# Marine heatwaves and cold-spells, and their impact on fisheries in the southern North Sea

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# Background

- Extremes in ocean temperature can harm marine life.
- News headlines focus on increased mortality and impacts on fisheries.
- Temperature also affects physiology, reproduction and growth.
- We study short duration extreme temperature events in the North Sea.
- Key question: do these temperature events impact important fish/shellfish stocks?

LIVE BBC NEWS CHANNEL

Page last updated at 12:18 GMT, Wednesday, 13 January 2010

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**Thousands of dead crabs wash up on Kent beaches**

**Thousands of dead crabs have been washed up on Kent's beaches after being killed by the cold weather.**

The velvet swimming crabs are littering beaches around Thanet, along with smaller numbers of whelks, sponges and anemones.

It is the second year that icy temperatures have killed off the sea creatures in such large numbers.

The crabs should not pose a danger to people or animals

BBC Kent
Sport, travel, wea to do, features an

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Storms wash up unusual sea life
24 Dec 09 | Nature & Outdoors

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BBC News, January 2010
https://www.bbc.co.uk/news

**Mass die-off of sea creatures follows freezing UK weather**

**Starfish and crabs among animals piled ankle-deep along parts of the North Sea coast**

Thousands of starfish washed ashore after UK storm – video

Massive numbers of starfish, crab, mussels and lobsters have been washed up on the North Sea coast of the UK, following the recent freezing weather and storms.

Tens of thousands of creatures are piled up ankle-deep in places along the Holderness coast in Yorkshire and similar mass mortality has been reported in Kent and Norfolk.

The Guardian, March 2018
https://www.theguardian.com/

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**Cold weather hits lobster supplies**

26 April 2013

Wholesale prices for lobster have risen sharply in the past few weeks

Prolonged cold weather has caused a shortage of Scottish lobster supplies, according to an industry body.

The Scottish Creel Fishermen's Federation said landings had fallen by as much as 90% off the east coast of Scotland, forcing a sharp rise in wholesale prices.

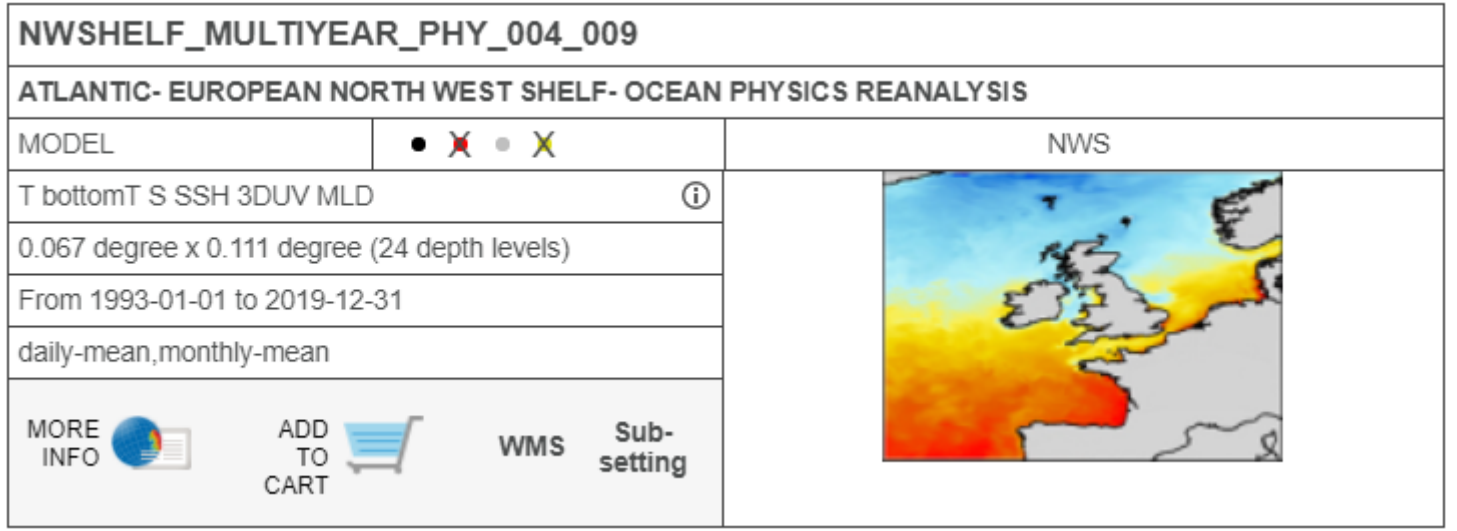
Langoustine catches were also reported to be as much as 70% down in the Clyde fisheries area

BBC News, April 2013
https://www.bbc.co.uk/news

## Methods: ocean temperature data

- Use near-bed temperatures (NBT) from model reanalysis for 1993 to 2019:
  - High quality (assimilates observations)
  - No gaps in time or space.
- Generate “annual cycle” climatology, and the 10th and 90th percentiles, and smooth (31-day window)[1].

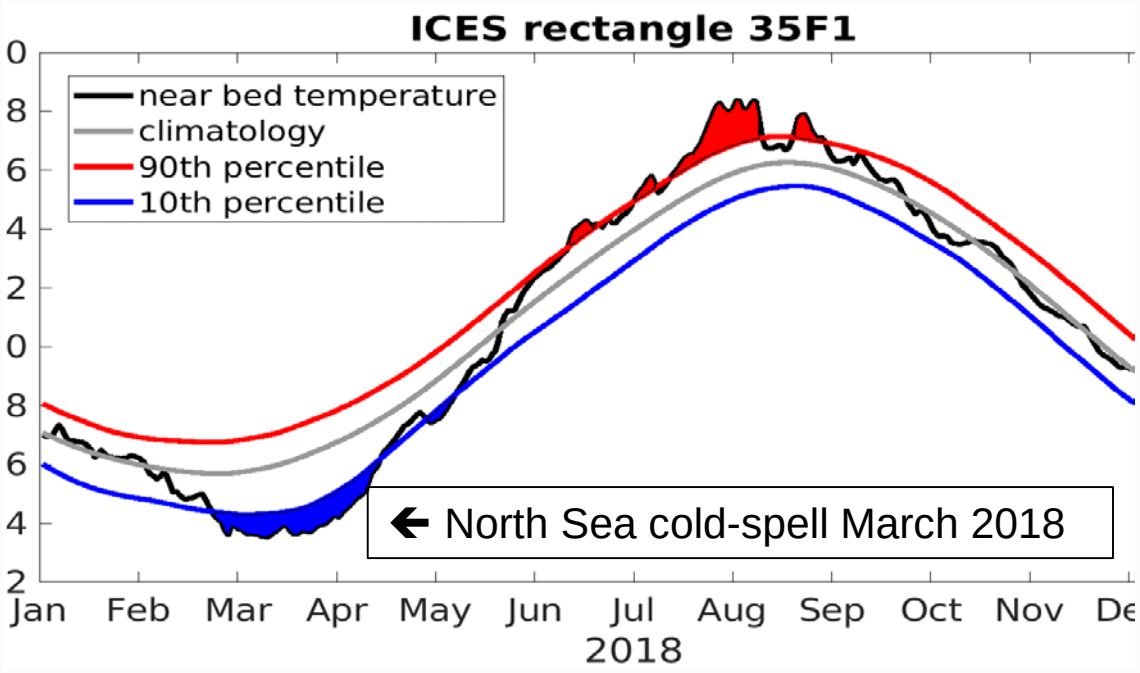
Reanalysis data downloaded from https://marine.copernicus.eu/




**Definitions:** periods of longer than 5 days with

NBT **> 90th percentile ➔ marine heatwaves**

NBT **< 10th percentile ➔ marine cold-spells**



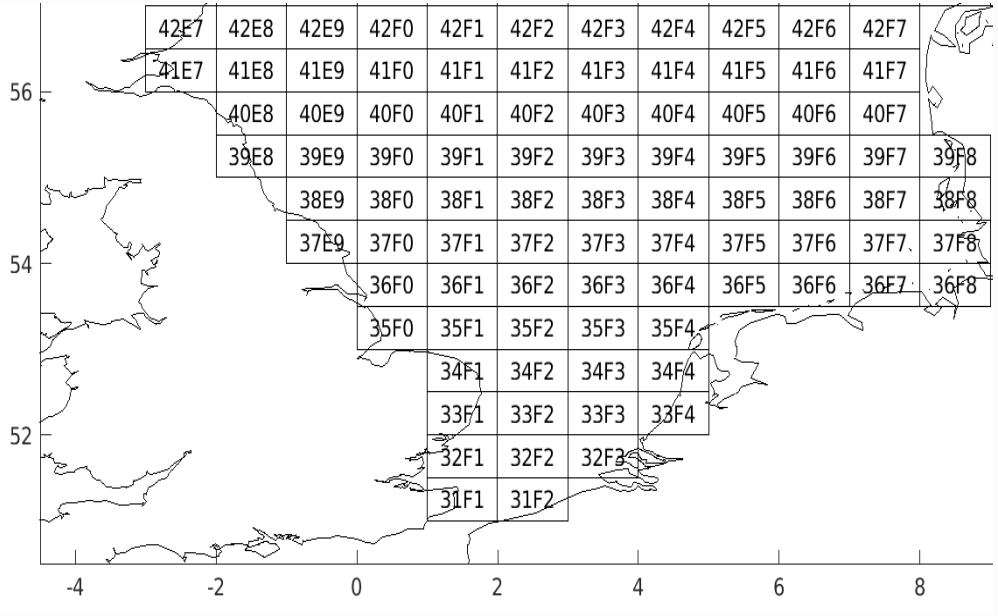

Example for 2018: off North Norfolk, UK
cold-spells (blue shading); heatwaves (red shading)



[1]Hobday et al. (2016) doi: https://doi.org/10.1016/j.pocean.2015.12.014

# Methods: quantify extreme events

Identify heatwaves and cold-spells per ICES rectangle south of 57°N in the North Sea



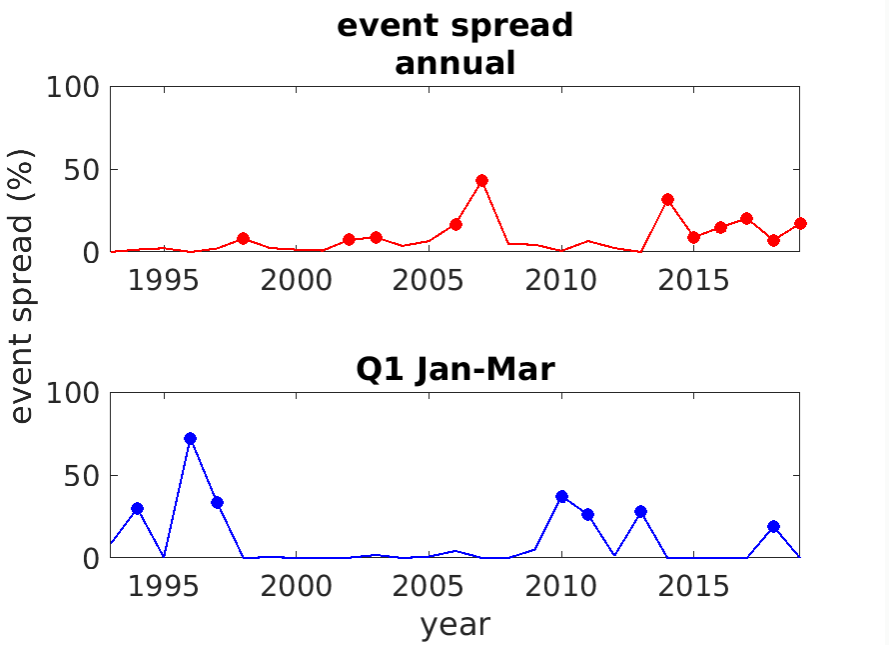

ICES (1977) Statistical Rectangle Coding System
http://ices.dk/sites/pub/CM%20Doccuments/1977/Gen/ICES%20Statistical%20Rectangle%20System%20Gen0377.pdf

The **event spread** is the % of ICES rectangles and days with extreme temperatures per time period.

Then define

1. extreme heatwave years: event spread > 7% (●)
   1998, 2002, 2003, 2006, 2007, 2014 – 2019

2. exteme cold-spell Q1s: event spread > 15% (●)
   1994, 1996, 1997, 2010, 2011, 2013, 2018



# Results: impact on fisheries (1)

Significant correlations[1] between heatwaves, cold-spells and detrended fisheries catch data[2] were found for

| species | annual heatwaves* | Q1 cold-spells |
|---|---|---|
| **annual catches correlations** | | |
| sole (*Solea solea*) | 0.60 | 0.46 |
| sea bass (*Dicentrarchus labrax*) | 0.48 | 0.47 |
| red mullet (*Mullus surmuletus*) | -0.47 | -0.42 |
| European lobster (*Homarus gammarus*) | 0.49 | |
| **Q1 (January to March) catch correlations** | | |
| edible crab (*Cancer pagurus*) | | -0.45 |

No correlations were found with heatwaves or cold-spells and detrended catches of cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), mackerel (*Scomber scombrus*), John Dory (*Zeus faber*) or Norway lobster (*Nephrops norvegicus*).



[1]Pearson correlation coefficient r, with *P-value < 0.05;* *with 5 year lag

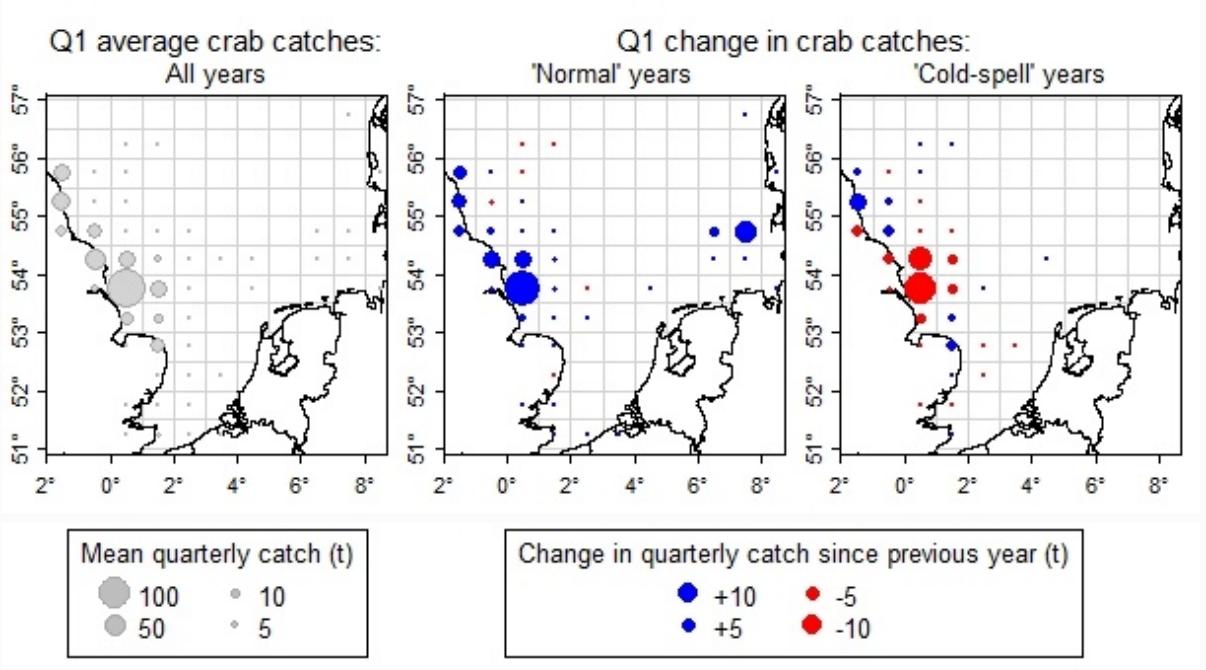
[2]Cefas/Defra Fisheries Activity Database (https://www.gov.uk/guidance/fishing-activity-and-landings-data-collection-and-processing)

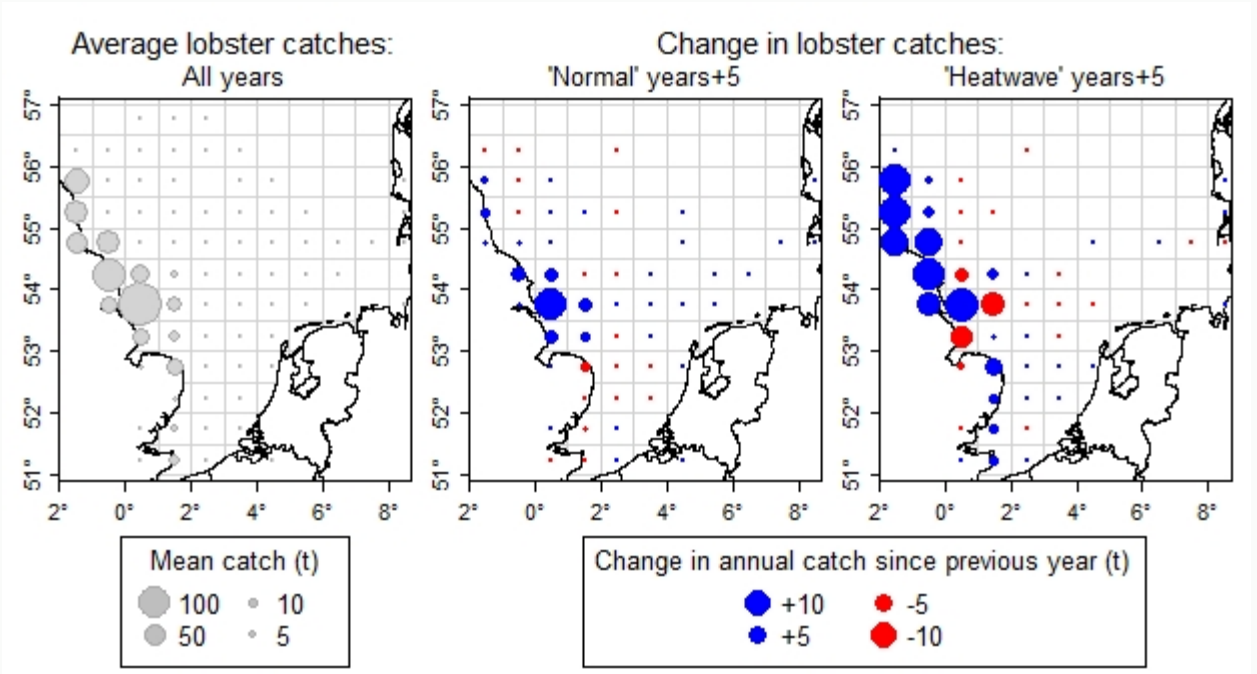
# Results: impact on fisheries (2)

Change in catch since previous year: comparing ‘normal’ years with high event-spread years.

**Top figure:** cold-spell Q1 (January to March)
Reduction in Q1 catches of edible crab.

**Bottom figure:** annual heatwaves
Increase in European lobster catches 5 years after heatwave years.






Wakelin et al. *in* von Schuckmann et al. Copernicus Marine Service Ocean State Report, Issue 5, *Journal of Operational Oceanography* (in press)

## Discussion and conclusions

- Temperature events might not be sufficiently extreme to affect catches of some species.
- Potential impacts of short term temperature extremes impacting on fish catch data include
  - migration to warmer/colder waters,
  - changes to spawning and growth (eg. impacting on fish catch 5 years later),
  - physiological damage, changing behaviour and increasing vulnerability to being caught,
  - mortality.
- Other factors (eg. changes to fishing effort, trophic or foodweb effects) also impact fish catches.

- To our knowledge, this is the first study to identify a link between extreme temperature events and key fish and shellfish stocks in the North Sea.
  - Increased sole, sea bass and European lobster catches occurred five years after annual heatwave years, while red mullet catches decreased.
  - Catches of sole and sea bass increased in years with widespread January to March cold-spells, while catches of edible crabs and red mullet decreased.

National Oceanography Centre

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