

Modelling climate change impacts in British Columbia's forest ecosystems: a holistic approach to understanding ecosystem vulnerability

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Outline

- Introduction
- An example: TFL 49
- An Example: B.V. SBS zone
- Framework for Management



Understanding landscape vulnerability

- In the context of SFM, the need to address potential vulnerability over time and space is important if planning decisions and objectives are to be achievable.
- Understanding what and where the vulnerabilities exist is a step in the reduction of uncertainty and risk associated with climatic change.





Tree Farm License 49
Okanagan Valley, BC

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Study area

- Located in Thompson Okanagan area of British Columbia (51°20'N, 119°55'W)
- Altitude ranges from 360 to 2040 m
- Mean summer temperature: 16.1°C,
- mean summer precipitation: 36.6 mm
- Major population growth area, with variety of pressures on landuse.



Study area

- **145,000 ha total area, with 136,744 ha of productive forest**
- **Covers four BEC zones**
 - Interior Douglas-fir (34%)
 - Montane spruce (38%)
 - Engelmann spruce – Subalpine fir (22%)
 - Interior Cedar Hemlock (6%)



Study area

- **13 tree species present:**
 - Lodgepole pine (41%)
 - Douglas-fir (28%)
 - Interior spruce (14%)
 - Subalpine fir (12%)
 - Trembling aspen (3%)
- <1%:
 - paper birch,
 - ponderosa pine,
 - western red cedar,
 - western larch,
 - Engelmann spruce,
 - black cottonwood,
 - whitebark pine,
 - black spruce



Risks

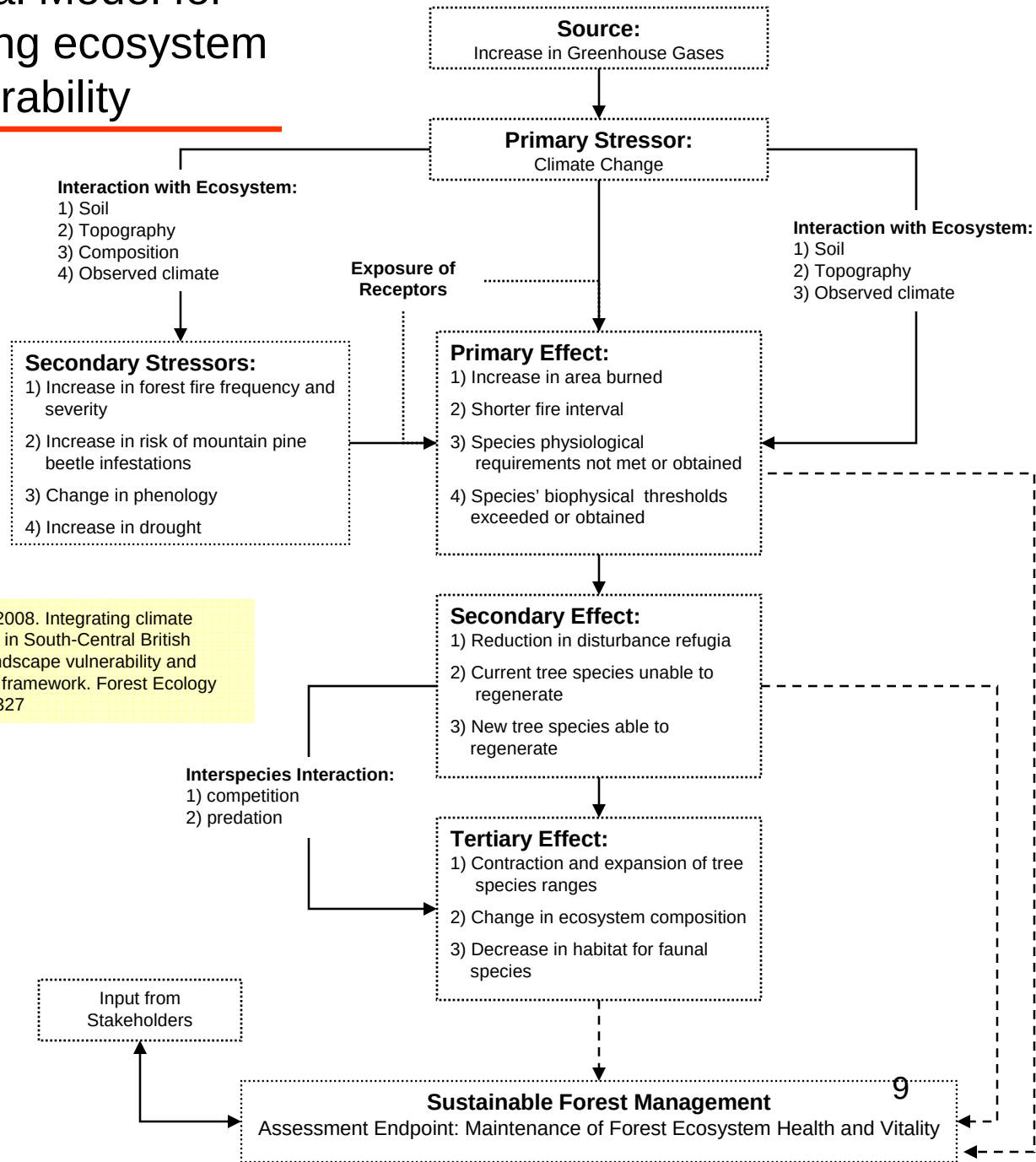
Risks identified on the TFL 49 landscape:

- **forest fire**
- **mountain pine beetle;**
- **drought;**
- **loss of ecosystem resilience**
- **loss of current biological diversity**

These risks were aggregated into a vulnerability assessment framework



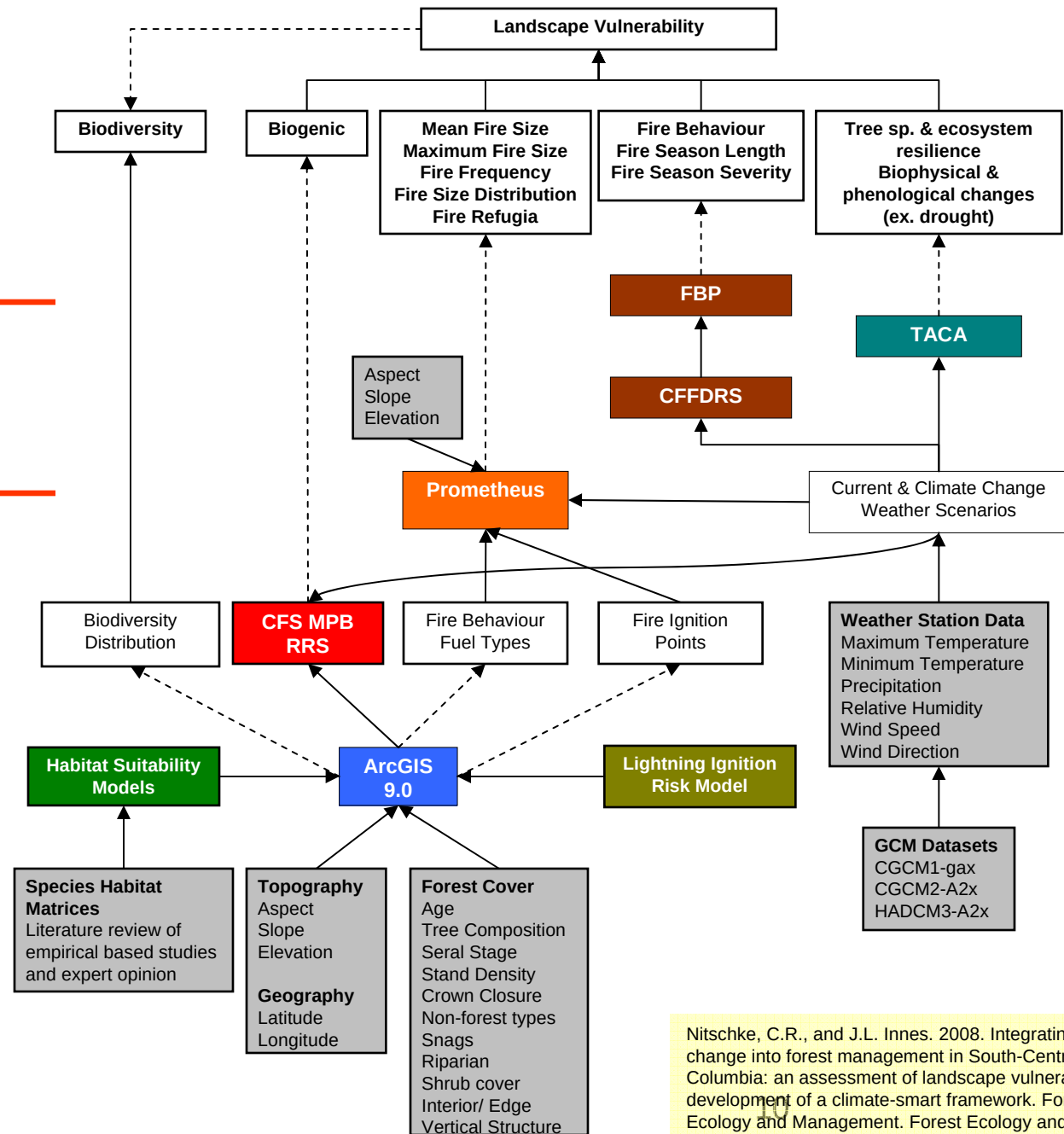
Conceptual Model for understanding ecosystem vulnerability



Nitschke, C.R., and J.L. Innes. 2008. Integrating climate change into forest management in South-Central British Columbia: an assessment of landscape vulnerability and development of a climate-smart framework. *Forest Ecology and Management* 256 (3): 313-327



Meta-Model for Multiple Determinants



Nitschke, C.R., and J.L. Innes. 2008. Integrating climate change into forest management in South-Central British Columbia: an assessment of landscape vulnerability and development of a climate-smart framework. *Forest Ecology and Management*. *Forest Ecology and Management* 256 (3): 313-327

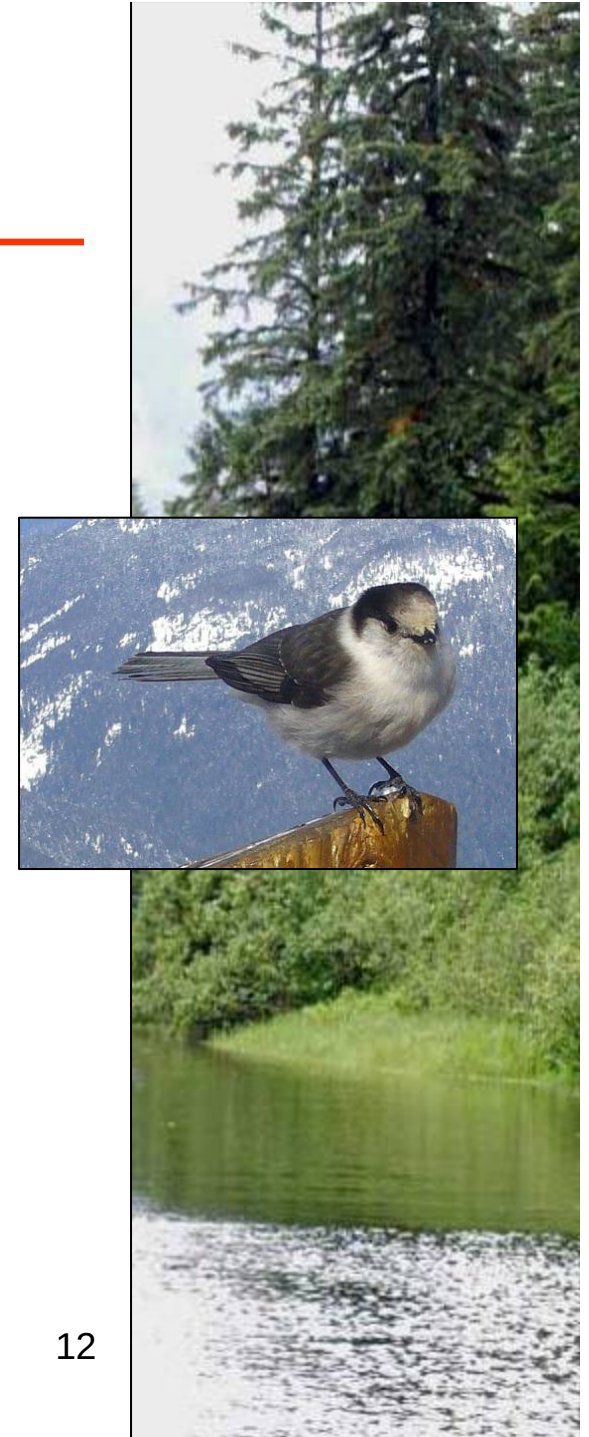
Climate

- 5 Weather Stations
- 7 weather scenarios created for each time period/GCM
 - **Current**
 - **CGCM1-gax (2020s, 2050s, 2080s)**
 - **CGCM2-A2x (2020s, 2050s, 2080s)**
 - **HadCM3-A2x (2020s, 2050s, 2080s)**
- 1 scenario represents the mean historical weather
- 6 scenarios generated from historical range of variation using error analysis techniques
- GCM outputs applied to daily values for each weather scenario using direct adjustment approach (Wang et al. 2006)

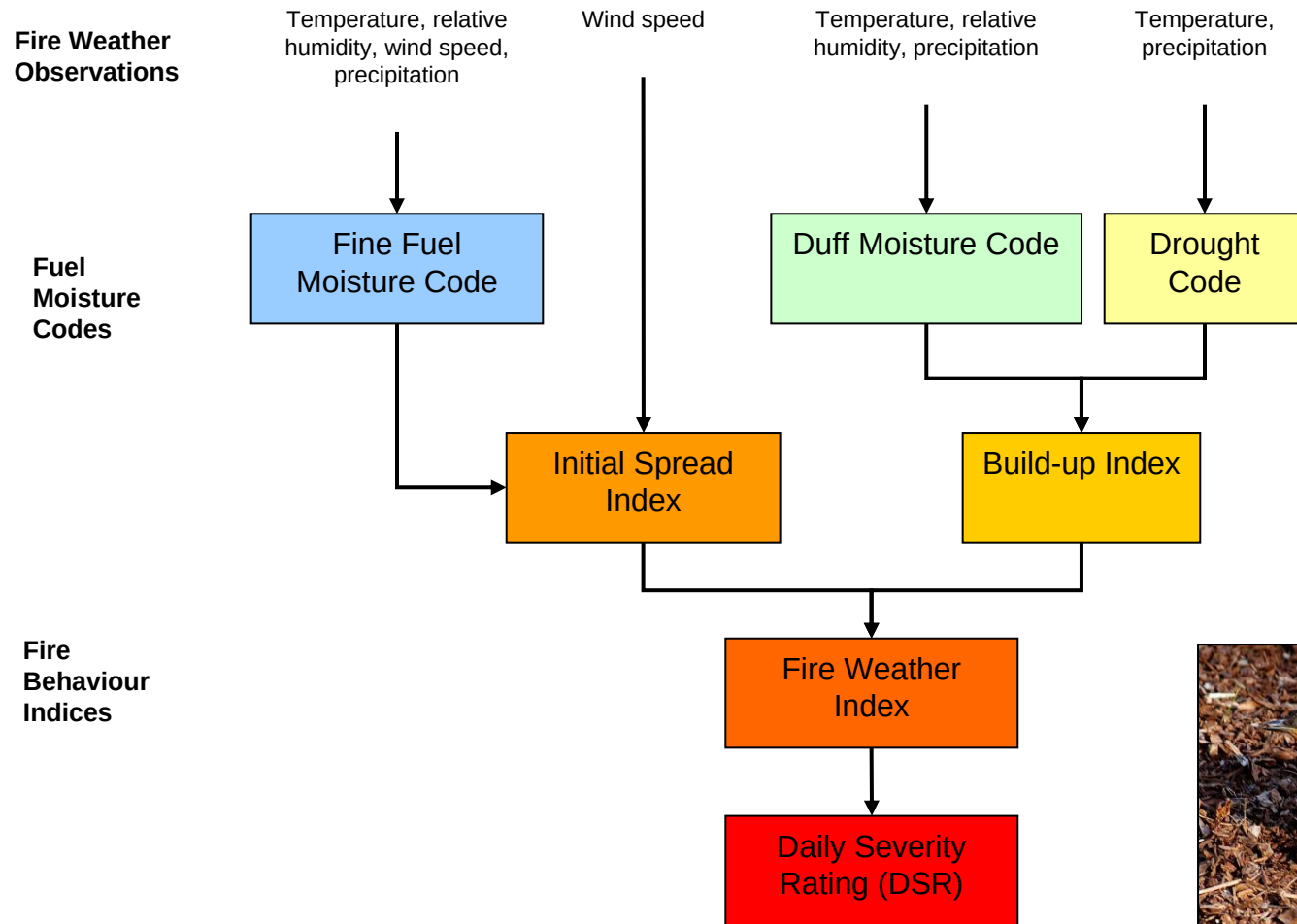


Fire weather

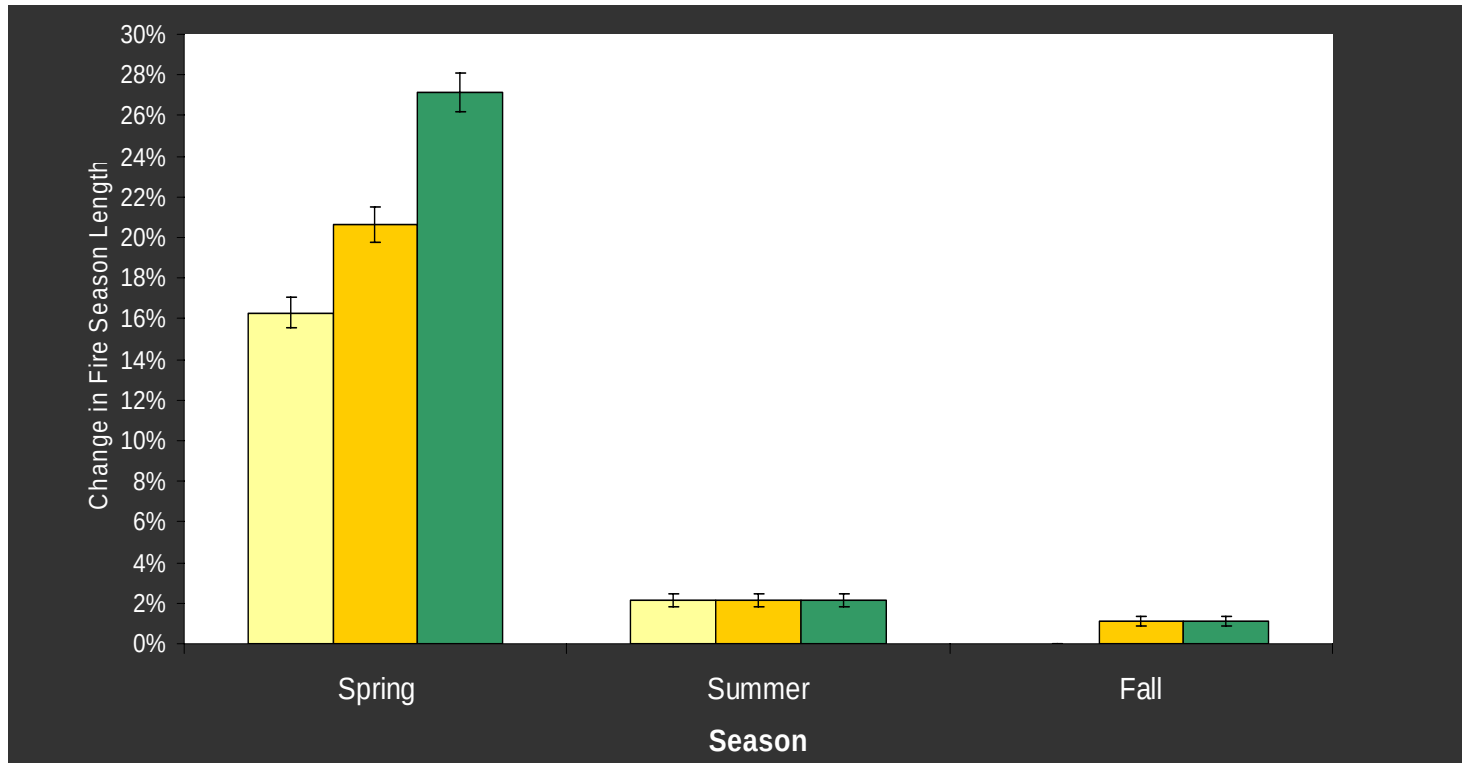
- 350 Climate Scenarios
 - 5 weather stations representing the PP, IDF, ICH, MS and ESSF BEC zones
- Canadian Forest Fire Weather Index
- Canadian Fire Behaviour Prediction System



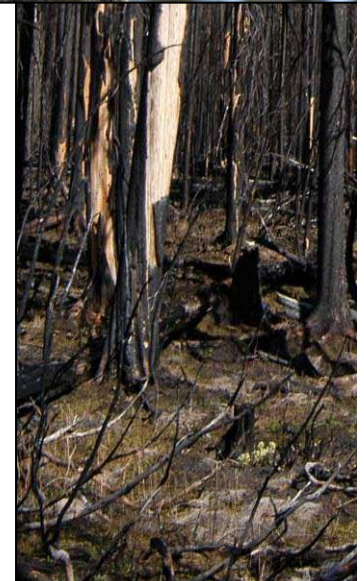
Canadian Forest Fire Weather Index



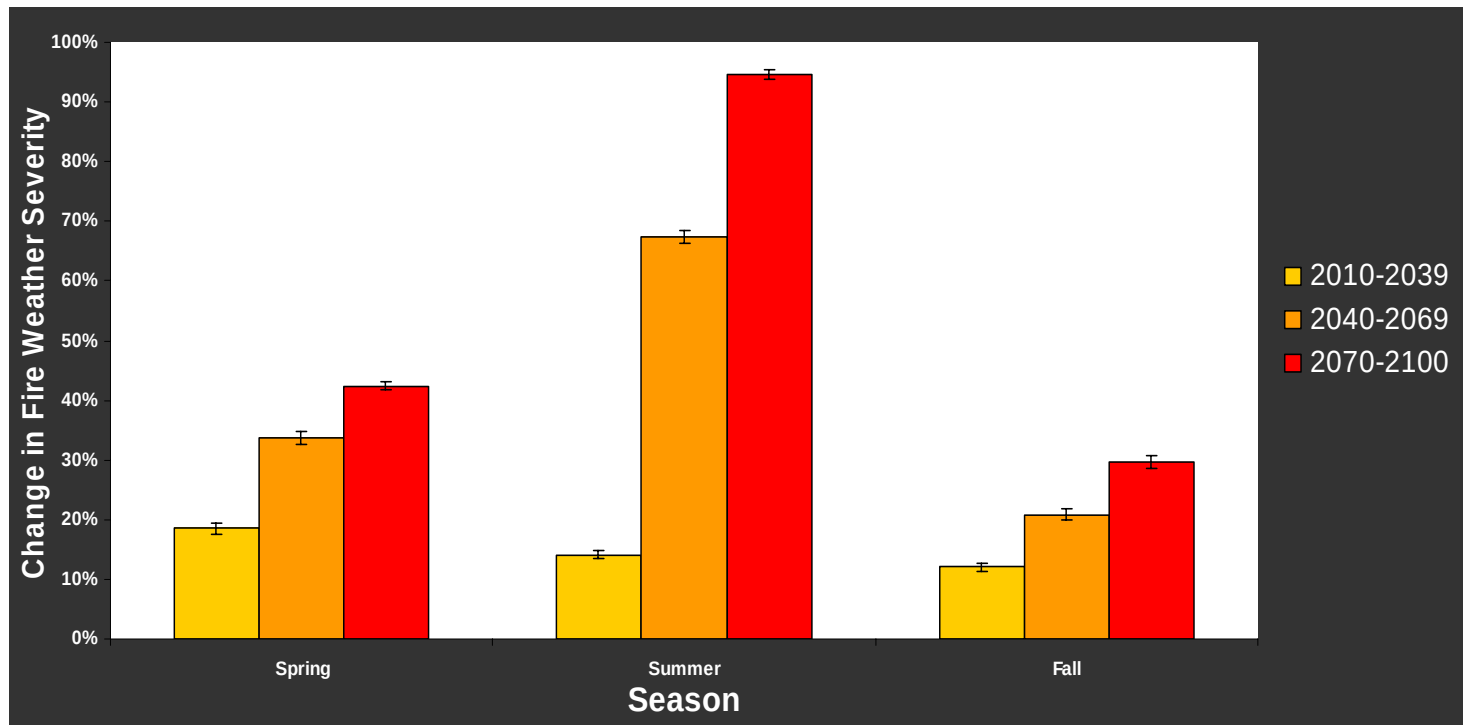
Fire Season Length



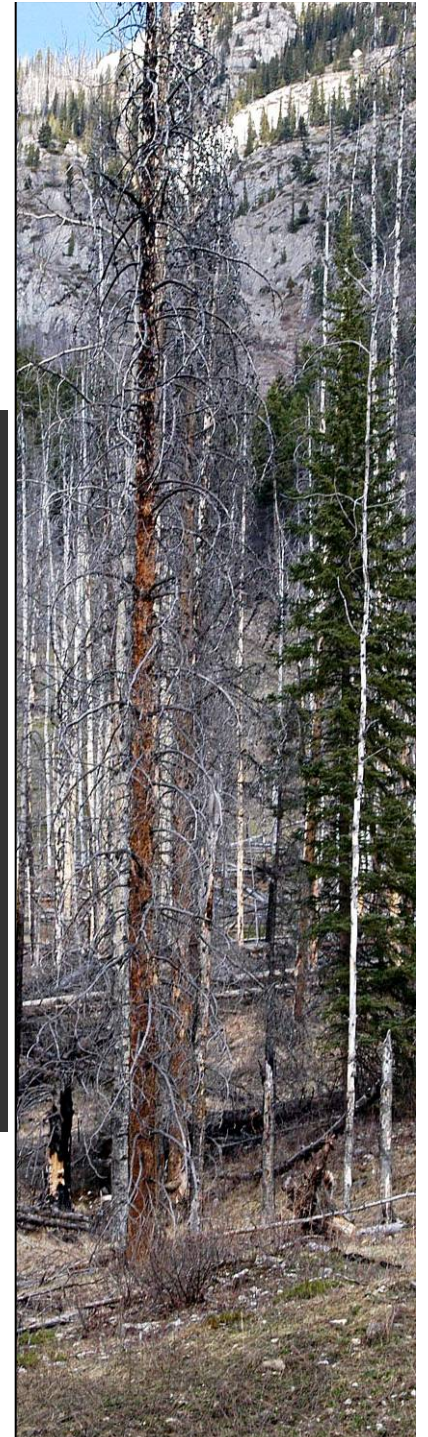
Nitschke and Innes, 2008



Fire Weather Severity

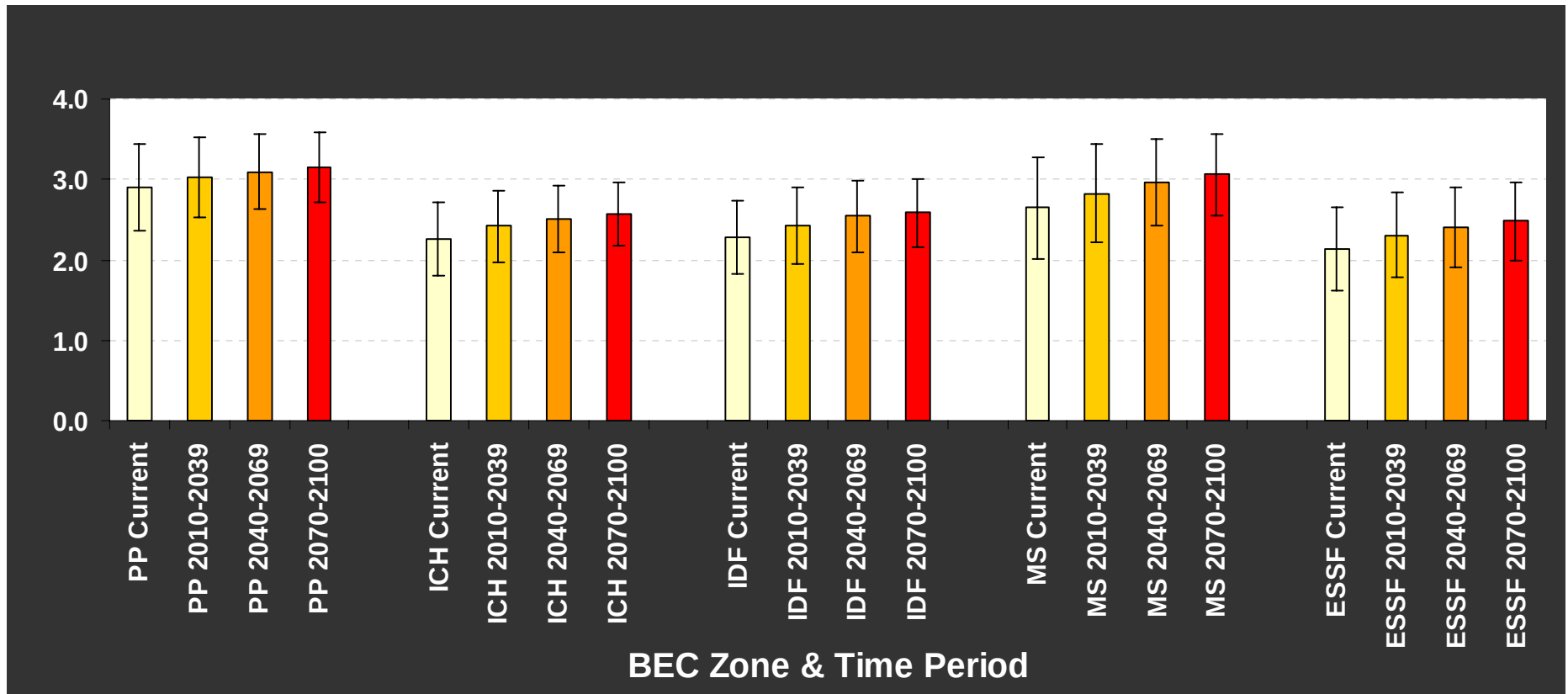


Nitschke and Innes, 2008



Fire Behaviour Rating

Nitschke and Innes, 2008



Fire Class	Fire Type	HFI Range (KW/m)
1	Surface Fire	1 - 500
2	Surface Fire with Torching	500 - 2000
3	Intermittent Crown Fire	2000 - 4000
4	Crown Fire	> 4000

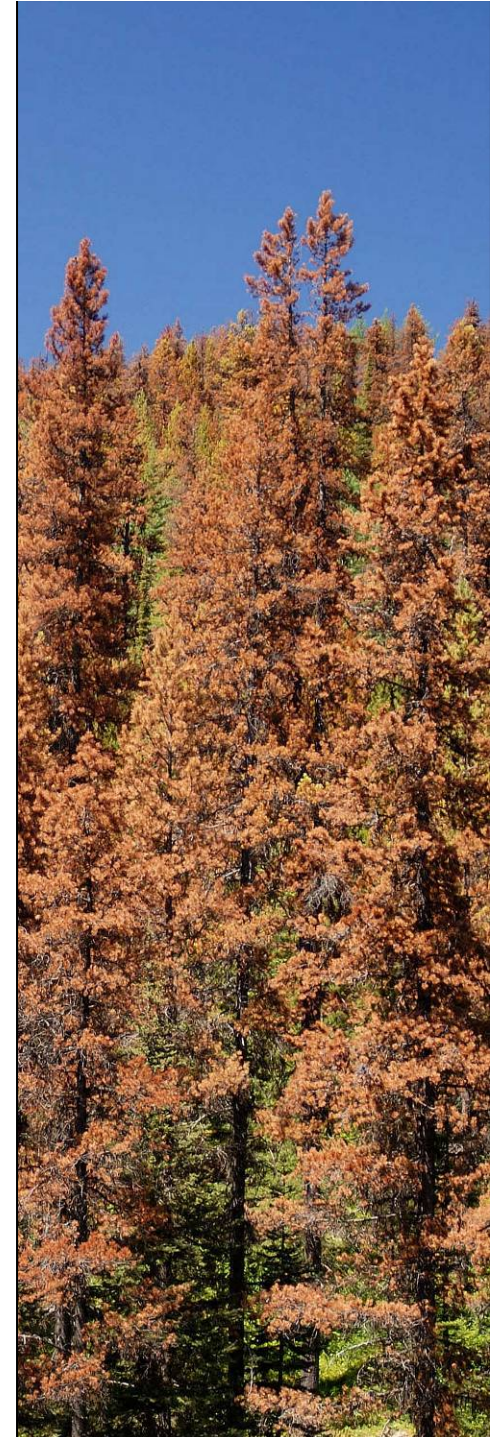
% of landscape at risk to MPB

**~ 39 % of the landscape currently at risk
~ 44 % is vulnerable**

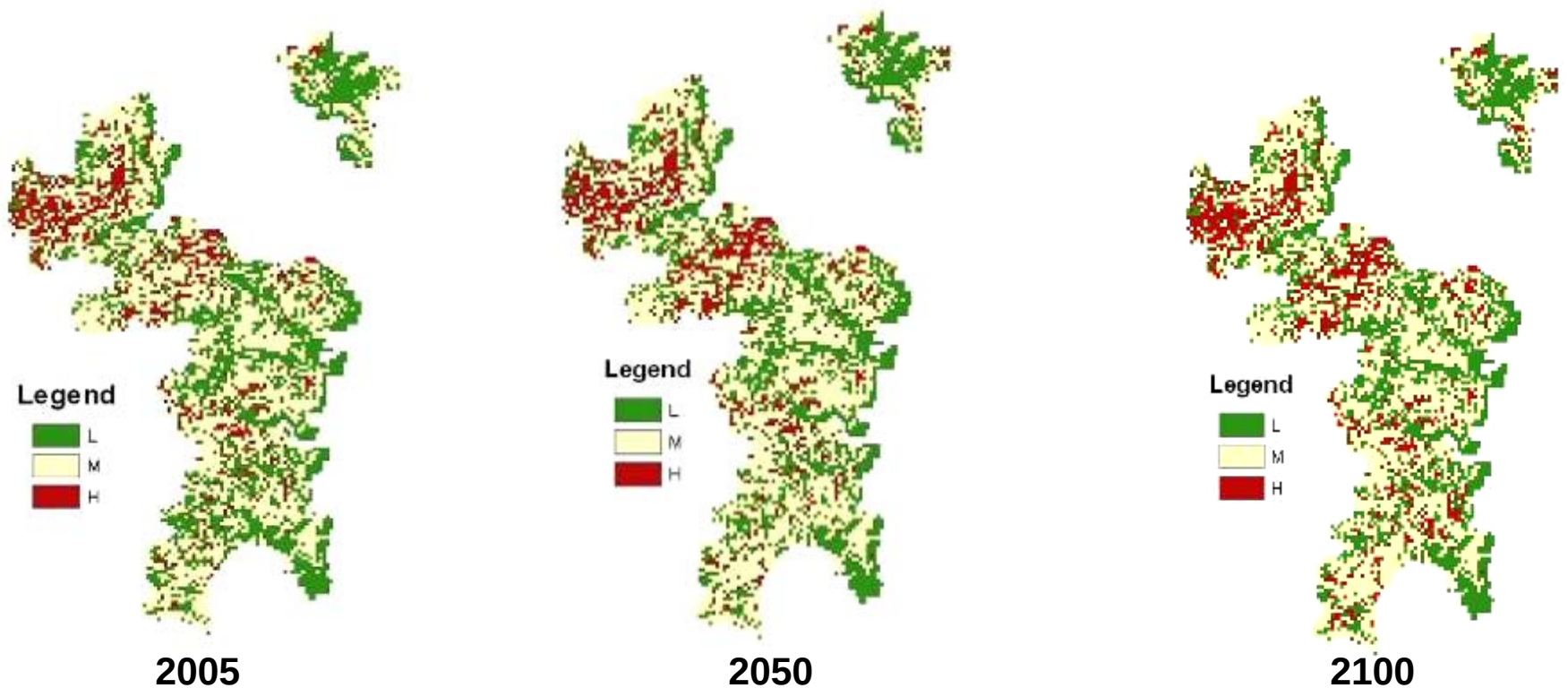
**~ 52 % of landscape vulnerable by the
2080s**

**Current epidemic is occurring when
ecosystems are resilient**

**Future epidemics will occur when
resilience is compromised**



Mountain Pine Beetle: Stand Susceptibility Index



Vegetation Response

- **Used Fundamental-regeneration niche model
TACA (Tree and Climate Assessment)**

Nitschke and Innes. 2008. A tree and climate assessment tool for modelling ecosystem response to climate change. *Ecological Modelling* 210 (3): 263-277.

- **The model used four biophysical/ phenological attributes**

Drought (AET/PET Ratio)

Bud burst - Frost

Growing Degree Day Requirement

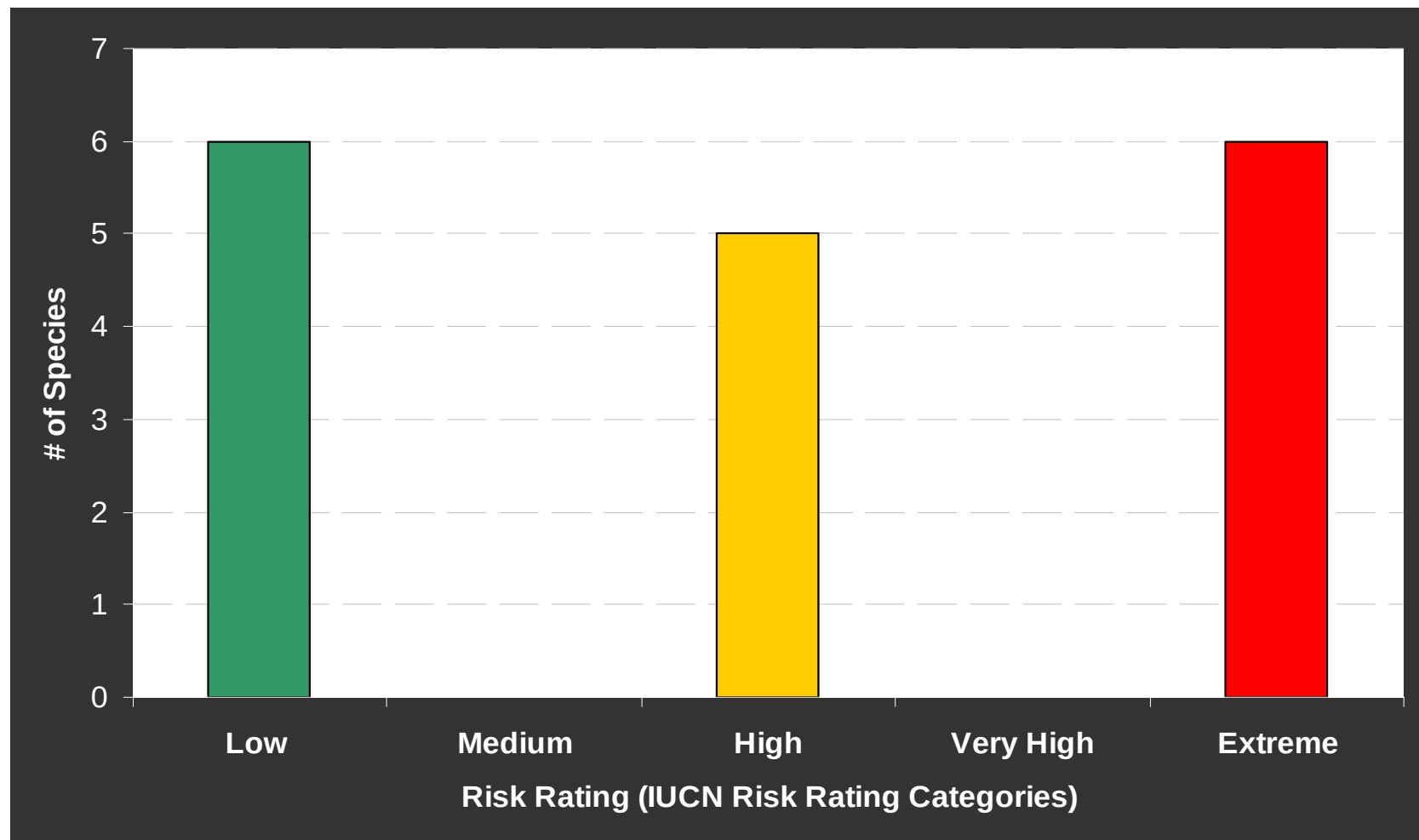
Chilling Requirement

- **Examined Species that are currently on TFL and
are found in Northern Washington**
- **Examined Water Deficit sites and Non-Water
Deficit Sites**

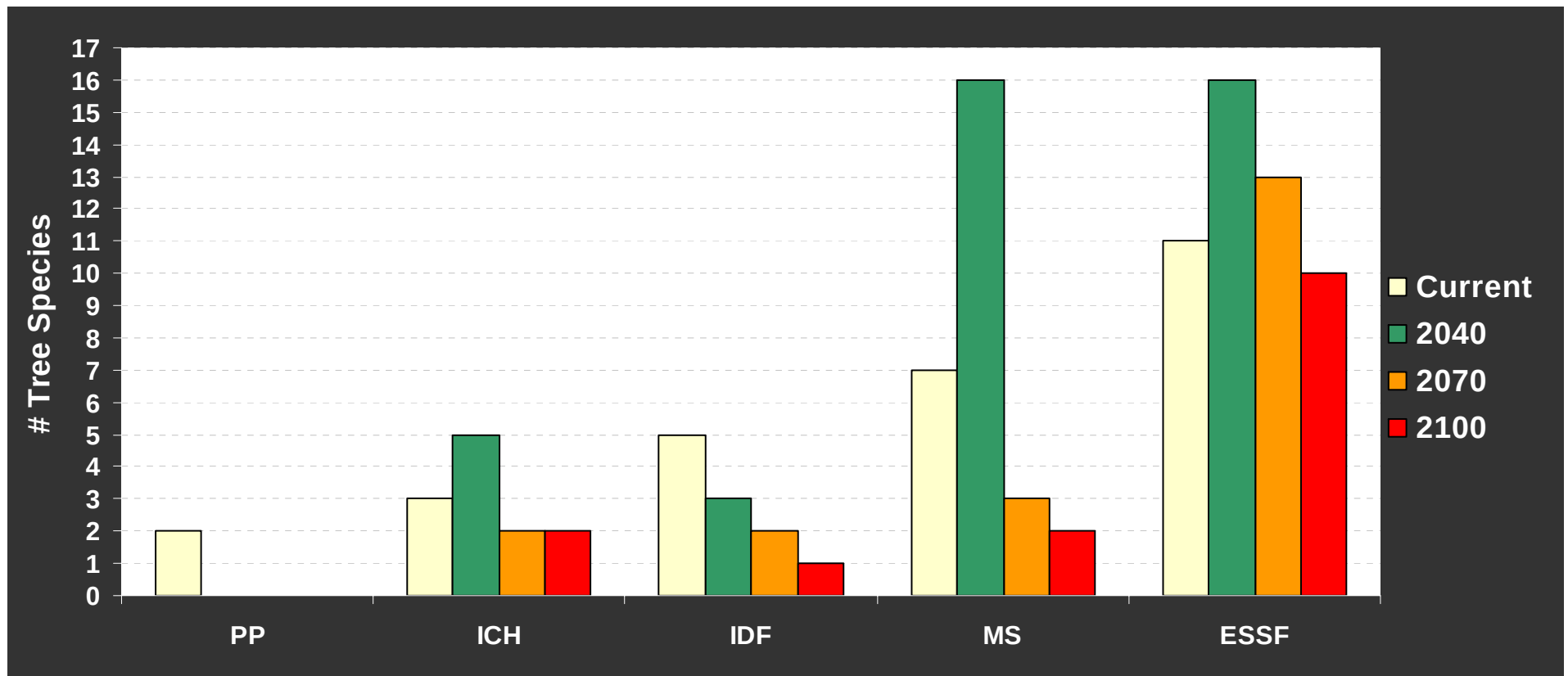


Potential decline in regeneration potential for dominant tree species in the North Okanagan

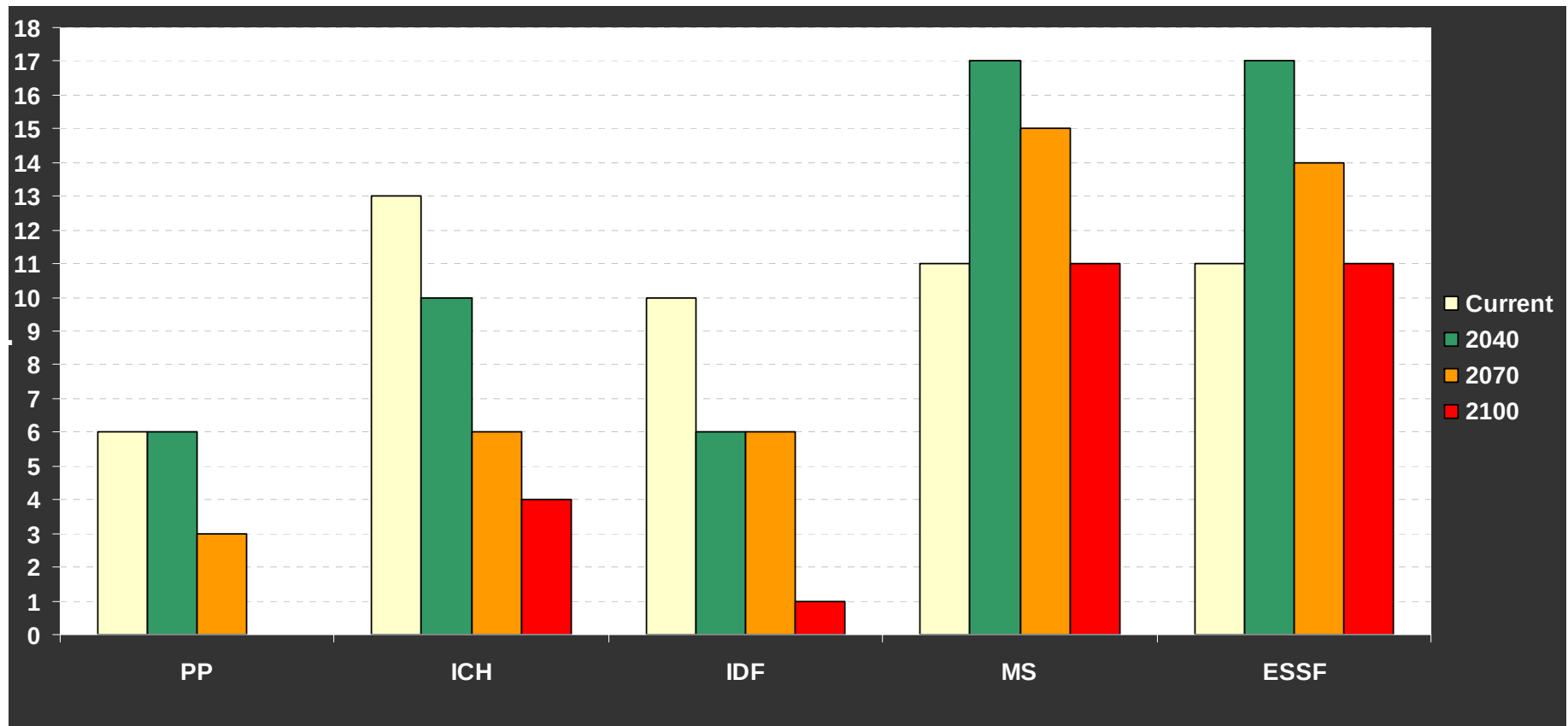
Contraction of current area available for regeneration



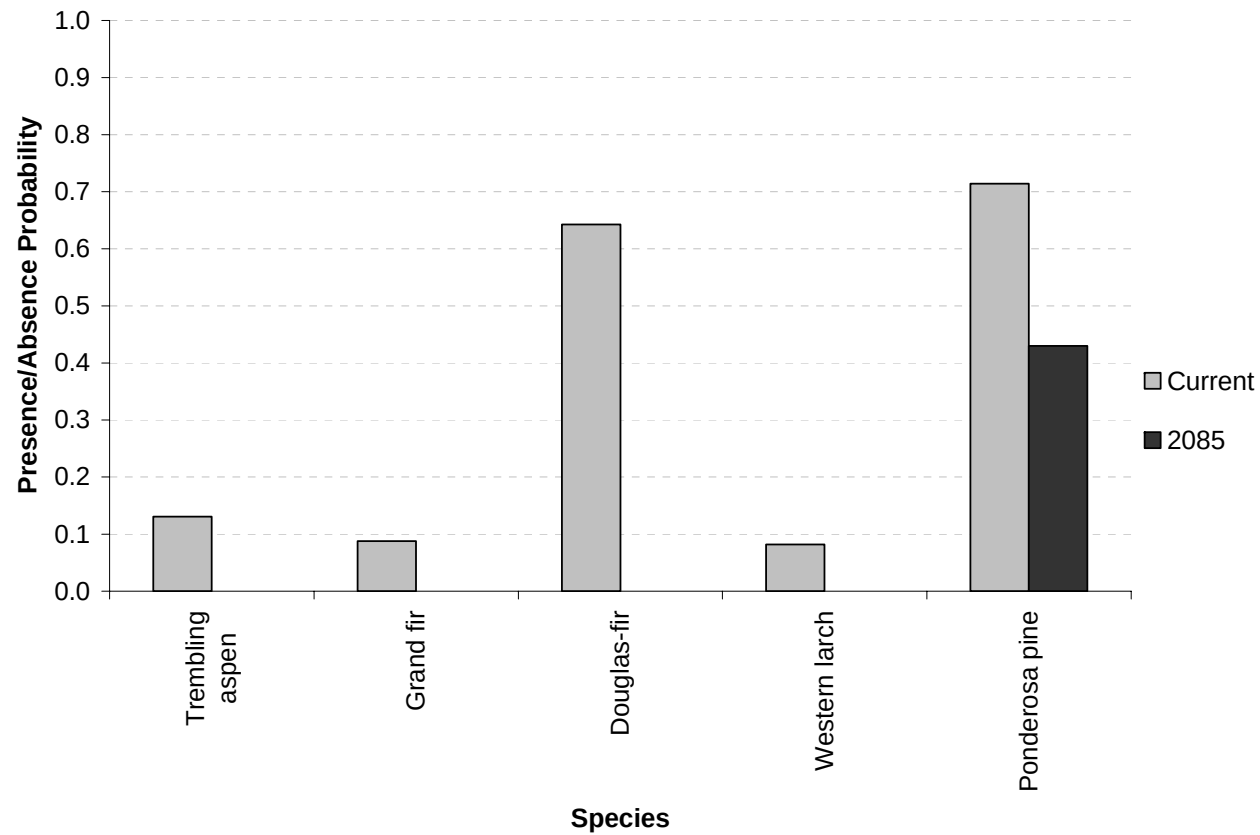
Water-deficit sites



No water deficit

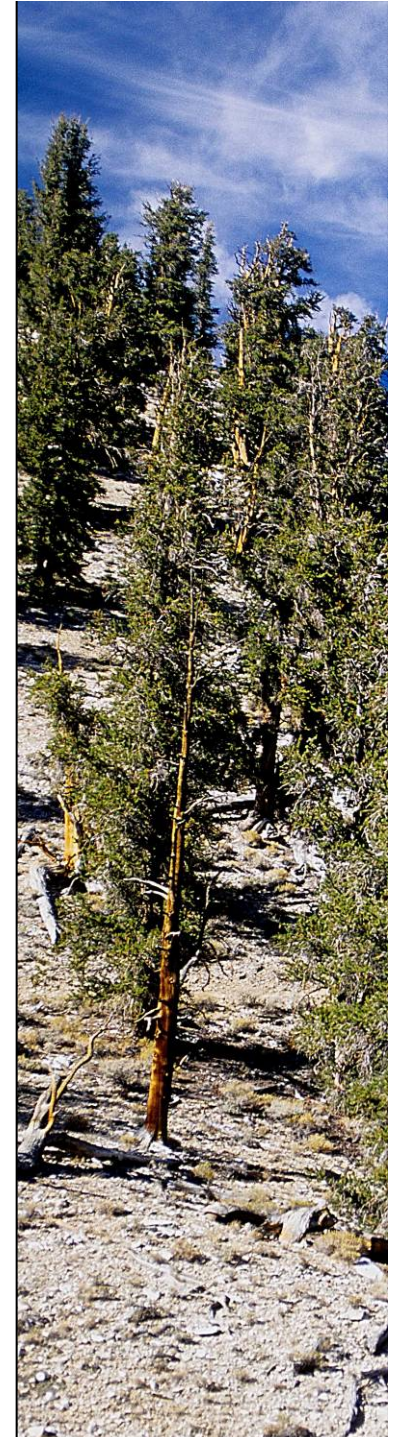


Species Response (IDF xh1)



Nitschke and Innes, 2008

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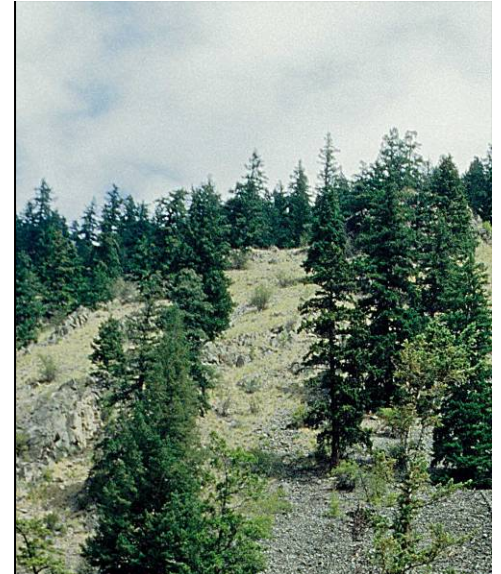
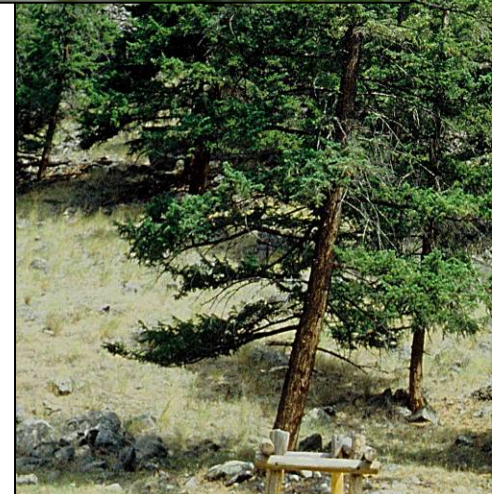
Changes in BEC zones

Current	PP ↓	IDF ↓	ICH ↓	MS ↓	ESSF ↓
2100	BG	PP	ICDF	IMC	ICGF



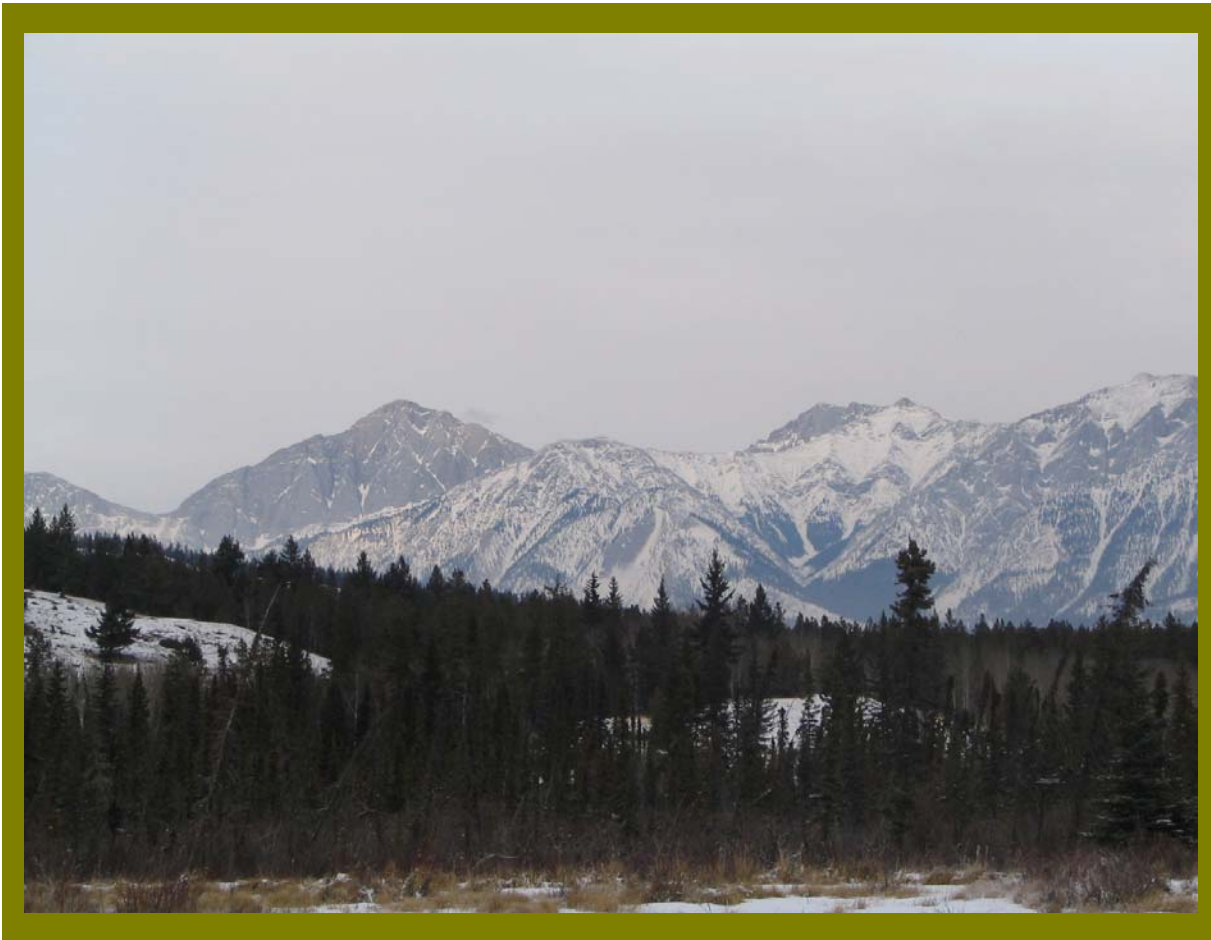
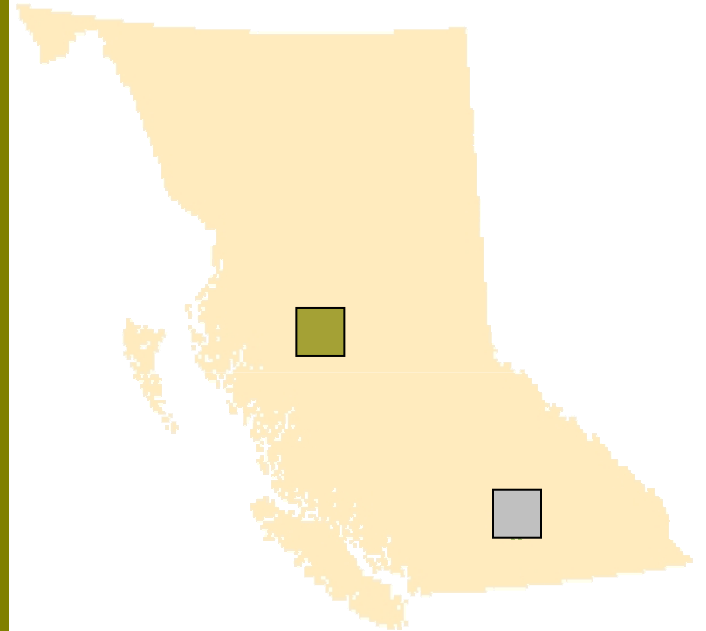
Species at Risk to Climate Change

- Species requiring mid to late successional habitat
34 out of 77 species (44.2 %)
- Species dependent on only paper birch, whitebark pine and/or spruce
8 out of 77 species (10.4 %)
- Species requiring late successional habitat
4 out of 77 species (5.2 %)
- Species requiring a combination of these attributes
3 out of 77 species (3.9 %)
 - Townsend's Warbler
 - Hermit Thrush
 - Moose (Winter Habitat)



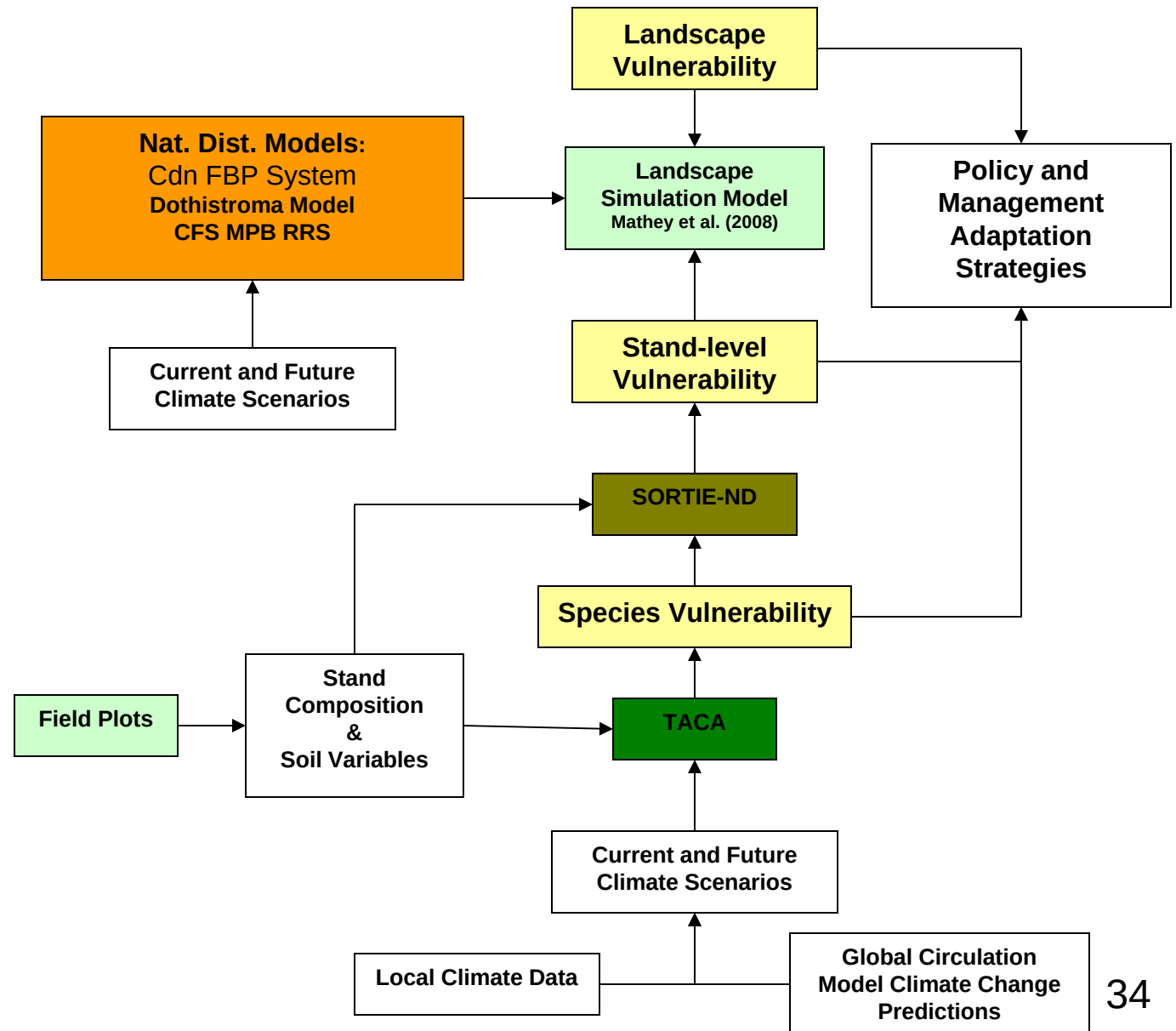
Sub-Boreal Spruce Ecosystem, Bulkley Valley, B.C., Canada

Nitschke, Astrup (in prep)

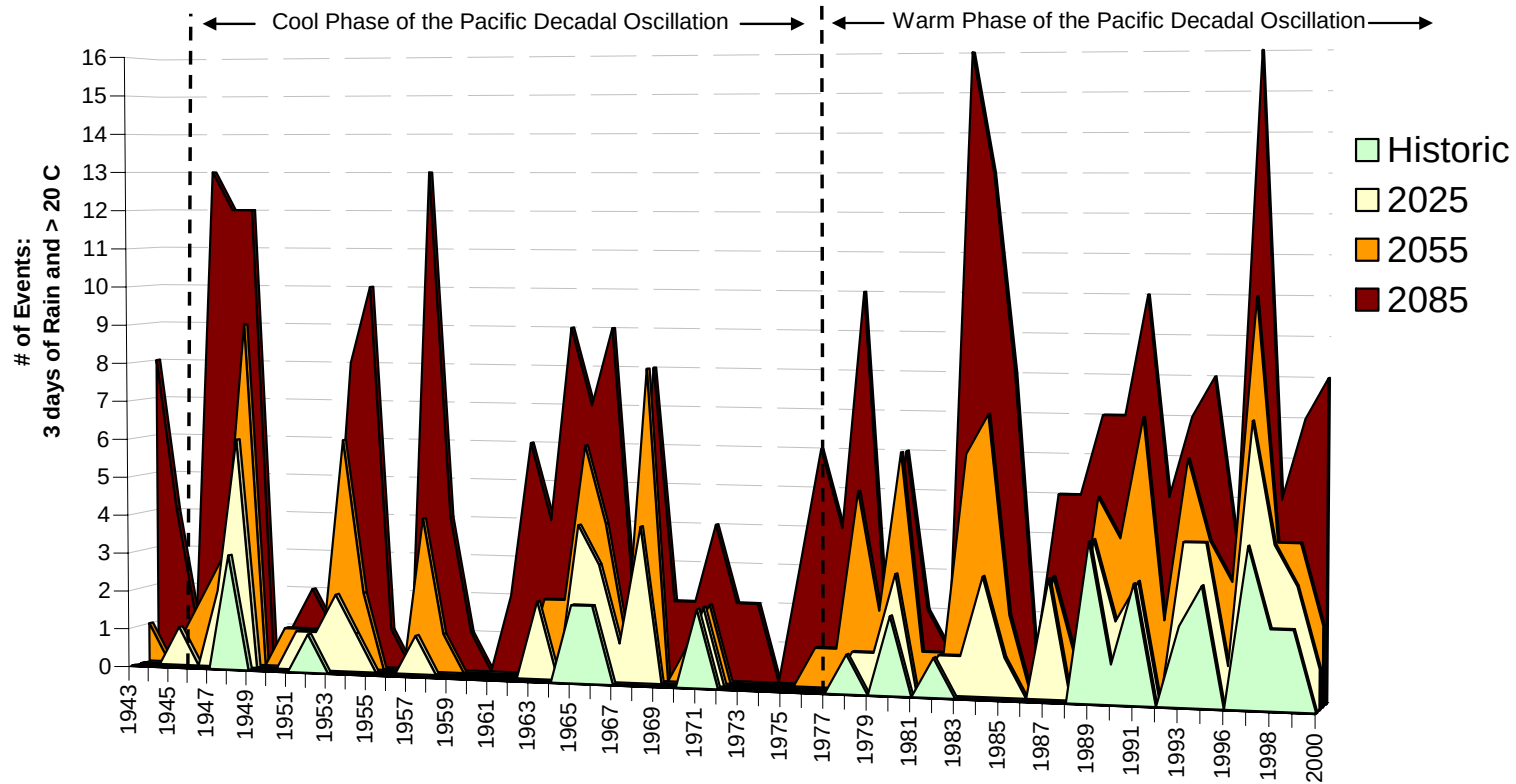




Meta-Model & Conceptual Framework



Dothistroma Risk



Waeber and Nitschke, 2008



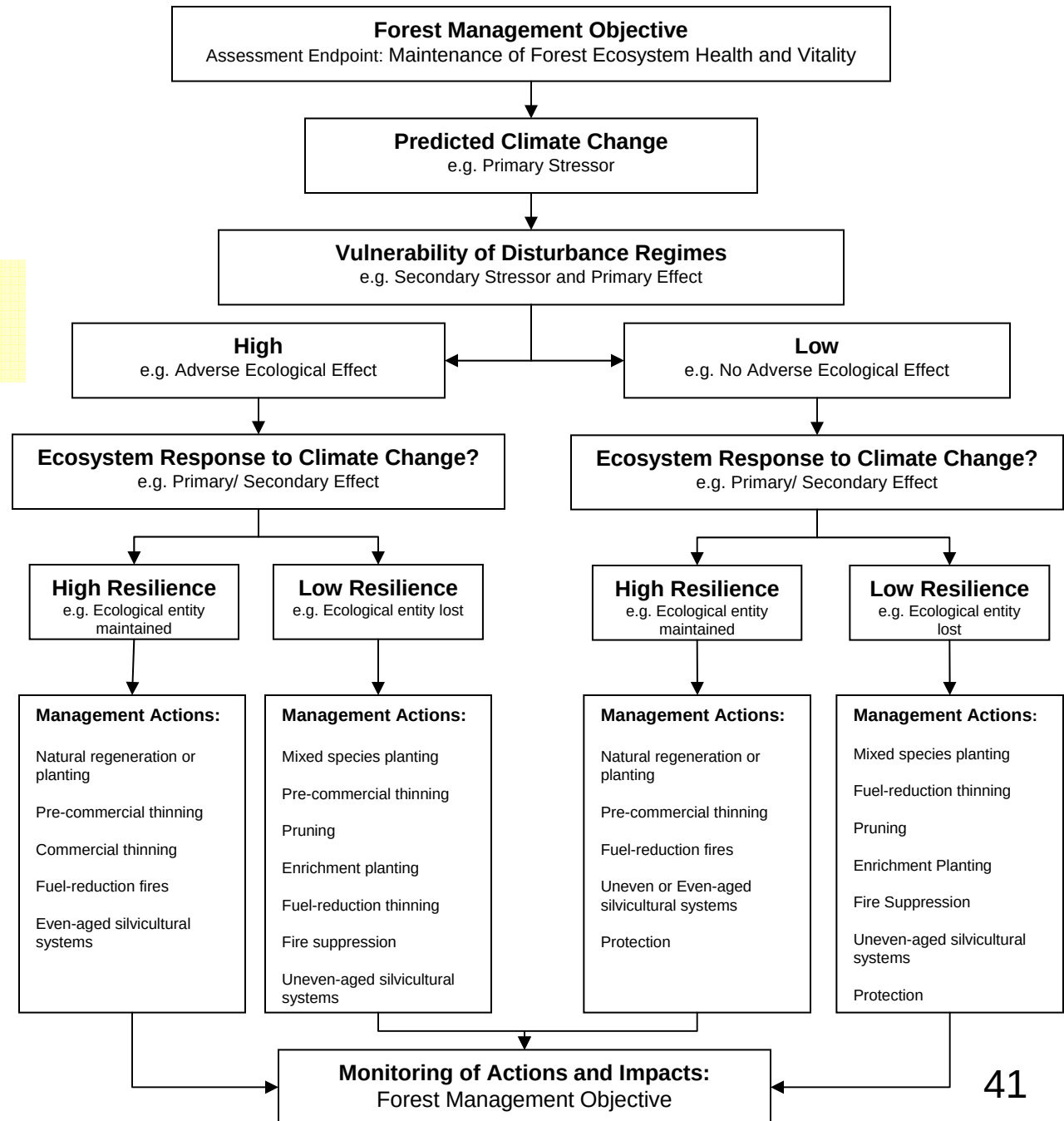


General Pattern of Response

- Increase in Disturbance Severity and Frequency
- Contraction from lower elevations to higher elevations
 - Increase in drought conditions
 - Increase in temperature
 - Decline in chilling weeks
- Contraction from xeric-mesic sites with increased water deficits
 - Drought
- Expansion to higher elevations
 - Increase in temperature
 - Increase in chilling weeks
 - Increase in frost free period
 - Decrease in growing season frosts

Climate-Smart Management Framework

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Thank You

- Sustainable Forest Management Network
- FIA-FSP
- FFEI

Questions?