

Recently Developed Tools Used In Climate Change Based Guidance For Species Selection

(Applications for BEC Database)

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BECWeb: <http://www.for.gov.bc.ca/hre/becweb/>

- BEC ecologists used some climate change based tools in The Regional Guidance for Species Use Based on Climate Change project

Tools Available:

- Regional BEC and Silvicultural Research Ecologists
- Regional Research Climatologist (Vanessa Foord)
- Landscape-level ecological species benchmarks paper (soon)
- Regional Guidance for Species Use Based on Climate Change (soon)
- Tree Species Selection Tool (Resource Practices Branch)
<http://www.for.gov.bc.ca/hfp/silviculture/TSS/tss.htm>

- My approach is purely based on projected *site* level changes
- This provides a site level foundation to start with but you still need to consider other factors some of which may prove to be limiting or warrant additional cautionary footnotes:

Genetics (SPU's - periodicity, phenology)

Forest health

Growth and yield (mixed spp versus single planting)

Soils (Geology/Parent Materials)

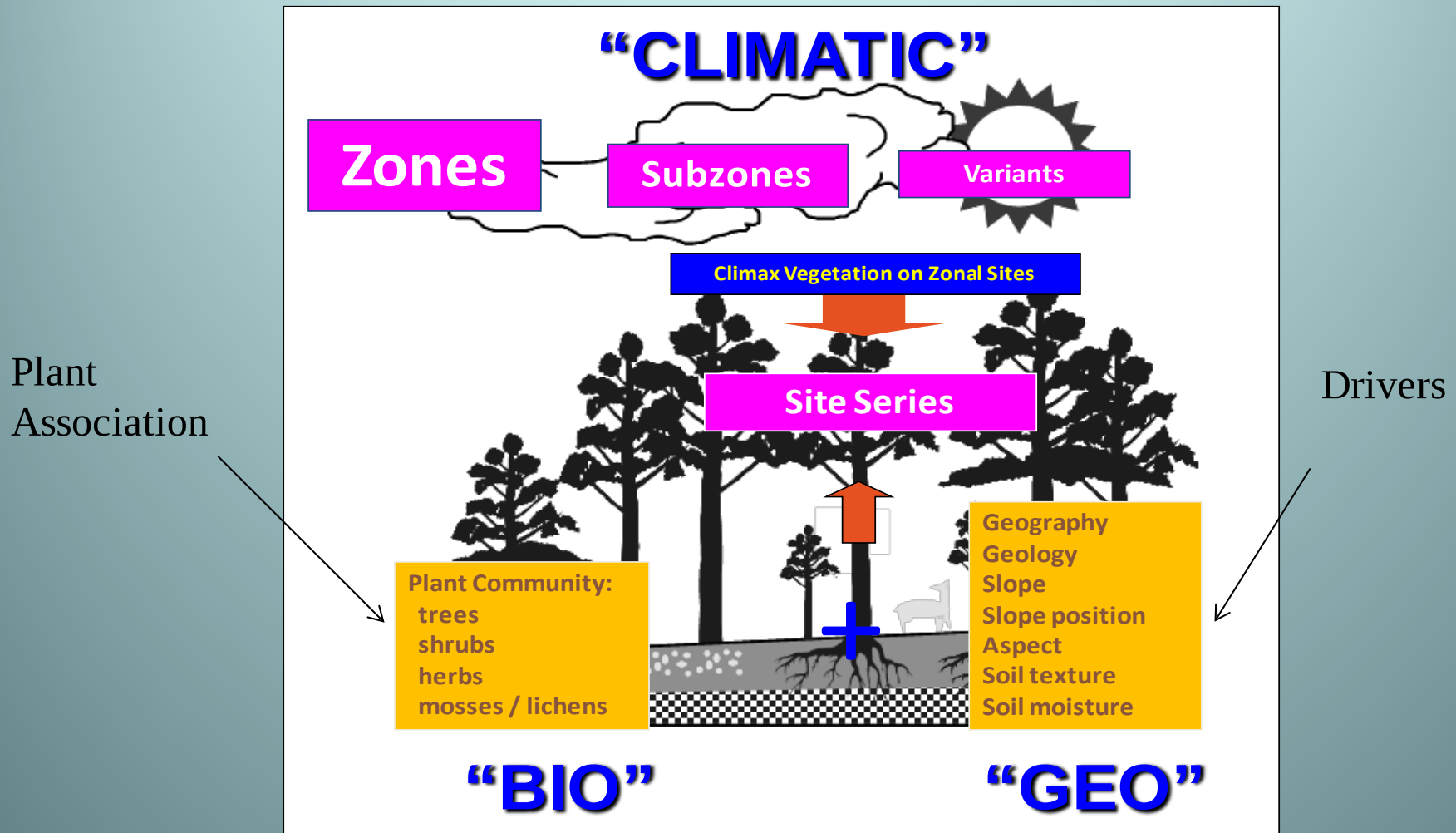
Cold Air/Frost Ponding potential, aspect

Extreme smr's

			Regeneration Guide										Free Growing Guide				
BGC			Species						Stocking(i)		Regen	Assessment		Min. Height(ii)			
Classification									Broadleaf	Target	MIN pa	MIN p	Delay	Earliest	Latest	Species	Ht
Zone/SZ	Series	Standards ID	Primary	Preferred (p)	Secondary	Acceptable (a)	Tertiary		(well-spaced/ha)			(Max yrs)	(yrs)	(yrs)		(m)	
SBSdk	01	85193	PI Sx	PI Sx	Fd ^{8,18}	Fd ^{8,18}		At ³ Ep ³	1200	700	600	7	12	15	PI	2.00	
															Fd	1.40	
															Others	1.00	

- 1990 - BEC classification incorporated into the Correlated Guidelines for Free Growing Stocking Standards for Ecosystems of BC
- The current Chief foresters Reference Guide uses BEC site series as the foundation for preferred and acceptable and/or 1°,2°,3° tree species selection
- BEC site series classification: site level units or ecosystems defined at the plant association level that reflect site capacity

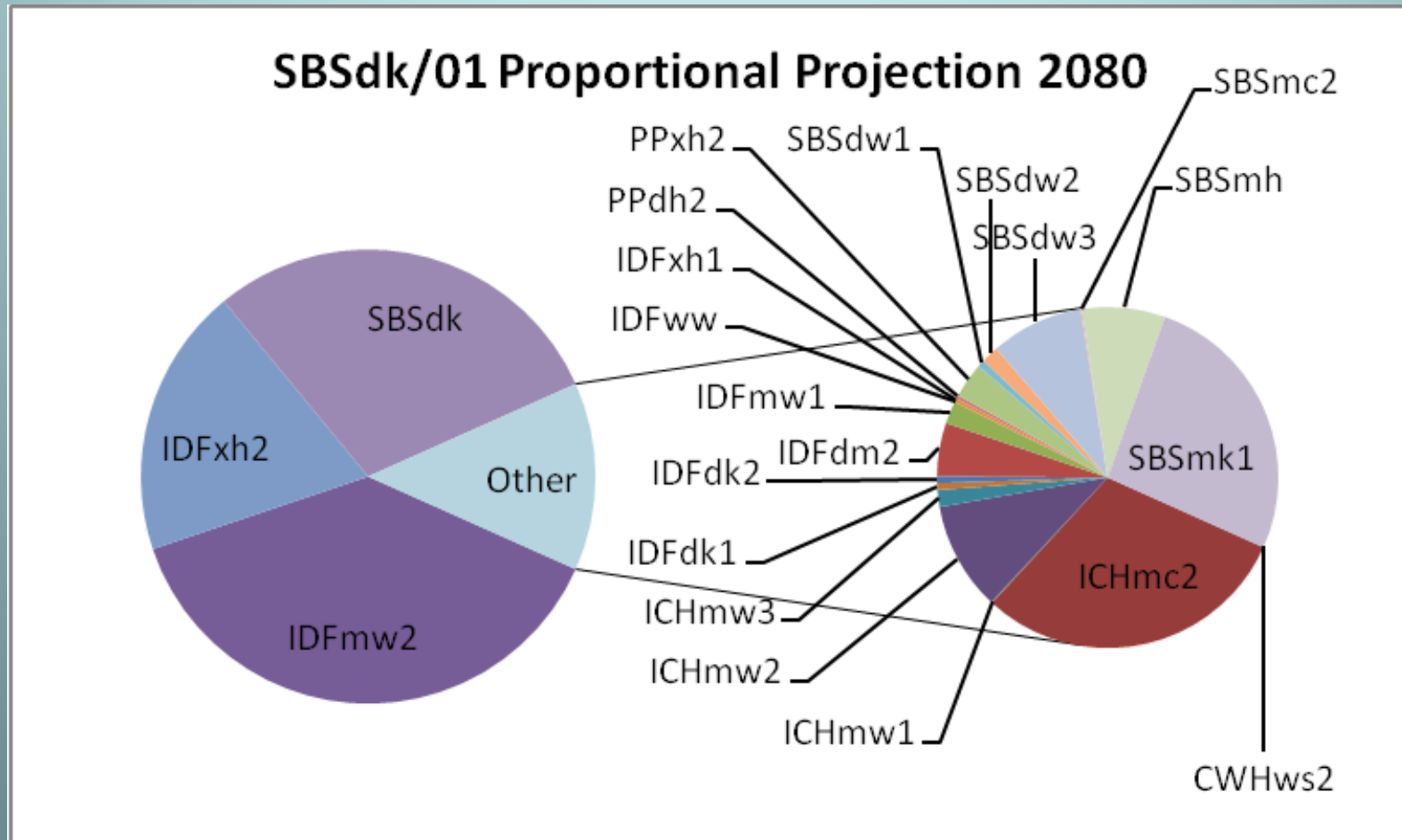
Strong climate level to site level relationship makes BEC site series an ideal unit of measure and platform for predicting future bio-climate conditions and species suitability



- In 2012 Resource Practice's Branch (RPB) (Winter and Astridge, 2012) initiated a climate change based species guidance project
- BEC Ecologists asked to participate in Phase 1 of the project using available tools to develop Reference Guide promotion/demotion rankings for species at the site series level (only the zonal 01 site series was used to start with).
- Projections for future BEC bio-climate envelope niches were produced by Wang et al. (2010 - UBC Dept of Forest Sciences) using the Climate – Western North America (WNA) model and run with 20 scenarios to generate a projection consensus map for 2020, 2050 and 2080
- Some tools ecologists used in the RPB project used were:
 - 1) BEC Database Tool (Bio-climate envelope/reference guide queries)
 - 2) Species Drought Risk Tool (FFESC)
 - 3) ClimateWNA Model

1) BEC Database Tool

- Ecosystem/climate niches incorporated into queries in the BEC data base and linked to the tables in the Reference Guide to produce a “% area change for existing BGC climate envelopes to future ones” for 2020, 2050 and 2080 along with the corresponding new suggested species selection (Rough-cut level)



BEC Database Tool Output

Current Reference Guide species status

Zone	Site Series	Act	At	Ba	Bl	Cw	Dr	Ep	Fd	Hm	Hw	Lw	Mb	Pl	Pw	Py	Sx	Sxs
SBSdk	01		4					4	2					1			1	

2080 projected % area changed and new species status

2080	Site Series	Act	At	Ba	Bl	Cw	Dr	Ep	Fd	Hm	Hw	Lw	Mb	Pl	Pw	Py	Sx	Sxs	% Area Changed
IDFmw2	01		4			3		4	1			3		1					37.70%
IDFxh2	01		4						1							1			18.98%
SBSdk	01		4					4	2					1			1		28.92%
Other	01																		14.40%
																			100.00%

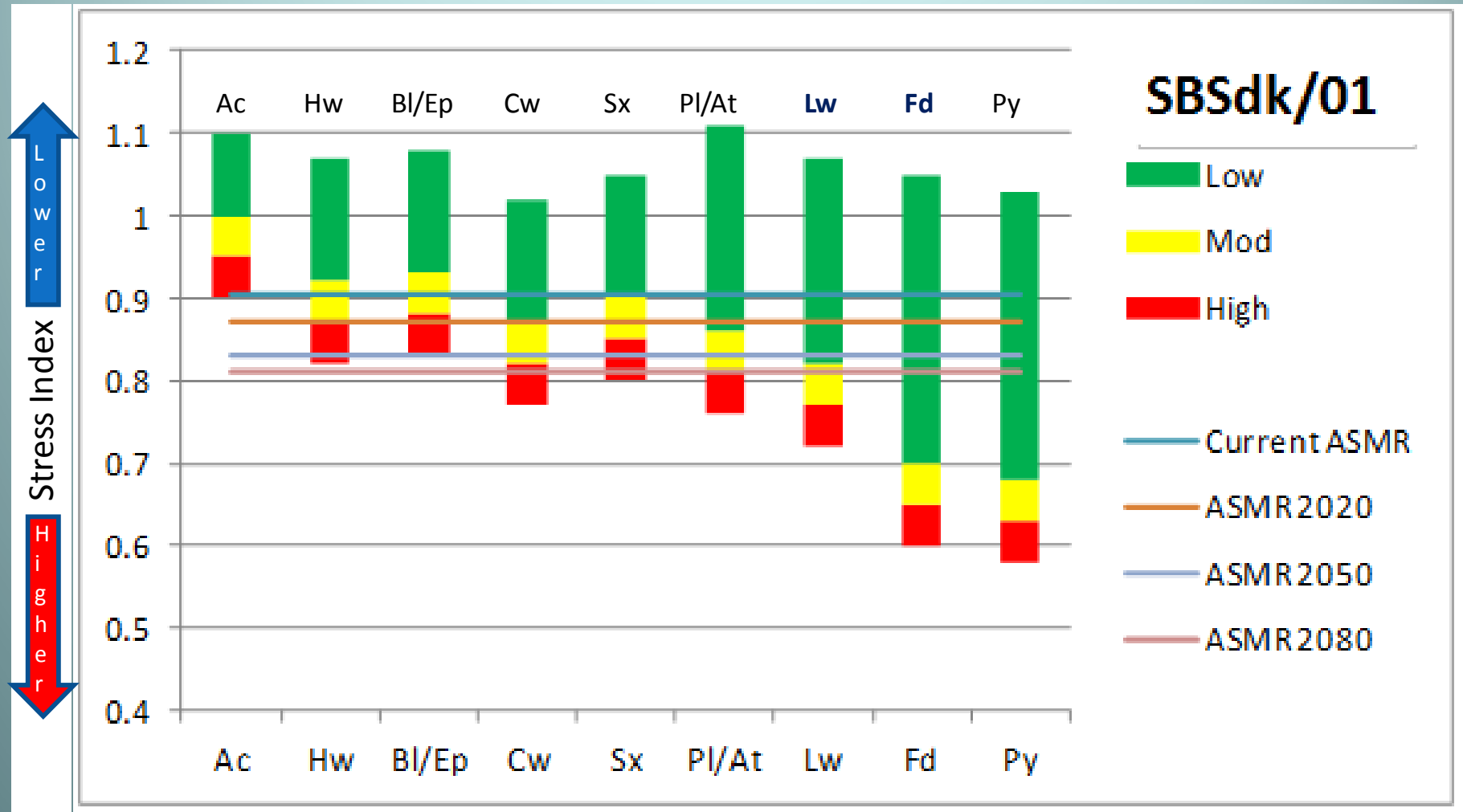
	Stays the same
	Was added
	Promoted
	Demoted
	Was removed
1	primary
2	secondary
3	tertiary
4	deciduous

2) Species Drought Risk Tool

- The Drought Species Risk Tool (DeLong et al. 2010-FFESC) projects future changes to actual soil moisture regime (ASMR), recently developed as part of Future Forest Ecosystems Scientific Council Project
- Changes over time in ASMR for all site series are modeled based on site factor inputs and downscaled global climate scenarios using the Tree & Climate Assessment Tool (TACA Mechanistic Model-Nitschke and Innes, 2008)
- Currently cold air (frost mapping) is also being completed as part of the Species Risk Tool as well

Species Drought Risk Tool Output

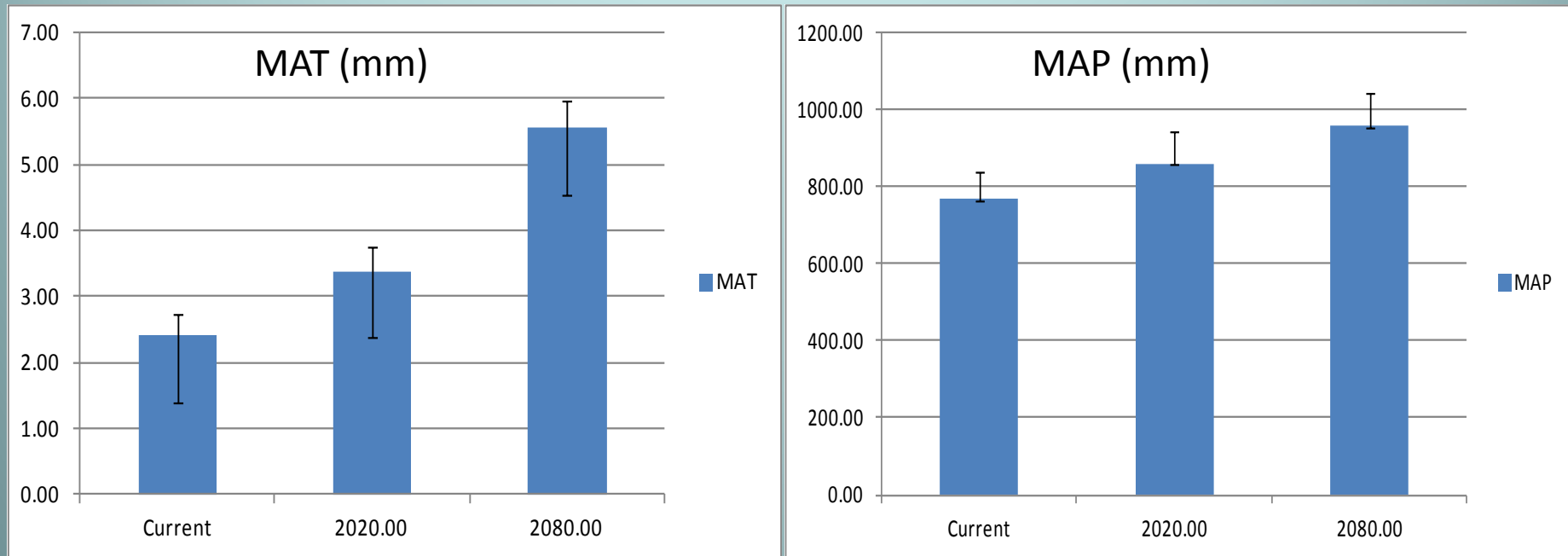
Relative species drought risk for current, 2020, 2050 and 2080 for SBSdk/01



3) ClimtaeWNA Model

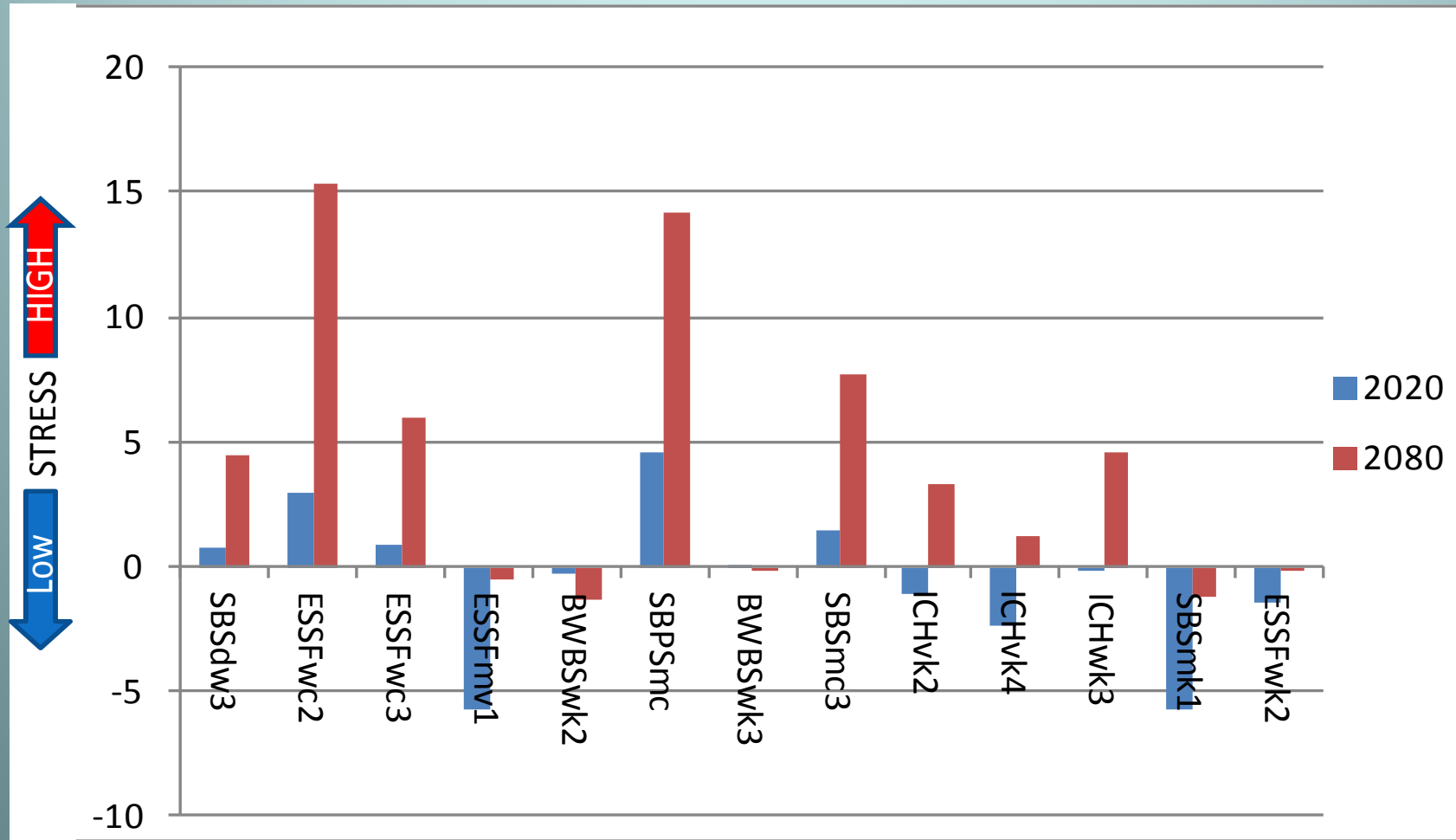
- Mean Annual Temperature (MAT),Precipitation (MAP) and Summer Moisture:Heat Index (SM:HI) generated for 2020 and 2080

(averaged here for 13 Omineca BGCs)



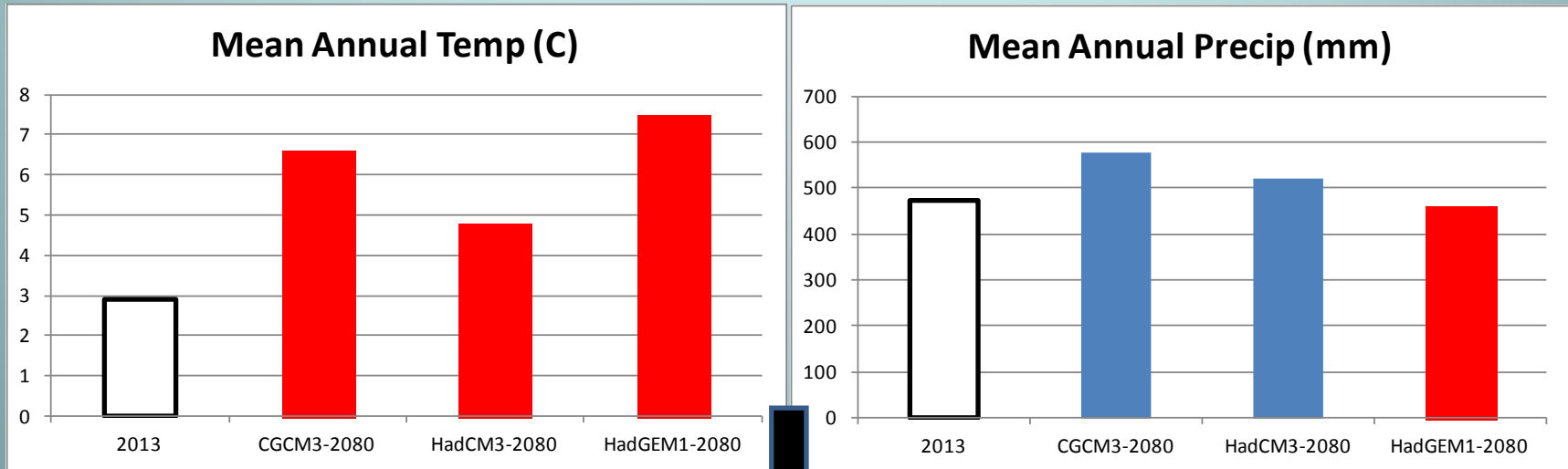
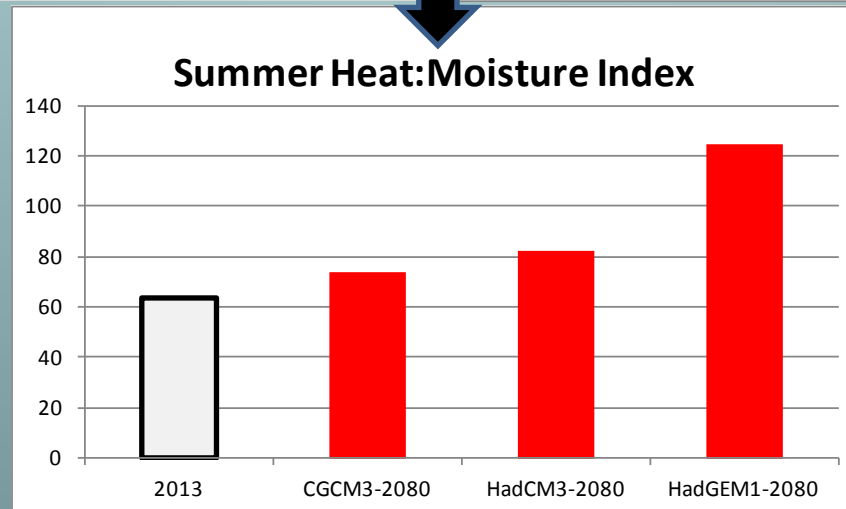


- Relationship between MAT and MAP drives SM:HI (a proxy for conductance and available water to plants)



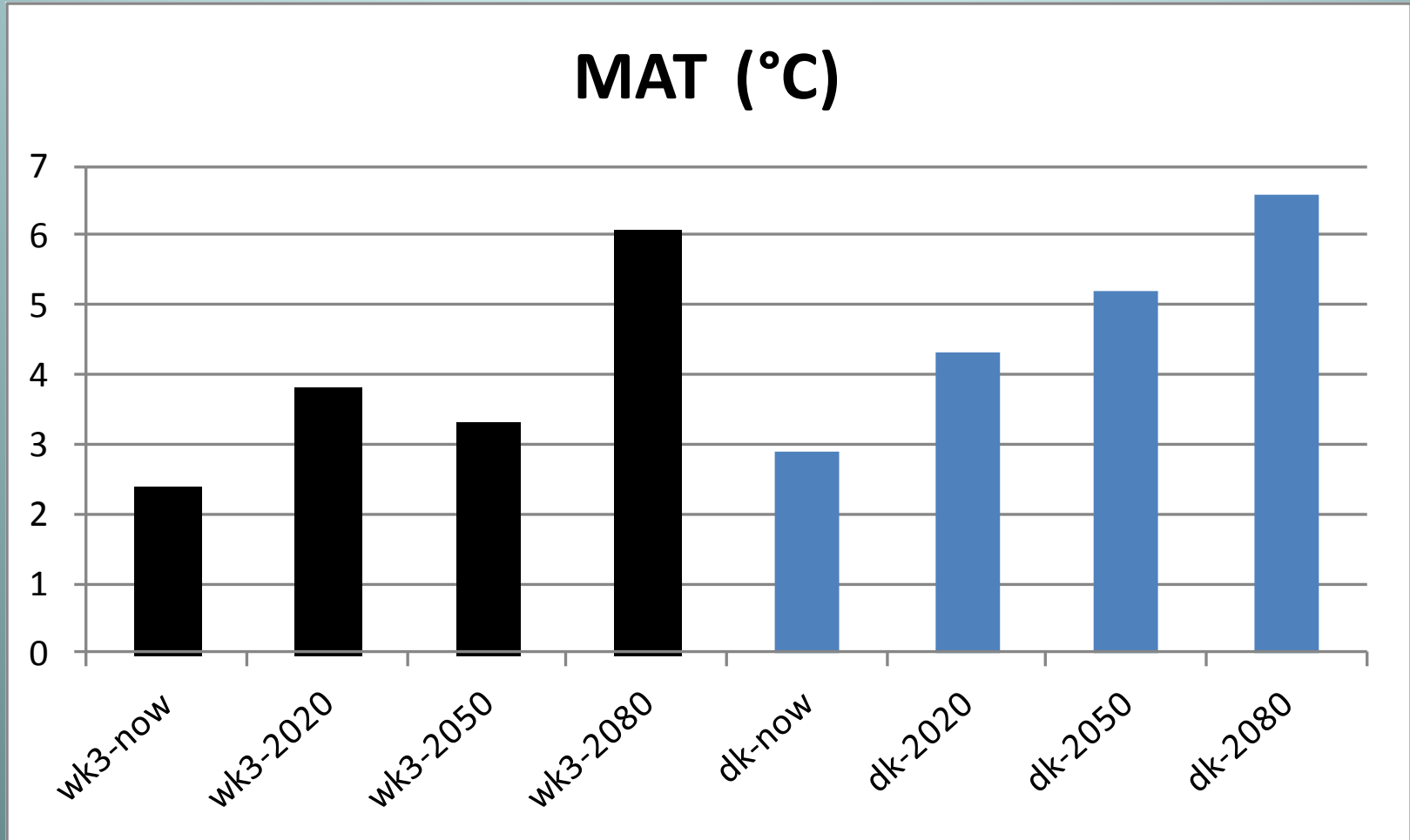
- UNCERTAINTY - Consider a range of outcomes (similar trends-different mag.)
- Species diversity may buffer against uncertainty (all eggs not in one basket)

Down scaled output from 3 GCMs - SBSdk

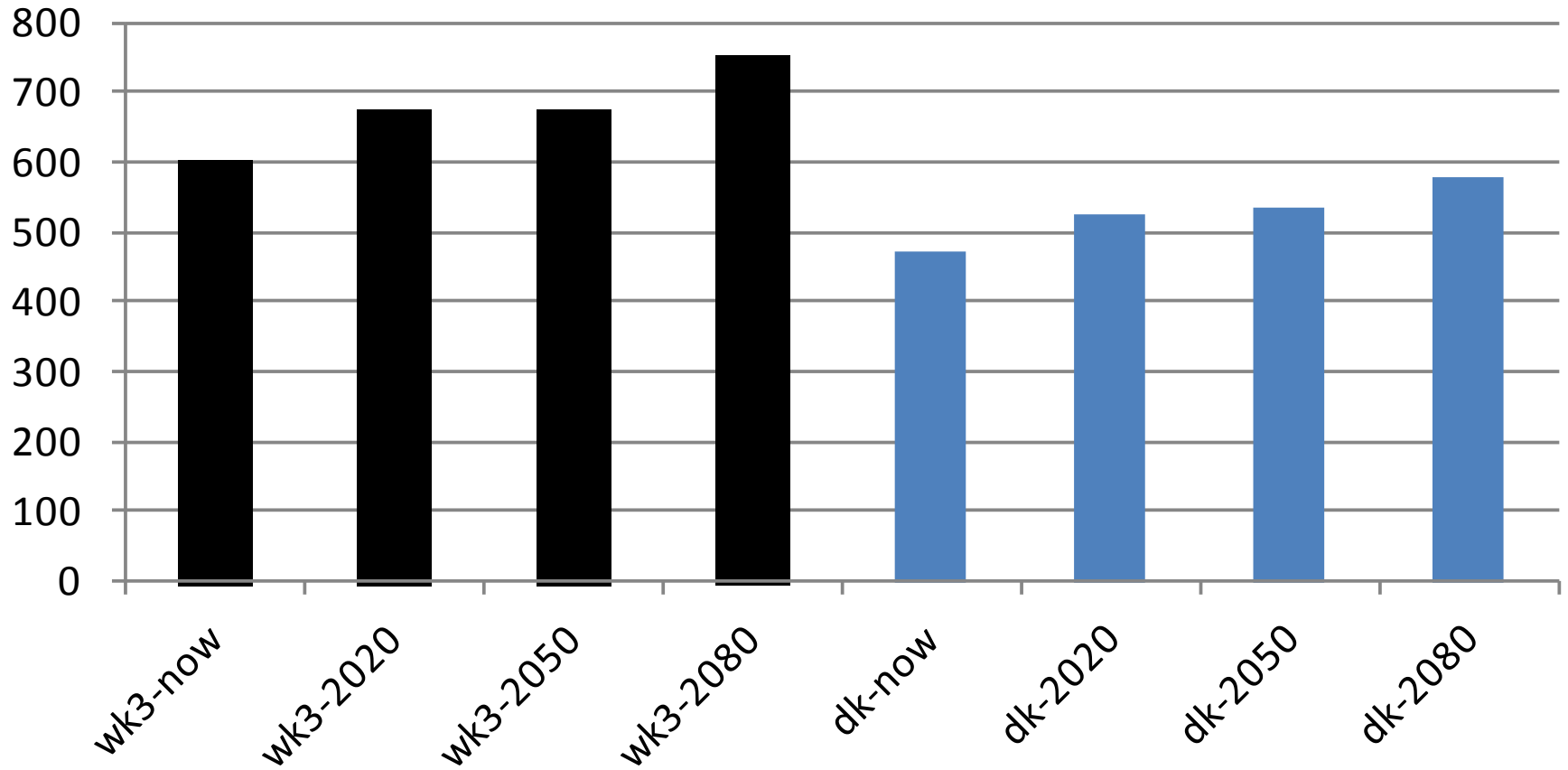


2. Changes in Climate and Soil Moisture for **SBSwk3** and **SBSdk**

- ClimateWNA - CGCM3_A2_Run4_2020s_2050_2080 (Wang et al. 2010)
- Stand Level Drought Risk Assessment Tool (DeLong et al, 2010)

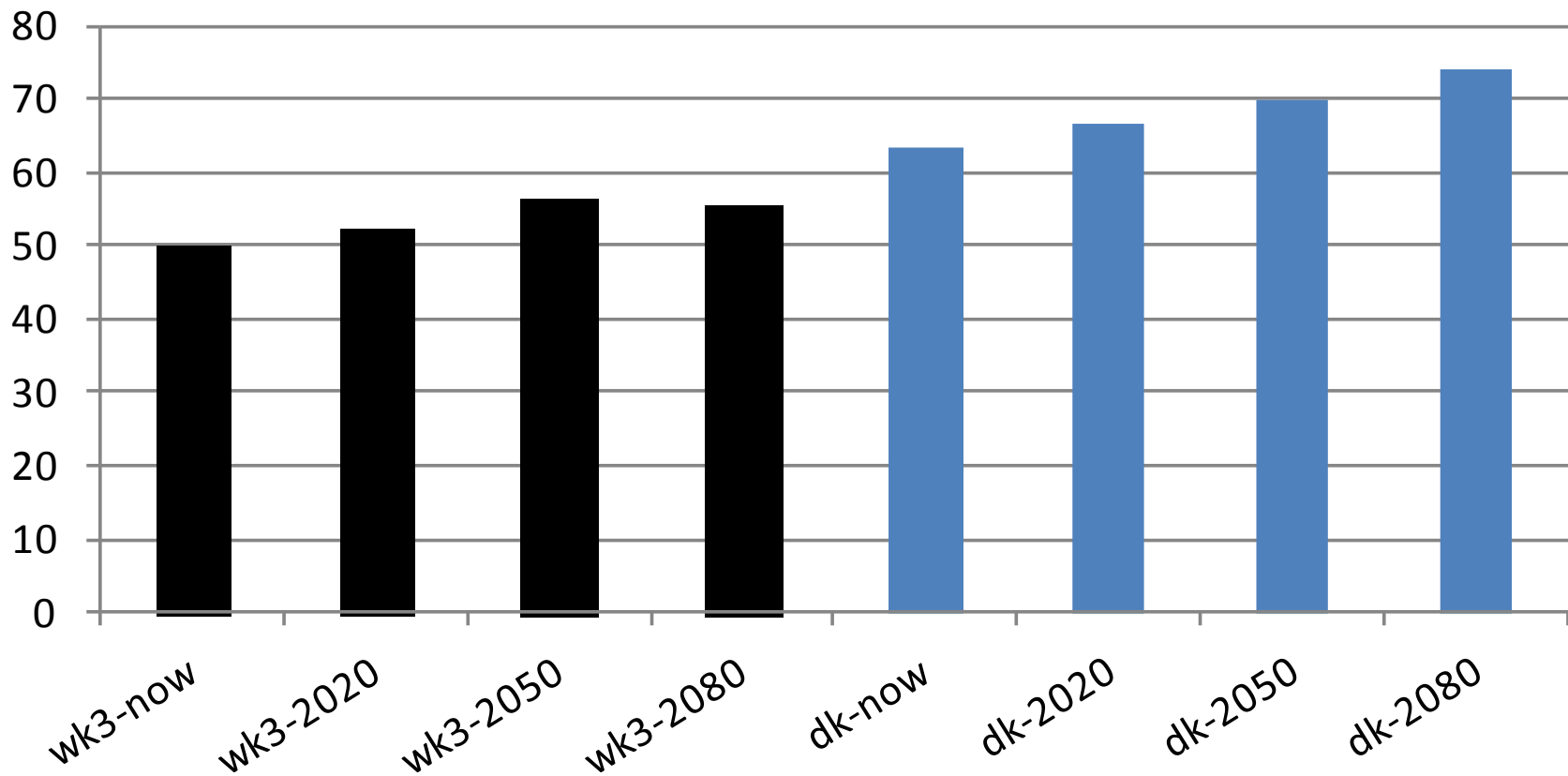


MAP (mm)



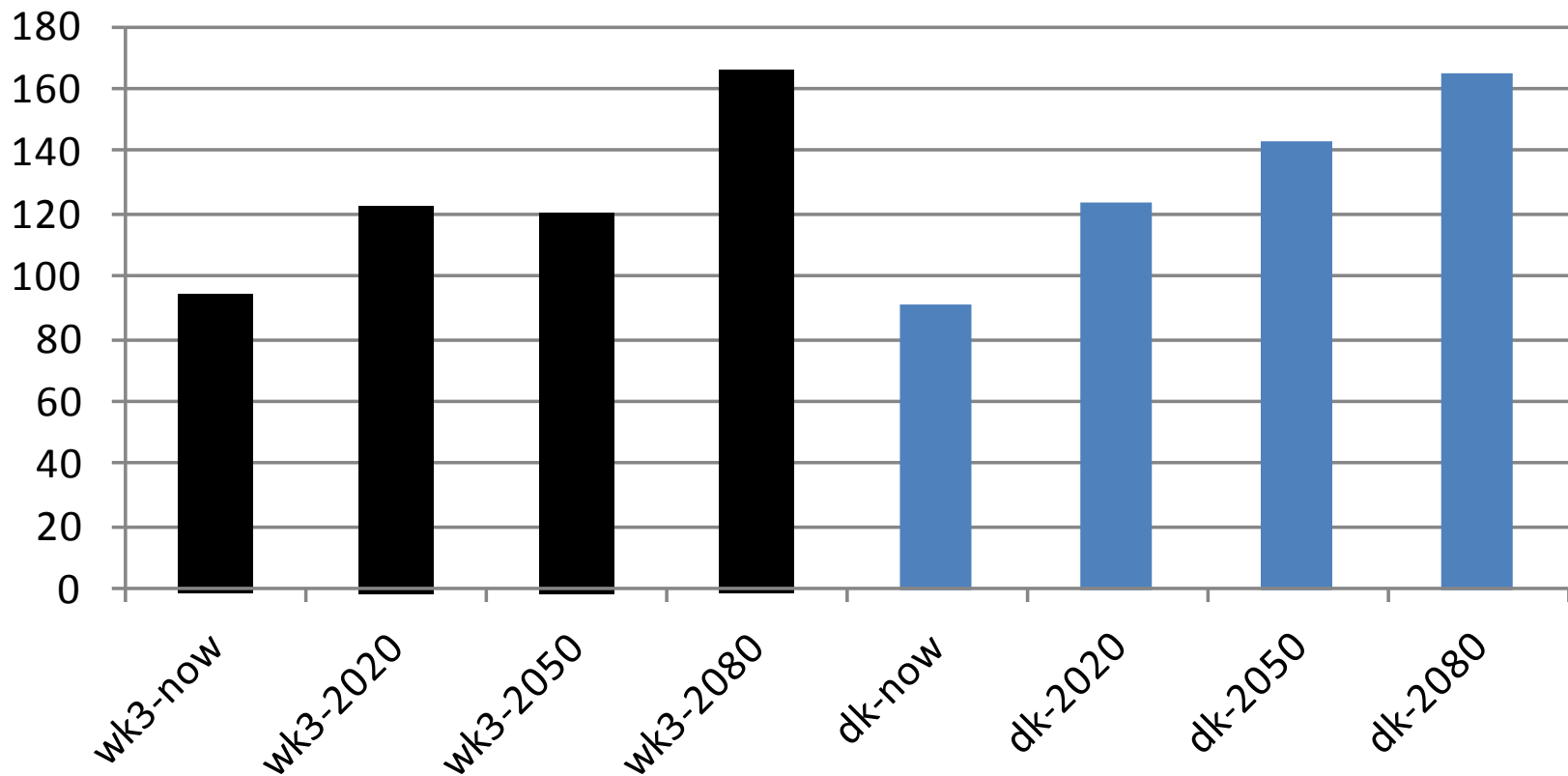
- MAT and MAP – implications for changes in SM:H Index (water demand) and tree stress/maladaptation OR new suitability

SH:M INDEX

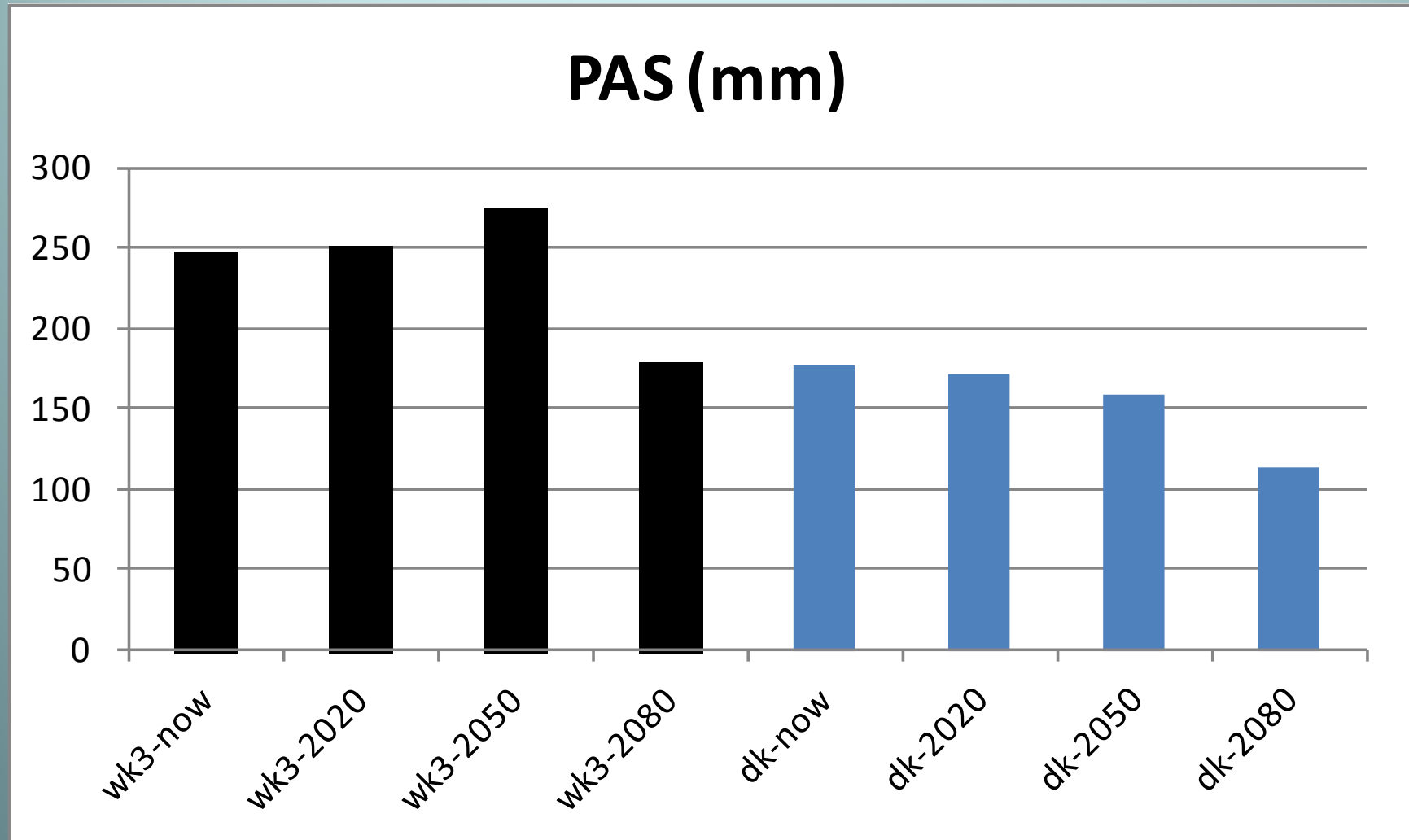


- FFP – implications for changes in frost limiting conditions (growing season) Careful-footnotes still apply (max and mins???)

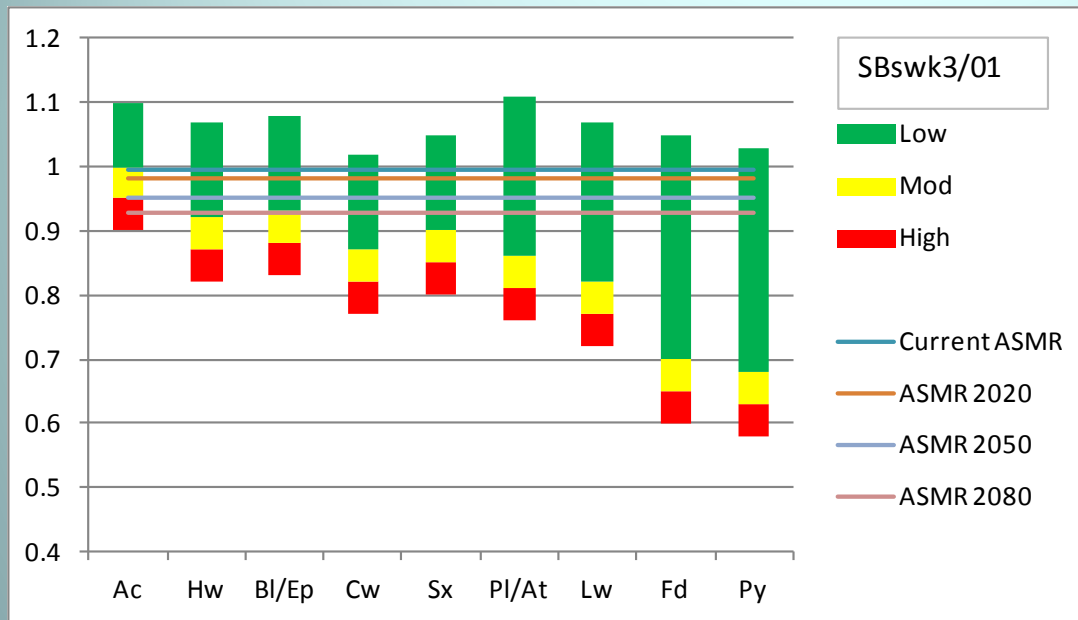
FFP



- PAS – implications for changes snow pack-diminished spring recharge/seepage/sub-irrigation and increased tree stress (e.g. Sx) and/or diminished snow-load and decrease in damage



Climate change/Drought Related Risk to Lw and Fd and establishment



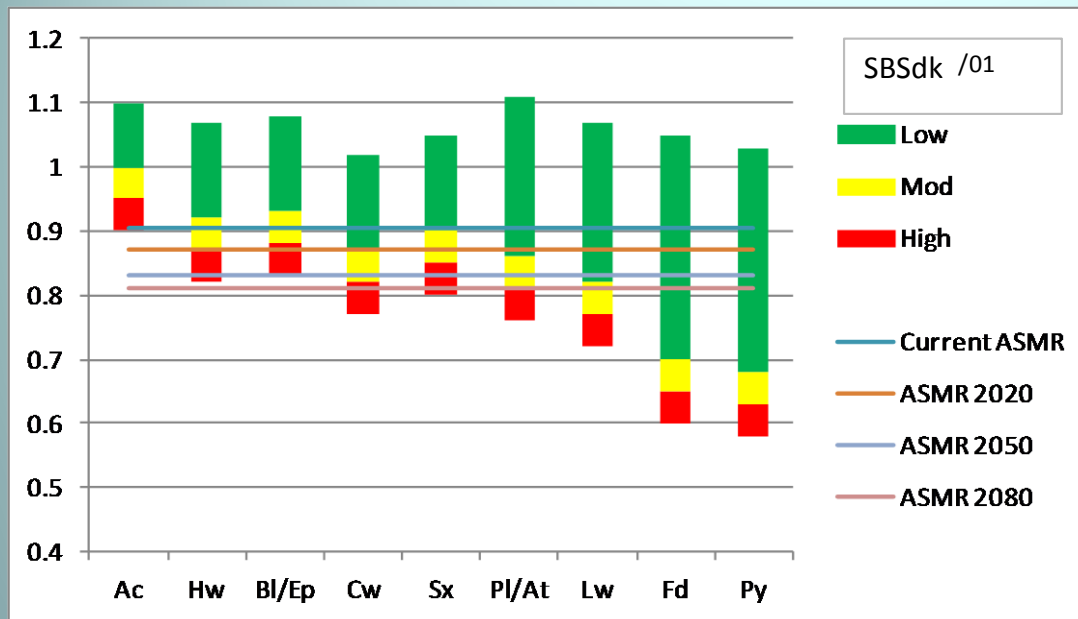
03=where Fd currently grows

SBSwk3

*= not drought risk = frost and excessive moisture and/or nutrient deficiency

SMR	Site Series	Fd - Current Establishment Drought Risk	Lw - Current Establishment Drought Risk	Fd-2080 Drought Risk	Lw-2080 Drought Risk
1	02	low	low	low	mod
2	02, 03	low	low	low	low
3	05, 04	low	low	low	low
4	05, 01, 06	low	low	low	low
5	05, 06, 07	*high	*high	low	low
6	08	*high	*high	*mod	*mod
7					

Climate change/Drought Related Risk to Lw and Fd



04=where Fd currently grows

SBSdk

*= not drought risk = frost and excessive moisture and/or nutrient deficiency

SMR	Site Series	Fd - Current Establishment Drought Risk	Lw - Current Establishment Drought Risk	Fd-2080 Drought Risk	Lw-2080 Drought Risk
1	02, 81	low	high	mod	vhigh
2	03, 04, 82	low	mod	low	high
3	05, 04, 82	low	low	low	high
4	05, 01, 06	low	low	low	mod
5	01, 06, 07, 08	*high	*high	low	low
6	09, 07, 08, 10	*high	*high	mod	mod
7					

Based on output from available tools ecologists were asked to recommend promotion, demotion, addition or deletion of species in a few subzone variants (zonal sites). Then created logic matrix:

1. Ran the VPRO database tool for zonal 01 sites and picked the dominant unit changes (13 BGC's with greatest % changed in my Regions)
2. Look at the zonal site series in the Drought Risk Tool projections to see if the logic agreed
3. Look at the ClimateWNA projected variables and see if the logic agreed
4. Formulated draft rational for promotion/demotion based on the assumptions of whether we could establish species now on site and/or whether species would be maladapted or not at rotation₂₁

- In the RPB draft document “**Suggested changes to the Reference Guide for FDP stocking standards**” an example of a conservative species promotion is Fd and Lw on SBSdk/06-07 circum-mesic richer sites

Current reference guide

SBSdk		Primary non-forested non-forested	Preferred (p) non-forested non-forested	Secondary	Acceptable (a)	Tertiary
06	85198	PI Sx	PI Sx		Fd ^{9,18}	Fd ^{9,18}
07	85199	Sx ^{1,32}	Sx ^{1,32}	PI ¹	PI ¹	

Suggested promotion in draft

Species	Present Category	Suggested Category	Preferred/ Acceptable Recommendation	Promotion or Demotion	Rationale/Footnotes
Fd	3	3(2)	Preferred	Promotion	Well drained somewhat drier soils. Avoid areas where there is potential of cold air/frost ponding.
Lw	0	3(2)	Preferred	Promotion	Southerly aspects and moist well drained soils preferred. Avoid areas where there is potential of cold air/frost ponding.

Autecology of Lw and Fd

•Primary ecological amplitudes for Lw and Fd are the same

•But still need to recognize the differences (strengths/weaknesses) between the species

Figure 2 – Lw ASMR

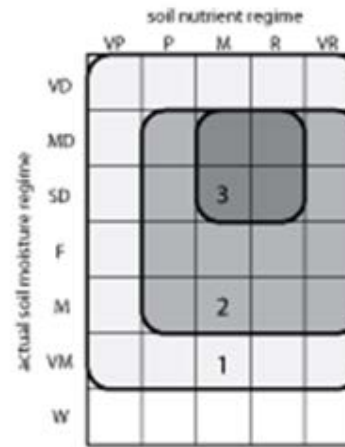
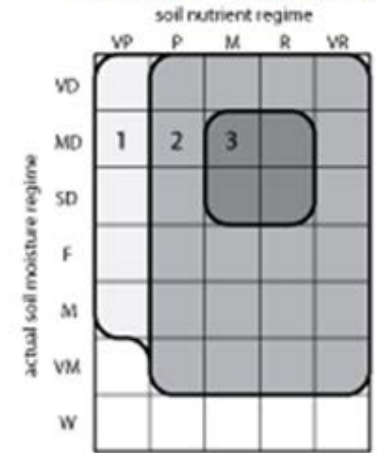


Figure 3 – Fd ASMR



Feature	Western Larch	Douglas-fir
	Tolerance Class	
northern extent	Currently south of 51 deg lat	Currently just north of 55 deg lat
Edaphic amplitudes	mod-dry to slightly-dry: medium-rich nut	mod-dry to slightly-dry: medium nut
low light	L	L - H
frost	M	L - M
heat	M	M - H
water deficit	M	M
water surplus	L	L
nutrient (mainly N) deficiency	M	M
snow	H	L - M
wind	H	H
	Risk Class	
fire	M (resist ground fire when mature)	M (resist ground fire when mature)
insects	*M (Lw case earer, sx budworm)	H (Fd beetle, bud worm, tussock moth)
fungi	L	*H (rootrot, butt rot, needle cast)
other agents	M (dwarf mistletoe)	L (browse, hair, rohdent...)
	Interperative Class	
Reproduction capacity	H	H
Seed disemintation capacity	M	H
Low light nat reg potential	L	L-H

Keep in Mind:

- Climate change is occurring and we need to use the tools we have to make educated BEST GUESSES
- Climate projections are based on a range of scenarios. Managing for the future should be based on a range of potential outcomes (not all eggs in one basket)
- Field data for Fd and Lw plantations, some up to 50 years old, indicate both species show excellent potential within parts of the ICHmc2, SBSdk, dw3, mc2 and CWHws1 (LePage, P and L. McCulloch 2010)
- Bioclimate models for Lw can be used in conjunction with modeled geographic patterns of genetic variation to develop and map for the contemporary climate the seed zones and seed transfer guidelines needed for reforestation (Rehfeldt G. E. And Jaquish, B.C, 2010).
- Need to be proactive but be aware of the assumptions of tools and models e.g:
 - 1) strengths and weaknesses in tree species responses (mixed vs single spp planting)
 - 2) site level changes
 - 3) need to maintain and initiate monitor more long term trials to answer some of these questions

Not sure what to plant here guys.
Maybe a beer or two would help?





FIN

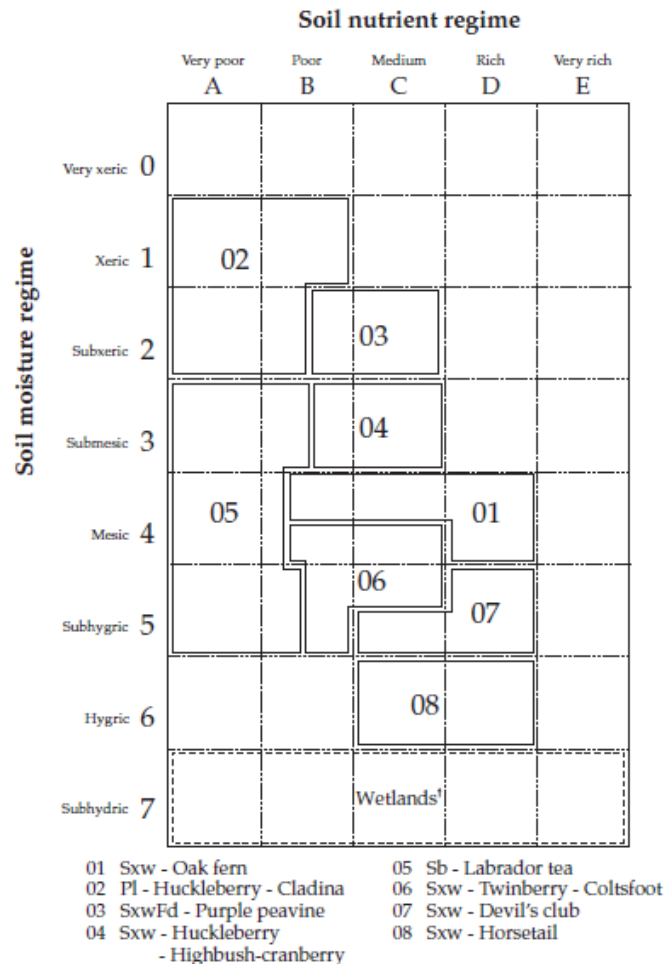
References and Links

The paper entitled Stand level Tool Paper_Nov_DeLong_etal.pdf is a draft manuscript so not published yet and, no link exists and I can't circulate widely so don't use the FTP link for that one but the other less detailed report is available on the Future Forest Ecosystem Scientific Council website at http://www.for.gov.bc.ca/hfp/future_forests/council/#completed-projects entitled "Risk analysis and Decision Support Tool" which covers the central concepts behind the work so just use this one and if they have more detailed questions they can get a hold me. Also, I have changed the footnotes below so that links to publications work. I have also included links to the associated models so that folks can play with these them selves

Resource Practices Branch - Tree Species Selection Tool -
<http://www.for.gov.bc.ca/hfp/silviculture/TSS/tss.htm>

DeLong, S.C, H. Griesbauer², and C. R. Nitschke, 2012 (accessed December 4, 2013). Risk Analysis and Decision Support Tool, Future Forest Ecosystem Scientific Council, Final Report,
http://www.for.gov.bc.ca/hfp/future_forests/council/#completed-projects . (To download or run Stand Level Drought Risk Assessment tool see http://www.for.gov.bc.ca/hfp/silviculture/TSS/Drought_Risk.html on the Tree Species Selection Tool website <http://www.for.gov.bc.ca/hfp/silviculture/TSS/tss.htm>)

Wang, T., E.M. Campbell, G.A. O'Neill, S.N. Aitken (2012). Projecting future distributions of ecosystem climate niches: Uncertainties and management applications. For. Ecol. Manage. 279:128-140. <http://www.sciencedirect.com/science/article/pii/S0378112712003118> (For further information on ClimateWNA (Western North America) Prism downscaling model see <http://cfcg.forestry.ubc.ca/projects/climate-data/climatebcwna/> ; to run the web version of ClimateWNA see <http://climatemodels.forestry.ubc.ca/climatewna/>



¹ See MacKenzie and Moran (2004) for classifying wetlands occurring in the area

FIGURE 9.1 Edatopic grid displaying site units of the SBSwk3 variant.

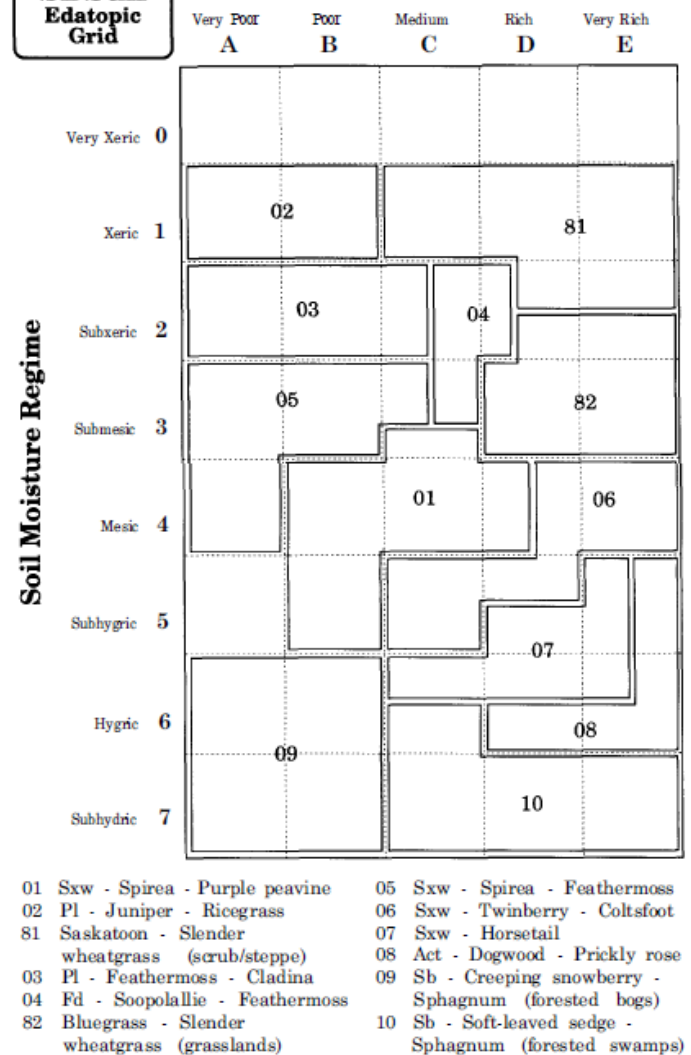


FIGURE 9. Edatopic grid displaying site units in the SBSdk subzone.