

衆瞽
摸象之圖



Prognosis^{BC} – Modeling Climate Change Effects in Forest Ecosystems

Donald Robinson & Sarah Beukema
ESSA Technologies
Vancouver, BC
www.essa.com

Prognosis^{BC} + Climate – A Triptych and Two Elephants

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Outline

Three parts...

- Overview of Prognosis^{BC}
- Outline of the Climate model extension
- Putting them together

Model Background & Structure

- BC variant: 10 coniferous + 3 deciduous species
- Requires inventory of trees
 - stand exams
 - compatible with RESULTS system
- Minimum site information: BEC/ss, slope, aspect, elevation
- Minimum tree information: tree count, species, dbh
- Additional inventory information helps
 - crown length
 - growth increment
- Nearly any kind of management can be simulated
 - even age entry
 - uneven age entry
 - thinning
 - pruning
 - natural regen
 - planted regen
 - fuel bed treatment

Model Background & Structure

- Extensions for
 - root disease
 - dwarf mistletoe
 - snags, CWD¹
 - regeneration
 - economics
 - climate effects**
 - mountain pine beetle
 - western spruce budworm¹
 - carbon
 - fire effects¹
 - habitat modeling
- Extensions modify growth & mortality of individual trees, thence stand structure
- Many kinds of disturbance can be simulated
- Limited climate-sensitivity

¹ *under development or testing in BC variant*

Incorporating Climate

Principal developer of Climate extension

Nicholas Crookston

USFS Rocky Mountain Research Station

Moscow, ID

Principal developers of BC species viability maps

Tongli Wang & Sally Aitken

Centre for Forest Genetics Conservation

UBC Forest Sciences

Vancouver, BC

One Thing About Elephants

What we think we know



Another Thing About Elephants

How do you eat an elephant?

- To make headway in our lifetime we need to integrate and simplify where possible: the art of modeling
- Prognosis^{BC} Climate extension integrates processes (physiology, genetics, interactions) at a practical level
- We know it is not the whole story: this is **Version 0.2**

We take one bite at a time

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Glossary & Concepts

1. Species viability score from contemporary climate and machine-learning model
2. Climate: GCM + IPCC + Year
3. Regeneration, growth, mortality, site: what trees do
4. Adaptation - 1 = species viability given climate
5. Adaptation - 2 = relative change in growth given climate

Full Disclosure...

6. Water use embedded in viability
7. No CO₂ effect upon growth
8. Seedlings never maladapted

Incorporating Climate

Organizing Framework

		To				
		R	G	M	S	A
From	C					
	R					
	G					
	M					
	S					
	A					

Key

C = climate

R = regeneration

G = growth

M = mortality

S = site

A = adaptation

Incorporating Climate

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Incorporating Climate

Species Viability

		To			
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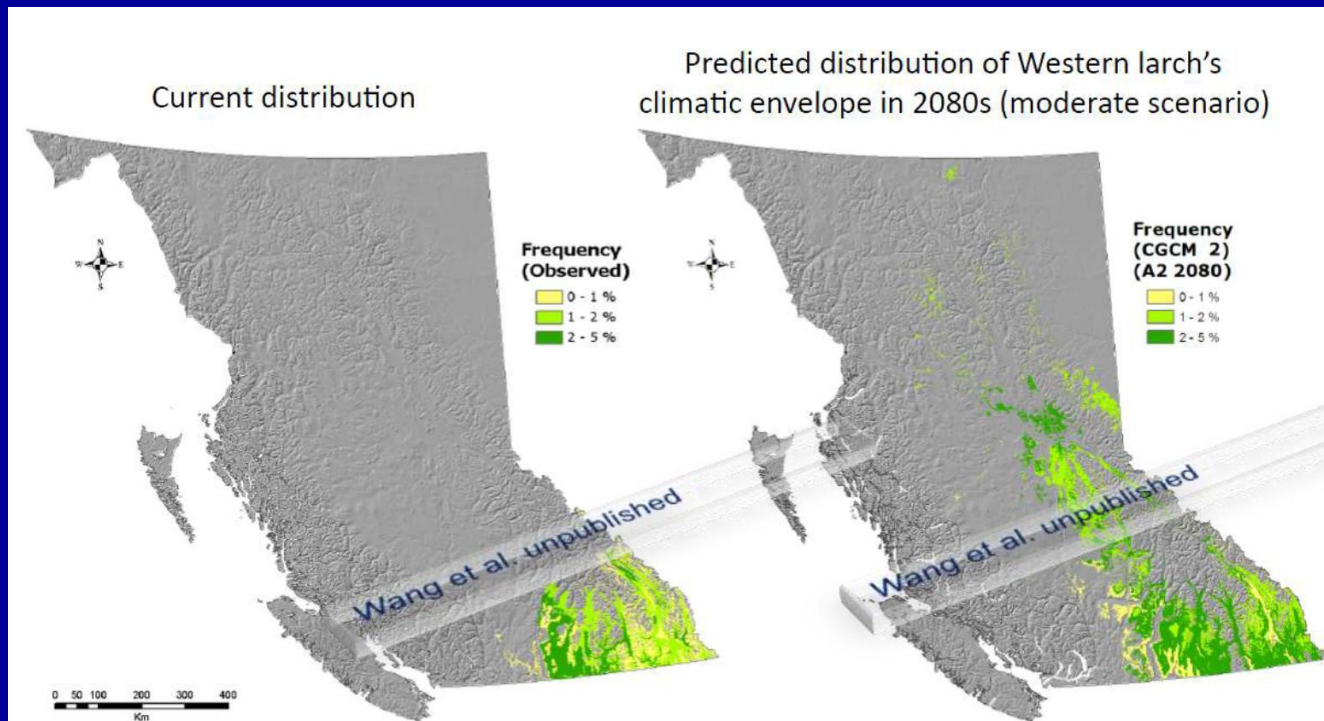
- Each species in stand (Lat, Long) assigned a viability score (0-1) based on presence-absence plot data fitted to contemporary climate
- climate surfaces spline- (US) or PRISM-based (BC)
- models created with Random Forests machine-learning algorithm (CART family)
- up to 35 variables (including interactions) in US models
- GCM and fitted viability models are external: fitted model predictions retrieved via web service using GCM + IPCC and stand Lat / Long

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Species Viability + Climate Scenario

Ex 1: western larch + CGCM2 + A2 – Wang et al. *in prep*

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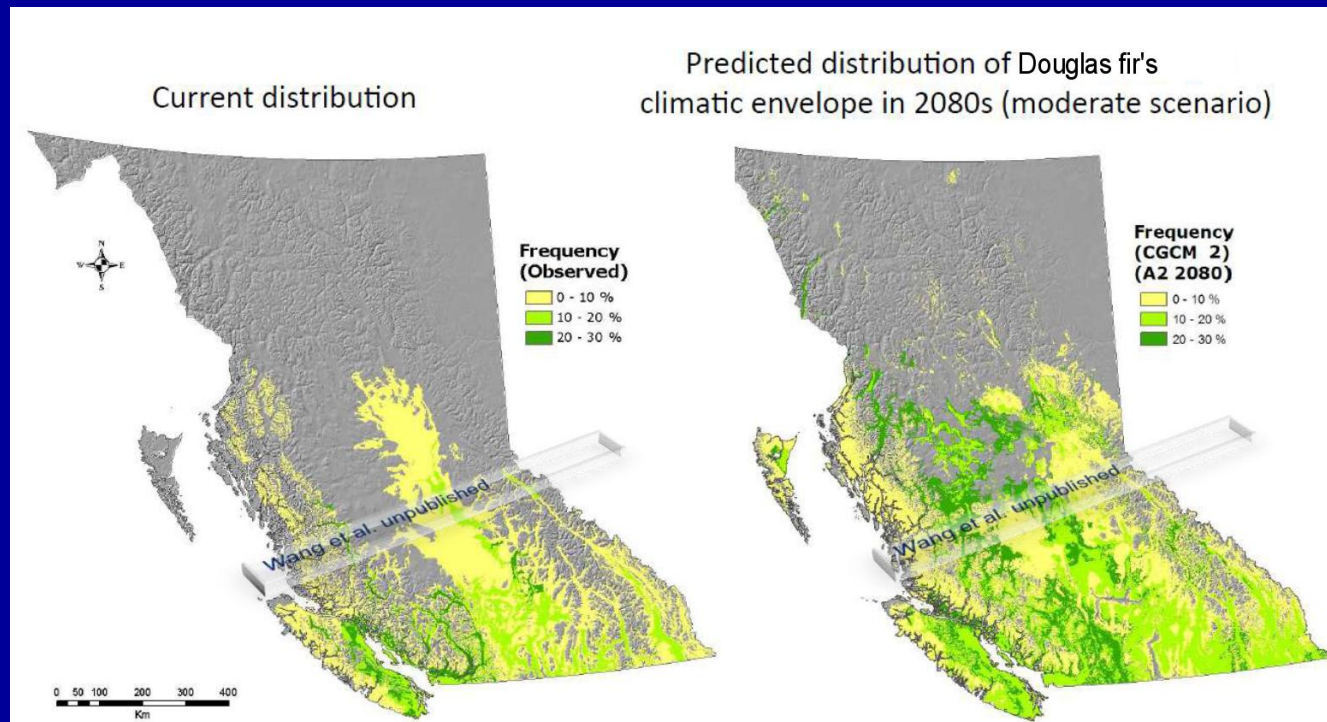


Incorporating Climate

Species Viability + Climate Scenario

Ex 2: Douglas-fir + CGCM2 + A2 – Wang et al. *in prep*

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Species Viability + Climate Scenario

example scores

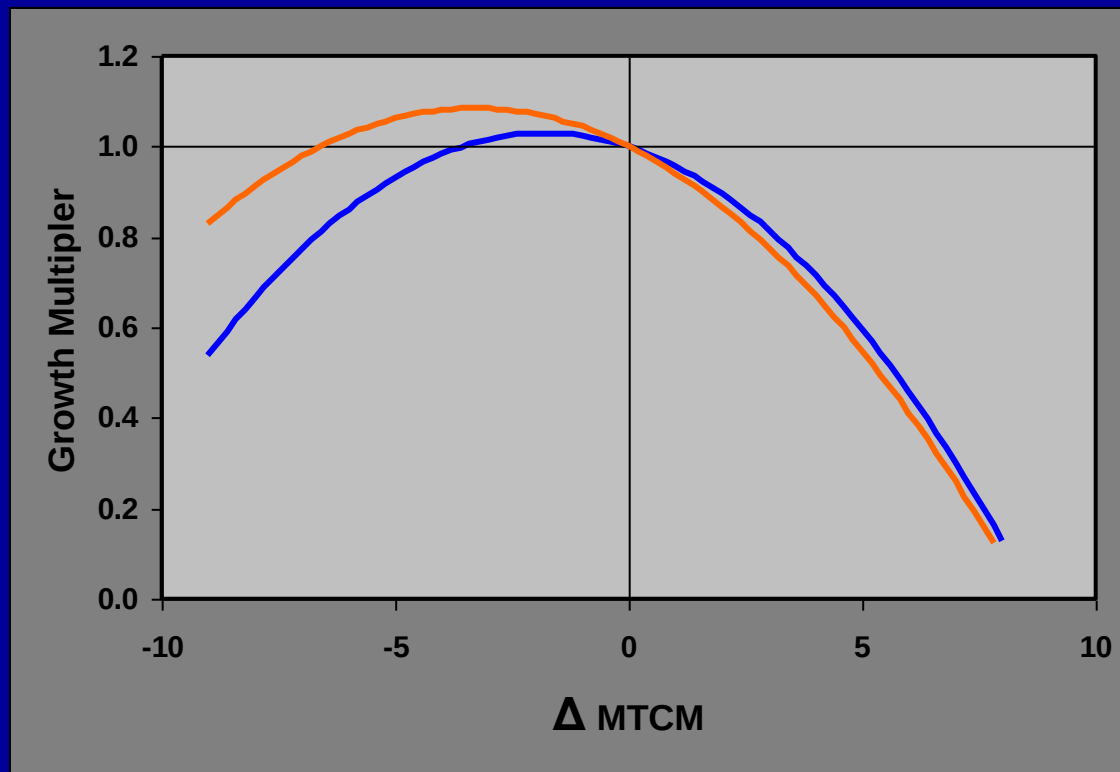
		To			
		R	G	M	S
From	C				
	R				
	G				
	M				
	S				

Species													
	BG	BL	EP	LW	PL	SE	PW	PY	AT	FD	CW	HW	AC
1990	.41	.99	.12	.09	.89	.93	.36	.28	.06	.83	.45	.49	.06
2030	.85	.65	.24	.58	.77	.70	.64	.62	.12	.70	.38	.22	.12
2060	.70	.61	.31	.42	.64	.51	.58	.77	.13	.59	.74	.36	.13
2090	.83	.42	.46	.45	.54	.52	.64	.76	.12	.72	.68	.55	.12
Manning Park, BC – CGCM3 + B1													

Incorporating Climate

Growth – varies with change relative to birth year

Ex 1: LW growth multiplier depends on $MTCM_B$, $\Delta MTCM$, ΔADI

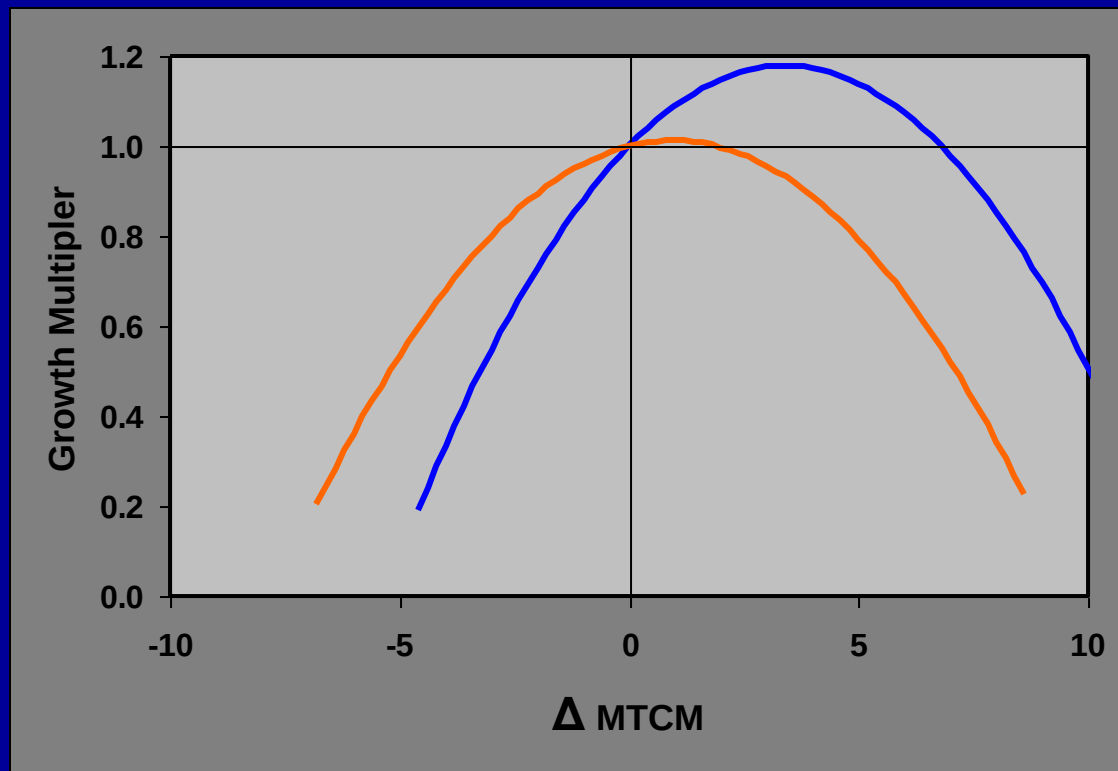


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Incorporating Climate

Growth – varies with change relative to birth year

Ex 2: FD growth multiplier depends on MAT_B , $\Delta MTCM$, ΔADI



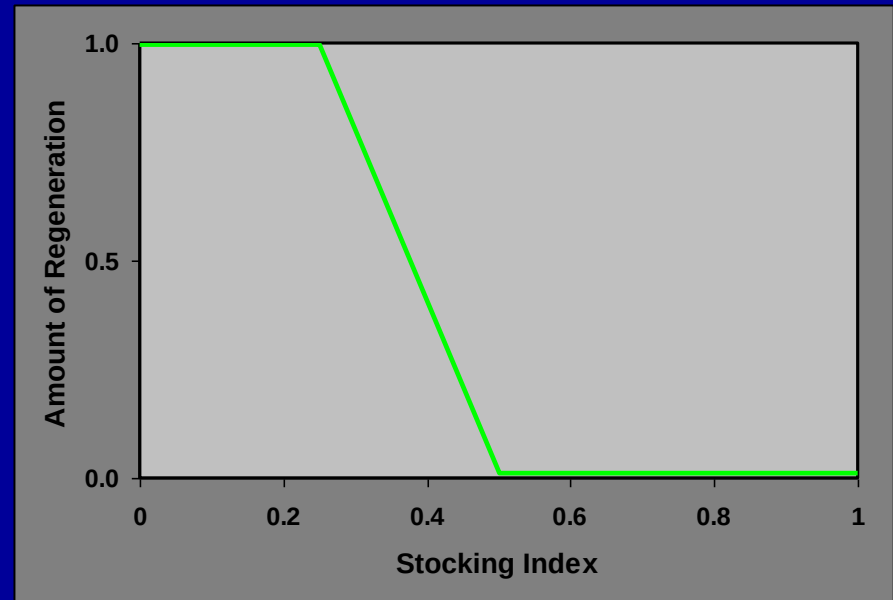
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Regeneration – simple viability-based additions

- Low stocking indicates available space
- user provides stocking threshold & amount of regeneration
- up to 4 top viability scores > 0.4 , weighted by viability

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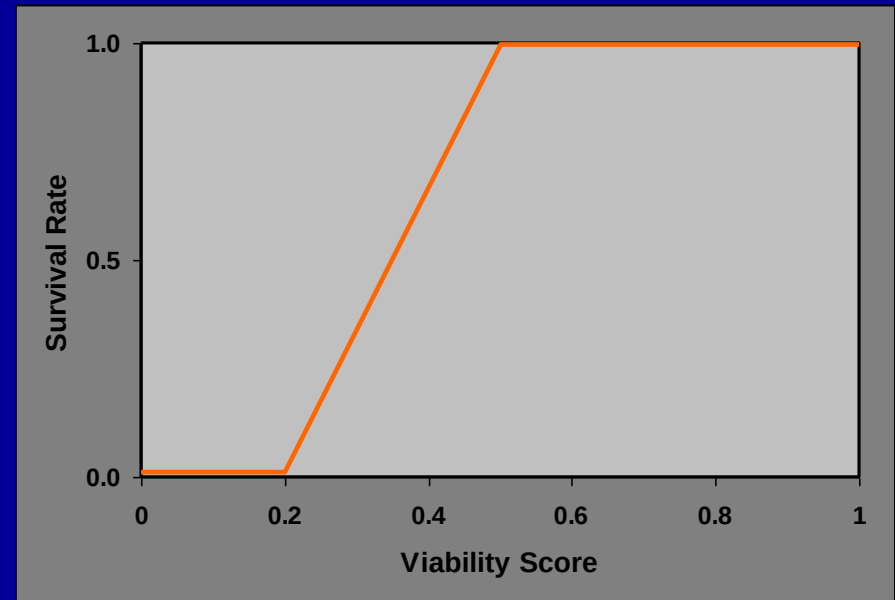


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Mortality – viability-based reduction

- < 0.5 reduces survival
- maximum of viability-mortality & base mortality

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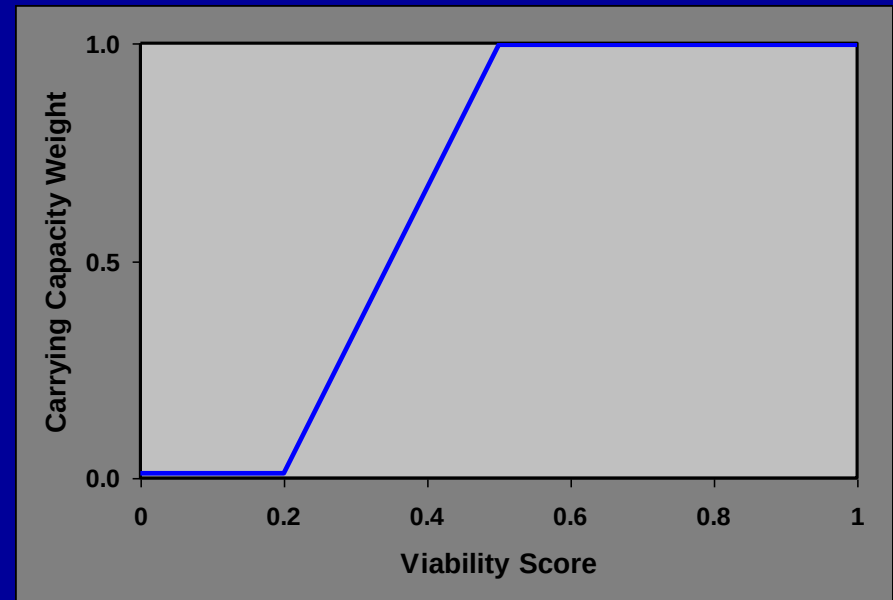


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Site – viability-based change in carrying capacity

- Weighted so that site score matches carrying capacity for contemporary climate and viability
- Current architecture does not allow a non-forested “stand” to become forested
- Carrying capacity is zero if no species are viable

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Some Results

- MSdk/01 – PL, FD leading
5 stands in Manning Park
6 stands in Kootenay National Park
- USFS climate surfaces ¹
- GCM + Scenario
 1. Historical
 2. CGCM3 + B1
 3. CGCM3 + A1B
 4. HADCM3 + A2

¹ http://forest.moscowfsl.wsu.edu/climate/customData/fvs_data.php

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Species Viability + Climate Scenario

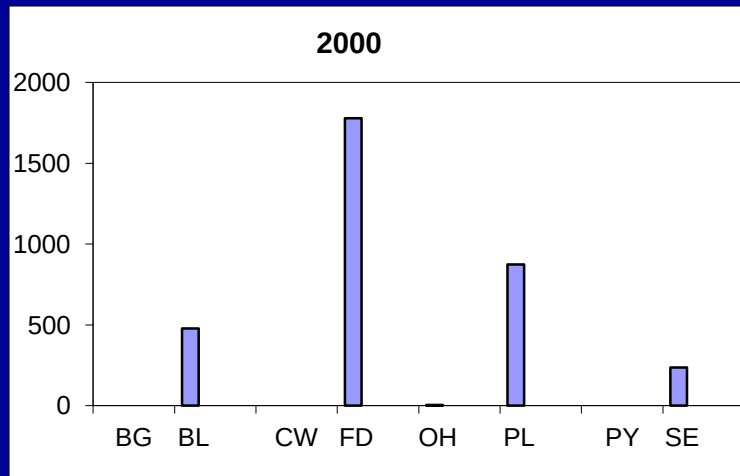
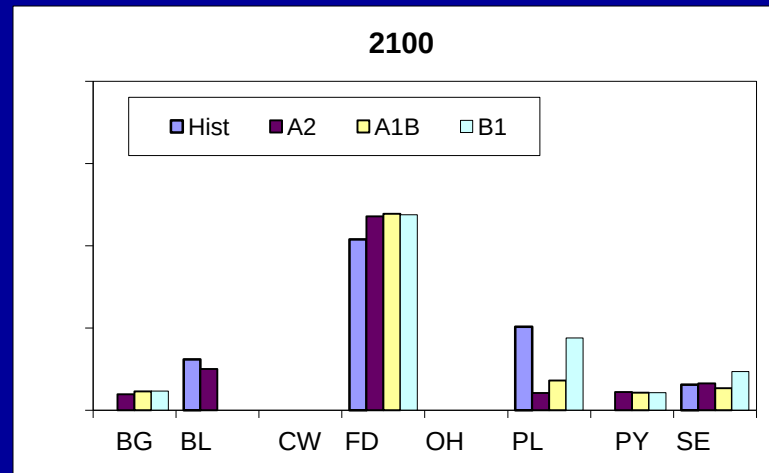
example scores

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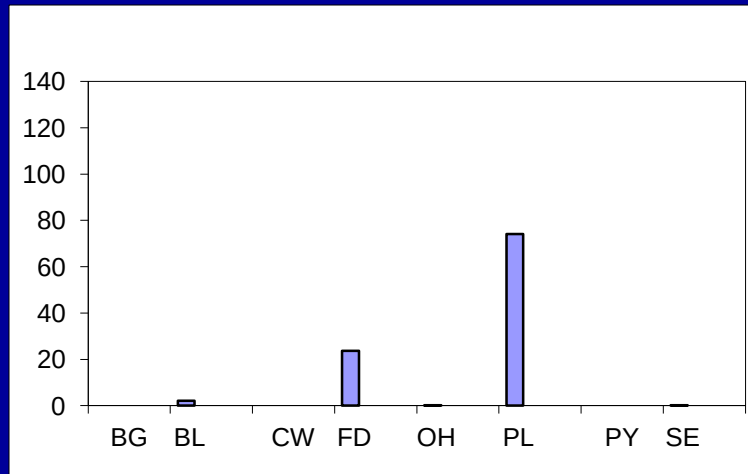
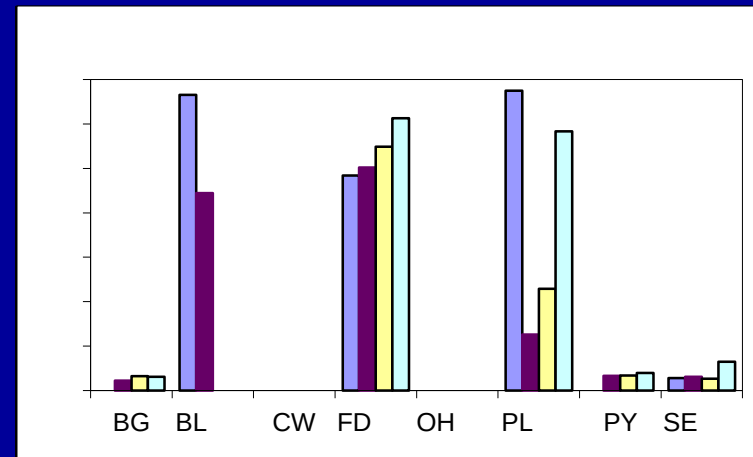
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Some Results from Manning Park

Density

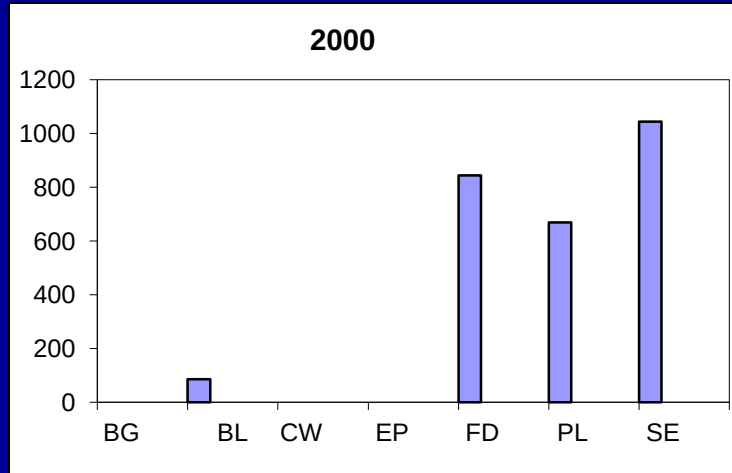
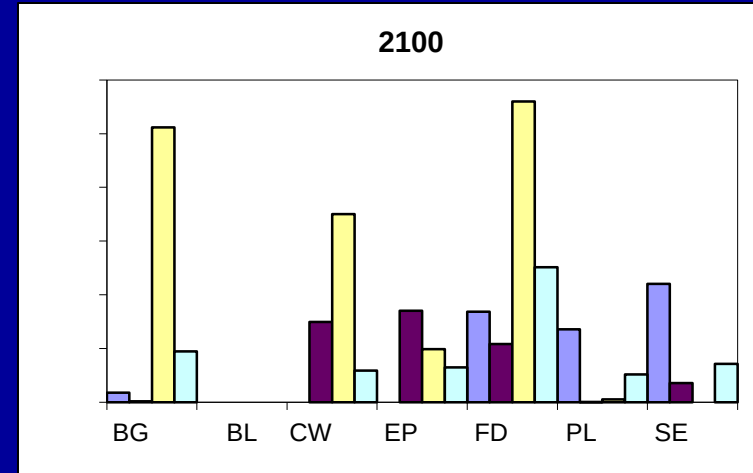


Volume

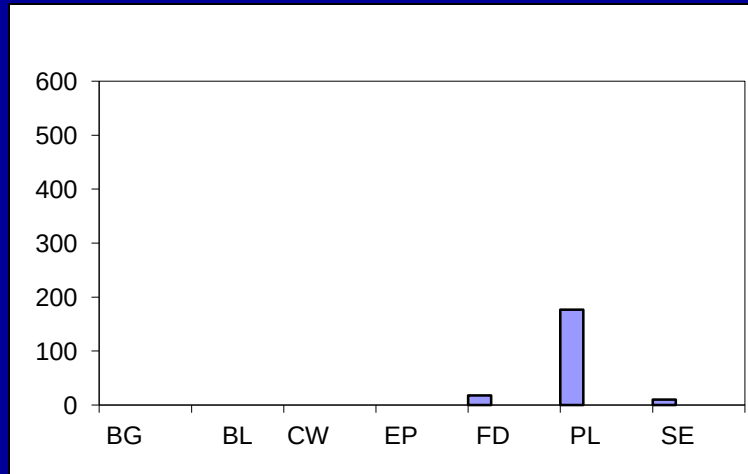
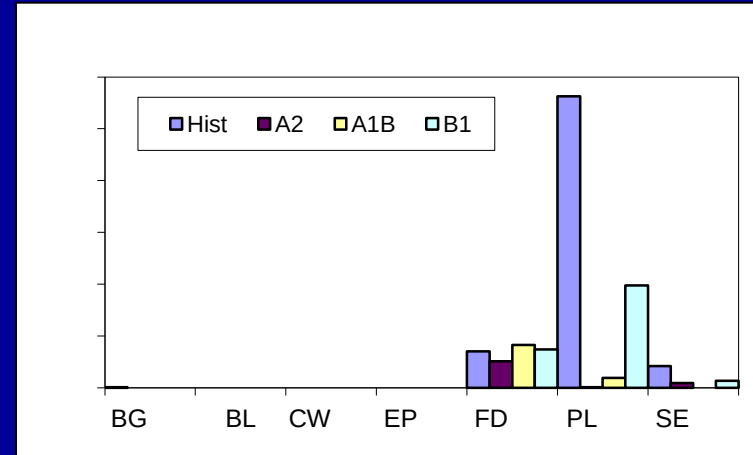


Some Results from Kootenay NP

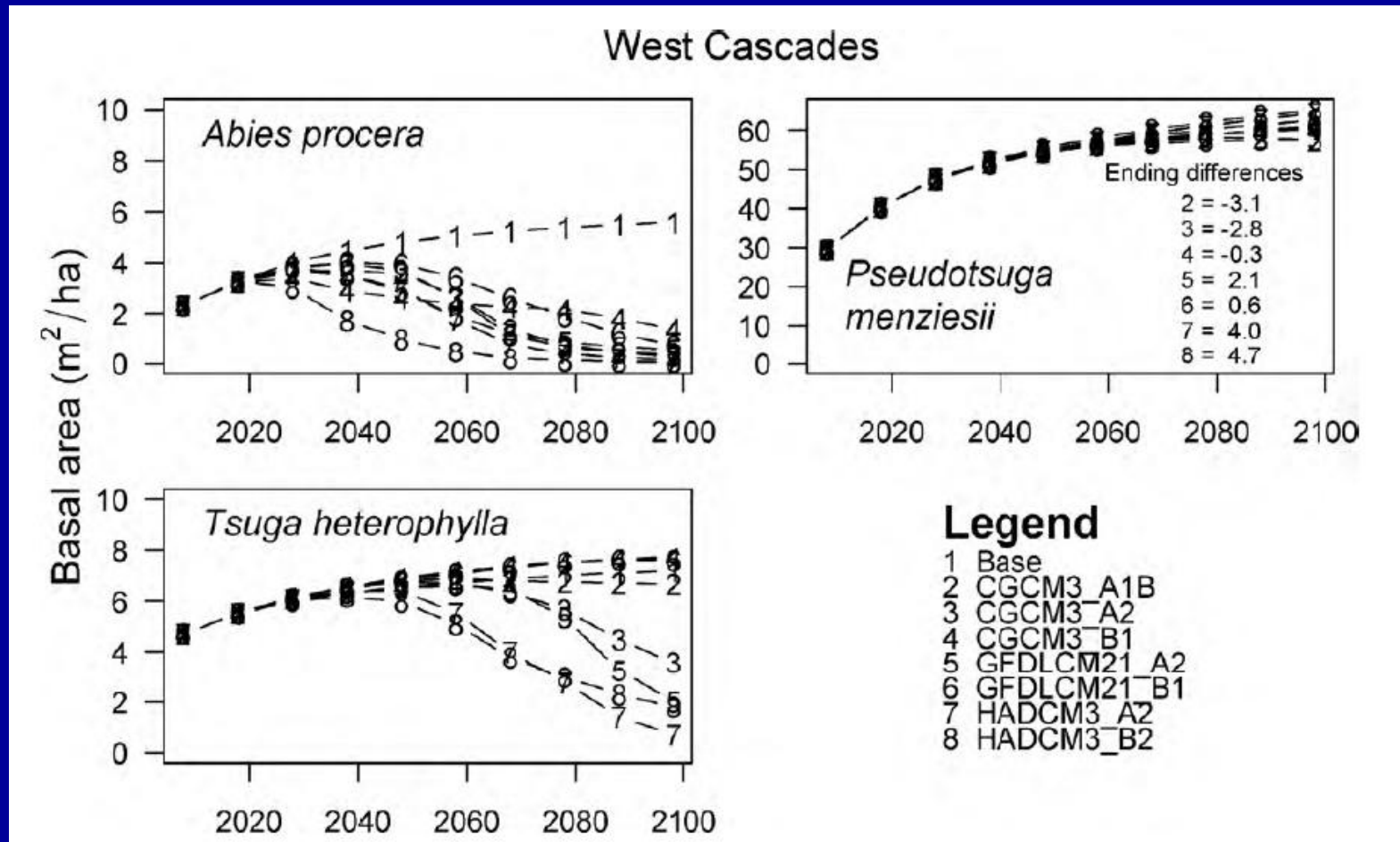
Density



Volume



Some US Results



Crookston et al. (2010)

Summary

- Prognosis^{BC} model is already available for much of BC
- Climate model depends on viability: assumes species could be present on the site.
- Viability incorporates major assumptions about early survival, reproduction and regeneration
- Useful for studying possible impacts of climate change

Next Steps – Improve Confidence

- Compare with physiological models (e.g. LPJ-Guess)
- BC predictions of future climate (USFS vs ClimateWNA)
- Develop climate-responses for other species (excellent BC data for PL)
- Climate sensitivity for carbon, insects, pathogens (temperature, moisture)
- Regional case studies –
 - Potential for species change
 - Planning implications
 - What management decisions can be addressed

Thanks!



