Historical tree species height growth of British Columbia associated with climate change

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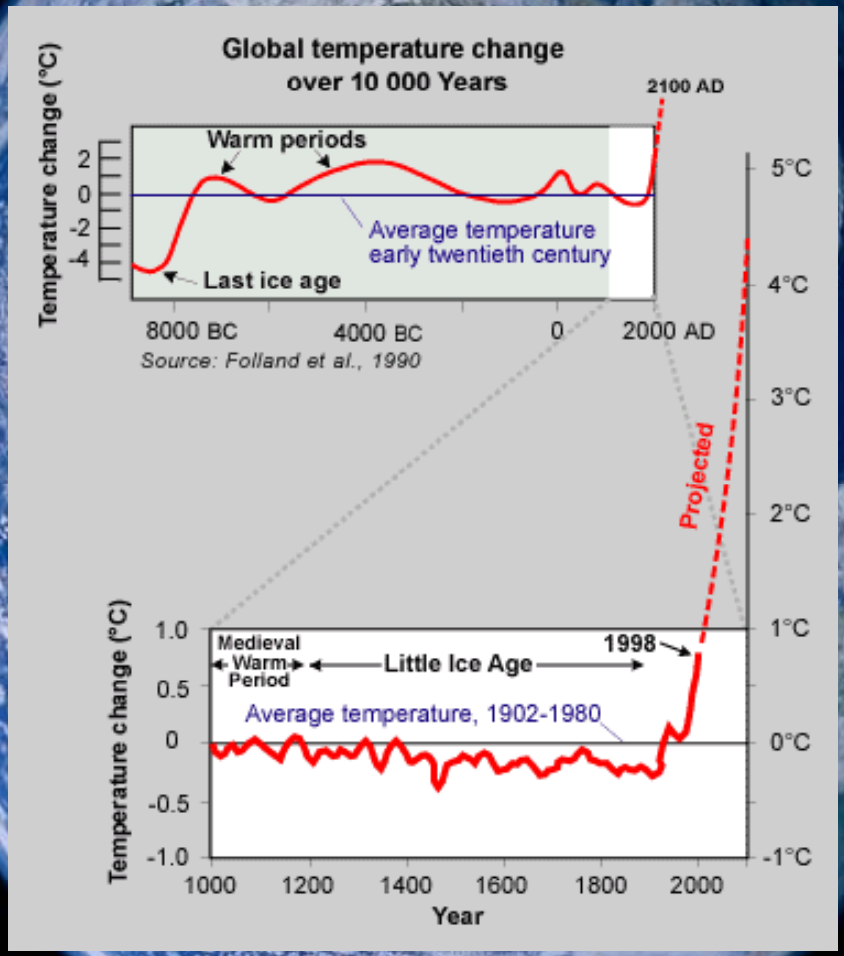
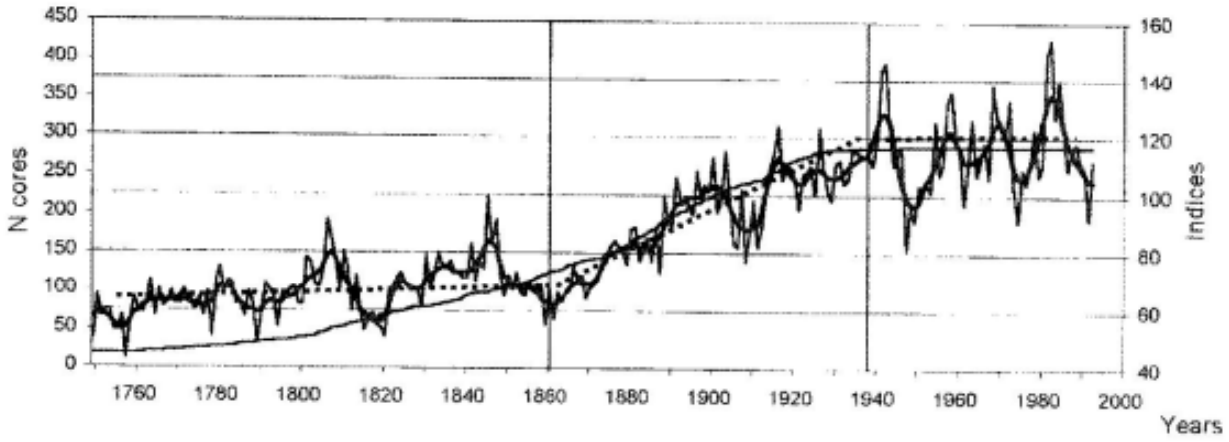
Introduction: Global change

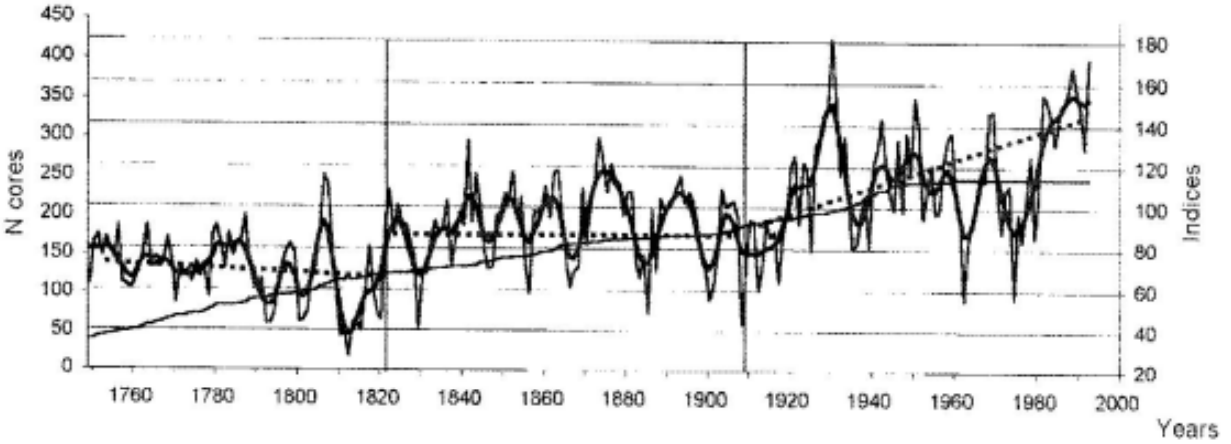


Introduction: Tree growth

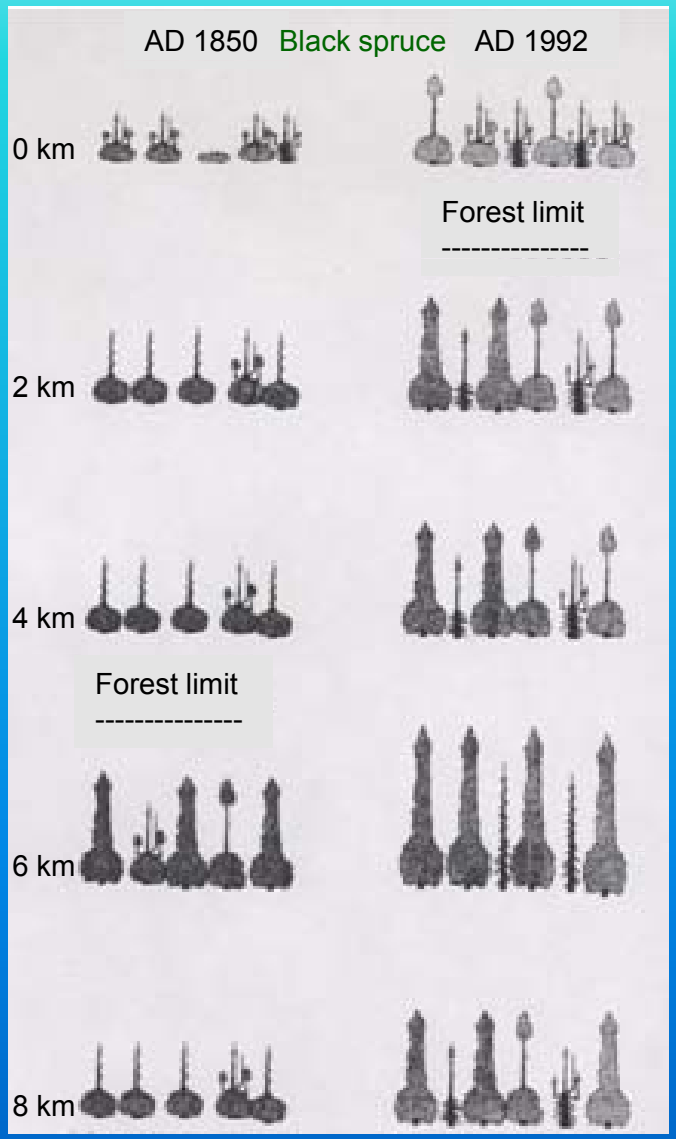
Norway spruce



European larch

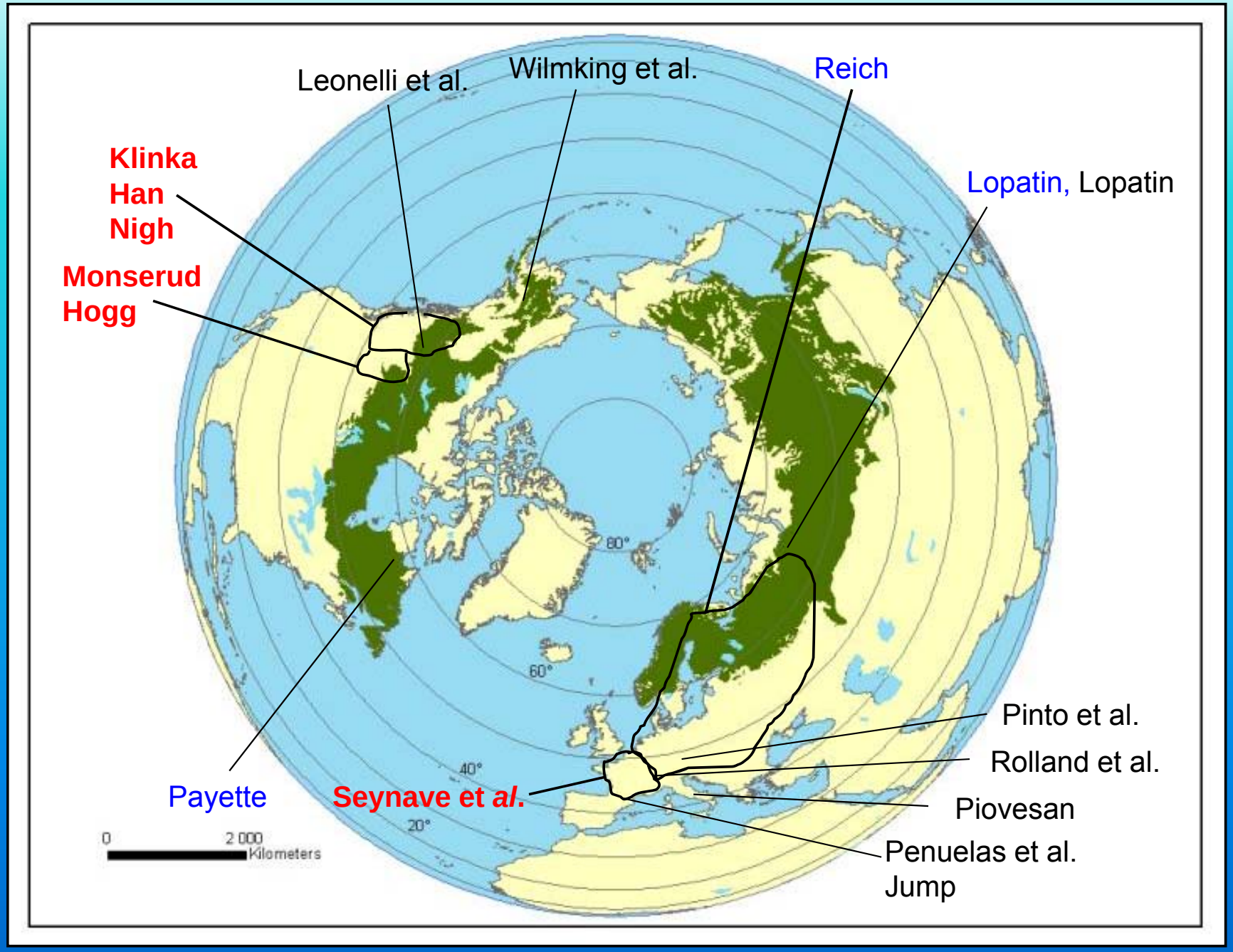


Rolland et *al.*, 1998



Lavoie & Payette, 1984

Introduction: Previous studies



Tree growth climate change

Introduction: Media interest

Los Angeles Times | ENVIRONMENT

Greenspace

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Warming climate could promote forest growth

October 19, 2009 | 9:51 pm

A warming planet is expected to bring a host of ills, including rising seas, spreading deserts and disease infestations. Yet it's not all bad news, apparently. Researchers at Oregon State University looked at a variety of climate models and found that higher-elevation forests in the Pacific Northwest can be expected to vigorously expand their growth with warmer temperatures -- up to 500% a year, under some scenarios.

That means more carbon sequestration. But there's a downside too: lower-level forests, where the majority of timber is harvested, could see declines as warmer temperatures dry up moisture. Their report was published in the journal Forest Ecology and Management. Read more here.

--Kim Murphy

Photo: Al Seib / Los Angeles Times

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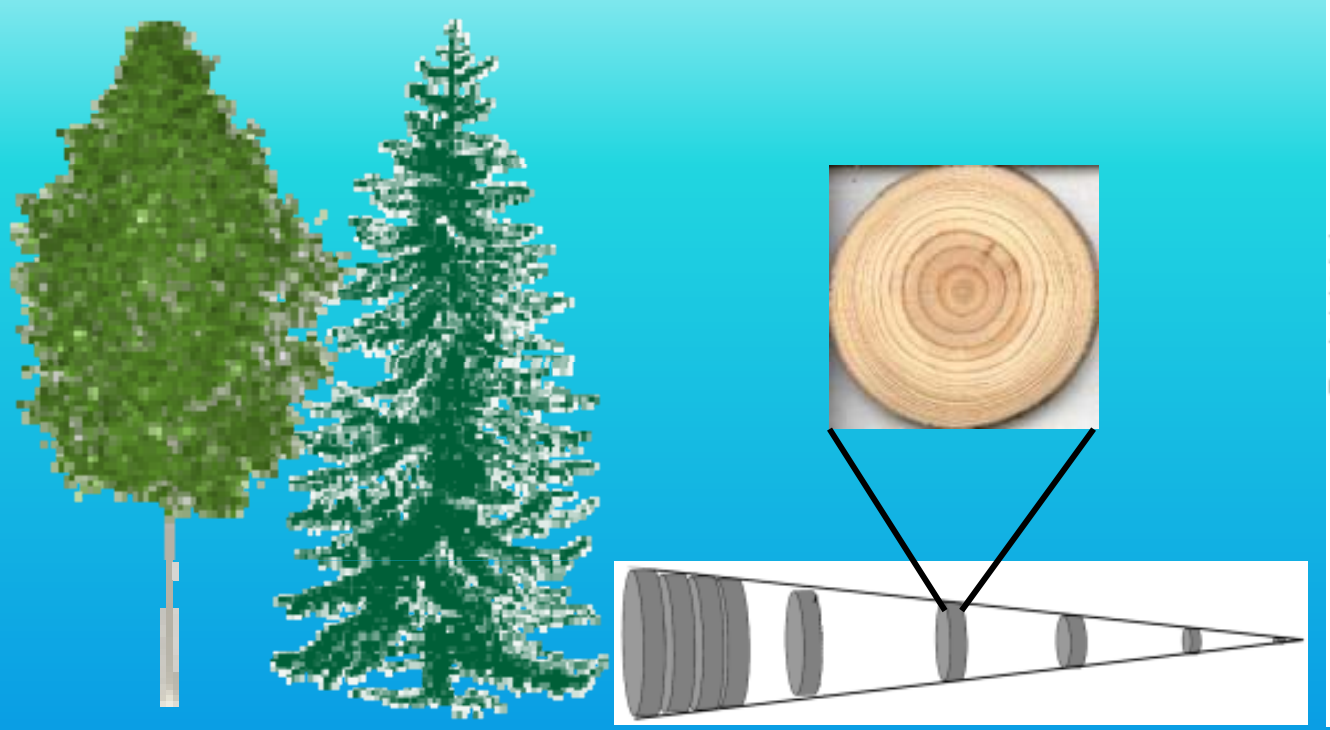
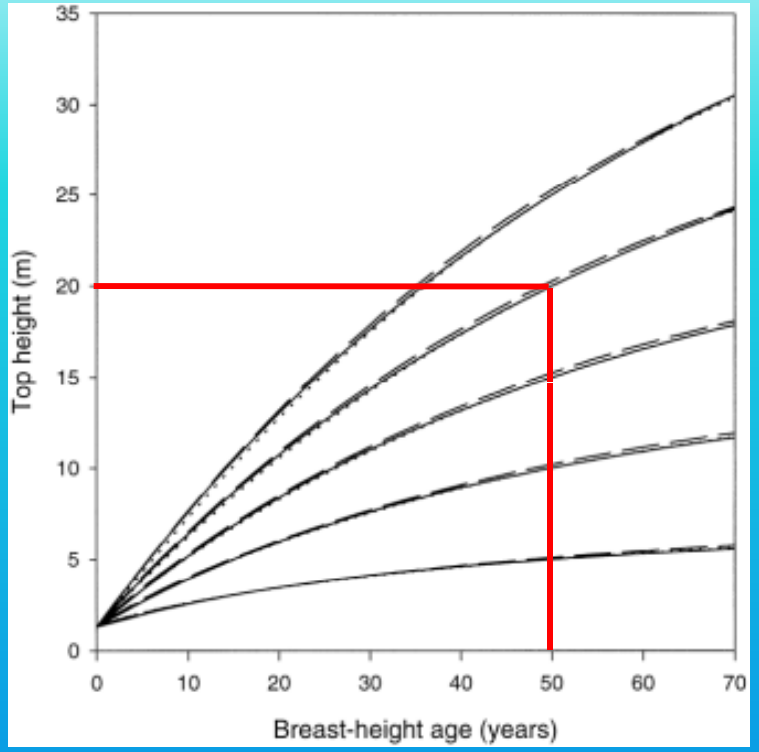
Photo: Al Seib / Los Angeles Times

Introduction: Definition of site index





Aspen (Chen et *al*., 1998)

- Height growth (Site index) versus radial growth,
- Common measurement to estimate stand productivity (forest management),
- Height growth related to diameter and volume of a tree,
- Available in forest inventory of the provinces i.e. BC, QC, NB…..

Introduction

Particularity

- Large amount of tree species (14 = 60% tall and medium sized (≥ 9 m height) trees of BC),
- Different geographic ranges,
- Study area: larger and higher number of sampling plots.

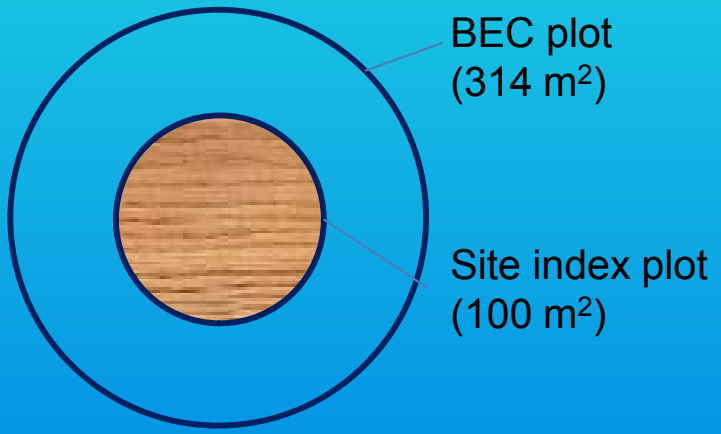
Hypotheses

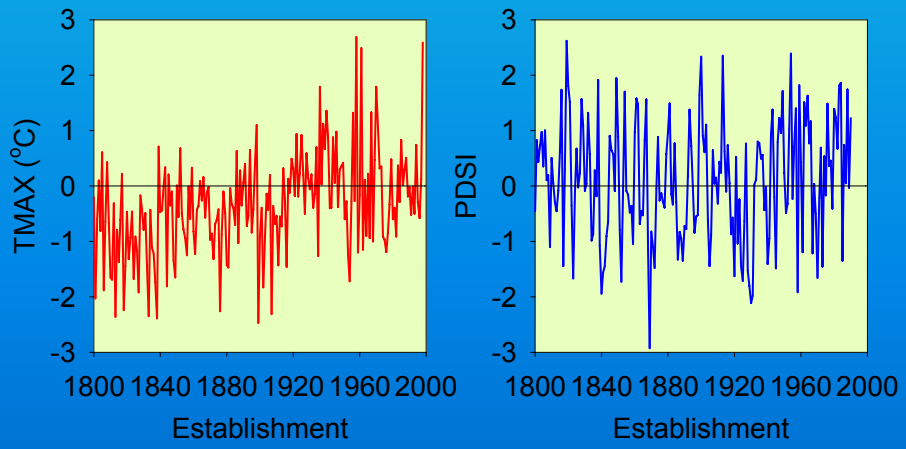
- I: climate change improves height growth for the entire species,
- II: height growth pattern differs with:
  - a) species geographic range,
  - b) Species ontogeny i.e. shade tolerance, leaf form i.e. broadleaf vs needles
  - c) geographic locations (latitude, longitude, elevation).

Material and methods

Samplings

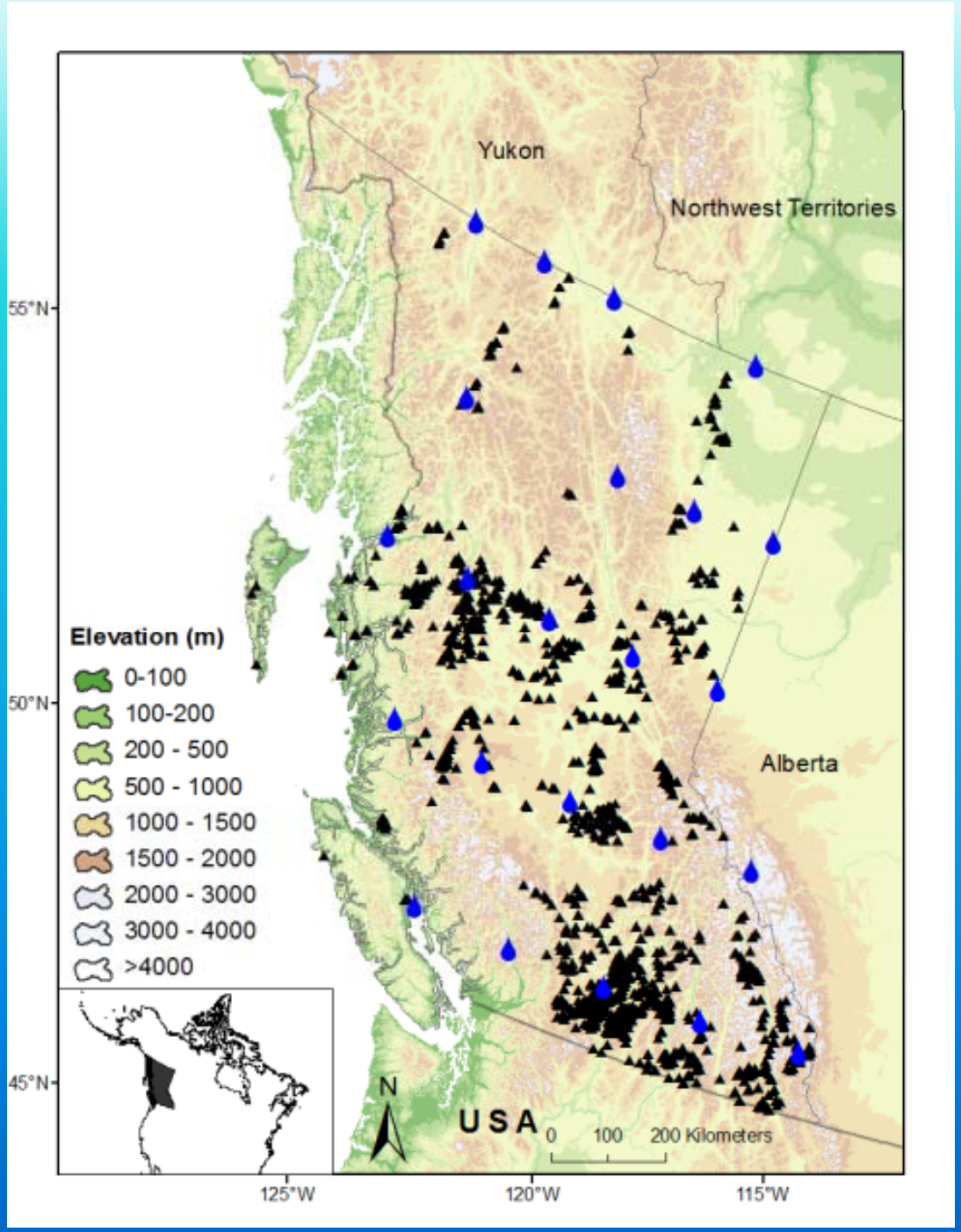
- BEC Plot (ecologically uniform, moderately dense, without major disturbance),
- Site index Plot (largest DBH, dominant or co-dominant, no suppressed or visible disease, full crown),
- Site description (Bioclim. zones, coordinates, topography, soil description, age, Total height, site index),
- Site index @ age 50 yrs (SI),
- Climate change : Anomaly Maximum Temperature TMAX (May-August)
  Palmer Drought Severity Index PDSI (May-August),





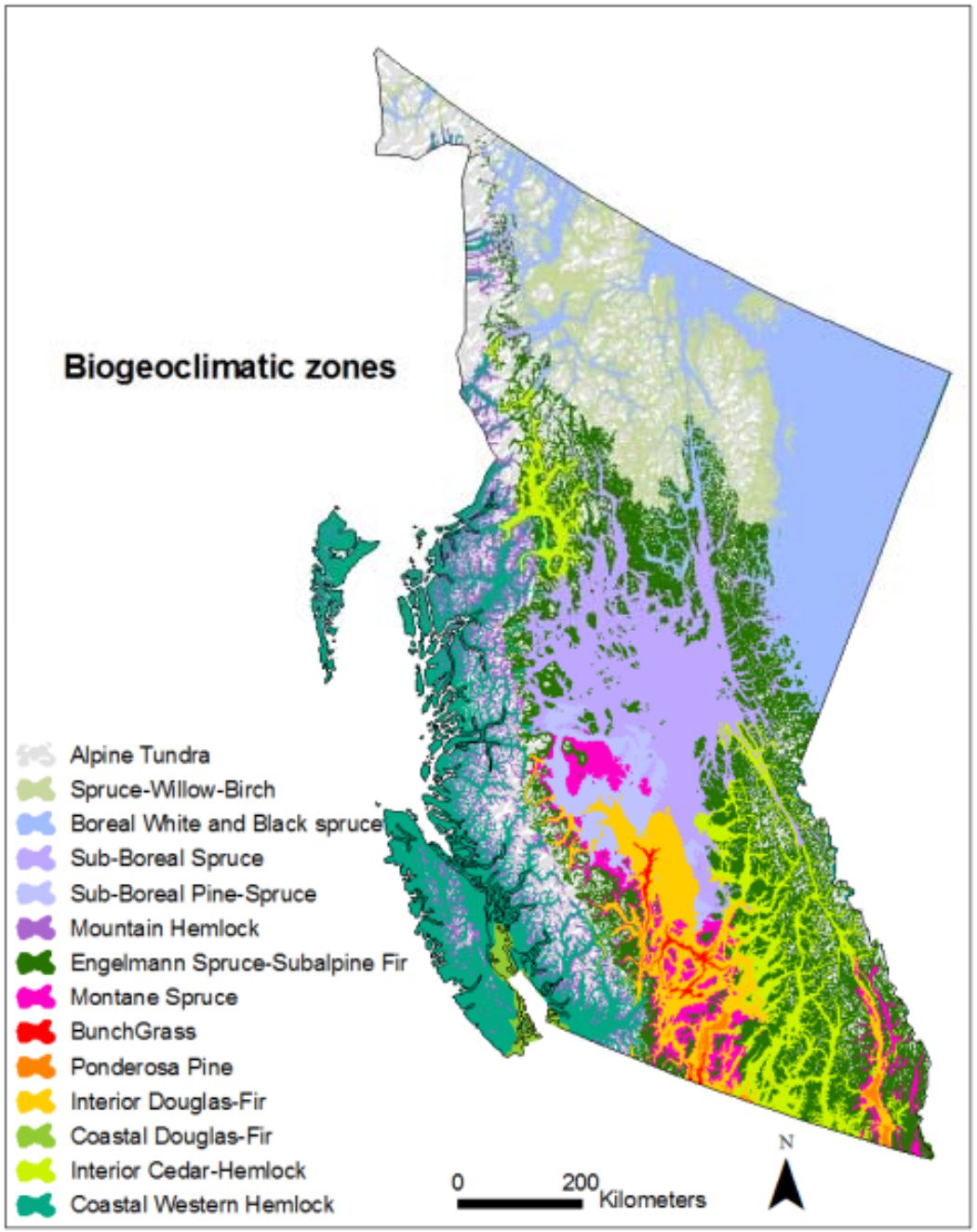
National Oceanic and Atmospheric Administration (NOAA; http://www.ncdc.noaa.gov/paleo/recons.html)

Material and methods



Study area (3027 sampling plots). Raindrop = PDSI location

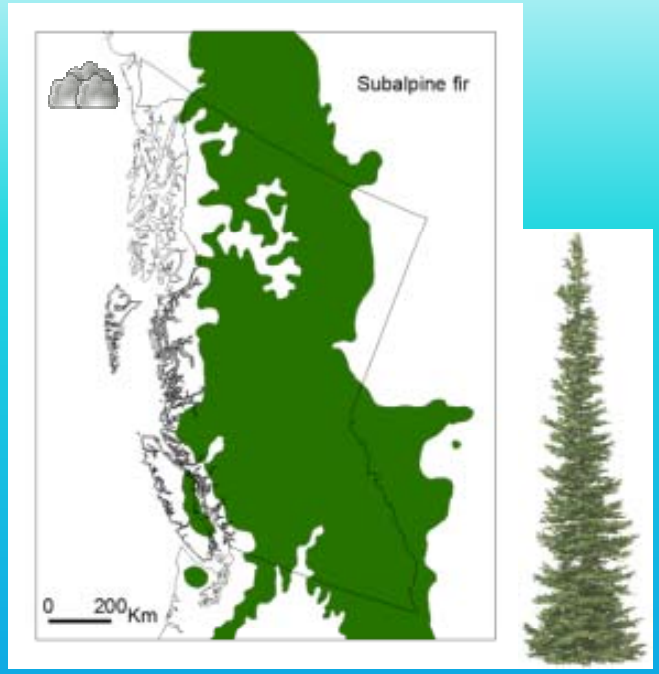
Material and methods

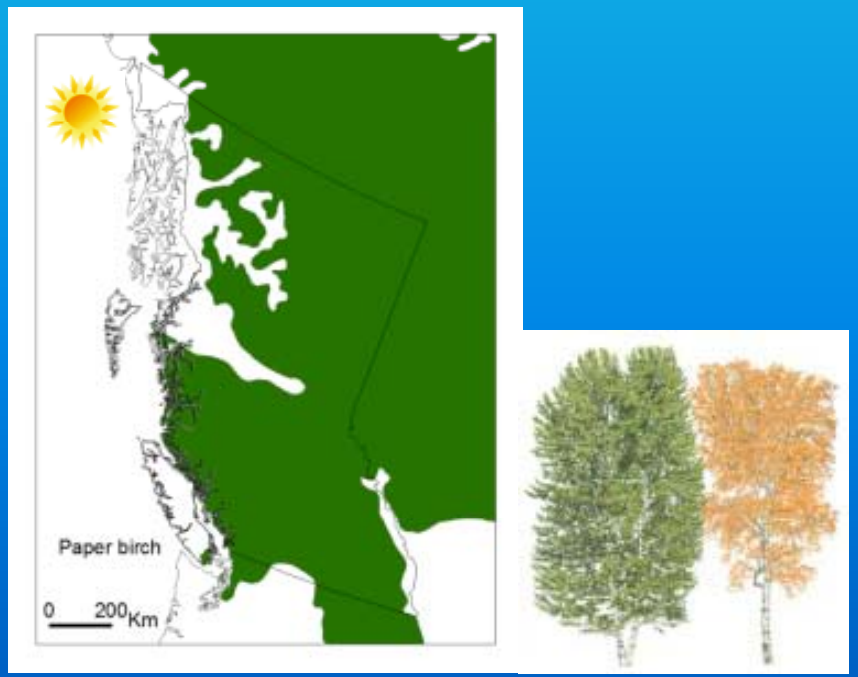


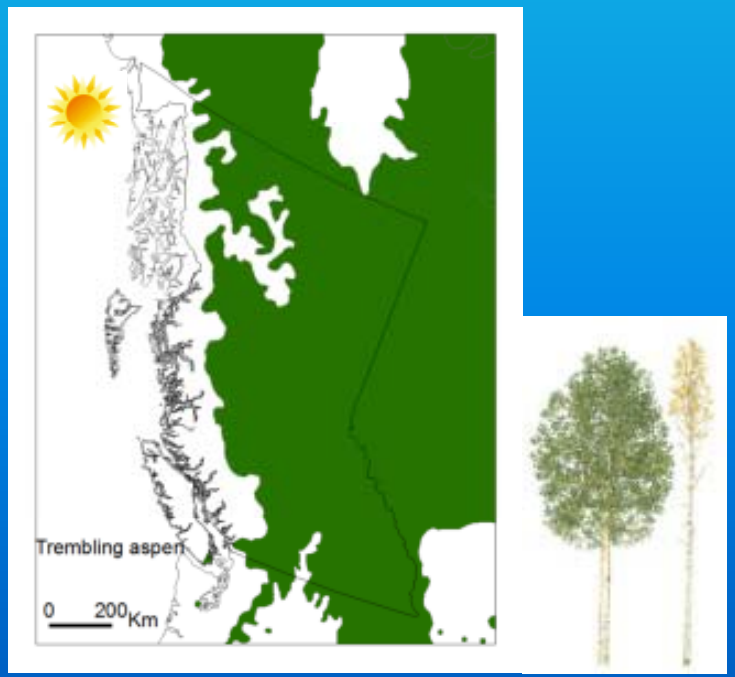
Biogeoclimatic zones	Mean annual Temperature (°C)	Mean annual Precipitation (mm)
Boreal White and Black Spruce	**-2.9-2**	**330-570**
Sub-Boreal Spruce	1.7-5	440-900
Sub-Boreal Pine Spruce	0.3-2.7	335-580
Engelmann Spruce-Subalpine Fir	-2-2	400->2000
Mountain Spruce	0.5-4.7	380-900
BunchGrass	**5.8-9.2**	**242-328**
Ponderosa Pine	4.8-10	280-500
Interior Douglas-Fir	1.6-9.5	300->1000
Interior Cedar-Hemlock	2-8.7	500-1200
Coastal Western Hemlock	**5.2-10.5**	**1000-4400**

Meidinger and Pojar 1991

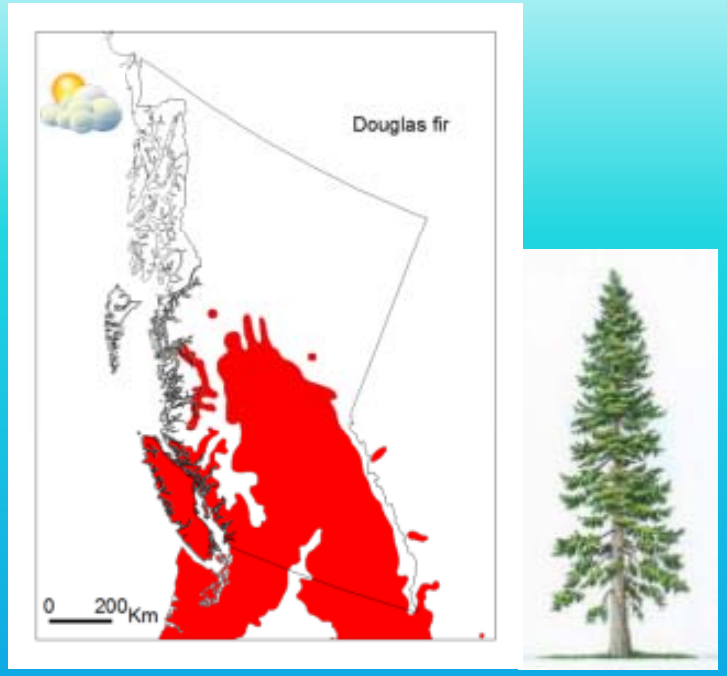
Material and methods: Studied tree species (GROUP I)

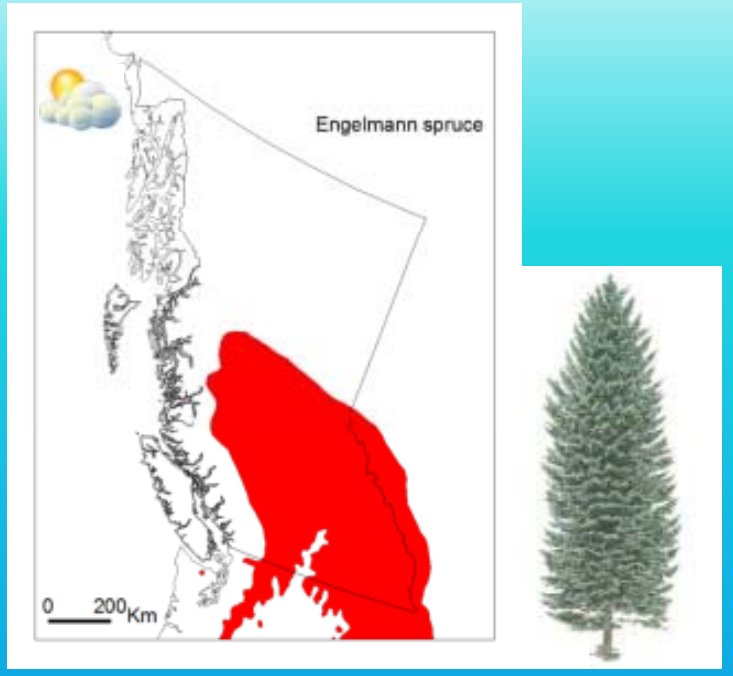


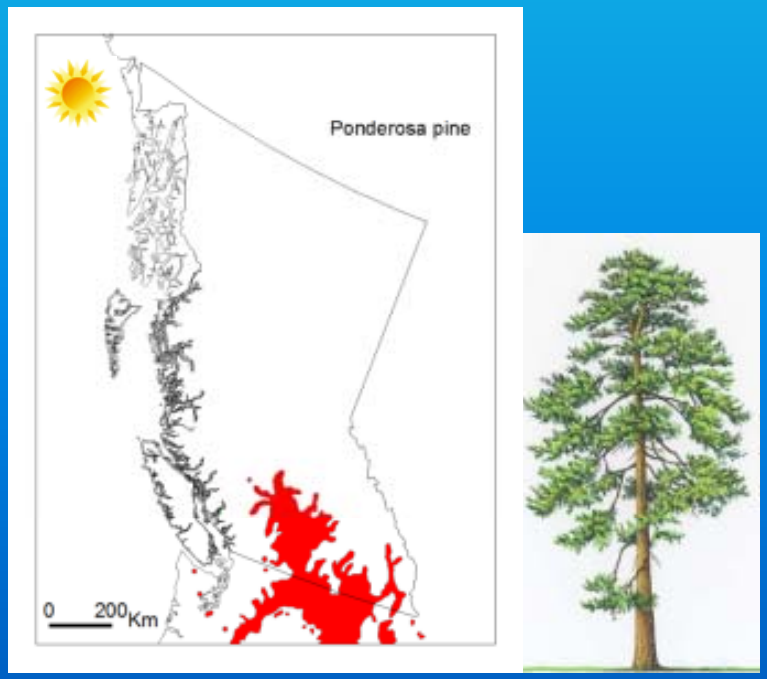


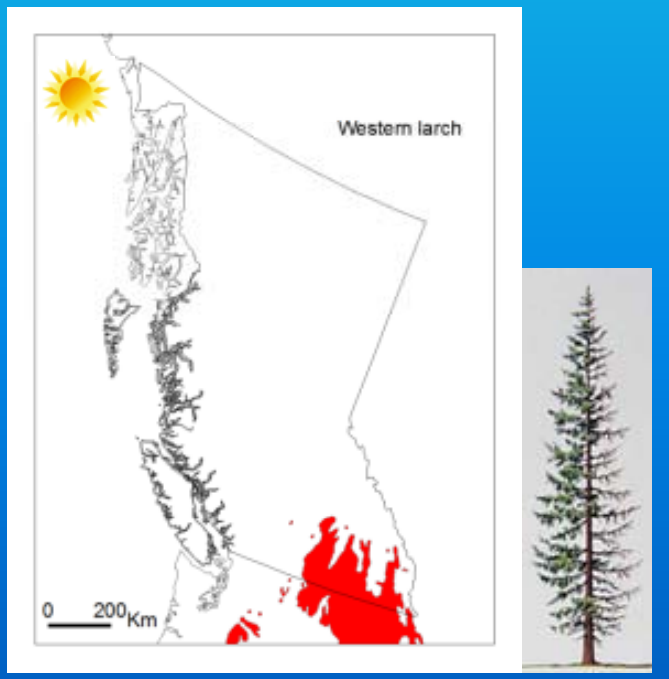


Material and methods: Studied tree species (GROUP II)

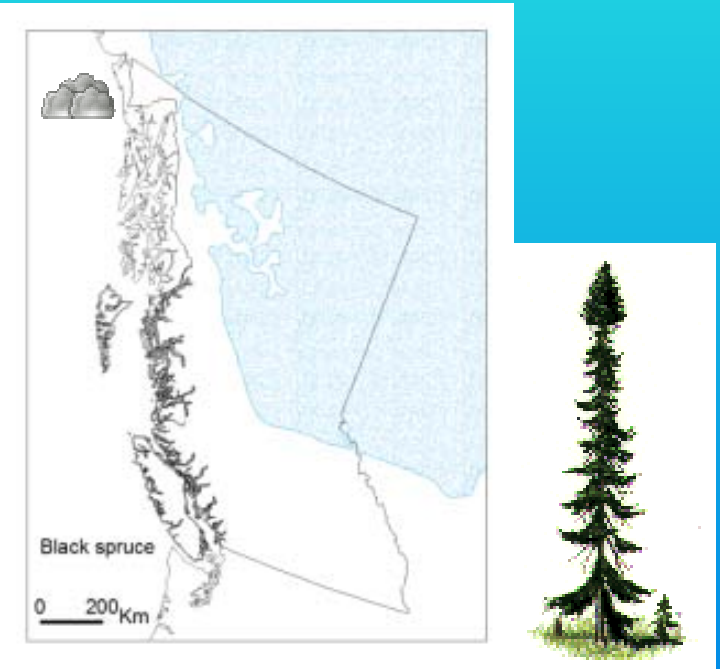


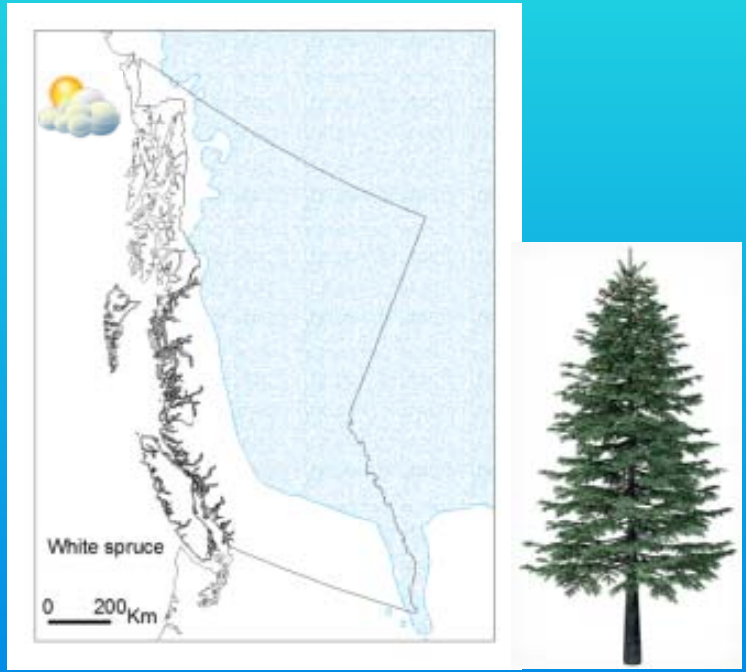




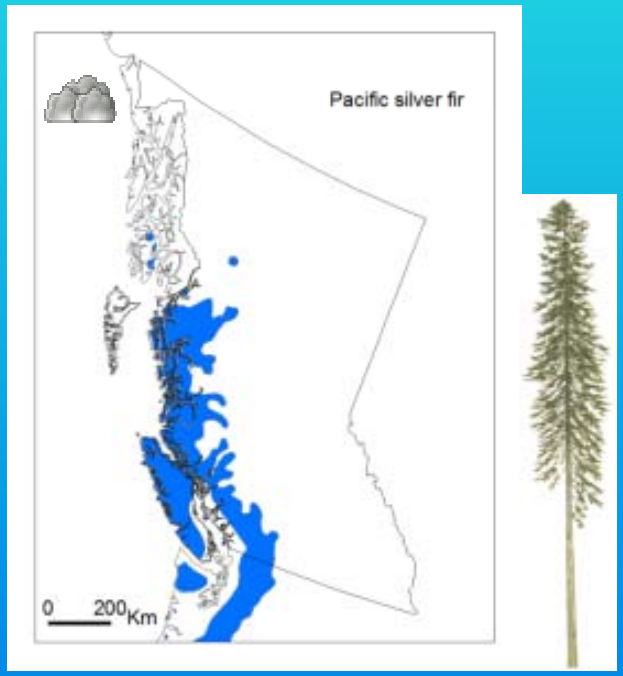


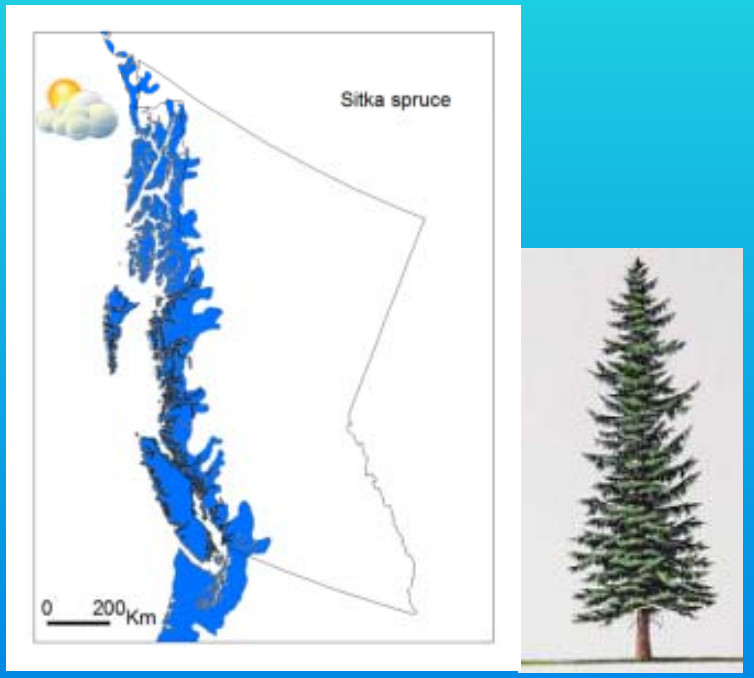
Material and methods: Studied tree species (GROUP III)



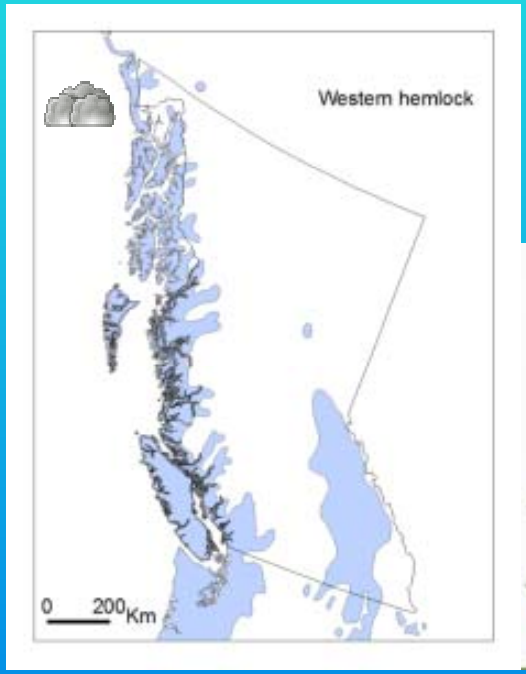


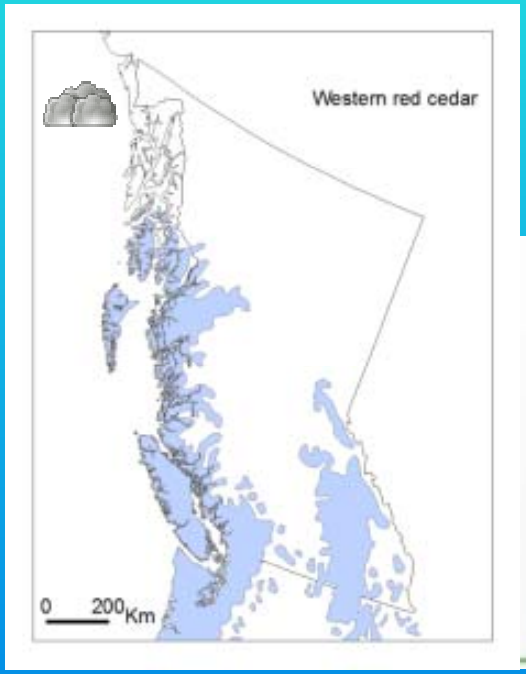
Material and methods: Studied tree species (GROUP IV)





Material and methods: Studied tree species (GROUP II and IV)





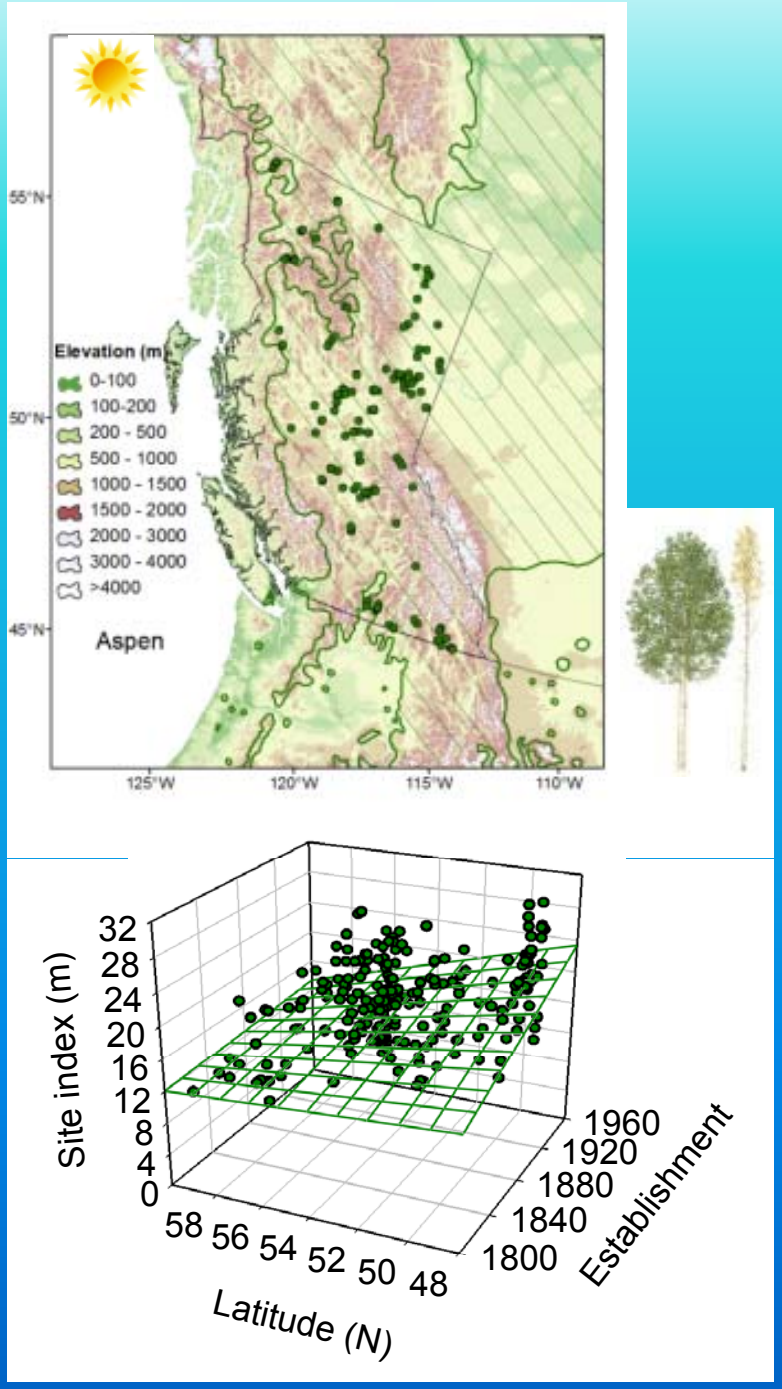
***Results*: Increase height growth with climate change (H1)**

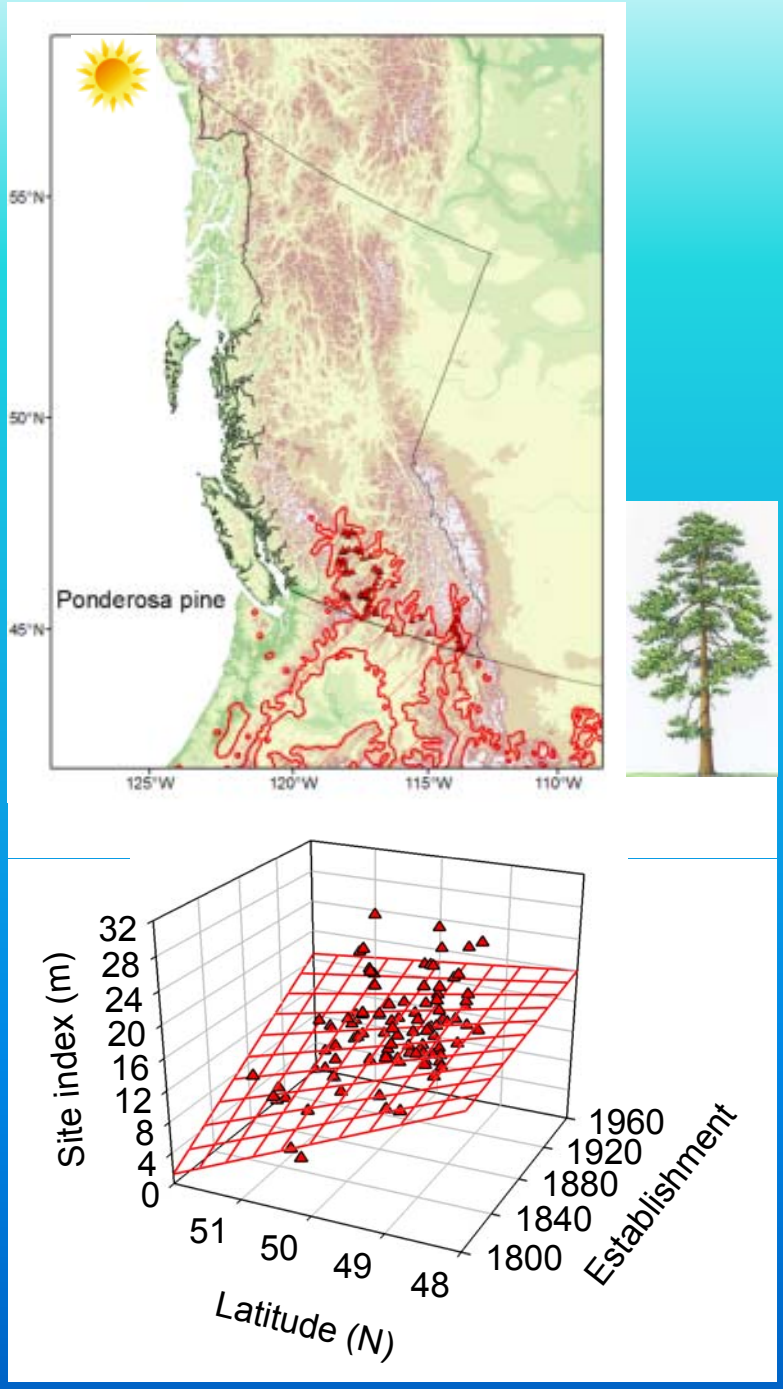
Table 1. Simple correlation between site index, climate change and establishment years. White colour indicates significant value at $\alpha = 0.05$.

Species ranges	Species	TMAX	PDSI	Establishment
Group I	Subalpine fir	0.052	**0.100**	**0.102**
	Lodgepole pine	**0.107**	**0.166**	**0.184**
	Paper birch	0.158	0.003	**0.289**
	Trembling aspen	**0.313**	0.037	**0.239**
Group II	Western hemlock[1]	0.223	0.010	0.214
	Western red cedar[1]	**0.431**	0.086	0.215
	Douglas fir	**0.095**	**0.193**	**0.258**
	Engelmann spruce	0.124	0.101	**0.251**
	Ponderosa pine	**0.319**	**0.201**	**0.433**
	Western larch	0.104	**-0.302**	0.219
Group III	Black spruce	**0.452**	**0.351**	**0.509**
	White spruce	**0.298**	**0.250**	**0.301**
Group IV	Pacific silver fir	0.264	**0.439**	**0.440**
	Western hemlock[2]	--0.146	0.187	**0.226**
	Western red cedar[2]	**0.420**	**0.371**	0.318
	Sitka spruce	0.257	**0.749**	**0.665**
Total		**0.301**	**0.242**	**0.366**

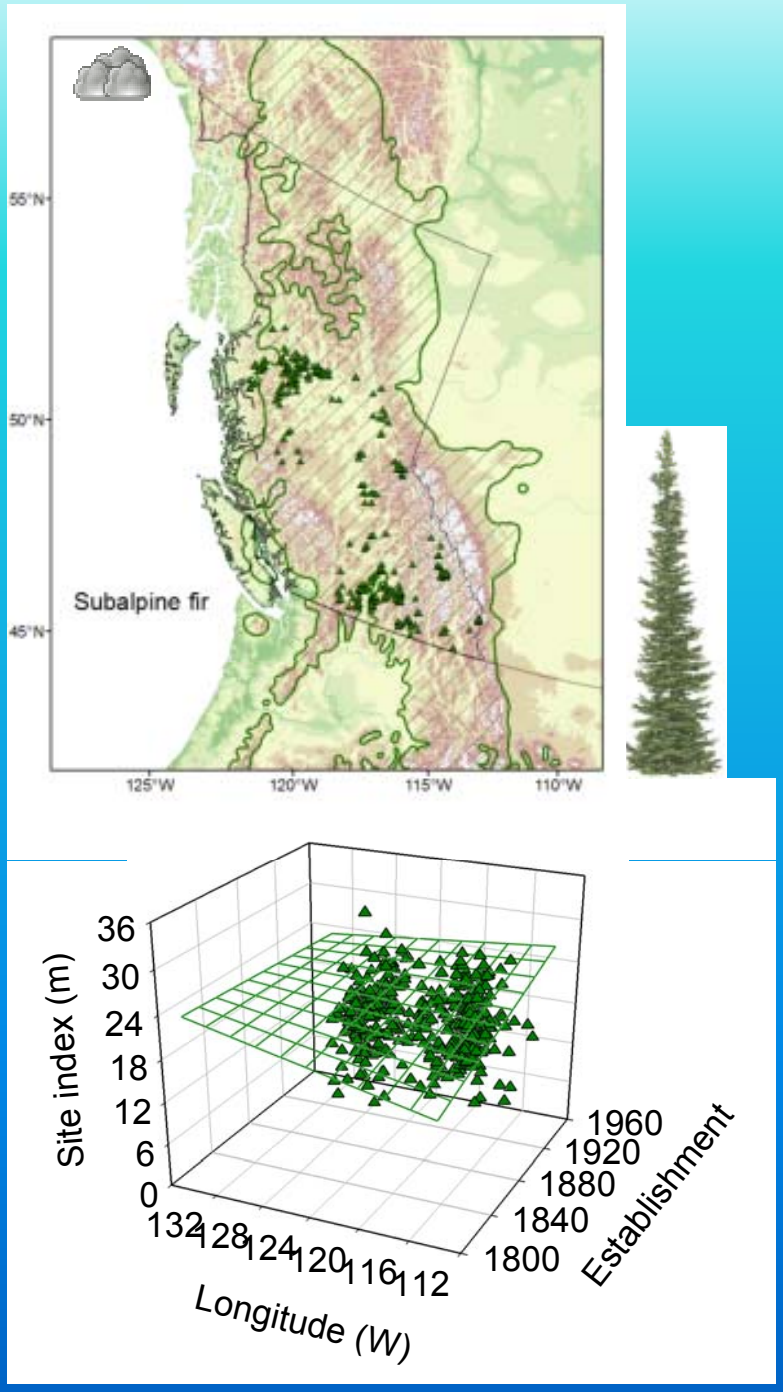
[1] Interior range.
[2] Coastal range.

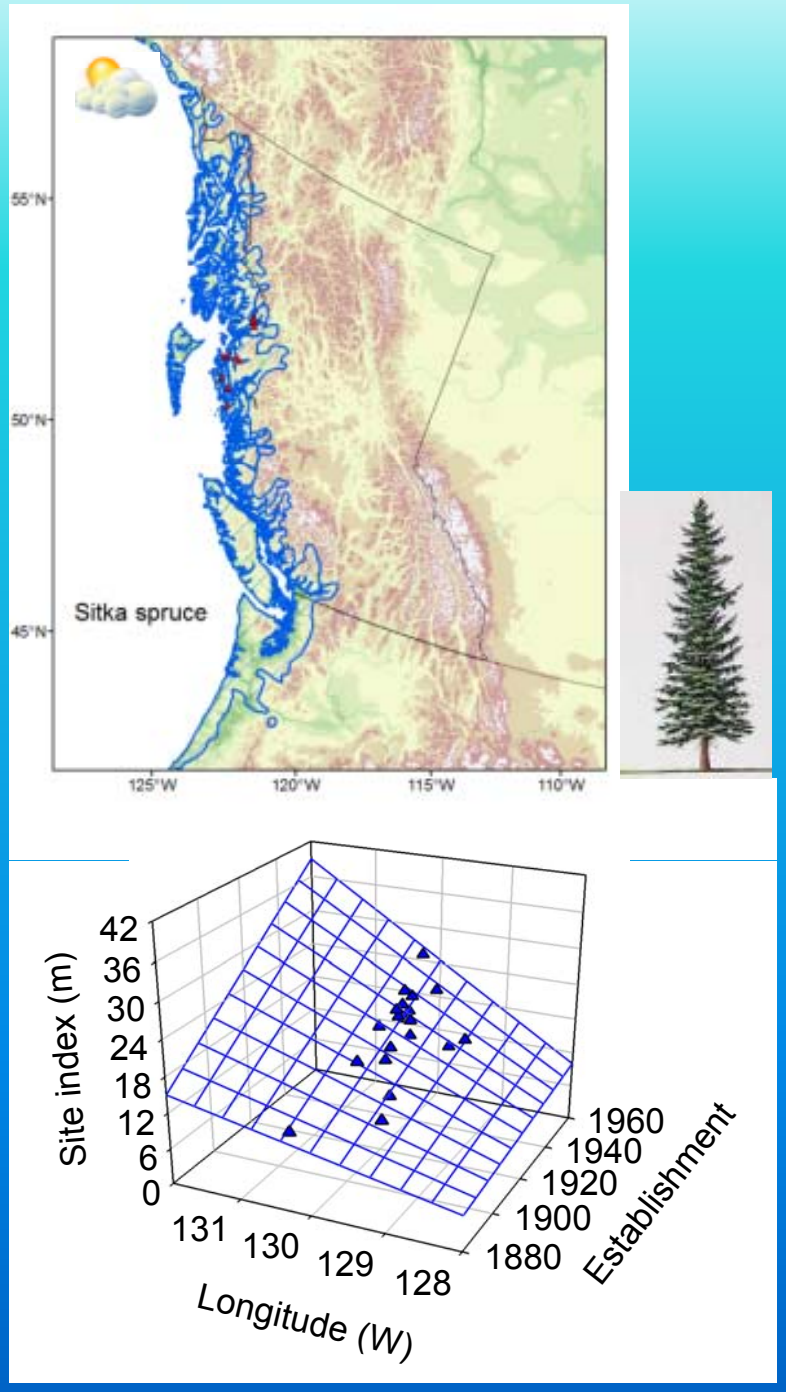
Results: Increase height growth with range, ontogeny and locations (H2)





Results: *Increase height growth with range, ontogeny and locations (H2)*





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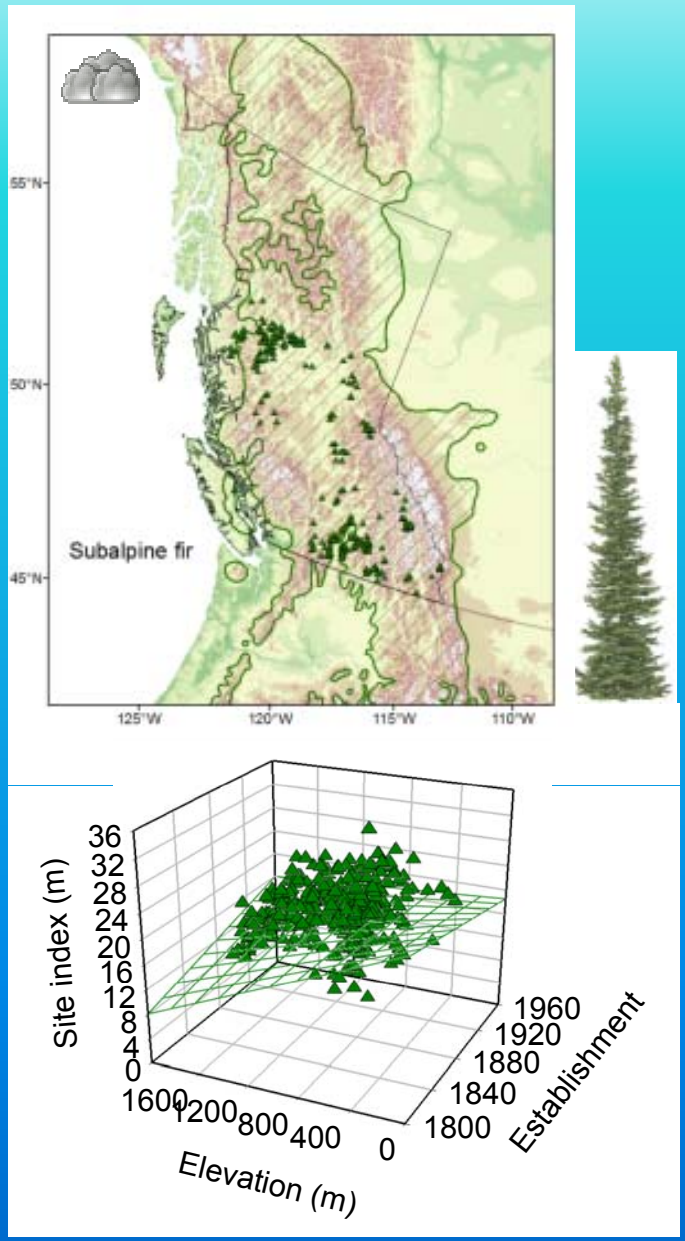

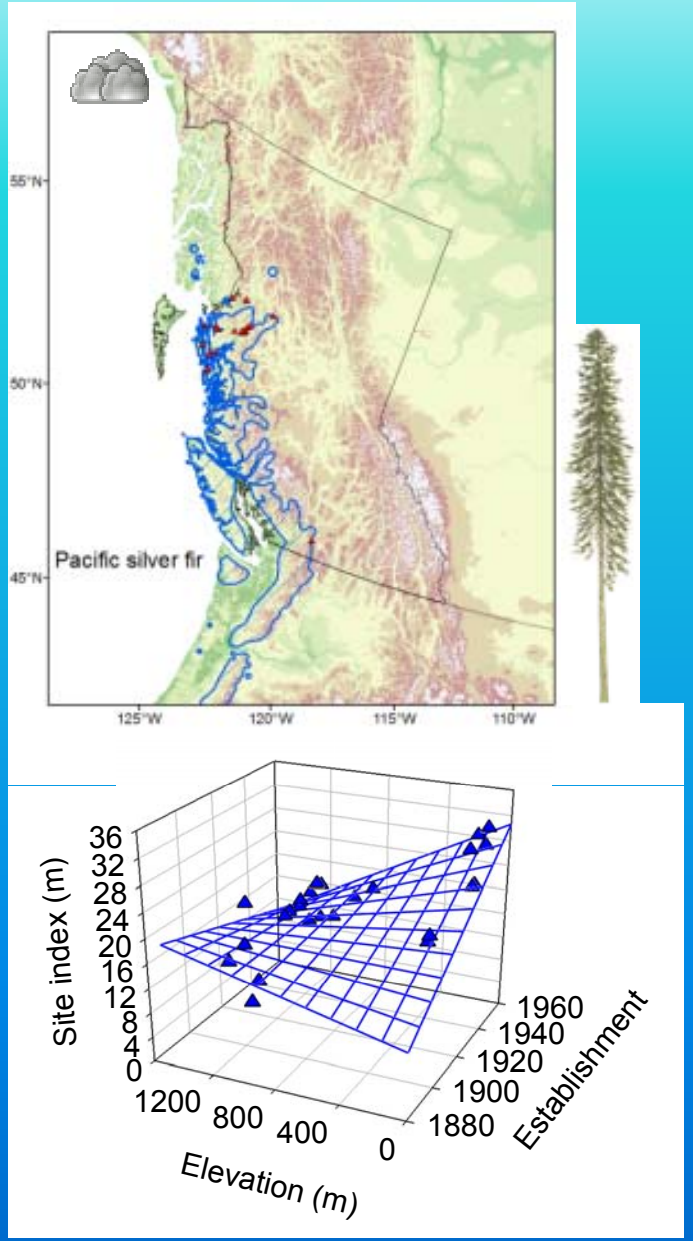

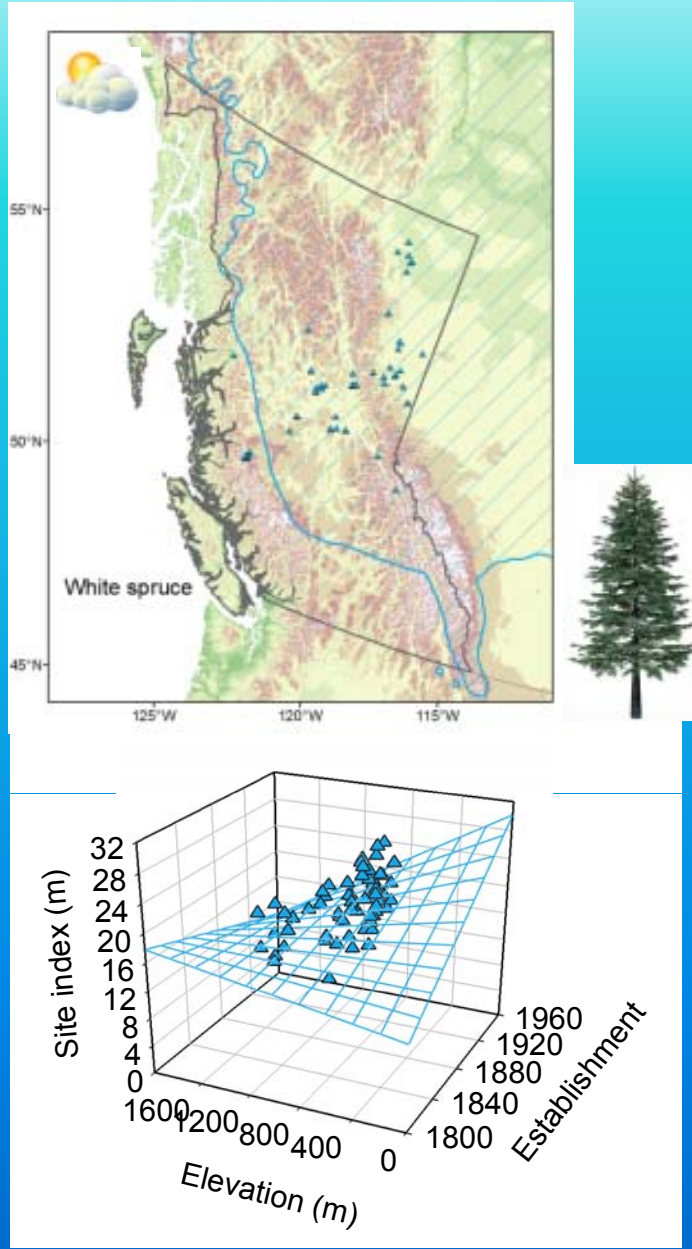

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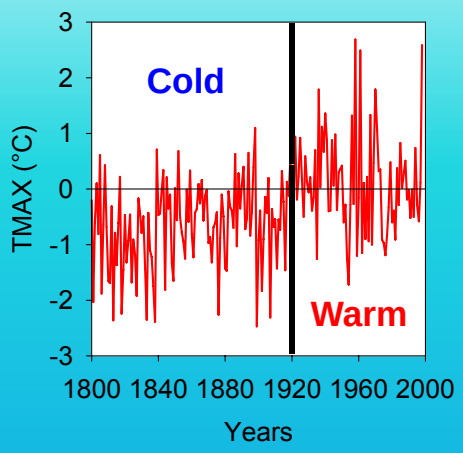
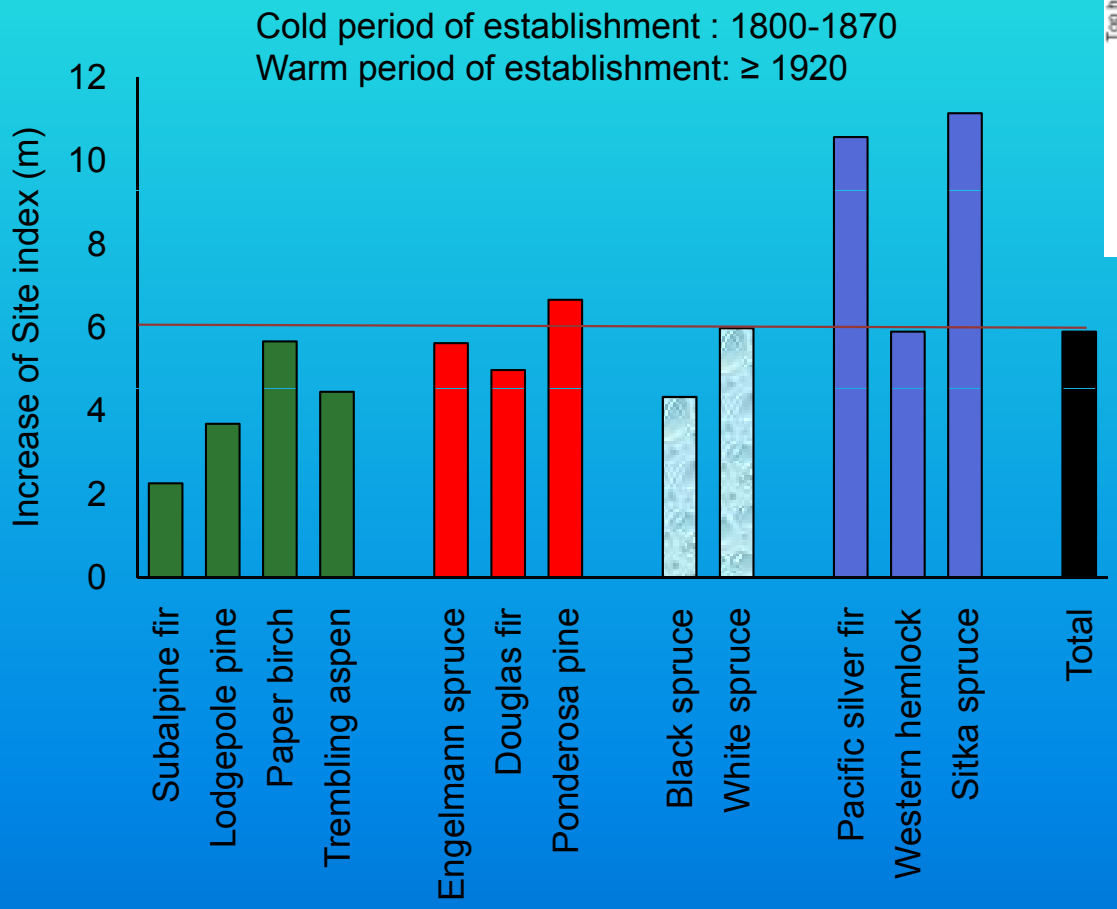
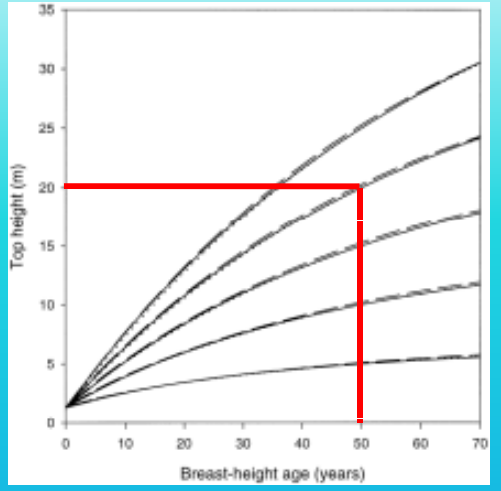






PHG = a_1*latitude + a_2*longitude + a_3*elevation + a_4*slope + a_5*aspect + a_6*establishment + ε ($0.09 > R^2 > 0.65$)

Conclusion: Tree growth & recent global warming

Shade tolerance

Microclimate

Geographic location

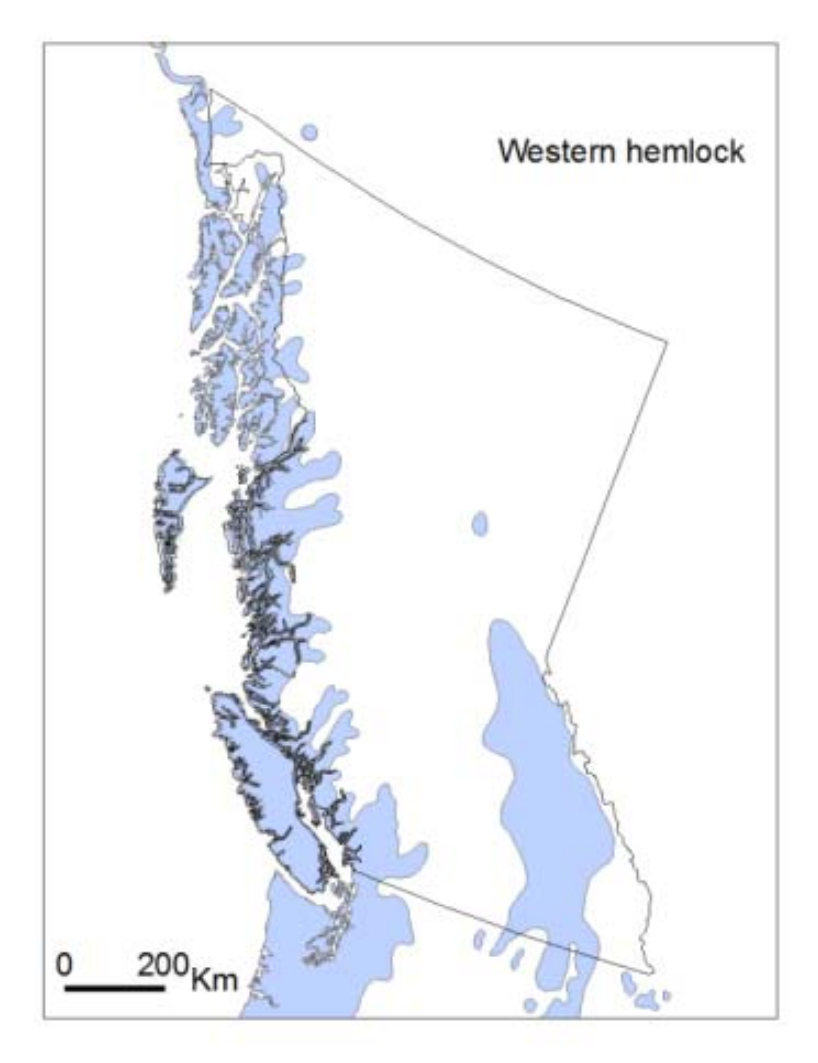
Non climatic range

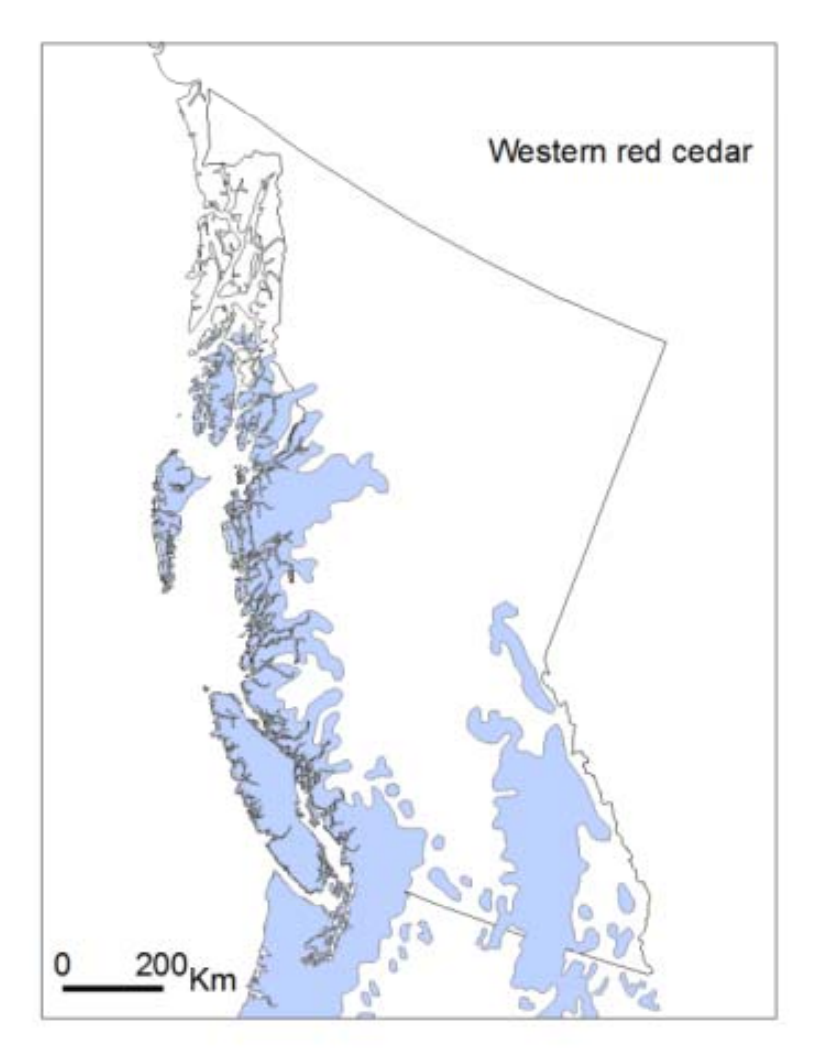
Ecological amplitude (groups)

Leaf form

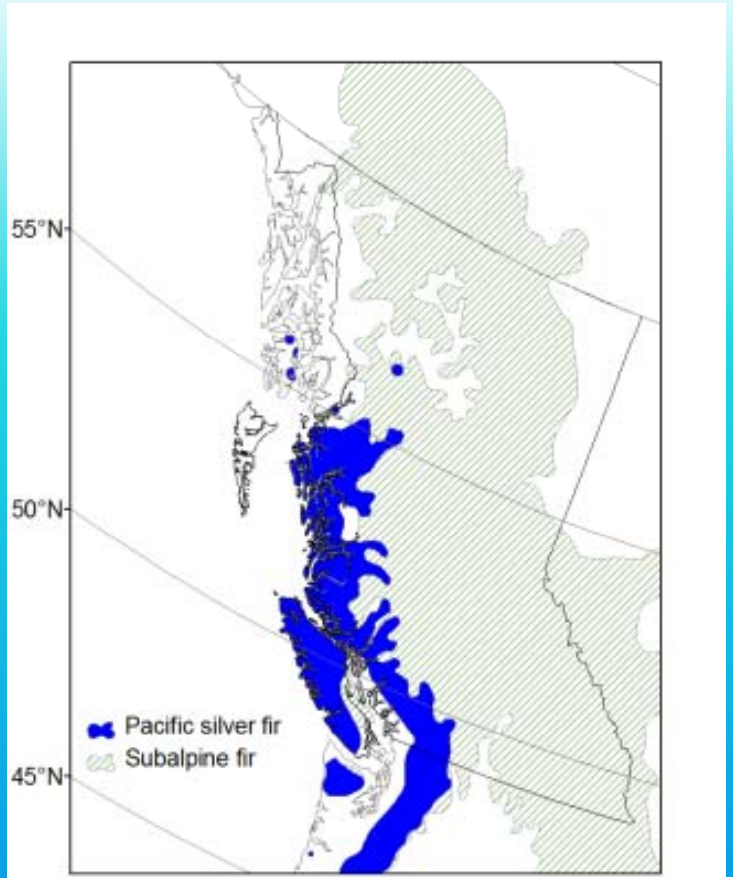
Soil properties

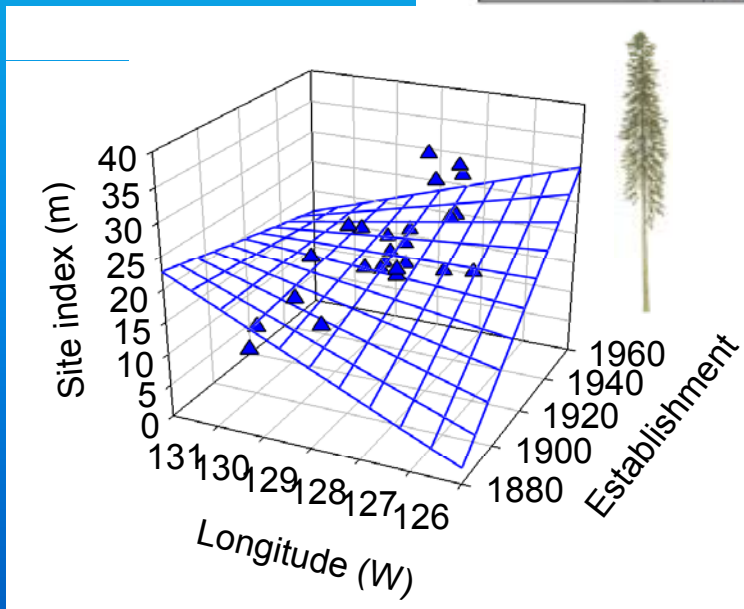
***Conclusion*: Postglacial hypothesis?**

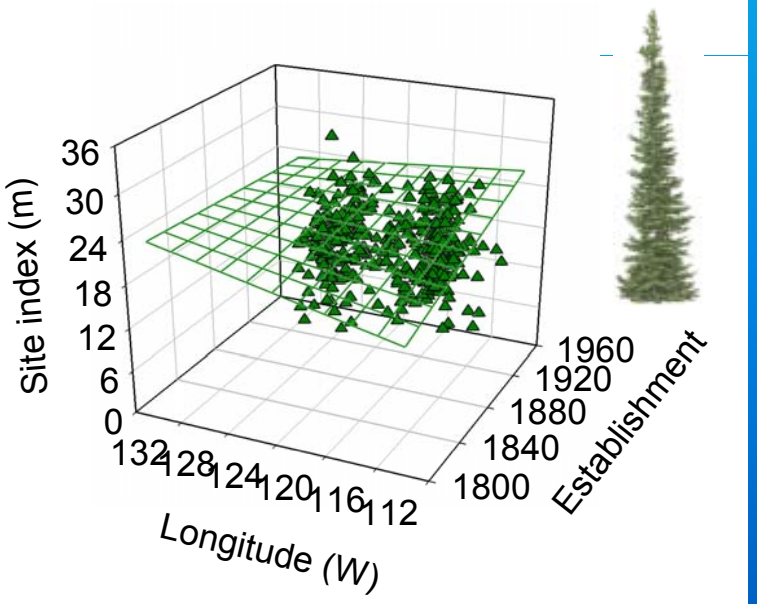




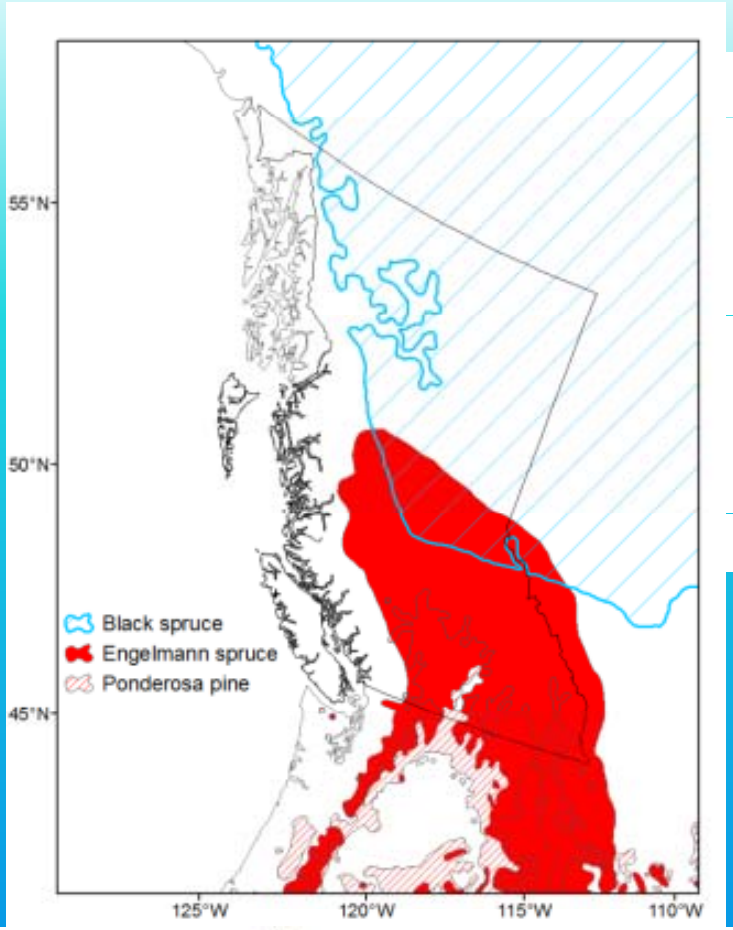
Perspectives

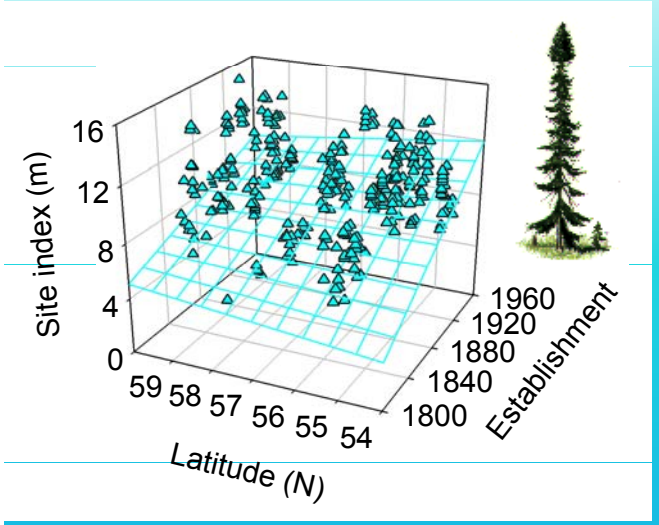


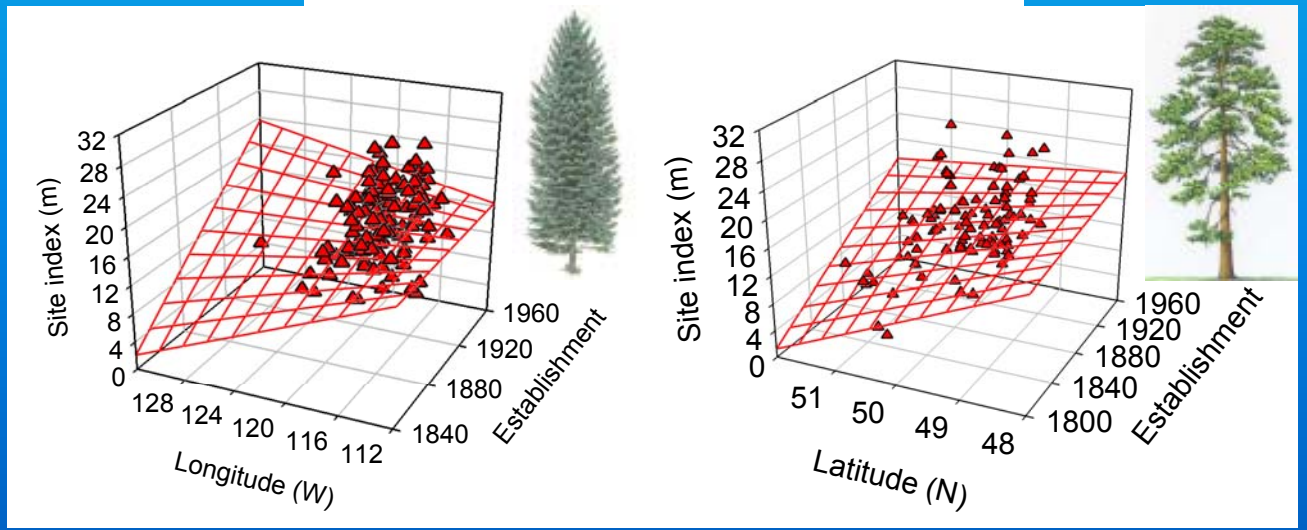




Perspectives





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