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Shellfish Association of Great Britain

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Marine Management Organisation

Impacts of climate change on shellfish production in Great Britain

by Fred Batista

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Centre for Environment Fisheries & Aquaculture Science

Shellfish Association of Great Britain

53rd Annual Conference & Dinner, June 6th & 7th 2023




Cefas Weymouth laboratory

- Aquatic animal health
  - Fish Health Inspectorate
  - National Reference laboratories (NRLs) for aquatic animal diseases
  - Epidemiology and Risk Assessment team
- Food safety
  - NRL for foodborne viruses
  - NRL for bacteriological contamination of bivalve molluscs
  - Biotoxin analytical chemistry testing in shellfish

Presentation structure

Climate change trends

Impacts on shellfish production

Impacts on shellfish health

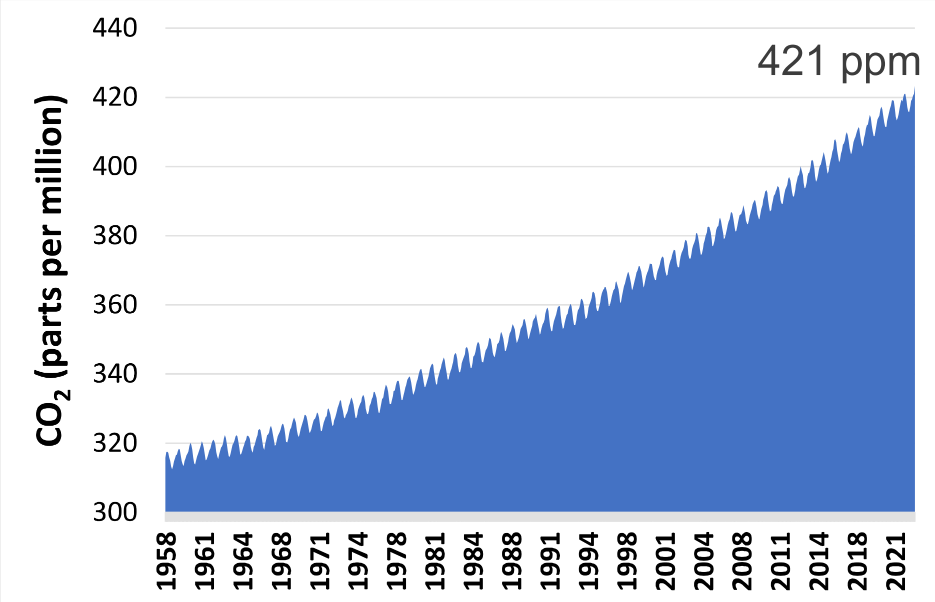
Adaptation – Shellfish health

15 minutes

Climate change trends

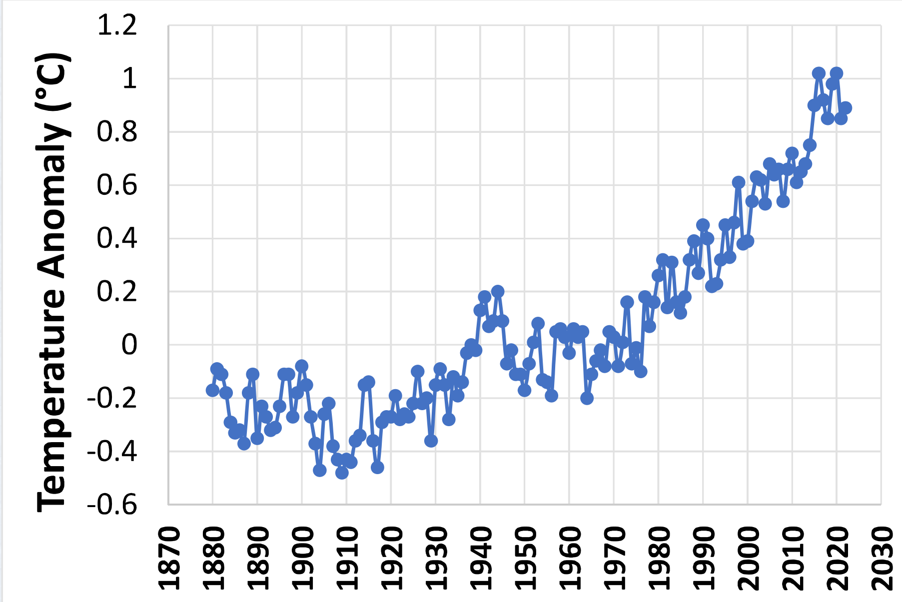
Global

Human activities have raised the atmosphere's carbon dioxide content by 50% in less than 200 years



Source: NASA/NOAA

Change in global surface temperature compared to the long-term average from 1951 to 1980



Source: NASA/GISS

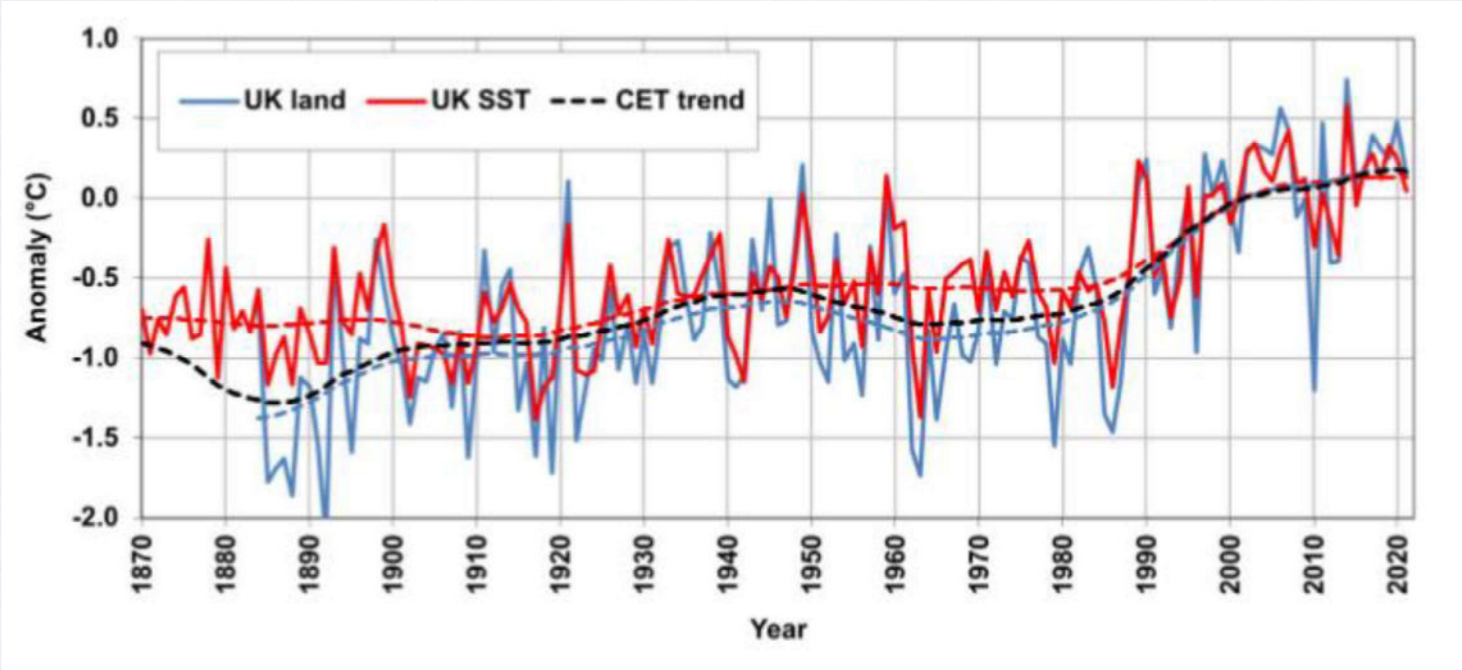
Climate change trends

UK

According to the Met office, the top 10 warmest years for the UK since 1884 have occurred since 2002

The SST in the most recent decade (2012–2021) has been on average 0.7 °C warmer than 1961–1990 *

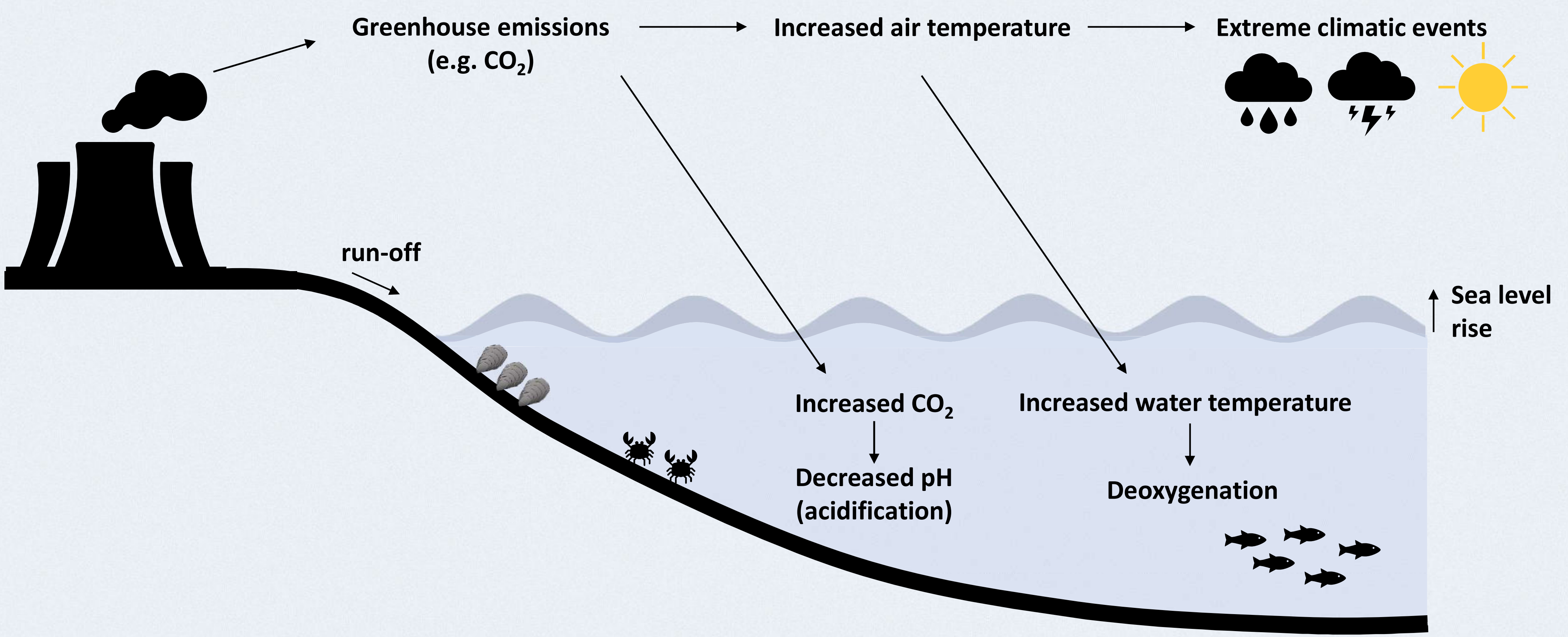
Nine of the ten warmest years for near-coast SST for the UK since 1970 have occurred between 2000-2021 *



SST – surface-seawater temperature *

* Source: Kendon et al. (2022). Int J Climatol

Impacts on shellfish production



Impacts on shellfish production

Main climatic stressors affecting shellfish

Temperature increase

Ocean acidification

Salinity changes

Extreme climatic events

Non-climatic stressors affecting shellfish

Harmful algal blooms (HABs)

Infectious diseases

Implications

Growth rate

Shell calcification

Reproductive success

Recruitment

Behaviour (e.g. lower olfactory sensitivity)

Mortality outbreaks

Impacts on shellfish production

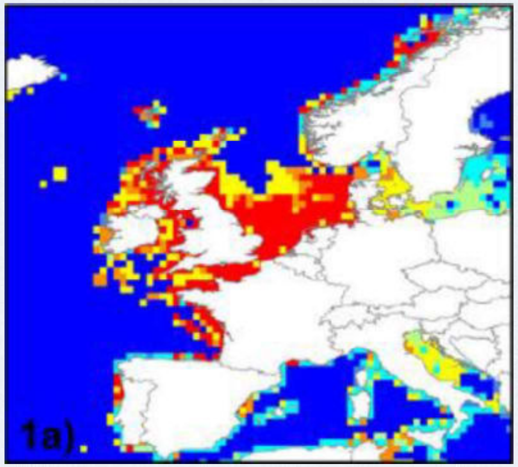
Species strategies to respond to changing environmental conditions

(1) Shifting geographic range

(2) Phenotypic plasticity to tolerate environmental change

(3) Genetic adaptation via evolution by natural selection to new conditions

(4) Persisting in the original habitat which may result in demographic decline or extinction



Applying distribution model projections for an uncertain future: the case of the Pacific oyster in UK waters

Aquatic Conserv: Mar. Freshw. Ecosyst. (2013)

MIRANDA C. JONES[a,b,c,*], STEPHEN R. DYE[a,b], JOHN K. PINNEGAR[b], RACHEL WARREN[a,c] and WILLIAM W.L. CHEUNG[d]

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Pacific oyster will experience an opening of suitable habitat in northern UK waters, reaching the Faroe Islands and the eastern Norwegian Sea by 2050

Impacts on shellfish production

Case study

Pacific oysters *Crassostrea gigas*

Adult Pacific oysters have a very wide tolerance to environmental factors:

- Growth occurs between 10 and 28 °C, with an optimum of around 20 – 25 °C
- Tolerate temperature below 0°C and short exposure of more than 40 °C

However,…

- Larvae and juveniles are less tolerant to environmental changes
- Larvae are more sensitive to pH decrease resulting in shell malformation and death

Impacts on shellfish production

Case studies

Warming sea temperatures in the North Sea appears to have been favourable for squid in the last 35 years

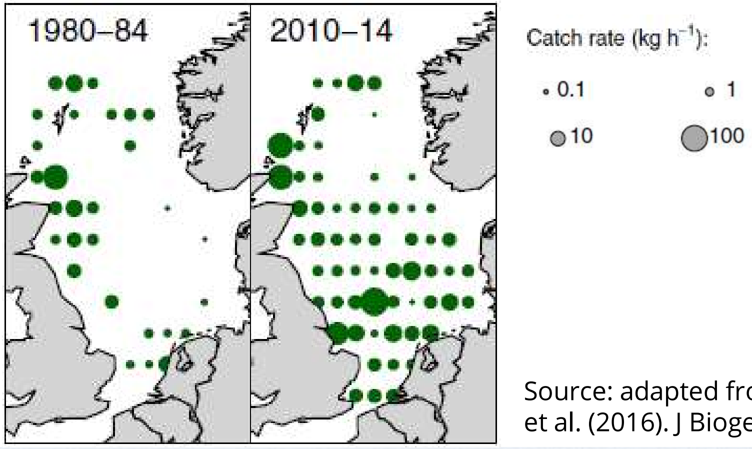
Journal of Biogeography (*J. Biogeogr.*) (2016) **43**, 2285–2298

ORIGINAL ARTICLE

Climate change and squid range expansion in the North Sea

Jeroen van der Kooij*, Georg H. Engelhard and David A. Righton

Centre for Environment, Fisheries and Aquaculture Science, Pakefield Road, Lowestoft NR33 0HT, UK



Source: adapted from vander Kooij et al. (2016). J Biogeogr

Acidification of the water can severely damage the sense of smell of crabs

Received: 30 December 2022 | Revised: 26 March 2023 | Accepted: 29 March 2023
DOI: 10.1111/gcb.16738

RESEARCH ARTICLE

Global Change Biology WILEY

Ocean acidification alters foraging behaviour in Dungeness crab through impairment of the olfactory pathway

Andrea Durant | Elissa Khodikian | Cosima S. Porteus

Department of Biological Sciences, University of Toronto Scarborough, Toronto, Canada

Impacts on shellfish production

2022

MCCIP Marine Climate Change Impacts Partnership

Climate change impacts on marine aquaculture relevant to the UK and Ireland

Murray, A.[1], Falconer, L.[2], Clarke D.[3] and Kennerley, A.[4]

[1] *Marine Scotland Science, Aberdeen AB11 9DB, UK*
[2] *Institute of Aquaculture, University of Stirling FK9 4LA, UK*
[3] *Marine Institute, Galway H91 R673, Ireland*
[4] *Centre for Environment, Fisheries and Aquaculture Science, Weymouth DT4 8UB, UK*

What is happening

In the UK, there have been no major changes to the types or locations of species farmed due to climate change

In Scotland, some shellfish areas have experienced poor spat settlement and mortality, but the link to climate change is not fully established

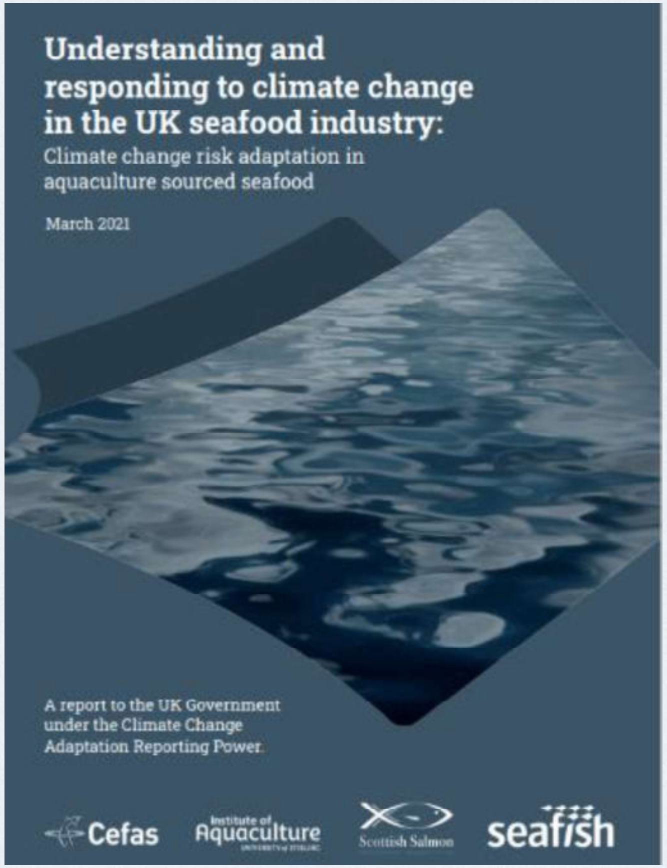
What could happen

Ocean acidification may reduce shellfish spat settlement

Warming conditions will lead to a rise in **shellfish pathogens**, with subsequent increased mortality

The risk of mortality due to more frequent and intense heatwave events will increase in the future, highlighting the need for adaptive management

Impacts on shellfish production



Potential climate change impacts	Spat collection undermined by storms, acidification and rainfall/run-off.	Temperature change may close some collection areas and open others

Adaptation responses

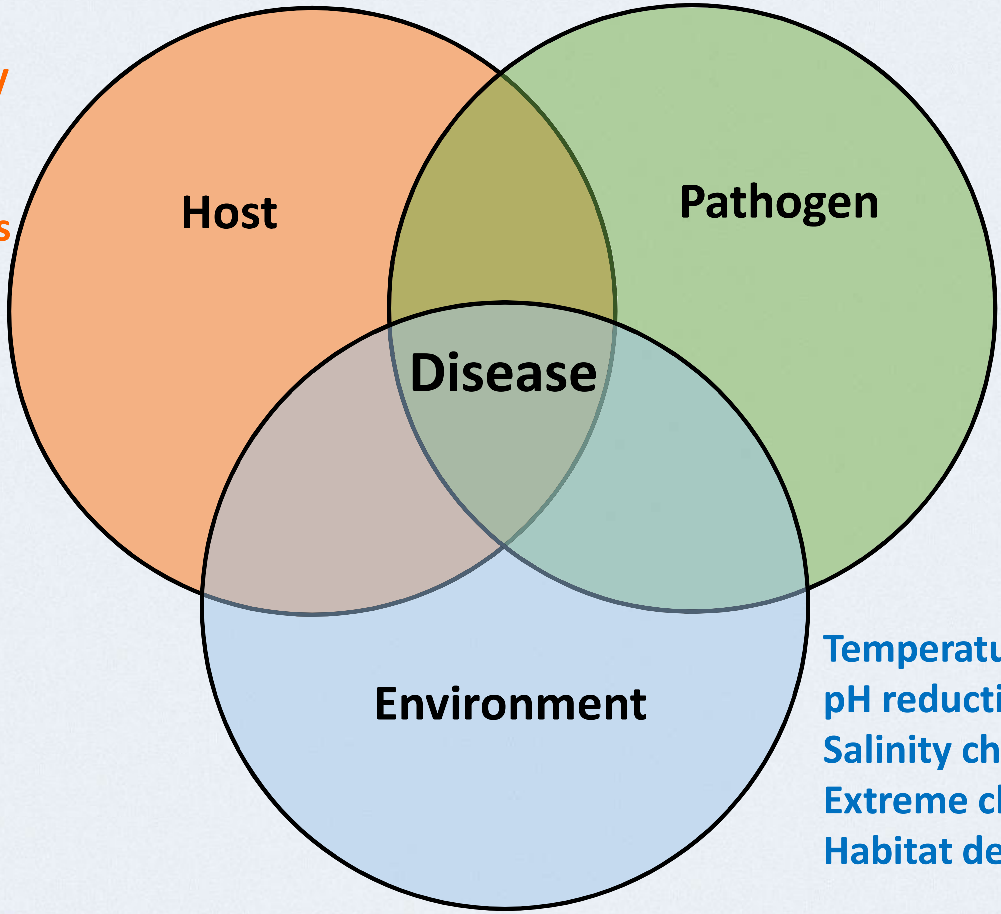
Already underway	• Changes in industry practice and operating procedures, and development of codes of practice
Short-term (2-5 years)	• Increase the level of environmental monitoring
Medium-term (5 -15 years)	• Develop procedures to handle new sources of contamination • Further research to help industry manage and explore opportunities in new conditions
Long-term (15 years plus)	• Ensure flexible and adaptive regulation / management • Examine wider ecosystem responses of other species

Impacts on shellfish health

Increased susceptibility

Change in behaviour

Geographic range shifts



Geographic range shifts

Change in virulence

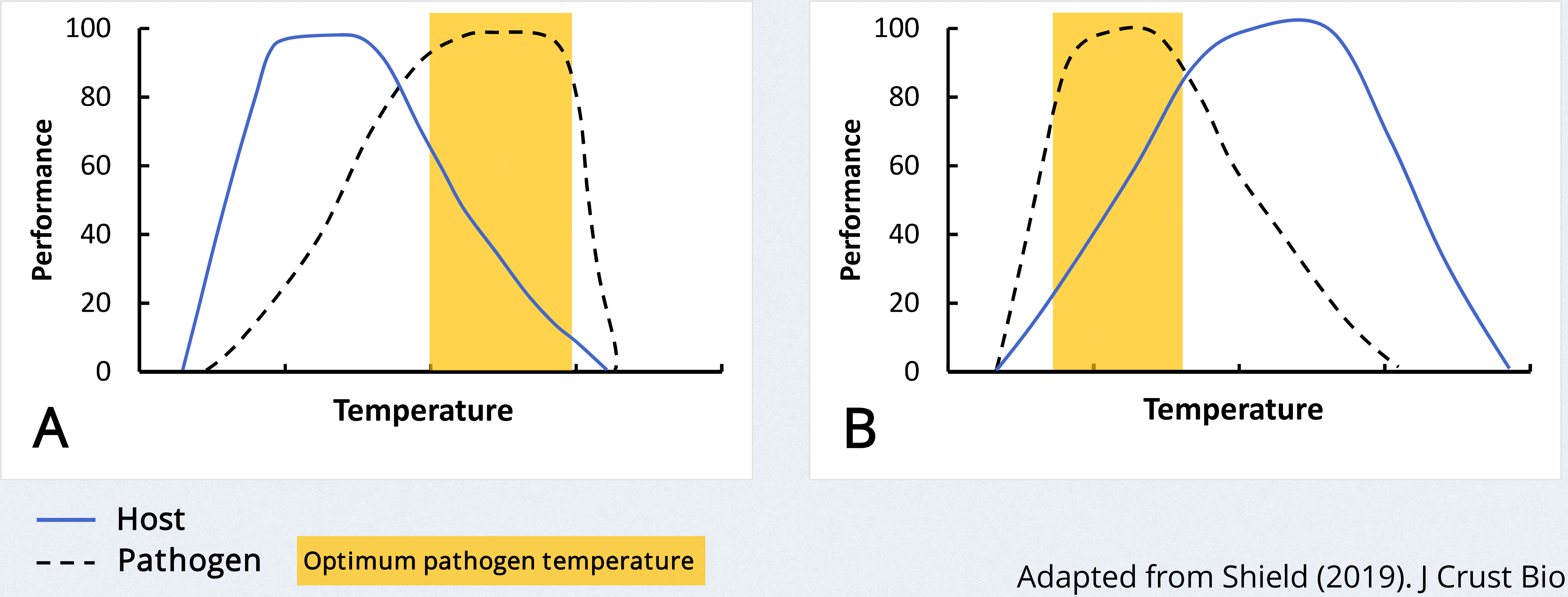
Change in abundance

New emergence

Temperature increase
pH reduction (acidification)
Salinity changes (precipitation)
Extreme climatic events
Habitat degradation

Impacts on shellfish health

Thermal performance curves



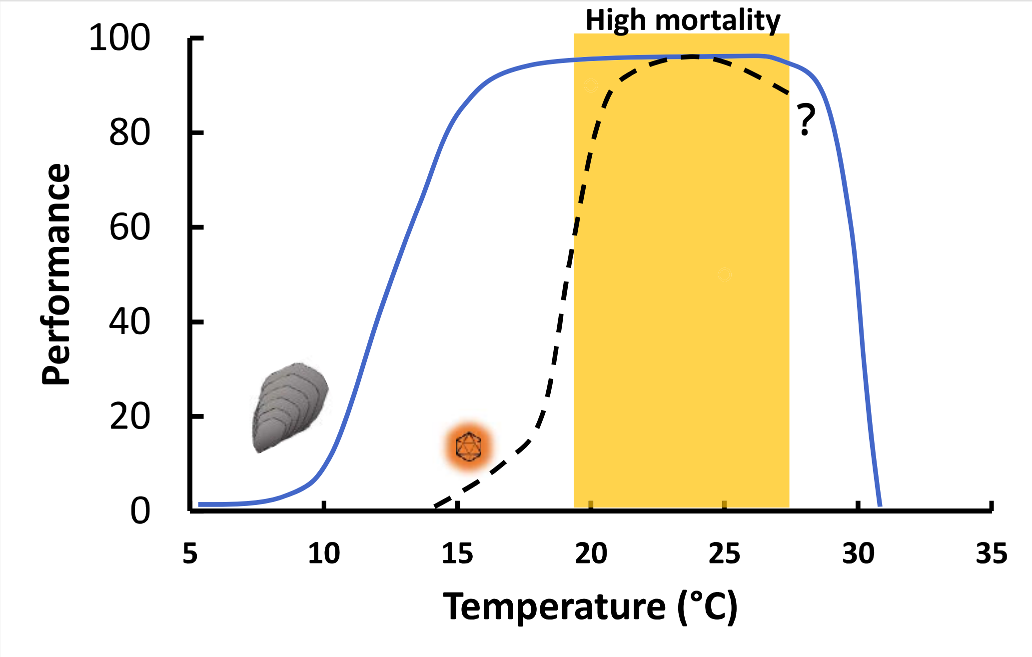
Adapted from Shield (2019). J Crust Biol

Impacts on shellfish health

Case study

Pathogen: Ostreid herpesvirus 1 microvar (OsHV-1 µVar)

Host: Pacific oyster *Crassostrea gigas*



Conceptual diagram of *C. gigas* and OsHV-1 thermal ranges

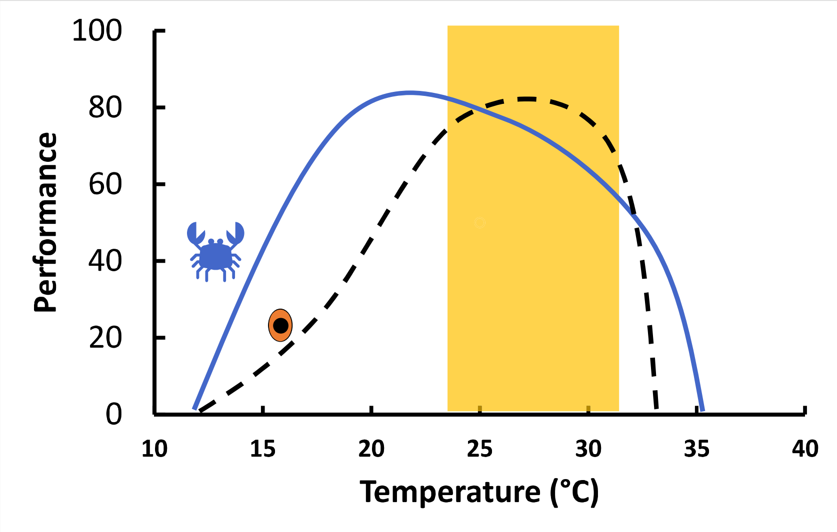
- Water temperature directly influences mortality caused by OsHV-1 µVar
- Mortality and viral replication very low at ≤14°C
- High mortality associated with OsHV occurs when water temperature is between 18–26°C
- Low mortality associated with OsHV occurs when water temperature is ≥ 29°C

Source: Delisle et al. (2020). J Exp Biol
Kantzow et al. (2016). DAO

Impacts on shellfish health

Pathogen: *Hematodinium perezi*

Host: Blue crab *Callinectes sapidus*



Adapted from Shield (2019). J Crust Biol

USA

Blue crab – *Hematodinium perezi*

- Infections are stable at temperatures ranging from 10 to 20 °C
- Became fatal at temperatures of 4 °C and ≥ 25 °C
- Reduction of parasite virulence above 30 °C

Source: Shield (2019). J Crust Biol

Europe

Crustacean– *Hematodinium sp.*

- *Hematodinium* sp. (≠ *H. perezi*) has been detected in several crustacean species including the edible crab *Cancer pagurus*
- Reduction in infection intensity as temperature decreased in the edible crab

Source: Chualáin et al. (2009). DAO

Adaptation – Shellfish health

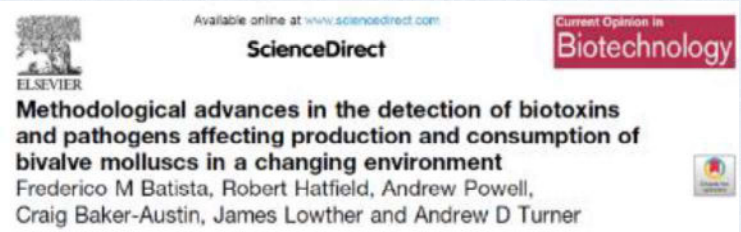
Improve our knowledge on shellfish health in the face of climate change

- Determine the direct and synergistic effects of multiple climate variables, such as temperature and pH, on disease
- Collect baseline data on diseases of cultured and wild shellfish populations
- Monitor shifts in host or parasite ranges as well as the rate of pathogen evolution and host response
- Develop diagnostic methods to include both targeted and screening approaches to discover new or emerging pathogens
- Develop modelling tools to advance understanding of shellfish health in a changing climate

Cefas is commencing a project which aims to better understand the implications of climate change for aquatic animal health and support policy decision for climate change adaptation in the UK

H. Tidbury & M. Teixeira Alves

Adaptation – Shellfish health


Available online at www.sciencedirect.com

ScienceDirect

Current Opinion in Biotechnology

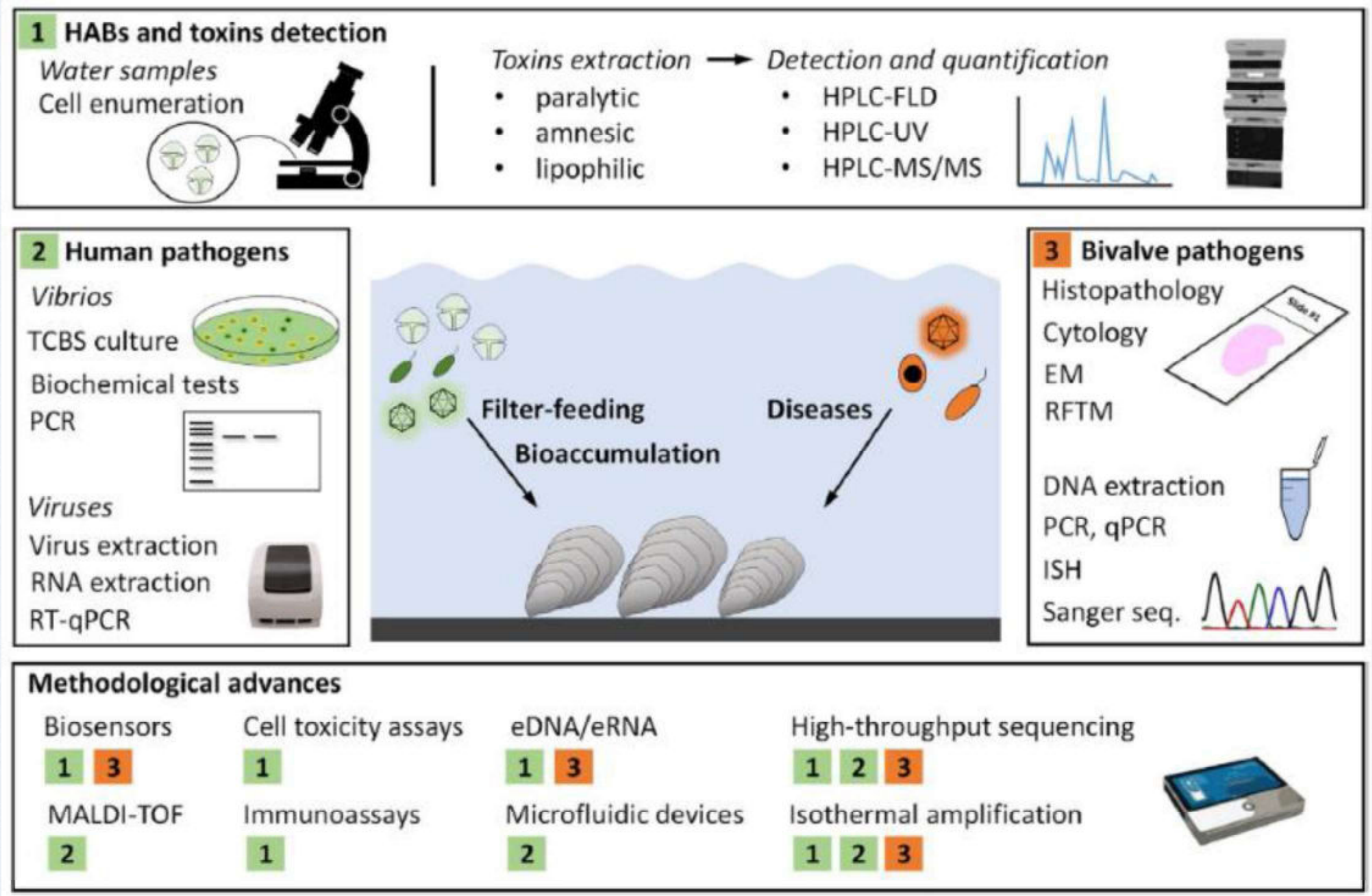
ELSEVIER

Methodological advances in the detection of biotoxins and pathogens affecting production and consumption of bivalve molluscs in a changing environment

Frederico M Batista, Robert Hatfield, Andrew Powell, Craig Baker-Austin, James Lowther and Andrew D Turner

COBIOT, 2023, **80**:102896

Environmental changes caused by human activities, such as climate change, can further aggravate biological hazards affecting shellfish



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Cefas

Adaptation – Shellfish health

Enhance management of shellfish health in the context of climate change

- Reinforce monitoring and measures to prevent the introduction of pathogens (e.g. *Bonamia exitiosa*)
- Prevent habitat loss and overharvesting
- Reduce nonclimatic stressors, such as coastal pollution (e.g. poor sewage treatment)
- Enhance collaboration between natural resource managers, producers, and researchers
- Improve knowledge on disease resistance of shellfish (e.g. breeding programs) and best practices

Thank you for your attention

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