Changes in Ecosystem Processes and Management in BC

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Global
- Carbon storage
- Climate change

Landscape
- Vegetation pattern
- Wildlife

Community (stand)
- Harvesting
- Interspecific competition
- Interactions with soil organisms

Population
- Genetics
- Establishment
- Host-specific Interactions

Individual
- Resource acquisition
- Nutrient exchange
- Resource allocation

1. Policies and practices applied at the stand scale feed back to lower and higher scales, sometimes with unintended consequences

    - Reforestation and free-growing
    - Maximum density rules
    - Regeneration method

2. These "unintended consequences" often result from forest simplification

- Increased disease
- Increased insect epidemics

3. Forest simplification may reduce forest resilience to evolving disturbance regimes brought by climate change

   - Affects future management options

4. Future forests should be designed for resilience based on a sound understanding of the link between pattern and process

   - E.g., diversity and resilience
   - Research should focus on basic understanding, not 'popular practical results'

Diversity begets resilience

(David Tilman and others)

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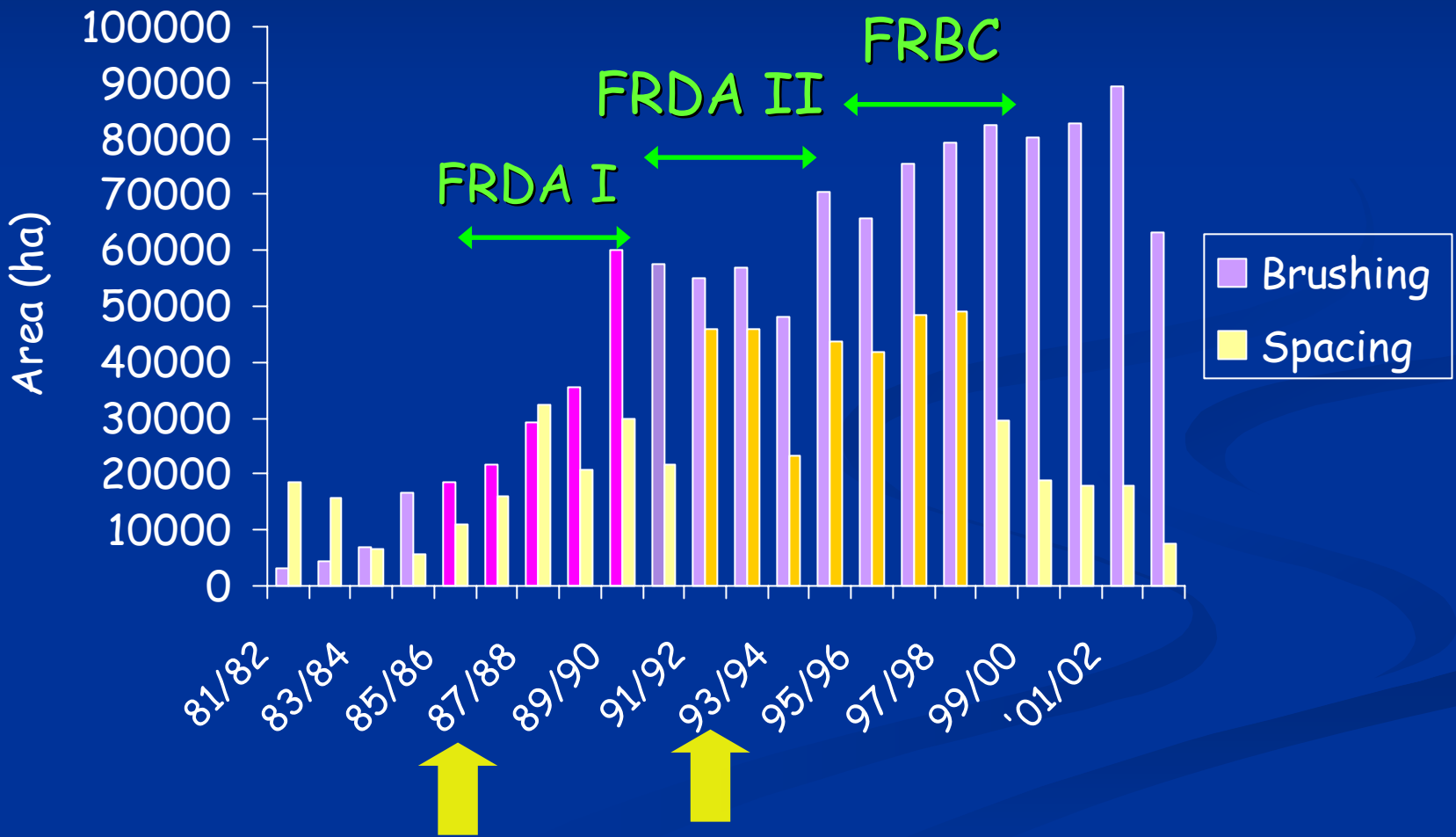
Typical management pathway

Assumptions of Management Pathway

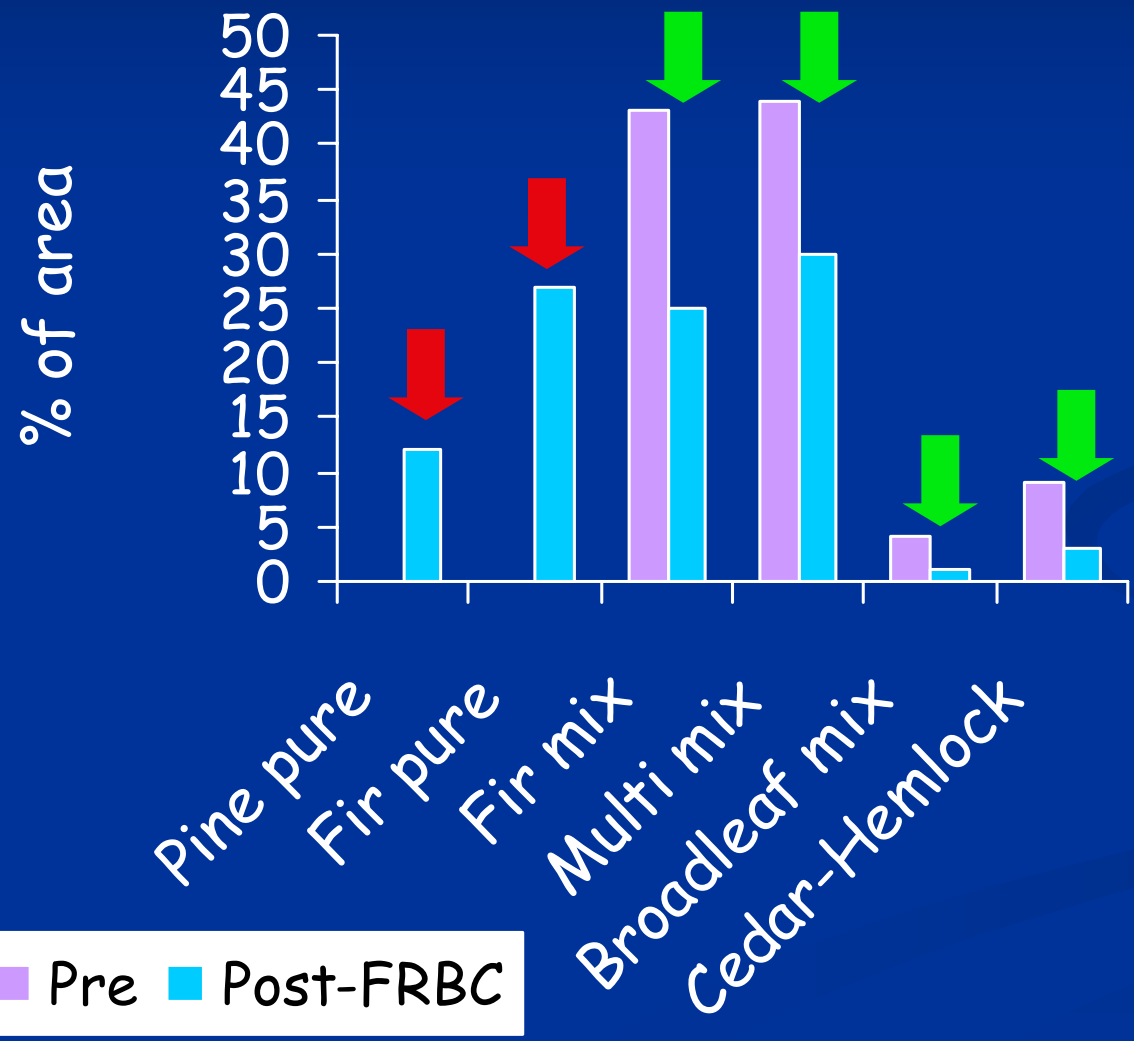
- Brush competes intensely with conifers for light
- Competition is intense even at low brush densities
- Competition is deleterious
- Brushing increases conifer growth
- Brushing increases conifer survival
- Conifer dominated ecosystems are "healthy"
- Conifers are more "valuable" than broadleaves

Free-growing regulations reflect these management assumptions

Silviculture practices reflect regulations and policy

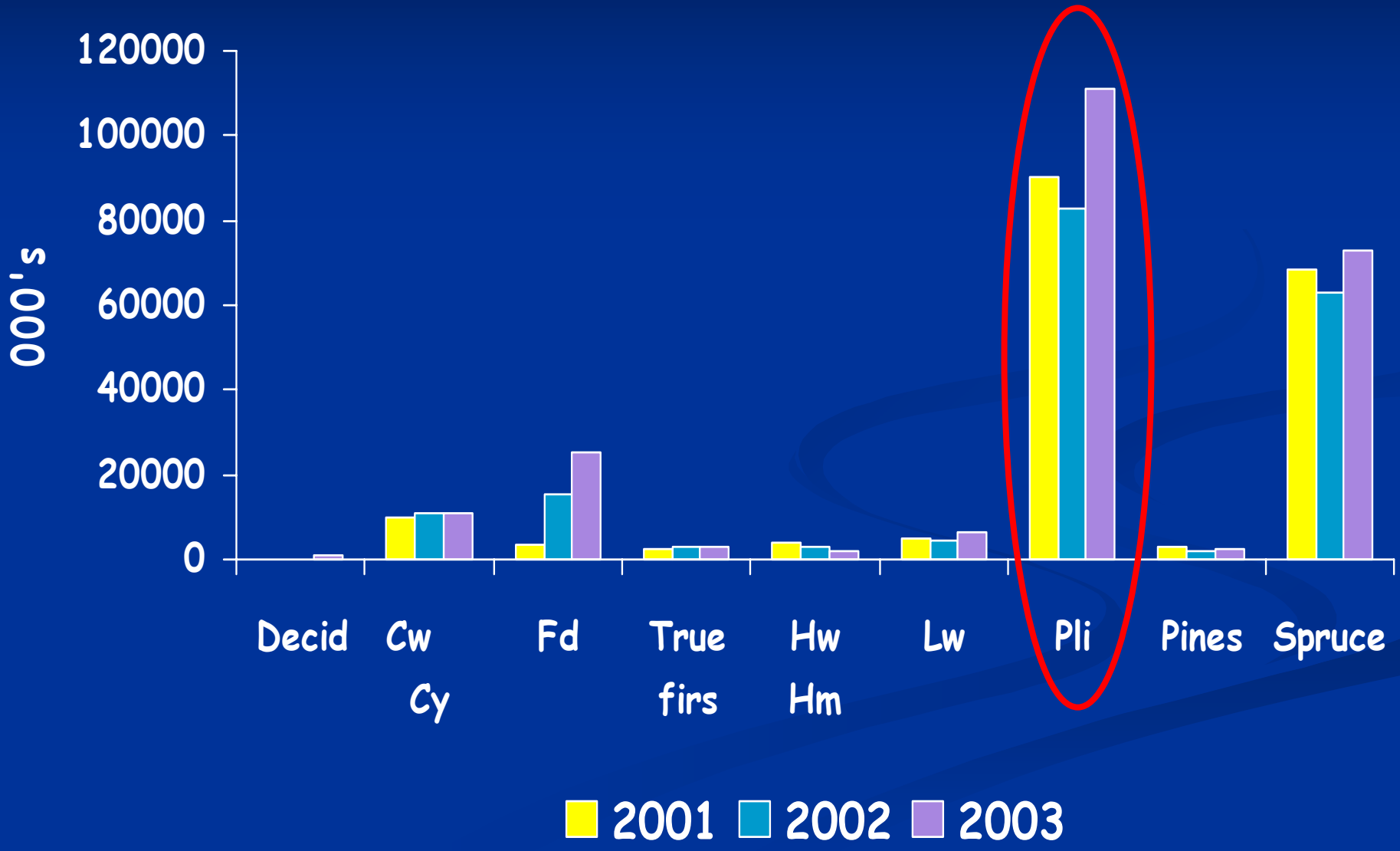


Stand types have changed as a result of brushing and spacing



- Created two pure classes: Pli and Fdi
- Reduced mixed classes by 40% overall

Lodgepole pine dominates planting programs in BC

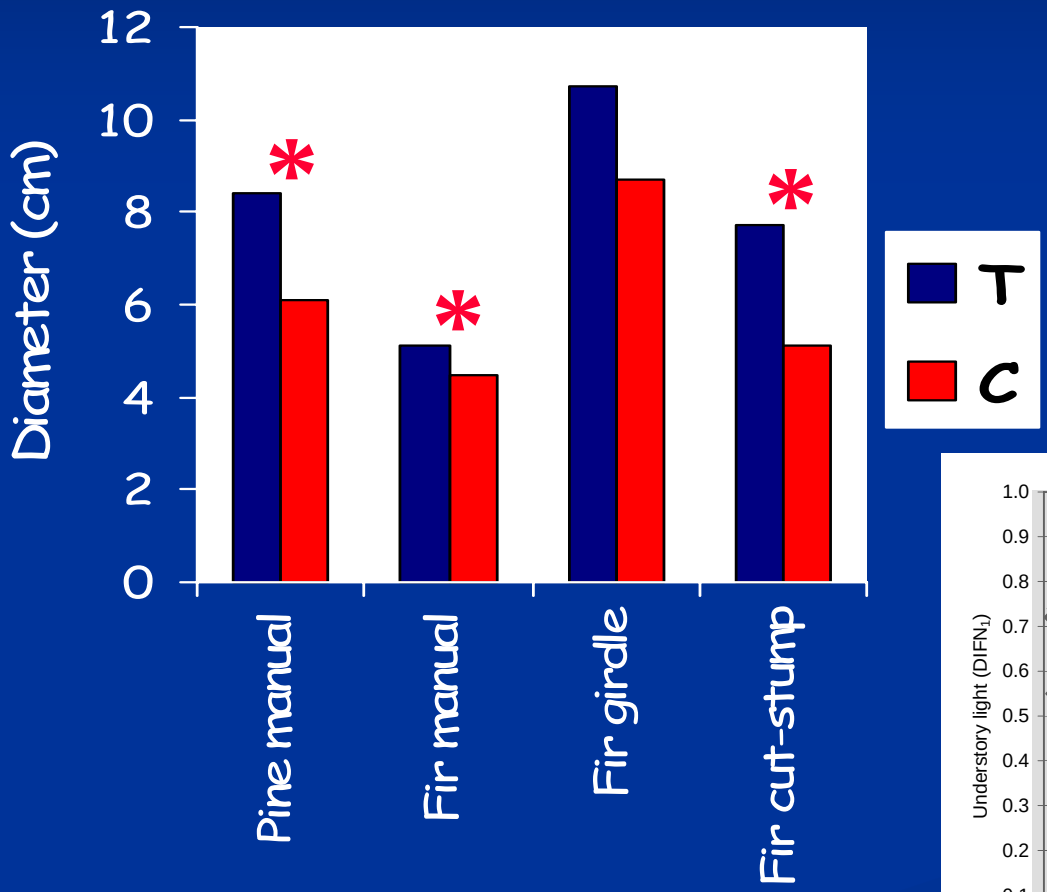


Concerns with Free-Growing

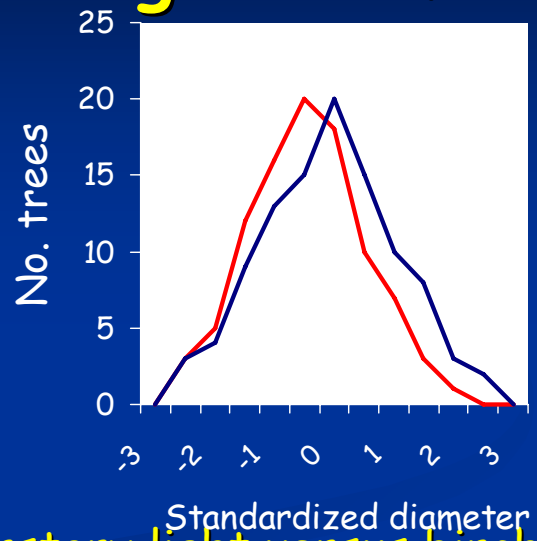
- Focus is solely on conifers
- Lodgepole pine over-planted to reach FG
- Competitive effects of 'brush' exaggerated
- Brushing is costly and often ineffective
- Stands may be less resilient
  - Armillaria, Dothistroma, root collar weevil, MPB
- Stands may be less productive
- Stands may be less valuable

Birch in the ICH

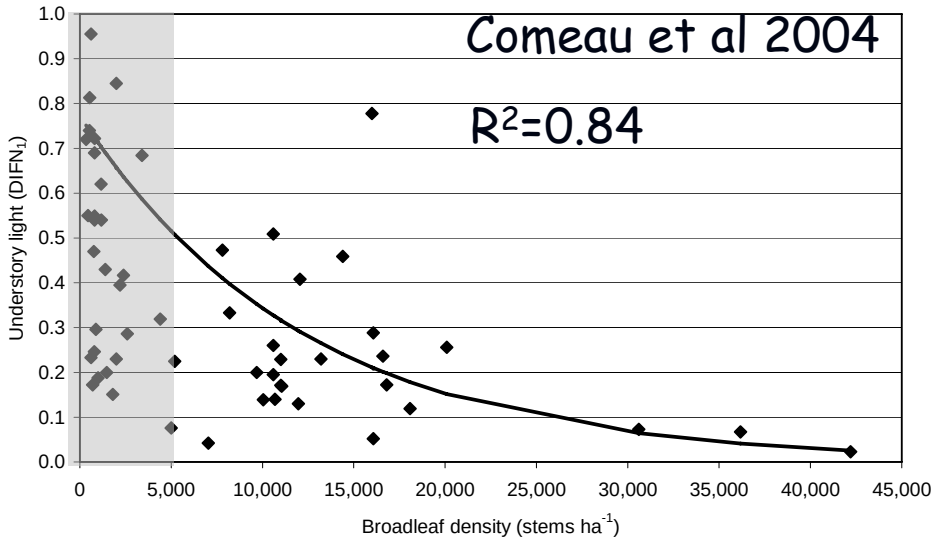
Average diameter, but not height, increased following most broadcast brushing treatments



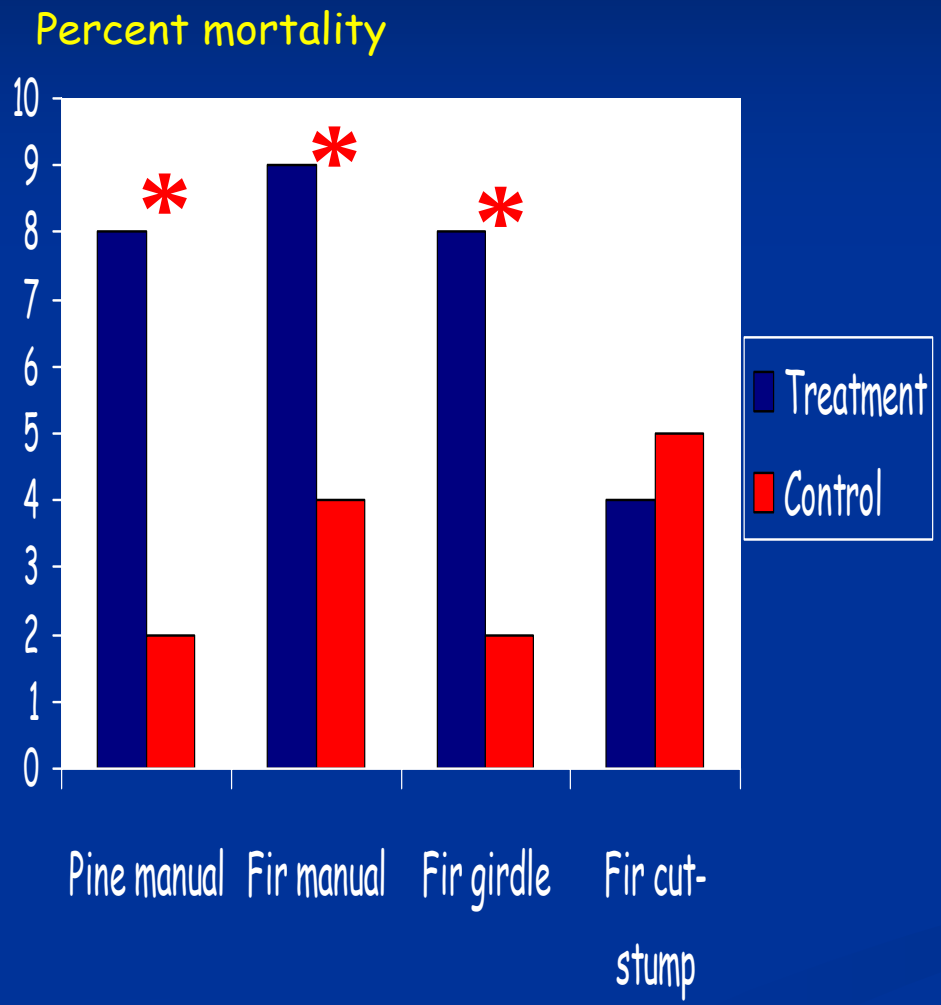
Simard et al. (2005)



Understory light versus birch density



Intensive manual brushing increased *Armillaria*-caused mortality: 5 years post-treatment



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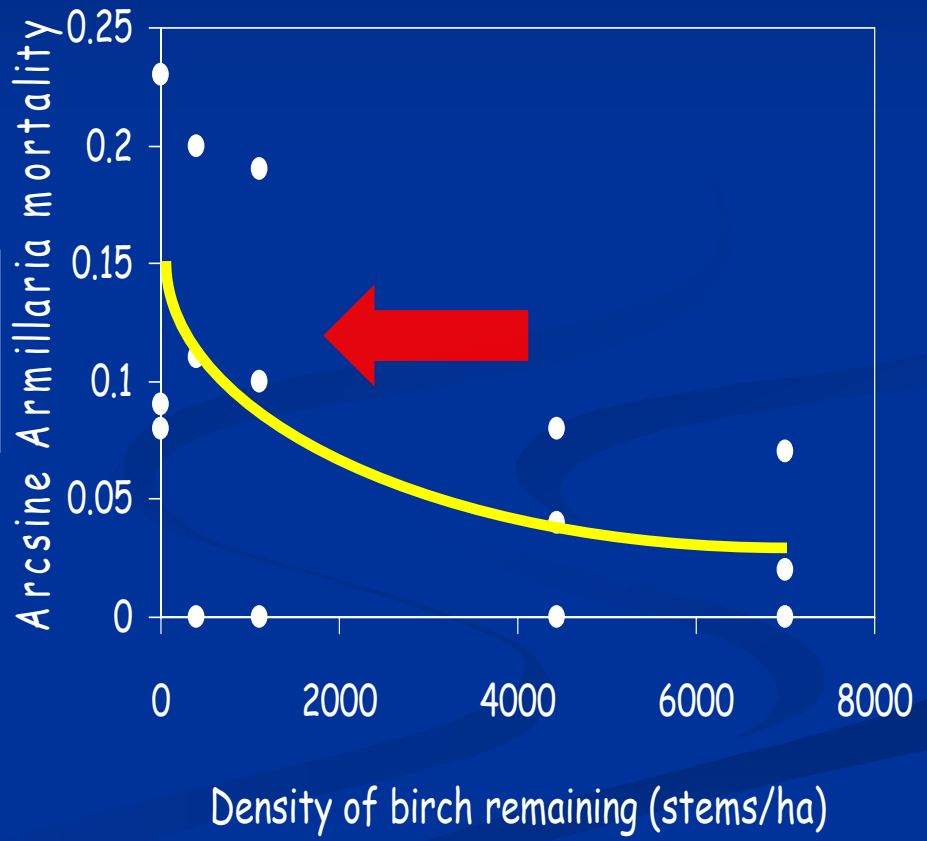
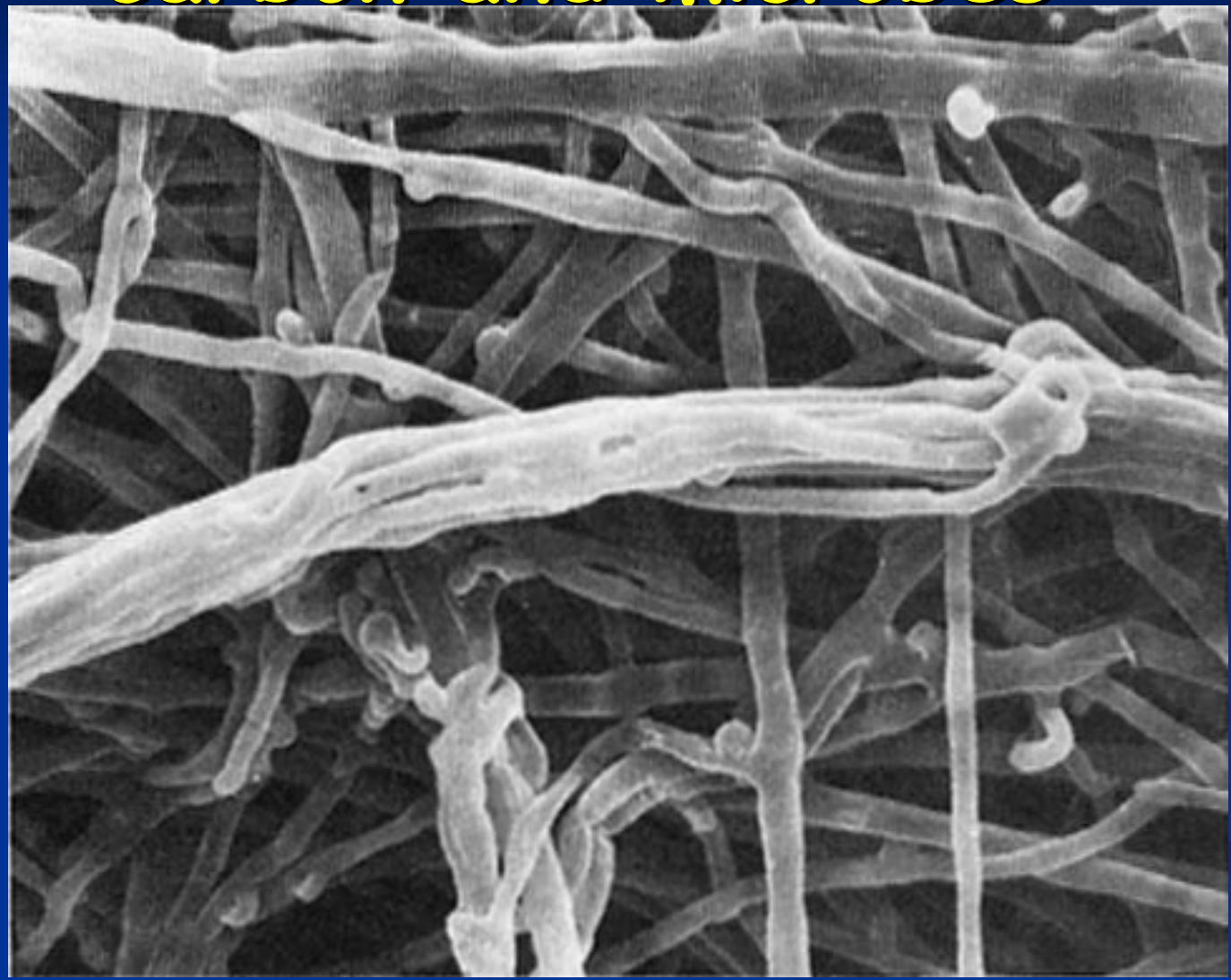


Baleshta et al. 2005

Why did weeding increase *Armillaria* mortality?

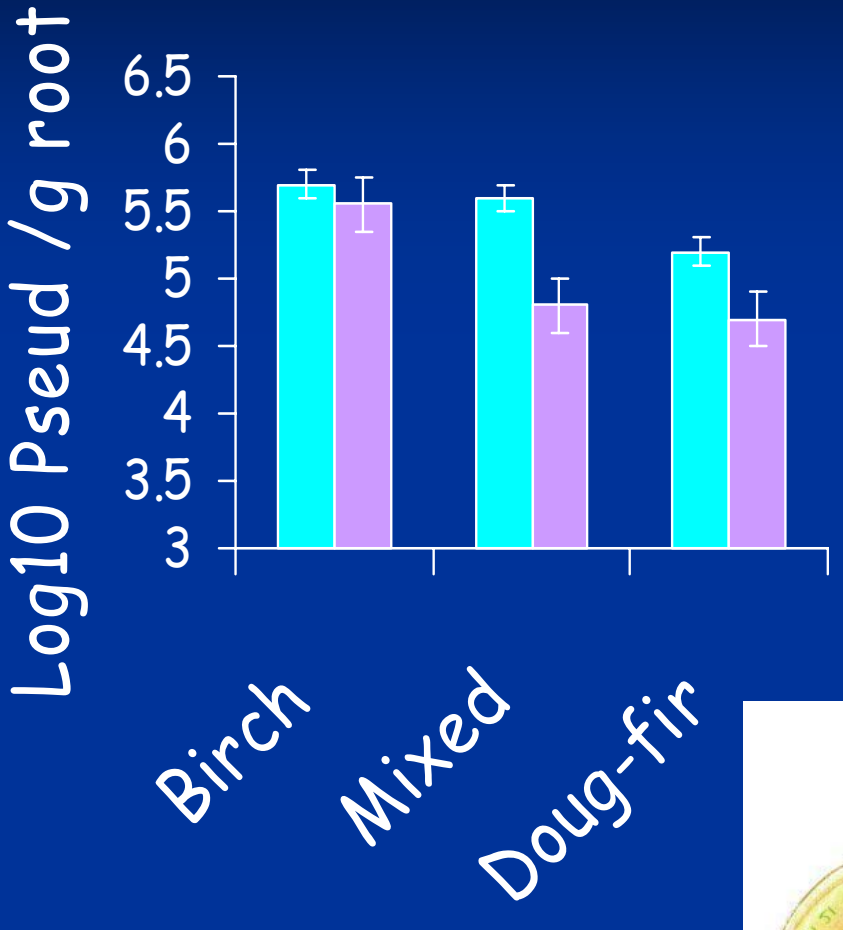
- Increased inoculum load
- *Armillaria is* strongly pathogenic on cut trees
- Conifers infected on contact with infected birch roots
- Chemically killed birch roots poor hosts for *Armillaria*
- Mixed stands more resistant to *Armillaria*

Birch mcyorrhizospheres are rich in carbon and microbes



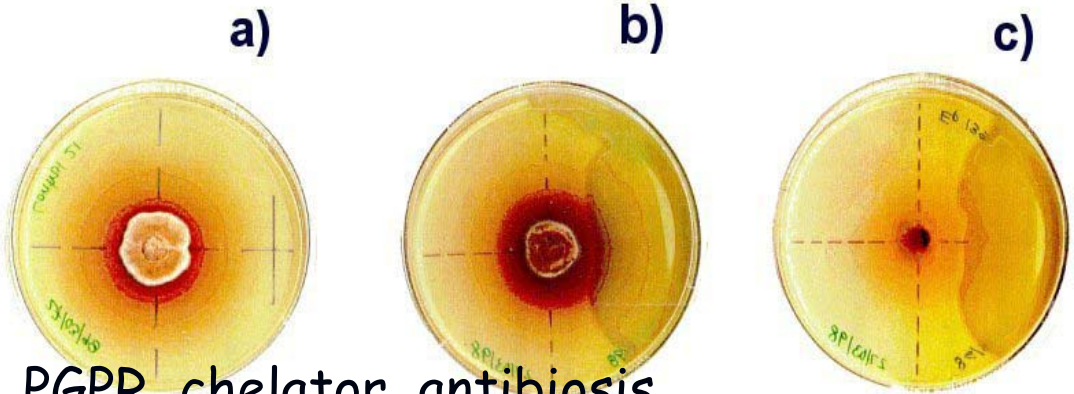
Magnification = 1310x; Massicotte and R. L. Peterson

Paper birch rhizospheres are more favourable for fluorescent pseudomonads



- Birch stands had 4X more than Douglas-fir
- Young stands had 2X more than mature stands
- Young mixed stand populations high due to birch

Delong, Lewis et al. 2002

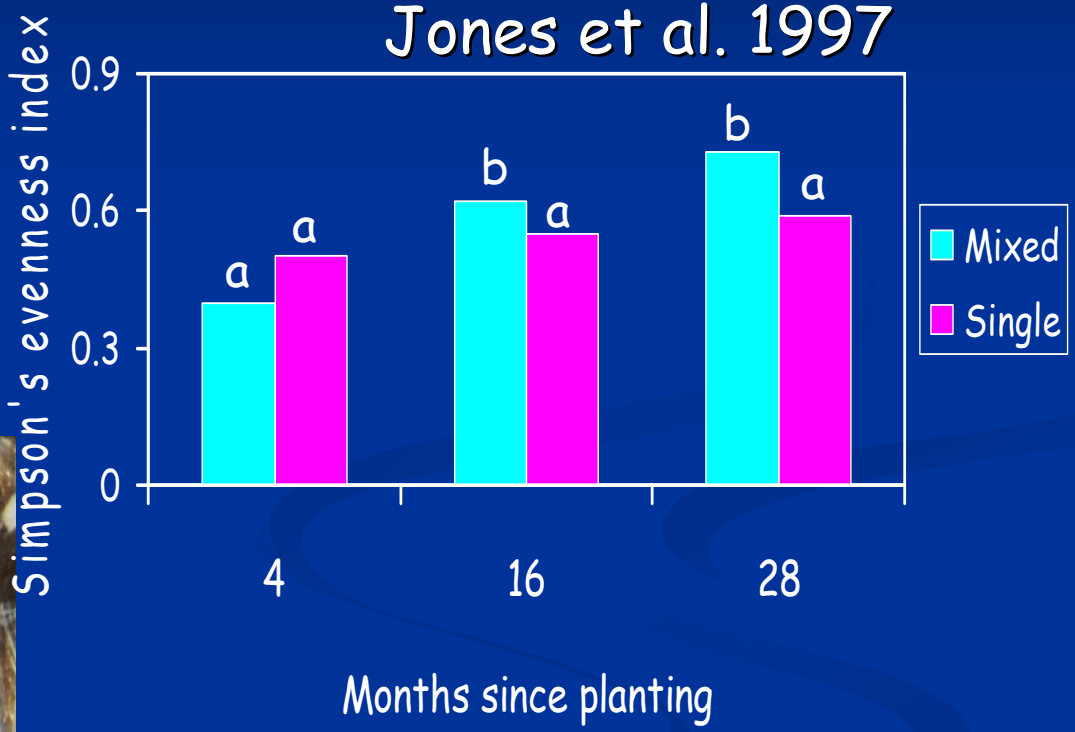


PGPR, chelator, antibiosis

Belowground diversity and function is important to trees

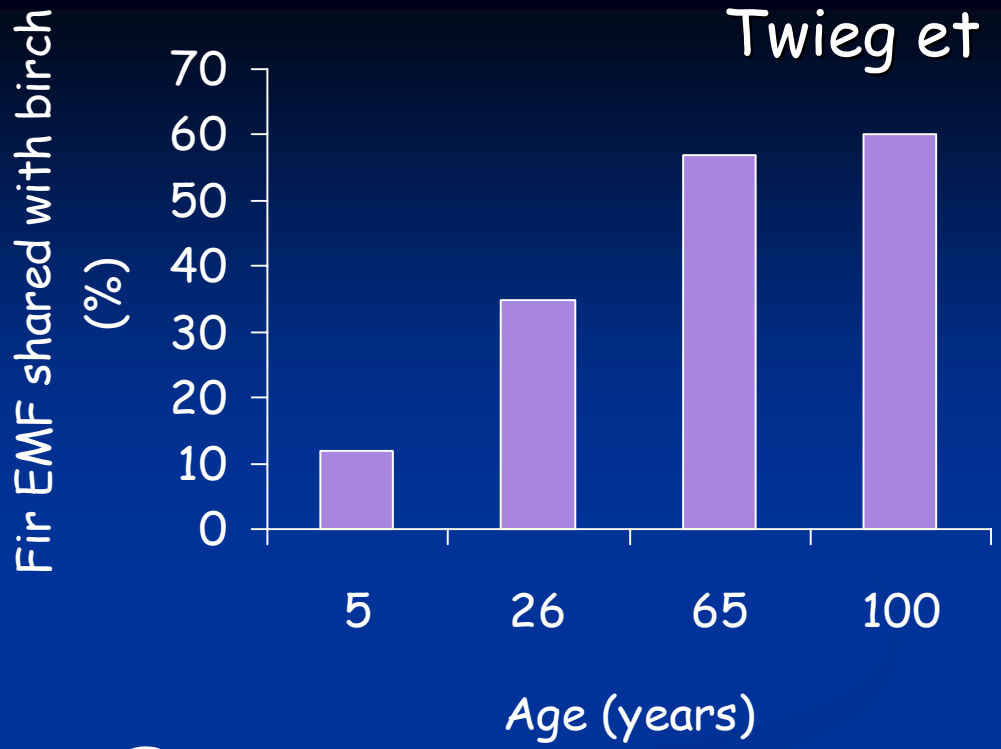
P
N
H_2O
protect
prolong

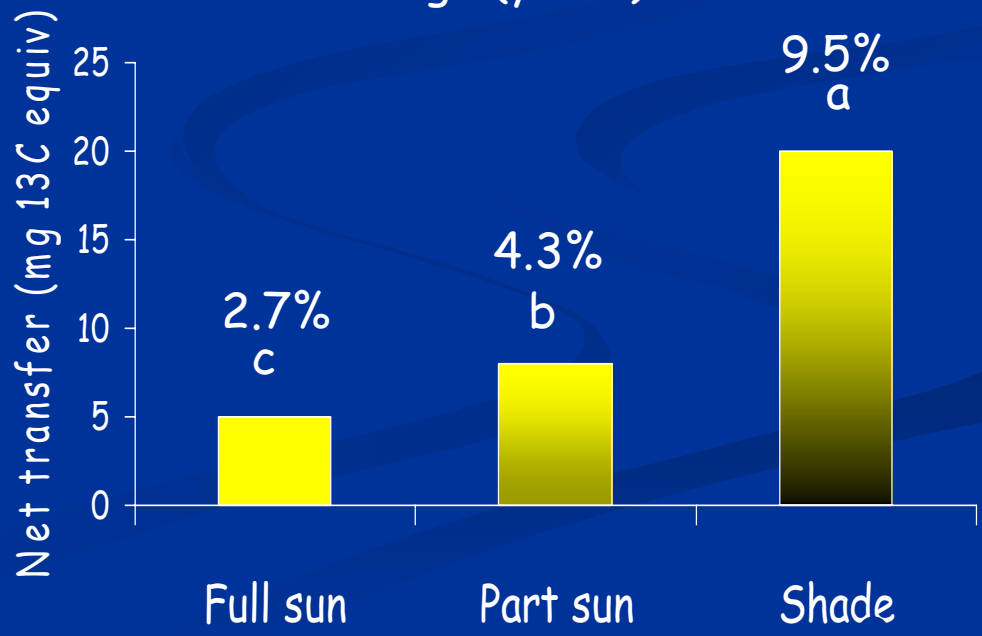
Jones et al. 1997



Fir EMF diversity increases when fir is mixed with birch

Twieg et al.

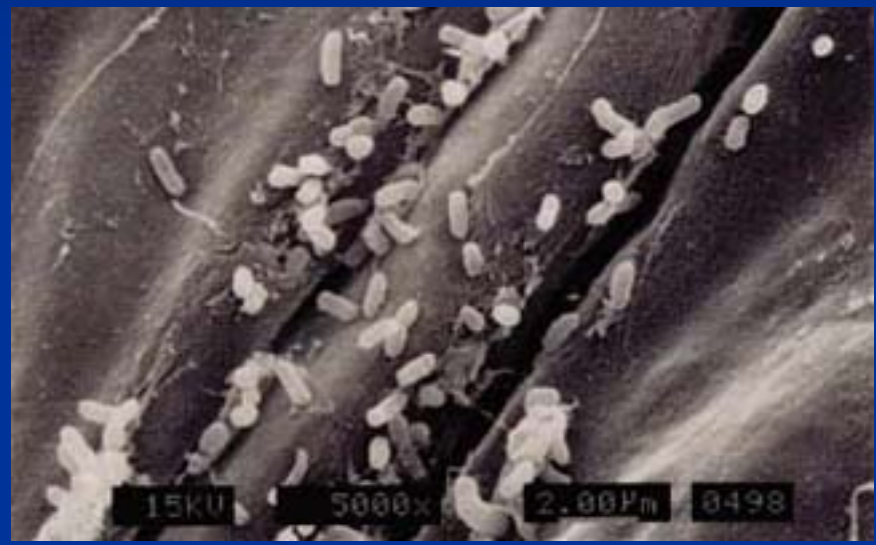




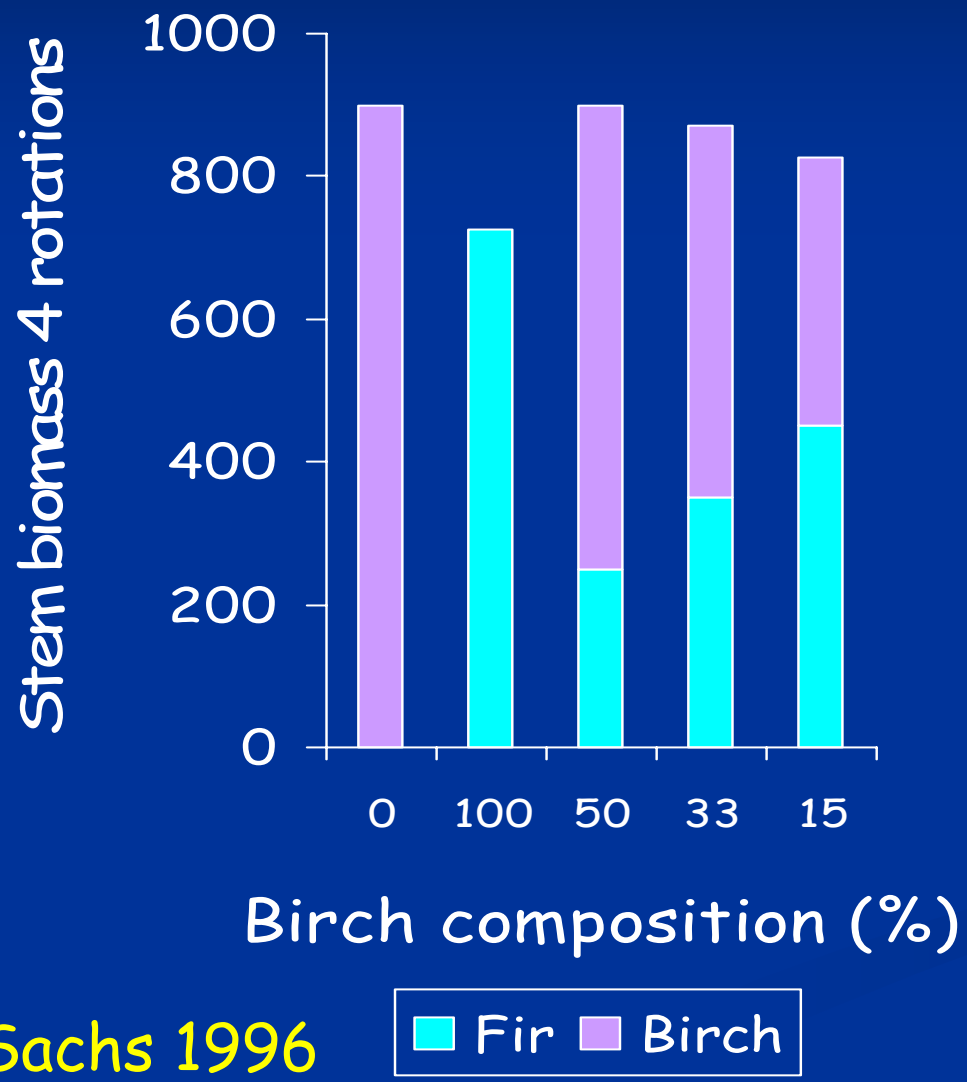
Net C transfer from birch to Douglas-fir increased with Douglas-fir shading

Simard et al. 1997

Birch tissues are rich in nitrogen



Mixed forests have stable long-term yields because of birch N inputs



- Lowest yield in pure Douglas-fir, declining over time
- Some proportion of birch needed to maintain high productivity
- Mixtures have stable yields over several rotations

Sachs 1996

Planting pine or fir and removing birch to meet free-growing has the potential to increase disease, reduce soil microbial diversity, and alter nutrient cycles, with implications for long-term productivity and resilience to infestations

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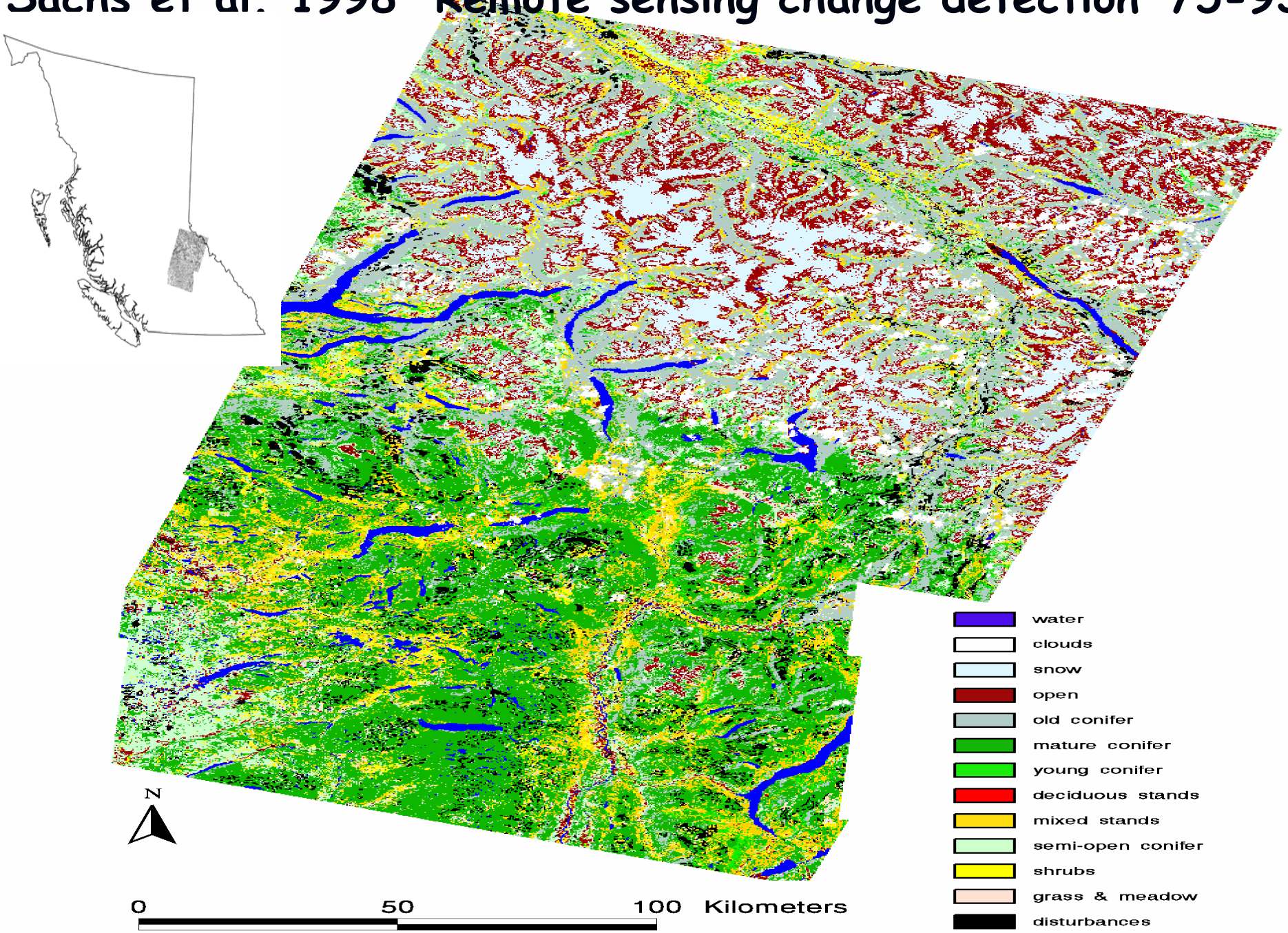
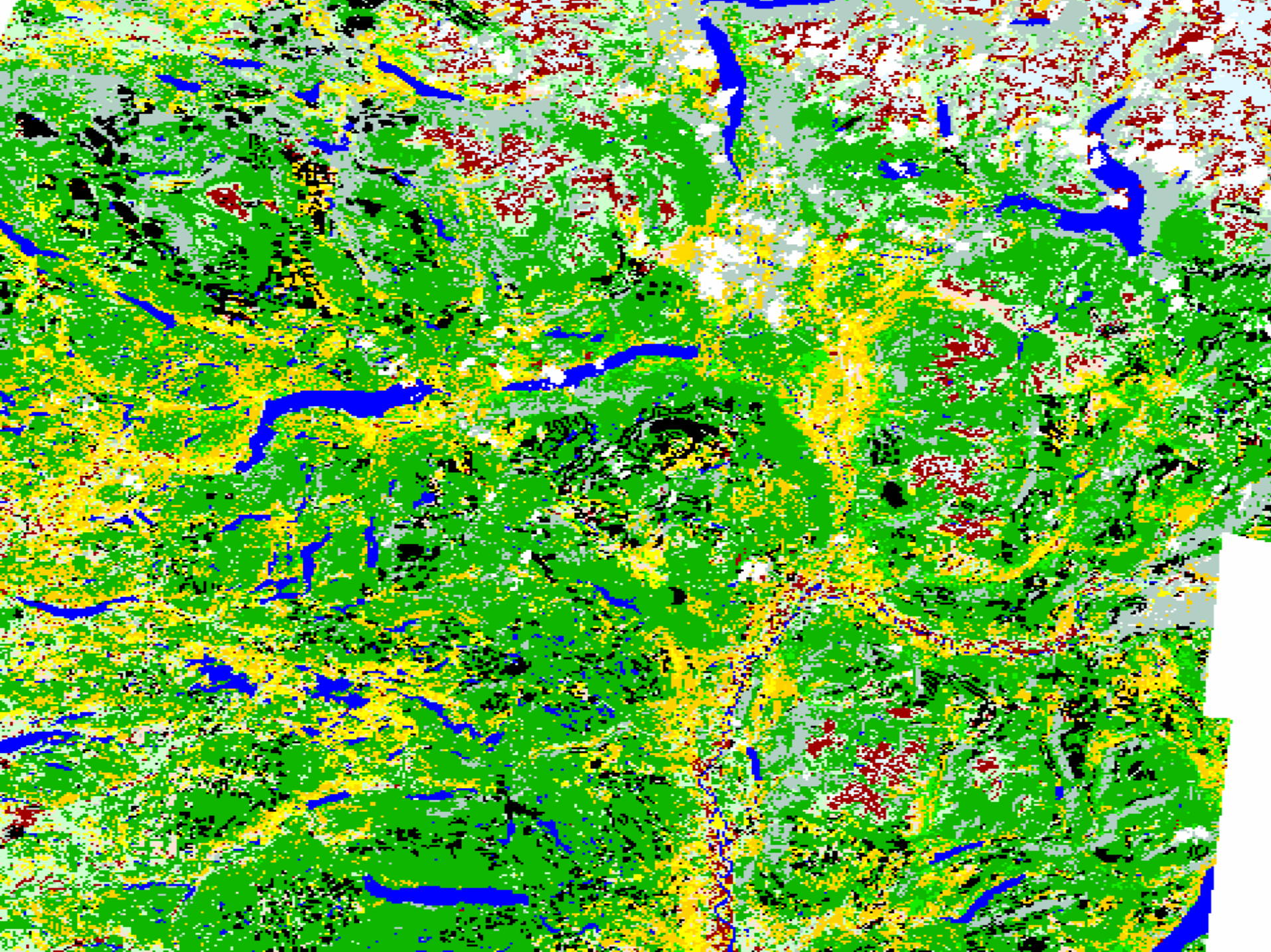
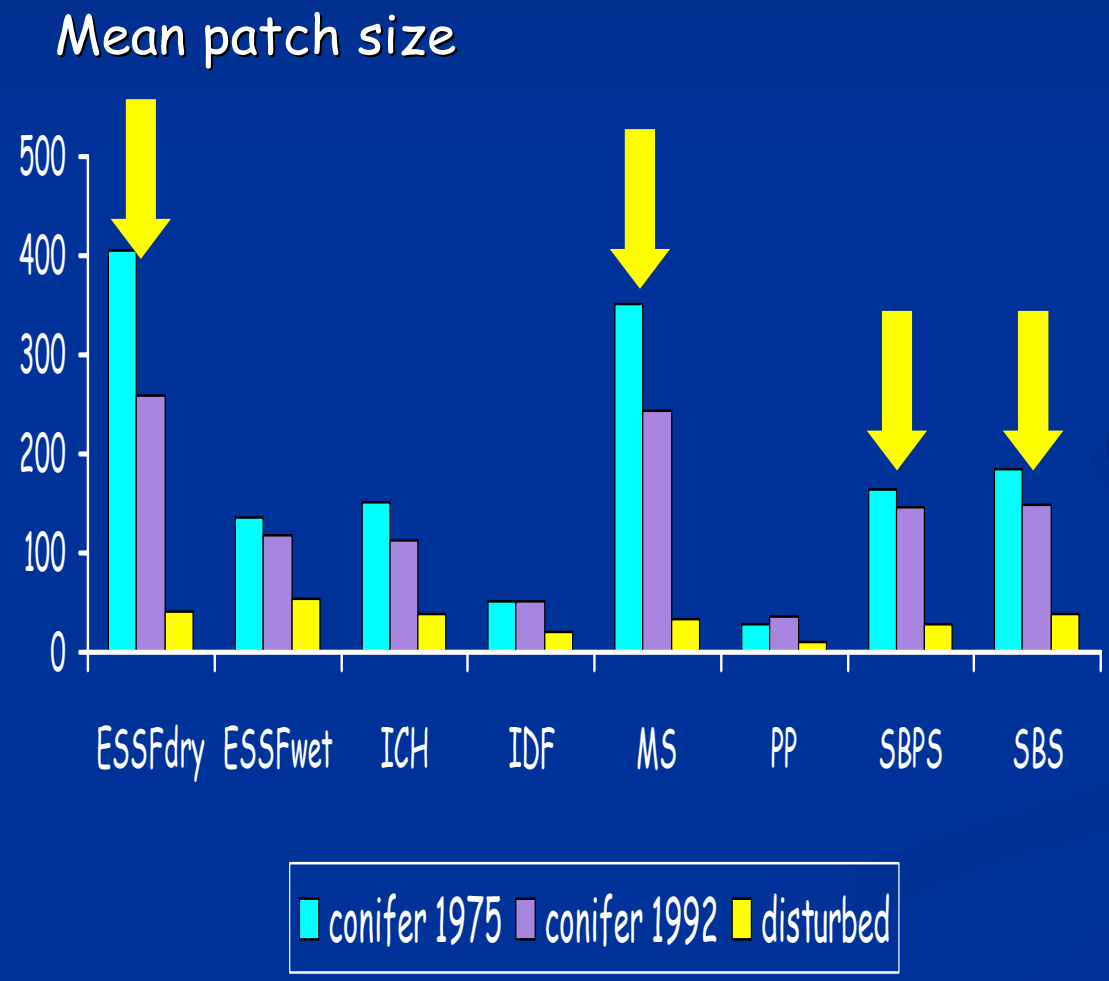
Harvesting effects on landscape patch patterns, wildlife patterns, the hydrological cycle, and the carbon cycle

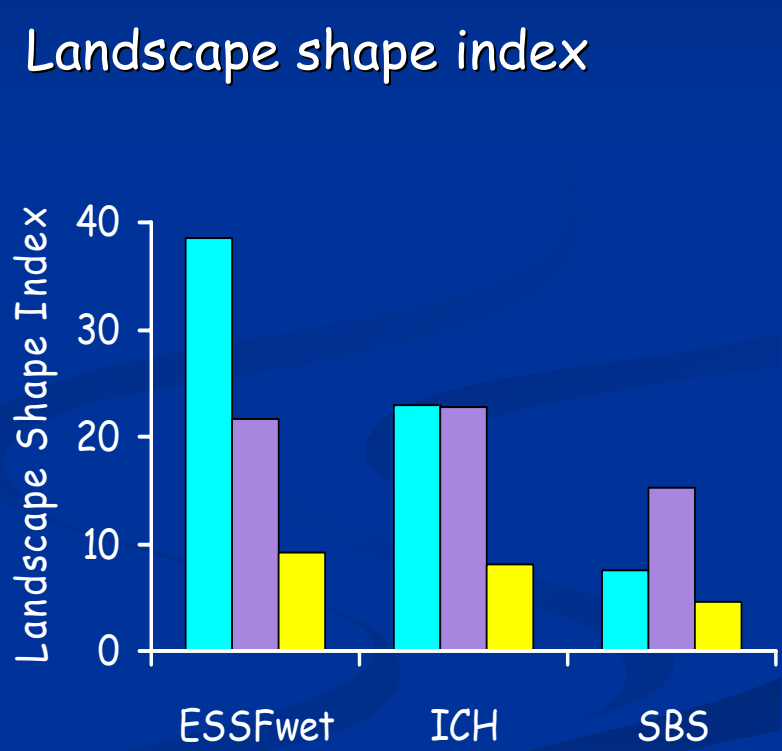
Sachs et al. 1998 Remote sensing change detection '75-93





Harvesting has simplified patch and landscape pattern



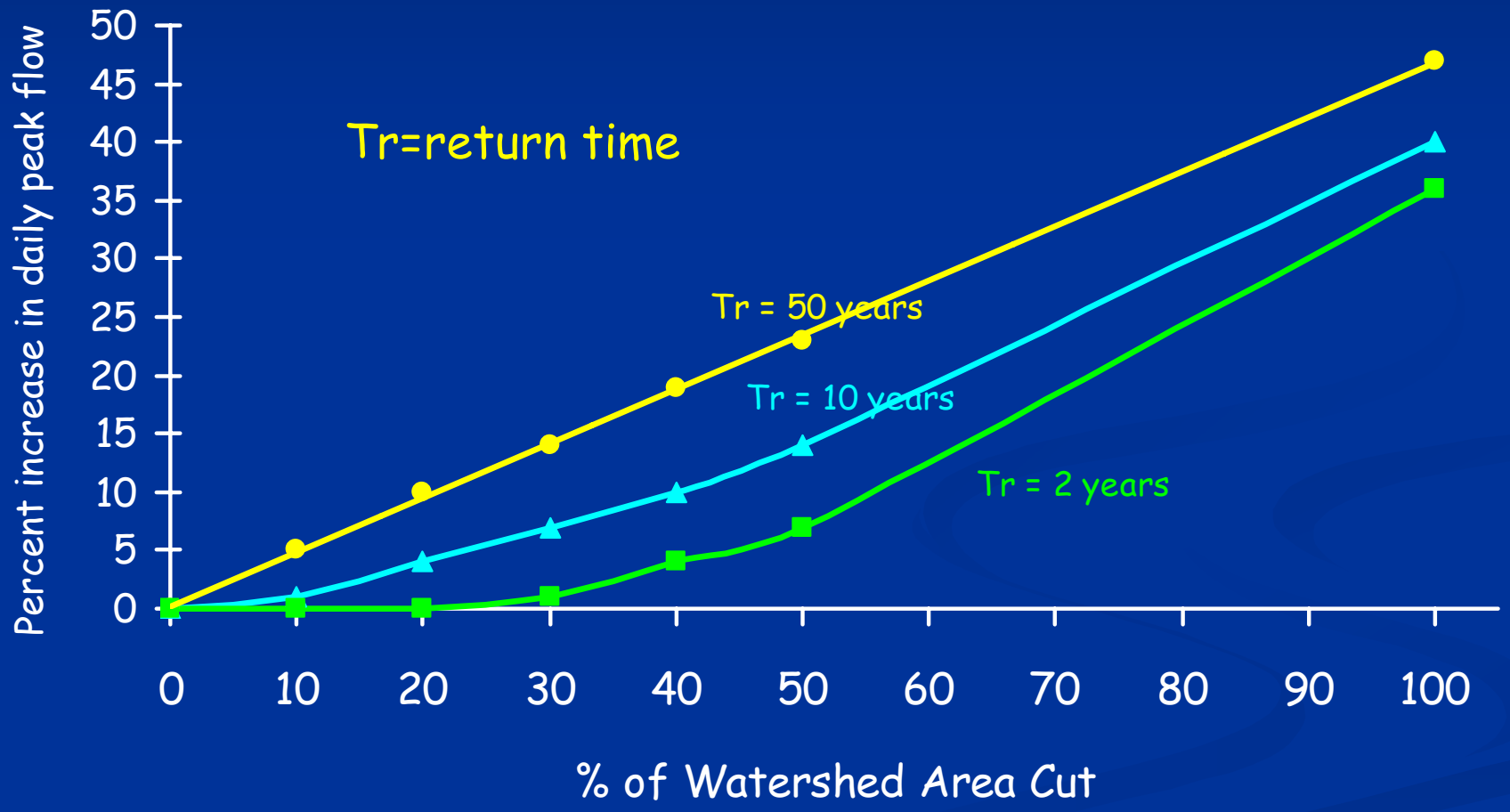


Disturbance increases peak flow

Winkler and Alila

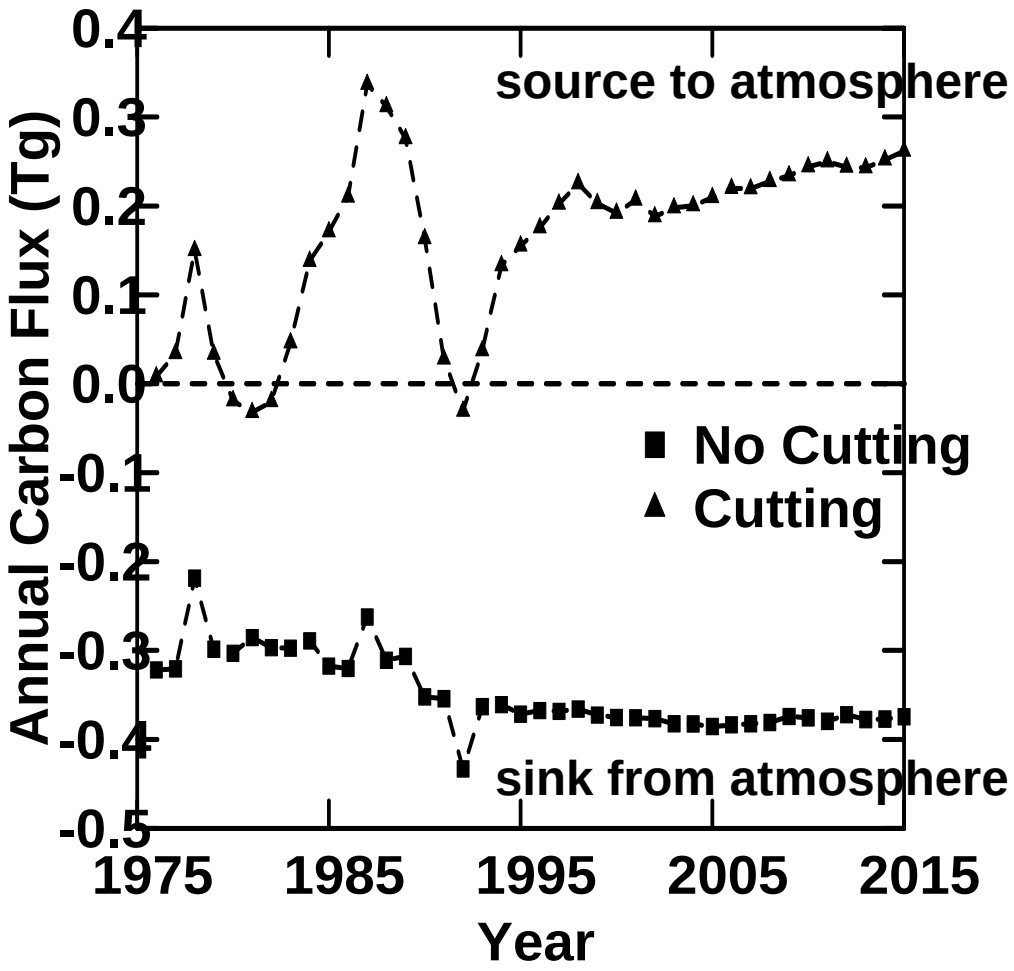
Kurz 2004

Predicted Changes in Peak Flow with Logging

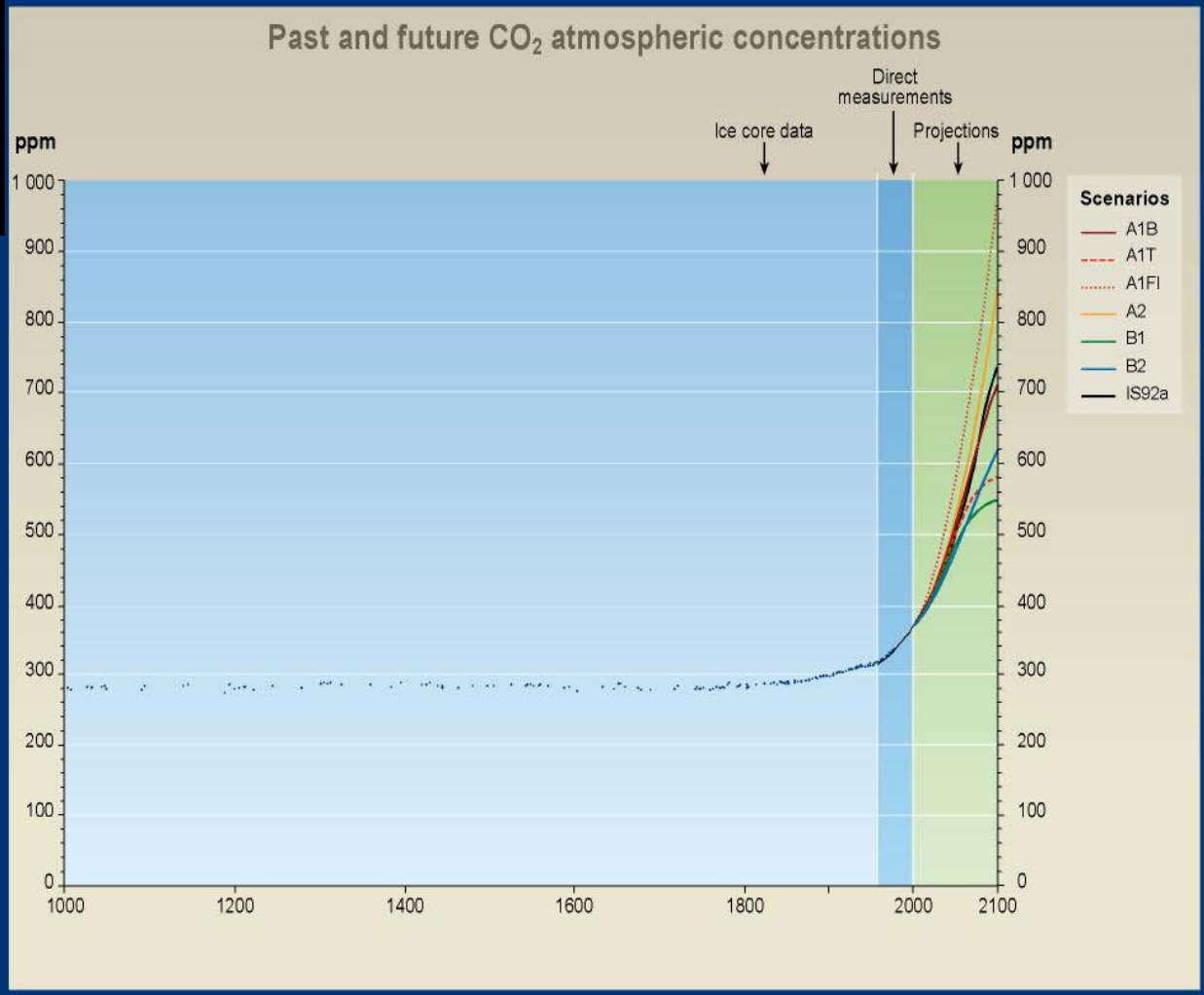


DHSV Model: Alila and Winkler

Harvesting has caused the ESSF to become a net carbon source in this study area

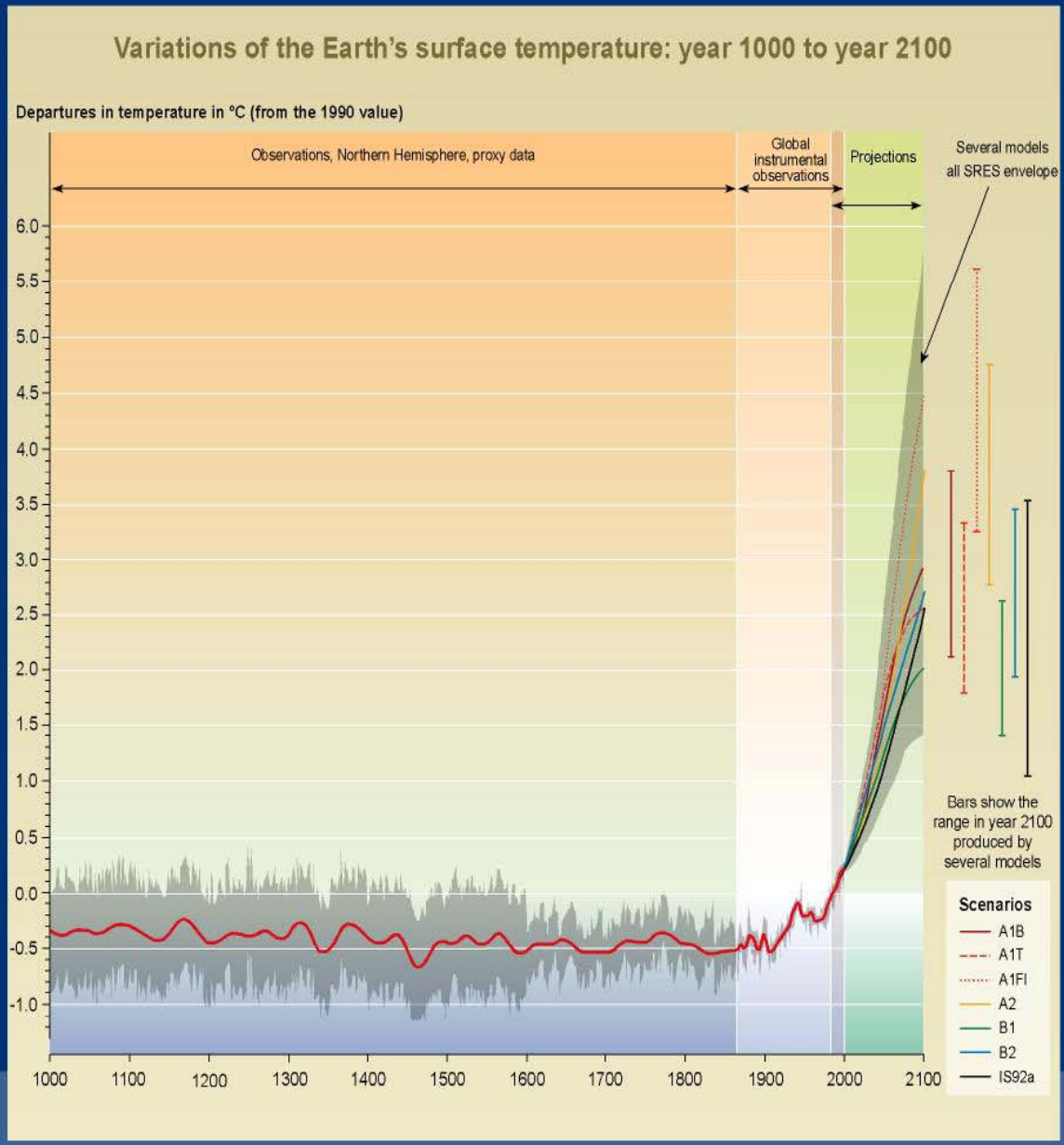


Sachs et al. 1998



SYR - FIGURE 9-1a

Variations of the Earth's surface temperature: year 1000 to year 2100



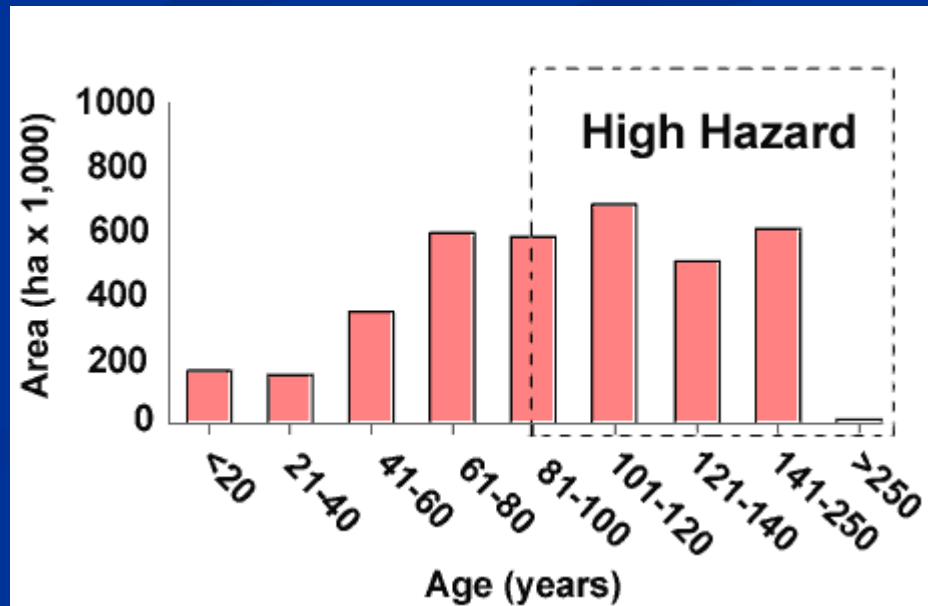
SYR - FIGURE 9-1b

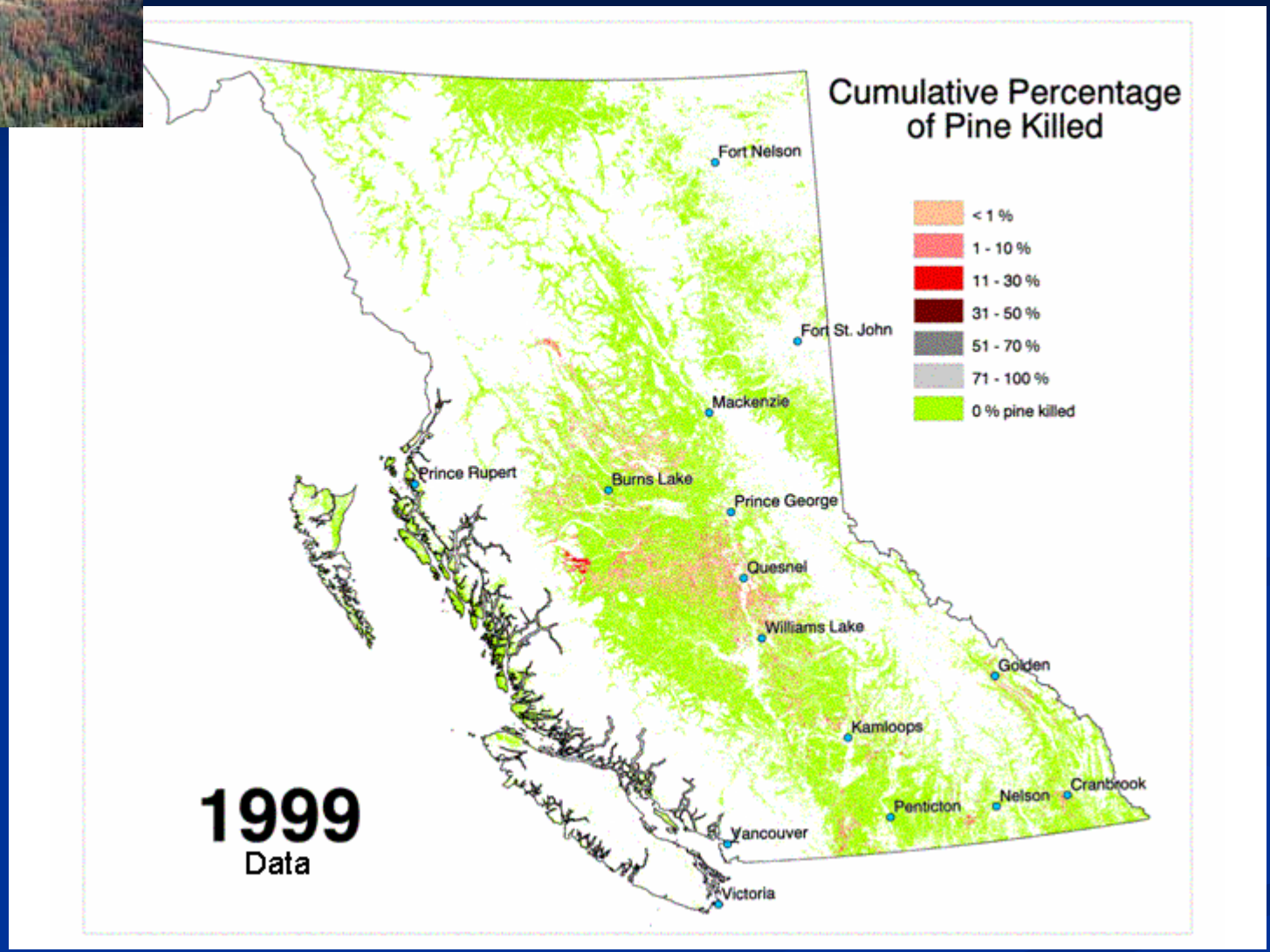
Warmer winters and prevalent host led to current mountain pine beetle epidemic

Central Interior British Columbia

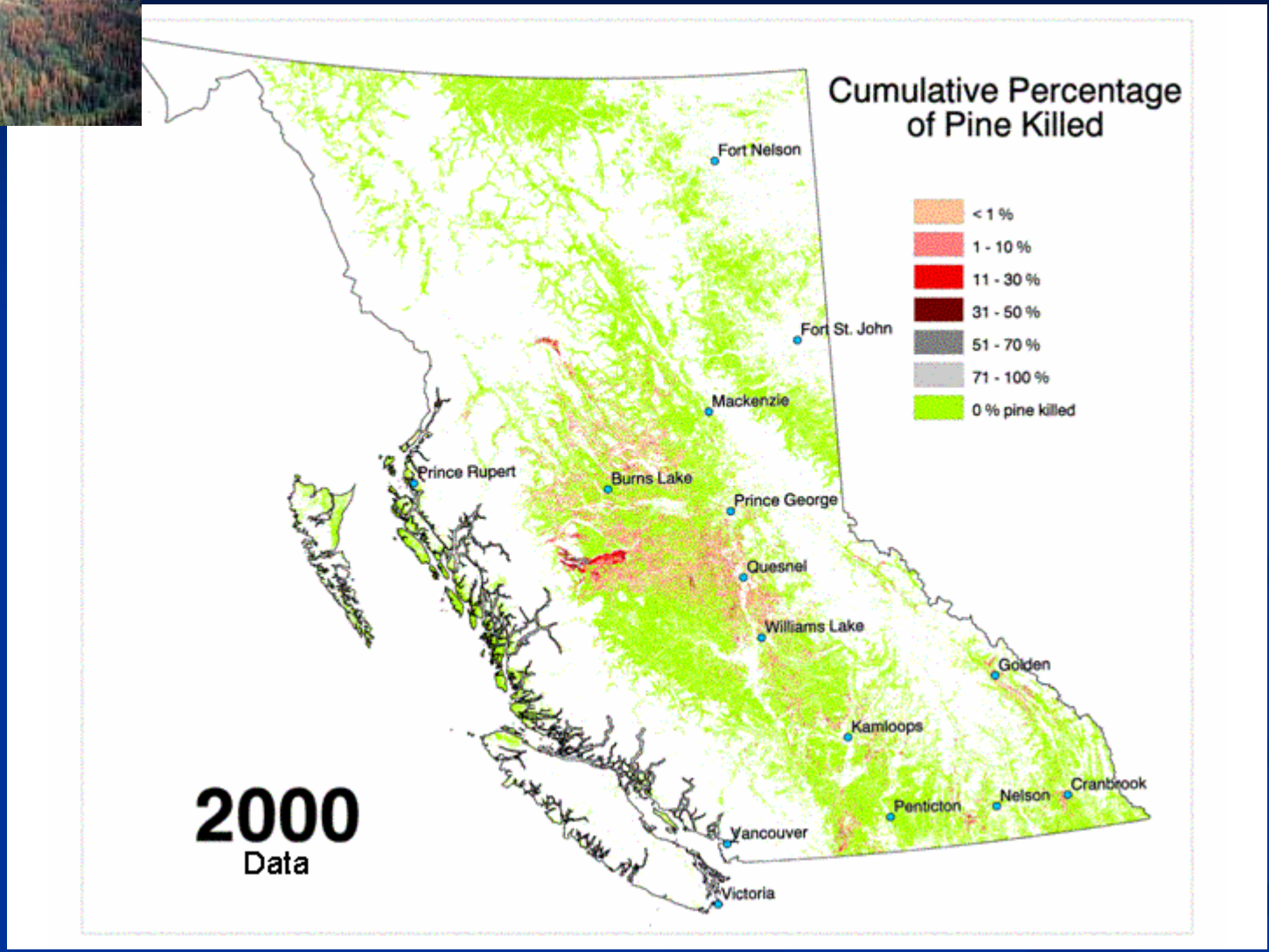
Since 1910:

- Area of mature LP (>80 yr) has tripled (Taylor & Carroll 2004)
- Average winter temp increase of 2.2-2.6°C
- With warmer conditions, beetle range has expanded to north and higher elevations (previously unsuitable areas; Carroll et al. 2004)
- In young stands

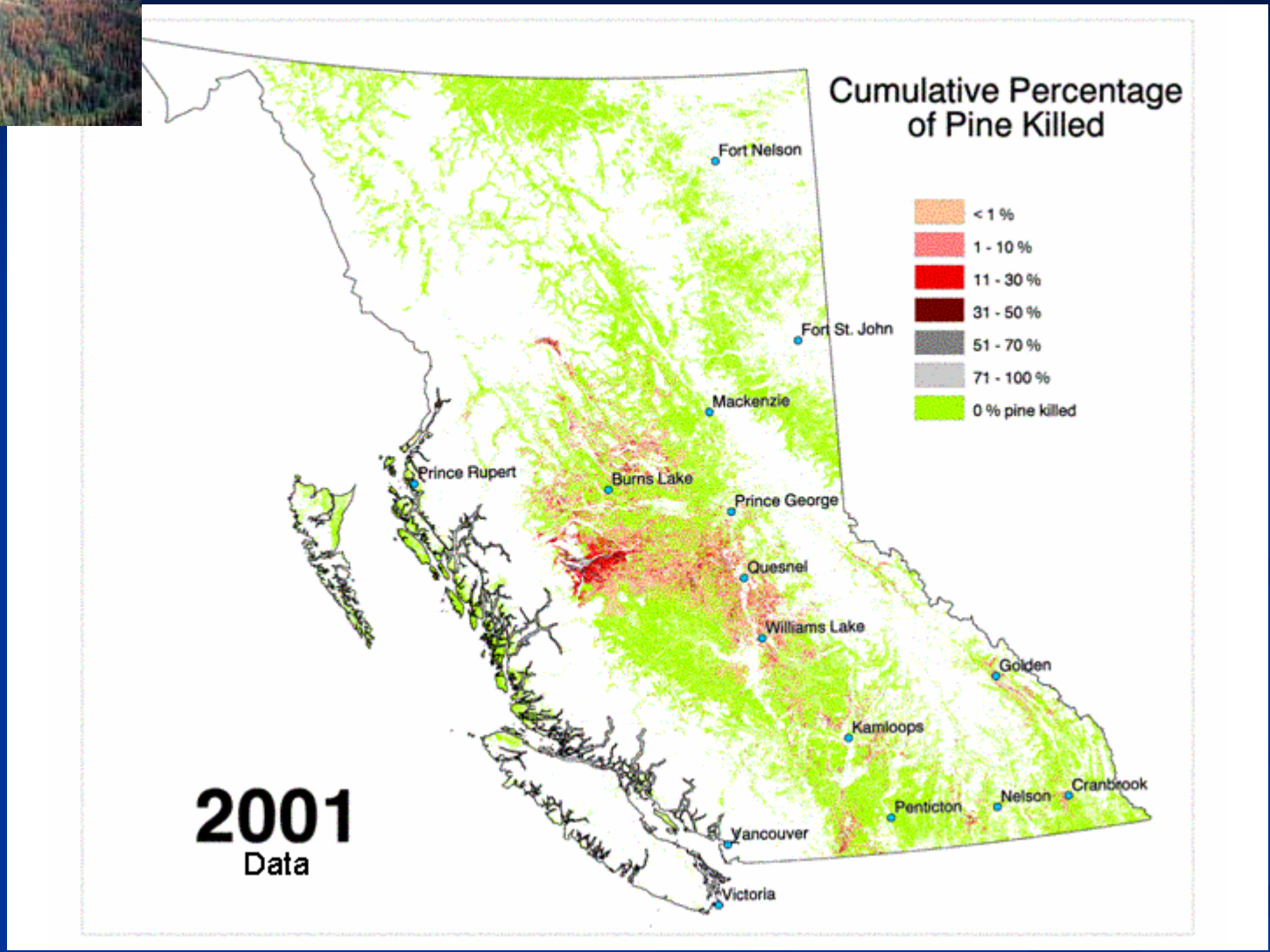




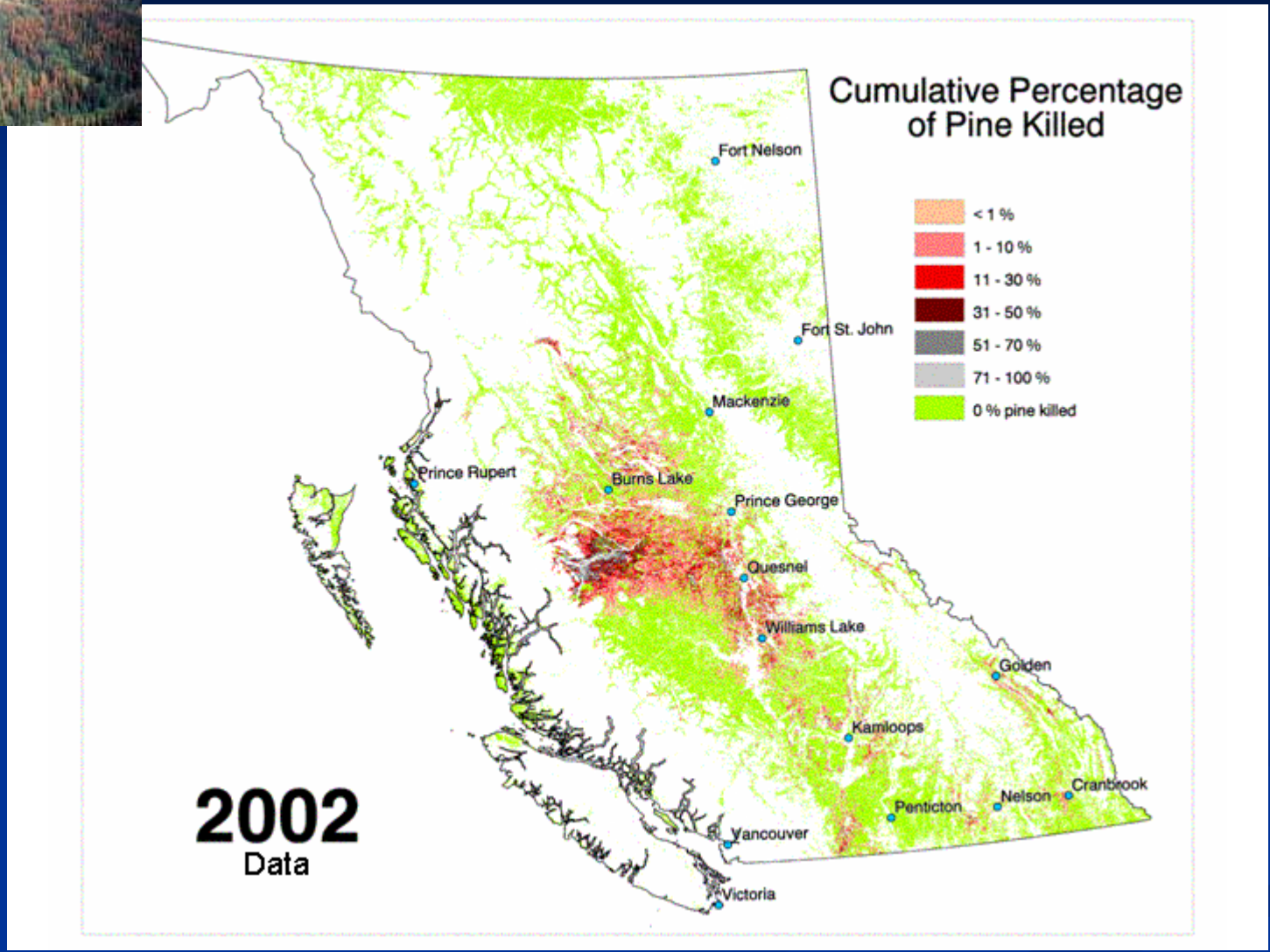
CFS: 164,567 ha



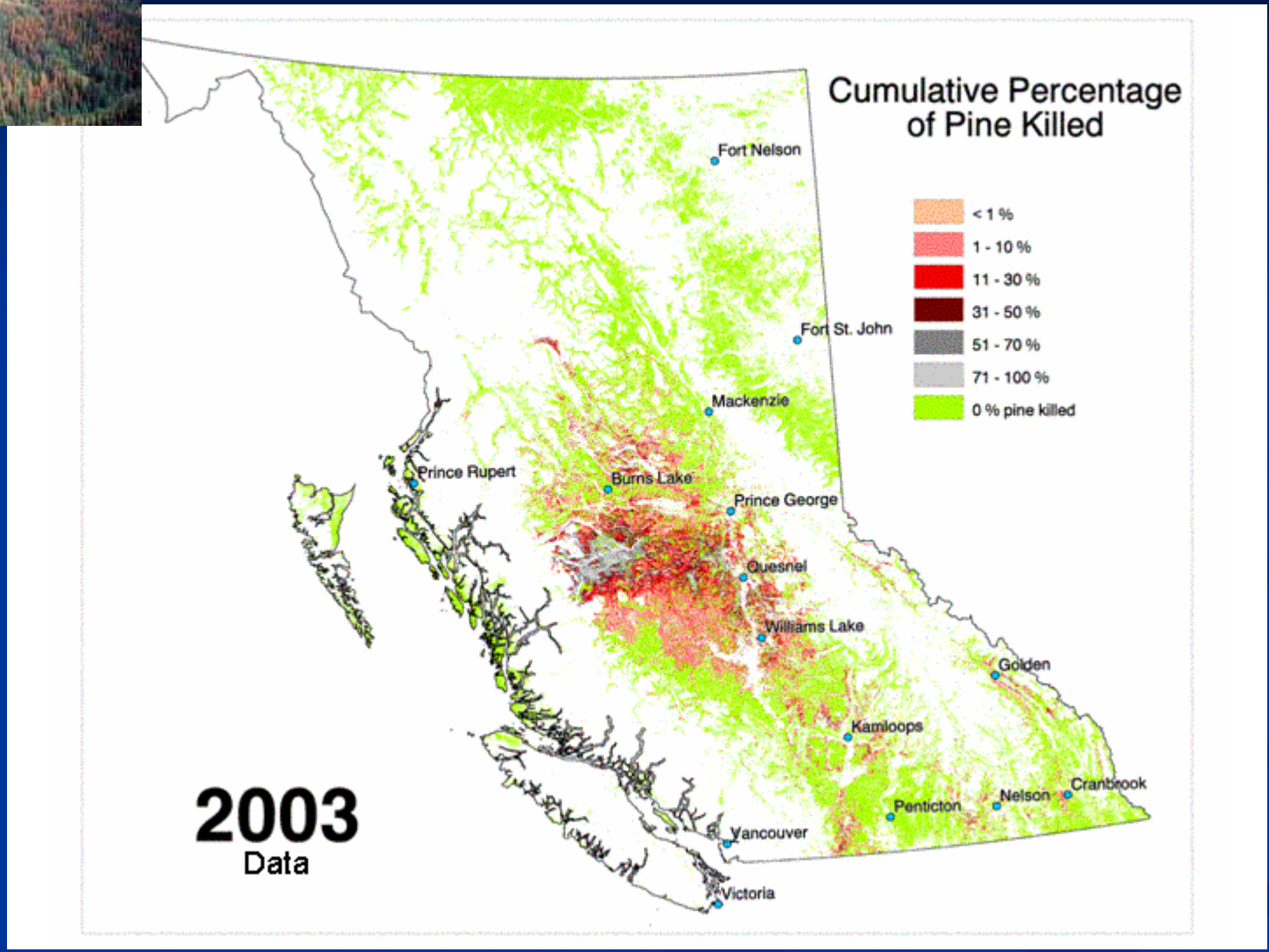
CFS: 284,041 ha



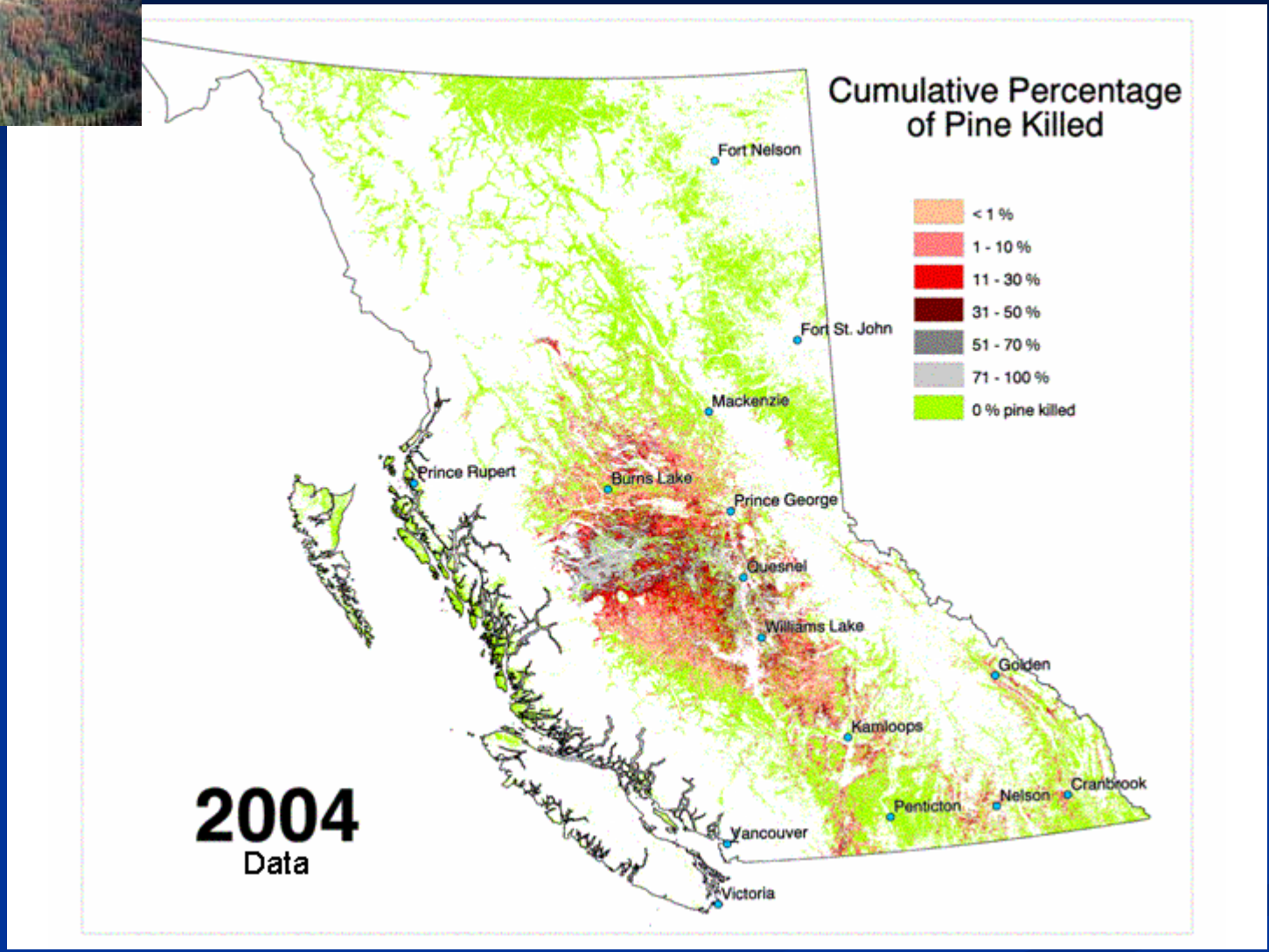
CFS: 785,491 ha



CFS: 1,968,641 ha



CFS: 4,066,817 ha



CFS: 7,021,886 ha

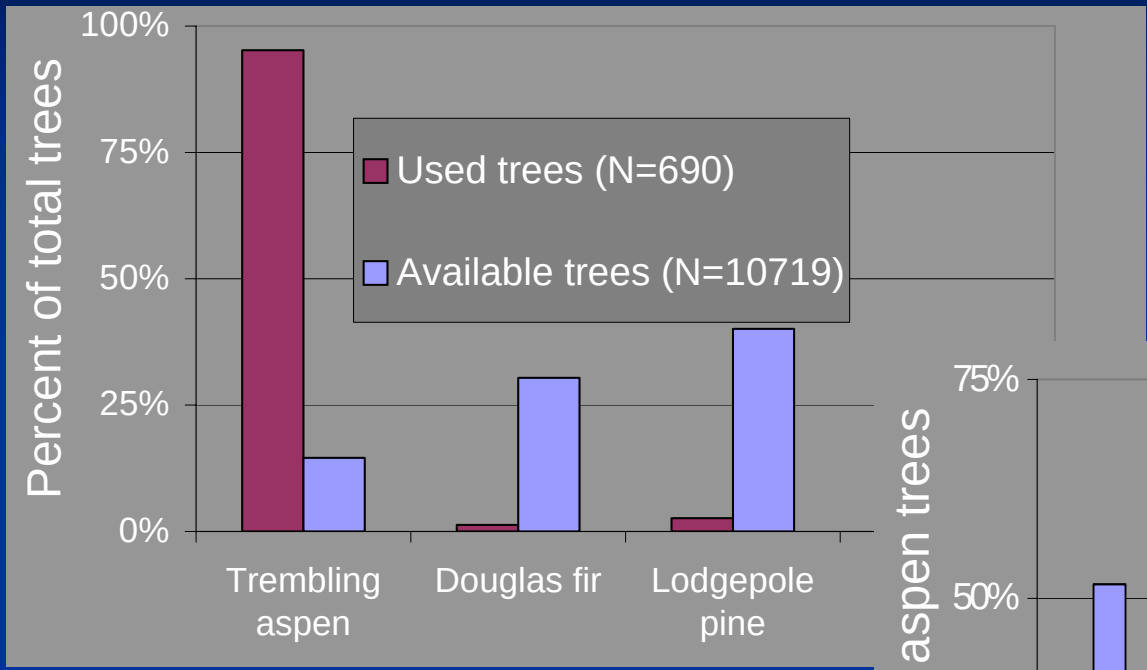
Kathy Martin and students (UBC)

Primary excavators - woodpeckers

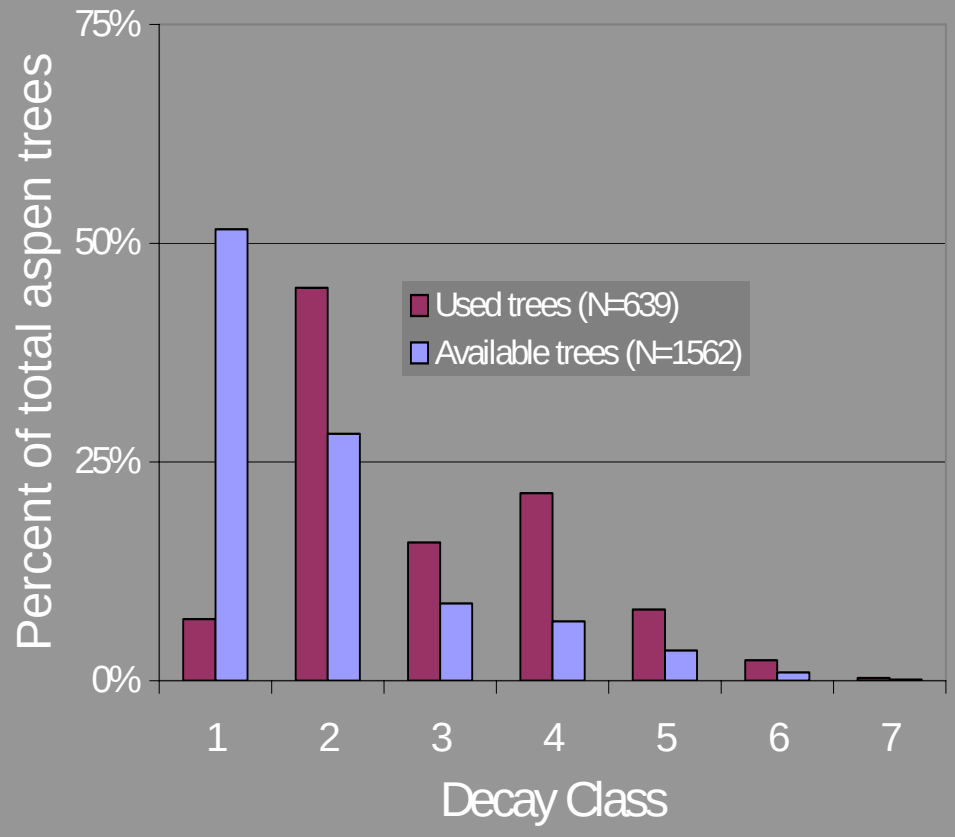
Secondary cavity-nesters -passerines, ducks, raptors, small mammals

Weak excavators (WCE) - chickadees nuthatches

Cavity Nest Site Selection (Martin)



Aspen is preferred



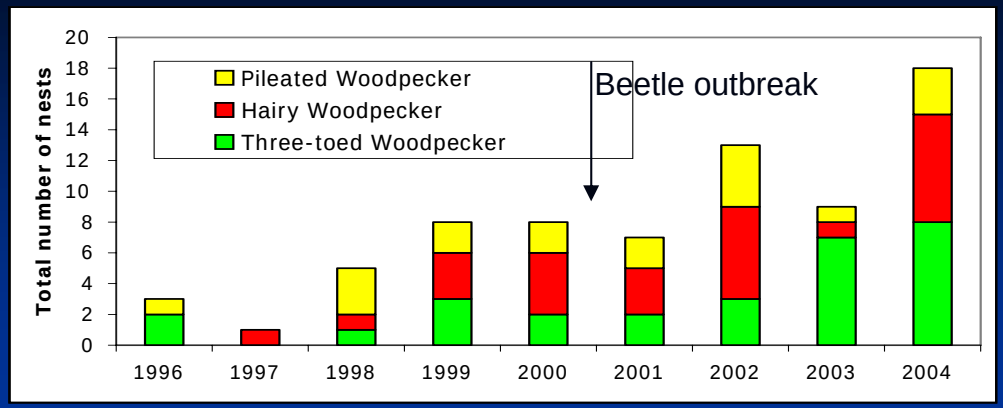
...especially when unhealthy or dead

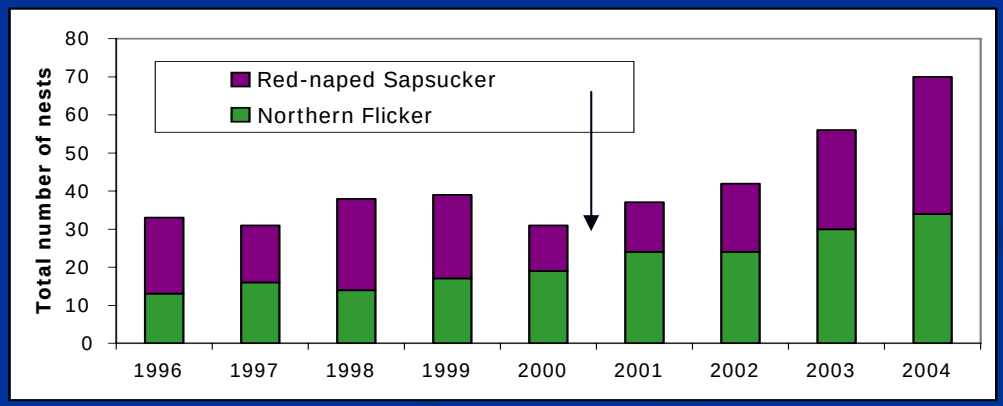
Forest decline correlates with increased nest density

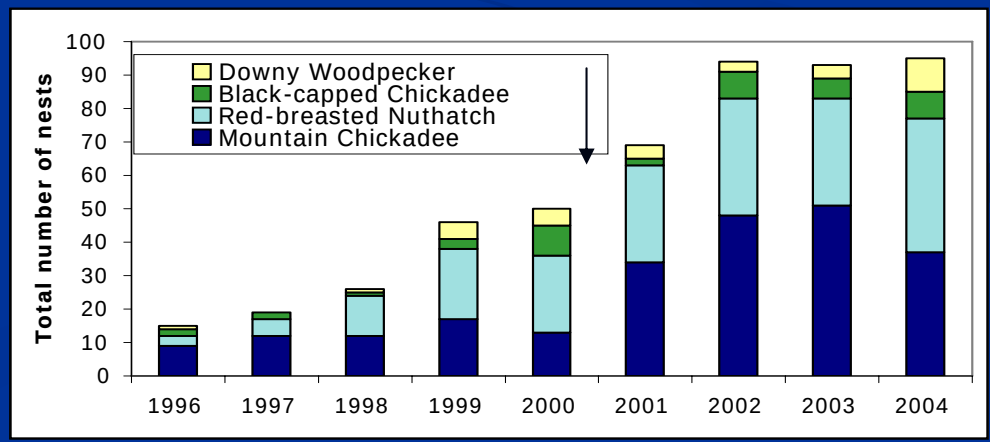
a.

b.

c.

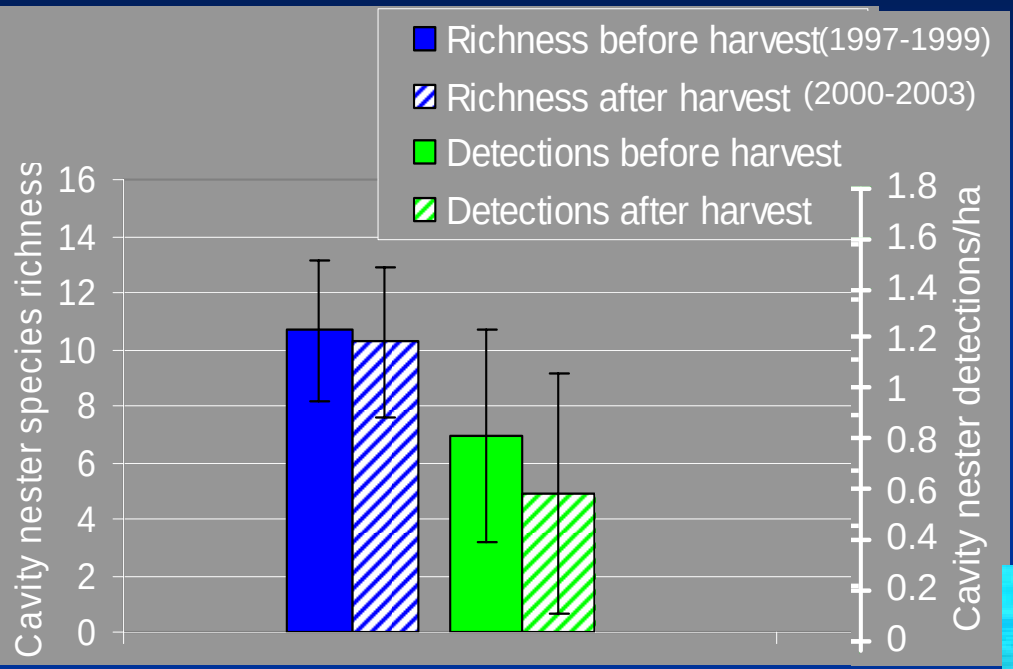






Martin

But cavity nester abundance may decrease after beetle-proofing



Martin and students

Harvest patterns and intensity affect higher scale patterns and processes such as patch pattern, peak runoff, atmospheric carbon flux, and wildlife movement, which feed back to patterns and processes at the stand scale

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Future Forests

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2. These "unintended consequences" often result from forest simplification

3. Forest simplification may reduce resilience to evolving disturbance regimes brought by climate change

4. Future forests should be designed for resilience based on a sound understanding of the link between pattern and process

5. Diversity begets resilience