



FISHERIES RESEARCH SERVICES

Emergence of IPNV from analysis of Fish Health Inspectors' data

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IPNV as a case study

- **Extensive, but restricted data set**
- **Thorough analysis undertaken**
 - Prevalence patterns
 - Dynamics
 - Process model
- **Results robust and simple**

Infectious Pancreatic Necrosis Virus emergence

- **IPN disease of farmed fish, particularly salmonids**
- **Caused by aquabirnavirus IPNV**
- **Increasing countries and species affected**
- **IPNV UK notifiable and movement control**

IPNV sampling

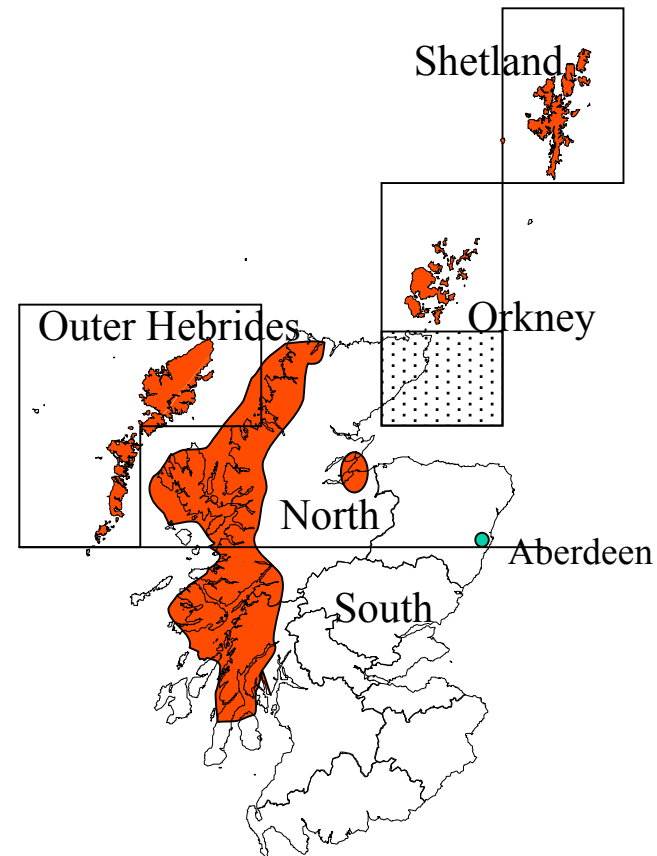
- **To inform movement controls Fish Health Inspectors sampled sites for IPNV**
- **Result a systematic sampling of all salmon farms**
 - Marine every 2 years
 - Freshwater annually
- **Samples generally 30 fish in 6 pools of 5**
- **Data stored in Aquadat**

IPNV data in Aquadat

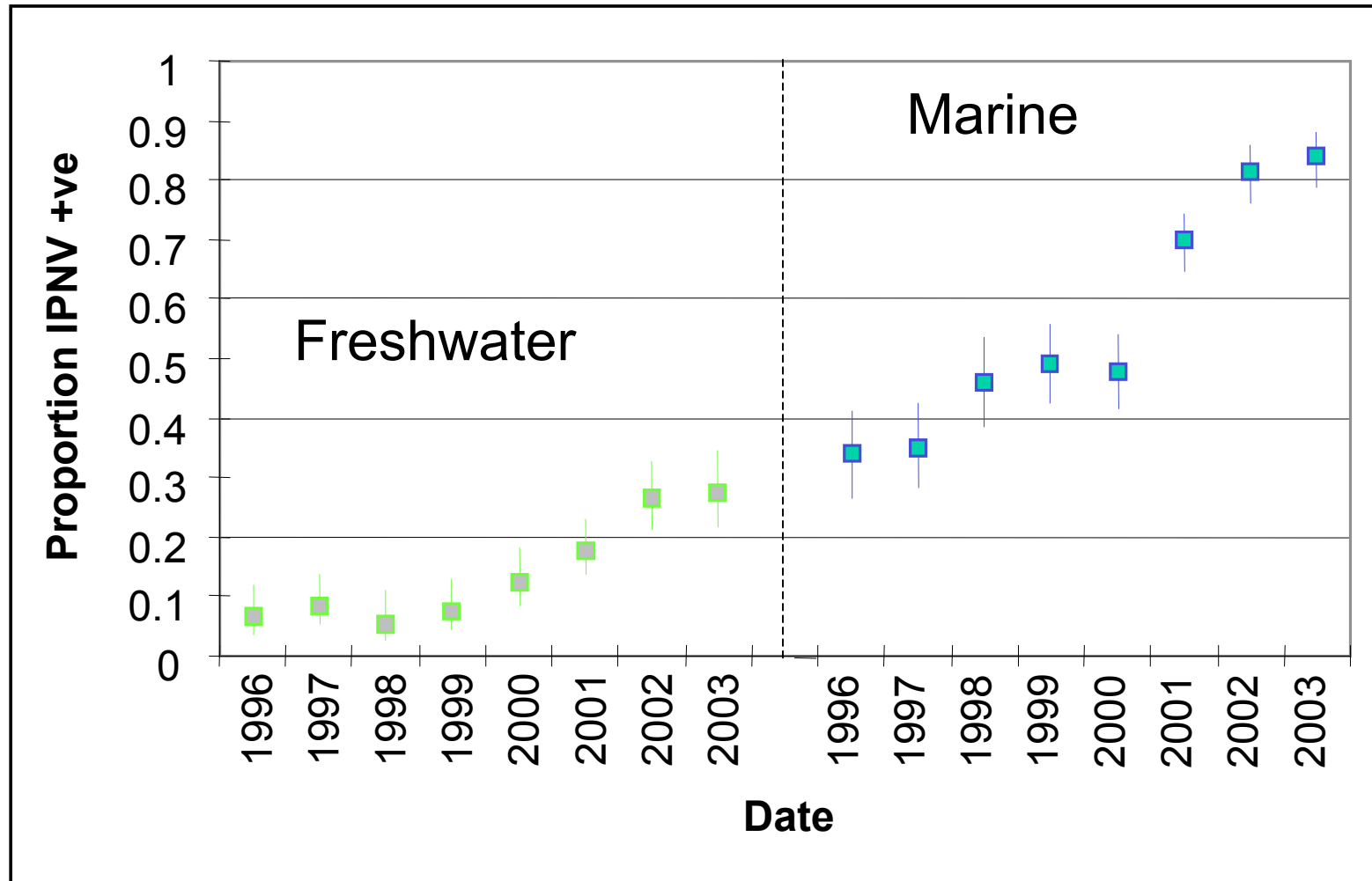
- **Data extensive, 1000s of observations**
- **Data from all parts of country**
- **Data of high quality**
- **However limited data**
 - Sample size
 - Species
 - Time
 - location
 - Test result
- **Lack of environmental/management data**

Converting to information

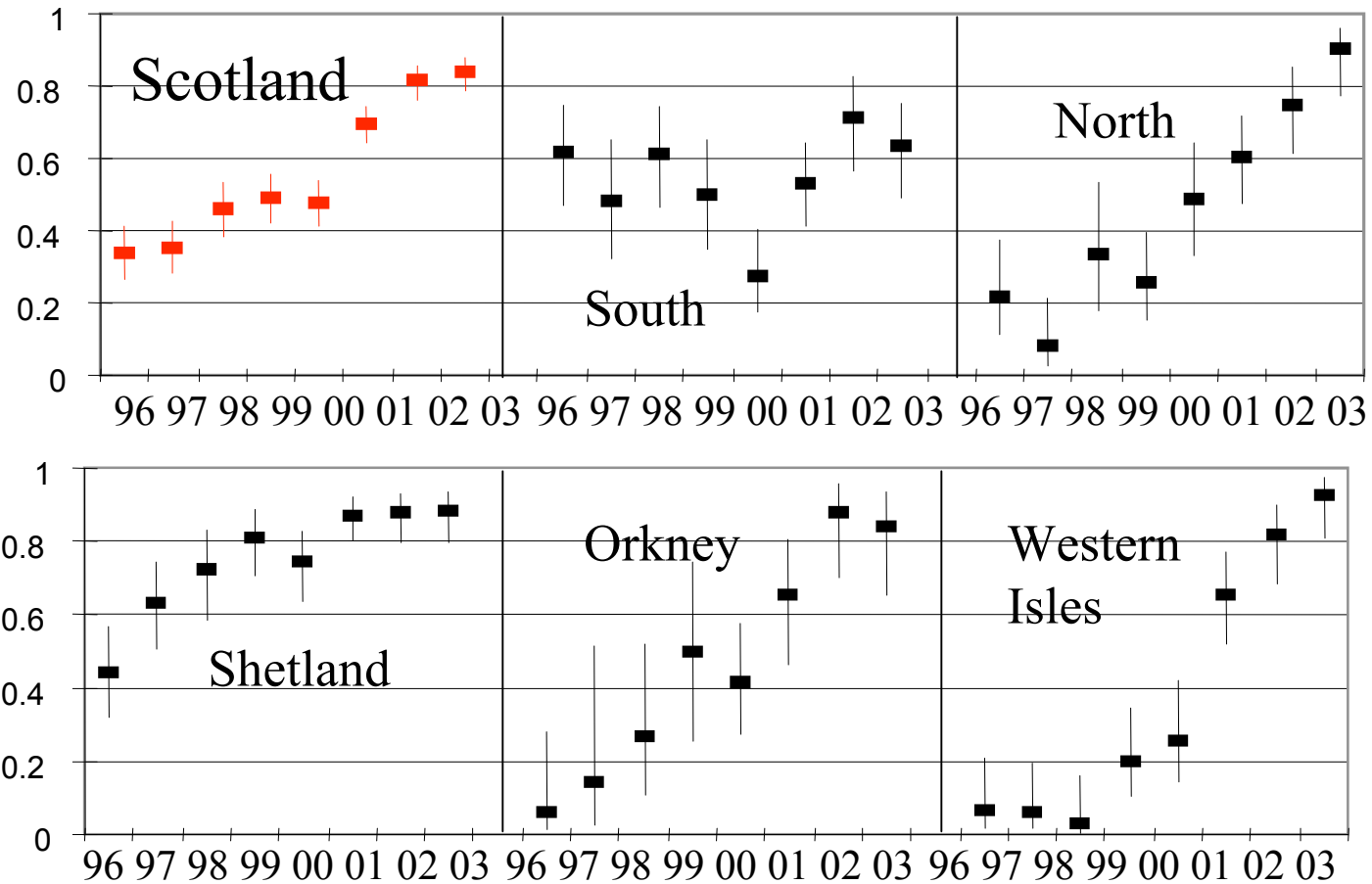
- **Annual IPNV**
- **Regional IPNV**
- **Convert to prevalence to discount effort**



National emergence



Regional marine IPNV emergence



Multilevel model analysis

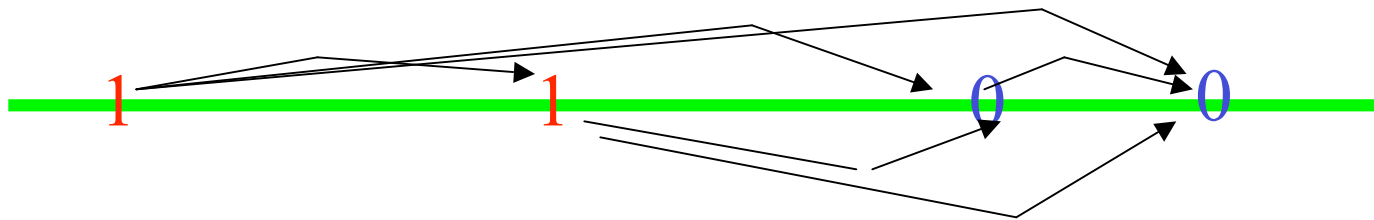
- **Multilevel model**
- **Causes of variance**
- **$IPNV = [1 + \exp(-\beta)]^{-1}$.**
 - Where $\beta = -1.138 (\pm 0.517)$
 - mean prevalence of 24%
 - Fw/marine large but uncertain
 - Inter-annual large and increasing
 - Inter-regional large but decreasing
 - Inter-seasonal minimal role

Dynamics: persistence

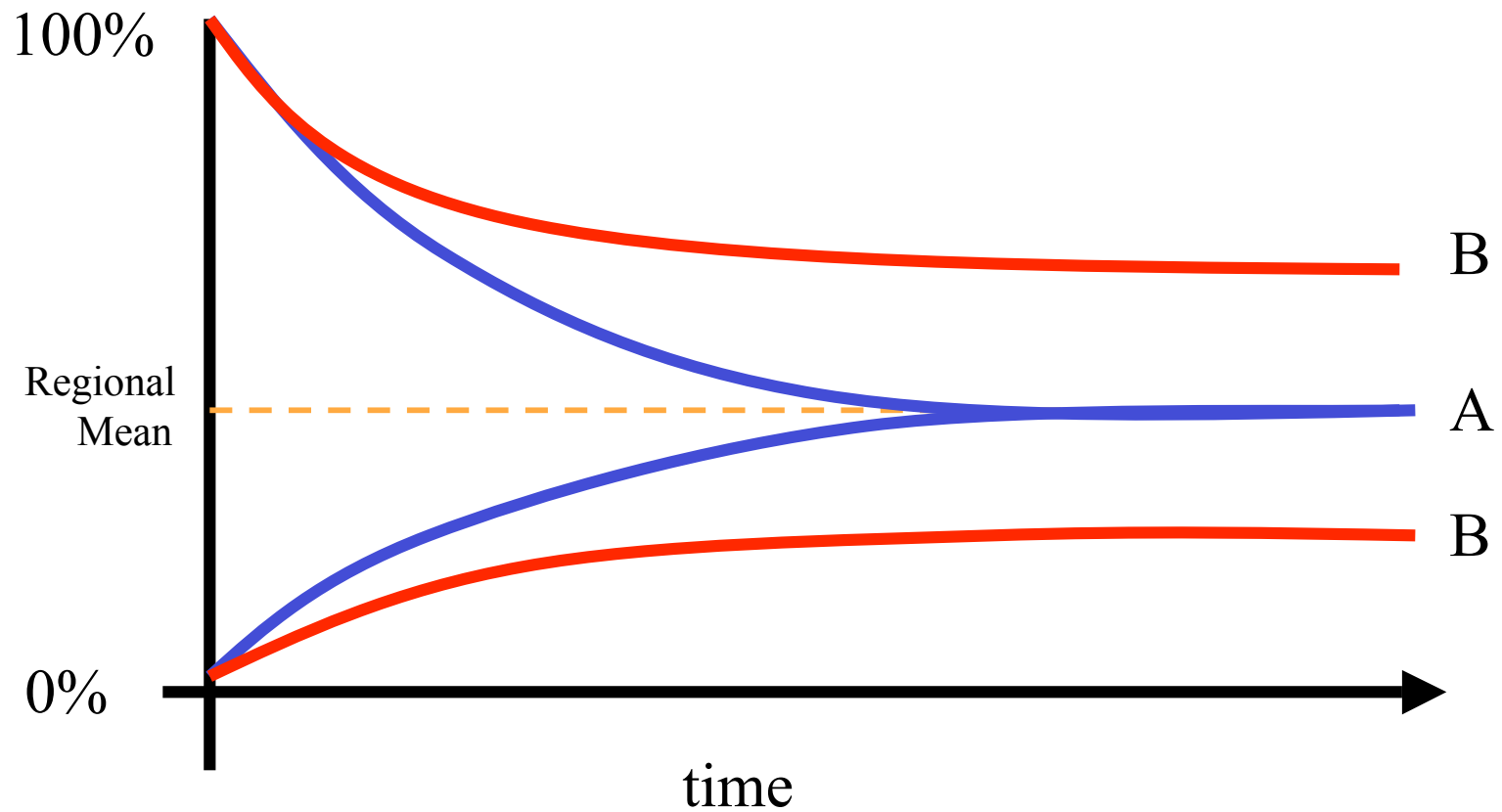
- **Static patterns derived**
- **But is infection dynamic or persistent**
- **The data can tell us**
- **Sites infection status at different times**
- **Does it change**

Modelling convergence

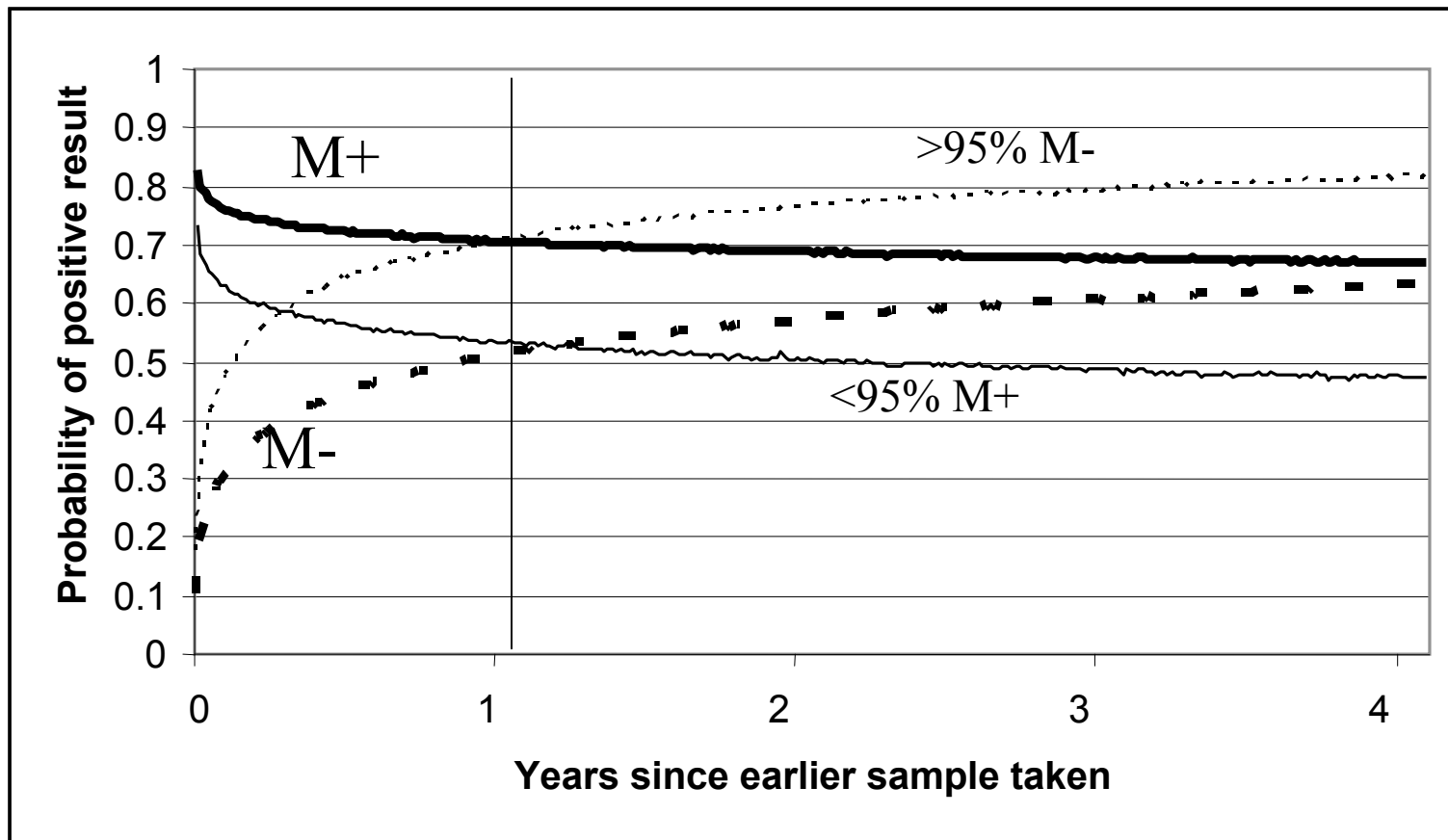
- For each site collected into pairs
- Divide into 2 lists where 1st sample positive and where 1st sample negative
- Find probability of second sample being infected with time



Two theories of change in conditional probability



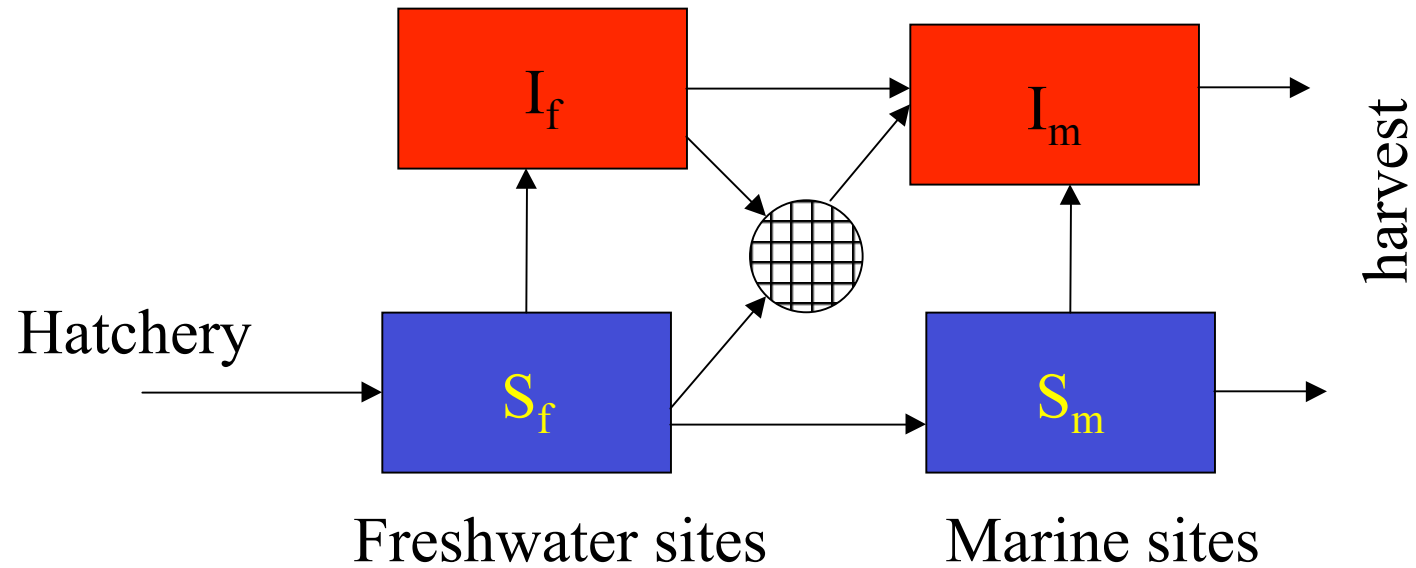
Scottish Marine IPNV infection conditional probabilities



Modelling infection

- **Prevalence increasing**
- **Infection dynamic**
- **SI model**
- **Calculate transmission coefficient**

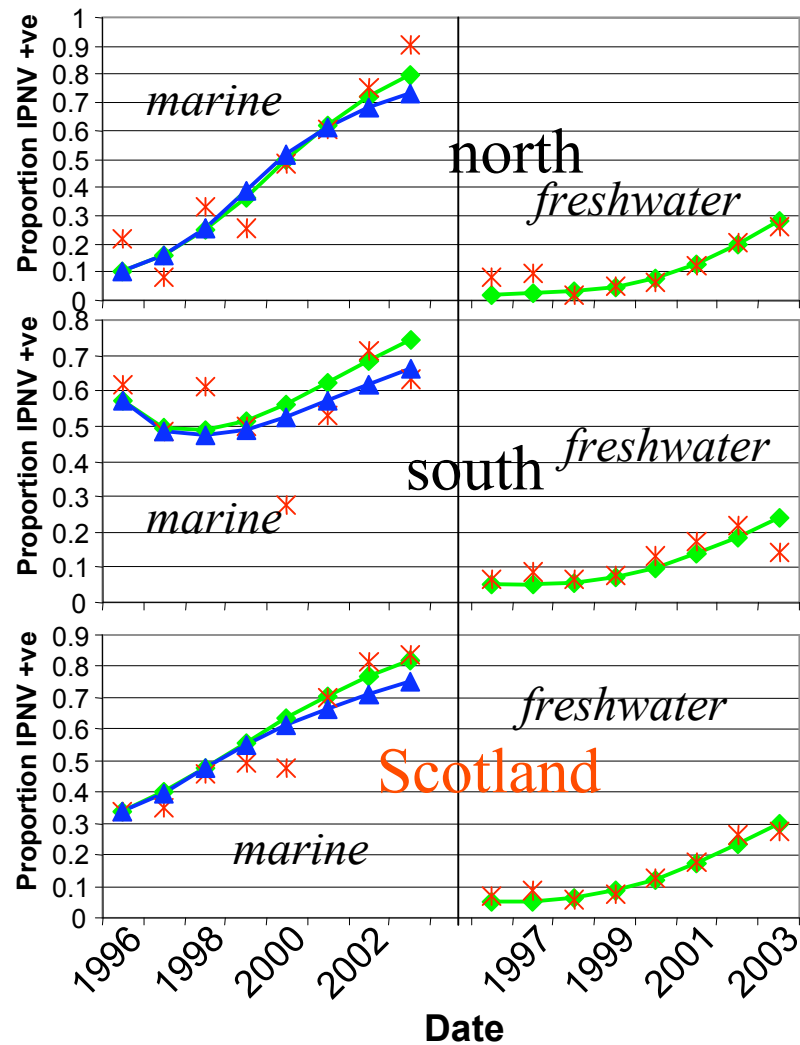
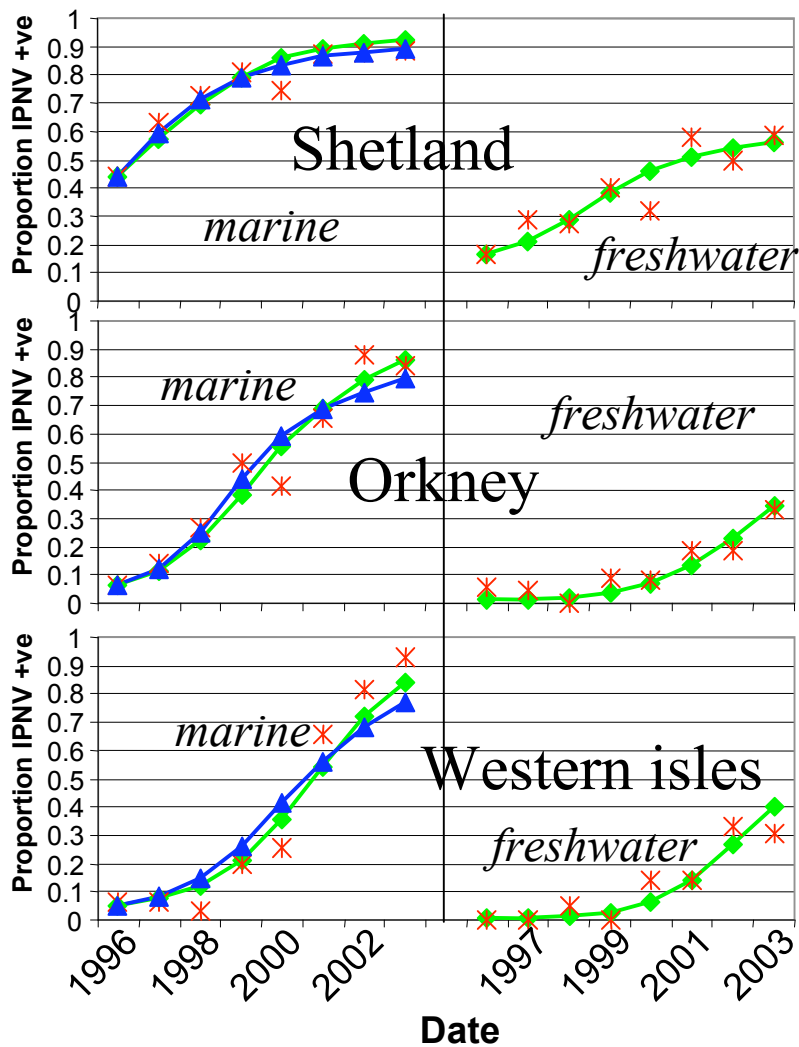
Model structure



Model equations

- $\frac{dS_f}{dt} = s - m_y b_f S_f I_f - s S_f$
- $\frac{dI_f}{dt} = m_y b_f S_f I_f - s I_f$
- $\frac{dS_m}{dt} = h(1 - X) - m_y b_m S_m I_m - h S_m$
- $\frac{dI_m}{dt} = hX + m_y b_m S_m I_m - h I_m$
- $X = I_f k / (1 + I_f(k-1))$

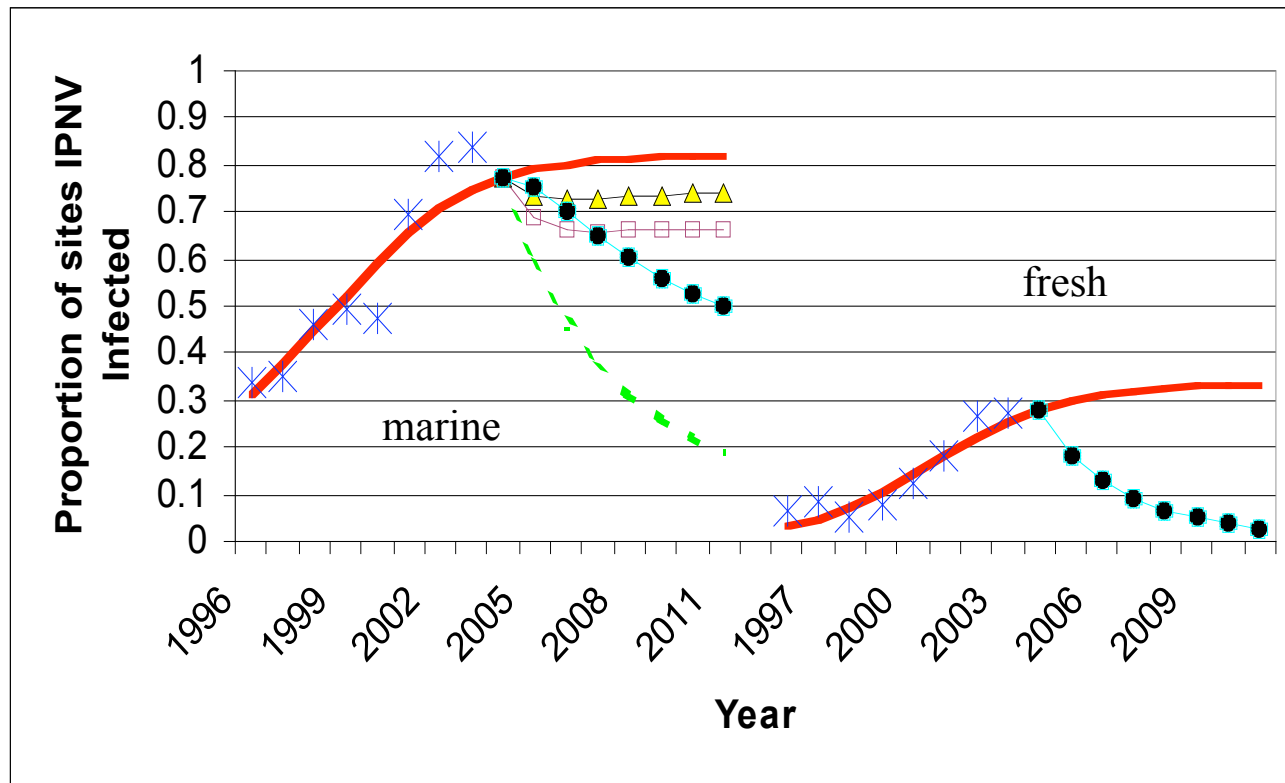
Model results



Model results

- **Transmission in freshwater and saltwater calculable by fitting observations**
- **Role of multiple smolt sources**
- **Prediction**
 - No change
 - $\frac{1}{2}$ transmission bf or bm
 - Cut inputs

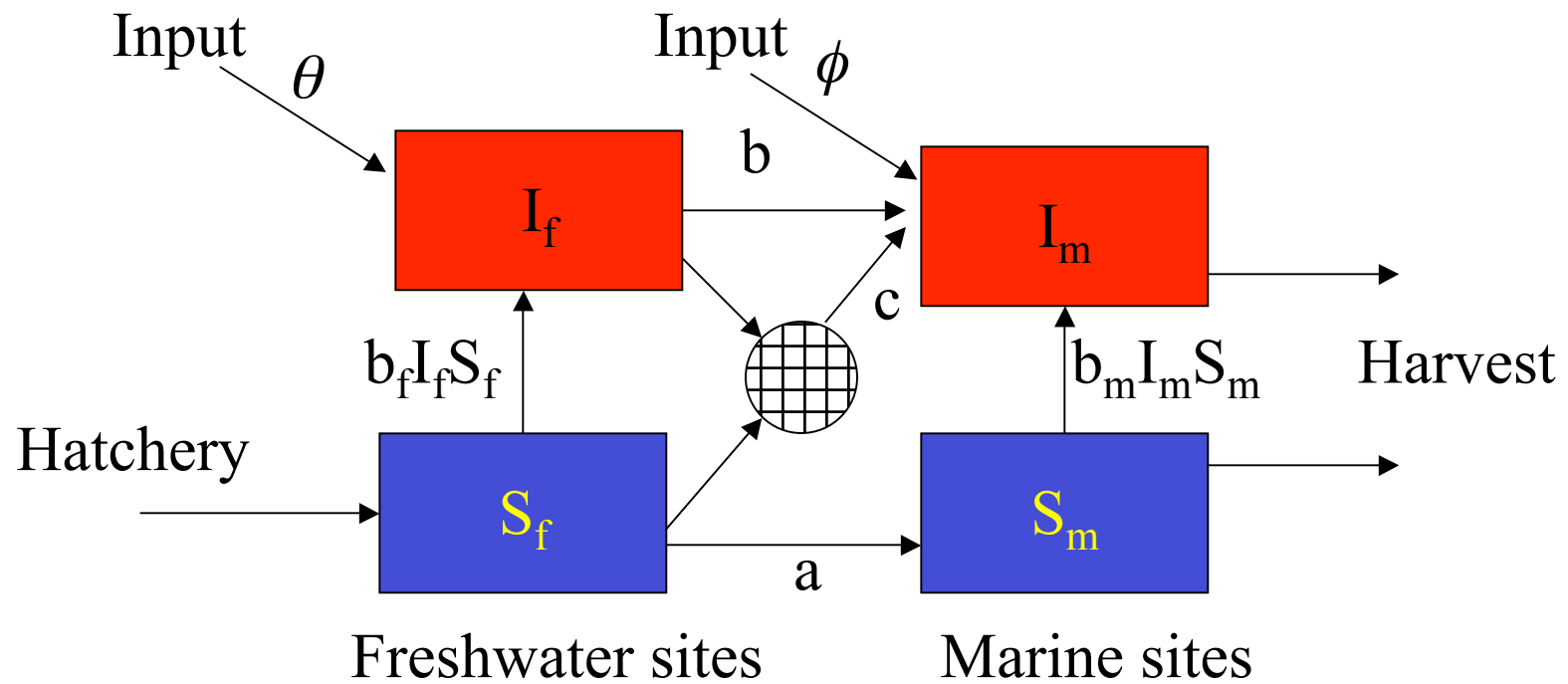
Model prediction



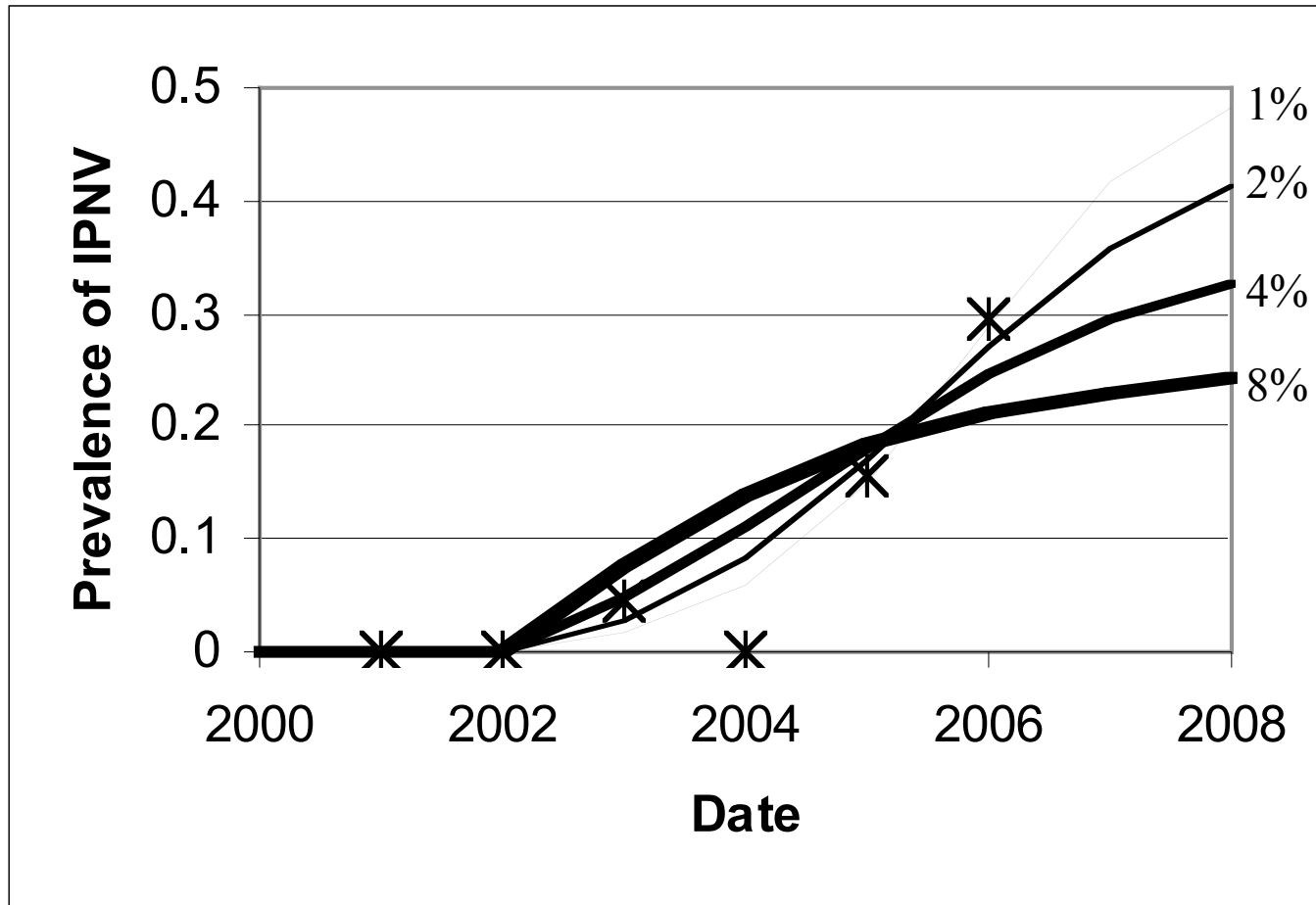
Irish data

- **IPNV also emerged in Ireland**
- **Similar data collection**
- **Smaller industry**
- **Model fitted**
- **Extended to include origin**
 - Could be imports
 - Could be transmission from other sector
 - Could be independent emergence

Model structure



Model results



IPNV data

- **Large quantity of data**
- **Simple data**
- **Enough to document**
 - prevalence,
 - spread and
 - dynamics of infection
- **Simple but robust**