Carbon Budget Model of the Canadian Forest Sector: CBM-CFS2

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Outline

1. Overview of CBM-CFS2
2. National results for Canada's total forest
3. Ongoing and planned activities

Overview of CBM-CFS2

Biophysical Model

- Purely biophysical model, applied at various scales

Data	Modelling
- forest inventory (area by age class)	- biomass pools C pools
- growth and yield	- dead organic matter C pools
- disturbances (fire, insects, harvest)	- disturbance impacts
- land-use change	- exchanges b/w pools and with atmosphere

- Carbon Budget Model of the Forest Products Sector (CBM-FPS)

Economic Linkages?

- Indirect economic linkages through
  - harvests
  - production of wood products
  - fire and insect suppression activities
  - afforestation/reforestation and deforestation areas

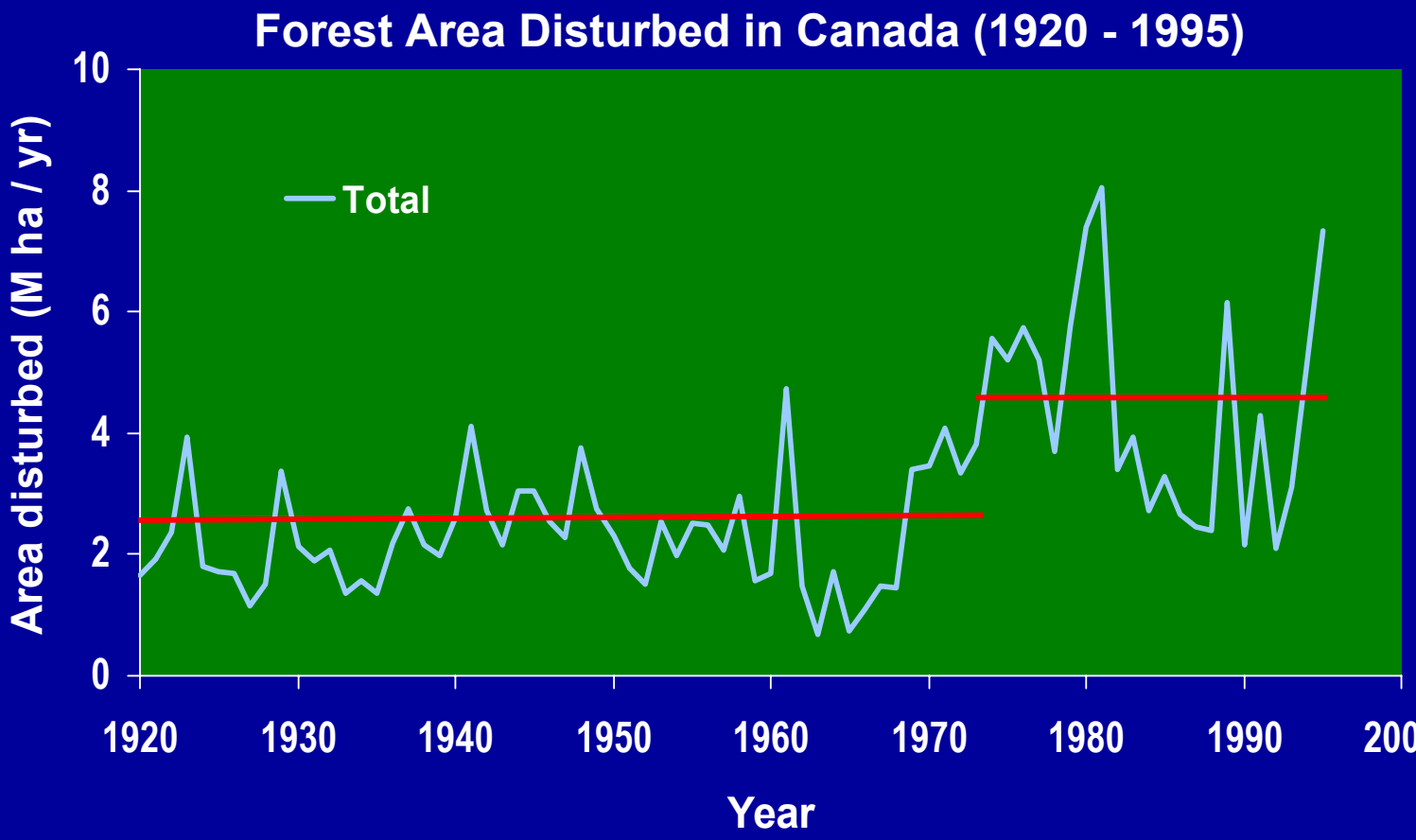
- Model has never been used to explicitly examine the influence of changes in economic variables (e.g. price of carbon or wood)

Stand and Landscape C Dynamics

- Stand level C dynamics
  - growth and decomposition processes, transfers between carbon pools and with atmosphere
- Landscape level C dynamics
  - disturbances, which determine age class structure
  - these dynamics are the dominant influence on Canadian forest C budget

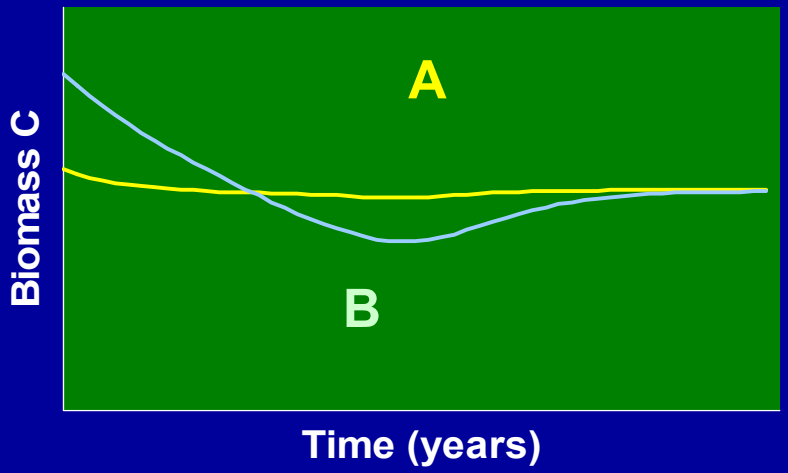
Importance of Disturbance Regime

Changes in the disturbance regime affect the age structure of the forest



Importance of Forest Age Structure

The current age structure influences our ability to affect C in the future



CBM-CFS2 Approach

- Define area and stratify
  - Stratify by ecosystem types in the area
  - Age-class structure of ecosystem types
- Model biomass and dead organic matter
  - Establish initial conditions
  - Model C dynamics
- Incorporate disturbances and land-use change
- Summarize C dynamics over space and time

CBM-CFS2 Approach - Step 1: Spatial Structure

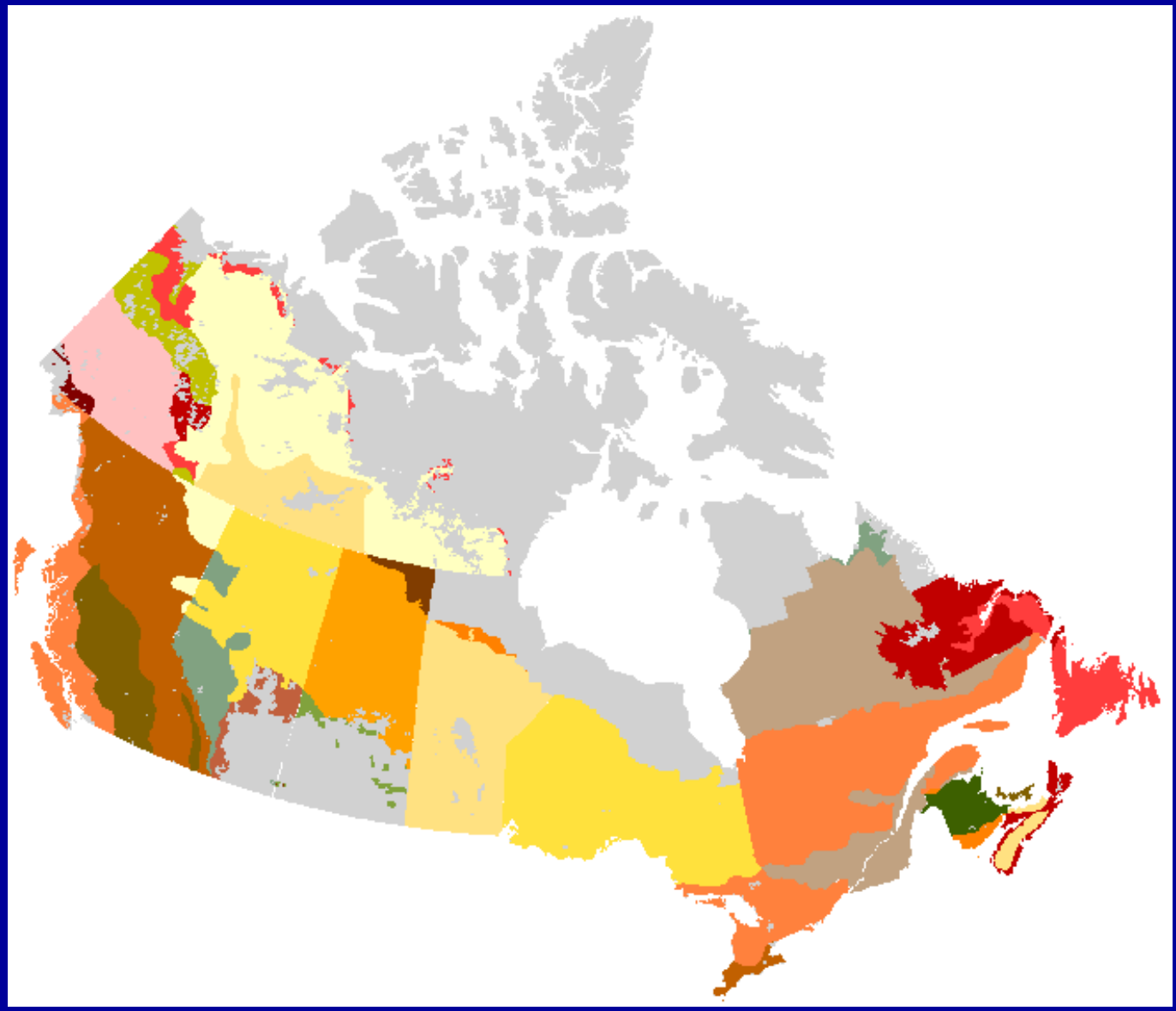
- 42 spatial units for all of Canada reflecting
  - 12 administrative units X 11 ecoclimatic provinces

- 5 forest inventory classifiers (productivity, site quality, stocking, maturity class, forest type)

  ⇒ areas for 457 forest ecosystem types

- Area records ('stands')
  - >10,000 records representing areas with different ages, ecosystem types and C stocks
  - not spatially explicit - records assigned to spatial units

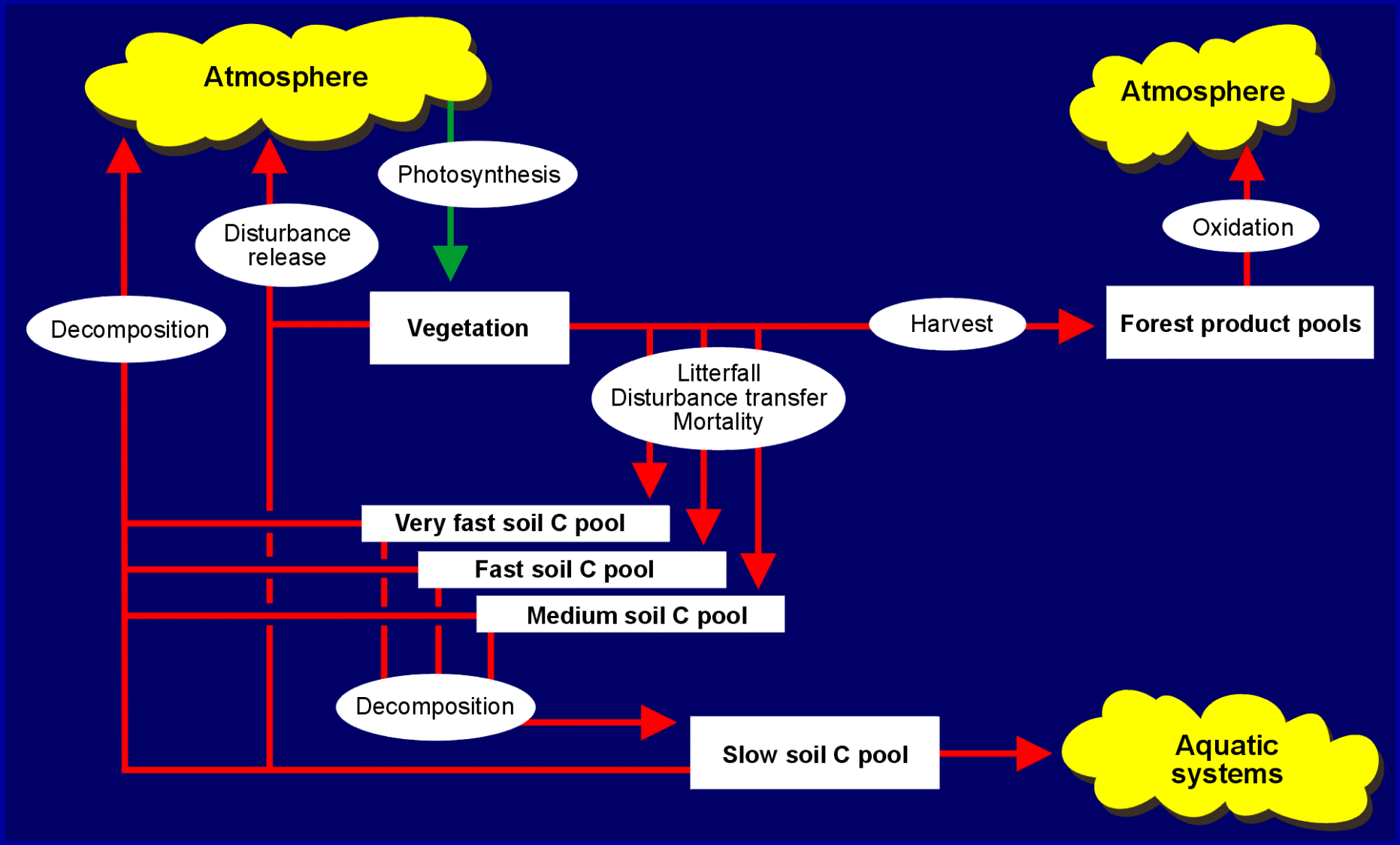
42 Spatial Units Used in CBM-CFS2



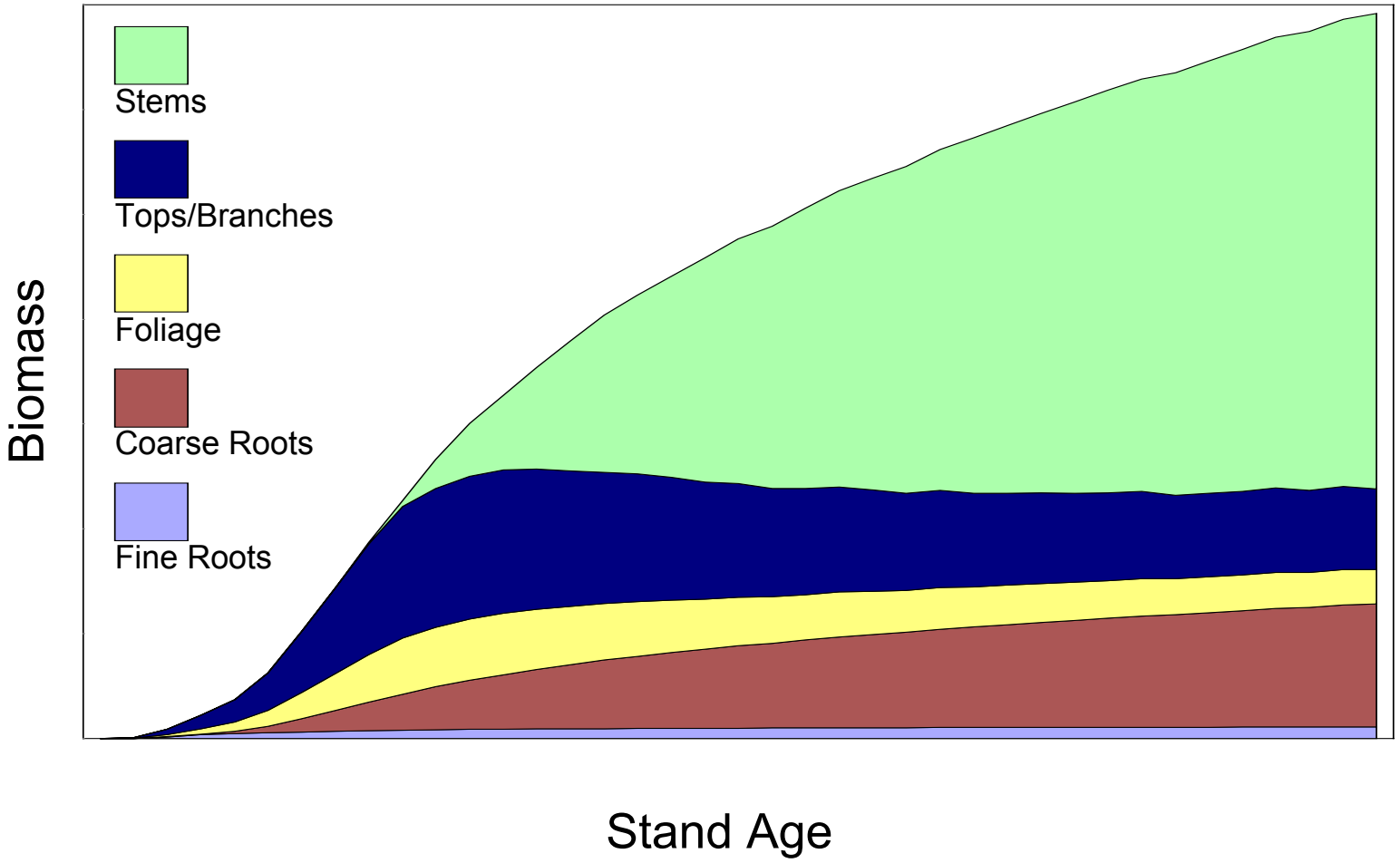
CBM-CFS2 Approach - Step 2: Forest Stand Carbon Dynamics

- Biomass and dead-organic matter dynamics
  - estimate biomass growth curves for each record
  - separate above-ground biomass into 4 pools
  - estimate below-ground biomass pools (2) and dynamics
  - determine initial dead organic matter stocks, and decomposition dynamics

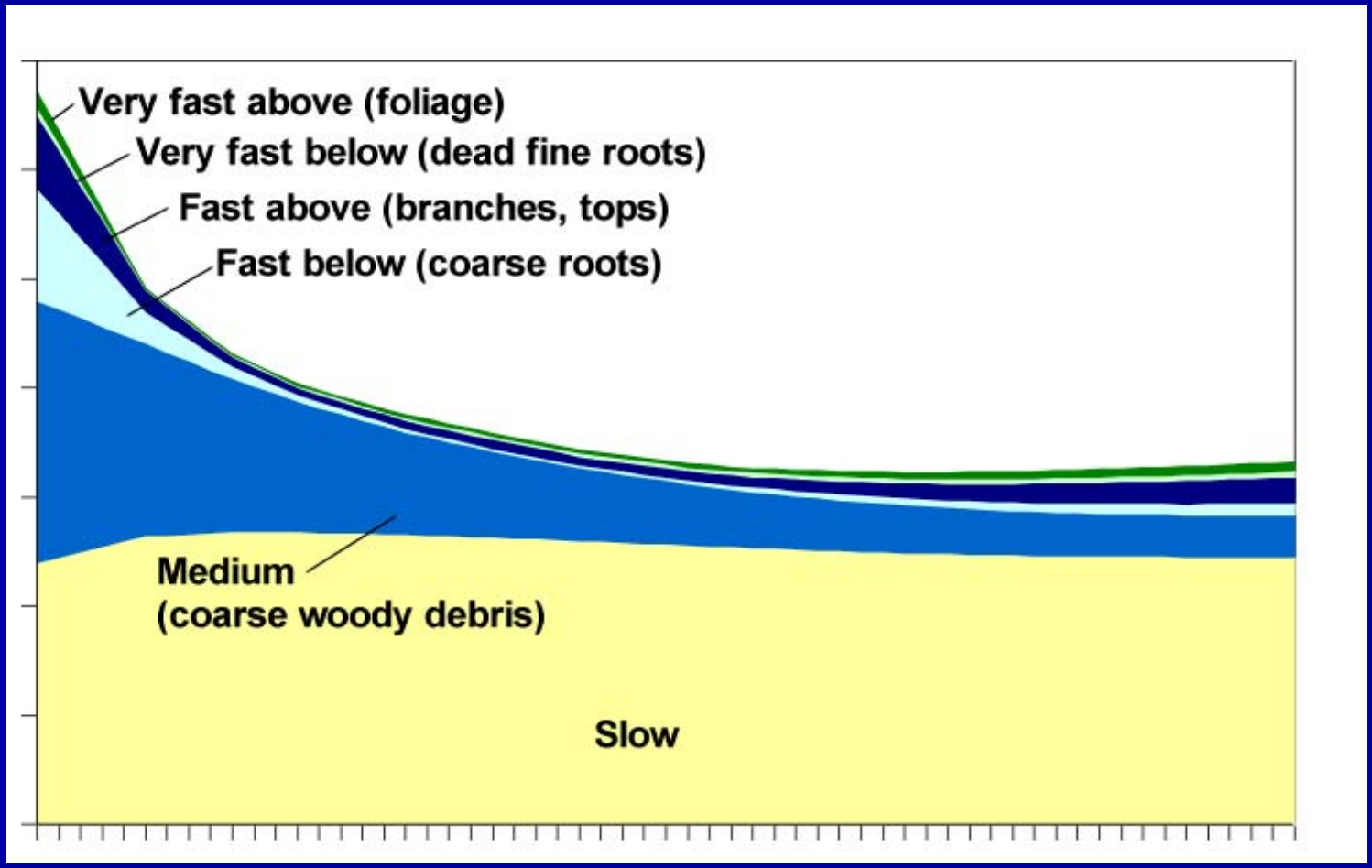
Carbon Pools in CBM-CFS2



Stand-Level Dynamics of Biomass Pools



Stand-Level Dynamics of Dead Organic Matter Pools

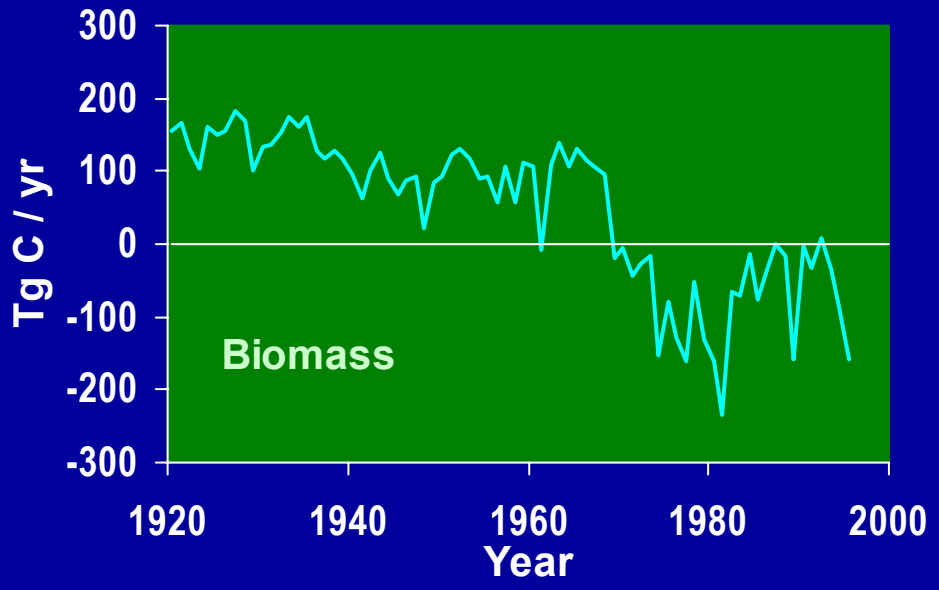


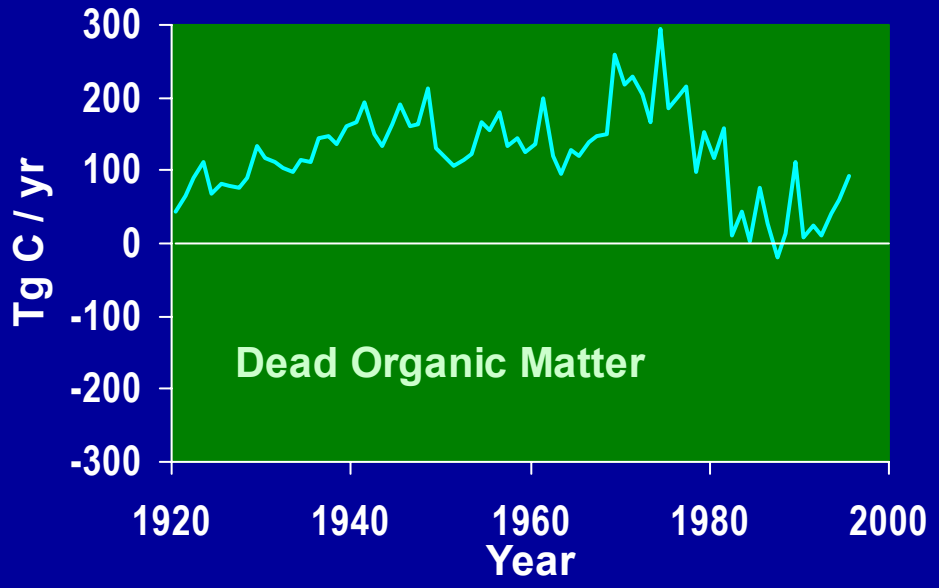
CBM-CFS2 Approach - Step 3 Disturbances

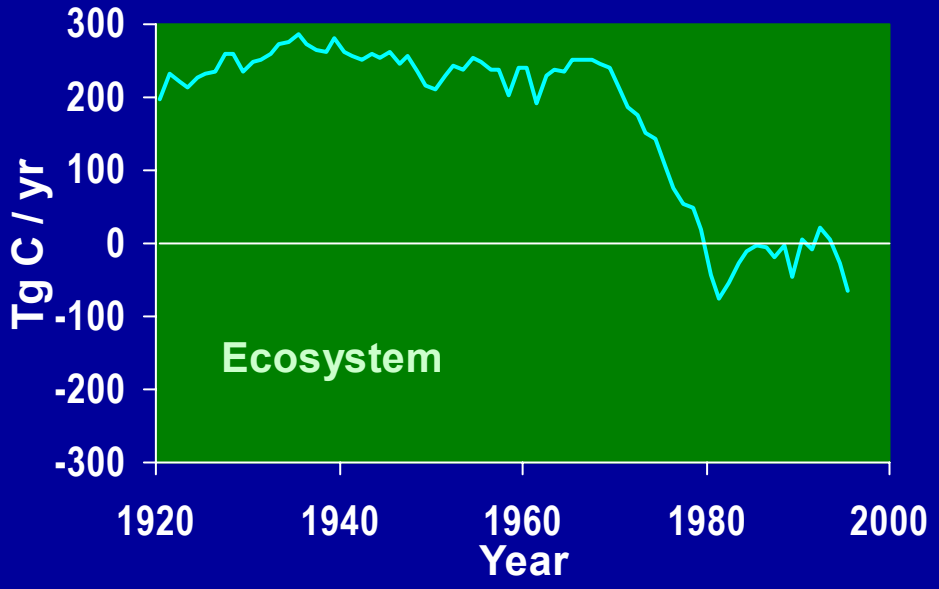
- 7 stand-replacing disturbance types (wildfire, insect-induced mortality, logging)
- Define carbon flows associated with each disturbance (% of each ecosystem carbon pool transferred)
- Define rules for distributing disturbed area across records (forest stands)

National Results for Total Forest

Estimated Change in Carbon Stocks, Total Canadian Forest 1920-95

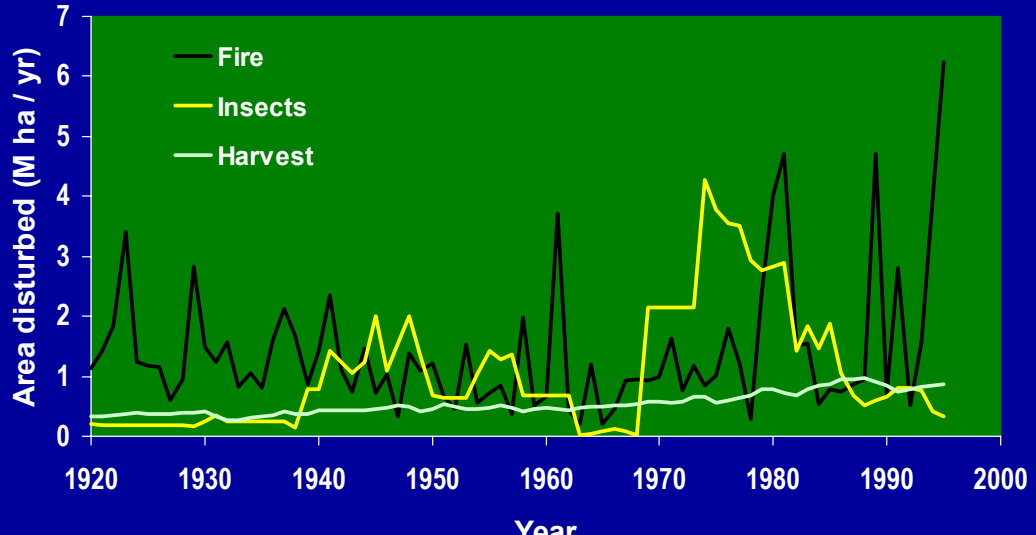






Projective Analyses

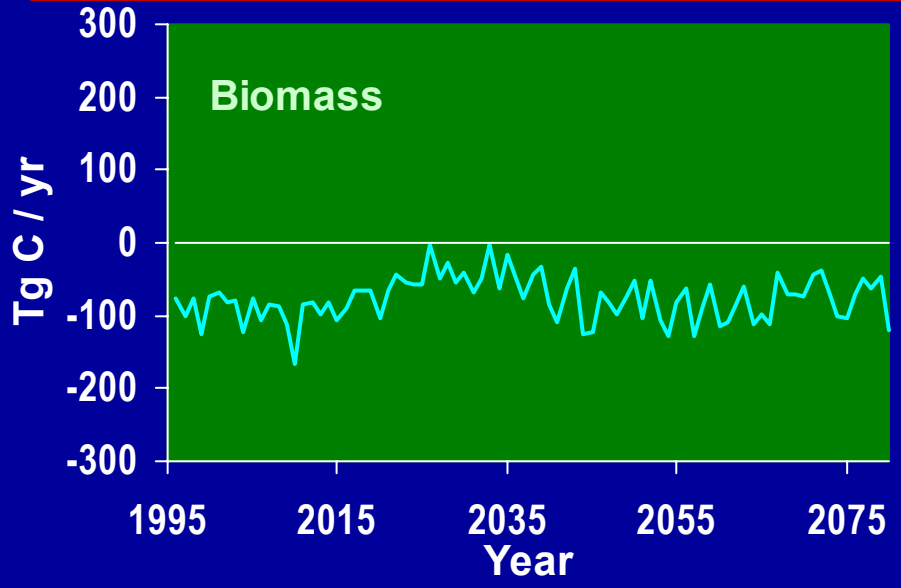
1. Base scenario:
    - Harvest level as projected to 2032 in previous analysis, then held constant
    - Natural disturbances: Historical average (Insects: 1980-1995, Fire: 1960-1995)
2. 20% lower harvest
3. 20% higher natural disturbances
4. 20% lower harvest, 20% higher disturbances

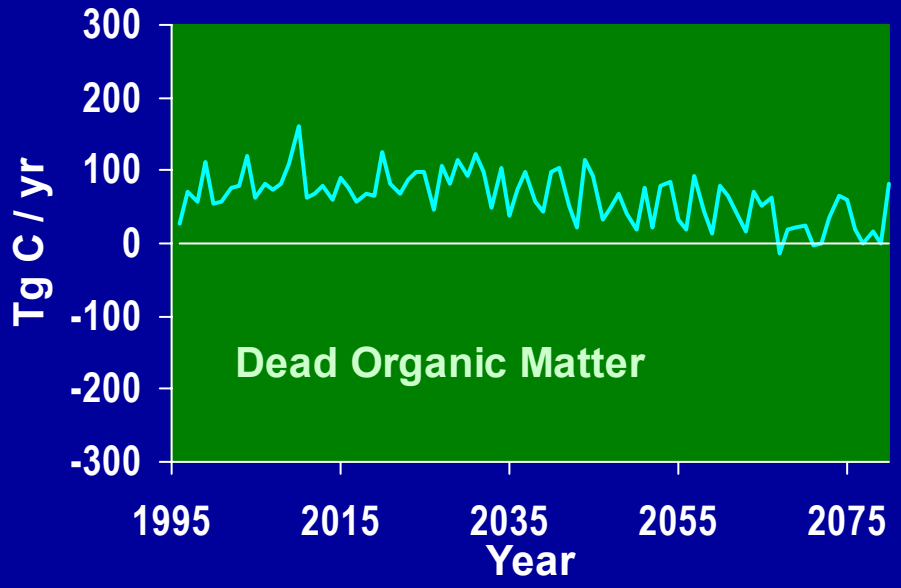


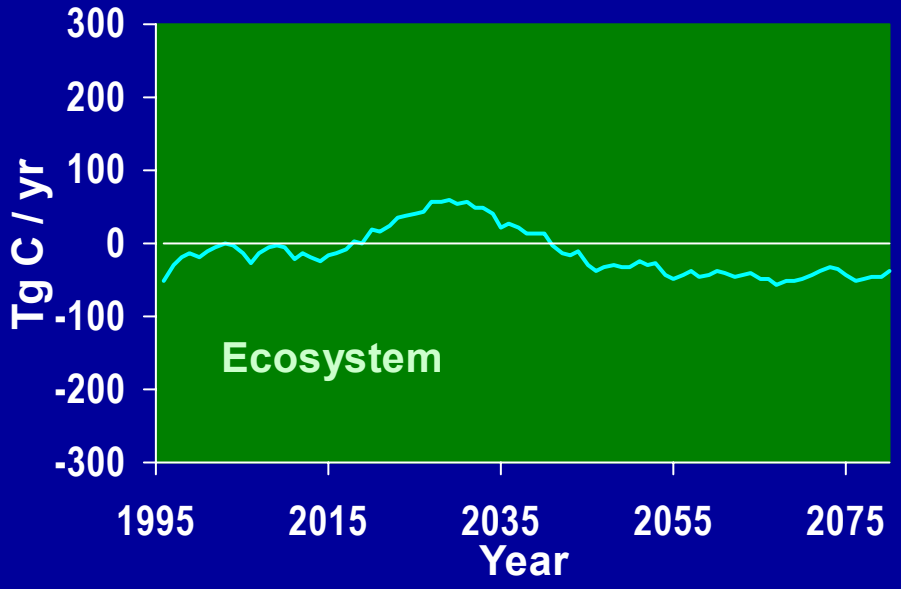
Projective Analysis

- Area: Total inventoried forest land in Canada (over 400 million ha)
- Simulation from 1996 to 2080
- Initialization of pools in 1996 from retrospective analysis, 1920-1995
- Does not include intensive management practices other than planting
- Growth rates and decomposition rates not changed for the simulations

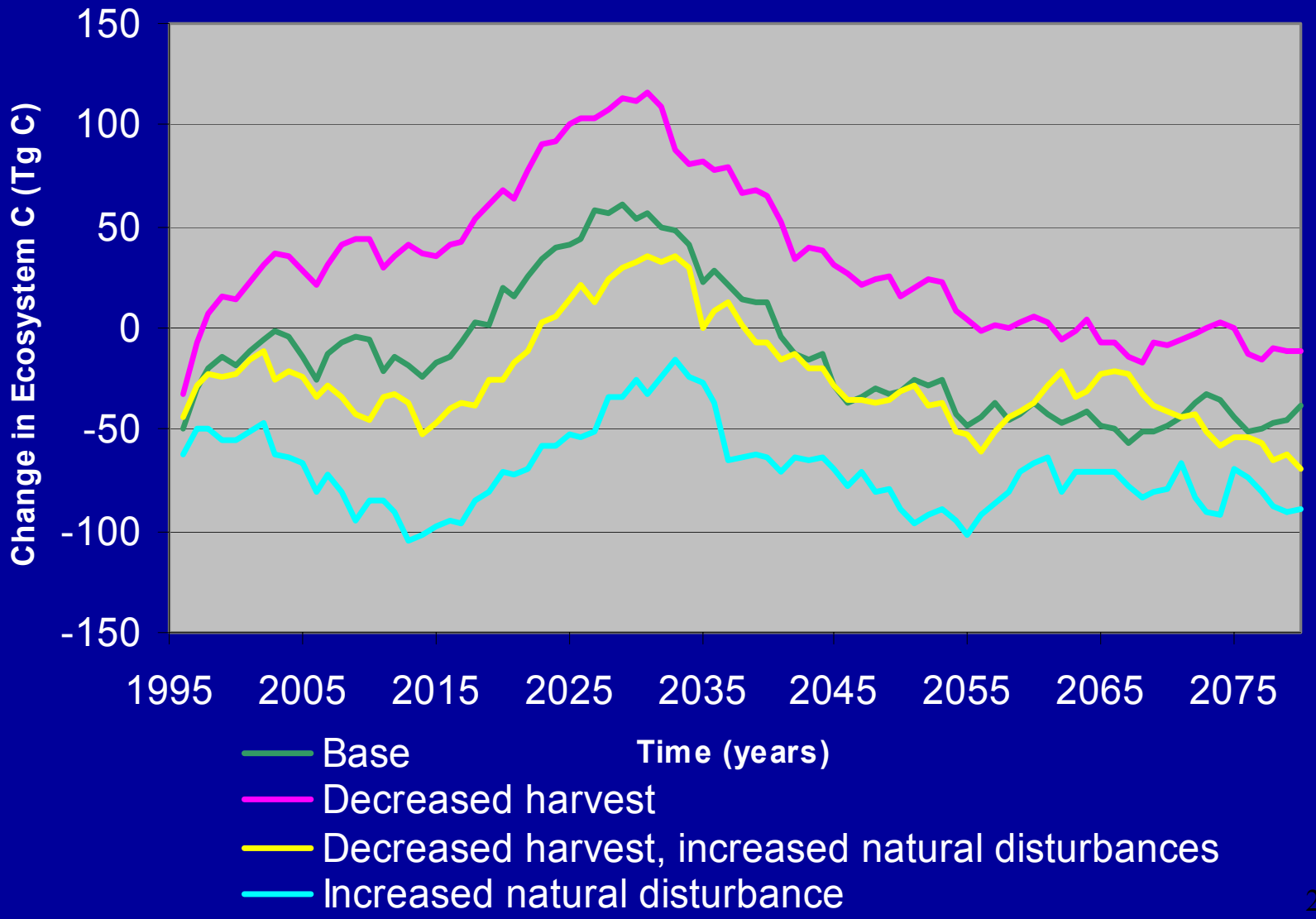
Results: Base Scenario
Change in Total Forest Carbon Stocks



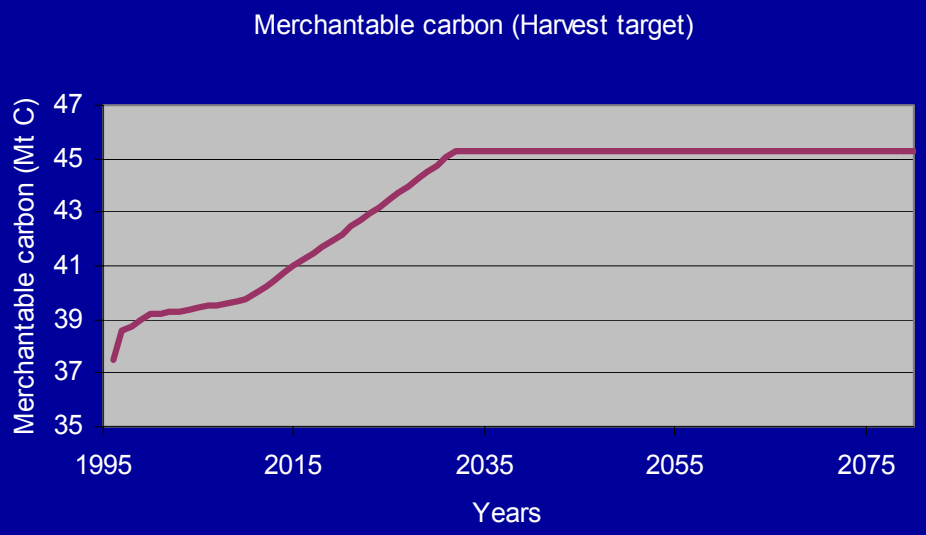


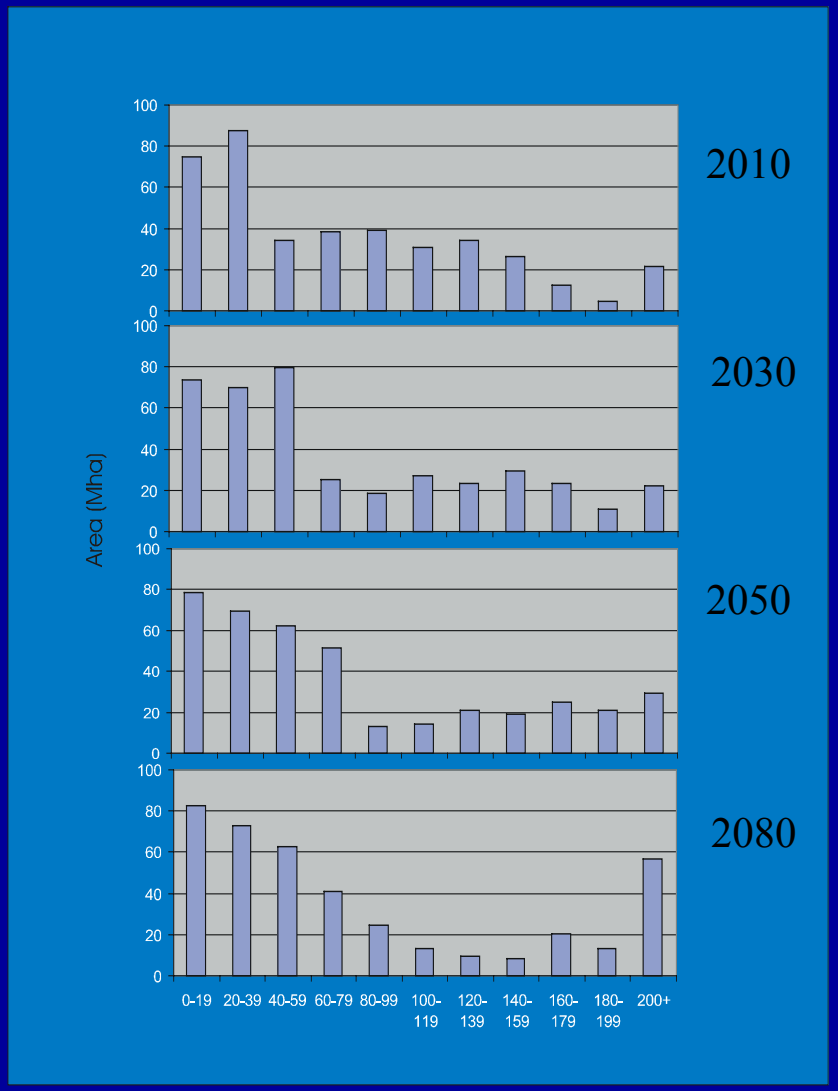


Results: Change in Total Forest Ecosystem Carbon Stocks



Examination of Base Scenario





Results Summary

- Cannot ignore long-term dynamics, driven by current age structure and future disturbances
- Managing harvests can have a large impact on ecosystem carbon stocks
- Need to think about possible impacts of climate change in considering GHG mitigation
- Caveats to model runs
  - results for total forest not managed forest
  - forest products pool not included

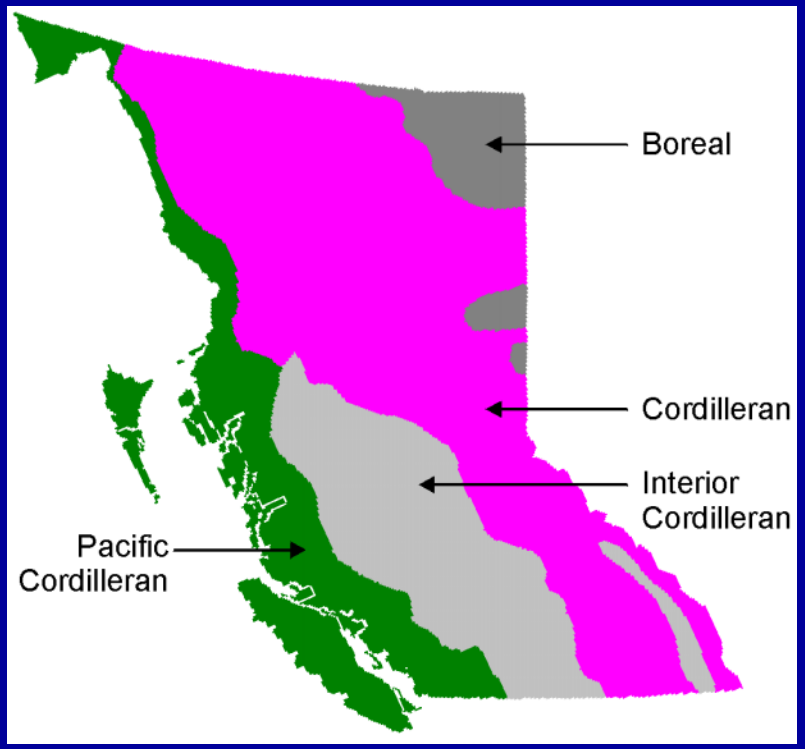
Ongoing and Planned Activities

Ongoing Work

- Improve data and modeling approaches
  - build closer linkages to forest inventory and growth and yield data sources
  - improve dead organic matter C estimates
- Incorporate deforestation and afforestation
- Make model more spatially explicit - needed to
  - improve ability to manage for carbon
  - improve predictive ability

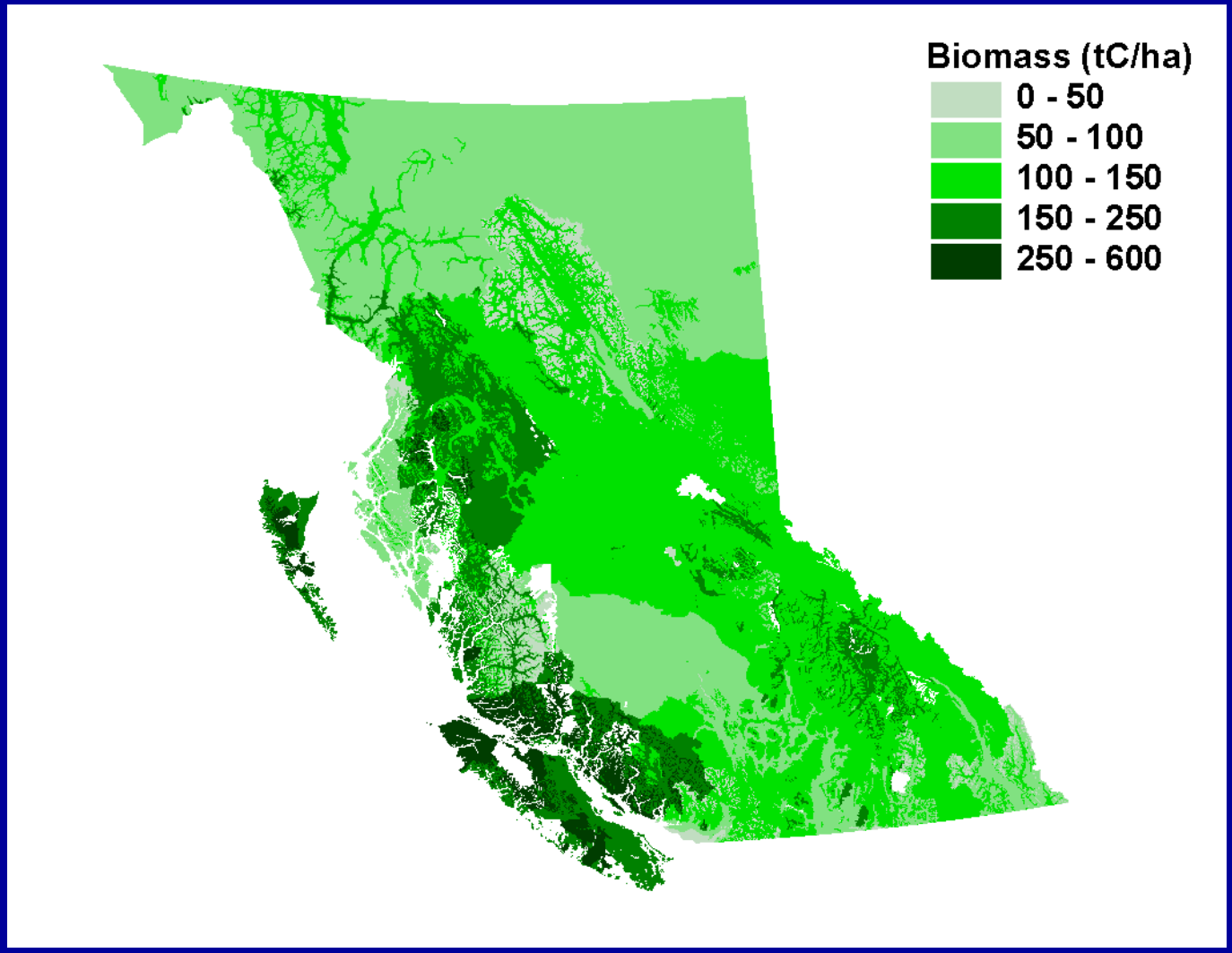
Spatially Explicit Application

- Applied to British Columbia
  - use very detailed provincial inventory and growth and yield information for each management unit
  - stratify each management unit by biogeoclimatic zone
  - spatially explicit - 750 spatial units instead of 4



British Columbia spatial units

Spatially Explicit Application



Planned Activities

- Develop forest C accounting tools, based on CBM-CFS2
- Characteristics of the tools:
  - use best available data including from new National Forest Inventory, and new land-use change detection system
  - employ standard accounting methods for C stock change reporting
  - incorporate best available science
  - are consistent across a range of spatial scales
  - are spatially explicit
  - will be readily accessible and useable to variety of users
  - will produce results that can be rolled-up to national statistics

Planned Activities

- Develop forest C accounting tools, based on CBM-CFS2
- Uses of the tools:
  - assist forest management decision-making at various levels from operational to provincial
  - provide transparent and verifiable estimates in accordance with international guidelines for accounting for Kyoto Protocol purposes
  - contribute to scientific research
  - support forest carbon crediting and trading, should this be established in Canada

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