CLIMATE CHANGE AND MYXOZOA

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For aquatic organisms its not all about temperature

Johnson et al. (2009) The British river of the future: How climate change and human activity **might** affect two contrasting river ecosystems in England. *Science of the Total Environment* 407:4787–4798.

Decrease in salmonids/ increase in coarse fish?

Synopsis- the freshwater environment is going to change, but we're not sure how

Alteration of water levels/ flow
Sedimentation
Eutrophication
Stratification
Acidification/ Chemistry
Ice cover
Ocean currents
UV light penetration
Runoff
Weather extremes

What methodologies exist or should be developed to predict effects of climate change on myxozoans

- What information would be most useful
- Effect of different methodologies on predictions

Literature- Climate change and parasites

During 1990s a series of ‘alarming’ papers were published on climate change and disease

Mosquito Mania / *The New York Times*

It is now recognised that many of the models were far too simplistic

Effects of climate change on parasitic organisms have to be considered alongside:-

- Habitat alteration
- Invasive species
- Agricultural practices
- Human activities

Predictive models liable to be complex and need to relate to specific diseases

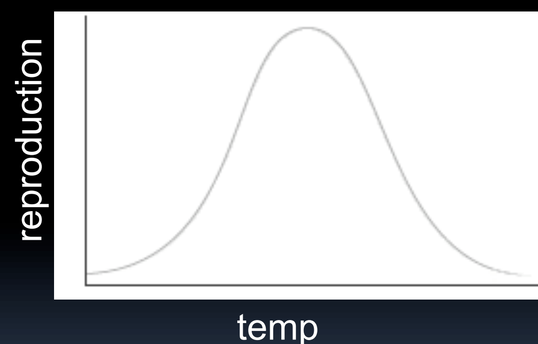
Climate change and parasites

Thermal physiology → Ectothermic hosts
Increase in reproductive rate

Thermal physiology ↓ Fish host
Immune response

Ectothermic hosts ↓ Parasite

Ectothermic hosts ↓ Invertebrate host



Climate models suggest in temperate areas min temp will increase more than max

Spatial (Altitude/ Latitude) and Temporal shifts

Effects of climate change most pronounced at **edges of parasite/ host distribution**

Disease models for climate change

Process based (Biological) models

Estimates how habitat suitability for a species changes with environment
Parameterising models requires knowledge of climate variables and vital rates
Use R_0
Can be over simplistic

Pattern based (Statistical) models

Relate field observations (presence/absence etc) to environmental factors
Determine the fundamental niche
Many based on assumption of linear relationships
Can be over simplistic

More complex models exist
eg Genetic Algorithm for Rule-set Production (GARP)/ boosted regression trees

Reliance on detailed datasets

MYXOZOA

Present challenges

Complex life cycles

For majority of species lack basic biological information

Few life-cycles validated

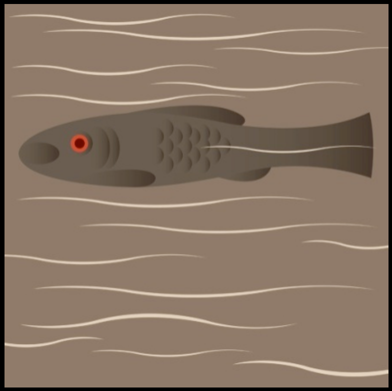
Modelling effects of climate change should be parasite specific

Myxozoans may extend/shift ranges but they could also become extinct

$\boxed{\text{Climate change will decrease biodiversity}}$

Distributions needed at catchment, country and continent level

For fish / invertebrate host and parasite



Geophysical data

A lot of data already available regarding habitat much in GIS format

Datasets still needed for many river characteristics e.g. sediment type

Effects of alterations in temperature/ precipitation

Use of existing catchment models (e.g. CLASSIC; Johnson et al. 2009)

It is feasible that collating together data could inform how climate changes may affect distribution

BUT

We lack

Reliable long term detailed datasets particularly distributions

Require information on

- Fundamental data on invertebrate hosts
  - Habitat preferences
  - Nutritional requirements
  - Effects of Predation (on hosts *and* parasites)
  - Diseases (other than Myxozoa)

- Immunology/ genetics
- Fish hosts
- Dose effects (*M.cerebralis* vs *T. bryosalmonae*)
- Interactions with other fish diseases
- Environmental factors

Can we model climate change and Myxozoa?

GIS and modelling techniques can be very data hungry

Early project
Too little data to make prediction
Feed (with data)

Mid project
Enough data to make reasonable prediction
Should move on...

Late project
Masses of data but model still demands more
More variables/ higher quality temporal and spatial data
Get some help/advice

What Myxozoa to examine?

Life cycles known
Distribution known
Monitoring data available on abundance, disease severity
Geographic distributions on edges of parasite's
temperature range
Already developed methodologies for diagnostics, monitoring
Economically important

Distribution- datasets

M. cerebralis- invasive species (North America)
T. bryosalmonae- (Europe, North America)
Ceratomyxa shasta (North America)
Enteromyxum leei (EU, life cycle?)
Kudoa spp (life cycle unknown)