Stand-replacing fires and carbon storage:

Effects of stand age and density on carbon storage in lodgepole pine ecosystems

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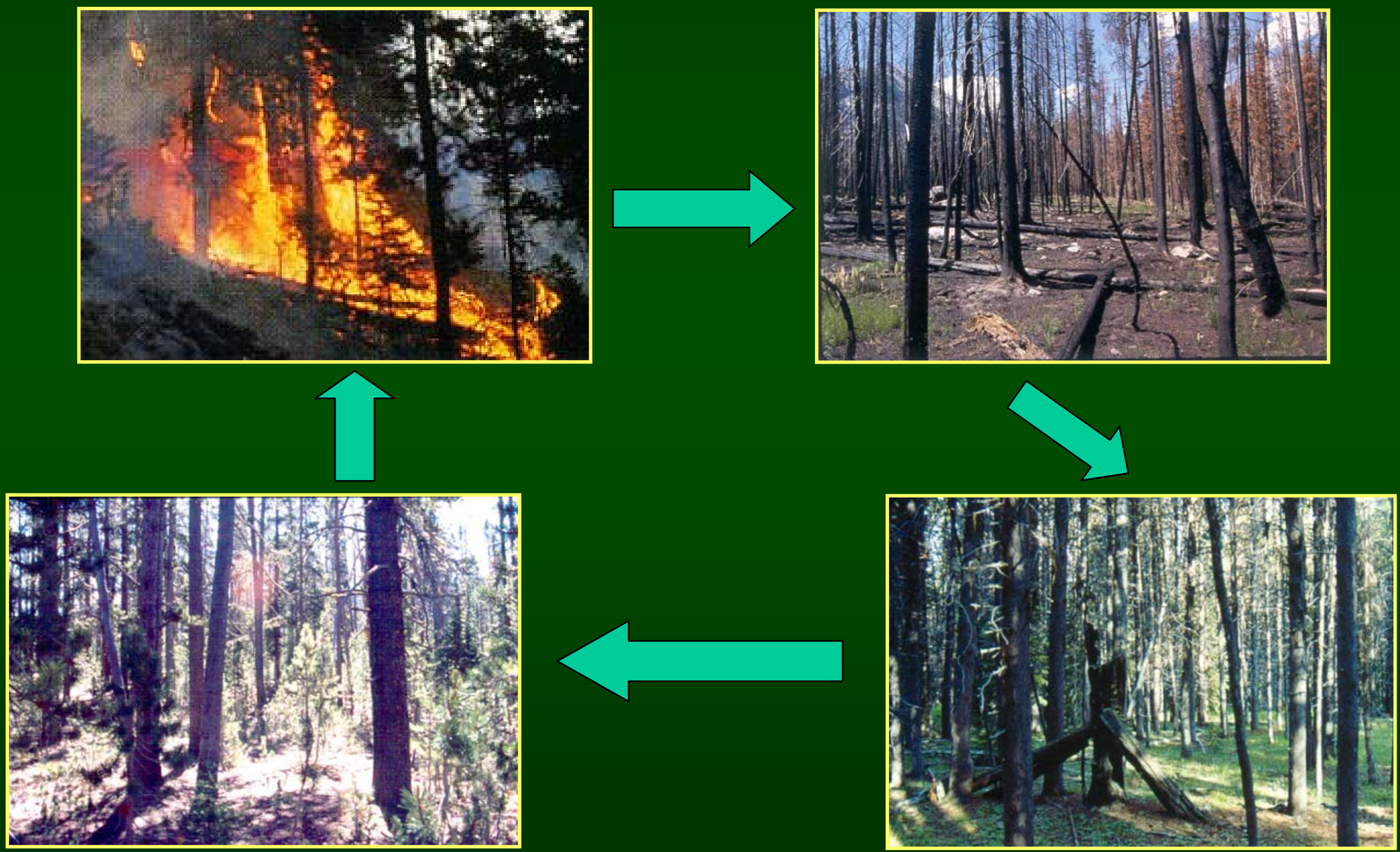
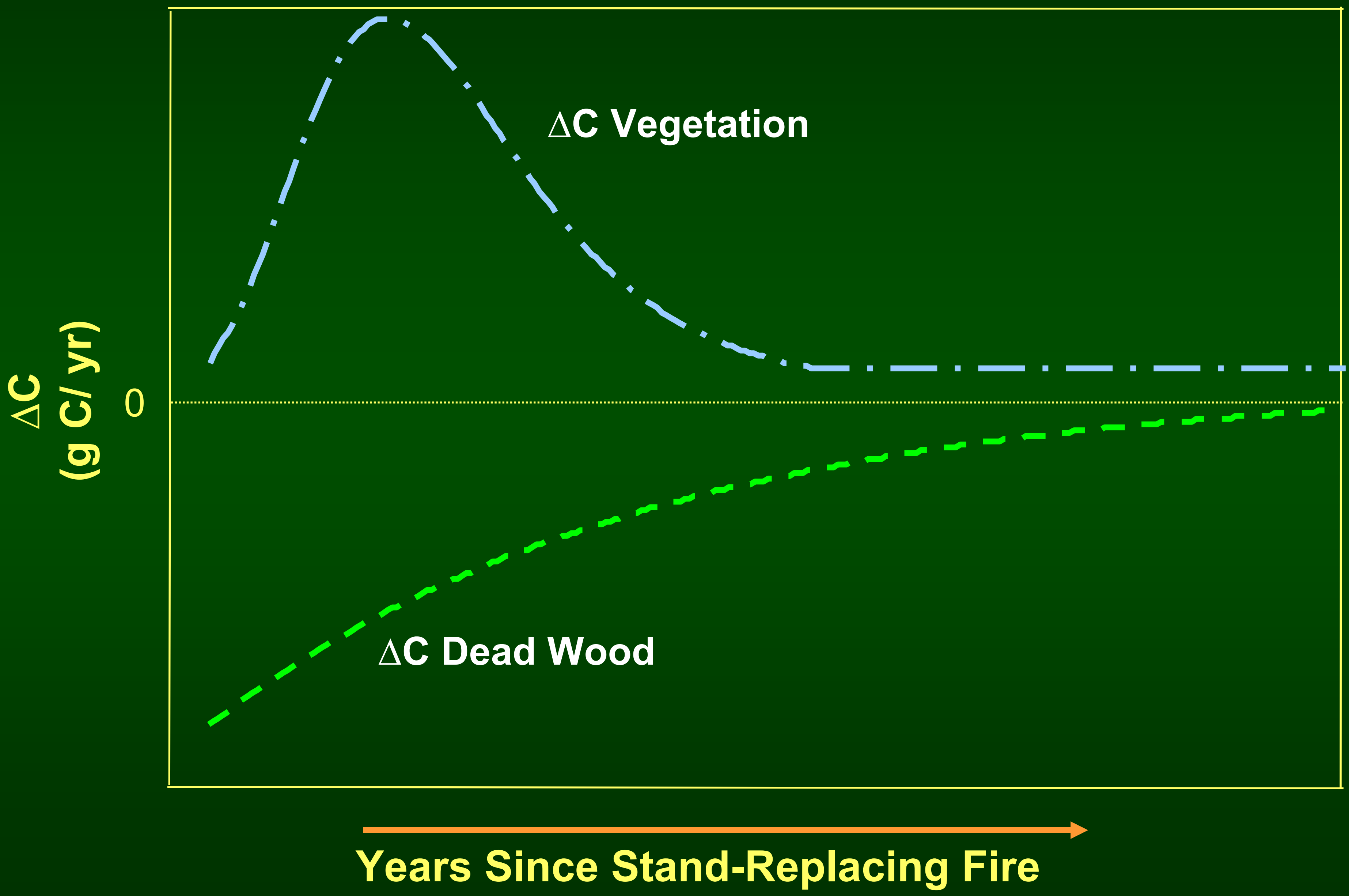
The Yellowstone landscape

- Stand-replacing fires
- 100-300 year fire interval
- Large, “natural” landscape
- Mosaic of stand ages and densities

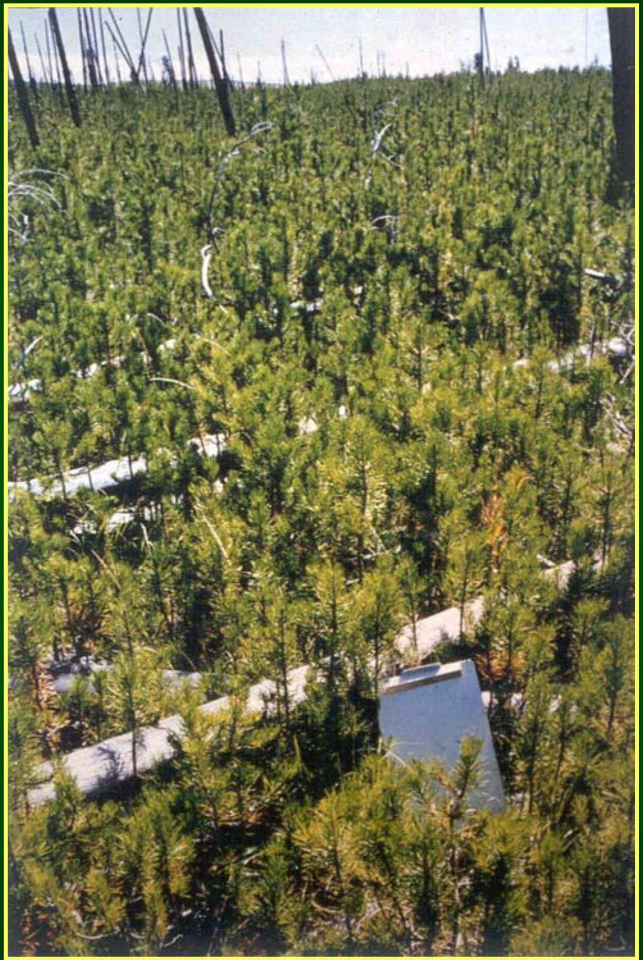
In directing succession, stand-replacing wildfires strongly affect carbon storage



Carbon balance = C gained – C lost



Variability in structure follows fires



>50,000 stems/ha

1,000 stems/ha

0 stems/ha

Questions:

- How closely related are carbon stocks (esp. live biomass and dead wood) to stand age?

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- How do carbon stocks vary with stand density?

- How variable are carbon pools within age and density classes?

Methods:

- Replicated chronosequences (n = 77 stands);

Age classes:
< 25 years
40-70 years
80-130 years
170-230 years
> 250 years

Methods:

- Replicated chronosequences (n = 77 stands);

High density

Density classes:

< 25	>50,000 stems/ha
40-70	> 5,000 stems/ha
80-130	> 5,000 stems/ha
170-230	Beetle killed
> 250	Beetle killed

Methods:

- Replicated chronosequences (n = 77 stands);

Moderate density

Density classes:

< 25	7 - 40,000 stems/ha
40-70	1,300 - 5,000 stems/ha
80-130	1,300 - 5,000 stems/ha

Methods:

- Replicated chronosequences (n = 77 stands);

Low density

Density classes:

< 25	< 1,000 stems/ha
40-70	< 1,300 stems/ha
80-130	< 1,300 stem/ha
170-230	Not beetle killed
> 250	Not beetle killed

Methods:

- Mass balance approach using field measurements of all C pools in 77 stands:

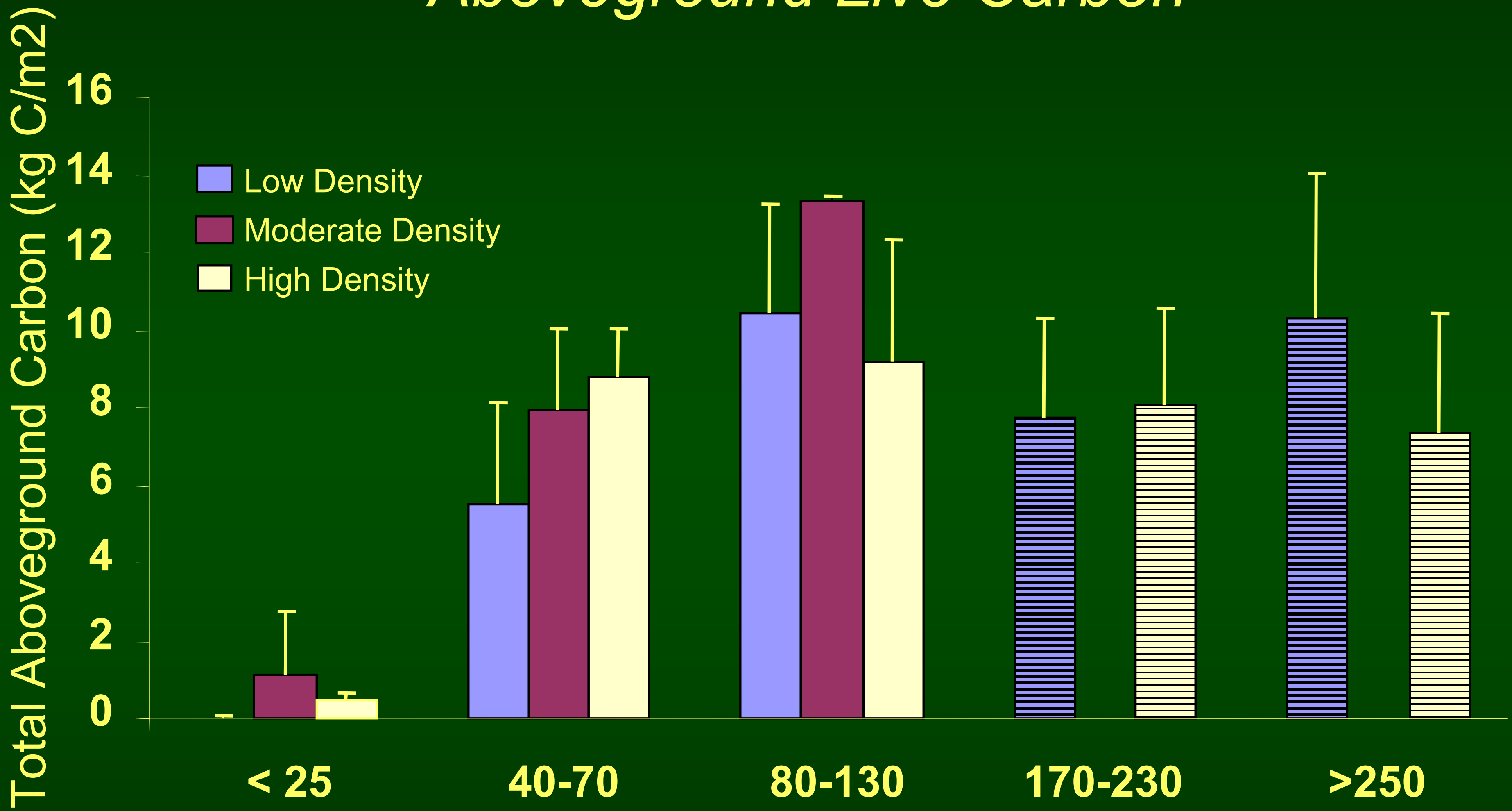
  Above and belowground biomass (on-site allometrics)

  Standing and down dead wood

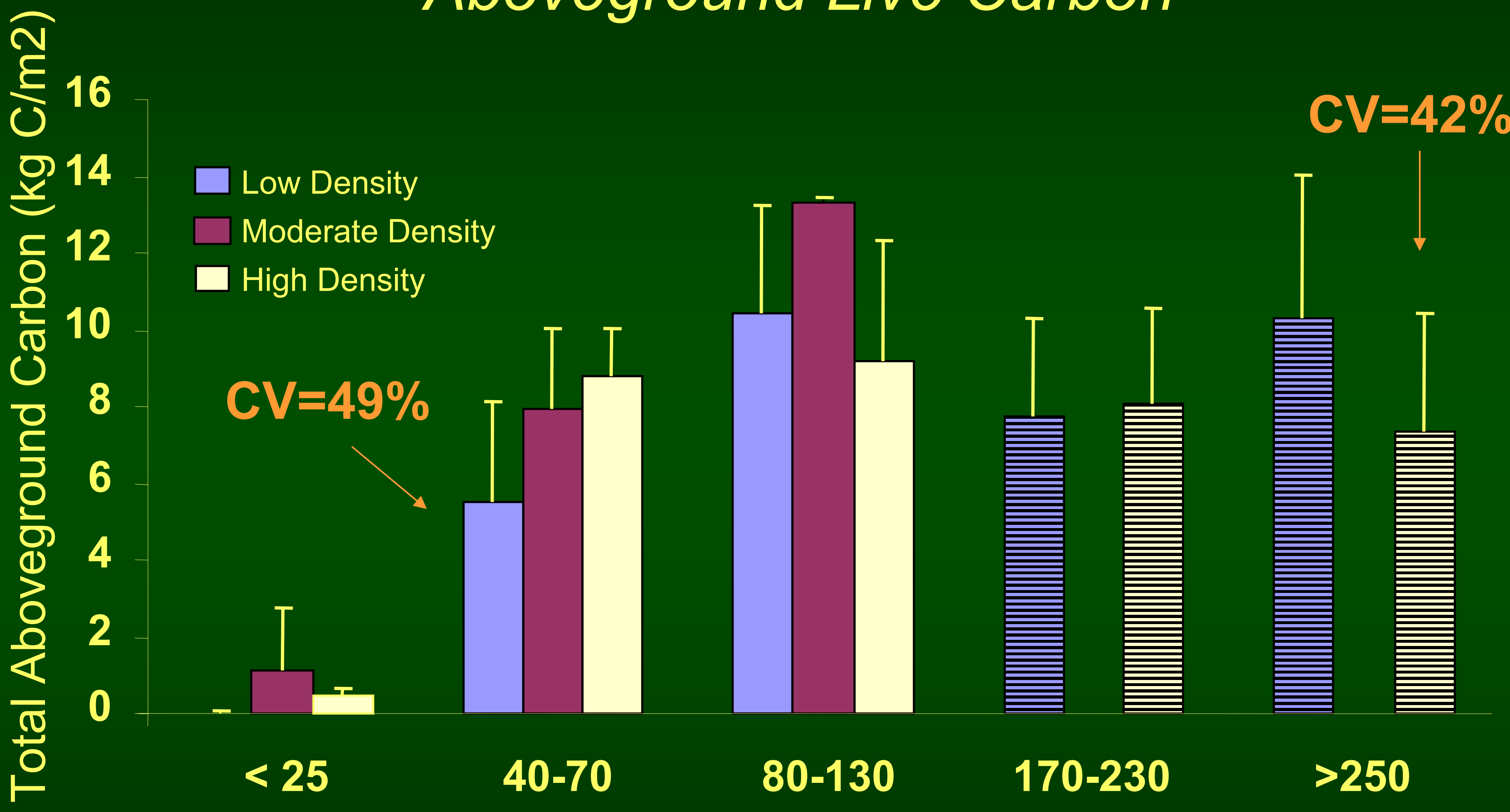
  Stumps and dead coarse roots

  Forest floor and mineral soil

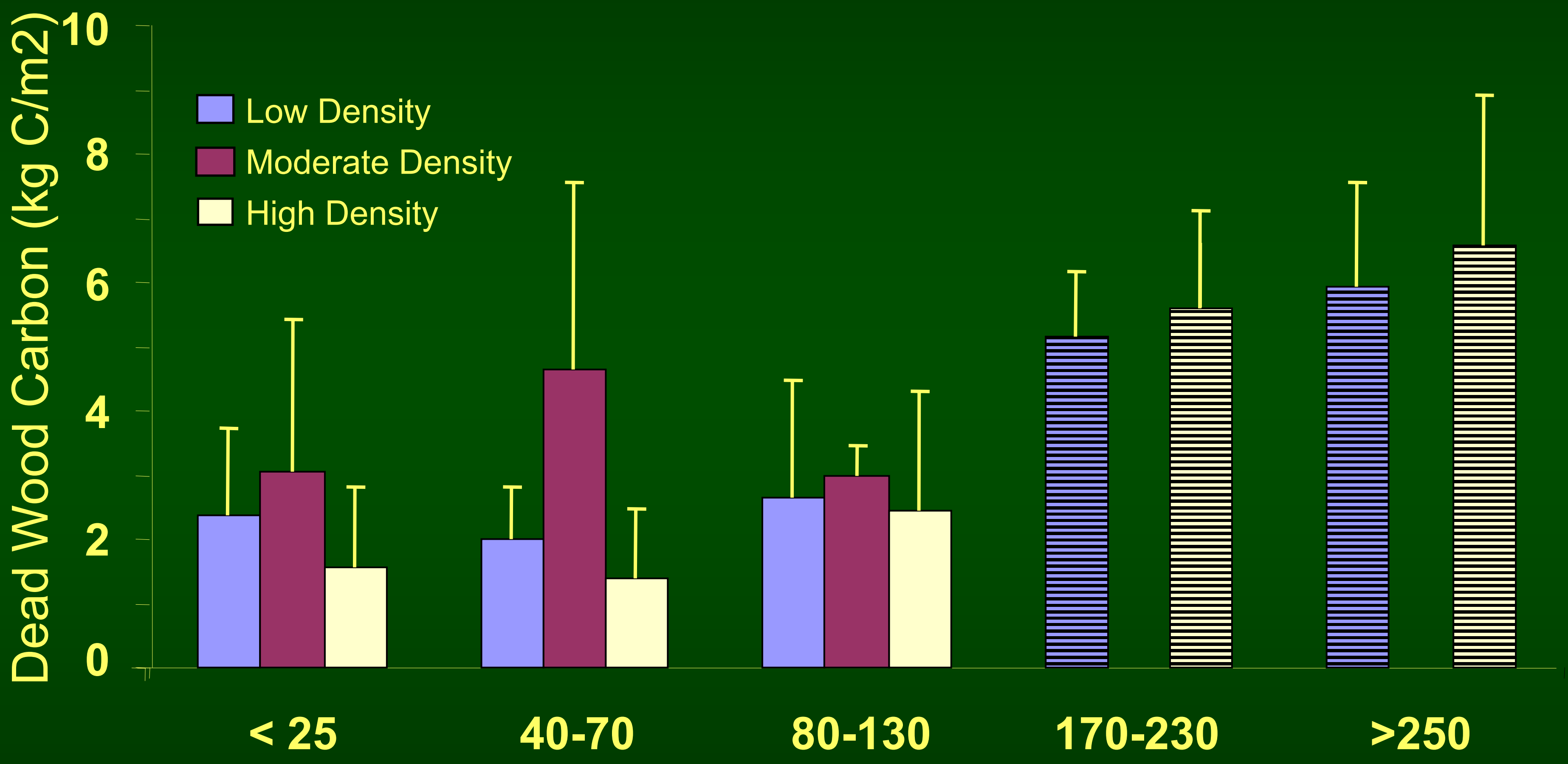
Aboveground Live Carbon



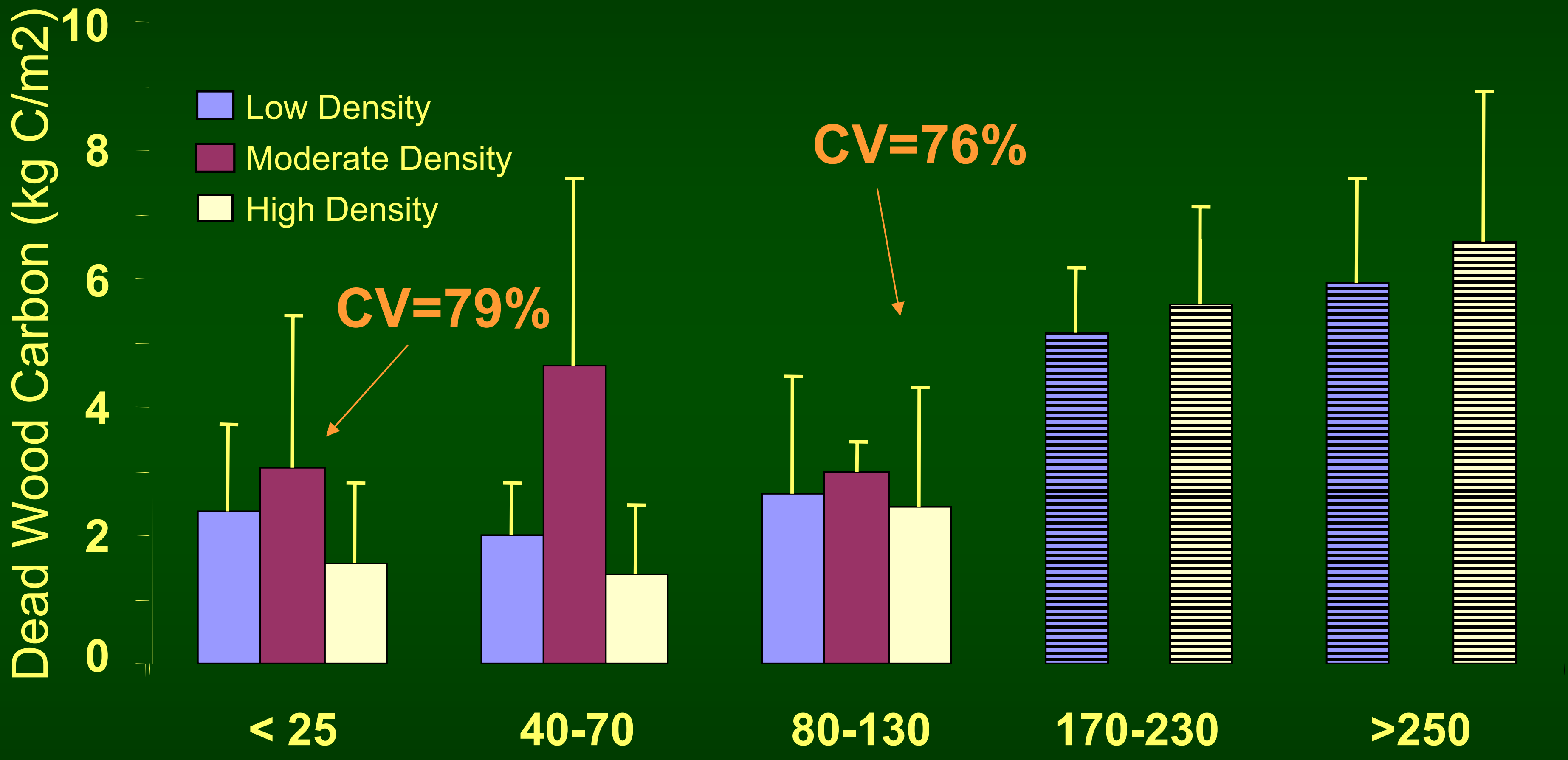
Aboveground Live Carbon



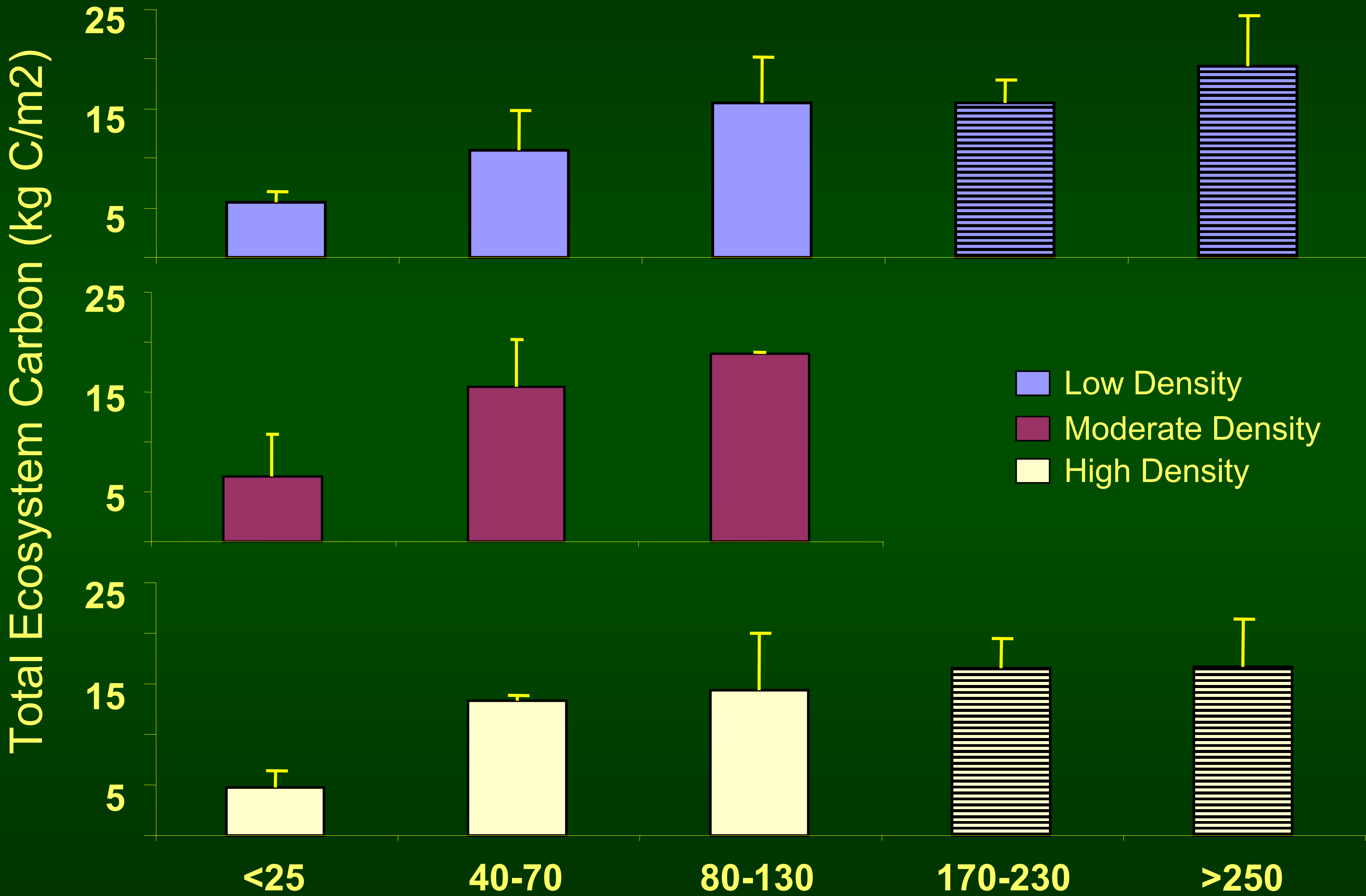
Dead Wood Carbon



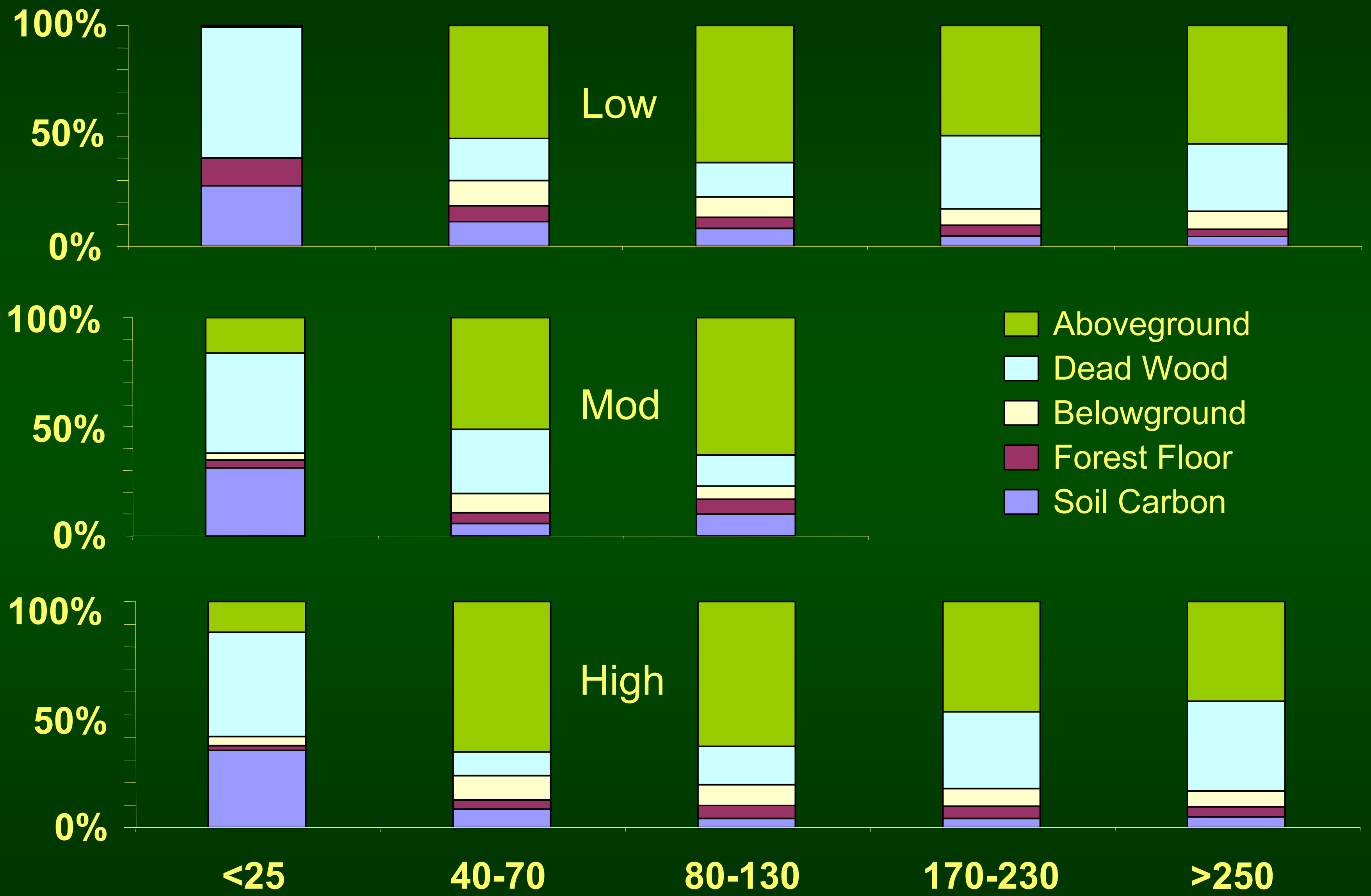
Dead Wood Carbon



Total Ecosystem Carbon Stocks



Location of Carbon Stocks



Conclusions:

- Carbon stocks for most important pools vary with age, but less with density.

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- Most change in carbon storage occurs in the first 100 years following the fire.

- Dead wood component varies more than live biomass within age and density classes.

Take-home Point:

For a single fire cycle, initial post-fire stand densities are probably not important for carbon storage on these landscapes; even the age effect is relatively short-lived.

Acknowledgements:

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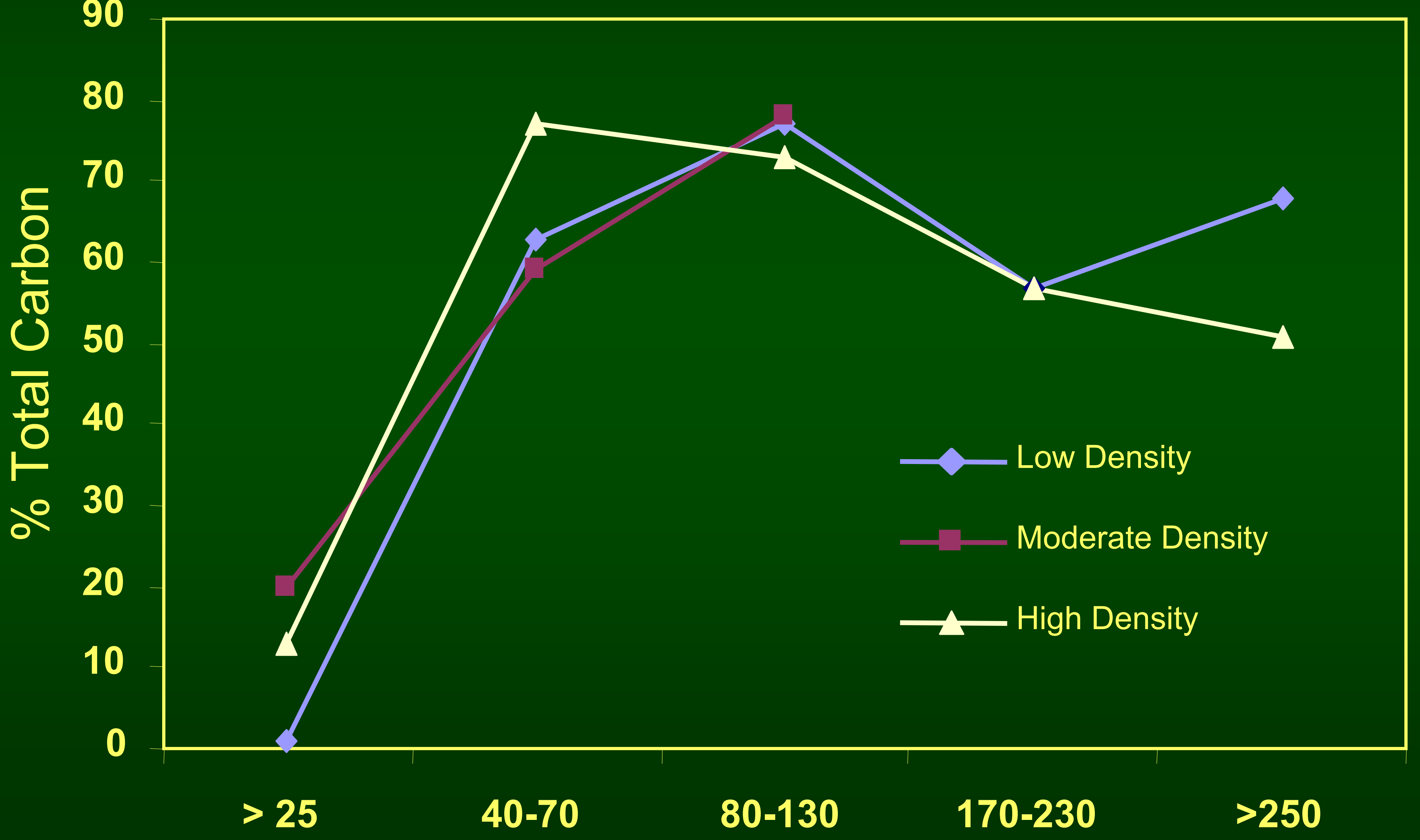
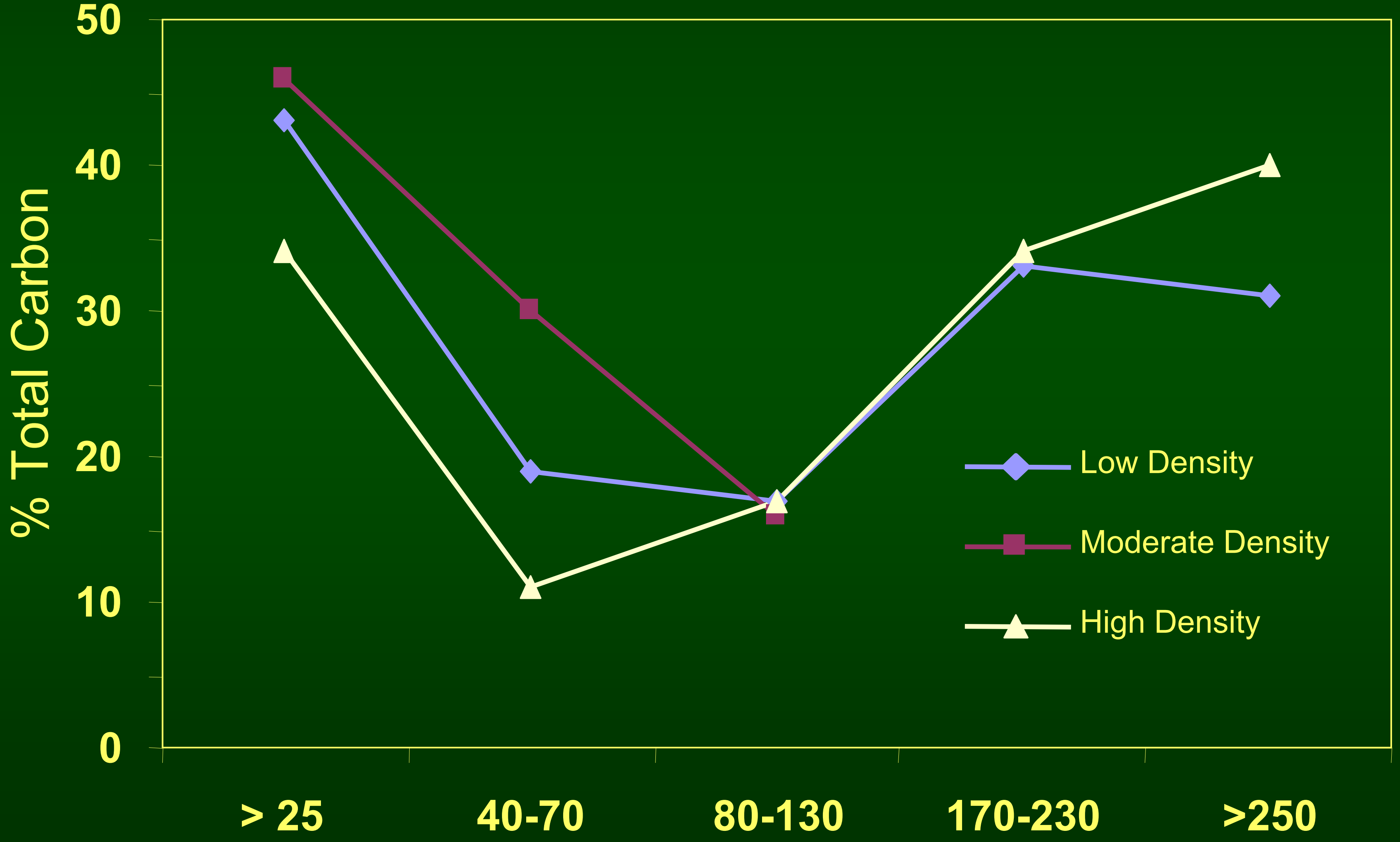
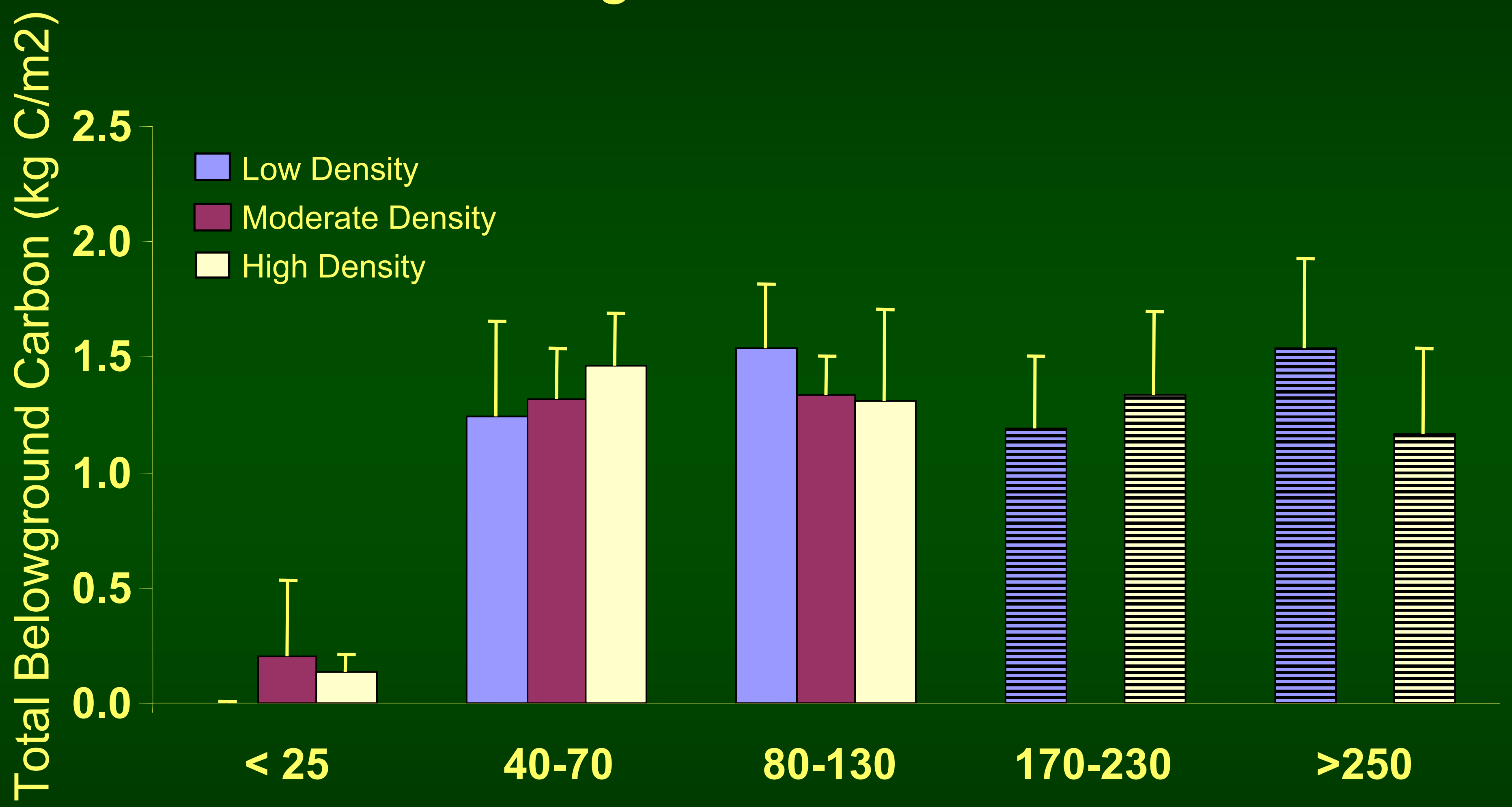
Percent of Total Carbon In Aboveground Biomass



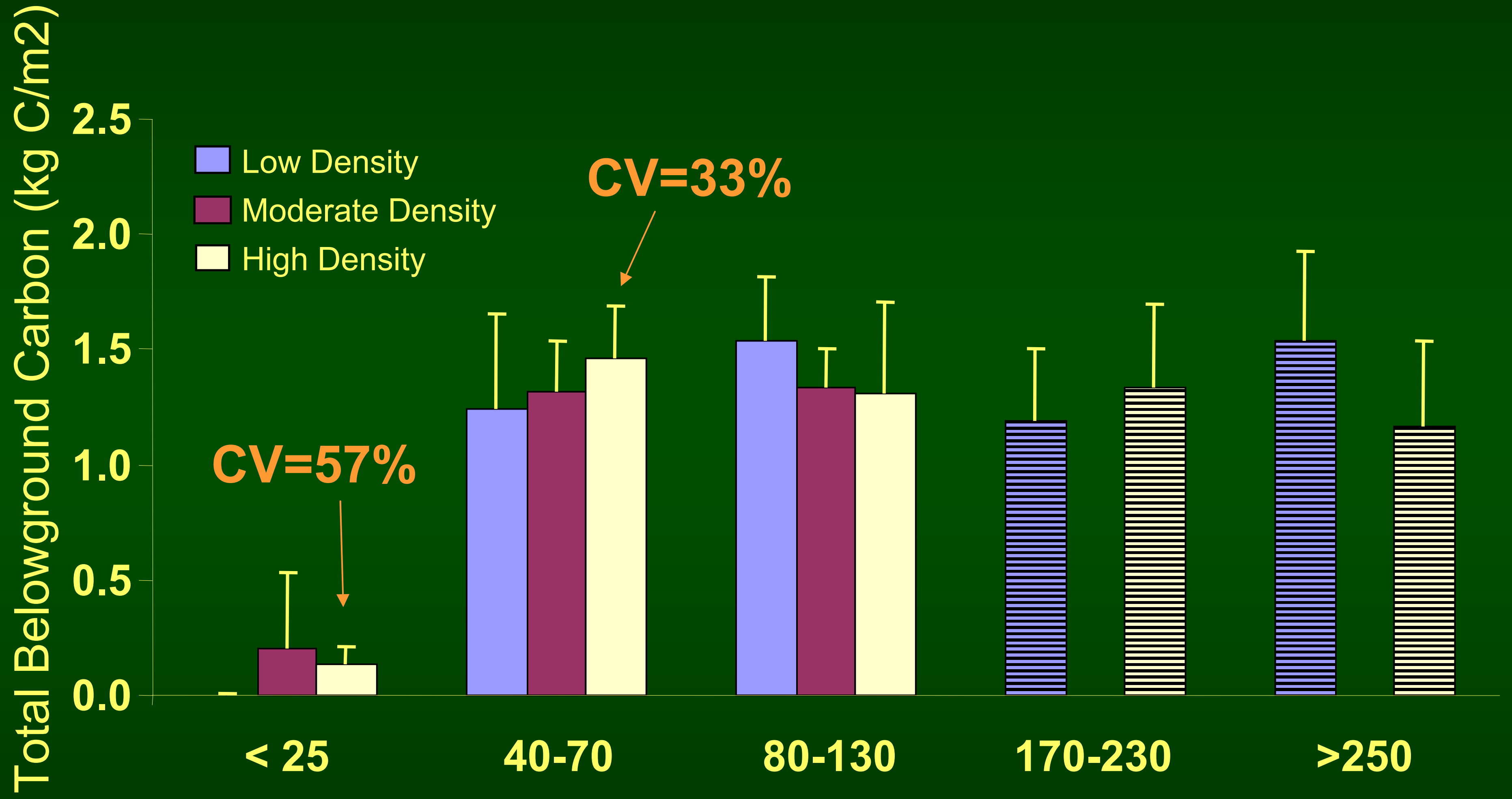
Percent of Total Carbon In Dead Wood



Belowground Live Carbon



Belowground Live Carbon



How important are stand age and density for carbon storage?

(Kashian et al. 2006, Bioscience)

- Stand age is less important than stand density in affecting landscape carbon storage; large changes in fire intervals (< 100 years) are necessary.

- Large (?) changes in the stand density distribution are necessary to shift landscape carbon storage.