

# A risk-mapping approach to assess the likelihood of establishment of spring viraemia of carp in the UK based on approximation of lake water temperatures from gridded air temperature data

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## Introduction

- Ambient water temperature is a key factor controlling the distribution and impact of disease in fish populations.
  - Optimum temperature ranges have been characterised for the establishment of important aquatic diseases exotic to the UK.
  - Seasonal temperature characteristics influence the likelihood that an exotic pathogen will establish and spread following introduction.
- Spring viraemia of carp (SVC) is an economically important disease exotic to the UK that impacts wild and stocked populations of cyprinid fish in lakes and fisheries; its optimal temperature range is 10-17°C.
- We have used a regression method to approximate daily average surface water temperature in lakes across the UK using gridded daily datasets of average air temperature provided by the UK Met Office.
- A spatial and temporal analysis of predicted water temperatures is combined with distribution data for populations of fish species susceptible to SVC to identify geographic areas where risk of establishment is highest.



## Materials and methods

- A linear regression model (Box 1) was used to approximate daily average still-water surface temperatures for 1997-2006 from 5km gridded daily average air temperatures for the UK<sup>1</sup>.
  - Model coefficients were generated by using long term daily water temperature recordings from 4 lakes.
  - The mean number of days per year that water temperature satisfied optimal criteria for establishment of SVC (i.e. 10-17 °C) for each grid cell was calculated (Figure 1).
- The distribution and density of fish populations susceptible to SVC was determined from (i) the Database and Atlas of Freshwater Fish (DAFF)<sup>2</sup> and (ii) the Cefas Live Fish Movements Database (LFMD)<sup>3</sup> (Figure 2).
- Temperature and distribution data were combined to provide overall Risk Scores for the establishment of SVC (Figure 3).

## Box 1. Linear regression model

$$W\_temp_0 = [a_1 \cdot Av\_A\_temp_{10}] + [a_2 \cdot TimeFunction_{0+150}] + b$$

where:

- $W\_temp_0$  = average water temperature for day 0
- $Av\_A\_temp_{10}$  = average air temperature for preceding 10 days
- $TimeFunction_{0+150}$  = Cosine(day of year) for day 0, plus seasonal offset of 150 days
- $a_1, a_2$  and  $b$  = regression coefficients

### Mean days 10 - 17°C

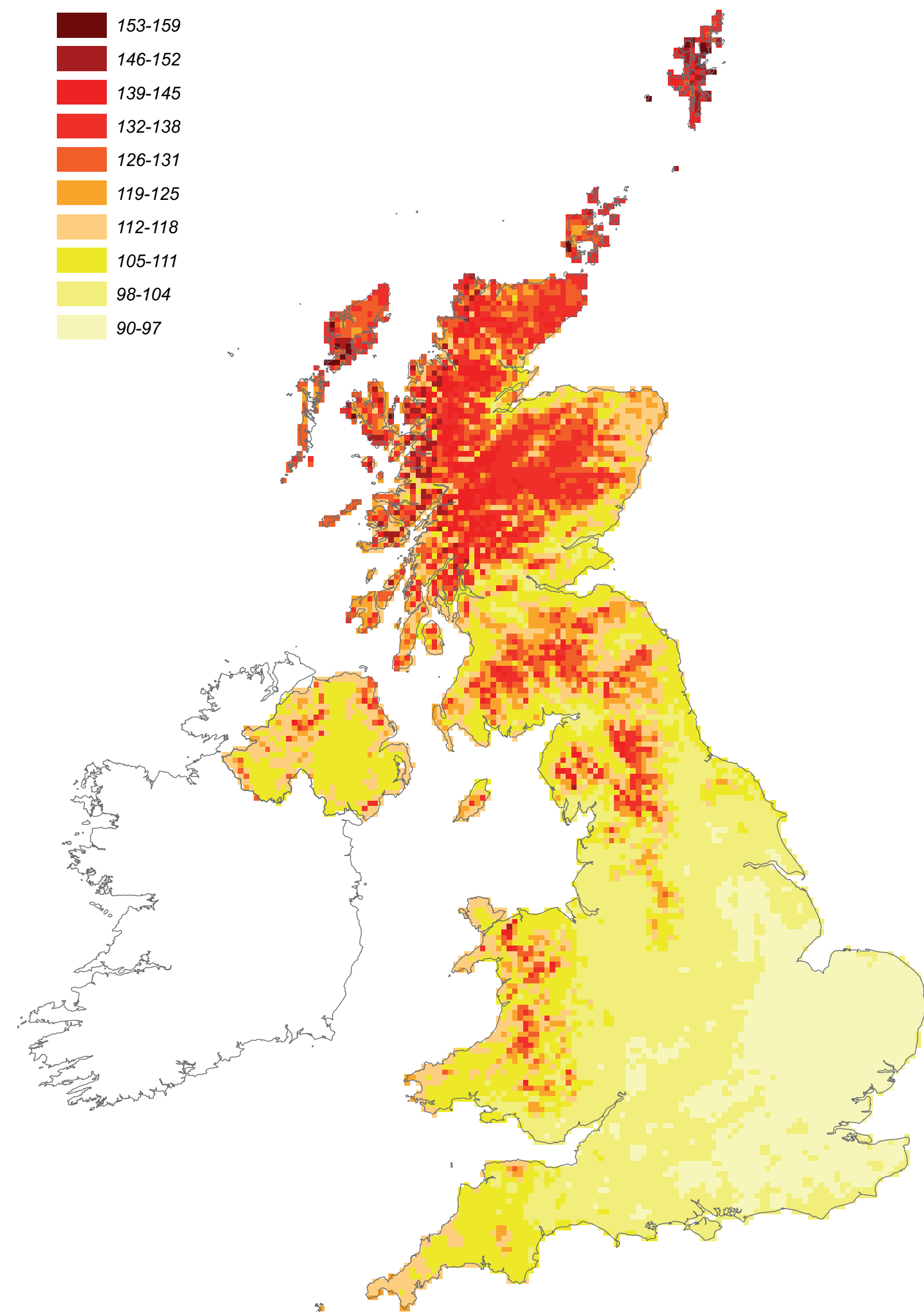


Figure 1. Number of days per year that estimated daily average lake surface temperatures satisfy optimum criteria for establishment of SVC (10-17 °C, means of 10 years, 1997-2006)

### Population density

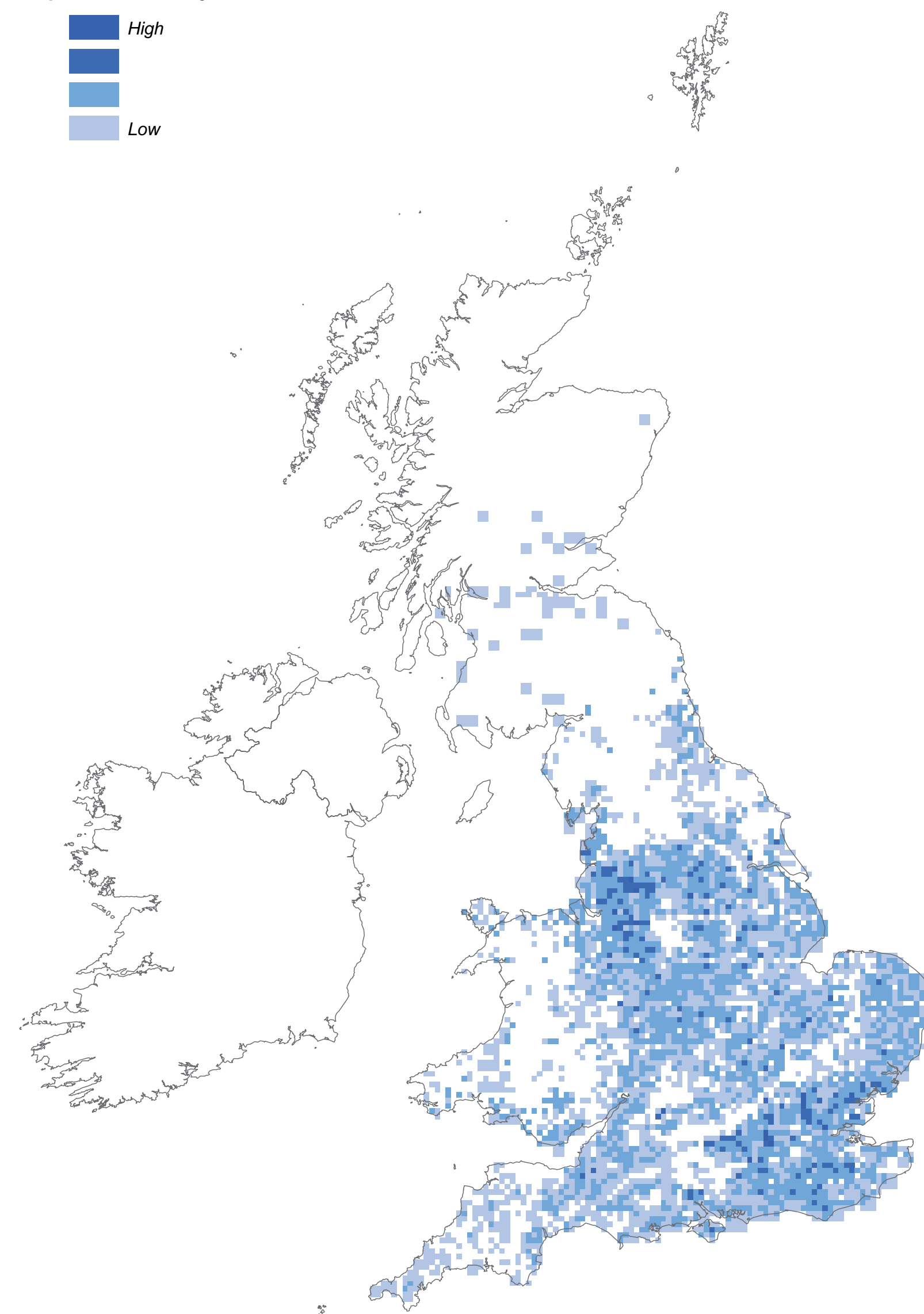


Figure 2. The distribution of SVC susceptible species (4 population density categories)

### Risk category

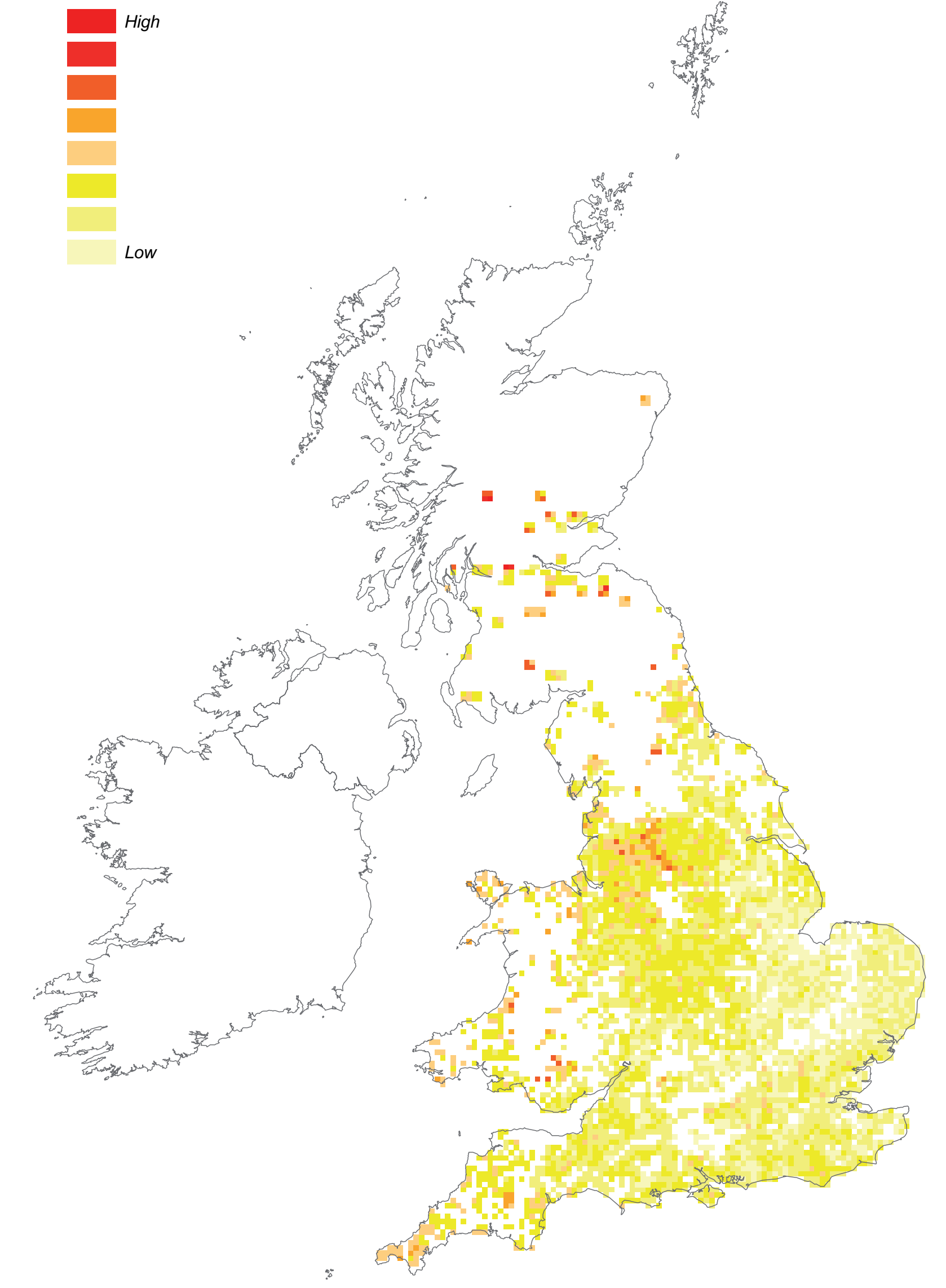


Figure 3. Combined risk categories for the establishment of SVC (8 risk categories)

## Results and Conclusions

- The average number of days per year that mean daily water temperatures were optimum for the establishment of SVC across the UK ranged from 90 to 159.
- Regions with the most permissive temperature profiles for SVC include the Scottish highlands, islands and southern uplands, high ground in northern England and Wales.
  - Few populations susceptible to SVC in the UK occur in areas with temperature profiles most likely to result in establishment of disease.
- Less than 1% of cells containing susceptible fish have the highest combined Risk Scores (6-8) (restricted to central England, south Wales and central Scotland).
- A risk based approach for surveillance of exotic pathogens in aquatic animal health management, allowing efficient use of resources directed towards high risk animals and geographic areas for early disease detection.
- This methodology could be used to examine the change in distribution of high risk areas for both exotic and endemic fish diseases under different climate change scenarios.

## Acknowledgements

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## Footnotes

<sup>1</sup> These data are freely available for research purposes (subject to registration) via UKCP09 – the UK Climate Impacts Programme (UKCIP): <http://www.metoffice.gov.uk/climatechange/science/monitoring/ukcp09/>

<sup>2</sup> DAFF is a joint project of the Centre for Ecology and Hydrology, Environment Agency and Joint Nature Conservation Committee

<sup>3</sup> Cefas developed and hosts the LFMD, a resource jointly owned by Cefas, Environment Agency, Welsh Government and Defra, to manage all data relating to Aquaculture Production Business authorisation and registration, aquatic animal imports and exports, the rearing and holding of non-native species and statutory aquatic disease testing and controls.