Fire, forest management, and the carbon dynamics of Canada's managed forest over the 21st century

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Wildland Fire Canada
October 2010

Natural Resources Canada | Ressources naturelles Canada

Canada

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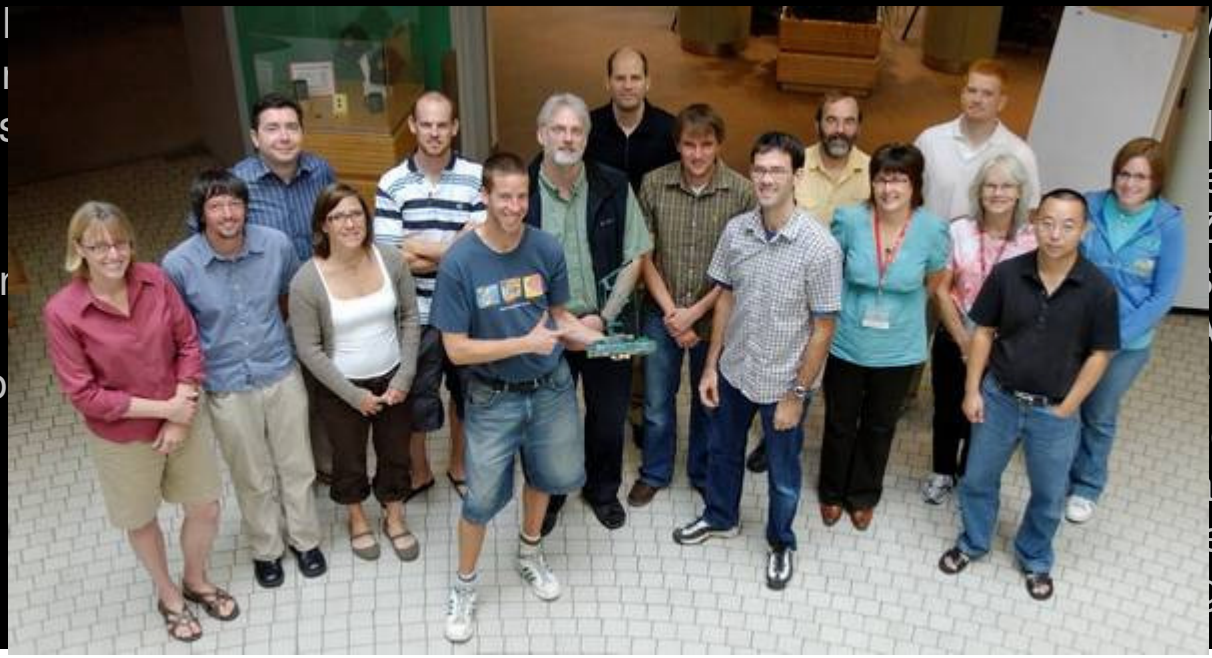
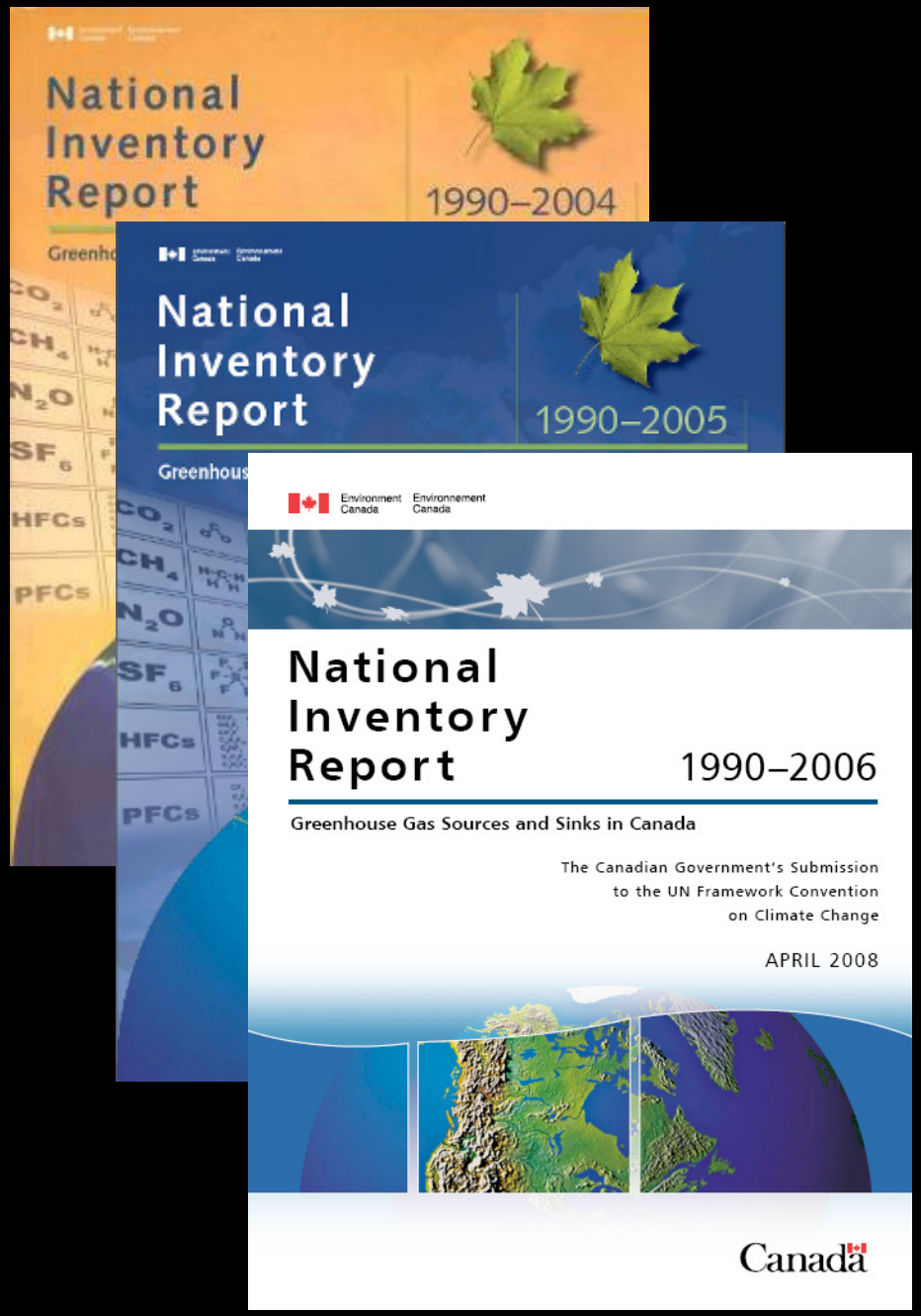
CFS Carbon Accounting Team



- CFS Carbon Accounting Team in Victoria and Edmonton in close cooperation with CFS policy community in Ottawa
- For national-scale analyses input from Resource Management Agencies in all Provinces and Territories
- Collaboration with scientists in CFS, universities in Canada and abroad, IPCC colleagues, and <u>many</u> others …



Canada's National Forest Carbon Monitoring, Accounting and Reporting System (NFCMARS)

- Monitoring for International Reporting
- Forecasting for scientific and policy analysis

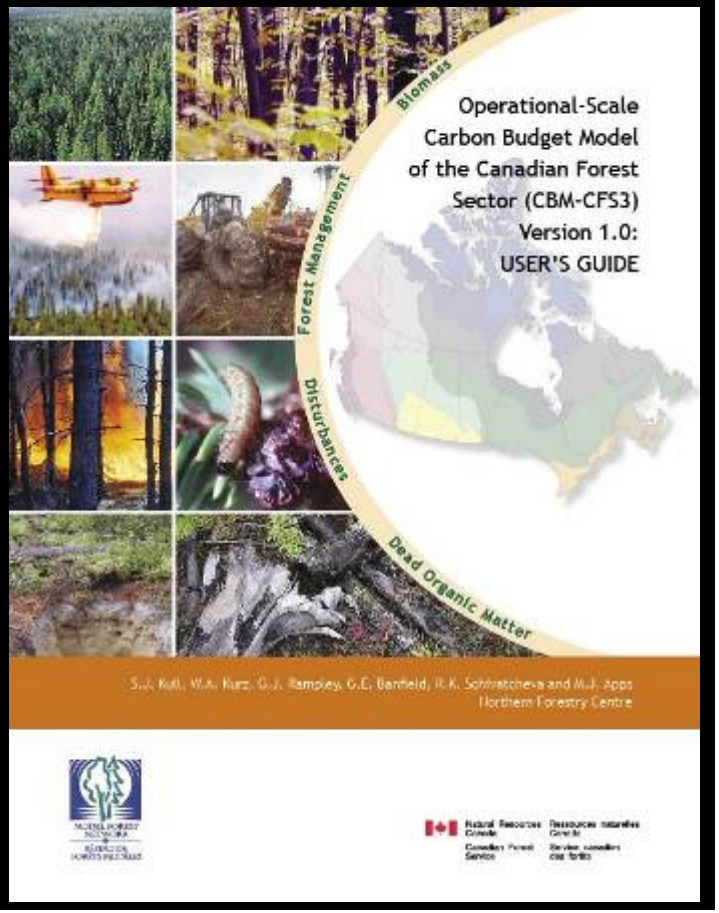
Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3)

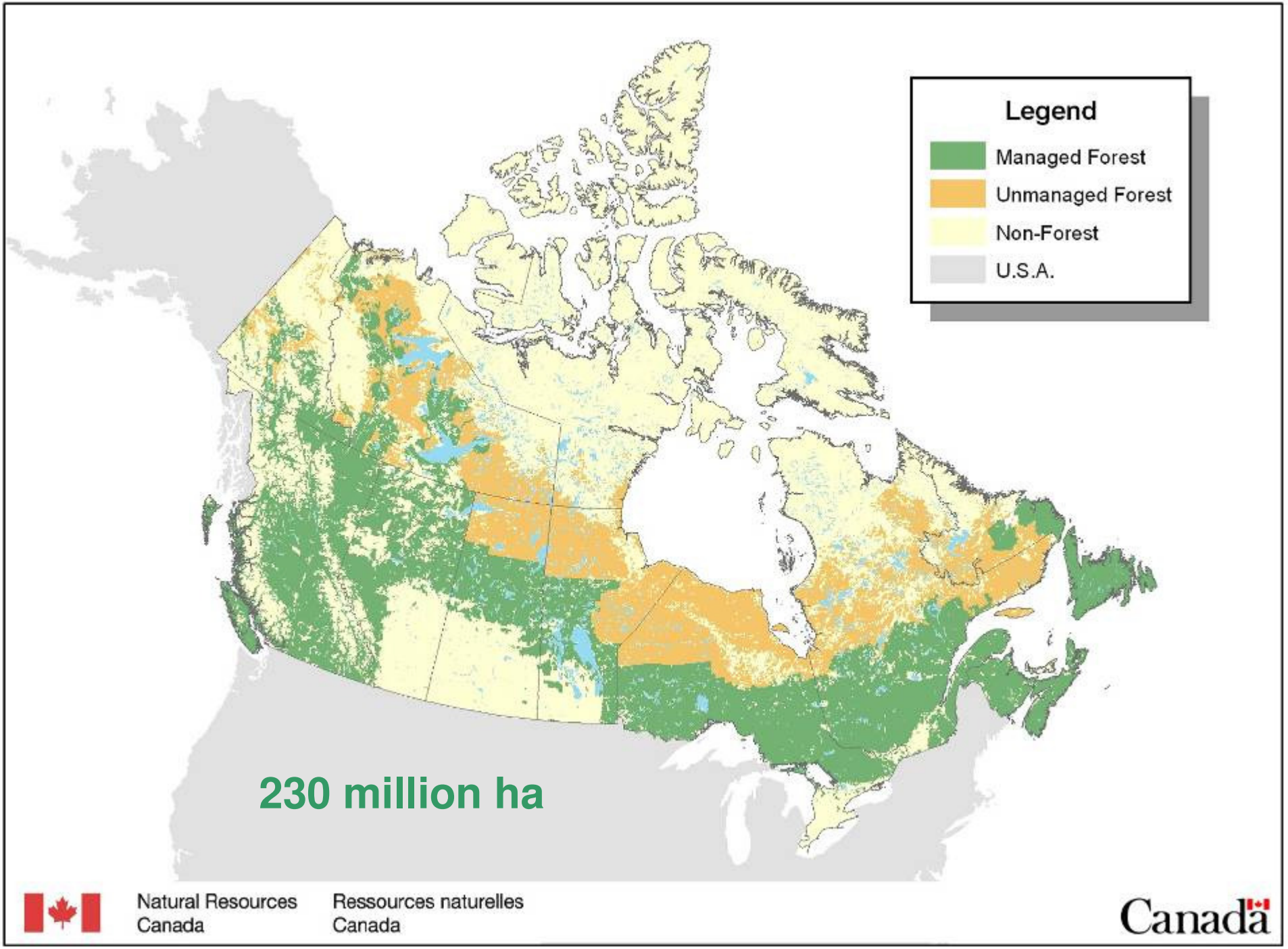
- An operational to national-scale model of forest ecosystem C dynamics developed to assess the past, present and future role of the Canadian forests in the global C cycle.
- http://carbon.cfs.nrcan.gc.ca

CBM·CFS3

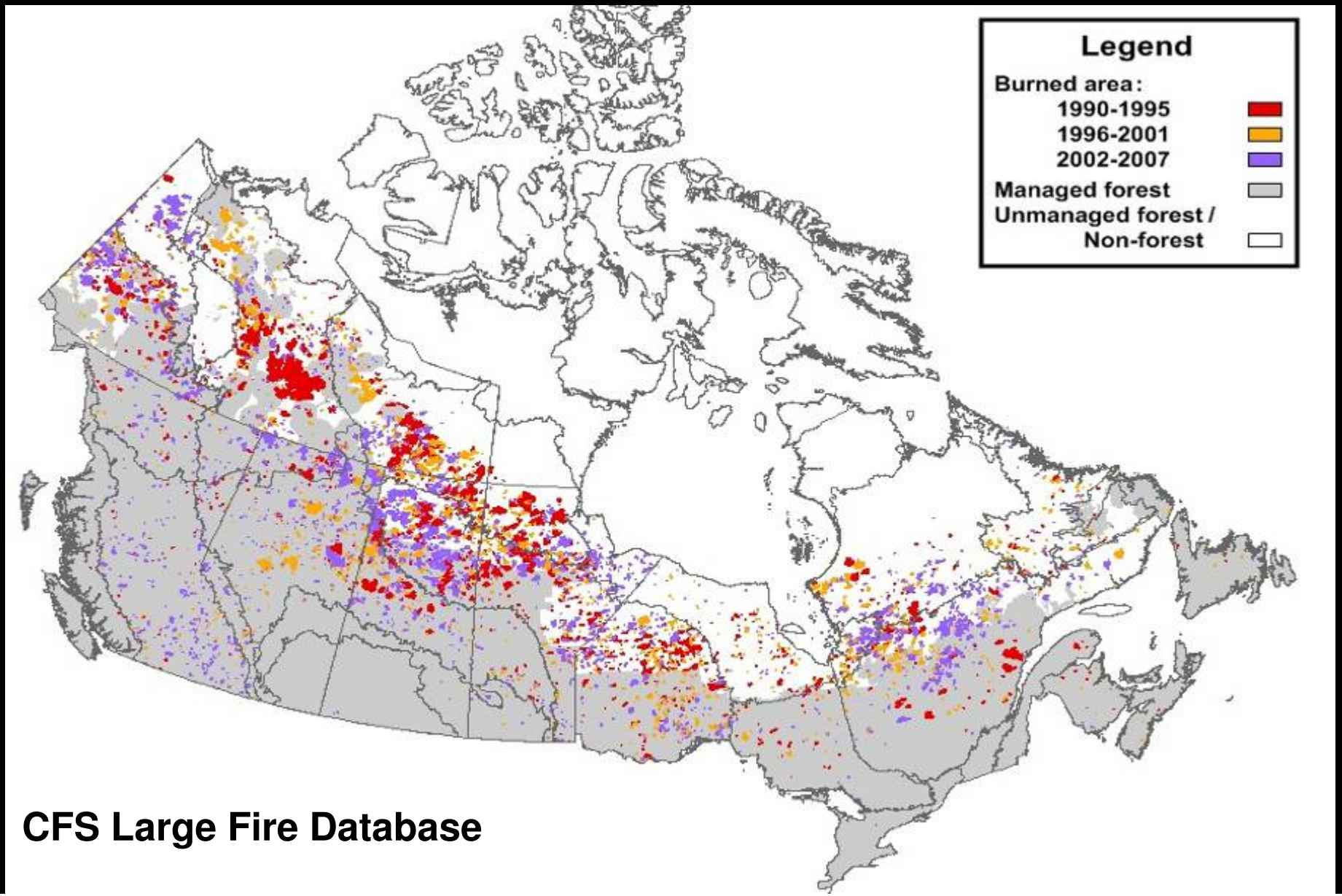
Operational Scale Carbon Budget Model of the Canadian Forest Sector Release 1.0

Canada



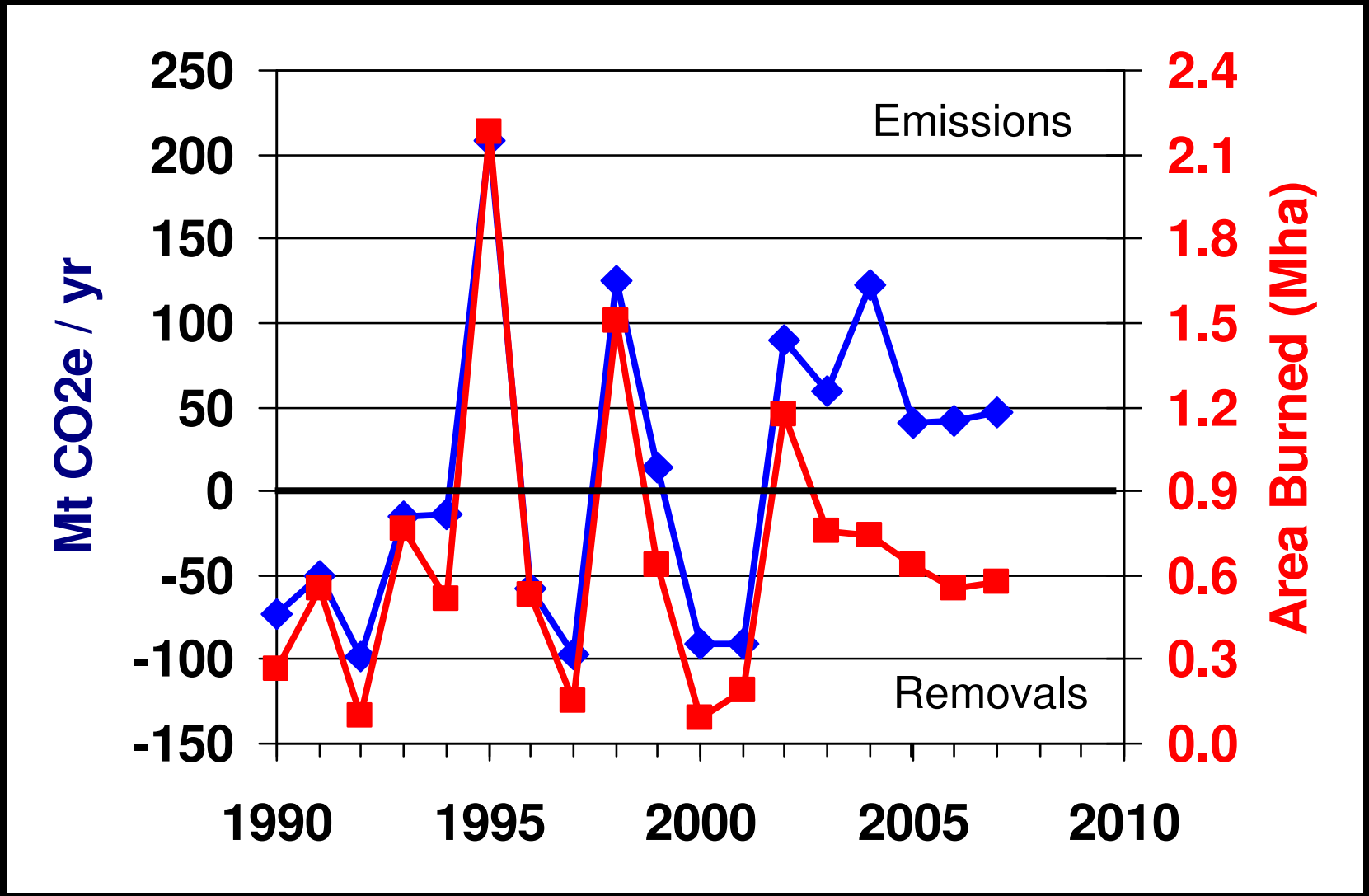

Legend
Managed Forest
Unmanaged Forest
Non-Forest
U.S.A.
230 million ha
Natural Resources Canada
Ressources naturelles Canada
Canada

Burned Area (1980- 2003)



CFS Large Fire Database

Large interannual variation in GHG balance resulting from wildfires



PNAS

Risk of natural disturbances makes future contribution of Canada's forests to the global carbon cycle highly uncertain

Werner A. Kurz*, Graham Stinson, Gregory J. Rampley, Caren C. Dymond, and Eric T. Neilson

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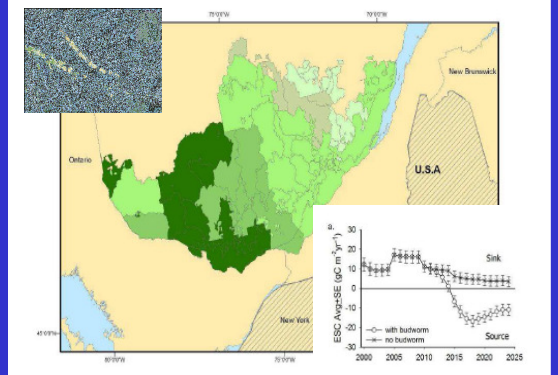
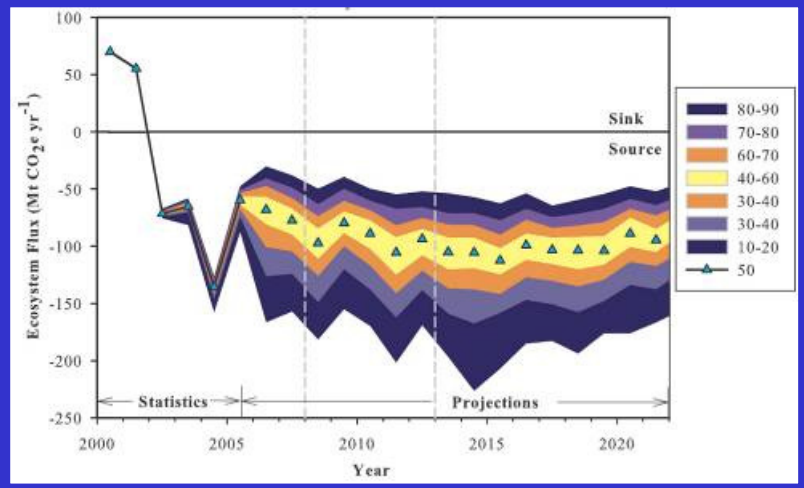
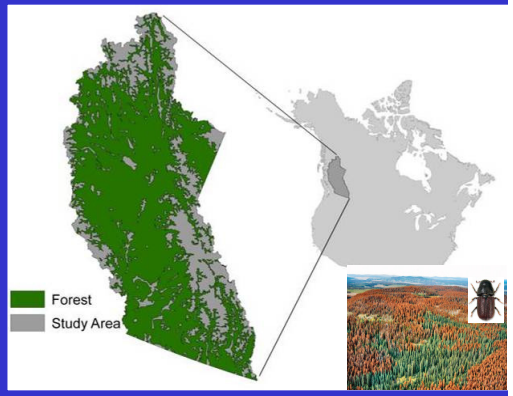


SBW – Dymond et al. (in press)



Up to 2022 only

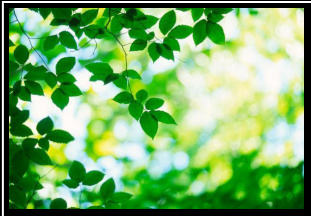
MPB – Kurz et al. (2008)



Climate Change and Forests: Multiple Interacting Effects

Changes in Fire Regime
- Future fire weather may be more severe
- Increase in annual area burned?

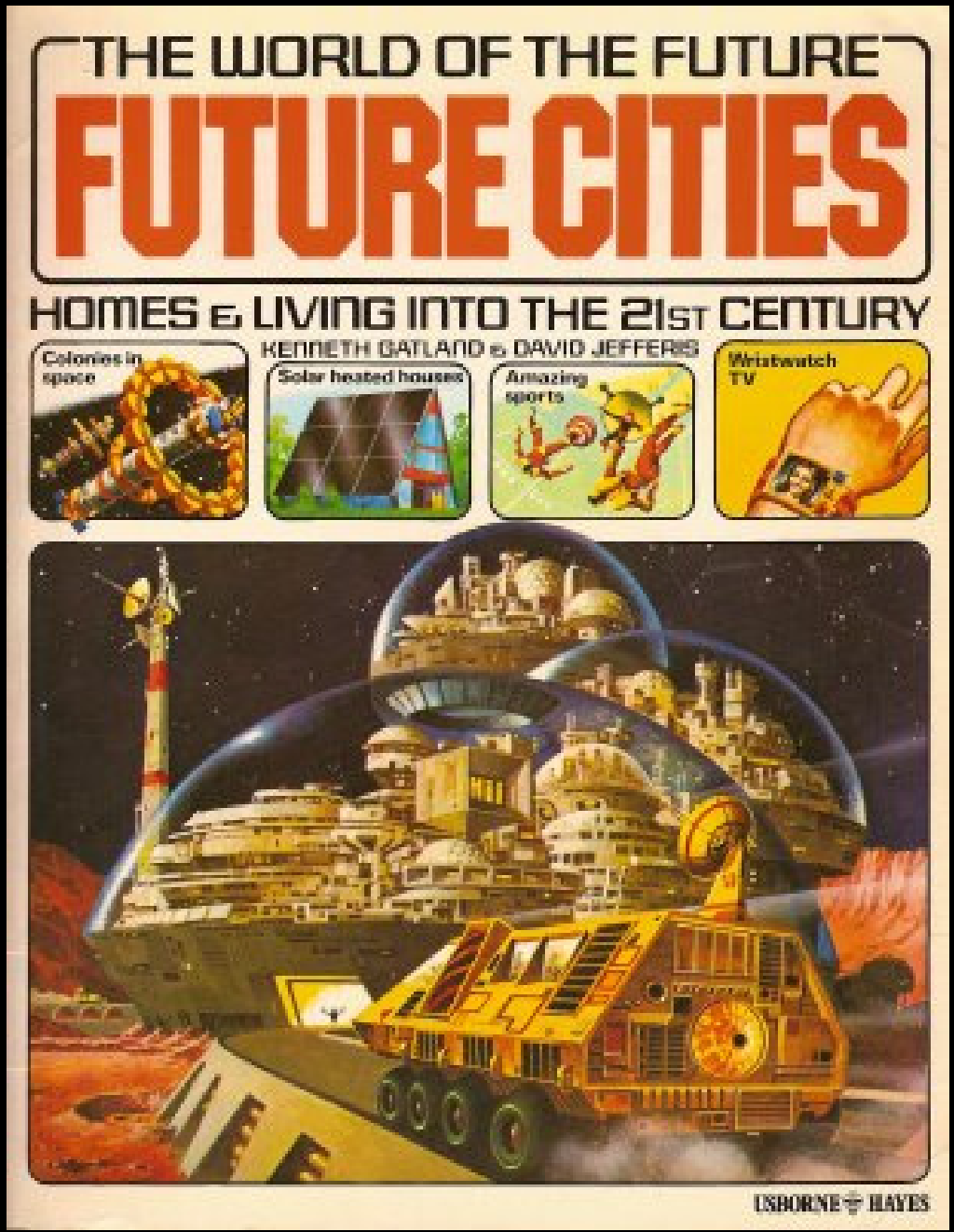
Changes in soil C decay rates
- Increase due to warmer temperatures?



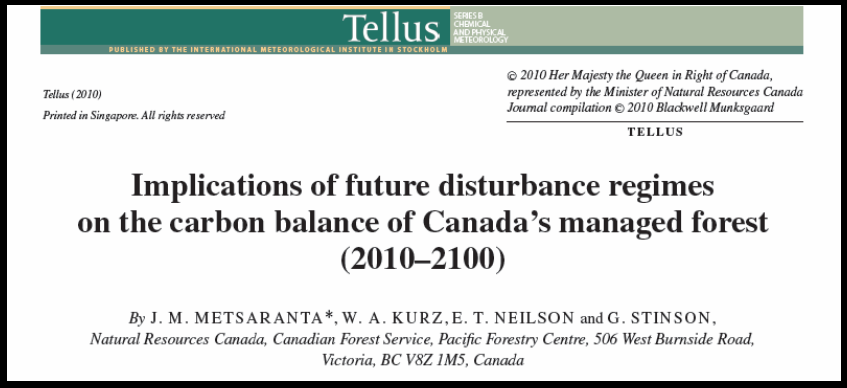
Changes in productivity
- Increase due to, e.g. CO_2 fertilization?
- Decrease due to, e.g., drought?

Predictions for the future (to 2100)

1. Impacts of increased area burned nationally
2. Interactive effects of changes in fire, productivity and decay regionally (BC)
3. Changes in the distribution of extreme annual area burned



1. Effect of Increasing Area Burned Nationally



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TELLUS

Implications of future disturbance regimes on the carbon balance of Canada's managed forest (2010–2100)

By J. M. METSARANTA*, W. A. KURZ, E. T. NEILSON and G. STINSON,
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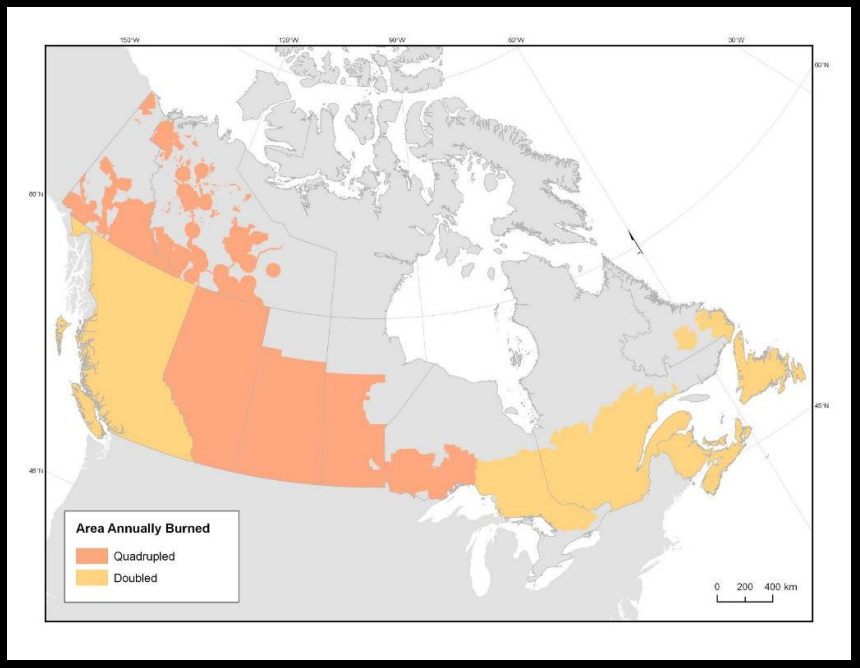
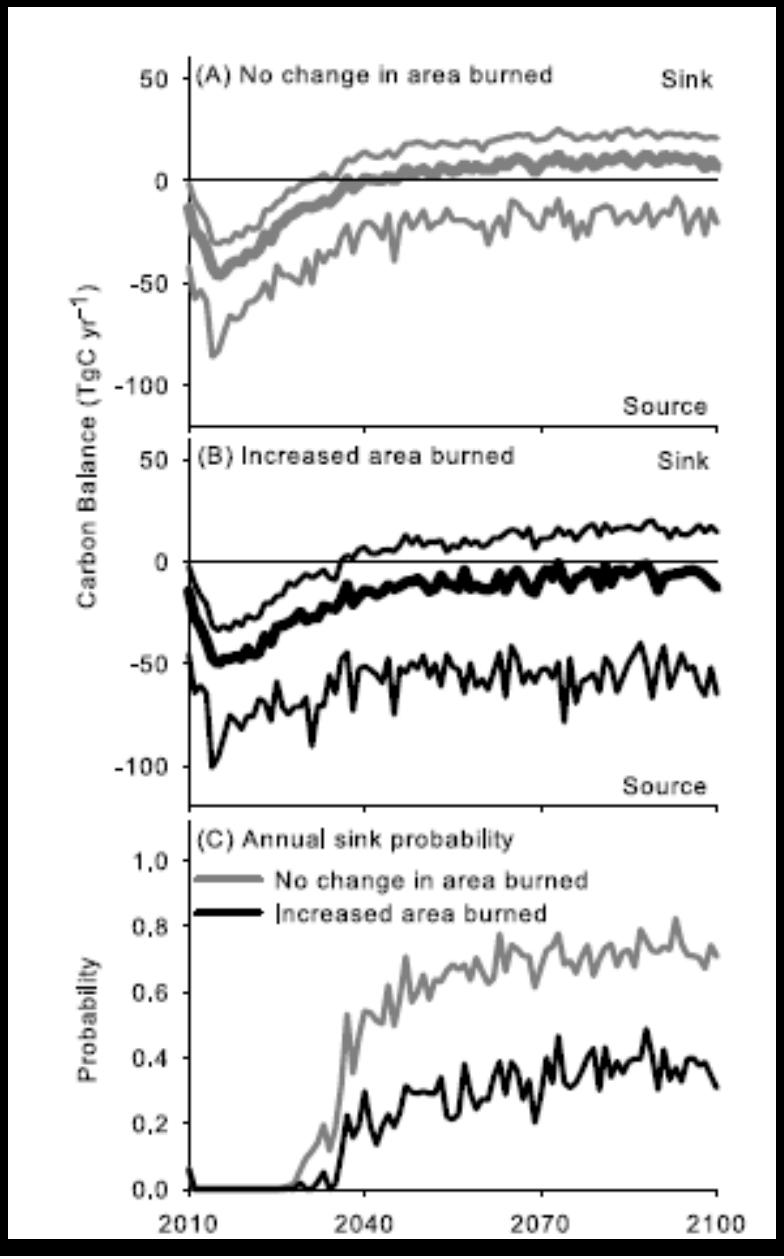


- Regional fire probability distributions
- Scenario 1: Annual area burned in the 21st century is similar to late 20th century observations (1959-1999)
- Scenario 2: Gradual ramp up factor applied to randomly drawn burned area increases fire between 2010 and 2100 by
  - factor 2 eastern Canada & BC (Flannigan et al. 2001)
  - factor 4 in western Canada (Balshi et al. 2008)
- 100 Monte Carlo simulations

Annual C Balance (Mt C)

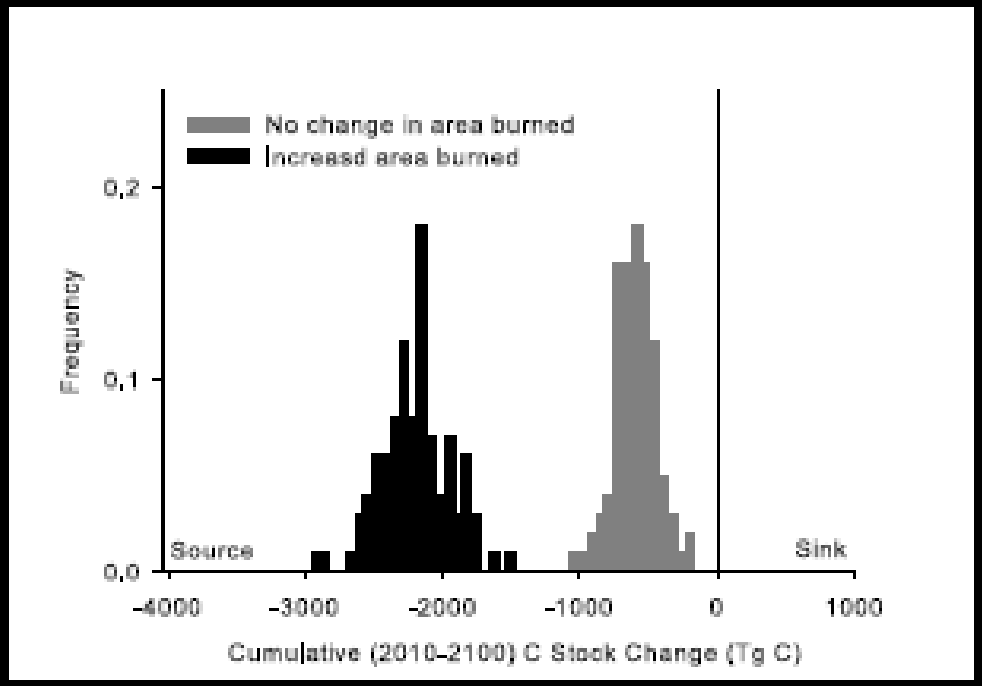


- After 2050, annual probability of a sink
- ~ 60% for no change in fire
- ~ 25% for increased fire

….BUT….

Cumulative C Stock Change (2010 to 2100)

- All runs under both scenarios are large cumulative sources
- Managed forest will have declining C stocks over the 21st century, whether area burned increases or not.

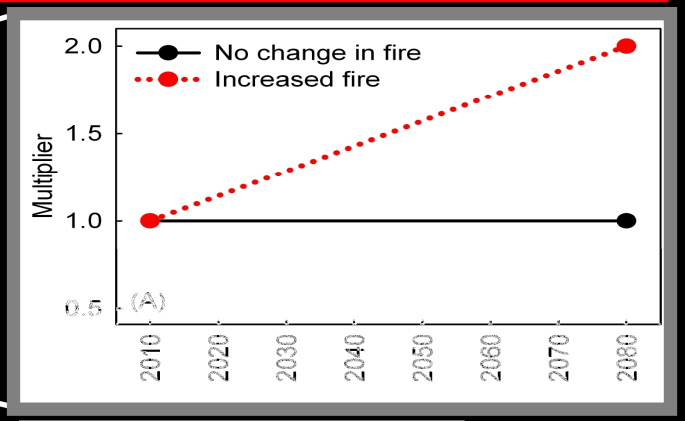


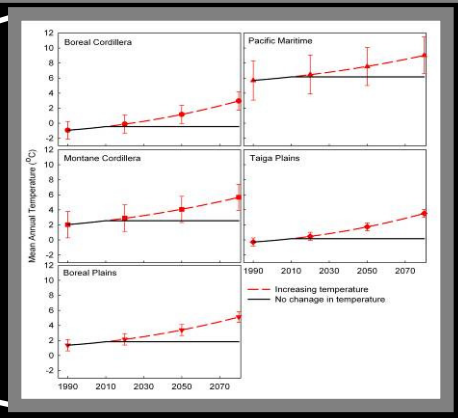
2. Interactive Effects Regionally (British Columbia)

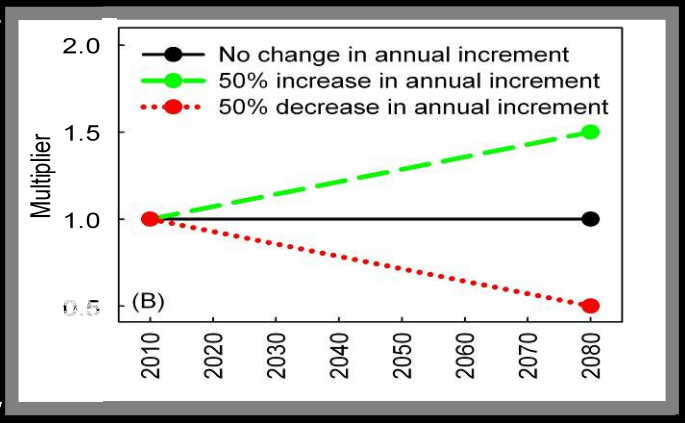
Forest Fire
(Gradual doubling 2010 to 2080)

Decay
(CGCM A2 = warmer temperatures)

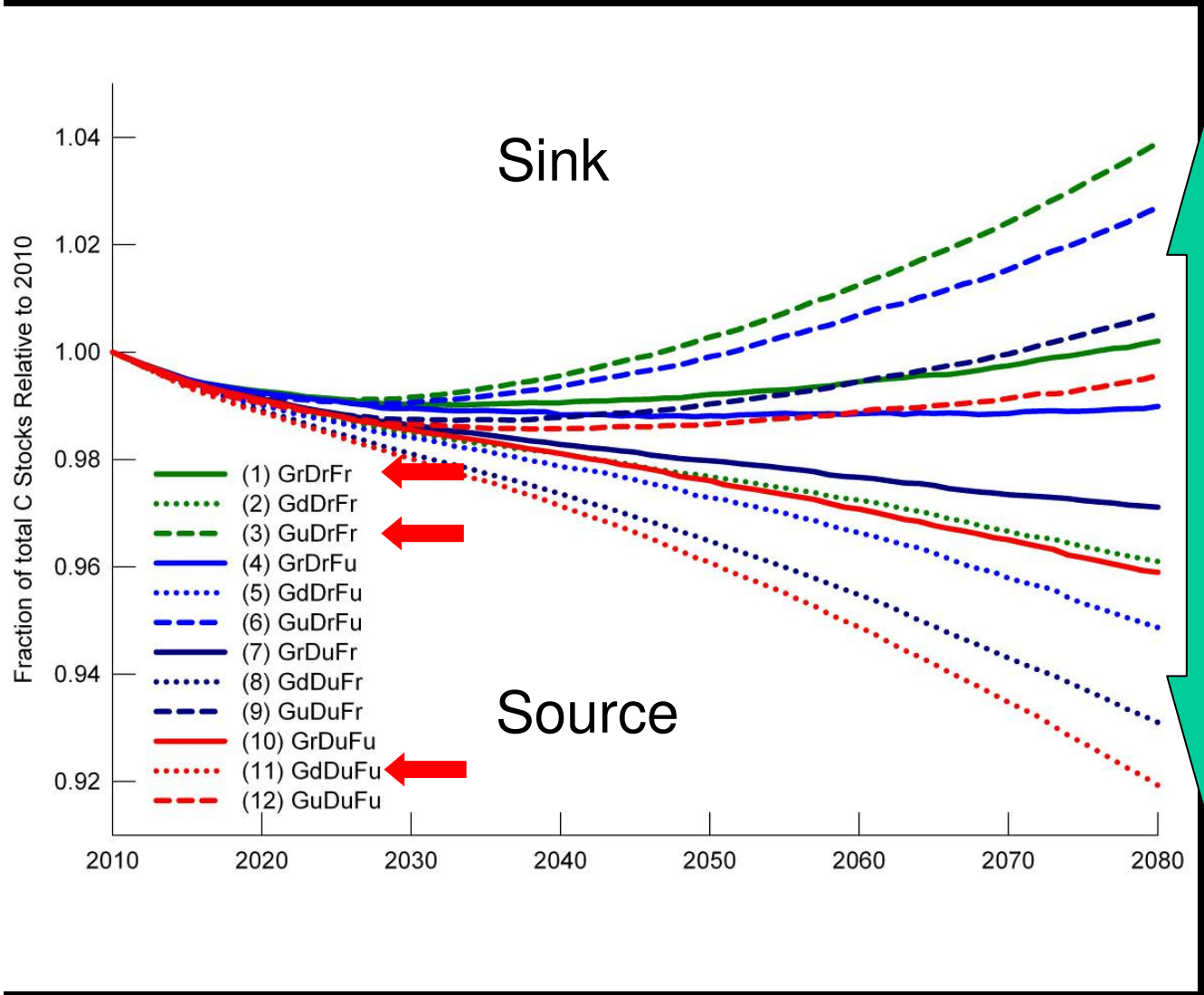
Productivity
(Up or Down)







Change in Total Ecosystem Carbon



Difference between endpoints of 12 realistic scenarios:

2.4 Pg C or

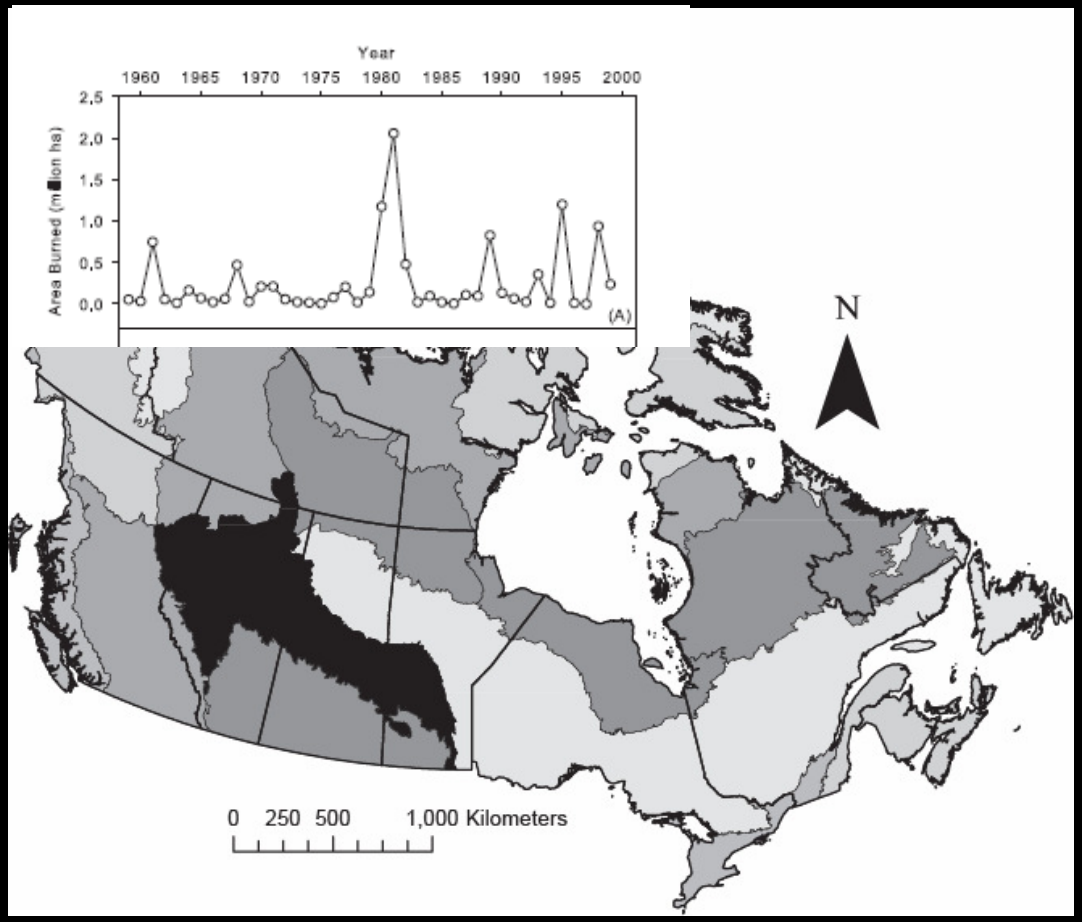
126 Mt CO_2e yr^{-1}

over 70-yr period

BC emissions in 2007: ~**65 Mt CO_2e**

Metsaranta JM, Dymond CC, Kurz WA, Spittlehouse D. in review

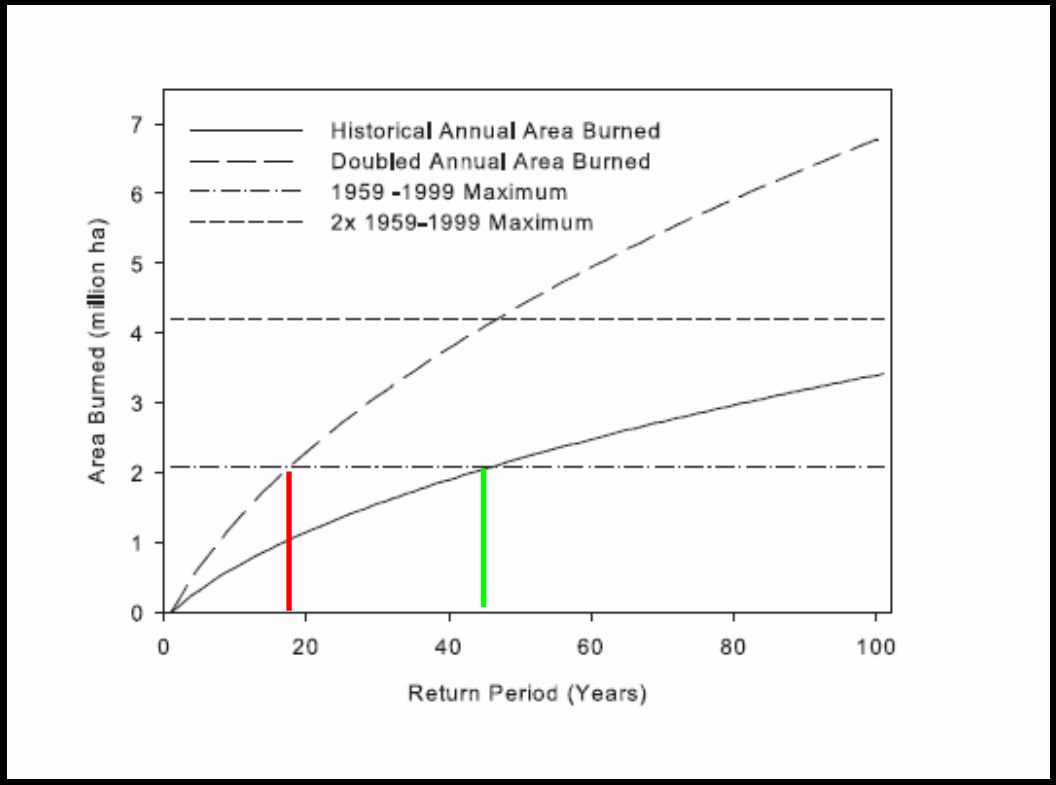
3. Changes in Extreme Fire Years



Metsaranta (in press). IJWF

- Boreal Plains
- 2.1 million ha burned in 1981
- Average area burned 260,000 ha (1959-1999)
- ~80% of total burned area occurred in ~20% of years with largest area burned
- Years with large area burned are most important

Changes in extreme fire years: Return Periods

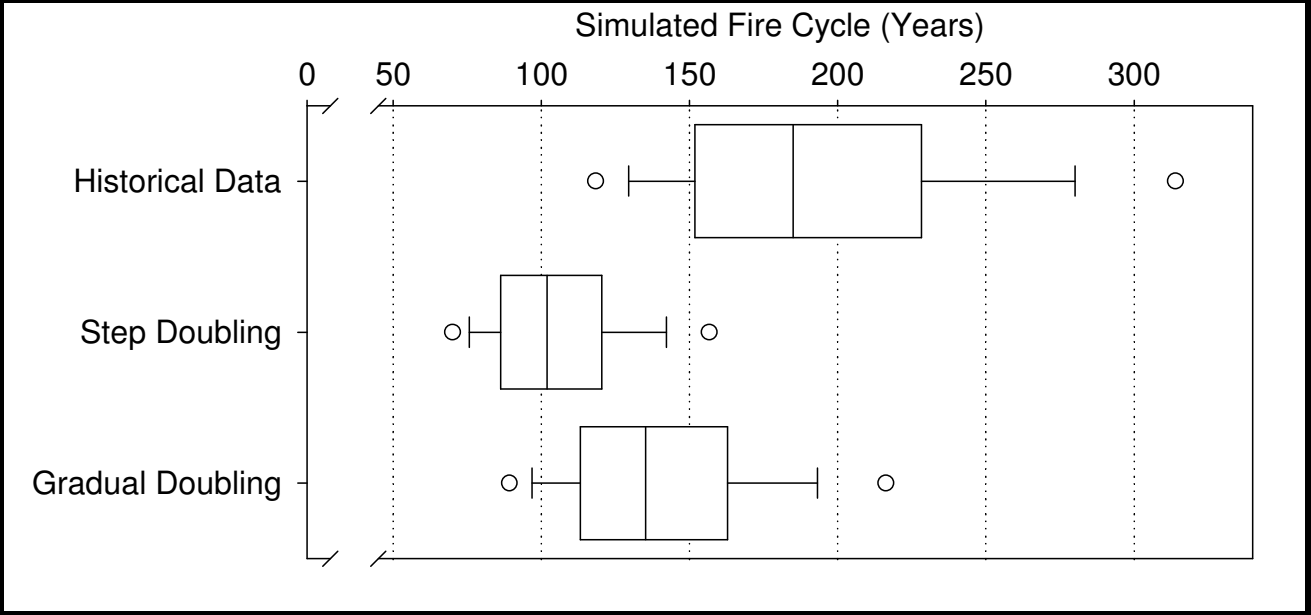


Metsaranta (in press). IJWF

- Based on historical data, 2.1 million ha expected to burn about once every 45 years
- If annual area burned doubles, 2.1 million ha area burned will occur once every 18 years

But, fire data are noisy!

- Based on time series of annual area burned that could be observed from 2000-2050, detecting a doubling of annual area burned is not guaranteed even if it has actually occurred!
- ~30% if doubling occurs gradually from 2000-2050
- ~70% if it occurred instantly in 2000



Metsaranta (in press). IJWF

Conclusions

- Climate changes will affect many processes (growth, decay, disturbances) with large differences between ecosystems and regions.
- Net impacts highly uncertain, but …

- **Asymmetry of risks:** unlikely that productivity increases can off-set increased disturbance losses in all regions
- **Monitoring and modelling** required to quantify direction and magnitude of feedback.

Conclusions

- Forests' response to climate change has the potential to provide positive feedback to future climate change through increased emissions that **could completely negate the benefits of mitigation efforts in all other sectors.**
- Years with annual area burned as large or larger than the maximum observed over the last half of the 20th century will become much more common

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