Swiss Needle Cast Lineage and Severity

Modelling coastal Douglas-fir's most severe Foliage disease

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CoAdapTree
Healthy Trees for Future Climates

Natural Resources Canada | Ressources naturelles Canada
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Research Context

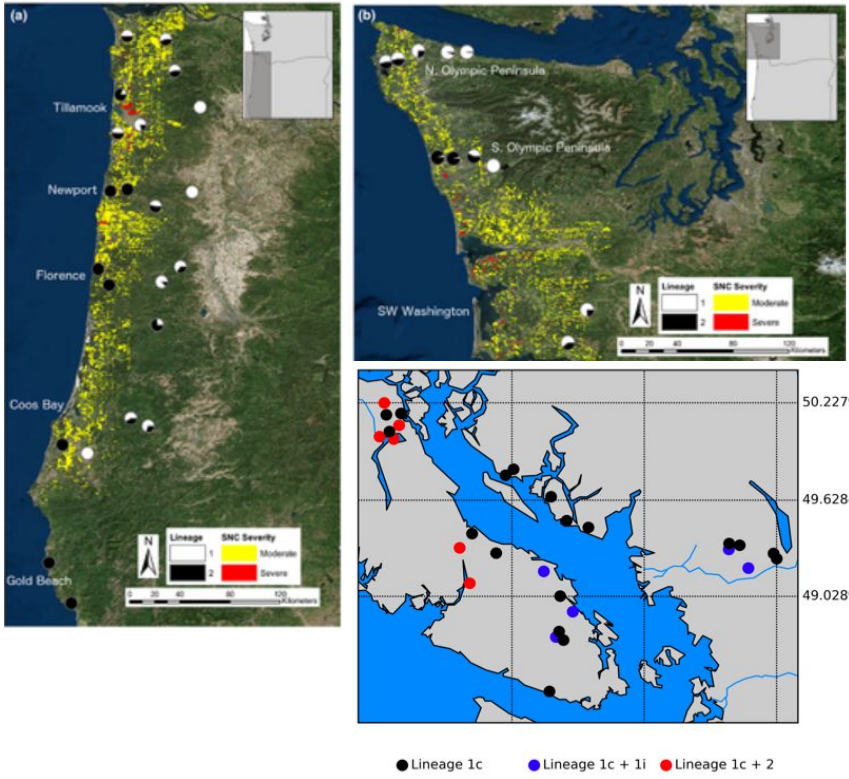
- Anthropogenic climate change alters biotic disturbances
- Coniferous forests severely affected
- Given unprecedented climate patterns, predictive modelling allows us to manage for different future outcomes
- Adaptation strategies:
  - **Assisted migration & seed transfer → Co-adaptree**

Background - Lineages and Severity

- Different lineages → different levels of pathogen virulence
  - E.g. Dutch Elm disease ulmi vs novo-ulmi
  - E.g. Phytophthora ramorum NA1, NA2, EU1, EU2
- The particular case of *N. gaeumannii* - intercellular
  - “Virulence” or “Pathogenicity” dependent on pseudothecia abundance → environmental conditions
  - Adaptation of each lineage to different climates is therefore crucial - if the conditions for growth are optimal, amount of tissue and therefore reproductive tissue should increase

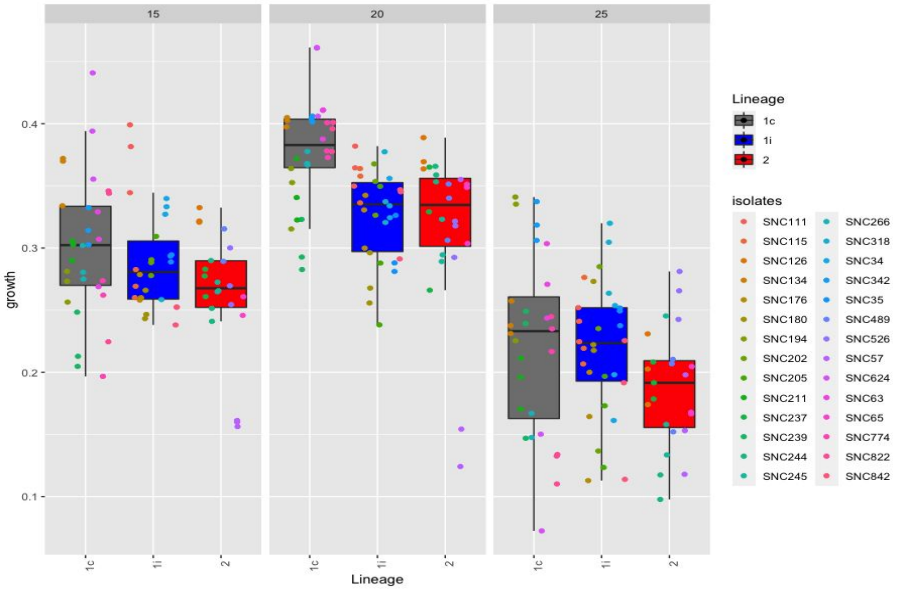
Background - Lineages, Severity and Climate

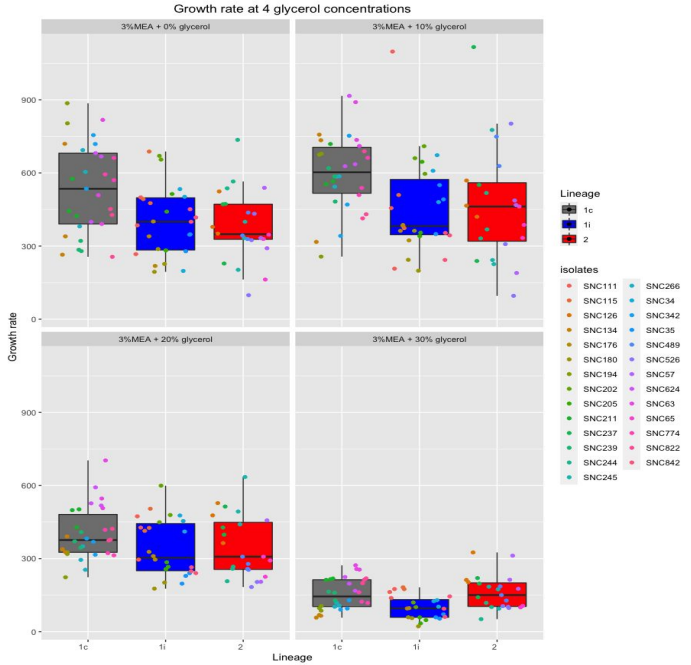
- 2 reproductively isolated lineages
  - More recently - L1i + L1c
- Differences in where lineages occur
  - In Oregon, lineage 2 most abundant where symptoms are most severe, but no symptoms on some sites where only Lineage 2 is present
  - In BC, 1c is present everywhere we looked L2 found in historical herbarium samples
- Emerging hypothesis: lineage 1c is encroaching on lineage 2, causing worse symptoms



Background - Lineages, Severity and Climate

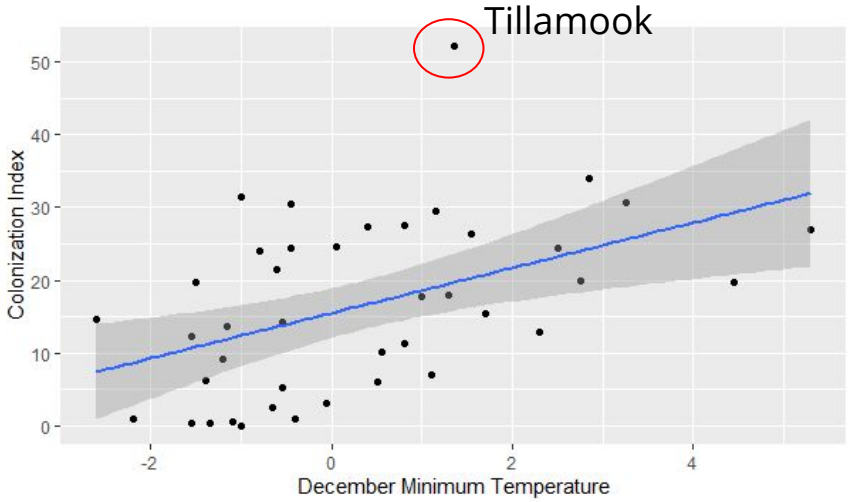
- Lineage 1c seems to have an advantage over the two others in almost every kind of environment





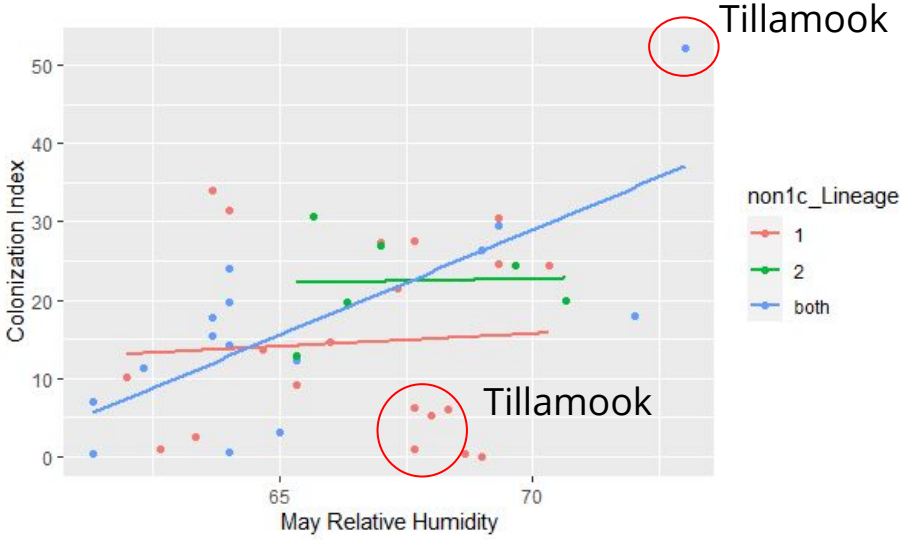
Severity Modelling - Lineages and Climate

- Combined BC monitoring plots + Bennett & Stone (2019) sites
- Climate NA data for years relevant to the 2-year-old needles' lifespan
- Significant positive relationship between Colonization index and winter minimum temperature
- Outlier - Tillamook site



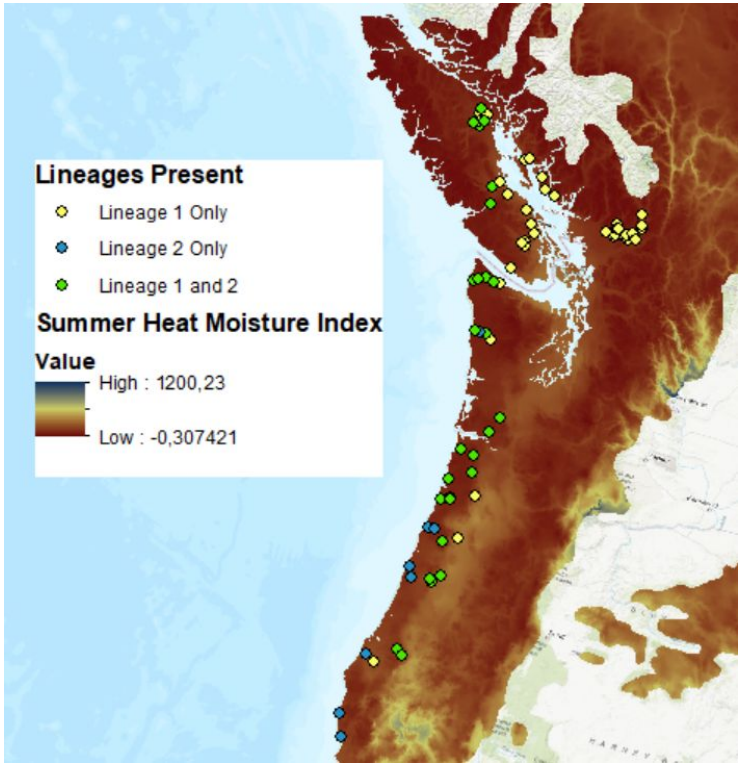
Background - Lineages, Severity and Climate

- Positive interaction between Relative Humidity in the spring and the presence of both lineages
- Tillamook outliers
- Generalized linear model - only~40% of variance explained by these variables
- Therefore: High quality maps of the spatial distribution of each lineage can provide clues to severity patterns!



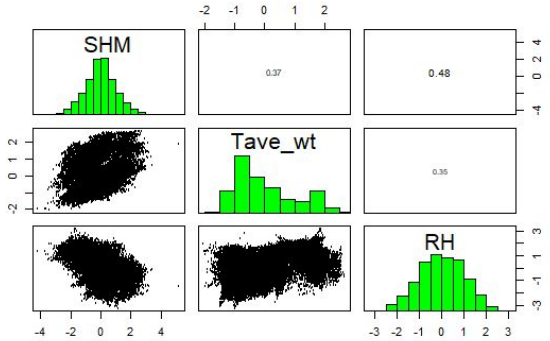
Modelling Lineage – Climate

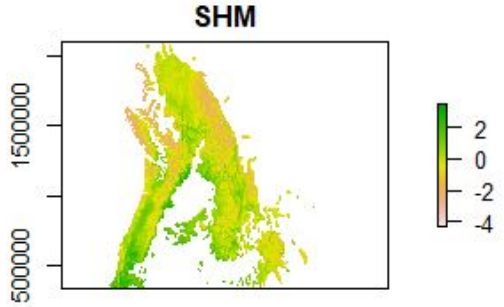
- Species Distribution modelling → Lineage Distribution modelling !
- Biomod2 package in R
- Presences of two lineages
  - (not enough points for L1i yet)
  - Lineage identification in WA & OR SNCC samples ongoing
- Ensemble of 3 models
  - Random Forest - bagged decision trees
  - GLM - logistic modelling
  - Maxent - maximum entropy

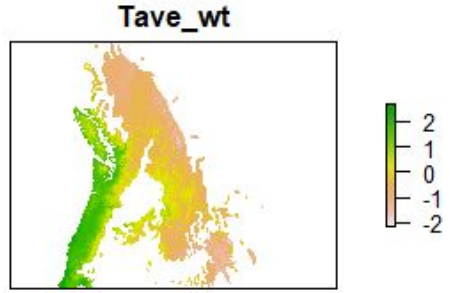


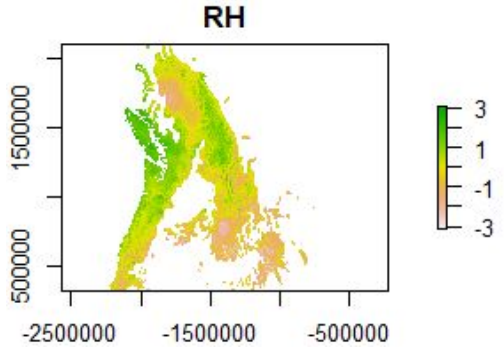
Modelling Lineage – Climate: Environmental Variables

- Bioclimatic variables obtained from ClimateNA/AdaptWest
- Current climate + future climate
  - RCP 8.5 scenario









SHM: Summer Heat Moisture Index (low = cool wet, high = hot dry)

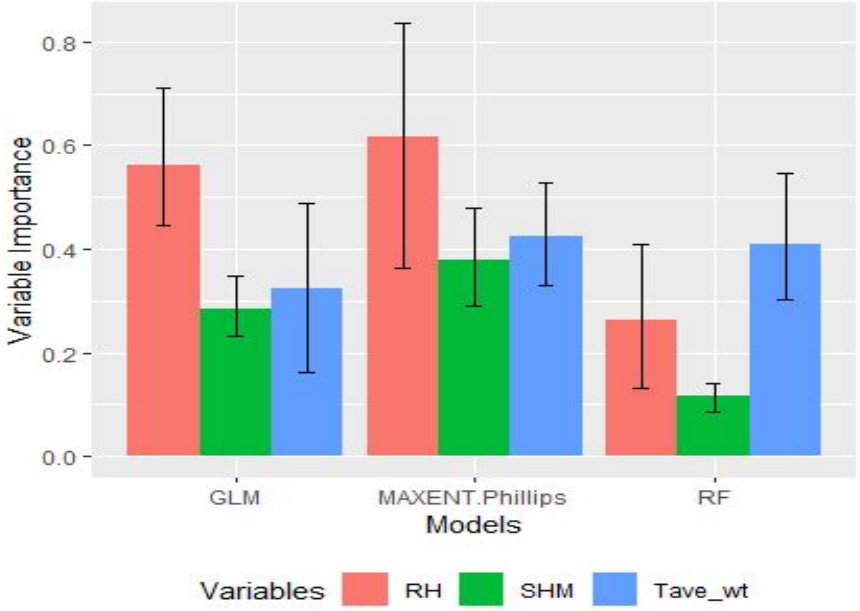
Tave_wt: Winter Average Temp

RH: Relative Humidity

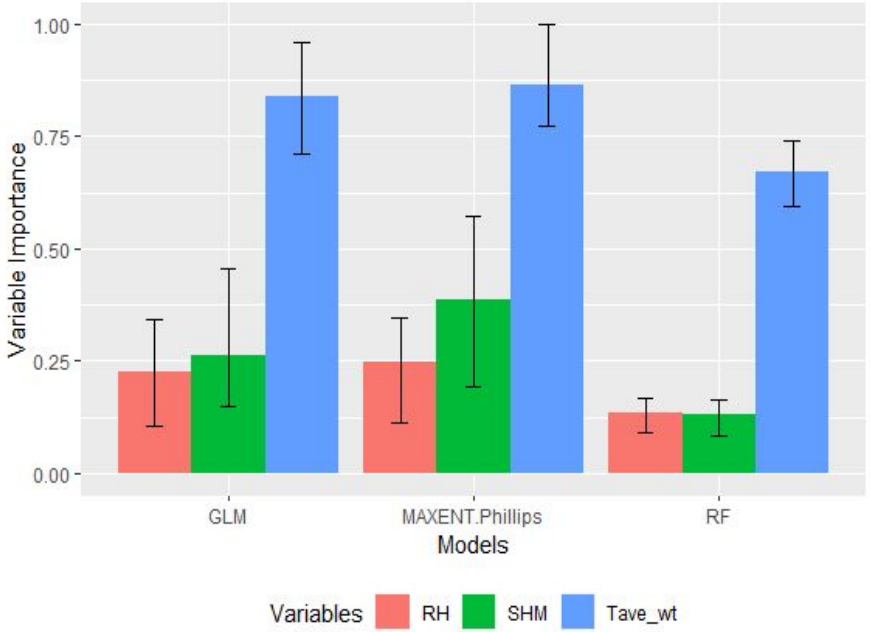
(Centered and Scaled)

Modelling Lineage – Importance of Climate Variables

- L1

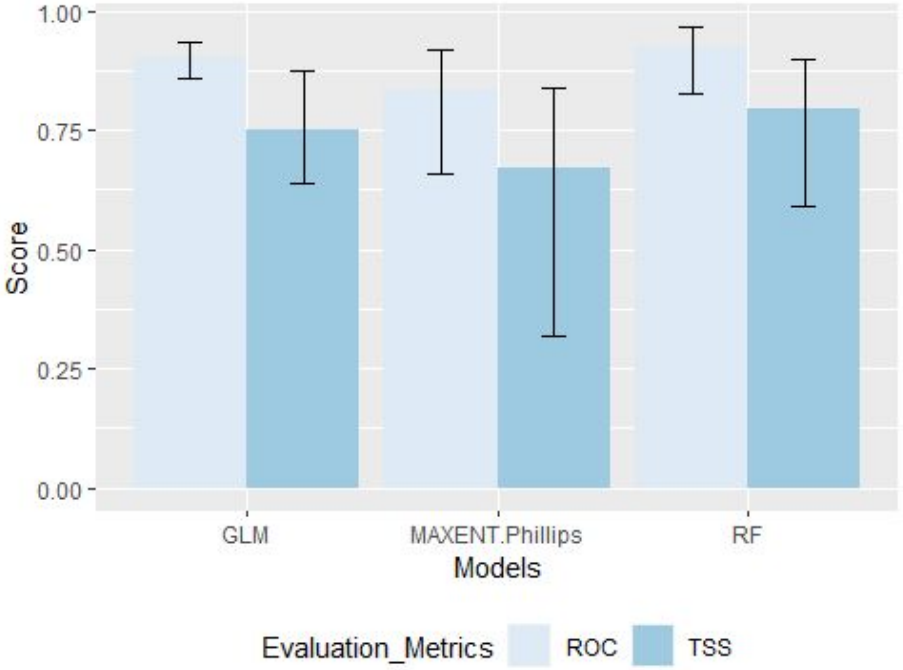


- L2

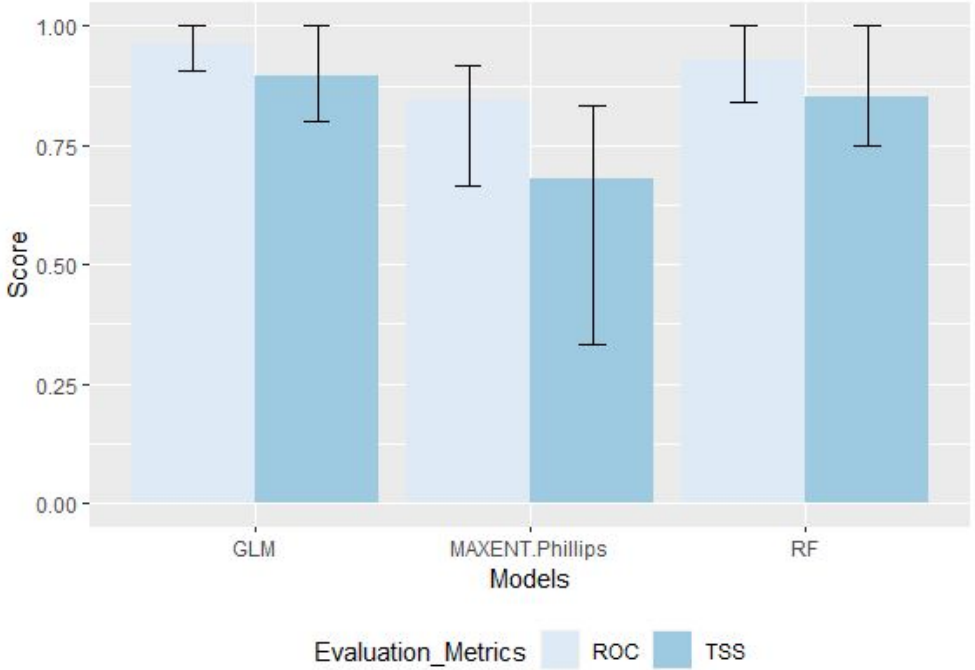


Modelling Lineage 1 - Model Evaluation

- L1

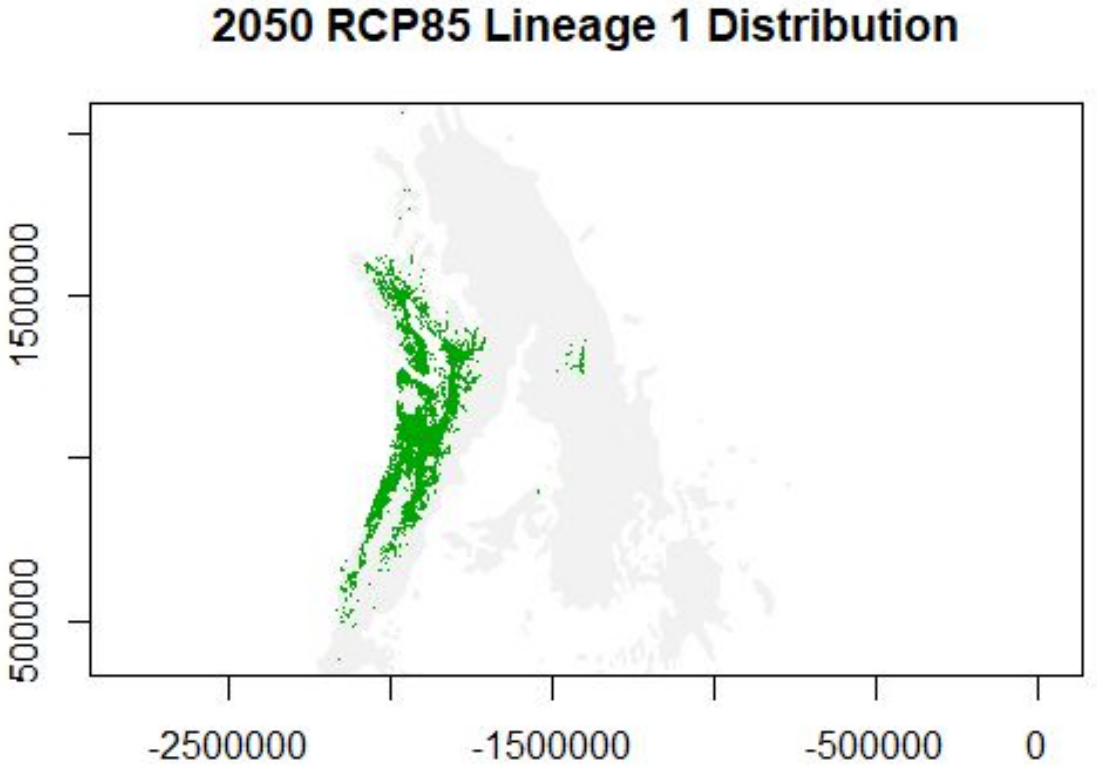


- L2



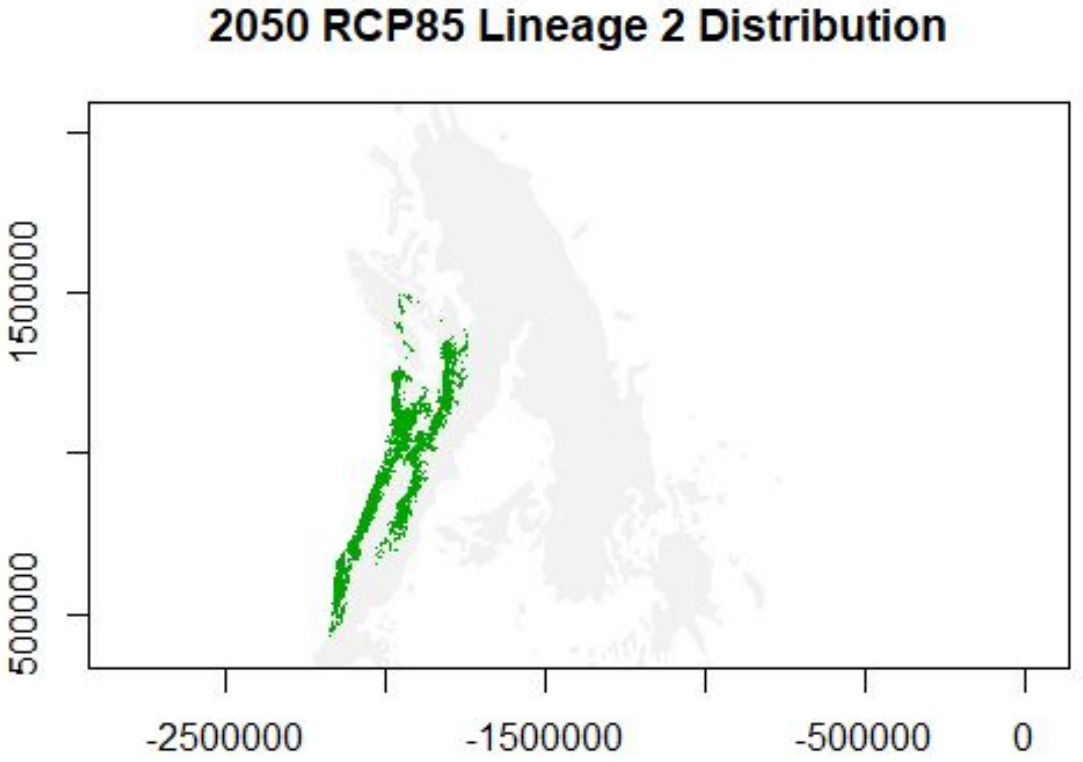
Modelling Lineage – Climate: Results

- Probability of Occurrence threshold = 0.5
- Lineage 1 moving slightly inland, but suitable area decreasing



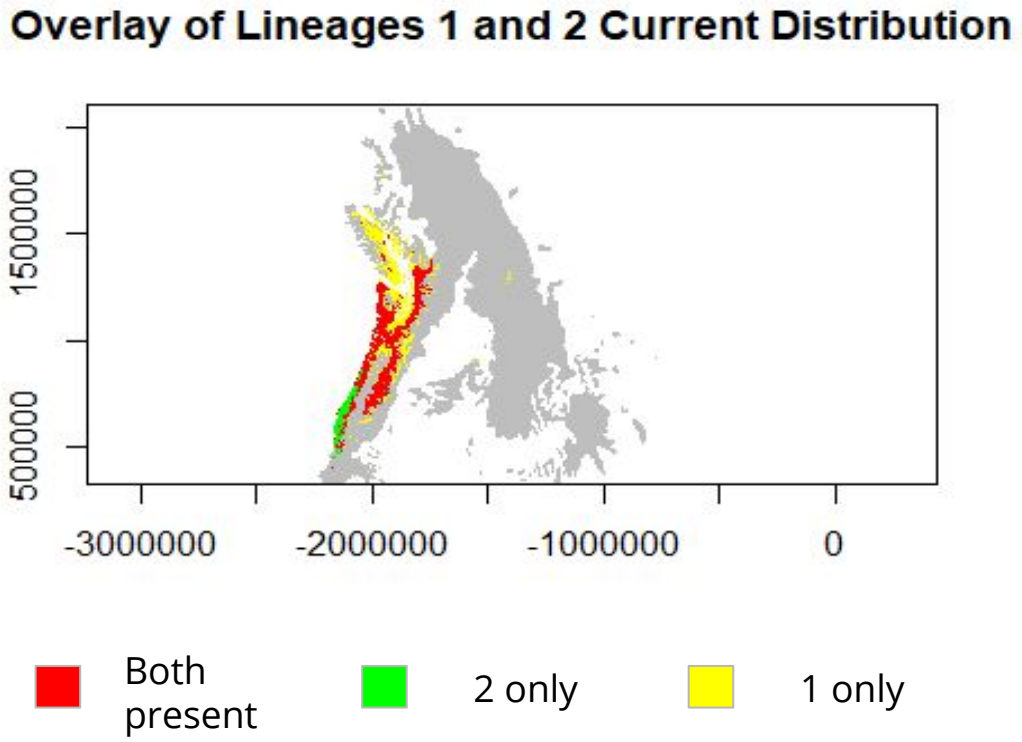
Modelling Lineage – Climate: Results

- Probability of Occurrence Threshold = 0.5
- Lineage 2 will move northwards, but climatically suitable area is decreasing as well



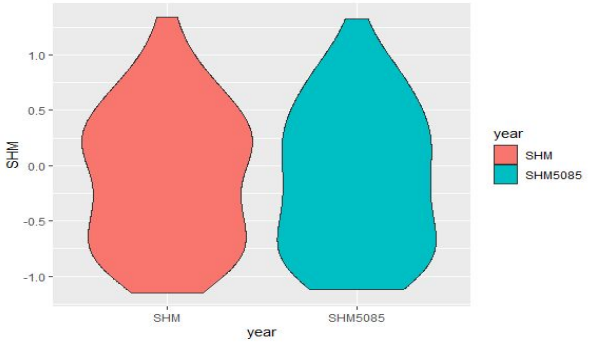
Modelling Lineage – Climate: Results

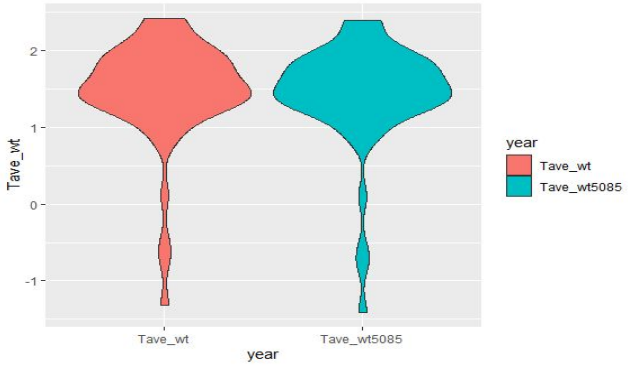
- Given severity trends, areas where both are present = higher overall severity
- Area where both are present will shift northwards



Modelling Lineage – Discussion

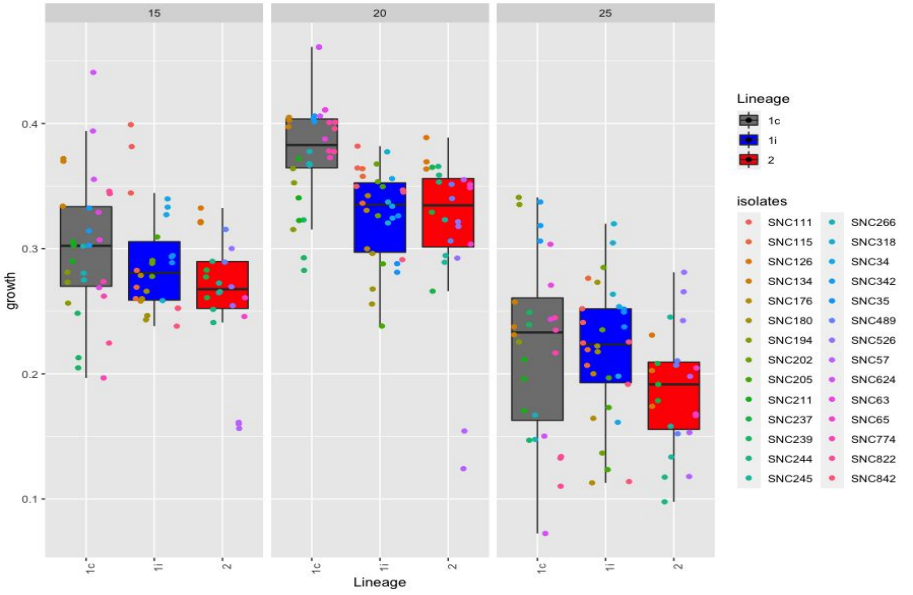
- Climate Change - Winter temperature doesn't seem to be changing that much in the next 30 years

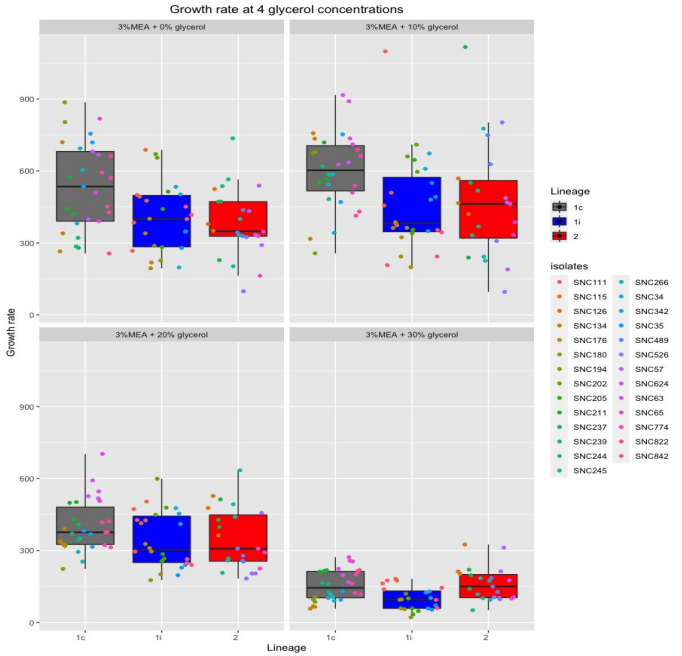




Modelling Lineage – Discussion

- Lineage 1c and Lineage 1i are in the same category- possibly confounding





Modelling Lineage – Climate: Next Steps

- More lineage presence points needed !!!
- Include L1i
  - only 13 relatively clustered presence points - not enough to create a reliable model
- Detect lineages at more sites - samples received from Oregon and Washington
- Include edaphic and host genetics factors
- Open to suggestions as to other variables to include in models !

Thank you !

Questions & Discussion

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