NATURAL RESOURCES CANADA - INVENTIVE BY NATURE

Forest Change: Climate change tools and adoption considerations

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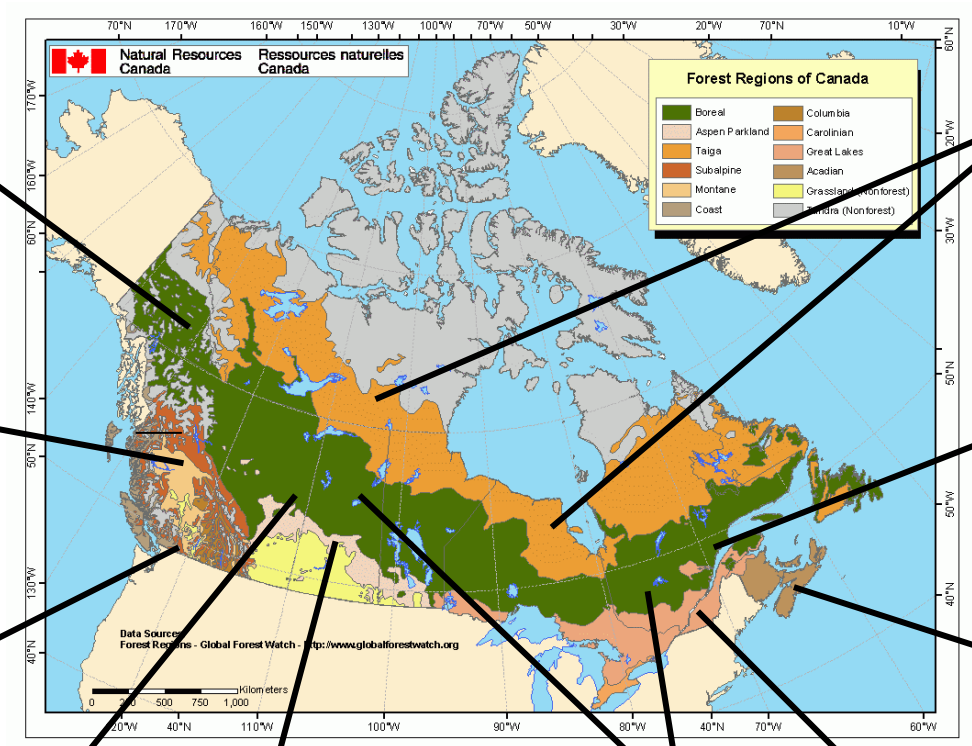
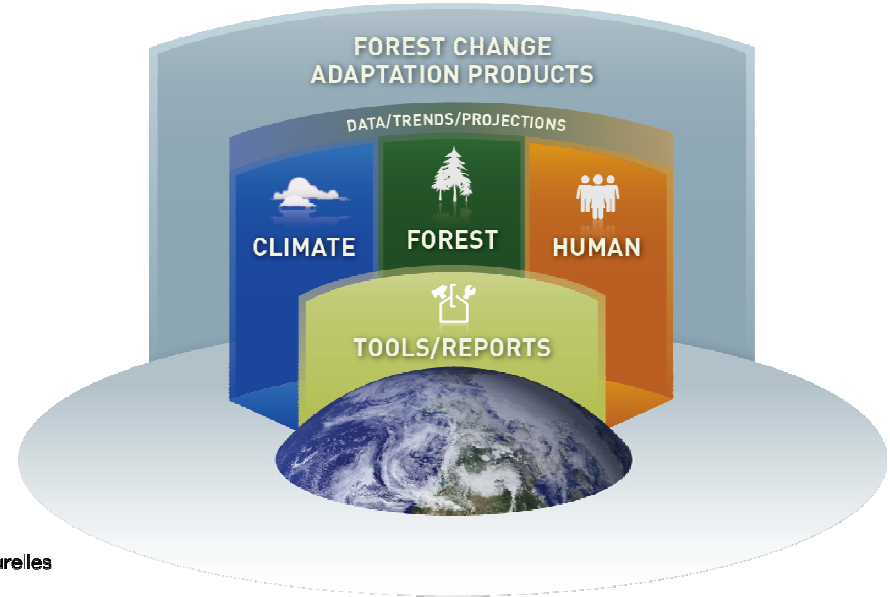
Climate change is already affecting Canada's forests

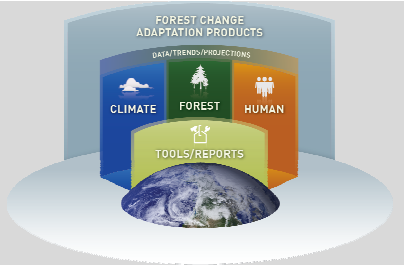


Forest Change Approach

Building on existing capacity, knowledge and expertise…

1. **A Tracking System** that reports on indicators of climate change impacts to identify forest sector vulnerabilities
2. **An Adaptation Toolkit** of actionable science for sustainable forest management under a changing climate
3. **Integrated Assessment** of climate change implications for the forest sector to guide policies and investment





Forest Change

Tracking System of Indicators

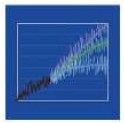
Integrated Assessment (IA)

Adaption Toolkit

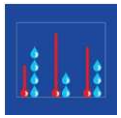
www.cfs.nrcan.gc.ca/forestchange

Links to tools and resources for adaptation

Climate

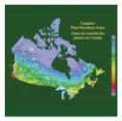


Climate modelling



Climate data for modelling

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

Mapping the Occurrence of Canada's Forest Pathogens

Forest Change Data Catalogue

National Tree Seed Centre

Human

CCFM reports

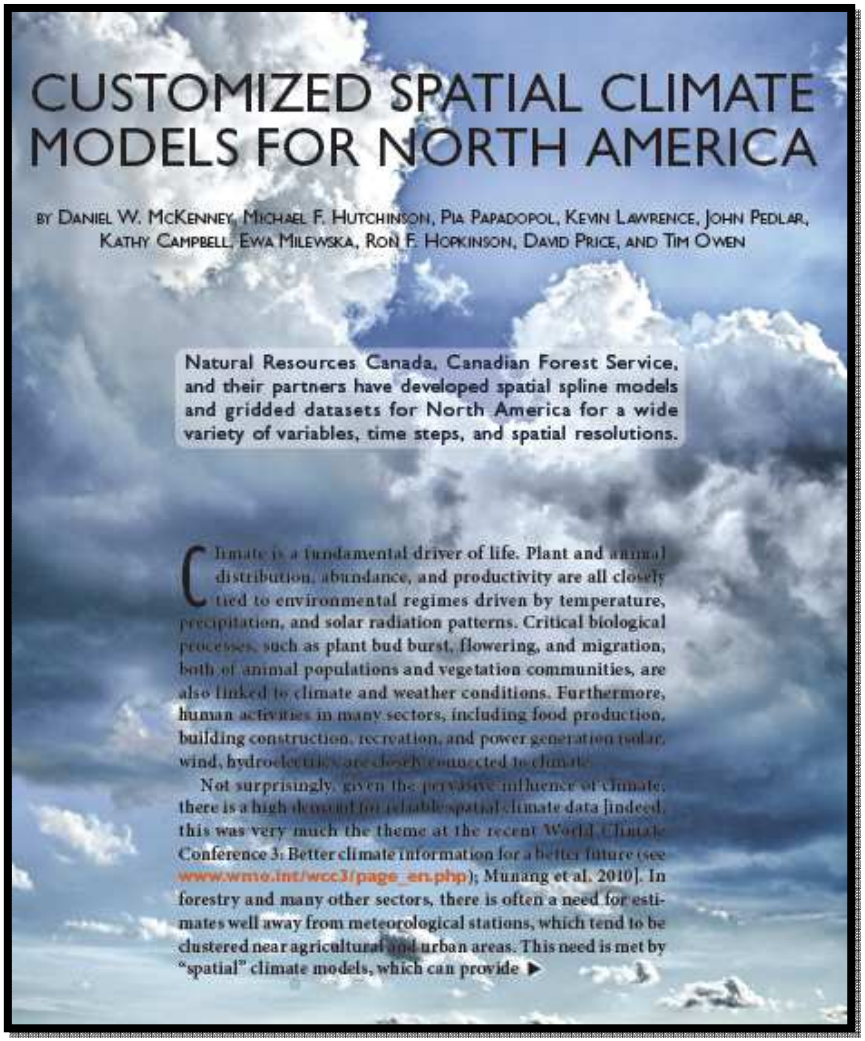
Database of adaptation options

PlantWatch

Forest Adaption Community of Practice (FACoP)

Spatial Climate Data

- Historical data (grids) starting from the late 1800s
- Over 80 variables available, including: MaxT, MinT, Precip, Growing Season, etc.
- Available for long-term means, historical monthly, and daily time steps
- Also Future data (grids) of downscaled IPCC AR5 scenarios for: 3 RCPs, 4 GCMs, 6 primary climate variables plus many more derived variables



McKenney, D.W. et al. 2011. Customized spatial climate models for North America. Bull. Am. Meteorol. Soc. 92(12): 1611-1622.

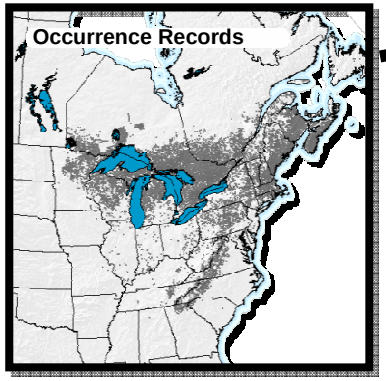
Spatial Climate Models

http://cfs.nrcan.gc.ca/projects/3

Plant Hardiness and species modeling

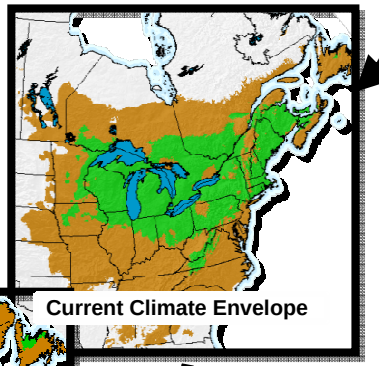
http://planthardiness.gc.ca

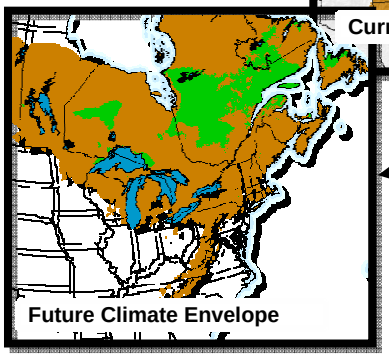
- Database contains approx. 3 million plant occurrence records for N.A.
- Data obtained from government agencies, NGOs, citizen scientists
- Climate envelope models have been generated for more than 3000 species
- Models indicate where suitable current and future climate may be found



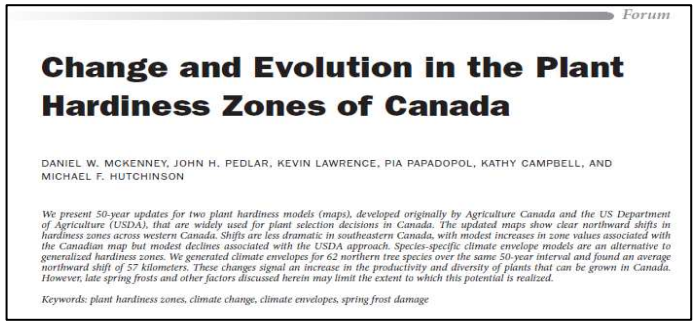
PARAMETER	MIN	5%	95%	MAX
Annual Mean Temperature	**1.2**	**3.9**	**15.8**	**19.5**
Mean Diurnal Range	6.8	10.2	13.7	14.6
Isothermality 2/7	0.21	0.24	0.39	0.44
Temperature Seasonality (C of V)	2.17	2.57	4.24	4.81
Max Temperature of Warmest Period	**18.8**	**25.4**	**33.3**	**35.2**
Min Temperature of Coldest Period	**-25.1**	**-20.7**	**-1.6**	**4.2**
Temperature Annual Range (5-6)	25.3	33.4	47.2	50.9
Mean Temperature of Wettest Quarter	-6.8	4	23.2	27.2
Mean Temperature of Driest Quarter	-16.1	-10.9	22	27.1
Mean Temperature of Warmest Quarter	12.8	17.4	25.7	27.6
Mean Temperature of Coldest Quarter	-16.4	-11	6	11.1
Annual Precipitation	**541**	**721**	**1437**	**2120**
Precipitation of Wettest Period	19	22	38	52
Precipitation of Driest Period	0	1	20	31
Precipitation Seasonality(C of V)	6	8	52	66
Prec				602
Pre				**469**
Precipitation of Warmest Quarter	**200**	**239**	**349**	**492**
Precipitation of Coldest Quarter	41	60	394	567

Climate Envelope Model





McKenney et al BioScience 2007, 2014



Forum

Change and Evolution in the Plant Hardiness Zones of Canada

DANIEL W. MCKENNEY, JOHN H. PEDLAR, KEVIN LAWRENCE, PIA PAPADOPOL, KATHY CAMPBELL, AND MICHAEL F. HUTCHINSON

We present 50-year updates for two plant hardiness models (maps), developed originally by Agriculture Canada and the US Department of Agriculture (USDA), that are widely used for plant selection decisions in Canada. The updated maps show clear northward shifts in hardiness zones across western Canada. Shifts are less dramatic in southeastern Canada, with modest increases in zone values associated with the Canadian map but modest declines associated with the USDA approach. Species-specific climate envelope models are an alternative to generalized hardiness zones. We generated climate envelopes for 62 northern tree species over the same 50-year interval and found an average northward shift of 57 kilometers. These changes signal an increase in the productivity and diversity of plants that can be grown in Canada. However, late spring frosts and other factors discussed herein may limit the extent to which this potential is realized.

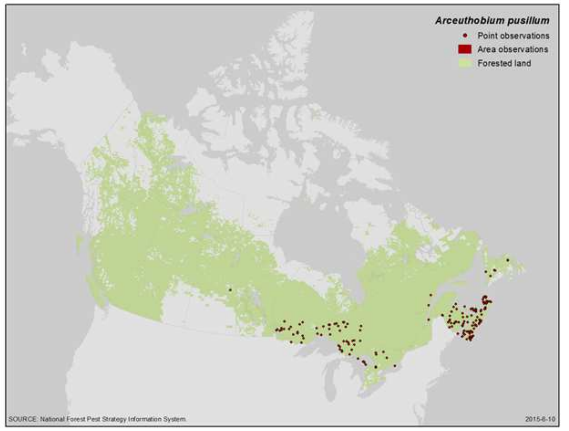
Keywords: plant hardiness zones, climate change, climate envelopes, spring frost damage

Forest Pathogens

Mapping the Occurrence of Canada's Forest Pathogens

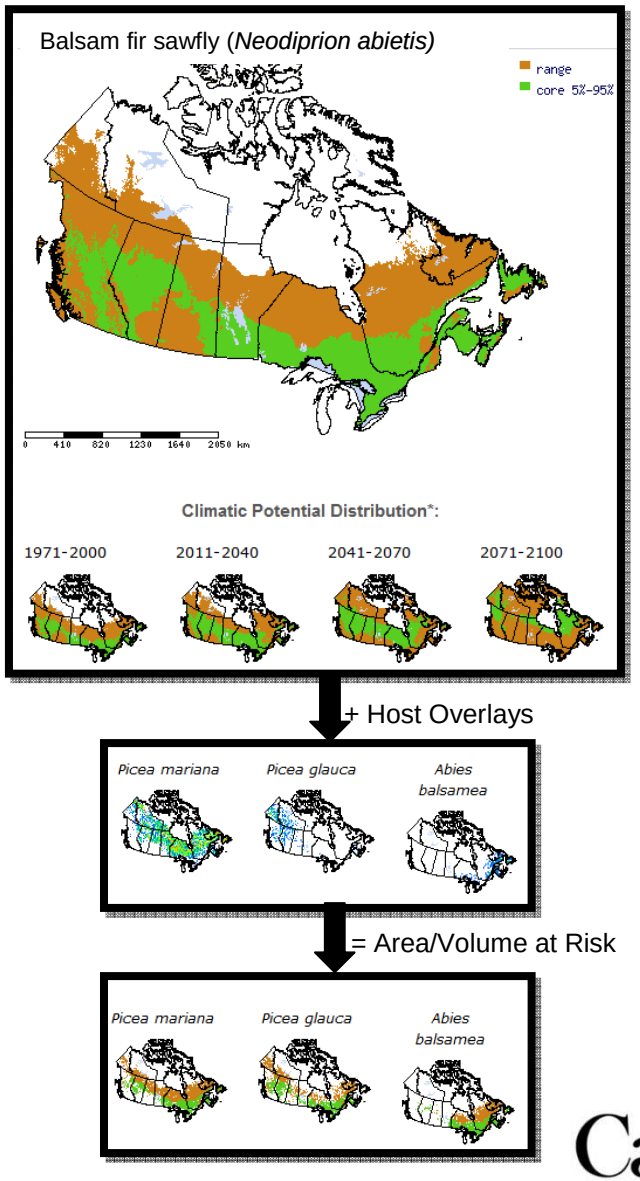
- A web application that provides 60+ years of broad-scale location data for native fungi and other microbes, many of which cause disease in Canada's forests
- Enables users to generate distribution maps for almost 3000 individual forest microbes including fungi and dwarf mistletoes
- Data and maps can be downloaded and used in other applications, e.g., integrated with maps or models of other disturbance agents

Rona Sturrock et al.



Risk Mapping of Forest Insects & Diseases

- database of historical insect and disease occurrences in Canada
- data obtained from sources (working on the inclusion of GBIF data)
- climate envelope models have been generated for more than 1500 species
- models indicate where suitable current and future climate may be found
- calculates area and volume of host species that are at risk to exposure in each time period



Catalogue of Provenance Trials

Written Report (PDF)

- Summary of each project
- 488 projects (1300 test sites)

Excel Database

- Test site locations
- Species
- Traits measured
- Site status
- Climate data (30-year averages)

By: Richard Winder

PFC# 49 All range lodgepole pine provenance trials

Database number	EP0657.06
Species	*Pinus contorta*
Year of establishment	1969
Number of populations	56

PFC# 9 Alberta G103 white spruce provenance trials

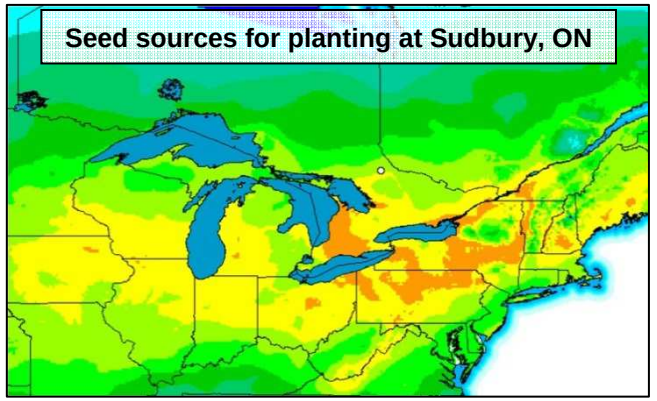
Database number	G103
Species	*Picea glauca*
Year of establishment	1980-1983
Number of populations tested	49
Geographic origin of tested populations	Alberta, Canada
Number of test sites	10
Geographic location of test sites	Hay River, AB; Zeidler Mill, AB; Sexsmith, AB; Swartz Creek, AB; Prairie Creek, AB; Chinchaga, AB; Calling Lake, AB; Virginia Hills, AB; Hanging Stone, AB; Calling Lake, AB
Traits measured	Survival, weather-related damage, tree form, height, DBH, insect damage, disease
Site status	Active
Relevance to climate change research	Wide range of latitudes
Contact person	Deogratias Rweyongeza

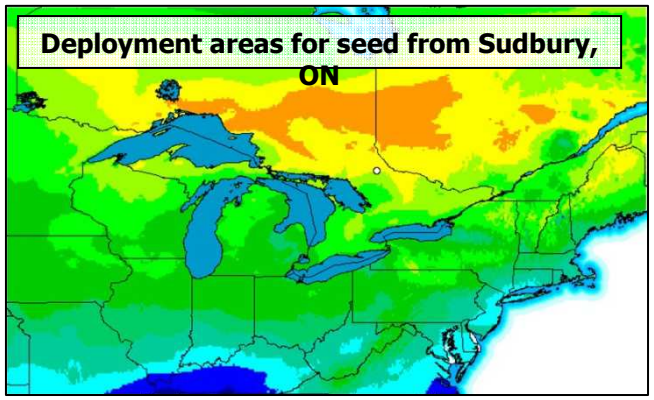
Catalogue of Provenance Trials

SeedWhere - a climate similarity mapping tool for seed source decisions

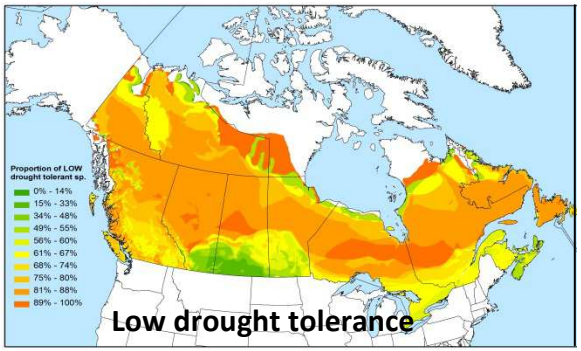
SeedWhere is a web application:

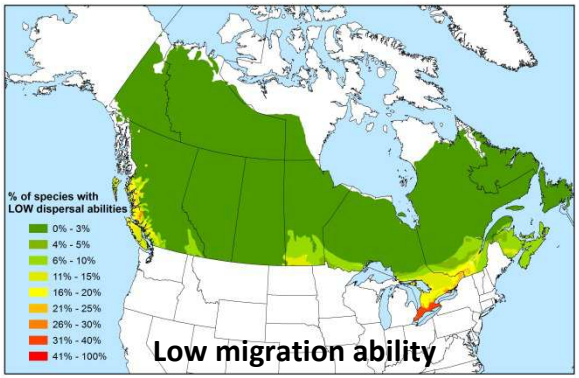
- Identifies areas with a current or future climate similar to the point of interest
- Can be used for both seed procurement and deployment





TOPIC Network: Traits of Plants in Canada

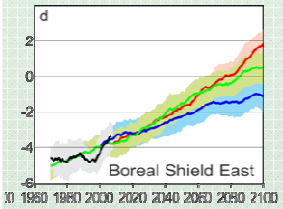




Isabelle Aubin et al

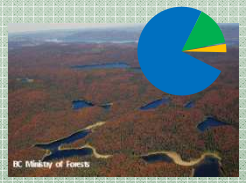
Ecological knowledge + biophysical predictors → INTEGRATED Vulnerability assessment

CLIMATE SCENARIOS

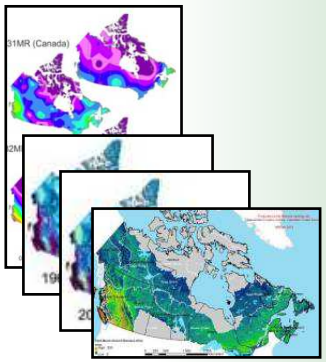


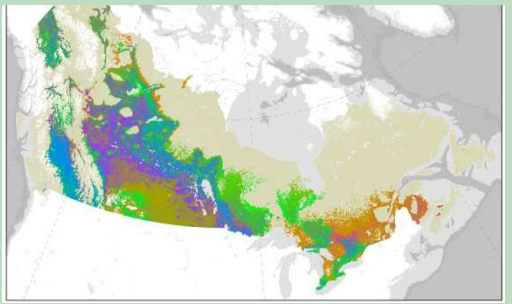
DROUGHT IMPACT

STAND COMPOSITION



SPECIES TRAITS





Map of Canadian tree vulnerability to drought

Integration of projected tree exposure & sensitivity to drought 2071-2100

Aubin et al. In preparation

Database of Adaptation Options

Forests

Adaptation options proposed in the literature

View adaptation options by reference

Showing 1 to 10 of 147 entries | Show 10 entries

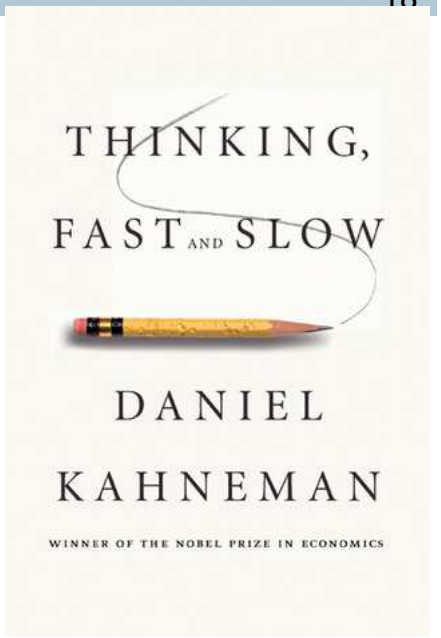
Filter items

Sub-system	Target areas of adaptation	General vulnerability	Detailed vulnerability	Adaptation option	References
Bio-physical	Enhance adaptive capacity	Forest productivity	Populations or species are no longer suited to site conditions	Plant broader and new mixes of tree species over landscapes	Campbell et al. 2009
Bio-physical	Enhance adaptive capacity	Forest productivity	Populations or species are no longer suited to site conditions	Plant species over a broader range of environments	Campbell et al. 2009
Bio-physical	Enhance adaptive capacity	Forest productivity	Populations or species are no longer suited to site conditions	Assisted range expansion: regional expansion of northern, inland, or upper elevational limit of species for reforestation to track climatic niches	Millar et al. 2007 Johnston et al. 2009 Pedlar et al. 2011 O'Neill et al. 2008
Bio-physical	Enhance adaptive capacity	Disturbances	Change in forest structure,	Maximize forested areas by quickly regenerating any degraded areas	Ogden and Innes 2007 Johnston et al. 2009

Looking forward

- NRCan adaptation program was renewed for 5 years (2016-2021) at the same level, building on Forest Change 1.0.
- Continued work on Tracking System; Tools; and "Regional" Integrated Assessments
- Visit our website – input and feedback are welcome
- http://www.nrcan.gc.ca/forests/climate-change/forest-change/17768

ADOPTION AND USE OF CC TOOLS



- Decision making is very complex
- Adoption is all about perceptions of costs and benefits
  - Many costs and benefits are subjective
  - Decision-makers (~7.5 billion of them on the planet now) must believe benefits outweigh the costs
  - "Transaction costs" are often overlooked
  - Uncertainty is rampant in climate change problems …for both impacts and the results of adaptation efforts
  - Time paths affect costs vs benefits
  - The interplay between public and private goods…particularly affects incentives
- Some of our "tools" seem to be very well used….why?

POLICY MECHANISMS TO SUPPORT ADOPTION

From Pannell, 2008. Land Economics

Category	Specific policy mechanisms included
Positive incentives	Financial or regulatory instruments to encourage change
Negative incentives	Financial or regulatory instruments to inhibit change.
Extension	Technology transfer, education, communication, demonstrations, support for community network
Technology development	Development of improved land management options, such as through strategic R&D, participatory R&D with landholders, provision of infrastructure to support a new management option.
No action	Informed inaction

ADOPTION AND USE OF CC TOOLS….

- NOTE the ultimate goal is aggregate changes to Economic, Environmental and/or Social conditions …small changes to big problems may be better than big changes to small problems…think about this when choosing your research portfolio!