CLIMATE CHANGE INFORMED SPECIES SELECTION

&

SOME IMPLICATIONS FOR REFORESTATION

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ITAC, January, 2021

TALK OUTLINE

1. The climate change-informed species selection (CCISS) and webtool
2. Some provincial level implications to species suitability and ranges
3. Status and on-going work

GOAL: FUTURE FORESTS CONTINUE TO PROVIDE DESIRED GOODS AND SERVICES

- Plant tree species that are adapted to both current and future conditions
- Then select best climate adapted populations (CBST)

A CLIMATE CHANGE-INFORMED SPECIES SELECTION (CCISS) ANALYSIS

- MODELS THE TRAJECTORY OF TREE SPECIES SUITABILITY THROUGH CLIMATE CHANGE PERIODS
- IDENTIFIES SPECIES ADAPTED TO SITE CONDITIONS NOW AND INTO THE FUTURE

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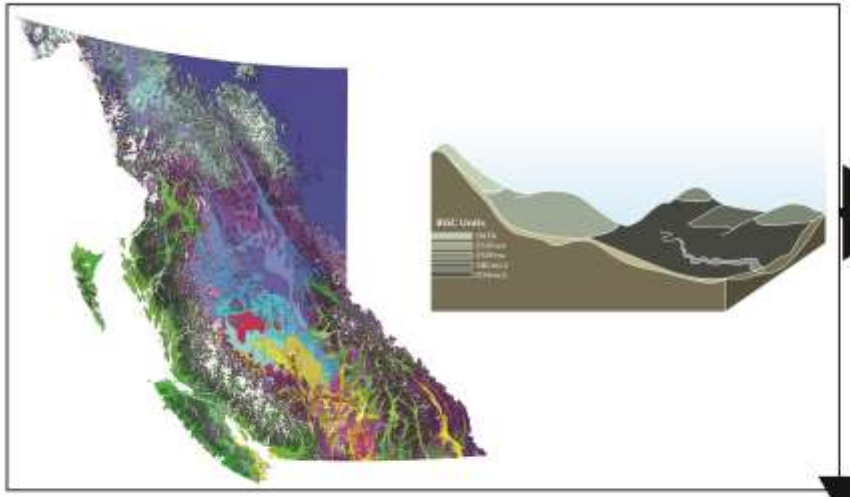
An ecological approach to climate change-informed tree species selection for reforestation

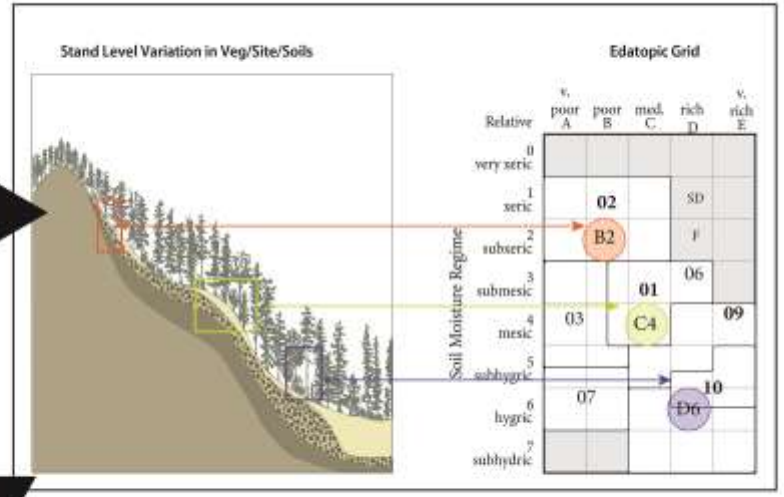
William H. MacKenzie [a,*], Colin R. Mahony [b]

APPLYING **BEC** TO SELECT ECOLOGICALLY APPROPRIATE TREE SPECIES

Subzone/Variants: ecologically equivalent climates



Site Series: ecologically equivalent sites in each subzone

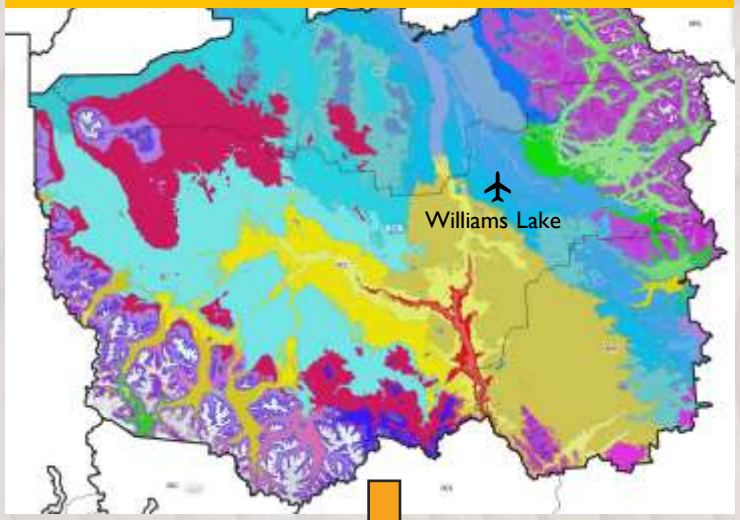


Tree Species Feasibility Rating by Site Series

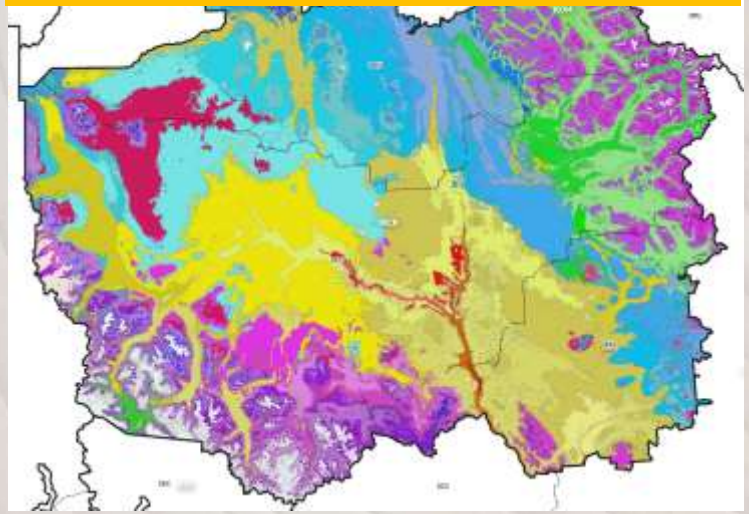
Site Series	Feasibility Rating 1	2	3
01 Sxw - Huckleberry	Bl Pl Sx		At
02 Pl - Huckleberry- Cladonia		Pl	At
03 SbPl - Feathermoss	Sb	Bl Pl Sx	At
06 Sxw - Oak fern	Bl Pl Sx		Act At
07 Sxw - Scrub birch - Feathermoss	Sx	Sb Pl	Act
09 Sxw - Devil's Club	Bl Sx	Pl	Act
10 Sxw - Horsetail	Bl Sx	Pl	Act

MODELLING BIOCLIMATE REDISTRIBUTION
WITH MACHINE LEARNING AND CLIMATE SURFACE DATA

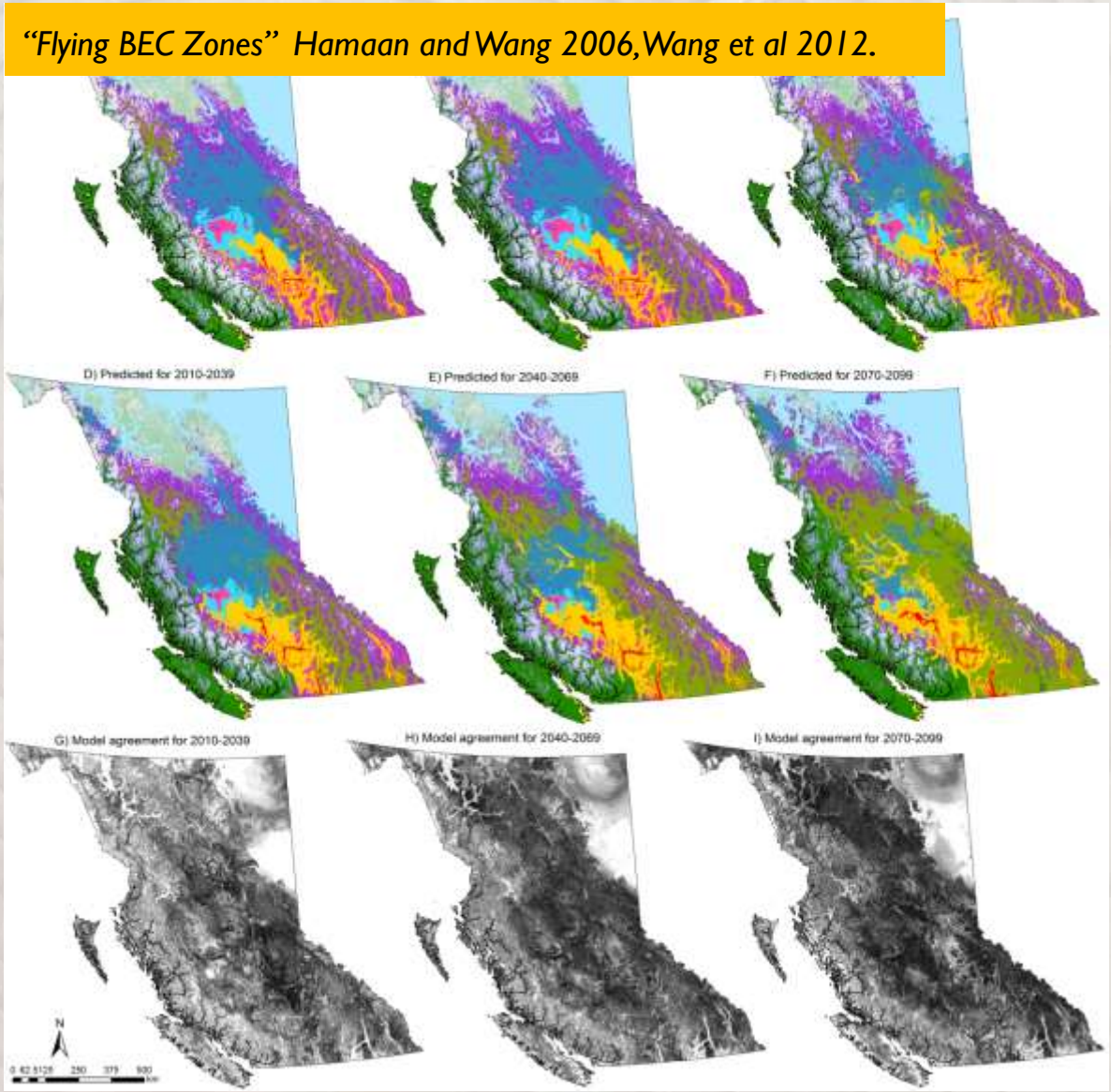
BEC mapped: historic 'normal' climate (1961-1990)



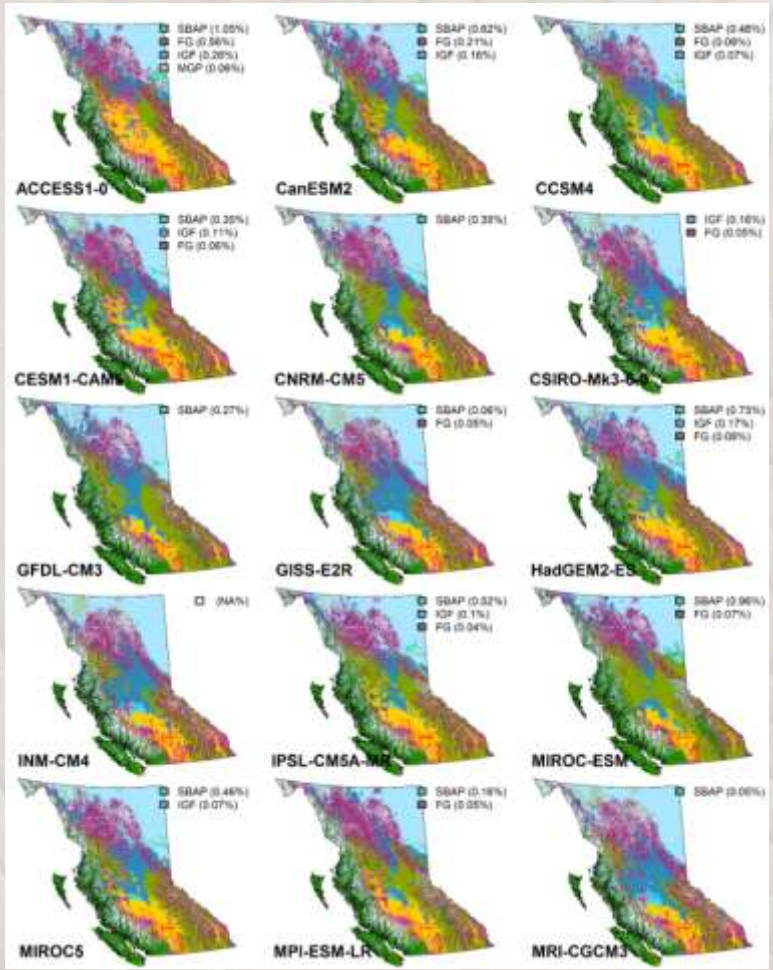
BEC projected current climate change (1991-2021)

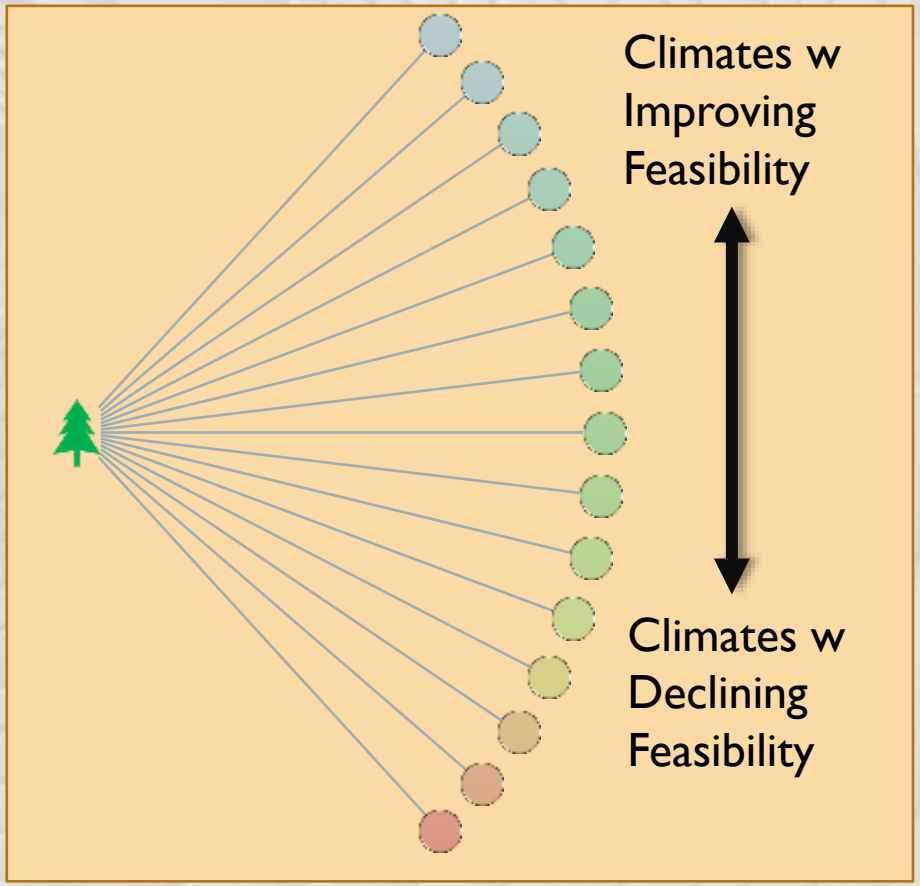


"Flying BEC Zones" Hamaan and Wang 2006, Wang et al 2012.



PREDICT TREE FEASIBILITY IN 30 MODEL-SCENARIOS OF CLIMATE CHANGE IN 20-YEAR PERIODS TO 2100

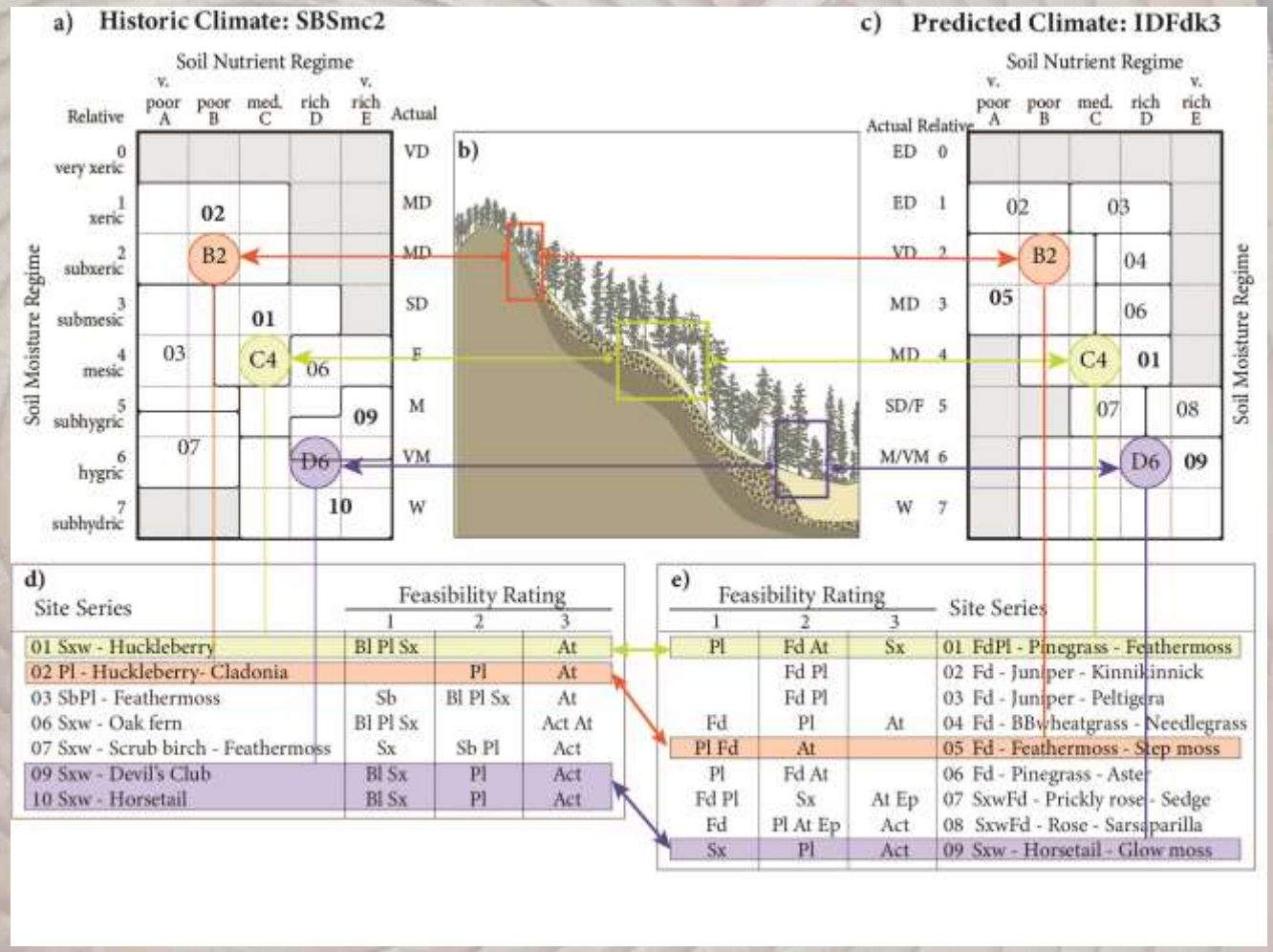




CCISS
FROM CLIMATE MODELLING TO SITE-LEVEL IMPLICATIONS

Aligning site series that occupy the same relative positions in the landscape

- Feasibility change is affected by edatopic position

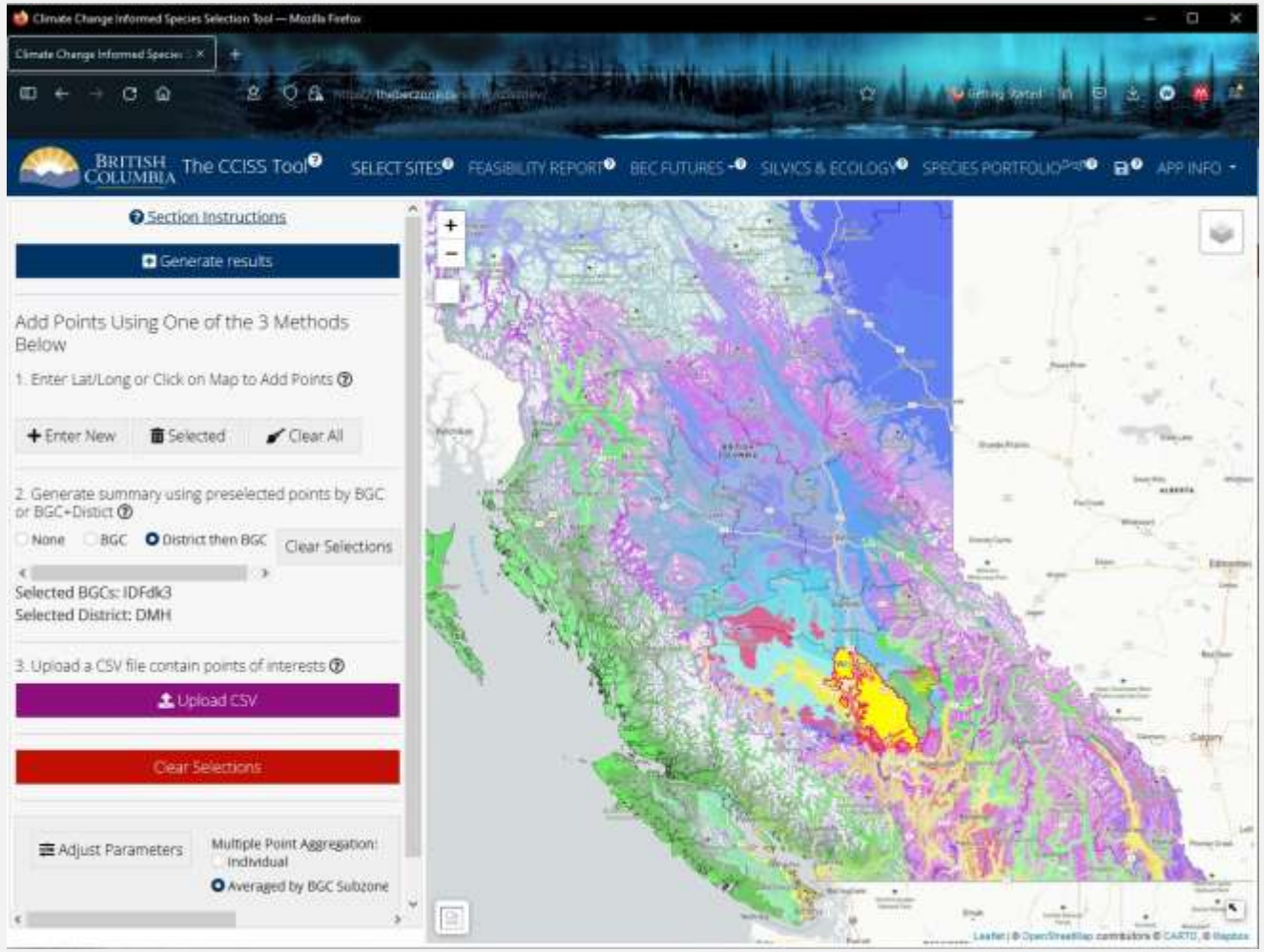


CCISS WEB APP

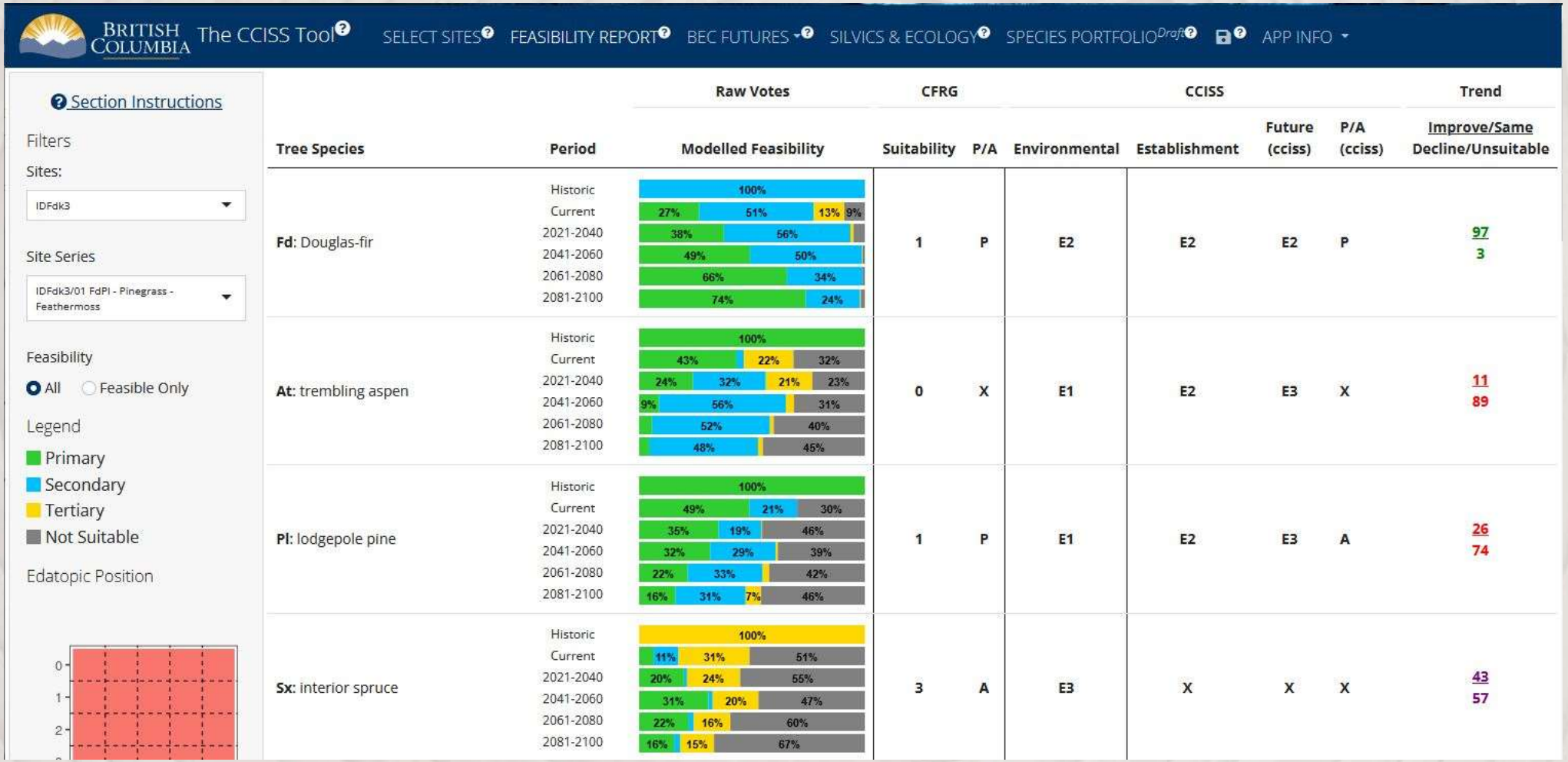
- New web app hosted on independent cloud servers and programming maintained by CCISS researchers
- Consolidates climate change implications to species feasibility for sites series at user specified geographic locations
- Displays 5 reporting tabs
  1. User selection of sites/area of interest
  2. Modelled feasibility changes by sites series, estimated feasibility rating for establishment and through rotation based on trend model agreement
  3. Alignment of CCISS to CFRG default stocking and silvics info from Klinka et al
  4. Draft portfolio analysis
- Export CCISS report to HTML or PDF

1. CHOOSE SITES OR AREAS OF INTEREST

- Choose specific location(s), or
  - A single BGC or
  - BGC x District
- Report by indiv site or averaged
- Change default model settings



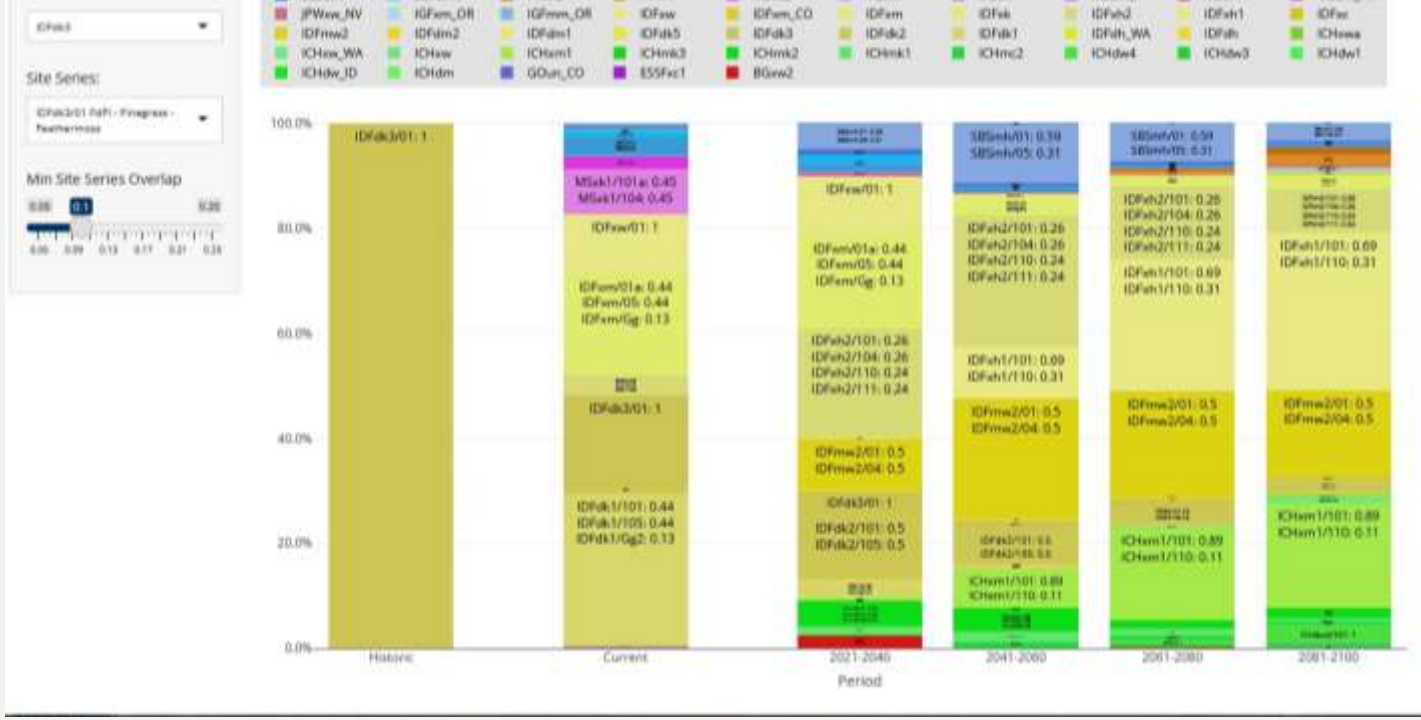
2. FEASIBILITY TRENDS BY SITE SERIES

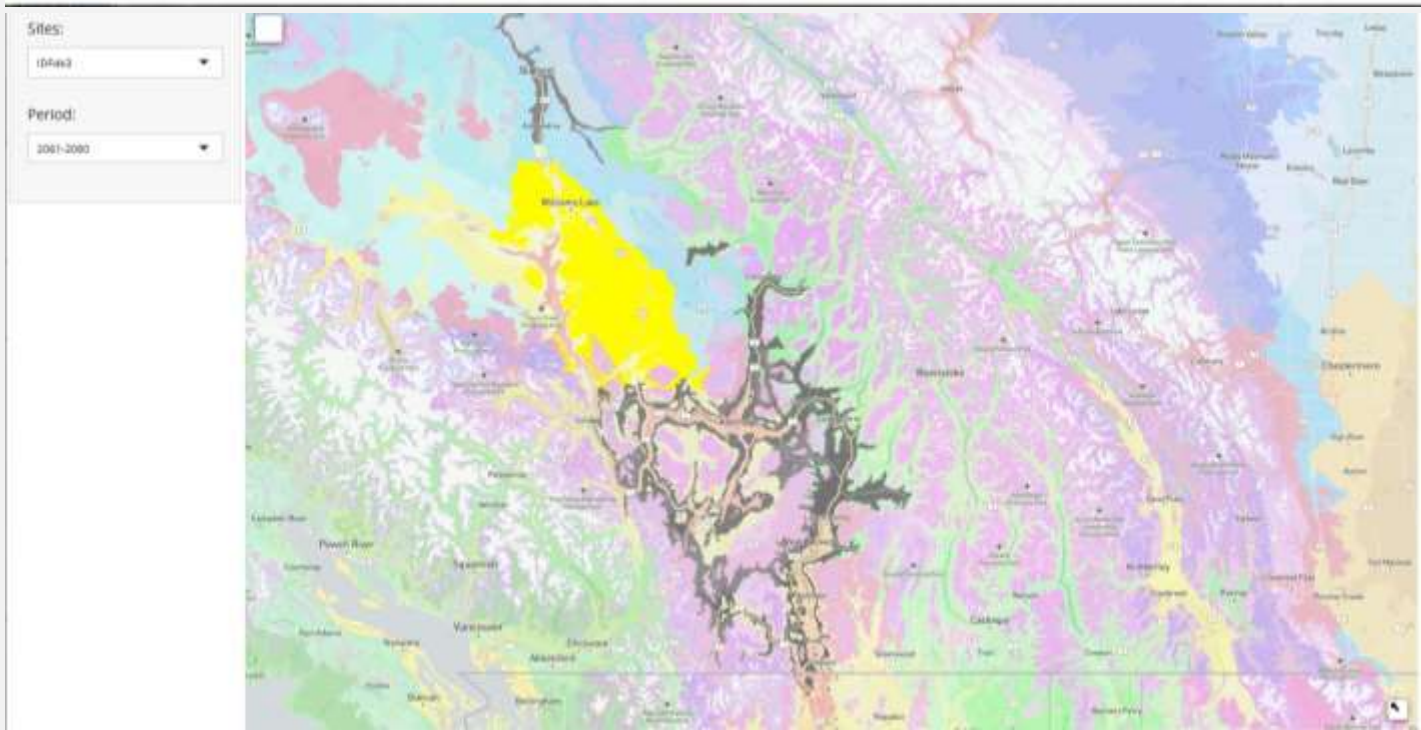


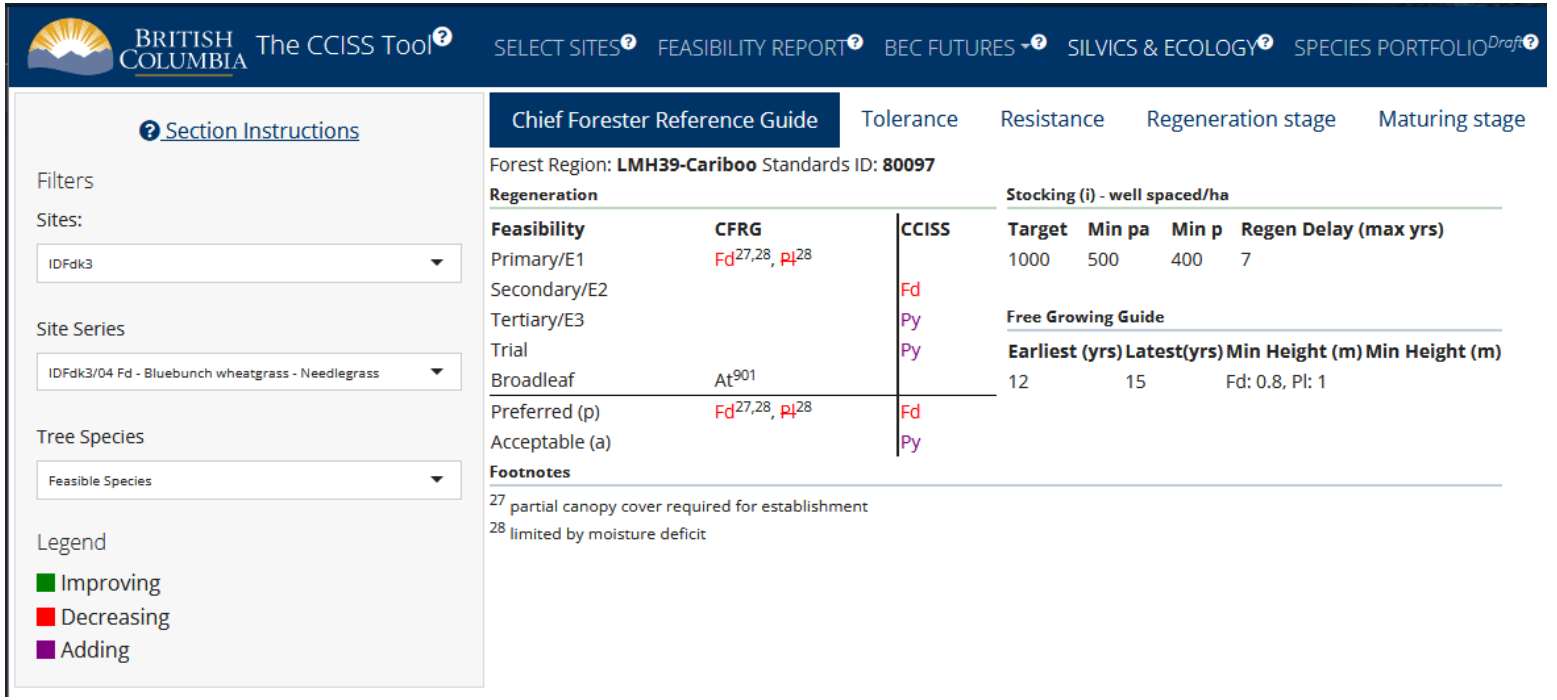
Tree Species	Period	Raw Votes Modelled Feasibility	CFRG Suitability	CFRG P/A	CCISS Environmental	CCISS Establishment	CCISS Future (cciss)	CCISS P/A (cciss)	Trend Improve/Same / Decline/Unsuitable
Fd: Douglas-fir	Historic	100%	1	P	E2	E2	E2	P	97 / 3
	Current	27% 51% 13% 9%							
	2021-2040	38% 56%							
	2041-2060	49% 50%							
	2061-2080	66% 34%							
	2081-2100	74% 24%							
At: trembling aspen	Historic	100%	0	X	E1	E2	E3	X	11 / 89
	Current	43% 22% 32%							
	2021-2040	24% 32% 21% 23%							
	2041-2060	9% 56% 31%							
	2061-2080	52% 40%							
	2081-2100	48% 45%							
Pl: lodgepole pine	Historic	100%	1	P	E1	E2	E3	A	26 / 74
	Current	49% 21% 30%							
	2021-2040	35% 19% 46%							
	2041-2060	32% 29% 39%							
	2061-2080	22% 33% 42%							
	2081-2100	16% 31% 7% 46%							
Sx: interior spruce	Historic	100%	3	A	E3	X	X	X	43 / 57
	Current	11% 31% 51%							
	2021-2040	20% 24% 55%							
	2041-2060	31% 20% 47%							
	2061-2080	22% 16% 60%							
	2081-2100	16% 15% 67%							

3. BEC FUTURES

- Ratio of BGCs and Site Series predicted
- Map of source BGCs for future climate periods.







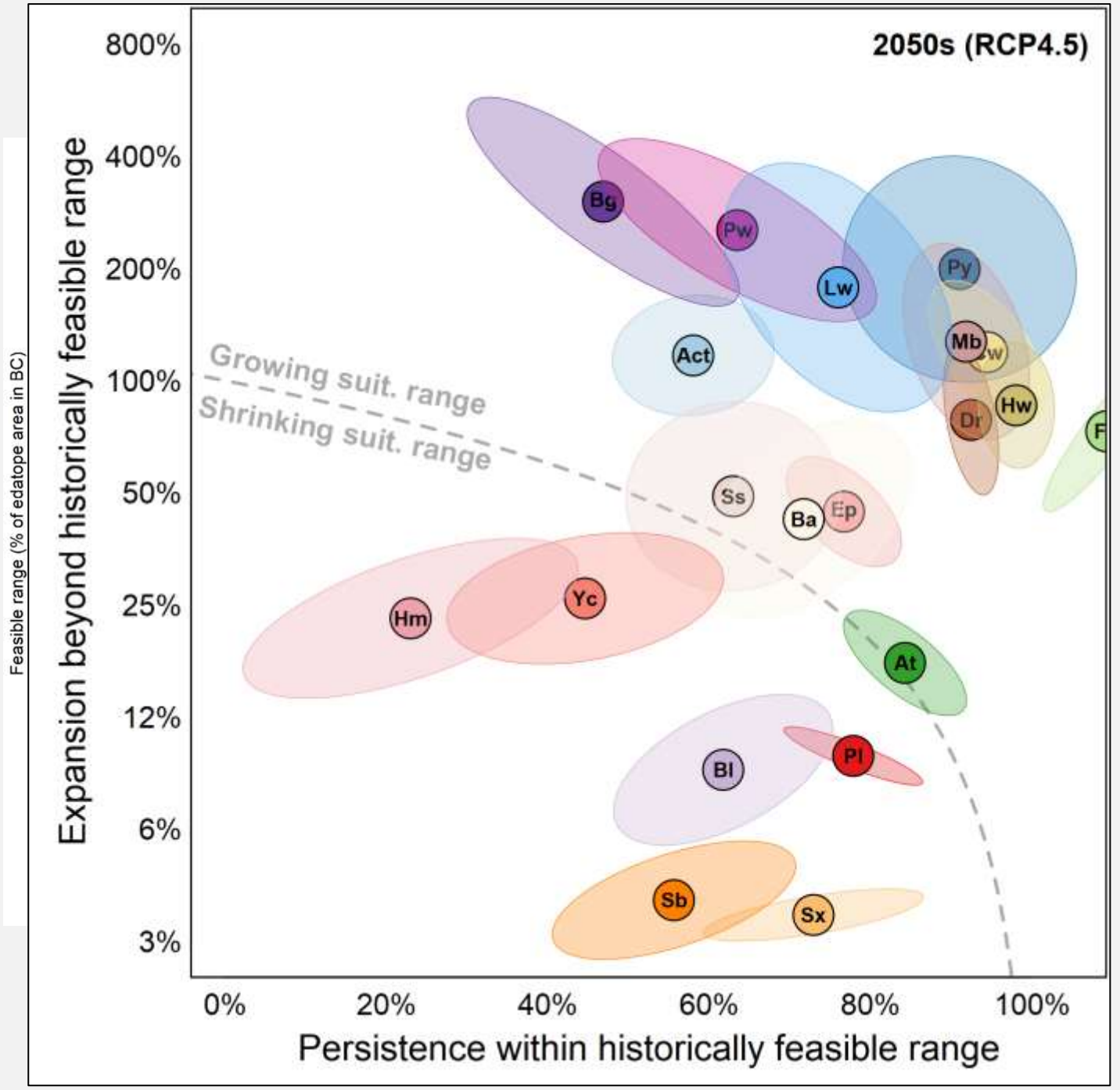
4. CCISS ALIGNMENT TO DEFAULT STANDARDS

SOME PROVINCIAL TRENDS IN SPECIES FEASIBILITY

- From Forest Ecology and Management paper
- Provincial level spatial trends in environmental suitability species under different edaphic conditions

PERSISTENCE AND EXPANDING FEASIBLE RANGE

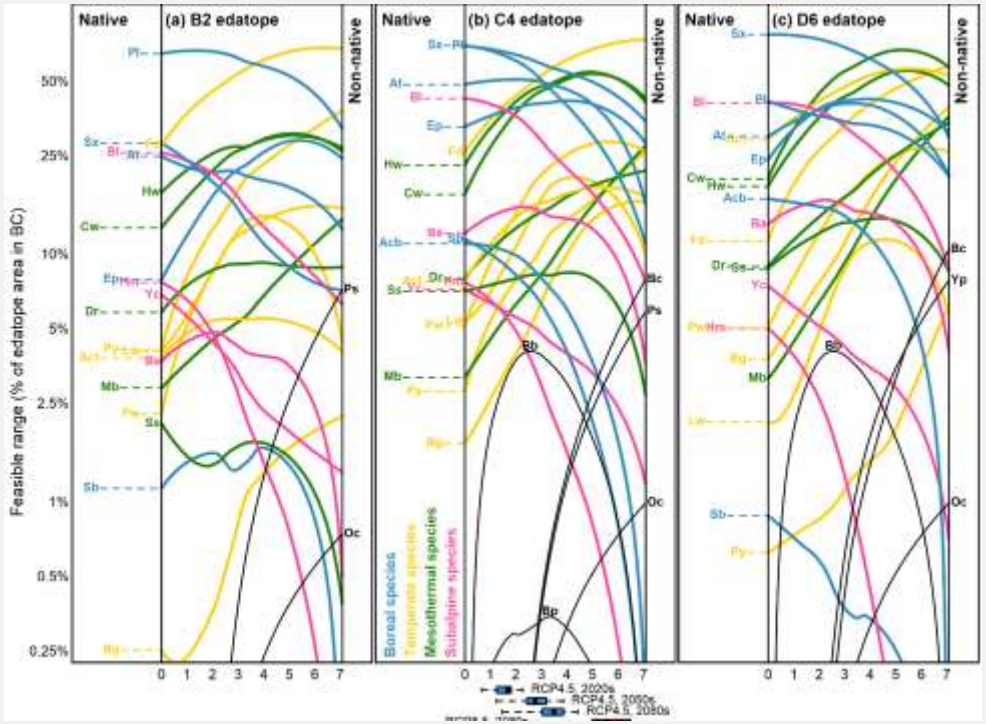
- Temperate and rain forest species persist and expand
- Boreal and subalpine species decline

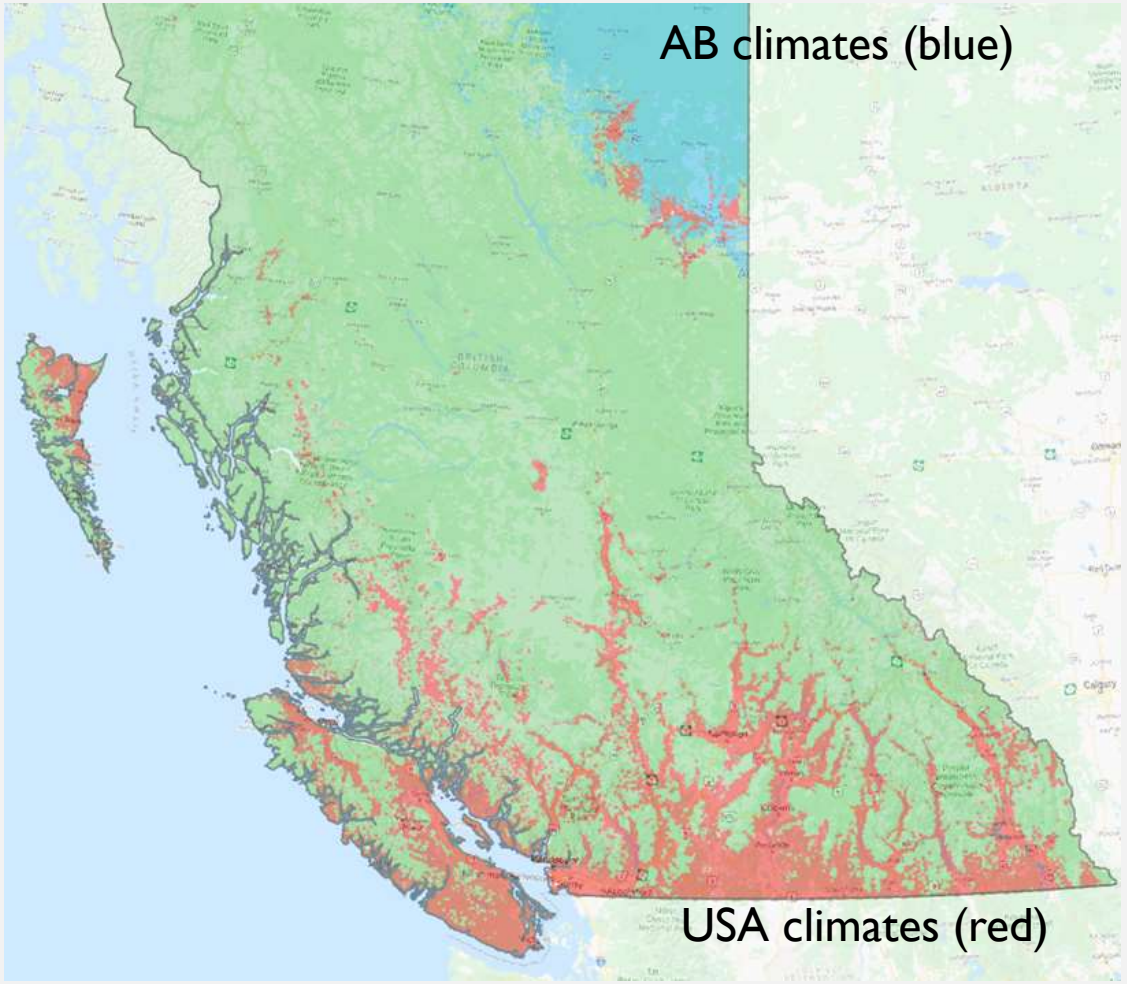


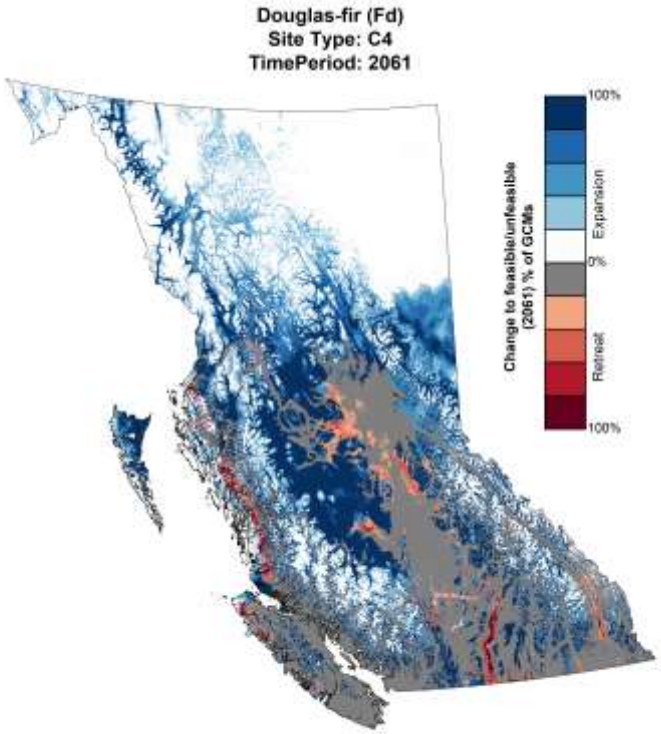
USA AND ALBERTA CLIMATES IN BC FUTURE BUT FEW SPECIES ADDITIONS

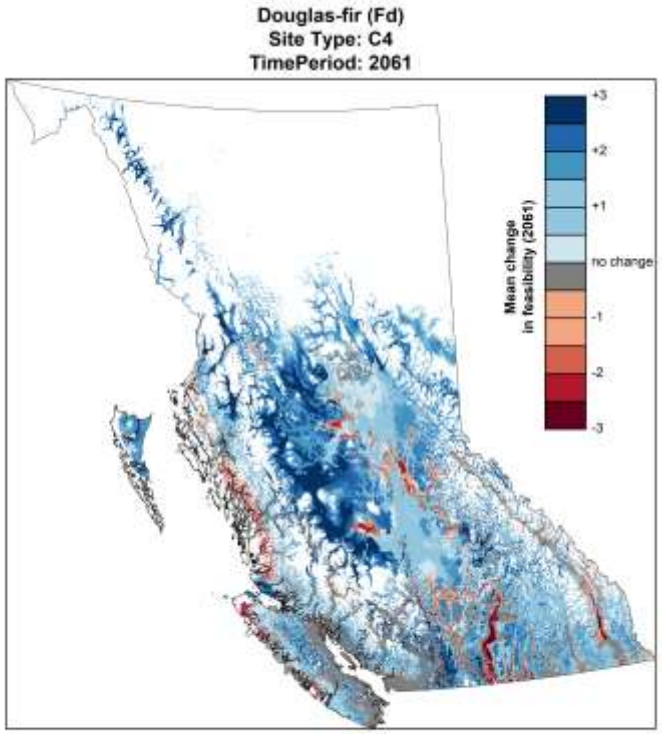
Alberta climates into the Peace

USA climates at low elevation southern coast and interior but few new species





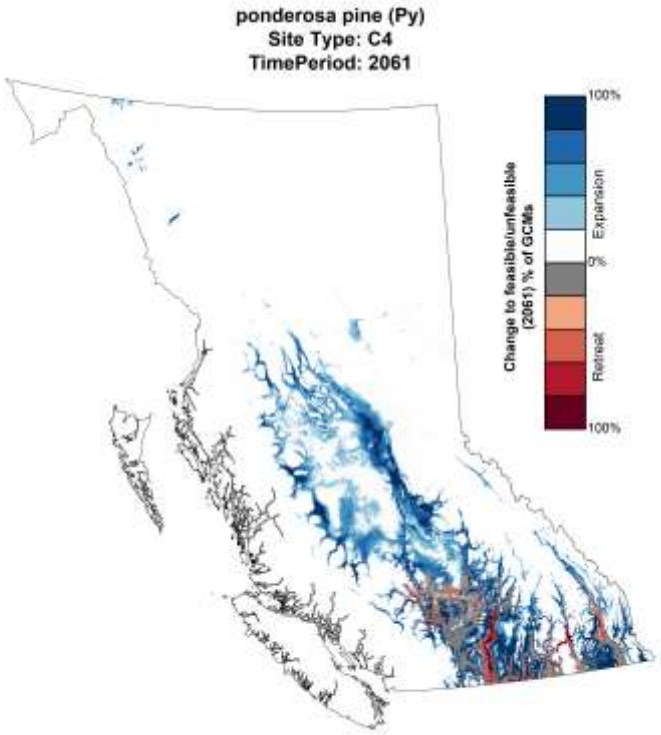


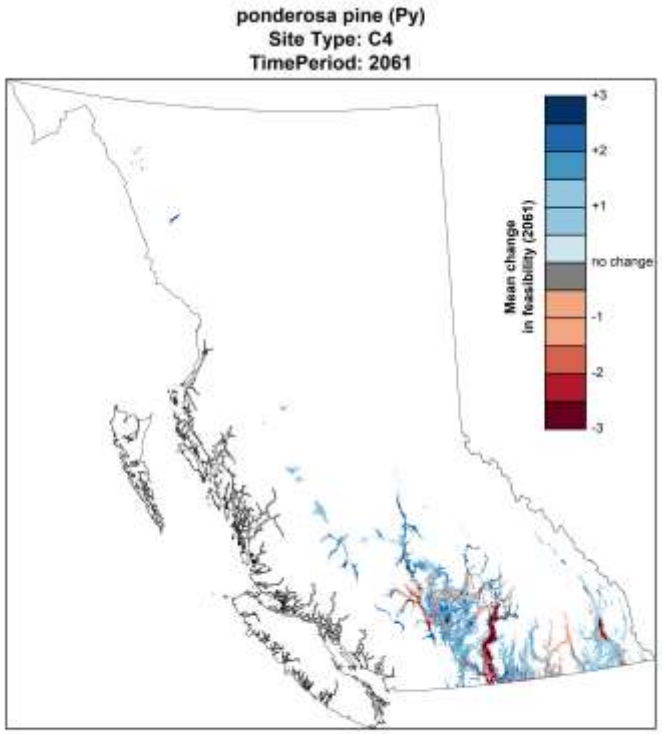


Expansion or Retreat (model agreement)

Mean change in feasibility rating

PROJECTED FUTURE DOUGLAS-FIR FEASIBILITY ON ZONAL SITES

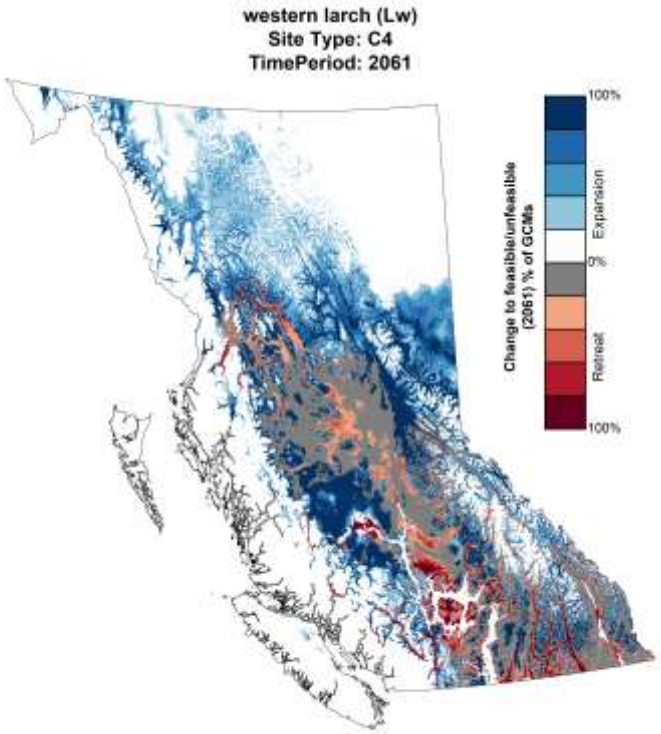


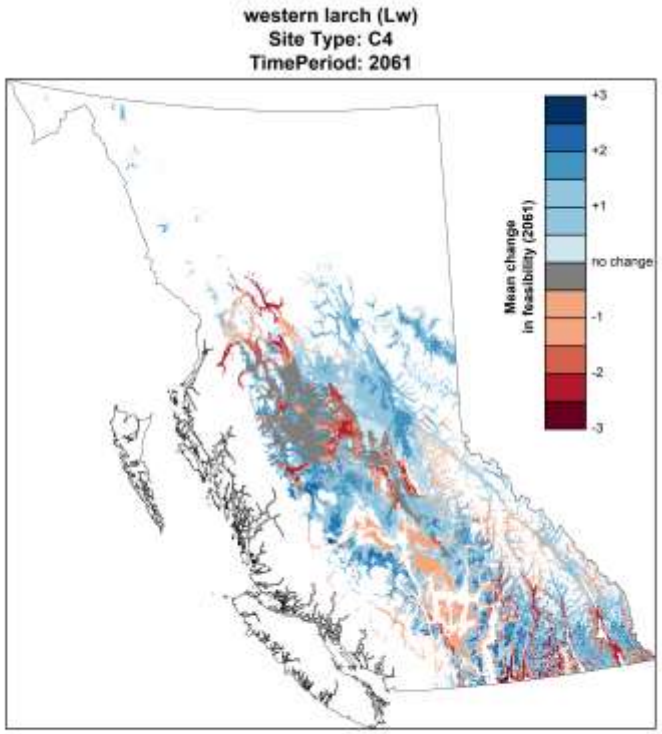


Expansion or Retreat (model agreement)

Mean change in feasibility rating

PROJECTED FUTURE
PONDEROSA PINE FEASIBILITY ON ZONAL SITES

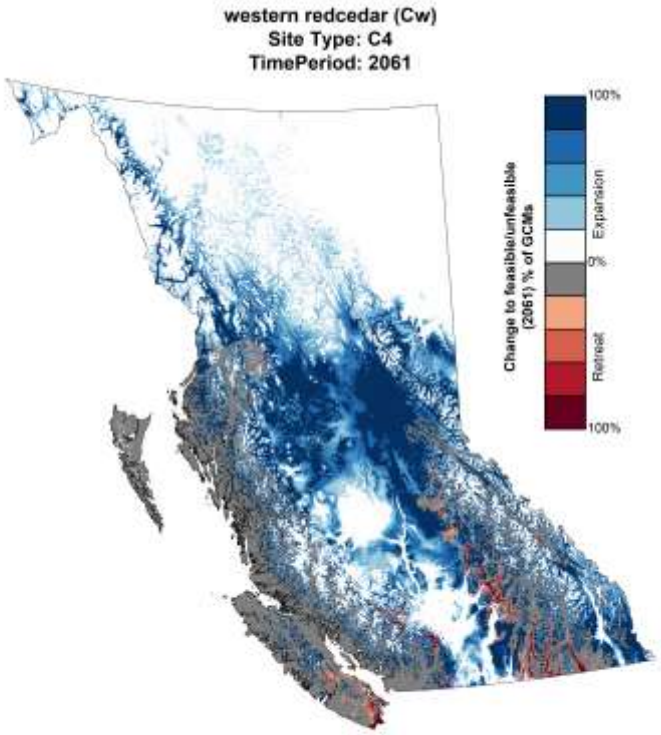


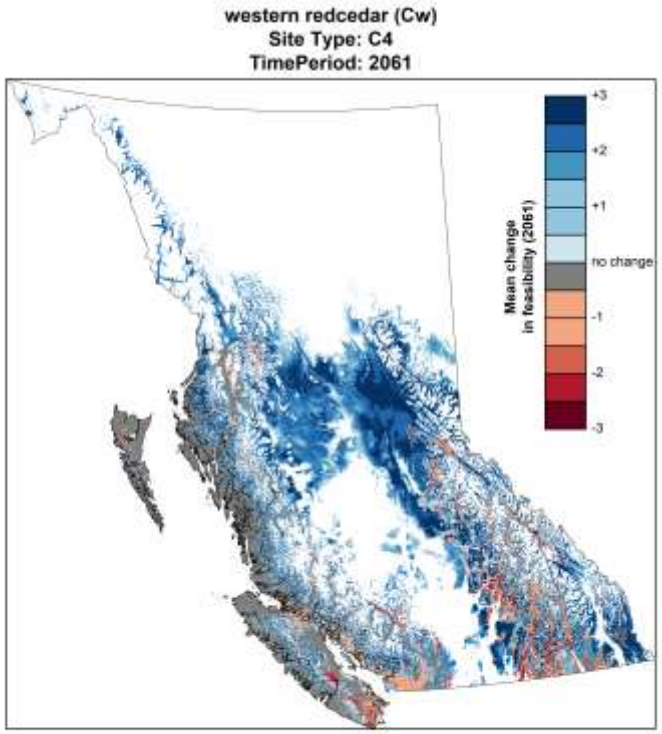


Expansion or Retreat (model agreement)

Mean change in feasibility rating

PROJECTED FUTURE
WESTERN LARCH FEASIBILITY ON ZONAL SITES
CHALLENGES WITH CURRENT JAQUISH IMPLEMENTATION

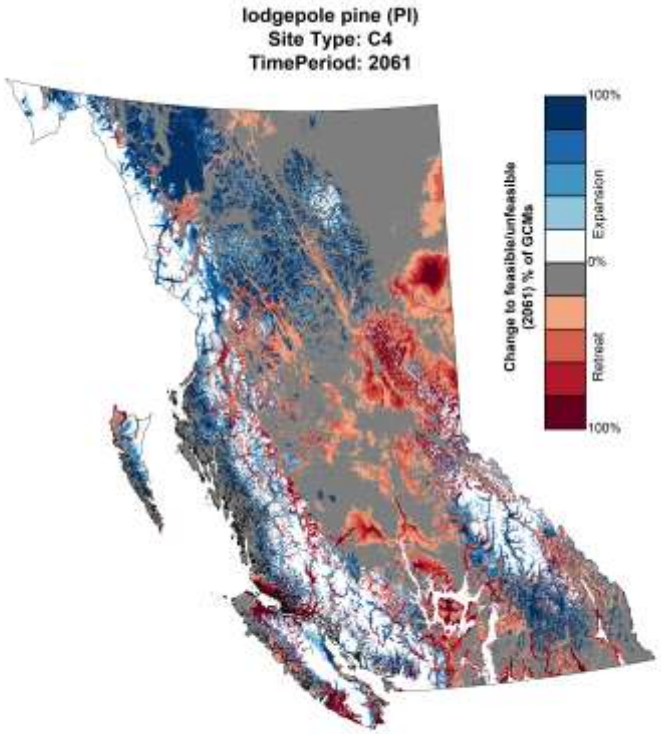


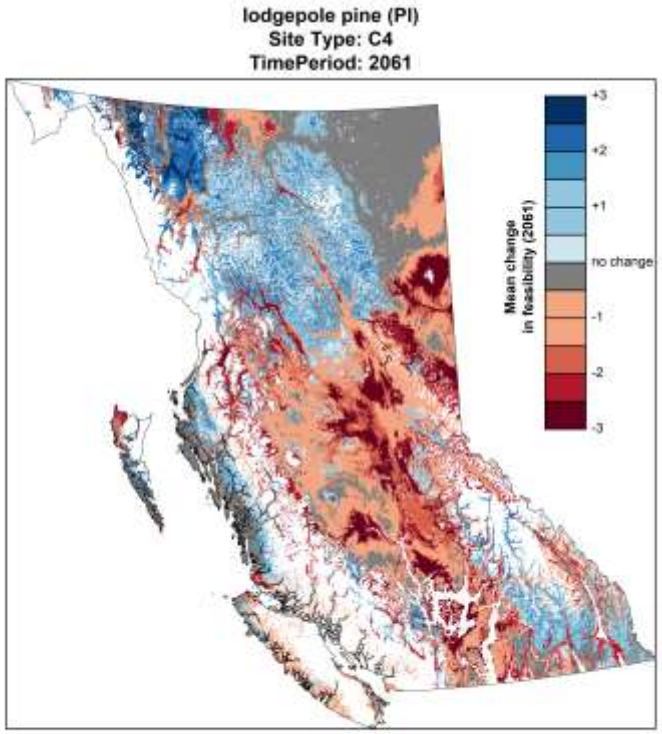


Expansion or Retreat (model agreement)

Mean change in feasibility rating

PROJECTED FUTURE PONDEROSA PINE FEASIBILITY ON ZONAL SITES

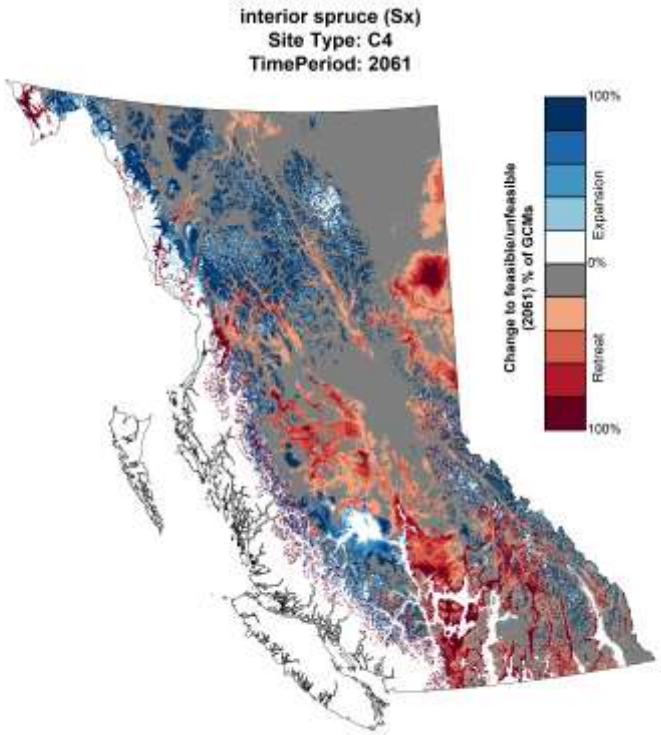


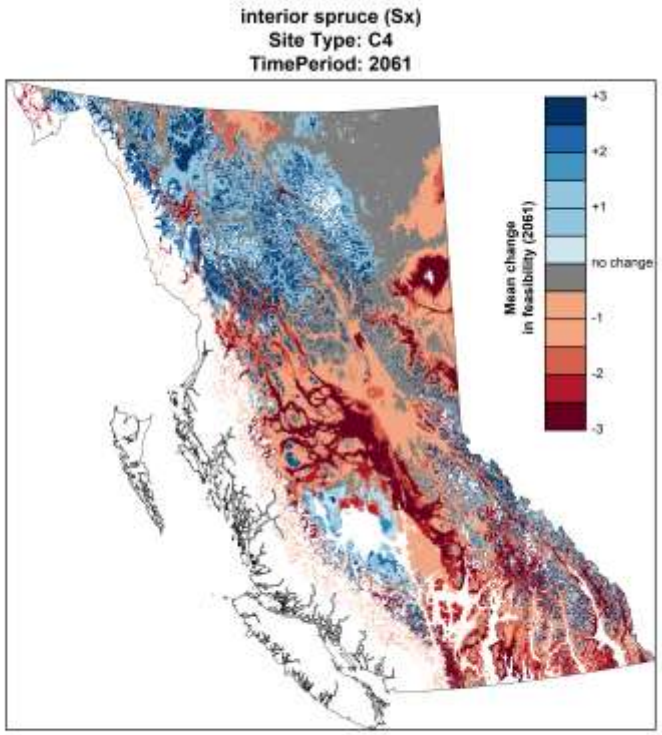


Expansion or Retreat (model agreement)

Mean change in feasibility rating

PROJECTED FUTURE LODGEPOLE PINE FEASIBILITY ON ZONAL SITES

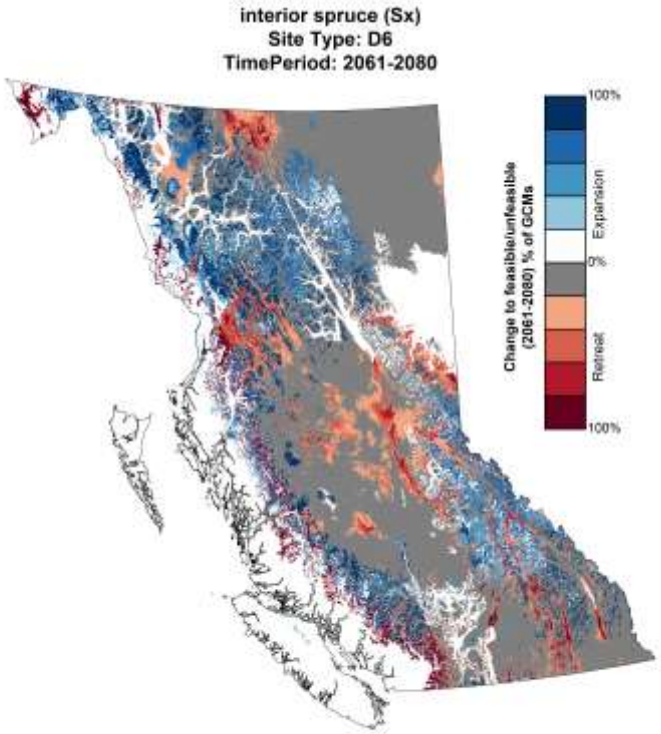


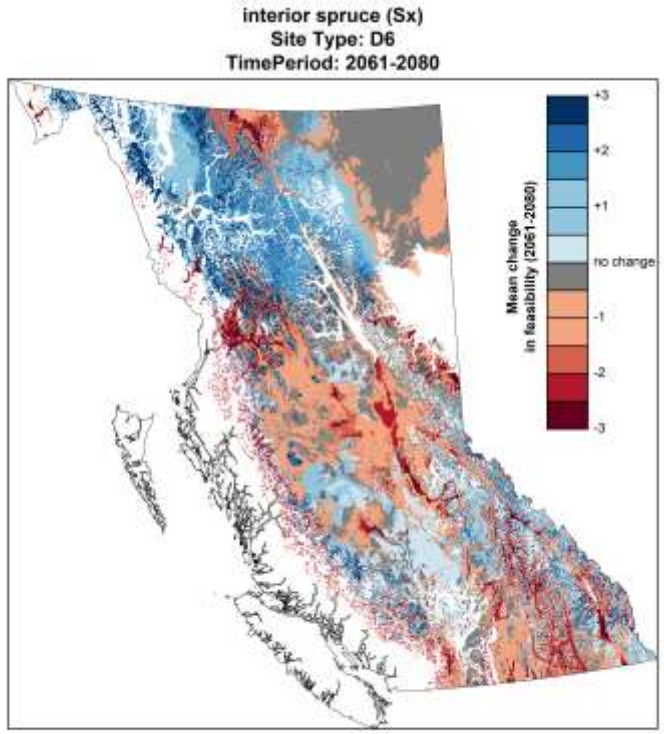


Expansion or Retreat (model agreement)

Mean change in feasibility rating

PROJECTED FUTURE
INTERIOR SPRUCE FEASIBILITY ON ZONAL SITES





Expansion or Retreat (model agreement)

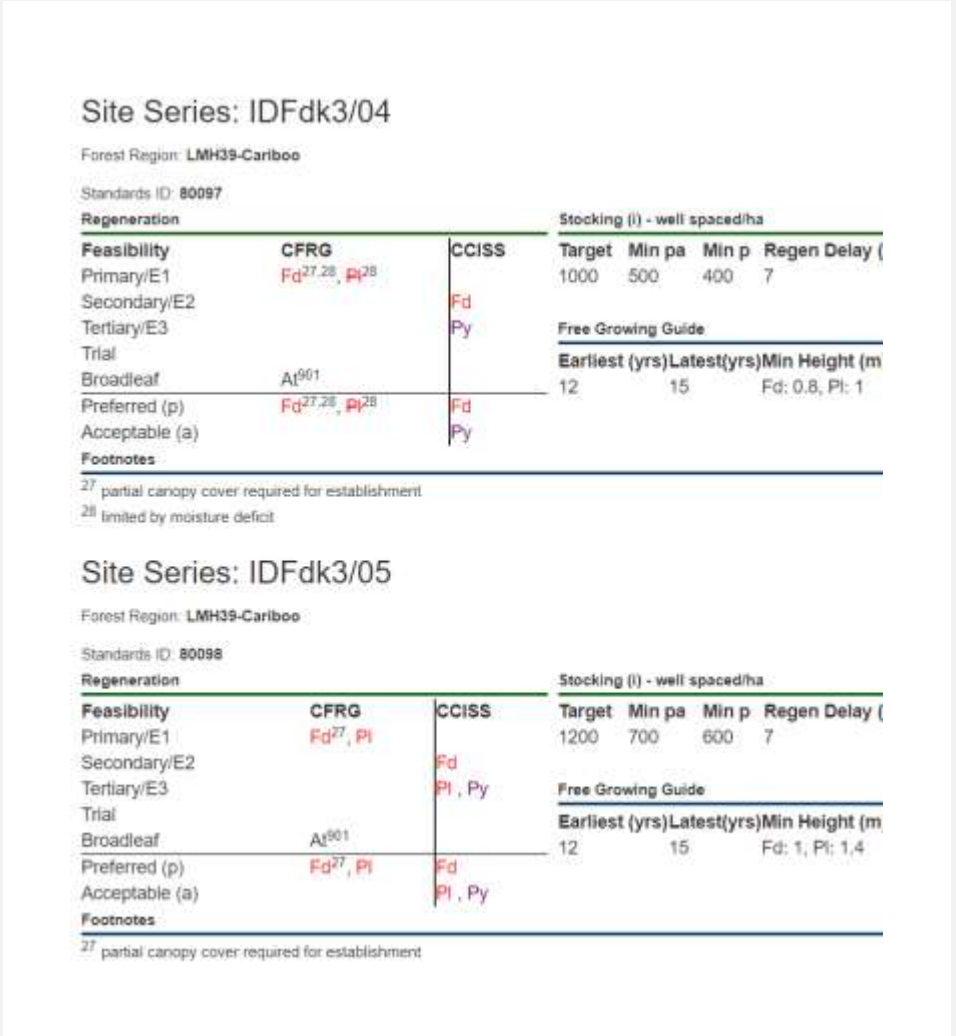
Mean change in feasibility rating

PROJECTED FUTURE
INTERIOR SPRUCE FEASIBILITY ON RICH HYGRIC SITES

CURRENT STATUS OF CCISS

1. Working towards executive approval
   - Some technical components to finalize
   - FN and Client consult - Limited staff for this work
2. Comprehensive comparison of CCISS with CFRG default standards by forest district
   - Avenue for review (and implementation) by Regions/Districts

Compare Default Standards with CCISS by District



Site Series: IDFdk3/04

Forest Region: **LMH39-Cariboo**

Standards ID: **80097**

Regeneration

Feasibility	CFRG	CCISS
Primary/E1	Fd[27,28], Pl[28]	
Secondary/E2		Fd
Tertiary/E3		Py
Trial		
Broadleaf	At[901]	
Preferred (p)	Fd[27,28], Pl[28]	Fd
Acceptable (a)		Py

Stocking (i) - well spaced/ha

Target	Min pa	Min p	Regen Delay (
1000	500	400	7

Free Growing Guide

Earliest (yrs)	Latest(yrs)	Min Height (m
12	15	Fd: 0.8, Pl: 1

Footnotes

[27] partial canopy cover required for establishment

[28] limited by moisture deficit

Site Series: IDFdk3/05

Forest Region: **LMH39-Cariboo**

Standards ID: **80098**

Regeneration

Feasibility	CFRG	CCISS
Primary/E1	Fd[27], Pl	
Secondary/E2		Fd
Tertiary/E3		Pl , Py
Trial		
Broadleaf	At[901]	
Preferred (p)	Fd[27], Pl	Fd
Acceptable (a)		Pl , Py

Stocking (i) - well spaced/ha

Target	Min pa	Min p	Regen Delay (
1200	700	600	7

Free Growing Guide

Earliest (yrs)	Latest(yrs)	Min Height (m
12	15	Fd: 1, Pl: 1.4

Footnotes

[27] partial canopy cover required for establishment

ADDITIONAL ONGOING WORK

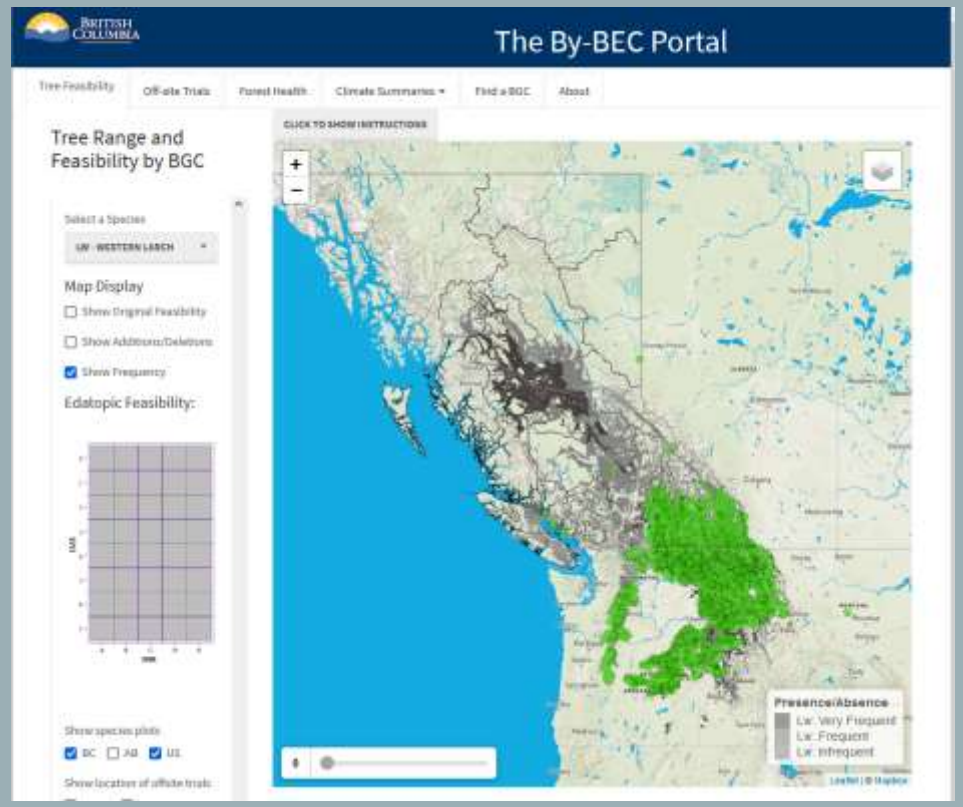
Assessment of existing off-site trials to support planting of CC-adapted species <u>now</u>

Forest health risk ratings by host:pest for each BGC for CCISS analysis and update CFRG

Modern Portfolio Analysis: Stand and Landscape Diversification to manage risk

REVIEW OF EXISTING OFF-SITE TRIALS TO SUPPORT RANGE EXPANSION

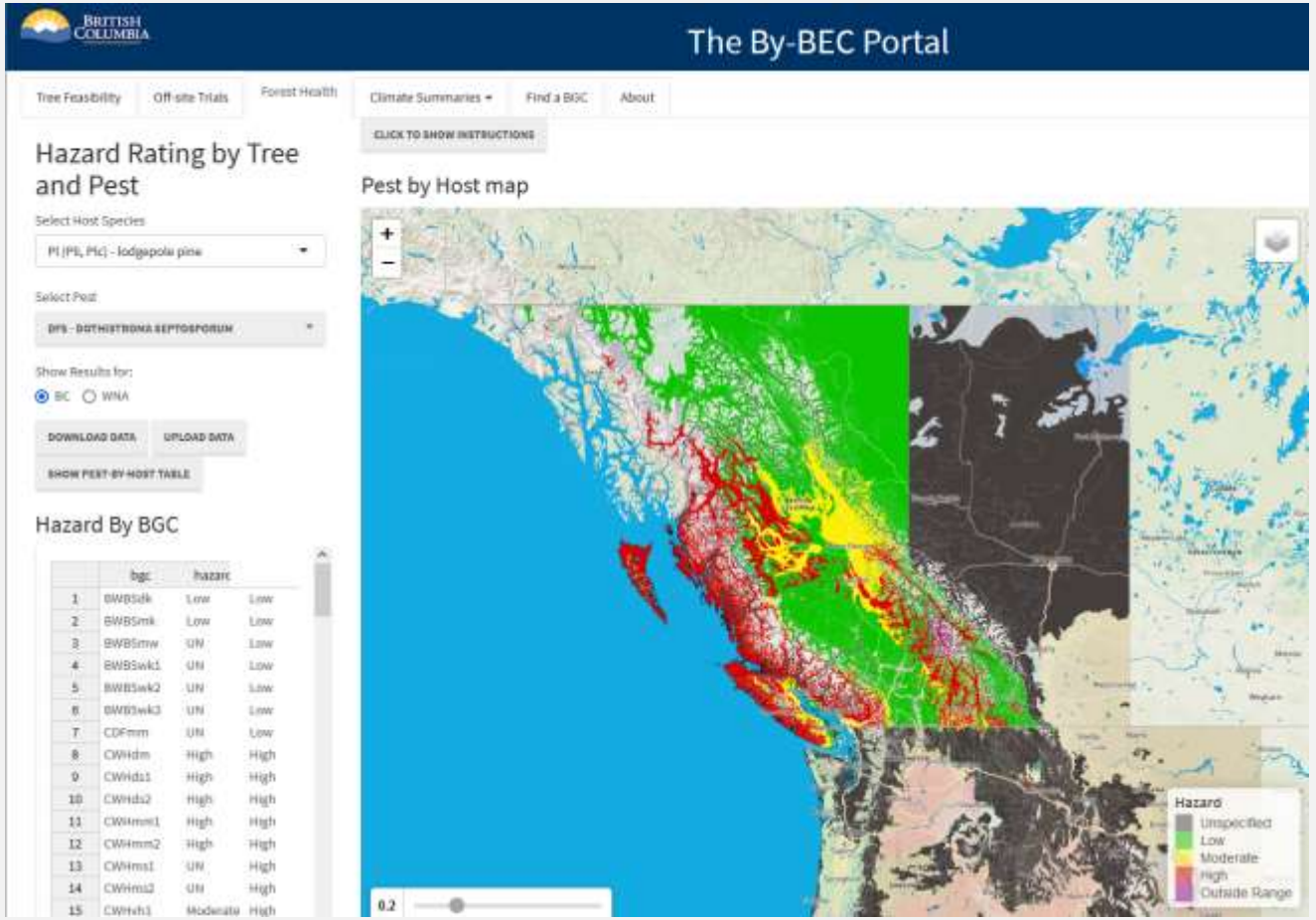
SAMPLED NATURAL LARCH STANDS (GREEN) AND EXPANDED JAQUISH RANGE (GREY)



EXISTING OFF-SITE LARCH PLANTINGS FOR POTENTIAL ASSESSMENT

FOREST HEALTH RISK BY BEC

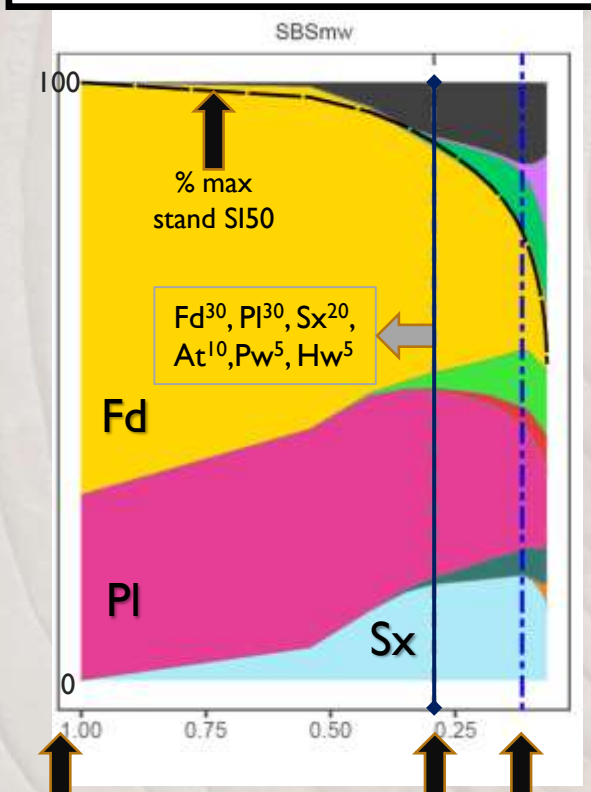
- 1. CCISS forecasting of changes to forest health risk with climate change
- 2. For consideration suitability ratings for climate change stocking standards



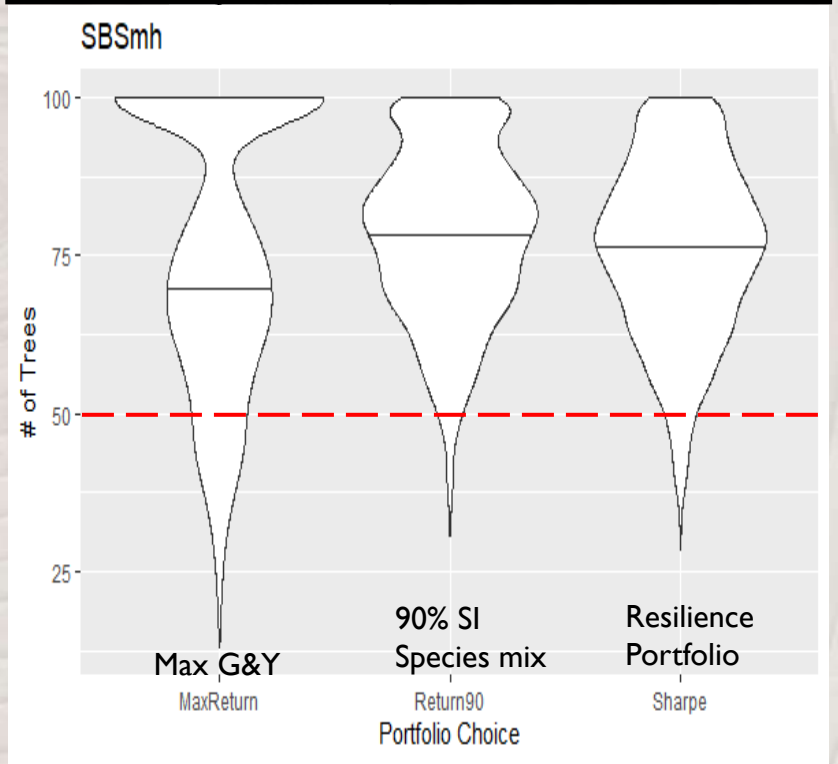
ADDRESSING CLIMATE CHANGE UNCERTAINTY
MODERN PORTFOLIO THEORY

Climate Change Optimized Tree Species Diversity

SPECIES MIX OPTIMIZED BALANCE G&Y WITH RESILIENCE



PROBABILISTIC LOSSES BY PORTFOLIO



% PLANTED TREES SURVIVING AFTER 70 YEARS (1000 MONTE CARLO SIMULATIONS)

IMPLICATIONS OF CCISS FOR SEEDLING REQUIREMENTS

- CCISS stocking standards may lead to increased planting of temperate and rainforest species; decline in boreal species
- Range expansion of new species from USA/AB into BC appears to be limited (but more for important for CBST)
- Operational implementation of range expansion for off-site species should be supported by trial data and this might take some time
- With changing climate there are likely to be more unexpected weather-mediated events with plantation losses that will need for replant/fill plant
- Species diversification in reforestation could lead to more balanced demand
- New non timber standards may lead to demand for previously ignored species (e.g. trembling aspen)

END