

# ***Fish, Flows and climate resilience: setting the scene***

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May 2019

# Introduction

- The future will be different warmer 2 to 4°C
- We need to change how we do things
- Observations and projections to underpin decisions
- Uncertainty and scale matter
- Resilience, science, grand challenges

# WARMING RIVERS & LAKES

## MORE 70°+ WATERS AFFECTING FISHING



**Stresses trout & salmon**



**Increases infectious  
bacteria and parasites**



**Shifts fishing seasons**

Sources: EPA; Michigan State University; Minnesota Sea Grant; Montana Fish, Wildlife and Parks

CLIMATE  CENTRAL

UK synthesis of observed impacts and expected changes?

# Disappearance of boreal plants in southern Britain: habitat loss or climate change?



**Hill and Preston (2015)**

Disappearance of boreal plants in southern Britain: habitat loss or climate change? *Biological Journal of the Linnean Society*, 115(3), 598–610. <https://doi.org/10.1111/bij.12500>

# Climate Change data and information

- What's out there?
- What's new?
- What's on the horizon?

# Climate Change Report Cards



## Water Climate Change Impacts Report Card 2016

This updated report card is for anyone who works with or has an interest in water in the UK. It looks at the effect of climate change on fresh water from source to sea – including rainfall, floods and droughts. The report card is intended to help people understand the scale of possible change and to help inform decisions about the way that water is managed. The report card looks forward over the rest of the 21st century.

Water is an essential and familiar part of everyday life, at home, at work and at leisure. Water is also at the heart of some of the most serious natural hazards faced in the UK – floods and droughts. Climate change may have many impacts on water; while some may be beneficial or easily managed, others require careful planning to avoid unacceptable consequences.

This report card is the 2016 update to the 2012-13 version. The update considers the scientific evidence published since 2013, as well as including new sections on snow, urban water, and estuaries. It complements other UK climate change report cards: the Marine Climate Change Impacts Partnership (MCCIP) marine report card and the Living With Environmental Change (LWEC) series that covers biodiversity, infrastructure, human health, and agriculture and forestry. Together these report cards provide a picture of past and future impacts of climate change in the UK.

**The report card covers the topics:**

- Temperature
- Rainfall
- Sea level
- Evapotranspiration – water evaporates or is transpired and other plants
- River flows
- Droughts
- Groundwater recharge and
- River water temperature
- River water quality and ecology
- Groundwater temperature and quality
- Water use
- Snow
- Urban Hydrology
- Estuaries



## Biodiversity Climate Change Impacts Report Card 2015

This publication summarises the impacts that climate change is having on land-based and freshwater species, habitats and ecosystems in the UK. It also presents the best available scientific evidence of the mechanisms causing change and what may happen in future.

This is one of a series of Report Cards published by the Living With Environmental Change Network. This summary is underpinned by a series of technical papers written by experts in the field, with the project overseen by a working group of sector scientists. Both the summary and technical papers have been peer-reviewed. In total, over 40 scientists from more than 20 different research and conservation organisations have contributed to this publication.

The Report Card updates and extends the previous version produced in 2013. The key messages remain similar, but the rapid pace of research has improved understanding in several areas. There is also new material on freshwater ecology and soil organisms.

**The Report Card covers the following topics:**

- Changes in UK climate
- Emerging patterns
- Plant communities and habitats
- Species
- Ecological processes and interactions

## What is happening

Cold-water fish communities are changing: the arctic charr is becoming scarcer as waters warm and it competes less well with the more thermally tolerant brown trout. ■M\*



Arctic Charr ©  
FreshwaterLife/  
Rob Holland

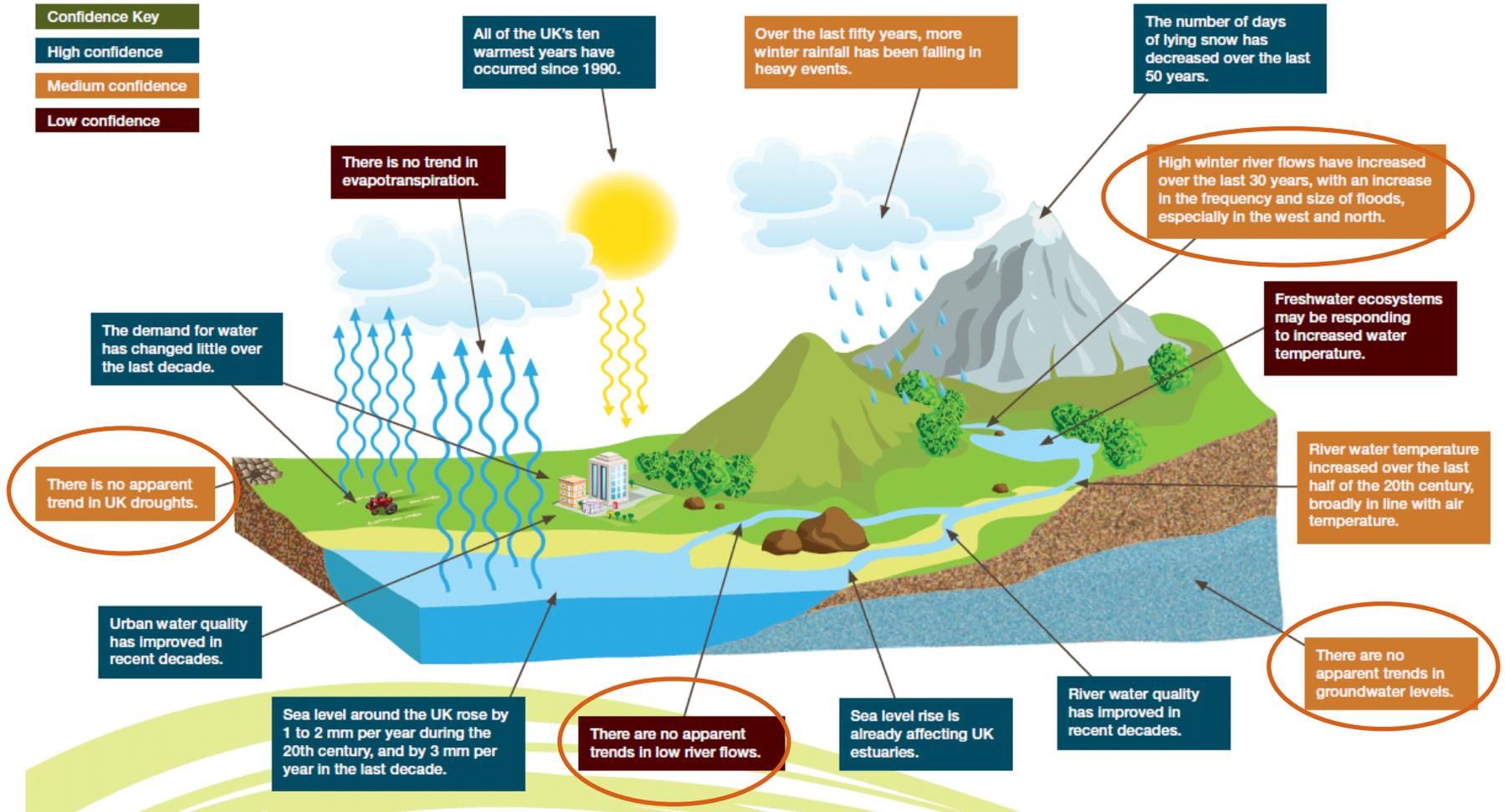
## What could happen

In the lowlands, there is likely to be a decline in cold-water salmonids and an increase in warm-water cyprinids (e.g. the carp) that reproduce earlier. In particular, the carp is likely to expand its range northwards and breed more effectively; this is likely to be exacerbated due to its popularity with anglers. ■H\*

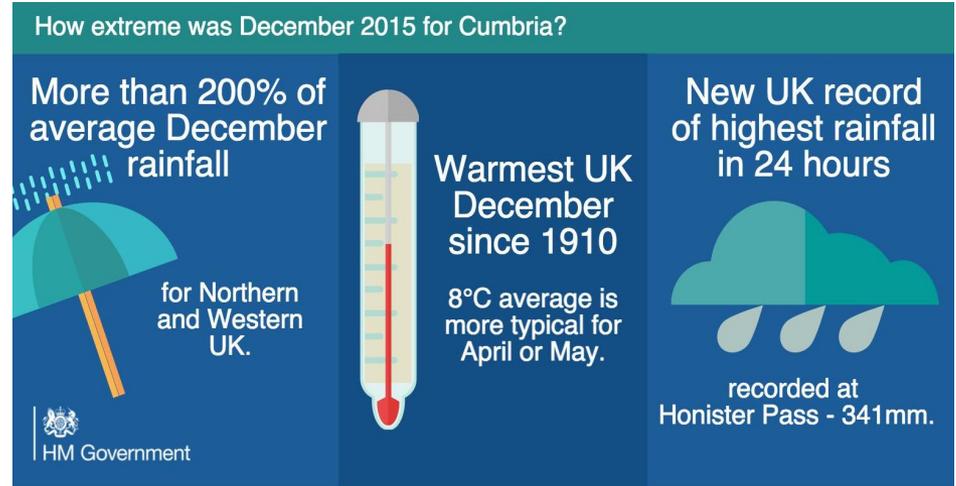
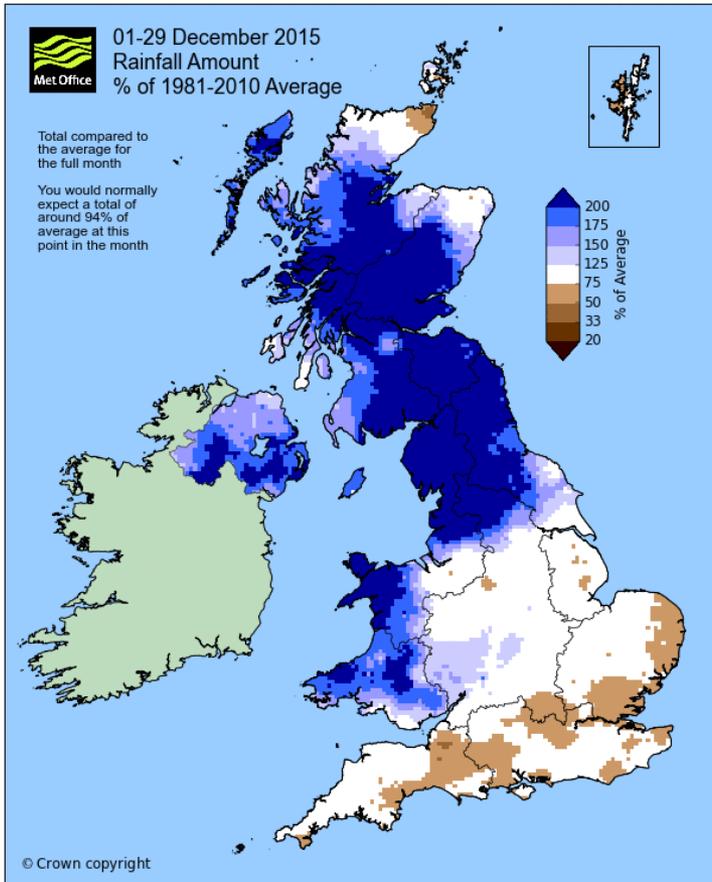
Coregonid fish (the schelly, powan, gwyniad, vendace and pollan) are currently in the southernmost part of their sub-arctic range (they are found in only a few lakes in Scotland, Wales and the Lake District) and will be increasingly threatened. ■H\*

There may be a decline in oxygen-demanding predators such as the pike and perch, resulting in higher survival of more fish that feed intensely on zooplankton; this will increase the level of algae and have negative impacts on shallow lakes dominated by vascular plants. ■M\*

# Observed changes in water



# Winter 2015/16



Impacts on juvenile salmon abundance in 2016?

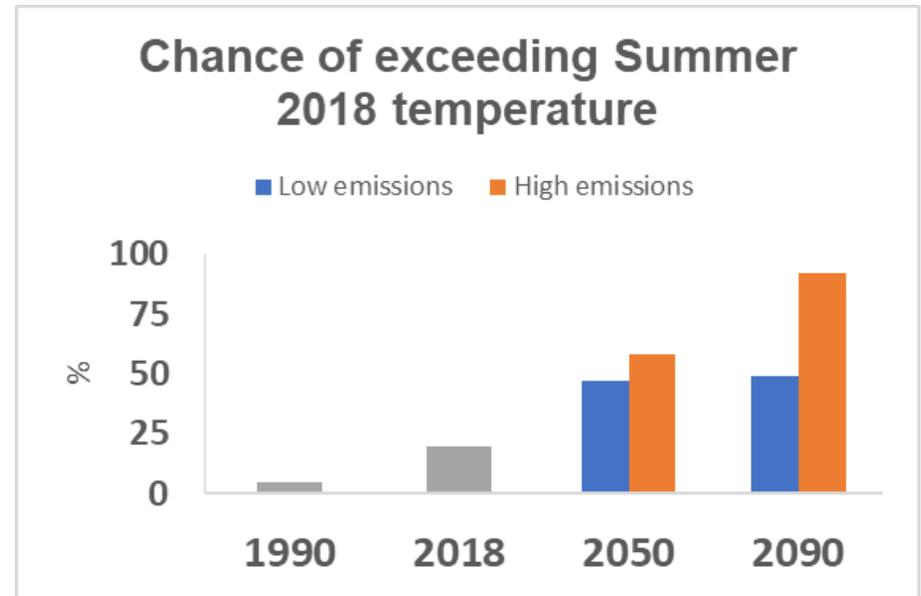
Response to extreme events, what matters most?

Variability, magnitude, frequency, sequence, indirect effects?

# New Climate Change Projections in 2018

## Summer 2018 heatwave

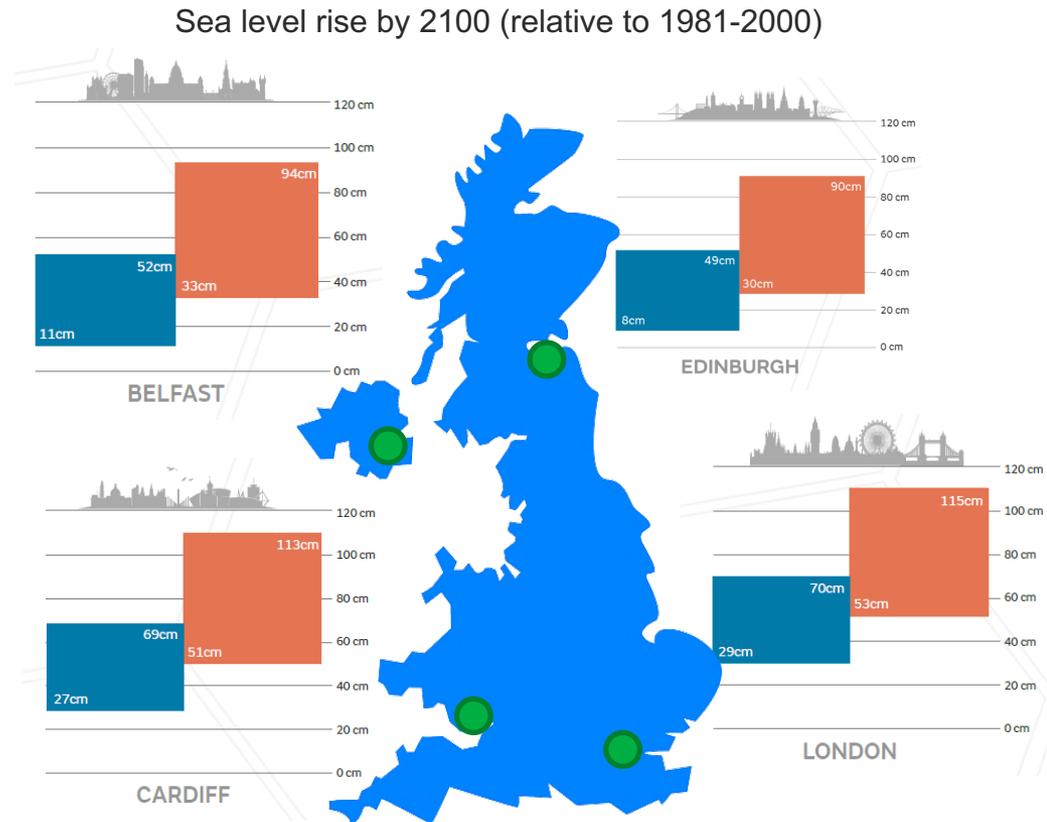
- Chance of such hot summers low in the baseline period (<10%)
- By mid-century the chance of hot summers will be of the order of 50%
- Beyond 2050 the chance of a warmer summer more strongly depends on emission scenario



Environment Agency screening for a high emission scenario (RCP 8.5)

# Headline climate changes UK

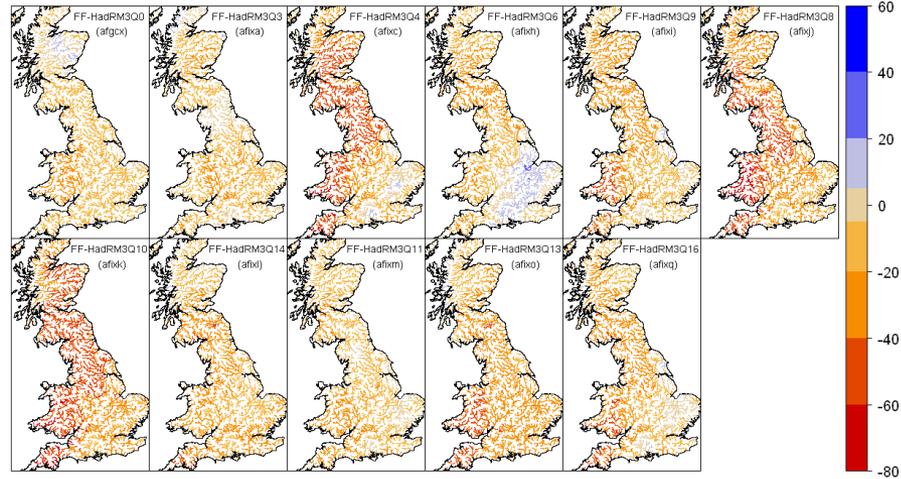
- All UK areas warm
- Hot summers more common
- Winters expected to become wetter, and summers drier
- 1m of sea level rise (2100) and 4m by 2300



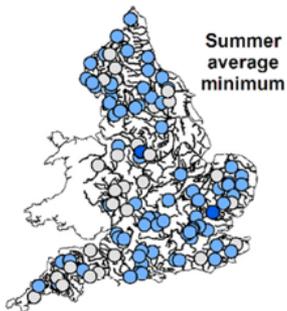
# Availability of climate change impacts information

Future flows hydrology

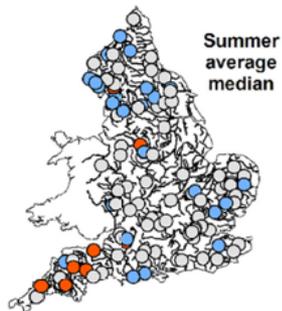
Change in Summer Flow (JJA, %) for the 2050s



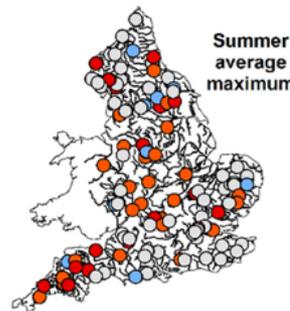
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Summer average minimum



Summer average median



Summer average maximum

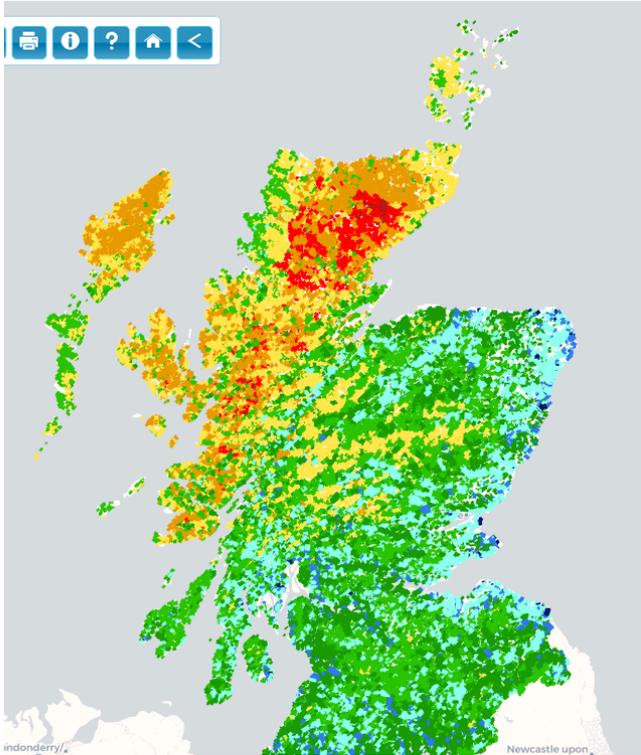
Change in phosphorus concentration (%)



Phosphorus projections



# Maximum Daily river temperature

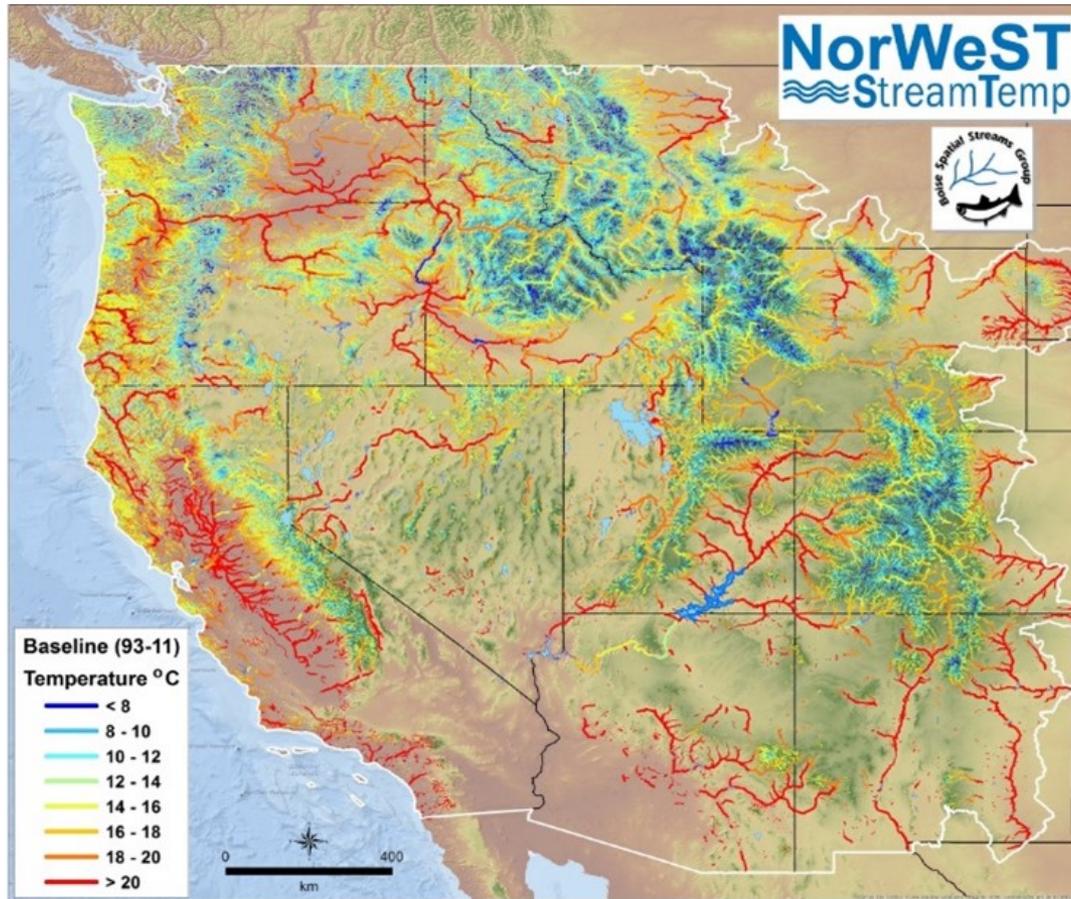


Predictions of maximum daily river temperatures for the hottest year in the last 20 years (2003)

Targeting measures to most sensitive places

Iain Malcom, Marine Scotland

# Interactive water temperature maps



Interactive maps using future climate scenarios (USA only)

# How can we prepare or adapt?

- Policies to improve resilience - **££££**
- Assess risk and vulnerability - **science**
- Increase awareness – **tell the story**
- Strengthen institutions - **provide early warning**

# Innovative (e)DNA technology for ecological assessments

Diatoms in rivers  
DNA metabarcoding



Fish in lakes eDNA  
metabarcoding



Single species  
eDNA assays for  
INNS



Platform for  
knowledge &  
information  
exchange



# Drivers, enablers and constraints



## Drivers

- Leadership
- **Vulnerability** to current weather events
- Need to **comply** with legislation or statutory guidance
- Enhance **reputation**
- A desire to seek **new opportunity**

## Enablers

- Leadership
- Access to usable **information**
- Ability to allocate **resources**
- A **learning** culture
- **Understanding** implications for the organisation
- Supportive internal **systems**

PROGRESS

## Constraints

- Lack of relevant **information**
- Lack of **confidence** on what to do
- **Short term** focus
- **Resource** constraints (time, money)
- **Benefits unclear** or hard to measure
- Socio-political **acceptability**
- Unsupportive **institutional** context and systems

Adapted from: [Arnell](#) and Carlton (2009), UKCIP (2010), Lonsdale et al (2010)



**“Climate change is the biggest threat we face”**

# 'Pathways to Catchment Resilience'

Emergent property or target to achieve?

- How do we define, measure and achieve catchment resilience?
- Large EA funded project over 2 years
- Organisational learning

# Conclusions

- The Future is different, we need to act differently
- Work out what will make the biggest differences
- We need to work together
- We need to work with those who can make a difference