Reflections on Old-Growth Forests: Disturbance, Structure, and Biodiversity

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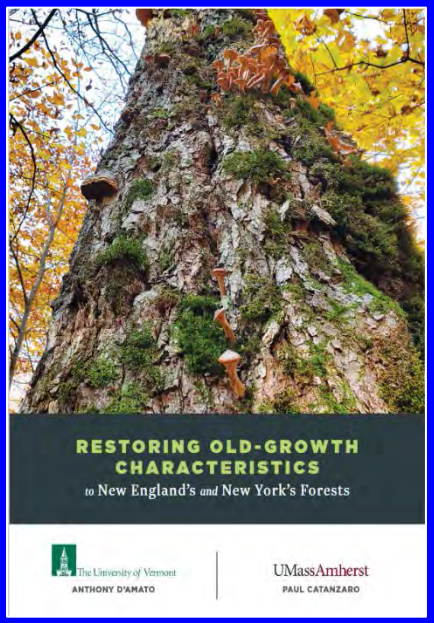
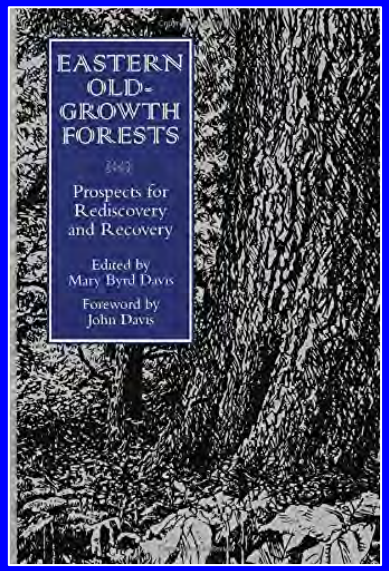
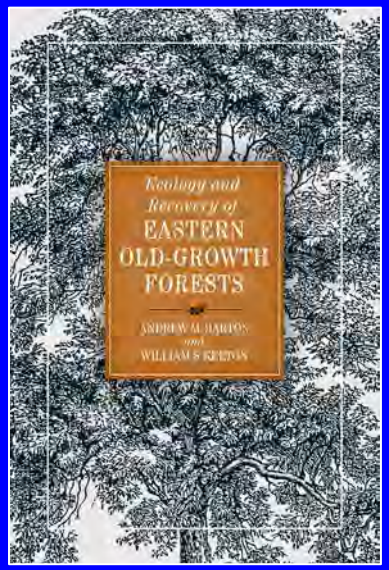
Benefits of old-growth forests

- Biodiversity protection
- Scientific inquiry
- Spiritual values
- Aesthetics, recreational value
- *Carbon storage*







No agreed-upon definition of old-growth

"There may never be a single, widely accepted definition of old growth … Because we deal with complex ecosystems, we have to be comfortable with flexible terms and some ambiguity"

Tom Spies, US Forest Service

Age criteria for eastern old growth

Examples (various publications):

- ‘Stand age’ greater than 120 years
- Mature canopy trees greater than 150 years
- Trees more than 50% of their max. age
- Dominant trees have reached their average life expectancy
- Trees older than the average interval between stand-replacing natural disturbances

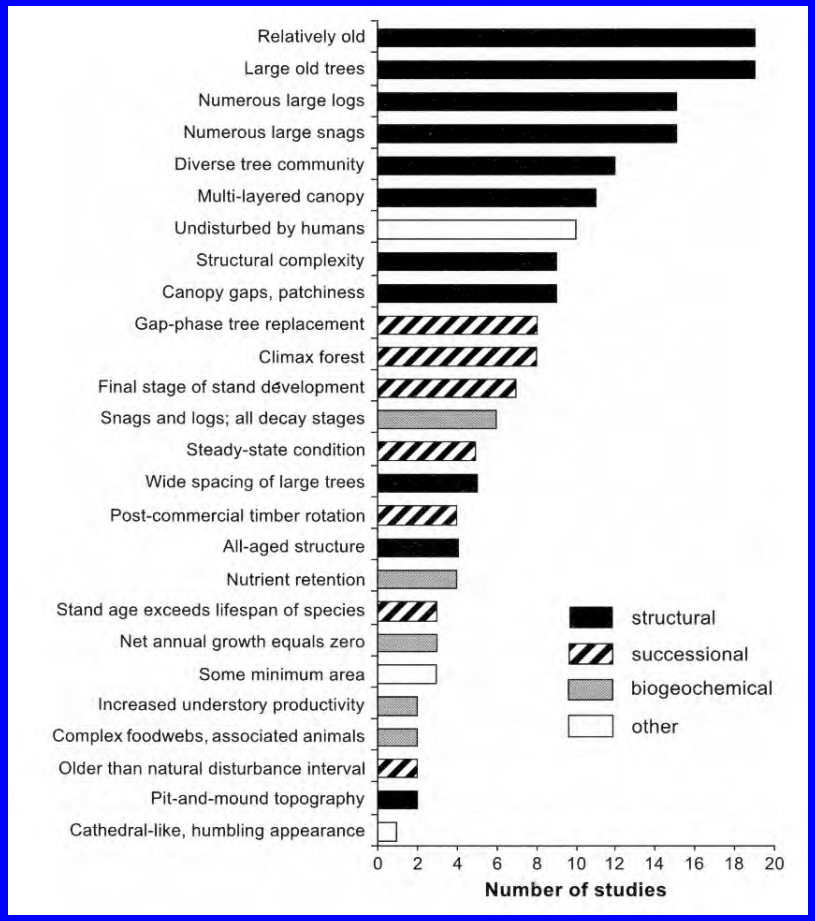
Great Britain's *Ancient Woodlands*

Structural criteria for eastern old growth

Examples (various publications):

- Presence of large living and dead trees
- Variation in tree diameters and heights
- Abundant downed woody debris *in various stages of decay*
- Patchiness in tree sizes and densities
- Diversity in canopy structure

Emphasis on Structure



Wirth and others. 2009. Old-Growth Forests

Table 5–1
A List of Conditions and Criteria Used to Define Old-Growth Forests

Condition	Criteria
Tree composition dominated by late successional species	Compositional
Diverse tree community	Compositional
Abundant arboreal lichens and fungi	Compositional/structural
High density of old trees at or near mean life expectancy	Structural
High density of large trees	Structural
Wide tree spacing	Structural
High density of large-diameter fallen logs	Structural
Multilayered forest canopy	Structural
Multiple gaps in forest canopy	Structural
Regeneration of dominant tree species within canopy gaps	Structural/functional

Hunter & Schmiegelow. 2011. Wildlife, Forests, and Forestry

Large Old Trees?

Norway spruce (*Picea abies*)

Norwegian (*Ken-Olaf Storaunet*)

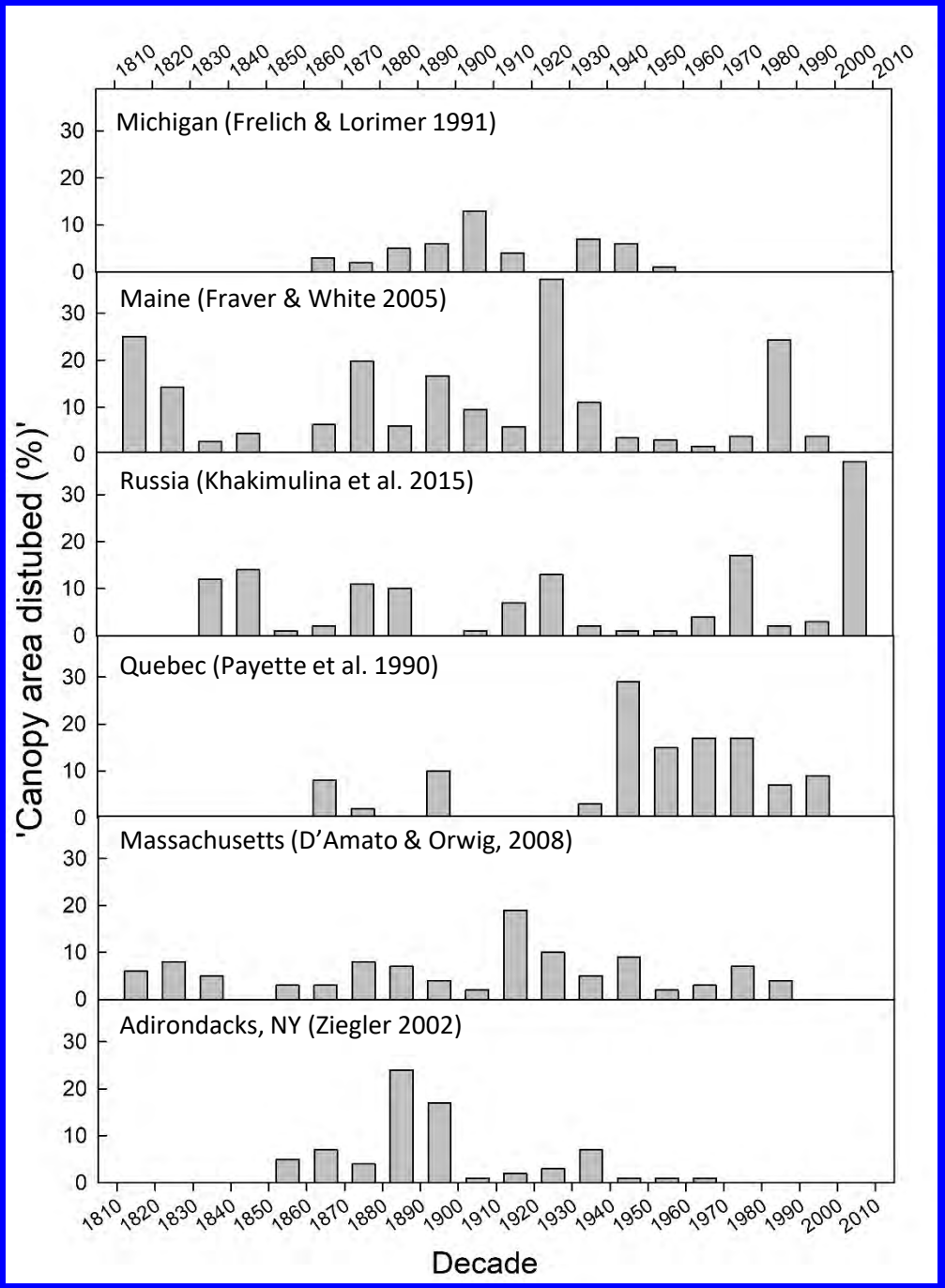
Intensively Managed

Old-growth

Simple Structure → Complex Structure

How does structural diversity develop?

Disturbance rates fluctuate through time



Big Reed Forest Reserve (5000 acres)

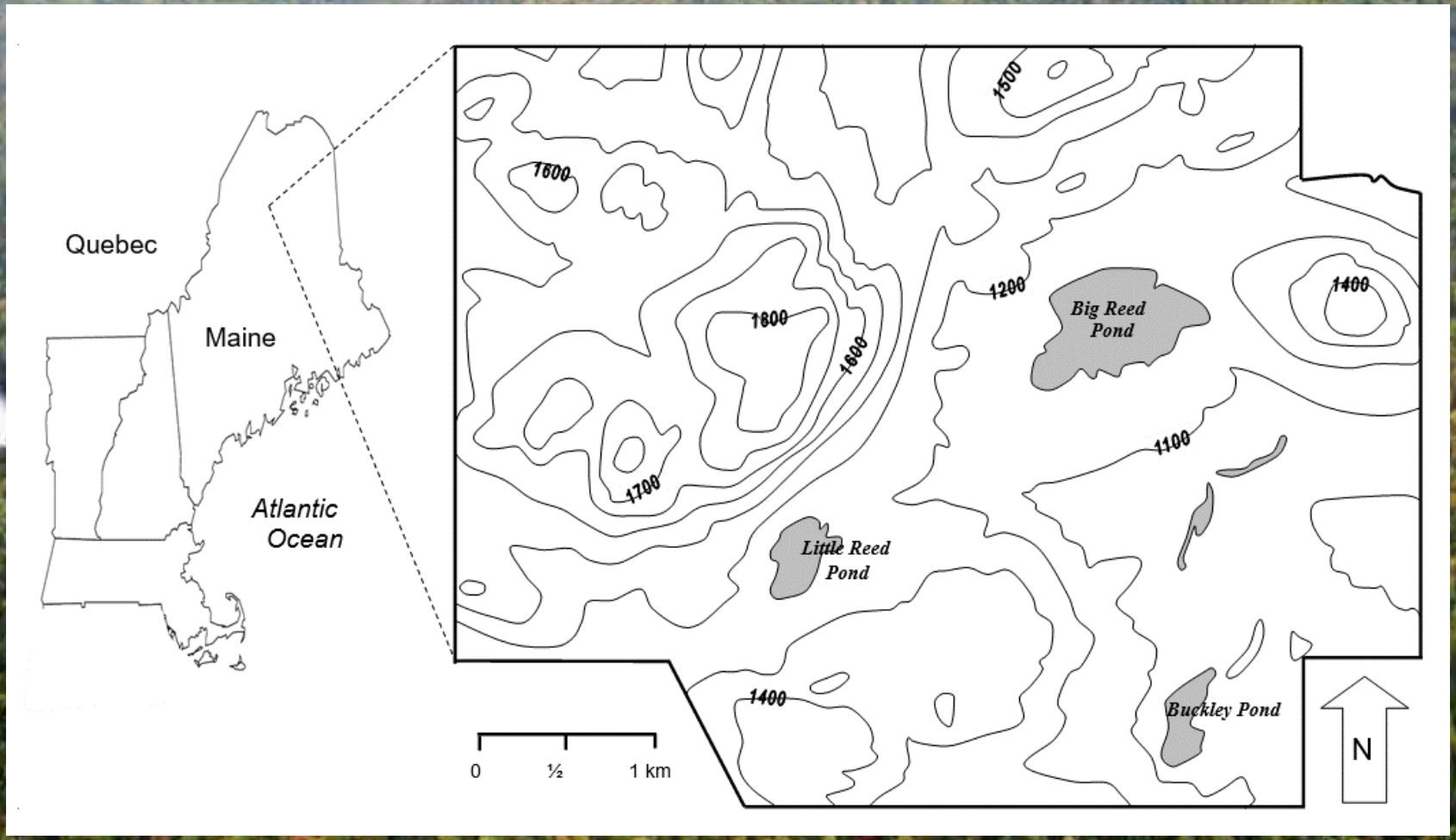
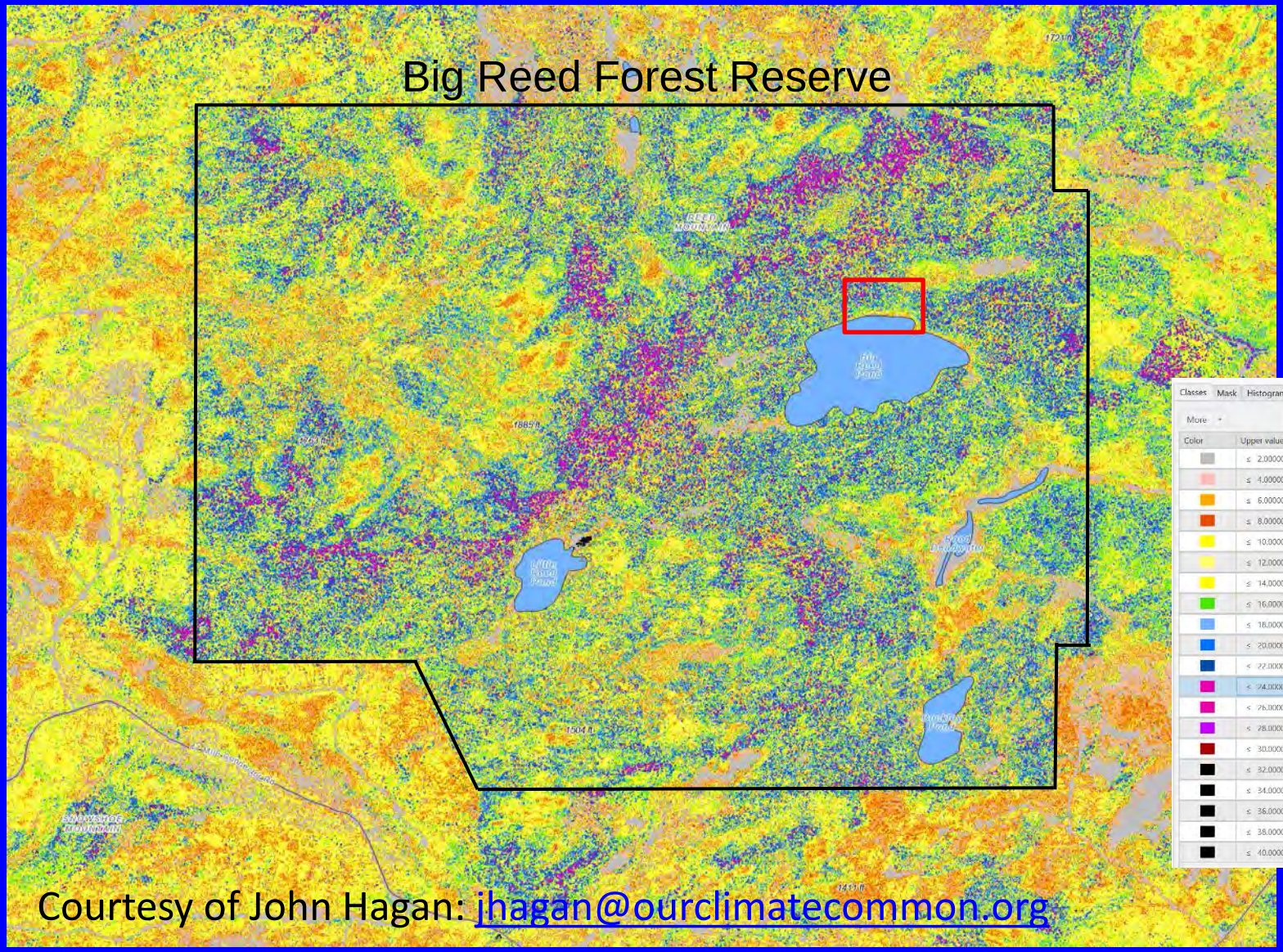


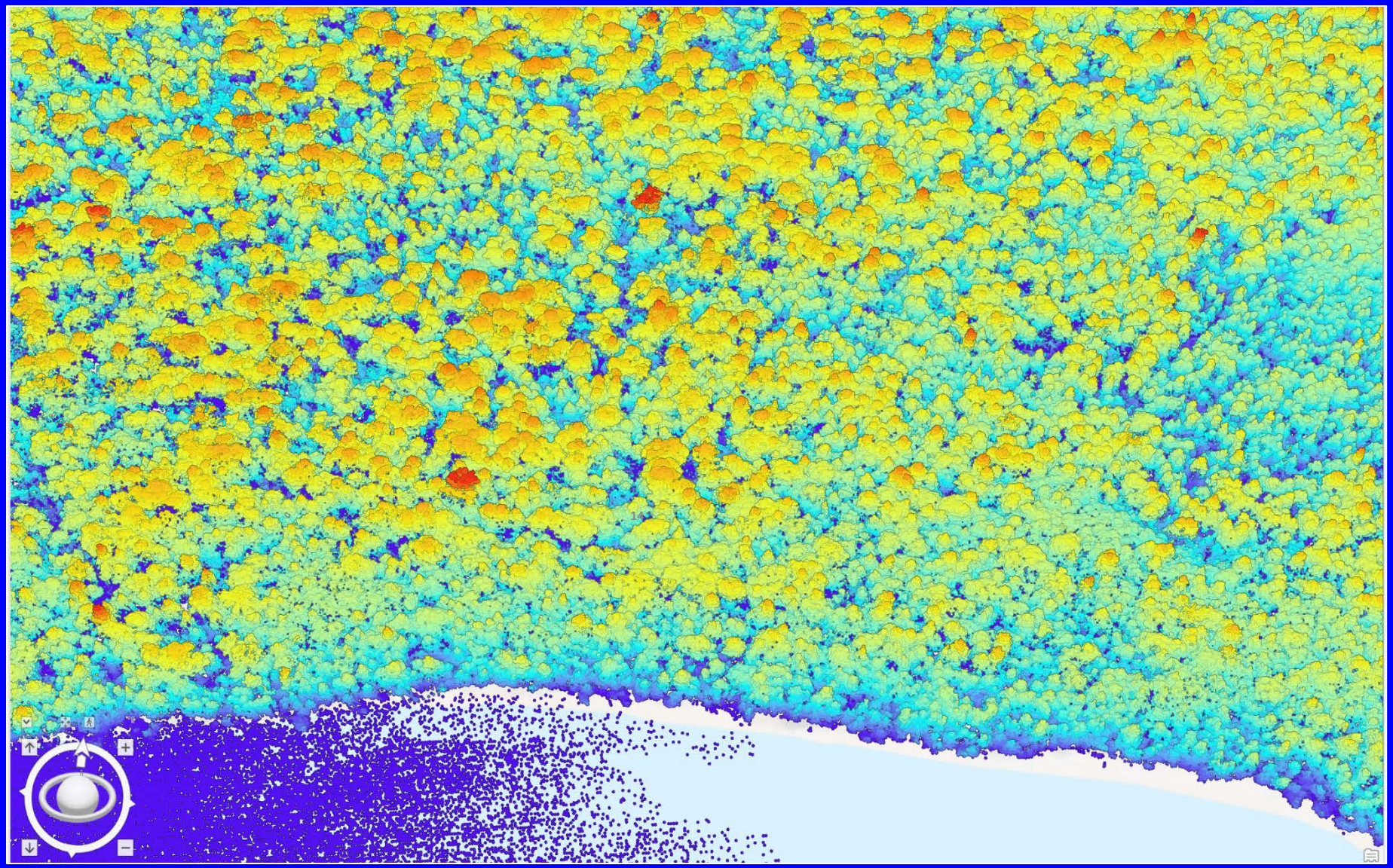
Photo: John Hagan

Old-growth forests include natural disturbance

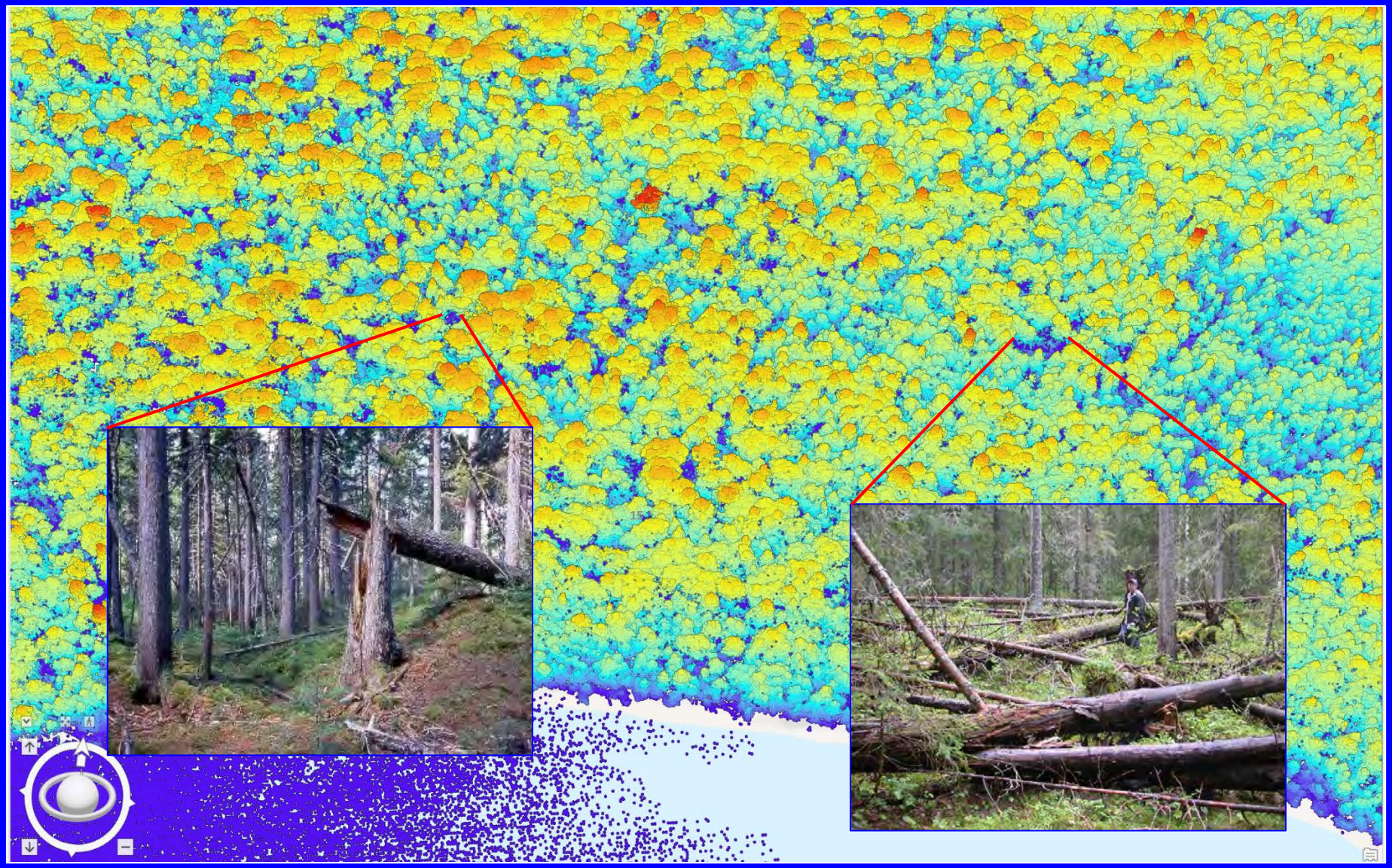


Courtesy of John Hagan: jhagan@ourclimatecommon.org

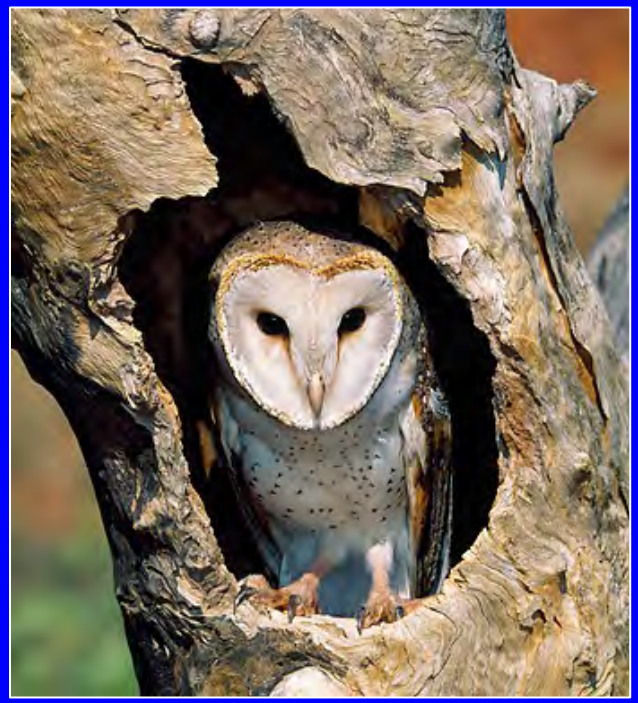
Old-growth forests are ‘gappy’



Old-growth forests are ‘gappy’



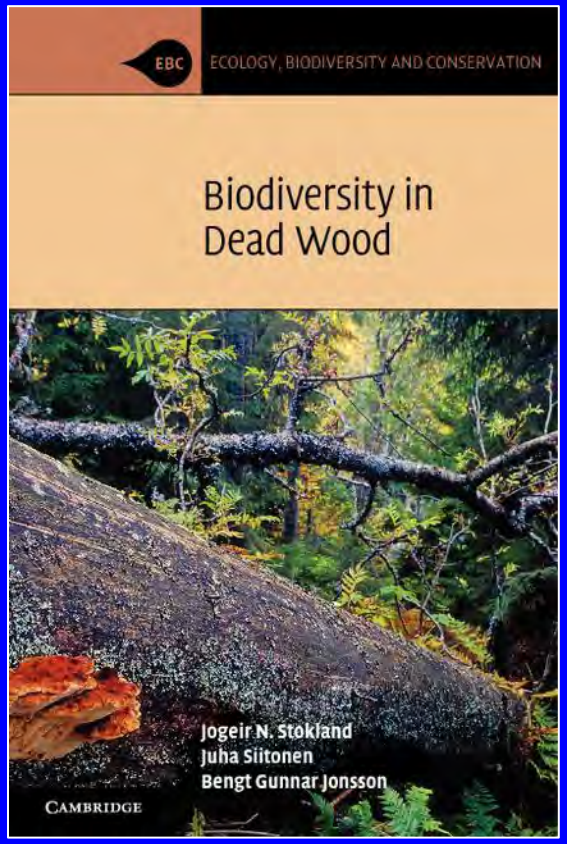
Disturbance (of course) creates deadwood



Subnivean passages

Deadwood-*dependent* organisms

(Saproxylic species *depend* on deadwood for at least one stage in their life cycle)



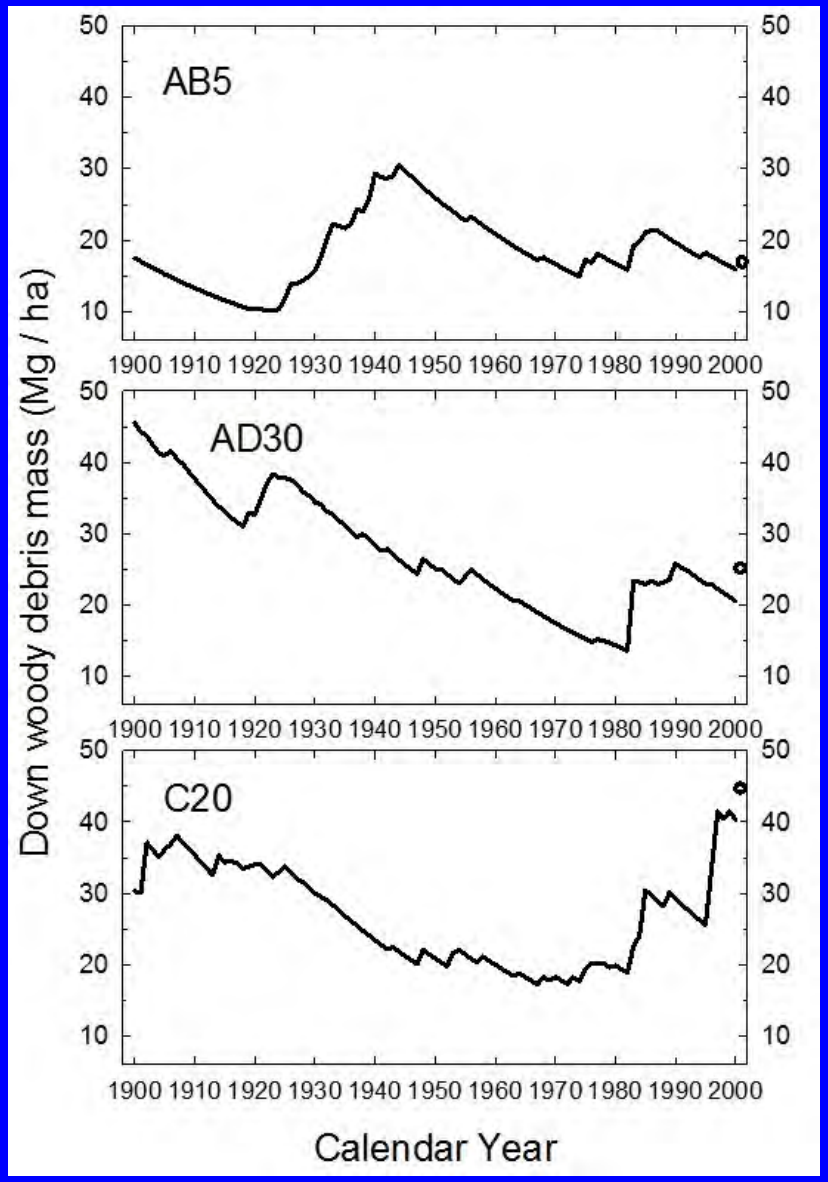
Deadwood-dependent organisms

- In Fenno-Scandinavia as a whole, 7000 species depend on deadwood
- Deadwood volume currently < 10% of pre-industrial levels (Sweden)
- Many deadwood-dependent species now red-listed (ex: 1/3 of Sweden's red-listed species depend on deadwood)

Maintaining diversity of saproxylics requires:

- Range of deadwood sizes
- Range of deadwood species
- Range of decay classes

Woody debris mass fluctuates through time

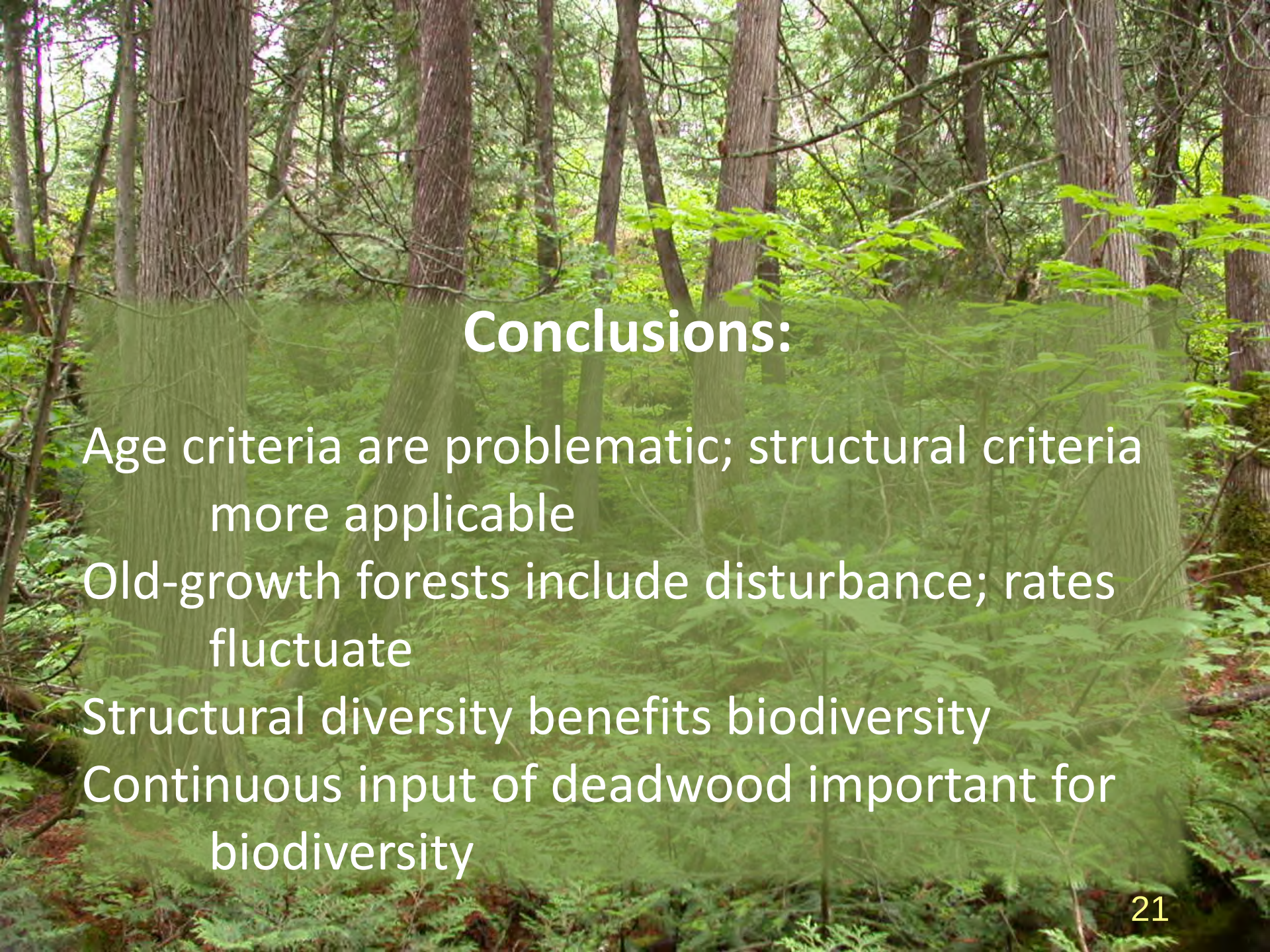


Three old-growth spruce stands, Big Reed Forest Reserve

Additions (disturbance)

Depletions (decay)

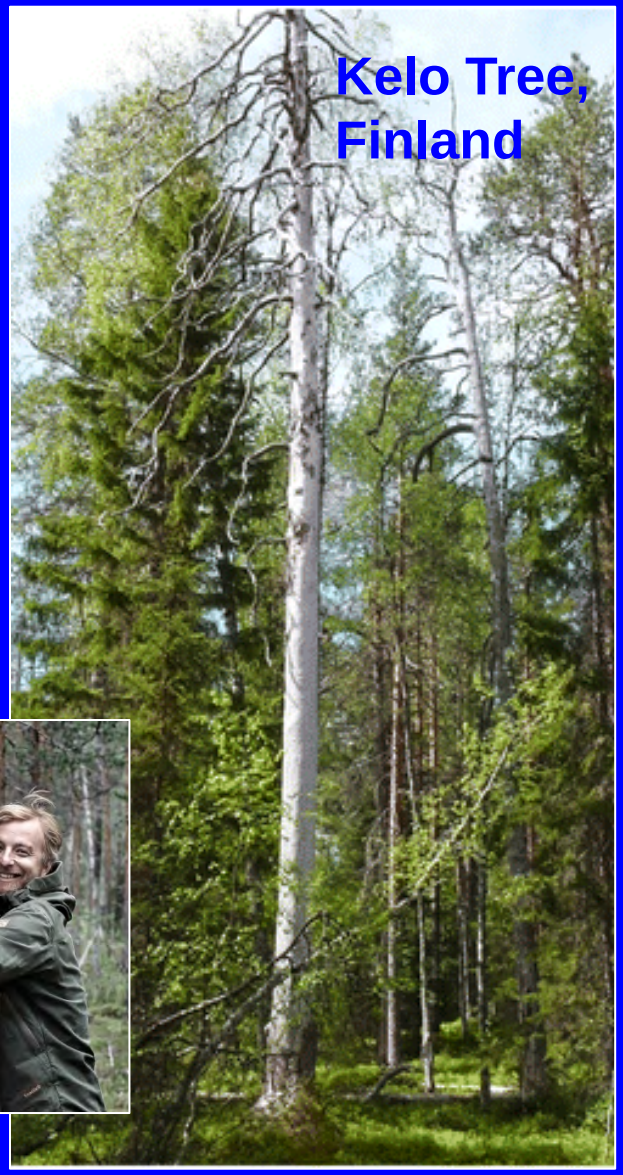
Fraver, Aakala & D'Amato 2017



Conclusions:

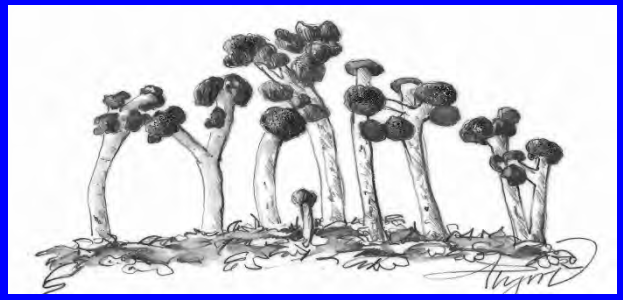
- Age criteria are problematic; structural criteria more applicable
- Old-growth forests include disturbance; rates fluctuate
- Structural diversity benefits biodiversity
- Continuous input of deadwood important for biodiversity

Time-demanding forest structures



Time (and microclimate) demanding forest structures

Stubble lichens in bark fissures
(*Calicium* species)

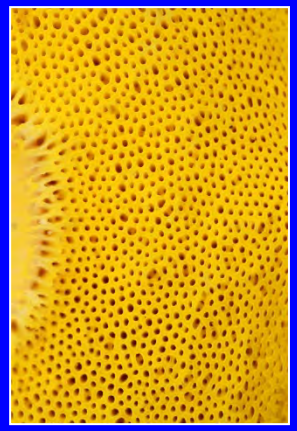


Epiphytic lichens in canopies
(*Usnea longissima*)

Wood-decay fungi

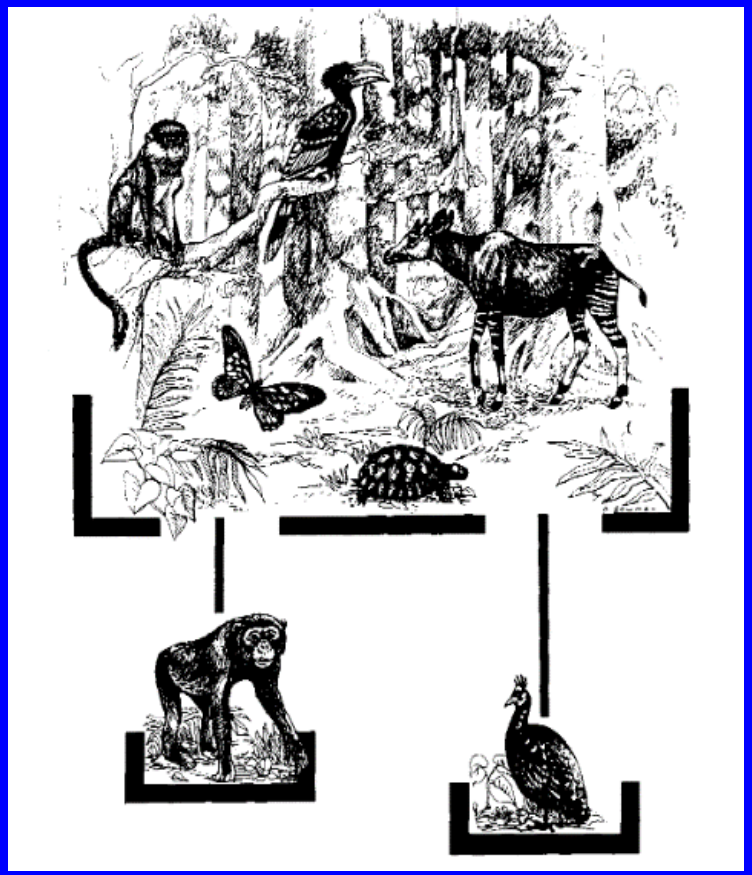
Corticioides

Polypores



Management?

‘Coarse-filter’ approach to maintaining diversity



Coarse Filter: maintaining or creating structural diversity will protect most species

Fine Filter: special measure may be needed for species that ‘slip through’

Hunter, Jacobson, Webb, 1988

Morticulture: Creating snags and woody debris

Figure 30.—A red pine snag created by removing most of the crown through use of small explosive charges, Chippewa National Forest, Minnesota. Photo credit: Harvey Tjader.

“High Stumps” (Sweden)

Natural stands

Harvested

Time (and microclimate) demanding forest structures

Neckera pennata
(neckera moss)

Lobaria pulmonaria
(lungwort lichen)

ECOLOGY

Global Decline in Large Old Trees

The loss of large old trees in many ecosystems around the world poses a threat to ecosystem integrity.

David B. Lindenmayer,[1] William F. Laurance,[2] Jerry F. Franklin[3]

Large old trees are among the biggest organisms on Earth. They are keystone structures in forests, woodlands, savannas, agricultural landscapes, and urban areas, playing unique ecological roles not provided by younger, smaller trees. However, populations of large old trees are rapidly declining in many parts of the world, with serious implications for ecosystem integrity and biodiversity.

The definition of "large and old" trees depends on the ecosystem, tree species, and environmental conditions under consideration. Both the size and the age of a tree affect characteristics such as the large internal cavities, complex branching patterns, and idiosyncratic canopy architectures that distinguish large old trees from younger and smaller trees (*1*).

Large old trees (see the figure, panels A to C) play critical ecological roles. They provide nesting or sheltering cavities for up to 30% of all vertebrate species in some ecosystems (*2*). Large old trees also store large quantities of carbon, create distinct microenvironments characterized by high levels of soil nutrients and plant species richness, play crucial roles in local hydrological regimes, and provide abundant food for numerous animals in the form of fruits, flowers, foliage, and nectar. In agricultural landscapes, large old trees can be focal points for vegetation restoration, facilitate ecosystem connectivity by attracting mobile seed dispersers and pollinators, and act as stepping stones for many animals.

Younger and smaller trees cannot provide most of the distinctive ecological roles played by large old trees (*3*). For instance, large old trees in Mountain Ash (*Eucalyptus regnans*) forests of mainland Australia provide irreplaceable shelter and nesting sites for more

[1]Fenner School of Environment and Society, The Australian National University, Canberra, ACT 0200, Australia. [2]Centre for Tropical Environmental and Sustainability Science, and School of Marine and Tropical Biology, James Cook University, Cairns, Queensland 4878, Australia. [3]School of Environmental and Forest Science, University of Washington, Seattle, WA 98195, USA. E-mail: david.lindenmayer@anu.edu.au

Published by AAAS

Old-growth?

Harvard Forest's Pisgah Tract, previously old-growth, blown over in the 1938 hurricane

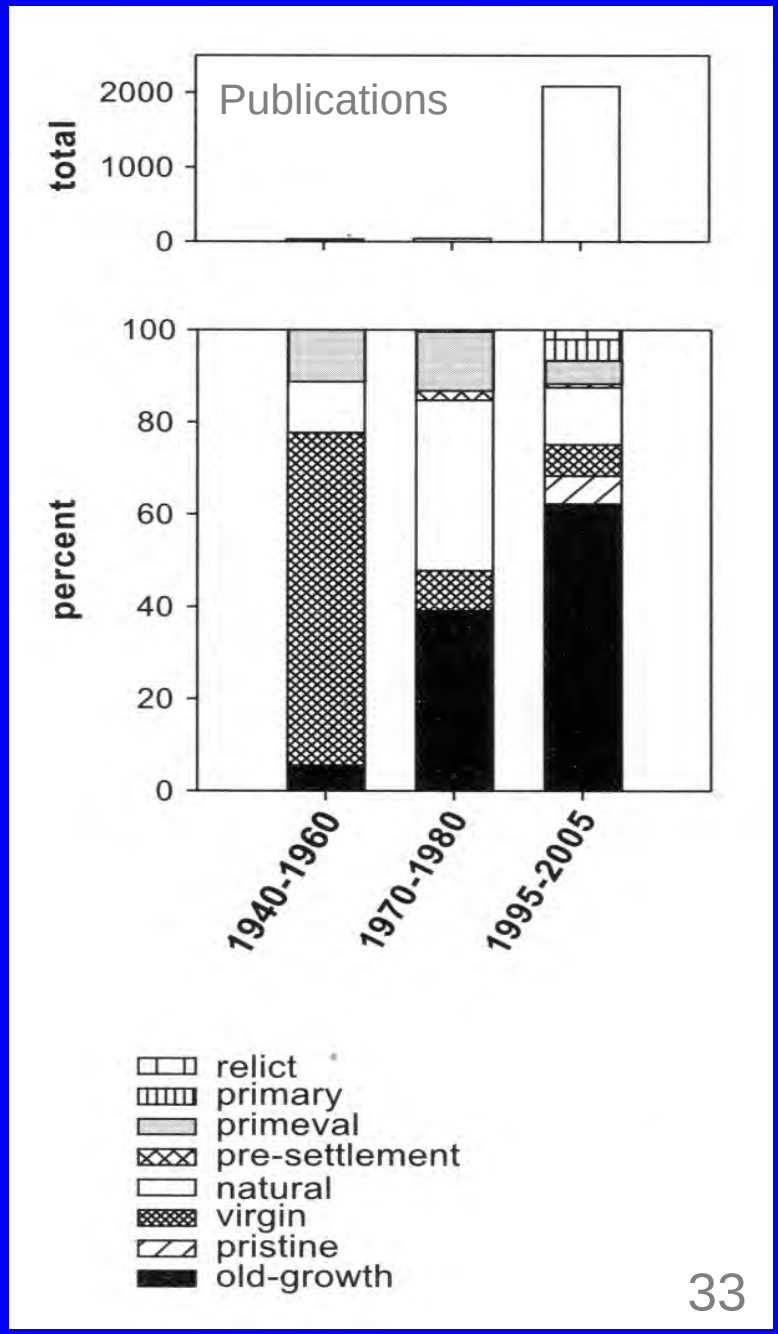
Perspectives on development of definitions and values related to old-growth forests[1]

Lee E. Frelich and Peter B. Reich

Environmental Reviews 11: S9-S22 (2003)

Alternate terms:

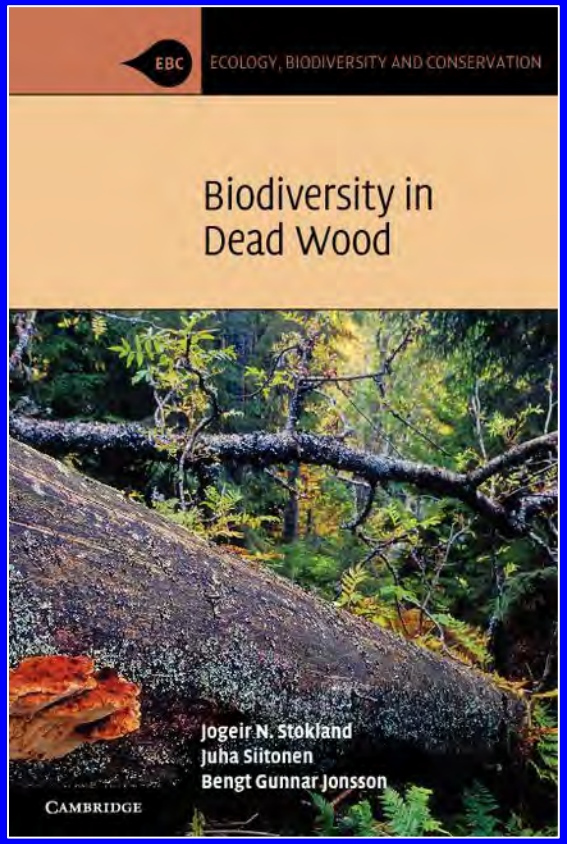
Ancient
Natural
Primary
Primeval
Pre-settlement
Pre-colonial
Pristine
Primitive
Virgin



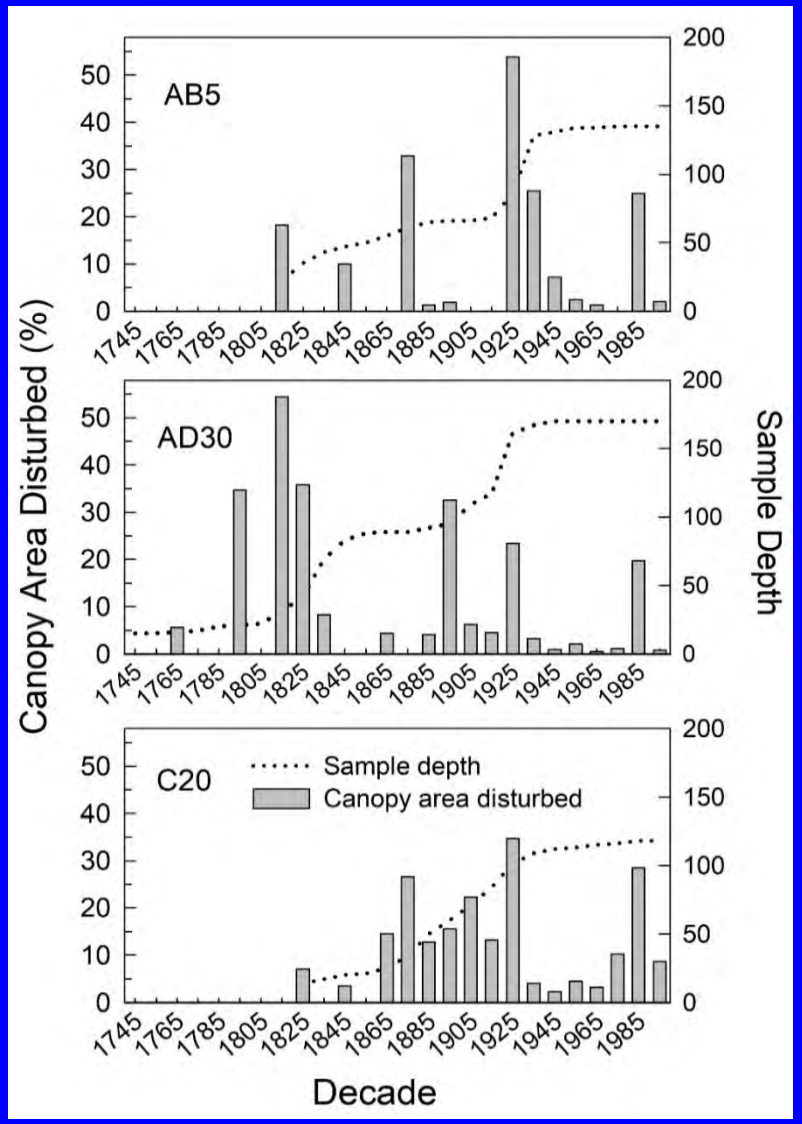
Wirth and others 2009. Old-Growth Forests

Deadwood-dependent Organisms

***Saproxylic species*: species that require deadwood at one or all stages of their life cycle (mostly, wood decay fungi and many beetles)**



Disturbance rates fluctuate through time



Three old-growth spruce stands, Big Reed Forest Reserve

Fraver & White 2005

How does structural diversity develop?

Natural disturbance creates structural diversity