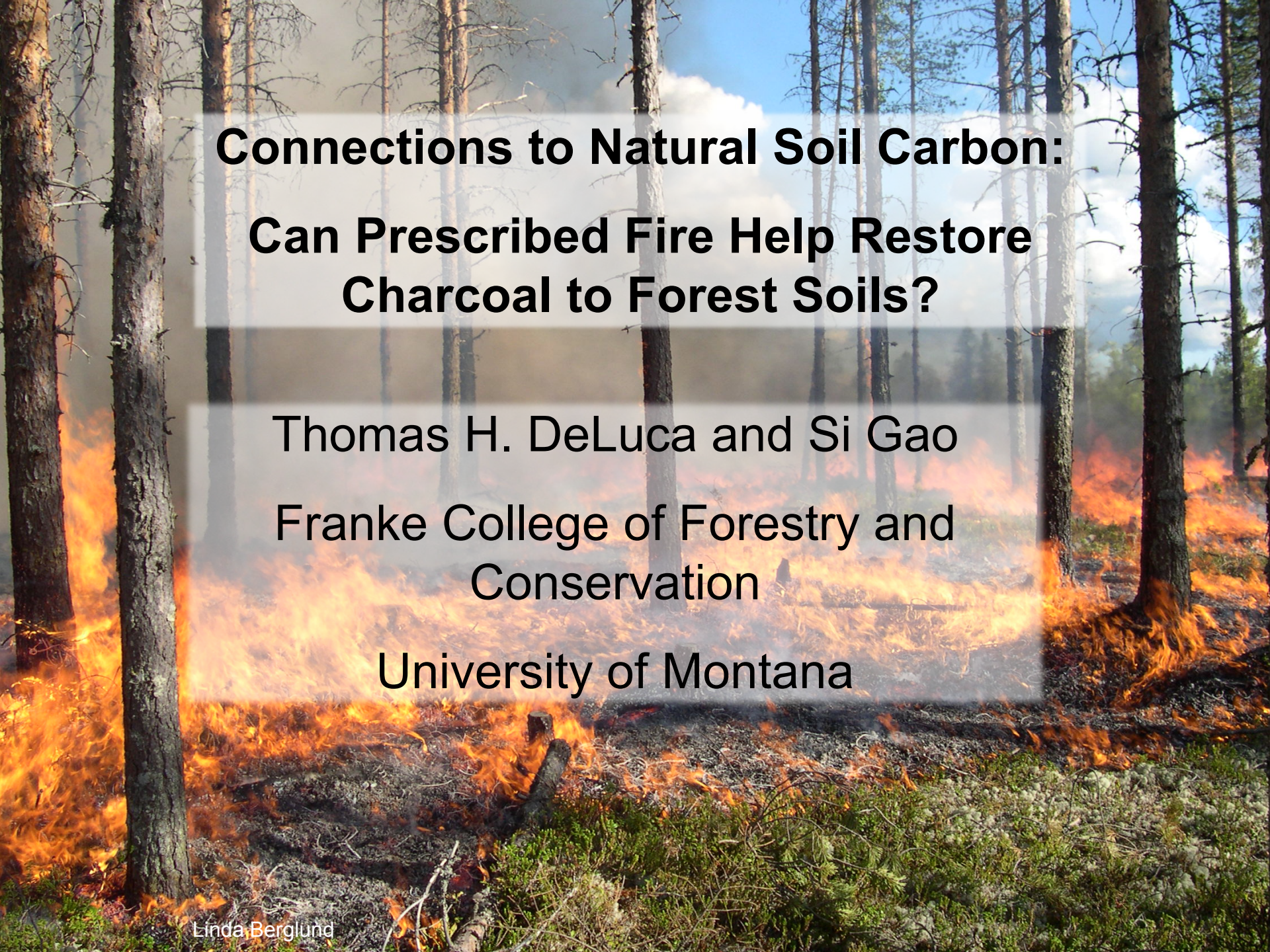


Connections to Natural Soil Carbon:

Can Prescribed Fire Help Restore Charcoal to Forest Soils?

Thomas H. DeLuca and Si Gao

Franke College of Forestry and Conservation

University of Montana

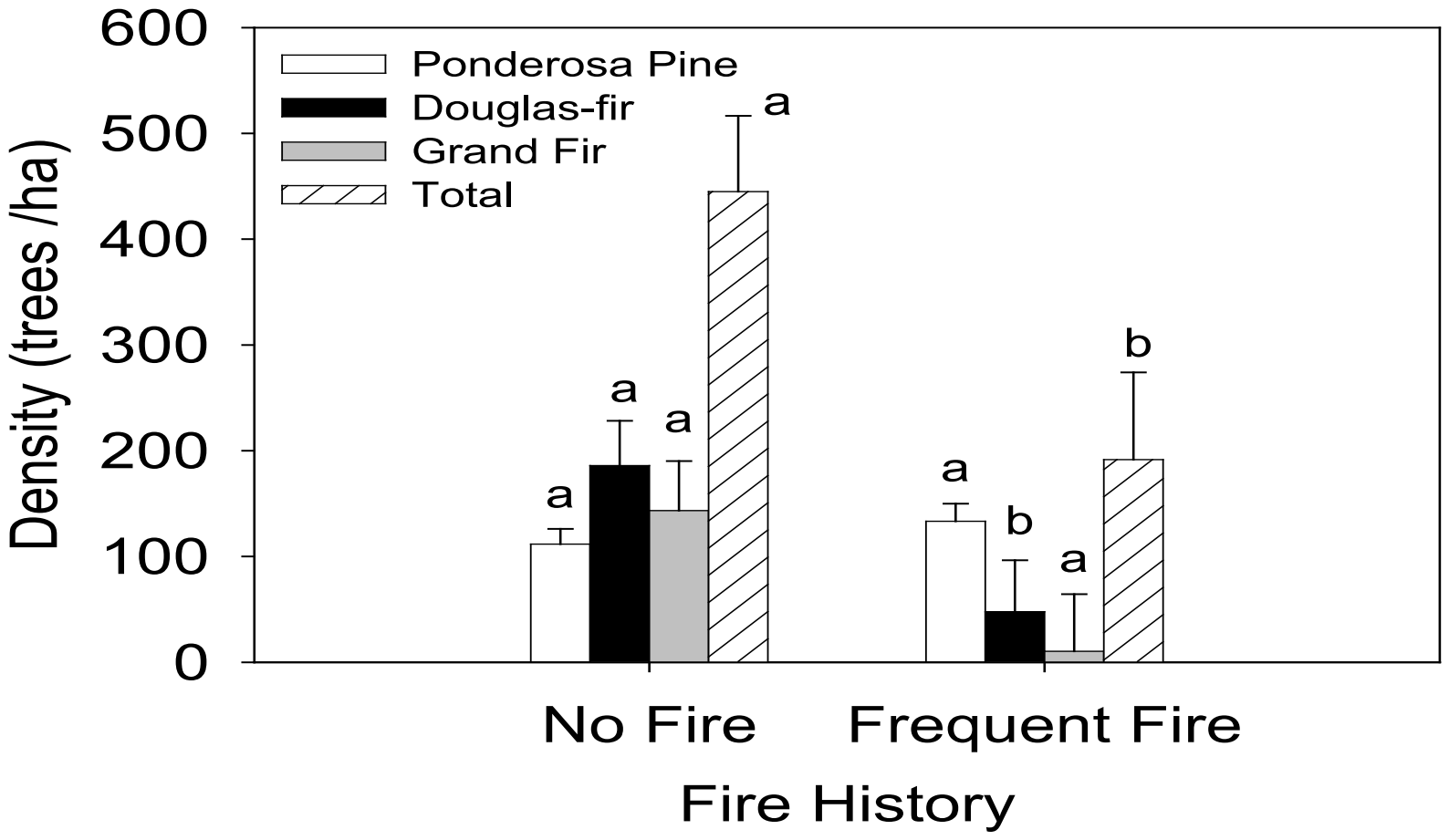
Linda Berglund

Fire is a fundamental disturbance in Western forests

Need to consider effect of:

- Fire suppression
- Prior stand management
- Fire severity
- Charcoal (PyC) generation

Carbon storage in fire maintained forest ecosystems?



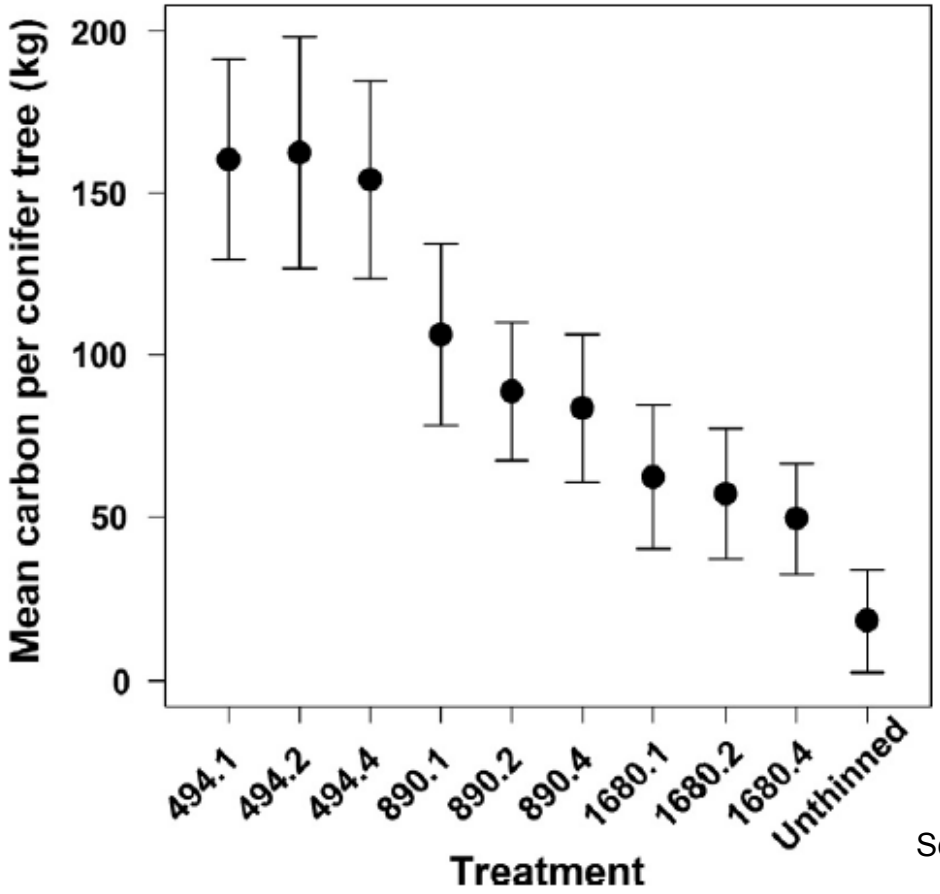
Old growth, fire suppressed

Big trees store more C

Second growth fire suppressed

Thinning can increase tree C

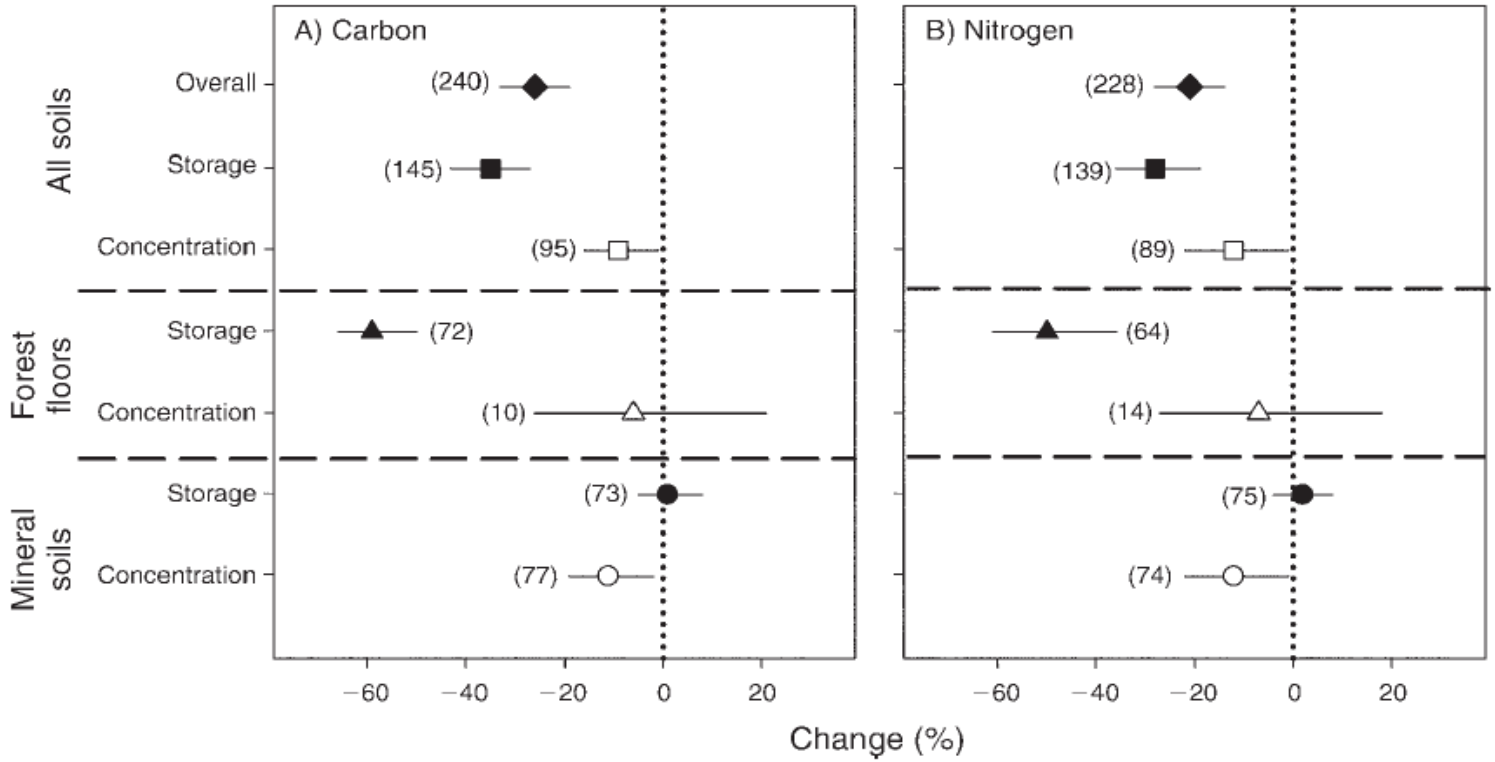
But not whole ecosystem C



Schaedel et al. 2017

Schaedel et al. 2017. Four study replicated sites in western Montana, 1, 2 or 4 thinning entries.

Fire and mineral soil C & N



Recurrent fire can reduce soil C

Pellegrini et al. 2017

Noted impact on forest floor C & N

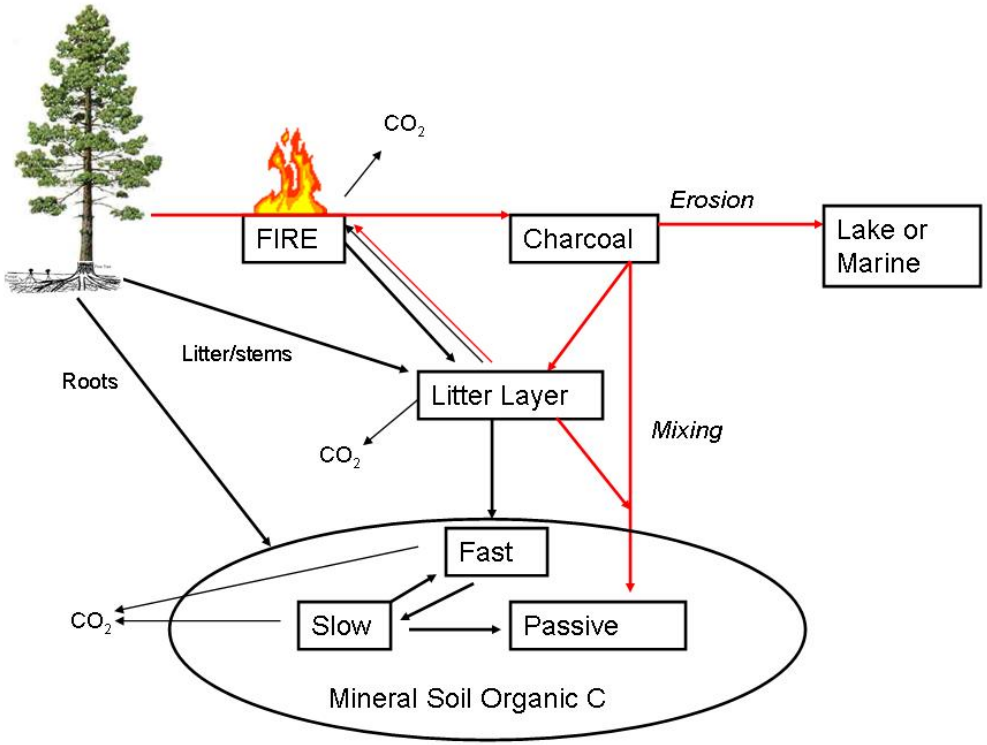
Often minimal effect on mineral soil C & N

Nave et al. 2011

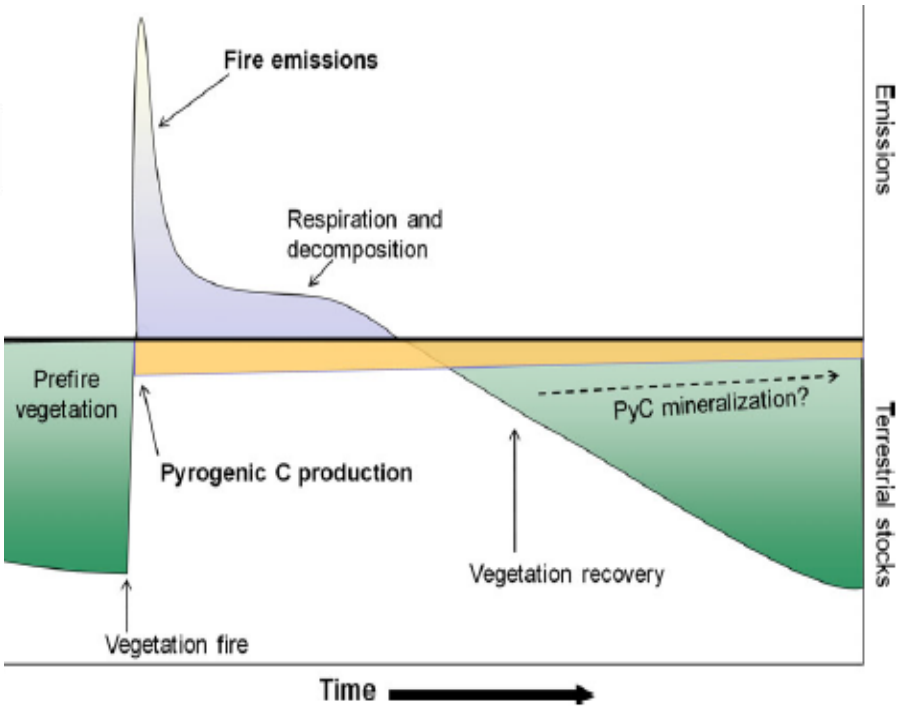

PyC is a legacy of all fire events
How much C gets stored in wildfire and Rx fire events?

PyC: Rapid formation of passive C

Rapid formation of passive C



DeLuca and Aplet (2008) Frontiers Eco Env

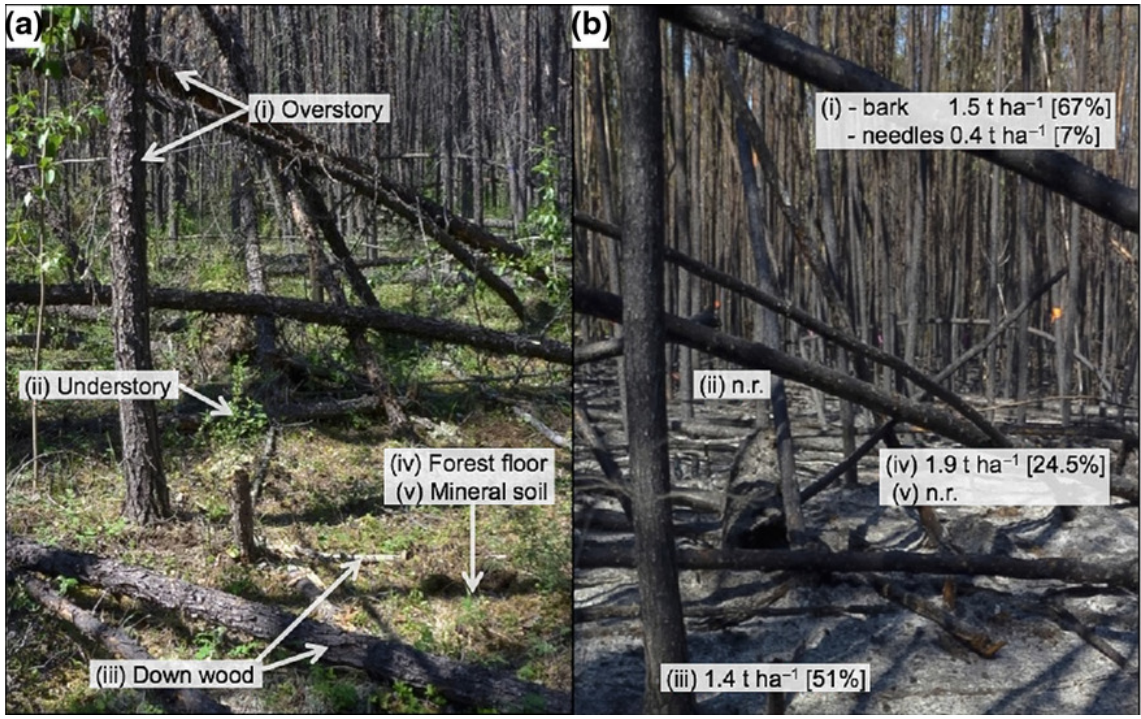


From Santín et al. (2016) GCB

Is PyC a significant part of ecosystem C?

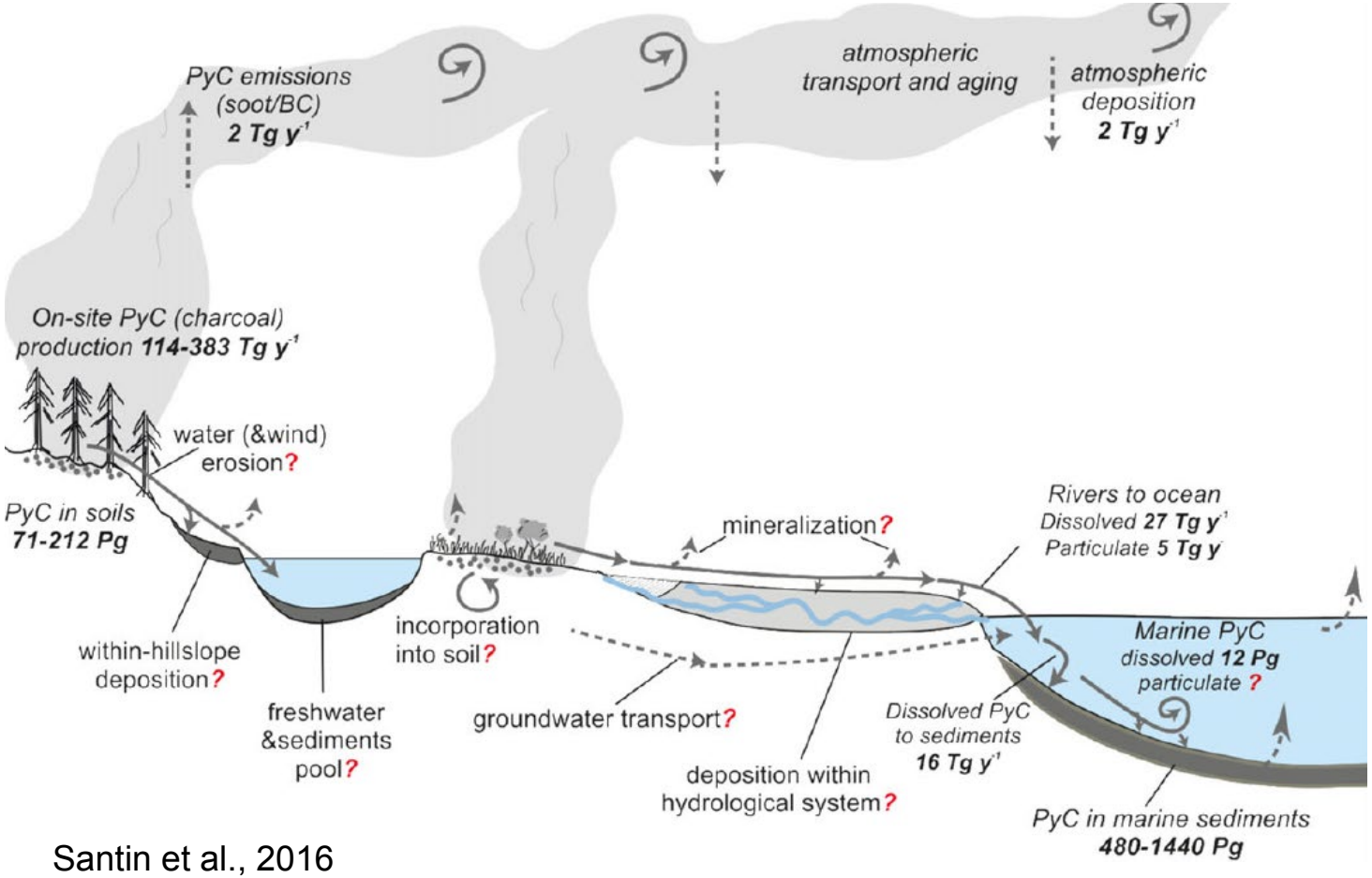
Charcoal from biomass

- Forest floor, down wood and overstory produced similar amounts of PyC
- Boreal fire
  - ~4.8 Mg PyC ha^{-1}
  - 27% of C
  - 115-383 Tg PyC yr^{-1}
- Where does PyC go?



Santín et al. 2015. GCB

Where does PyC go?

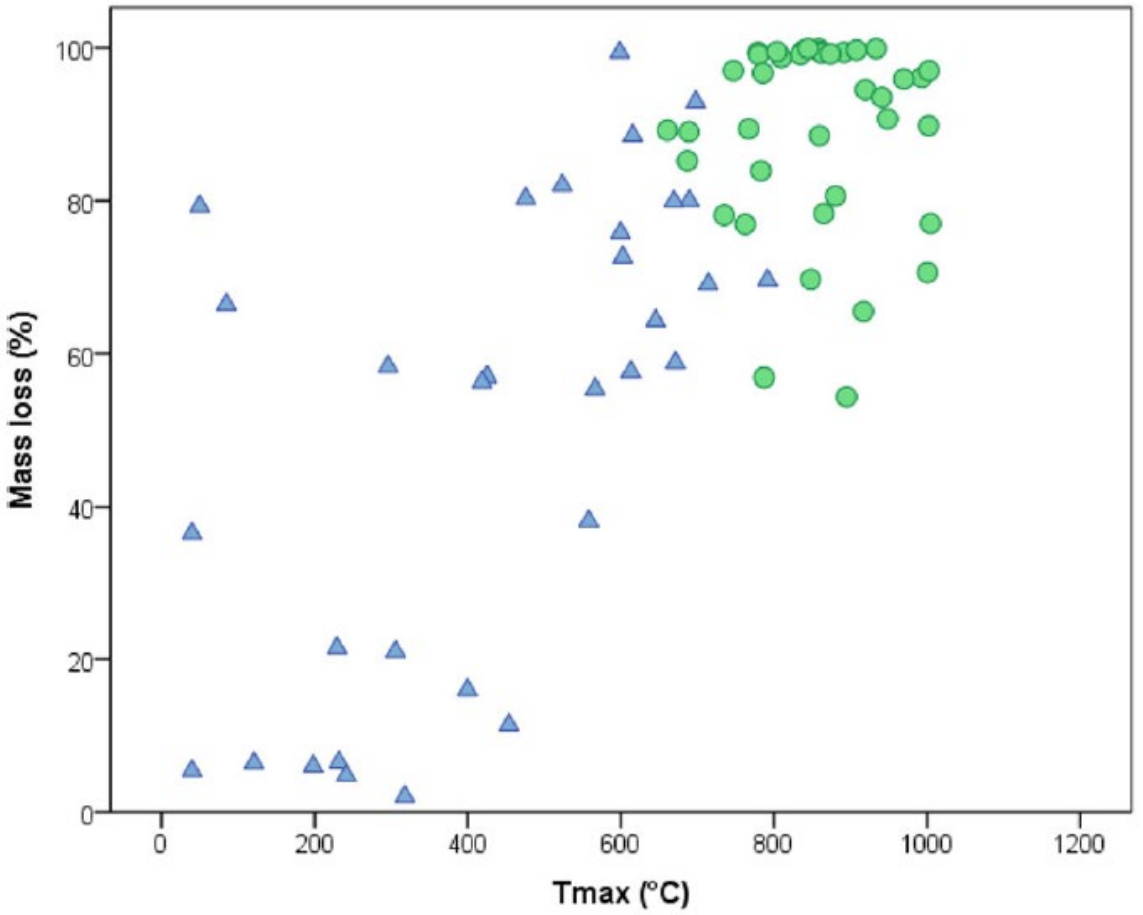


Santin et al., 2016

PyC conversion rates v temp

Mass loss during fire (pine, cedar & charcoal)

- Increased temps = increased loss
- But, more biomass exposed to fire in higher severity fires



Doer et al. 2018

Global Fire PyC Production?

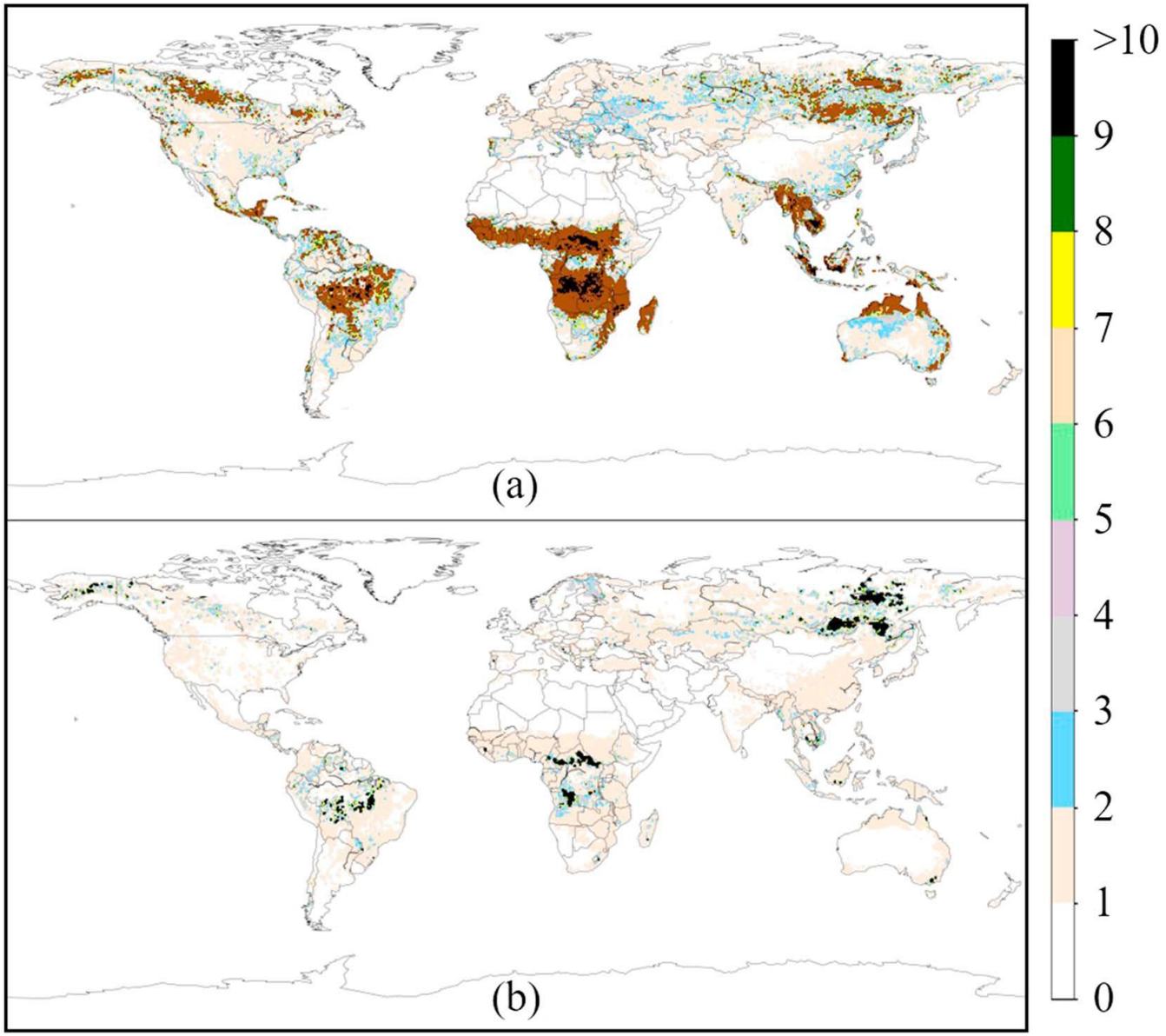
PyC production
(g PyC m^{-2} yr^{-1})

GFED4 (a) and
TEM6 (b)

Monte Carlo
analysis of CO_2/PyC
ratio

=0.2 -0.6% global NEP
= 153 Tg PyC yr^{-1}

Wei et al. 2018

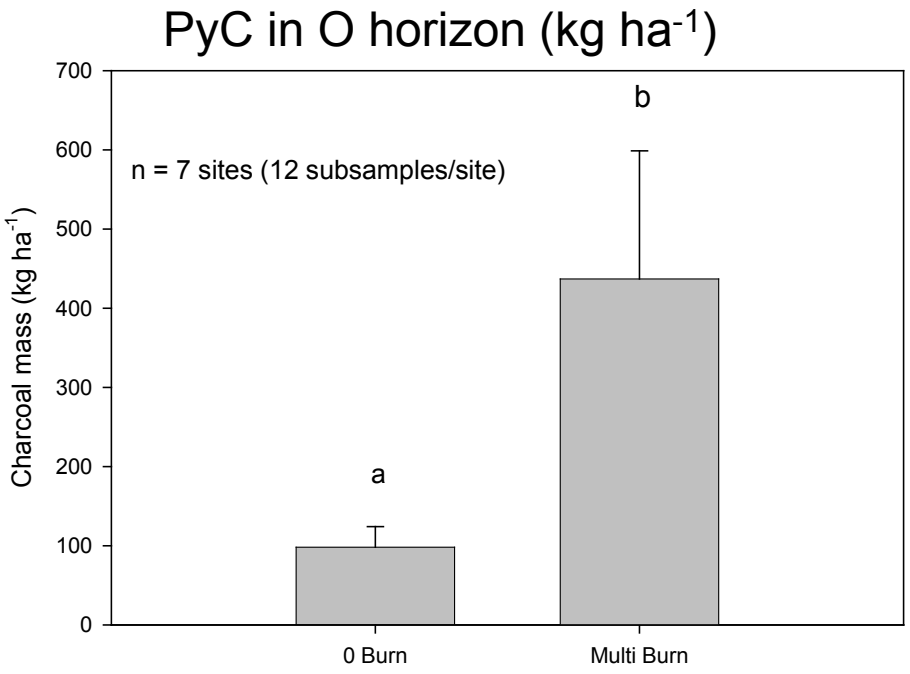


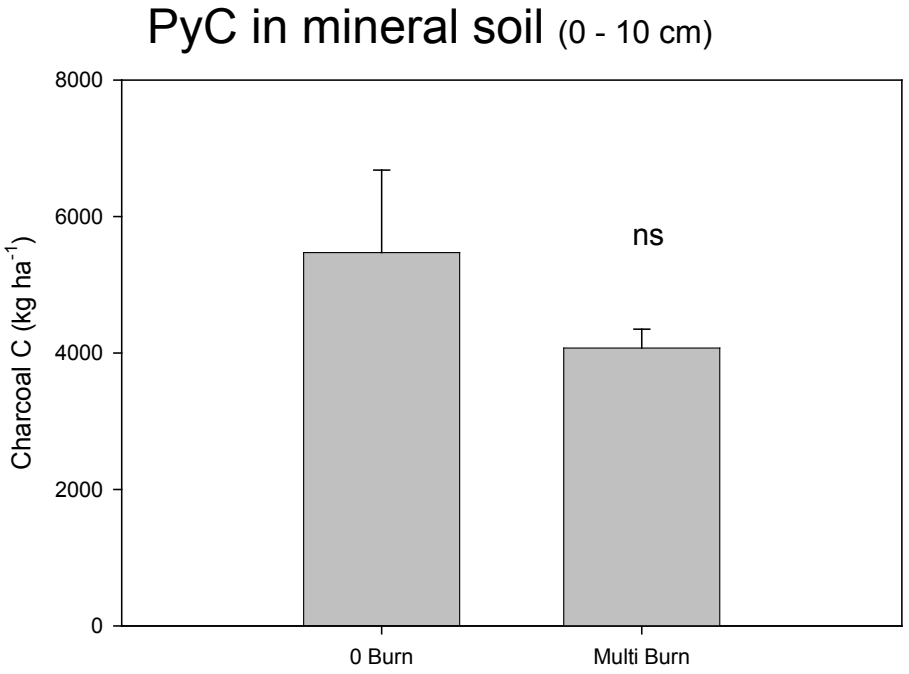
PyC Storage with Fire Northern Rockies

- Wilderness 0, 1, 2, or 3 wildfires 120 yr
  - Wildfire PyC accumulation
- Fire, Fire Surrogates Study
  - Thin, thin burn, burn no thin
- Meta analysis of existing studies

Soil PyC PIPO 0 - 3 fires in 130 years

Frank Church and Selway Bitterroot Wilderness

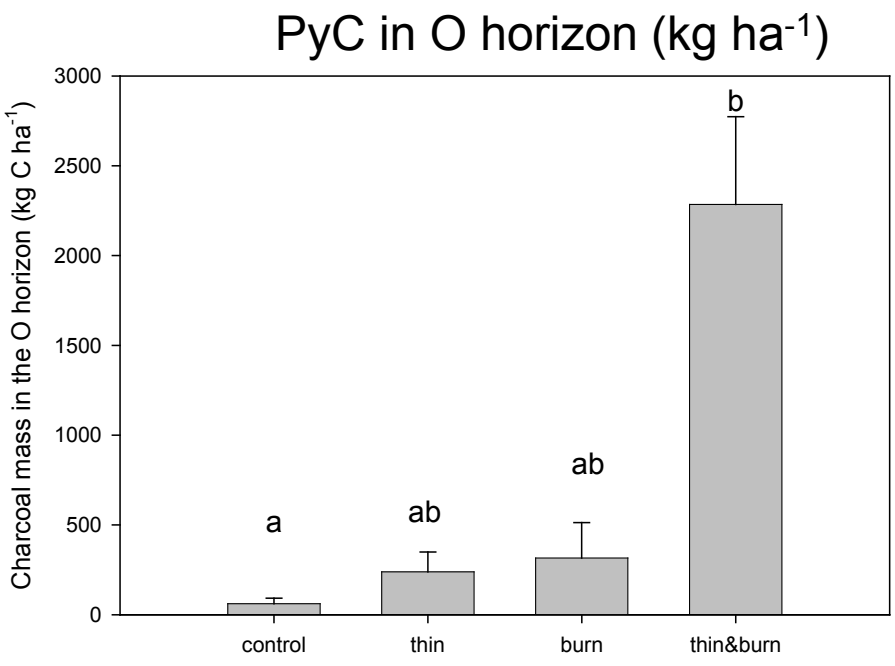


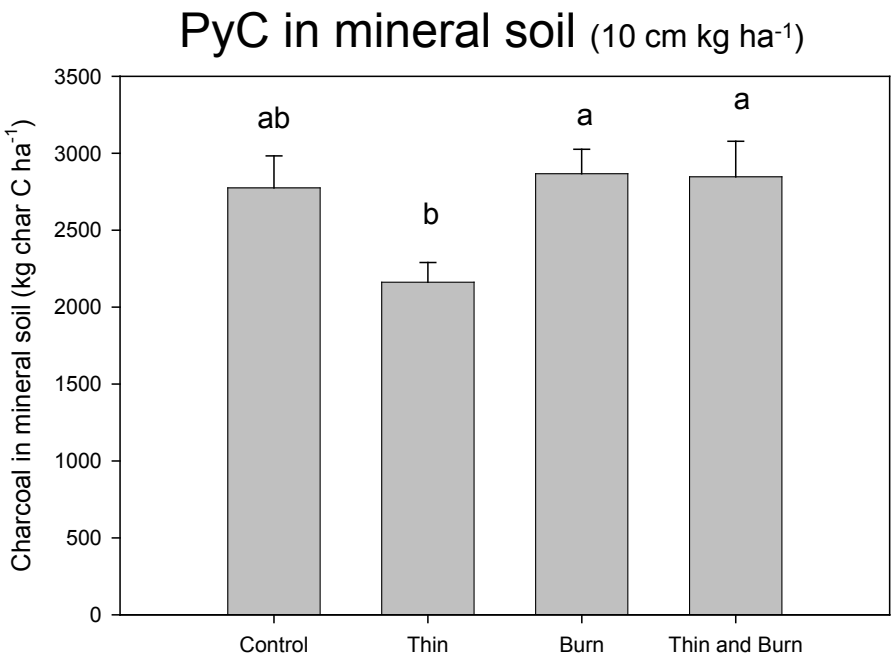


Data from Brimmer (2006); Kurth et al. (2006), and DeLuca and Sala (2006)

PyC Production with Restoration

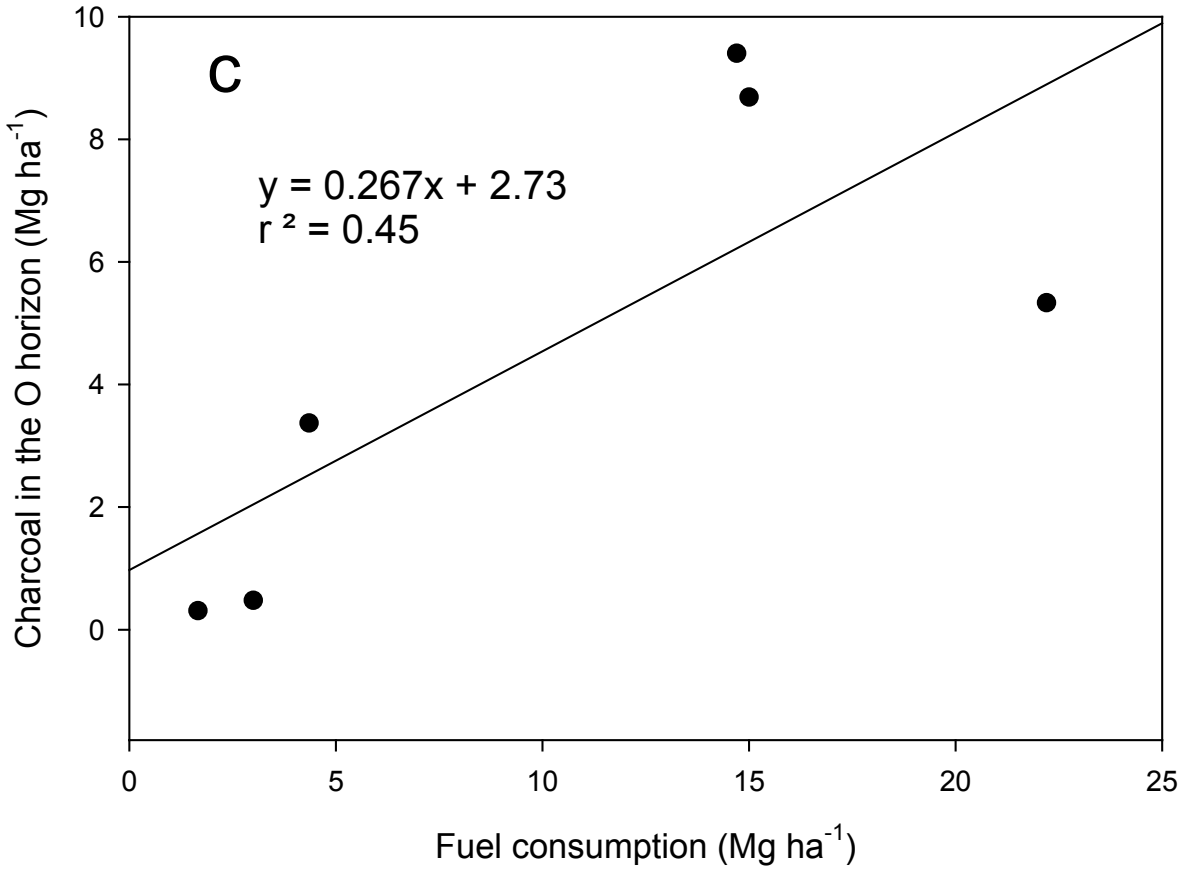
Restoration treatments (FFS Plots MT) and PyC





DeLuca et al., unpublished

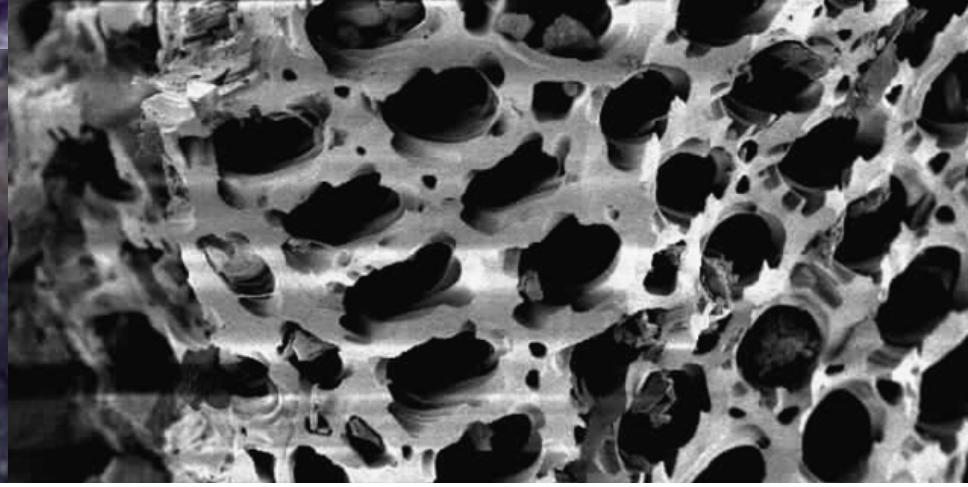
Fuel Consumption and PyC Formation

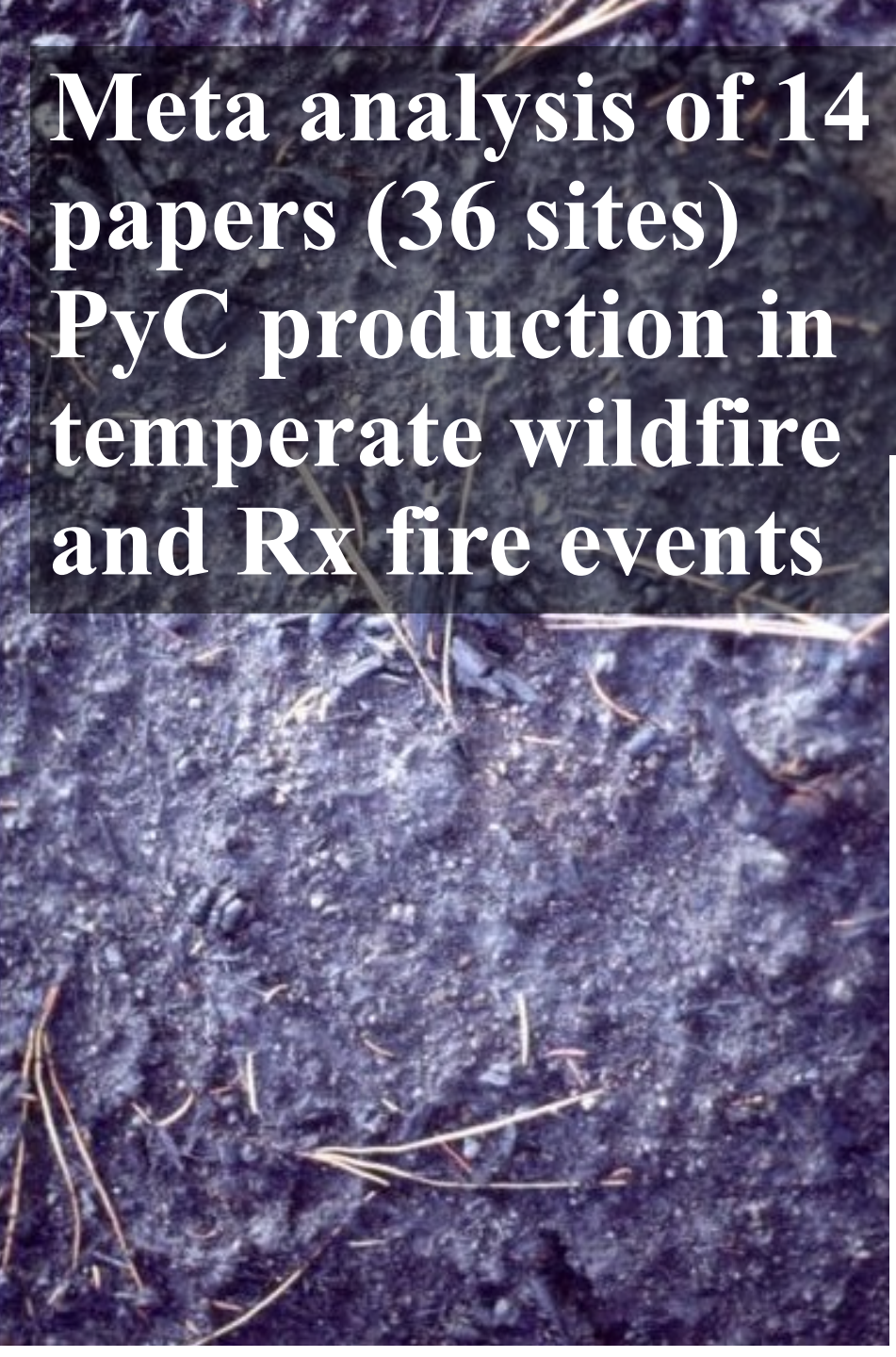


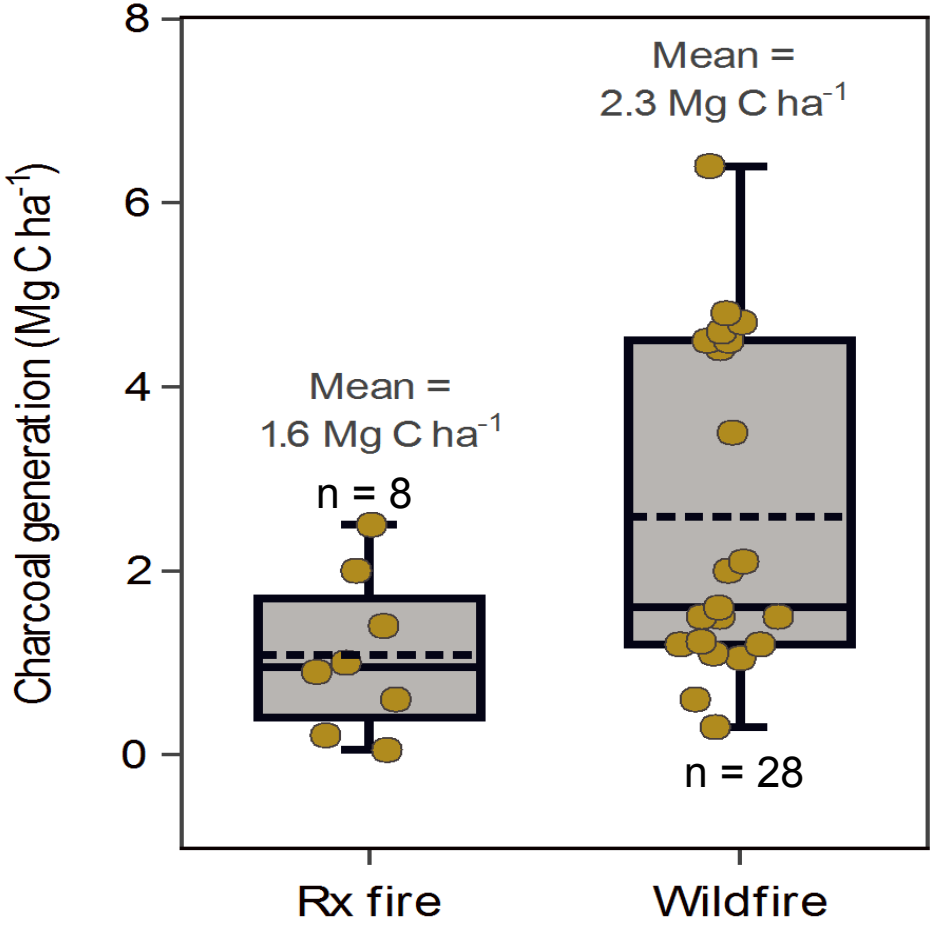
	'C as a % fuel nsumed
Prescribed F Thin and Bu	8.0
Prescribed F Burn Alone	3.0

DeLuca et al., unpublished

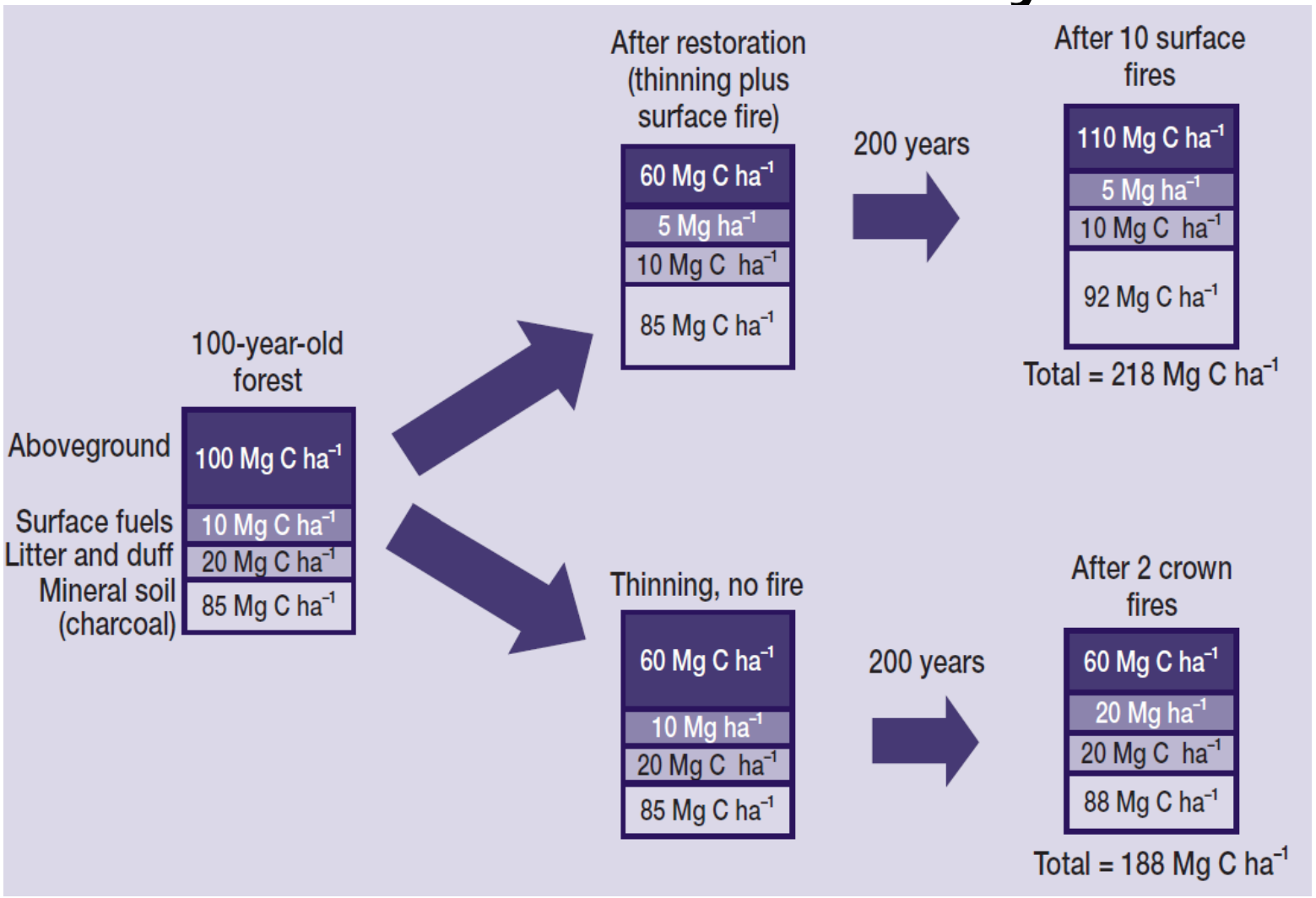
Meta analysis of 14 papers (36 sites) PyC production in temperate wildfire and Rx fire events







Hypothetical PyC with two or ten fires in 200 yrs



DeLuca & Aplet, 2008

Discussion

- Fire emits C, but also forms PyC
- Globally PyC is significant ~150 Tg C as PyC yr^{-1}

- Restoration thin + fire = ~1 – 2 Mg PyC ha^{-1}
- Thin alone = no additional PyC
- Wildfire PyC = 2 – 3 Mg PyC ha^{-1}
- Recurrent fire: less PyC/fire than single hot fire, but recurrent fire generates more PyC
- Prescribed fire will restore soil PyC

Questions

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