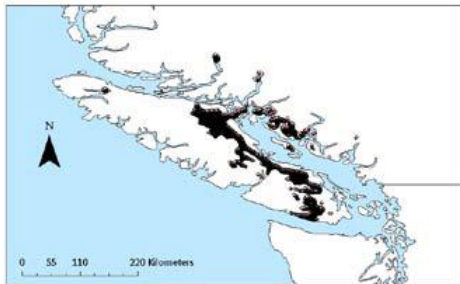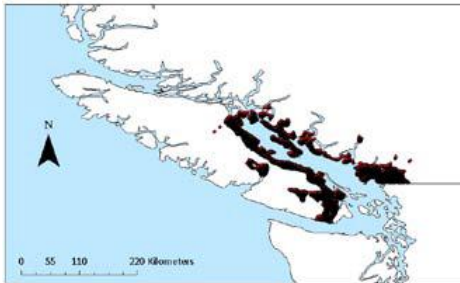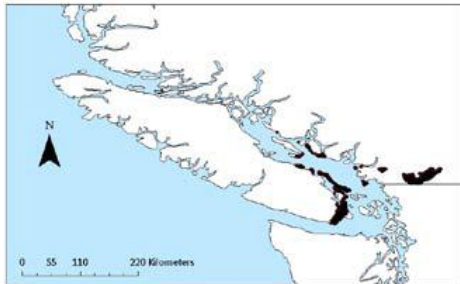# Climate Change and Its Ecological Effects on BC's Coastal Forests


Heather Klassen
Sari Saunders
Andy MacKinnon
MFLNR - Coast Research Ecology
February 26, 2015

Outline

- What IS "climate change" and what will it look like on the coast?

- How does climate change affect forests and forest management?

- What research is being done to understand climate change and its impacts?

- What tools are available to interpret climate change and guide operations?

Climate Change is not a new issue...
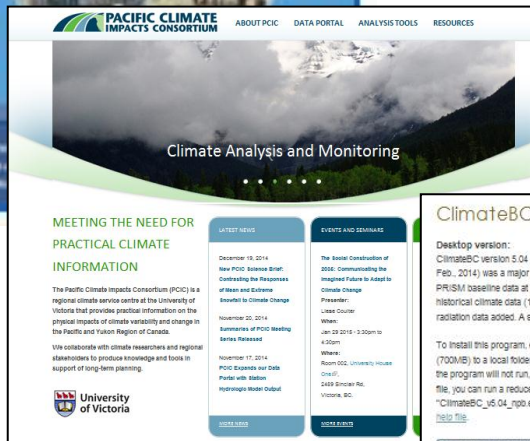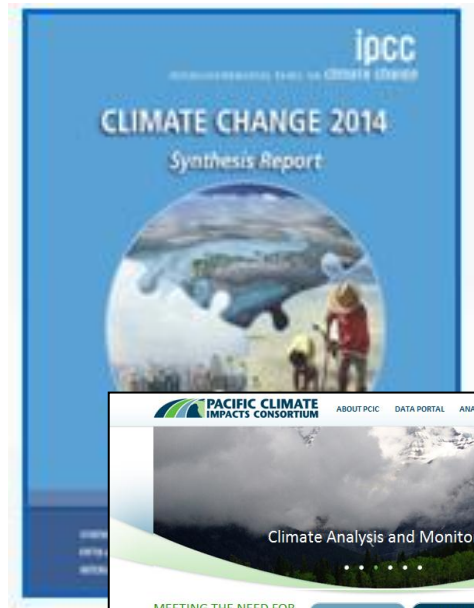
Characterizing Climate Change
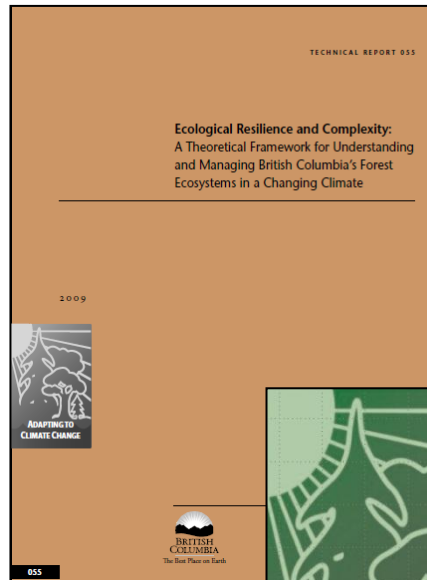
Providing Operational Guidance
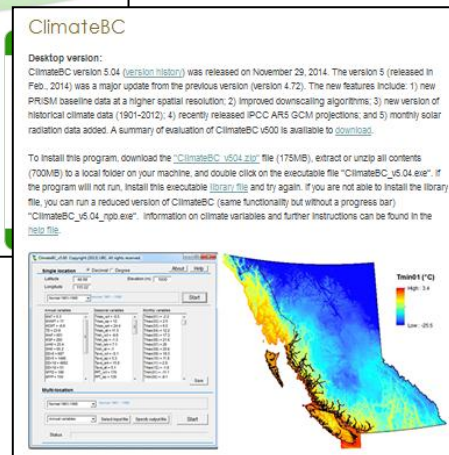
What is Climate Change?
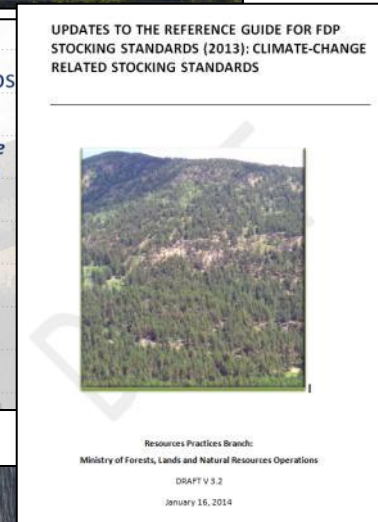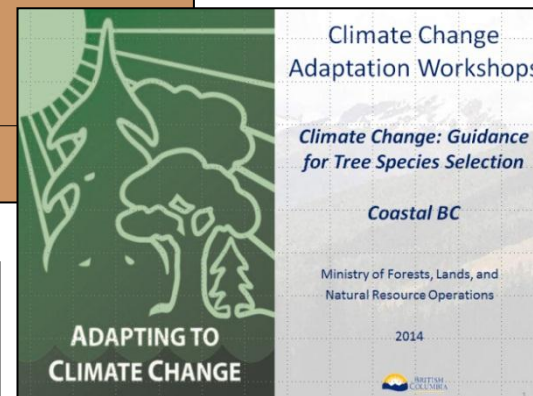
- Change to central tendencies
  - Generally wetter winters
  - Generally warmer summers
- Changes to variability
  - Greater extremes occurring more often
- Changes at multiple scales
  - Regional (e.g., BEC variant)
  - Subregional (e.g., a watershed)
  - Site level
  - Interactions across levels of climate influence
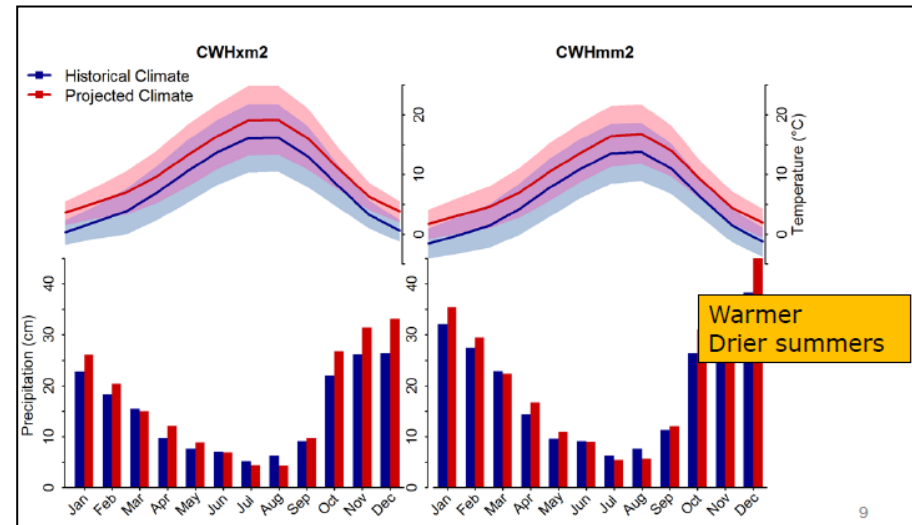
Carpenter et al. 2014

CGCM3.1 A2 emissions scenario 2061-2090

Detecting and Characterizing Climate Change

- Climate data
  - Baseline data, monitoring, model verification
    - PCIC Climate station network
  - Interpolated/modelled spatial layers (current)
    - ClimateBC/ClimateWNA
  - Projections (future)
    - IPCC
    - PCIC
    - ClimateBC
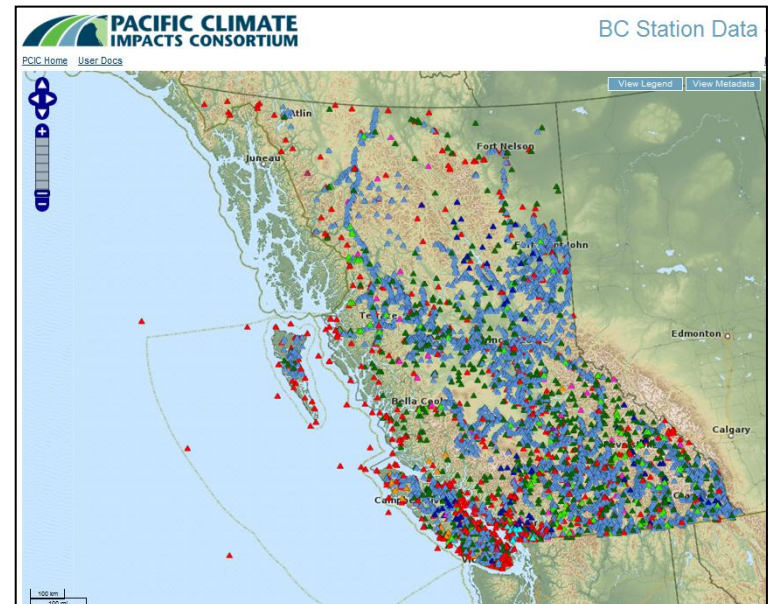
Predicting and Projecting Climate Change Across Scales

– Provincial- BEC
  - BGC zone/variant level (Wang et al.)
  - Transboundary - US PNW, SE AK (MacKenzie et al.)
  - Strathcona TSA (Jones)

– Species
  - Tree species (and ecosystems) (Gray; Rehfeldt; Iverson)
  - Dry coastal species (CDFmm and CWHxm) (Klassen)
  - Seed source and deployment zones (O'Neill)
  - Plant hardiness zones (CFS - McKenney)

– Site level/site types
  - Sayward Forest (Dunbar & Dymond)
  - Dry south coast climate change project (MFLNR)

Shamaya Consulting and Forsite Consulting

(Jones 2008)

Page 21
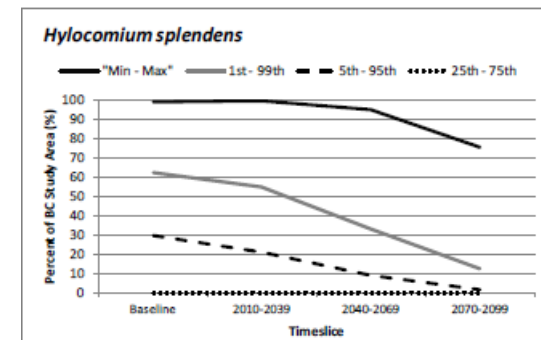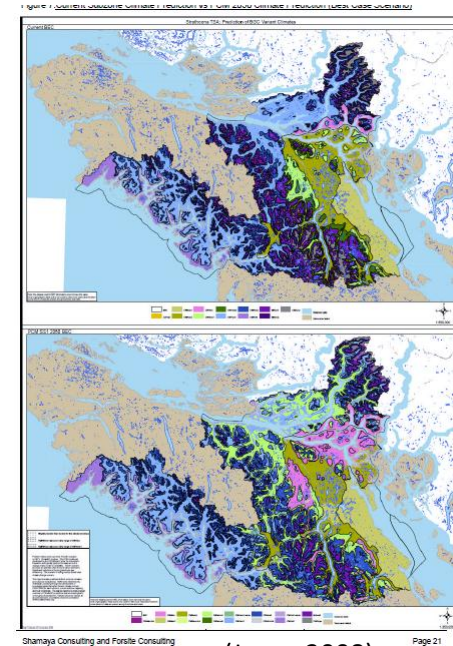
Climate Change Impacts on Forests and Landscapes

- Regional climate (distributions of BEC units)
  - Shift of units upward in elevation? Loss of alpine?
- Potential species ranges (bioclimate envelopes)
- Ecosystem processes
  - Regeneration
  - Productivity
  - Competition
  - Decomposition (nutrient turnover, availability, storage)
- Disturbance regimes (wind, landslide, flood, fire)
- Hydrological regimes
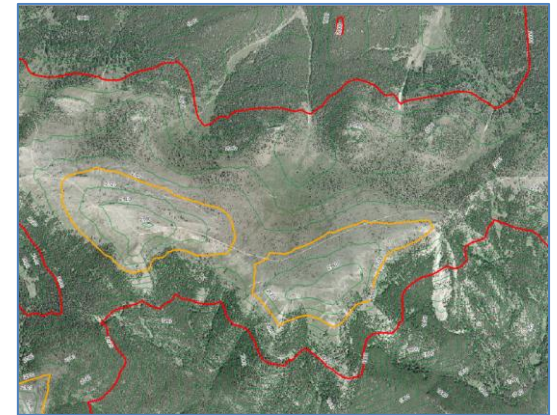
*Greater uncertainty
- Nature of the landscape
- Response to management and to other disturbances

Climate Change Research –
Modelling Bioclimate Envelopes for BEC Variants

A) Currently mapped B) Modeled C) Predicted for 2001-2009
D) Predicted for 2010-2039 E) Predicted for 2040-2069 F) Predicted for 2070-2099
G) Model agreement for 2010-2039 H) Model agreement for 2040-2069 I) Model agreement for 2070-2099
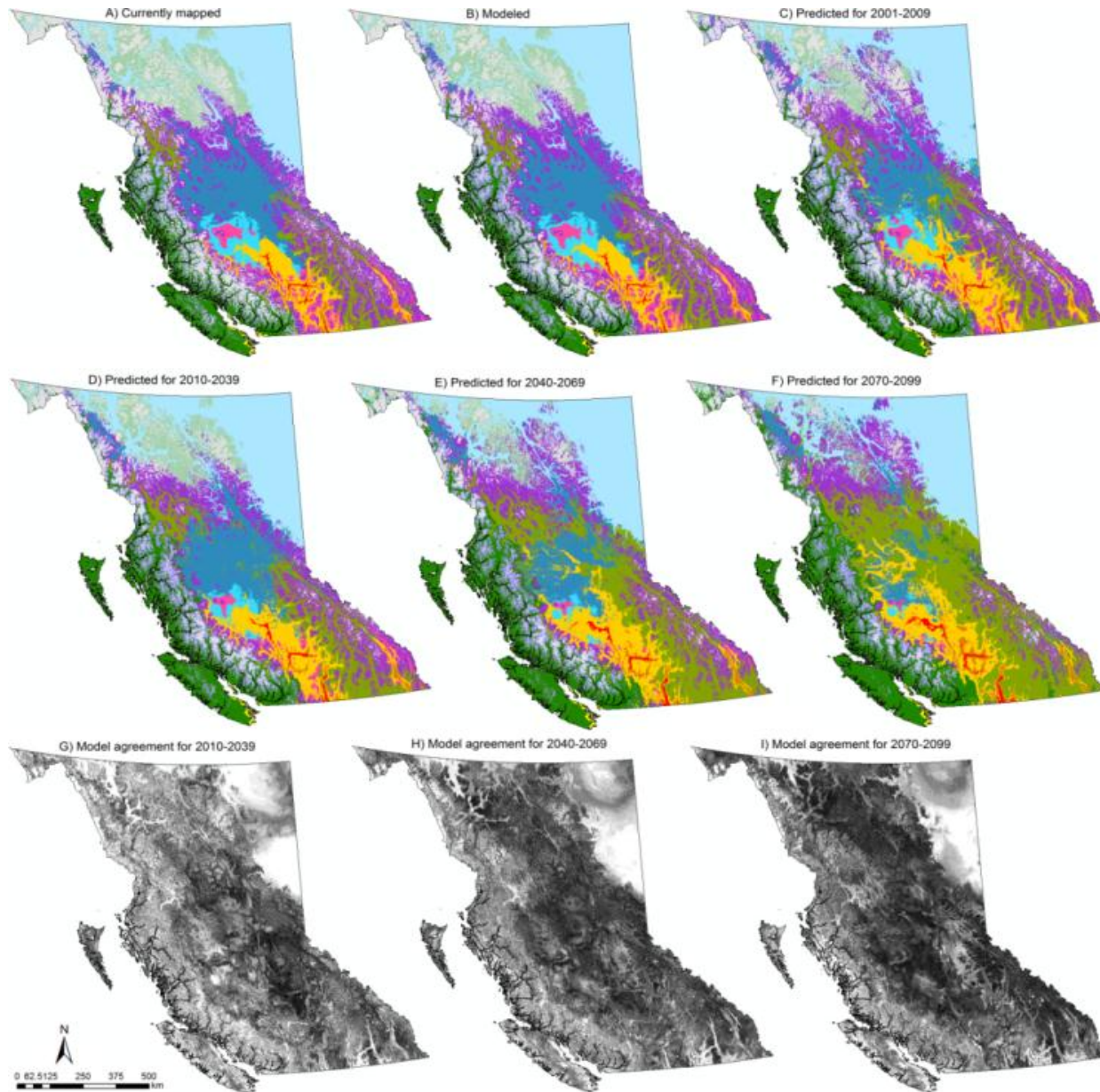
- Geographic distribution of BEC zones using consensus of 20 climate change scenarios

- Model agreement varies in time and across BEC units

Wang et al. 2012

Climate Change Research – Modelling Distributions of Species or Site Series

Klassen 2012
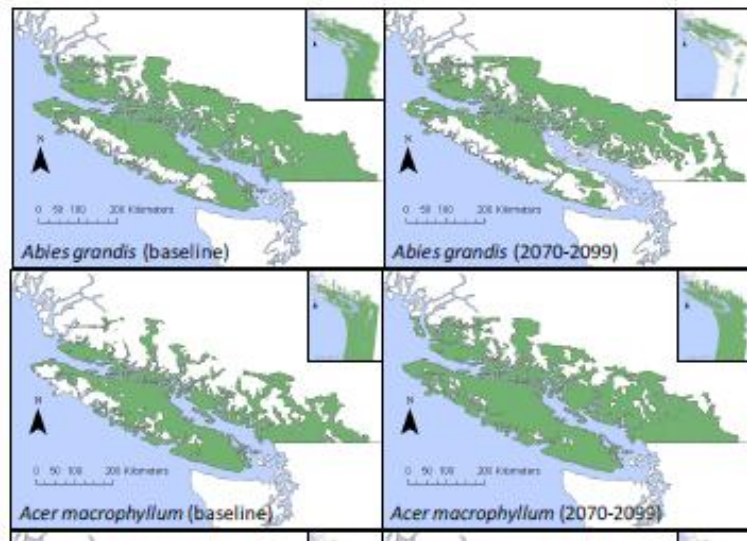
Carpenter, et al. 2014

- Projections of bioclimate envelopes suggest that tree species will respond differently across space and time with projected changes to climate
  - Some may decline (Bg)
  - While others thrive (Mb)
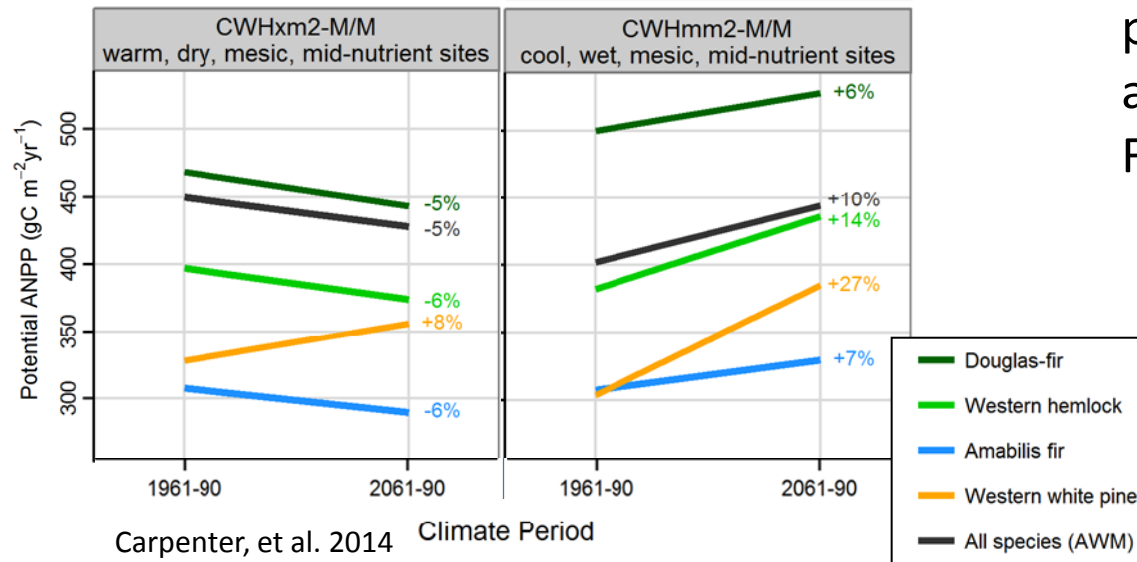
- Trends in projections of productivity vary across species and site types in the Strathcona Forest
  - Surprising results for these "cooler" site types?
  - Models suggest hypotheses for structured field research

Climate Change Research – field projects

Dry South Coast Ecosystems Climate Change Project

- Quantification of climate-site-vegetation relationships
  - understanding dynamics of complex systems
  - assessing ecosystem and landscape-level models of resilience
- Basis for testable hypotheses and prediction of potential changes to these ecosystems under cumulative stress
- Recommendations for attributes that can be monitored in the field as indicators of climate shift

CDFz (40-130 m)
June 1, 2010 – May31, 2013   9.3C   657 mm

CWHz (40-250 m)
2010-2013   8.8C   886 mm

Sampling Transect
CDF mm
CWH xm
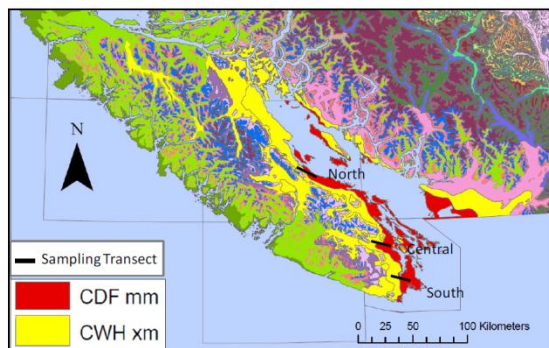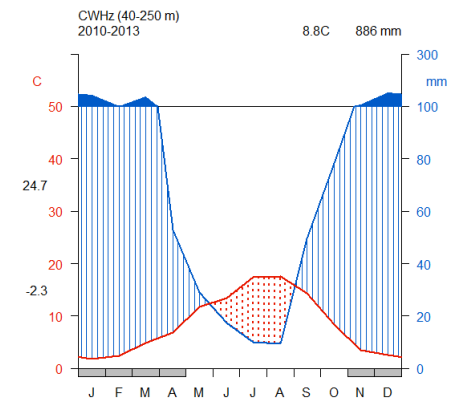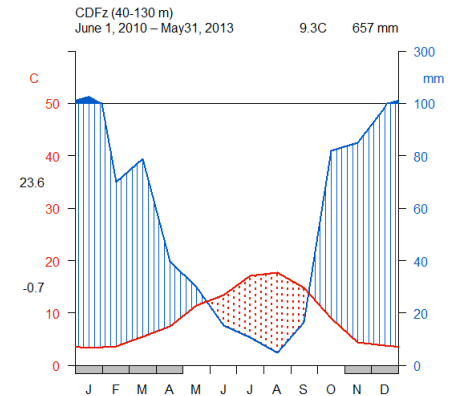
Climate Change Research – field projects

– Coast Experimental Watersheds Project (CEWs)

  • Retrospective and experimental work by physiographic unit and hydrologic regime (anticipate homogeneous response to climate change)

    – Geomorphic and fluvial disturbance

    – Hydrological regime

  • High elevation weather stations – detection of change and validation of models
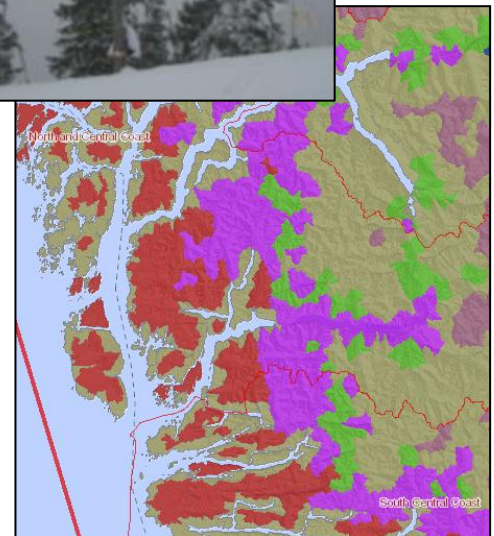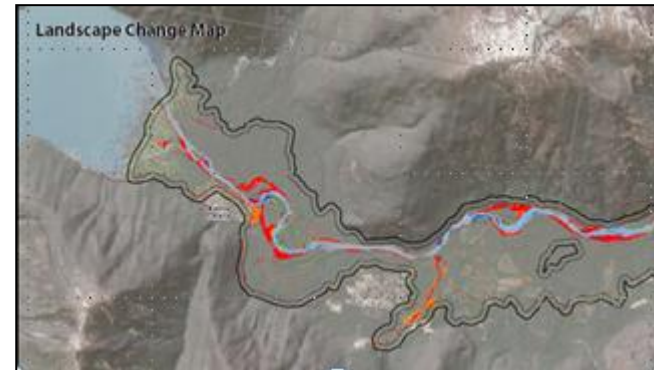
Climate Change Research – lots of related initiatives are underway on the coast!

- FLNR tree breeding programme
- Ectomycorrhizal spatial ecology and implications for assisted migration (Kranabetter et al. 2014)
- Evolutionary responses of tree populations to climate change and experimental tree planting (high elevations), Aitken lab, UBC

Forest Management Under Climate Change - Strategic Guidance

- Chief Forester's Memo on Stand and Landscape Level Species Composition (2009)

- FLNR Forest Stewardship Action Plan for Climate Change Adaptation(2012-2017)

- FLNR Climate Action Roadmap (2013)

- FLNR Climate Change Strategy (2013-2018)

- FLNR Coast Climate Change Action Plan
  - Threats, vulnerabilities
  - Impacts
  - Actions (mitigation and adaptation)
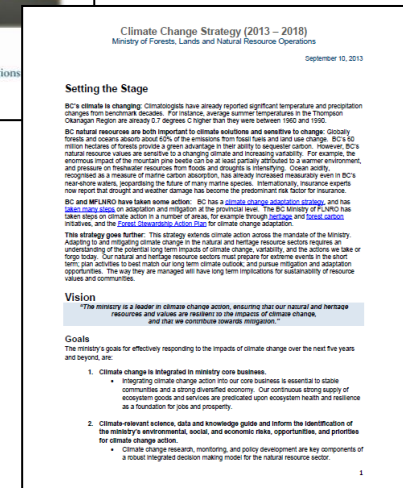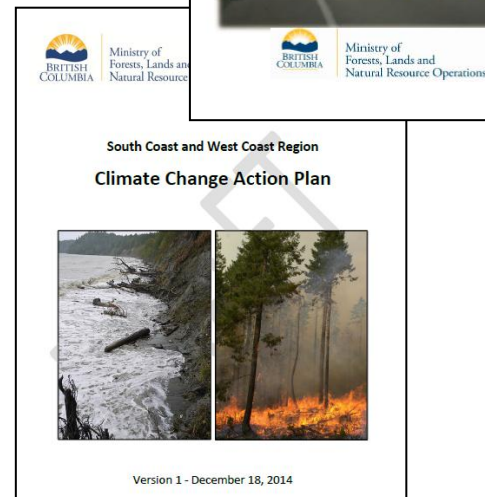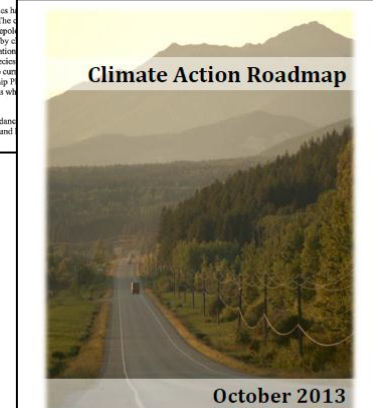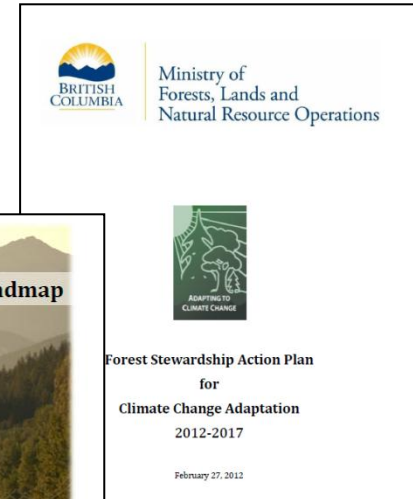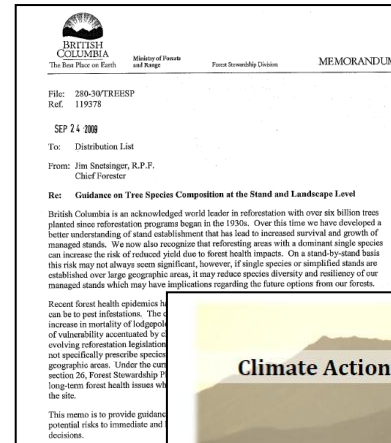
Climate Change Operational Tools - updates to BEC classification, mapping, interpretations

- Changes to climate, changes to technology, changes to management...
  - Climate data
  - Mapping software
  - Modelling techniques
- BEC updates - use of climate data with plot data
  - Revised classification
  - Refined mapping
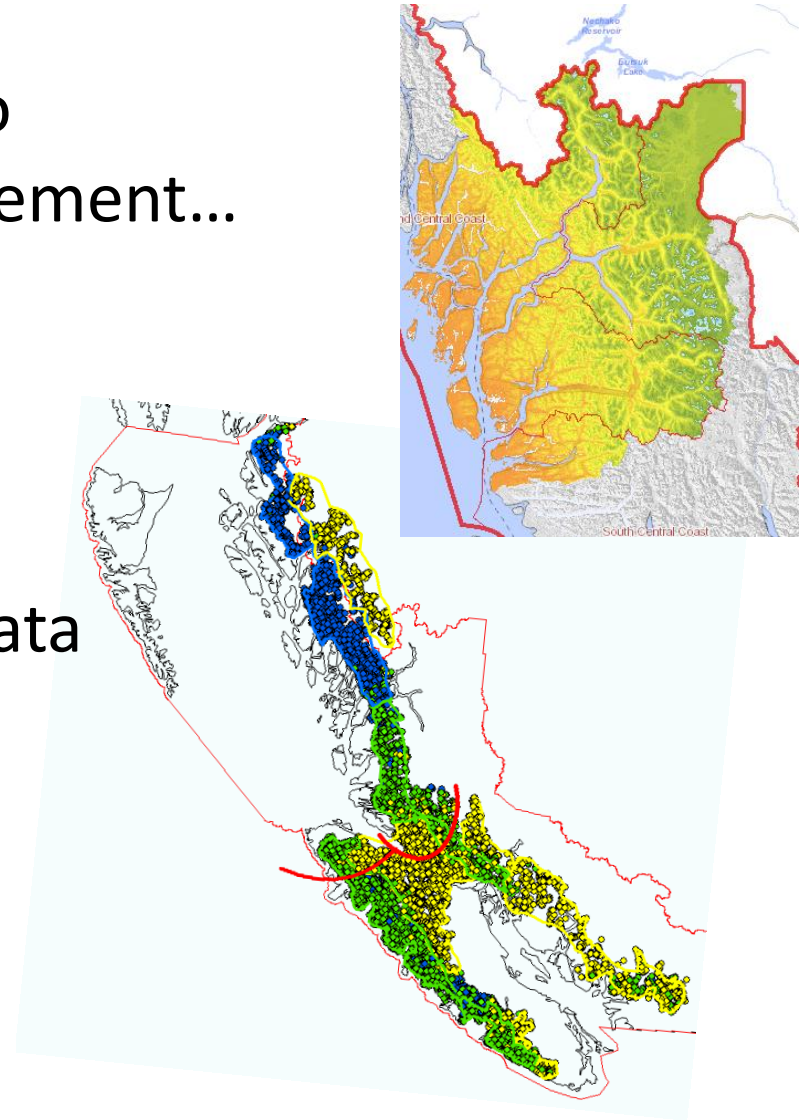
Climate Change Operational Tools – tree species diversity across scales

- Maintain ability of an ecosystem to *respond* to environmental change (including climate change)
- Reduce ecosystem *vulnerability* to any single future disturbance event
- Improve the potential for an ecosystem to *reorganize* following disturbance (maintain function)

A Diversity Approach Would…

- Promote and accept a wider range of management intents
- Encourage species mixes
- Reduce levels of species conversion in landscape
- Consider uncertainty and climate change in species selection
- Reduce efforts to bring all stands to a uniform standard
- Encourage experimentation and adaptive management
- Evaluate success at a landscape scale to allow variable management at the stand level
- Evaluate success over longer time scales
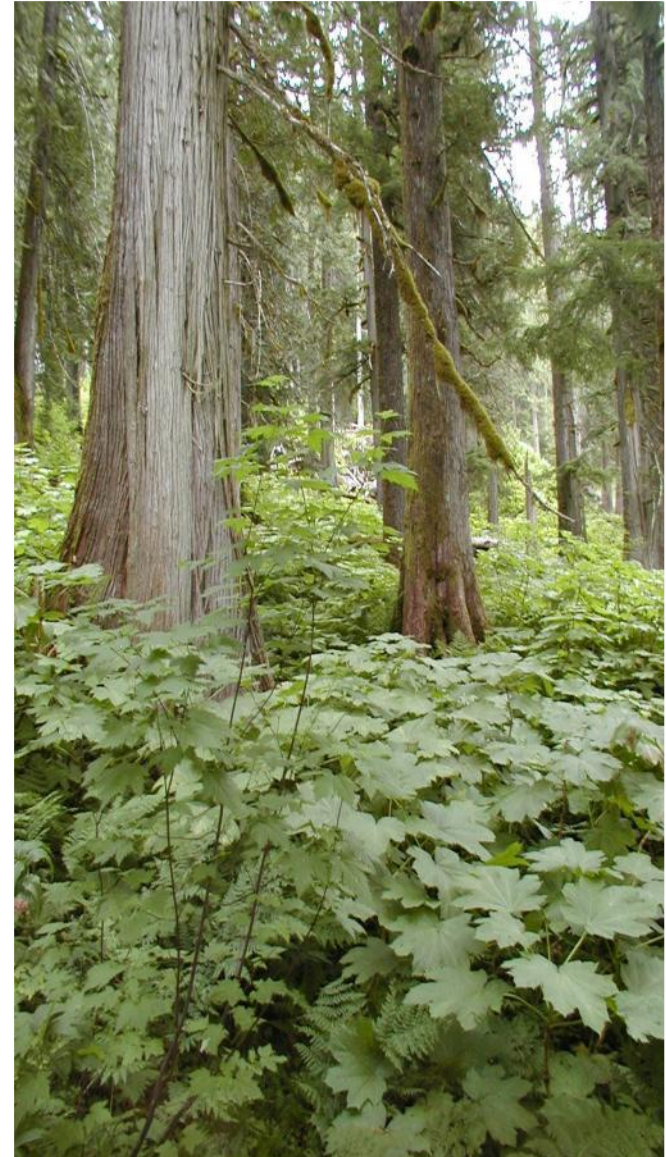
Climate Change Operational Tools

- ## Tree Species Selection Tool
  - ### Ecological suitability (by BEC unit)

    "Coniferous or deciduous tree species that are adapted to a site's environmental conditions, including the variability in these conditions that may occur over time."

  - ### Landscape level diversity guidance

Tree species diversity - Stand Scale

Tree Species Diversity:

•Reduces:
- risk of complete stand failure
- pest outbreak severity

• Enhances:
- stand yield in a changing environment
- structural attributes of habitat diversity
- range of forest products

MHmm1/01 Proportional Projection 2020

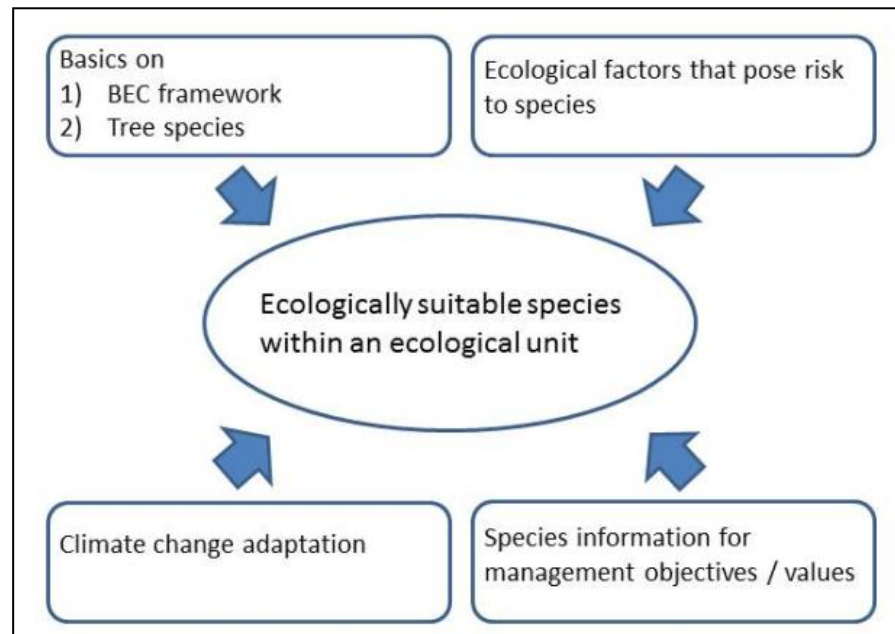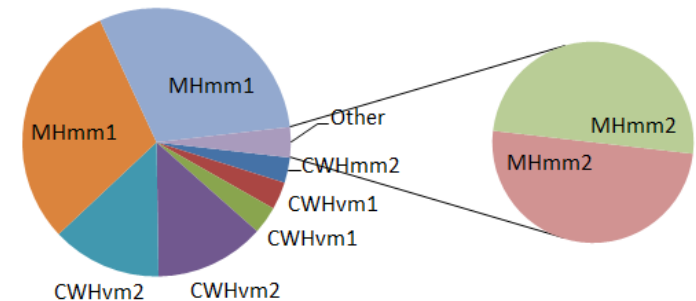| 2020	Region	Series	Act	Ba	Bl	Bp	Cw	Dr	Fd	Hm	Hw	Mb	Se	Ss	Yc	Proportion
CWHmm2	Vancouver	01		-1		-1	2		2	0	2		1		-1	5.18%
CWHvm1	Pr Rupert	01		0		-1	3	add		-3	1			2	-3	5.64%
CWHvm1	Vancouver	01	add	0		-1	3	add	2	-3	2	add		1	-3	5.64%
CWHvm2	Pr Rupert	01		0		-1	2			-2	1			2	-1	22.43%
CWHvm2	Vancouver	01		0		-1	2		3	-2	2			2	-1	22.43%
MHmm1	Pr Rupert	01		0		-1				0	0				0	51.00%
MHmm1	Vancouver	01		0		0				0	0				0	51.00%
MHmm2	Pr Rupert	01		0	1	-1				0	0				-1	3.09%
MHmm2	Vancouver	01		0	1	0				0	-1		2		-1	3.09%
CWHmm2	Vancouver	01		2			2		2	1	1		3		2	
CWHvm1	Pr Rupert	01		1			1	4			2			2		
CWHvm1	Vancouver	01	4	1			1	4	2		1	4		3		
CWHvm2	Pr Rupert	01		1			2			3	2			2	2	
CWHvm2	Vancouver	01		1			2		1	3	1			2	2	
MHmm1	Pr Rupert	01		1						1	3				1	
MHmm1	Vancouver	01		1		3				1	3				1	
MHmm2	Pr Rupert	01		1	3					1	3				2	
MHmm2	Vancouver	01		1	3	3				1			2		2	

Tree species diversity - Landscape Scale

Landscape Level Diversity:

Reduces:

- Cumulative effects of individual stand-level decisions
    - risk of widespread losses from species-specific pests
    - spread and impact of other natural disturbances (e.g., fire)

- Enhances:
    - flexibility in stand management while meeting broader targets
    - feasibility of evaluating experimental options

W. MacKenzie

Tree Species Selection Tool:
BEC ZONES: Coastal Western Hemlock
CWHvm1 - Submontane Very Wet Maritime

Old forests dominate the CWHvm1 landscape (61% of the forested are consists of age class 7-9 forests), though about 20% of the forested area consists of younger natural stands resulting from landslide and windthrow events as well as some wildfires. A significant portion of the CWHvm1 landscape (18% of the forested area) consists of immature stands resulting from forest harvesting. Most of this harvested area occurs south of the North Coast Forest District, and stands are mostly less than 40 years old, though some older second growth stands up to 80+ years old are scattered along the coast. Evidence of hand logging (removal of single trees or small groups of trees) is prevalent along some coastal inlets. In recent years significant helicopter logging, targeting redcedar, has also occurred on the mid and north coast. Old natural stands are western hemlock and redcedar – dominated (36% and 34% respectively), often with an amabilis fir component. Sitka Spruce occurs on nutrient rich sites and some yellow cedar and shore pine are found on poorer, wet sites. Douglas fir occurs only in the southern portions of the CWHvm1. Younger natural stands also tend to be hemlock – cedar dominated, though many have a significant red alder component and variable amounts of the other coniferous species, depending on the disturbance history. Some southern fire-regenerated second growth has a significant Douglas fir component.

Age class distribution as a % of total forest area [Source: VRIMS 2008]

Stand age class	7-9 natural forest	7-9 harvested forest	4-6 natural forest	4-6 harvested forest	1-3 natural forest	1-3 harvested forest
% of total forest area	61	0	10	1	10	18

Tree species distribution in natural old/mature (age class 7-9) and natural immature (age class 4-6) as a % of the total natural old/mature and natural immature forest cover respectively [Source: VRIMS 2008]

Species	B	Cw	Fd	Hw	Ss	Yc	Dr	Pl
% of total natural old/mature (age class 7-9) forest cover	11	34	3	36	4	11	0	2
% of total natural immature (age class 4-6) forest cover	5	14	12	48	2	1	14	1

Operational Tools – Climate based Considerations for Tree Species Selection

- Bayesian Belief Network Tool
  - Evaluating suitable **species mixes** at the stand scale given BEC site series and future climate scenarios

- Climate based seed transfer
  - Based on analysis of the climate of source provenance and climate projections of deployment locations (O'Neill)
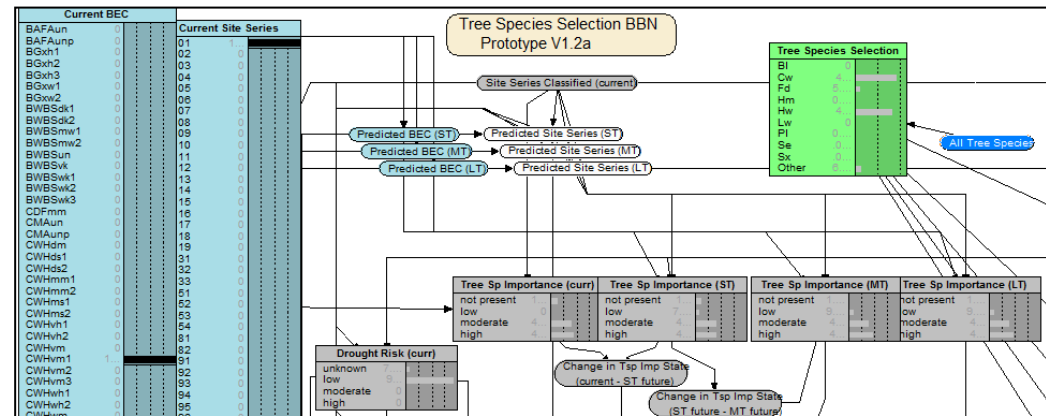
Climate Change Adaptation:
Transitioning to a Climate-Based (Forest Tree) Genetic Resource Conservation and Management System in British Columbia

Climate-Based Seed Transfer (CBST)

Project Charter

July 2012

Opportunities for Collaboration

– Field Data
- BEC plots
- Mensuration
- Microclimate

– Suggestions for BEC mapping and classification improvements

– Observations of climate change impacts

– Adaptive management approaches

– Joint development of experiments