Coarse-Scale Disturbance Patterns on FMF Landscapes

- Types of disturbances
- Frequency of disturbances
- Seral-stage representation
- Non-forested lands
- Natural disturbance integration

Disturbance Types on the FMF

- **Forest Fires -**
  - **lightning & people caused**
  - **Stand-replacing and stand-maintaining**
- **Wind**
- **Herbivory**
- **Flooding / stream meander**
- **Slides**
- **Insects & disease**
- **Cultural**
  - **Harvesting**
  - **Oil, gas, and mining activity**
  - **Urban development**

Based on experience and knowledge to date, *the majority* of the forest on the FMF is even-aged.

… meaning that we can use stand age data to represent coarse-scale disturbance activity patterns.

Why are Good Age Data Important?

- **Helps to identify landscapes of differing disturbance activity.**
- **Disturbance Frequency**
  - ***Fire Cycle** -average time to disturb equivalent area of a landscape.*
  - ***Fire Return Interval** - average time between disturbances at a single site.*
- **Seral-stage retention across a landscape (ie. how much area in "old growth"?).**
- **Fuel-management and fire risk.**
- **Determines what a "patch" is.**

Potential Inventory Age Problems:

- Representing “natural” conditions is difficult.
  - Cultural activity (harvesting, oil and gas, roads, urban, recreation, fire / pest / disease control).
- Accuracy is questionable.
  - Ground sampling intensity and location
  - Aging methods
  - Breast height age
- Class definition issues:
  - Age-class boundaries width
  - Width of the “Older than” class.
  - What a “patch” is.

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  - **Age-class boundaries width**
  - **Width of the "Older than" class.**
  - **What a "patch" is.**

Representing "Natural" Conditions, or Bandaloop Luck

Jasper National Park:

No harvesting, excellent fire protection, & complete fire history age maps*

Weldwood FMA:

***Most of* a fire history map* from 1961, little harvesting prior, excellent fire protection since**

**** A fire history map is NOT the same as inventory age.***
- methodology, sampling intensity.

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  - Cultural activity (harvesting, oil and gas, roads, urban, recreation, fire / pest / disease control).
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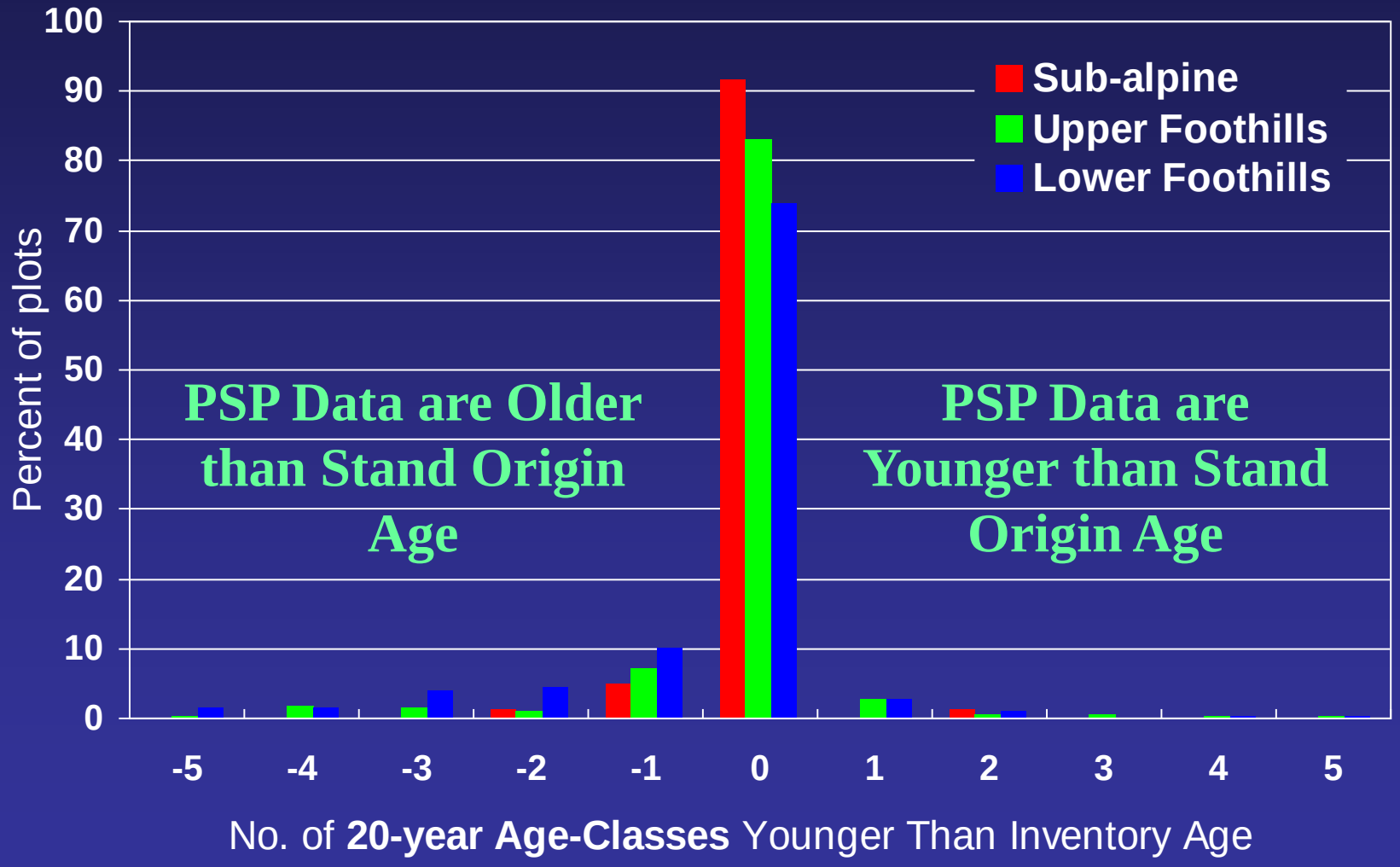
How Good Are the Fire History Stand Ages?



Potential Inventory Age Problems:

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- Class definition issues:
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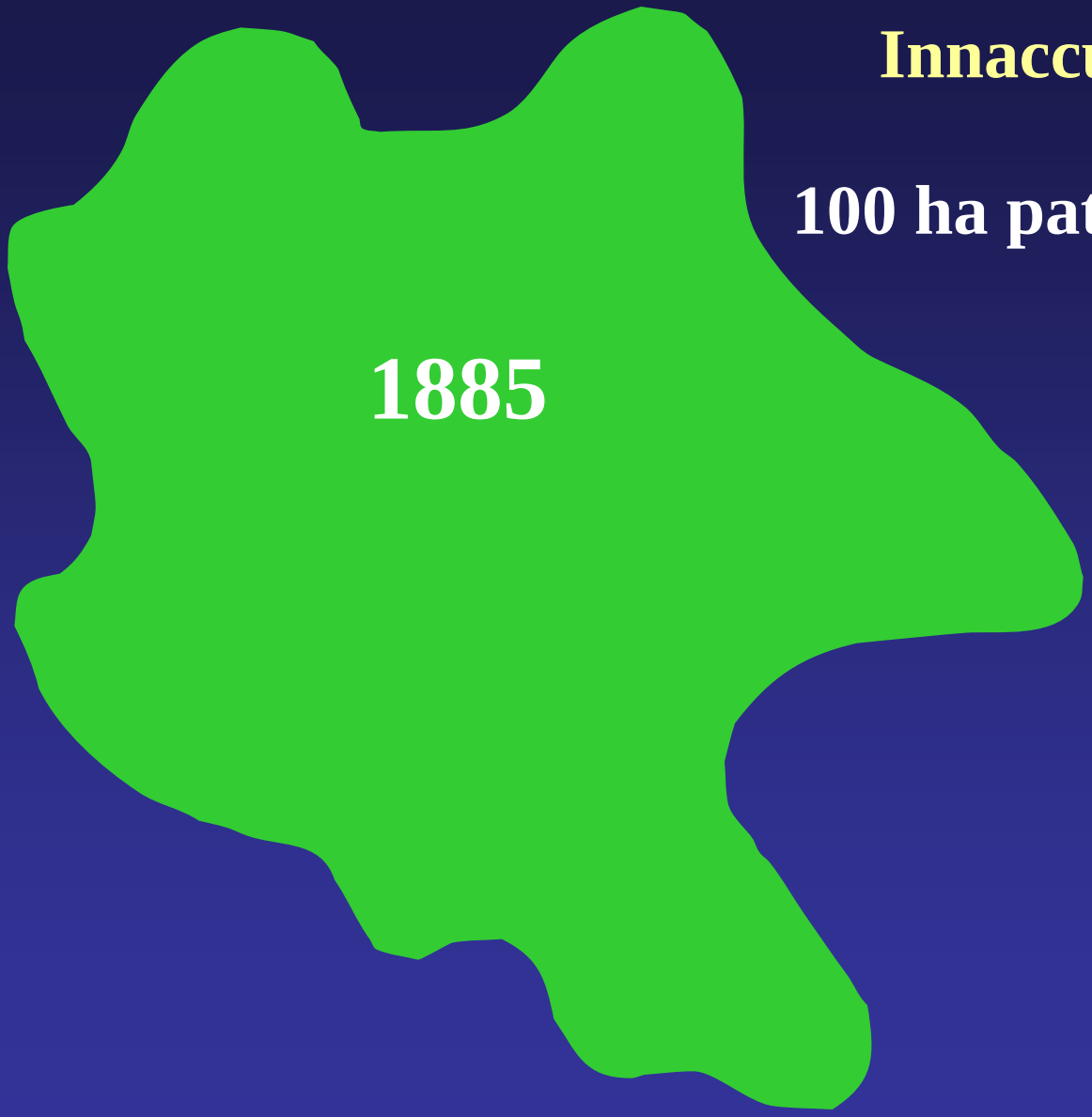
  - Width of the "Older than" class.
  - What a "patch" is.

With Coarse, Innaccurate Maps:

100 ha patch 1880-1899



With More Accurate, High Resolution Maps:

80 ha patch 1880-1889

10 ha patch 1870-1879

10 ha patch 1890-1899

How Do We *Want* to Define a Patch?

Tradeoff between effort and accuracy.

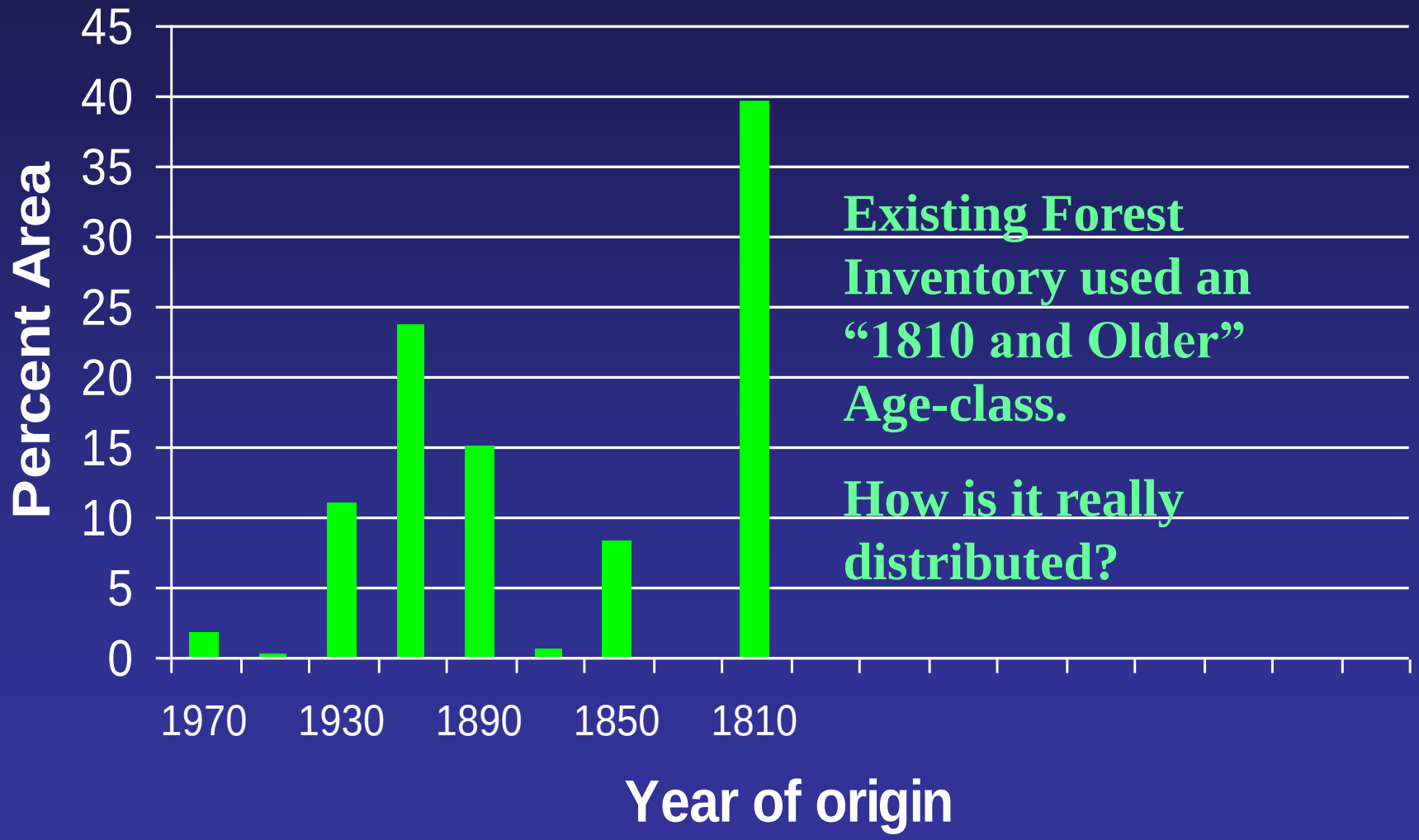
Do we need to know the exact year of origin of every patch of every age?

Probably not.

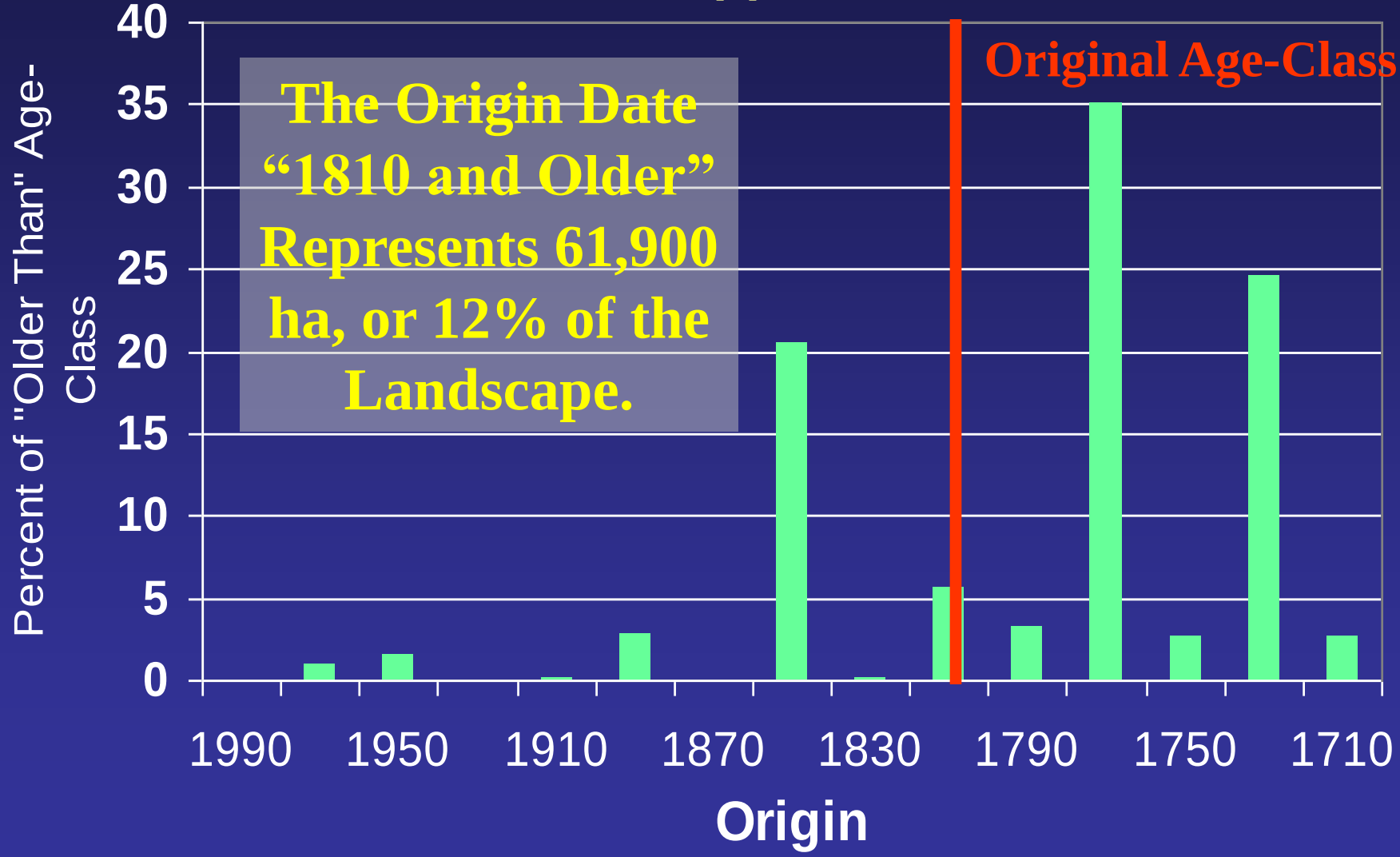
A 10-20 year class allows for several years worth of disturbance activity. Ecologically, they are *probably* similar 10-20 years later. Much easier to define and map.

PATCH = The contiguous, gross area of same-aged (within 20 years) forest. (includes islands & non-forested areas).

Subalpine (east) Age-Class Distribution From Forest Inventory

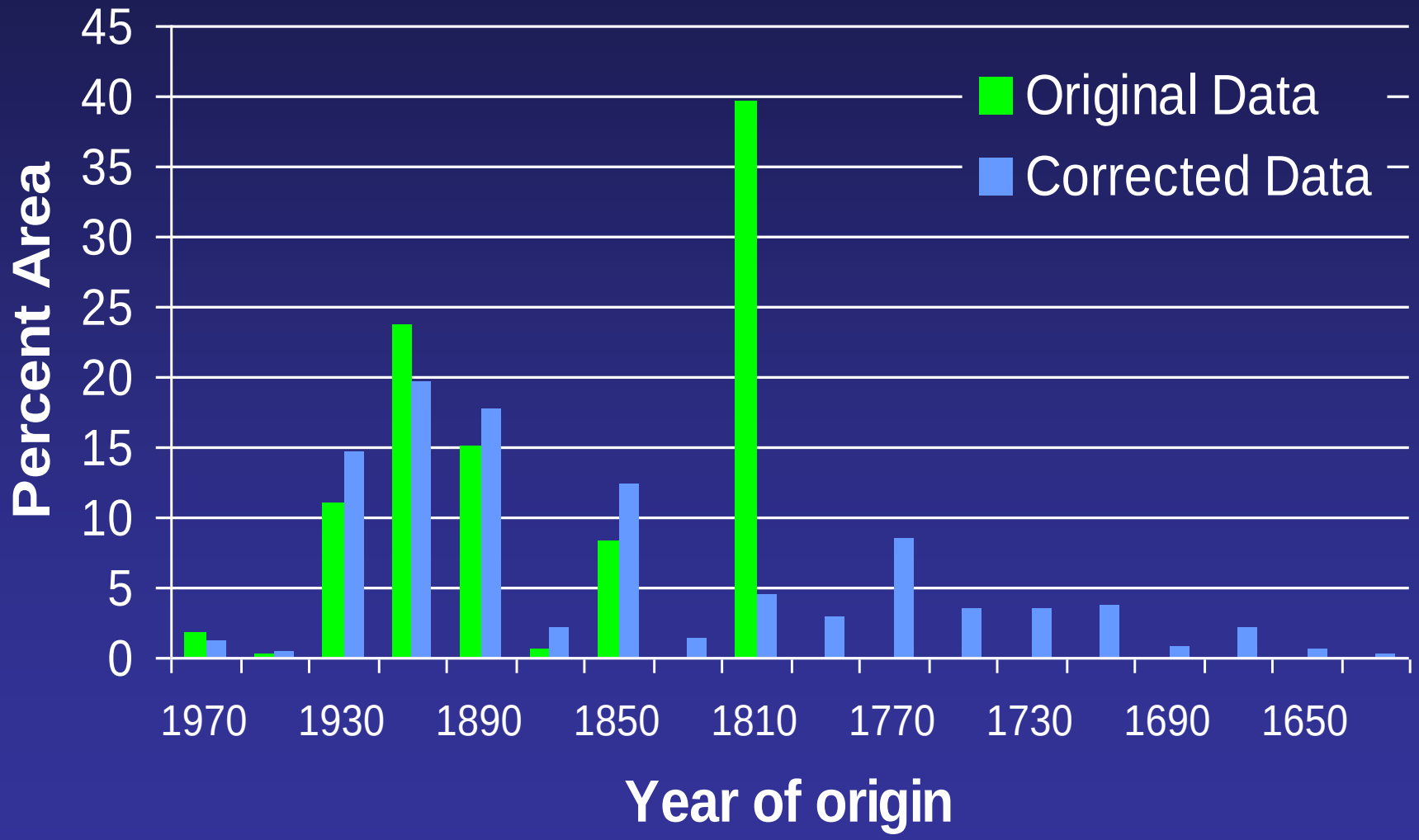


Actual Distribution of the "Older Than" Age-Class for the Upper Foothills



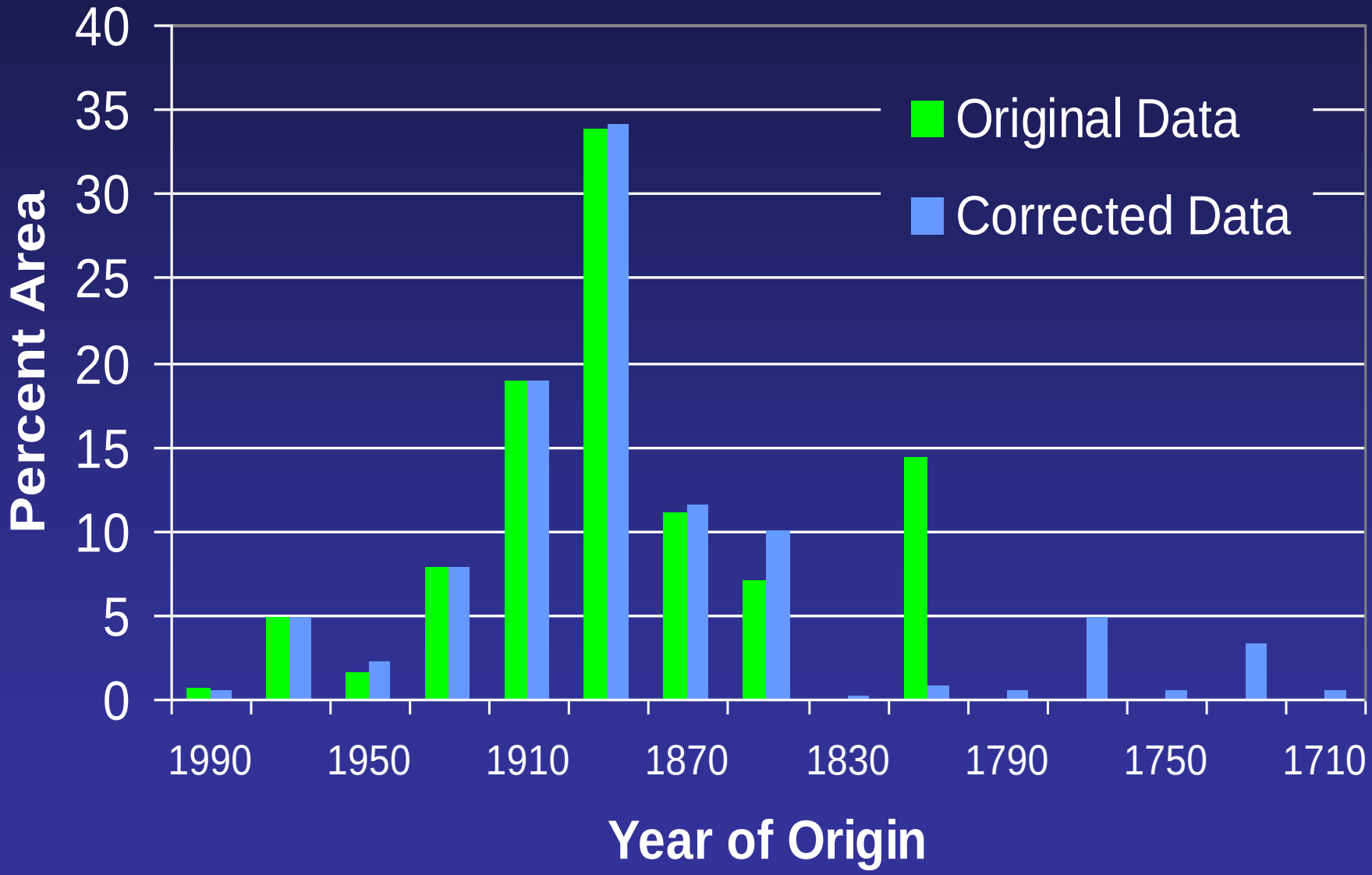
Subalpine (east) Age-Class Distribution

With and Without Age Corrections



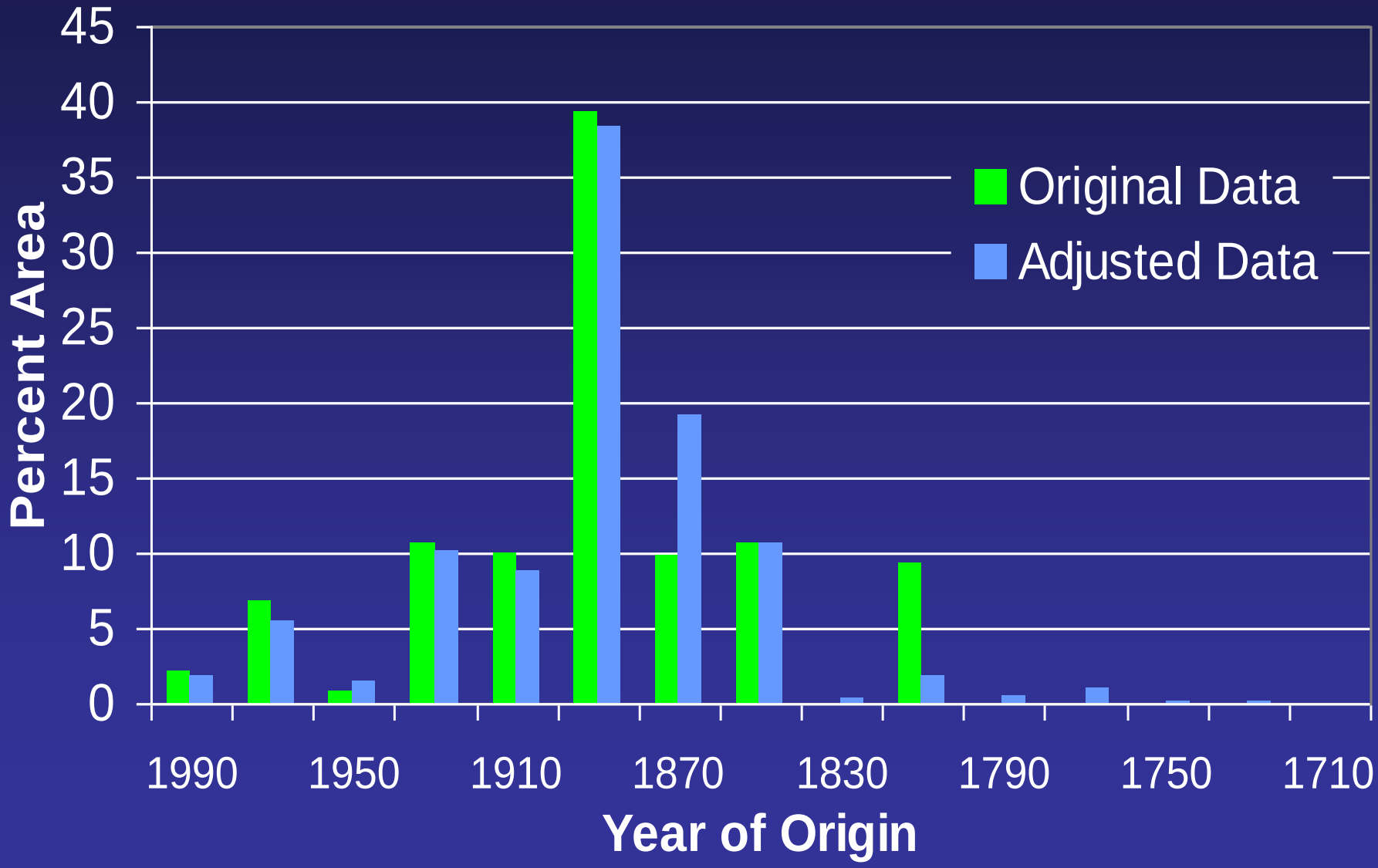
Upper Foothills Age-Class Distribution

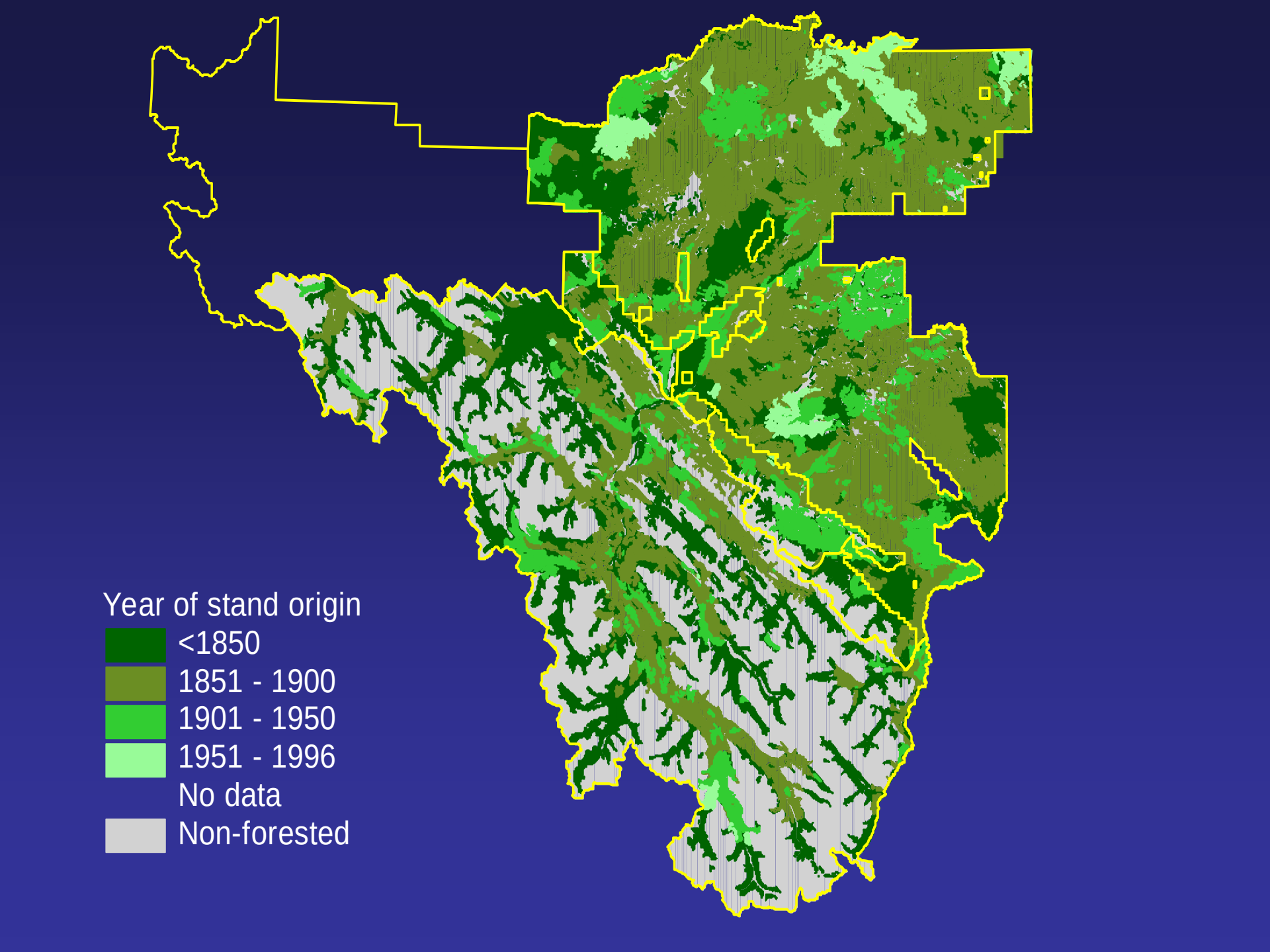
With and Without Age Corrections



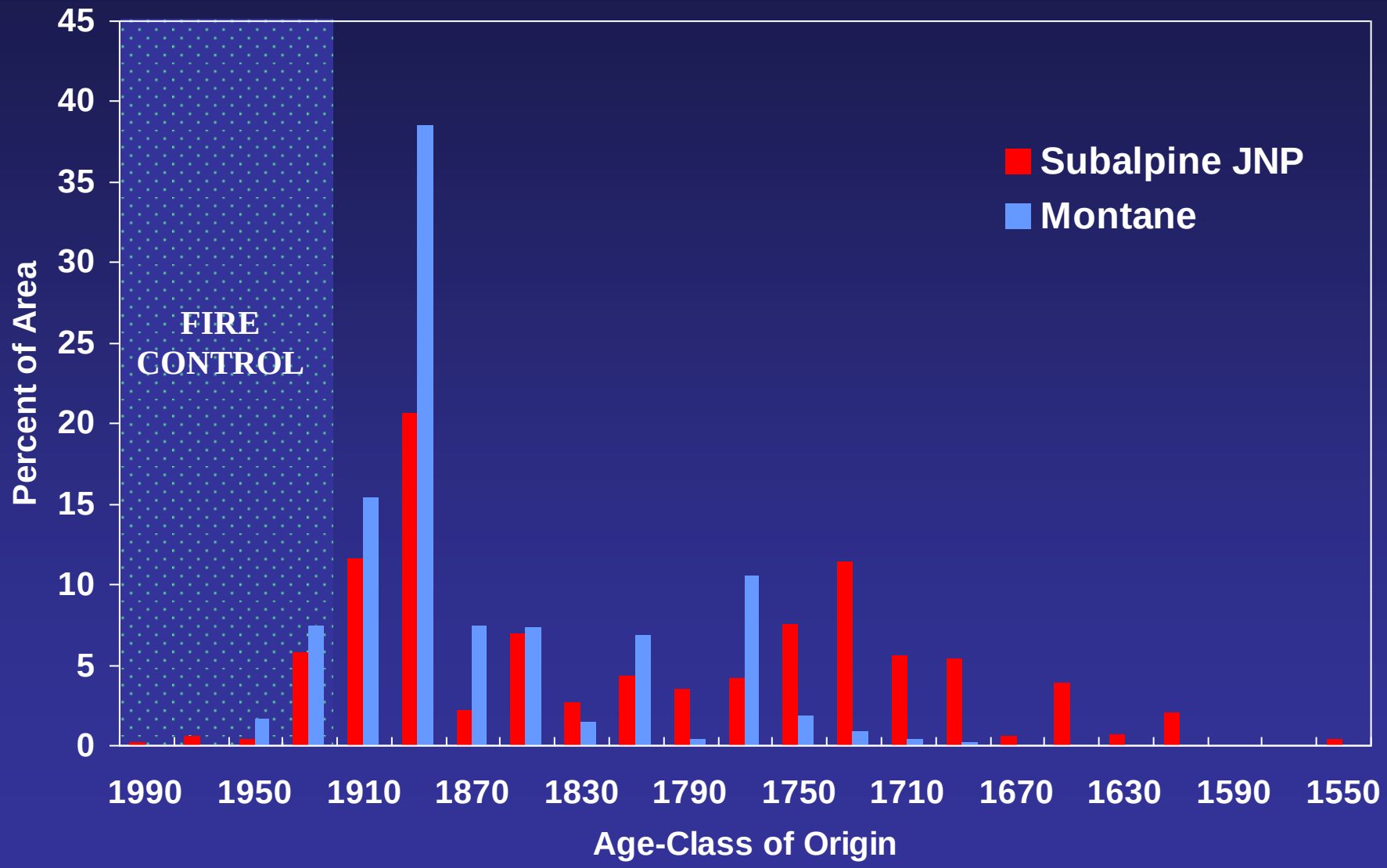
Lower Foothills Age-Class Distribution

With and Without Age Corrections

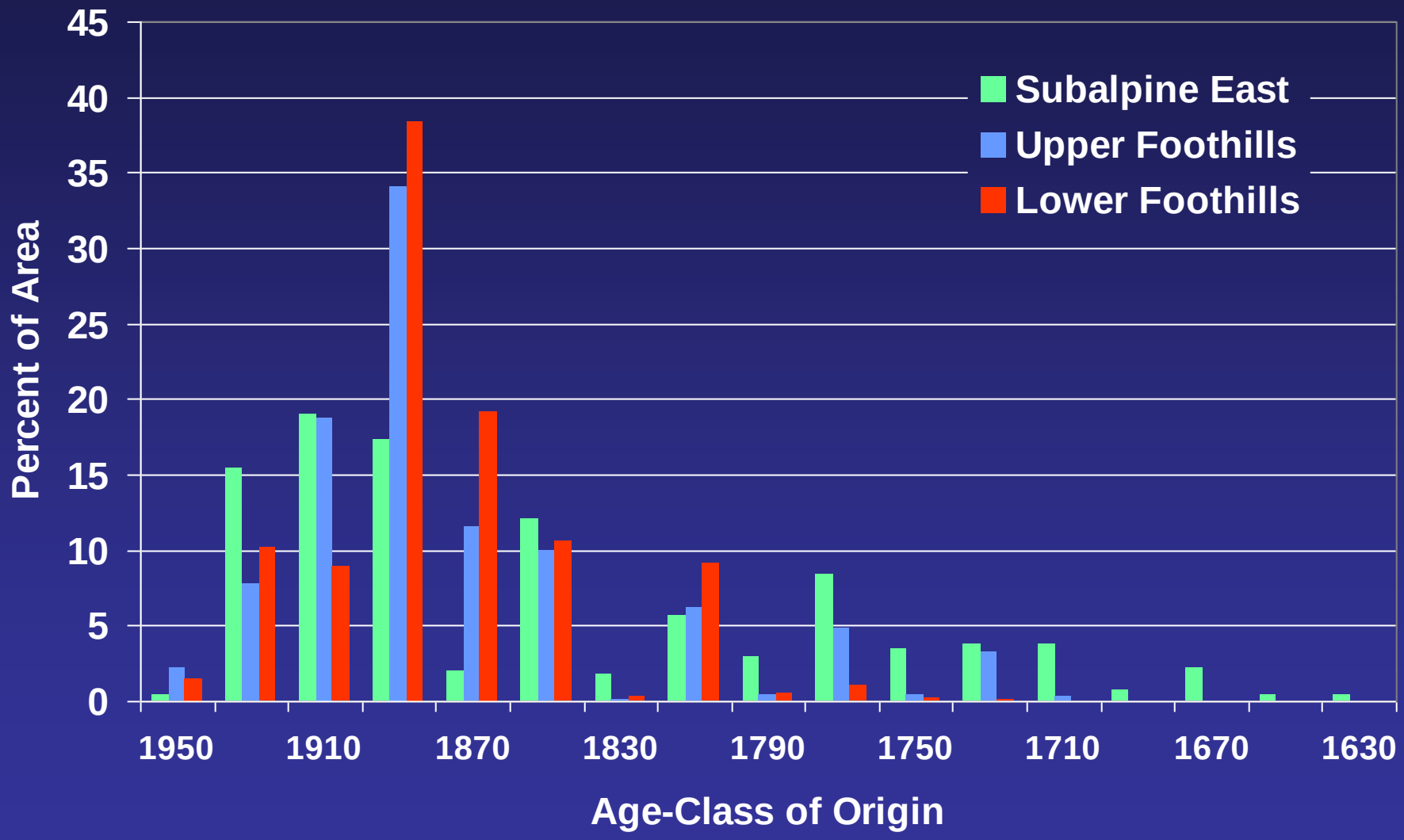



Year of stand origin
<1850
1851 - 1900
1901 - 1950
1951 - 1996
No data
Non-forested

JNP Age-Class Distirbutions



1950 Age-Class Distribution of the Foothills East



Average 1950 Fire Cycles on FMF Landscapes

Landscape	From 1950 A.C. Dist'n.
Lower Foothills	76 years
Upper Foothills	82 years
Subalpine east	110 years
* Subalpine JNP	150 years
* Montane	91 years

** includes ~20-30 years of fire control*

Older Forest as of 1950 on FMF Landscapes

Landscape	%>300 yrs	%>200 yrs	%>100 yrs
Lower Foothills	0	0	16
Upper Foothills	0	4	21
Subalpine east	2	15	45
* Subalpine JNP	7	37	59
* Montane	0	3	30

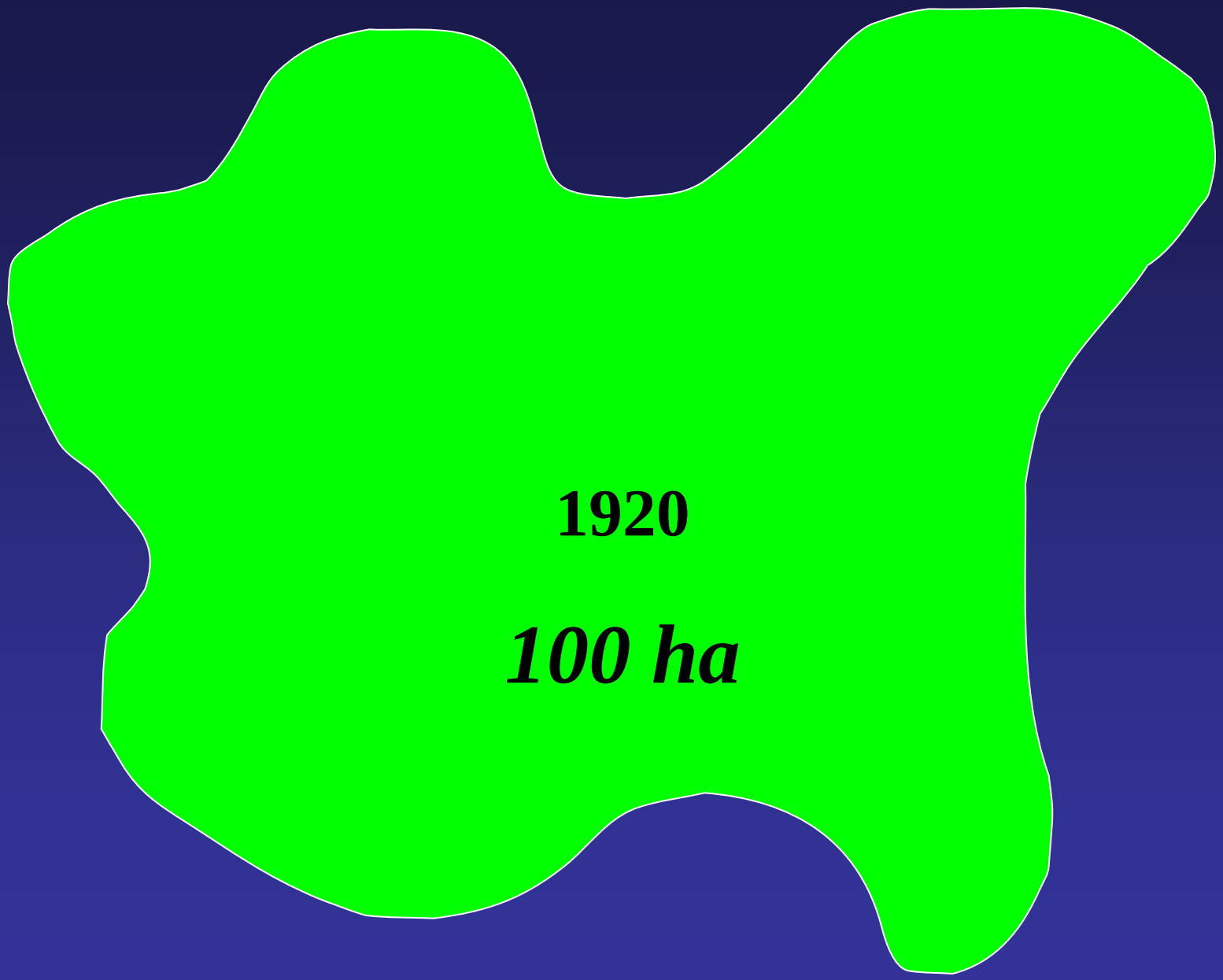
** includes 20-30 years of fire control*

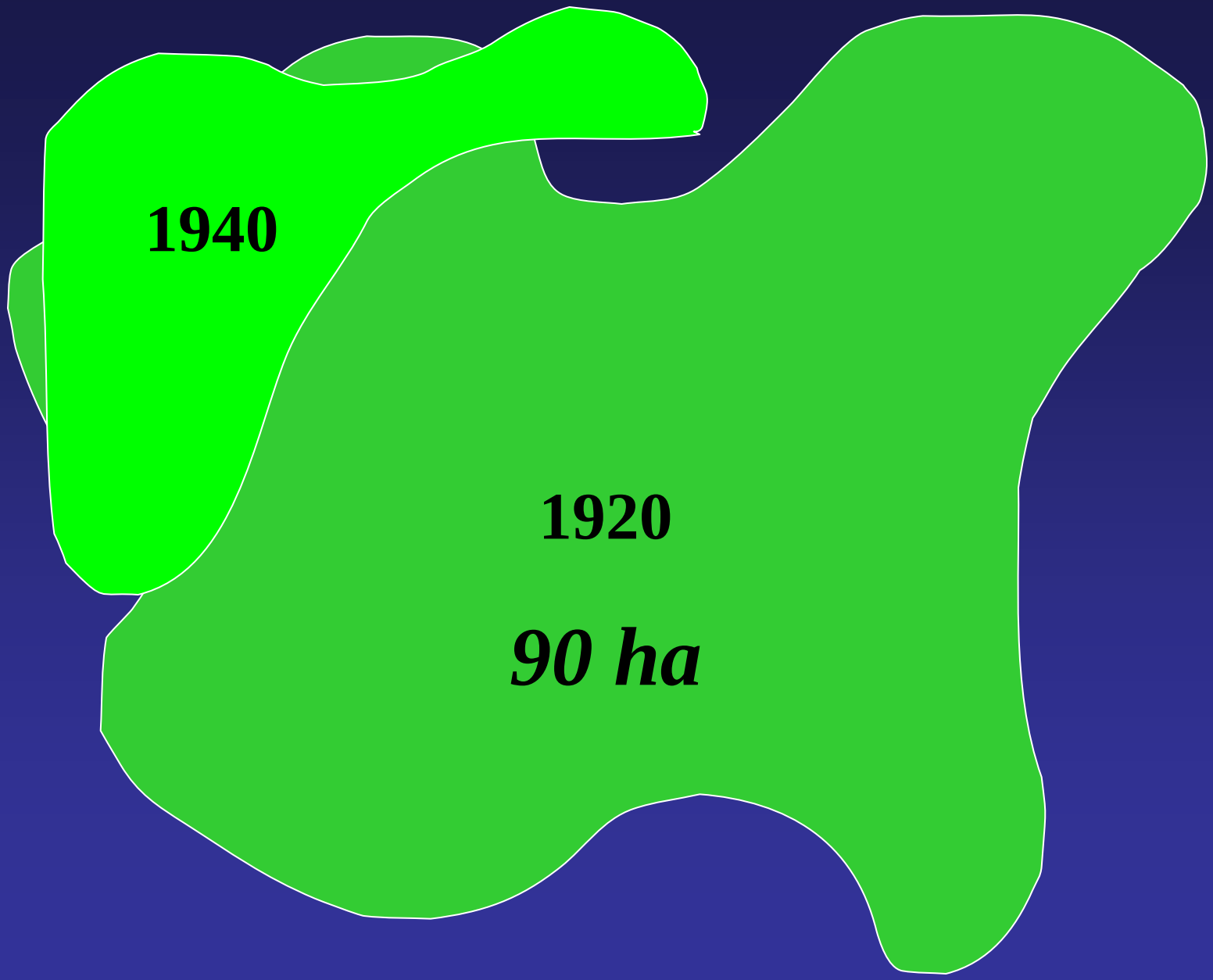
So far….

- **High degree of confidence that most stands are even-aged, and therefore well represented by age-classes.**
- **Distinctive rates of disturbance for each natural subregion = *landscapes.***
- **Distinctive levels of young, mid-seral, and old growth forest in each natural subregion.**

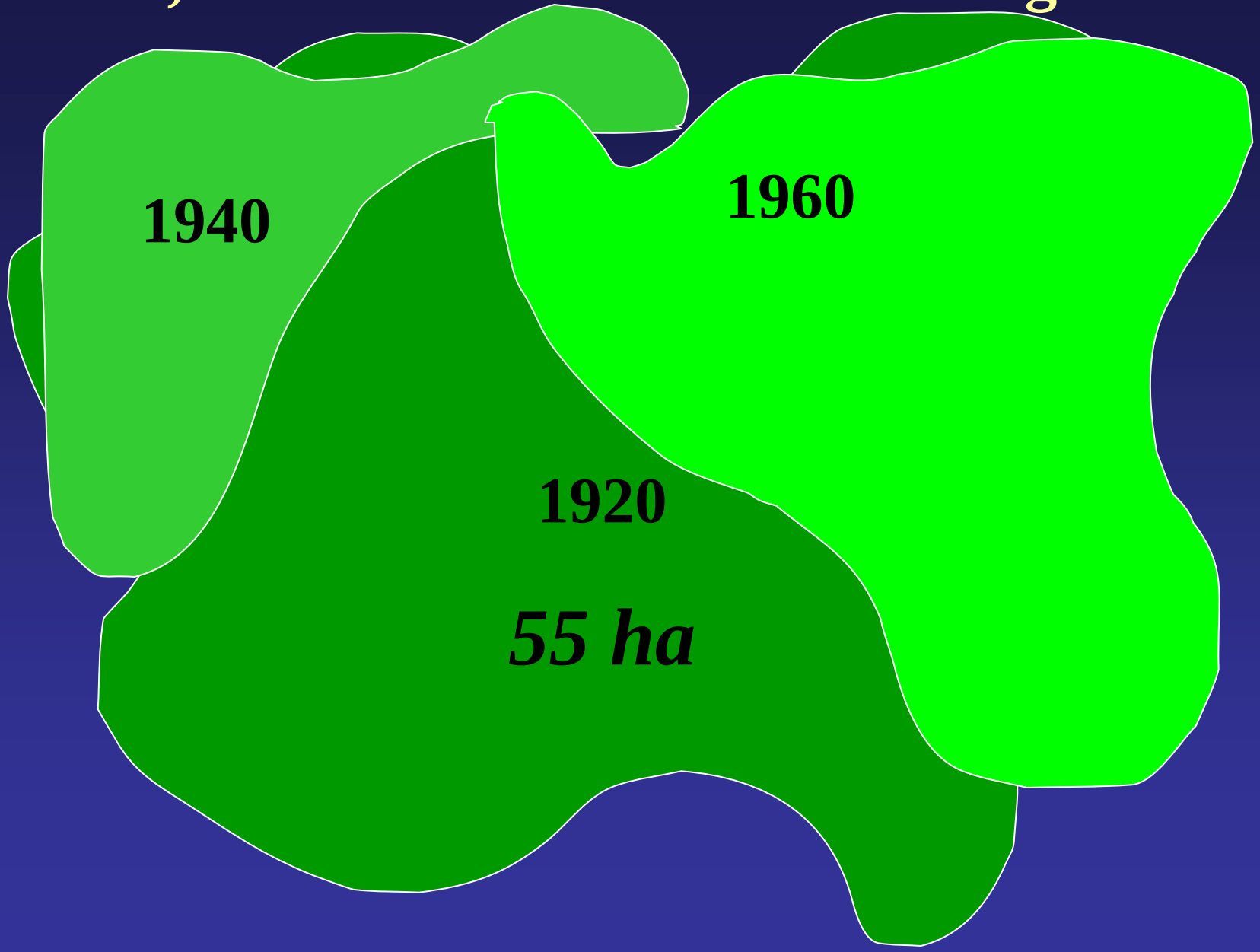
HOWEVER, despite high data quality, the description of age-class "pattern" has been limited by the sample size (1).

Increasing the Sample Size - How?

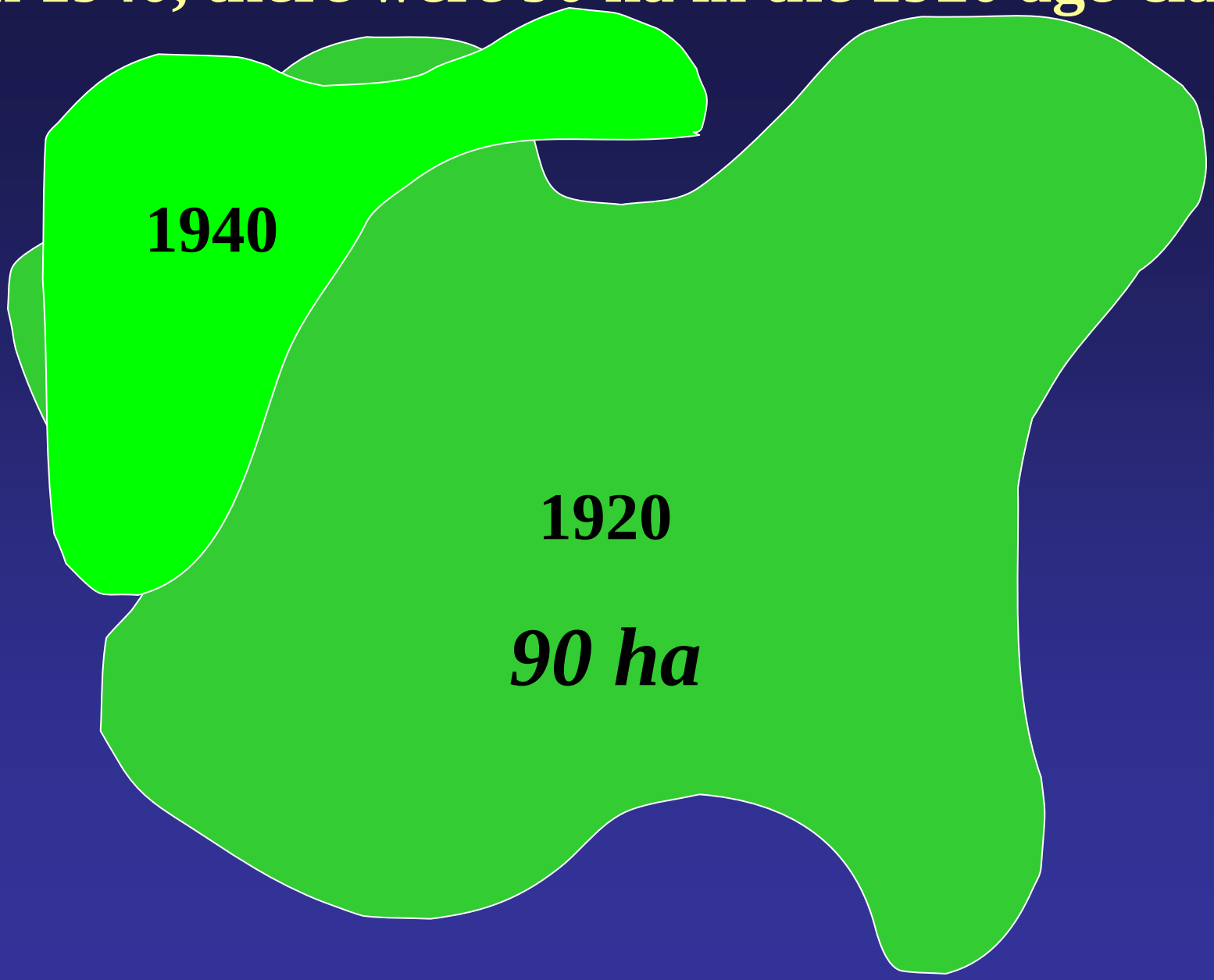



1940
1920
90 ha

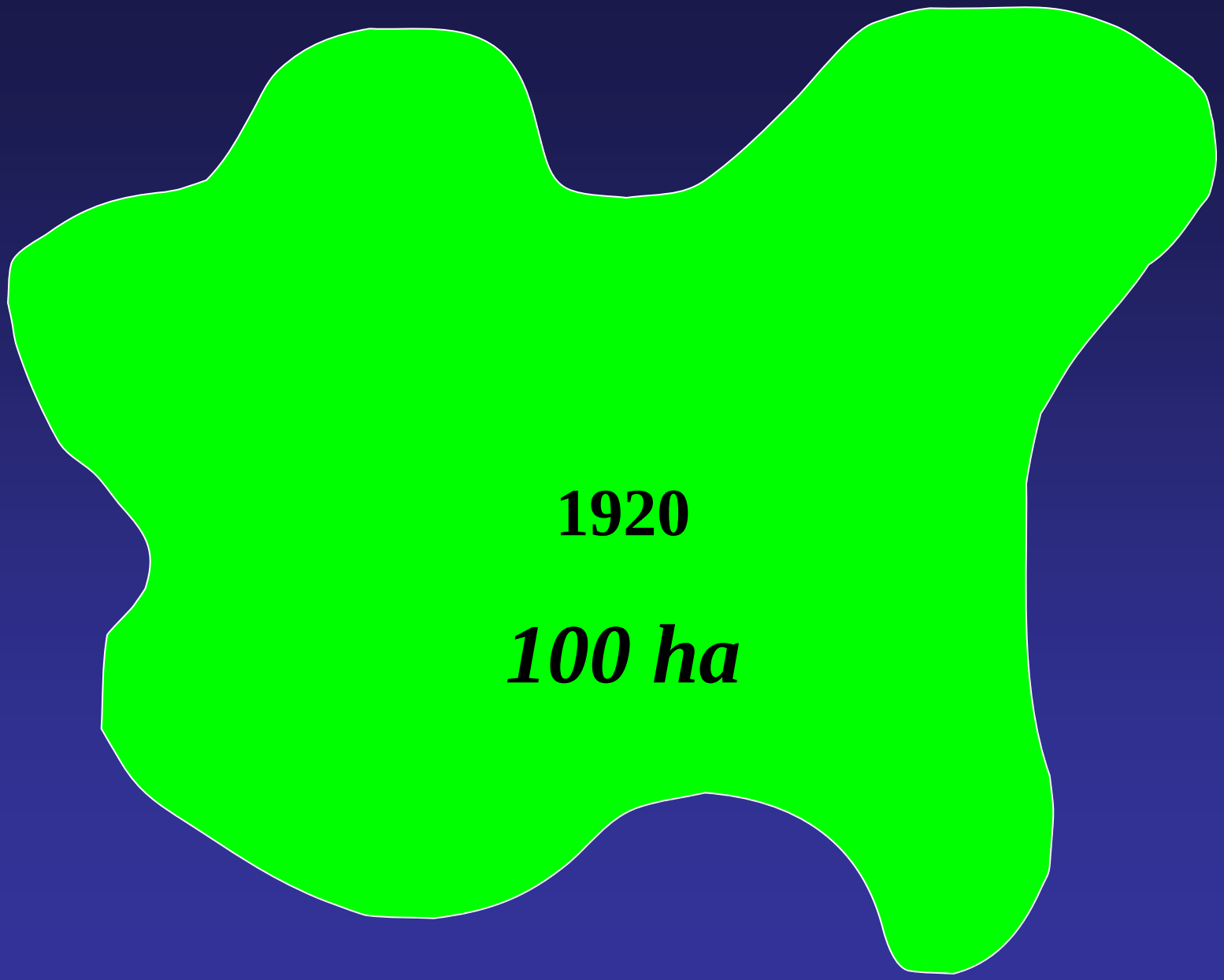
In 1960, there were 55 ha in the 1920 age-class



In 1940, there were 90 ha in the 1920 age-class



Original Area Disturbed in 1920 is 100 ha



Rollback Demonstration

assume proportional to area:

	Areas in 1950		Projected Areas in 1940
1950 area =	100 ha		
1930 area =	200 ha +	20% x 100 =	220 ha
1910 area =	200 ha +	20% x 100 =	220 ha
1890 area =	600 ha +	60% x 100 =	660 ha

Upper Foothills "Rollback"

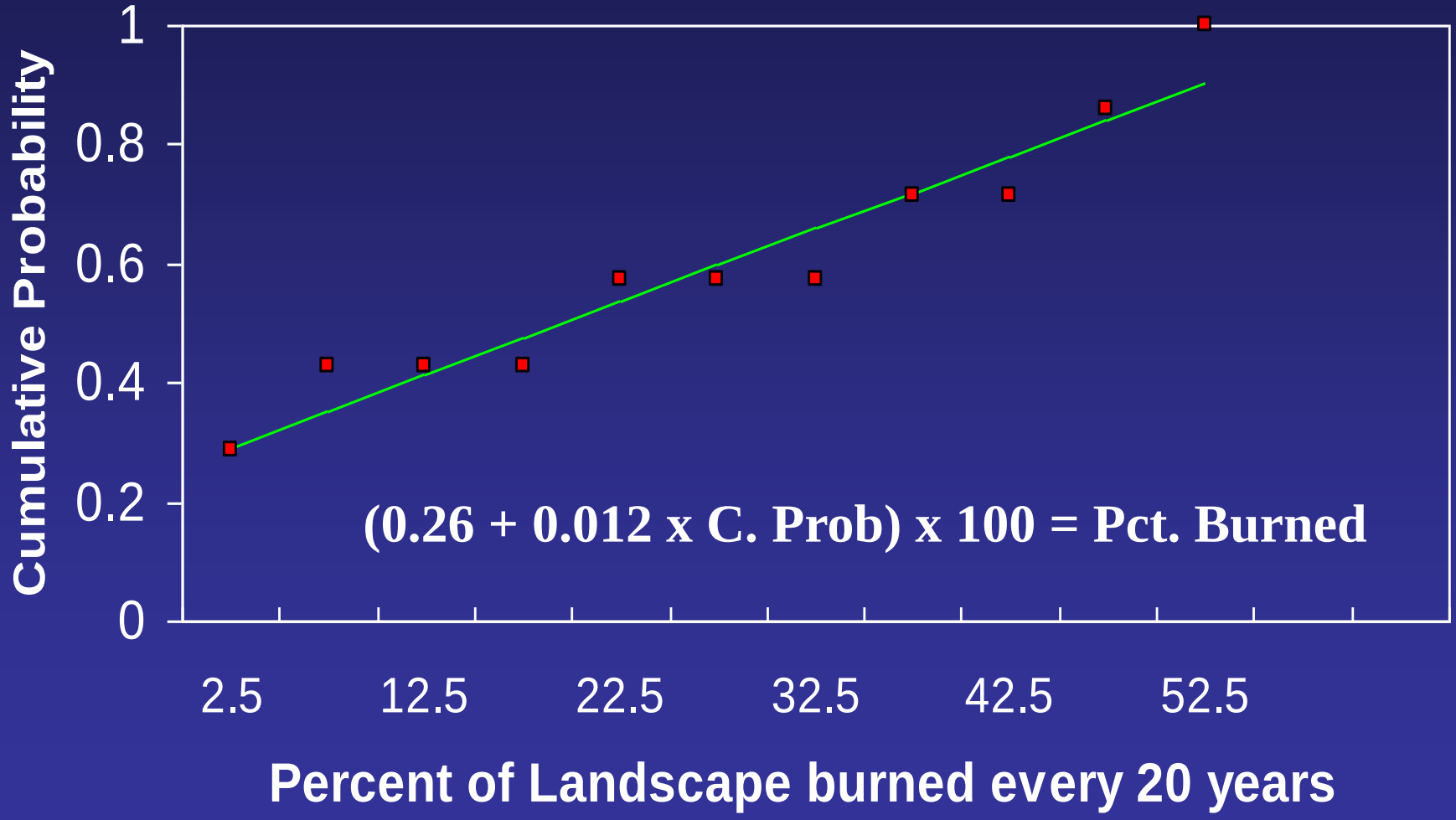
Period	% Area in 1950	Est. Area Disturbed
1930-1949	2	2
1910-1929	8	8
1890-1919	19	22
1870-1889	34	51
1850-1869	12	36
1830-1849	10	47
1810-1819	<1	6
Average		24

24% every 20 years = 1.2% per year = 83 year fire cycle, versus 82 years from previous estimate.

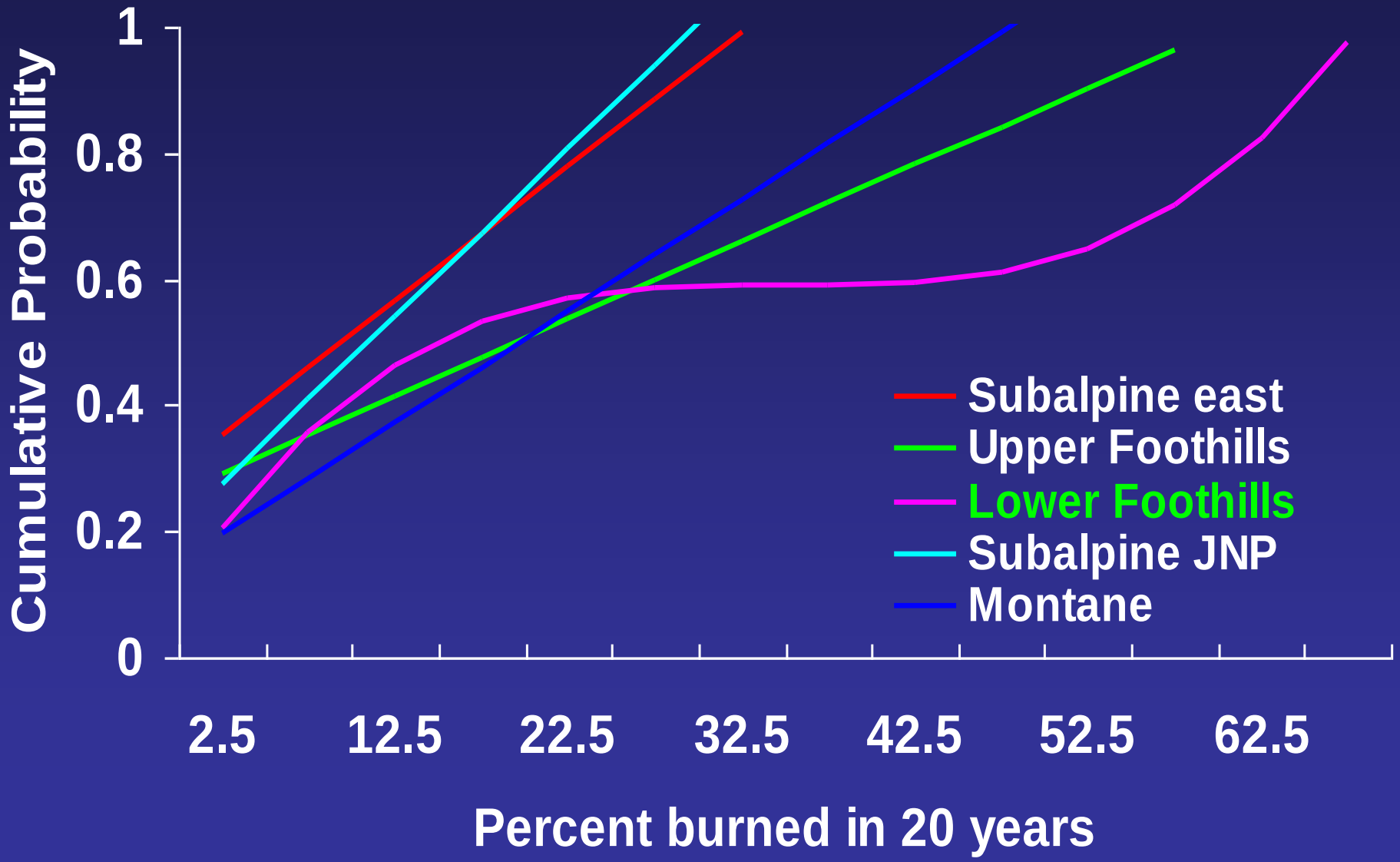
Rollback Estimates of Areas Disturbed on FMF Landscapes

Period	Lower	Upper	Sub east	Sub JNP	Montane
1930-1949	2	2	1	-	-
1910-1929	11	8	15	6	8
1890-1919	11	22	23	12	17
1870-1889	53	51	27	25	50
1850-1869	55	36	4	4	20
1830-1849	67	47	27	12	24
1810-1829	6	1	4	5	6

Area Disturbed per 20 Year Period for the Upper Foothills Landscape



Cumulative Probabilities of Rate of Burn for the Foothills Model Forest



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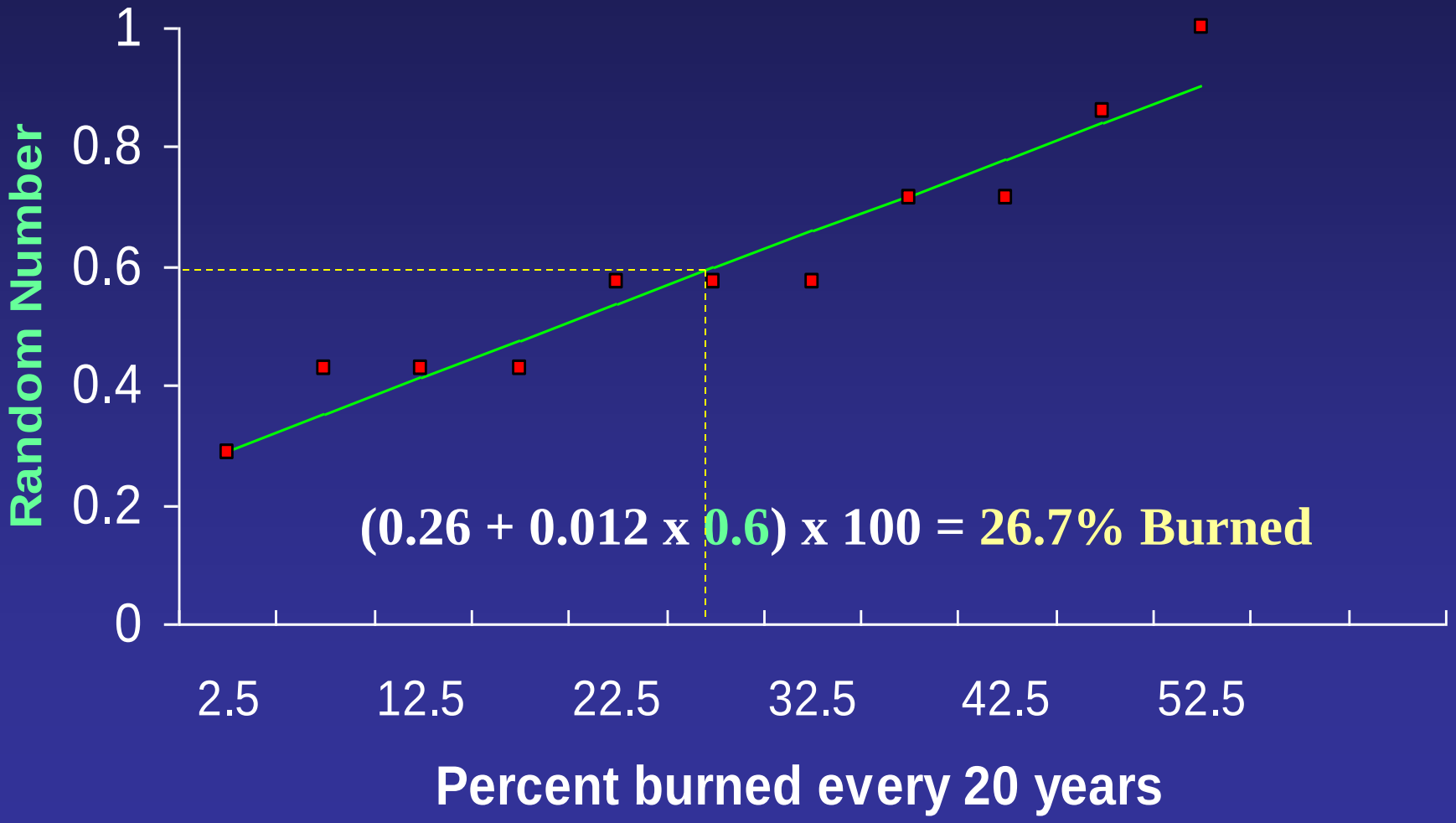
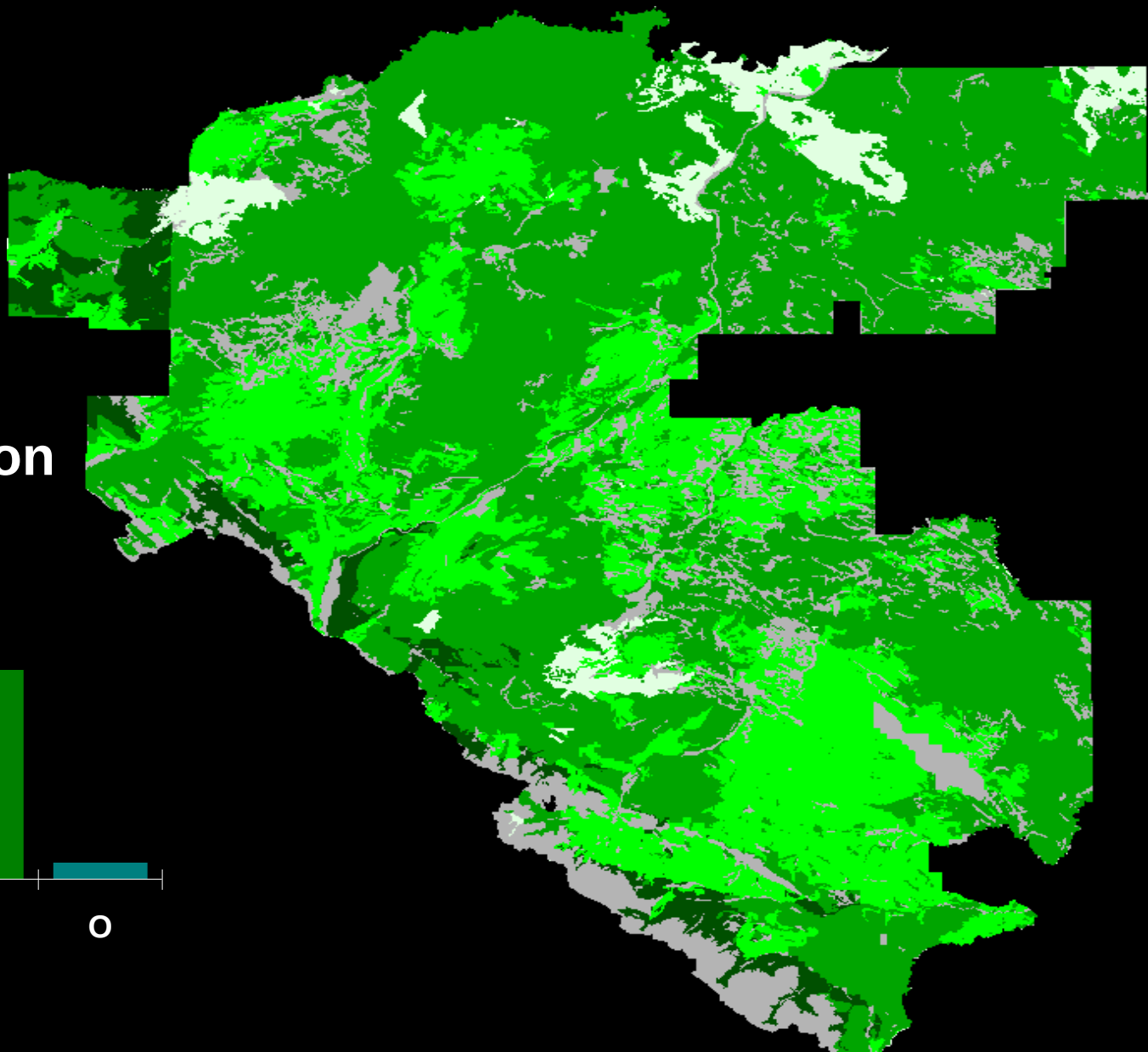


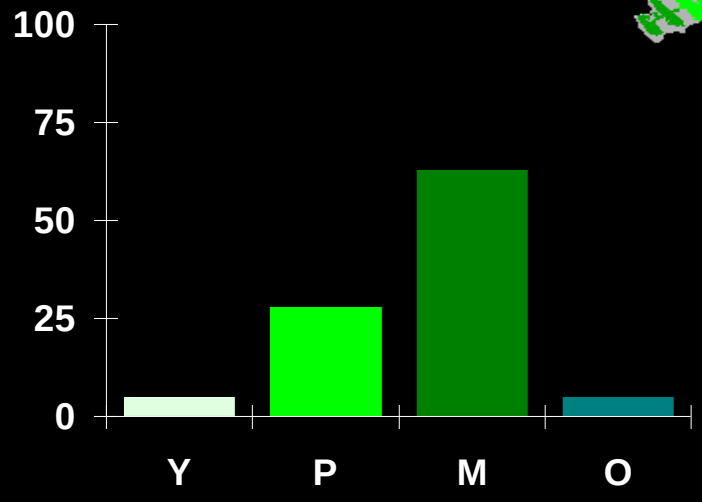
Project the Range of Disturbance Rates Over Time, Through Space

- **Equations derived from rollback estimates of 20 year disturbance rates.**
- **Spatially explicit disturbance model (LANDMINE)**
- **Disturbance size equations.**
- **Random number generator.**
- **Initial conditions.**

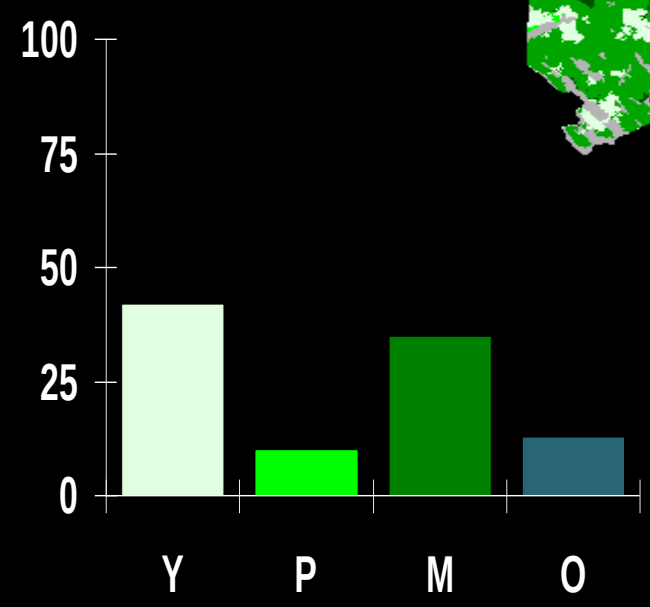
Landscape in 1950 - Initial Condition



AC Distribution



Landscape in 20 Years?



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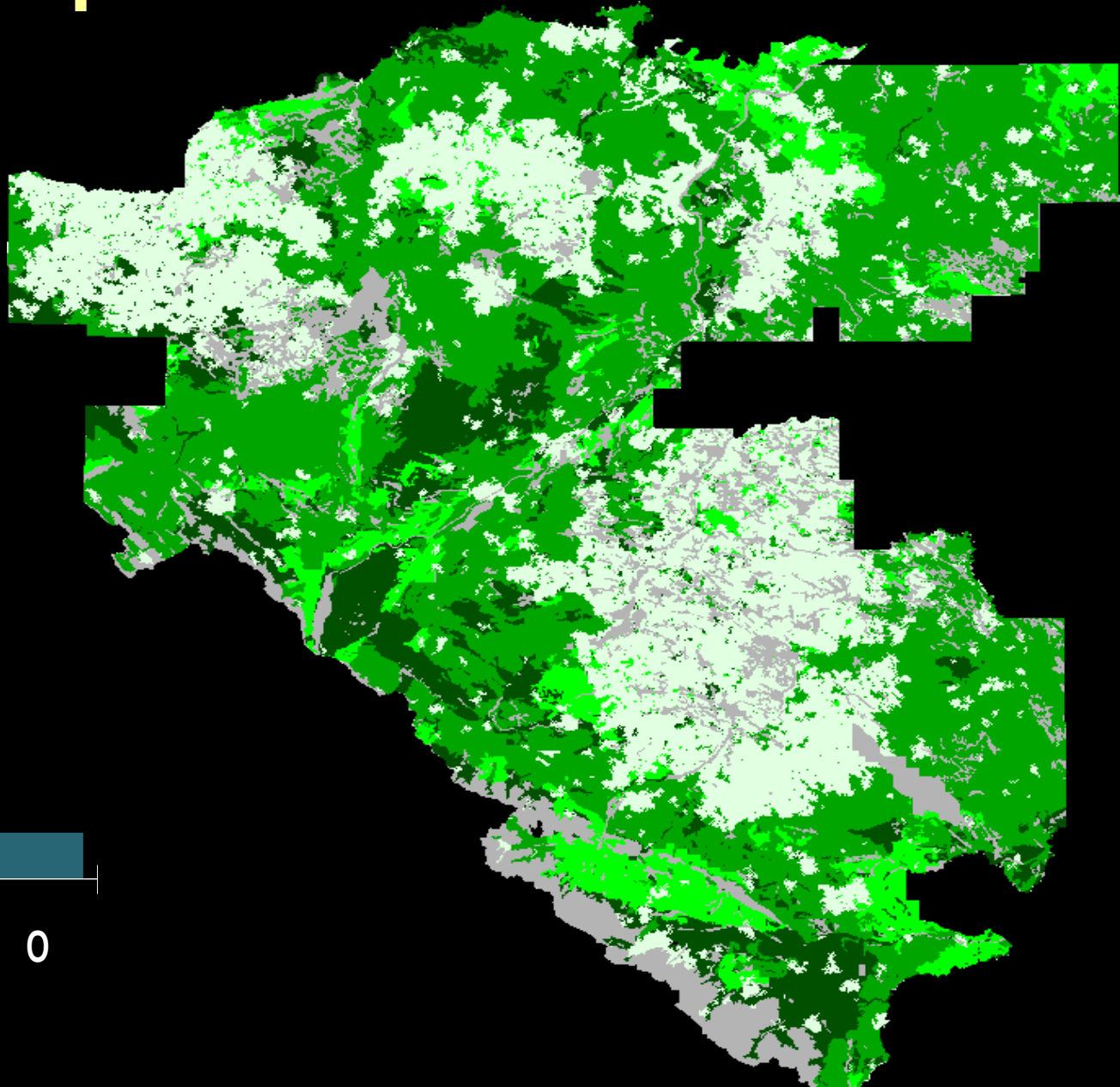

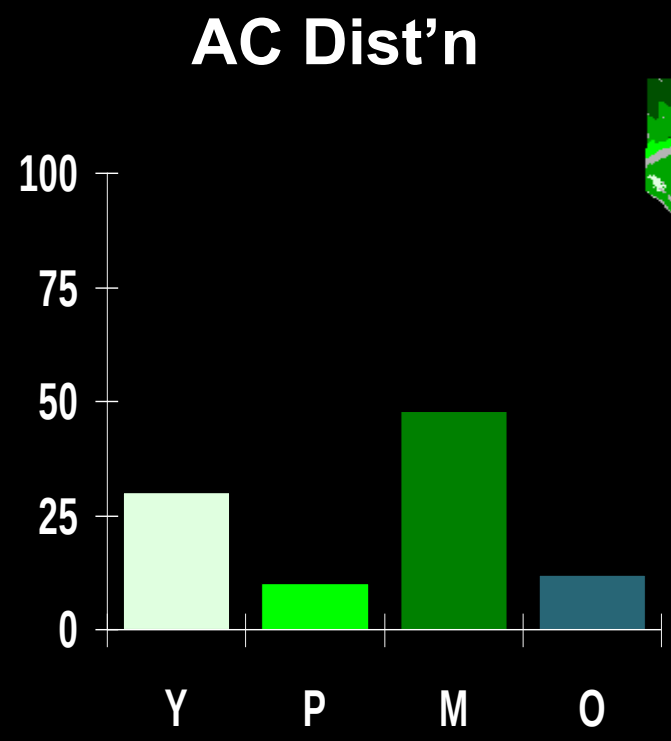

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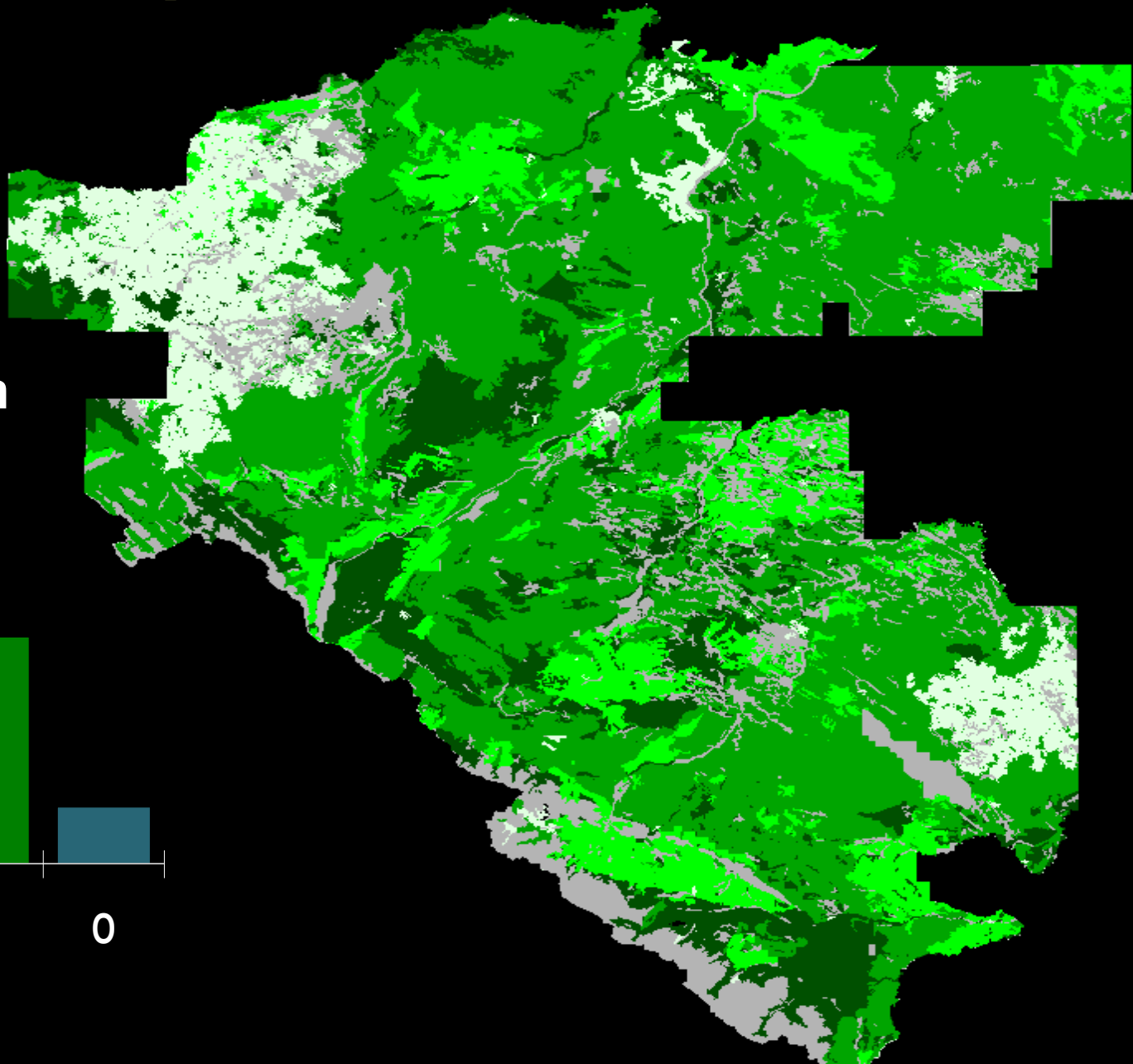
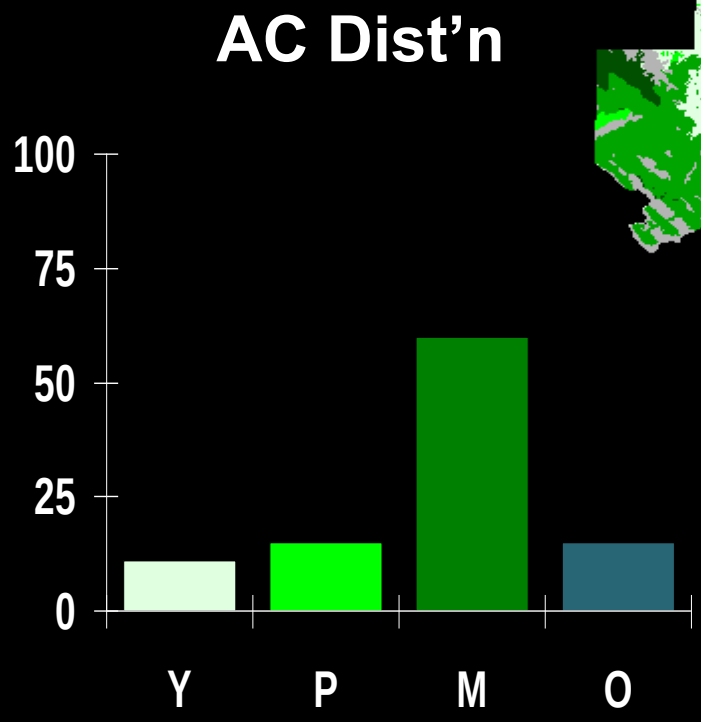
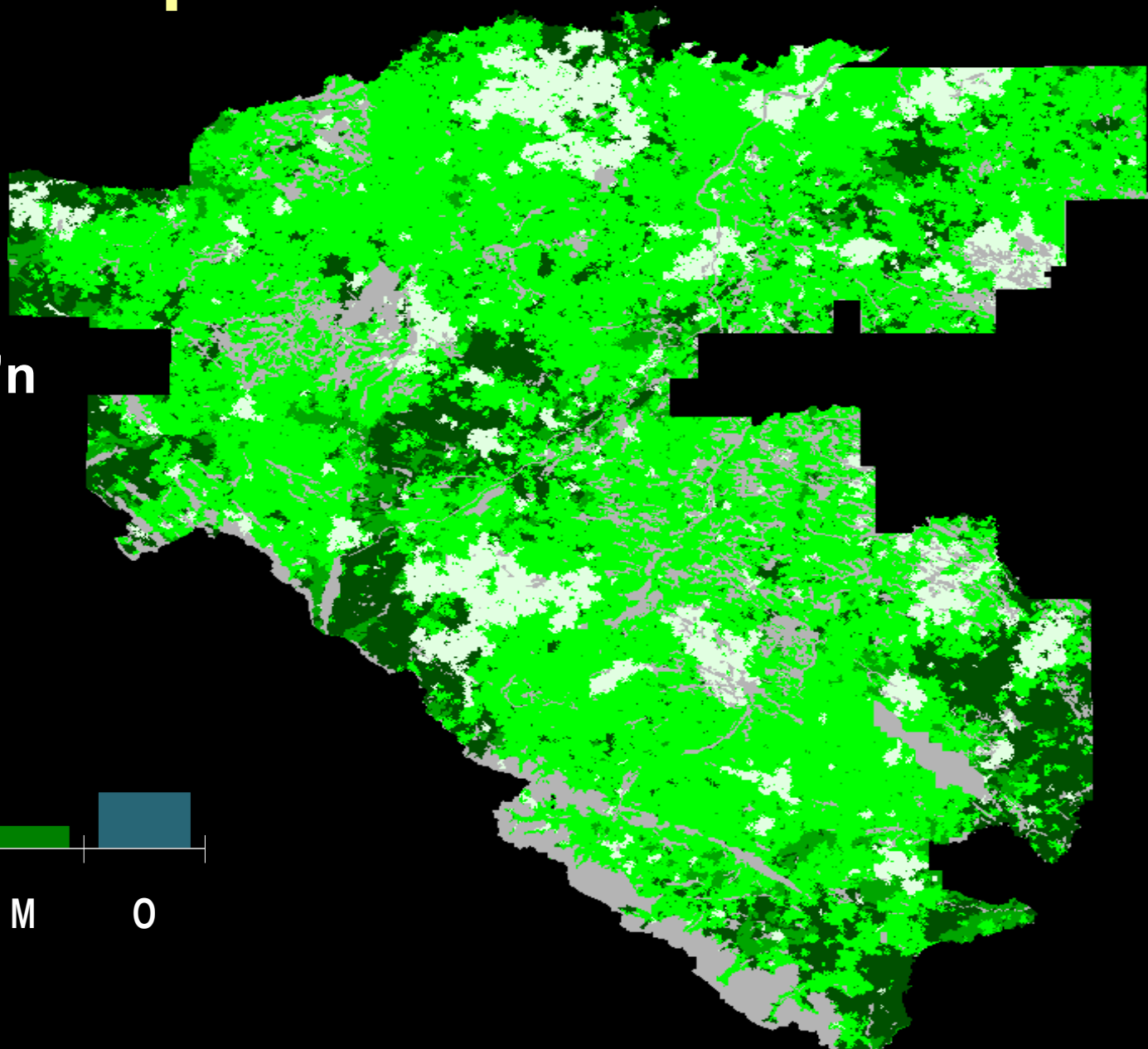
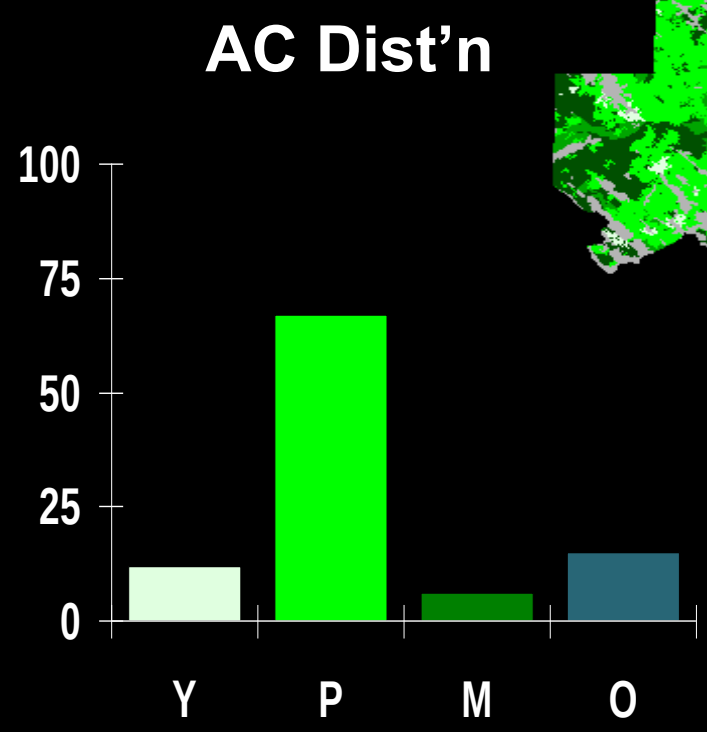


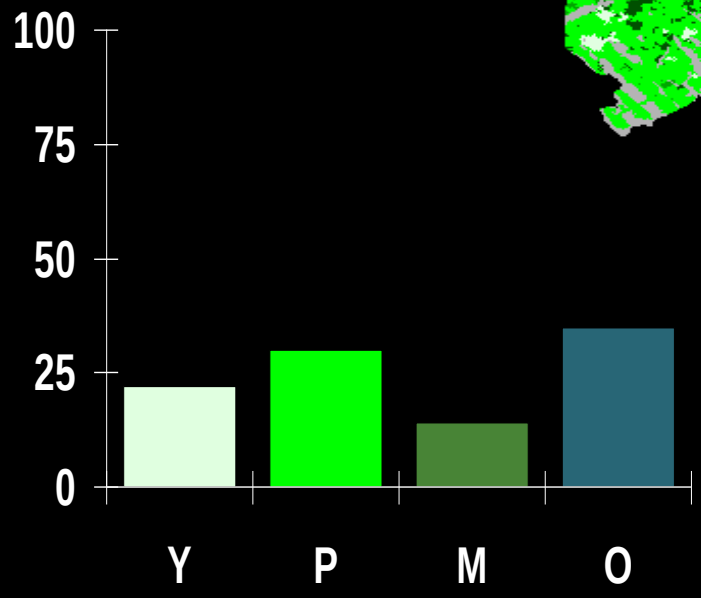


Landscape in 100 Years?



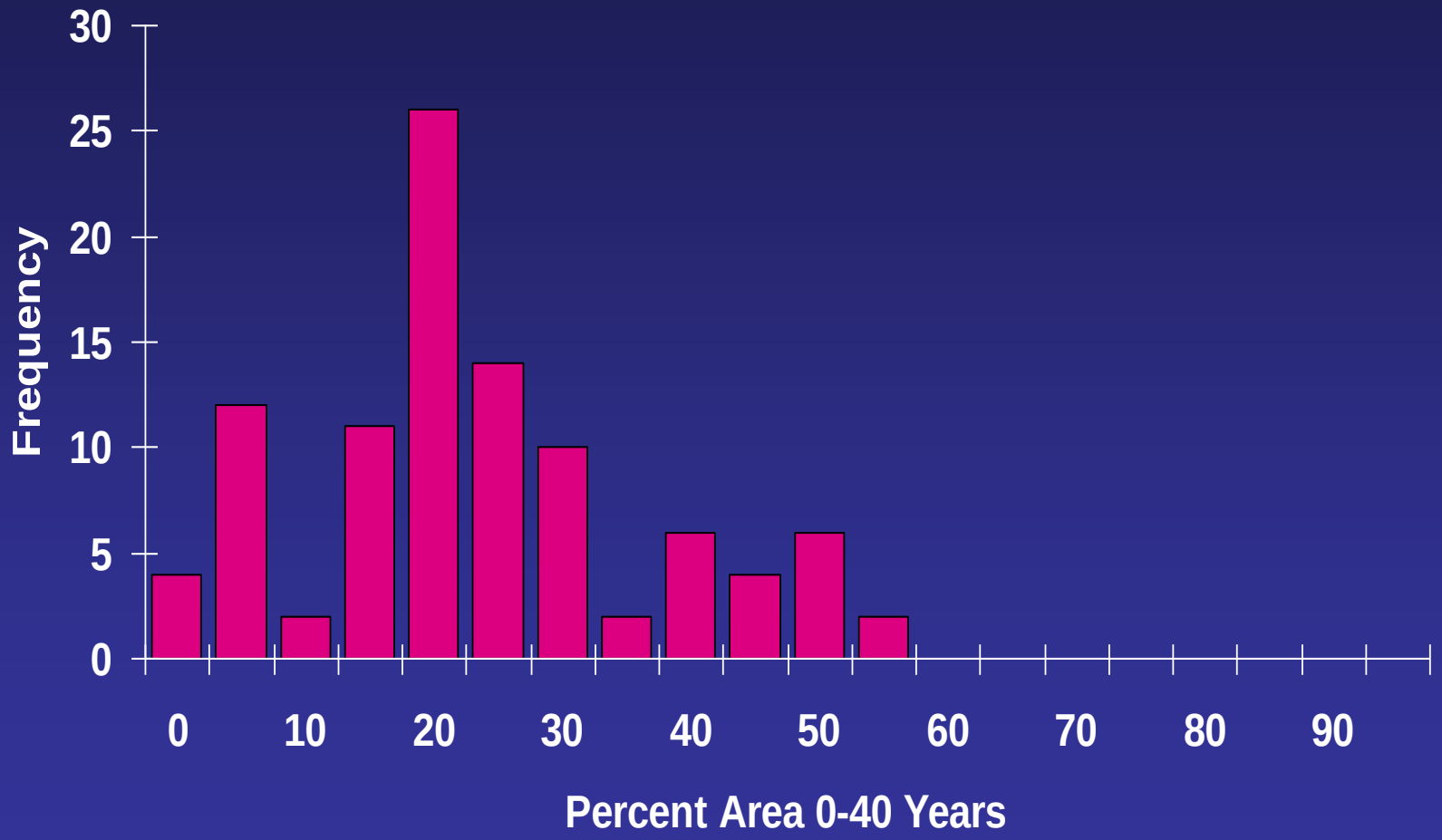


Landscape in 100 Years?



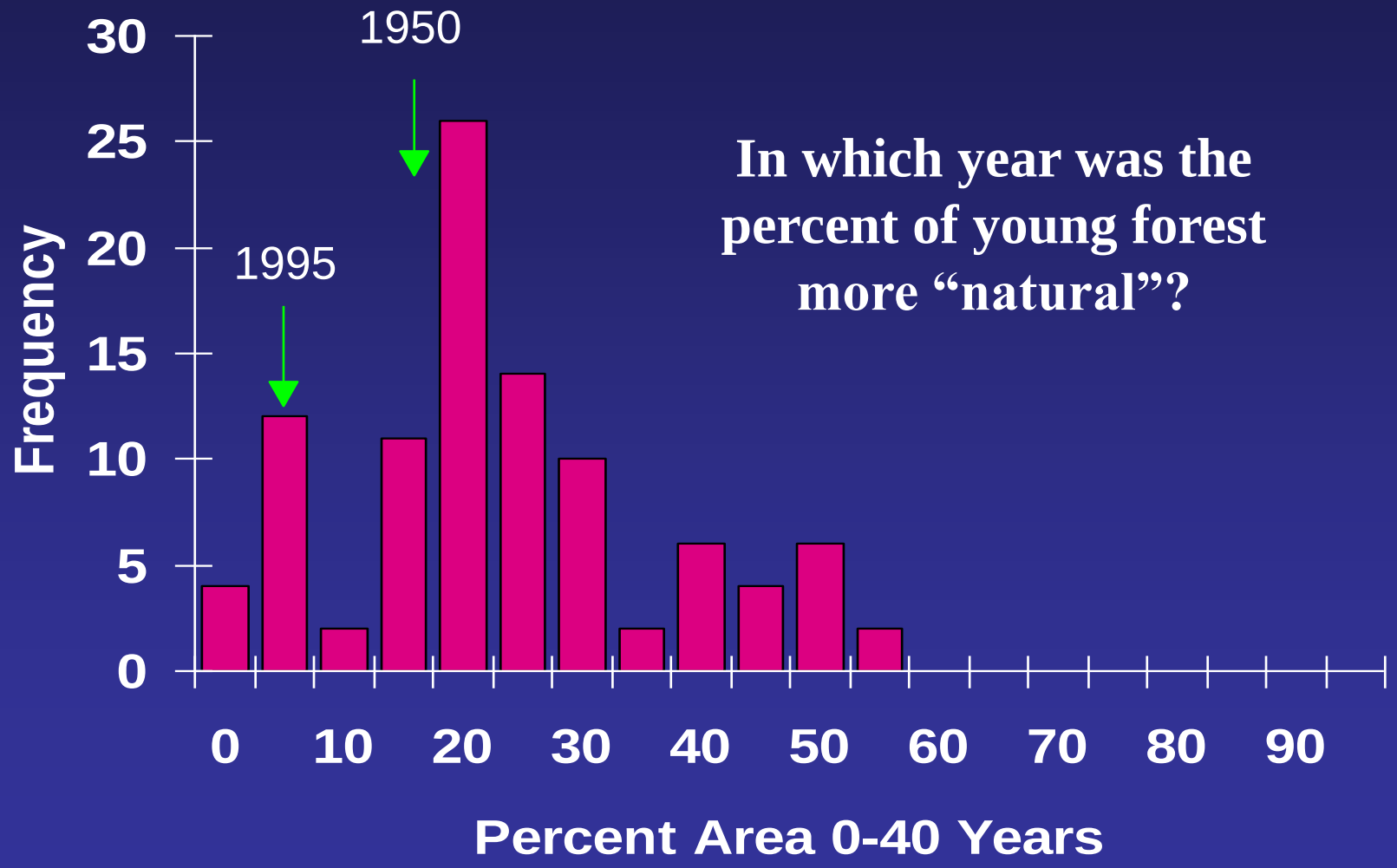
Projected Historical Range of Area

for the Young Seral-Stage of the Sub-alpine East



Projected Historical Range of Area

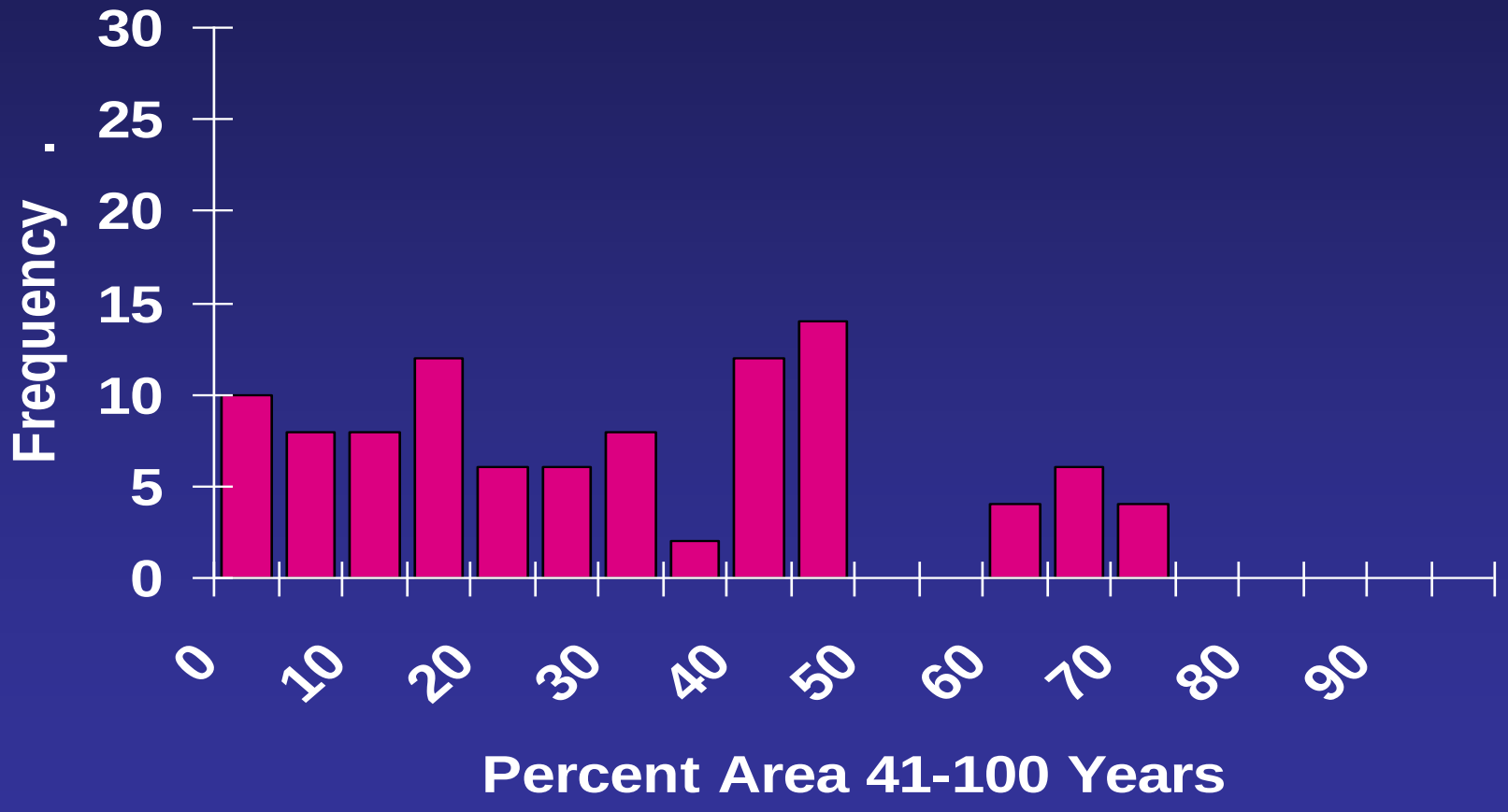
for the Young Seral-Stage of the Sub-alpine



In which year was the percent of young forest more "natural"?

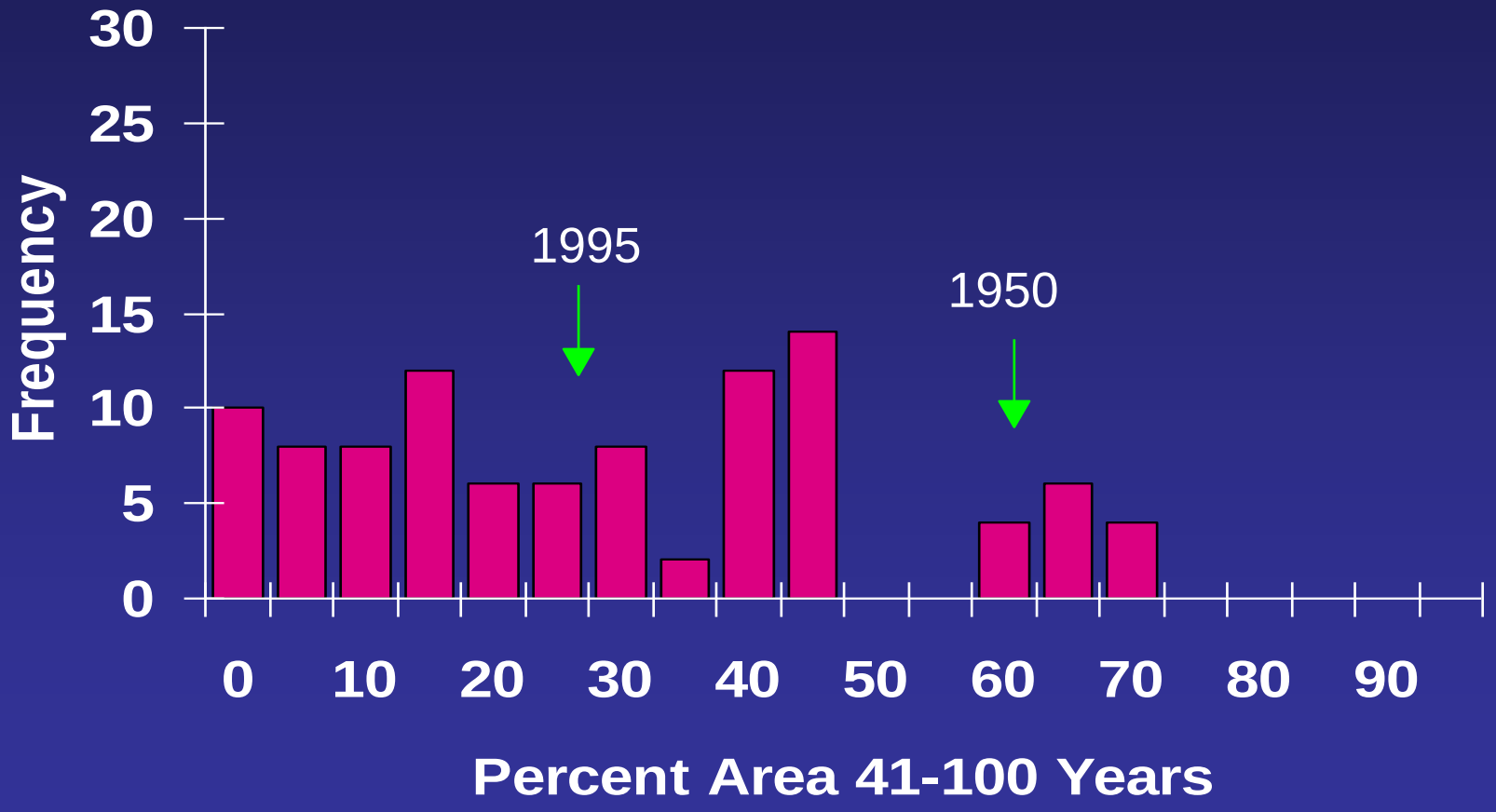
Projected Historical Range of Area

for the Pole Seral-Stage of the Upper Foothills



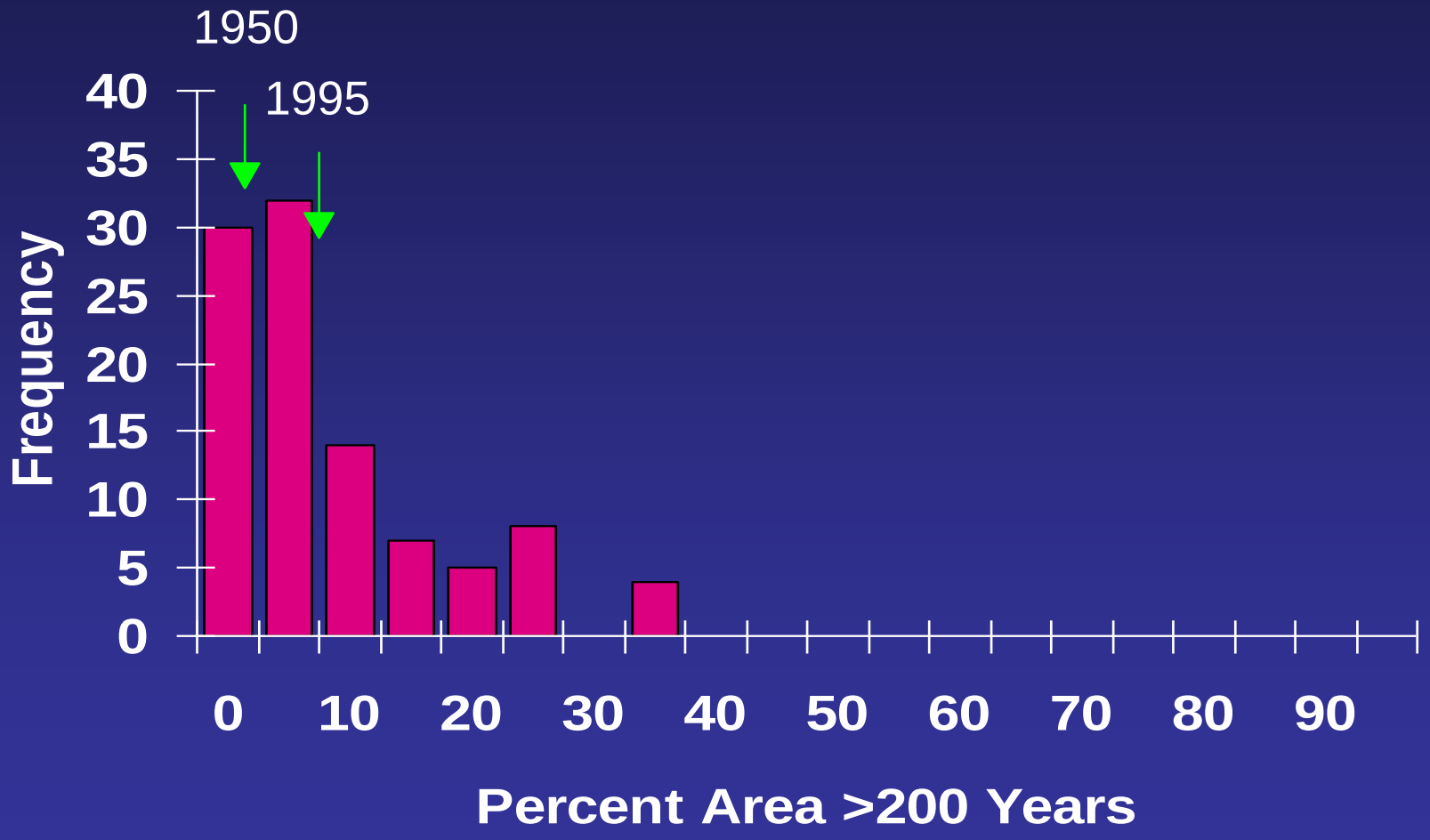
Projected Historical Range of Area

for the Pole Seral-Stage of the Upper Foothills



Projected Historical Range of Area

for the Mature Seral-Stage of the Upper Foothills



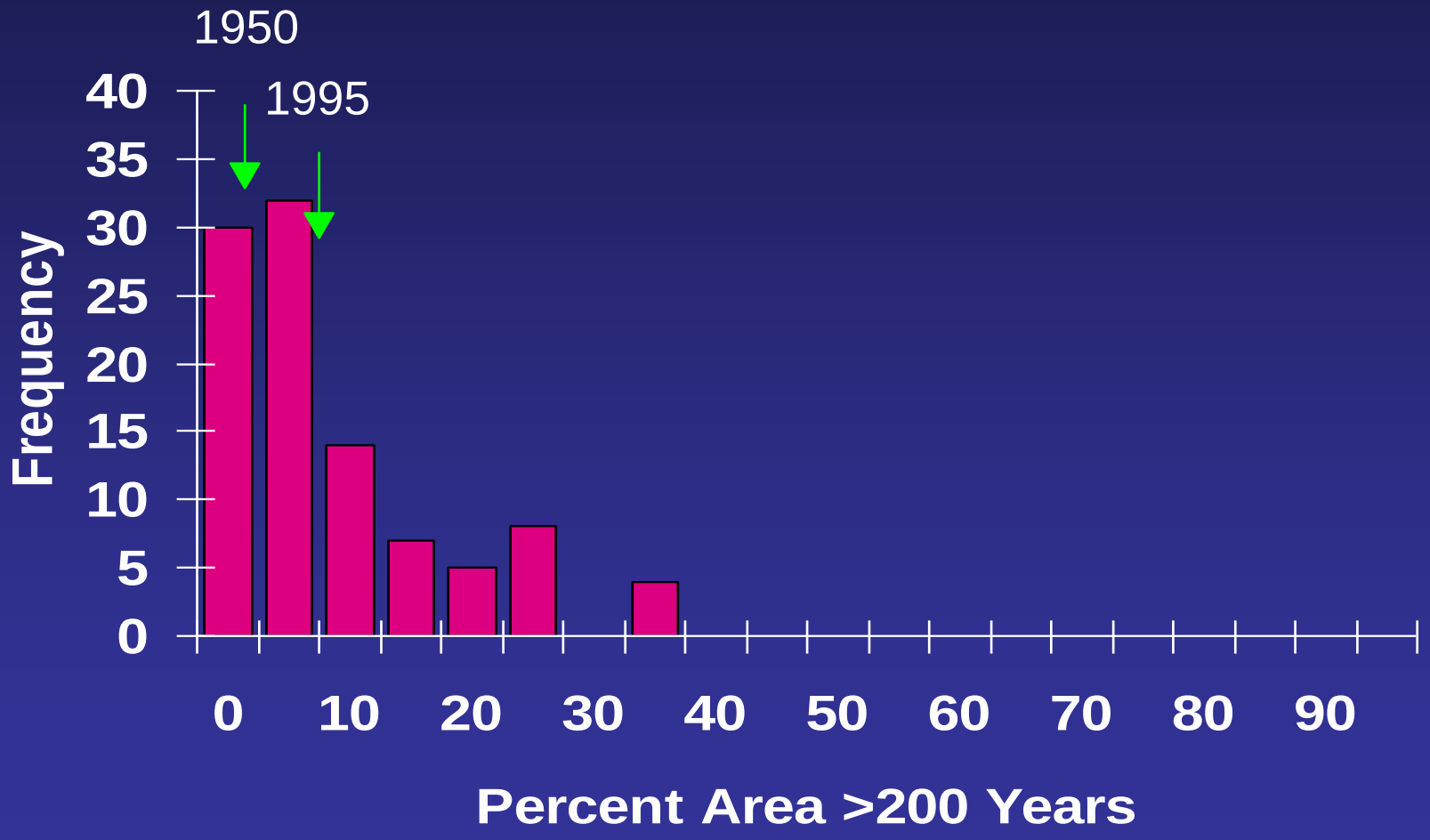
Older Forest as of 1950 on FMF Landscapes

Landscape	%>300 yrs	%>200 yrs	%>100 yrs
Lower Foothills	0	0	16
Upper Foothills	0	4	21
Subalpine east	2	15	45
* Subalpine JNP	7	37	59
* Montane	0	3	30

** includes 20-30 years of fire control*

Projected Historical Range of Area

for the Mature Seral-Stage of the Upper Foothills



Older Forest as of 1950 on FMF Landscapes

Landscape	%>300 yrs	%>200 yrs	%>100 yrs
Lower Foothills	0	0	16
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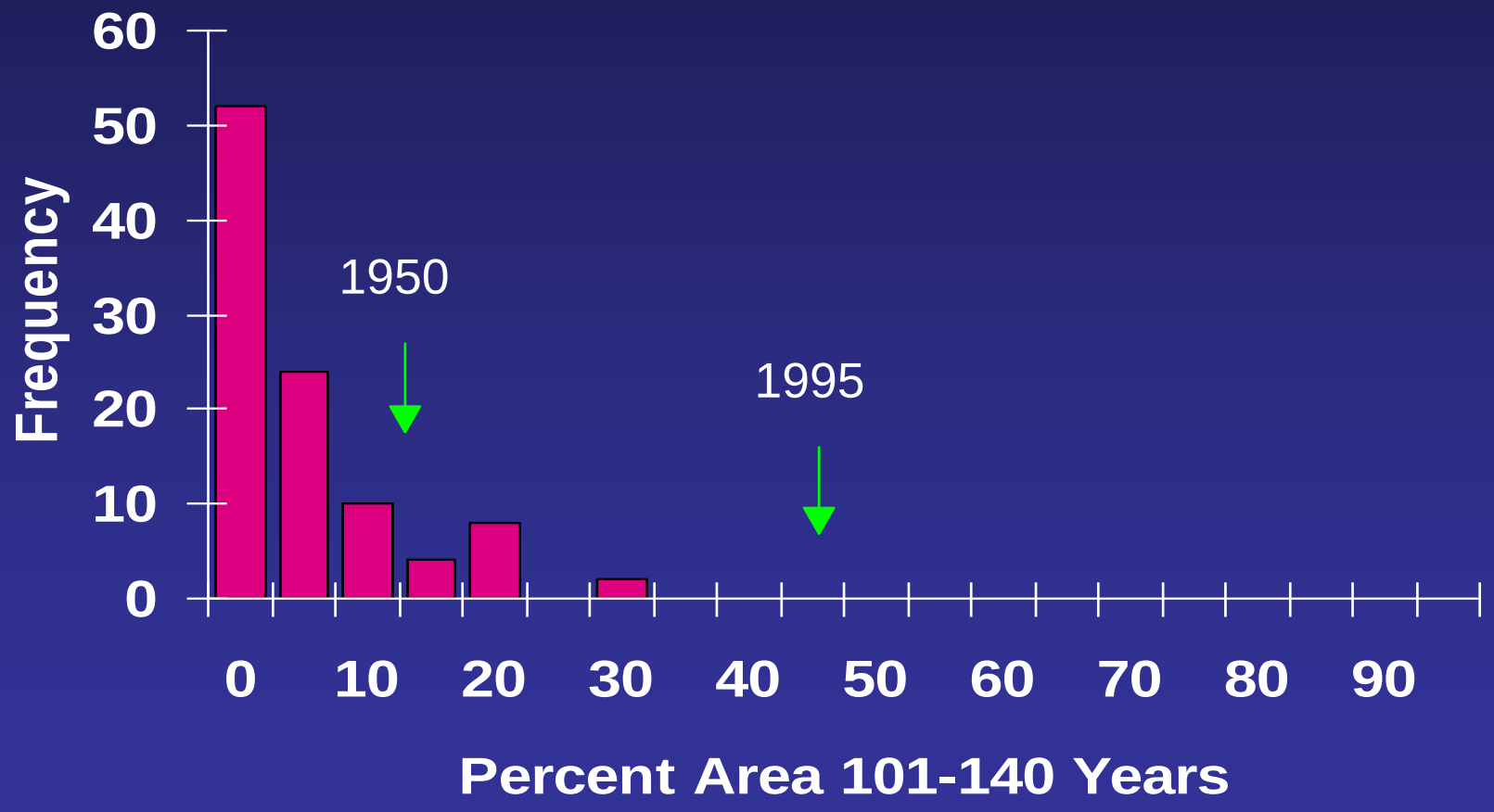
* Montane	0	3	30

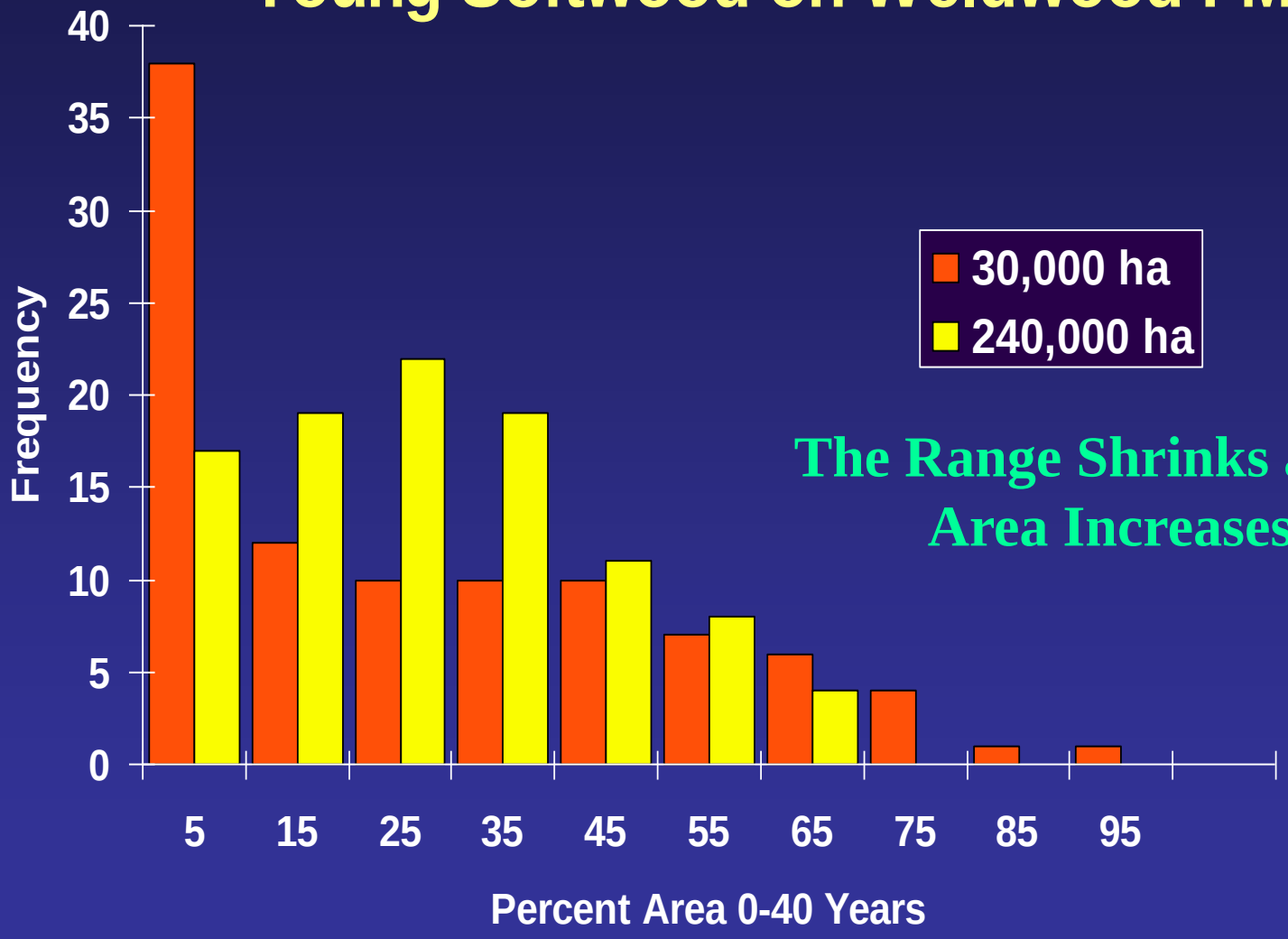
** includes 20-30 years of fire control*

Projected Historical Range of Area

for the Mature Seral-Stage of the Lower Foothills

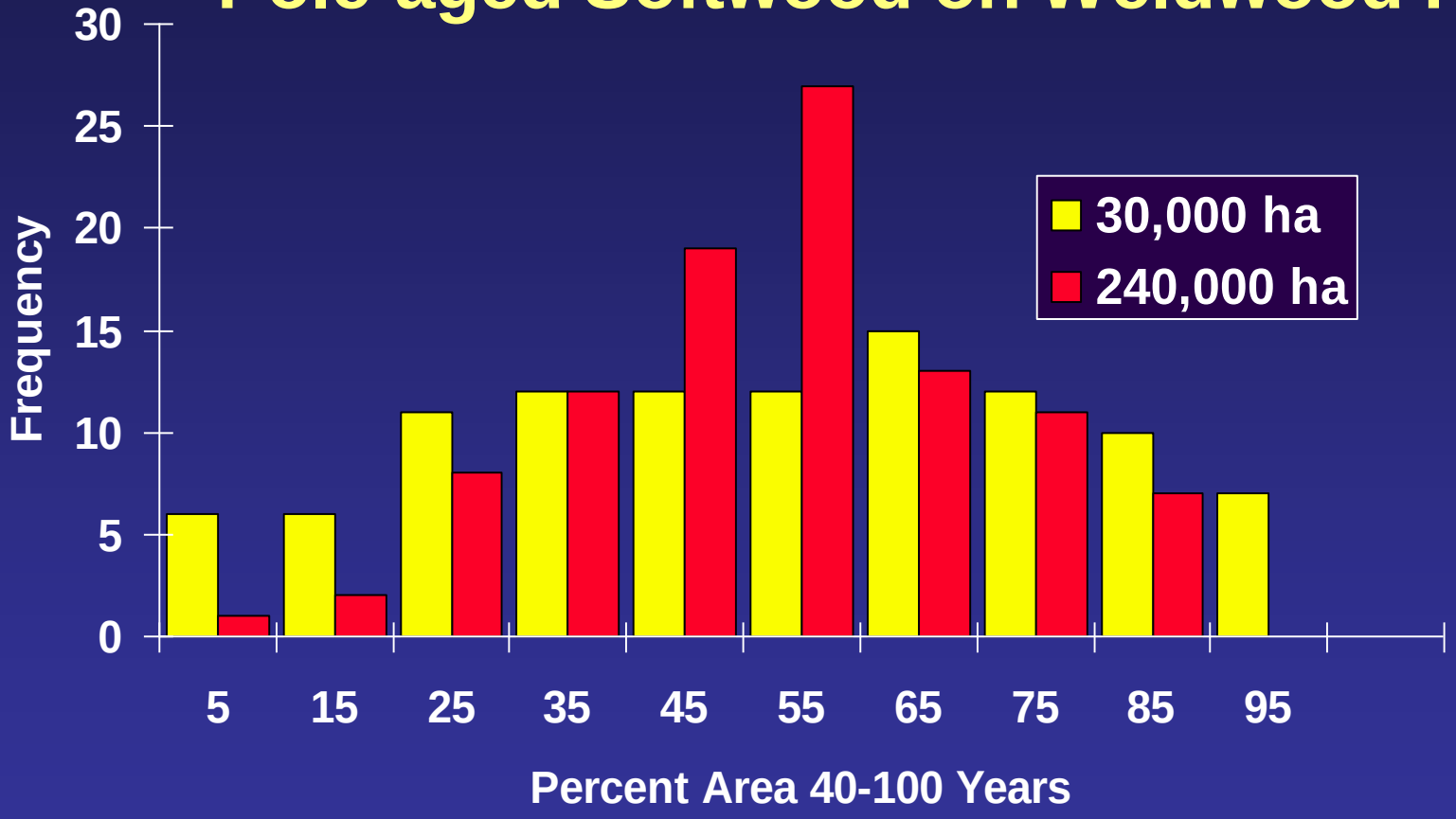


Simulated Historical Range of Percent of Young Softwood on Weldwood FMA

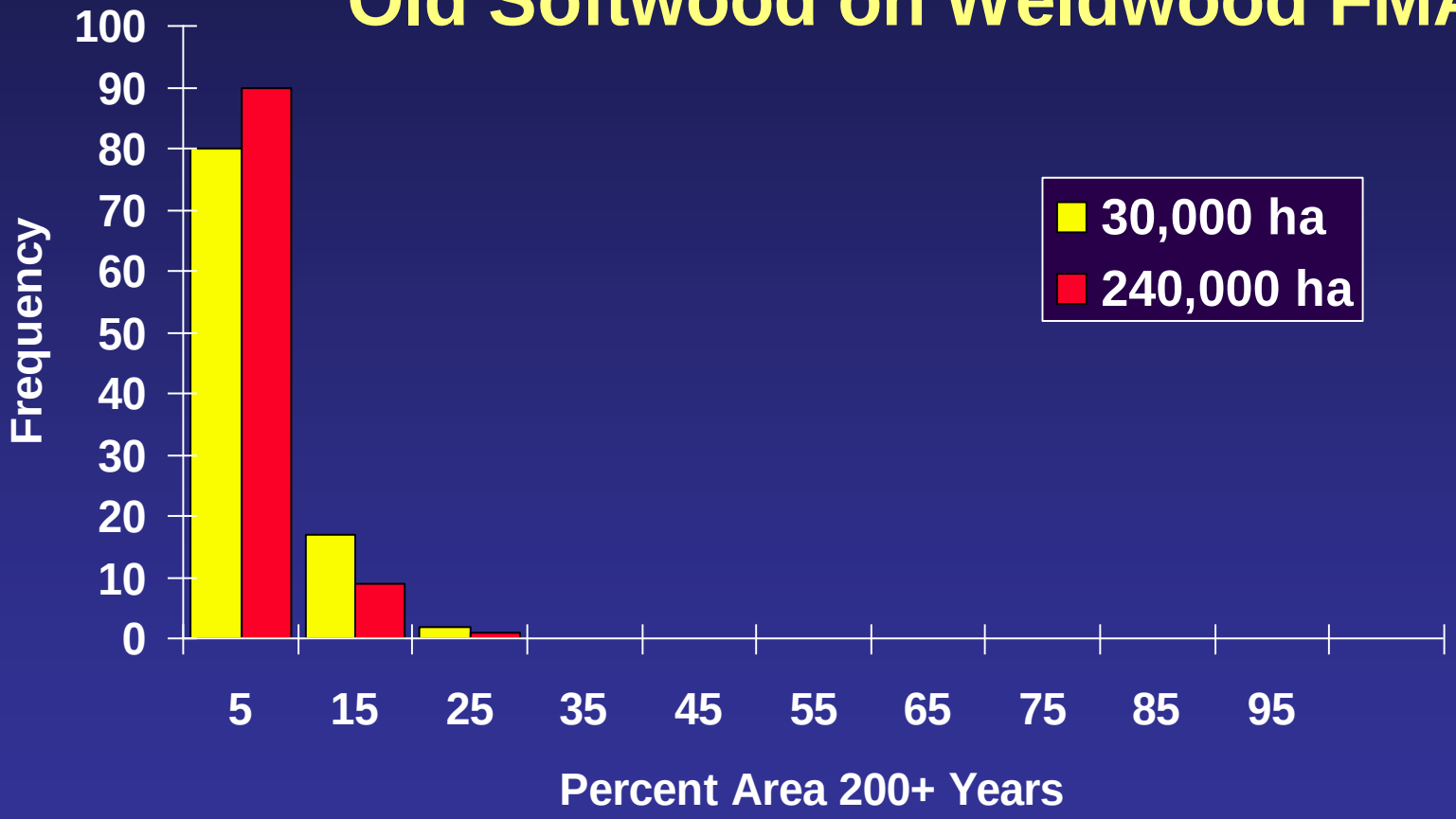


The Range Shrinks as the Area Increases

Simulated Historical Range of Percent of Pole-aged Softwood on Weldwood FMA

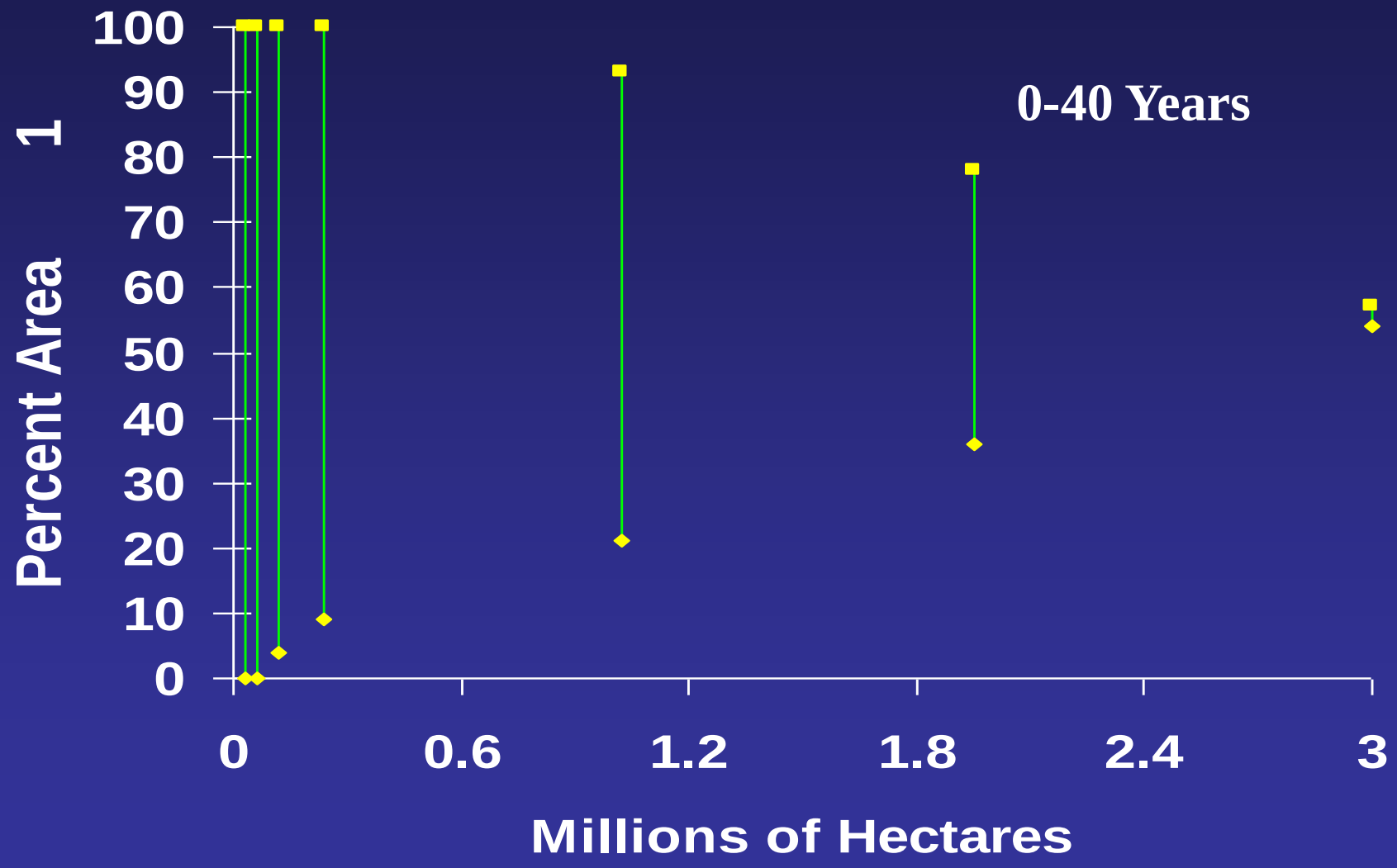


Simulated Historical Range of Percent of Old Softwood on Weldwood FMA



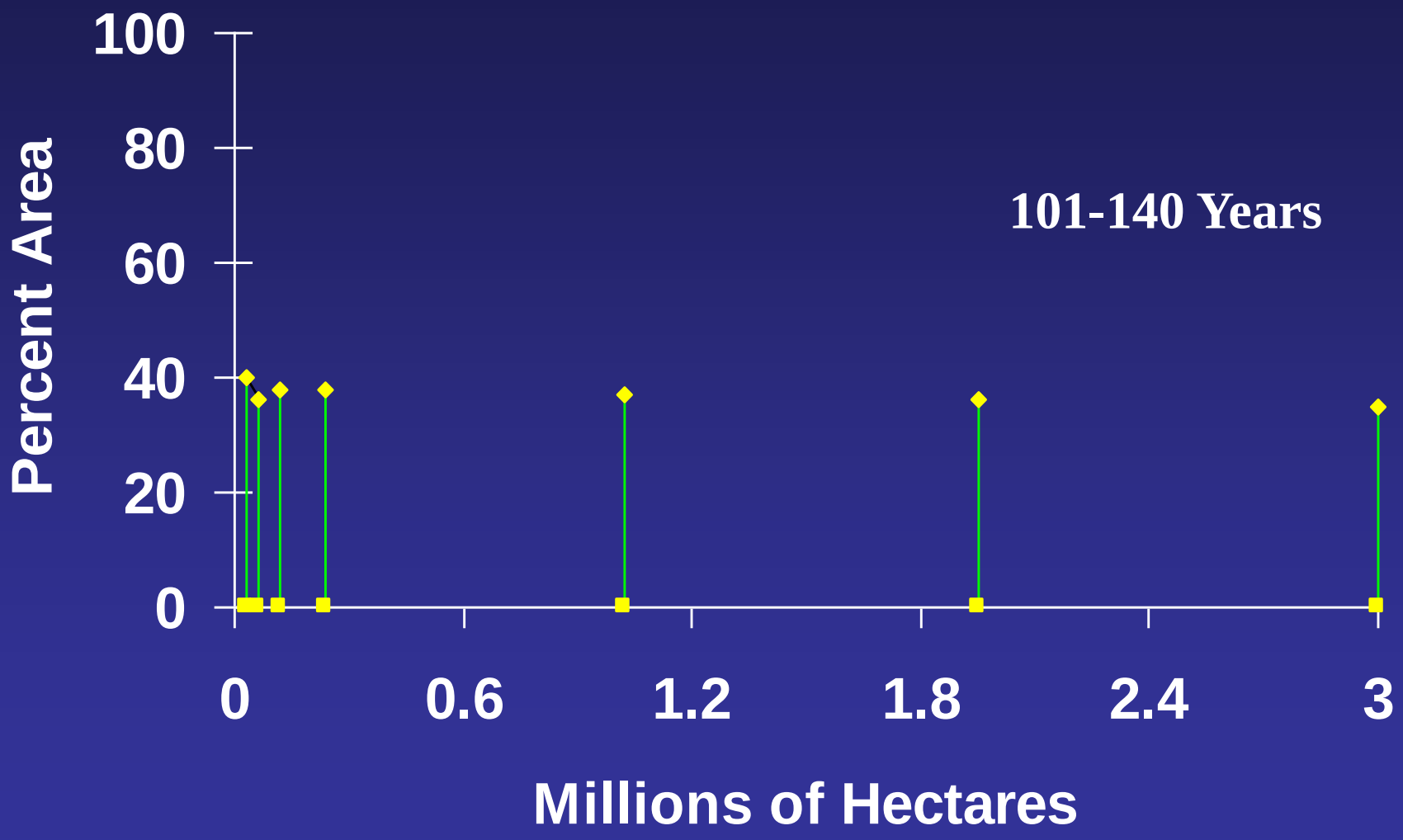
Range of Young Forest Percentages

From Simulation for the Lower Foothills



Range of Old Forest Percentages

From Simulation for the Lower Foothills



Age-Class Variability Patterns

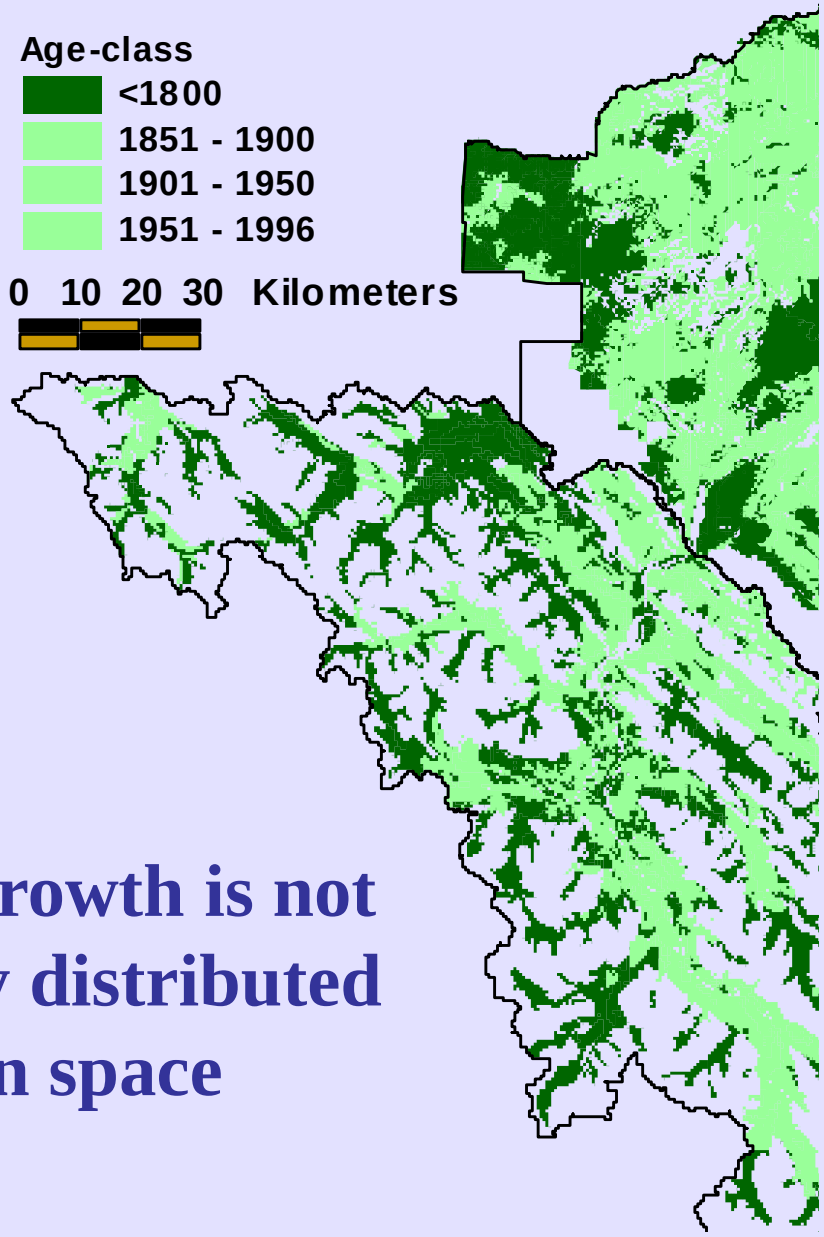
In theory, a very large land area may "stabilize" all age-class variation.

In practice, an "equilibrium point" does not exist (where there is no variation), but smaller areas do exhibit higher age-class variability than larger ones.

Age-Class Variability Patterns

This means that smaller areas (<100,000 ha) experienced regular, extended periods of extreme age-class variation, and probably had no "old growth" to speak of for many years, even decades.

Corollary of this is that "old growth", like any other age-class, tends to cluster over very large areas.



Old-growth is not evenly distributed in space

Age-Class Summary

- **Age-class distributions have temporal patterns, the range and shape of which may be unique to natural subregions.**

  Is the Lower Foothills range of disturbance indicative of spring vs. summer fire events?

- **The range of temporal variability is generally quite wide, ranging from between 1 and 2 percent of the land area disturbed to over 50% for a given 20 year period.**

- **Areas of the same age-class cluster over large areas.**

What Else at Coarse Scales?

- Fire threat
- Climate change
- Interaction of fire with other natural disturbances
- Non-forested areas
- Fire and salvaging

Overview of the Foothills Model Forest

Area	Forested	Non-For	Total
Lower Foothills	260,500	35,000	295,500
Upper Foothills	520,000	67,000	587,000
Sub-alpine east	242,500	43,000	285,500
Sub-alpine JNP	401,000	633,000	1,034,000
Montane	85,000	10,000	95,000
TOTAL	1,509,000	788,000	2,297,000

Of Non-Forested... ~ 620,000 ha rock and ice

~ 84,000 ha non-flammable

~ 84,000 ha flammable

Non-Forested Areas: How Much Do We Know?

- **Build up of duff, peat?**
- **Potential for growing trees - soil temperature, germination sites?**
- **Biodiversity implications? Who uses them? Carbon storage?**

Natural Disturbances Will Happen

… so we might as well take advantage.

- **Integration of temporal age-class variability.**
- **Create ecological benefits of natural disturbance that cultural disturbances cannot create (*given that salvage policies allow for it*).**
  - **Disturbance of non-forested areas.**
  - **Stand-level structure, leaving biomass on site, nutrient release, compaction.**
- **Fewer wood flow surprises?????**

Impact of Fire on Timber Supply
Ideal Example Only (not based on FMF)

Fire Cycle Today (with fire control)	Harvest Level Reduction / Expected Long-run Loss
1,000 years	2%
500 years	5%
250 years	10%
200 years	15%
150 years	18%
100 years	30%

Disturbance Design Issues at Coarse Scales

- **Non-forested areas are part of the landscape and much of it evolved with fire. We do not know the full impacts of removing fire on these areas.**
- **Natural disturbance will happen, and there are some positive aspects that a salvage policy can take advantage of.**
  - ***Disturbance of non-forested areas.***
  - ***De-stabilizing age-class pattern over time.***
  - ***Fine-scale patterns that cultural disturbance activities cannot match.***

Disturbance Design Issues at Coarse Scales

- ***In this case*, ecological subregions are good means of differentiating areas with distinctive fire cycles.**
- **Age-class distributions vary over space. Same-aged areas tend to cluster.**
- **Age-class distributions vary tremendously over time. Where there are "nodes" of old-growth today, there were likely none 100 years ago.**