

# Smolt age and fine scale marine growth of Atlantic salmon post-smolts in the Northeast Atlantic

Arne J. Jensen<sup>1</sup>, Niall Ó Maoiléidigh<sup>2</sup>, Katie Thomas<sup>2</sup>, Sigurdur M. Einarsson<sup>3</sup>, Monika Haugland<sup>4</sup>, Jaakko Erkinaro<sup>5</sup>, Peder Fiske<sup>1</sup>, Kevin D. Friedland<sup>6</sup>, Asta K. Gudmundsdottir<sup>3</sup>, Jari Haantie<sup>5</sup>, Marianne Holm<sup>4</sup>, Jens Chr. Holst<sup>4</sup>, Jan A. Jacobsen<sup>7</sup>, Jan G. Jensås<sup>1</sup>, Jorma Kuusela<sup>5</sup>, Webjørn Melle<sup>4</sup>, Kjell Arne Mork<sup>4</sup>, Vidar Wennevik<sup>4</sup> and Gunnel M. Østborg<sup>1</sup>

<sup>1</sup> Norwegian Institute for Nature Research, Norway, <sup>2</sup> Marine Institute, Ireland, <sup>3</sup> Institute of Freshwater Fisheries, Iceland, <sup>4</sup> Institute of Marine Research, Norway, <sup>5</sup> Finnish Game and Fisheries Research Institute, Finland, <sup>6</sup> National Marine Fisheries Service, RI, USA, <sup>7</sup> Faroe Marine Research Institute, Faroe Islands

## Objectives

To study age and detailed growth pattern occurring between stocks of Atlantic salmon post-smolts from different parts of Europe caught on feeding grounds in the Northeast Atlantic.

## Collection of samples

Twelve surveys with surface trawls, covering a large area of the Northeast Atlantic, were carried out in 2002, 2003, 2008 and 2009 to collect samples of Atlantic salmon post-smolts during their marine feeding migration, altogether 2 242 post-smolts were captured.

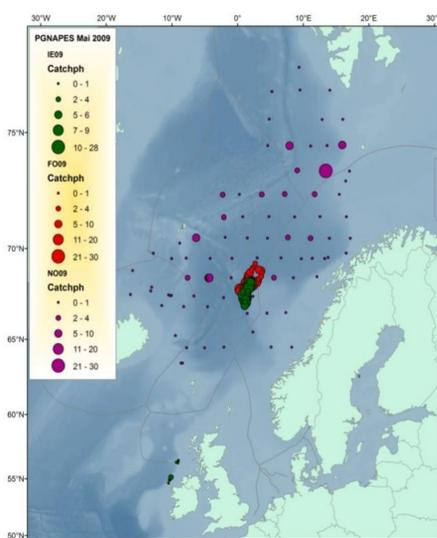


Fig. 1. Map of catches of post-smolts per trawl hour at surveys conducted in 2009. Size of catch corresponds to size of dots. Green: Marine Institute, Ireland; Red: Faroe Marine Research institute; Mauve: Institute of Marine Research, Norway.

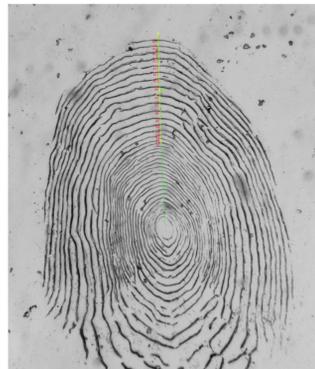


Fig. 2. Scale of a two year old post-smolt captured in the Norwegian Sea 12<sup>th</sup> July 2008, with measurement of the freshwater zone (green) and intercirculi distances in the marine zone (red).

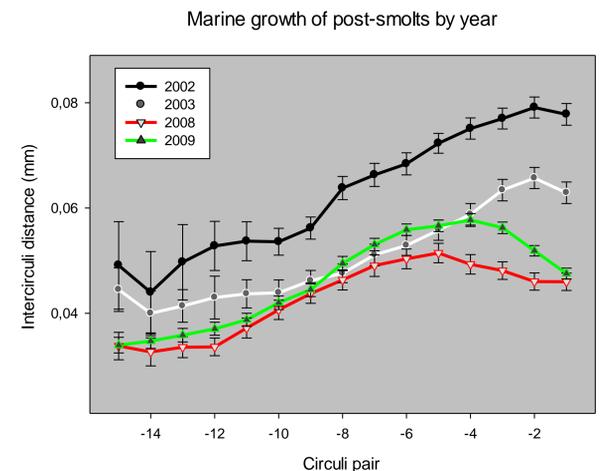


Fig. 4. Intercirculi distances ( $\pm$  95% conf. int.) in the marine zone of scales of post-smolts captured at the Vøring Plateau Area in 2002, 2003, 2008 and 2009. Distances are from the outer edge of the scales and towards the origin (from right to left).

## Results

- The predominating smolt age of post-smolts of wild origin was two years, followed by one and three years, and a few four years old fish.
- The average rate of circuli formation in the marine zone of scales was estimated to be 6.3 days per circulus.
- Both age structure and number of marine circuli in the scales suggest that the majority of the post-smolts caught belong to populations of southern European origin.
- Marine growth rates were found to vary among different areas and years, as growth rates were highest in 2002, followed by 2003 and 2009, and lowest in 2008.
- Also, the first marine intercirculi distances were narrowest in one year old smolts, successively increasing with smolt age, indicating that growth rates during the first period at sea were lowest for salmon of southernmost origin.
- Although only four years of data, the results suggest that annual variation in growth rate of post-smolts before July these four years was controlled by food availability rather than sea temperature.

## Methods

Smolt age and growth signatures were extracted from scale samples of Atlantic salmon post-smolts using image processing. By this method, growth can now be estimated over short periods of time, at the order of weeks during the summer periods and months during winter.

Intercirculi distances were applied as a proxy variable of growth rate and the number of marine circuli as a proxy of time the post-smolts spent at sea. Together with smolt age, a model was developed to indicate the origin of the fish.

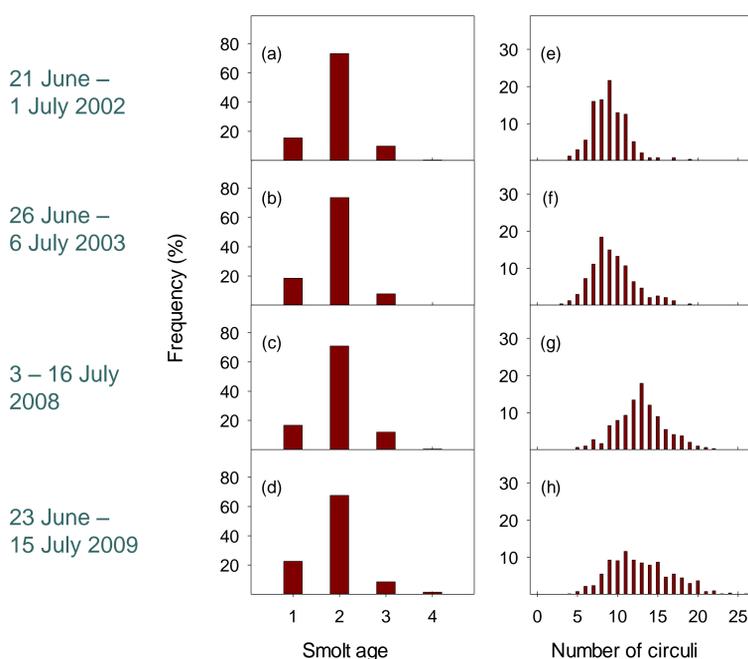


Fig. 3. Smolt age and number of marine circuli in scales of post-smolts captured at the Vøring Plateau Area in 2002, 2003, 2008 and 2009.

Marine growth of post-smolts by smolt age

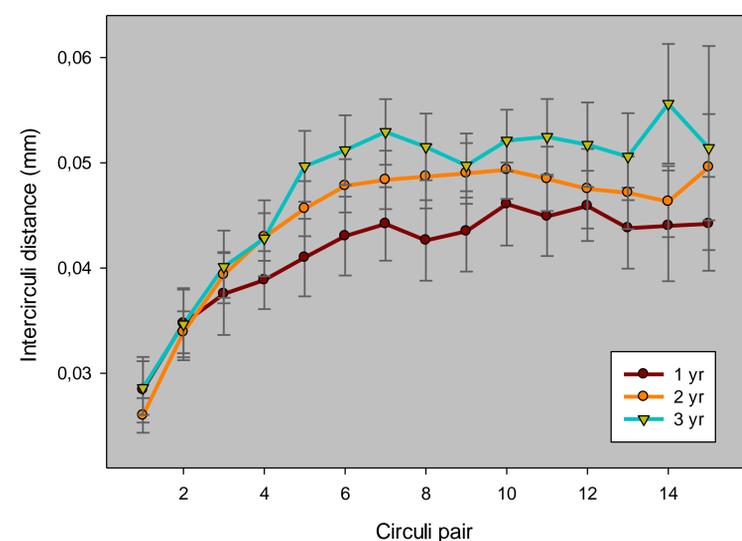


Fig. 5. Intercirculi distances ( $\pm$  95% conf. int.) in the marine zone of scales of one-year-old, two-year-old and three-year-old post-smolts, aligned from the end of the freshwater zone of the scale and toward the edge of the scale (from left to right). Circuli pair no. 1 is the distance between the last circulus laid down in fresh water and the first one in sea water.