Climate modifies competitive interactions in a late-seral Douglas-fir forest

Student Research Symposium
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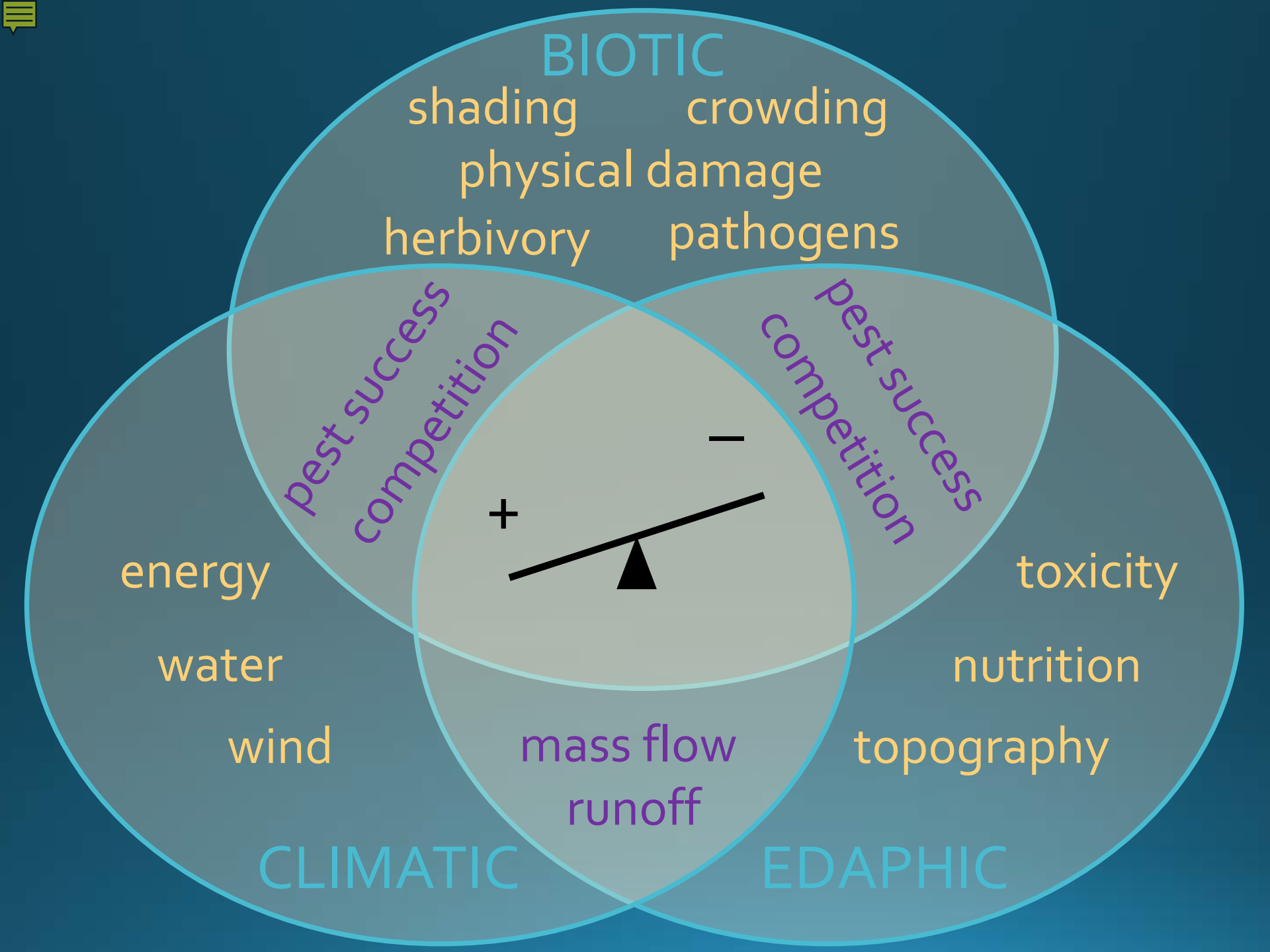
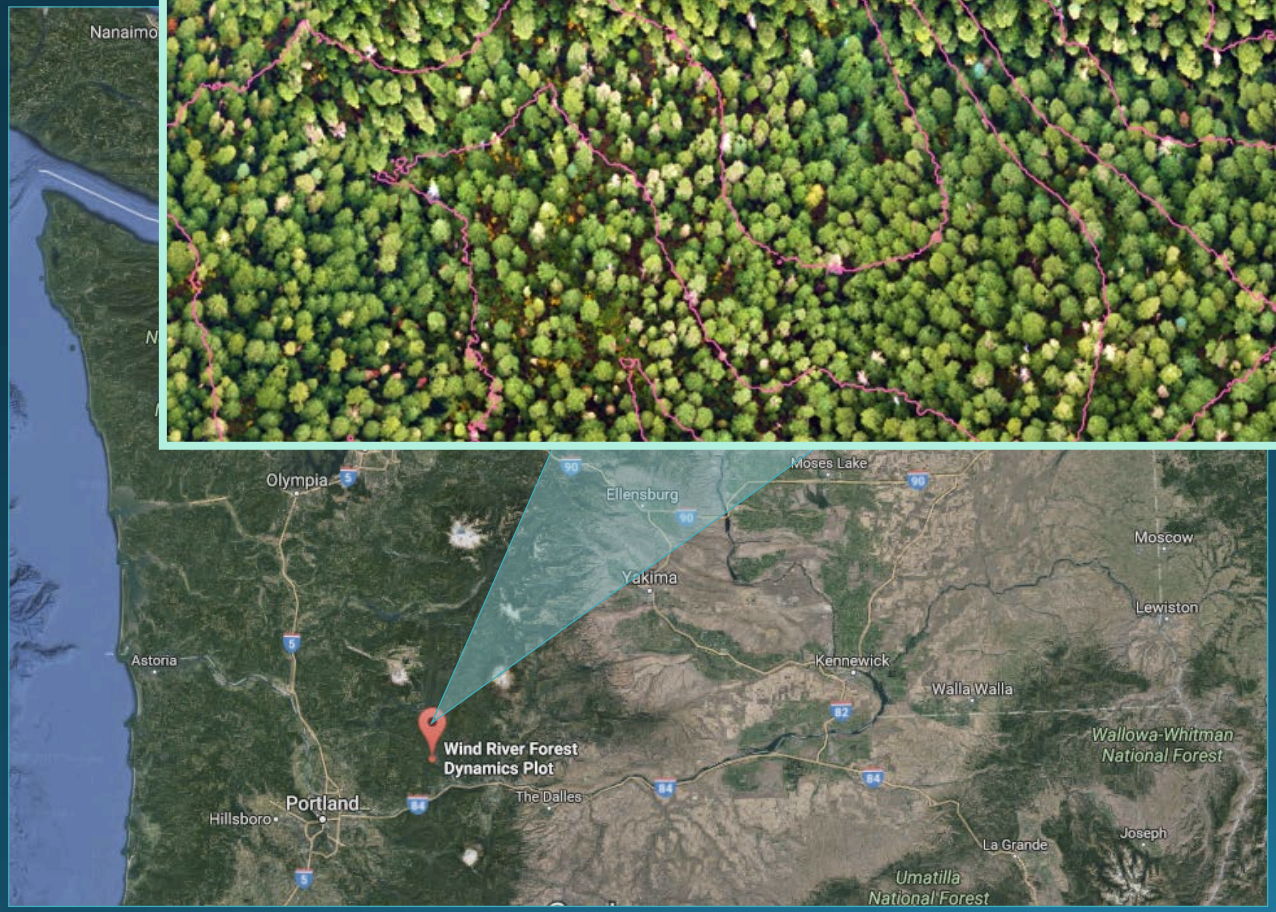

BIOTIC
shading
crowding
physical damage
herbivory
pathogens
pest success
competition
pest success
competition
–
+
energy
water
wind
toxicity
nutrition
topography
mass flow
runoff
CLIMATIC
EDAPHIC

Wind River **F**orest **D**ynamics **P**lot



Meters 0 50 100 200

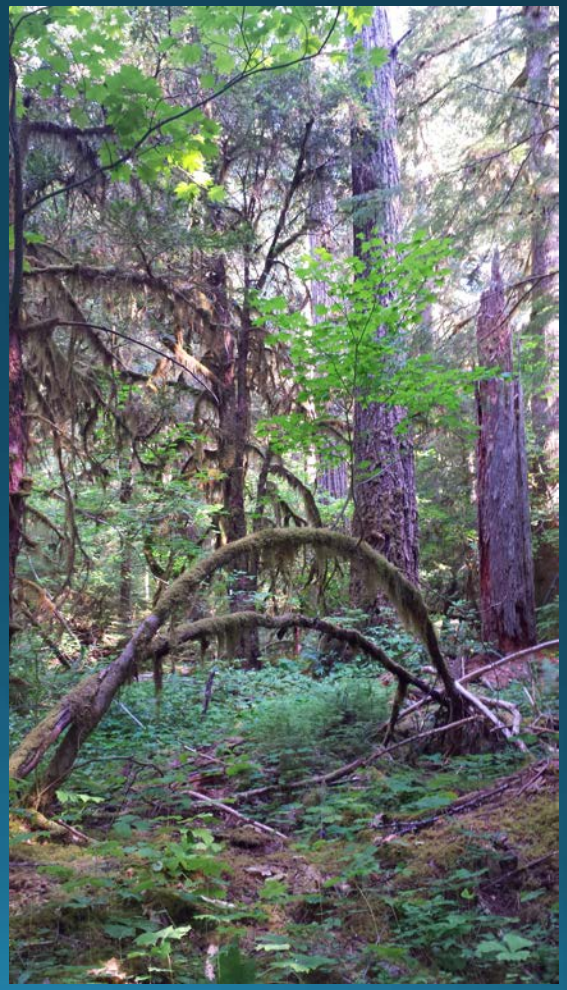
Research Objectives

1. Quantify interactive effects

   Does tree mortality depend on biotic, edaphic, climatic contexts?

2. Project into future

   Will population trends change with changing climate?



1. Interactions

Biotic

Hegyi (conspecific)
Hegyi (heterospecific)
Species richness

$$H_i = \sum \frac{DBH_j}{(1 + Distance_{ij})(DBH_i)}$$

Edaphic

N	Fe	Elevation
P	Al	
TEB		

Climatic

Climatic water deficit
Snowpack

1. Interactions

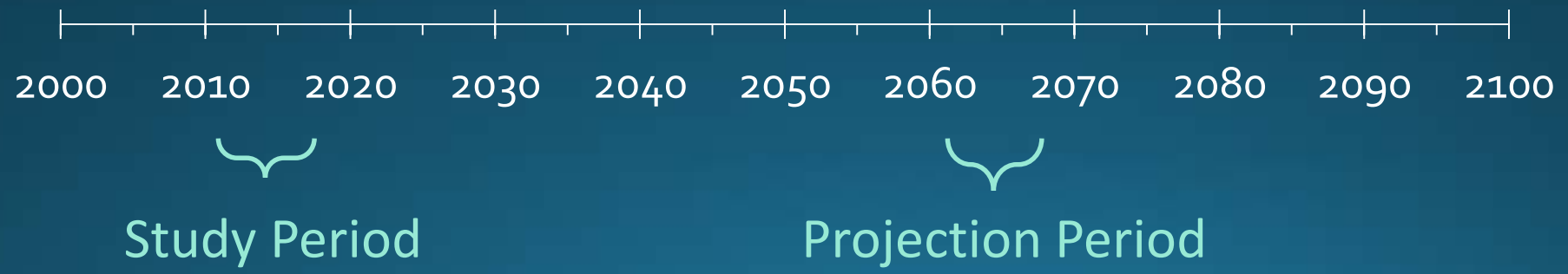
Cox Regression

- time-invariant predictors
- time-variant predictors
- Hazard = instantaneous probability of event at time (t)

$$h(t) = e^{(ß_i X_i + \ldots + ß_k X_k)} \lambda(t)$$

2. Projections

CCSM4	National Center for Atmospheric Research, USA
GFDL-CM3	National Oceanic and Atmospheric Administration, USA
GFDL-ESM2M	National Oceanic and Atmospheric Administration, USA
GFDL-ESM2G	National Oceanic and Atmospheric Administration, USA
HadGEM2-CC	Hadley Centre for Climate Prediction and Research, UK
HadGEM2-ES	Hadley Centre for Climate Prediction and Research, UK



Results

1. Interactions

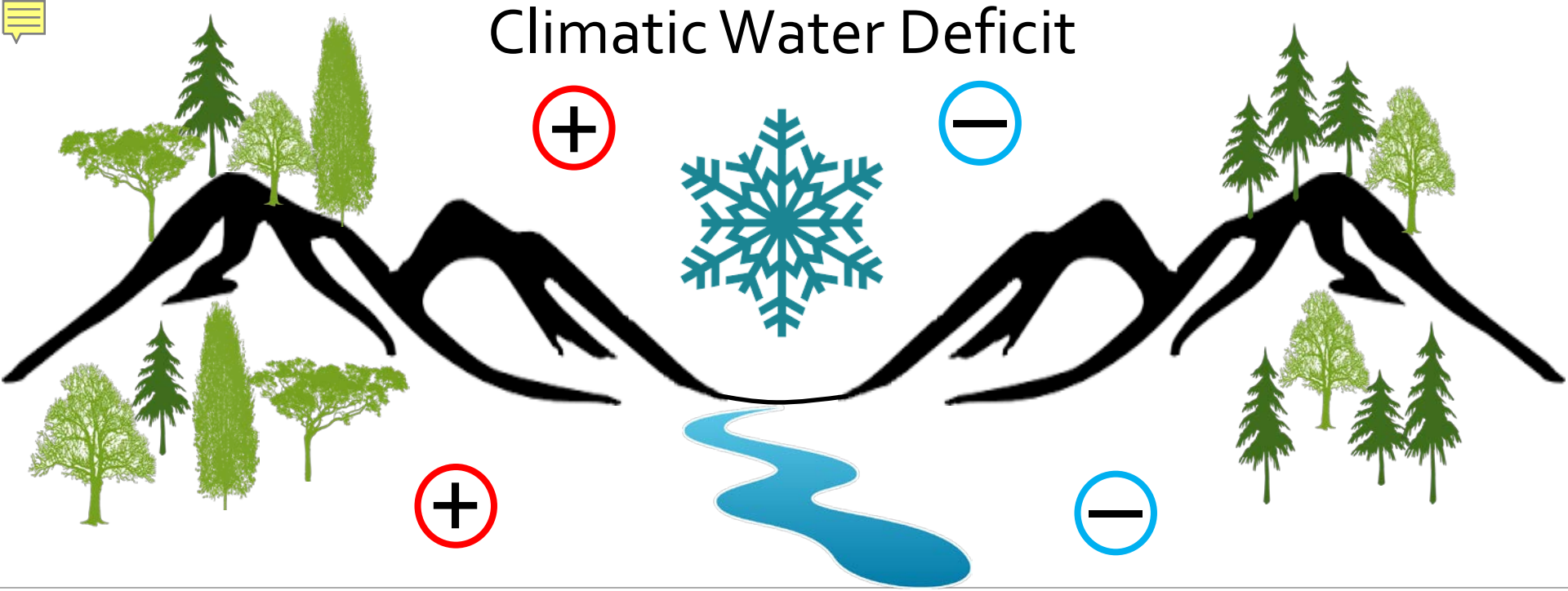
Primary Effects Model

Al	–
Fe	+
N	+
P	
TEB	–
Elevation	
Deficit	–
Snowpack	–
Hegyi (con)	
Hegyi (het)	+
Richness	

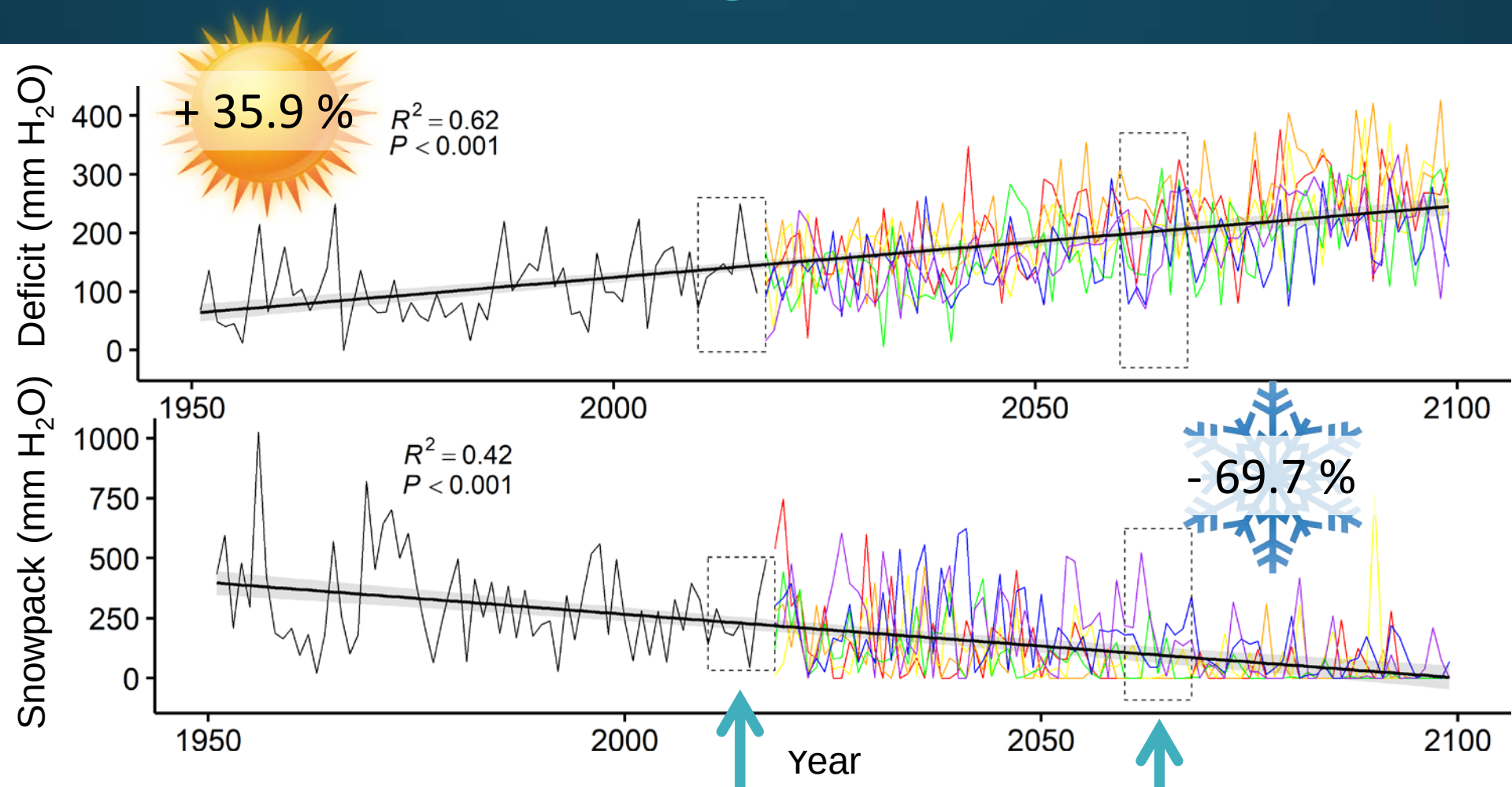
Interactive Effects Model

Al	–	
Fe	+	
N	+	*
P		
TEB	–	*
Elevation		*
Deficit	+	*
Snowpack	–	*
Hegyi (con)		
Hegyi (het)	+	*
Richness	–	*

Climatic Water Deficit



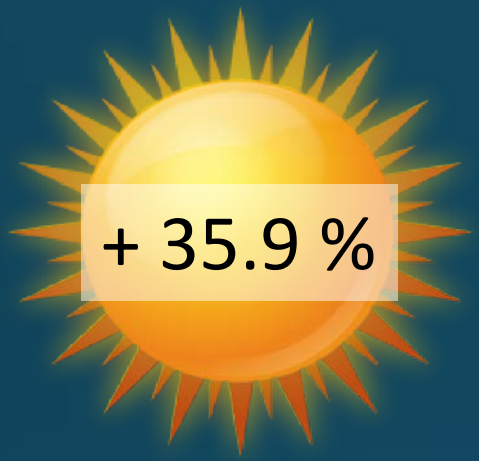
2. Projections

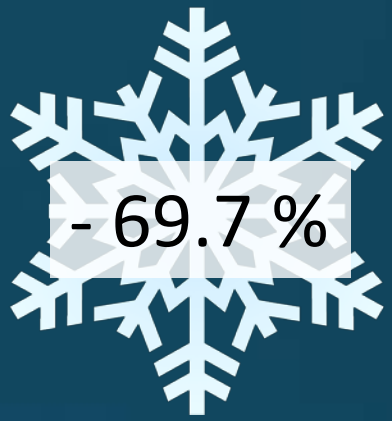


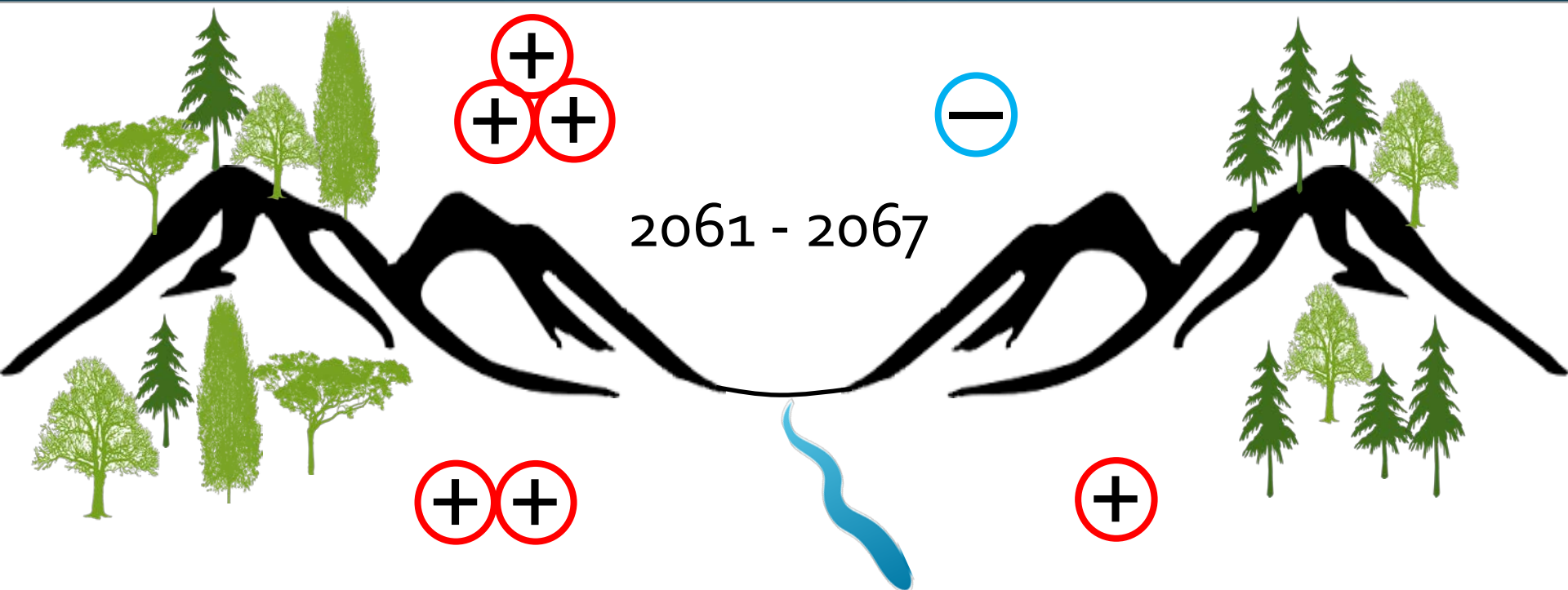
Study Period

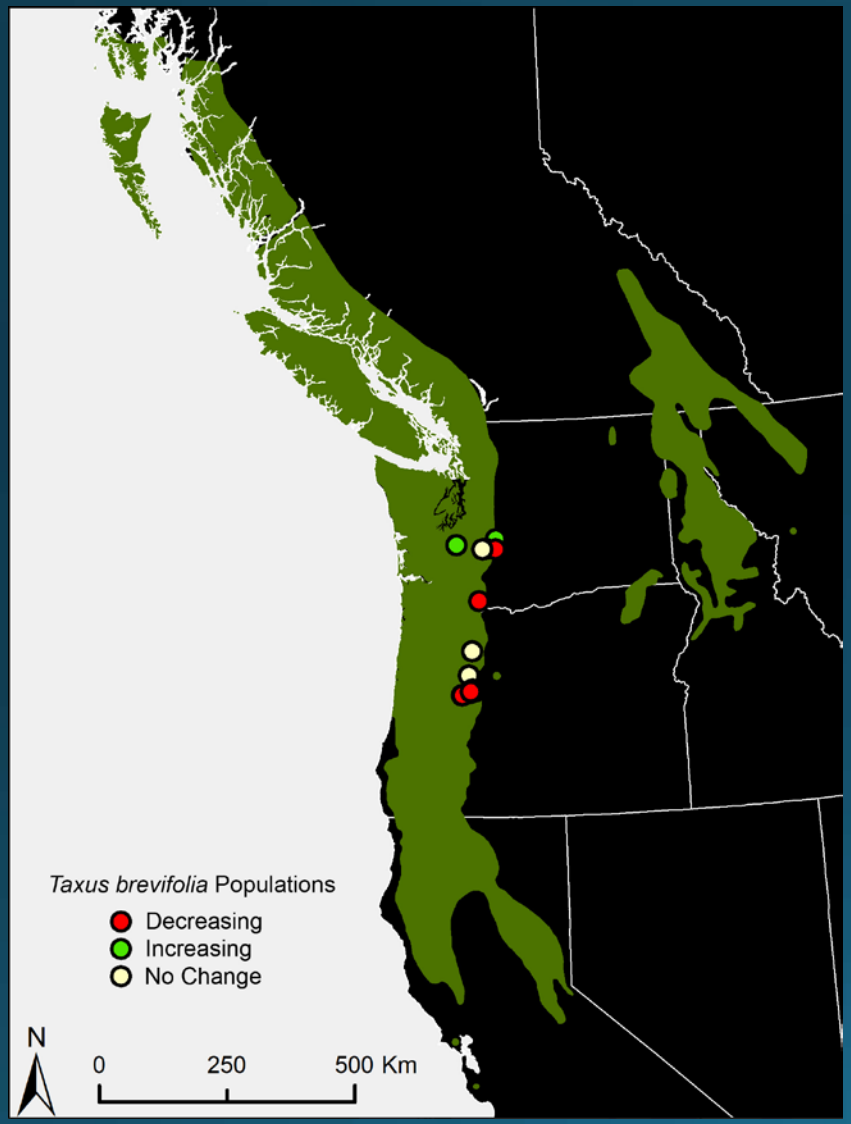
Projection Period

2. Projections









Sparsely heterospecific
+ drier site
tissues acclimated to low water
low competition for water

Conclusions

- Hypothesis-generating study

  Unique mechanisms per interaction

- Interactions must be considered
- Inter-annual climate variability matters

  Extrapolation to long-term trends uncertain,

  but in agreement with mortality projections (Das et al. 2013)

Acknowledgements

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PRISM

past.def

Min.	Mean	Max.
71.9	144.9	250.5

future.def

Min.	Mean	Max.
154.9	196.9	236.3

past.snow

Min.	Mean	Max.
42.67	252.57	494.72

future.snow

Min.	Mean	Max.
30.62	76.49	104.38

1. Interactions

Cox Regression

- time-invariant predictors
- time-variant predictors

Hazard = instantaneous probability of event at time (*t*)

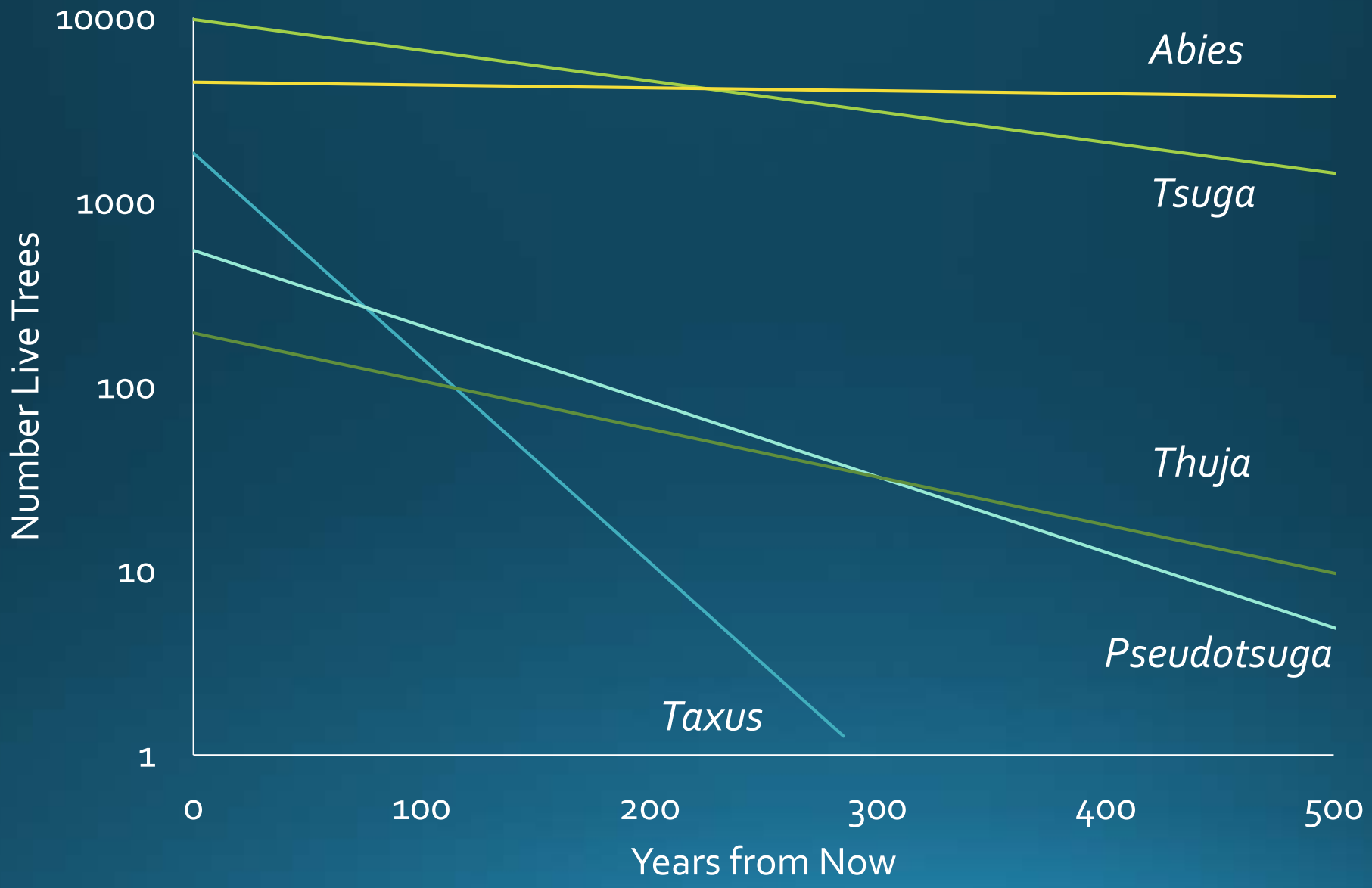
$$h(t) = e^{(ß_i X_i + \ldots + ß_k X_k)} \lambda(t)$$

Hazard ratio = predictor effect on hazard

$$HR_i = e^{n * ß_i}$$

$$HR_i = e^{n * [ß_i + (ß_{i,k} X_k) + (ß_{i,j} X_j) + (ß_{i,j,k} X_j X_k)]}$$

$$P_t = P_0 e^{rt}$$


10000
1000
100
10
1
Number Live Trees
0
100
200
300
400
500
Years from Now
Abies
Tsuga
Thuja
Pseudotsuga
Taxus