Relationship between seasonal sea- temperature change and PD dynamics

at marine farming sites for salmon

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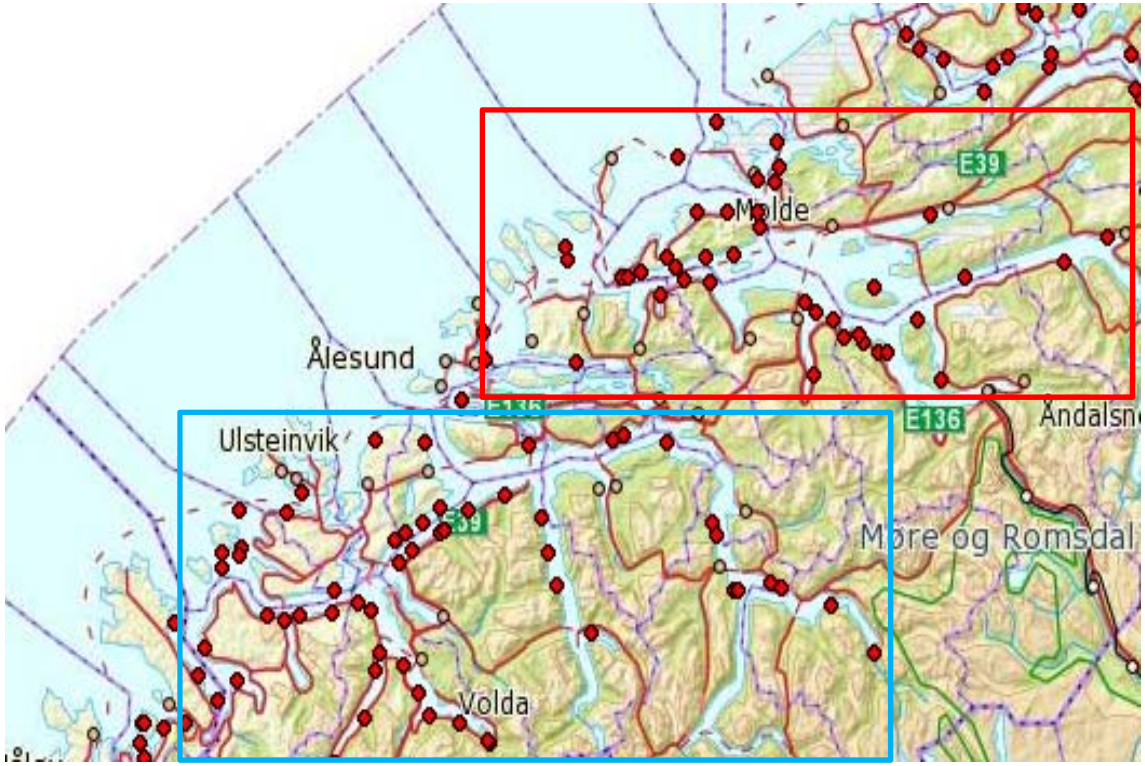
Study area and study population



38 PD (SAV3) infected cohort in the area from 2006 until 2012

Aims:

Find correlation between temperature dynamics and PD dynamics

– <u>Analyse how temperature influence PD incubation time</u>

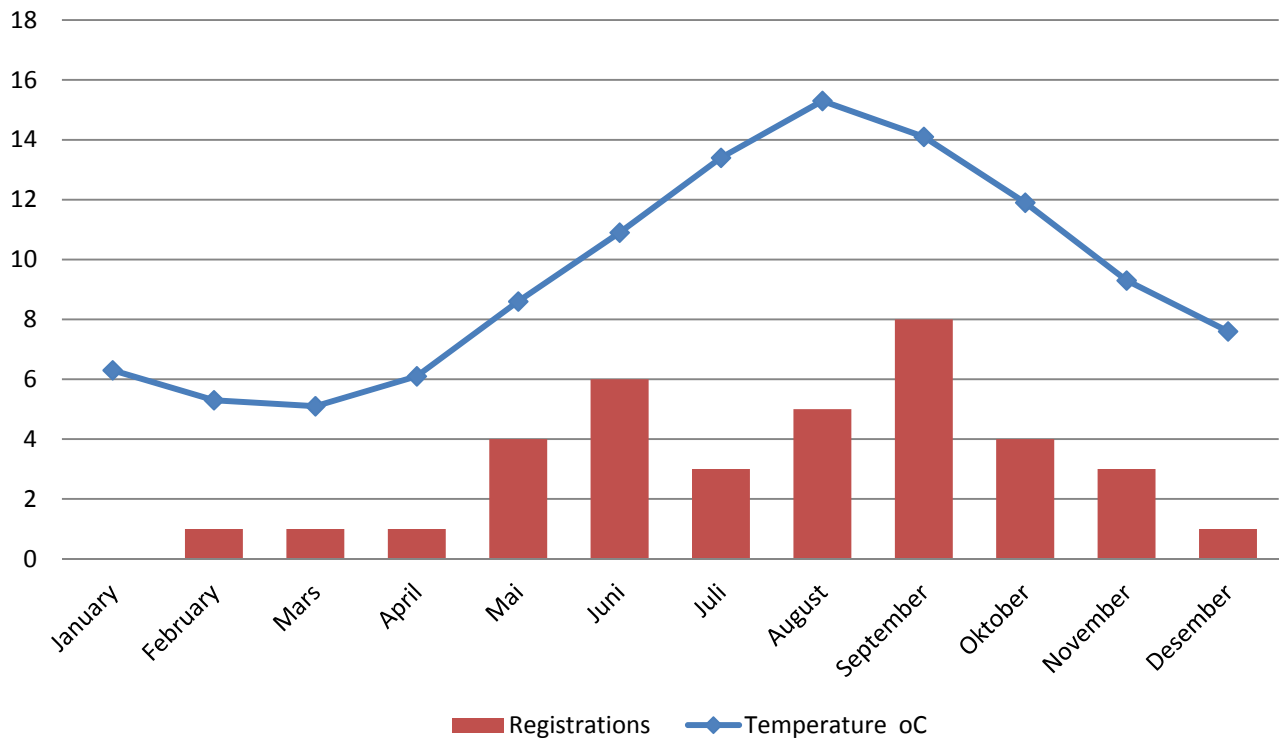
1. Analyse temperature dynamics

1. Analyse disease dynamics

2. Analyse other aspects

- Viral diseases (IPN, CMS, HSMB)
- Sea lice treatment
- Infection pressure

Sea temperature and PD registrations



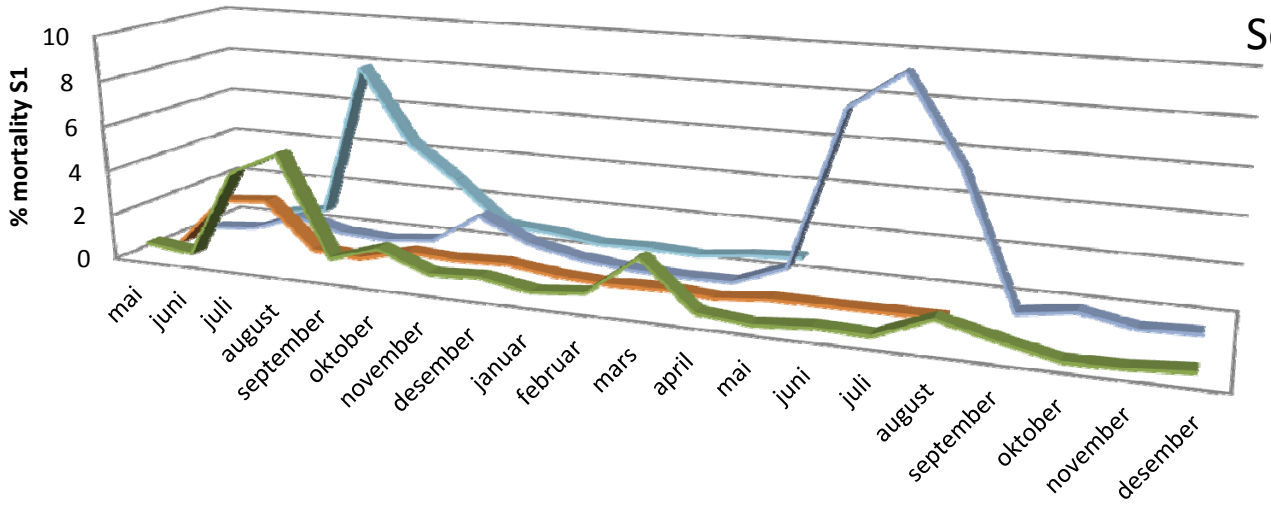
Questions : Is the registration related to temperature?

Is the month PD is registered the month of outbreak?

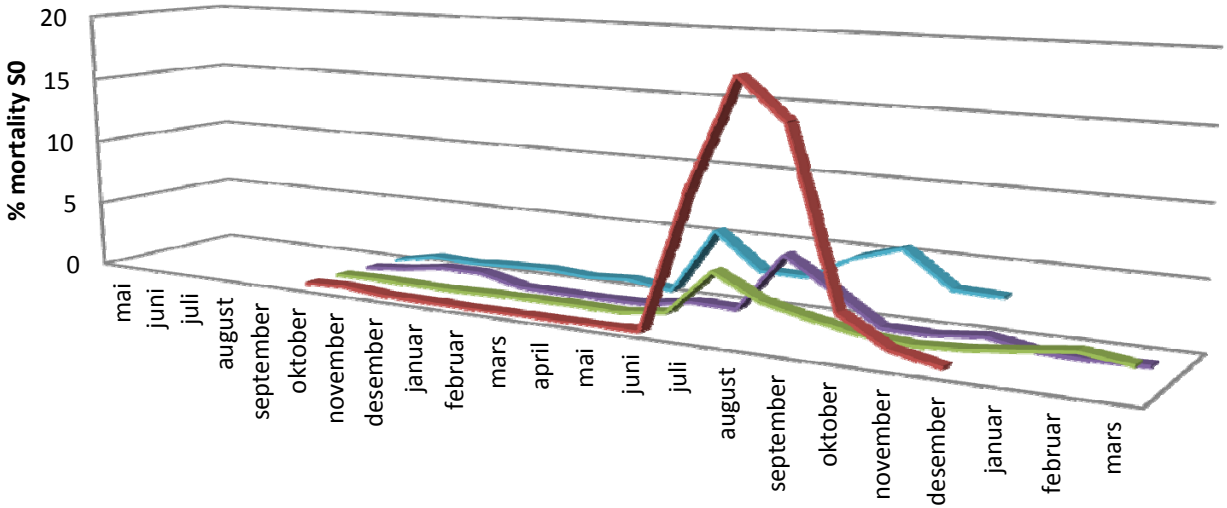
Studies of mortality dynamic in SAV3 infected Salmon necessary!

Mortality peaks in SAV3 infected S0 and S1 cohorts

Sea-transfer in spring

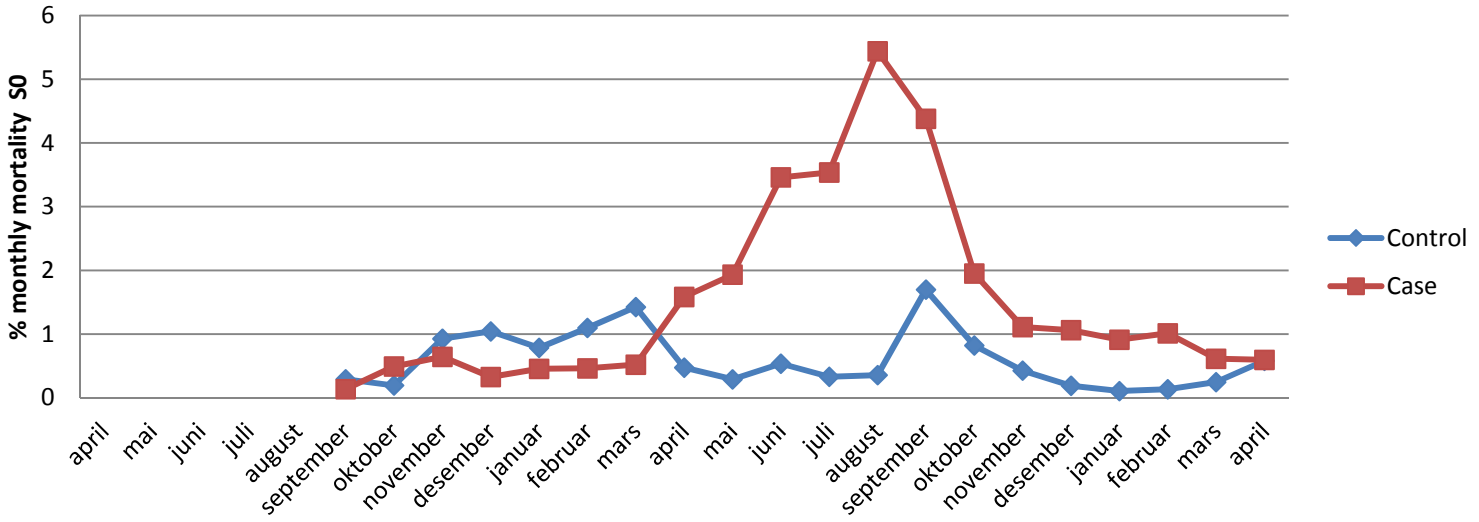


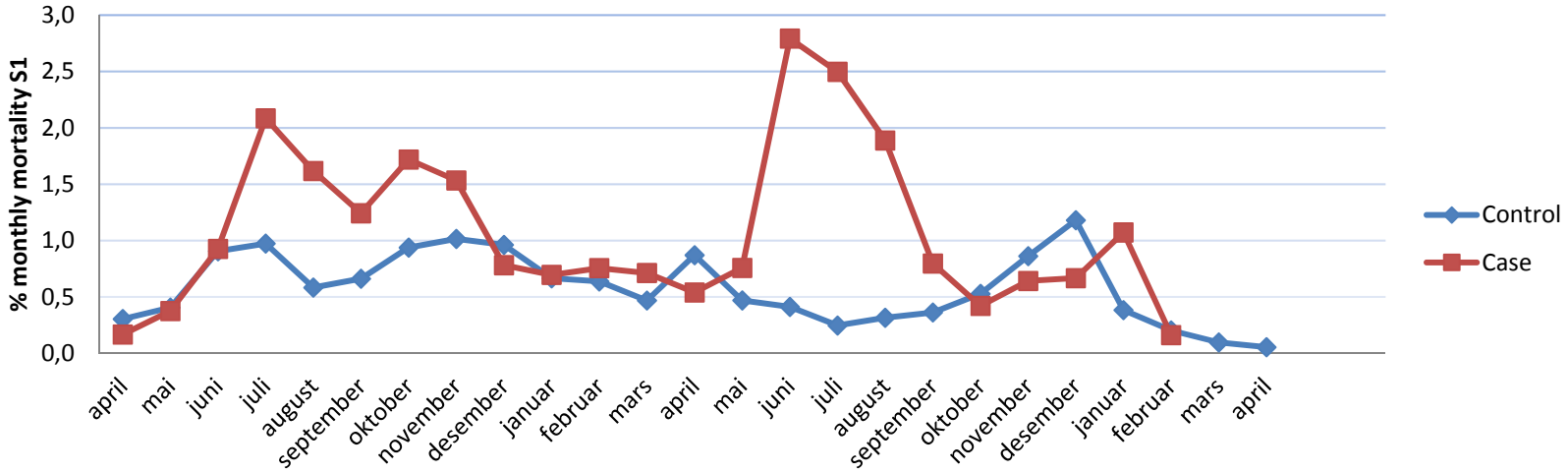
Sea-transfer in autumn



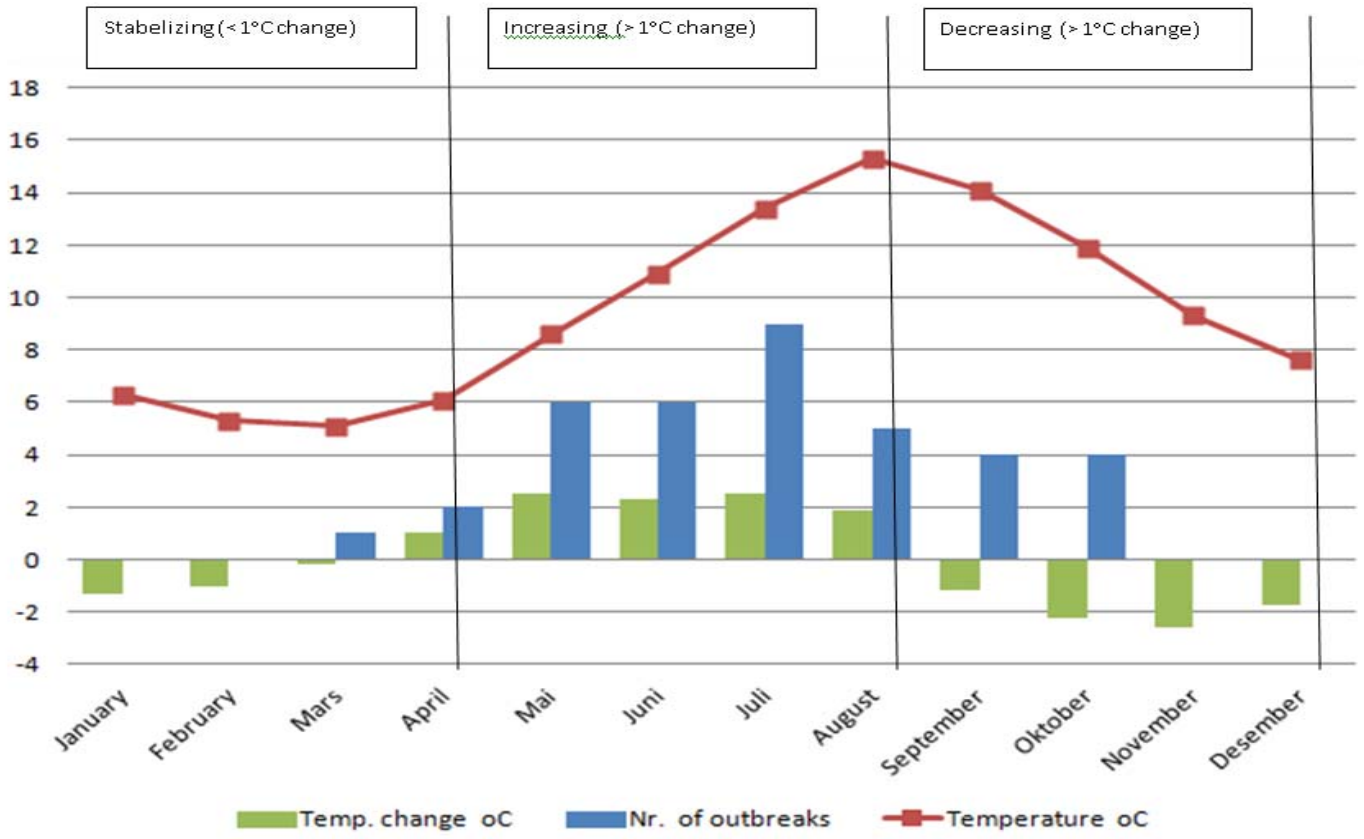
Peak in mortality = Time of outbreak

Mean monthly mortality in Spring and autumn smolt





Sea temperature change and PD outbreaks



Is the PD outbreak related to the temperature alone or the temperature change?

Identification disease development dependent on a hydrodynamic model!

MODS (www.mods.sinmod.no) The hydrodynamic model

The model reflects:

- Contact network:

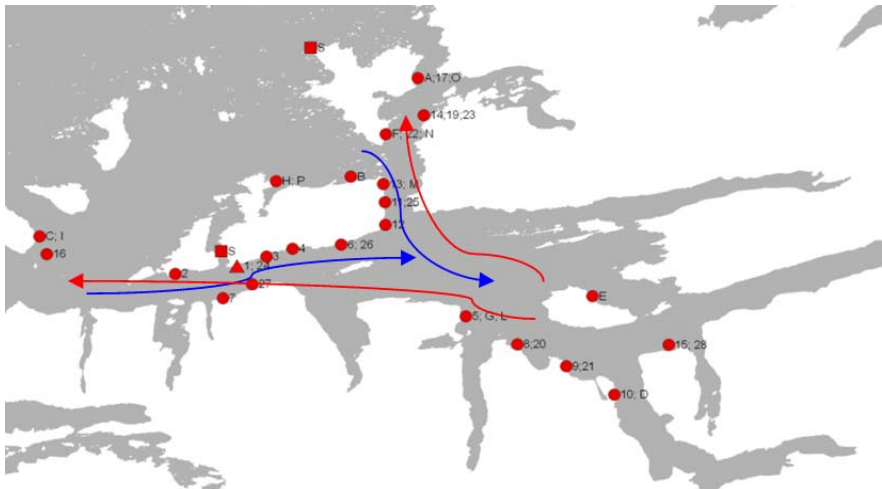
  When a susceptible cohort is receiving virus from infected farming sites.

- Infection pressure

  The % virus particles reaching other farming sites by currents.

- Virus survival

  Half-life in relation to temperature



Hydro-dymamics to identify PD dynamics

Definitions and assumptions on phases in disease development

1: Time of outbreak

Based on the month with peak in mortality after being in water contact with infected farms.

2: Infectious period

Based on time from outbreak until slaughtered out.

3: Time of exposure

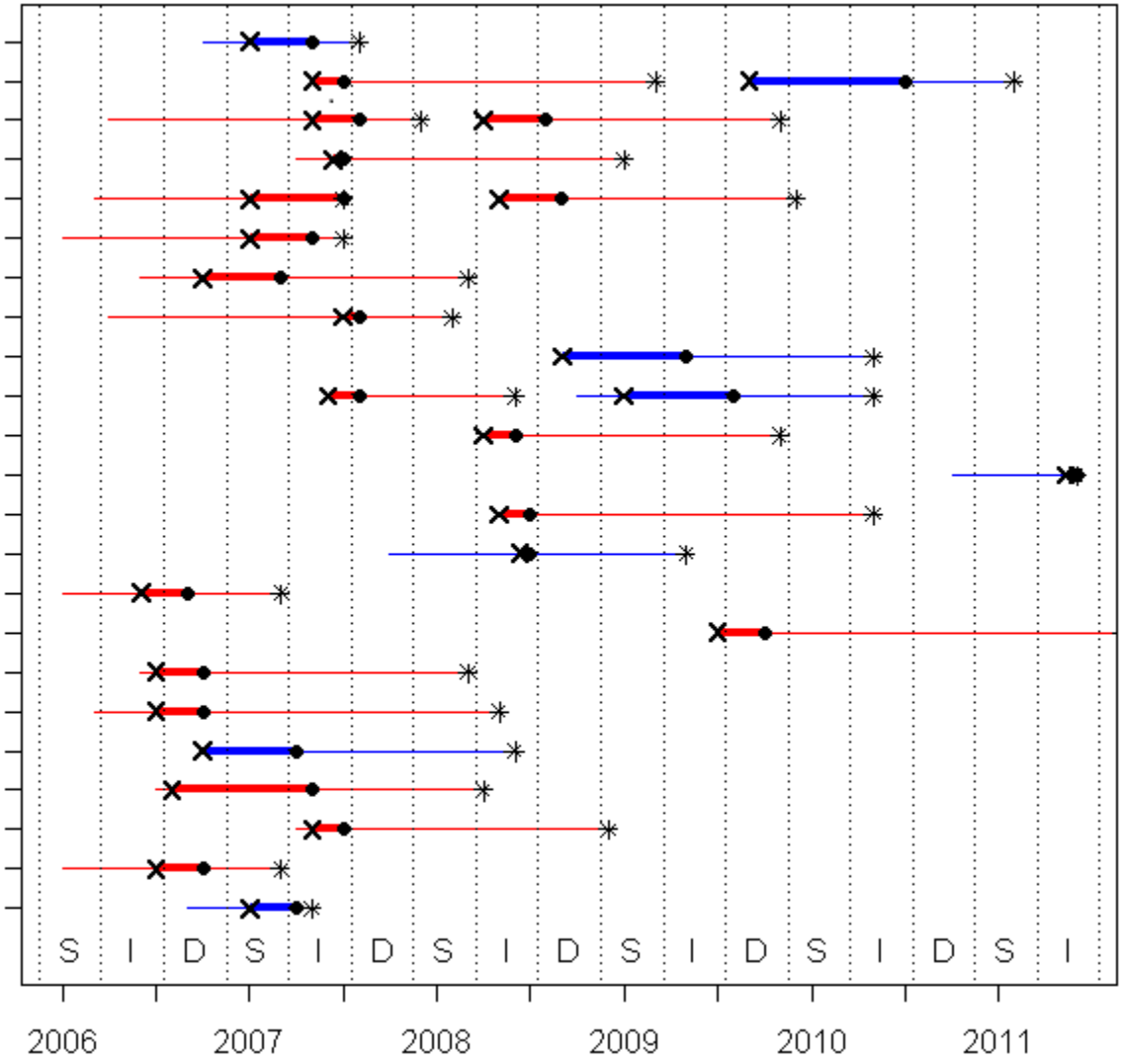
Based on the month when the susceptible cohort is exposed by SAV3 from infected farms by water contact

4: Incubation period

Based on time from exposure until outbreak

AIM: Analyse how temperature change influence PD incubation time

Thick line = Incubation time = time from exposed until outbreak



= time of exposure

= time of outbreak

∗= Slaughtered out

Blue line = autumn smolt

Red line = spring smolt

D = decreasing temperature

I = increasing temperature

S = stable temperature

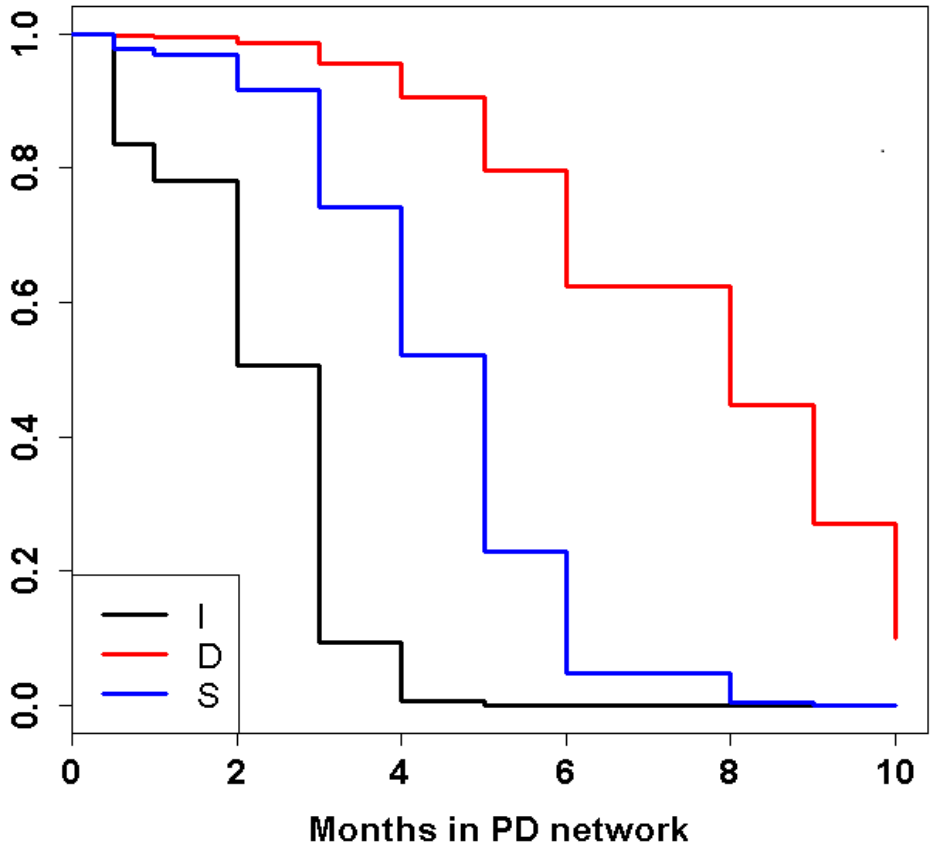
Preliminary results

1. No correlation between the monthly temperature in the sea and the incubation time

2. Correlation between temperature change and incubartion time

- No effect of IPN, HSMI or CMS infection (3 months before PD outbreak) on incubation time
- No effect of sea lice treatment (2 months before PD outbreak) on incubation time.
- No effect of LBD
- No effect of smolt group on incubation time
- No effect of vaccination

The probability of avoiding a PD outbreak



Cohorts in infective networks will get PD
but when the temperature decreasing it will take longer time

Relevant studies:

1. Stress related to temperature elevation may be linked to hypoxic stress.
   Temperature stress increased plasma cortisol , serum IgM and susceptibility to virus in Sea bass (Varsamos et al. 2006).

2. Cortisol have been reported to suppress both the specific and non-specific immune system in carp (Saha et al. 2004).

3. Overconsumption of oxygen in Norwegian salmon farms is most prominent from May until August (Torgersen et al. 2009).

4. The rate of cortisol release increased significantly when fish was exposed to increasing temperature. (Takahara et al. 2011).
   It was no change in rate of release when the temperatures decreased

5. Thermal stress may induce down regulation of the immune system. Salmon adaptation to increasing temperature , is slow and require weeks. Decreasing temperature induce fewer stress responses and regulation is done in days (Torgersen et al. 2009).

6. In the winter pathogenic fish virus may replicate within the host cells as a state of persistent infection and lower temperature can delay the outbreak (Chi et al. 1999).

Conclusion

1. Thermal stress leads to down-regulation of the immune system
2. Habituation to increasing temperature is likely to affect the immune system
3. Increasing temperatures may trigger outbreak in infected fish

Implications for salmon farming

When there is risk of getting an infection from nearby farms:

- Avoid stressful operations until periods of decreasing or stable temperature
  - if possible.
- Slaughter out
  - if time for sale and size of the fish is suitable for acceptable prizes in the market.