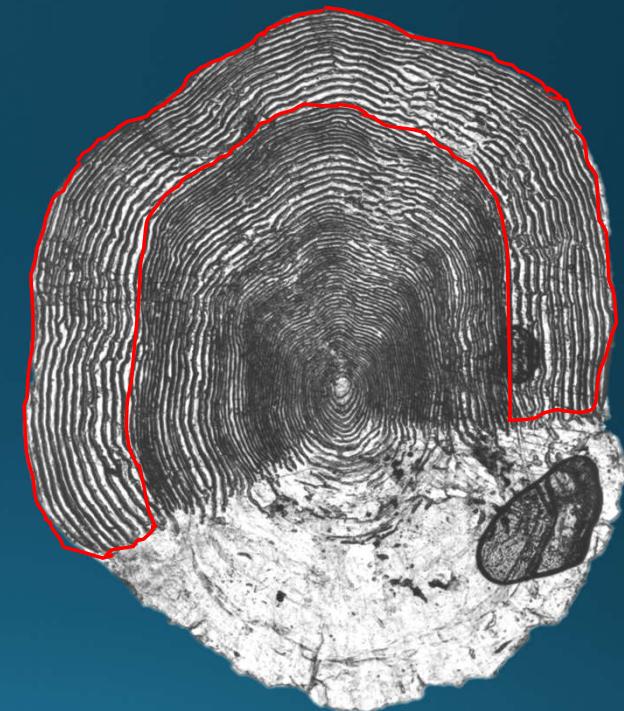
- Isotopic geolocation usually requires collection of baseline data
- Tool from MacKenzie *et al.* (2011) uses SST as a proxy for  $\delta^{13}\text{C}$  of primary producers
- Time series of scale  $\delta^{13}\text{C}$  should correlate with SST at the marine foraging location
- Advantage: can be used on archived scales

- Geolocation tool currently in use
- Requires validation
- Scales from the Greenland scale archive
  - 100 fish captured at feeding grounds
  - 1968 - 2018



# Validating the geolocation tool

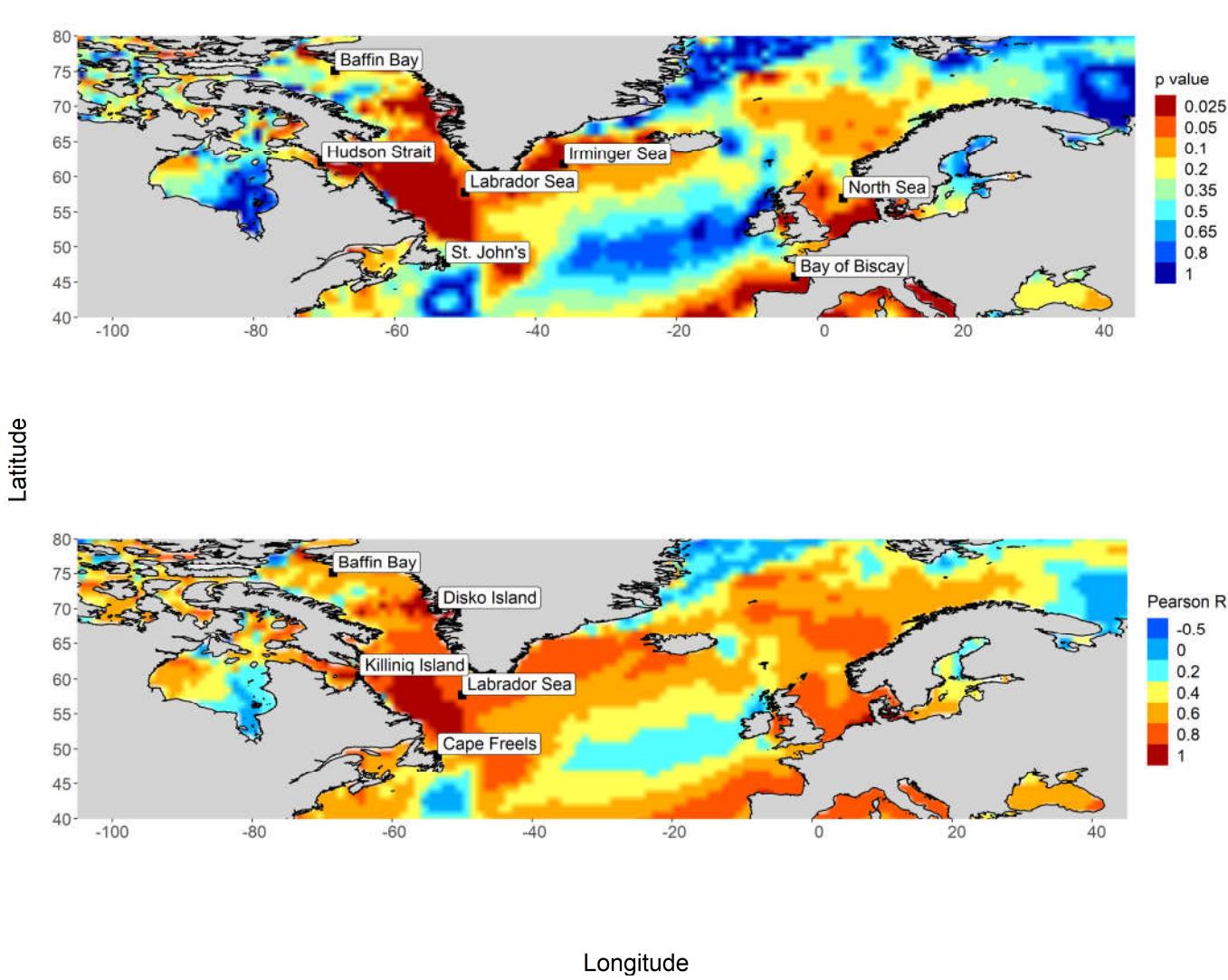
- Excised temporally distinct portion of cleaned scales
- SIA of  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$
- Strength and significance of the correlation between scale  $\delta^{13}\text{C}$  and SST was mapped



**In prep:** O'Toole, C., Brophy, D., Stroh, A., Weigum, E., Hayden, B., White, P., Trueman, CN., Robertson, MJ., and Graham, CT. Carbon isotope geolocation tool successfully identifies the foraging location of Atlantic salmon captured at sea.

# Results

- Combination of p value and Pearson's correlation coefficient determines feeding location of the Labrador Sea



# Discussion



- Approach can determine broad feeding location
- Results of this geolocation tool can be interpreted with increased confidence

# Cortisol analysis

- Cortisol is a hormone released as a stress response
- Usually measured in blood
- Disadvantages of blood cortisol
  - Invasive
  - Sampling can interfere with real-time cortisol levels
  - Not a measure of chronic stress



# Cortisol analysis

- Alternative matrix needed to

Contents lists available at ScienceDirect

Aquaculture

journal homepage: [www.elsevier.com/locate/aquaculture](http://www.elsevier.com/locate/aquaculture)

ELSEVIER



Comparative assessment of cortisol in plasma, skin mucus and scales as a measure of the hypothalamic-pituitary-interrenal axis activity in fish

Annaïs Carbajal<sup>a</sup>, Felipe E. Reyes-López<sup>b</sup>, Oriol Tallo-Parra<sup>a</sup>, Manel Lopez-Bejar<sup>a,1</sup>, Lluís Tort<sup>b,\*1</sup>

Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: [www.elsevier.com/locate/ecolind](http://www.elsevier.com/locate/ecolind)

ELSEVIER



Genetic pathways underpinning hormonal stress responses in fish exposed to short- and long-term warm ocean temperatures

Alexander Goikoetxea<sup>a</sup>, Bastien Sadoul<sup>a</sup>, Eva Blondeau-Bidet<sup>b</sup>, Johan Aerts<sup>c</sup>, Marie-Odile Blanc<sup>a</sup>, Hugues Parrinello<sup>d</sup>, Célia Barrachina<sup>d</sup>, Marine Pratlong<sup>d</sup>, Benjamin Geffroy<sup>a,\*</sup>

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Aquaculture

journal homepage: [www.elsevier.com/locate/aquaculture](http://www.elsevier.com/locate/aquaculture)

ELSEVIER



Thermal stress response of juvenile milkfish (*Chanos chanos*) quantified by ontogenetic and regenerated scale cortisol

Inken Hanke<sup>a,b,\*</sup>, Bart Ampe<sup>c</sup>, Andreas Kunzmann<sup>a</sup>, Astrid Gärdes<sup>a</sup>, Johan Aerts<sup>b,d</sup>



Conservation  
Physiology

Volume 7 • 2019

10.1093/conphys/coz052

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Research article

Temporal profiles of cortisol accumulation and clearance support scale cortisol content as an indicator of chronic stress in fish

Frédéric Laberge<sup>1</sup>, Irene Yin-Liao<sup>1</sup> and Nicholas J. Bernier<sup>D, 1,\*</sup>



[www.fishbio.com](http://www.fishbio.com)

# Adapting method for *S. salar*



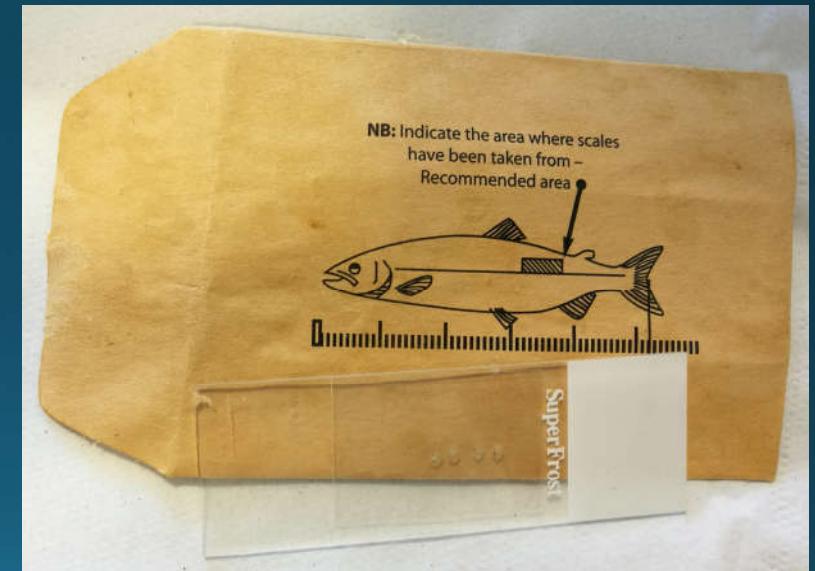
- Adapted methodology to GCMS instead of UPLC-MS/MS
- Optimised for lower sample weight
- Extracted cortisol from scales of fish kept under known conditions

In prep: O'Toole, C., White, P., Thomas, K., Ó Maoiléidigh, N., Fjelldal, PG., Hansen, T., Graham, CT., Brophy, D. Scale cortisol concentration in Atlantic salmon post-smolts is influenced by temperature.

# Post-smolt analysis

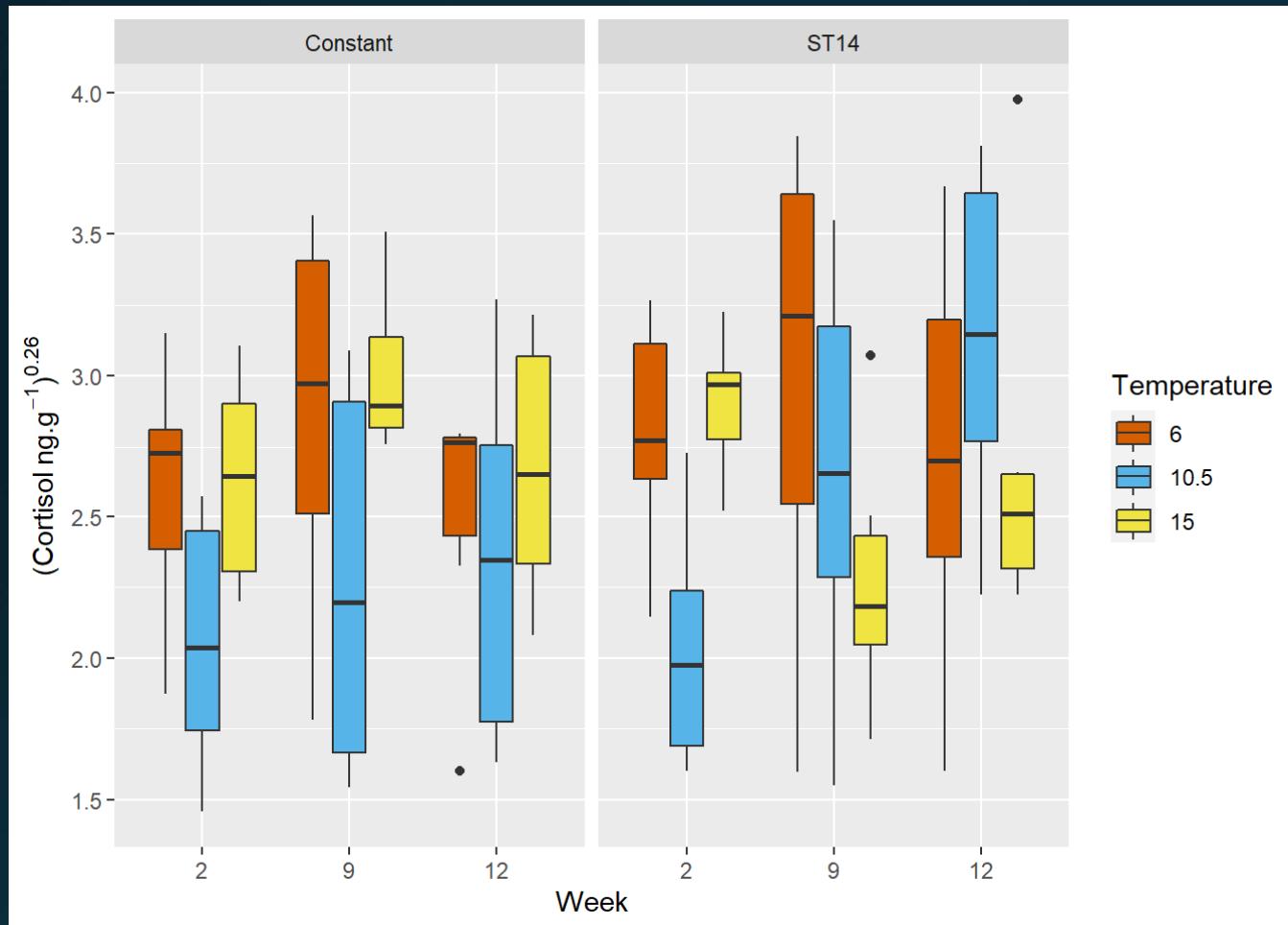
- Post-smolts kept for 12 weeks in differing temperature and feeding regimes (Thomas *et al.*, 2019)
- Cortisol extracted from 156 samples

6°C	10.5°C			15°C
Constant  ST14 	Constant 	ST7 	ST14 	ST28 
				Constant  ST14 



# Results

- Range of cortisol  
5.28 – 215.93ng/g
- When constantly fed, cortisol was significantly higher at 15°C than 10.5 °C
- Also sig. higher at 6°C prior to Holm correction



# Causes of cortisol increase

- Cortisol can increase due to other factors:
  - Smoltification
  - Maturation
- Cortisol increase at both 6 and 15°C suggests a stress response due to temperature



[www.espacepourlavie.ca](http://www.espacepourlavie.ca)

# Cortisol analysis of archived scales

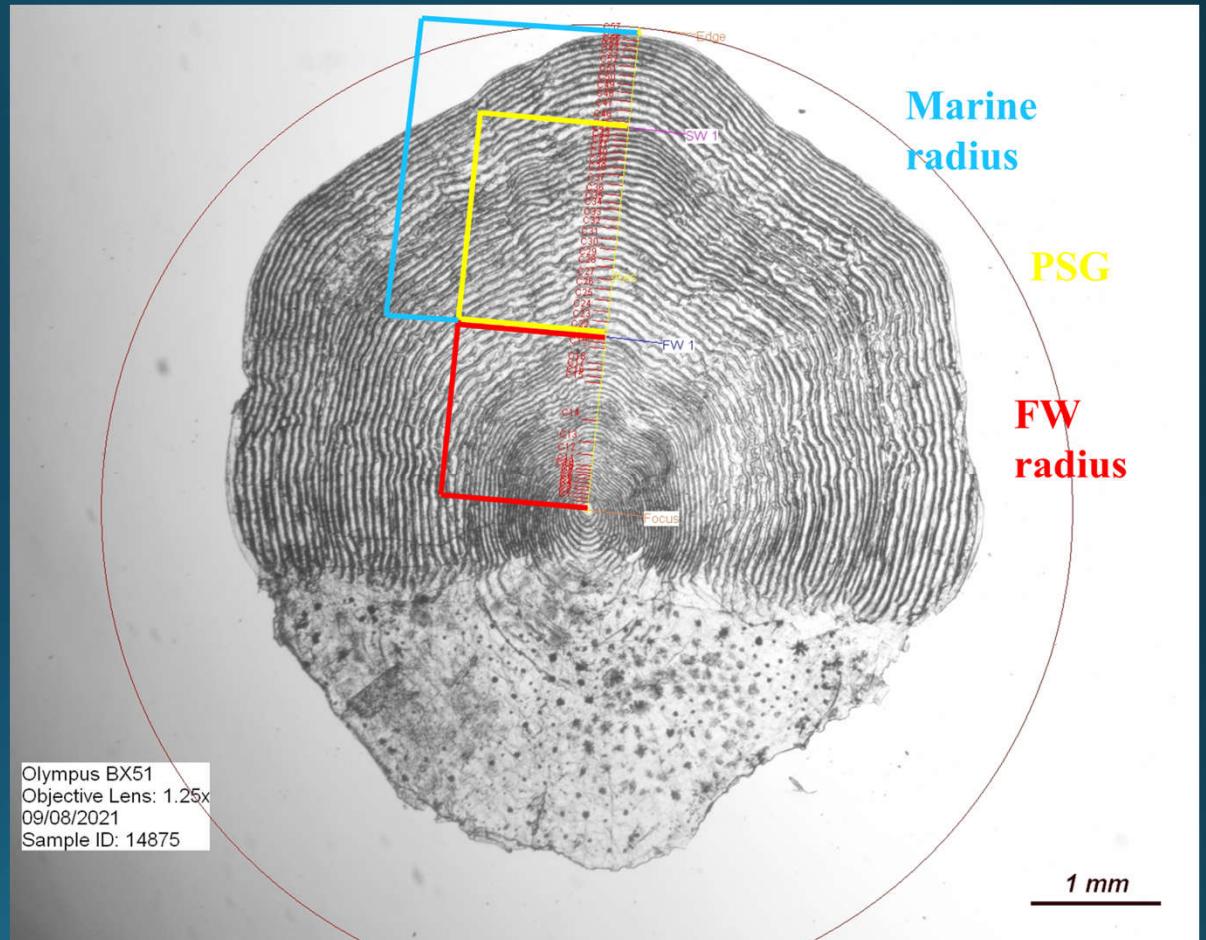


- Completed stability study prior to analysis
- Examining temporal trends in cortisol of salmon at sea
  - Analysed with environmental factors including NAO, SST, food availability

**In prep:** O'Toole, C., White, P., Ó Maoileidigh, N., Conroy, C., Stroh, A., Graham, CT., Brophy, D. Cortisol in scales of adult Atlantic salmon shows substantial individual variability with no annual signal.

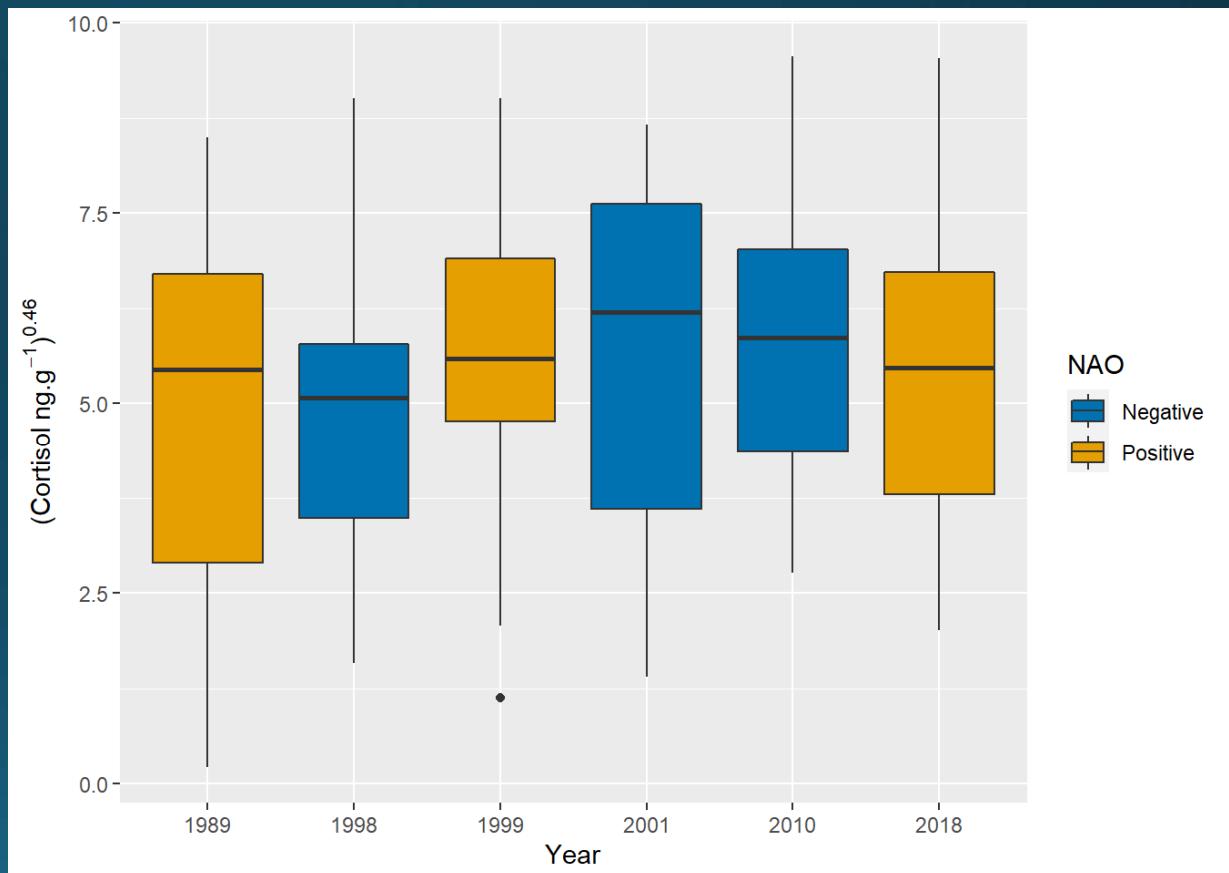
# Method

- Cortisol extracted from archived scale samples ( $n = 120$ )
  - 20 fish from 6 years
  - 1989 – 2018
- Marine portion of scale excised



# Results

- Range of cortisol: 4.05 – 135.37ng/g
- No interannual variation in cortisol
- Annual effect on growth measurements



# Discussion



Mellan Media

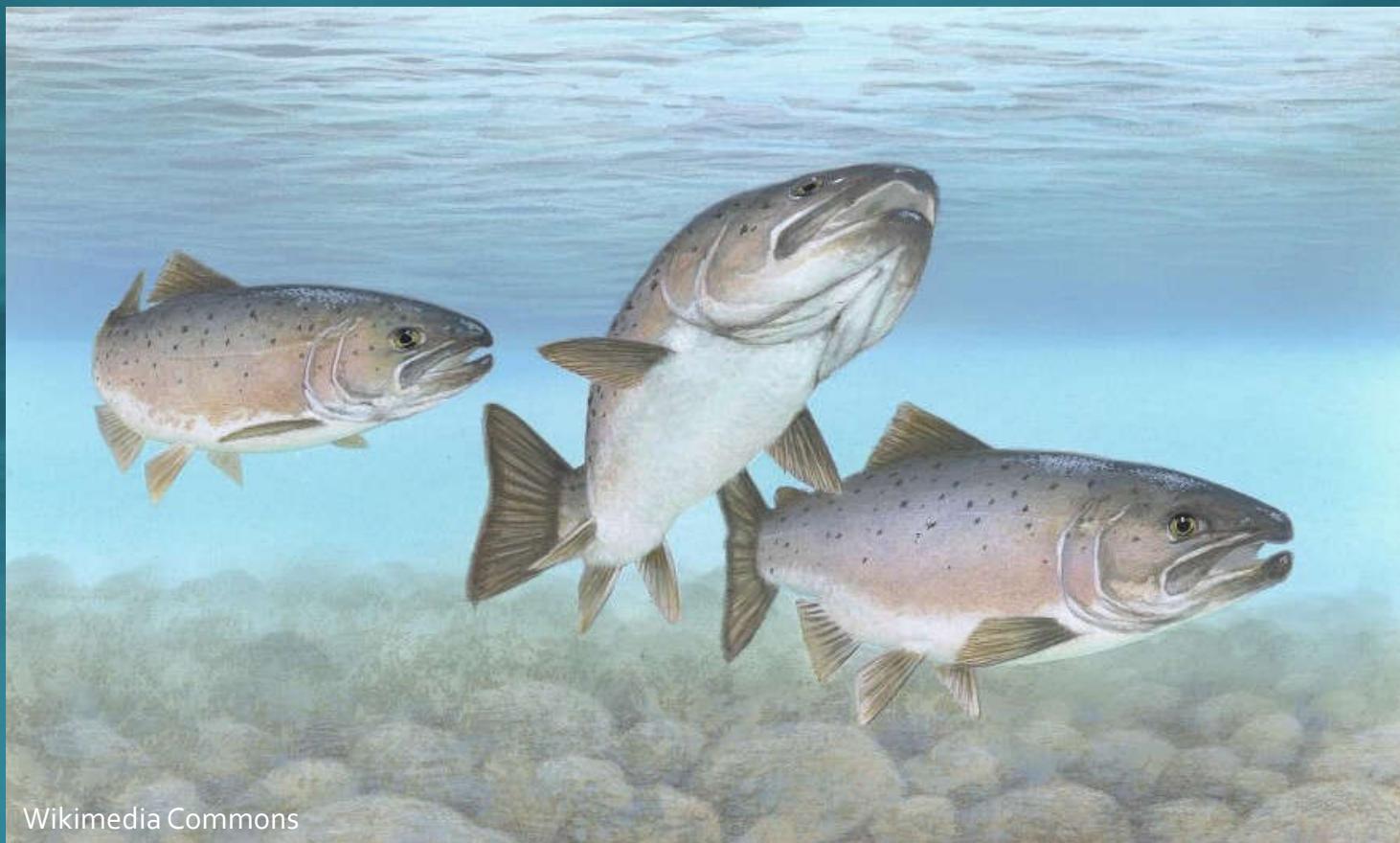
- First study to analyse cortisol from archived scales
  - Determined stability
- Individual variability appears to play a large role in cortisol fluctuations
  - Multiple causes
- Many stressors occur during the marine phase

# Overall conclusions

- This research showcases the value of archived scales for understanding the marine phase:
  - Determining feeding location
  - Using scale cortisol as a biomarker for temperature stress
  - Examining cortisol in archived scales
    - Potential to compare with survival and reproductive output



# Thank you for listening



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