Pine Sawfly and its climatic and environmental controls

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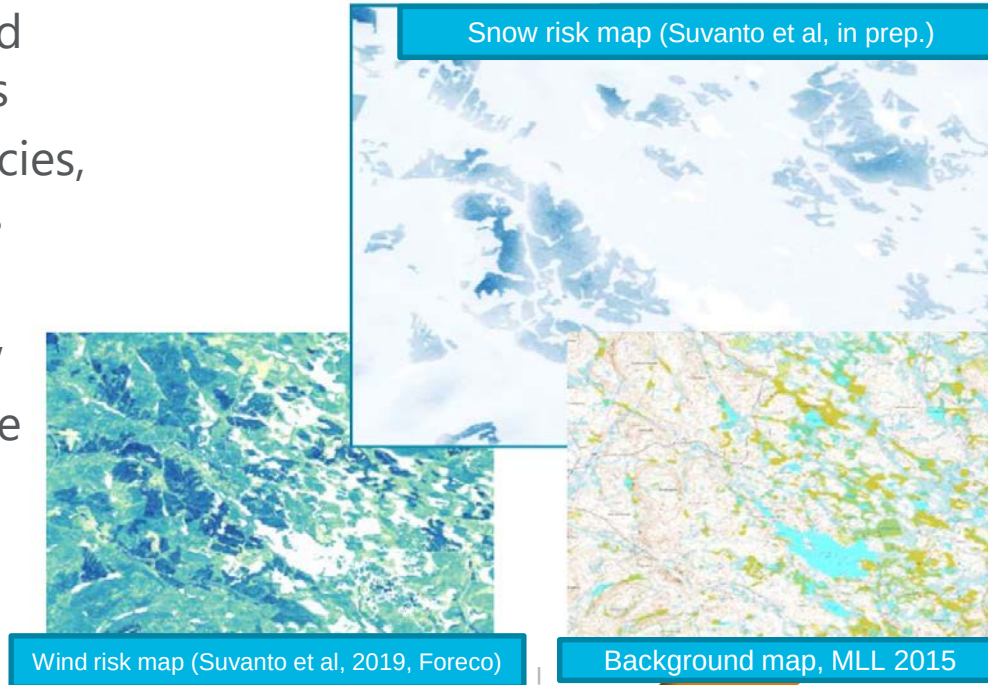
Motivation

- Need to map the disturbance environment of Finland's forests.
    - climate mitigation targets and permanence of carbon stocks
    - Forest use scenarios and policies, owners management choices

- Abiotic disturbances: wind and snow
- Biotic damage agents are much more unpredictable.



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Study content and questions

- Damage caused by Pine sawflies (*N. sertifer, D. Pini*)
    - Important forest pests native to Europe.
    - *N sertifer c*auses defoliation and severe growth losses
        - 20-40% during 5-10 yr, 4% mortality after outbreaks
    - Damage often on drier pine sites
    - Outbreaks occur in irregular intervals of 6-13 years

• Can we identify factors that have promoted or suppressed Pine Sawfly damage occurrence in Finland?

1. What are the risks of damage at different types of sites?
2. How climate contributes to outbreak epidemics?

Fig: Martti Varama

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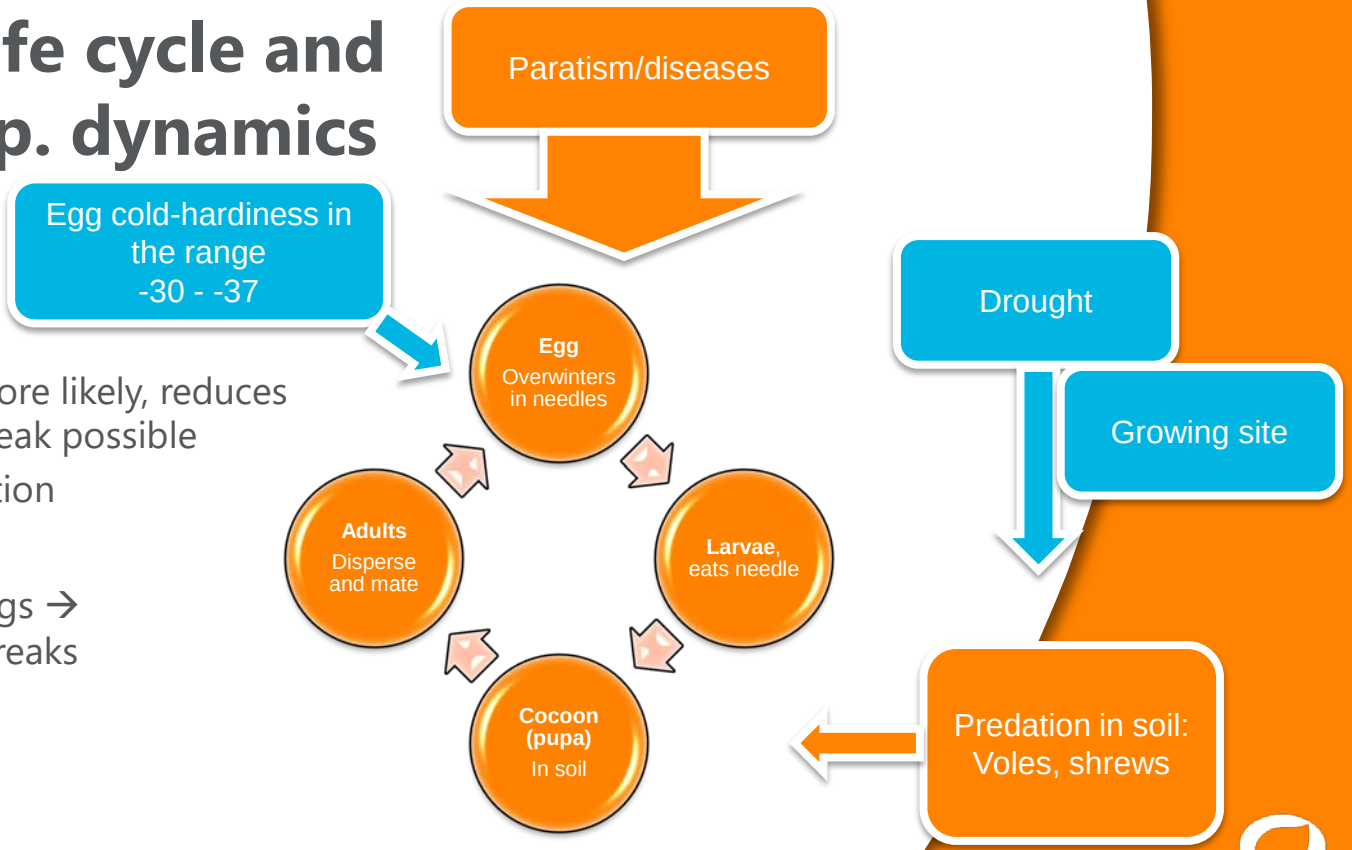
Pine sawfly life cycle and drivers of pop. dynamics

Drought stresses trees, or more likely, reduces mammal predation → outbreak possible

- Dry sites with lesser predation

Winter extreme frosts kill eggs → prevents or terminates outbreaks



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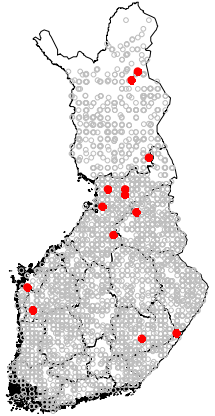
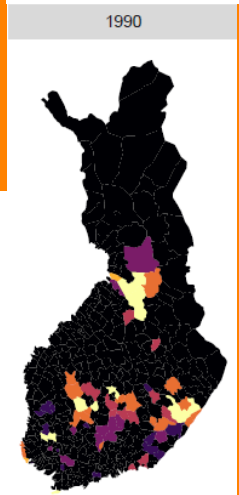
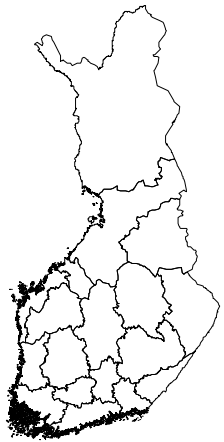
Materials and methods

1. **Site risk level analysis:**
   - Annual observations of damage in ICP I network, 1986-2008)
   - Damage 0/1 (when 1/3 of the trees in showed damage)
   - Covariates: Site type, mean rainfall, likelihood of extreme frost
2. **Climate driver analysis:**
   - Combined ICP+NFI + Municipal records of damage outbreaks to create 1961-2018 data series
   - Standardized damage records in datasets and aggregated for 18 regions
   - Covariates: annual winter minimum T, SPEI







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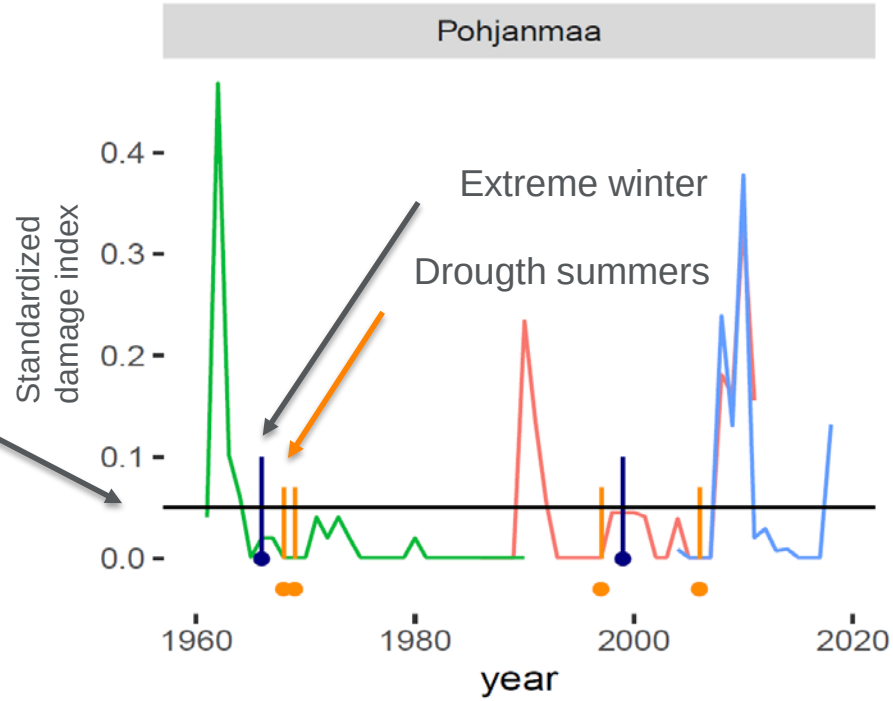
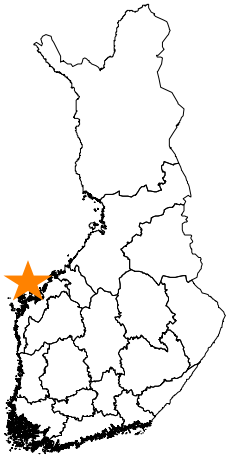
Long term time series and climate drivers

Outbreak limit was set to 5% of maximum outbreak that was detected in data series





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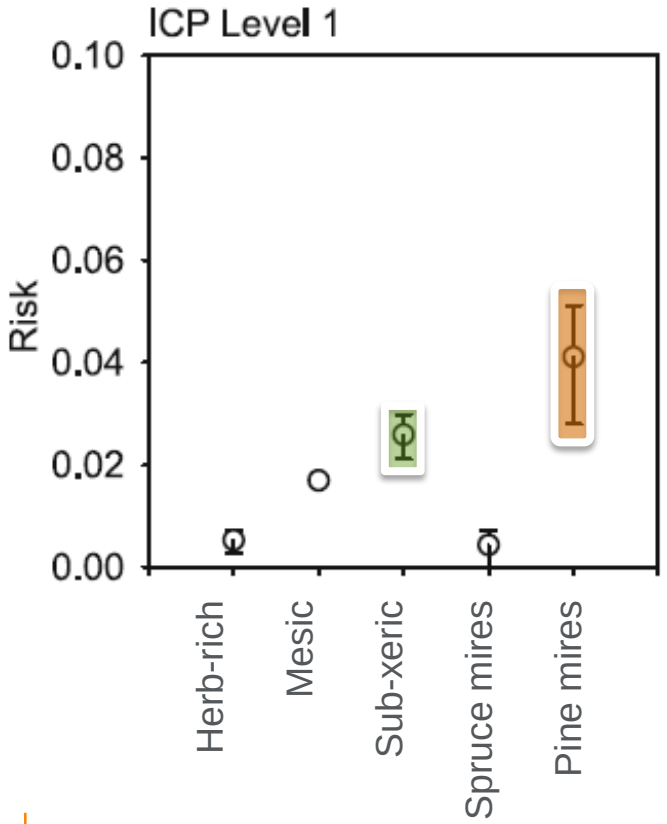
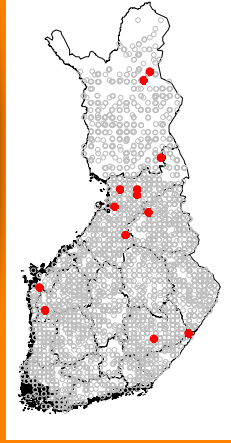
Site risk: outbreaks most likely at poor sites

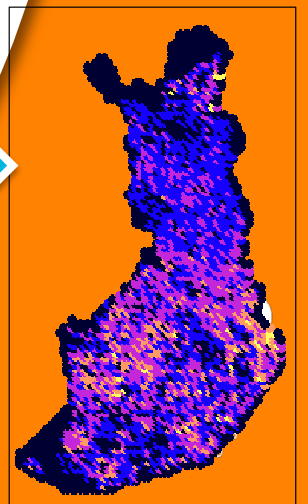


High risk areas are poor and dry sites

Highest risk areas are pine mires (where WTD is near surface)

+ likelihood of extreme winter





Nevalainen S,, Sirkiä, S., Peltoniemi M., Neuvonen, S., Annals of Forest Science (2015)

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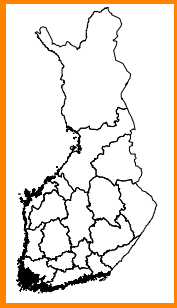
Climate drivers: mild winters and dry previous summers promote damage in trees

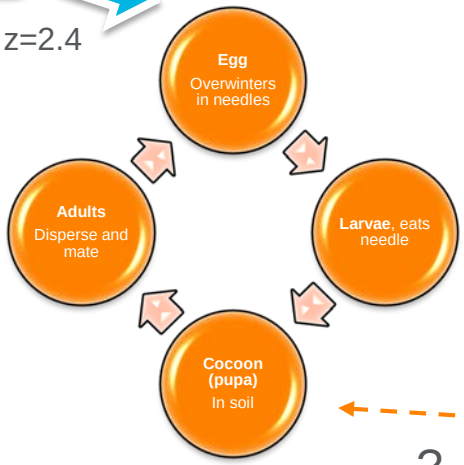


*, p < 0.01, z=2.9

Winter min T

*, p=0.01, z=2.4

Pine mean vol.



Drought. y-1

*, p=0.05, z=1.9

Drought. y-2

*, p=0.001, z=2.6

?

Fig: Wikipedia

?

Logit (p=outbreak | no outbreak in prev. year) ~ covariates

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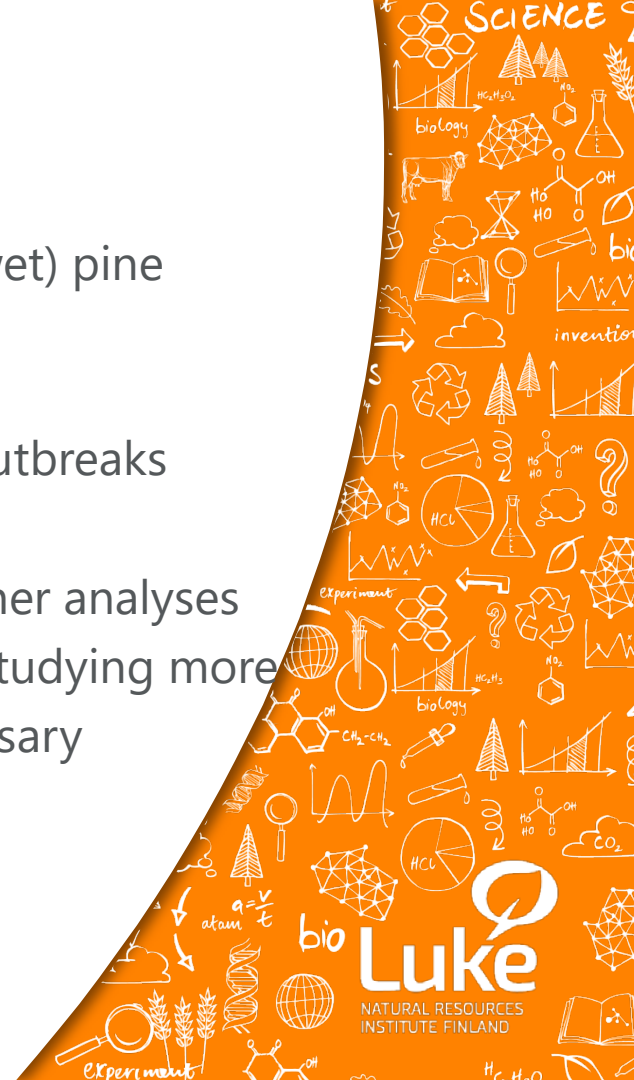
Summary and outlook

- Damage risks are highest in poor dryish sites (and wet) pine mires
- Climate varion influences outbreak dynamics:
    - Previous summer drought predisposes for outbreaks
    - Extreme winter reduces outbreak probability
- Real reasons for drought/dry site effect require further analyses
    - Role of mammal feeding of cocoons worth studying more
- Spatio-temporal analysis of data series seems necessary



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