

Fishing influences sensitivity of fish growth to warming

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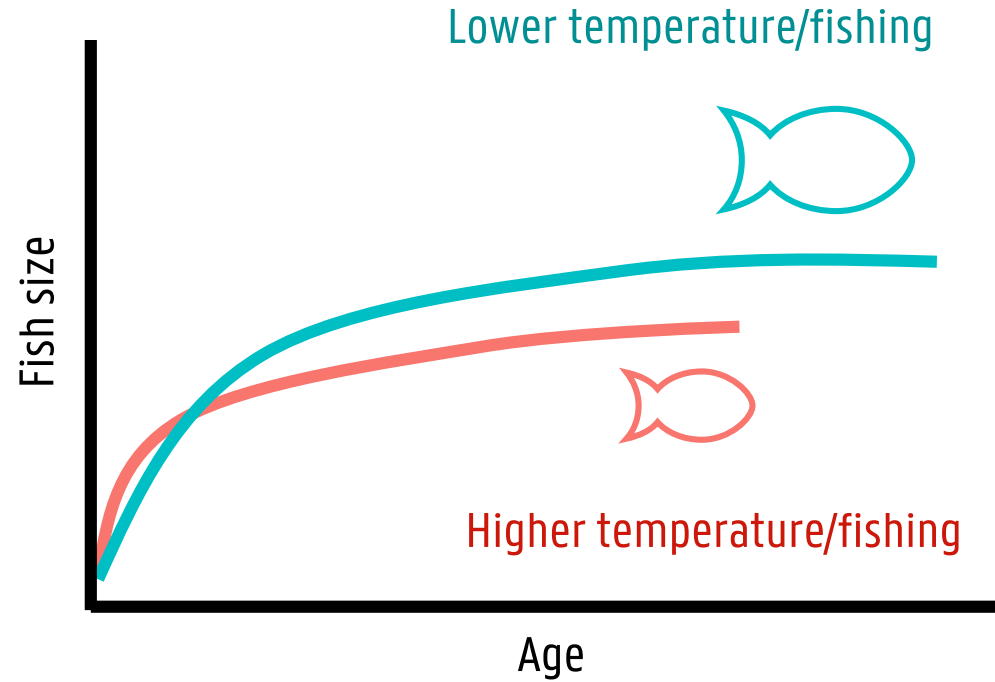
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⁴French Research Institute for Exploitation of the Sea (IFREMER)

INTRODUCTION

Temperature
(Temperature size rule)
X
Fishing pressure
(Fisheries Induced Evolution)

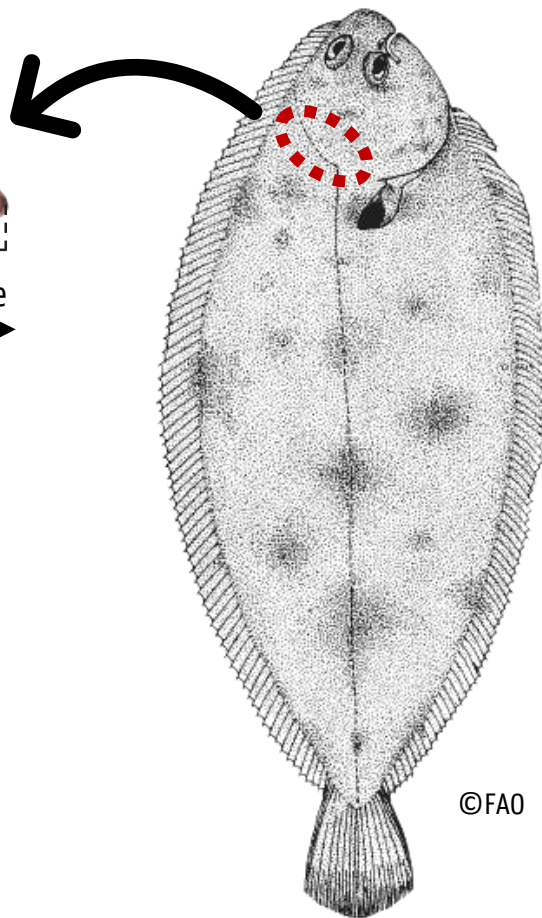
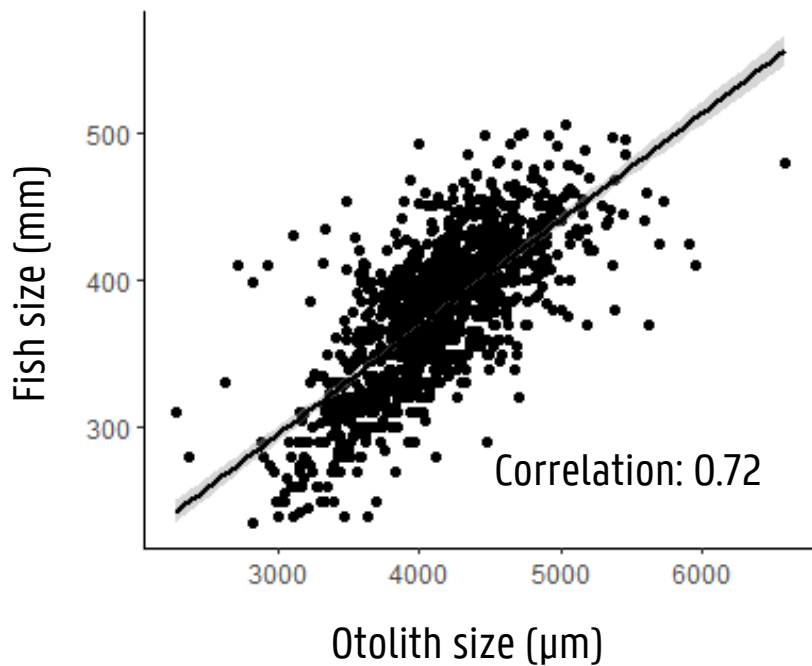
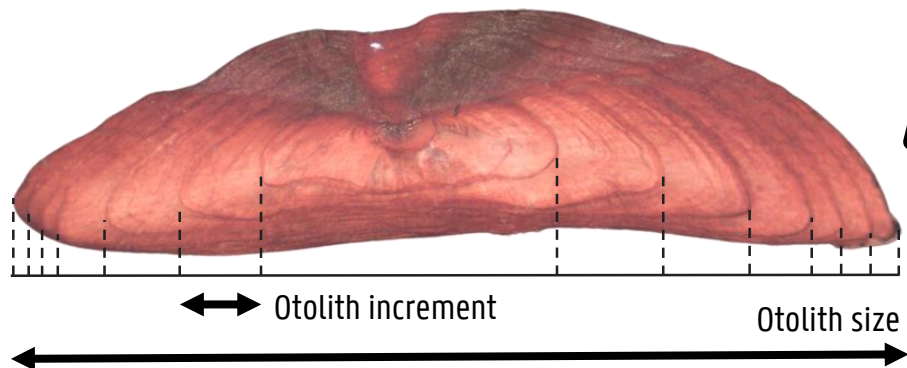


Research questions

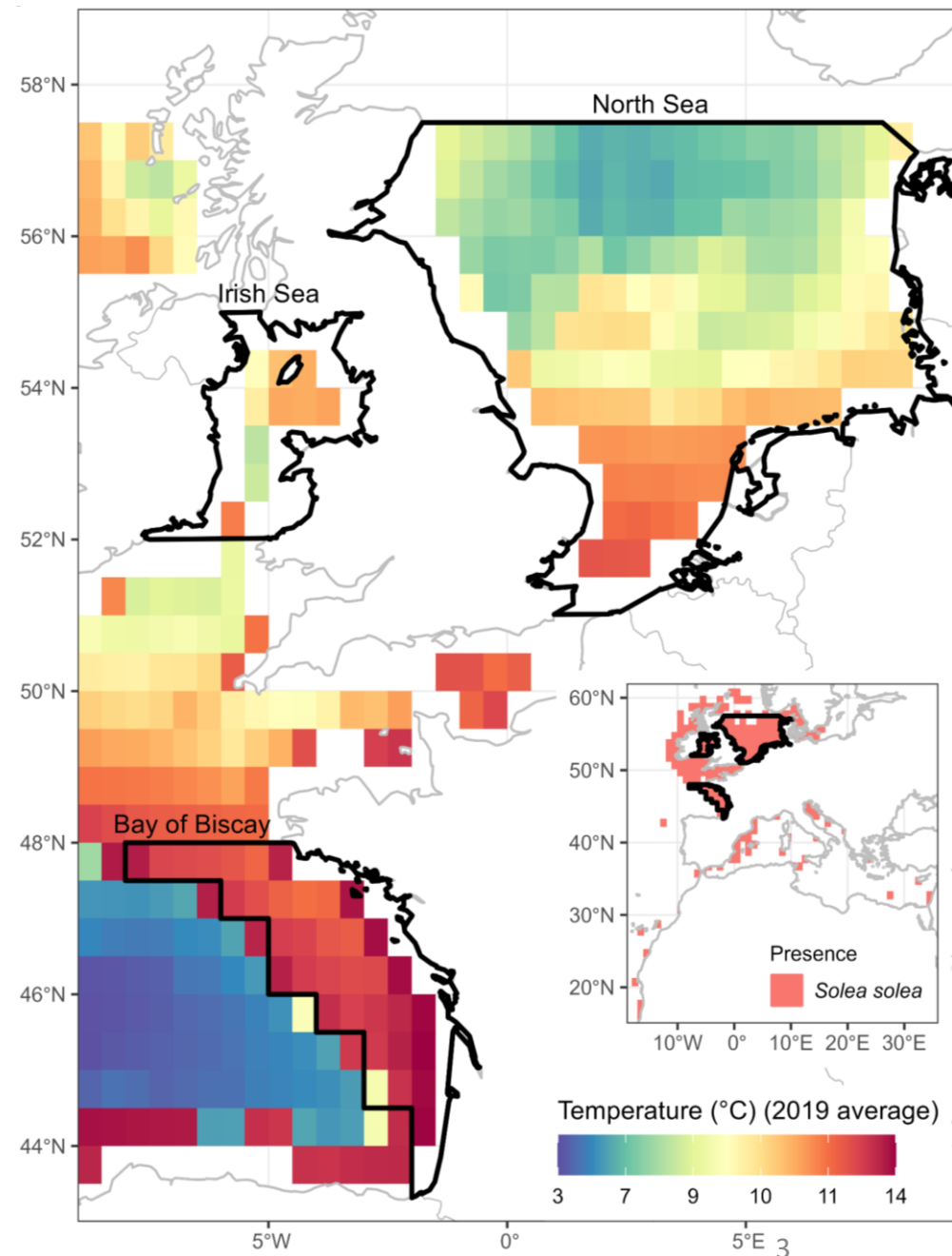
1. What is the effect of temperature on fish growth?
2. What is the effect of fishing pressure on the temperature – growth relationship?

METHODS

15284 otolith increments formed in 1958-2019



Common sole
Solea solea



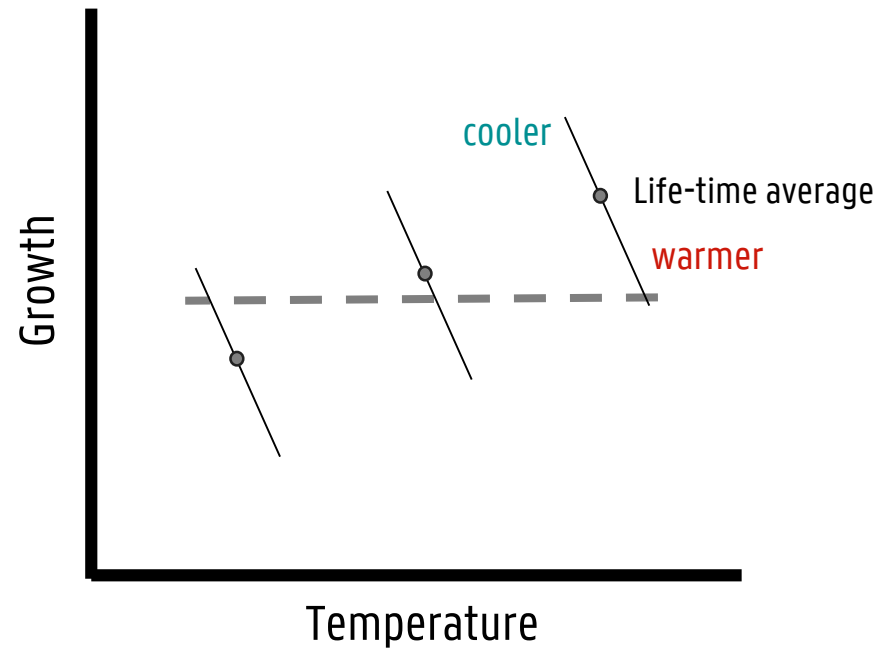
Linear mixed-effect models

Growth \sim Intrinsic Effects + Extrinsic Effects + Random Effects

Age	Temperature	FishID
Age At Capture	Fishing Mortality	Year
	Density	

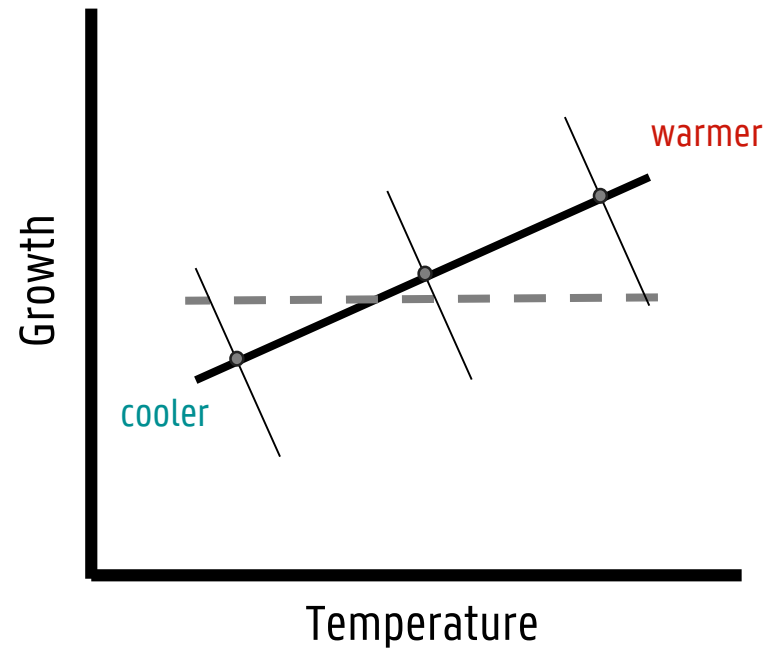
METHODS

Temperature effect
(population average) { within-individual effect



METHODS

Temperature effect
(population average) { within-individual effect
between-individual effect



RESULTS

Density

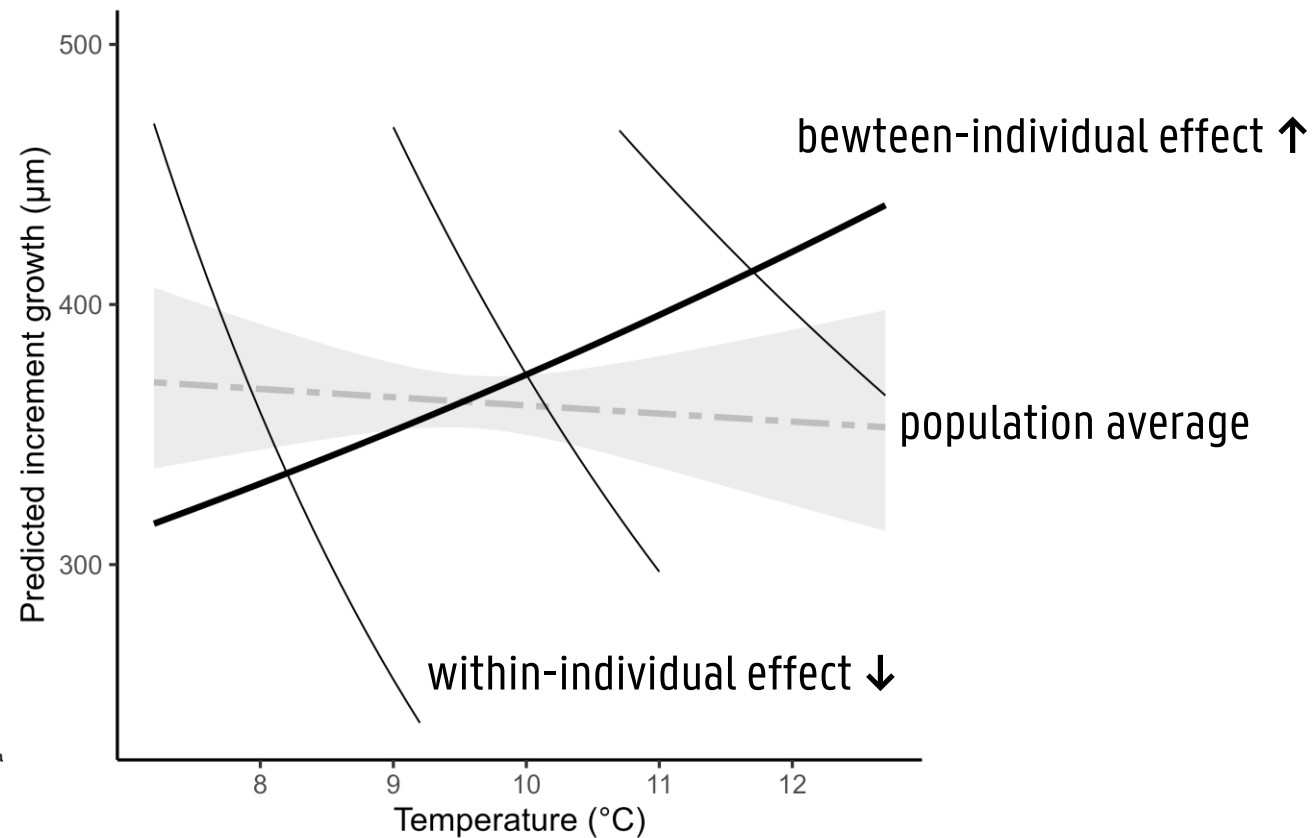
POSITIVE ↑

Fishing mortality

NO EFFECT

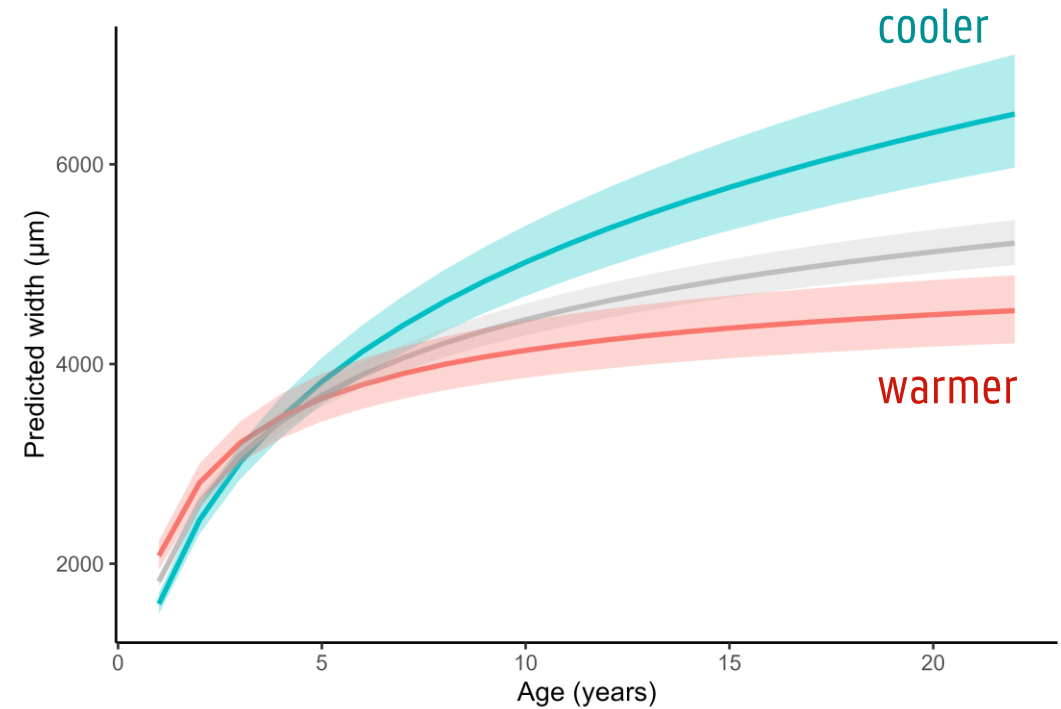
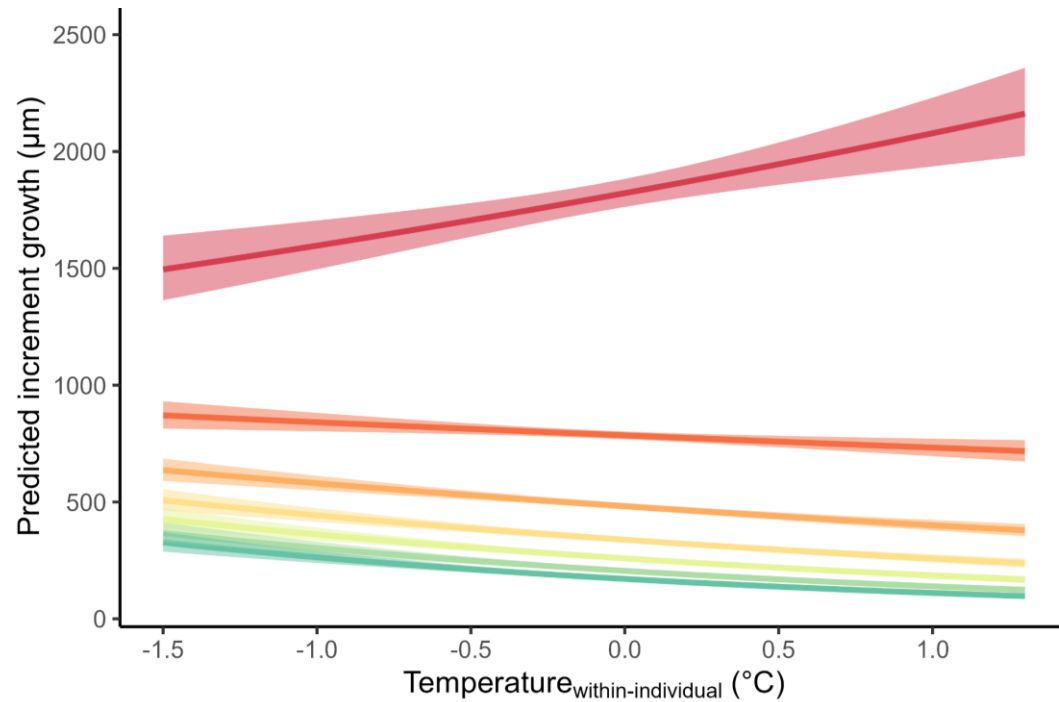
RESULTS

Density	POSITIVE ↑
Fishing mortality	NO EFFECT
Temperature (population average)	NO EFFECT
	{ within-individual effect NEGATIVE ↓
	{ between-individual effect POSITIVE ↑



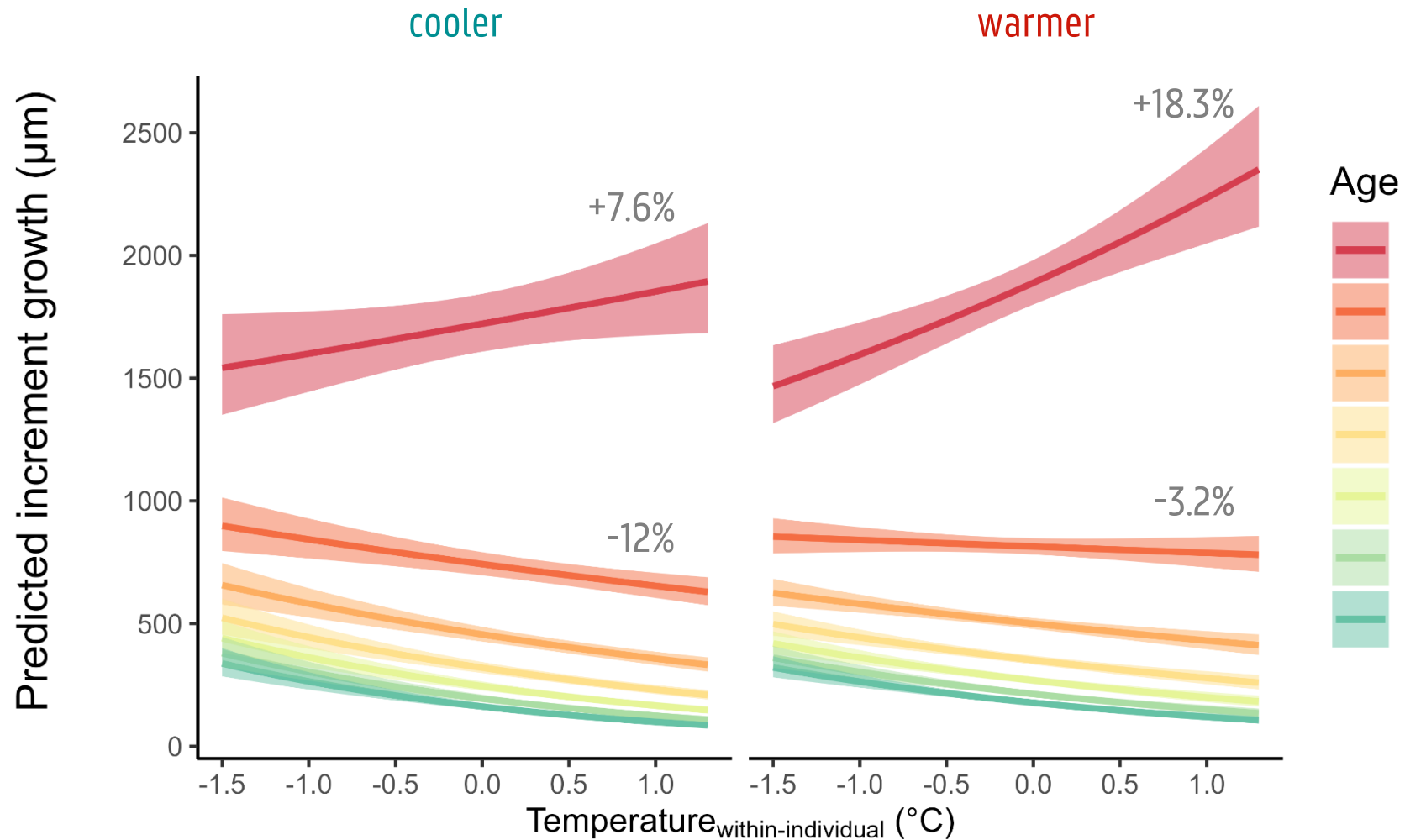
RESULTS

within-individual effect * age



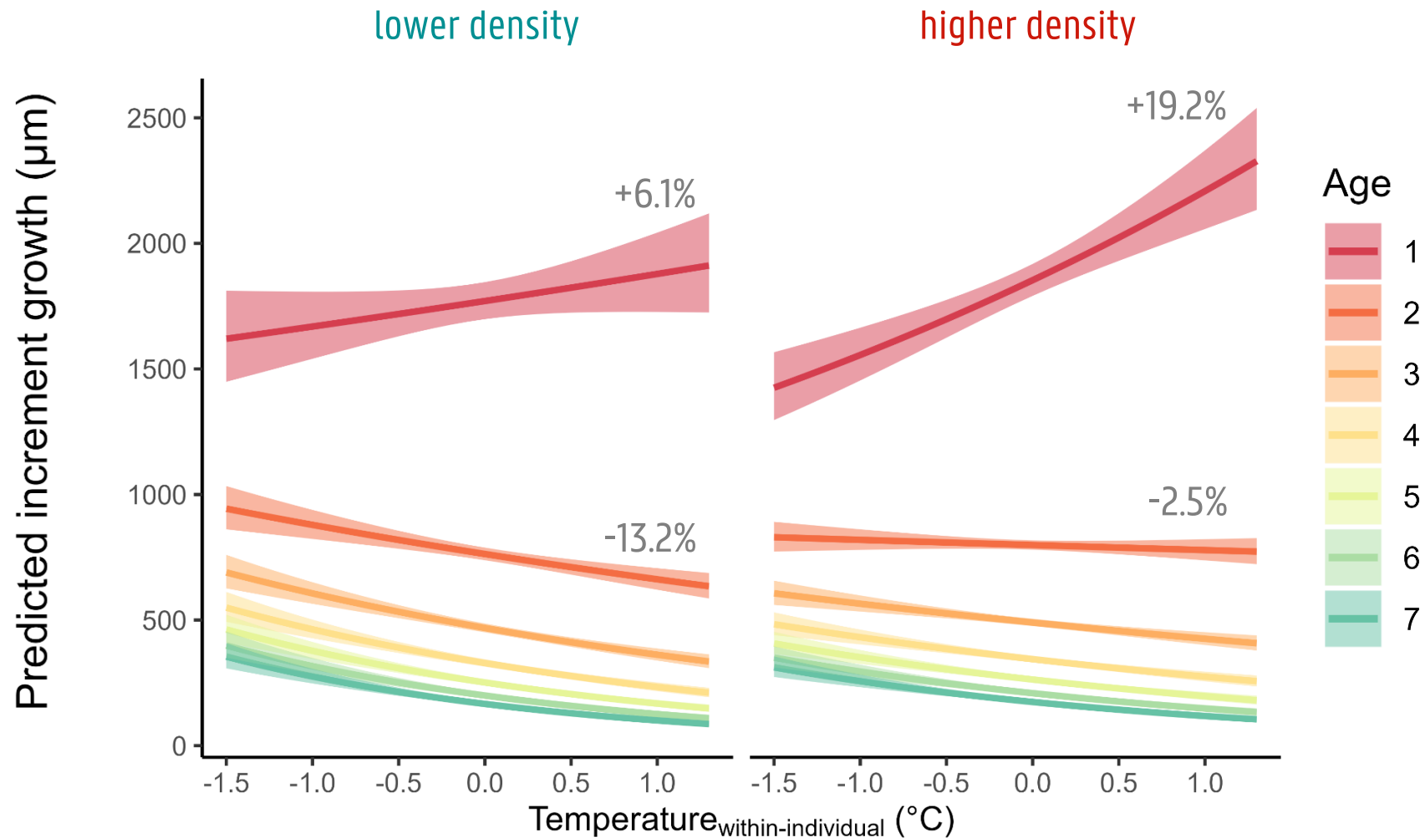
RESULTS

within-individual effect * **between-individual effect**



RESULTS

within-individual effect * **density**



TAKE-HOME MESSAGE

1. What is the effect of temperature on fish growth?

- Response of fish growth to temperature is derived from both within- and between-individual effects
- Common sole (*Solea solea*)
 - within-individual effect: positive at younger ages, negative at older ages – **Temperature Size Rule**
 - between-individual effect: positive

2. What is the effect of fishing on the temperature – growth relationship?

- Fishing influence temperature – growth relationship via density dependence
- Lower density (higher fishing)
 - reduces positive effect in younger ages
 - amplifies negative effect in older ages

Thank you for your attention

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