

The issue of reproductive challenges for cod when waters warm

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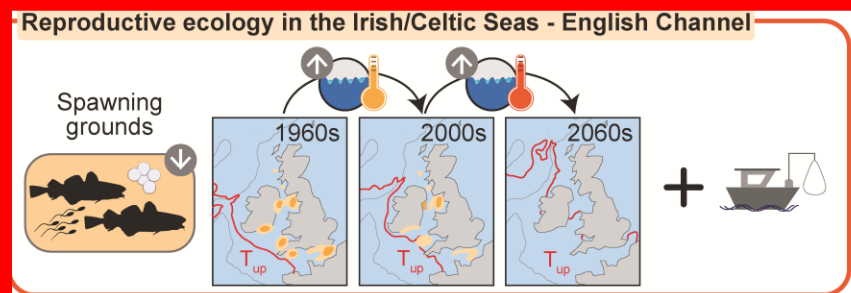
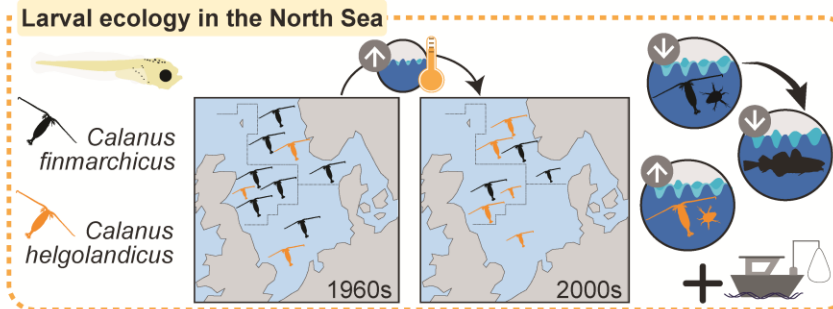
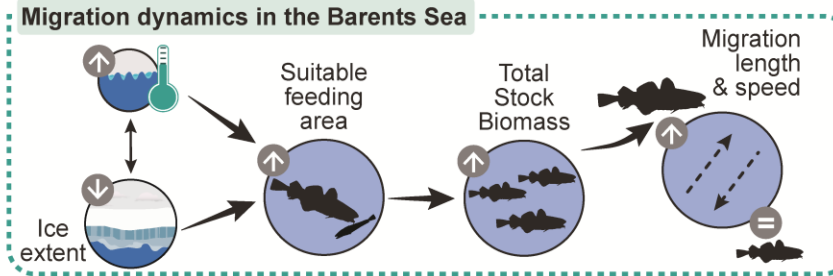
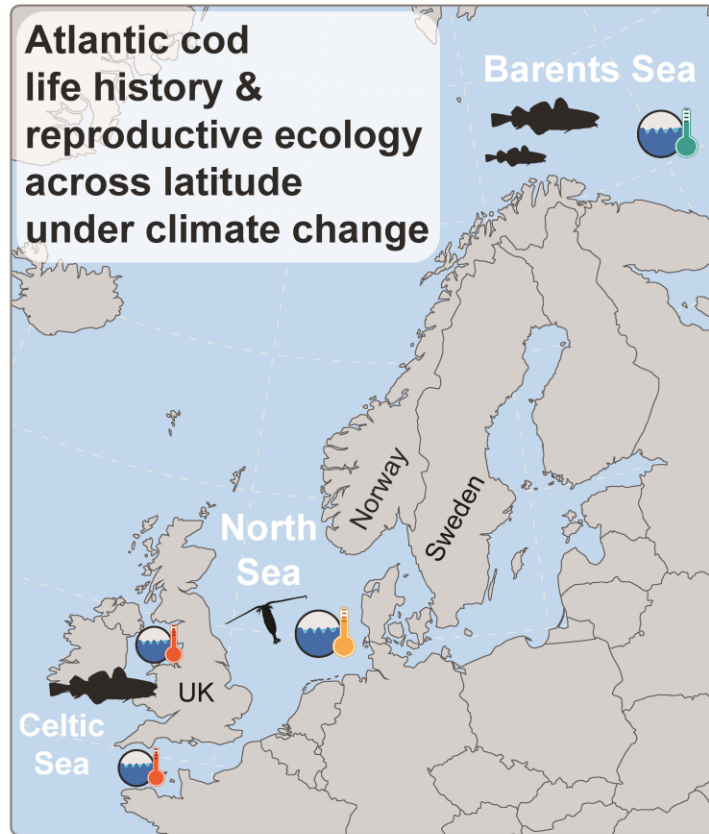
WORKING GROUP 1 (IRISH SEA)

13 March 2023



this talk

addressing «the weak link in the chain»



Legend

Impact of T on cod:

- ↑ Increase
- ↓ Decrease

Direct impact

Indirect impact

Over-fishing

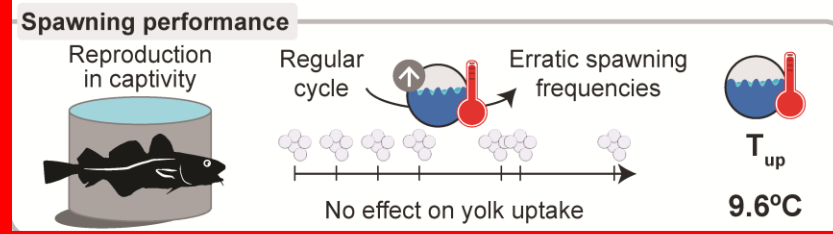
Large cod

Small cod

$T > T_{up}$

$T < T_{up}$

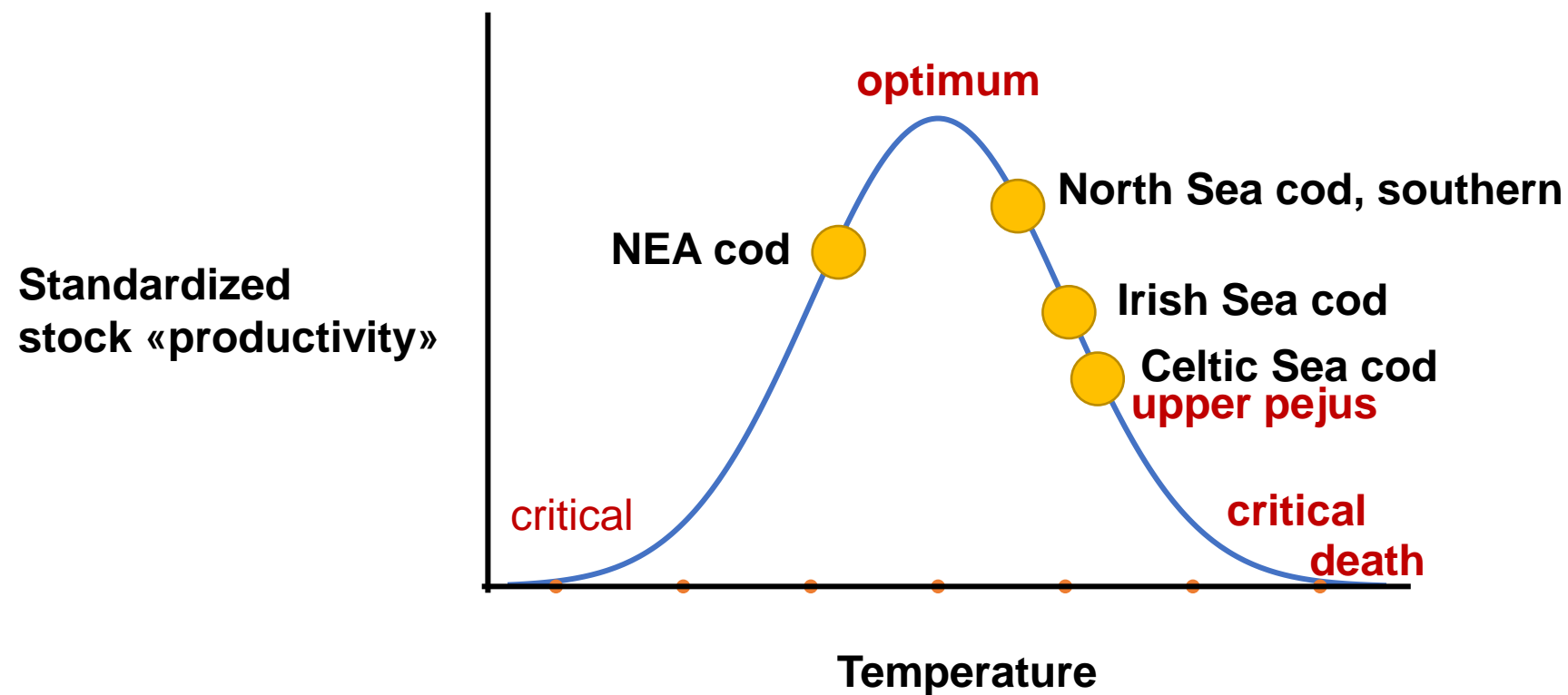
$T \ll T_{up}$



Adding in also information from «climate impact assessments»

(Kjesbu et al., 2022, *Fish and Fisheries*),

we claim – here with reference to a schematic “dose-response curve” – that the present situation is something like this:



what does the literature tell us?

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REVIEW PAPER

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From gametogenesis to spawning: How climate-driven warming affects teleost reproductive biology

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Abstract

Ambient temperature modulates reproductive processes, especially in poikilotherms such as teleosts. Consequently, global warming is expected to impact the reproductive function of fish, which has implications for wild population dynamics, fisheries and aquaculture. In this extensive review spanning tropical and cold-water environments, we examine the impact of higher-than-optimal temperatures on teleost reproductive development and physiology across reproductive stages, species, generations and sexes. In doing so, we demonstrate that warmer-than-optimal temperatures can affect every stage of reproductive development from puberty through to the act of spawning, and these responses are mediated by age at spawning and are associated with changes in physiology at multiple levels of the brain–pituitary–gonad axis.

...including that the spawning (ovulatory) cycle of cod is **extremely** fine-tuned and sophisticated, and easily disturbed

spawning interval:
time between batches: 2-3 days

spawning frequency:
the inverse of spawning interval

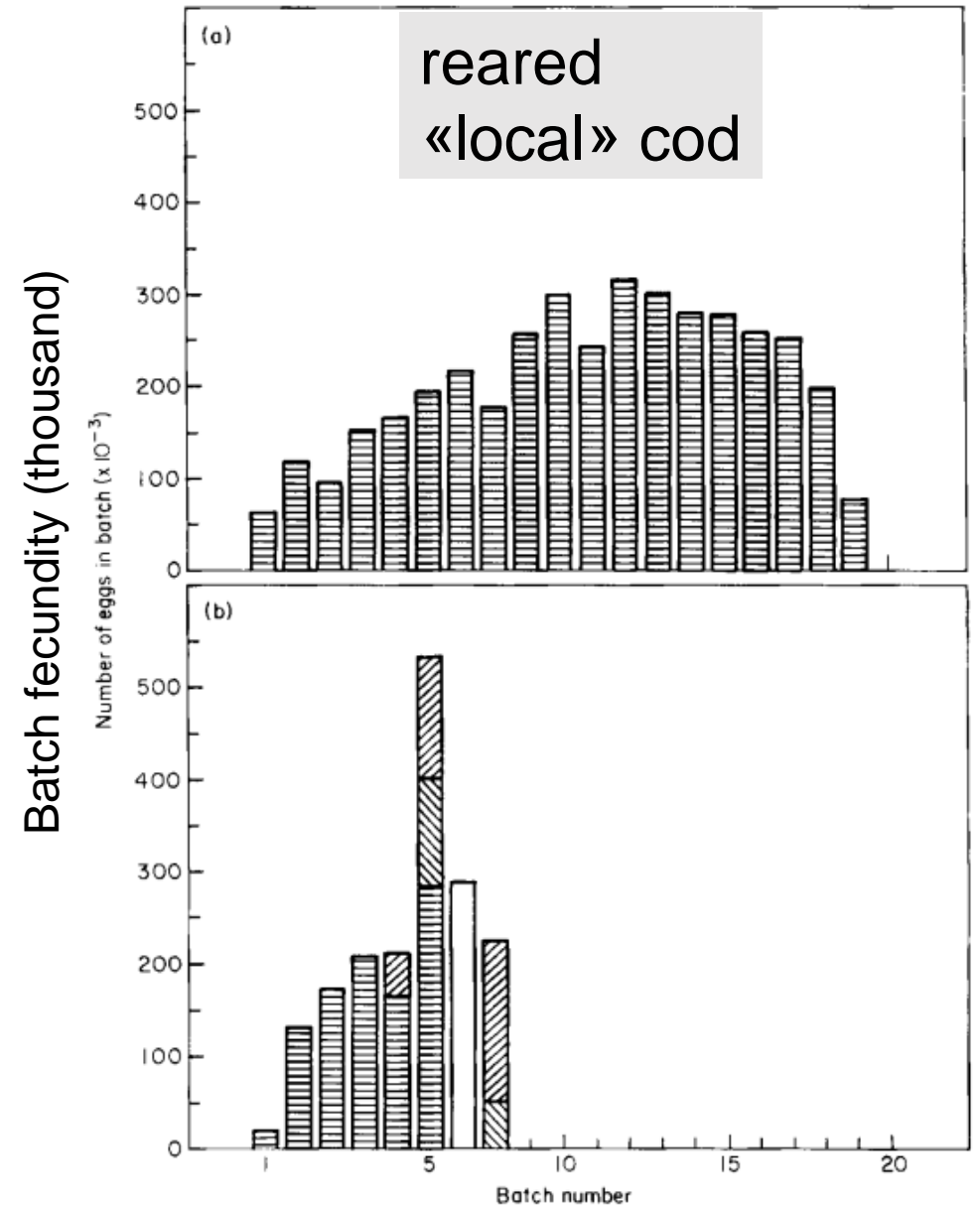


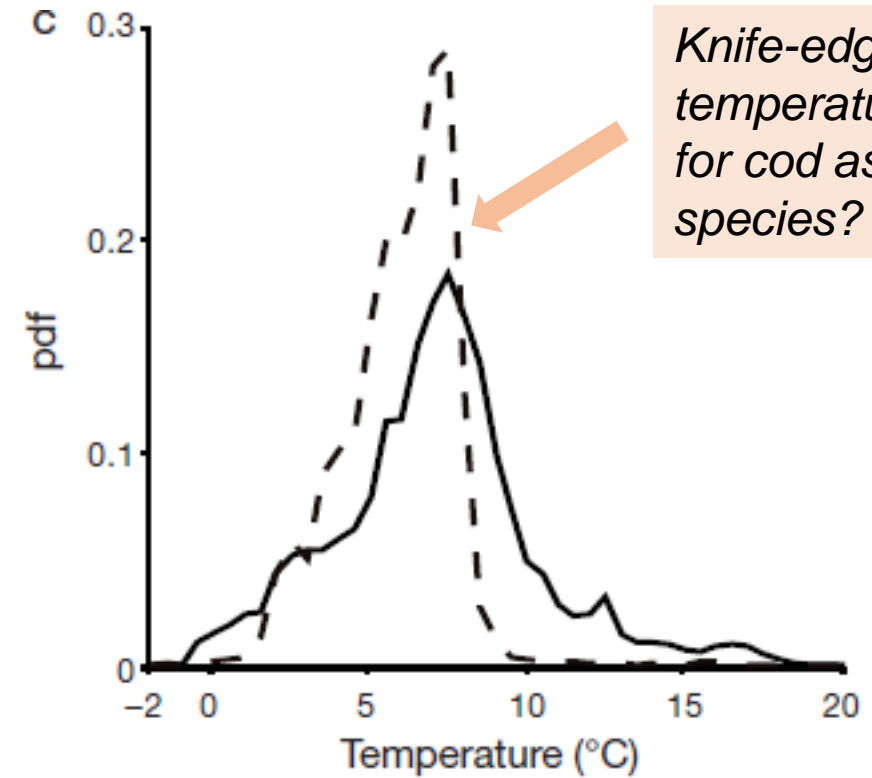
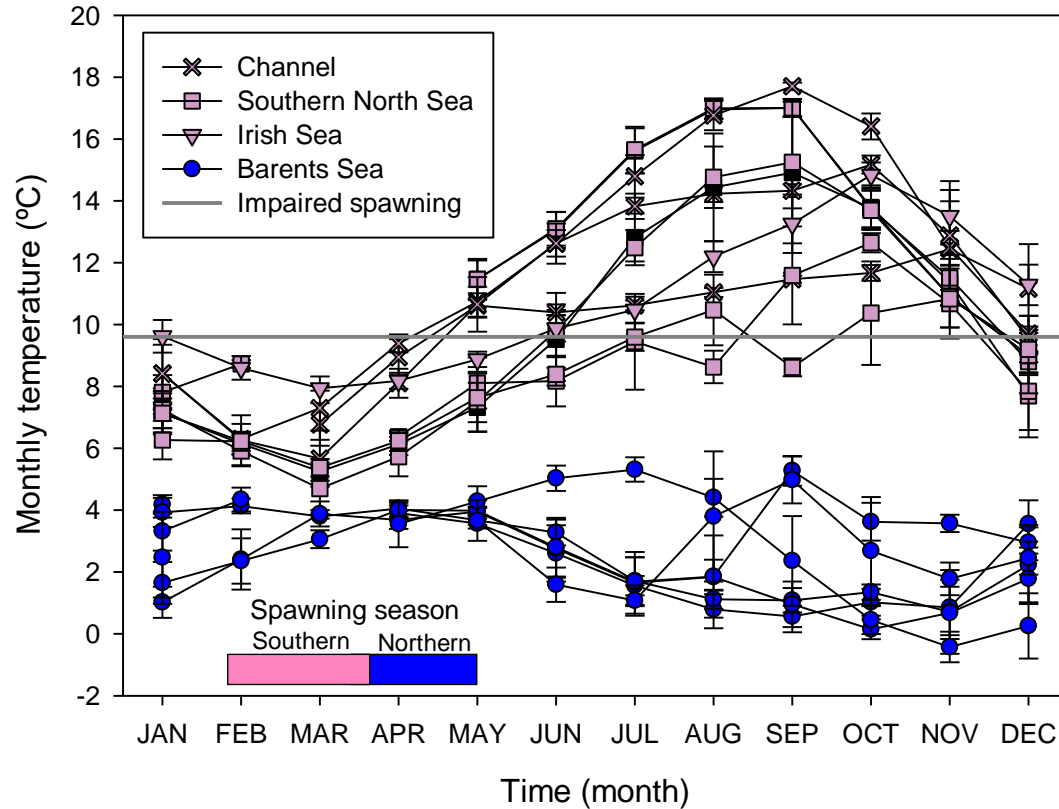
FIG. 1. The spawning activity of a regular (a) and an irregular (b) spawning female cod. (a) Female 1 (b) Female 18 (removed after batch no. 8). ▨ Unfertilized; ▩ activated, but unfertilized; ▧ fertilized; □ fertilization rate unknown.

Kjesbu. 1989. *JFB*

...data-storage tags

Righton et al. 2010. *MEPS*

Kjesbu et al. 2010. *CJFAS*



...aquaculture (broodstock) cod

Seasonal shift in spawning of Atlantic cod (*Gadus morhua* L.) by photoperiod manipulation: egg quality in relation to temperature and intensive larval rearing

the parents were
«local» cod

Terje van der Meeren¹ & Vladimir P Ivannikov²

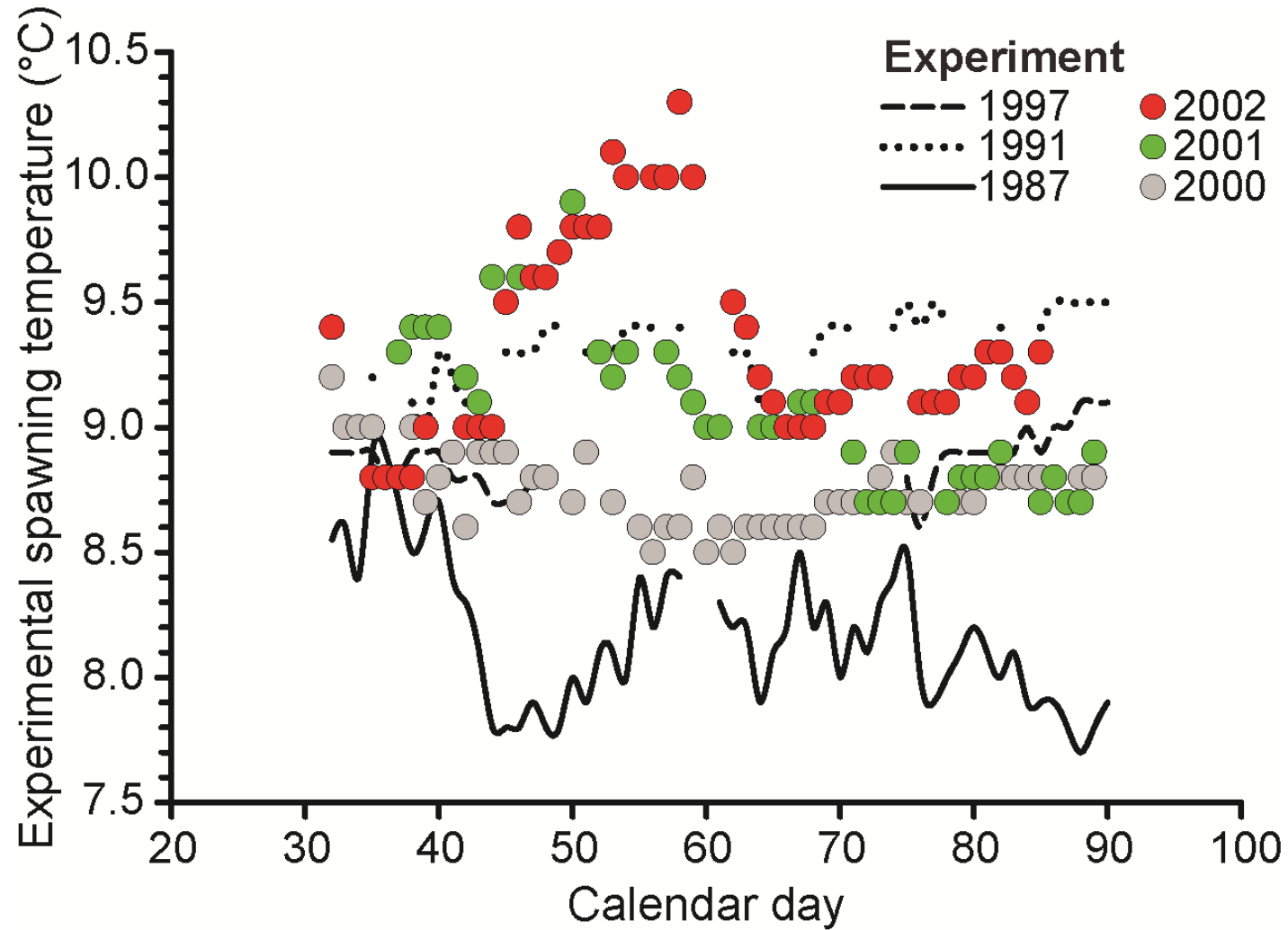
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Temperatures above 9.6 °C resulted in significant reductions in fertilization and normal egg development. Concurrently, fractions of dead and unfertilized eggs increased with elevated temperature. Actual relative fecundity was not affected by temperature. Egg characteristics improved when temperature was controlled and lowered below 9.6 °C.



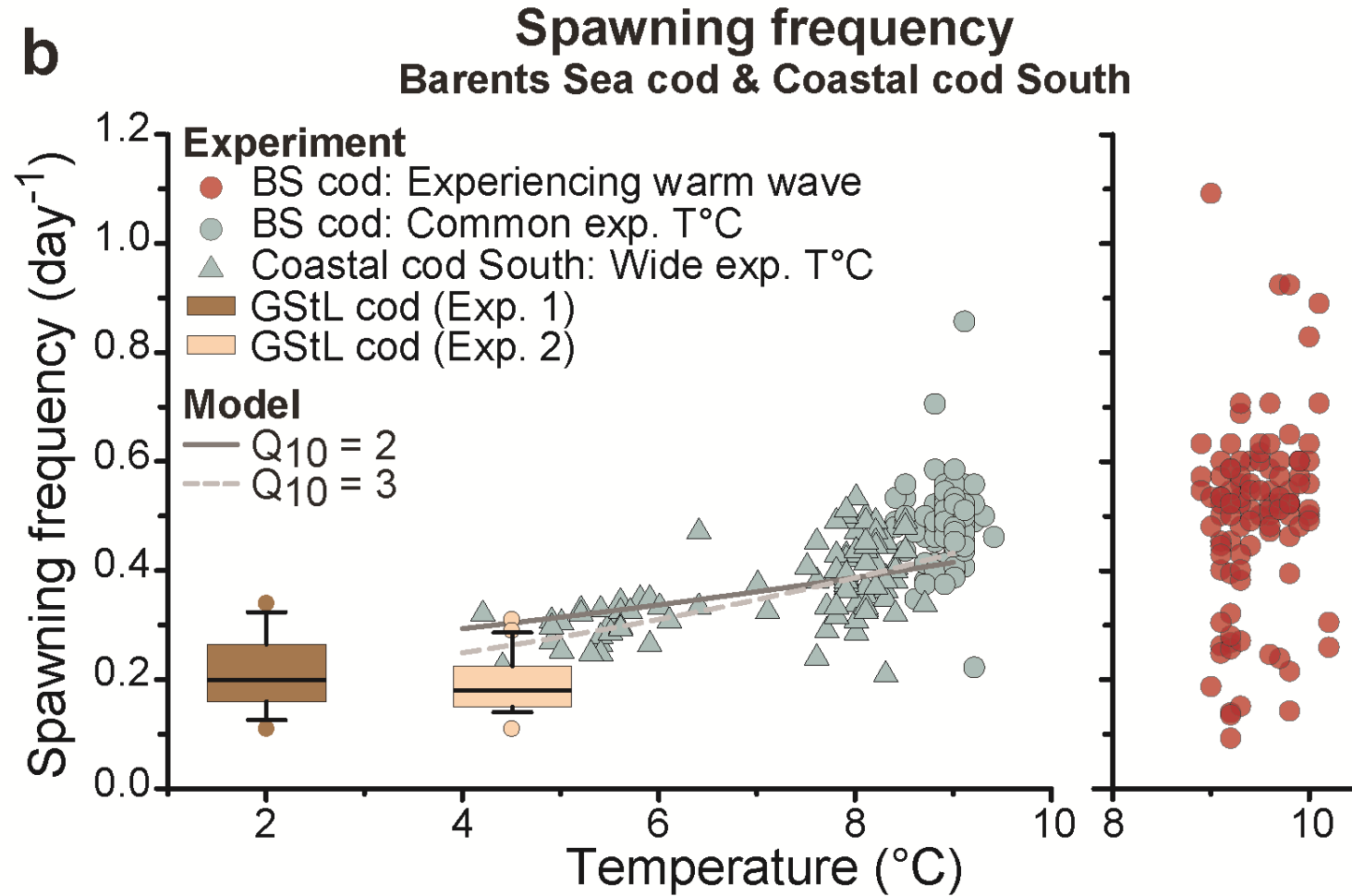
...coincidences – a “warm wave” in the inlet water



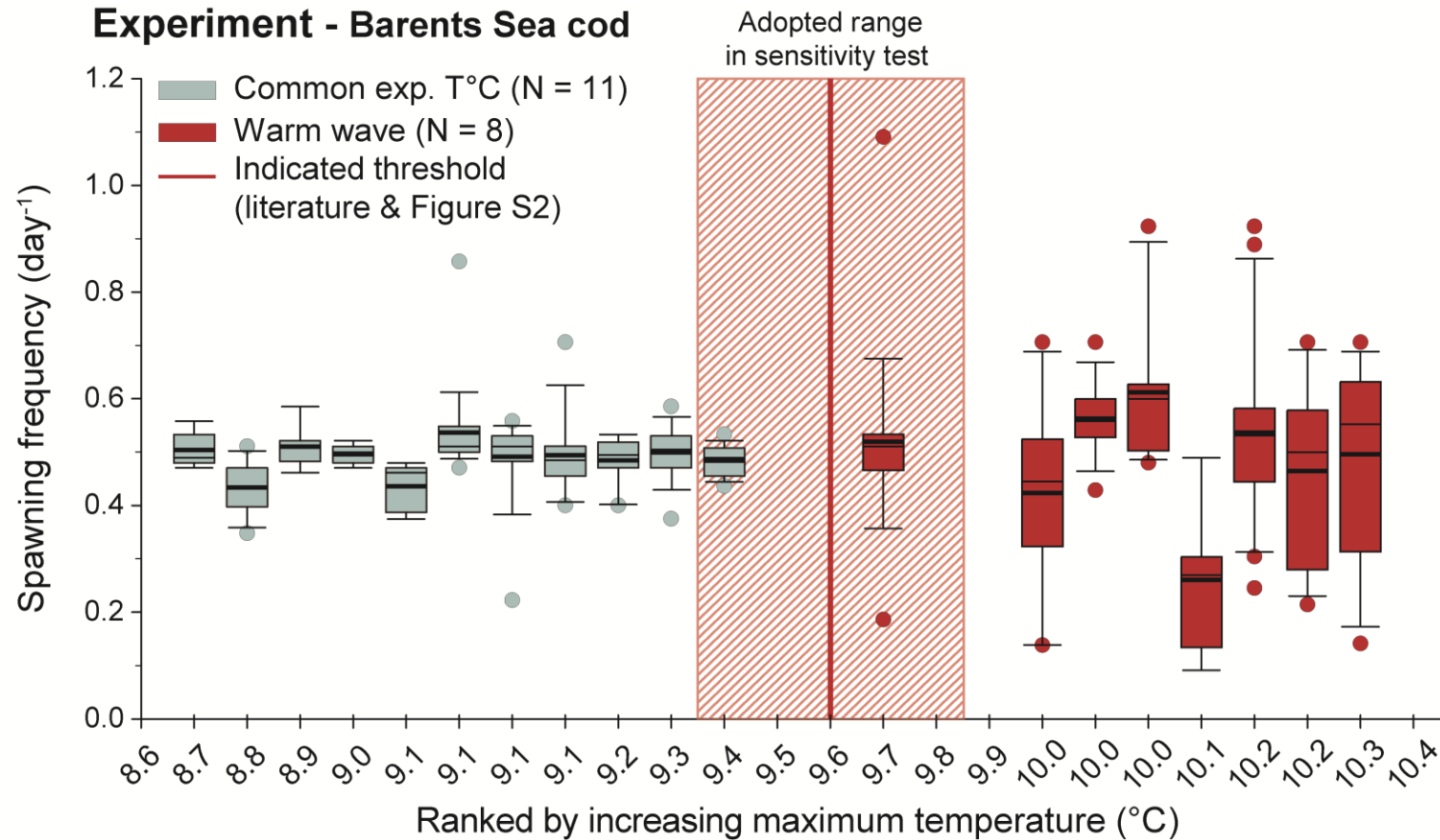
NEA cod



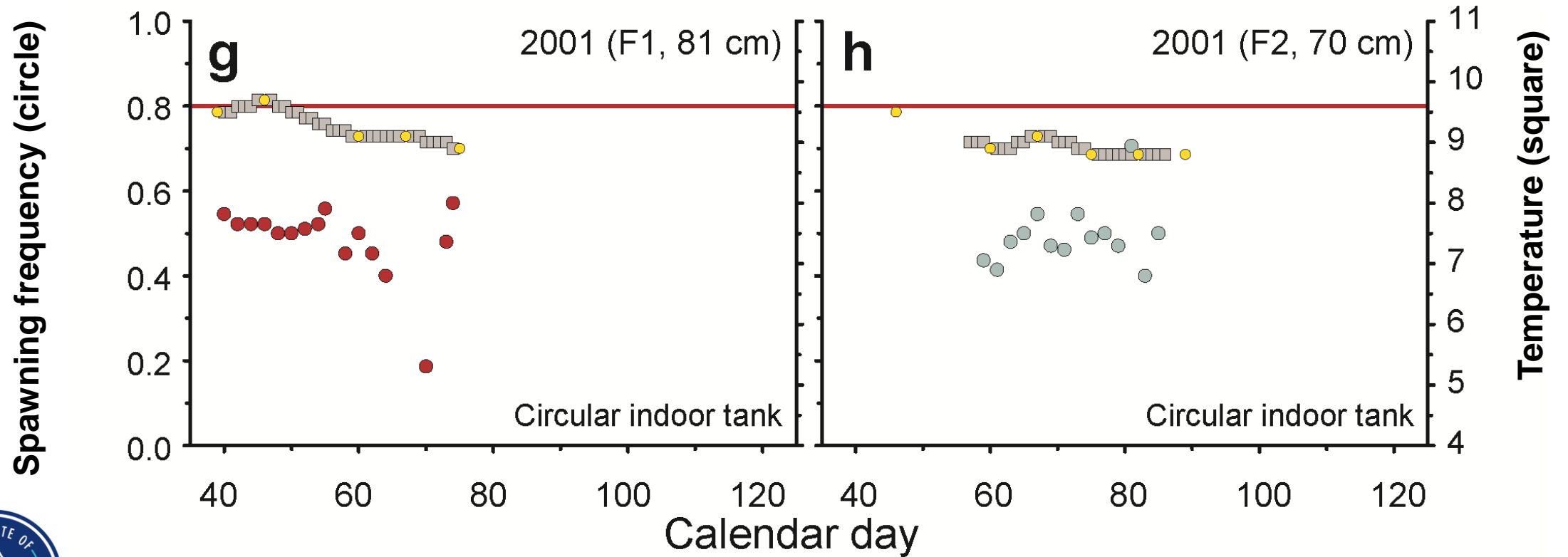
...finding highly erratic spawning frequency “somewhere” above 9 °C



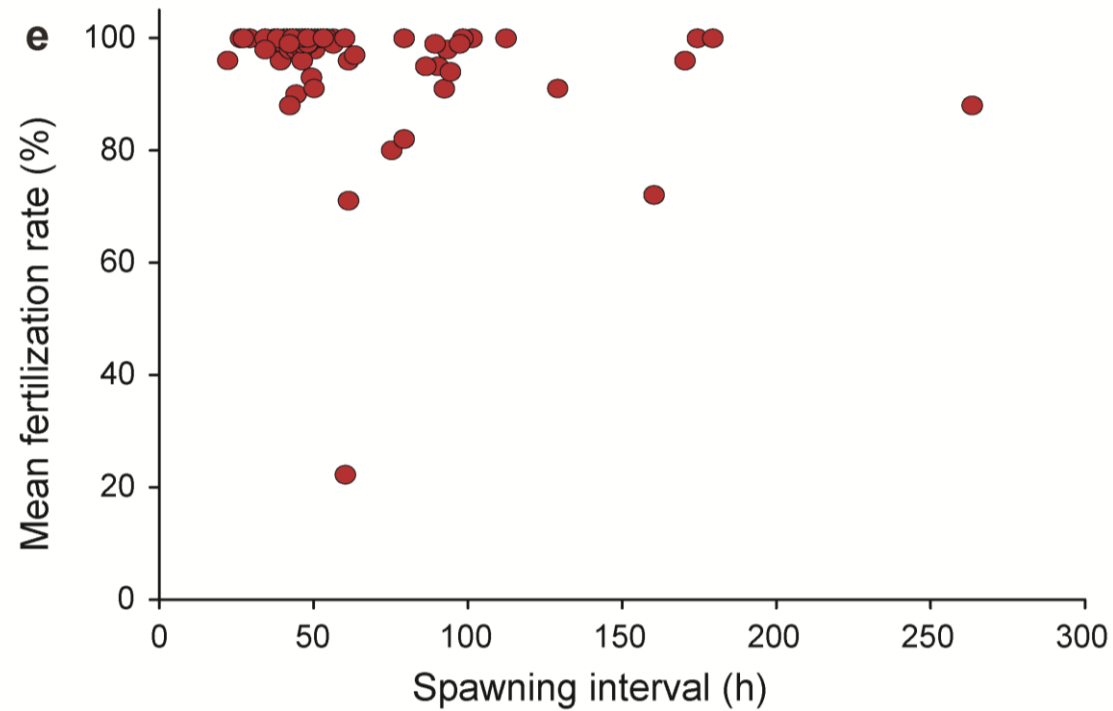
...more precisely a threshold “somewhere” between 9 and 10°C



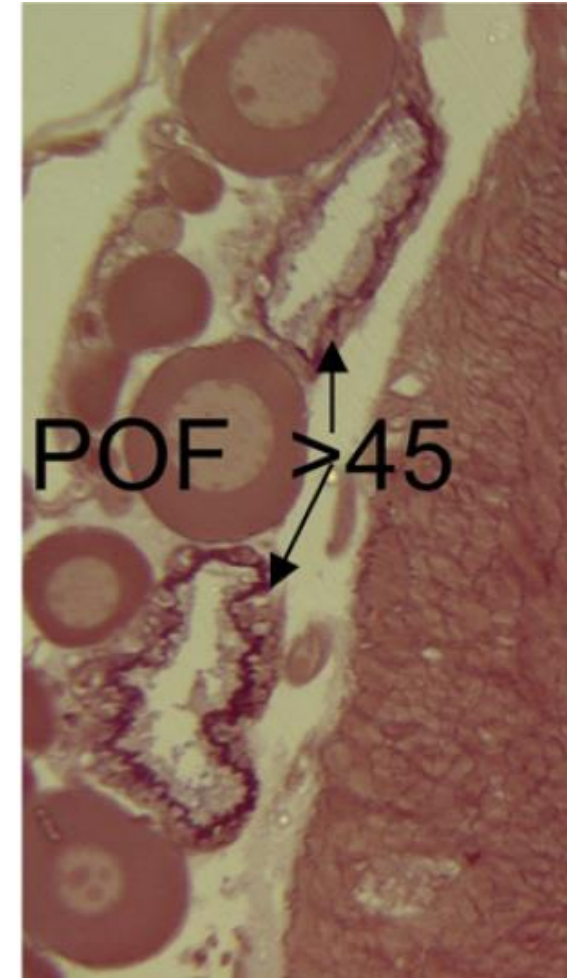
...even more precisely a threshold around $9.6 (\pm 0.25) \text{ C}^\circ$
upper pejus



...the oocytes are likely “trapped” in their follicles



Kjesbu et al. 2023. *Fish and Fisheries*

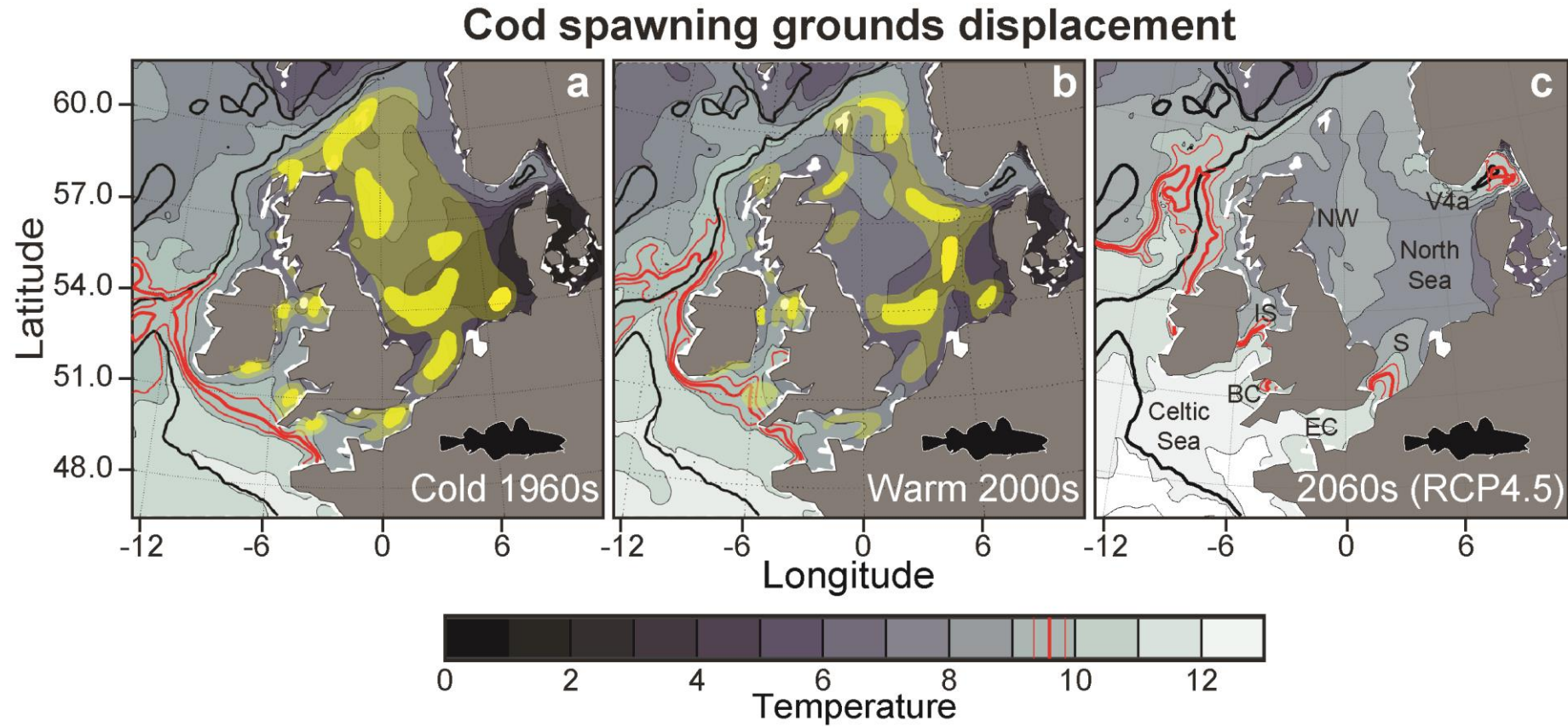


Witthames et al. 2023. *Fisheries Research*

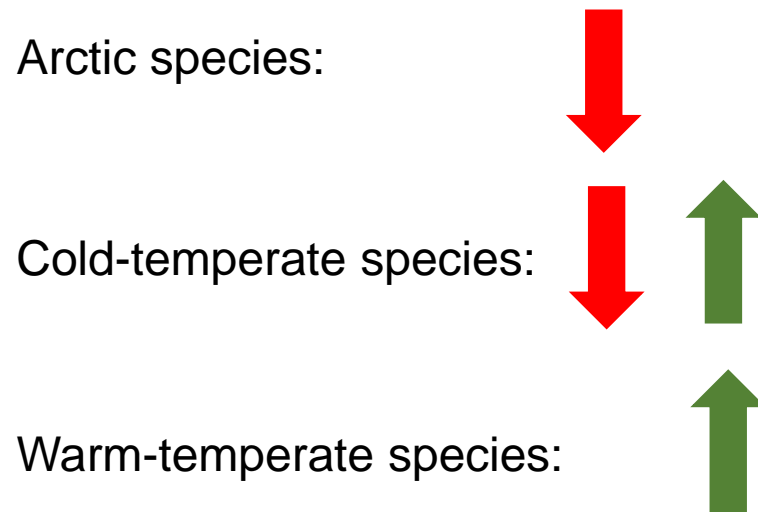


...the implications for spawning ground persistence

Fate of southern cod spawning grounds RCP 4.5, ROMS/CORE2/SODA/NorESM1-M, 2006-2070



*“The currently outlined directional effect patterns characterizing the 39 assessed North East Atlantic stocks with either declining, neutral or increasing productivity appeared **closely linked to their thermal window of tolerance**”*



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Final remark:

We continue working on this topic, including gene expressions + doing more detailed dst-analyses .



Thank you for your attention



Røst, Lofoten. 7 April 2018. Photo: osk