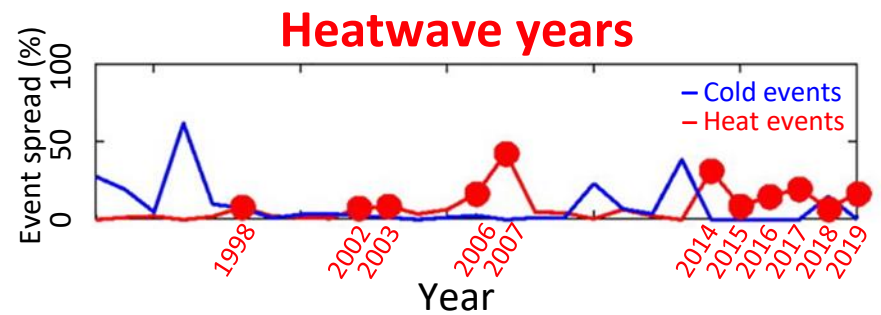
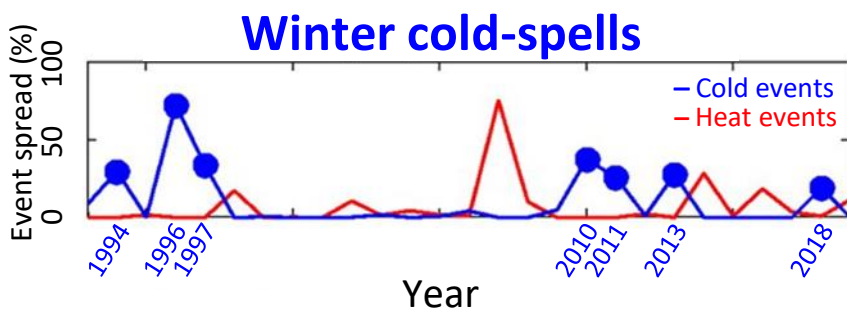


A known climate change 'hotspot' – what about temperature extremes?

The North Sea supports many important commercial fisheries, and is a climate change 'hotspot.' Temperatures here are rising faster than in surrounding seas, so it is unsurprising that there have already been many studies on **long-term climate change** in the North Sea. However, few studies are yet to look at the effects of **temperature extremes**, and the potential consequences for fisheries.

In the North Sea, marine **heatwaves** could potentially have a **high impact** on many key stocks. Similarly, there are many documented cases of impacts of **cold-spells** on fish and invertebrates, including **mass die-offs**.

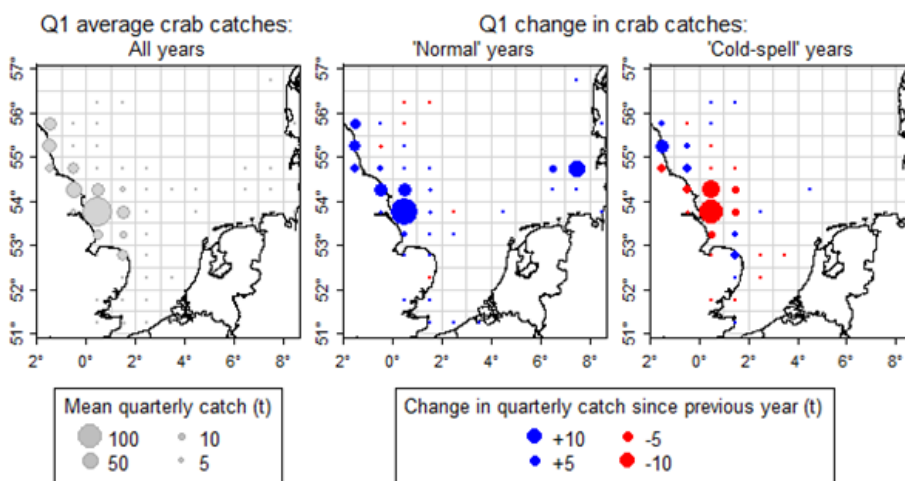
For the southern North Sea, we found evidence of **widespread anomalous** heatwaves and cold-spells **throughout the period 1993–2019**. Here we highlight these, and show how these have had **impacts on a range of important fish and shellfish stocks**.



Cold-spells: impacts on fisheries catches

In the **same** year that winter cold-spells occurred (in January–March):

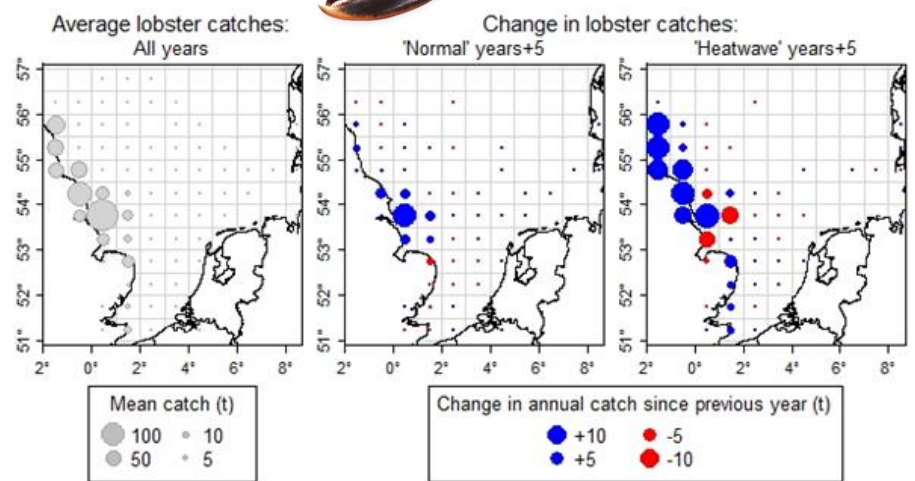
- Fisheries catches of sole and sea bass **increased**.
- Fisheries catches of red mullet and edible crab **decreased**.



Heatwaves: impacts on fisheries catches

For heatwaves, no in-year effects on catches were found, but we did find lagged effects by 5 years following the temperature events:

- Fisheries catches of sole, lobster and sea bass **increased**.
- Fisheries catches of red mullet **decreased**.



Conclusions

In the North Sea, **both** heatwaves and cold-spells **can be linked** with changes in fisheries catches.

- Following cold-spells, immediate, negative effects suggest direct mortality impacts.
- Following heatwaves, lagged effects suggest impacts on recruitment and survival of juveniles, only witnessed in the fisheries catches some years later – once individuals are large enough to be caught.

So far, most climate change research in the North Sea has focussed on the long-term temperature trend. With extreme events – especially heatwaves – likely becoming increasingly common in the future, we encourage the study of their impacts on ecosystems and fisheries.

