CLIMATE CHANGE INFORMED SPECIES SELECTION (CCISS)

A DECISION AID FOR REFORESTATION

UPDATES IN 2018

Will MacKenzie, update to CBST, May 14, 2019

GOALS OF CCISS

- Leverage what we already know (BEC)
- Integrate with existing decision systems (stocking standards by BGC/site series)
- Produce 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

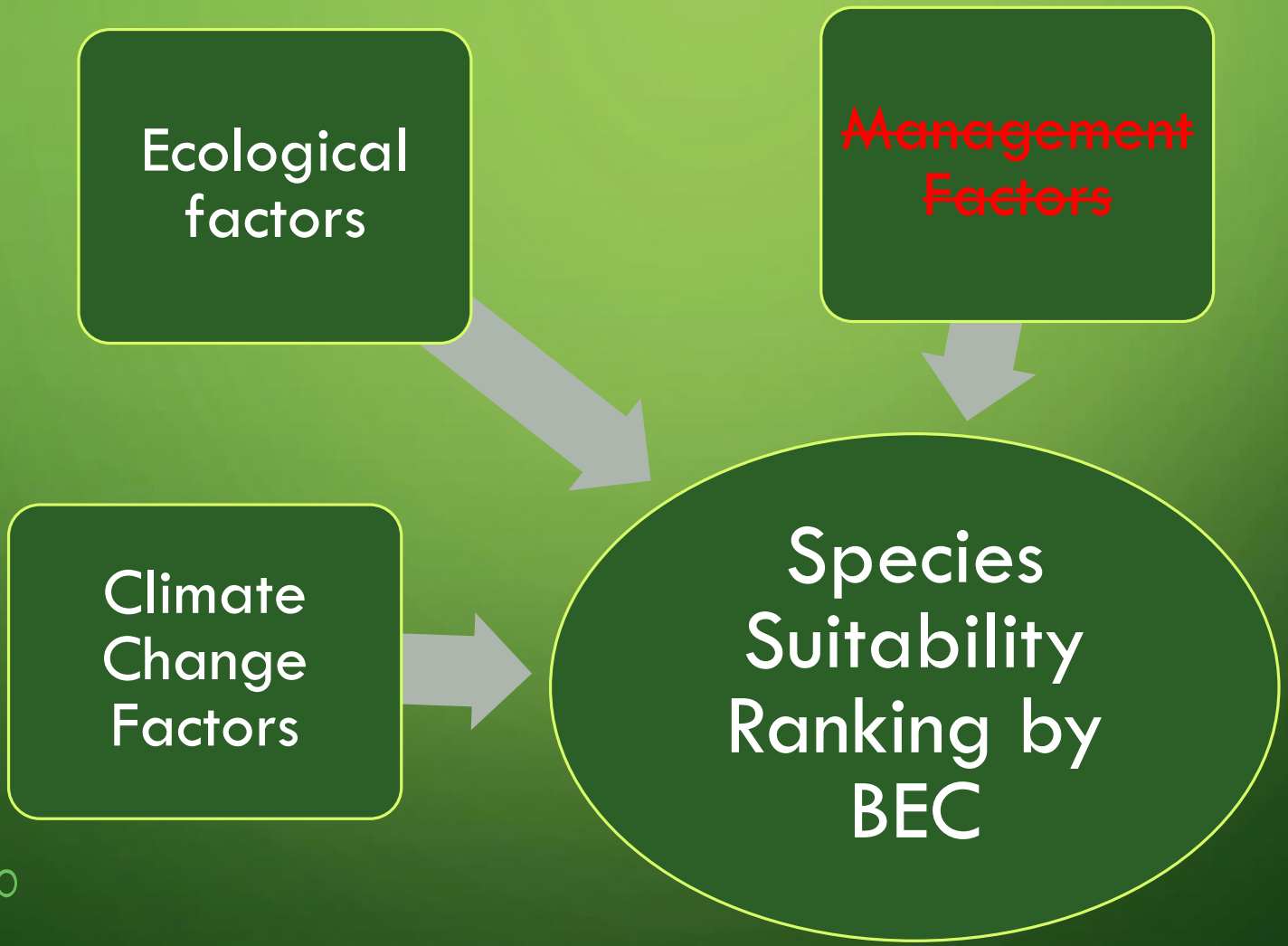
OBJECTIVE

- **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**

INPUT INTO REFORESTATION DECISIONS

- STEP 1: Species selection (ecological suitability)
  - Species suitable for the climate + site conditions +
  - Management objectives and considerations
- STEP 2: Seedlot selection (CBST)
  - Seedlots adapted to climate
- Both need a climate change focussed adjustment

SPECIES SELECTION



CCISS APPROACH

- Predict future BEC from each of 30 model/scenarios using machine-learning analysis (randomForest)
  - 2018 tuning of model based on research
- Align species suitability ranks for each of the predicted future site series.
  - Using new environmental suitability
- Based on the degree of model agreement:
  - Promote/Demote/remove current species based on projected suitability trajectories
  - Identify range expansion opportunities
  - Identify the range/diversity of species suitable to address climate future uncertainty

Components of CCISS

1. CLIMATE DATA

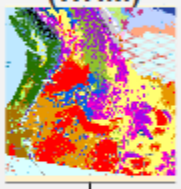
Global Circulation Models (various)

PRISM climate (PICS)

ClimateBC (UBC)

Spatial BEC (Regions)

USA BEC (WHM)



2. BIOCLIMATE ENVELOPES

Web-T
(Found

30 Future Climates

RandomForest

Model of BGC (WHM)

3. ANALYSIS

Future Predicted BGCs (WHM)

Align Equivalent Site Series (WHM)

Species Suitability by Site Series (Region/FAIB)

Interpretations

OUTPUT
Suitability Trajectory across all modelled futures (WHM)

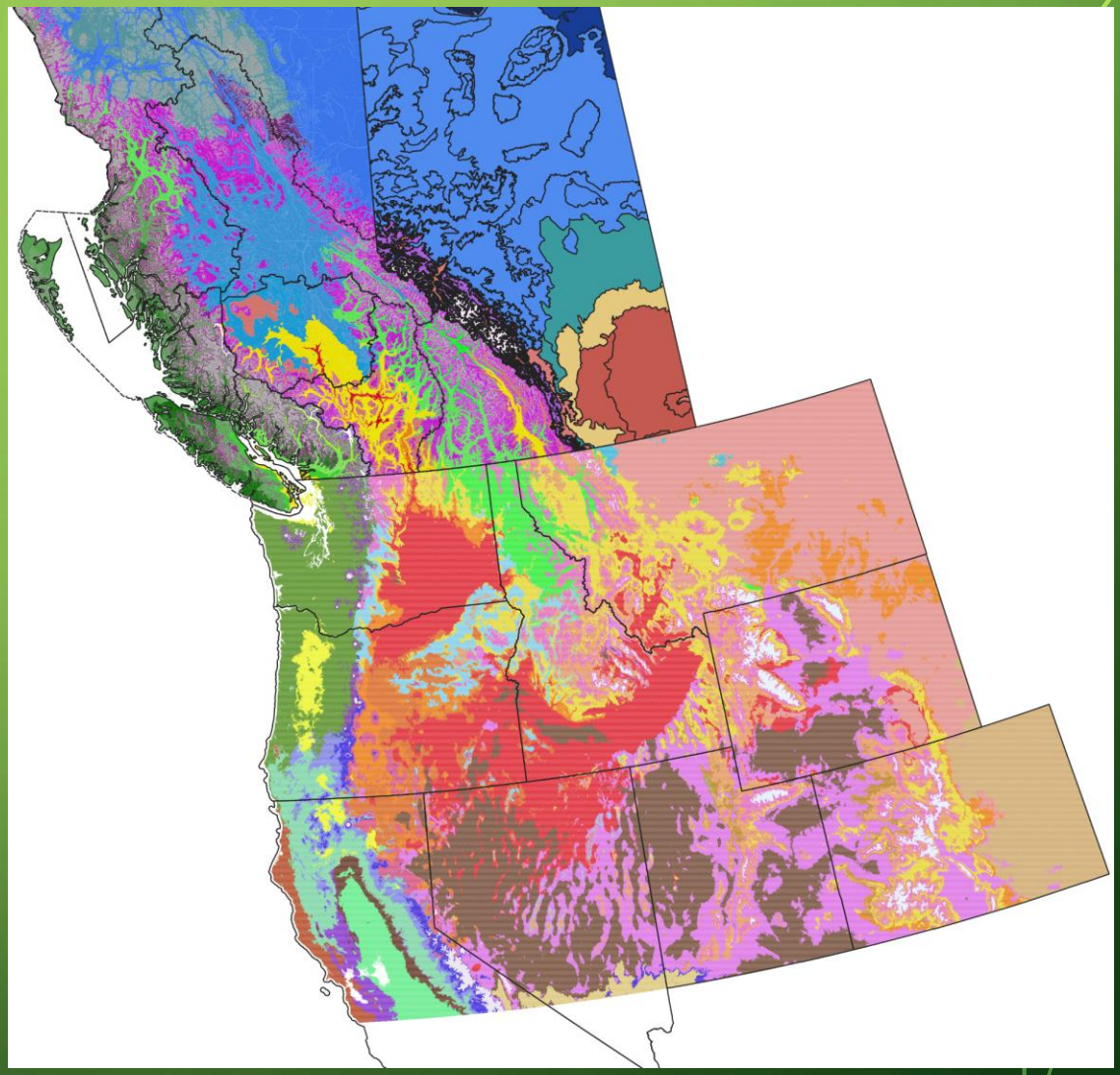
4. TREE SPECIES** SUITABILITY for Climate Change

2018-2019 UPDATES

1. Improve Climate Surface (project with Spittlehouse, Foord, Anslow finish end of 2019)
2. Spatial Layers of BGC
3. Updates to Random Forest model analysis based on research
4. Species suitability Ratings
5. Web tool upgrades

SPATIAL LAYERS OF BGC

- BECv12 likely within the year.
  - Largish changes to Southern Interior
  - Still awaiting Coast reclassification
- USA_BGC: Final model to be pre-published (BioRxiv) summer of 2019 for review



4. NEW SUITABILITY RATINGS

- "Reference Guide" ratings include sawlog objectives
  - Undesirable species down rated
  - Highly desirable species over rated
  - Some variable ratings between regions
  - Sometimes "best possible" ratings given a '1' where no species is v. suitable
- New E- ratings based purely on species - climate/site suitability
  - Reference guide = presence/absence + footnotes
  - Autecology (Klinka and Krajina)
  - BEC data
  - Modelling
  - Now includes deciduous and non-commercial
  - Forest Health Issues not included - yet

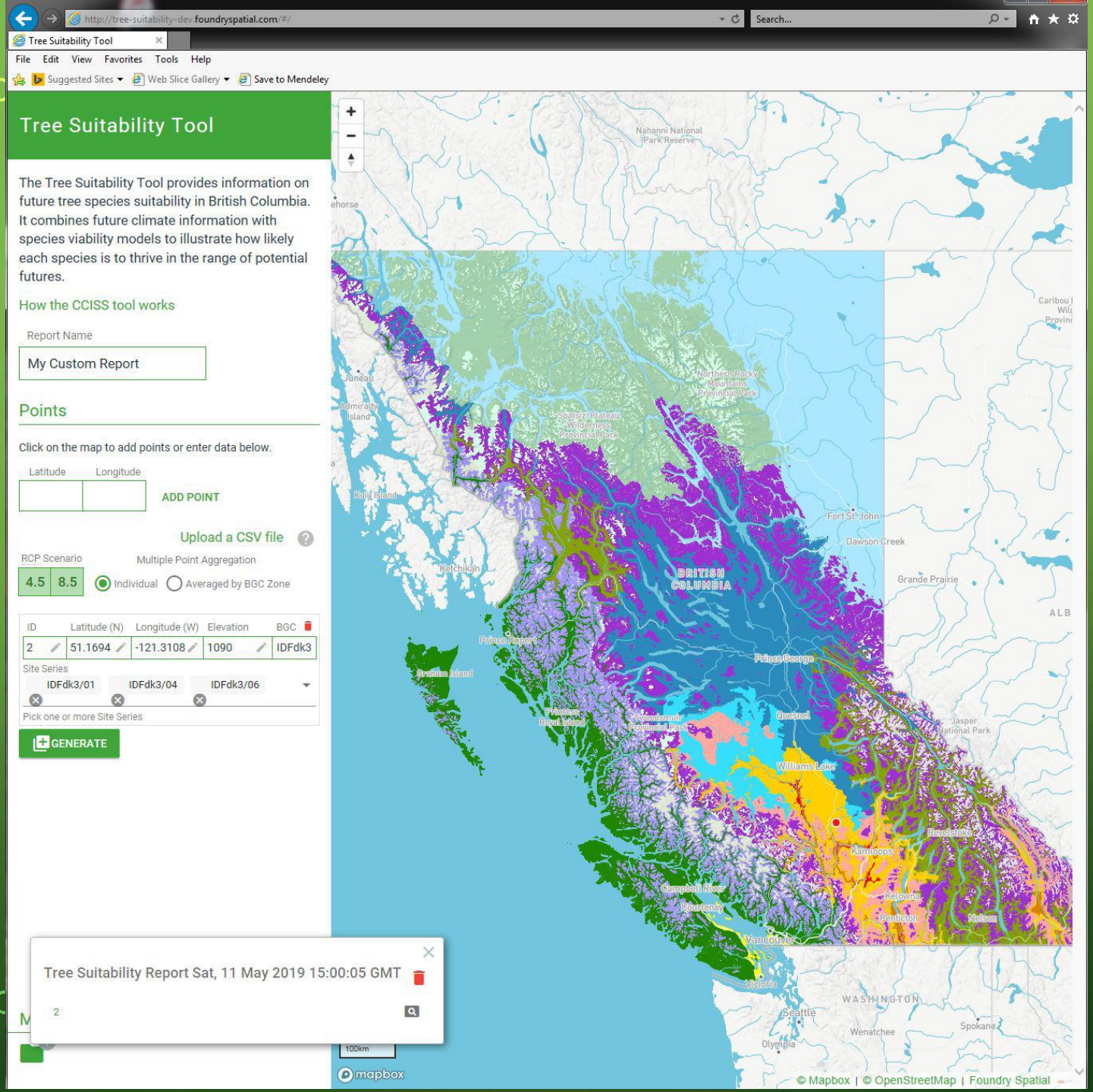
CHIEF FORESTERS REFERENCE GUIDE

BGC Classification		Regeneration Guide Species						Stocking(i)			Regen Delay
			Conifer				Broadleaf	Target	MIN pa	MIN p	
Zone/SZ	Series	Standards ID	Primary	Preferred (p)	Secondary	Acceptable (a)	Tertiary	(well-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]	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	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

5. CCISS WEBTOOL (2018)

Mach I version built as a demonstration product

1. Minimal changes to look and information in 2018
2. Converted from R to Python and
3. Incorporate ClimateBC into server environment
4. Awaiting finalized model updates for major update
5. Management green-light


http://tree-suitability-dev.foundryspatial.com/#/
Search...
Tree Suitability Tool
File Edit View Favorites Tools Help
Suggested Sites
Web Slice Gallery
Save to Mendeley
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
ID
Latitude (N)
Longitude (W)
Elevation
BGC
2
51.1694
-121.3108
1090
IDFdk3
Site Series
IDFdk3/01
IDFdk3/04
IDFdk3/06
Pick one or more Site Series
GENERATE
Tree Suitability Report Sat, 11 May 2019 15:00:05 GMT
2
BRITISH COLUMBIA
Prince George
Williams Lake
Kamloops
Kelowna
Vancouver
Victoria
Seattle
WASHINGTON
Fort St John
Dawson Creek
Grande Prairie
Ketchikan
Juneau
Nahanni National Park Reserve
Northern Rocky Mountains Provincial Park
Spatsizi Plateau Wilderness Provincial Park
Quesnel
Jasper National Park
Revelstoke
Penticton
Nelson
Campbell River
Courtenay
Wenatchee
Spokane
Olympia
100km
mapbox
© Mapbox | © OpenStreetMap | Foundry Spatial

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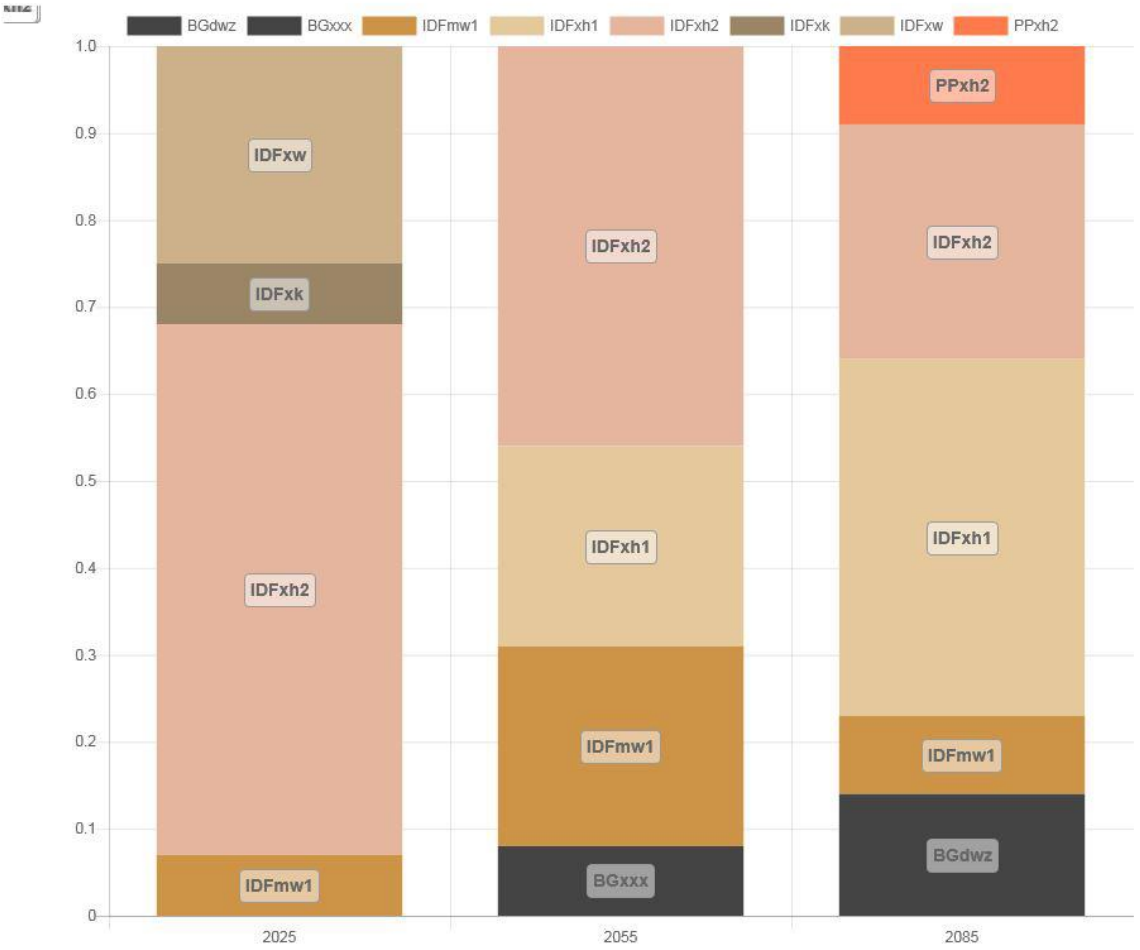
FUTURE SUITABILITY | DETAILED SPECIES SUITABILITY | BGC FUTURES | MODEL CONFIGURATION

BGC Futures: ratio of models predicting BGC

Current BGC: IDFdk3



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FUTURE SUITABILITY | DETAILED SPECIES SUITABILITY | BGC FUTURES | MODEL CONFIGURATION

Future Suitability

Site Series
IDFdk3/01 : FdPl - Pinegrass - Feathermoss

Predicted Suitability

Species	Current Suitability	New Establishment Suitability (2010-2040)	Es
At: trembling aspen	3	X	Cc Ri:
Fd: Douglas-fir	1	1	Lo
Pl: lodgepole pine	1	X	Hi
Py: ponderosa pine	X	2	Lo
Sx: interior spruce	3	X	Hi

Reference Guide: SILVICS TABLE | Applying CCISS in stocking standard development

Forest Region:

Regeneration

Standards ID	80094.0	Climate Change
Primary	Fd(27.0 ,32) ,Pl	Fd, Fd(27.0, 32), Pl
Preferred (p)	Fd(27.0 ,32) ,Pl	
Secondary		
Acceptable (a)	Sx(13.0 ,28)	
Tertiary	At(901.0) ,Sx(13.0 ,28)	At(901.0), Sx(13.0, 28)

Stocking (i) - well spaced/ha

Target	Min pa	Min p	Regen Delay (max yrs)
1200	700	600	7

Free Growing Guide

Earliest (yrs)	Latest (yrs)	Min Height (m)	Min Height (m)
12	15	Sxw: 0.8	Fd: 1.0, Pl: 1.4,

Footnotes

Site Series
IDFdk3/04 : Fd - Bluebunch wheatgrass - Needlegrass

Site Series
IDFdk3/06 : Fd - Pinegrass - Aster

Tree Suitability Report Sat, 11 May 2019 15:00:05 GMT / Point: 2

FUTURE SUITABILITY | DETAILED SPECIES SUITABILITY | BGC FUTURES | MODEL CONFIGURATION

Detailed Species Suitability

Site Series
IDFdk3/01 : FdPl - Pinegrass - Feathermoss

Primary | Secondary | Tertiary | Not Suitable

Species	Period		Calculated Suitability	Inter-period Trajectory	Mortality Risk	Model Agreement
At : trembling aspen	Current	100.0%				
	2010-2040	79.0% 21.0%	3.43	No Change	Moderate	Moderate
	2040-2070	73.0% 27.0%	4.00	Declining	Moderate	Moderate
	2070-2100	60.0% 40.0%	4.00	No Change	High	Low
Cw : western redcedar	Current	100.0%				
	2010-2040	7.(93.0%	4.00	No Change	Very High	High
	2040-2070	30.0% 70.0%	4.00	No Change	Very High	Moderate
	2070-2100	21.0% 79.0%	4.00	No Change	Very High	Moderate
Ep : common paper birch	Current	100.0%				
	2010-2040	11.(89.0%	4.00	No Change	Very High	High
	2040-2070	23.0% 77.0%	4.00	No Change	Very High	Moderate
	2070-2100	9.0 91.0%	4.00	No Change	Very High	High
Fd : Douglas-fir	Current	100.0%				
	2010-2040	100.0%	1.00	No Change	Low	High
	2040-2070	87.0% 5.8.0	1.36	No Change	Low	High
	2070-2100	70.0% 15.0% 15.0%	1.74	No Change	Low	Moderate
Lw : western larch	Current	100.0%				
	2010-2040	7.(93.0%	4.00	No Change	Very High	High
	2040-2070	23.0% 13.0 5. 59.0%	4.00	No Change	Very High	Low
	2070-2100	9.0 23.0% 9.0 59.0%	4.00	No Change	Very High	Low
NS* : None Suitable	Current	100.0%				
	2010-2040	100.0%	4.00	No Change	Very High	High
	2040-2070	92.0%	4.00	No Change	Very High	High
	2070-2100	85.0%	4.00	No Change	Very High	High
Pl : lodgepole pine	Current	100.0%				
	2010-2040	4.3 93.0%	4.00	Strongly Declining	Very High	High
	2040-2070	12.0 11.0 77.0%	4.00	No Change	Very High	Moderate
	2070-2100	5.4 91.0%	4.00	No Change	Very High	High
Py : ponderosa pine	Current	100.0%				
	2010-2040	86.0% 7.(7.0	1.21	Strongly Improving	Low	High
	2040-2070	69.0% 23.0% 8.0	1.54	No Change	Low	Moderate
	2070-2100	76.0% 9.0 15.0%	1.68	No Change	Low	Moderate
Sx : interior spruce	Current	100.0%				
	2010-2040	7.(93.0%	4.00	Declining	Very High	High
	2040-2070	23.0% 77.0%	4.00	No Change	Very High	Moderate
	2070-2100	9.0 91.0%	4.00	No Change	Very High	High

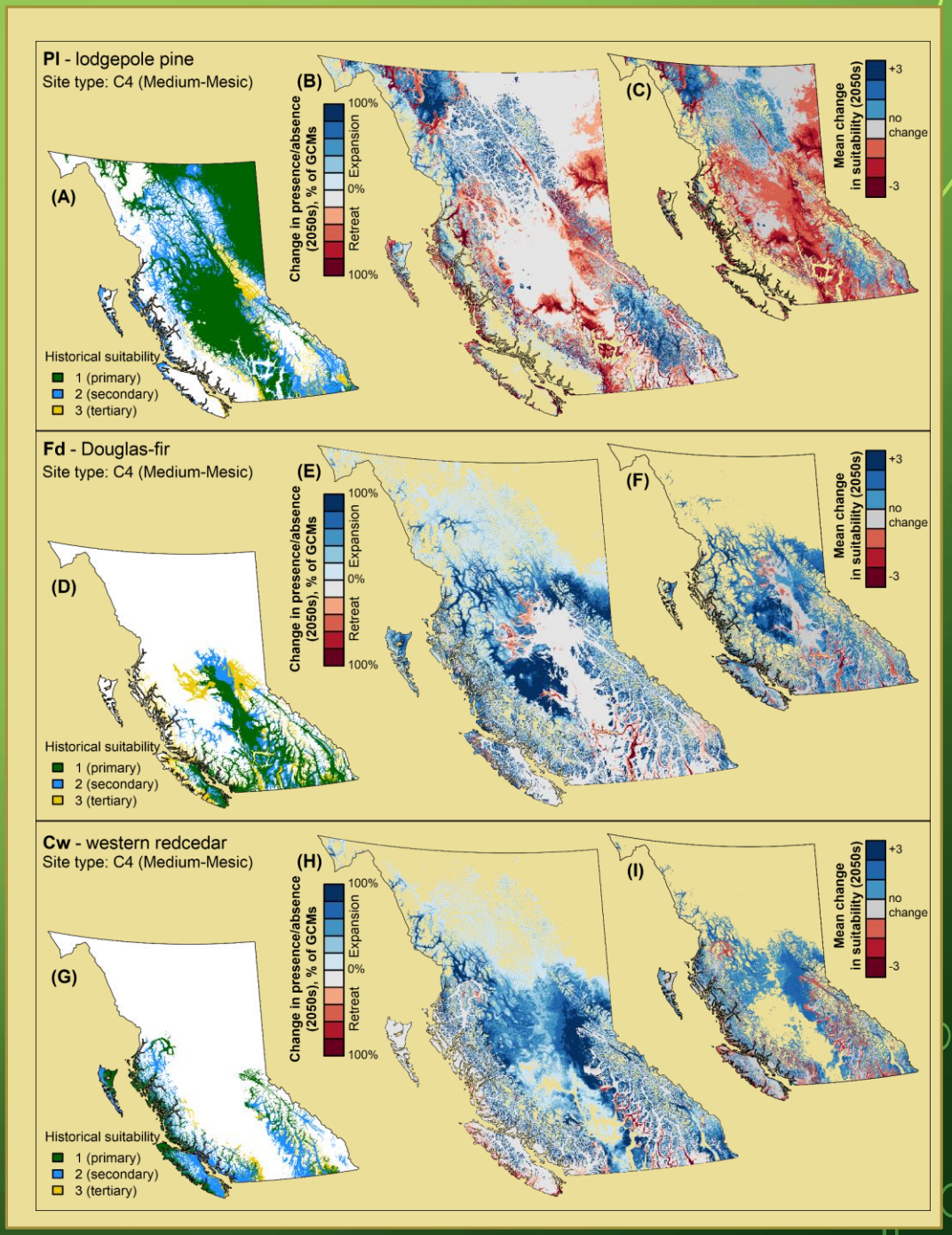
* NS = no tree species are suitable (e.g. grasslands). Primary suitability percentage of NS indicates the proportion of future site conditions where no trees species are deemed suitable.

Site Series
IDFdk3/04 : Fd - Bluebunch wheatgrass - Needlegrass

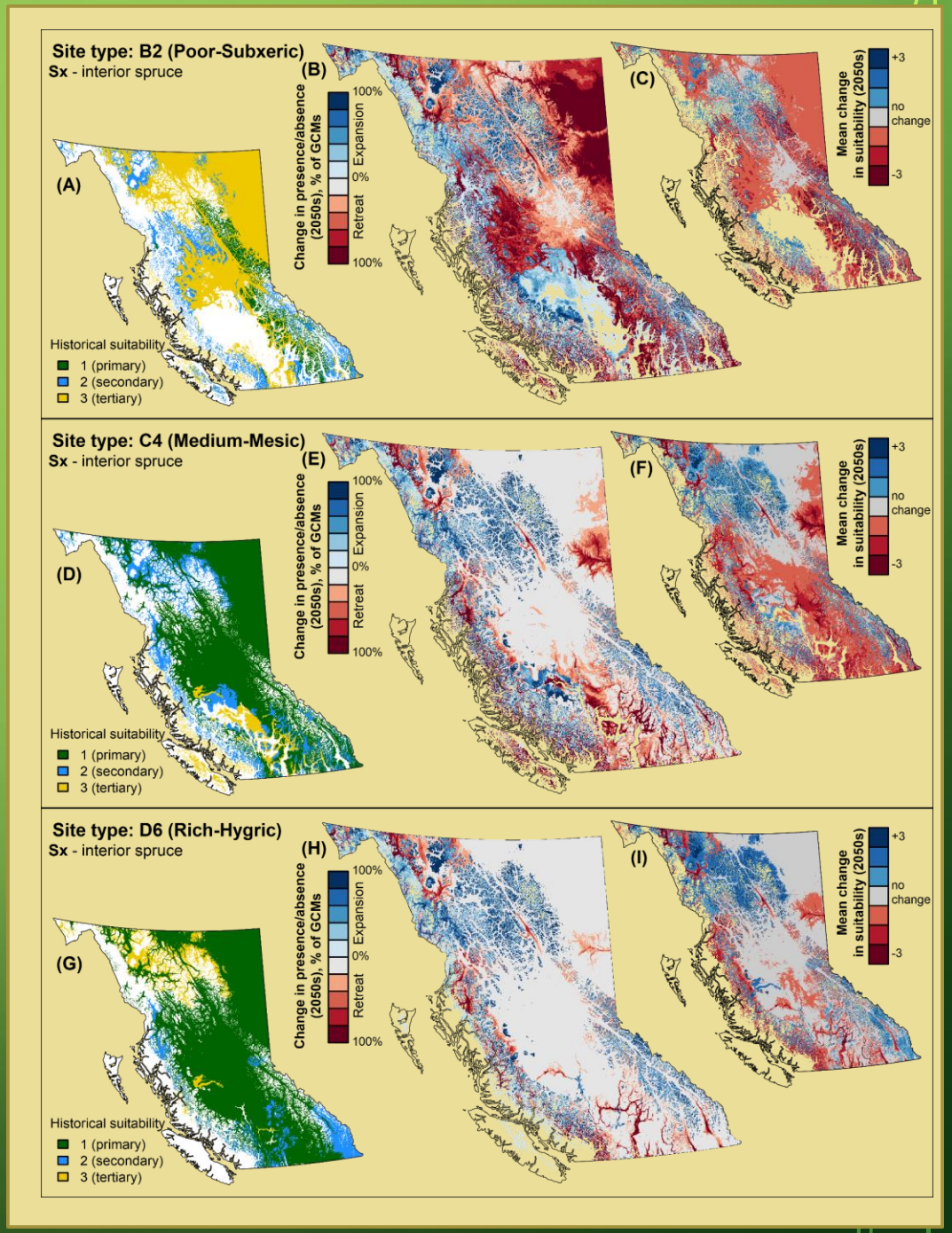
PROVINCIAL TRENDS IN SPECIES SUITABILITY OVERVIEW

- 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 (Cw, Hw)

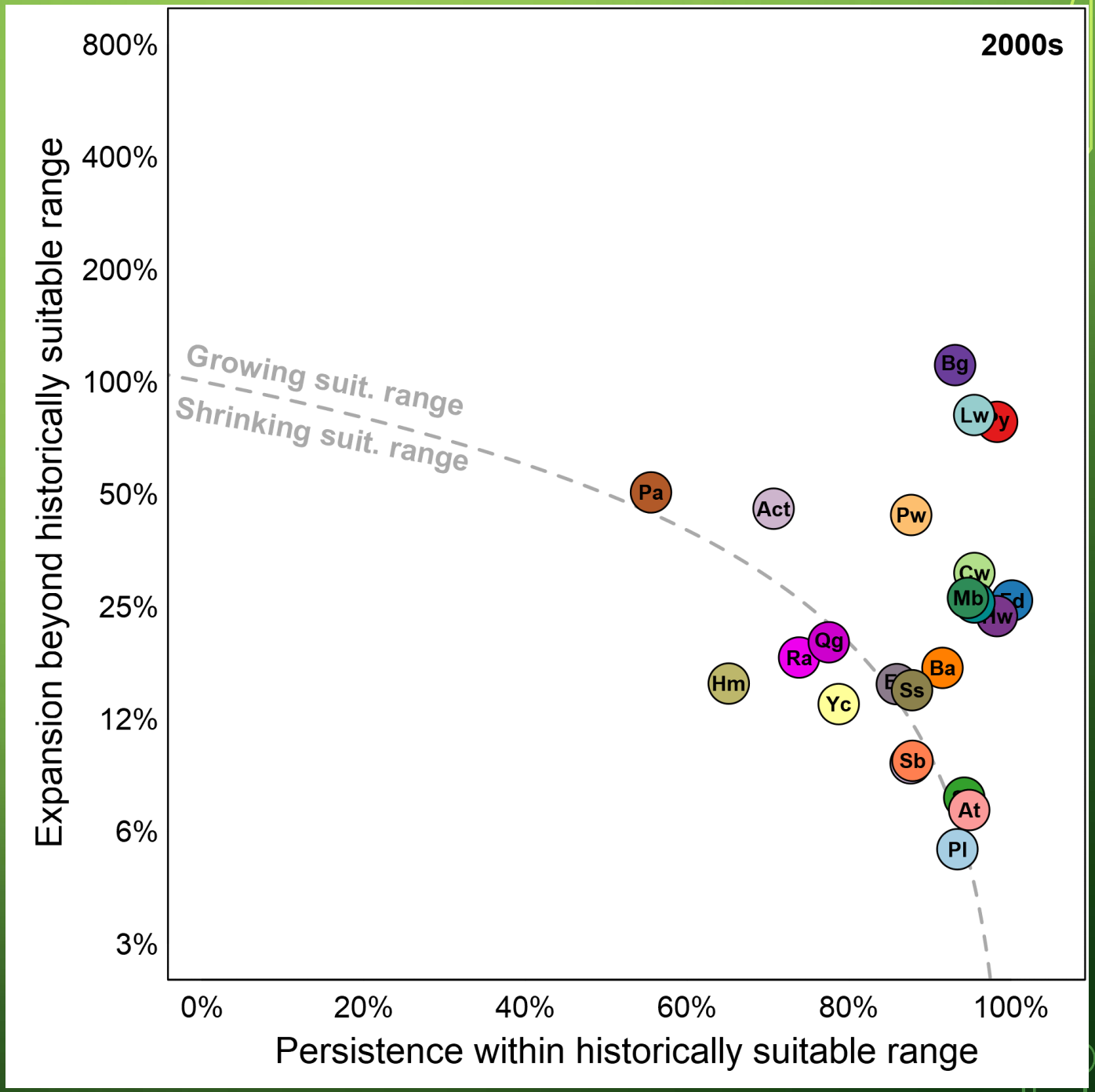
CHANGING PRESENCE AND SUITABILITY (ZONAL SITES)



VARIABILITY BY EDATOPIC POSITION



MESIC/ MEDIUM SITES



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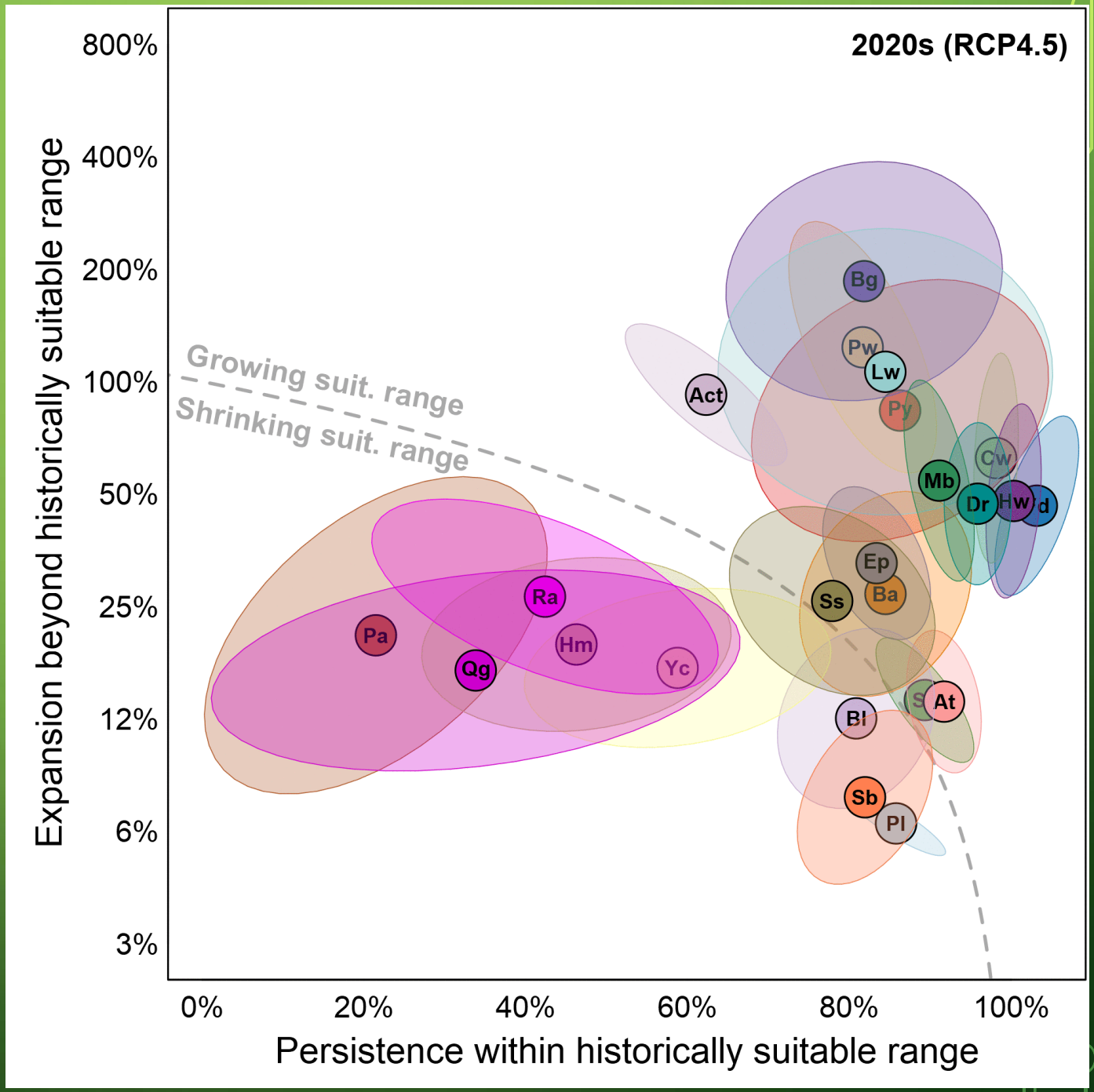

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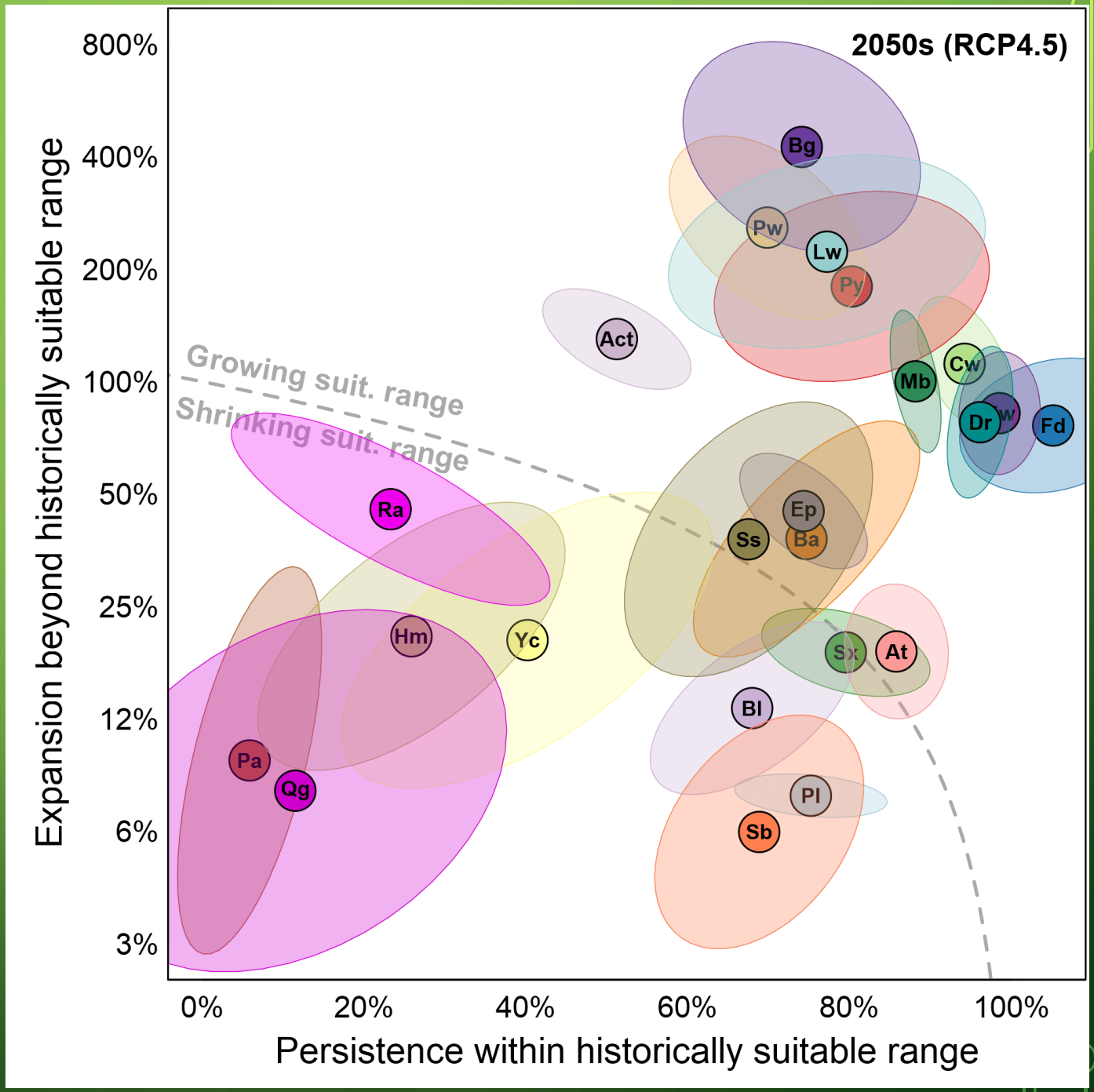

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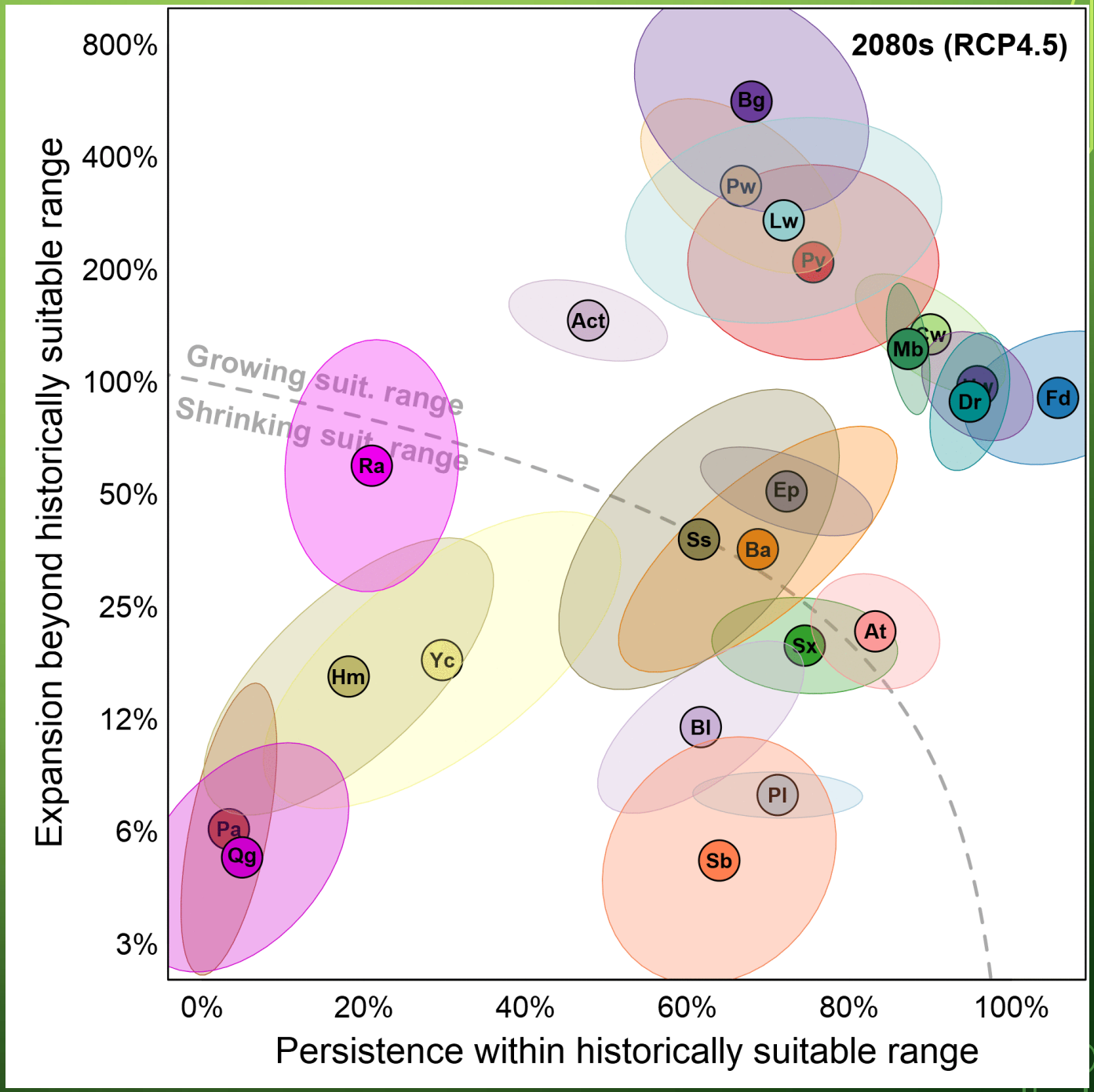

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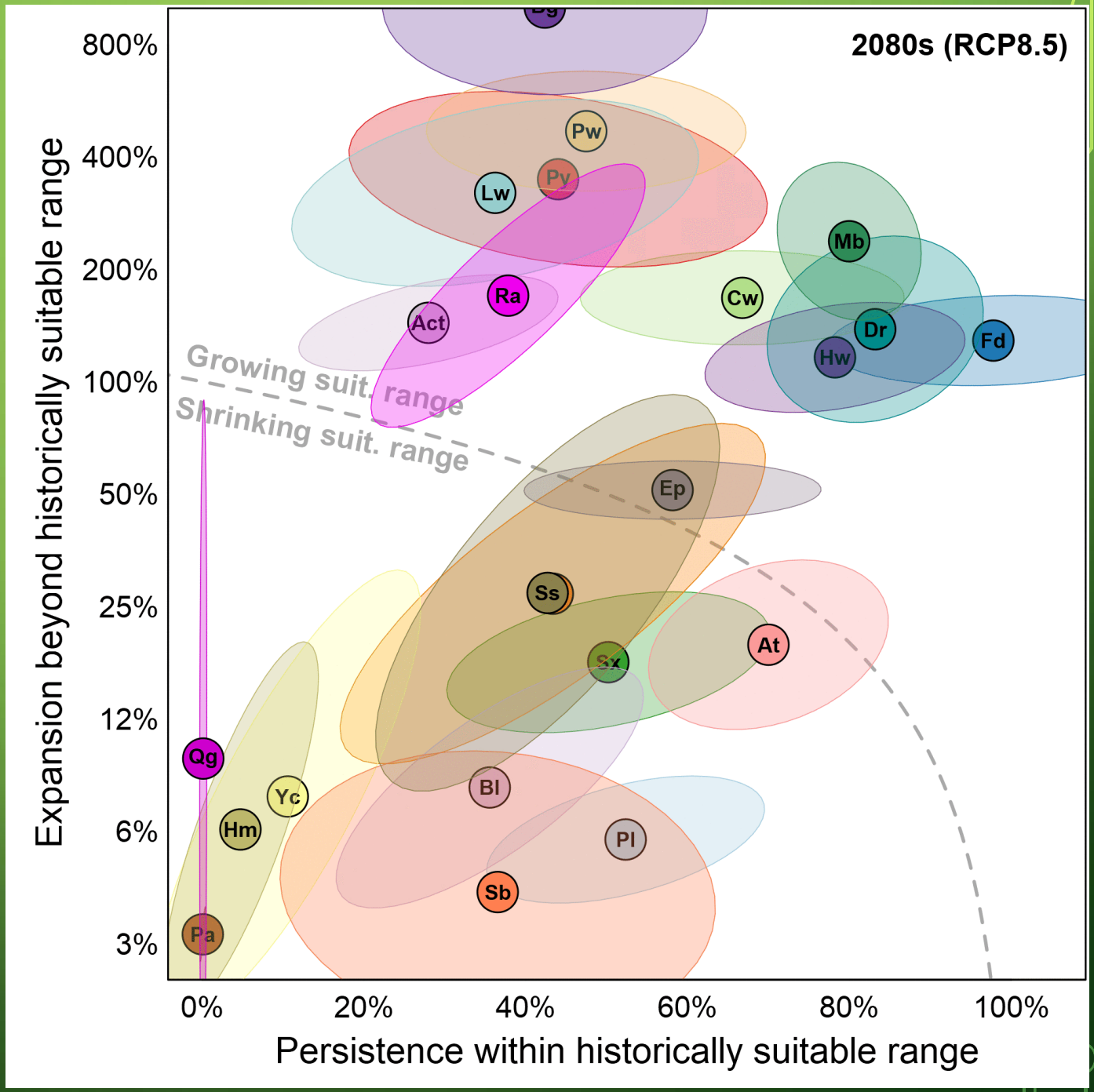
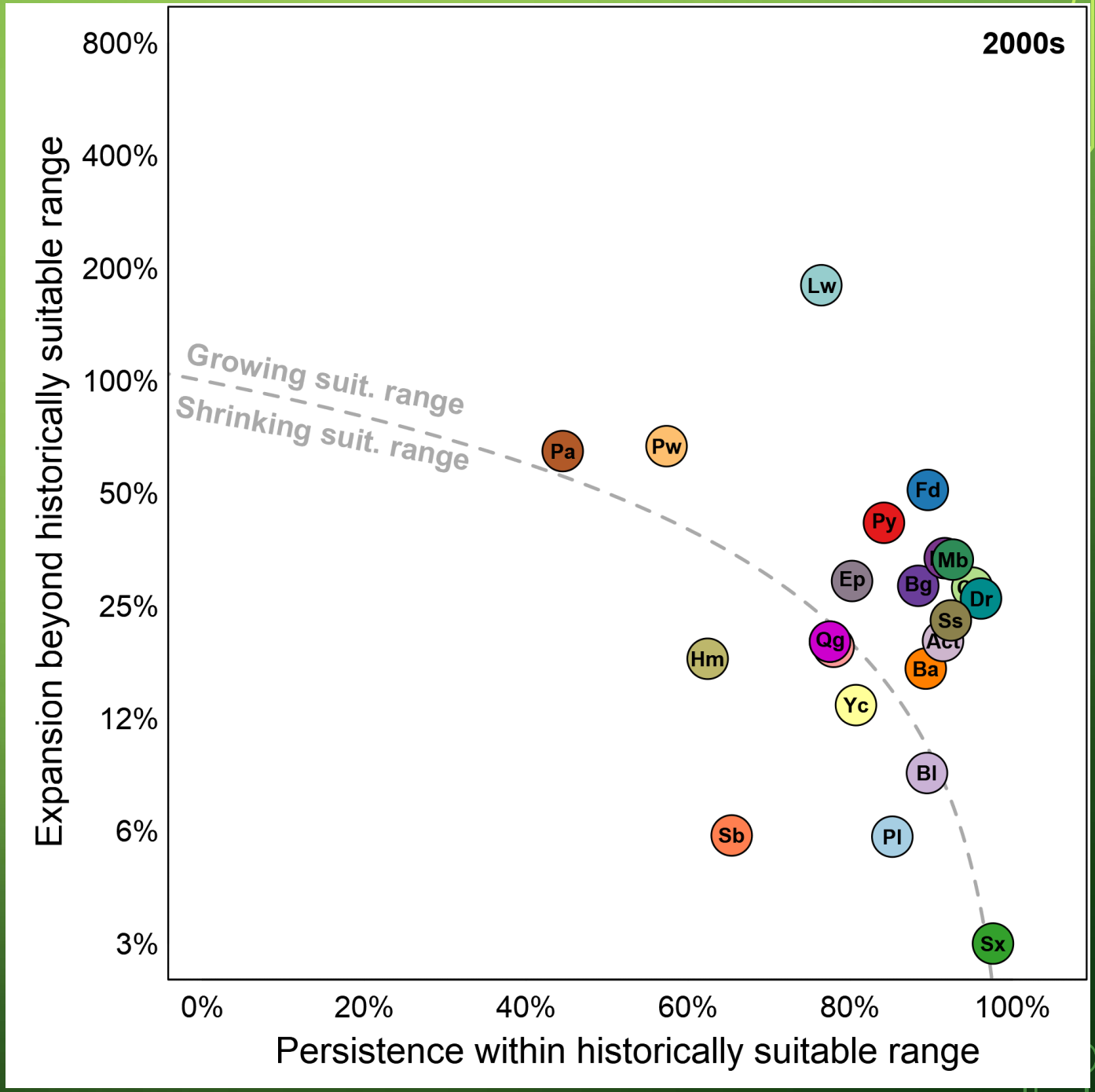
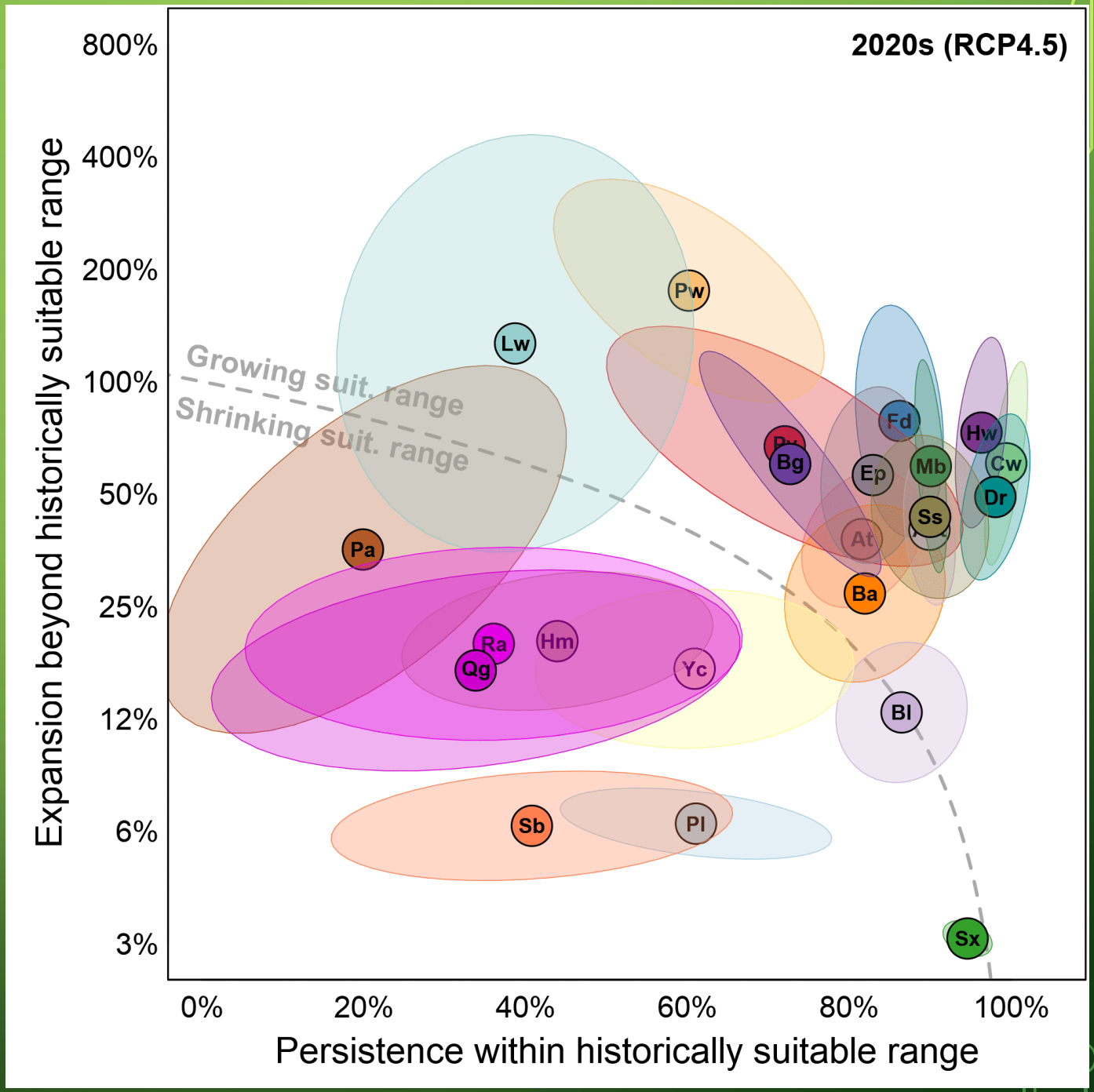


HYGRIC /RICH SITES



HYGRIC /RICH


2020s (RCP4.5)
Expansion beyond historically suitable range
800%
400%
200%
100%
50%
25%
12%
6%
3%
Growing suit. range
Shrinking suit. range
Pw
Lw
Fd
Hw
Bg
Ep
Mb
Cw
Dr
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At
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Pa
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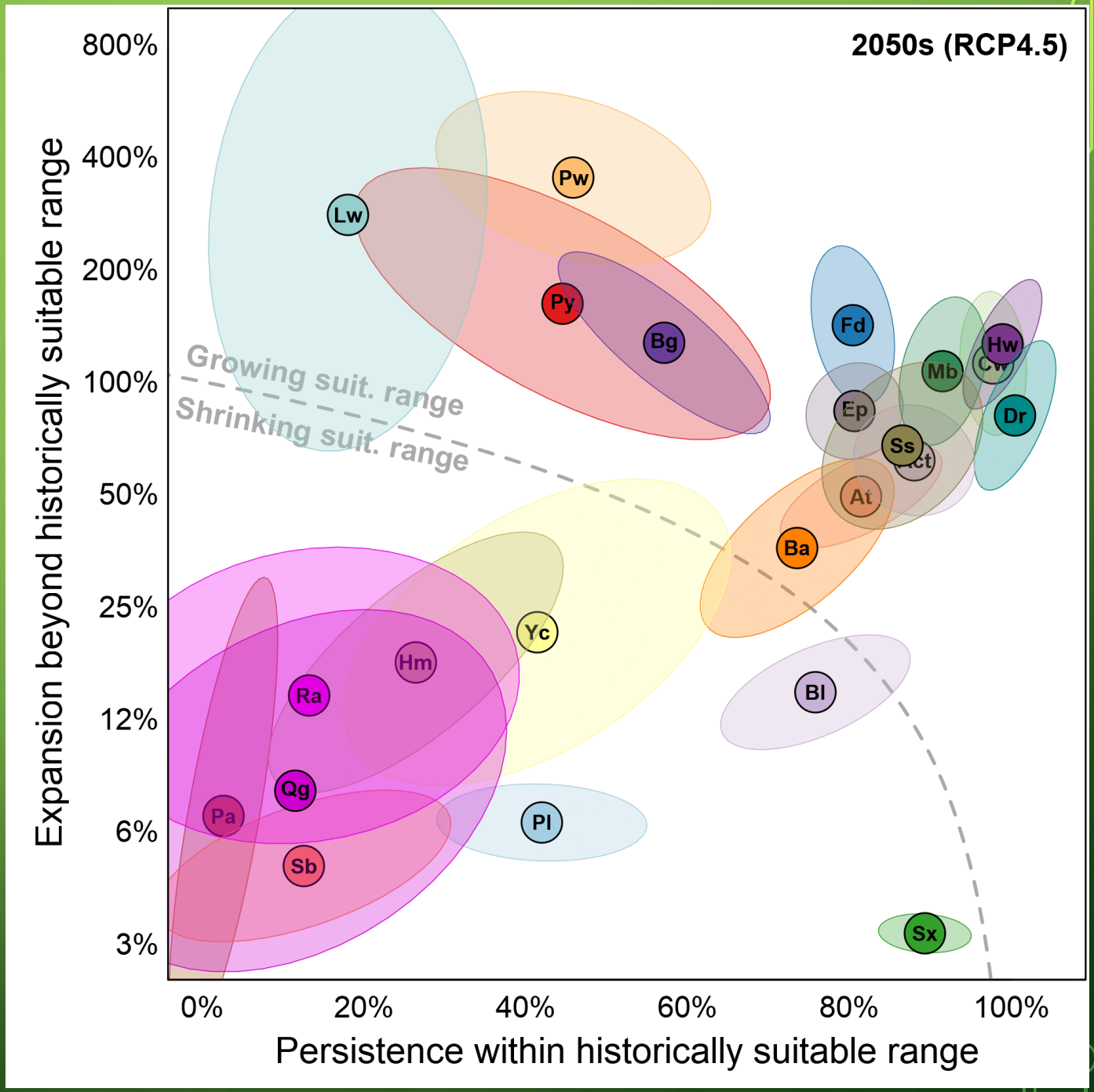
Pl
Sx
0%
20%
40%
60%
80%
100%
Persistence within historically suitable range

HYGRIC /RICH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Expansion beyond historically suitable range
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Growing suit. range
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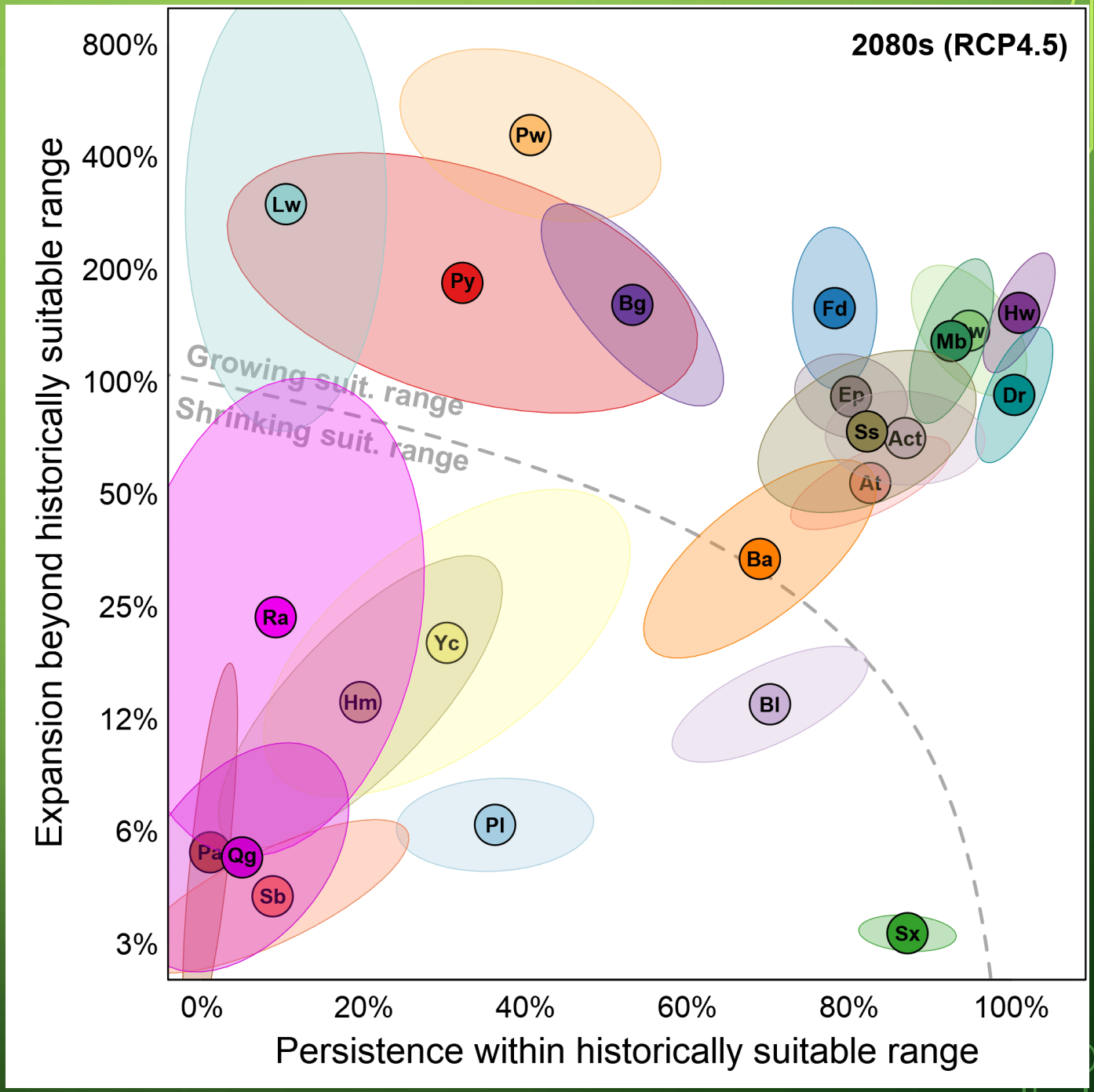
60%
80%
100%
Persistence within historically suitable range

HYGRIC /RICH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Expansion beyond historically suitable range
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Growing suit. range
Shrinking suit. range
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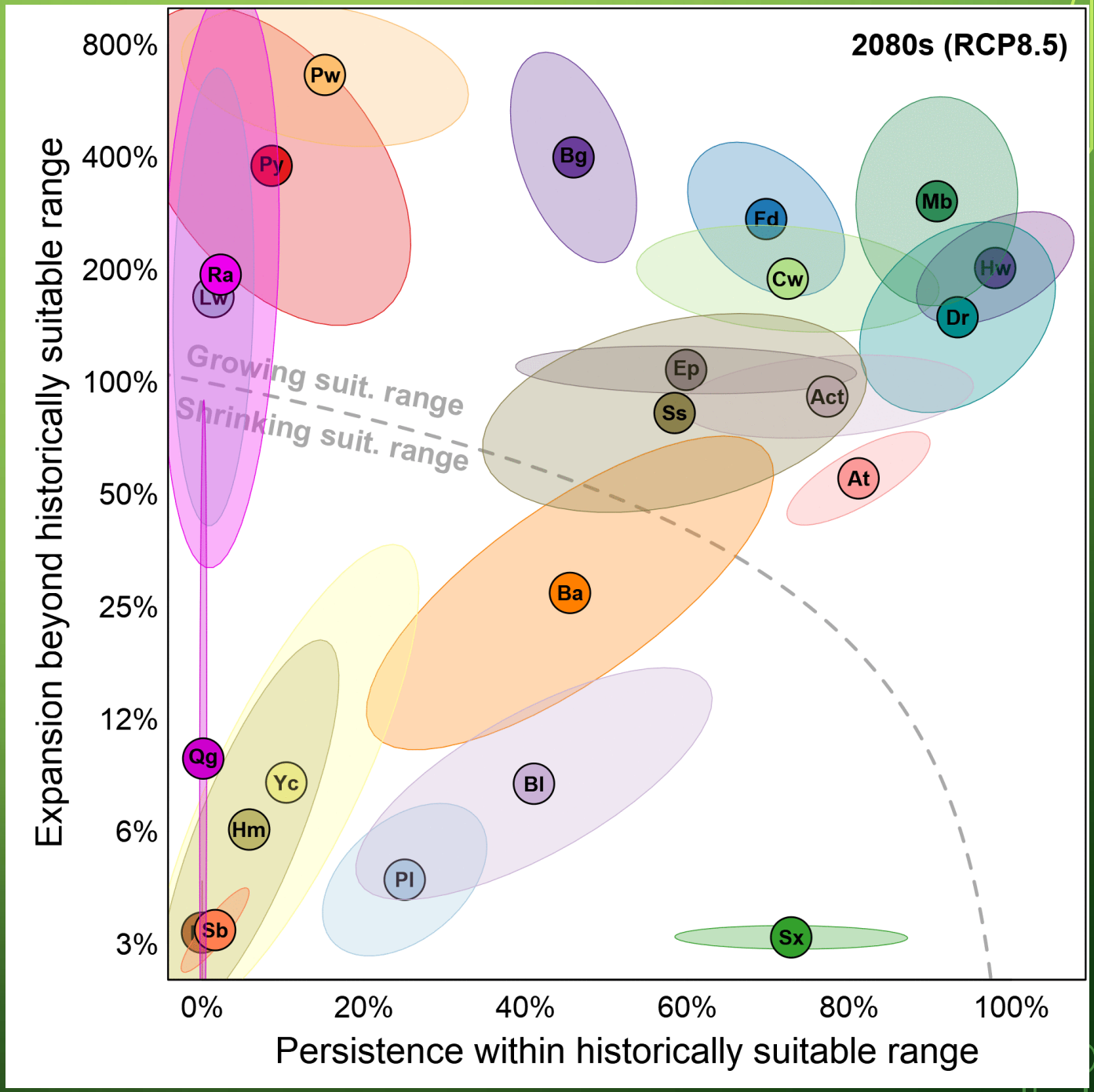
100%
Persistence within historically suitable range

HYGRIC /RICH


2080s (RCP8.5)
Expansion beyond historically suitable range
800%
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200%
100%
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12%
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3%
Growing suit. range
Shrinking suit. range
Pw
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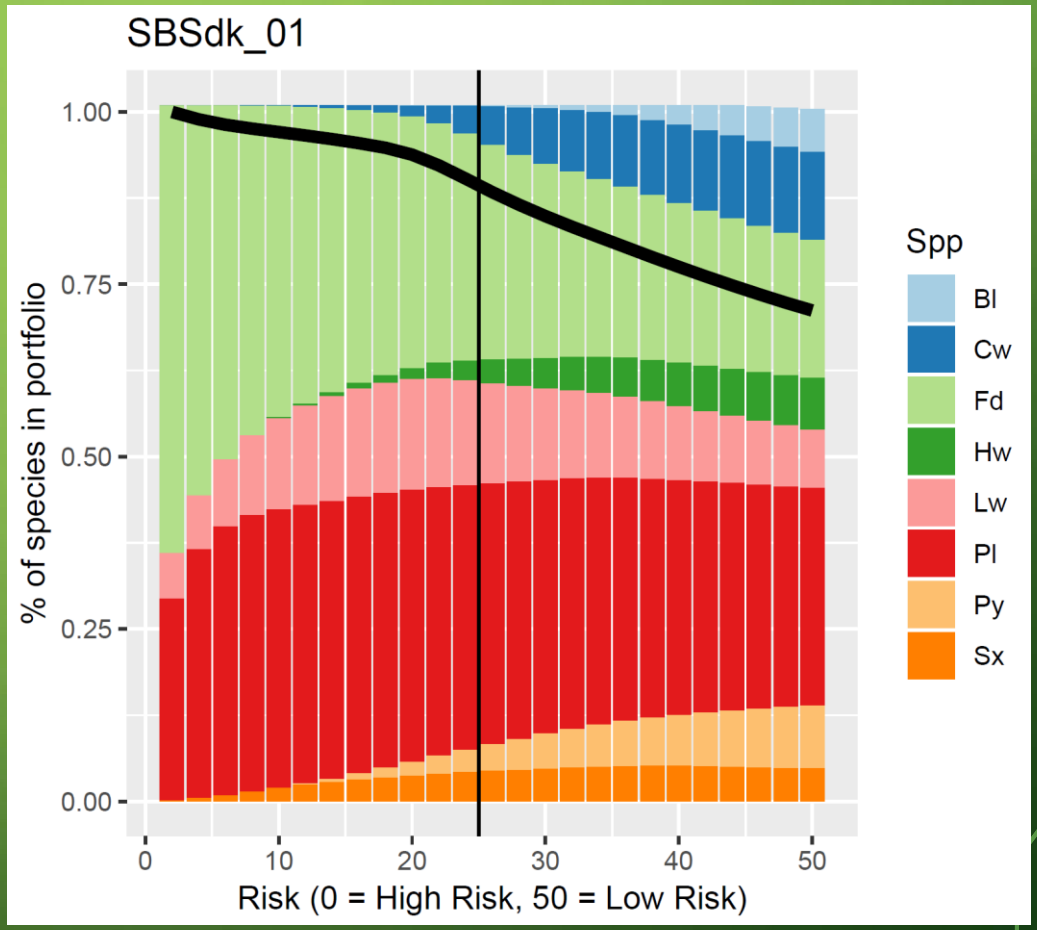
Sb
Sx
0%
20%
40%
60%
80%
100%
Persistence within historically suitable range

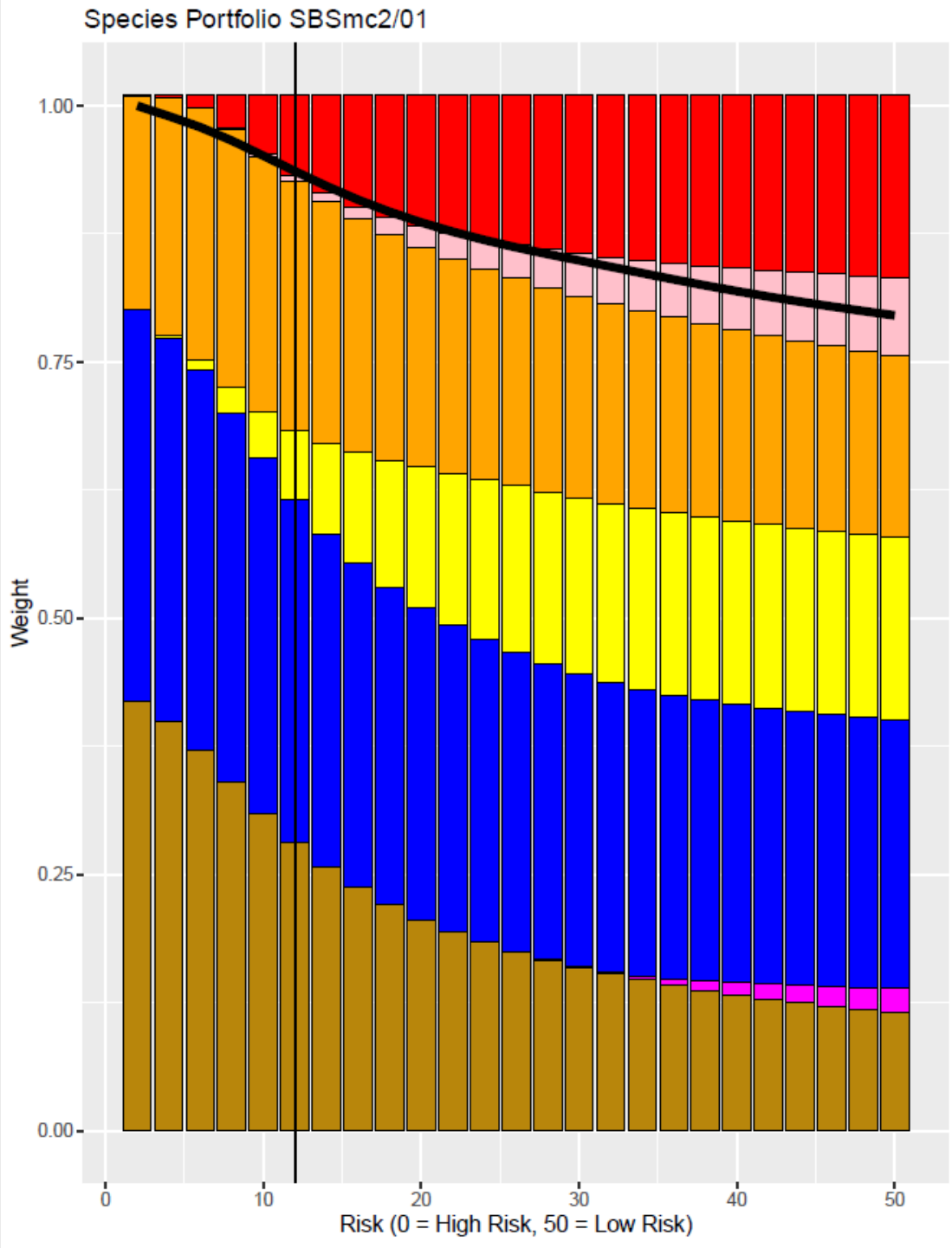
MODERN PORTFOLIO THEORY FOR OPTIMIZED SPECIES SELECTION

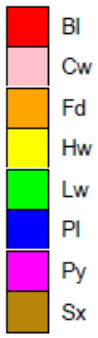
- We want to encourage diversity (stand and landscape) for reducing risk and for other values
  - CCISS (CBST) outputs may encourage picking single "winners" (risky) versus a diversity of appropriate sp.
- Modern Portfolio Theory is an avenue for calculating optimized species ratios for managing risk given uncertainties in climate change

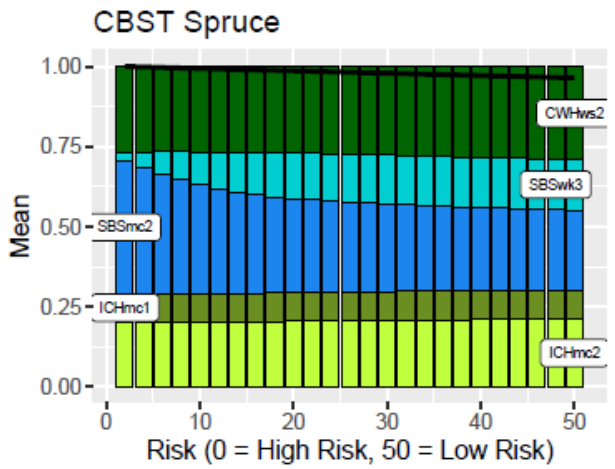
Bulkley TSA ISS

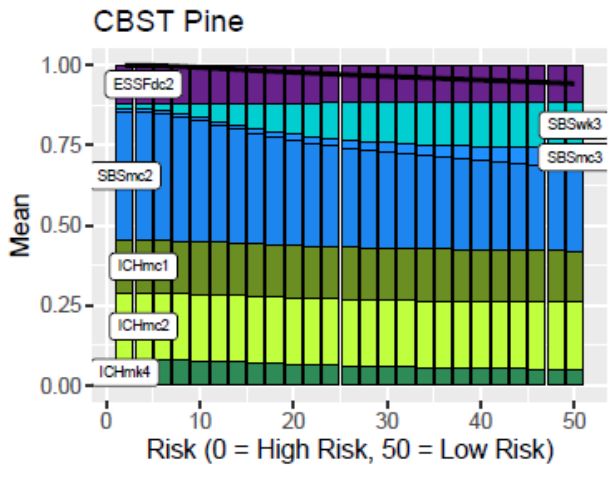
MPT GIVES A RANGE OF PORTFOLIO OPTIONS: ALL ARE OPTIMIZED TO DEAL WITH CLIMATE CHANGE AND ASSOCIATED UNCERTAINTY




Species Portfolio SBSmc2/01
Weight
1.00
0.75
0.50
0.25
0.00
0
10
20
30
40
50
Risk (0 = High Risk, 50 = Low Risk)


Spp
Bl
Cw
Fd
Hw
Lw
Pl
Py
Sx


CBST Spruce
Mean
1.00
0.75
0.50
0.25
0.00
CWHws2
SBSwk3
SBSmc2
ICHmc1
ICHmc2
0
10
20
30
40
50
Risk (0 = High Risk, 50 = Low Risk)

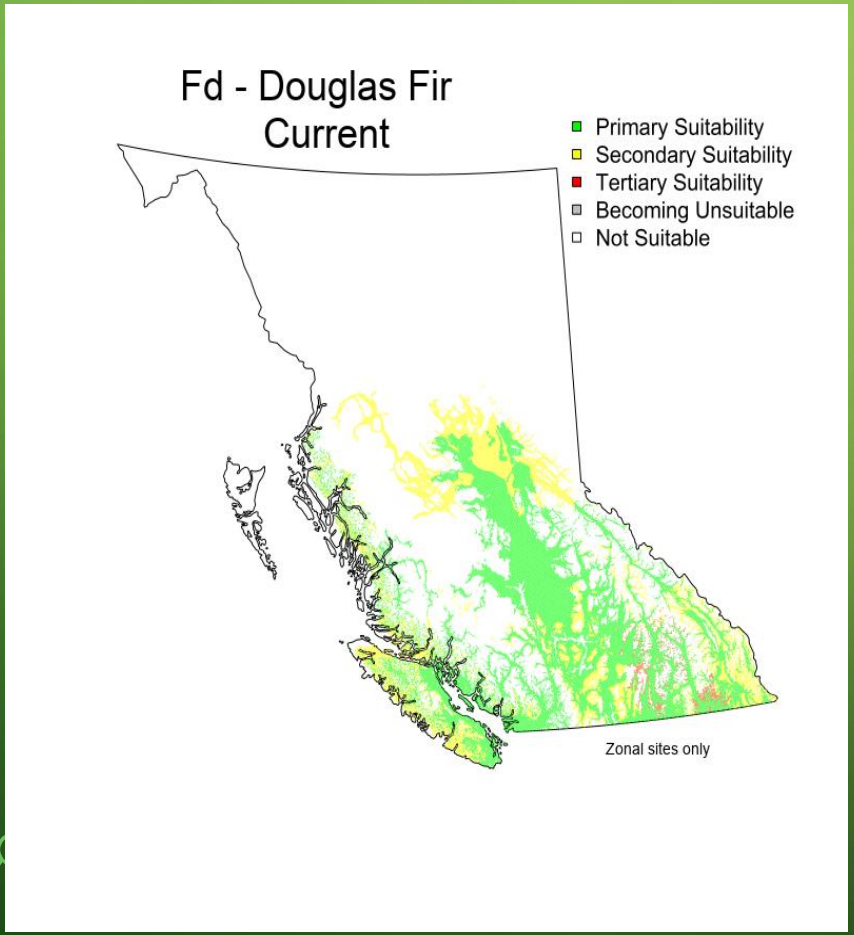

CBST Pine
Mean
1.00
0.75
0.50
0.25
0.00
ESSFdc2
SBSwk3
SBSmc3
SBSmc2
ICHmc1
ICHmc2
ICHmk4
0
10
20
30
40
50
Risk (0 = High Risk, 50 = Low Risk)

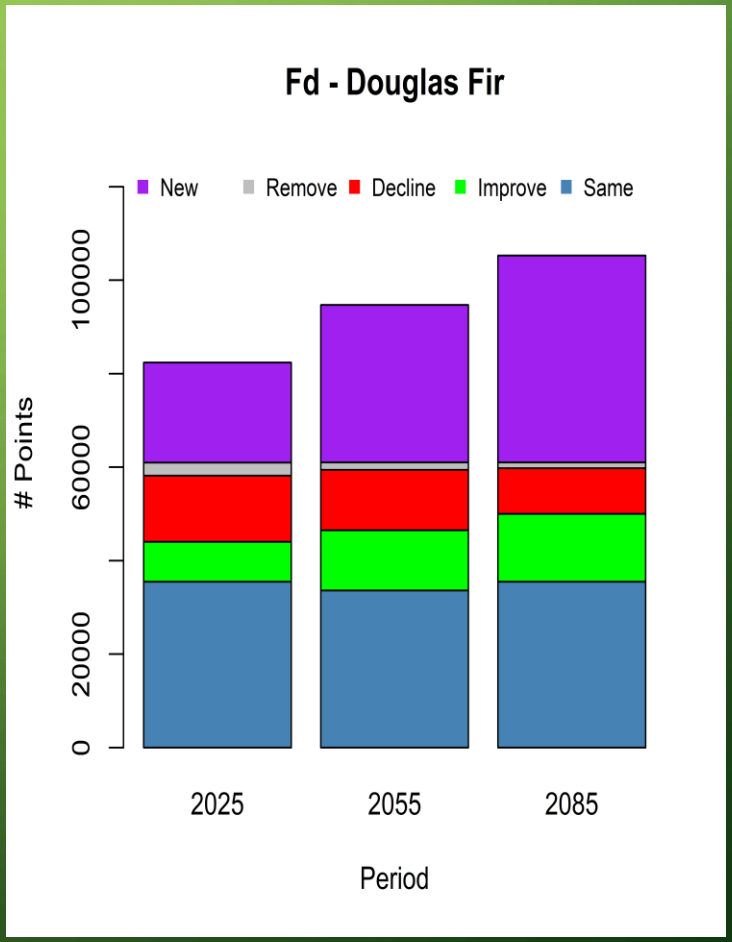
2019 WORK

- Focus on review of inputs.
- Review of Species Suitability + Footnotes
- Journal Publication
- Update of Webtool format, data, reporting options
- Towards formal release?
- Draft Modern Portfolio species/seedlot selection function for review

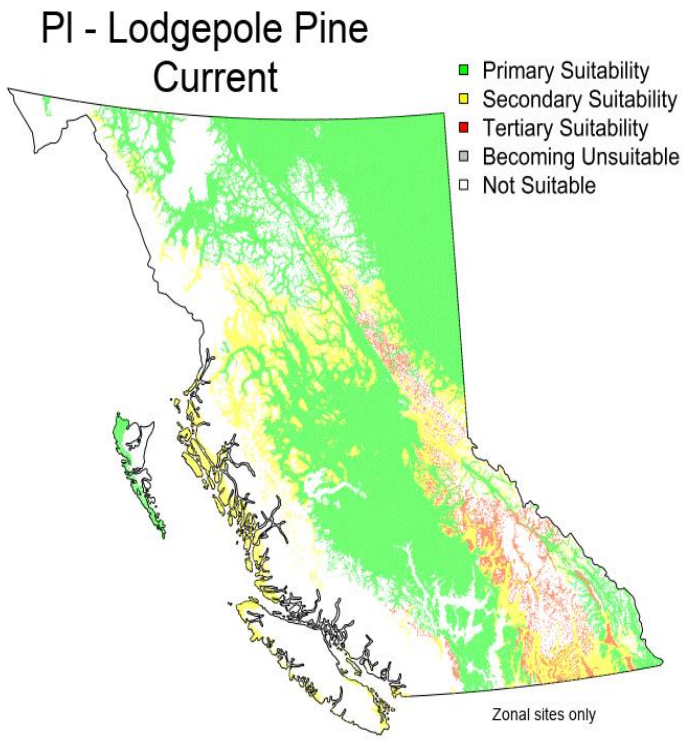
END

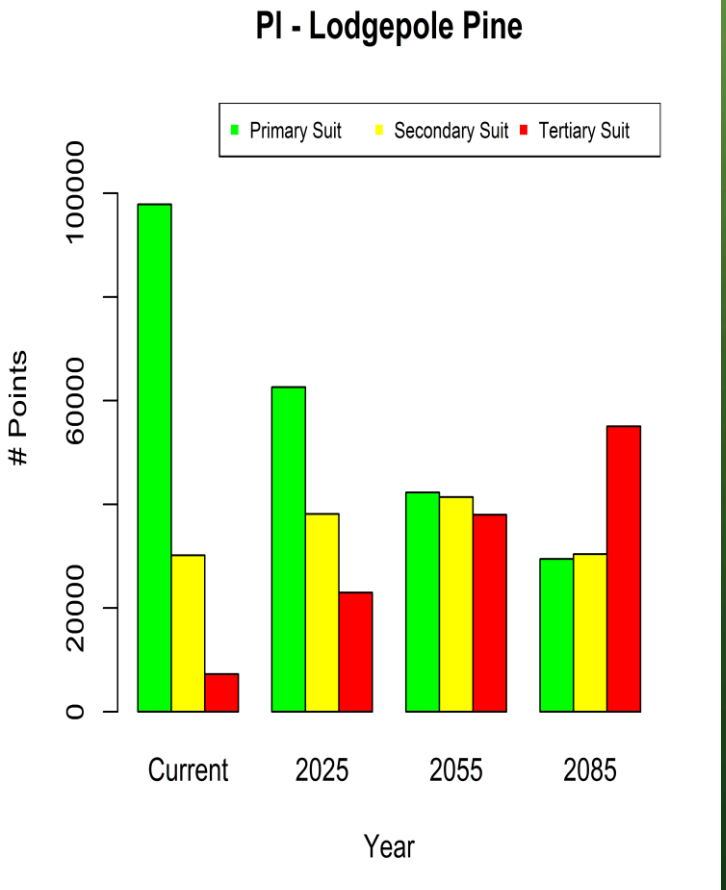
CHANGE IN DOUGLAS-FIR SUITABILITY
(ONLY ZONAL SITES)



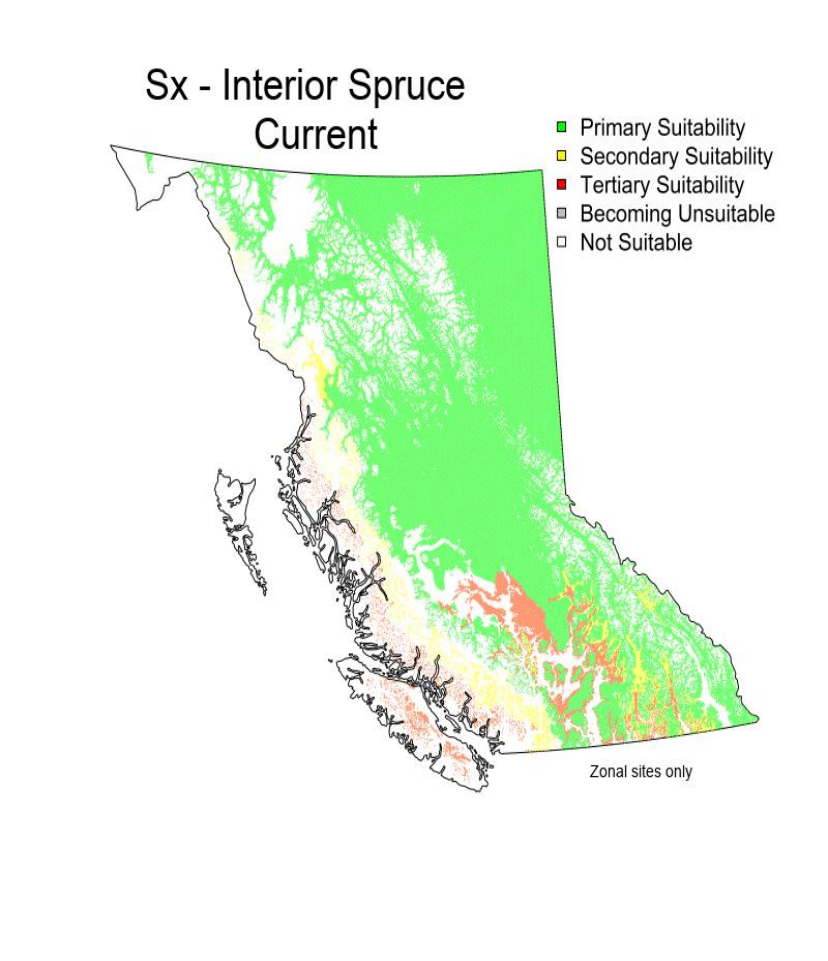


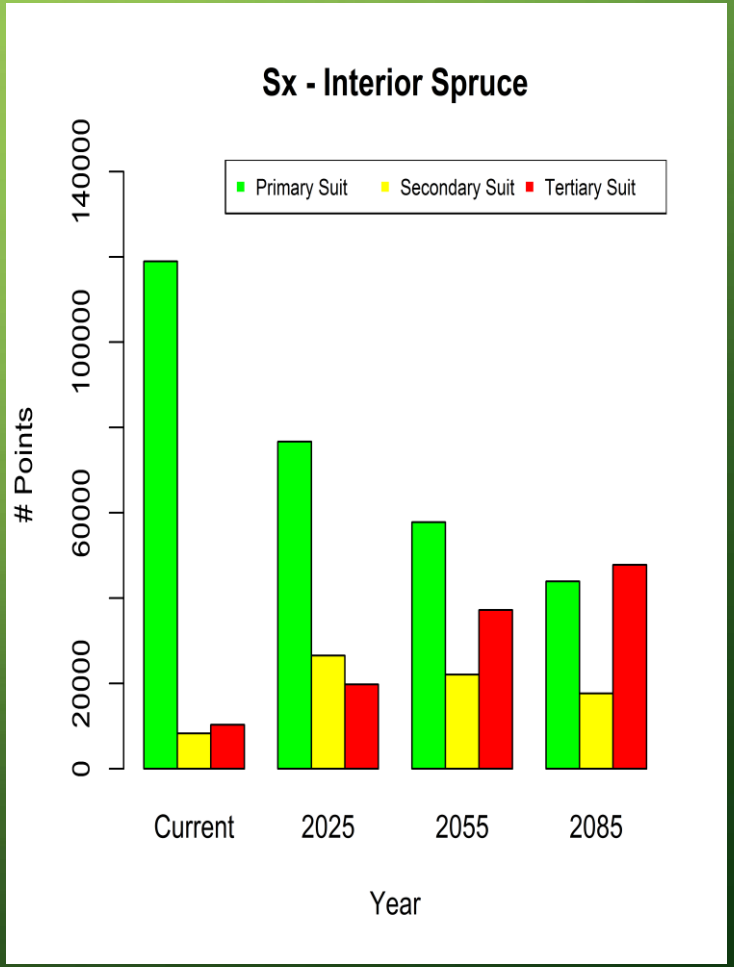
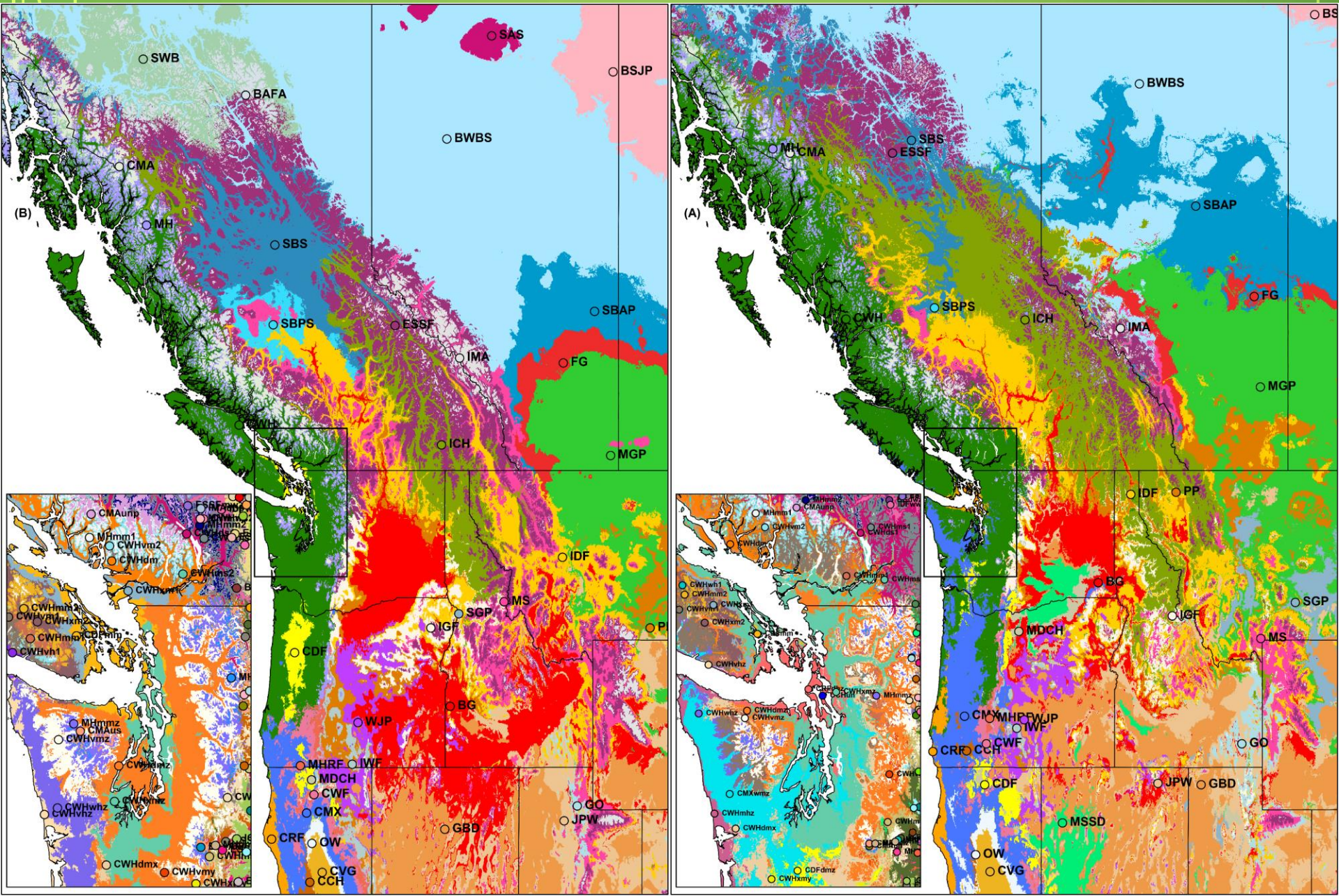
CHANGE IN LODGEPOLE PINE SUITABILITY (ZONAL SITES)





CHANGE IN INTERIOR SPRUCE SUITABILITY (ZONAL SITES)





USA BEC for Modelling