Leiðandi
vettvangur í tíu ár

How will Icelandic cod react to warming global oceans?

Gotje von Leesen

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North Sea cod stocks fall to 'critical' level says Ices report

BBC

By Kevin Keane
BBC Scotland's environment correspondent

28 June 2019

Share

North Sea cod to lose sustainability 'blue tick' as fish population falls

The Guardian

MSC certificate to be suspended in October just two years after it was awarded

Nfld. & Labrador

Northern cod stock down by 30%, still in 'critical zone'

CBC

Cod stocks had been showing improvement since 2012, but declined in past year

Janelle Kelly · CBC News · Posted: Mar 23, 2018 2:30 PM NT | Last Updated: March 23, 2018

Cod stocks on course to crash if ocean warming continues

The Guardian

Barents Sea is key source of UK cod imports and could see temperature rises of over 6C

Jonathan Watts *Global environment editor*

@jonathanwatts

Fri 25 Jan 2019 14.40 GMT

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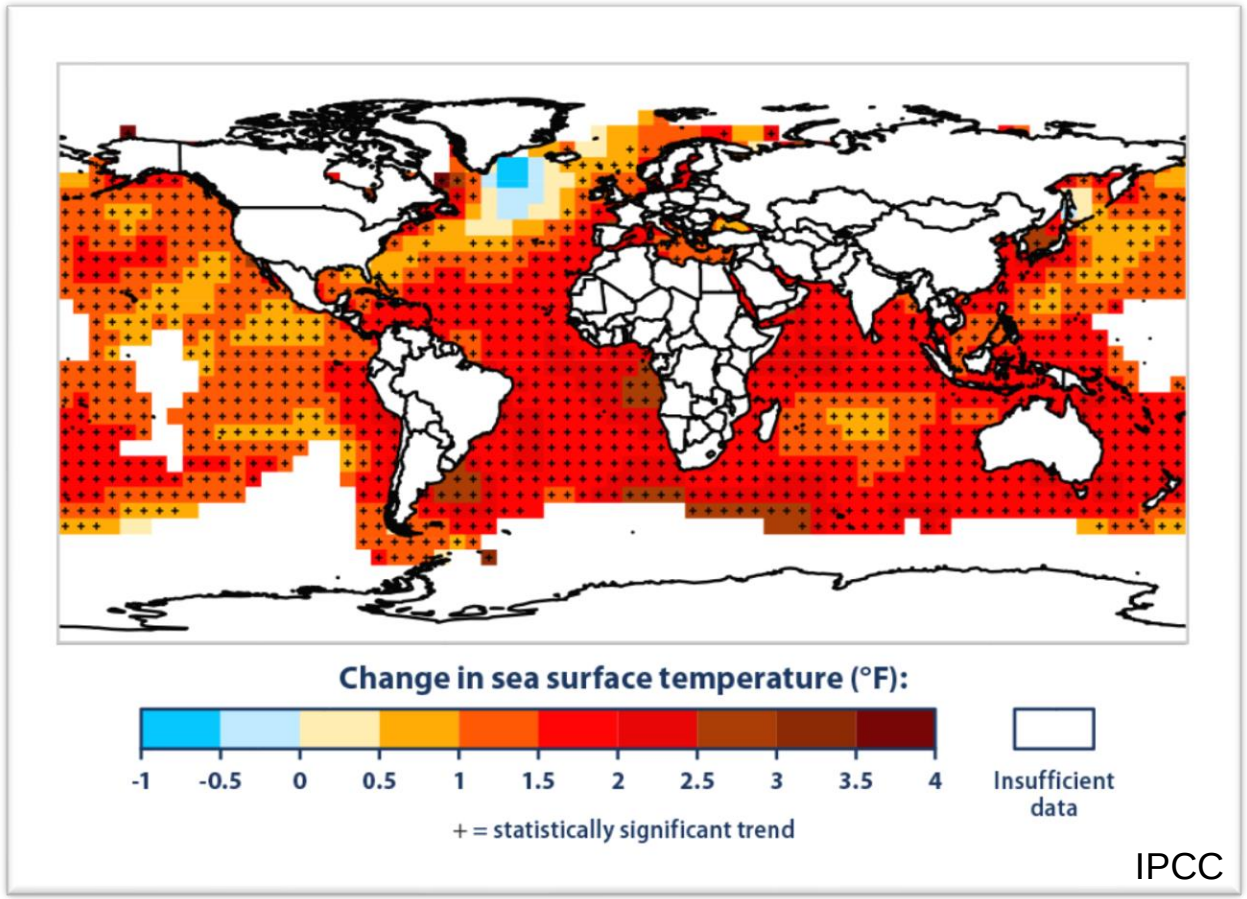
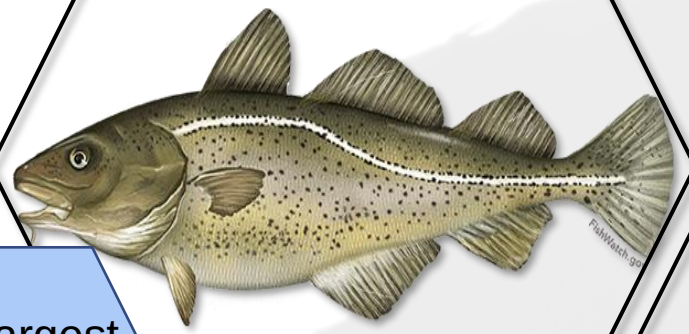


IPCC

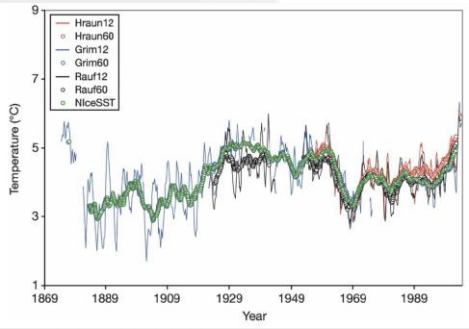
Cod (*Gadus morhua*)



- One of the largest cod stocks in the world
- Most important fish for Icelandic fisheries
- Teleost fish

Otoliths – environmental recorders

Increasing water temperatures



Hanna et al. 2006

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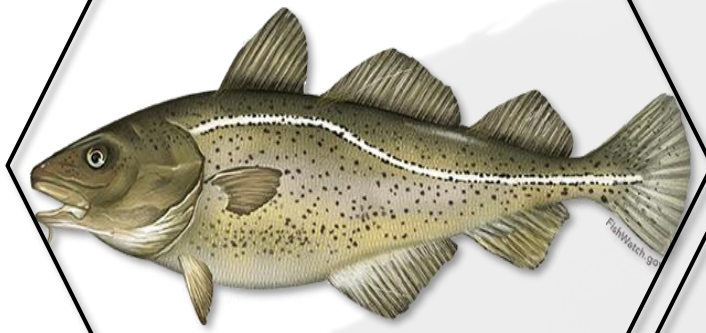

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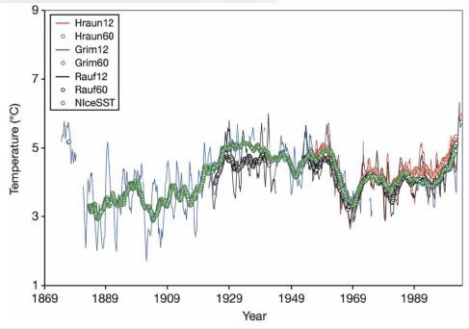


Hanna et al. 2006

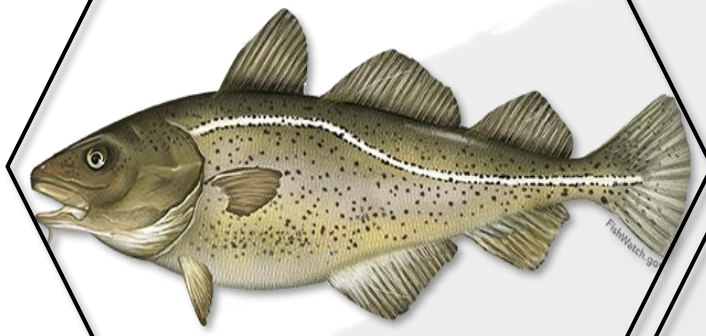
Otoliths – environmental recorders

Iceland

- Calcified structure for balancing and hearing
- Continuous growth
- Metabolically inert

?

Cod (*Gadus morhua*)



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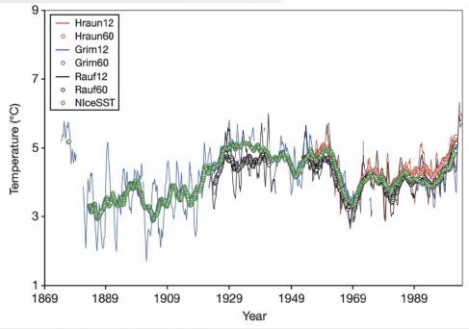


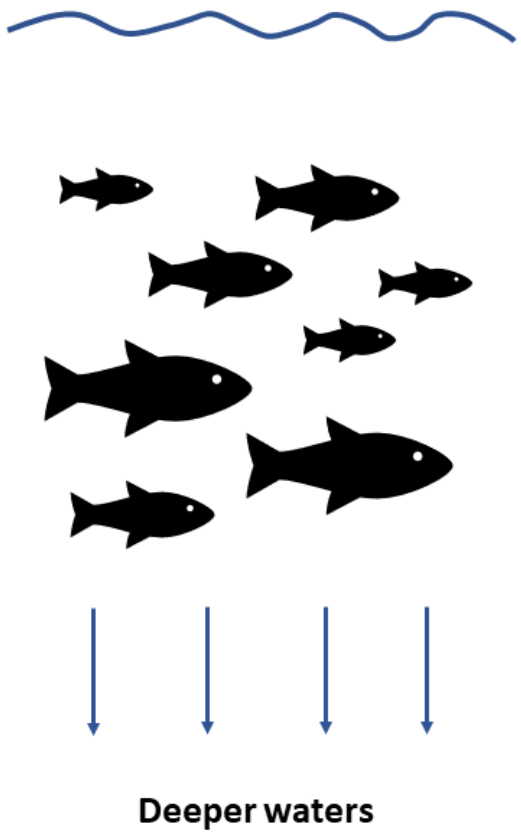
Hanna et al. 2006

Otoliths – environmental recorders

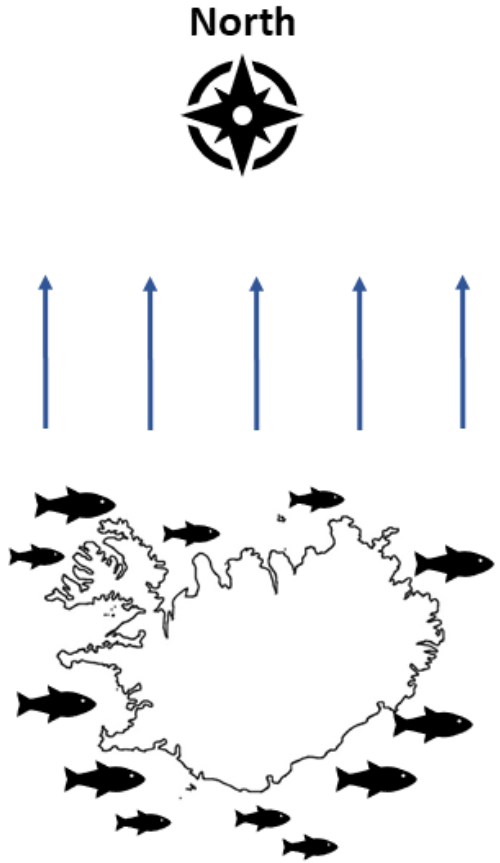
Iceland

$\delta^{18}O_{otolith}$

Possible reactions of cod to increasing water temperatures



- Horizontal or vertical migration to remain in their preferred temperature range
- No distribution shift: metabolically costly (Pörtner et al, 2001)
- Disadvantages of thermoregulatory movement: move away from otherwise favorable conditions (e.g. spawning ground, changing prey-predator interactions, …) (Brander, 2003)



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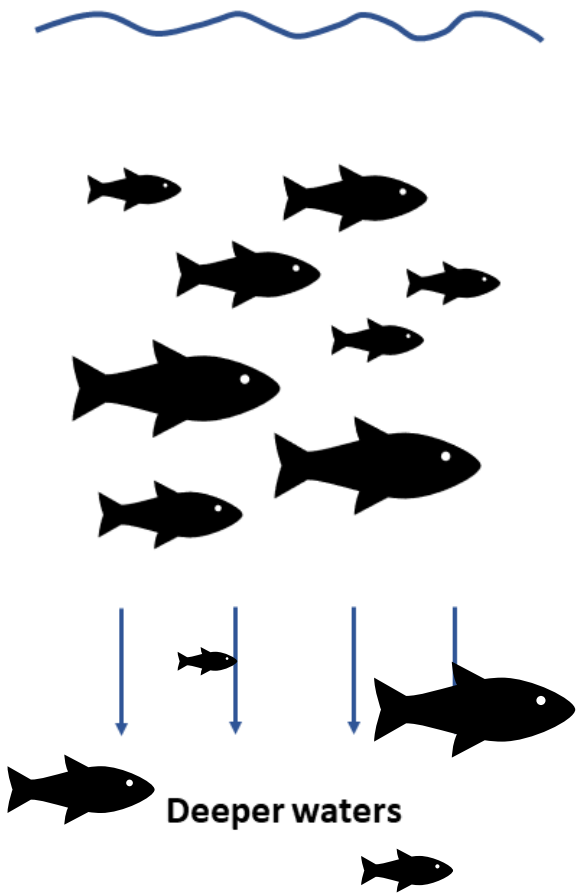

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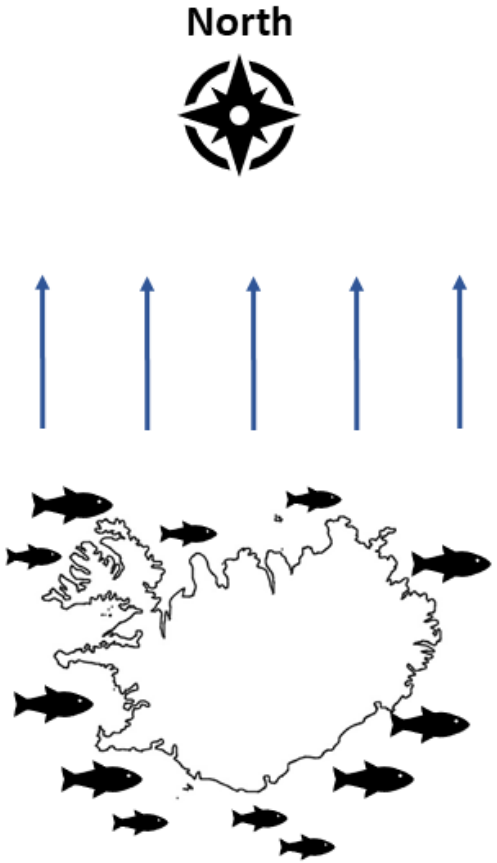

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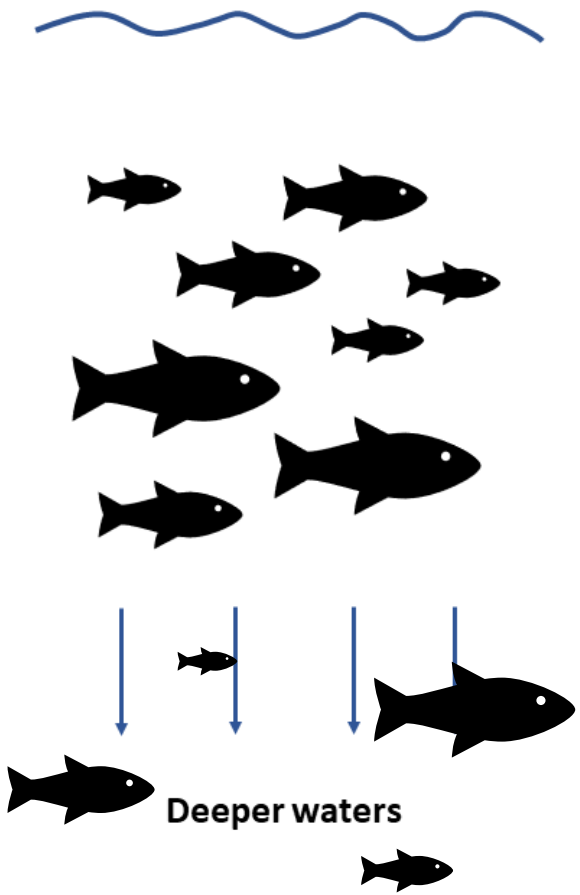

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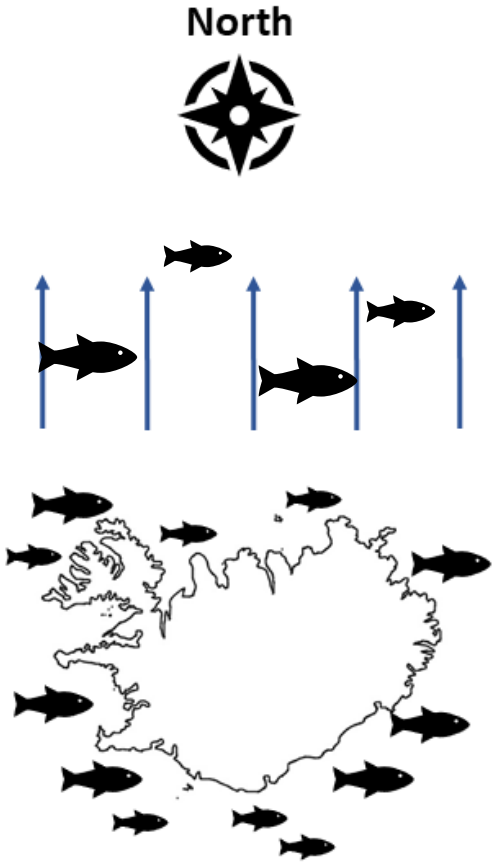
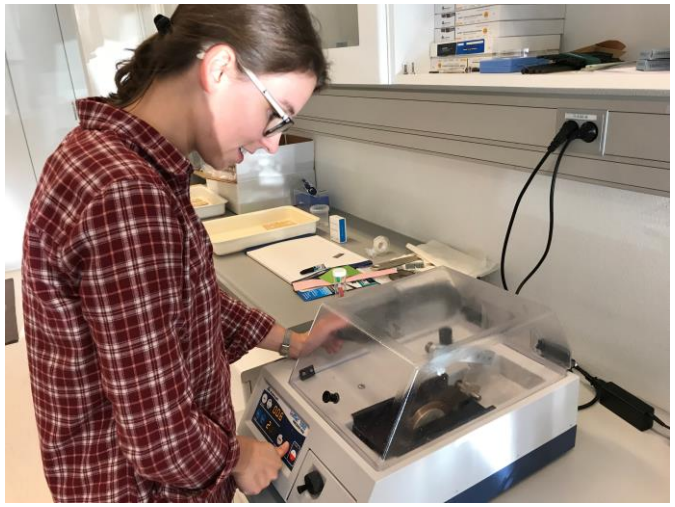
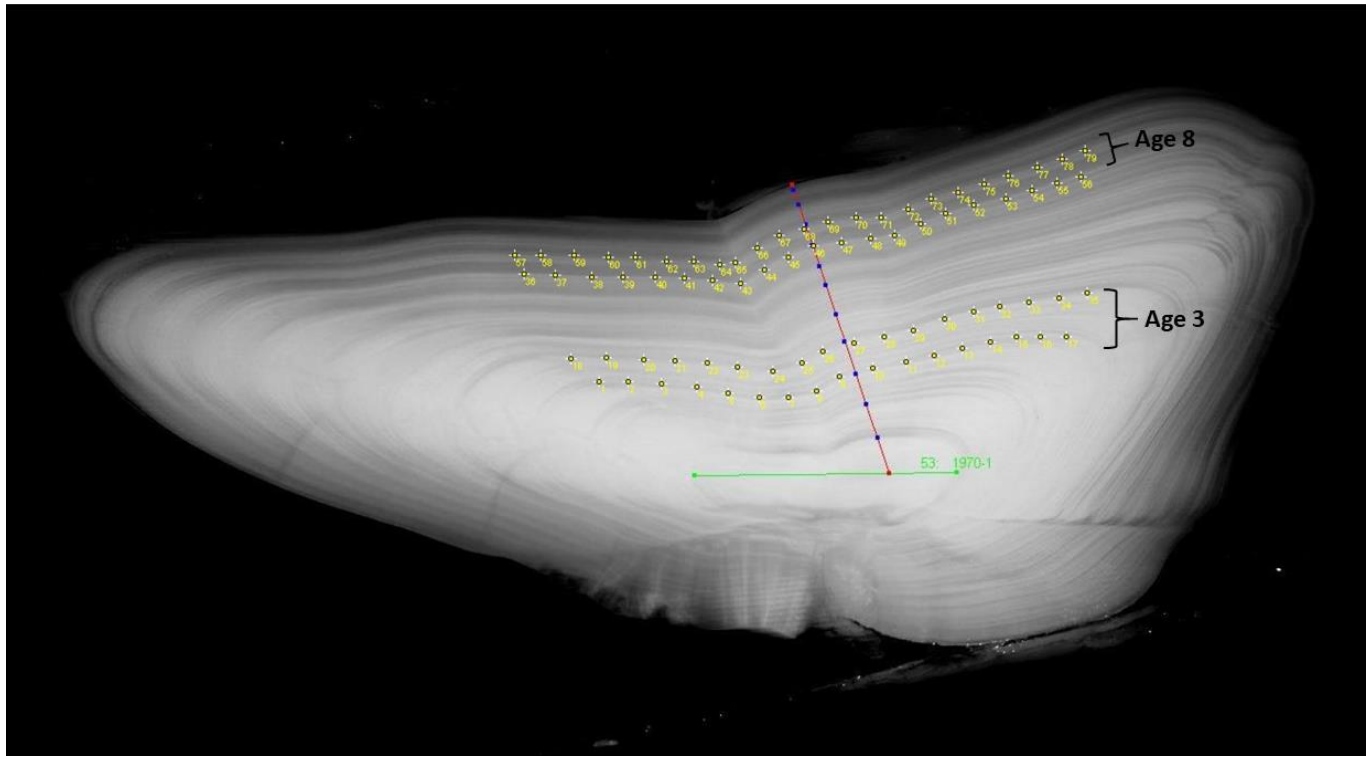


Otolith sections

- 500 isotope assays
- Age ≥ 10 years
- Difference between lifestages:
  age 3 → immature and
  age 8 → mature
- Isotope-ratio mass spectrometer: $\delta^{18}O_{otolith}$ measurements

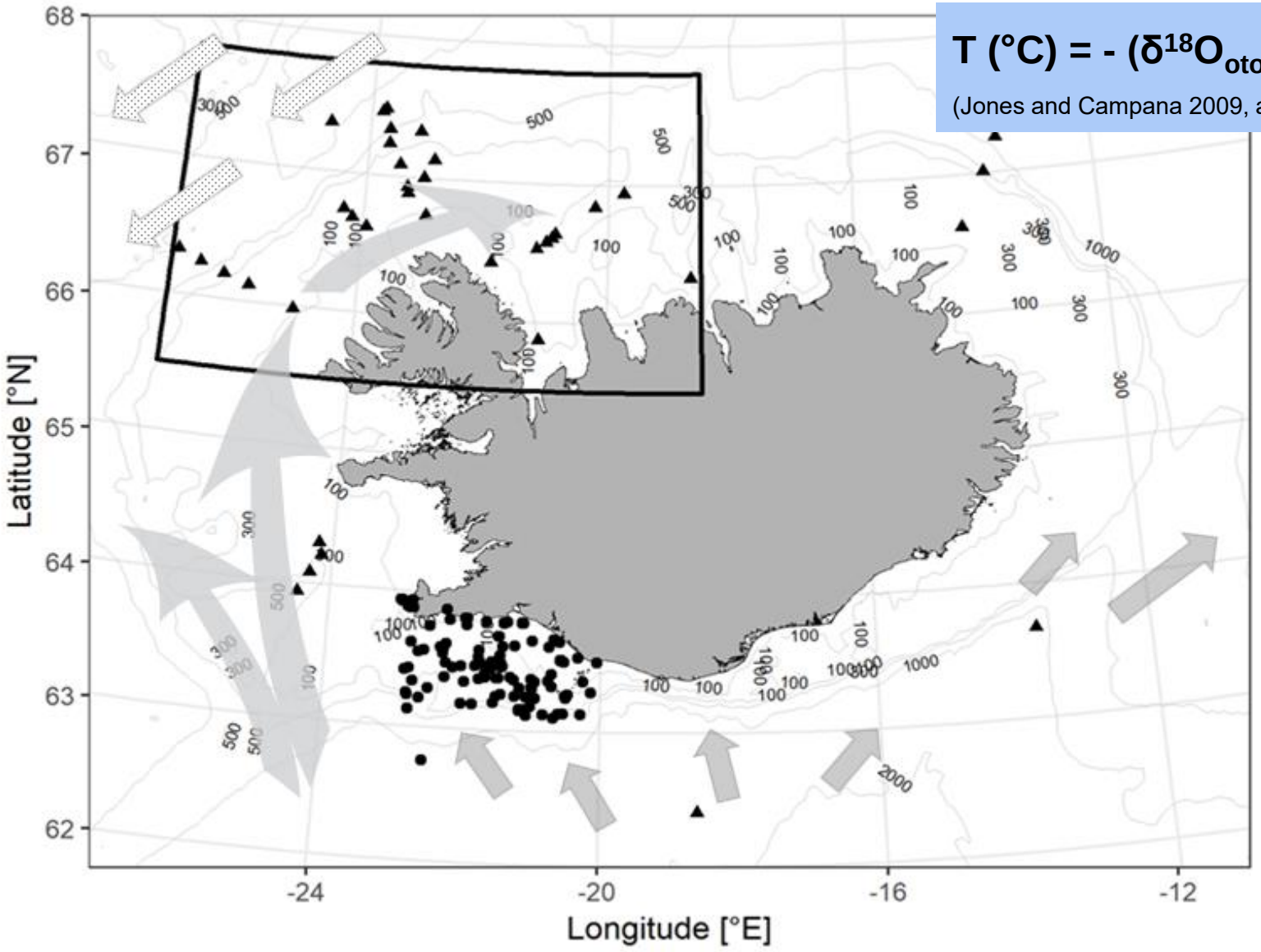




Reconstruction of otolith-based temperatures

$$T\ (°C) = -\ (\delta^{18}O_{otolith} - (\delta^{18}O_{water} - 0.27)) \times 0.206^{-1} + 18.010$$

(Jones and Campana 2009, adapted from Kim and O'Neil, 1997)



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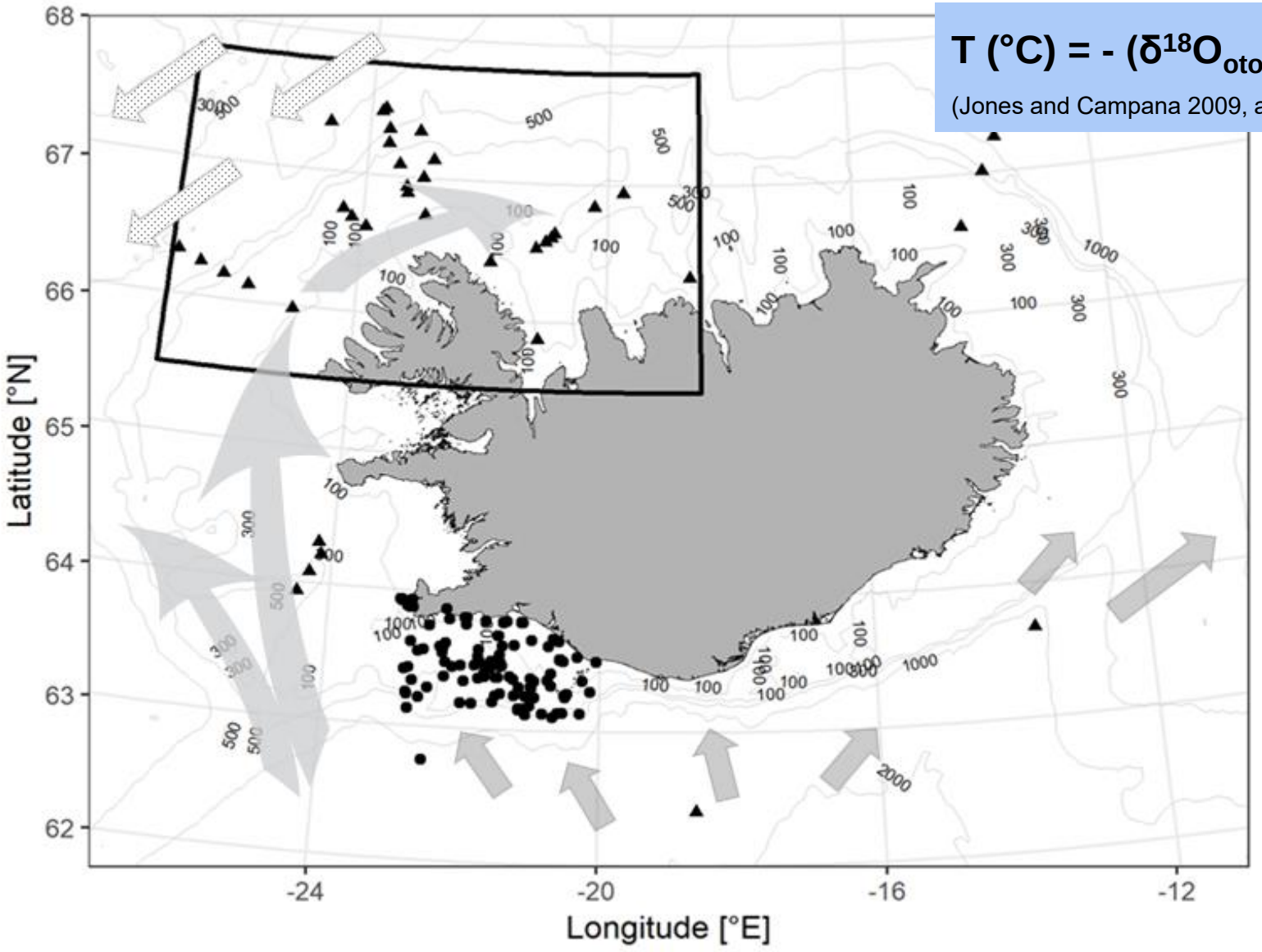
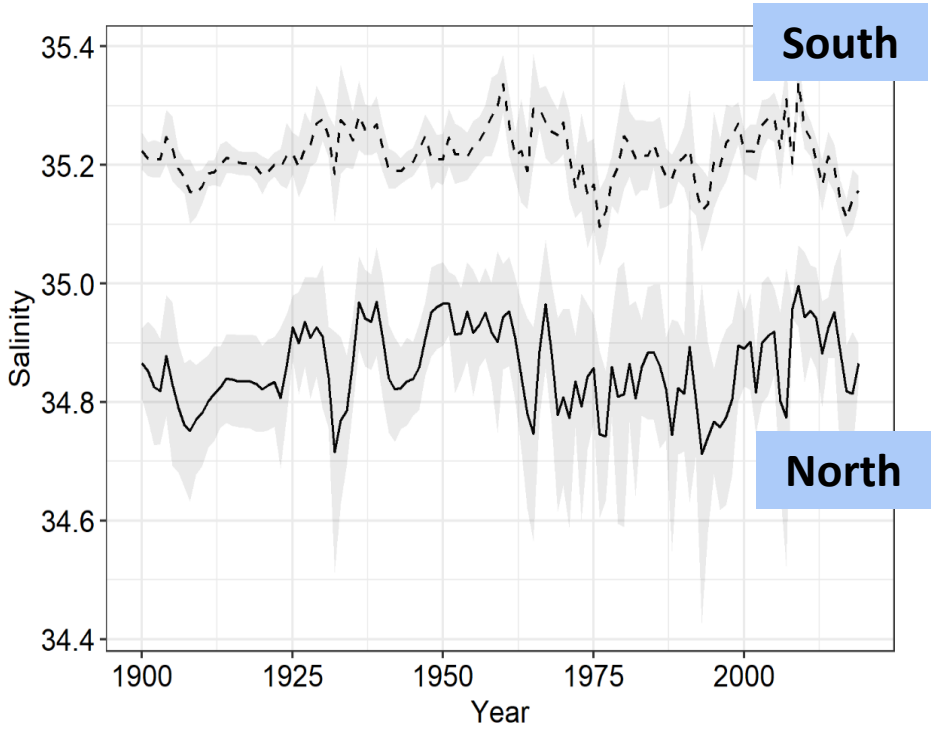


Salinity mixing curve:

$$\delta^{18}O_{seawater} = 0.58 \times S - 20.12$$



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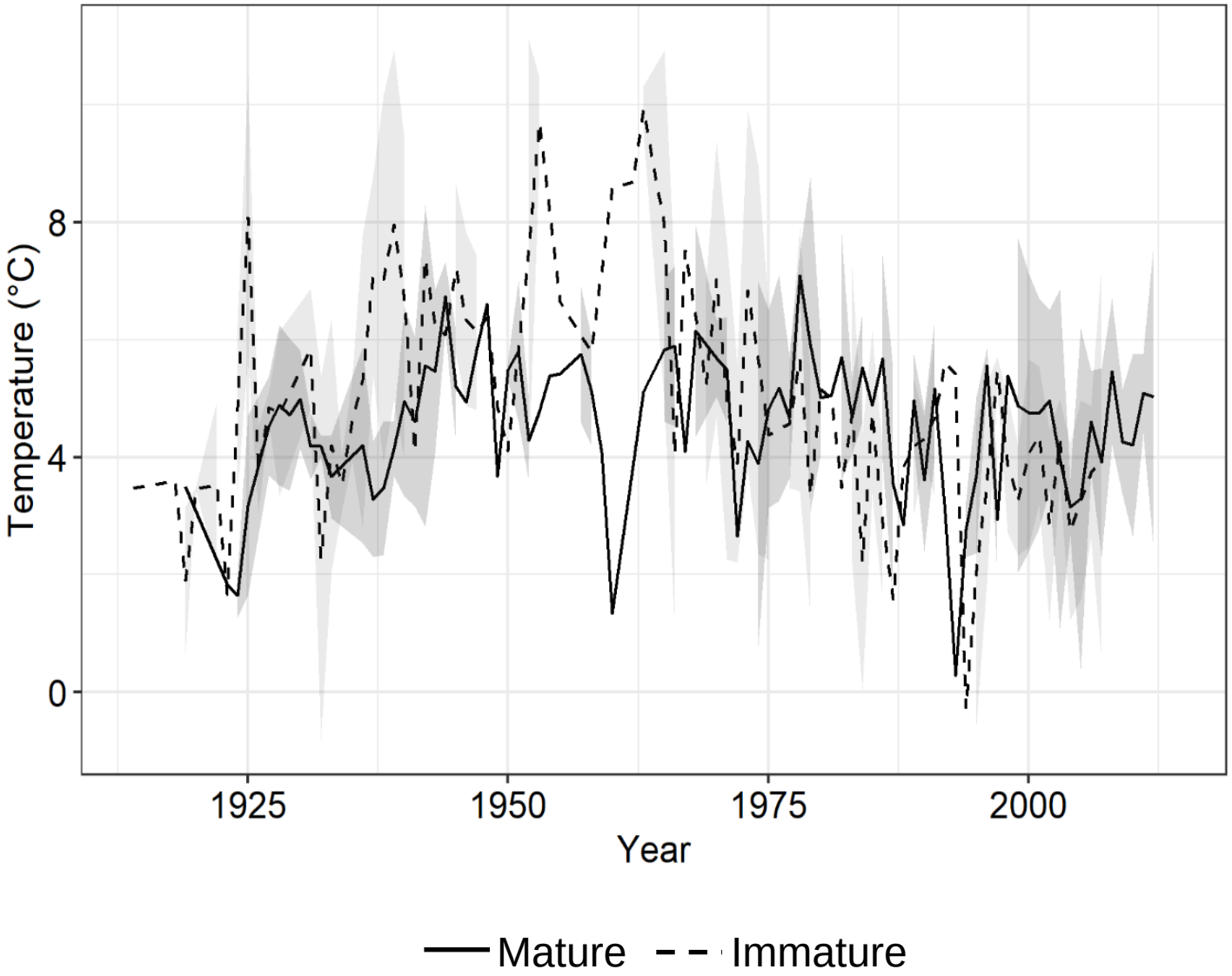
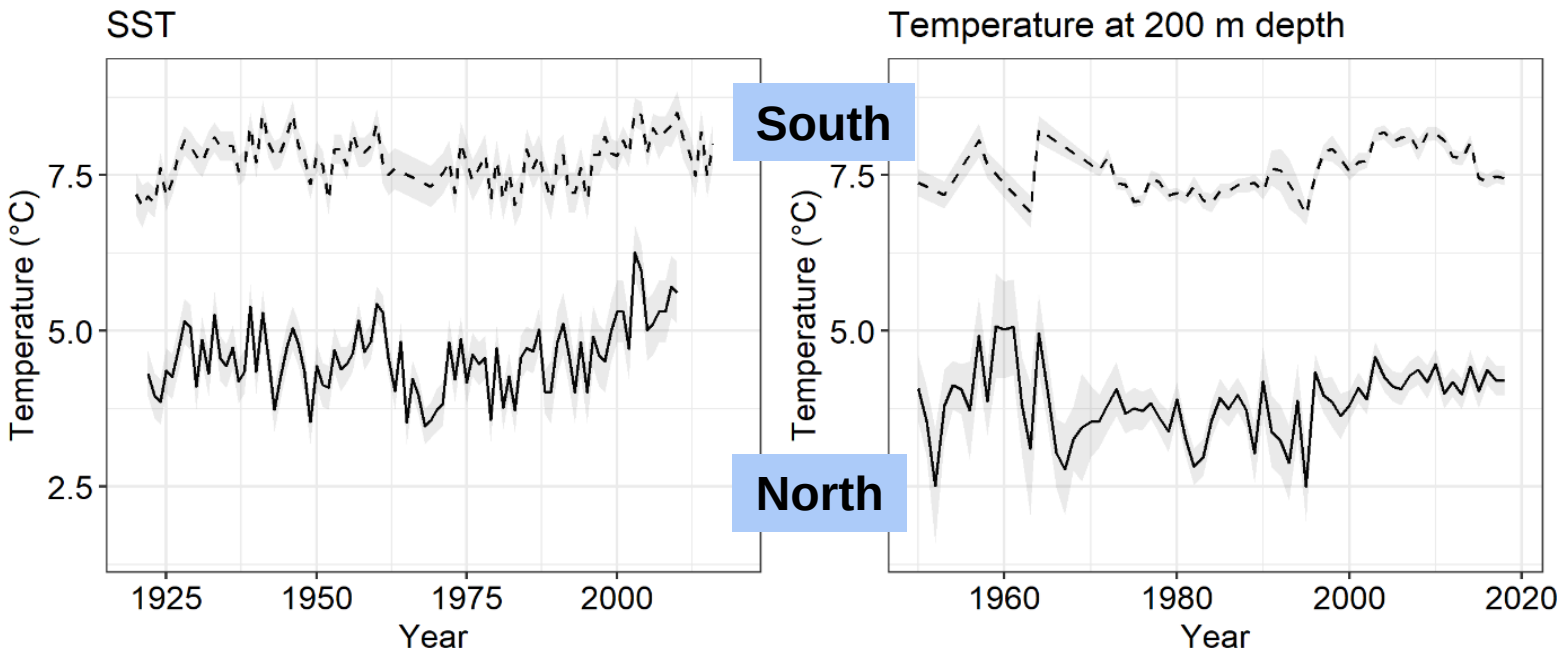


- **Significant differences in $\delta^{18}O_{otolith}$ between life stages ($p < 0.001$)**
  → Thermal window widths varies for juvenile and adult cod
- **Sex does not have an effect**

Actual water temperatures around Iceland

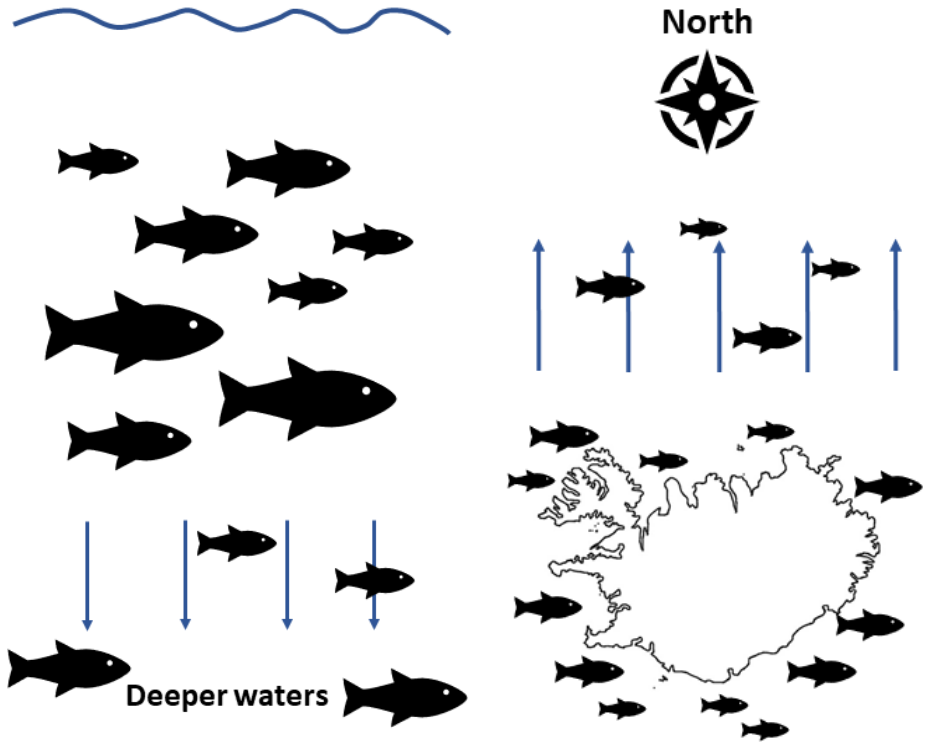
Significant correlation with water temperatures

SST: $p < 0.001$
water temperatures at 200 m depth: $p < 0.01$



→ **Cod did not move as a response to increasing water temperatures**

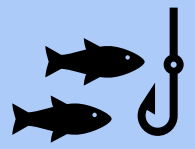
But does that mean that cod are going to passively remain where they are as the global oceans warm?



- Critical annual mean temperature for cod: 12°C (Myers et al, 1997; Drinkwater, 2005)
  ↔ mean reconstructed otolith-based temperature: 4.8°C
- Northward movement of cod has been observed, but not at an individual level
  → adult cod do not move (Neat and Righton, 2007)
- Distribution shift by settlement or recruitment

Implications for fisheries

Icelandic cod were exposed to changing water temperatures during the last 100 years
→ Cod did not move to avoid unfavorable temperatures



Response to global warming might vary between ecotypes

Otolith-based temperature is an important tool for responsible fisheries management

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MARINE & FRESHWATER RESEARCH INSTITUTE

rannís

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Héðinn Valdimarsson

and everybody involved in the Rannis project: "*Long-term otolith and bivalve growth chronologies in relation to cod stock dynamics and climate in the Northeast Atlantic*"