



Climate Change Informed Species Selection (CCISS)

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Coastal Silviculture Committee Winter 2019 Meeting
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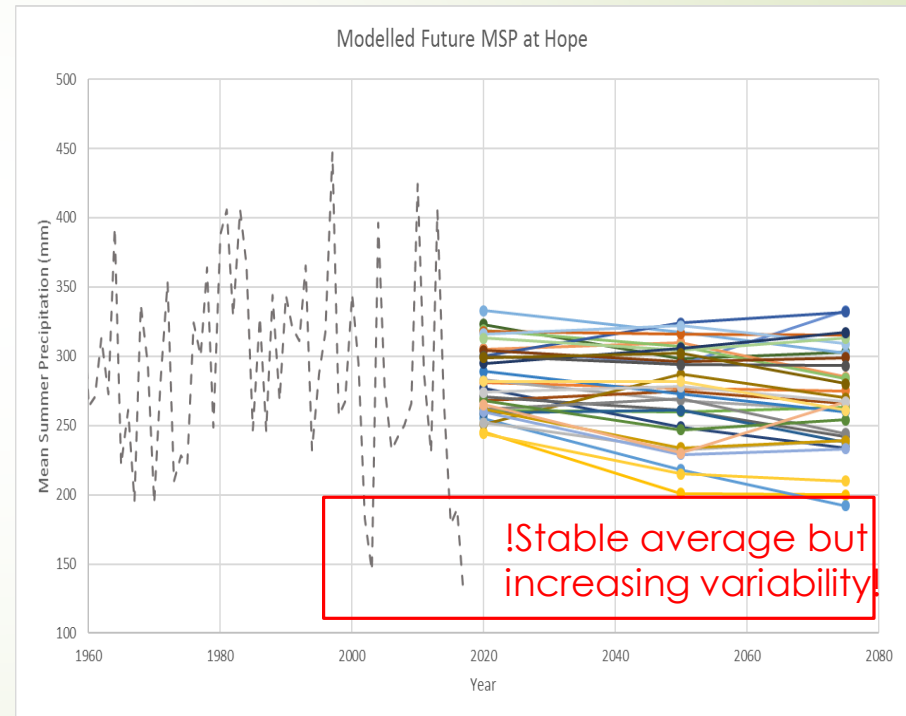
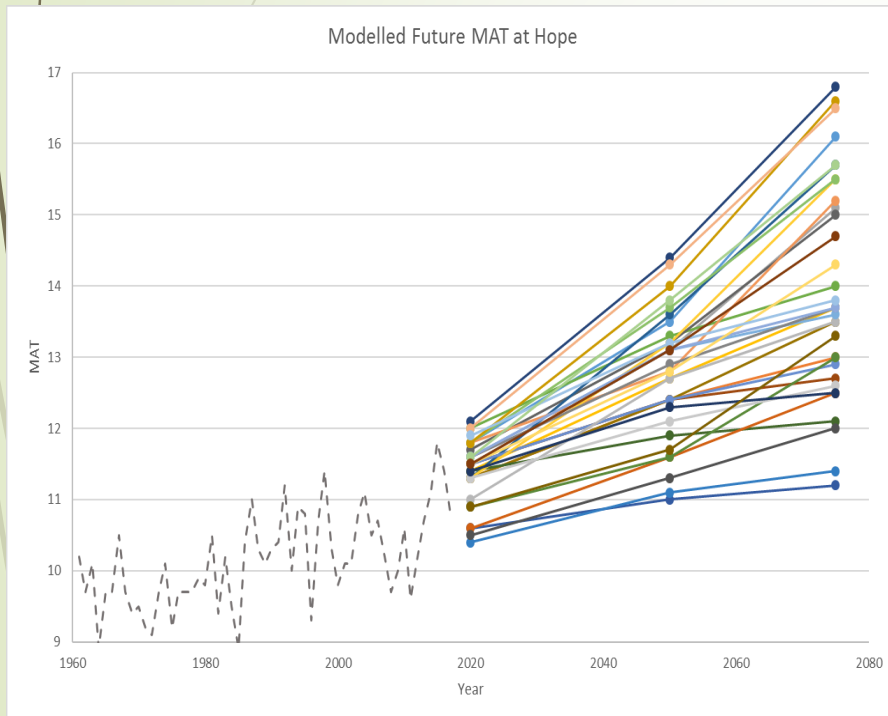
Objective

“We want our managed stands to adapt or self-organize after unexpected disturbances or changes and to continue to provide desired goods and services.” (D. Coates NSC presentation 2011)

We want our forest landscapes to have sufficient diversity to limit the impacts of a single species-specific disturbances and improve adaptability to a changing environment

Climate change:

A range of magnitude and variability



Data from ClimateBC 5.6



Forestry is a Long-Term Investment

When climate is “normal”

- ▶ Local species and seedlots are a good conservative strategy

When climate is changing

- ▶ Local stock may become less suitable or unsuited over time
- ▶ Best are stock that more closely match future climates (stable or improving suitability into future)
- ▶ Climate uncertainty - diversify to minimize risk



3 Tools to Address CC adaptation in reforestation

1. Climate-Based Seed Transfer (CBST)

- Choosing seed from areas that better match the near future climate

2. Climate Change Informed Species Selection (CCISS)

- Choose species suitable now and in future climates.

3. Species Portfolios for Climate Change

- Balancing the ratio of species we plant on the landscape to mitigate risk in a changing climate

❖ “Off-site” species trials

- Evaluation and incorporation of “off-site” species into operational management

CCISS tool

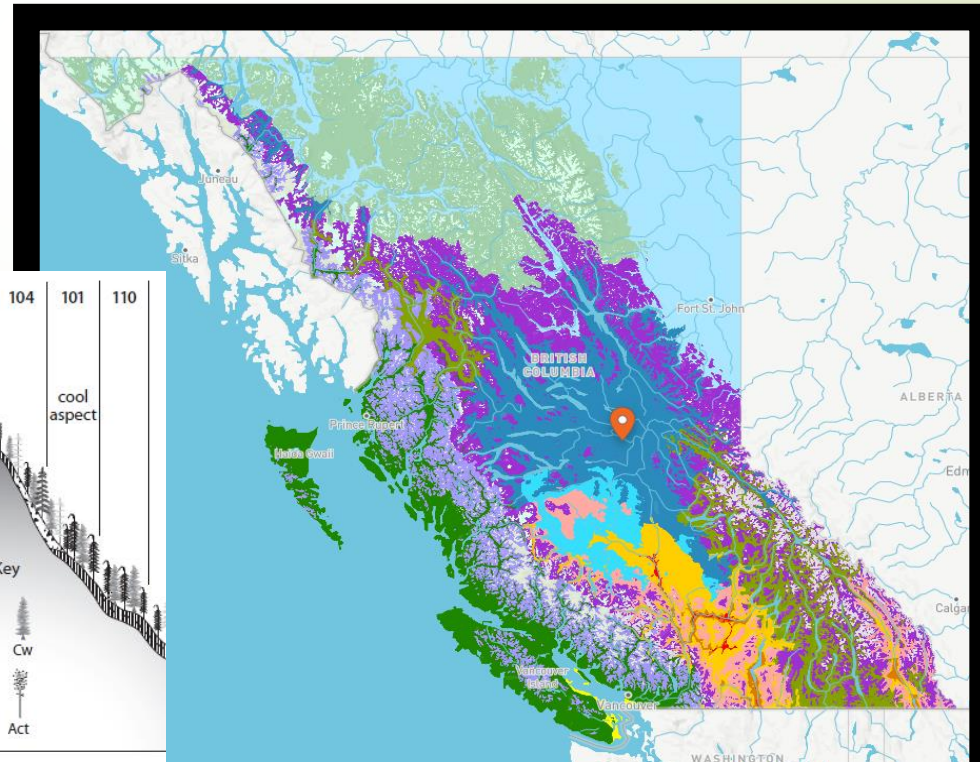
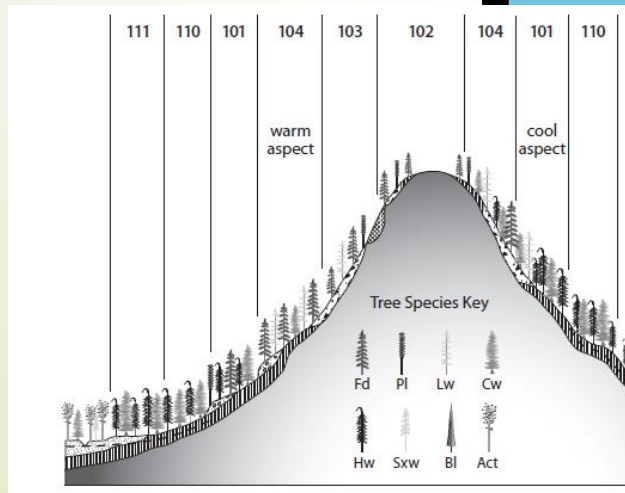
Choosing Suitable Species

- Climate Range
- Site Distribution
- Suitability rating



CCISS is BEC-based

- Biogeoclimates that can be modeled with climate change (Hamman and Wang)
- Site Series - ecological variation within climate regimes
- Species Suitability ratings by Site Series



Chief Forester's Reference Guide

BGC		Regeneration Guide										
Classification		Species							Stocking(i)			Regen
Zone/SZ	Series	Standards ID	Conifer				Broadleaf		Target	MIN pa	MIN p	Delay
			Primary	Preferred (p)	Secondary	Acceptable (a)	Tertiary		(w ell-spaced/ha)			(Max yrs)
ICHmw2	101	1050312	Fd ⁵⁸ Lw	Fd ⁵⁸ Lw Cw Hw ²⁰¹ Pw ³¹	Cw Hw Sx ^{10,13} Pw ³¹	Bl ^{10,13,202} Sx ^{10,13}	Bl ^{10,13}	Act ^b At ^a Ep ^a	1200	700	600	4
	102	1050313	Fd ⁵⁸ Pl	Fd ⁵⁸ Pl	Lw	Lw Py ^{9,14,203}	Py ^{9,14,203}	At ^b	1000	500	400	7
	103	1050314	Fd ⁵⁸ Lw	Fd ⁵⁸ Lw		Pl ²⁰⁰ Pw ³¹ Cw ¹³ Py ^{9,14,203}	Pl Pw ³¹ Cw ¹³ Py ^{9,14,203}	At ^a Ep ^b	1000	500	400	7
	104	1050315	Fd ⁵⁸ Lw	Cw ^{10,201} Fd ⁵⁸ Lw Pw ³¹	Cw Hw Pw ³¹	Pl Hw Py ^{9,14,203} Sx ^{10,13} Sx ^{10,13}	Pl Sx ^{10,13} Bl ^{10,13} Py ^{9,14,203}	At ^a Ep ^a	1200	700	600	7
	110	1050316	Cw	Cw Hw ²⁰¹ Fd ^{1,14,32,58} Lw ^{1,14,32}	Fd ^{1,14,32,58} Hw Lw ^{1,14} Pw ³¹ Sx	Fd ^{1,14,32,58} Sx ^{10,13}	Bl ^{10,13}	Act ^a At ^a Ep ^a	1200	700	600	4
	111	1050317	Cw ³² Sx	Cw ³² Pw ^{1,31} Sx	Hw ³² Pw ³¹	Fd ^{1,14,32,58} Hw ³² Lw ^{1,14,32}	Fd ^{1,32} Lw ^{1,32} Bl	Act ^a At ^a Ep ^a	1200	700	600	4
	112	1050318	Sx	Sx Cw ^{1,32}	Bl ²⁰² Cw ^{1,32}	Hw ^{1,32} Bl ²⁰²	Hw ^{1,32}	Act ^a	1200	700	600	4



CCISS

*If a projected future climate
is similar to
a current BEC climate
then*

*We can apply interpretations from that climate
to projected futures*

BEC interpretations:

- Tree species selection
- Site productivity/carbon sequestration
- Habitat, biodiversity, forage values
- Other

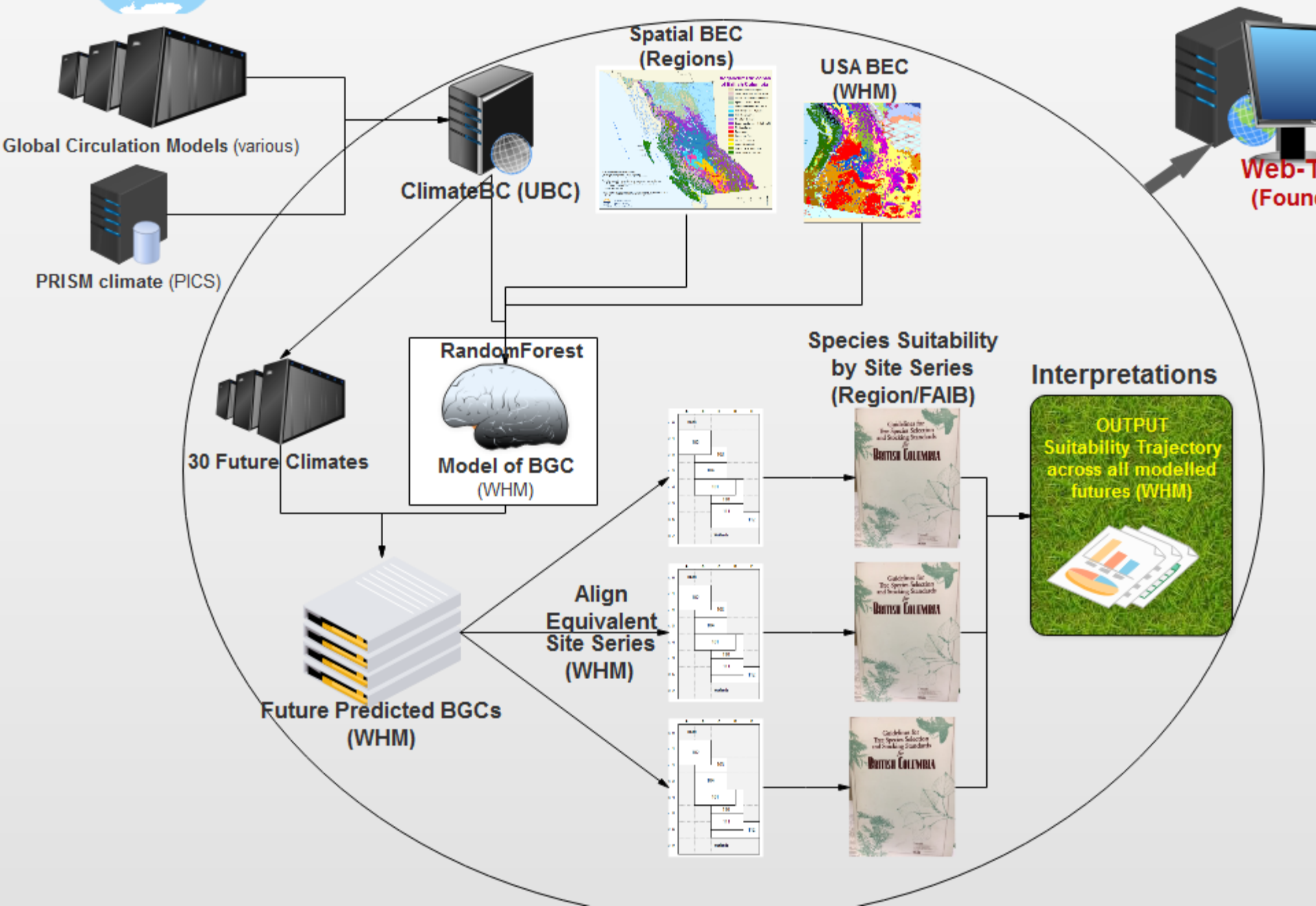


Intent of CCISS

- Provide climate change adaptation guidance for reforestation
- Leverage what we already know (BEC)
- An **Adaptive Management** analysis framework
 - easily updatable to convert improved information into guidance adjustments
- Web-based delivery of guidance derived from real-time analysis
 - Promote/Demote current species based on projected suitability trajectories
 - Identify range expansion opportunities
 - Identify the range/diversity of species suitable to address climate future uncertainty
 - Recognize and manage for new climate regimes for BC



Components of CCISS



CCISS Webtool

Tree Suitability Tool

The Tree Suitability Tool provides information on future tree species suitability in British Columbia. It combines future climate information with species viability models to illustrate how likely each species is to thrive in the range of potential futures.

How the CCISS tool works

Report Name
My Custom Report

Points

Click on the map to add points or enter data below.

Latitude Longitude
ADD POINT

Upload a CSV file ?

RCP Scenario
4.5 8.5

Multiple Point Aggregation
☒ Individual ☐ Averaged by BGC Zone

GENERATE

My Reports

Mapbox | OpenStreetMap | Foundry Spatial

The screenshot shows a Windows 10 taskbar. On the left, there is a search bar with the text "Type here to search". To its right are several application icons: a folder icon, a mail icon, a globe icon, a document icon with "VP" on it, a calendar icon, a Chrome browser icon, a PowerPoint icon, and a photo icon. On the far right of the taskbar, the system tray displays the date and time as "14:45 2019-02-24", along with icons for network, volume, and other background applications. The background of the desktop shows a map of the world.

Prediction of future BGC climates

FUTURE SUITABILITY

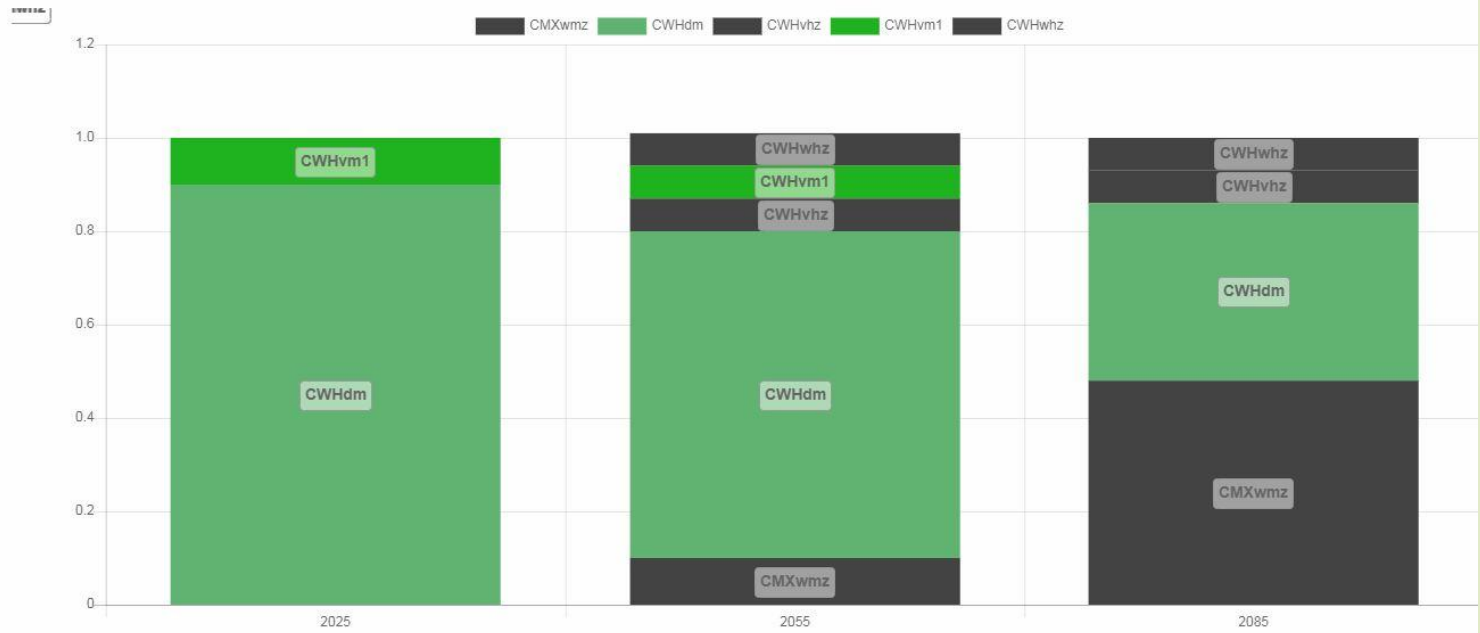
DETAILED SPECIES
SUITABILITY

BGC FUTURES

MODEL CONFIGURATION

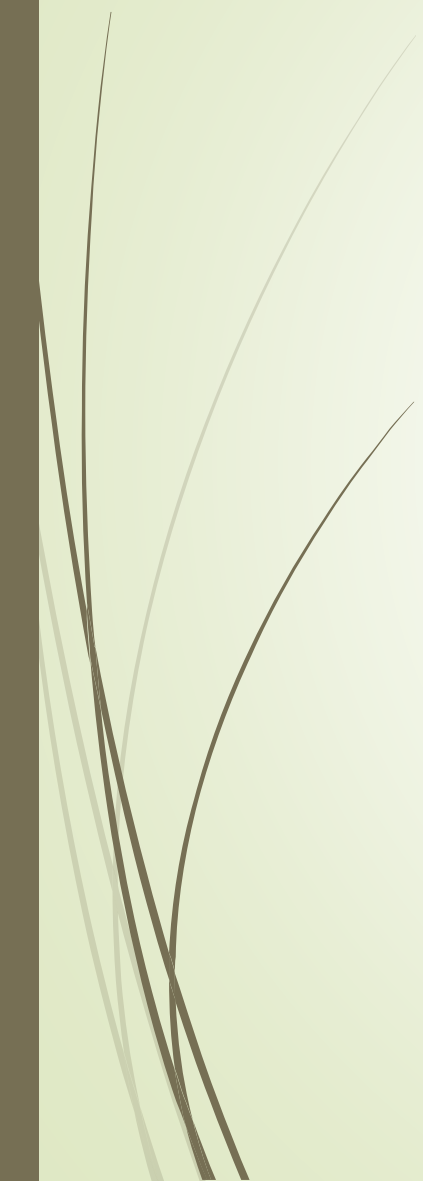
BGC Futures: ratio of models predicting BGC

Current BGC: CWHvm1





Align suitability ratings between current and all future BGCs

- CCISS aligns equivalent site series between current and each future BGC by edatopic position
 - Sums the ratio of sites series with the same suitability rating for each species
- 

Model agreement on species suitability

DETAILED SPECIES SUITABILITY

BGC FUTURES

MODEL CONFIGURATION

Detailed Species Suitability

Site Series
CWHvm1/01 : HwBa - Blueberry

Primary Secondary Tertiary Not Suitable

Species	Period	Calculated Suitability
Act : black cottonwood	Current	100.0%
	2010-2040	100.0%
	2040-2070	88.0% 12.0%
	2070-2100	44.0% 56.0%
Ba : amabilis fir	Current	100.0%
	2010-2040	10.0% 90.0%
	2040-2070	8.0% 92.0%
	2070-2100	100.0%
Cw : western redcedar	Current	100.0%
	2010-2040	10.0% 90.0%
	2040-2070	8.0% 81.0% 12.0%
	2070-2100	44.0% 56.0%
Dr : red alder	Current	100.0%
	2010-2040	100.0%
	2040-2070	88.0% 12.0%
	2070-2100	44.0% 56.0%
Ep : common paper birch	Current	100.0%
	2010-2040	90.0% 10.0%
	2040-2070	81.0% 19.0%
	2070-2100	44.0% 56.0%
Fd : Douglas-fir	Current	100.0%
	2010-2040	90.0% 10.0%
	2040-2070	81.0% 19.0%
	2070-2100	44.0% 56.0%
Hw : western hemlock	Current	100.0%
	2010-2040	10.0% 90.0%
	2040-2070	8.0% 81.0% 12.0%
	2070-2100	44.0% 56.0%

Lw : western larch	Current	100.0%	
	2010-2040	90.0% 10.0%	3.20
	2040-2070	81.0% 19.0%	3.38
	2070-2100	44.0% 56.0%	4.00
Mb : bigleaf maple	Current	100.0%	
	2010-2040	100.0%	3.00
	2040-2070	88.0% 12.0%	3.23
	2070-2100	44.0% 56.0%	4.00
Ot : tanoak	Current	100.0%	
	2010-2040	100.0%	4.00
	2040-2070	12.0% 88.0%	4.00
	2070-2100	56.0% 44.0%	2.76
Pw : western white pine	Current	100.0%	
	2010-2040	90.0% 10.0%	3.20
	2040-2070	81.0% 19.0%	3.38
	2070-2100	44.0% 56.0%	4.00
Ra : arbutus	Current	100.0%	
	2010-2040	90.0% 10.0%	2.30
	2040-2070	12.0% 81.0% 8.0%	2.12
	2070-2100	56.0% 44.0%	1.44
Ss : Sitka spruce	Current	100.0%	
	2010-2040	10.0% 90.0%	4.00
	2040-2070	8.0% 92.0%	4.00
	2070-2100	100.0%	4.00

Simplified New Suitability Rating

FUTURE SUITABILITY

DETAILED SPECIES SUITABILITY

BGC FUTURES

MODEL CONFIGURATION

Future Suitability

Site Series

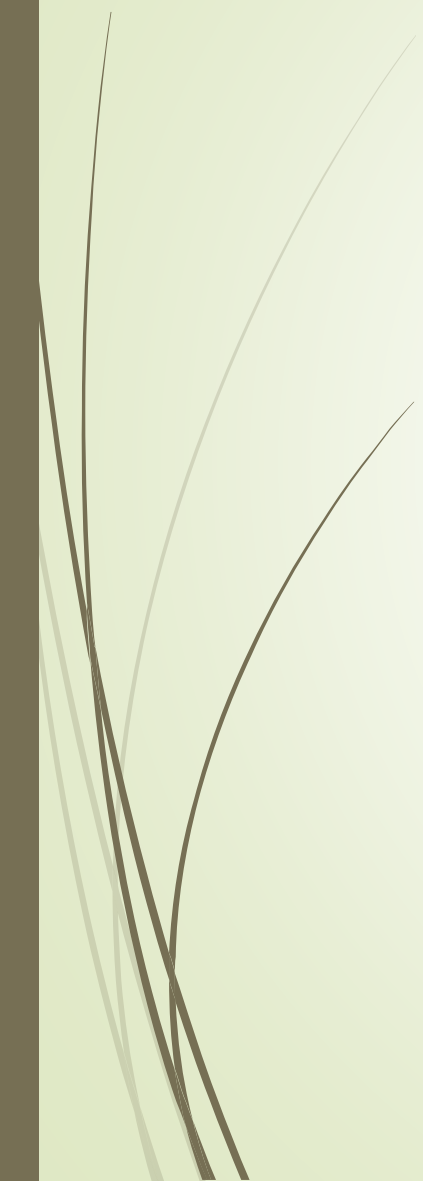
CWHvm1/01 : HwBa - Blueberry

Predicted Suitability

Species ↑	Current Suitability	New Establishment Suitability (2010-2040)	Establishment Risk	Continuing Trend at mid rotation (2040-2070)
Act: black cottonwood	3	3	Moderate CC Risk	—
Ba: amabilis fir	1	X ●	High Risk	—
Cw: western redcedar	1	2 ●	Moderate CC Risk	↘
Dr: red alder	2	2	Low CC Risk	↘
Ep: common paper birch	X	3 ●	Low CC Risk	—
Fd: Douglas-fir	2	1 ●	Low CC Risk	—
Hw: western hemlock	1	2 ●	Low CC Risk	↘
Mb: bigleaf maple	3	3	Moderate CC Risk	—
Ra: arbutus	X	3 ●	Low CC Risk	↗
Ss: Sitka spruce	2	X ●	High Risk	—

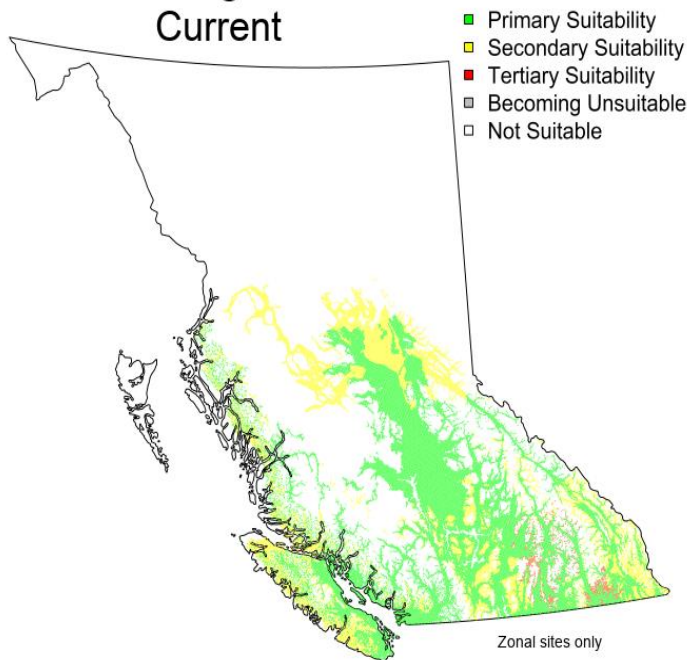


Provincial Trends in Species Suitability

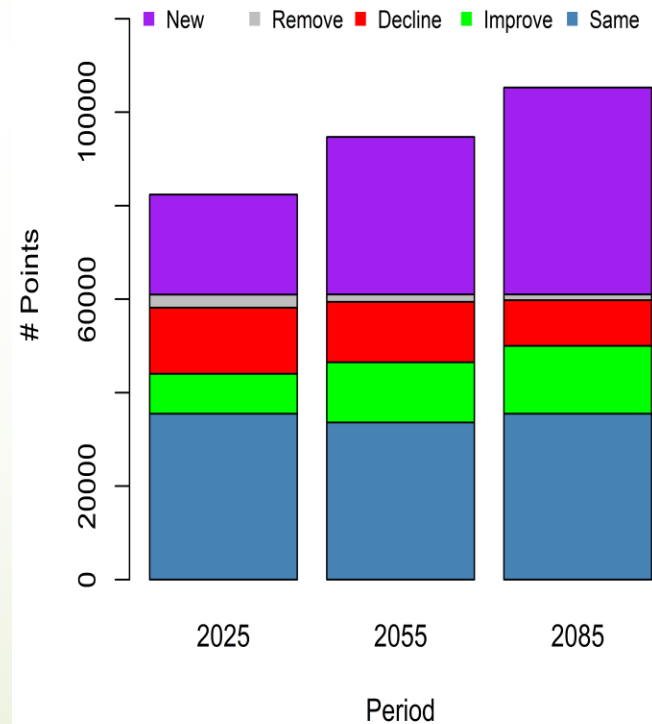
- ▶ Temperate species: improving suitability and expanding range (Fd, Py, Lw, Bg, Pw)
 - ▶ Boreal species: declining suitability and declining range (Pl, Sx, Bl, Sb)
 - ▶ Rainforest species: expanding range in the cool interior and upslope (Cw, Hw).
- 

Change in Douglas-fir suitability (only Zonal sites)

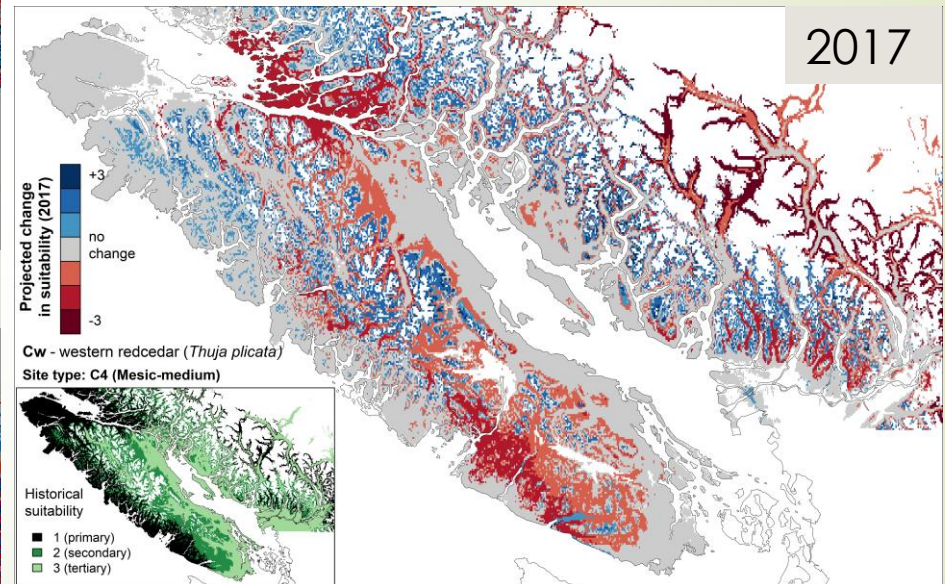
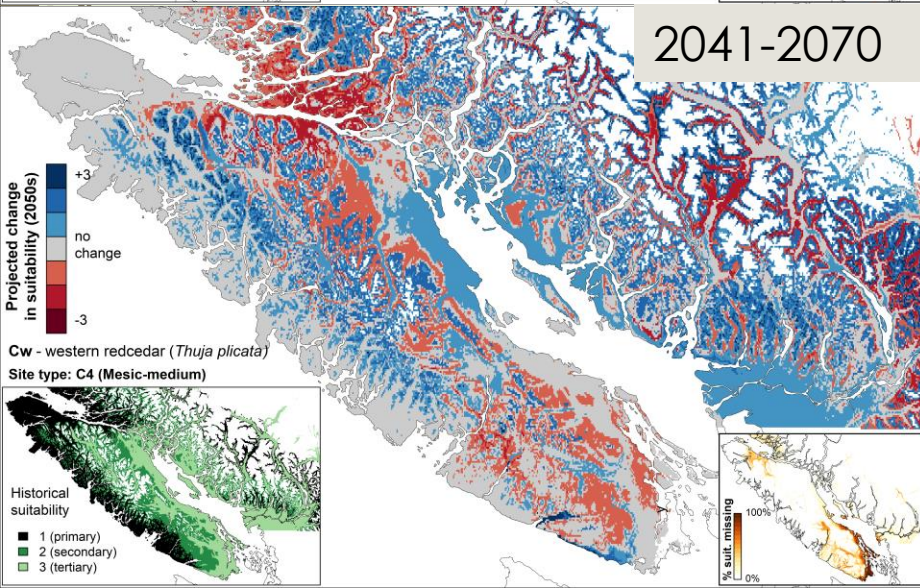
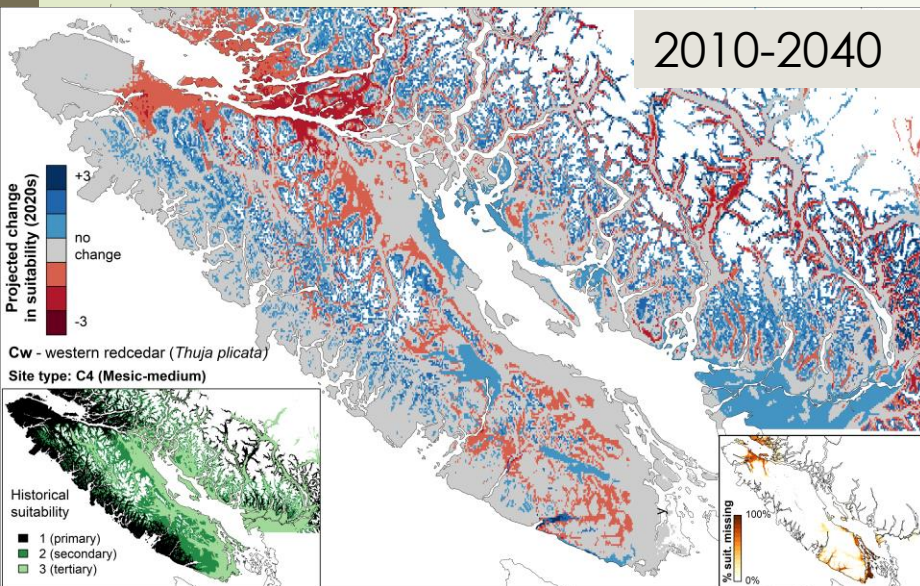
Fd - Douglas Fir
Current



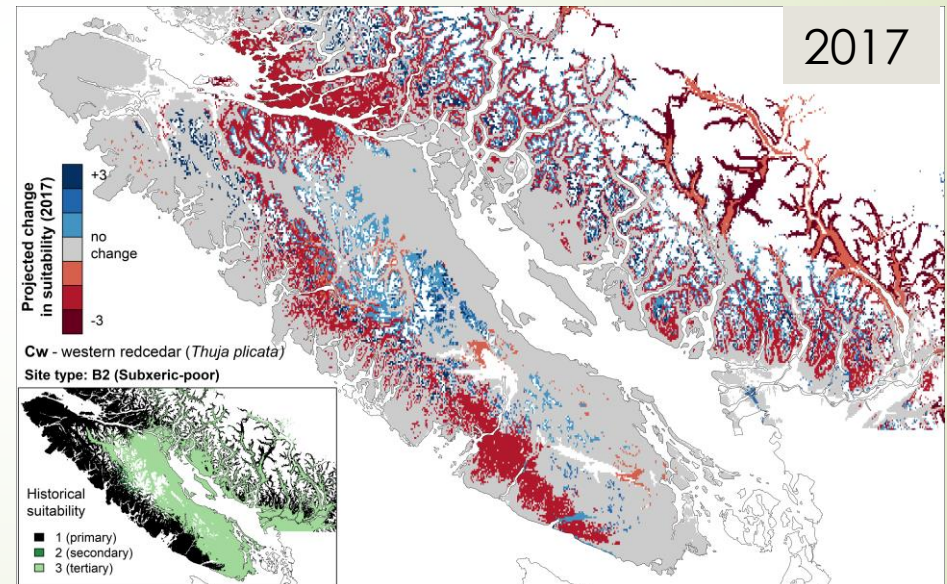
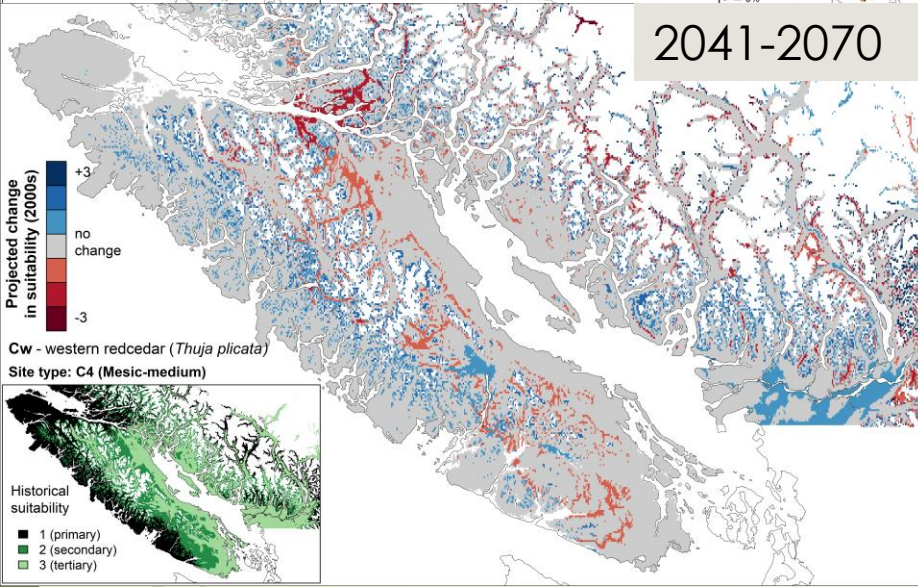
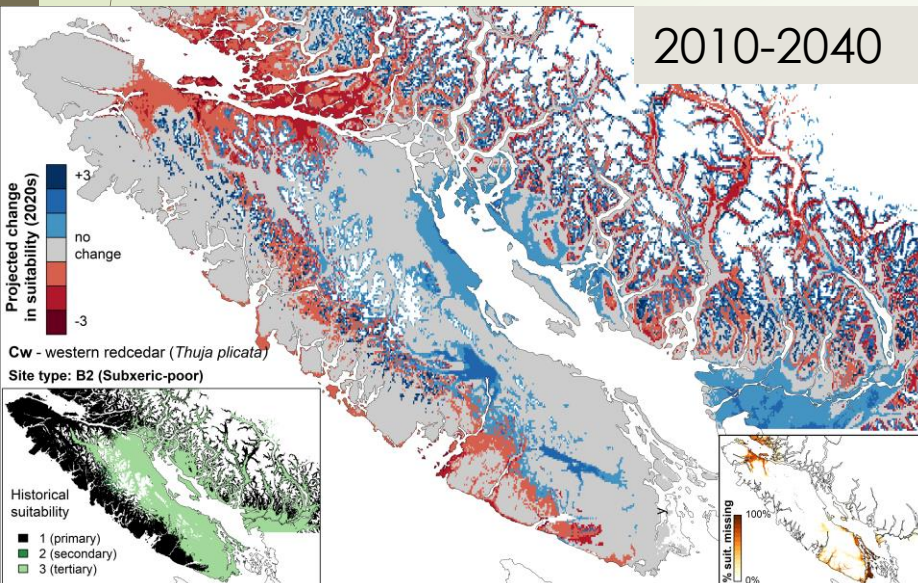
Fd - Douglas Fir



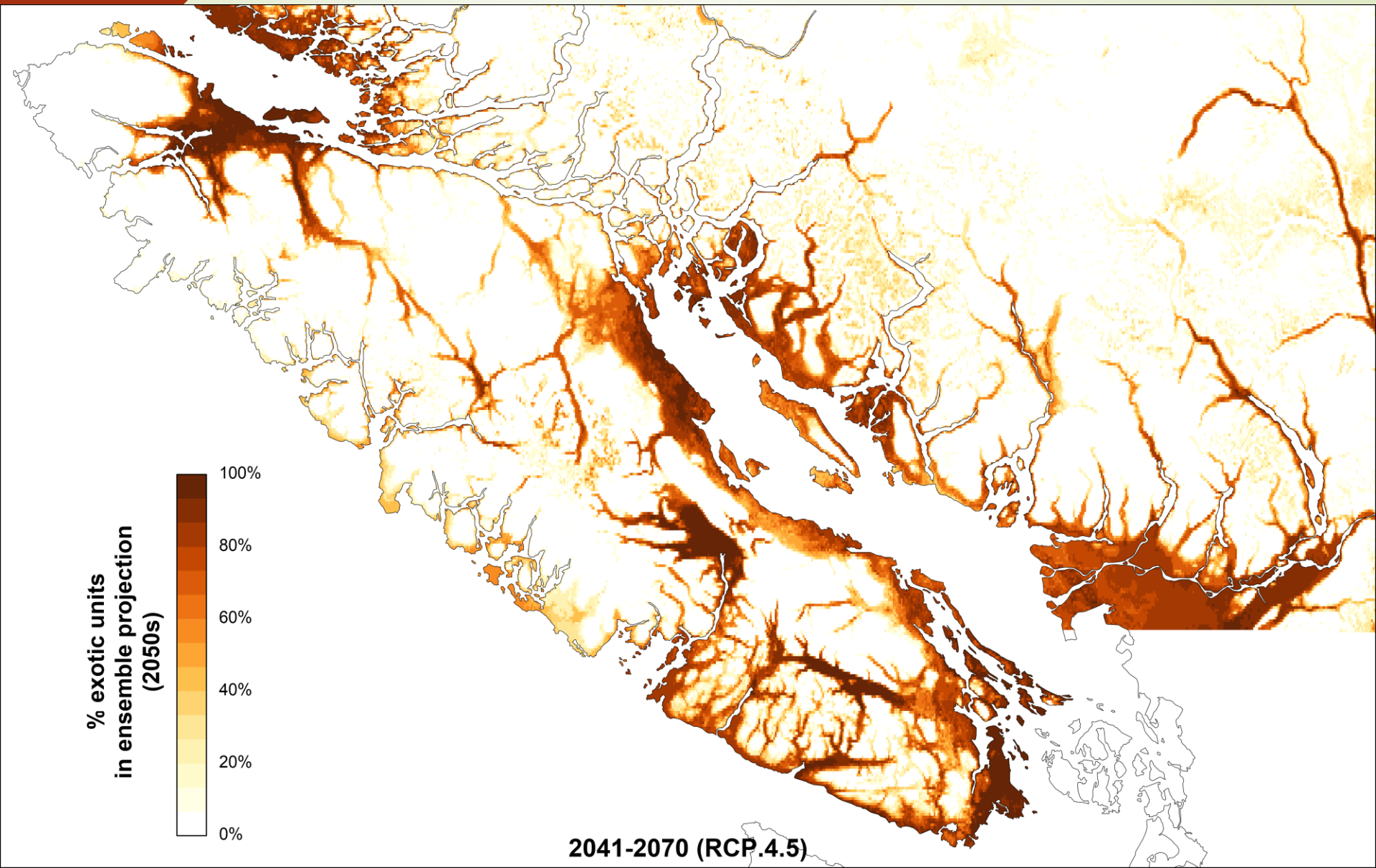
Change to Redcedar suitability on zonal sites



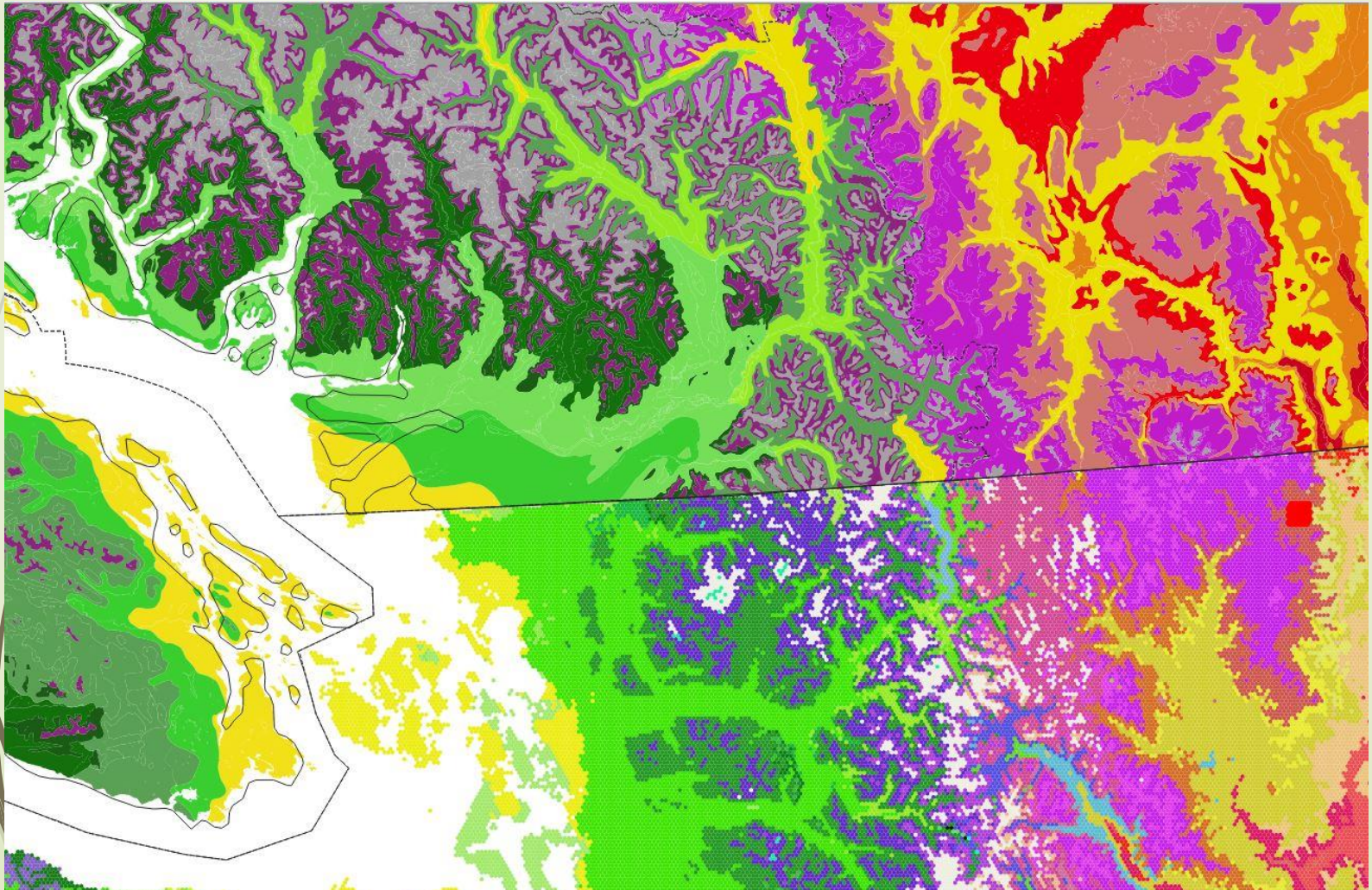
Change to Redcedar suitability on subxeric sites



Non-BC future climates

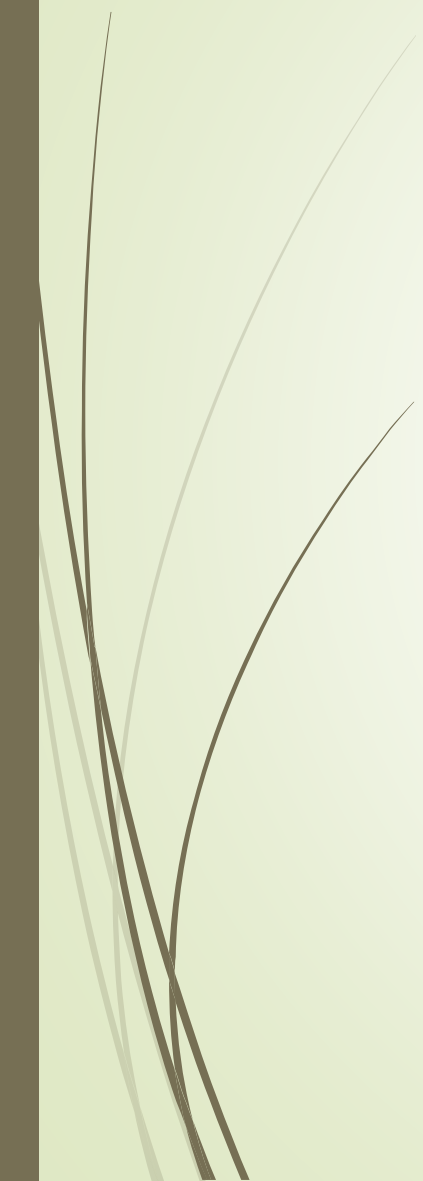



Modelled USA BEC Units and Species





CCISS tool in summary

- Aligns site-level species suitability for multiple plausible futures from existing information
 - Presents the ratio of model agreement on future suitabilities through three future time periods
 - Gives an indication of suitability trends and certainty
 - IS NOT definitive but a best-estimation of future condition
 - No Right/Wrong but Better/Worse answers
- 



Before formal release (Fall 2019?)

- Technical method review
- Species suitability ratings update and review
- USA_BEC mapping and species “finalized”
- Website and Guidance Documentation
- Ongoing assessment of historic “offsite” species trials and assignment of newly suitable species



Species Portfolio Tool:

Optimal mixes for uncertain climate futures

Uses CCISS output:

- 30 modelled futures with changes to species suitability in a
- sequence of predicted BGCs for current, 2025, 2055, 2085 time periods

+ Growth potential over time (SIBEC)

+ Covariance of species (differential species response to climate)

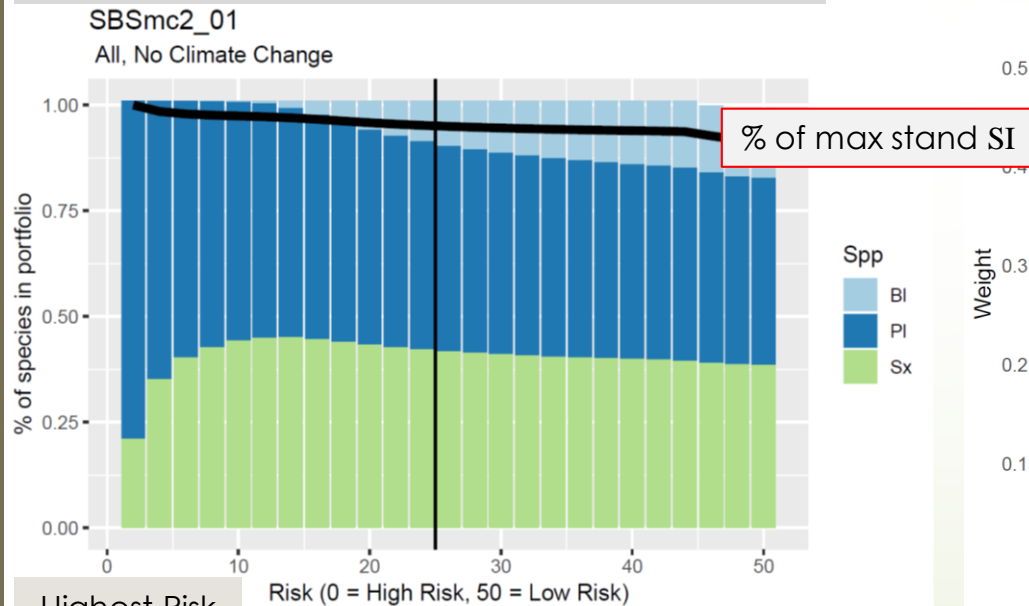
= Ratio of climate change adapted species that best minimize overall risk while maximizing returns

- Application at the Landscape level

Species portfolio example:

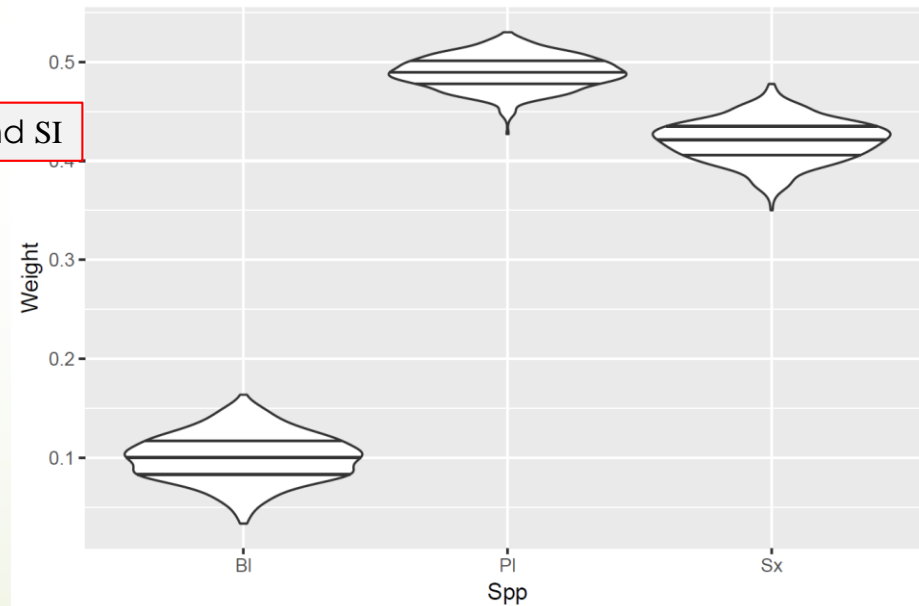
SBSmc2/01 in Bulkley TSA: Status Quo Portfolio

Optimal species ratios for a
Chosen level of Risk



Highest Risk
High Return

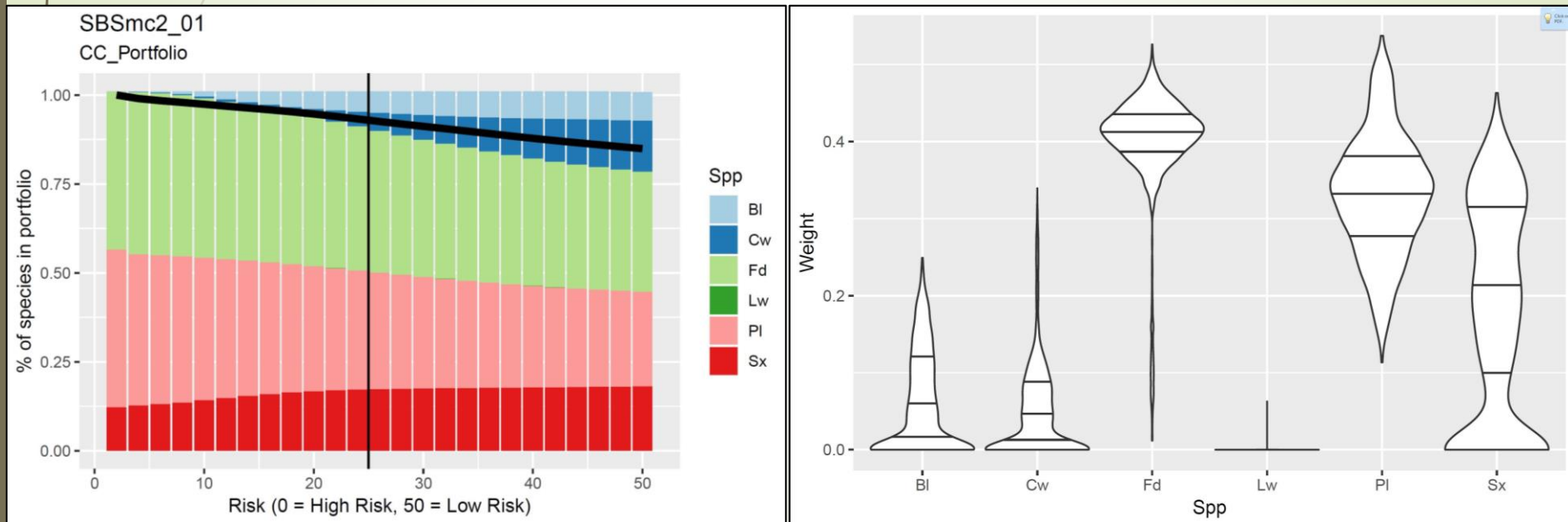
Ratio of each species (at 25 Risk)



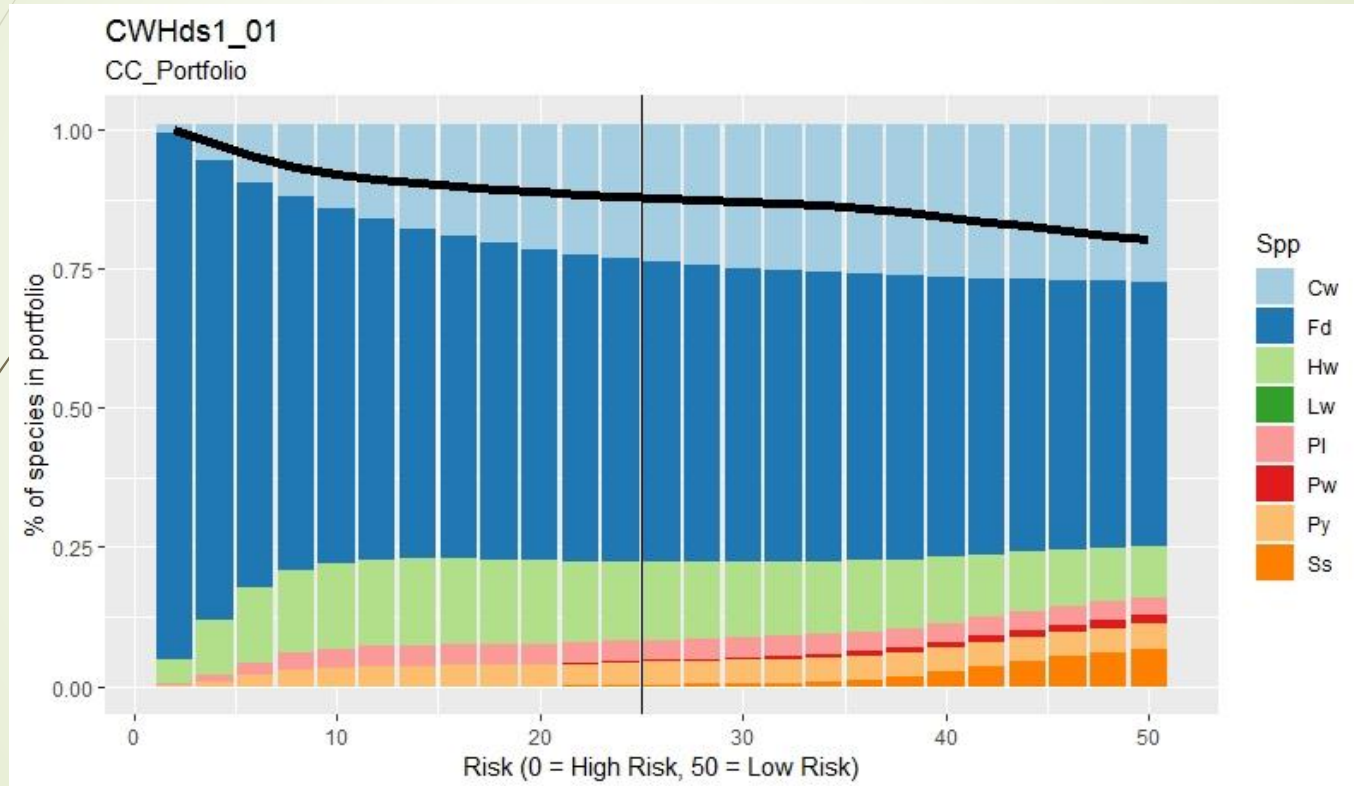
Species portfolio example:

SBSmc2/01 in Bulkley TSA: (near ICHmc2)

Climate Change Portfolio



Species portfolio for Risk avoidance



Unexpected losses in one species (environmental change, forest health, etc) are minimized by other species in the portfolio




Portfolio Module Timeline

- New enough not to have an acronym!
- Preliminary analytical method complete
- Q. How sensitive is the Portfolio to approximations?
- Also Fall 2019?



Newly Suitable Species

Can they be successfully established now?



Information to support adding new species to suitability tables

Some possible sources:

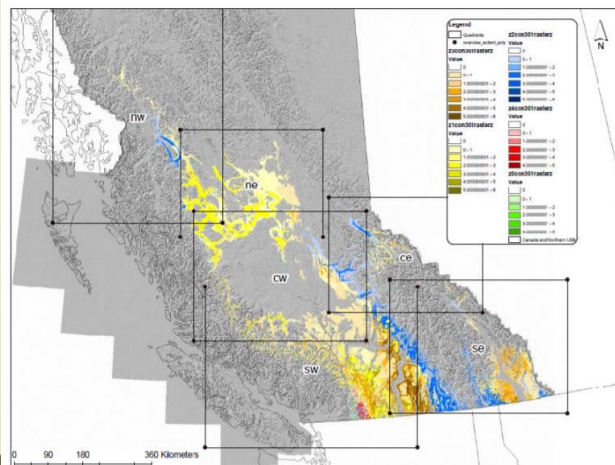
- 1) Operational and research trials of “offsite” species
- 2) Successful managed plantations
- 3) Bioclimate range modeling (Gray and Hamann, Wang, McKenney, BEC)
- 4) Applying an understanding of species environmental limitations, abiotic and biotic barriers, autecology, silvics
- 5) Extrapolating suitability into intermediate or similar climatic/site conditions (ICHmc2 – **ICHmc1** – SBSdk)
- 6) Other?

4 Types of Off-Site Species

- **Type 1: Historically suitable** – Well-established stands exist ~pre-1990. Historic Fundamental Niche larger than Realized Niche
- **Type 2: Presently Suitable** - has become suitable in the modern period (1991-2017). Successful young stands
- **Type 3: Predicted Suitable** - becoming suitable now and in the near future
- **Type 4: Not suitable** - not predicted to become suitable in the near future but is in future periods
- **(Type 5?: Not suitable in any future)**

Type 1: Historically suitable

- Species was already suitable in the reference period (1961-1990) but was not found naturally
- Geographic or migratory barriers
 - Successful plantations ~>30 years old
 - Models suggest suitable historical suitability
 - Extrapolated suitability of above



30-year western larch in the SBS dk (Skeena Region)

A Call for Information and Data

- We are looking for existing “off-site” species trial data to support modelling and confidence ratings. (Pam Dykstra and Hardy Griesbauer)
- Consider using CCISS to guide establishment new species trials

Accelerating development of old forest structure and carbon sequestration in Old Growth Management Areas post wildfire
Sari Saunders and Heather Klassen, Research Vegetation Ecologists, FLNRORD; Craig Wickland, Forest Stewardship, FLNRORD; Bruce Blackwell, Deon Louw, BA Blackwell & Associates; Frank DeGagne, Sea to Sky NRD; Jack Sweeten, Chilliwack NRD; and Lori Daniels, University of BC

Particularly large fires (for the coast!) occurred within the drier south coast watersheds of the Nahatlatch (Chilliwack NRD) and Elaho and Upper Lillooet (Sea to Sky NRD) watersheds in 2015. These wildfires damaged timber resources and areas of the non timber harvesting land base, including a number of Old Growth Management Areas (OGMAs) (Fig. 1), and climate change projections for this landscape suggest that the importance of wildfire as a disturbance agent will continue to increase here over time. Capacity to restore wildfire damaged OGMAs is critical where there are few options for replacement.

We are establishing operational trials to assess the feasibility of using *experimental planting and climate change-informed species selection* to:

- Accelerate successional development of old growth structural and compositional characteristics;
- Enhance rates of carbon sequestration in regenerating stands; and,
- Develop a framework to assess resilience of stands to subsequent disturbances on low-moderate severity vs. high severity wildfire sites.

This past season, field crews

- Identified experimental replicates in three fires (Grizzly, North, and Boulder)
- Measured post fire (pre treatment) structure, site conditions (e.g., soil), vegetation
- Identified and classified control locations, to compare to the treatments over time

Currently, the team is designing experimental treatments using

- the Climate Change Informed Species Selection (CCISS) tool,
- TASS/TIPSY stand development modelling (Fig. 3), with support from FAIB analysts




Figure 1. Field work in a high severity burn, Grizzly fire, Chilliwack NRD)



Figure 2. Fire severity mapping (orange = low/mid; red=high) for an OGMA.

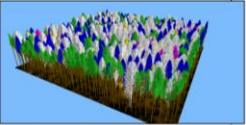


Figure 3. Stand structure and composition after 50 years for a climate change informed

Recent Coast Area Research Trials (Saunders and others)



A Final Comment:

Climate change reforestation is a
“Wicked Problem”

- Parts of the problem that cannot be known
- No Definitive Right/Wrong Answers
- But Better and Worse Strategies
- Building information and tools to support moving to a more innovative reforestation policy
- But plan for more diversity on the landbase
- Investigate more innovative silviculture
 - Learn what is possible

END

