Carbon Sequestration in the Boreal Forests of Saskatchewan

Mark Johnston
Saskatchewan Research Council
johnston@src.sk.ca

Energy Managers Task Force
12 January 2012

Carbon sequestration in Saskatchewan forests

- How much is there?
- What factors determine the amount?
- How does it change over time and why?
- Can it be enhanced through human activity?

Why forests?

- The following slide is based on the Global Carbon Project's annual update on the global carbon cycle
- Released December 05 2011
- http://www.globalcarbonproject.org/
- Highly recommended!

Fate of Anthropogenic CO_2 Emissions (2010)

9.1±0.5 PgC y^{-1}

0.9±0.7 PgC y^{-1}

+

5.0±0.2 PgC y^{-1}

50%

2.6±1.0 PgC y^{-1}

26%

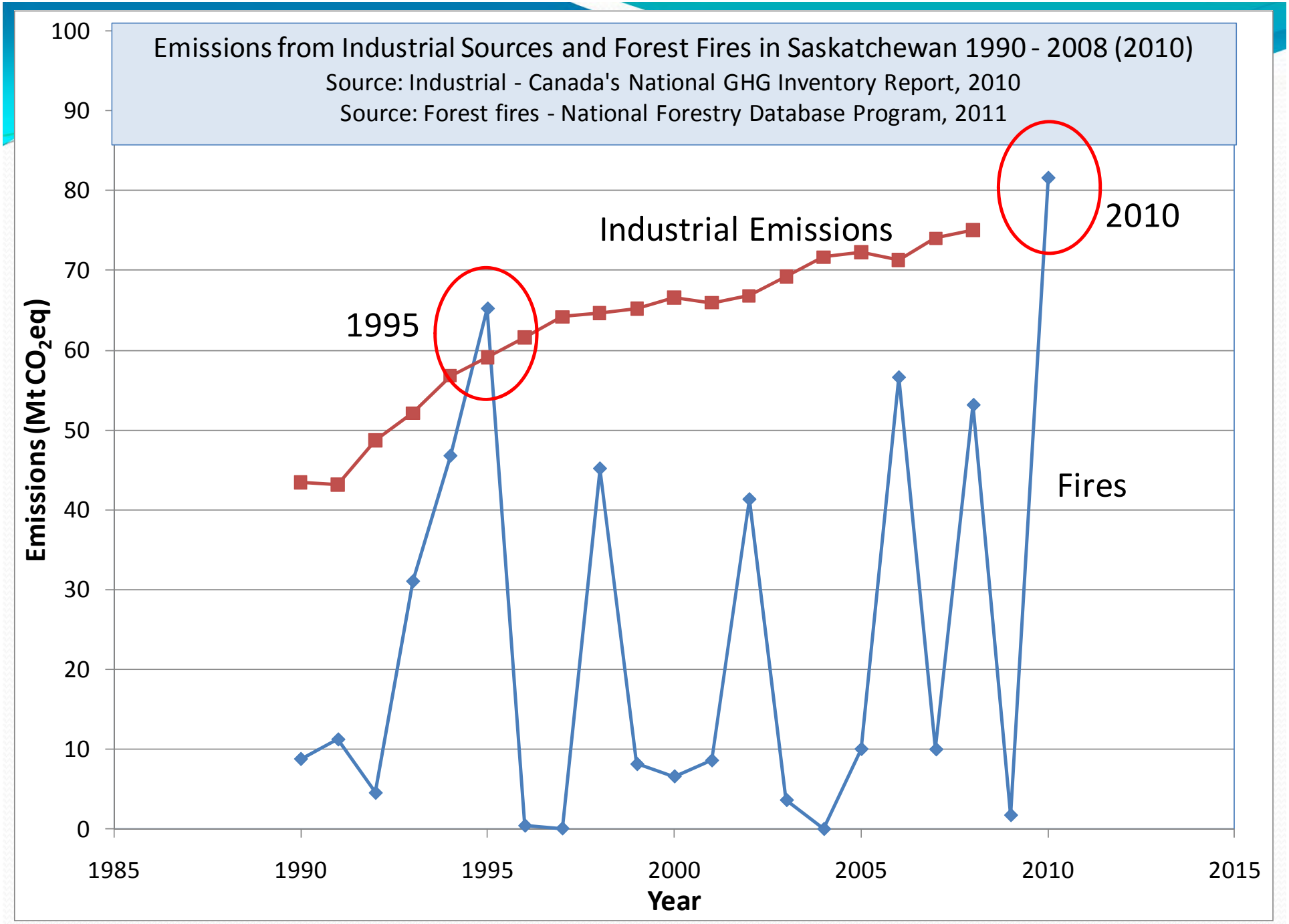
Calculated as the residual of all other flux components

24%

2.4±0.5 PgC y^{-1}

Average of 5 models

Global Carbon Project 2010; Updated from Le Quéré et al. 2009, Nature Geoscience; Canadell et al. 2007, PNAS


Emissions from Industrial Sources and Forest Fires in Saskatchewan 1990 - 2008 (2010)
Source: Industrial - Canada's National GHG Inventory Report, 2010
Source: Forest fires - National Forestry Database Program, 2011
Industrial Emissions
2010
1995
Fires
Emissions (Mt CO2eq)
Year
100
90
80
70
60
50
40
30
20
10
0
1985
1990
1995
2000
2005
2010
2015

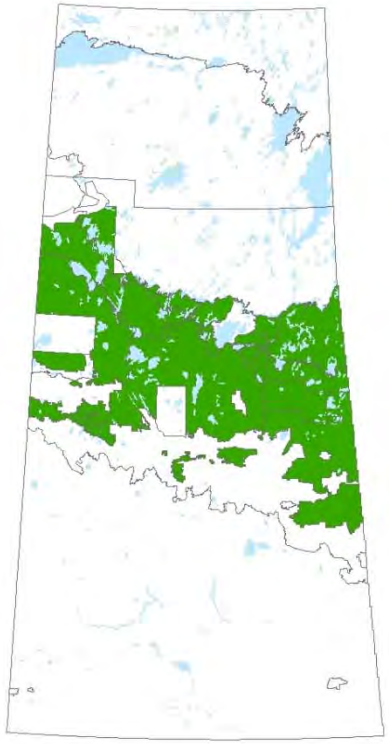
Federal Government's Risk Analysis

- Used to support decision-making under the Kyoto Protocol
- Annex I countries had options to include forest management (and other activities) in their GHG reporting
- Canada (Fed-Prov) carried out a highly sophisticated risk analysis based on forest carbon budget modeling at the provincial and national level (2001-2006)
- Used Monte-Carlo analysis to generate a distribution of outcomes – probability-based decision-making
- Will give an overview of the analysis with updated information

Silly question: What is a forest?

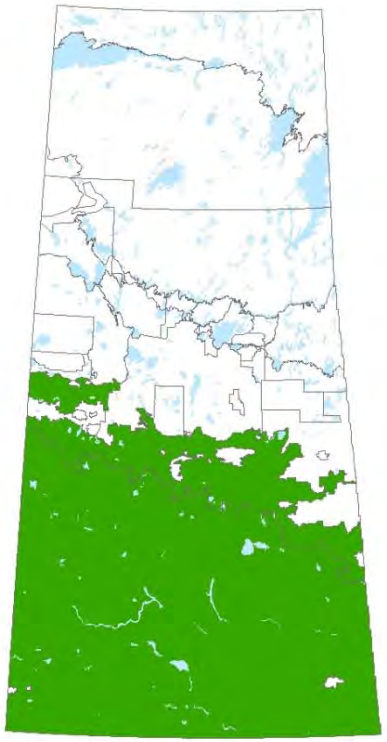
- Risk analysis recognized several categories of forest land based on the extent of human intervention (i.e. management):
  1. Area of forest contributing to AAC
  2. Area where additional harvesting could occur
  3. Area subject to fire and insect management
  4. Area of protected forest – provincial parks etc.

- Area of forest outside of these areas not considered



1 Area used to define AAC

FMS 1
6.4 Mha

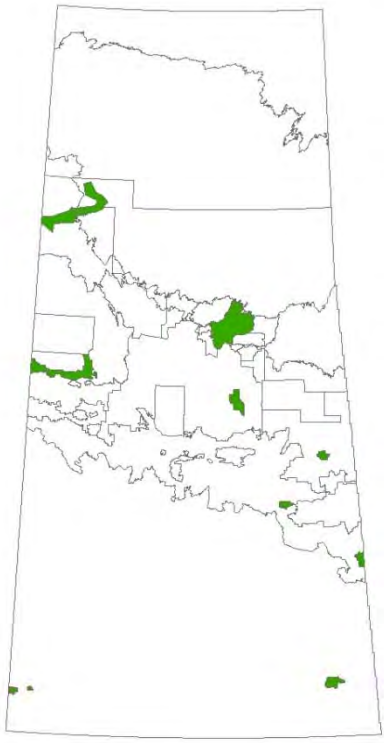


2 Area where additional harvesting may occur

FMS 2
1.5 Mha

3 Additional area with fire and insect management

FMS 3
4.9 Mha



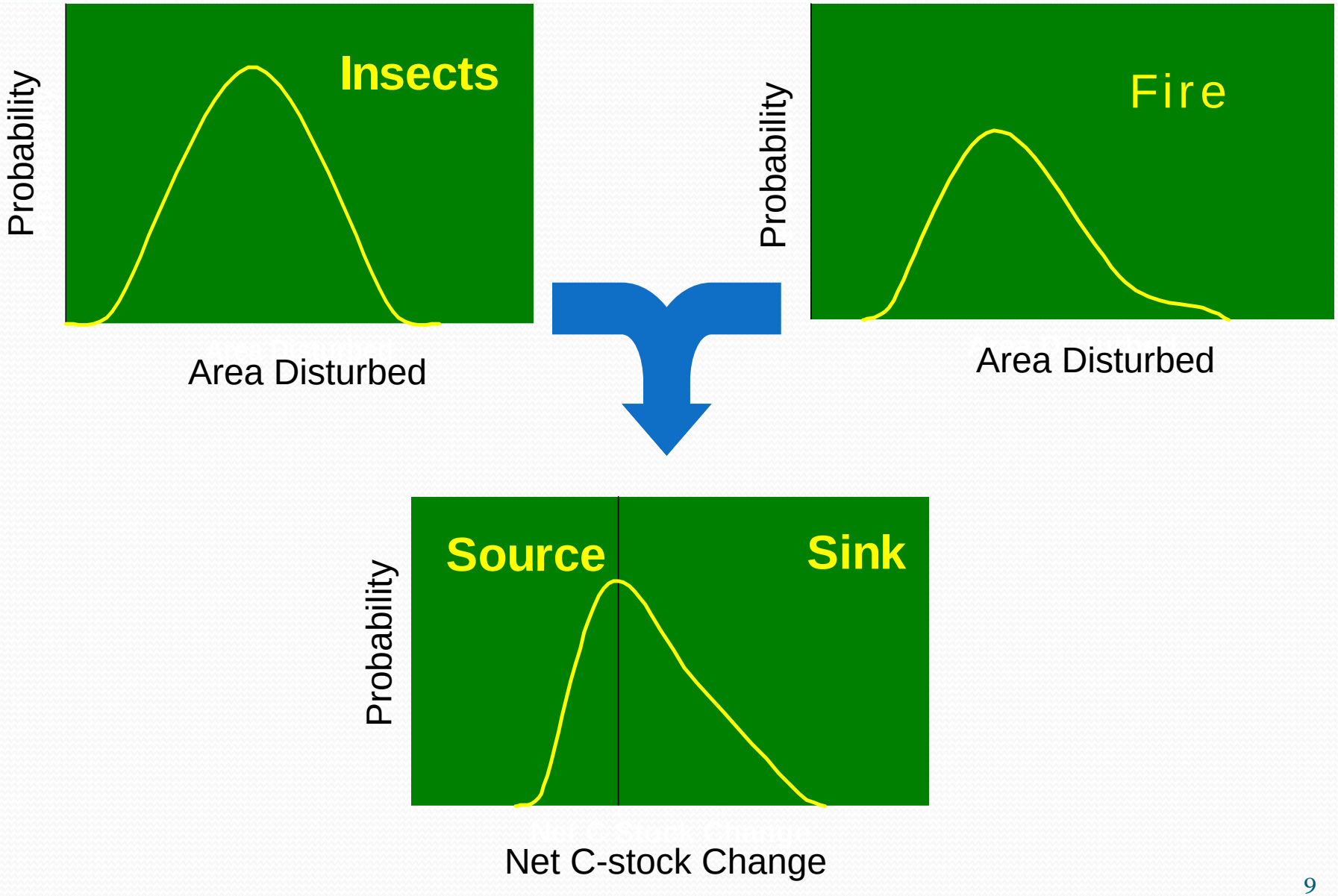
4 Province-specific scenario
Provincial parks only

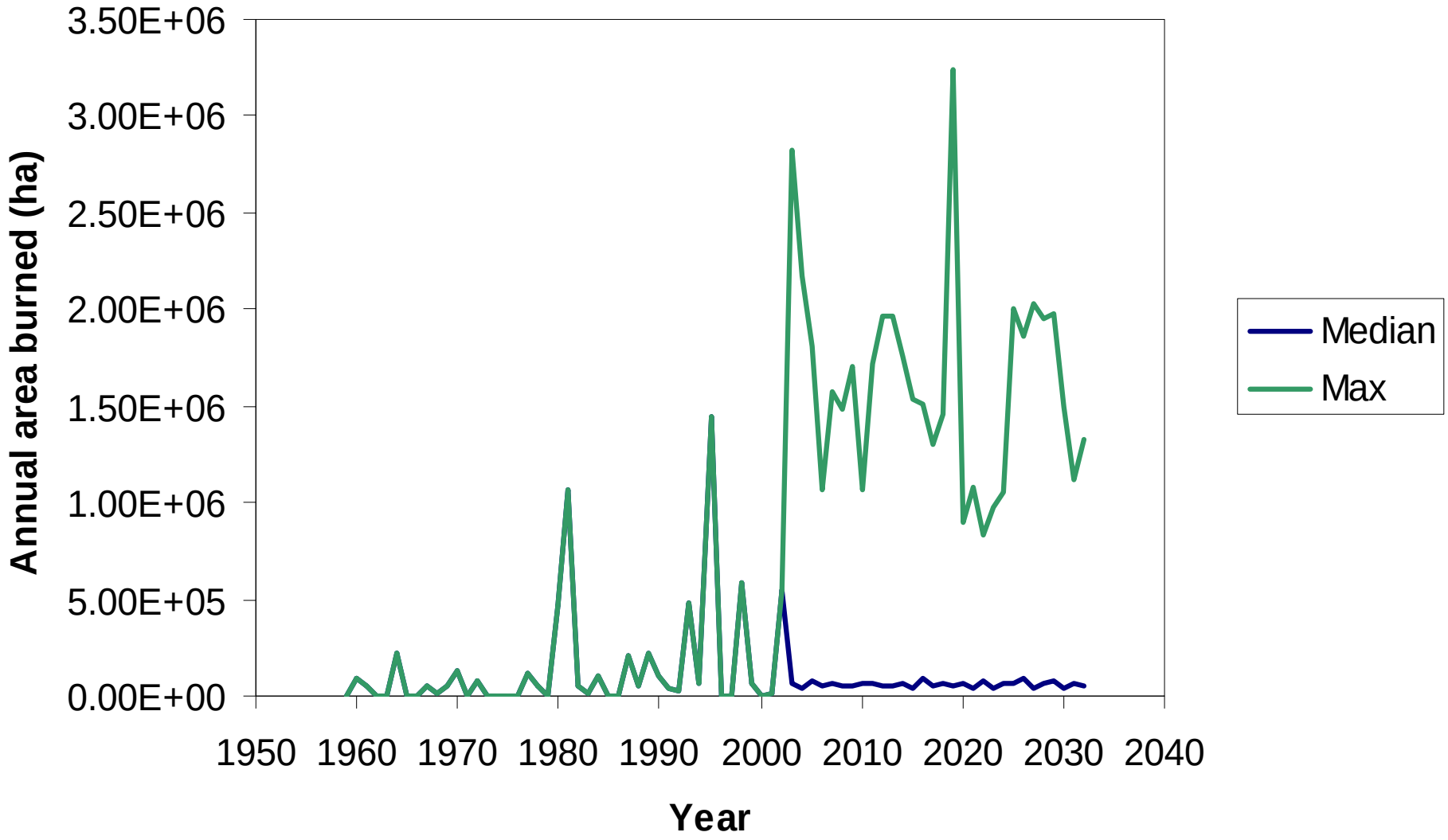
FMS 4
0.55 Mha

All maps are at the 1:12 000 000 scale

Source: Canadian Forest Service, SK Risk Analysis, 2005

Background: Probabilistic risk assessment during CP

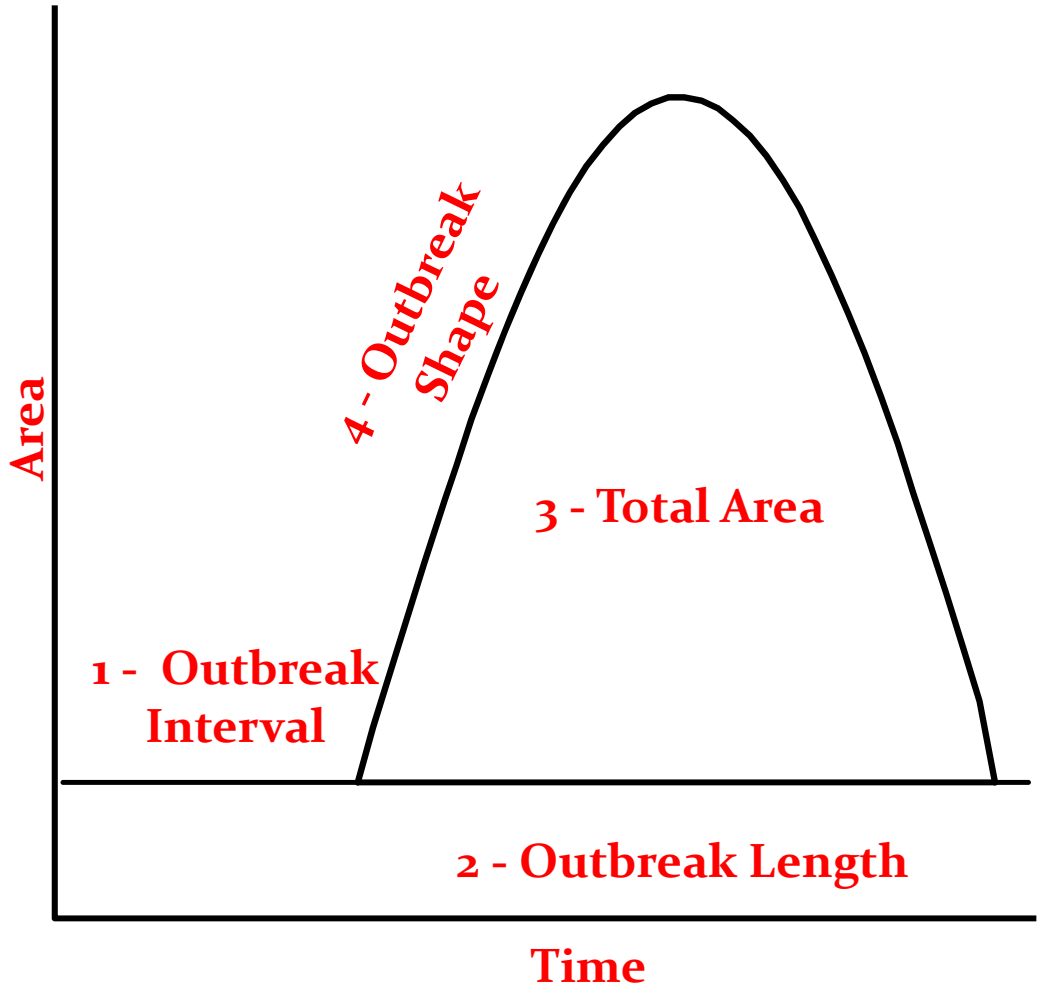



3.50E+06
3.00E+06
2.50E+06
2.00E+06
1.50E+06
1.00E+06
5.00E+05
0.00E+00
Annual area burned (ha)
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
Year
Median
Max

Characteristics of Insect Outbreaks

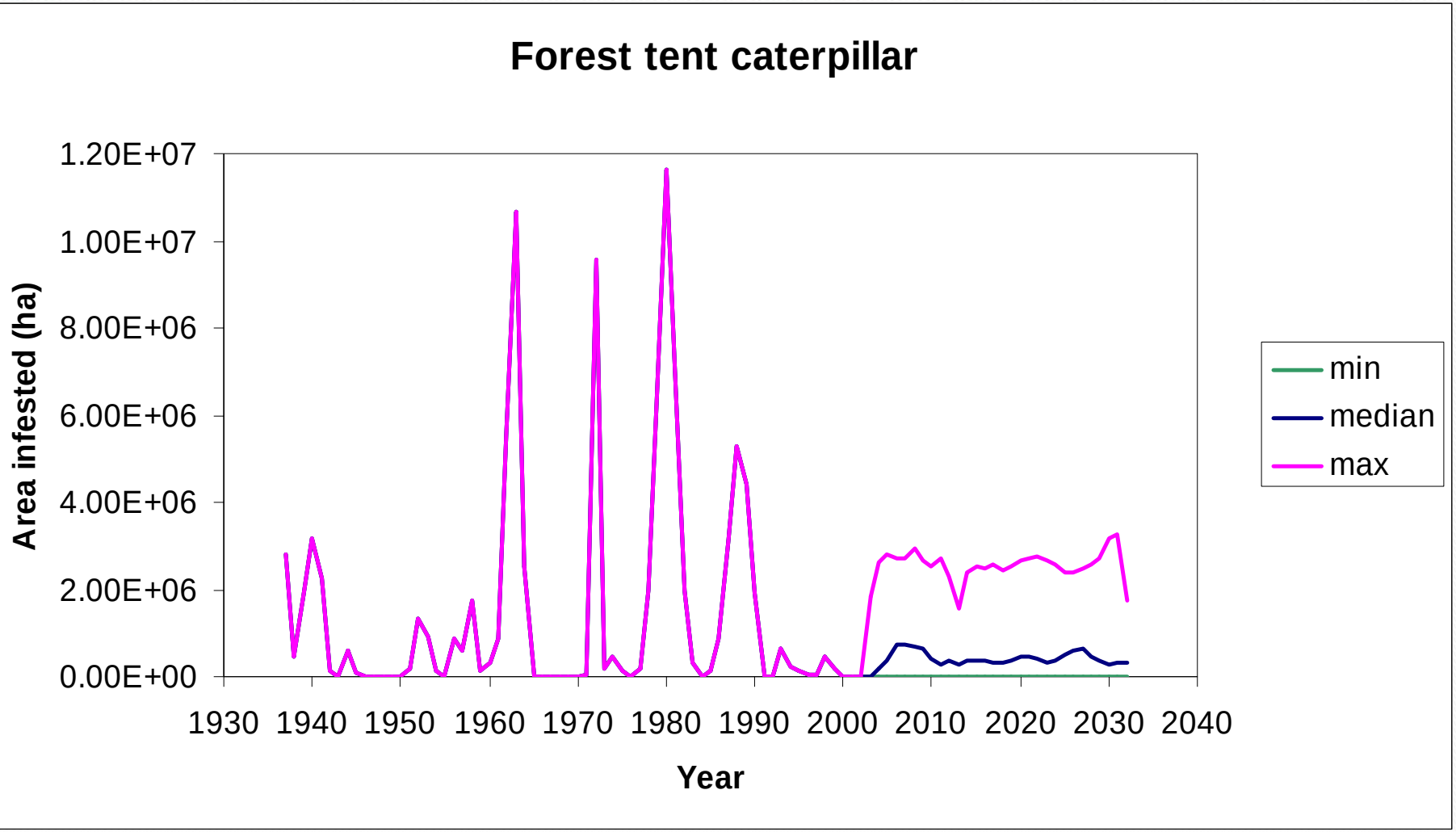
Stochastic Parameters

1. **Interval between the end of one outbreak and the start of the next**
2. **Outbreak Length**
3. **Area of outbreak**
4. **Temporal dynamics of the outbreak (shape).**

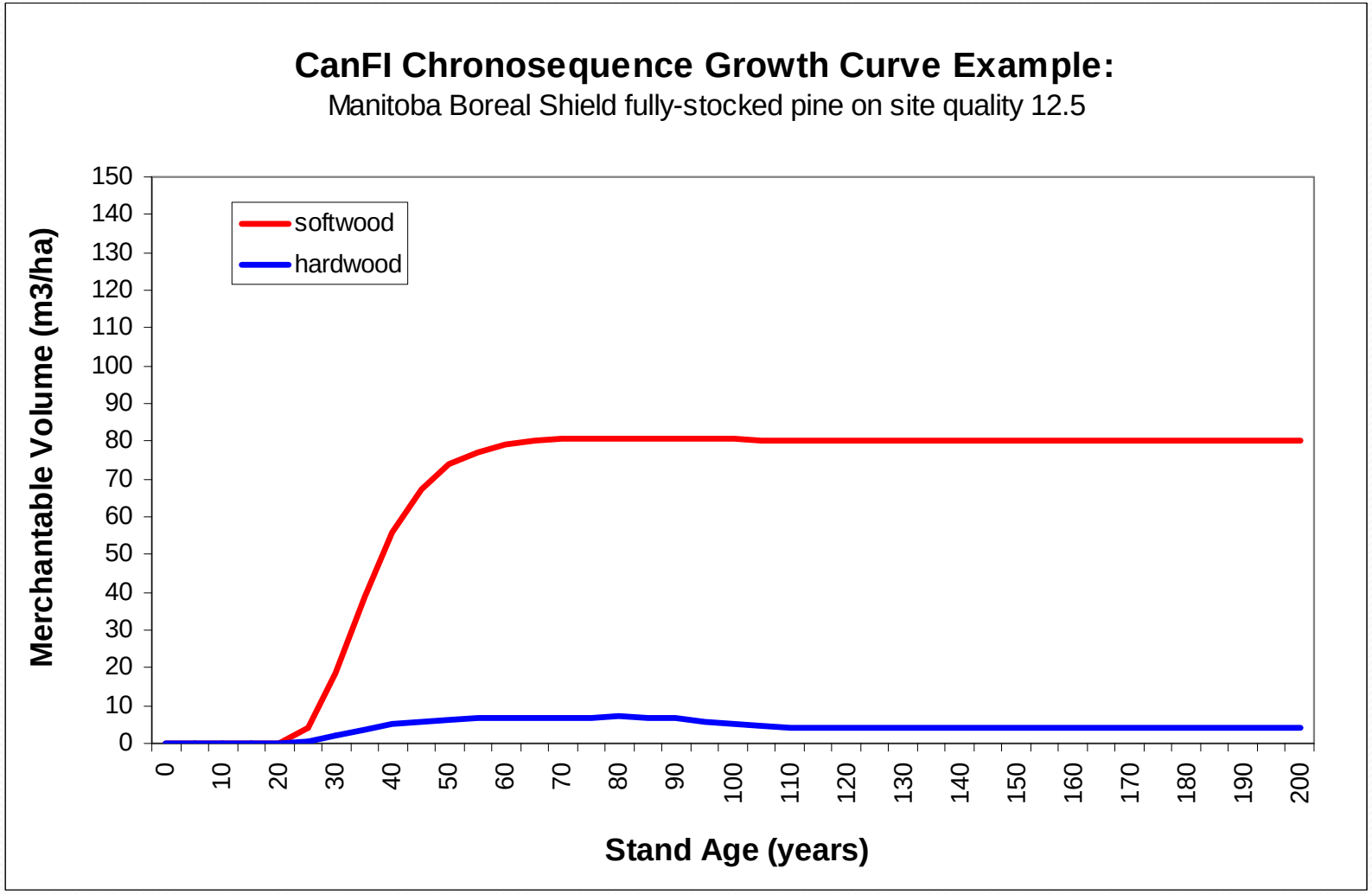


Insects

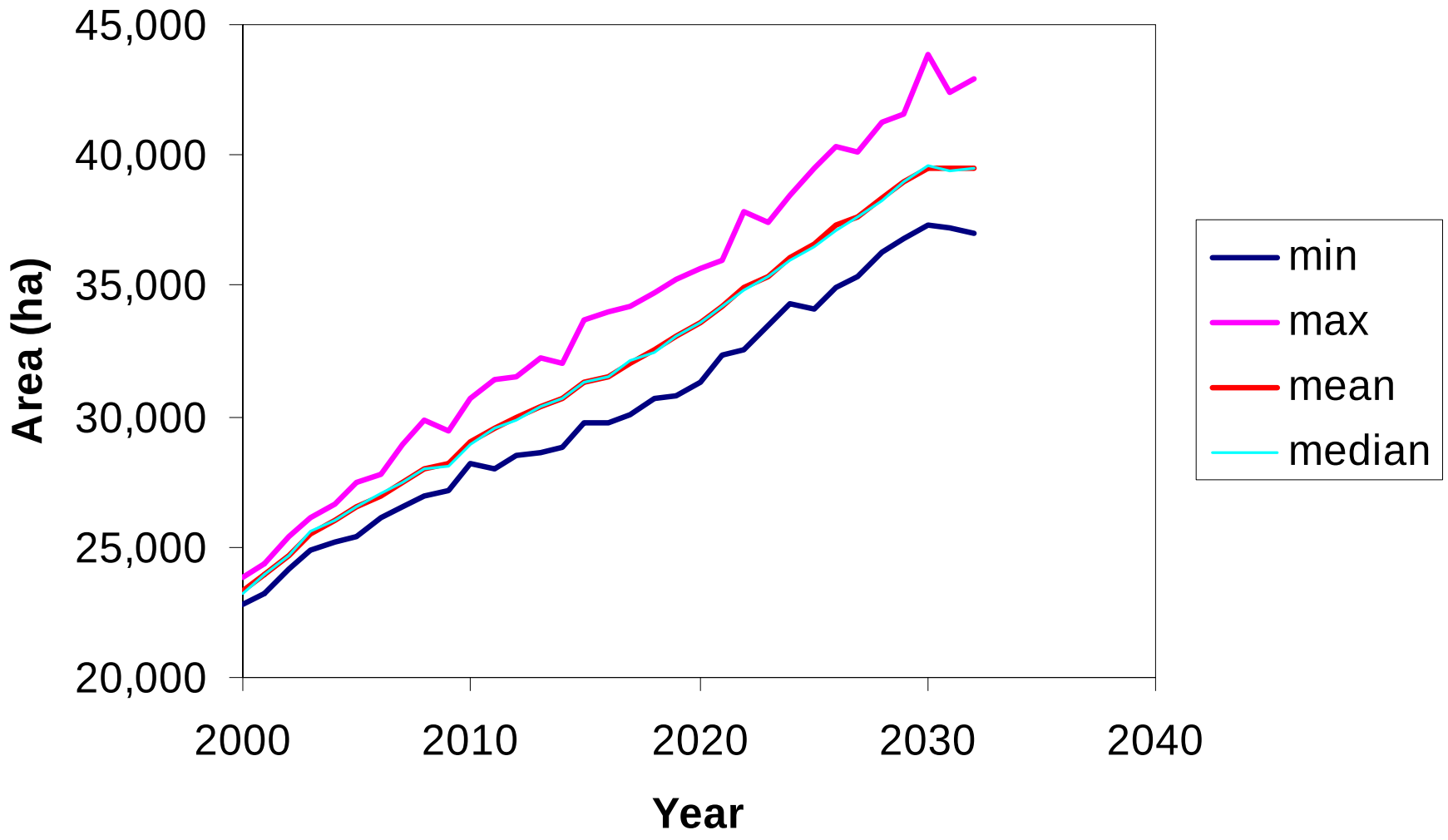
- Included both mortality and loss of growth
- Three main pests of SK forests:
  - Forest Tent Caterpillar
  - Spruce Budworm
  - Jack Pine Budworm
- Analysis could now be redone with Mountain Pine Beetle scenarios!


Forest tent caterpillar
Area infested (ha)
1.20E+07
1.00E+07
8.00E+06
6.00E+06
4.00E+06
2.00E+06
0.00E+00
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
Year
min
median
max

184 growth curves represented growth rates for various forest types, e.g.:



Harvest


45,000
40,000
35,000
30,000
25,000
20,000
Area (ha)
2000
2010
2020
2030
2040
Year
min
max
mean
median

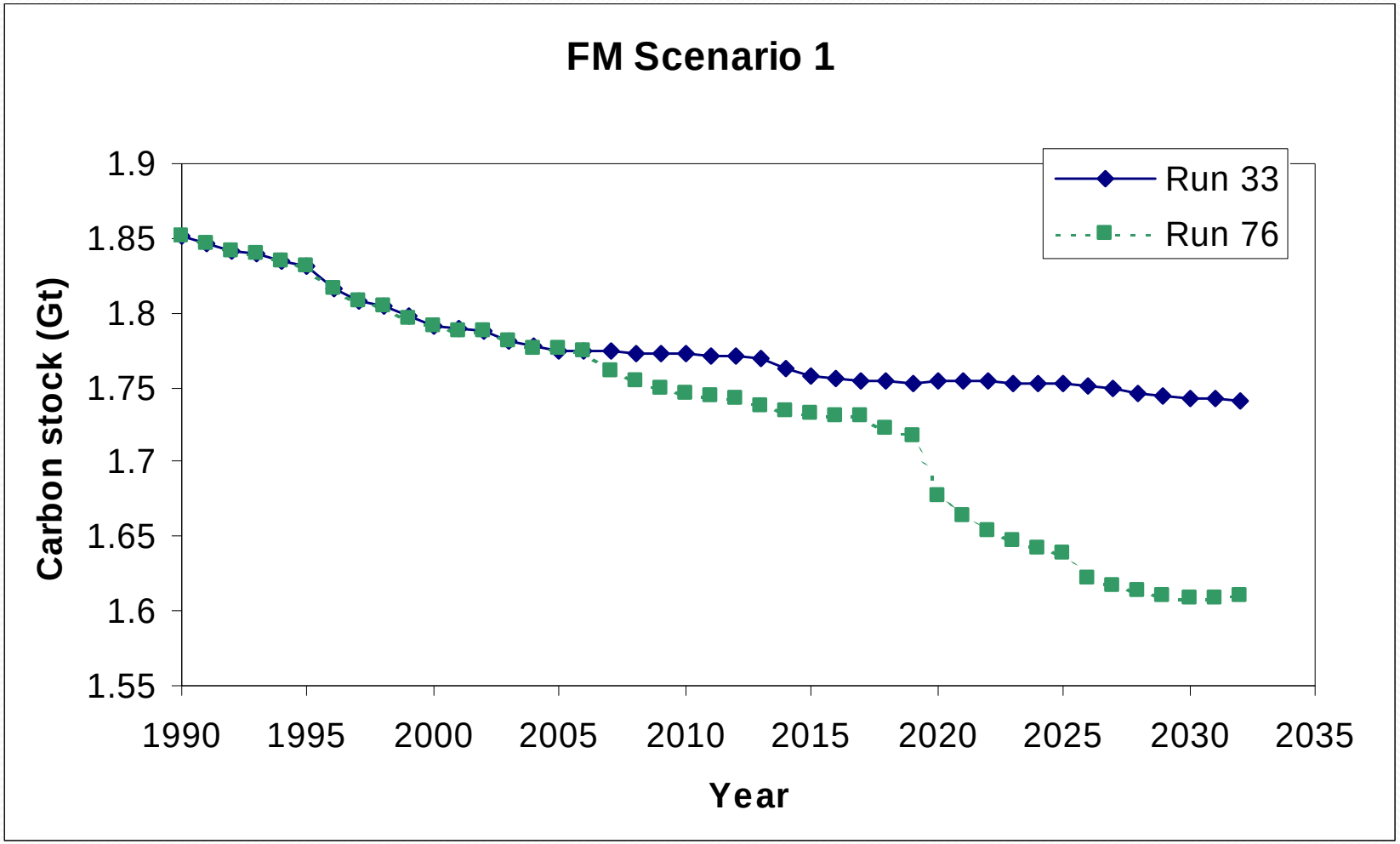
Carbon stock estimates

Forest Management Scenario 1 Year 1990

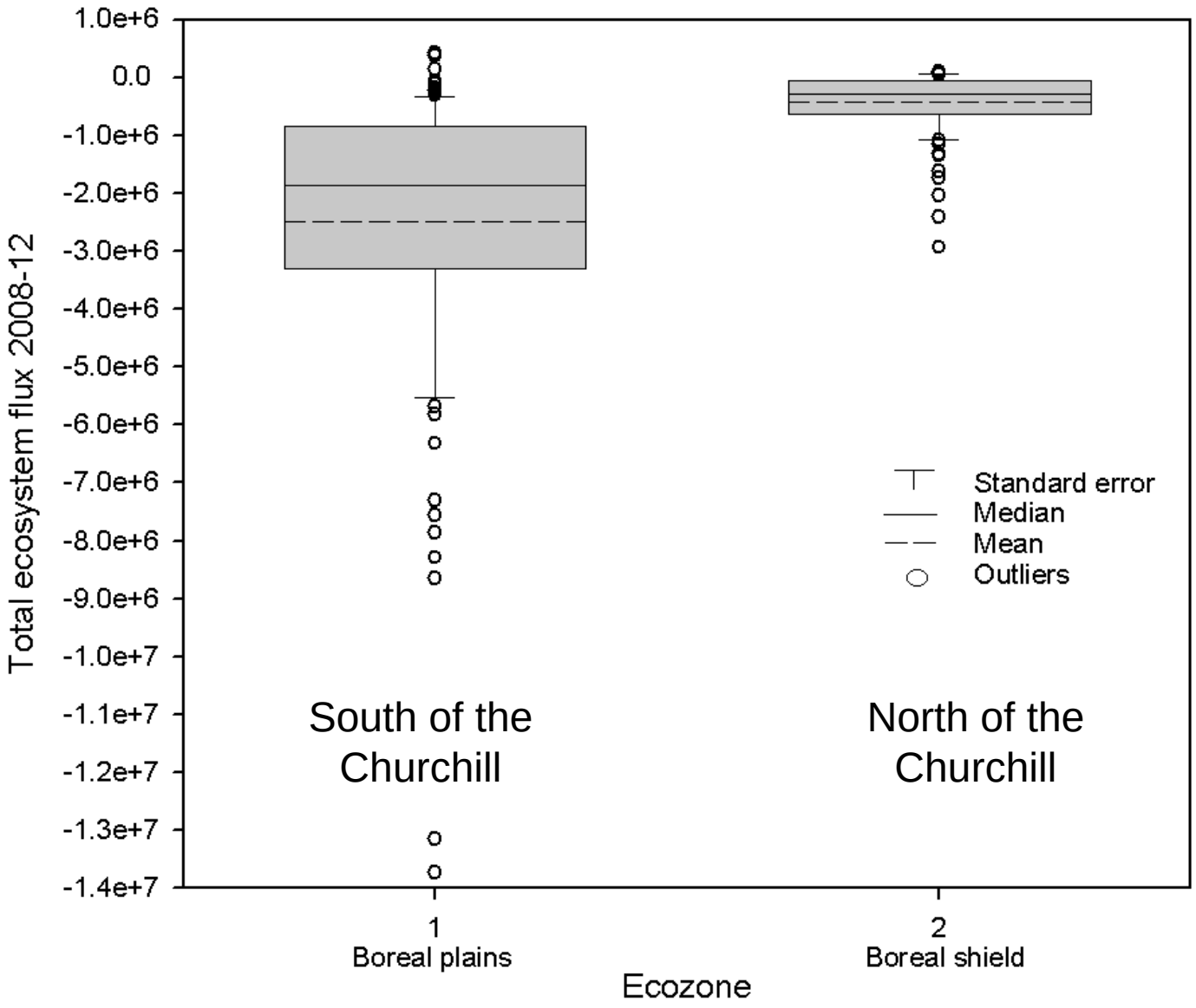
Stratum	Area (Mha)	Biomass (Mt C)	Dead Org. Matter (Mt C)	Ecosystem (Mt C)
Boreal Shield	1.02	60	240	300
Boreal Plains	5.39	321	1 211	1 532
Prairies	0	0	0	0
Total	6.41	381	1 451	1 832

Carbon stock dynamics

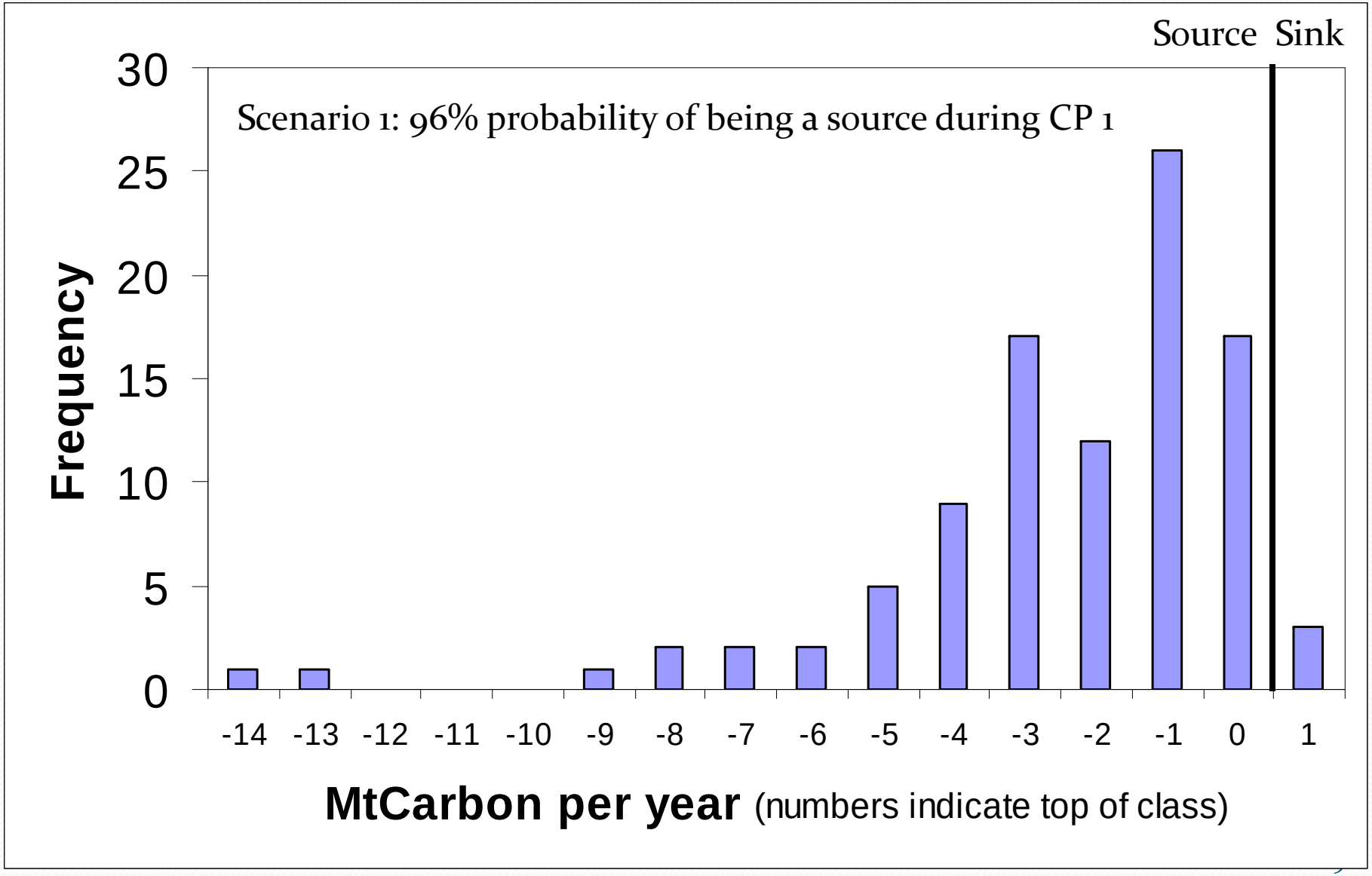
- Monte Carlo runs with highest or lowest total carbon in 2032



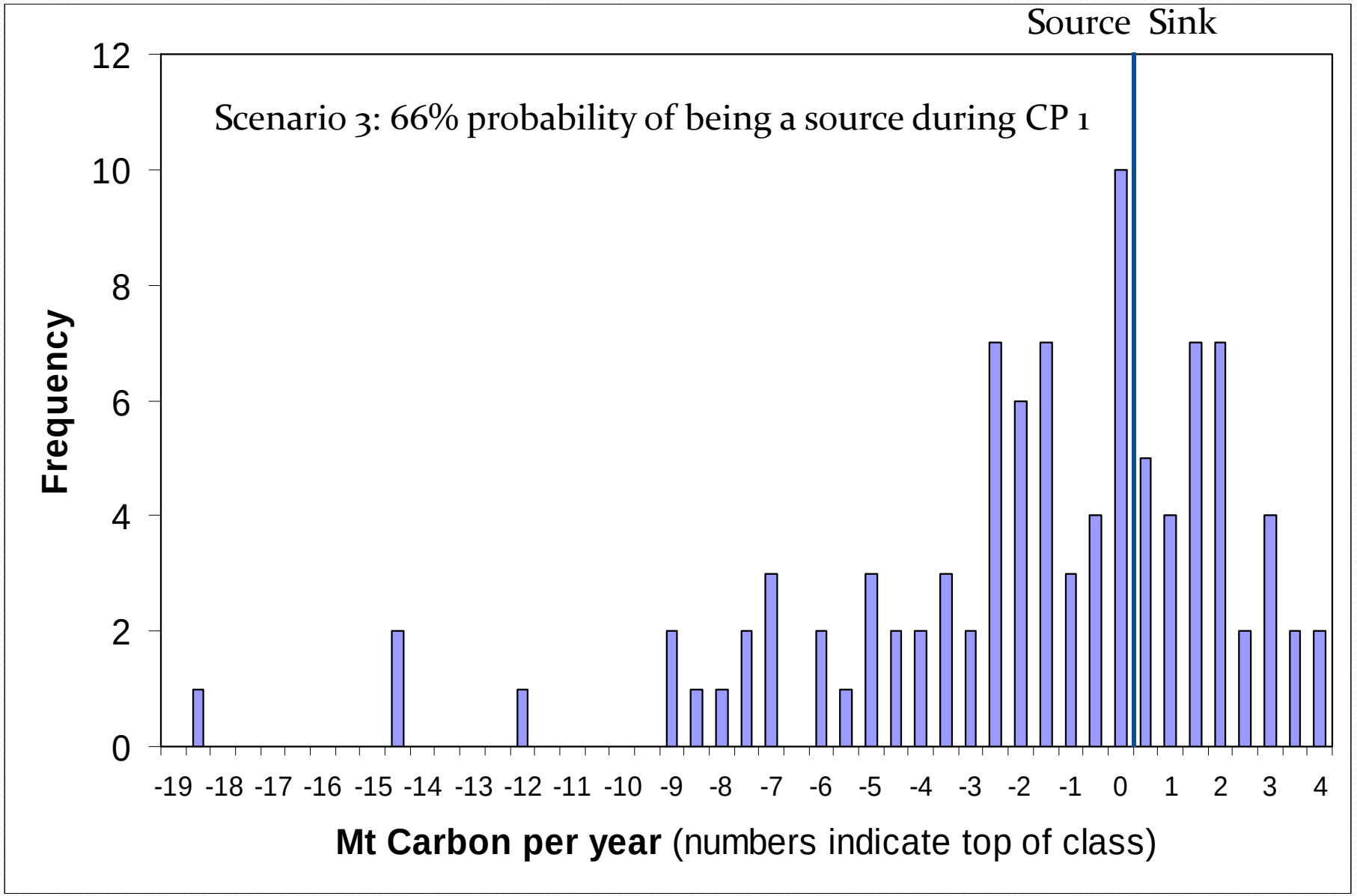
2008 – 2012 Distribution of Total Ecosystem Flux among MC runs



Provincial - 2008-2012 Total ecosystem flux



Provincial - 2008-2012 Total ecosystem flux



Conclusions

- The net carbon balance of Saskatchewan will be strongly affected by annual disturbance rates and the defined monitoring area.
- The probability distribution of the 2008-2012 net C balance is asymmetrical, with a risk of between 66 and 96% that the provincial forest will be a carbon source in the future.
- This analysis ignores the impacts of climate change, which are likely to increase the frequency and intensity of insect outbreaks and fires.

Enhancing sequestration

- Reducing impacts of disturbance
  - Fire suppression, insect control
    - Cost, environmental impacts?
- Forest management practices
  - Improved planting stock, GM trees, stand management
    - Social license?
- Afforestation with fast-growing species
  - High C accumulation rates – up to 10 times natural forest
  - Role in SK economy – forest products, bioenergy
    - Social license, economic viability?