

Title

Small fish thrive, large fish compromise: effects of warming on reproductive investment of Northeast Atlantic sole (*Solea solea*) populations

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Abstract

Reproductive investment, defined as “the proportion of total energy or resources allocated to all elements of reproduction”, is a major life-history trait affecting individual fitness. Understanding reproductive investment is crucial to elucidating how populations develop under environmental changes and to sustainably manage them. Although reproductive investment in fish has been studied extensively, how it scales with body size remains a subject of debate. On the one hand, most theoretical growth models assume isometric reproductive scaling, implying that larger individuals have the same relative reproductive investment as smaller individuals. On the other hand, empirical data, mostly from wild populations, showed that hyper-allometric reproductive scaling is common in fish and other taxa, implying that larger individuals have higher relative reproductive investment than smaller individuals. In this study, we investigated how the reproductive investment of common sole (*Solea solea*) scales with body size and how this is influenced by warming temperature. To this end, we applied a mixed-effects modelling framework to a comprehensive 19-year collection of gonad weights (2004-2022) from four sole populations in the North Sea, Irish Sea, Bristol Channel and Celtic Sea North, and Eastern English Channel. Our findings show that sole’s reproductive investment scaled hyper-allometrically with body size. Additionally, increasing temperature increased reproductive investment in small fish but reduced it in large fish. These insights provide a foundation for future development of a growth model for sole accounting for its hyper-allometric reproductive investment and shed light on how temperature changes impact sole’s reproductive investment.

Keywords: common sole, gonad, reproductive investment

Presentation type: Oral