

Effects of weather and overstory on understory productivity of shortleaf pine savanna, woodland, and forest

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Importance of understory



Biodiversity

Carbon and
nutrient cycling

Wildlife habitat

Grazing



Controls over understory productivity

Woody Cover (reduces)

- Shade
- Competition for water and nutrients
- Litter

Weather (drier conditions reduce productivity, but can also reduce woody cover)

- Drought
- Climate Change

Fire (increases)

- Nutrient mineralization
- Litter reduction
- Woody cover reduction



—————> Reduces understory
—————> Benefits understory

Overarching question

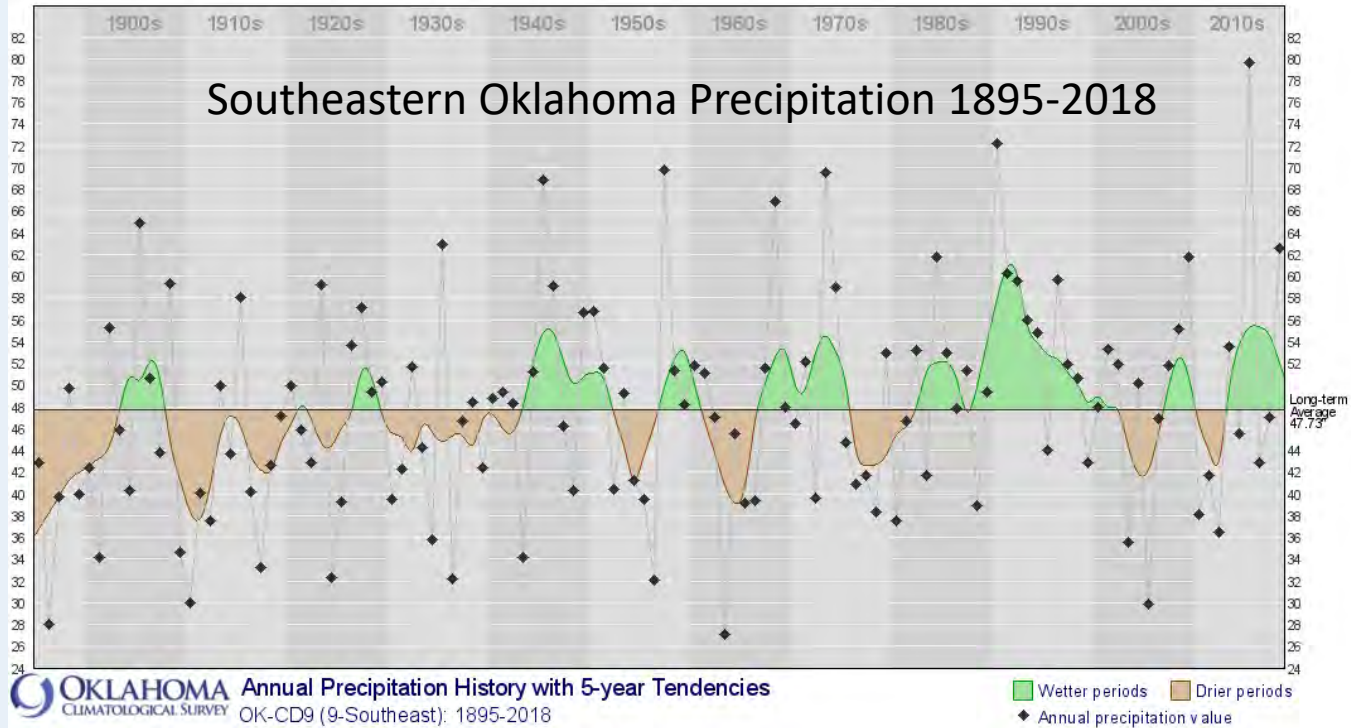
How can we better manage to optimize ecosystem services, especially faced with drought and potential climate change?

- Grazing
- Timber
- Wildlife habitat

80", 2032 mm

47.7", 1212 mm

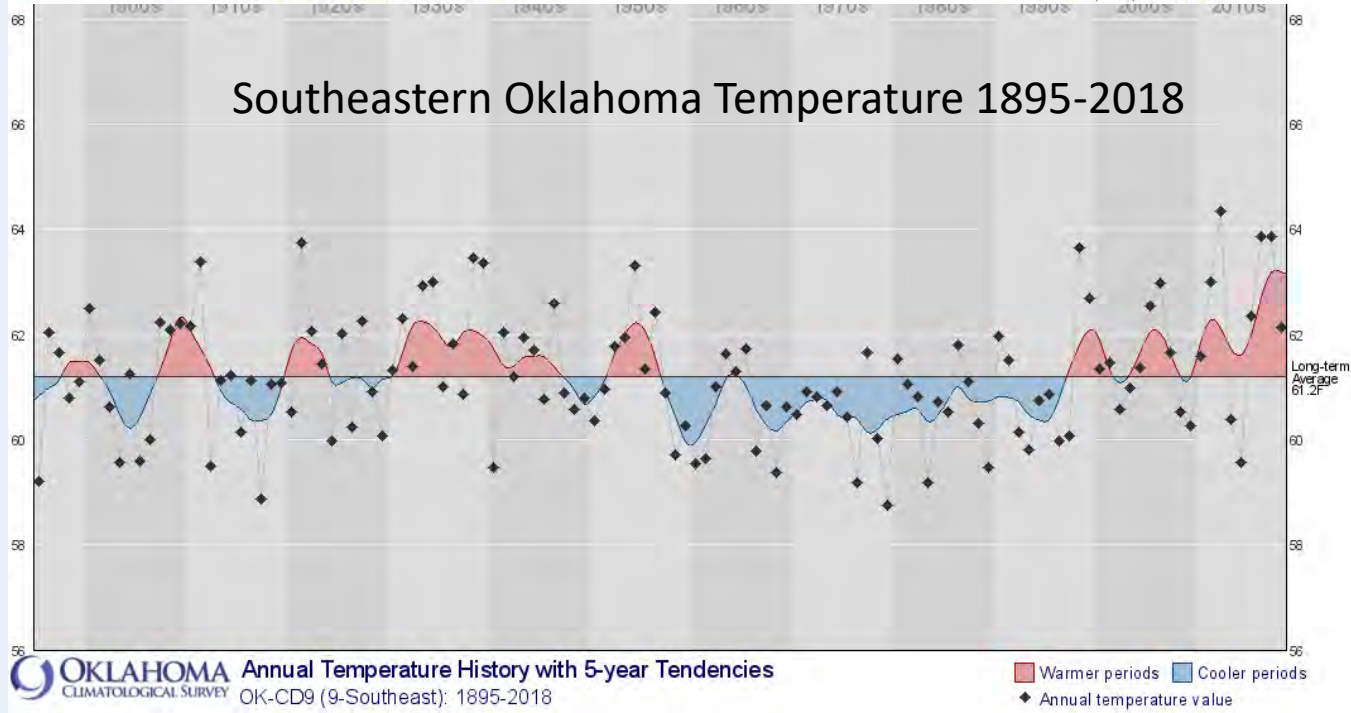
27", 686 mm



64.5 F, 18.1 C

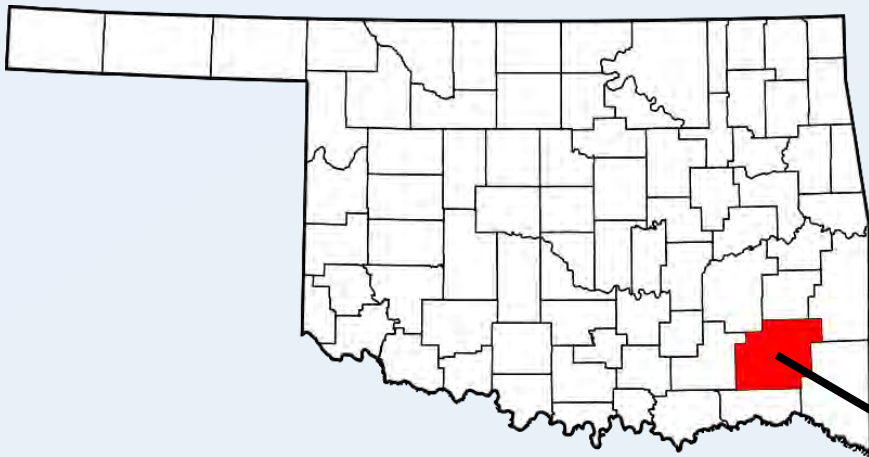
61.2 F, 16.2 C

58.6 F, 14.8 C



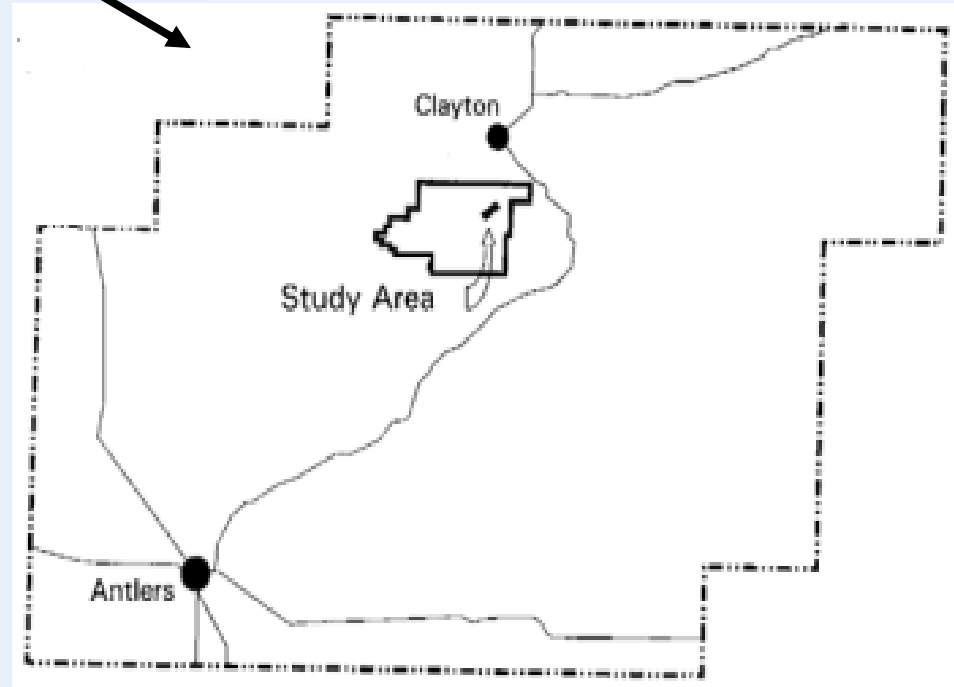
Specific Questions

- 1) How does understory productivity vary among ecosystems?
- 2) How is understory productivity affected by overstory condition?
- 3) How does variation in temperature and precipitation affect understory productivity?
- 4) How does time since fire affect understory productivity?
- 5) Does annual fire for 30+ years affect forb or woody understory components?



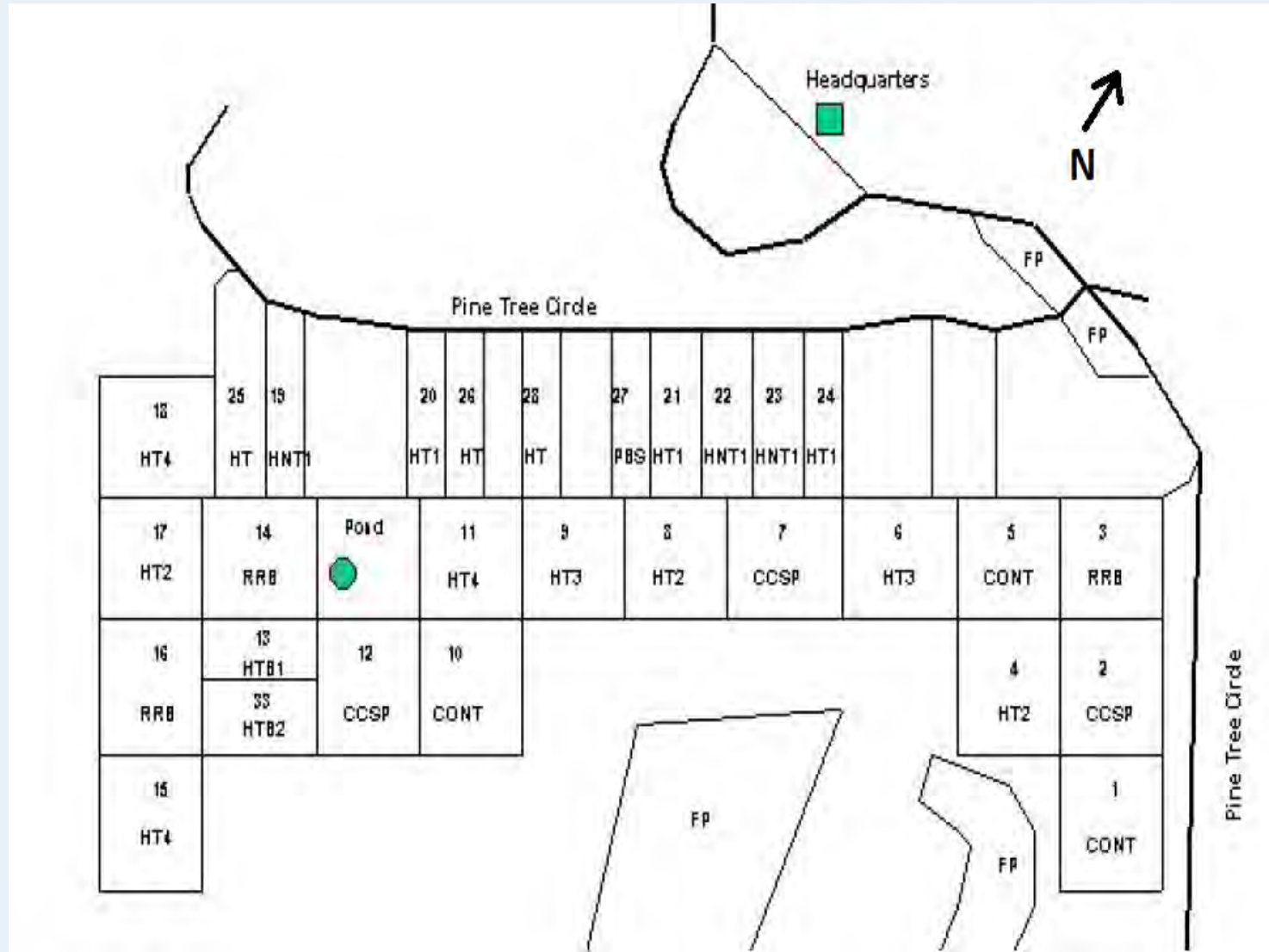
Site:

- Southeast Oklahoma
- Pushmataha Forest Habitat Research Area (FHRA)
- 130 acres
- Treatments begin 1984
- ~1300 mm ann precip



The Masters' Plots

- 26 units
(0.8 to 1.6 ha)
- 9 Treatments
 1. Control ←
 2. CCSP
 3. RRB
 4. HNT1 ←
 5. HT ←
 6. HT1 ←
 7. HT2 ←
 8. HT3 ←
 9. HT4 ←



H = commercial pine harvested, T = hardwoods thinned using herbicide, number = fire return interval

Common species

Overstory vegetation

- Shortleaf pine (*Pinus echinata*)
- Post oak (*Quercus stellata*)
- Hickory (*Carya spp.*)

Understory vegetation

- Little bluestem (*Schizachrium scoparium*)
- Big bluestem (*Andropogon gerardii*)
- Variety of aster, panicum and *Dichanthelium spp.*
- Poison ivy (*Toxicodendron radicans*)
- Sumac (*Rhus spp.*)

CONTROL Mature Forest

3 REPLICATIONS

No treatments

Last disturbed by
logging ~90 years
ago



HT
Even-aged forest

- 3 Replications
- Treatments
 - Harvest Pine timber
 - Thin hardwoods
 - No fire



HT4
Uneven-aged
woodland

- 3 Replications
- Treatments
 - Harvest Pine timber
 - Thin hardwoods
 - Prescribed fire at 4 year interval



HT3 Savanna

- 2 Replications
- Treatments
 - Harvest Pine timber
 - Thin hardwoods
 - Prescribed fire at 3 year interval



HT2 Savanna

- 3 Replications
- Treatments
 - Harvest Pine timber
 - Thin hardwoods
 - Prescribed fire at 2 year interval



HT1

Savanna/grassland

- 3 Replications
- Treatments
 - Harvest Pine timber
 - Thin hardwoods
 - Prescribed fire at 1 year interval



HNT1

Post oak savanna

- 3 Replications
- Treatments
 - Harvest Pine timber
 - No Thin hardwoods
 - Prescribed fire at 1 year interval







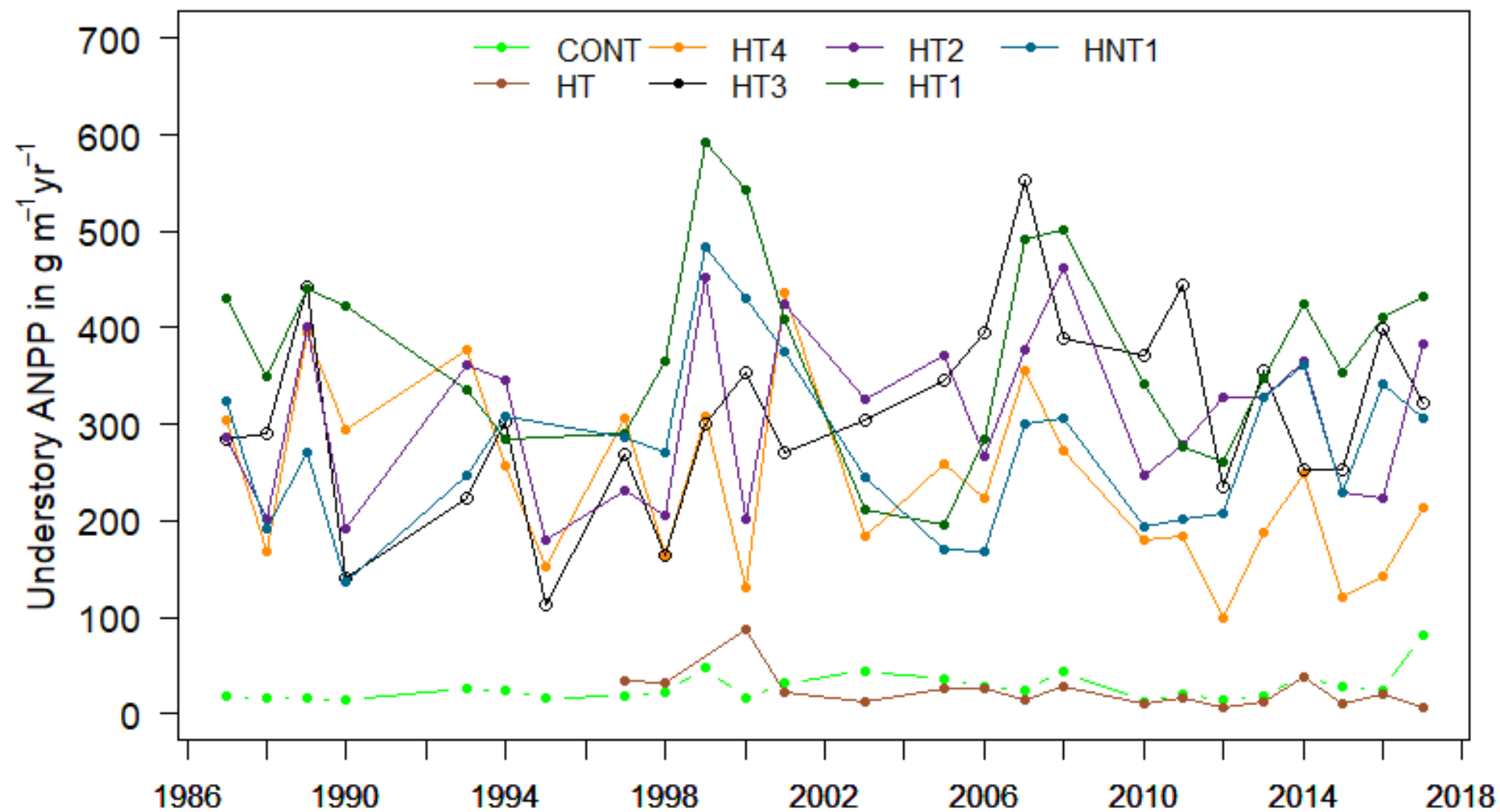
Annual clip plots in
Sept/Oct



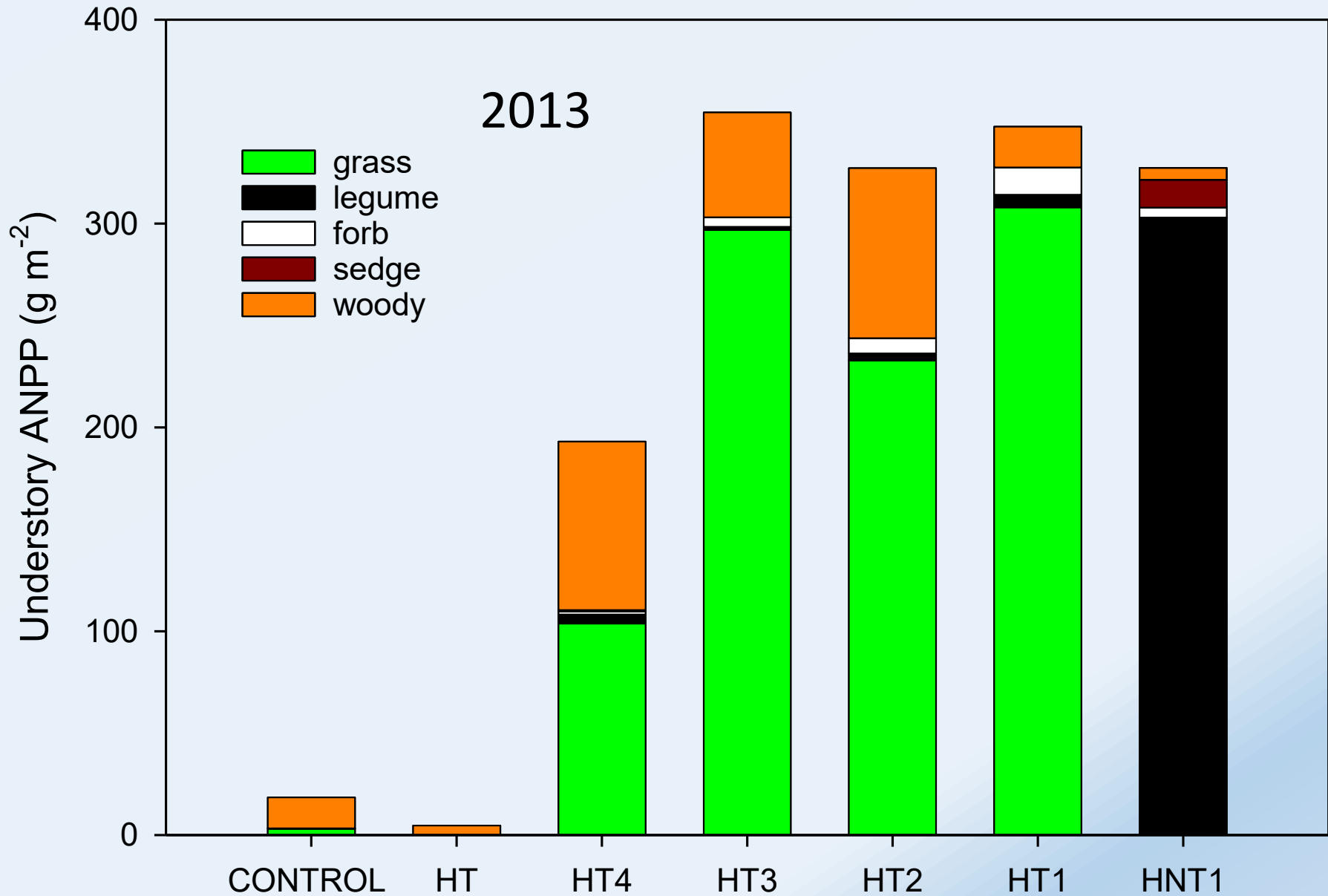
10 plots per unit

How does the understory vary among ecosystems?

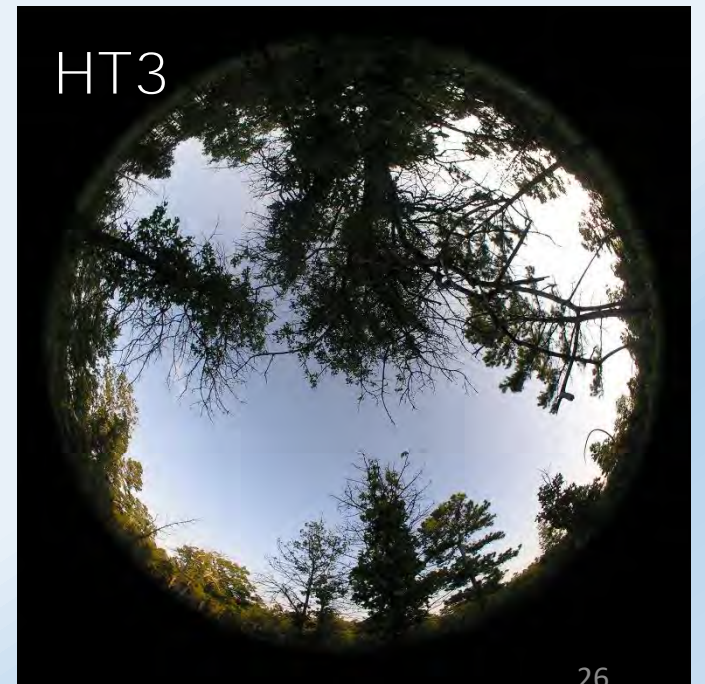
Understory productivity over time

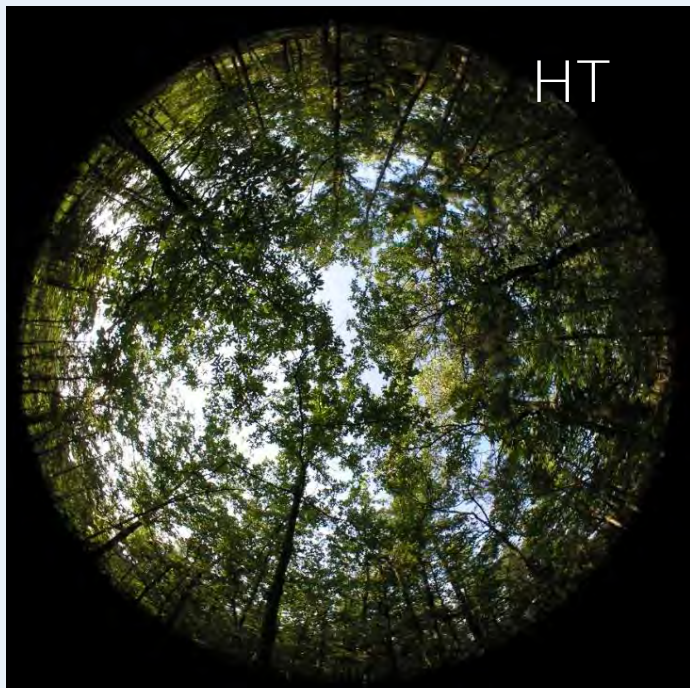


Understory productivity typical of current condition

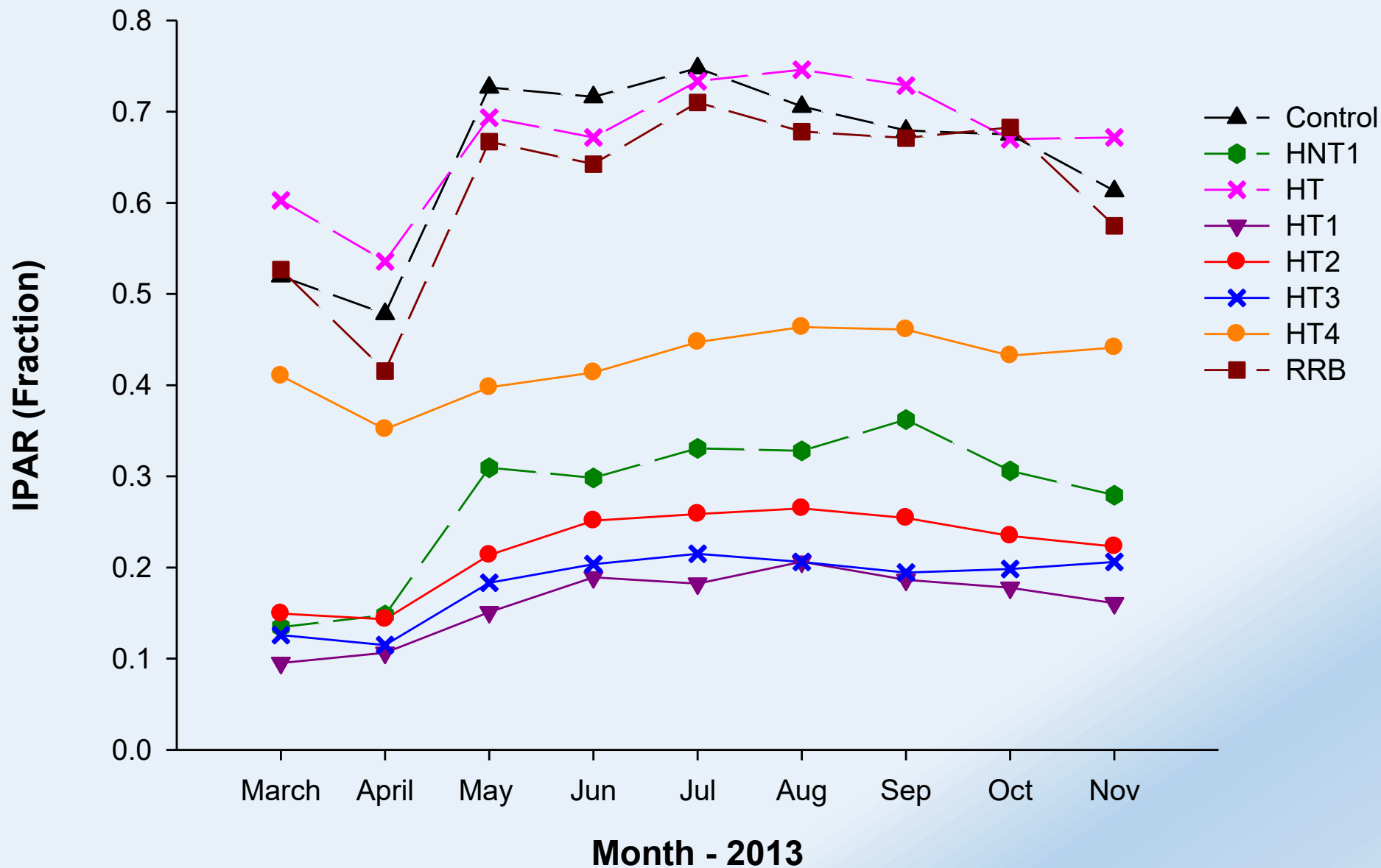


How does overstory condition affect understory productivity?

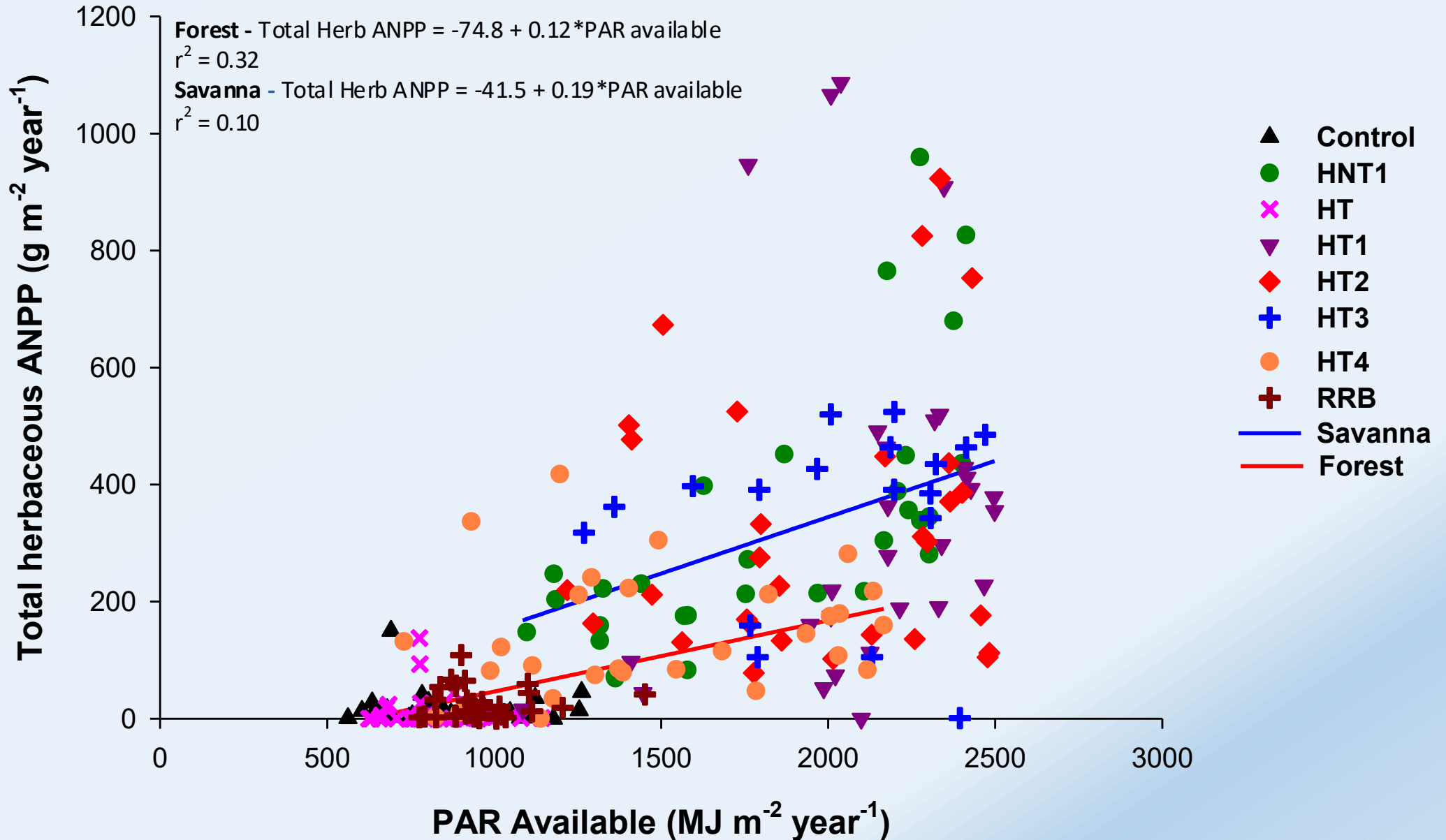




Fraction of sunlight captured by overstory



Sunlight reaching understory vs productivity



How does interannual weather variation
affect understory productivity?

Fuel Loading
**varies with total rainfall, its
seasonal distribution, stand
conditions, burn frequency**

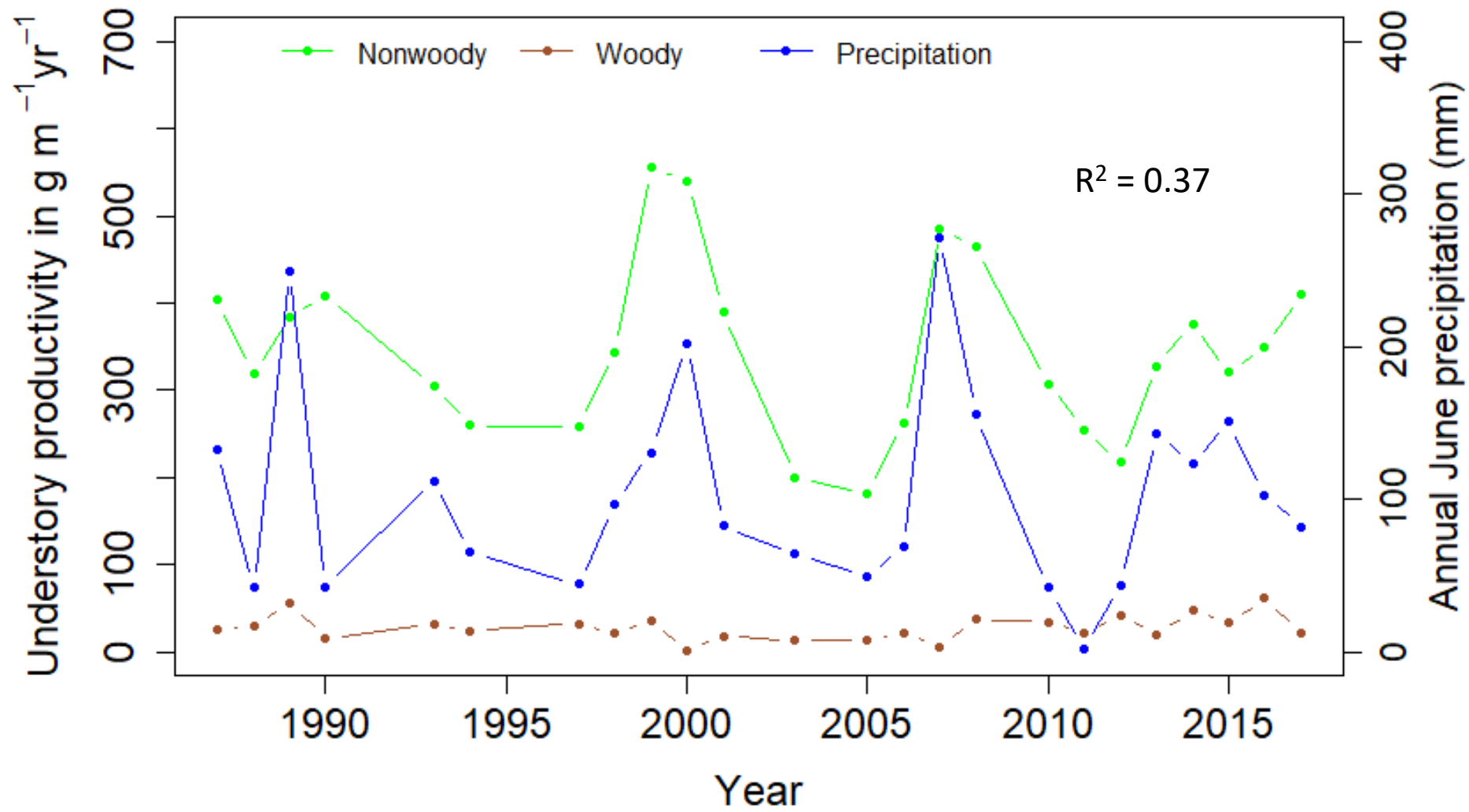


**SAME
PLOTS**

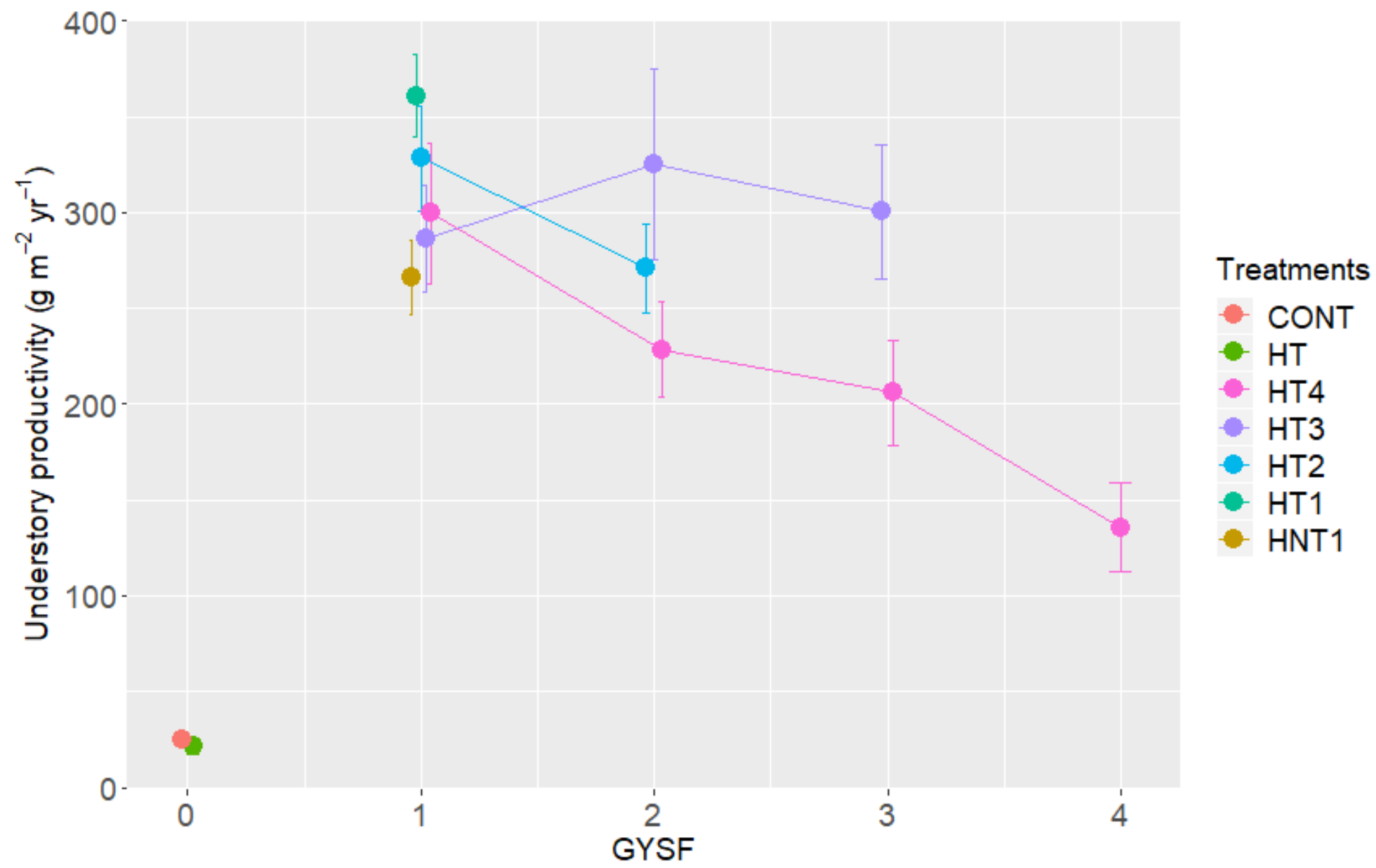
**2011 – 670 mm rainfall (26”)WY
Sept Standing Crop -1453 kg/ha**

**2000 – 1256 mm rainfall (49”)WY
Sept Standing Crop- 5500 kg/ha**

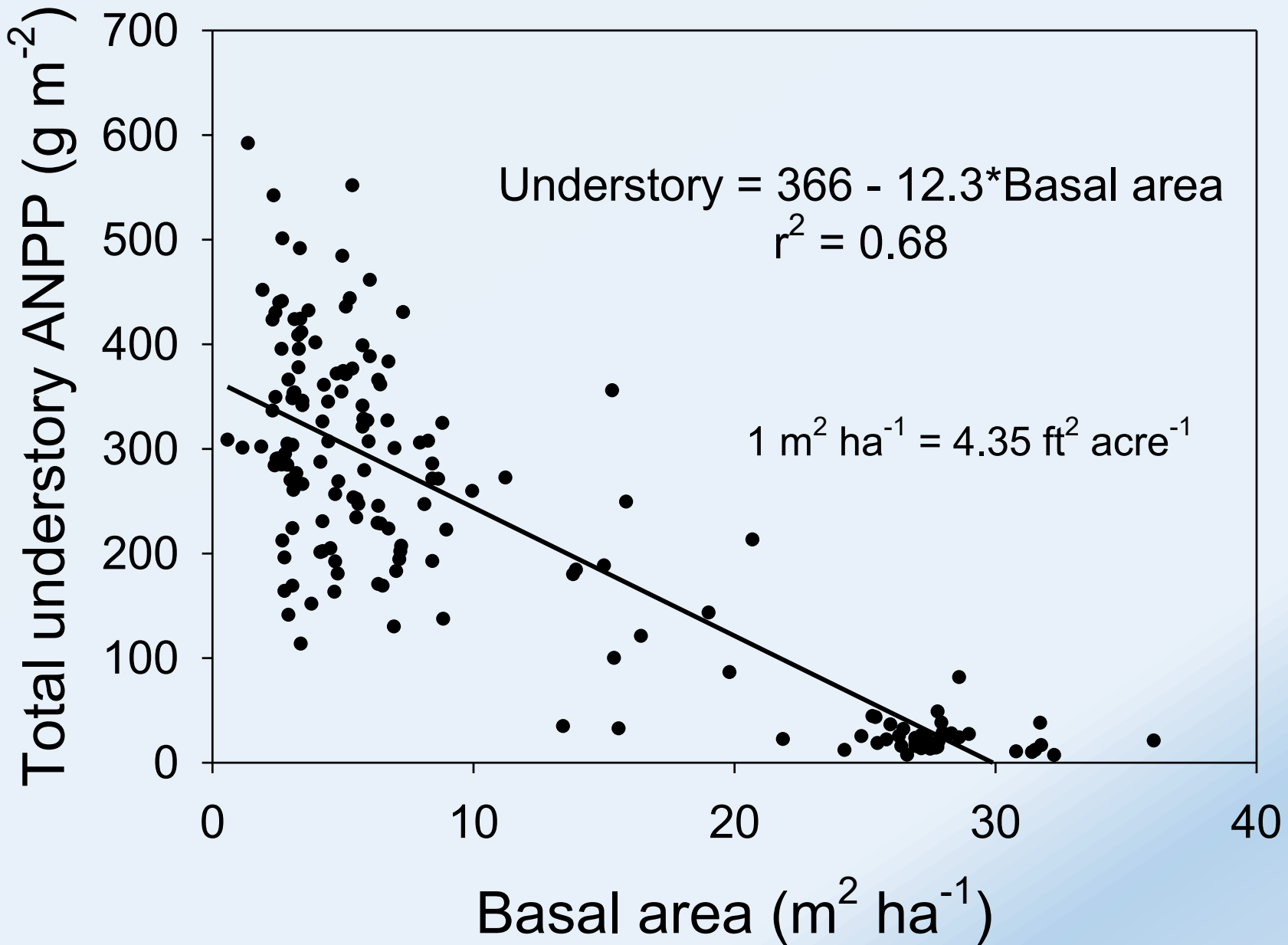


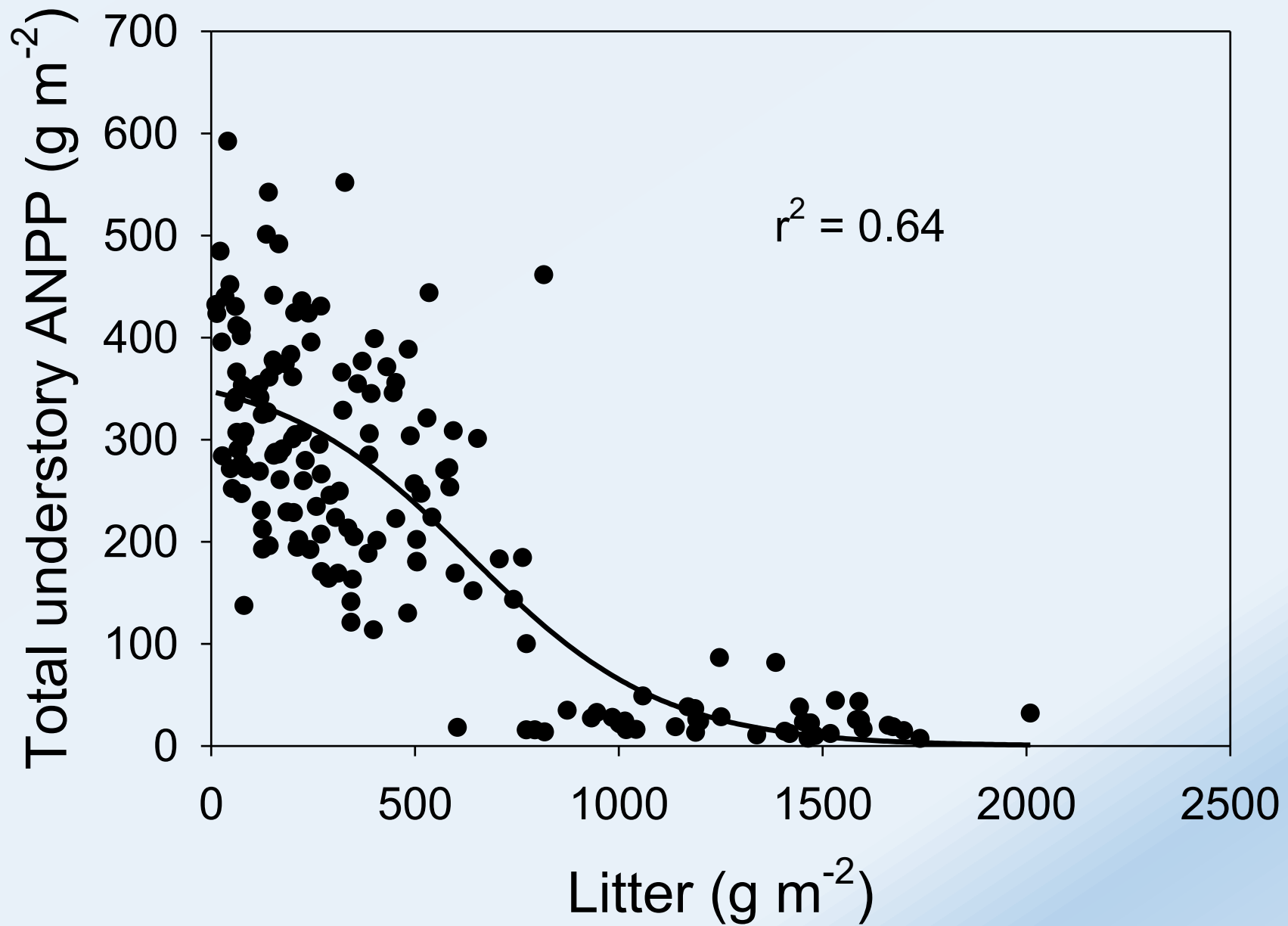


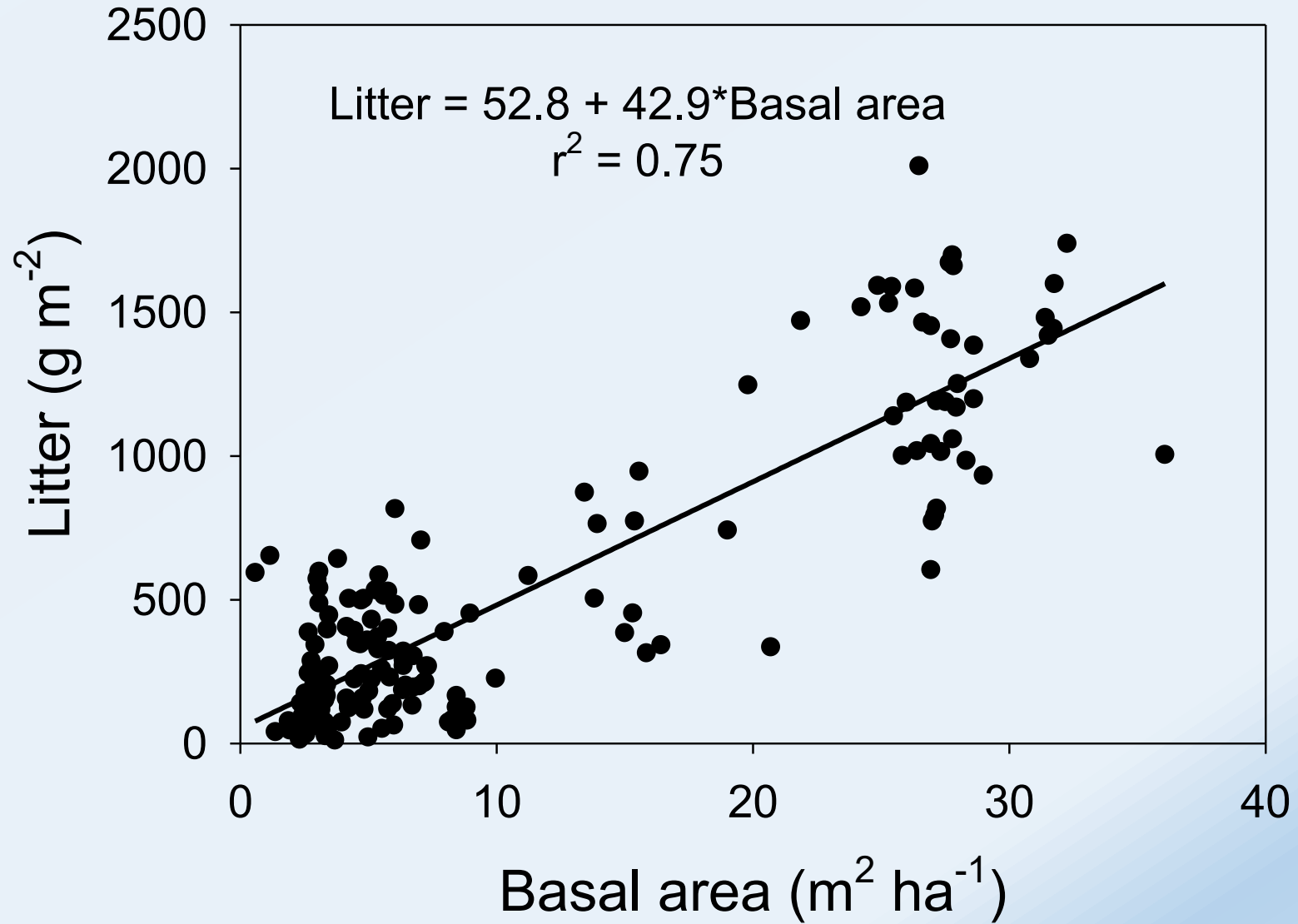
How does time since fire affect understory productivity?



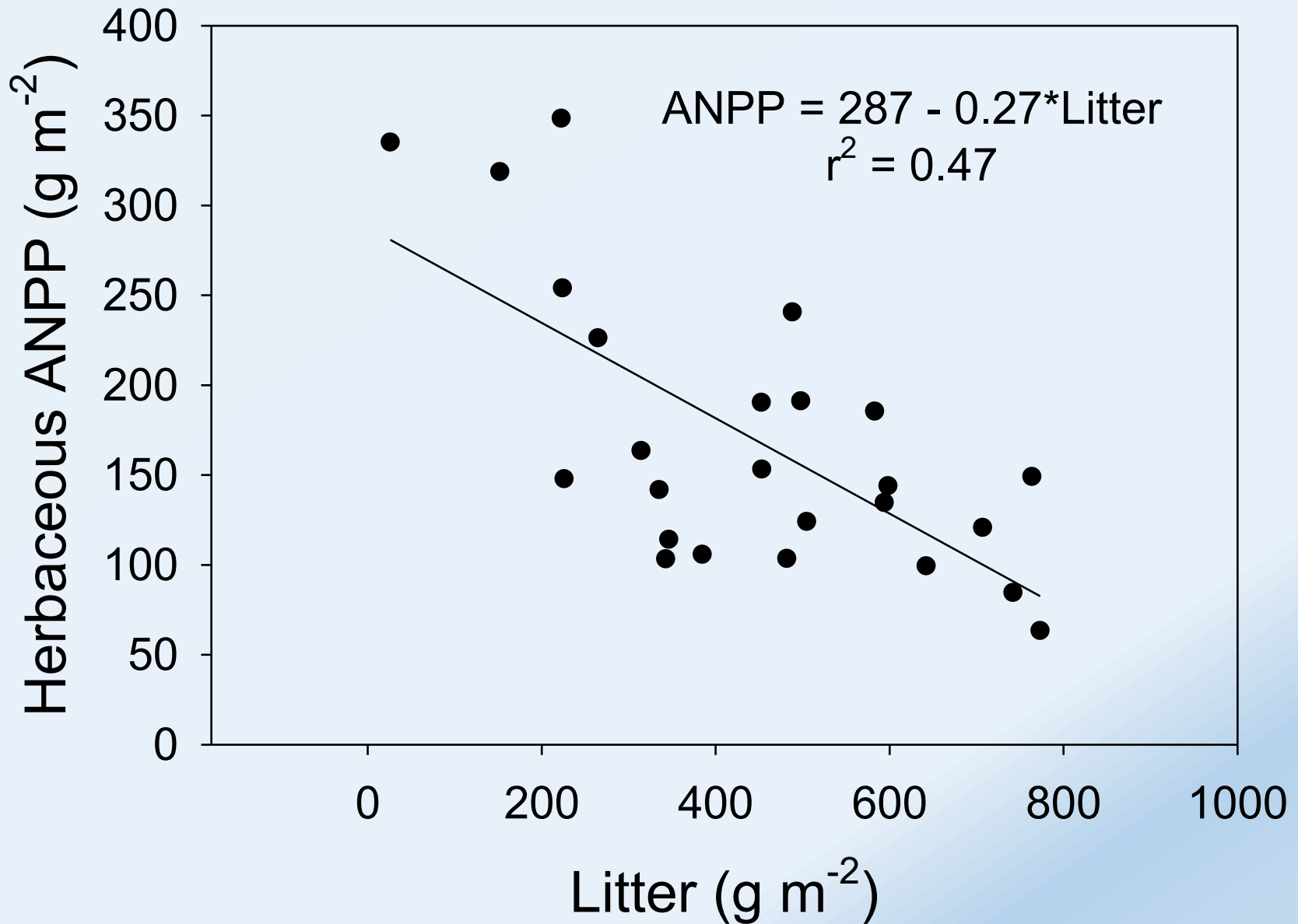
Predictive relationships for understory productivity





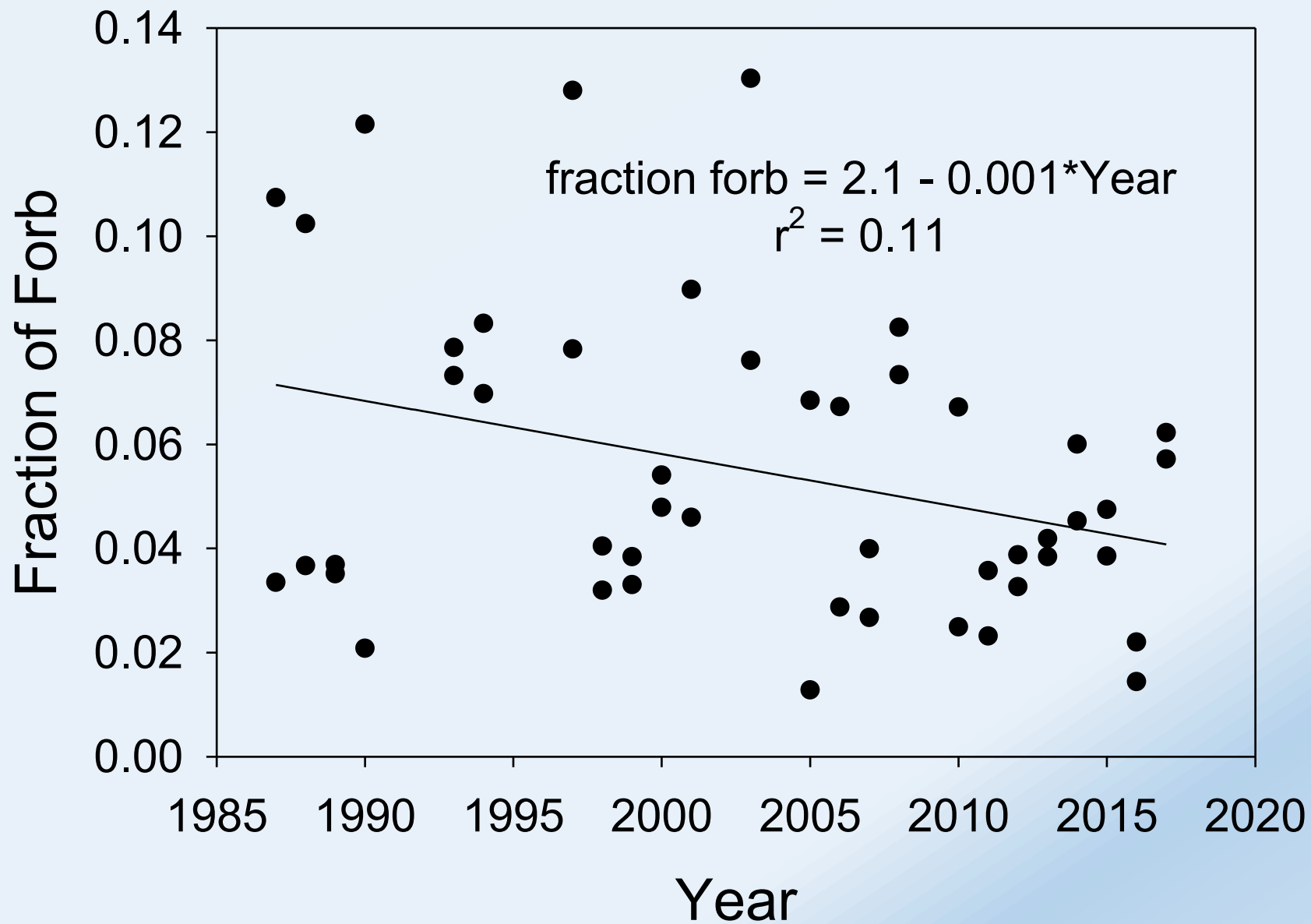


Litter effects at constant BA; HT4 Only

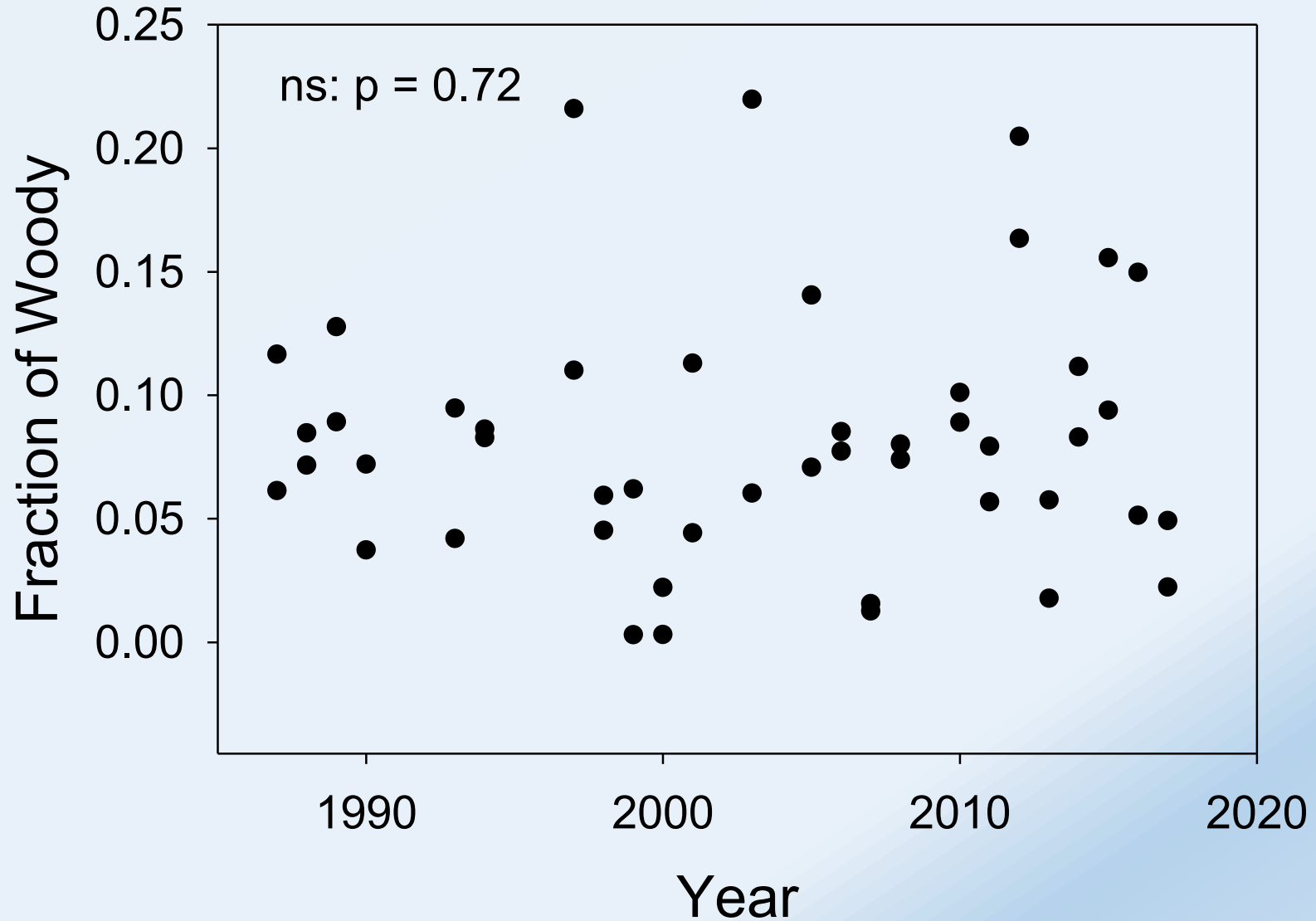


Does annual burning for 30+ years
reduce forb or woody understory?

Annually burned HT1 and HNT1



Annually burned HT1 and HNT1



Conclusions

- Understory productivity strongly correlated with overstory canopy development and litter accumulation
- While litter and overstory are correlated, they do have some effects independent of one another
- Herbaceous productivity best correlated with June precipitation
- Herbaceous productivity stimulated by fire, in part due to litter reduction
- Annual fire may slightly reduce forb abundance

Management Implications

- Burn, burn, burn
- Fire return intervals of three years or less are necessary to maintain conditions for understory productivity
- Not all basal area targets are the same. Given harvest of mature pines at this study site, target basal around ~45 ft²/ac which is lower than typical 60 ft²/ac
- **Even if BA 'creeps up', by reducing litter, burning increases understory**

Acknowledgements

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Questions?

