Canadian Forest Service
Climate Change Program

PRF ASCC Workshop
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100+ years of forest service

The Canadian Forest Service provides science and policy expertise and advice on national forest sector issues. We promote:

- environmental leadership in Canada’s forest sector
- a visionary approach to sustainable forest management planning and policies
- a science and research-based understanding of the forests
CFS research and program portfolio
CWFC: Develop fibre based knowledge, tools and techniques to help the forest sector transition to a low-carbon economy and aid in Canada’s climate change mitigation and adaptation activities.

Forest Climate Change: Research to understand the risks to forest from climate change and to contribute to national climate change mitigation activities.
Some key roles of the CFS

• Lead on national forestry issues

• Enable sustainable forest management policy and practice through provision of knowledge, expertise, and tools

• Convene, coordinate, and facilitate knowledge sharing
Addressing challenges of Sustainable Forest Management (SFM) in a changing climate

• Managing increased uncertainty in an already complex system
• Challenging institutional and organizational norms
  – barriers, opportunities, enablers
  – planning and operations
  – reactive versus proactive approaches
  – predictive/optimisation management versus robust management
• Priming ‘potential’ requirement for transformational change
Climate change creates the need to think deeply about how forestry is conducted in Canada.

The underlying challenge facing sustainable forest management in a changing climate is uncertainty. An uncertain future calls for a transformation in the way forestry is conducted in Canada. Traditionally forestry has used the past to predict the future. This assumption simply does not hold true any longer.

The CCTF focused on providing knowledge and tools to prepare Canada’s forest sector for an uncertain future through proactive adaptation.
Over the past year CCTF released the last of its reports:

1. Assisted Migration (Ste.-Marie): provides a summary of Assisted Migration issues and feasibility (released June 2014)

2. Criteria and Indicators in a changing climate (Williamson and Edwards): provides background on how SFM C&I may be affected by climate change impacts (e.g., do the C&I capture CC impacts?) and calls for a national conversation to be started on how to include climate change into SFM C&I (now a CCTF-2 objective) (released June 2014)

3. A guidebook for assessing vulnerability and mainstreaming adaptation into decision making (Edwards et al.). Provides structured guidance for forest resource professionals to assess vulnerability of SFM and identify implementable adaptation options. – hard copies released this week; not officially released publically yet. Was announced by Ministers in June 2014.
**Methodology considerations**

General and applicable across a range of scales (from strategic to operational) and jurisdictional contexts

Useful and practical in aiding forest managers in identifying adaptation options and implementing adaptation measures – it is not a prescriptive guide to adaptation

The framework should be easily understood by Canadian forest practitioners and easy to apply

Consistent with international and national assessments

Ultimate goal of CCFM adaptation approach - mainstreaming adaptation into all aspects of SFM (stage 6).
Vulnerability:
In the context of climate change, the degree to which a system is susceptible to, and unable to cope with, the adverse effects of climate change, including climate variability and extremes. It is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity (Parry et al. 2007)

CCFM approach is a systems approach to adaptation. Need to consider biophysical elements (climate, forests, habitat, water, etc.) and human elements (people, values, management objectives, etc.). The incorporation of human elements into the SFM VA process is rather unique and offers a slightly different approach than ecosystem VA. By explicitly incorporating management objectives and organizational & institutional adaptive capacity into the process one can determine the vulnerability of SFM objectives to climate change impacts.
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provides practical guidance for applying the CCFM SFM Vulnerability Assessment and Adaptation Framework.

provides a structured decision-making process for acquiring climate change knowledge to help guide SFM adaptation decisions and actions

focuses on how to assess the vulnerability of SFM system (objectives) to climate change and identify options for mainstreaming adaptation into decision making

Examples of Vulnerability Assessment using the CCFM approach

http://www.iea.org/energy/energyefficiency/energystandardization/

Contact: Sheri Andrews, Saskatchewan Research Council

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1. Many of the models and analyses upon which the key findings are derived have yet to be peer reviewed by the external scientific community.
2. The models and methods used were selected partly on the basis of which models and methods were most appropriate and efficient given the timeline and requirements of the assessment. Other models and methods may generate different results, and therefore, may provide different key findings.
Now that I have covered the context, let’s talk about forest change

We deliver the program in three major components

First the Tracking System which is designed to report on indicators of climate change impacts in order to raise awareness, informing monitoring efforts and adaptation decision-making

The second component is the Adaptation Toolkit—which includes a range of practical tools and knowledge products based on scientific research to support adaptation

And lastly the Integrated Assessment – For this piece, we, the CFS become the users of information. We bring together knowledge from a range of disciplines to develop an integrated picture of the combined effects of multiple climate-related impacts on Canada’s forests and forest sector from the present until 2100
### CFS Forest Change Indicators

<table>
<thead>
<tr>
<th>System</th>
<th>Topic</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate</td>
<td>Drought</td>
<td>• Climate Moisture Index (CMI)*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Palmer Drought Severity Index (PDSI)*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Soil Moisture Index (SMI)*</td>
</tr>
<tr>
<td></td>
<td>Fire weather</td>
<td>• Start + end + length of fire season*</td>
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<tr>
<td></td>
<td>Growing season</td>
<td>• Length of growing season*</td>
</tr>
<tr>
<td></td>
<td>Permafrost</td>
<td>• Permafrost temperature</td>
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<tr>
<td>Forest</td>
<td>Tree species distribution</td>
<td>• Distribution of tree species*</td>
</tr>
<tr>
<td></td>
<td>Fire regime</td>
<td>• Annual area burned*</td>
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<tr>
<td></td>
<td></td>
<td>• Number of large fires*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fire seasonality*</td>
</tr>
<tr>
<td></td>
<td>Tree mortality</td>
<td>• Percent annual loss of living tree biomass *</td>
</tr>
<tr>
<td></td>
<td>Pest incidence</td>
<td>• Pest species distribution</td>
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<tr>
<td></td>
<td>Forest growth</td>
<td>• Radial growth trends</td>
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<td></td>
<td>Phenology</td>
<td>• Timing of budburst</td>
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<td></td>
<td>Windthrow</td>
<td>• Uprooting return interval</td>
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<tr>
<td>Human</td>
<td>Cost of fire protection</td>
<td>• Wildfire suppression resource expenditures*</td>
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<td></td>
<td>Wildfire evacuations</td>
<td>• Number of evacuations &amp; evacuees*</td>
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<td></td>
<td></td>
<td>• Evacuations location*</td>
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<td></td>
<td>Wildland Urban Interface</td>
<td>• Population at risk of forest fire</td>
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<tr>
<td></td>
<td>Transportation</td>
<td>• Freeze-thaw of winter roads</td>
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</table>
How are the indicators presented on the website?

- Why drought is important
- Read how drought and its indicators are defined
- What has changed
  An example for drought: CMI in the aspen parkland
Indicator outlook

3 time periods
- Short-term: 2011-2040
- Medium-term: 2041-2070
- Long-term: 2071-2100
Reference period: 1981-2010

3 greenhouse gas emissions scenarios
- Representative Concentration Pathway (RCP) 2.6: Rapid emissions reductions
- RCP 4.5: Moderate emissions reductions
- RCP 8.5: Continued emissions increases

[Map of Climate Moisture Index (CMI) under different climate scenarios and timeframes]
Downloadable maps and data

- PDF
- Shape
- Raster
- txt/xs
- NetCDF
- ASCII

Downloadable files:

<table>
<thead>
<tr>
<th>Topic</th>
<th>Subject</th>
<th>Scenario</th>
<th>Data</th>
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</thead>
<tbody>
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<td>Drought</td>
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<tr>
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<td>Soil Moisture Index (SM)</td>
<td>3/5</td>
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<th>Type</th>
<th>Format</th>
<th>Author(s)</th>
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<td>D. T. Price, E. H. Hogg, D.W. McKeaney</td>
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<td>xls</td>
<td>D. T. Price, E. H. Hogg, D.W. McKeaney</td>
<td>Download</td>
</tr>
</tbody>
</table>
Adaptation tools and resources are available

**FOREST**
- Canada's Plant Hardiness
- SeedWhere
- Assisted migration of tree species
- Canada's National Forest Inventory
- Bioclimatic Mapping of Forest Insects and Diseases
- Spatial Discrete Event Simulation
- Forest Change Data Catalogue

**HUMAN**
- CCRM reports
- Database of adaptation options
- PlantWatch
- Forest Adaptation Community of Practice (FACoP)

**CLIMATE**
- Climate modelling
- Climate data for modelling

WWW.CFS.NRCAN.GC.CA/FORESTCHANGE
CFS National Integrated Assessment

- **Initial vision**: internal science-policy exercise to guide Federal policy and investment

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The cumulative effects of disturbances and other changes to the forest will be complex

- Pests, such as mountain pine beetle, and drought may leave trees more susceptible to fire, and could lead to a doubling of the annual area burned by the end of this century.
- Projected changes to forest productivity and tree species composition will add to the cumulative effects on forests
• This analysis includes risk of fire, drought, mountain pine beetle and spruce budworm.

• Most regions of Canada are already susceptible to disturbances of one form or another. The impact that climate change is projected to have is an increase in the intensity and extent of overall disturbances.

• Forest Sector Regions that are exposed to the increase in disturbances are considered to be at higher risk.
Forest mitigation strategies: What to optimize?

Minimise net Emissions to the Atmosphere

Maximise Carbon Stocks

Non-forest Land Use

Forest Ecosystems

Biofuel

Wood Products

Fossil Fuel

Other Products

Source: IPCC 2007, AR4 WG III, Forestry

Land-use Sector

Forest Sector

Services used by Society

IPCC SRES scenarios
Forest mitigation options

- Increase (or maintain) forest area
  - Reduce deforestation, increase afforestation

- Increase stand-level carbon density
  - Silviculture, harvest systems with partial cover, avoid slashburning, reduced regeneration delays, species selection, fertilization, tree improvement programs

- Increase landscape-level carbon density
  - Longer rotations, conservation areas, protection against fire and insects

- Forest management technologies for mitigation portfolios exist and are implemented operationally.
Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3)

- An operational-scale model of forest C dynamics.
- Allows forest managers to assess carbon implications of forest management: increase sinks, reduce sources
- Builds on ~25 years of CFS Science
- Available at: carbon.cfs.nrcan.gc.ca

Kurz et al. 2009, Ecological Modelling
CBM-CFS3 builds on existing forest planning information

- Volume/age curve(s)
- Detailed forest inventory
- Litter fall and decomposition
- Volume to biomass conversion
- Disturbance(s)
- Land-use change(s)
- CBM-CFS3
- Results database

Harvest schedule

Harvest scheduling tool

e.g., Remsoft Spatial Planning System

Kull et al. 2016
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Summary

• CFS has a long history of forest science and programs supporting mitigation and adaptation
• We have the data, knowledge, and tools to start adaptation
• Stronger focus on local science-management partnerships is happening and more is required (e.g., PRF ASSC trial).