



Future Forests Ecosystems Scientific Council Seminar Series 2012

Tree Species Selection is Key to Maximizing Long Term Ecological and Socioeconomic Values Under Climate Change



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Outline of Presentation

1. Study Overview

- Objectives
- Study Area
- Study Species

2. Decision Support Tools

- Bayesian Models
- Decision Nets

3. Case Study of Quesnel TSA

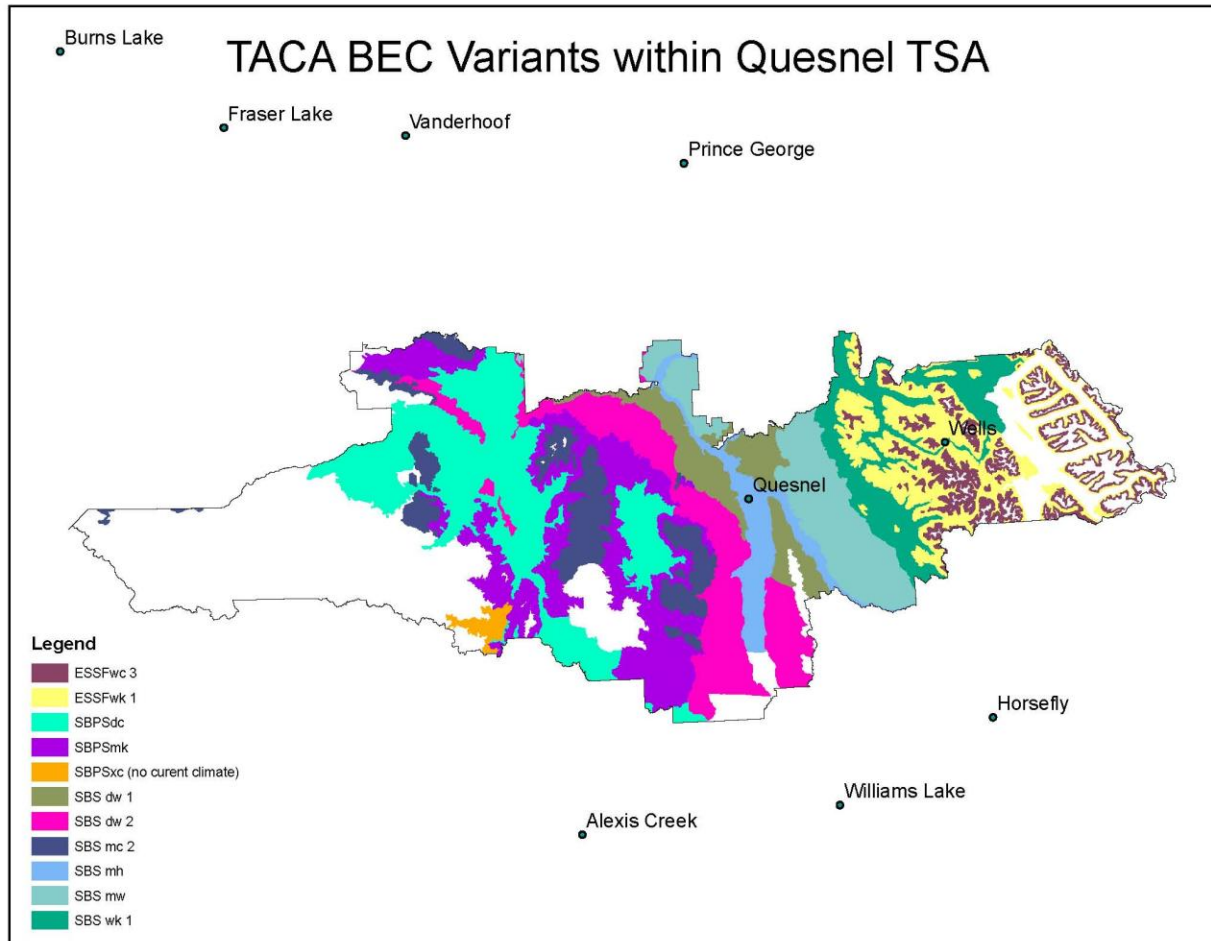
- BEC and TACA projections
- Ecological Indicators
- Socioeconomic Indicators

4. Summary and Conclusions

Study Objectives

1. **Develop decision support tools that would facilitate design and assessment of landscapes that will be resilient to climate change, while factoring in both ecological and socioeconomic factors.**
2. **Compare the relative importance of direct climate change effects, indirect climate change effects, MPB risk factor, silvicultural regime, and climate change-induced tree mortality on ecological and socioeconomic parameters.**
3. **Conduct a case study for the Quesnel TSA for the 2020, 2050, and 2080 time horizons.**

Study Area



Study Species Selection Criteria

1. Forest specialist
2. Empirical data must be available for all of the following:
 - Direct effects of climate as observed from Interior BC
 - Response to mountain pine beetle epidemic
 - Response to forest and habitat attributes
 - Response to harvesting and salvage logging
 - Independent data for testing

Ecological Indicators Study Species

Red-breasted Nuthatch



Photo: S.P. Barrette

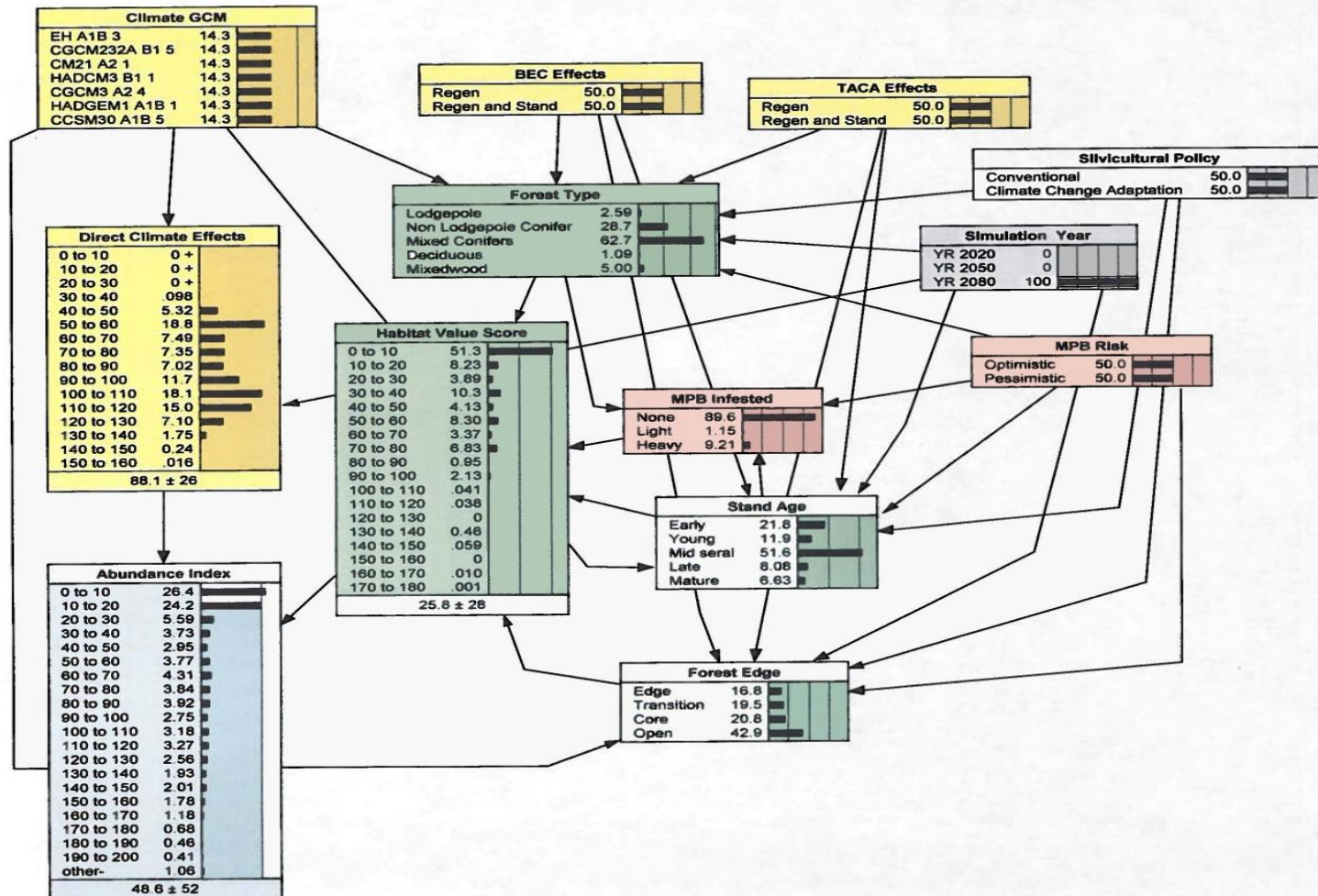
Swainson's Thrush



Drawing: National Geographic



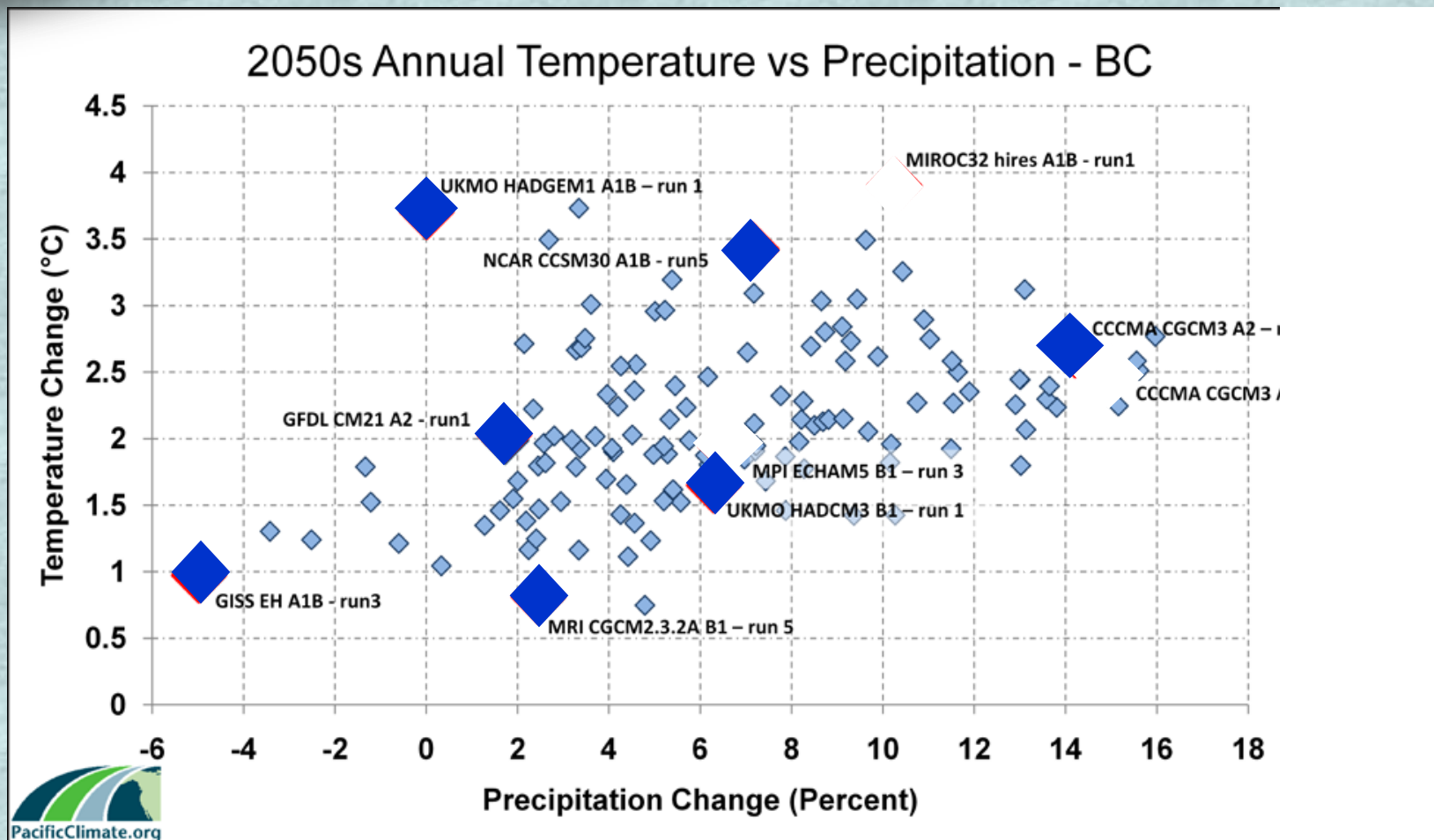
Bayesian Model Swainson's Thrush



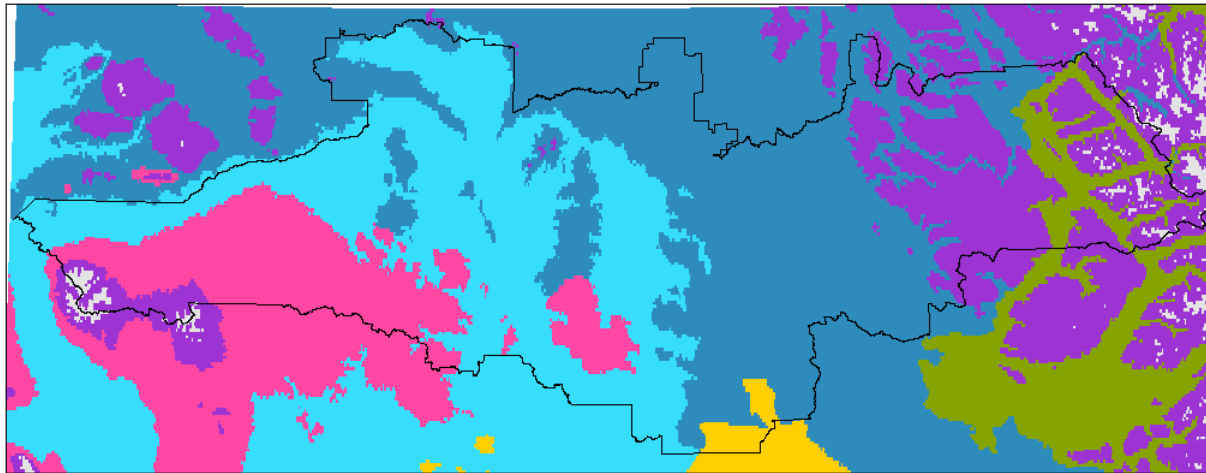
Bayesian Model: Climate GCM Node

Study GCMs

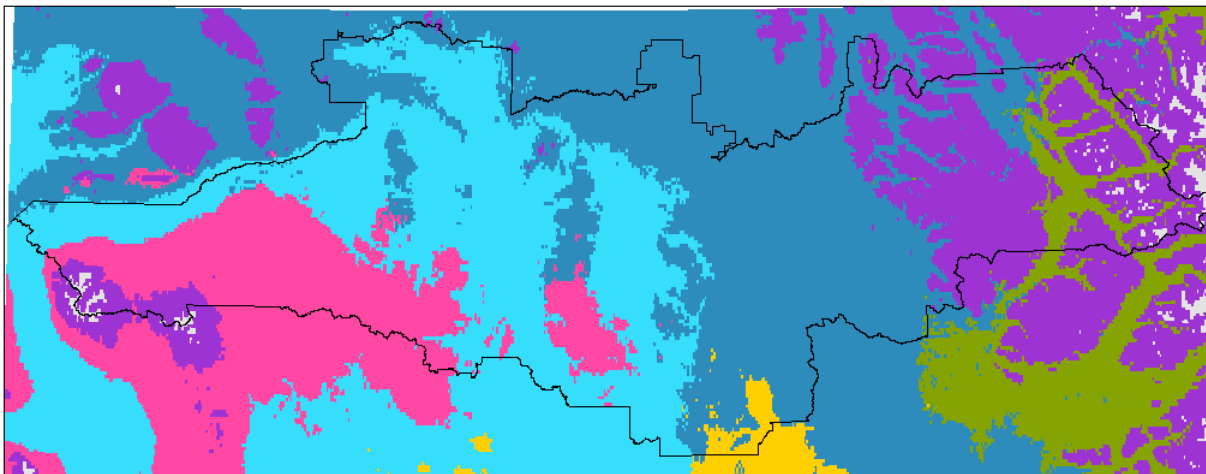
Climate GCM	
EH A1B 3	14.3
CGCM232A B1 5	14.3
CM21 A2 1	14.3
HADCM3 B1 1	14.3
CGCM3 A2 4	14.3
HADGEM1 A1B 1	14.3
CCSM30 A1B 5	14.3



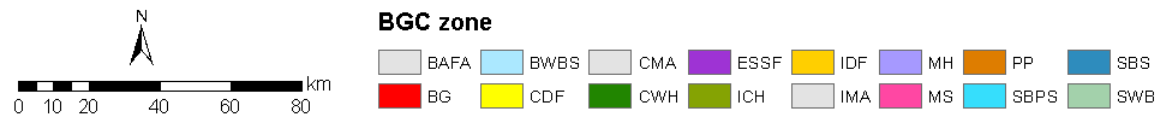
Bayesian Model BEC Projections



Observed



Predicted
1961 – 1990



Bayesian Model TACA Effects



- Tree and Climate Assessment (TACA) tool developed by Nitschke and Innes (2008) for modeling ecosystem response to climate change
- Input variables include climatic as well as edaphic parameters (e.g., soil moisture regime, soil texture, rooting depth, available water holding capacity, percolation rate)
- Modeled at the level of the BEC variant
- Edaphic parameters based on Craig DeLong's PSP values (2010, pers. comm.)

Bayesian Model TACA Effects

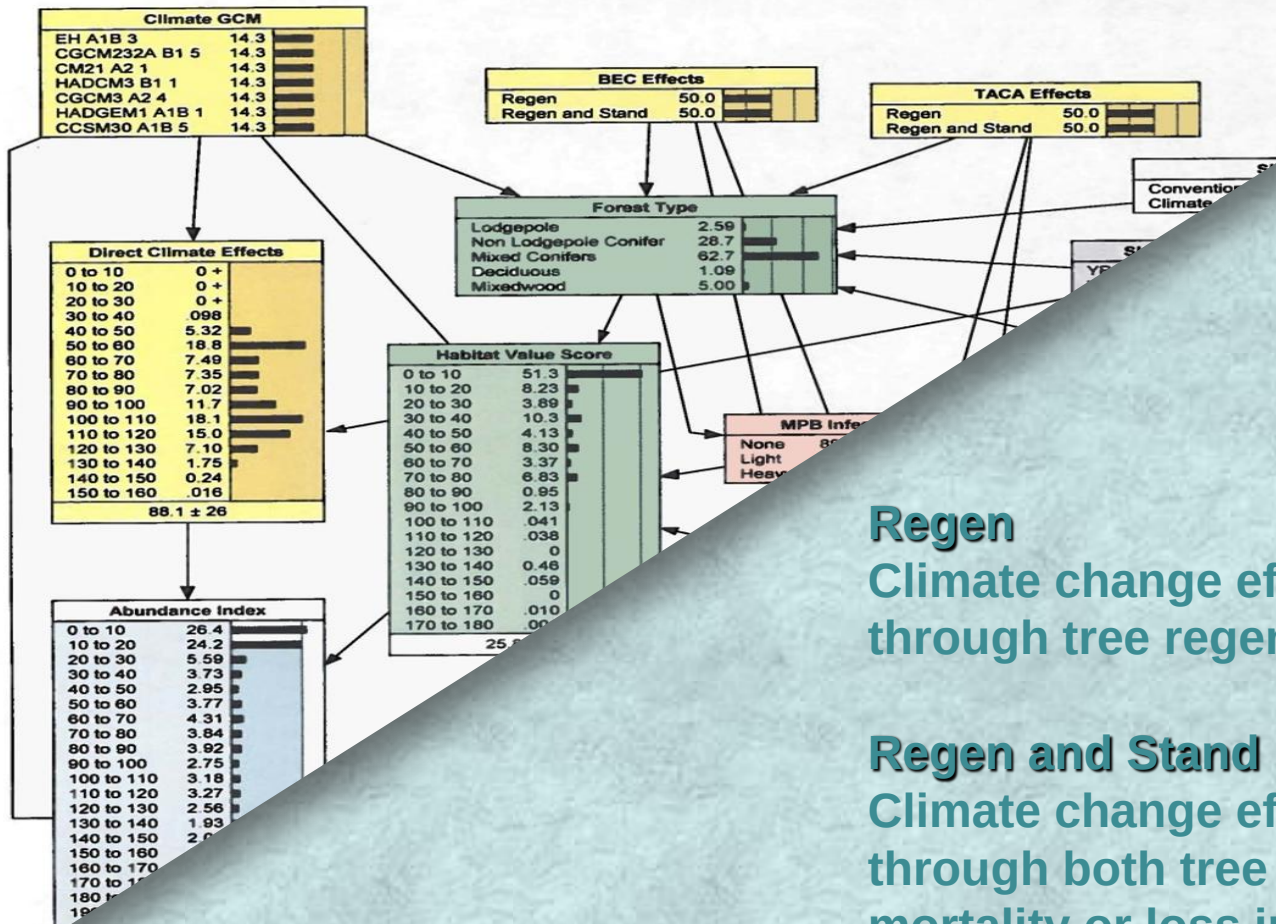
AET/PET indicates probability of tree mortality

(DeLong, pers. com.)

- Direct mortality due to drought
- Indirect mortality due to disturbance agent

Soil Moisture Regime		
AET/PET Ratio	ACTUAL SMR	Water Deficit
AET/PET < 0.30	Extremely Dry	Yes
AET/PET ≥ 0.30 < 0.55	Excessively Dry	Yes
AET/PET ≥ 0.55 < 0.65	Very Dry I	Yes
AET/PET ≥ 0.65 < 0.75	Very Dry II	Yes
AET/PET ≥ 0.75 < 0.85	Moderately Dry	Yes
AET/PET ≥ 0.85 < 0.95	Slightly Dry	Yes
AET/PET ≥ 0.95 < 1.0	Fresh	Minimal
AET/PET ≥ 1.0	Moist	No

Bayesian Model: SWTH BEC & TACA Effects Nodes



Regen

Climate change effects are mediated through tree regeneration.

Regen and Stand

Climate change effects are mediated through both tree regeneration and mortality or loss in productivity of maladapted stands.



Bayesian Model Silvicultural Policy Node

Silvicultural Policy	
Conventional	50.0
Climate Change Adaptation	50.0

Simulation Year
YR 2020

Conventional Silviculture

1. Regenerated species based on BC Ministry of FLNRO restocking standards for current BGC variants.

Climate Change Adaptation Silviculture

1. Regenerated species based on BC Ministry of FLNRO restocking standards for projected shift in BGC variant.
2. Species identified in Step (1) are evaluated for susceptibility to drought mortality using TACA modeling..



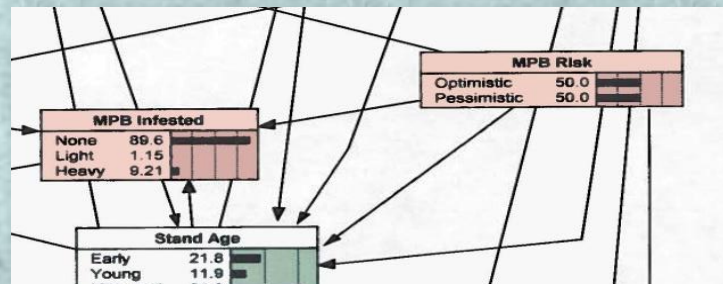
Bayesian Model MPB Risk Node

Stand susceptibility

- was calculated as function of stand age, amount of pine, tree density, location (Shore & Safranyik 1992)

Beatle pressure index

- Optimistic (10 infested trees > 3 km)
- Pessimistic (>100 infested trees within stand)



Socioeconomic Indicators

Harvested Volume



Chipping Sparrow
(Open Habitats,
Early Sere)

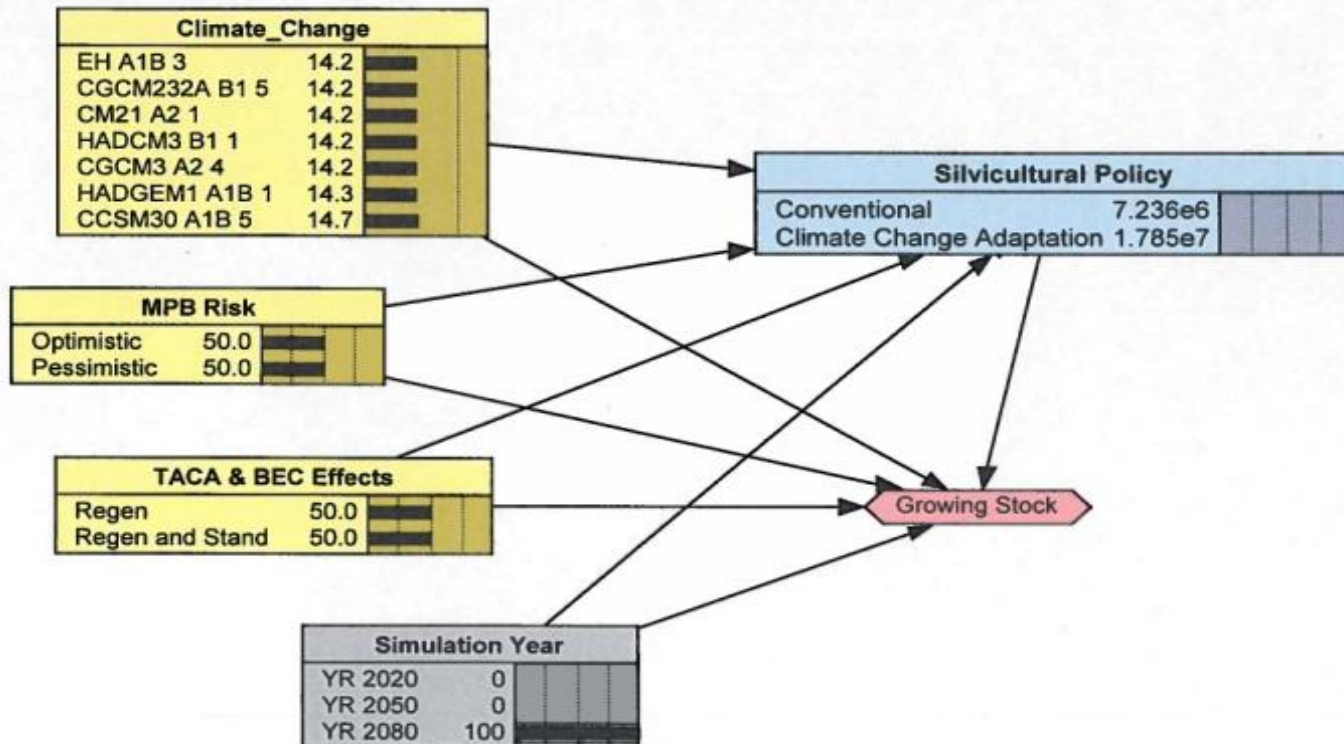
- Dusky Flycatcher

Growing Stock



Decision Net

Standing merch volume: All tree species



Case Study

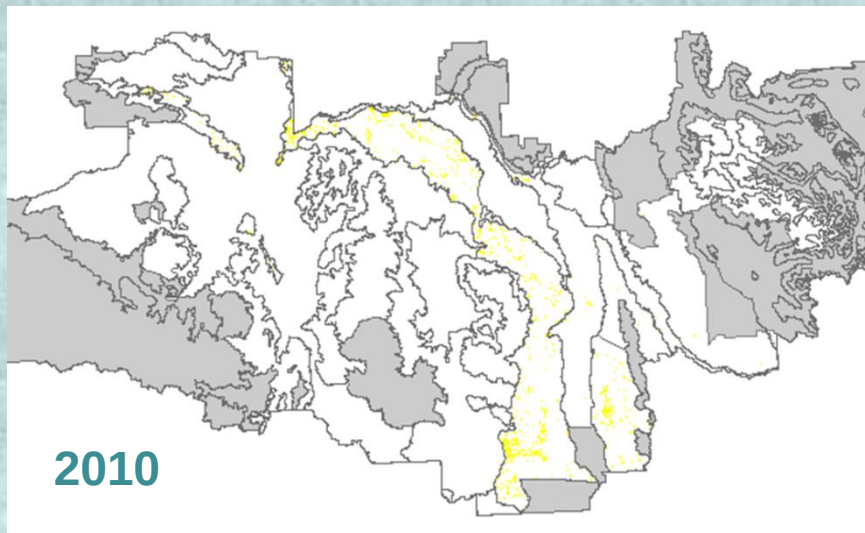
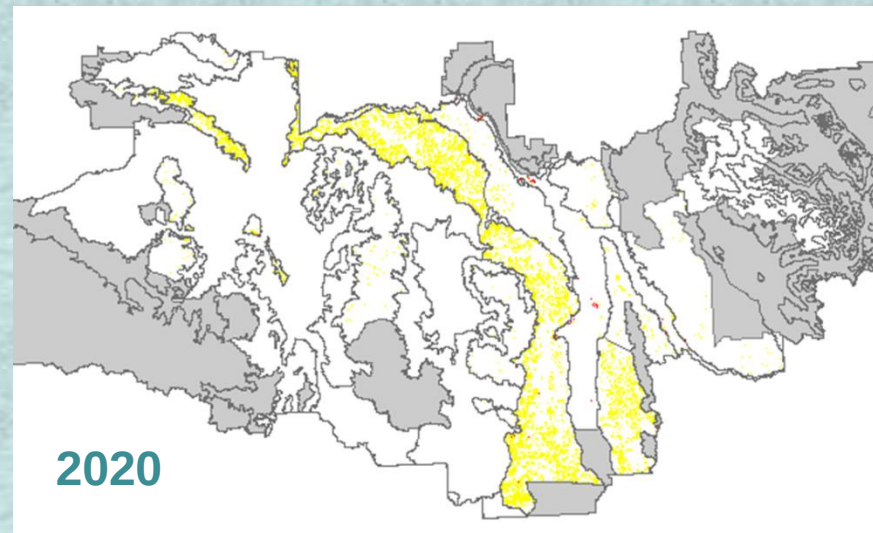
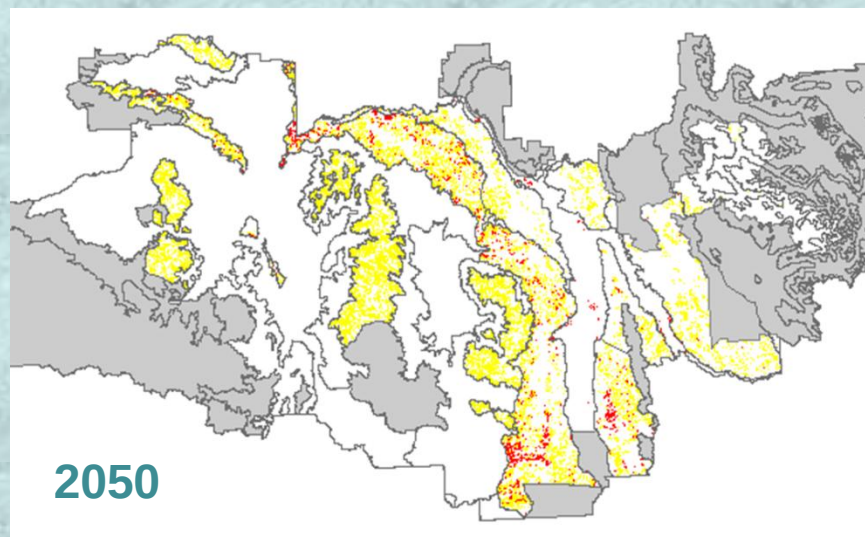
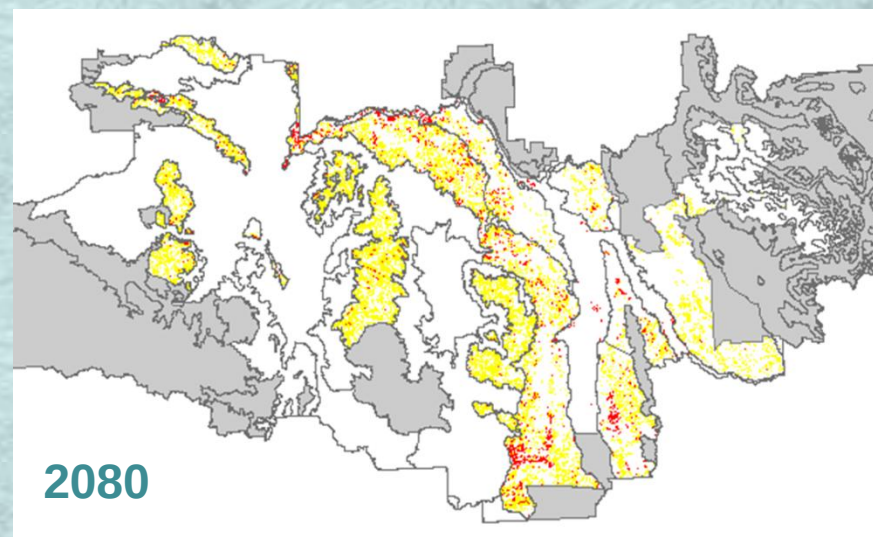
Management Scenario

Our management scenario closely followed the assumptions and recommendations from the most recent Timber Supply Review (TSR4) for the Quesnel TSA

- AAC determination prorated to size of our study area.
- Future AAC set to the MOFLMRO timber supply analysis baseline scenario projecting sustainable flow between 2020 and 2069.
- Partition rate is 83.75% pine and 16.25% non-pine.
- Shelf life of 20 years for MPB attacked stands.
- Stands are eligible for harvest when they reach 120 m³/ ha.
- Biodiversity guidelines for wildlife tree patches.

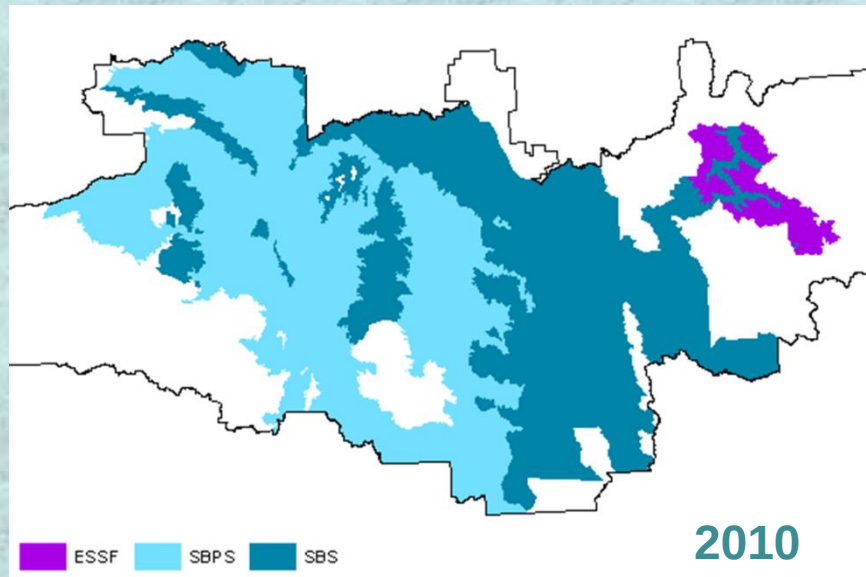
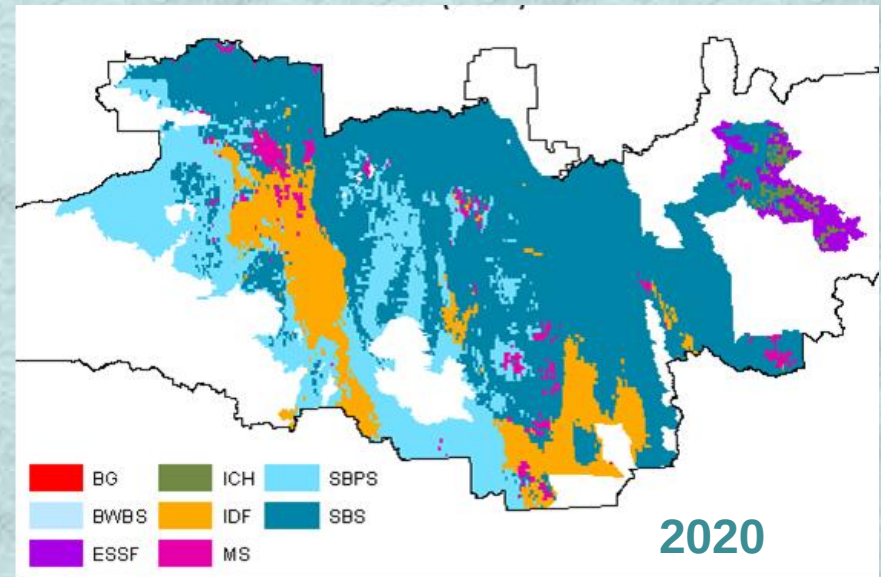
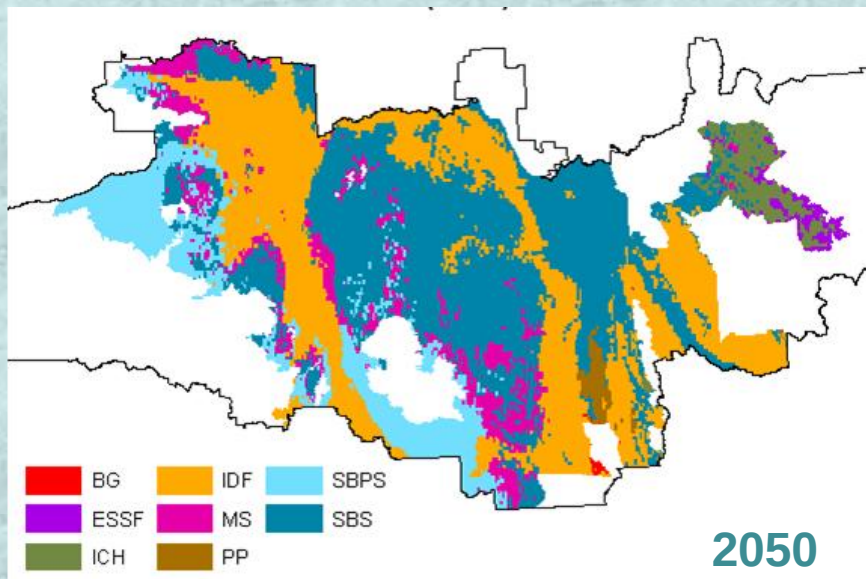
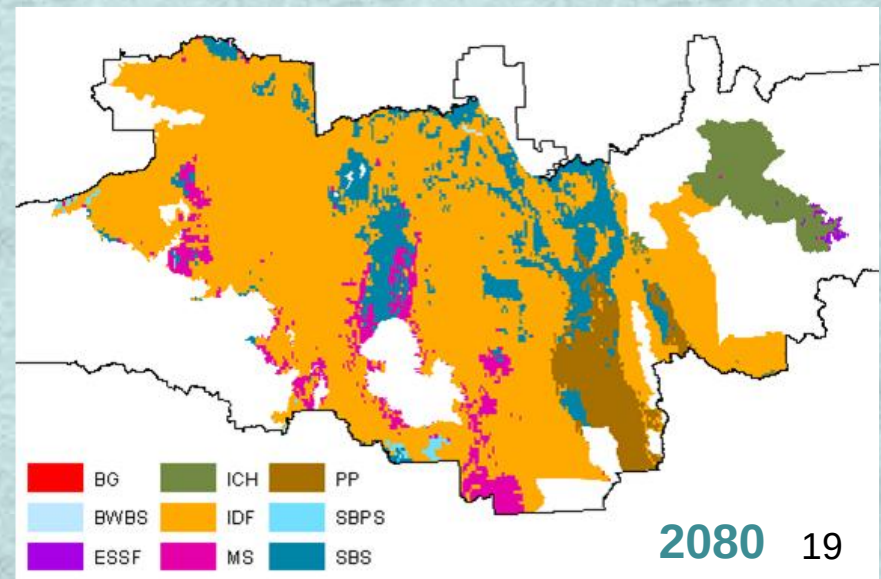
Case Study Results

Lodgepole Drought Mortality – GCM6



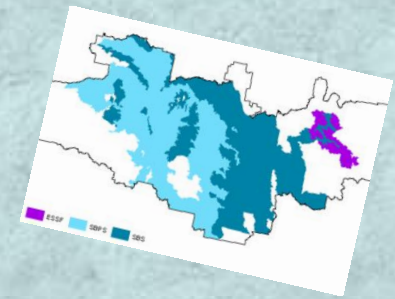
Case Study Results

Biogeoclimatic Projections – GCM1



Case Study Results – 7 GCMs

Shifts in Biogeoclimatic Zones

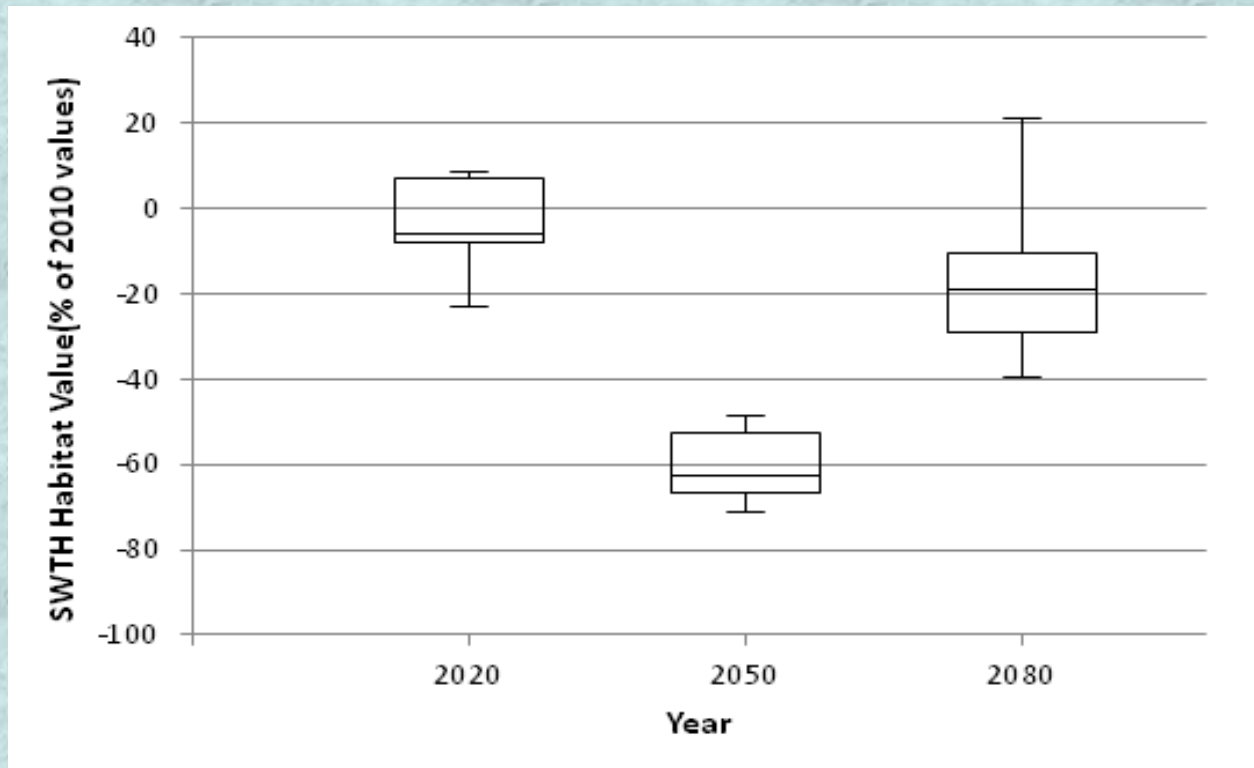


	2010	2020	2050	2080
BG		0.03	0.04	0.01
BWBS			0.01	0.37
CWH		0.01	0.08	0.08
ESSF	4.0	1.65	0.56	0.26
ICH		5.69	7.35	14.85
IDF		15.21	35.61	45.15
MS		0.57	1.52	0.82
PP		0.19	3.34	7.91
SBPS	48.1	13.38	6.51	1.54
SBS	47.9	63.26	44.98	29.02



Case Study Results – Ecological Indicators

Swainson's Thrush Habitat Values





Case Study Results

What affects SWTH habitat values?

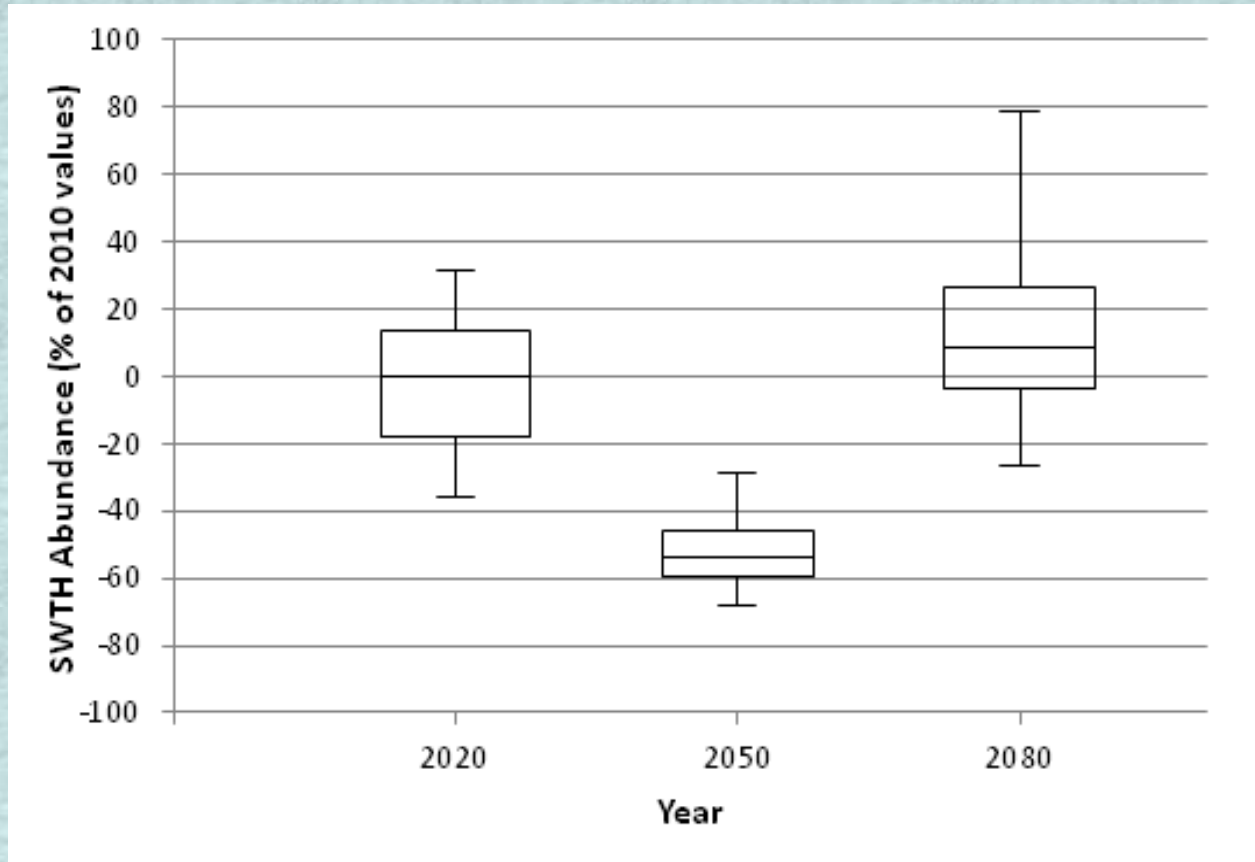
- GCM scenario was not an important factor regardless of time horizon or model assumptions

	Mean Difference (% of 2010 values)		
	2020	2050	2080
Conventional vs Adaptation	0.4	-1.1	-14.0
Optimistic vs Pessimistic MPB	14.0	12.6	16.6
Regen vs Regen+Stand	7.1	3.6	9.5



Case Study Results – Ecological Indicators

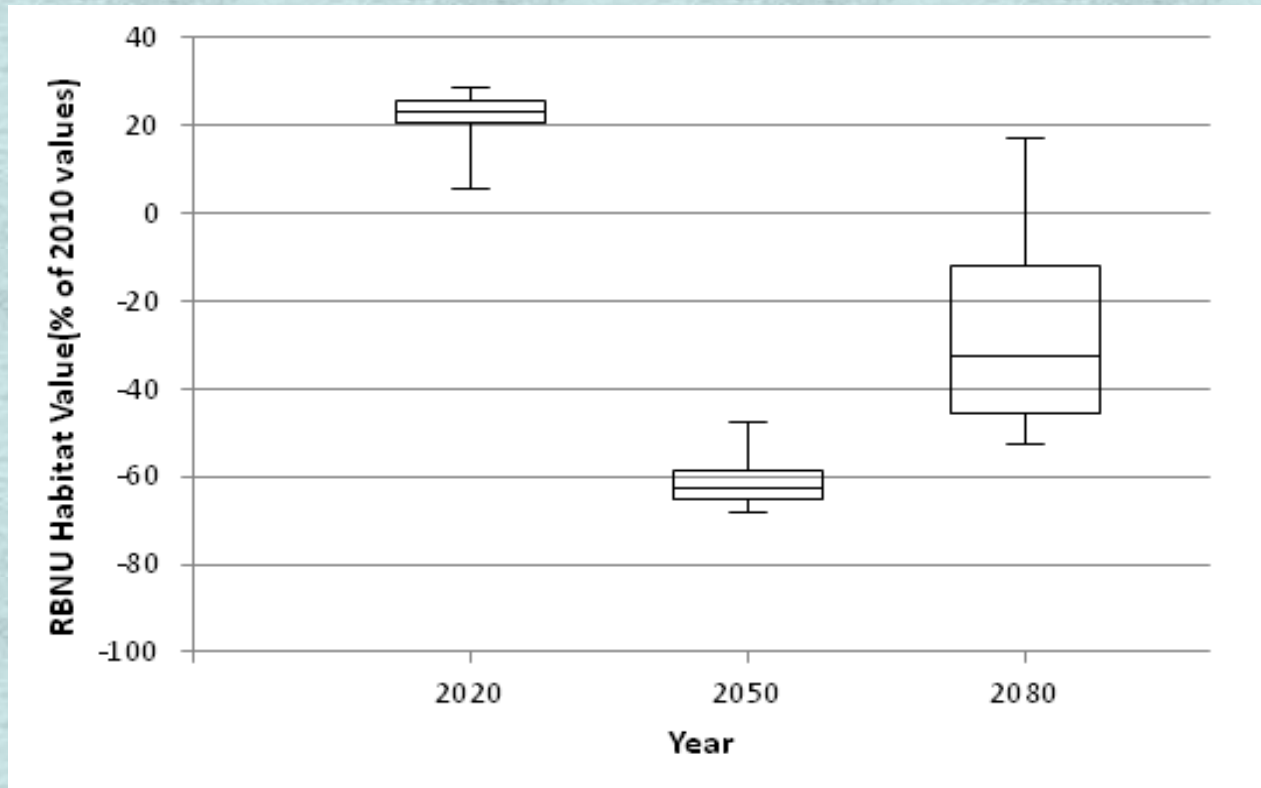
SWTH Abundance





Case Study Results – Ecological Indicators

Red-breasted Nuthatch Habitat Values





Case Study Results – Ecological Indicators

What affects RBNU habitat values?

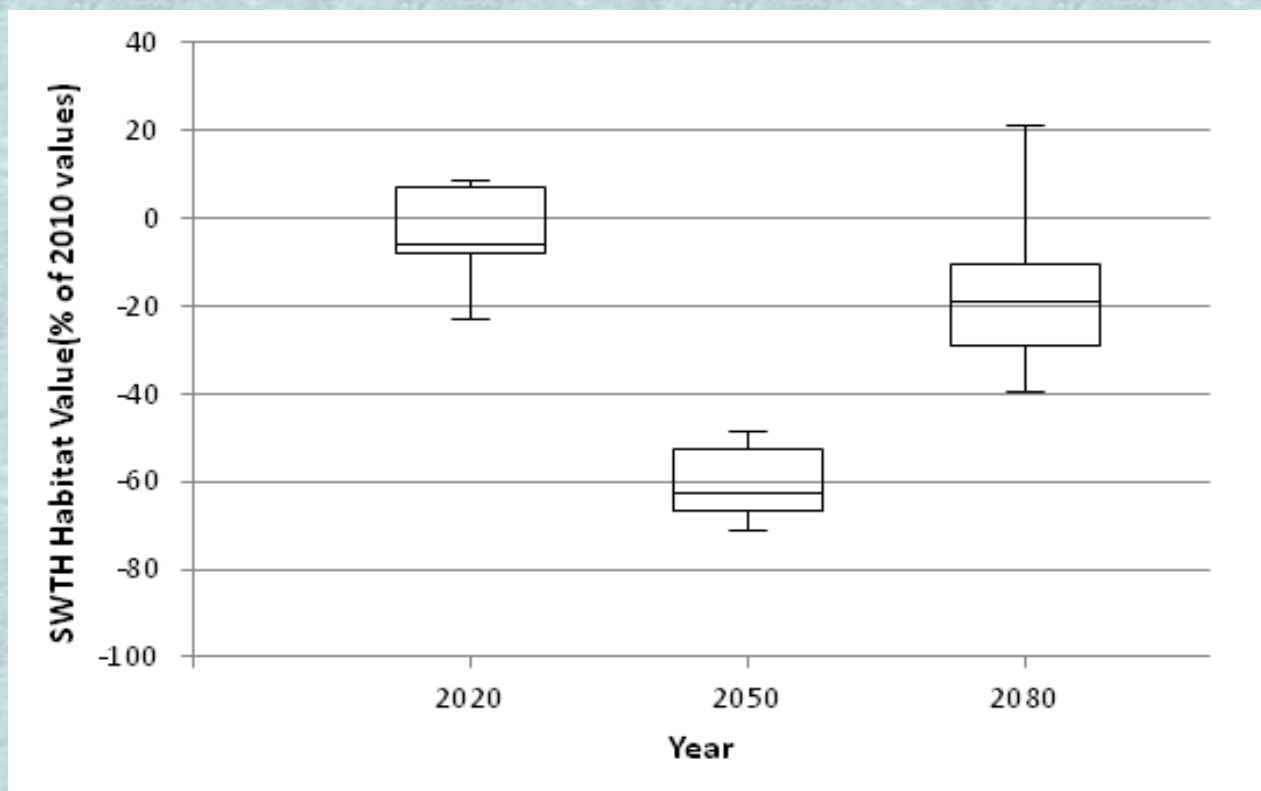
- GCM scenario was not an important factor regardless of time horizon or model assumptions

	Mean Difference (% of 2010 values)		
	2020	2050	2080
Conventional vs Adaptation	ns	-3.9	-33.0
Optimistic vs Pessimistic MPB	ns	7.5	12.0
Regen vs Regen+Stand	6.6	2.5	10.4



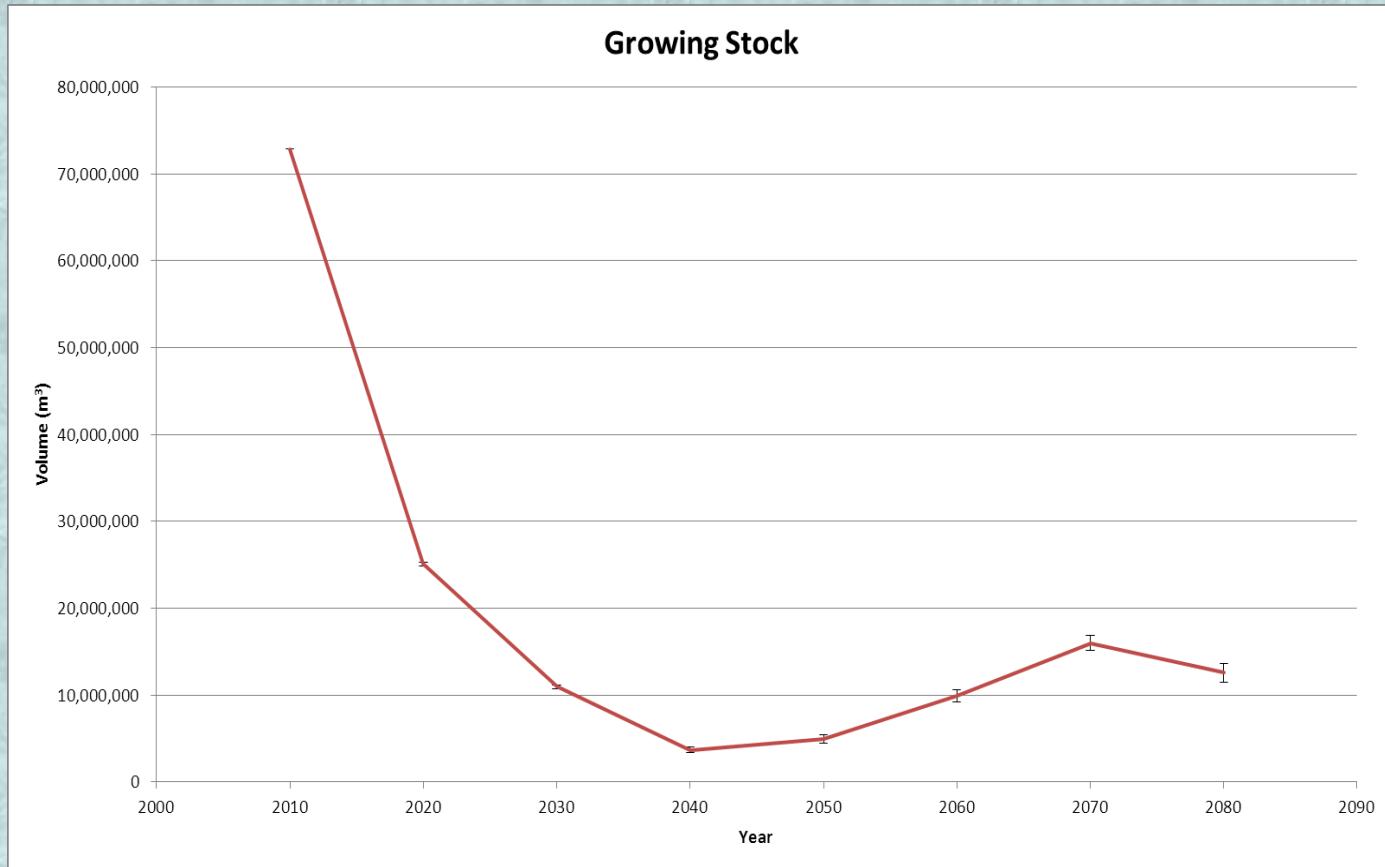
Case Study Results – Ecological Indicators

RBNU Abundance



Case Study Results – Socioeconomic Indicators

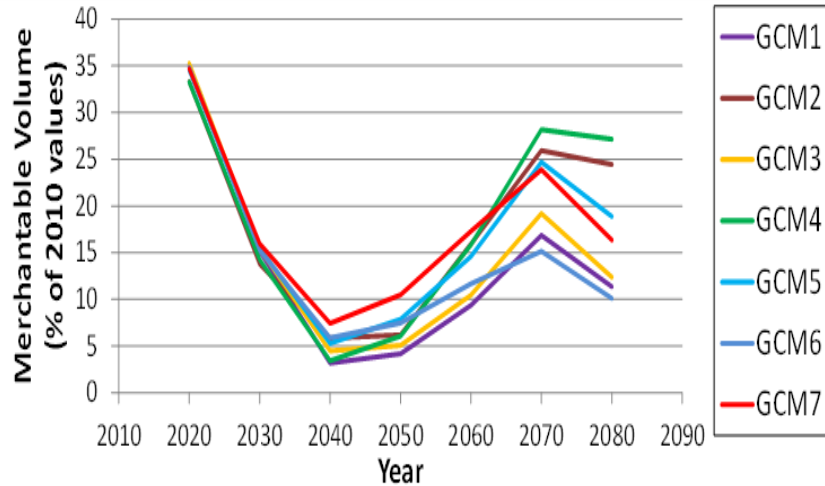
Standing Merchantable Volume



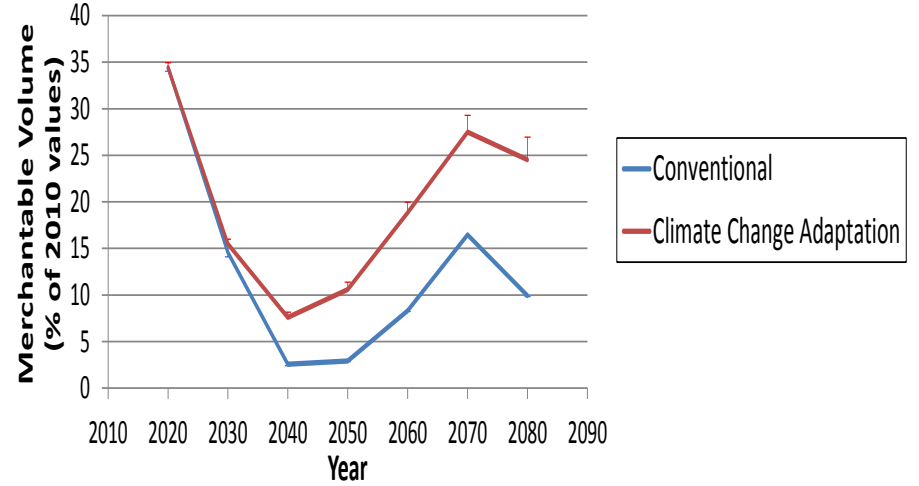
Case Study Results – Socioeconomic Indicators

Standing Merchantable Volume

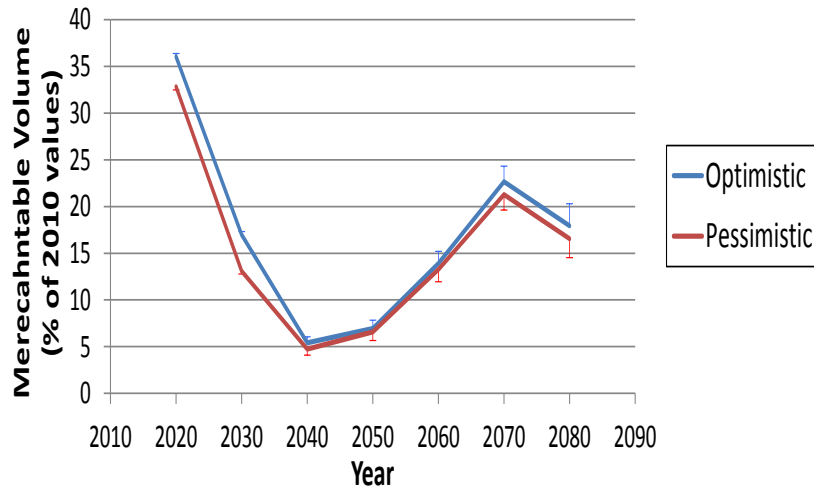
GCM



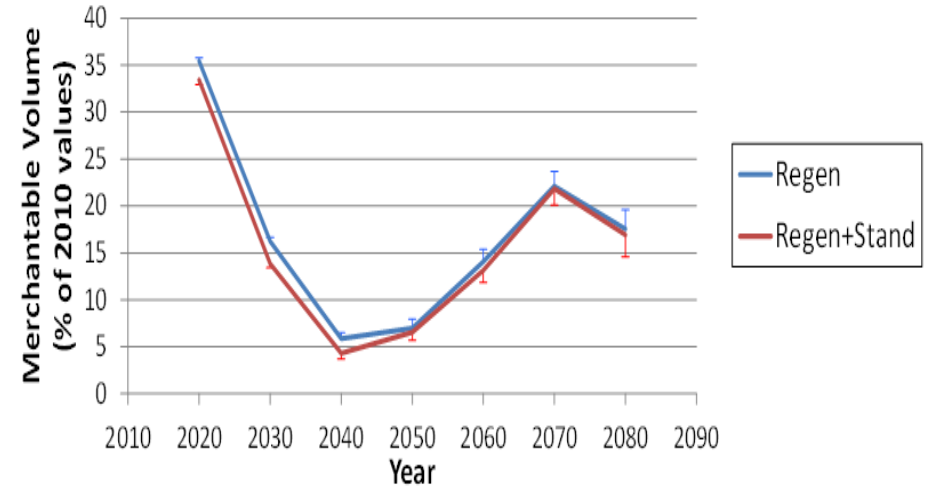
Silviculture



MPB



Climate Change Mechanism

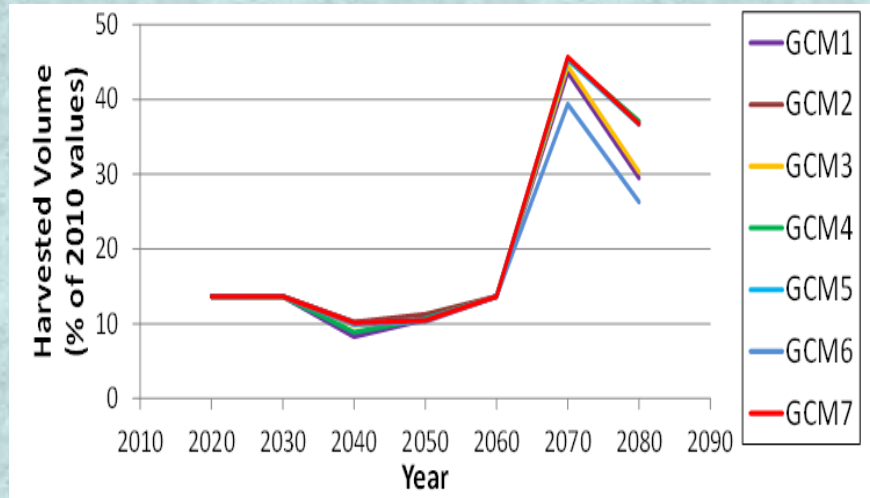


Case Study Results – Socioeconomic Indicators

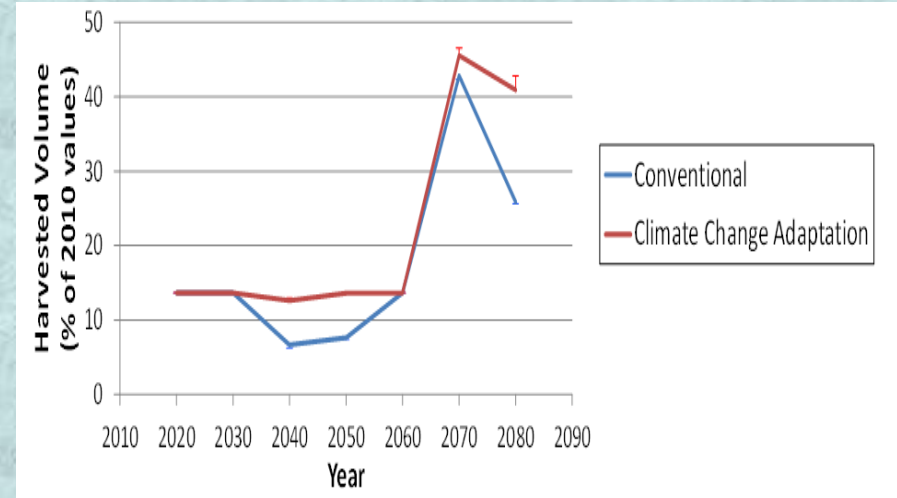
Harvested Volume



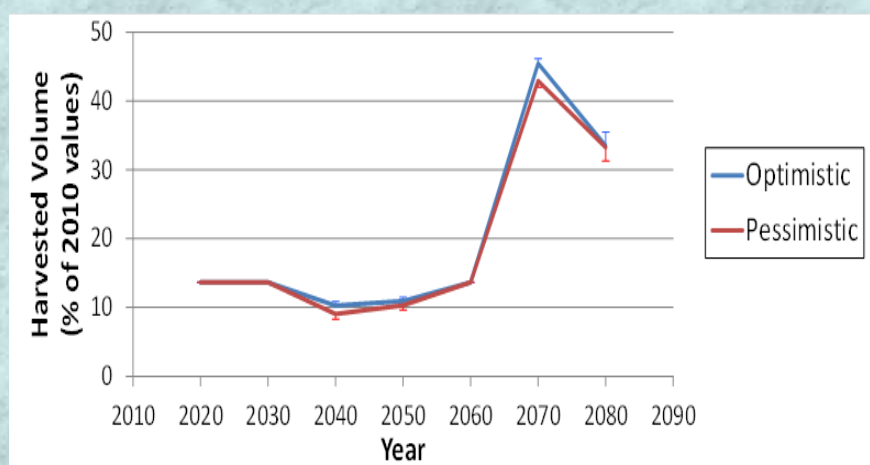
GCM



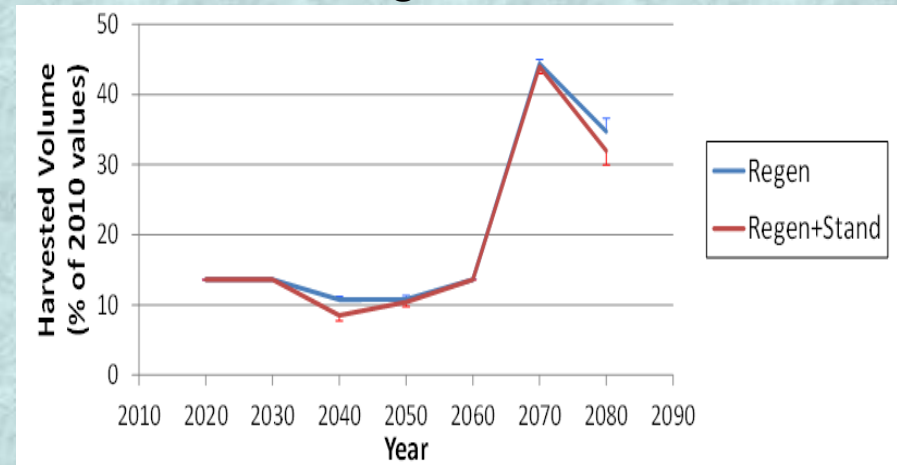
Silviculture



MPB



Climate Change Mechanism





Ecological Indicators Summary



- Conservation of habitat values in the 2050 time horizon will be best achieved by reducing the MPB risk factor.
- Conservation of habitat values in the 2080 time horizon will be best achieved by having a climate change adaptation silviculture strategy in place, that integrates risk reduction in MPB risk factor.
- Inevitable steep declines in habitat values in the mid-term will be partially countered by sometimes favorable direct effects of changing climates on RBNU and SWTH.
- In the long term, projected abundances varied greatly depending on model assumptions and uncertainties, but an adaptation silvicultural strategy shifted RBNU populations to a positive status despite highly unfavourable conditions in all other factors.



Socioeconomic Indicators Summary



- A climate change adaptation silviculture strategy maximized both the growing stock and the harvested volume in the 2050 and 2080 time horizons.
- In contrast, neither the MPB risk factor nor the loss in volume associated with maladapted trees had much impact on the growing stock for the 2050 and 2080 time horizons.
- In the mid term when growing stocks were at their lowest, a climate change adaptation policy was the only factor allowing the harvested volume to approach the target AAC, regardless of uncertainties in GCM scenario, MPB risk factor, and losses associated with maladapted stands.

Conclusions

- A climate change adaptation strategy that aligns tree species regeneration with projected shifts in biogeoclimatic zones can mitigate impending fall downs in ecological and socioeconomic values. In particular, an adaptation-based regeneration regime should be effective in mitigating long term declines in wildlife values as well as mid- and long- term declines in both harvested volume and volume of standing merchantable timber.
- Because there appears to be negative consequences associated with not choosing a climate change silvicultural strategy, and because an adaptation based tree species selection regime was compatible for all ecological and socioeconomic values evaluated in this research, regardless of modeling uncertainties, we strongly recommended that forest managers integrate an adaptive tree species selection protocol in the immediate future.

Acknowledgements

FFuture Forest Ecosystems Scientific Council
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