# Natural Disturbance as a Template for Ecosystem-based Management

Species and Spaces

FEESA

July 13, 1997

# Outline

- Relevance of natural disturbance to ecosystem-based management (“Why?”)
- Landscape Patterns
- Island Remnants / Meso - scale patterns
- Stand Structure
- Summary

# Why interest in natural disturbance?

- Management for all species individually is impractical
- All species respond to patterns created by natural disturbance (directly or indirectly)
  - Wildfires have occurred for thousands of years
- Some management practices already resemble some natural disturbances
  - Forest harvesting & wildfire
- Increased similarity between managed and natural disturbances would better conserve populations

# Operating Within the Range of Natural Variability

- "The unmanaged forest... is subject to a variety of natural processes and disturbance such as succession, nutrient cycling, fire, flood, blowdown, insect attack and disease.
- These processes vary in duration, frequency of occurrences, size of affected area and severity.
- For each type of process, there will be a particular range of variability.

Alberta Forest Conservation Strategy, draft July 8, 1996

# Operating Within the Range of Natural Variability...

- The result is a mosaic of natural communities representing the range of natural variability in forest ecosystems.
- Each of these communities plays an integral role in maintaining the diversity and function of the forest ecosystem.
- An understanding of “natural variability” is fundamental to the implementation of ecological management.

Alberta Forest Conservation Strategy, draft July 8, 1996

# Operating Within the Range of Natural Variability...

- Human activities are replacing natural disturbances.
- This trend has the potential to simplify the diversity of the forest and, over the next several decades, may push it beyond the historic range of natural variability.
- Ecological management proposes that we use human activities to maintain that range of natural variability.

**Alberta Forest Conservation Strategy, draft July 8, 1996**

# Achieving Ecological Management through Adaptive Management

- "The key idea behind ecological management is that we can substitute planned, human activities for random and naturally occurring biological processes within the range of variability of those processes."
- Requires the following 4 new assumptions:

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# Assumption 1

- Human activities can approximate natural processes, at least to some degree.
- From a forestry perspective, this may be accomplished through:
  - the use of cutblocks of different sizes and shapes,
  - by variation in rotation age, and
  - by varying the percentage of removal within harvested areas.

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# Assumption 2

- **"That our treatment of the forest will fall within the range of natural variability with respect to area, shape, age class and severity of disturbance (within socially acceptable limits). Natural processes will still inevitably occur."**

**Alberta Forest Conservation Strategy, draft July 8, 1996**

# Assumption 3

- That human activities carried out in a manner that bears some resemblance to natural ecological events, will result in the conservation of biodiversity, maintenance of ecosystem structure and function, and generate a sustainable flow of goods and services provided by the forest.

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# Assumption 4

- That by a process of “adaptive management”, forest managers will be able to determine what practices work and to detect problems, and correct them, before irreversible damage occurs to either individual species or the ecosystem as a whole.

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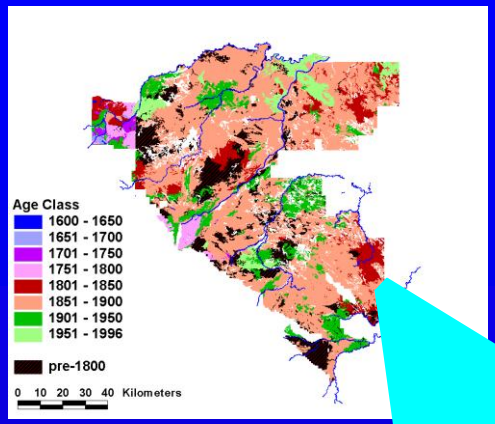
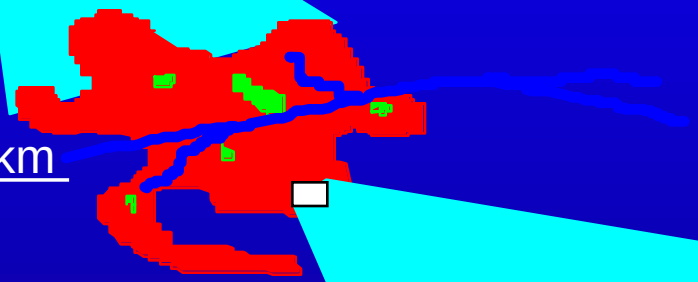
# Scale is important



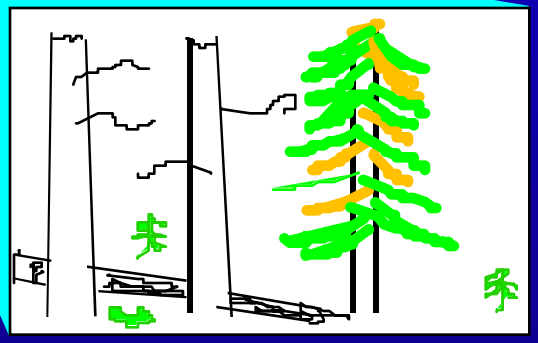

100 km

Mosaic of many wildfires

Structure within a wildfire



10 km

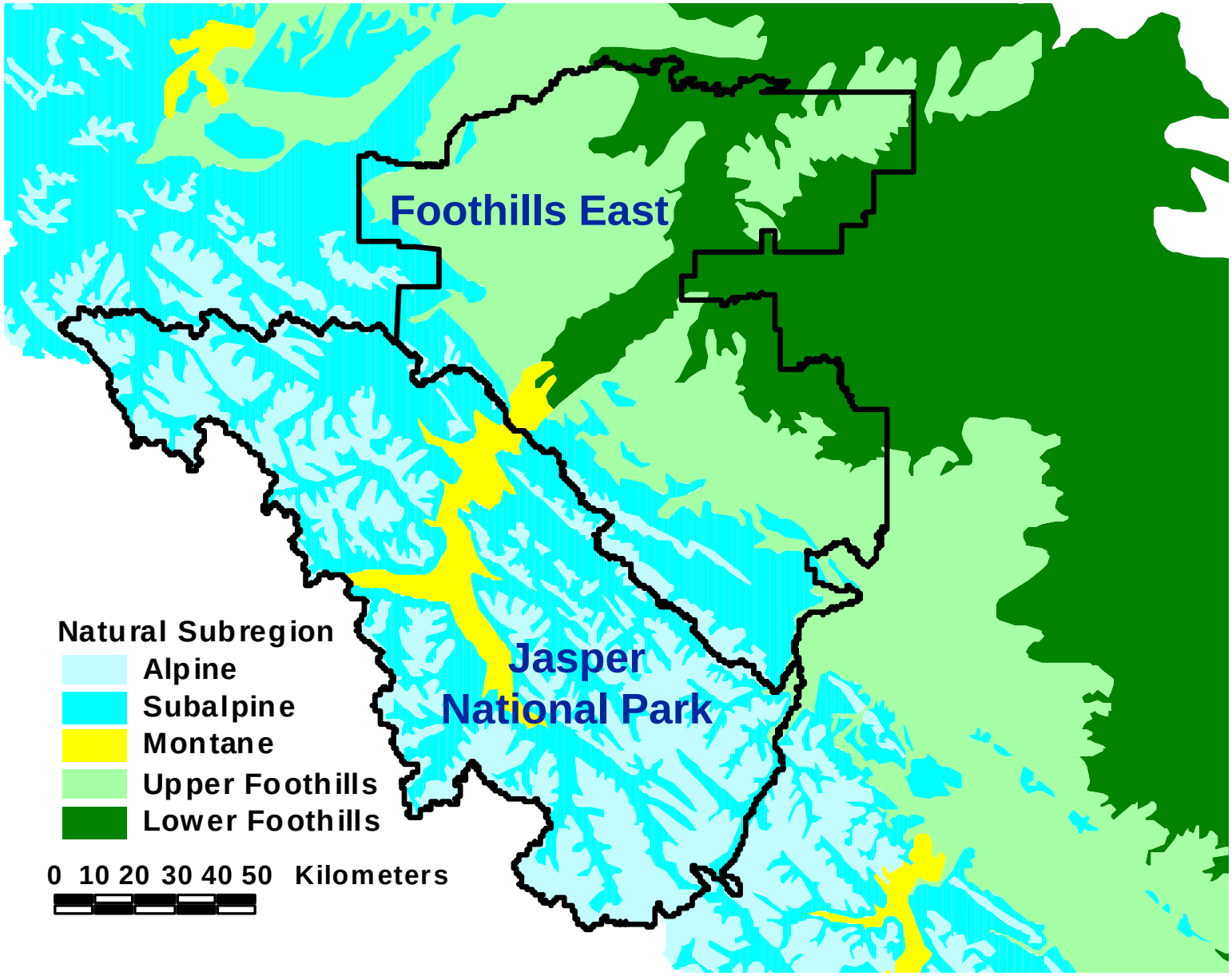


0.001 km

Structure within a stand

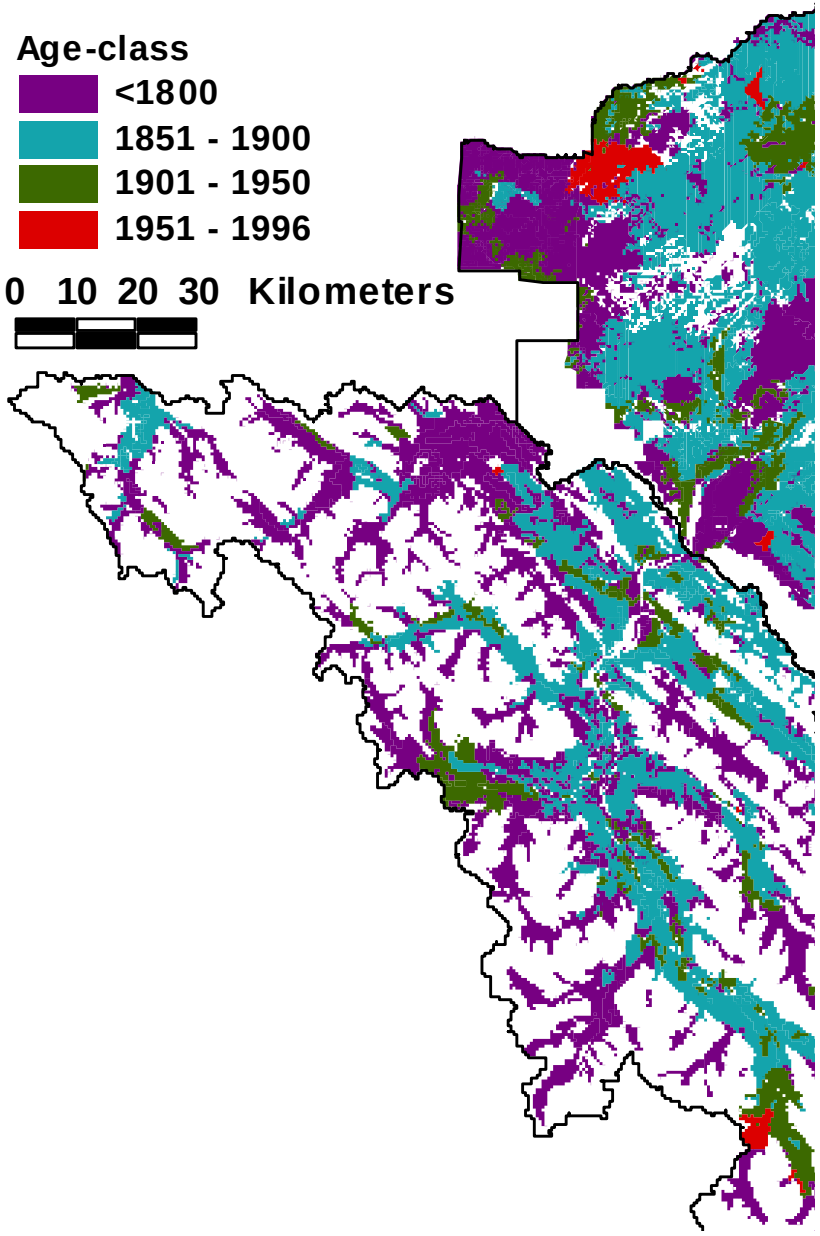
# Landscape Disturbance Regimes

- Describe natural disturbance regime across the Foothills Model Forest, including frequency, size, and spatial arrangement of stand-replacing wildfires
  - Weldwood FMA area
  - Other Provincial lands
  - Jasper National Park
- Assist ecological basis for management planning
  - Harvest scheduling in working forests
    - Weldwood's Hinton FMA area
  - Fire management in protected areas
    - Jasper National Park, Willmore Wilderness Park
- Goal is to conserve biological diversity by maintaining future seral stage representation and spatial arrangement within the range of natural variability


Foothills East
Jasper
National Park
Natural Subregion
Alpine
Subalpine
Montane
Upper Foothills
Lower Foothills
0 10 20 30 40 50 Kilometers

# Inventory: Stand Origin Map

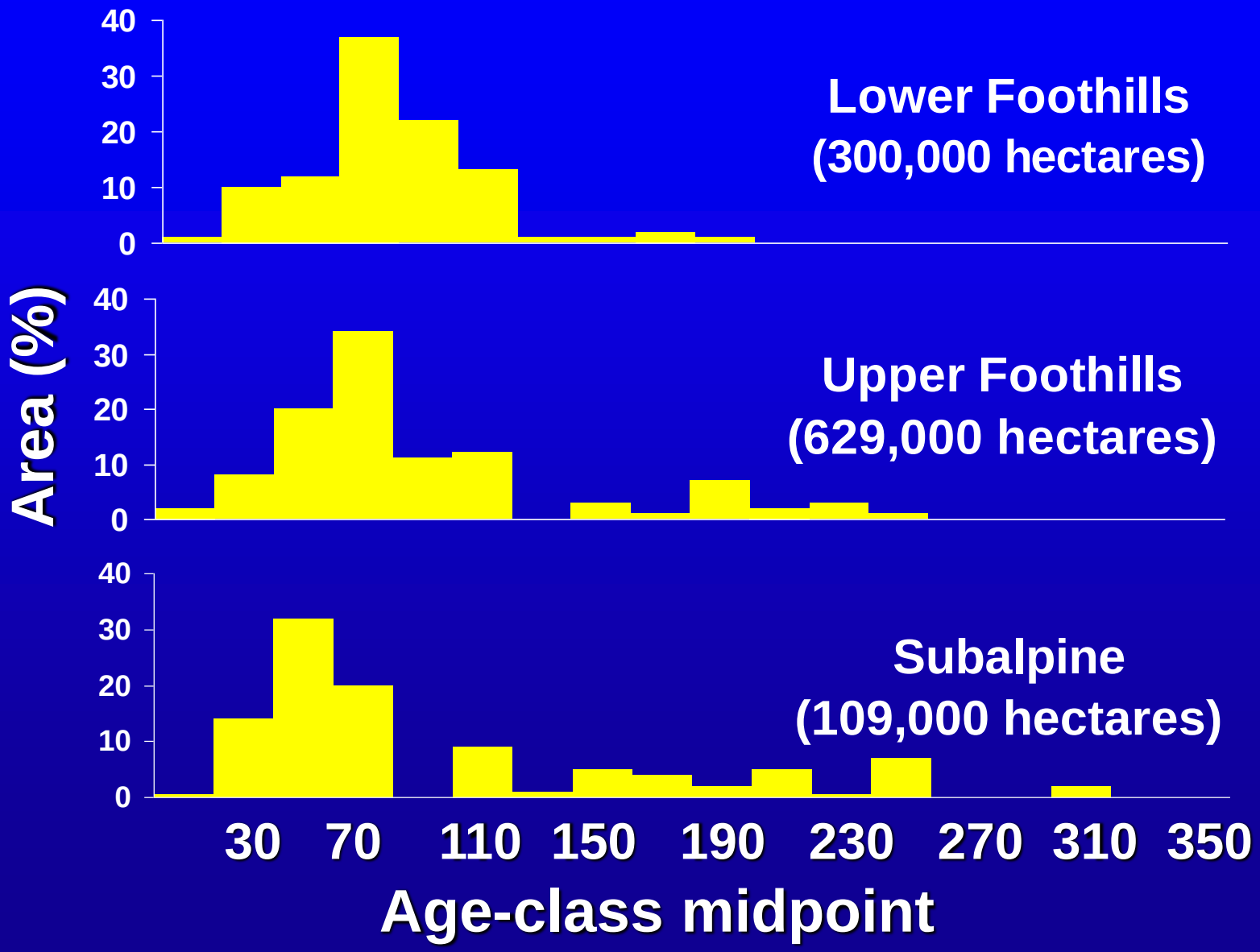
- 1:50,000 time-since-fire mapping
  - coarse resolution, smallest patches not mapped
- air photo interpretation of historical fire boundaries
- ground sampling for evidence to date fire events
- adequate for past 150 years, less confidence in age of older stands


Age-class
<1800
1851 - 1900
1901 - 1950
1951 - 1996
0 10 20 30 Kilometers

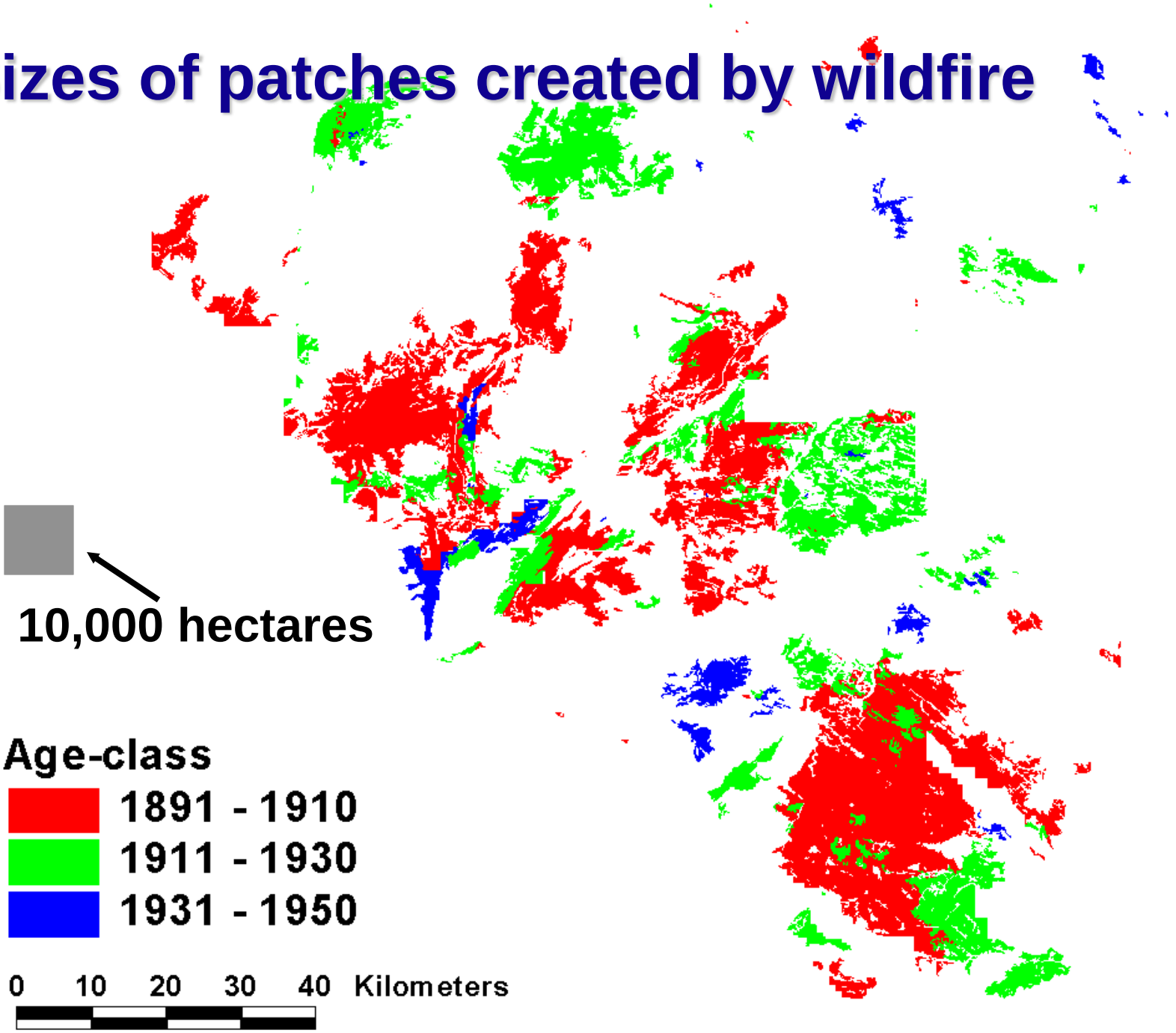
# Analysis

- Stratify by ecological units
  - patch age
  - patch size
  - patch spatial arrangement
- Relationships between stand origin and
  - topography (slope, aspect)
  - watercourses
- Understand process behind the observed patterns

# Patch Age (as of 1950)

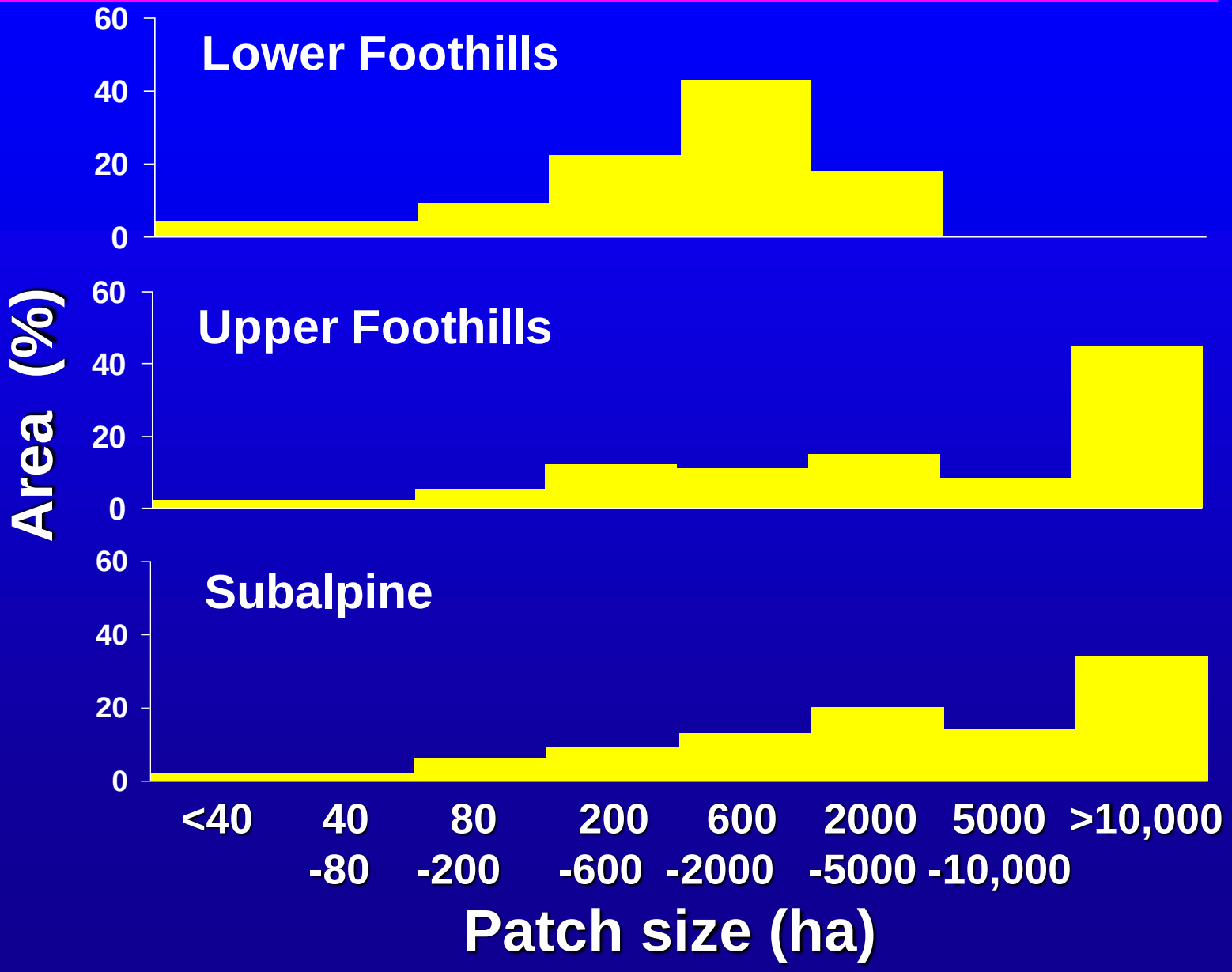


# Sizes of patches created by wildfire

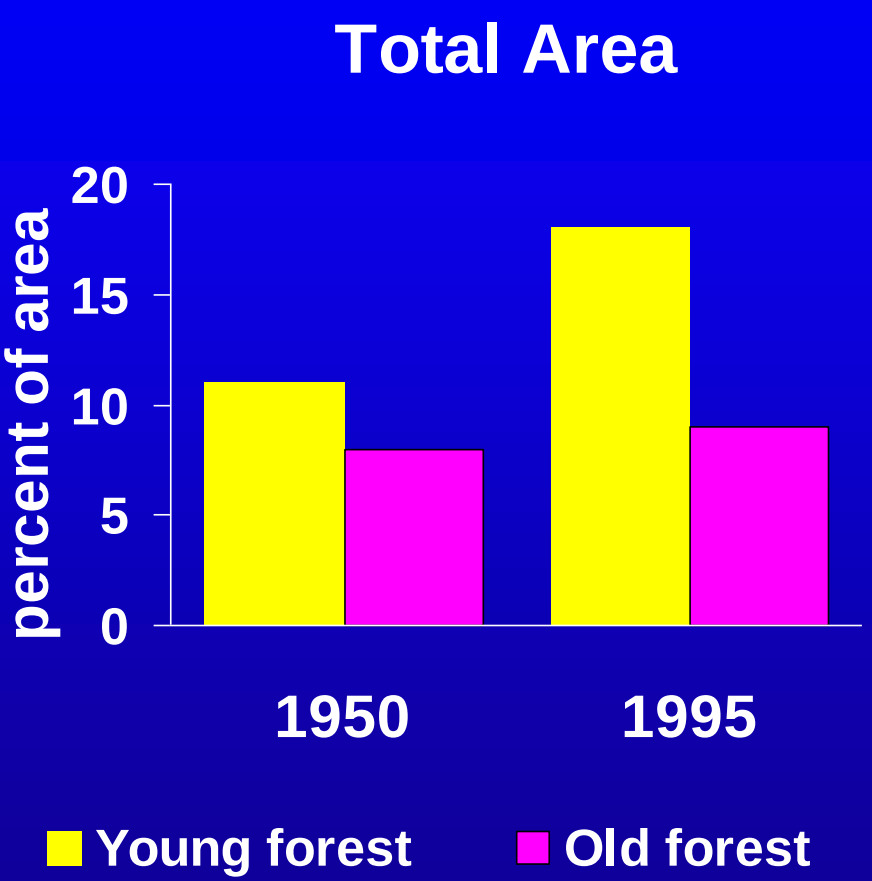


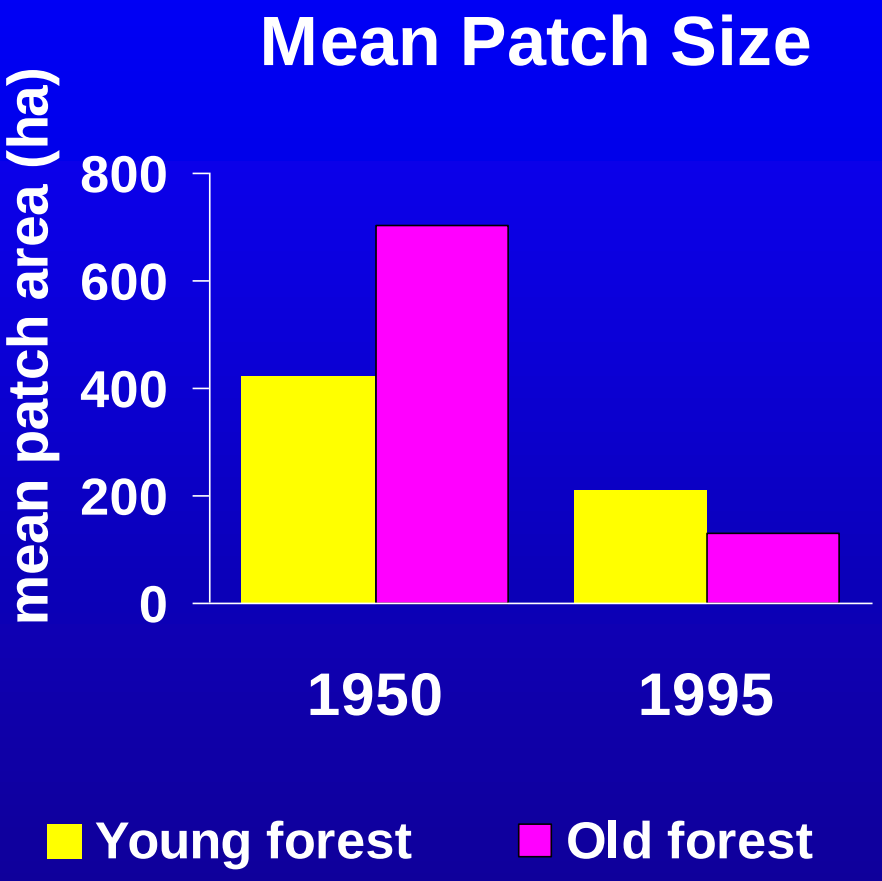
(20-yr classes)

# Patch size



# Changes in area & patch size

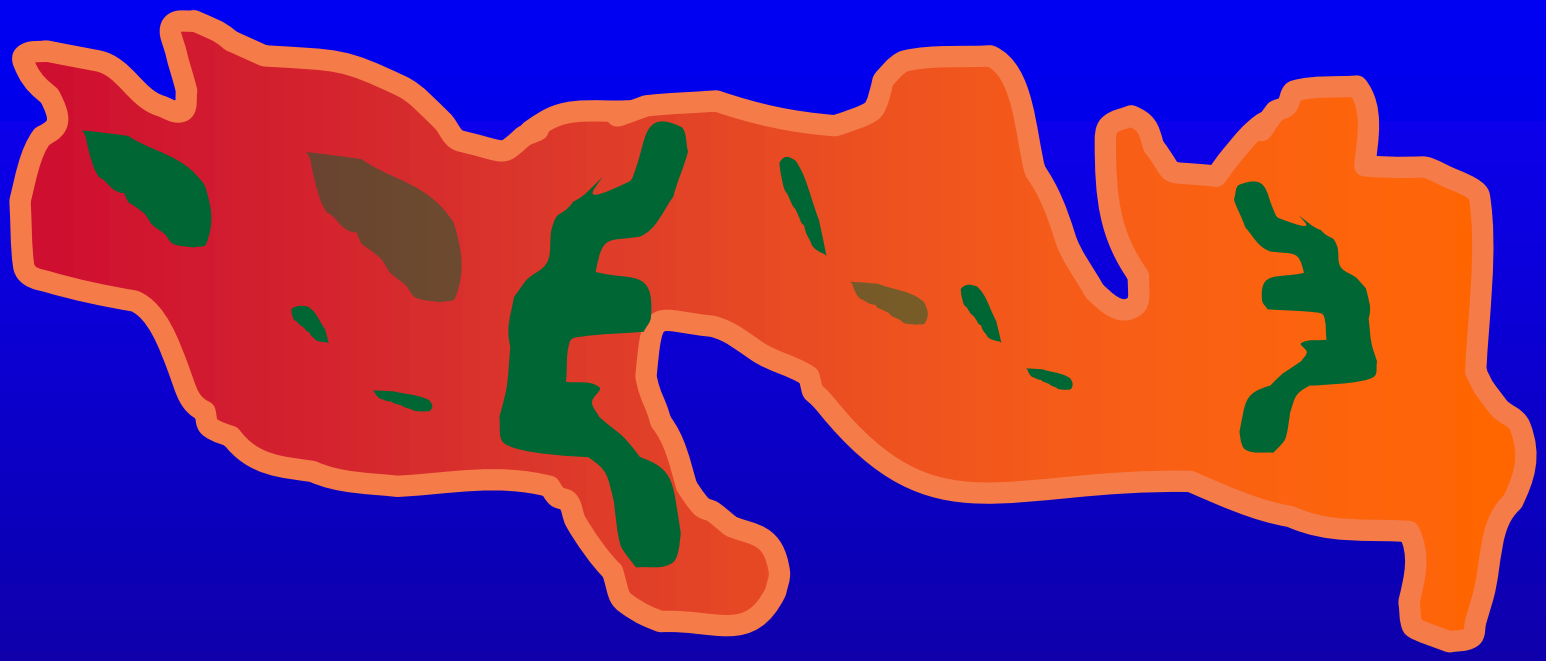


# Island remnants

- Wildfires create burned matrix in which unburned residuals are embedded
- These residuals are variable in size
- These residuals are not arranged randomly
  - aspect, slope, watercourses
- Post-burn structure in the burned matrix is also variable, due to
  - variable fire intensity
  - variable forest structure prior to wildfire

# Island remnants



# Island Remnants

# Stand Structure

- Estimate the range of variability in deadwood structures of stands recently disturbed by wildfire and by logging in the Rocky Mountain Foothills of Alberta

- Work in progress, results are preliminary

# Deadwood in forest ecosystems

- Disturbance can quickly generate large inputs of deadwood
  - wildfire, wind, insect outbreaks
- Exists in 3 “pools” (Harmon et al. 1986):
  - present before disturbance
  - created by disturbance
  - added after disturbance
- Standing vs down “populations” of deadwood

# Deadwood

# Deadwood in Rocky Mountain Foothills

- Stand-replacing wildfire has been a dominant process shaping the distribution and structure of forest communities
- Most of the landscape exists as patches created by very large wildfires (over 100 $km^2$)
- Tree mortality following wildfire is variable, but frequently very high
- Tree boles usually remain, forming a "cohort" of standing deadwood, which eventually enters down deadwood population

# Deadwood and forest harvesting

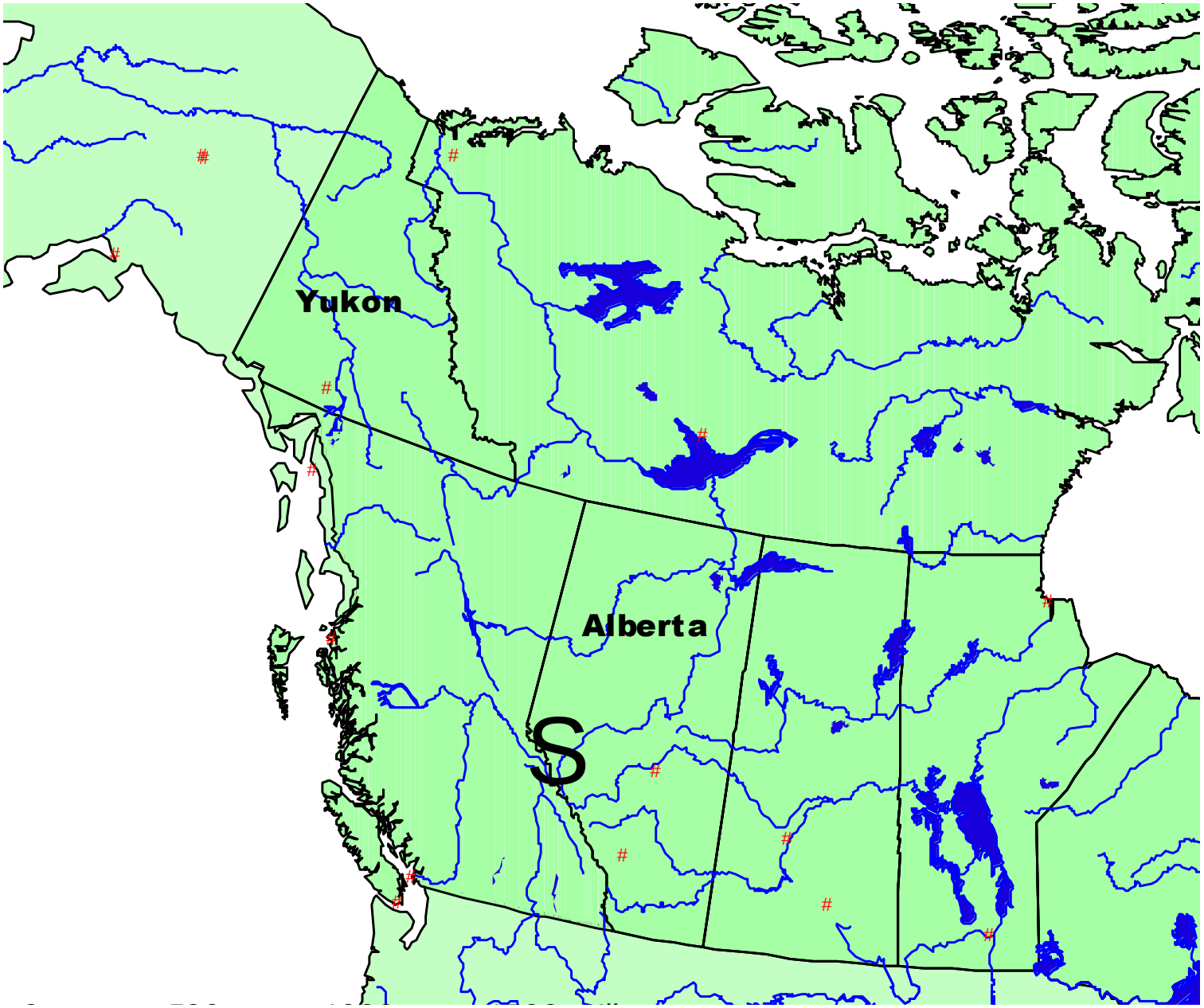
- 500 $km^2$ harvested in Alberta, 1994/95
- Clearcutting is dominant harvest method
- Historical trend → increased utilization
  - e.g., less than 5% merchantable wood volume remaining
- Recent trend → decreased utilization (?)

# What we don't know

- Range of variability in deadwood structures
  - post-wildfire communities *vs* post-harvest communities
- Fate of the deadwood cohort after wildfire
  - vertical arrangement (standing *vs* down)
  - colonization by lichen, fungi, plants
  - decay, assimilation into organic layer
- Time to "convergence" after fire, logging
  - Lee, Crites et al. (Boreal Mixedwood)

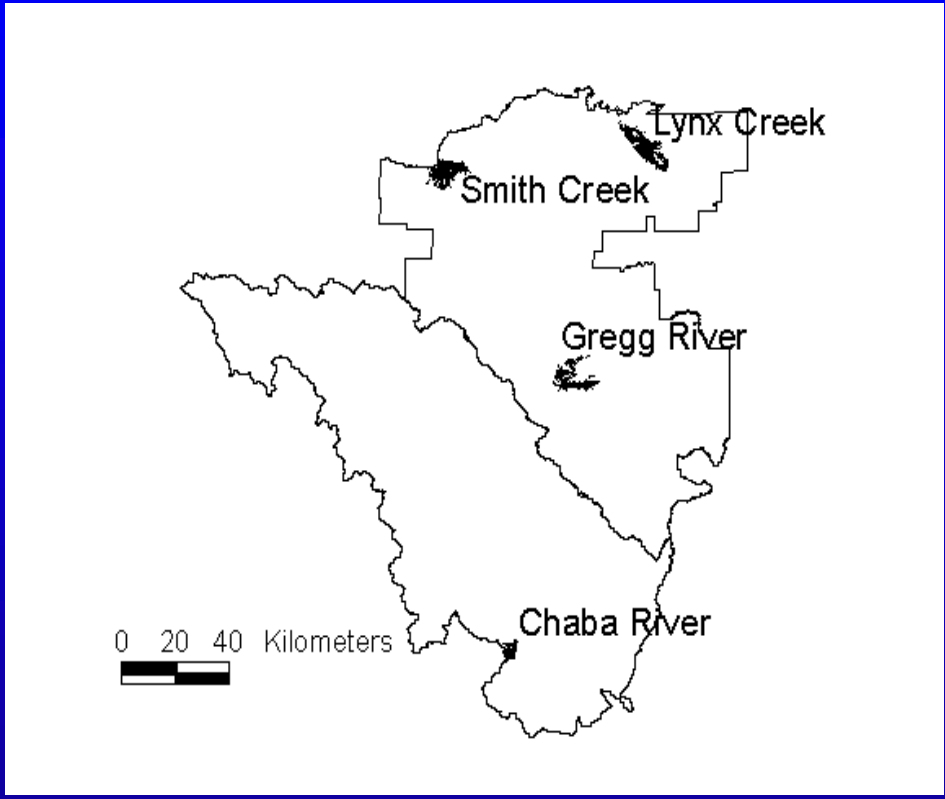
# What we could do if we knew more

- Identify extent to which the range of "natural" variability in deadwood structures is beyond the "managed" range
- Have historical "catalogue" for comparison with future managed forests
- Design studies that assess the effectiveness of management options intended to expand the "managed" range
  - biodiversity
  - productivity


Yukon
Alberta
S

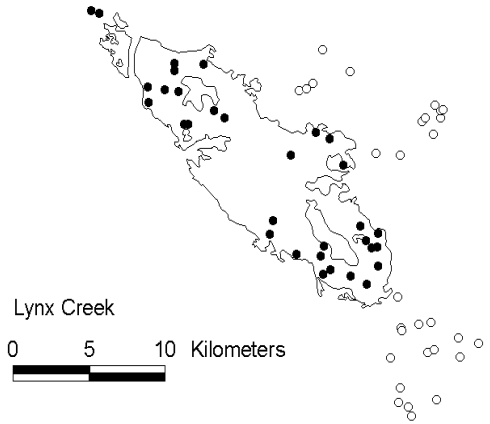
# Study areas

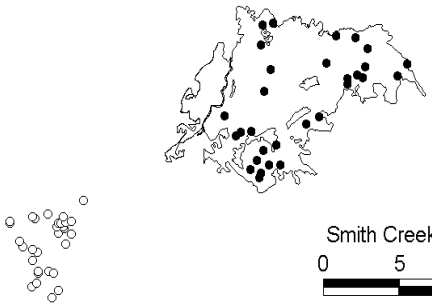
- 1 Mountain wildfire
  - 34 yr.
- 3 Foothills wildfires
  - 35 - 40 yr.
- 3 Foothills harvests
  - 23 - 27 yr.

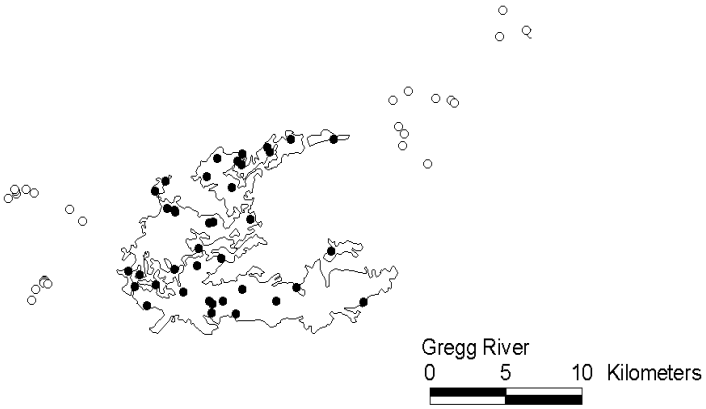


# Sample plot layout

- 30 plots per site (15 in Mountain burn)
- (almost) randomly located



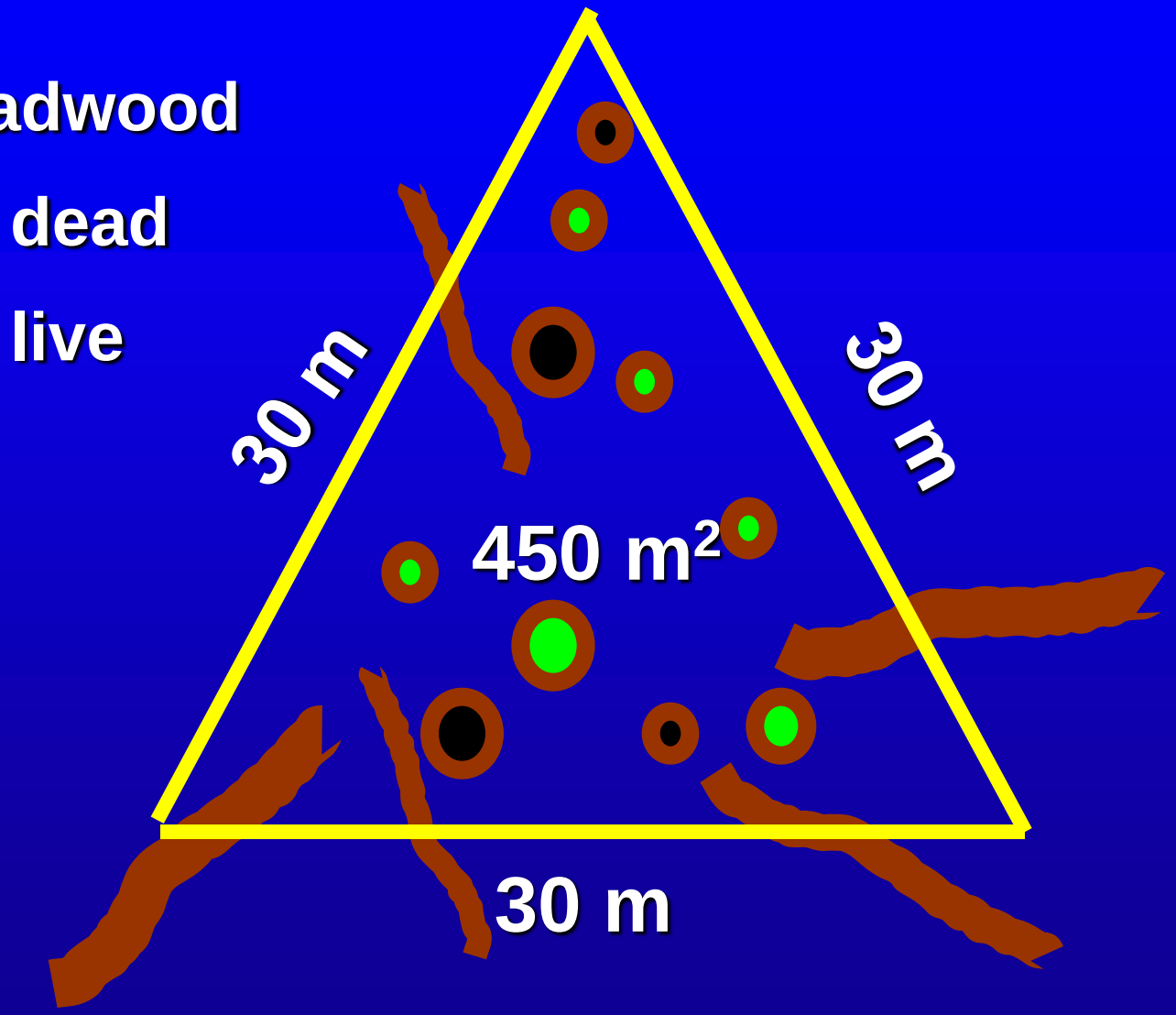



# Sampling method

down deadwood

standing dead

standing live



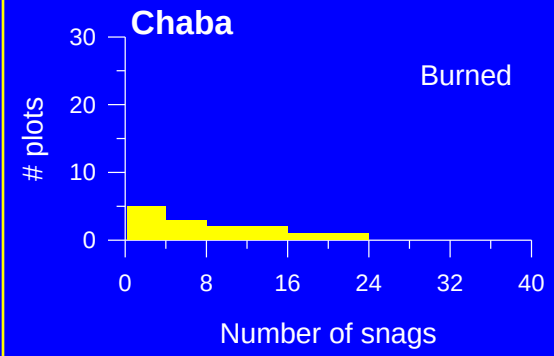
# All snags

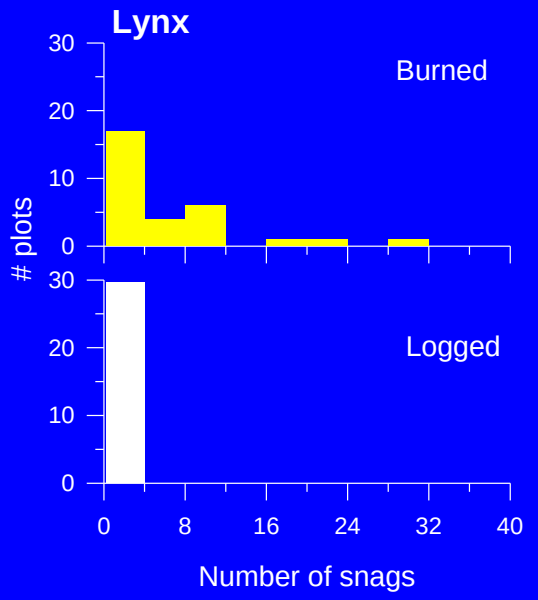
*Burned sites*

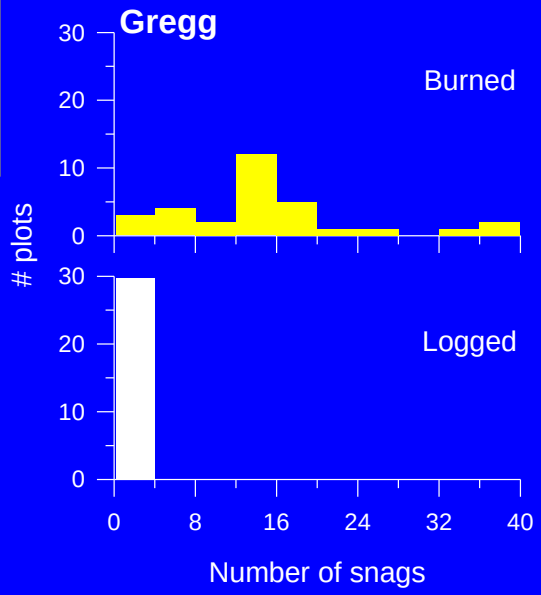
0 ->500 snags /ha, usually <100 snags /ha

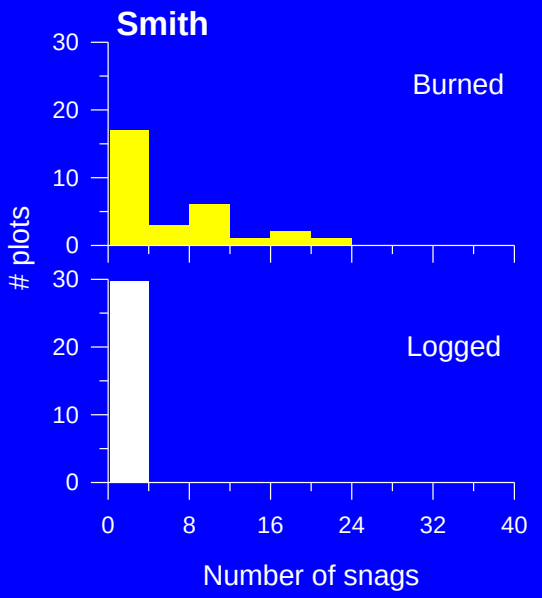
*Logged sites*

snags very rare, usually absent



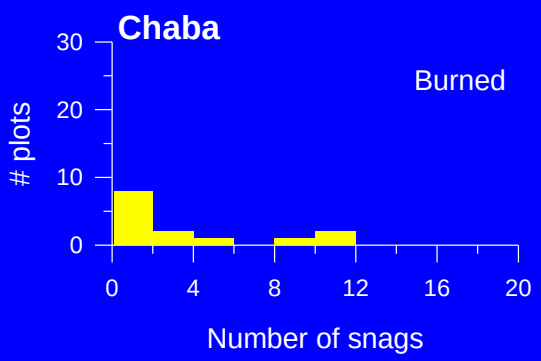
# Only snags > largest live tree

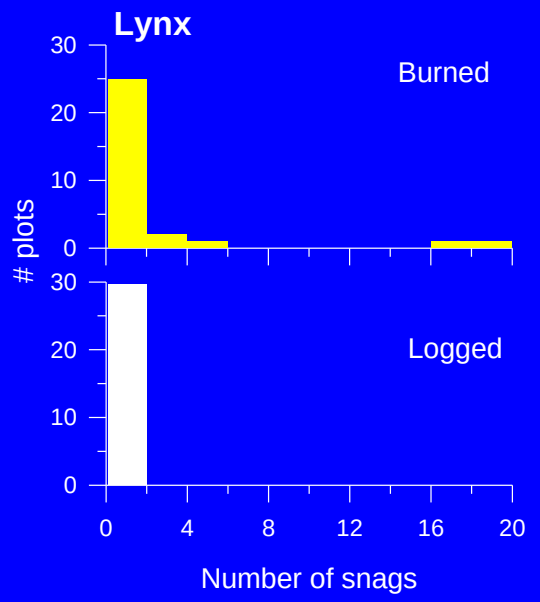
*Burned sites*

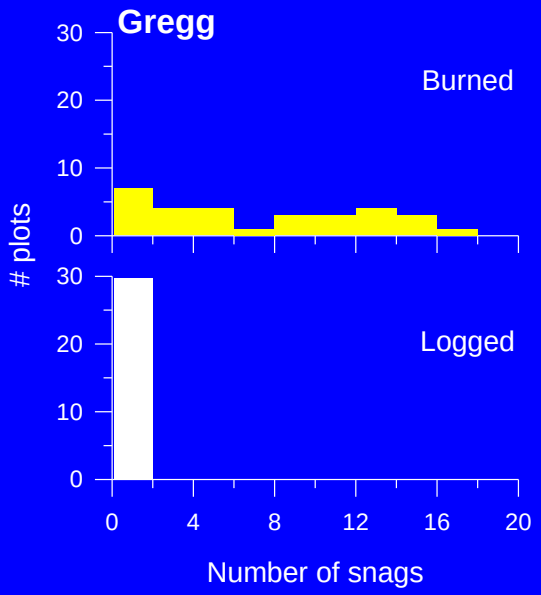
usually <50 snags /ha, occasionally higher

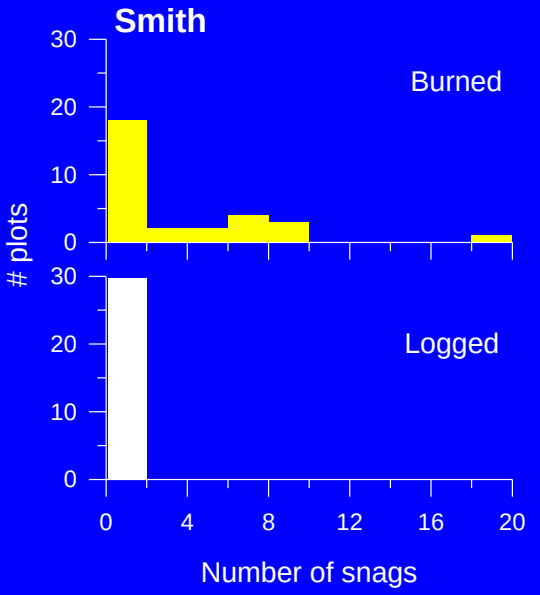
*Logged sites*

virtually none



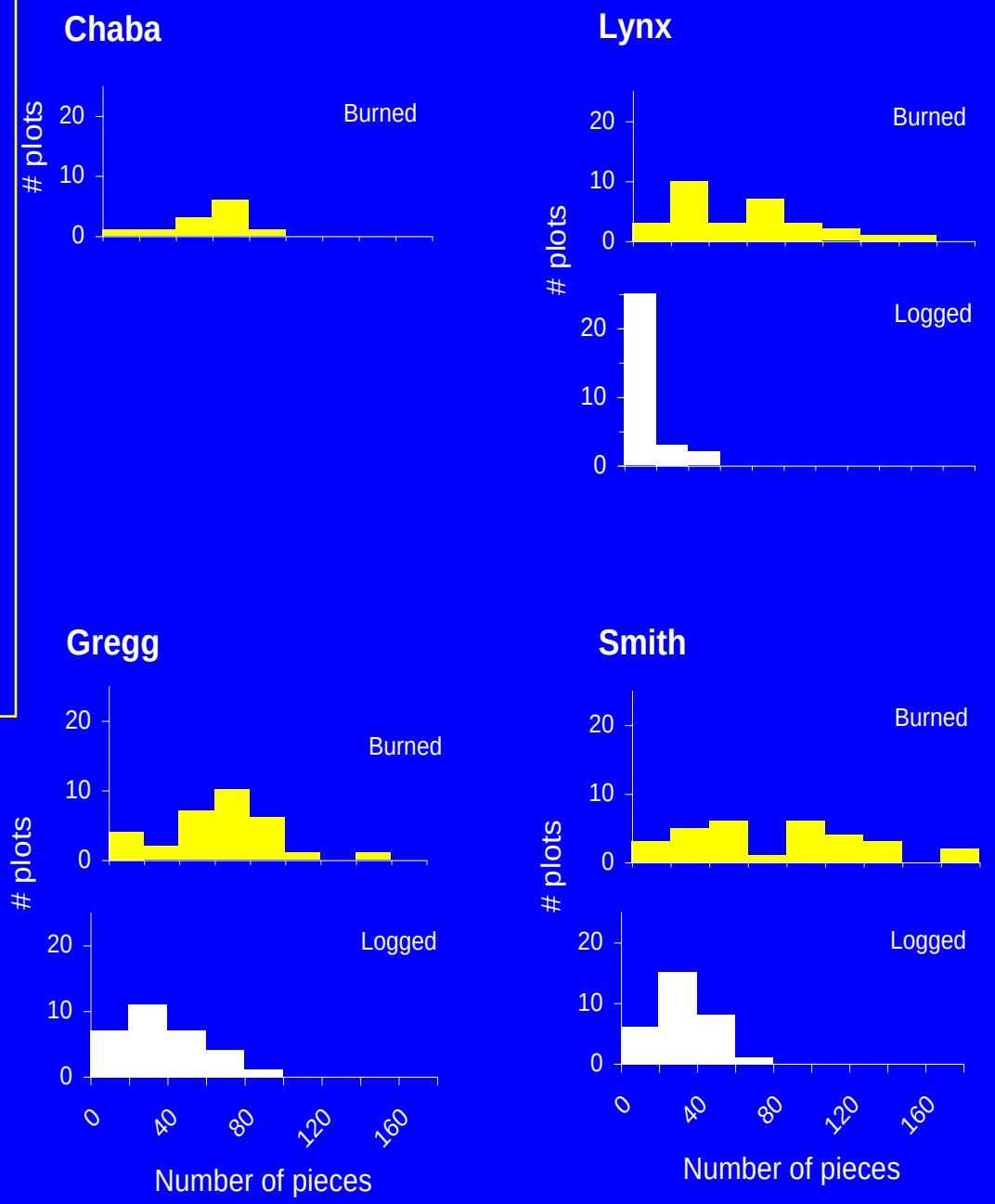



# Number of pieces of down deadwood

*Burned sites*
highly variable

*Logged sites*
less variable, usually fewer



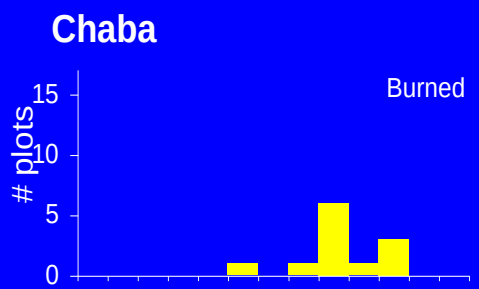
# Size of down deadwood > 7 cm diameter

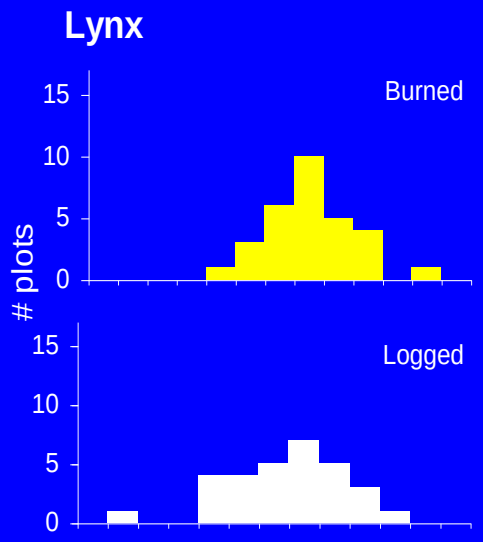
*Burned sites*

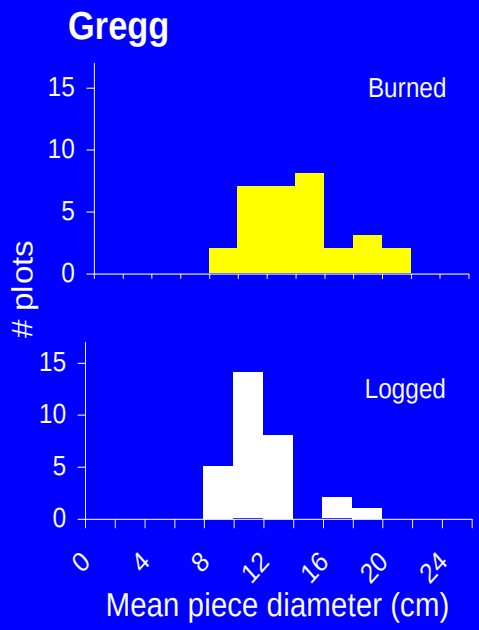
average 12 cm diam.

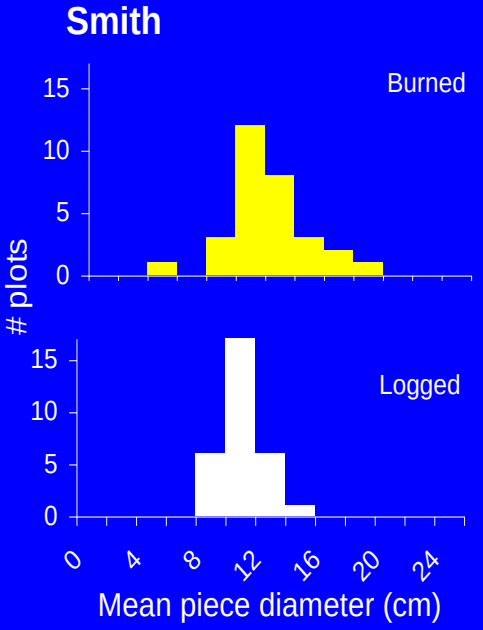
*Logged sites*

similar



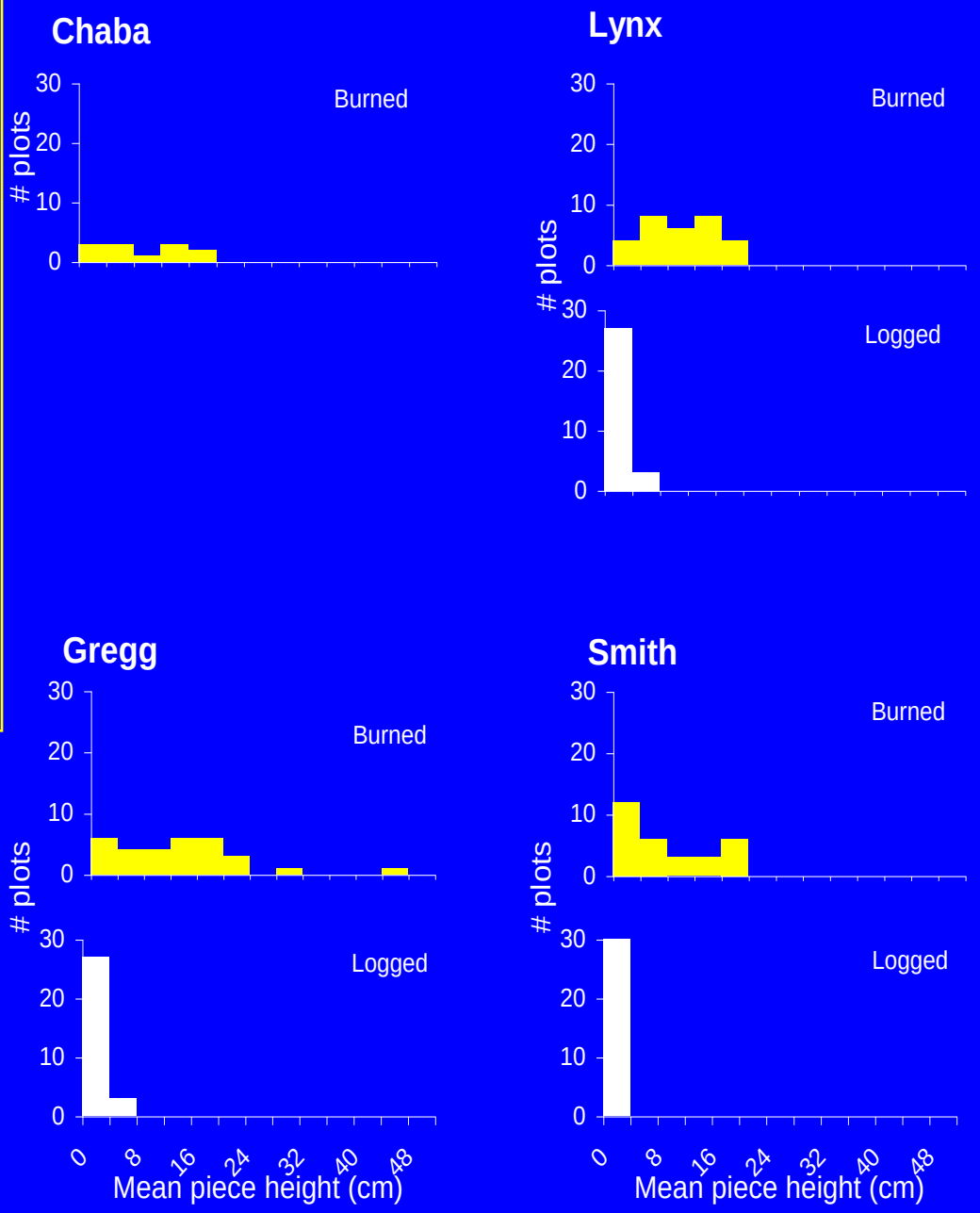
# Height of down deadwood

*Burned sites*

average up to 20 cm off ground

*Logged sites*

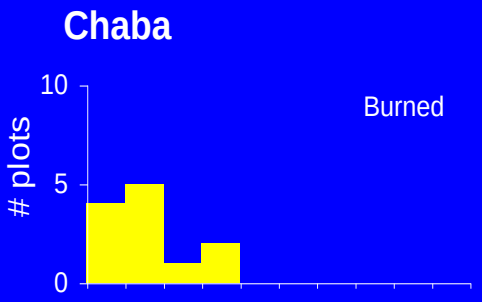
usually on ground

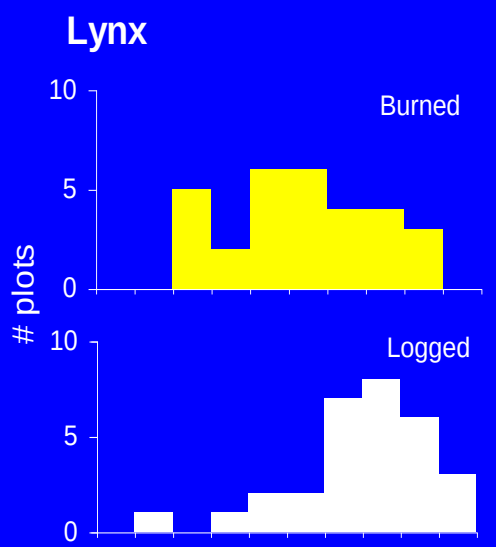


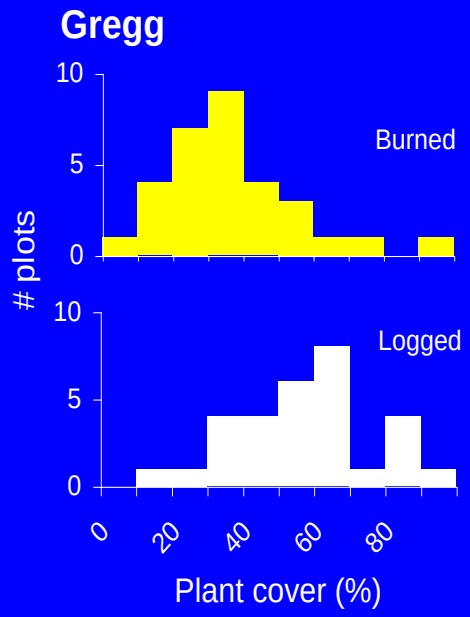
# Attached plants on down deadwood

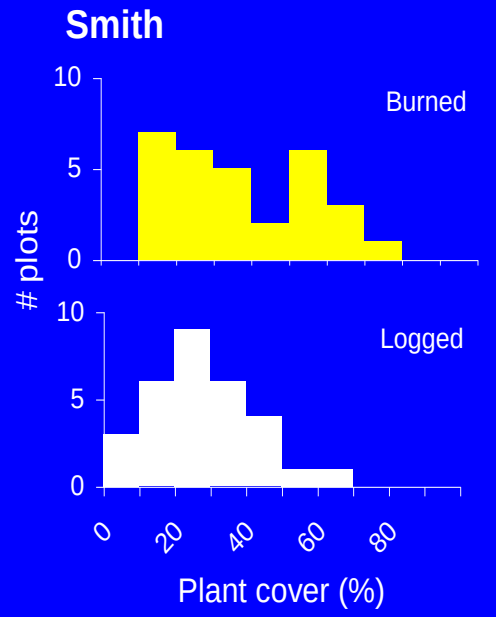
*Burned sites*
variable

*Logged sites*
variable



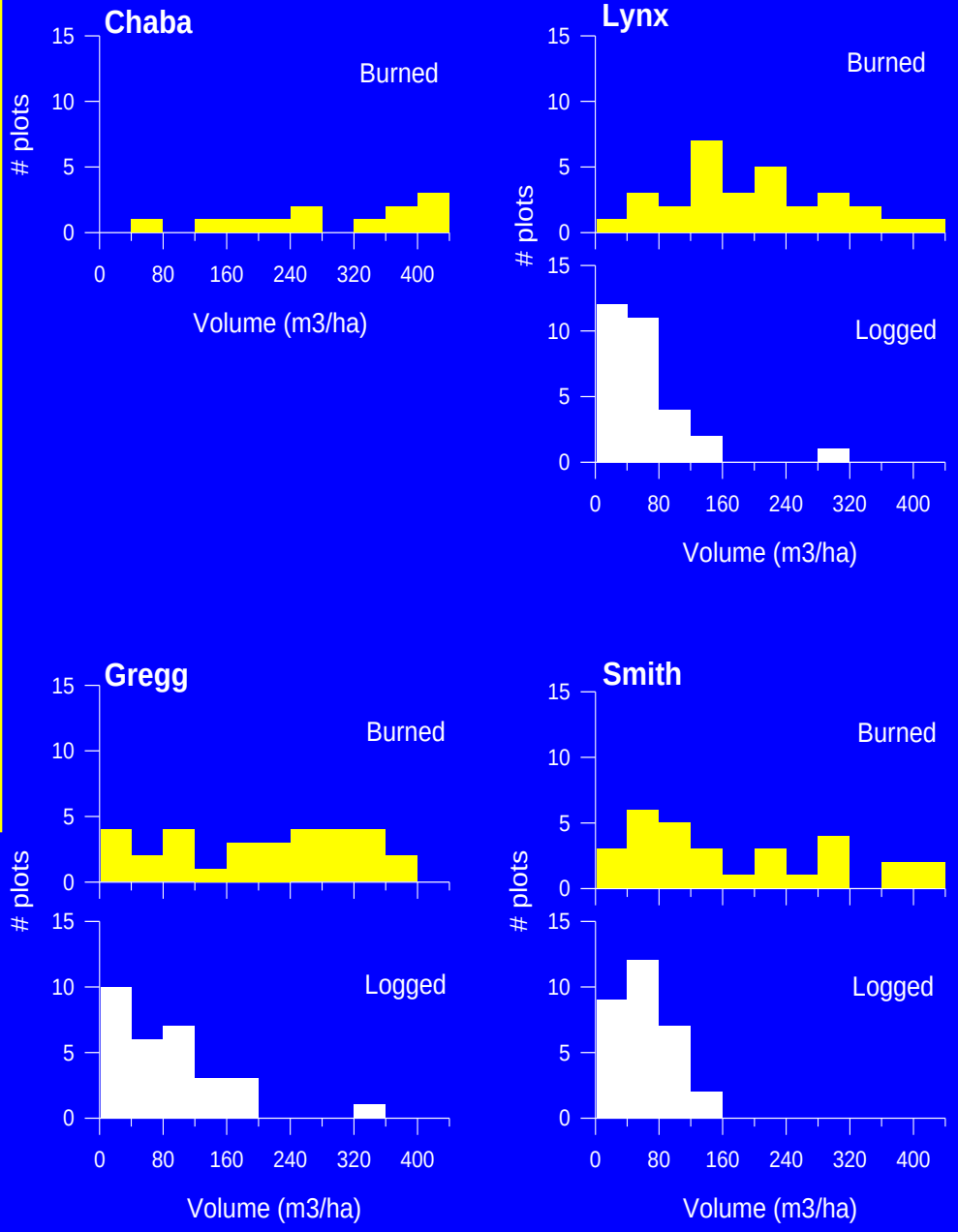
# Total volume of down deadwood

*Burned sites*

variable, up to > 300 $m^3$ / ha

*Logged sites*

less variable, average 1/3 of burned sites



# Summary

- Natural disturbances are highly variable and not well characterized
- The range of variability created by natural disturbances can be estimated at a range of scales
- Management options can be developed that perpetuate at least part of the range of variability caused by natural disturbances
- Monitoring and research are needed to estimate the effectiveness of alternative management options

# Natural Disturbance Program

- Program Team
  - Dan Farr, Foothills Model Forest
  - Don Harrison, Alberta Environmental Protection
  - Hugh Lougheed, Weldwood of Canada
  - Alan Westhaver, Jasper National Park
- Project Collaborators
  - Dave Andison, Bandaloop
  - Rick Bonar, Weldwood
  - George Mercer, Jasper NP
  - Luigi Morgantini, Weyerhaeuser
  - Marie-Pierre Rogeau, Banff
  - Chris Spytz, Weldwood