The Impact of Fire on Soil and Plant Nutrients in Calcareous Subtropical Wetlands

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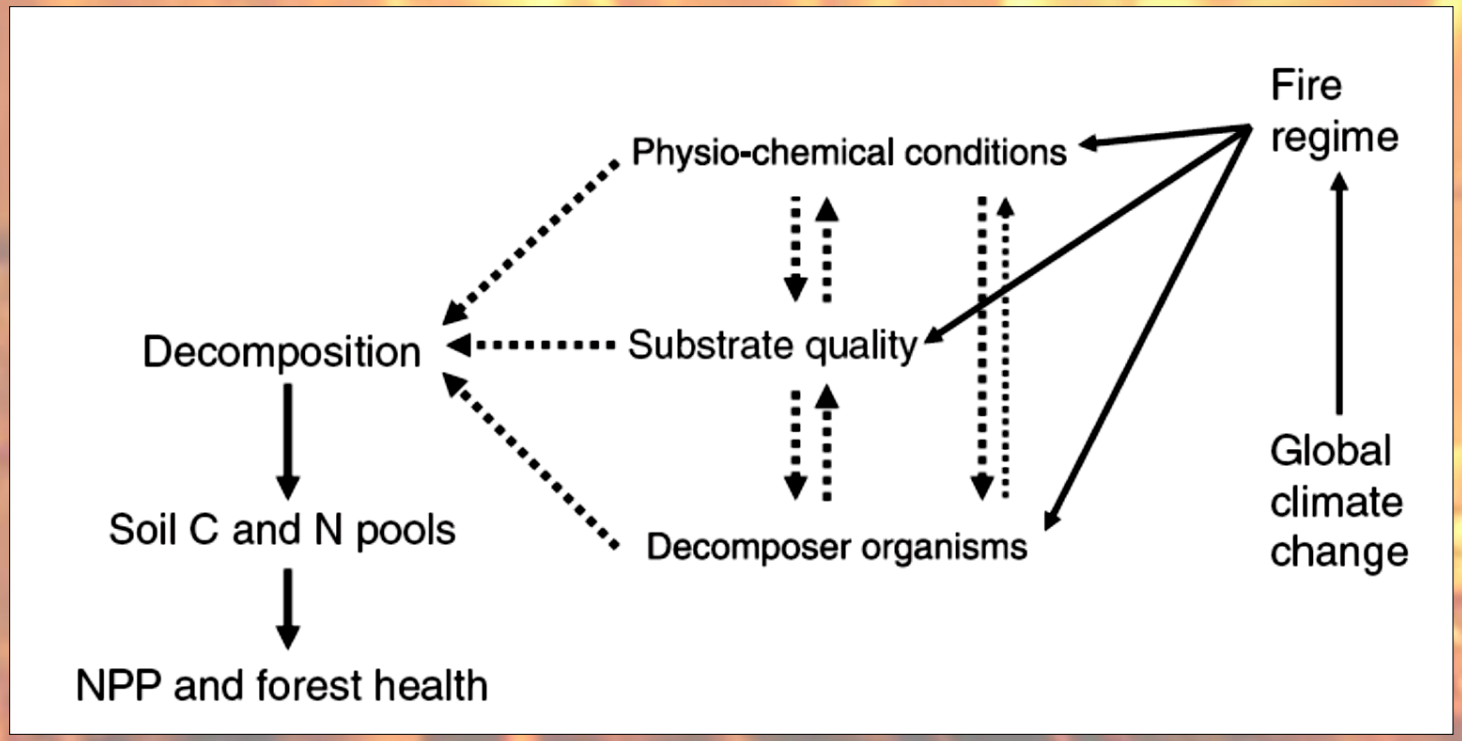
Fire Biogeochemistry

- Consumes fuel (organic matter)
- Nutrient loss (N volatilization)
- Nutrient inputs (Ash deposition)
- Vegetation shifts



Brennan et al. (2009)

Burning Questions

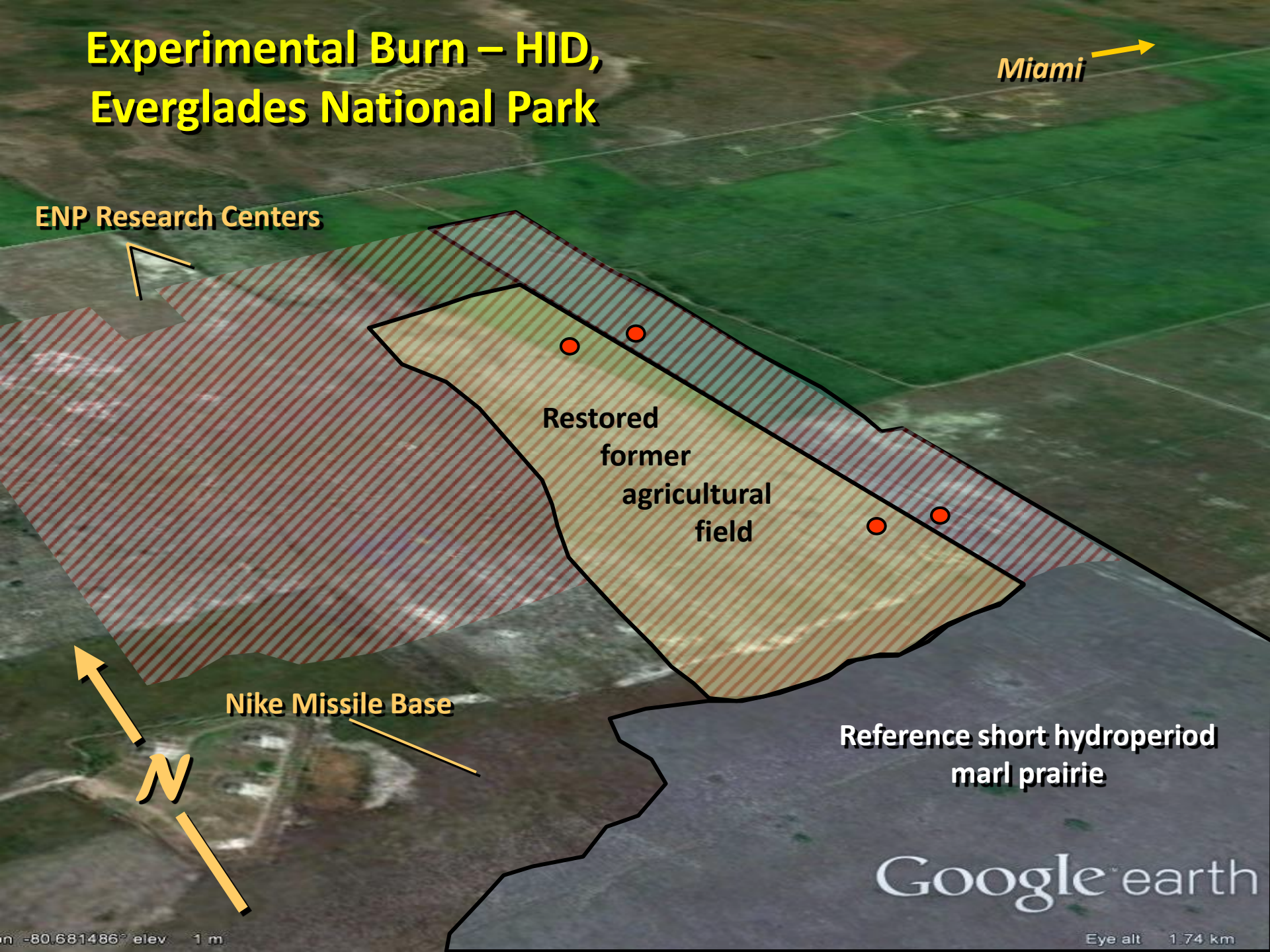
- Seasonally dry systems?
  - Soil temperature?
- Effect of fire on wetland biogeochemistry?
  - Nutrient inputs (P), losses (C, N)
  - Productivity, species shifts (longer term)
- P-limited, calcareous systems?

Study Site

- Prairie wetland (wet grassland)
- Short hydroperiod
- Marl, calcareous, P-limited
- “Fire-adapted”

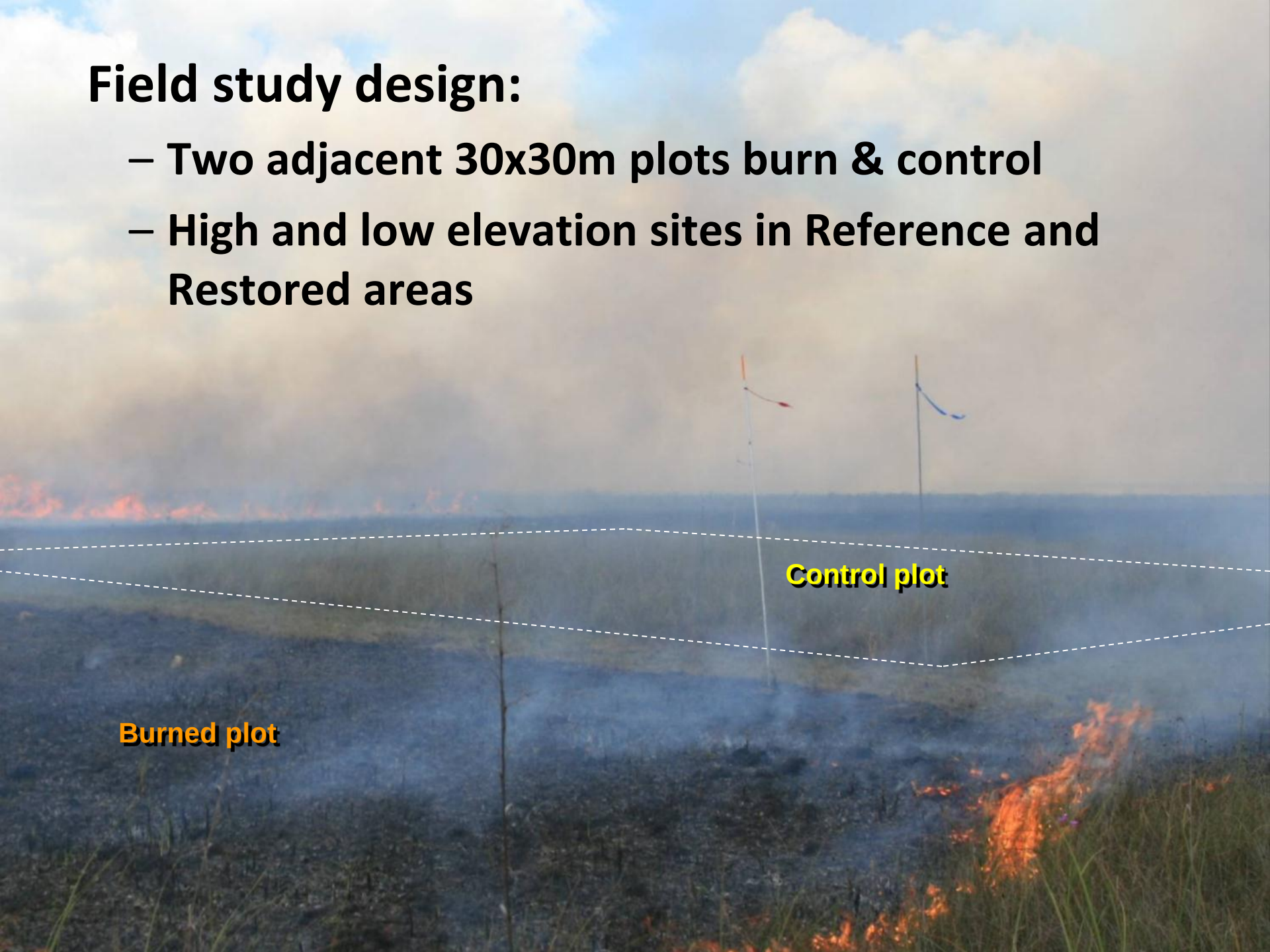
Restoration

- Former agricultural use
- High P soils scraped to bedrock
- Succesion toward P limitation
- Vegetation management


Experimental Burn – HID, Everglades National Park
Miami
ENP Research Centers
Restored former agricultural field
Nike Missile Base
N
Reference short hydroperiod marl prairie
Google earth
-80.681486° elev 1 m
Eye alt 1.74 km

Field study design:

- Two adjacent 30x30m plots burn & control
- High and low elevation sites in Reference and Restored areas



Thermocouples dataloggers, Pyrometers

Biomass Harvesting, nutrient budgets

Reference Site

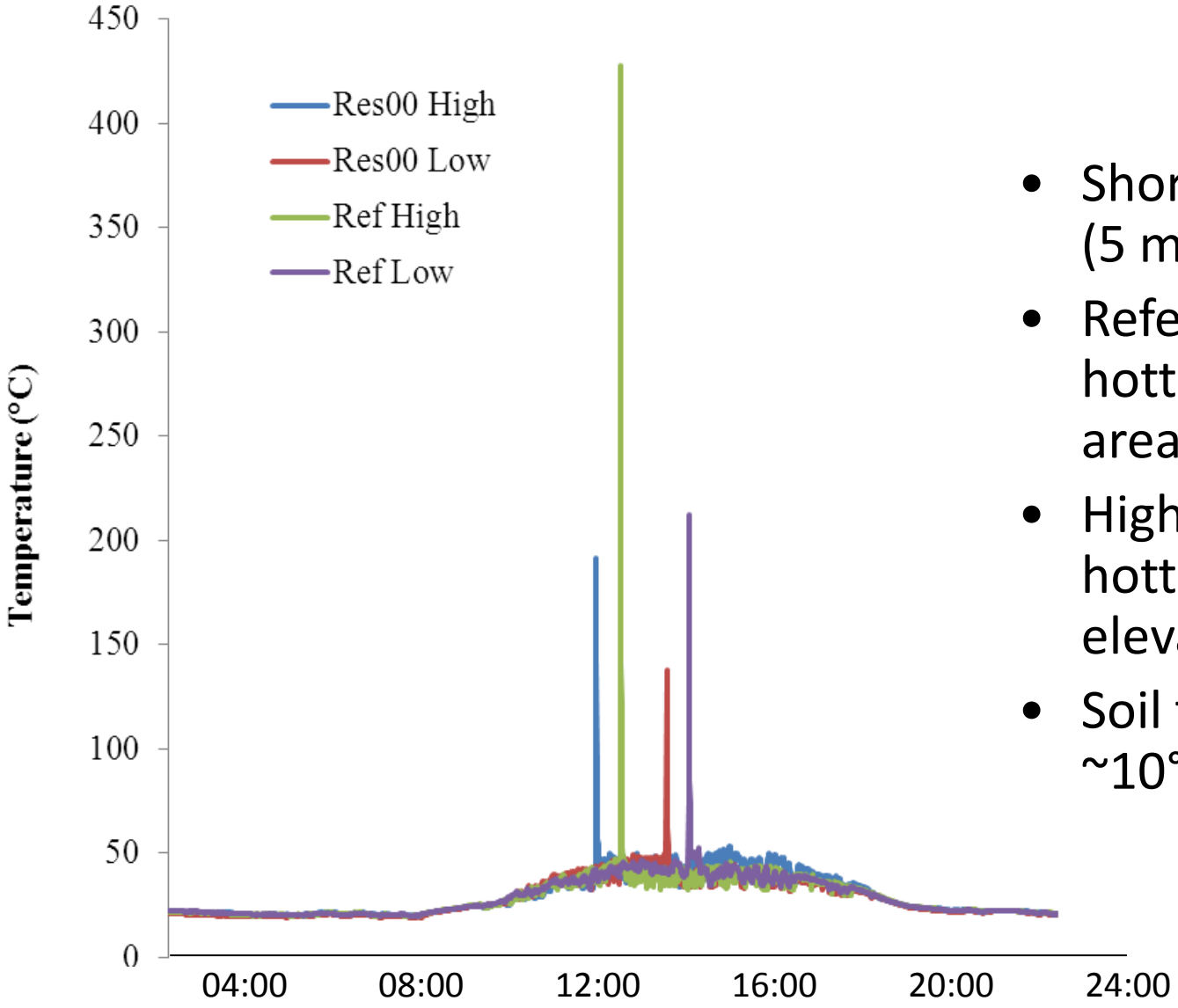
Restored Site

2 days

1 month

1 year

Temperature/Intensity



- Short-duration fires (5 min)
- Reference fires hotter than Restored areas
- High elevation fires hotter than low elevation
- Soil temps elevated ~10°C

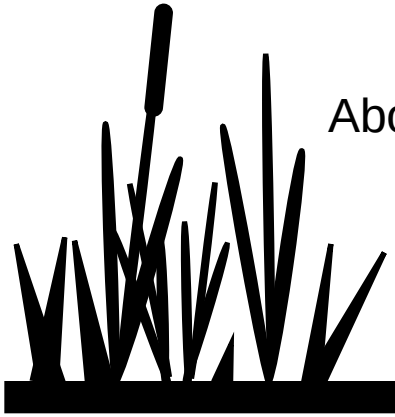
Ash Deposition

Reference

	Pre-Fire	Post-Fire (2day)
	----------mg m^{-2}----------	
Above-Ground TP	**55.3**	**58.9**
Live Biomass	13.7	0.01
Dead Biomass	8.22	1.23
Litter	3.04	1.06
Periphyton	30.2	56.7

~22 mg P m^{-2}

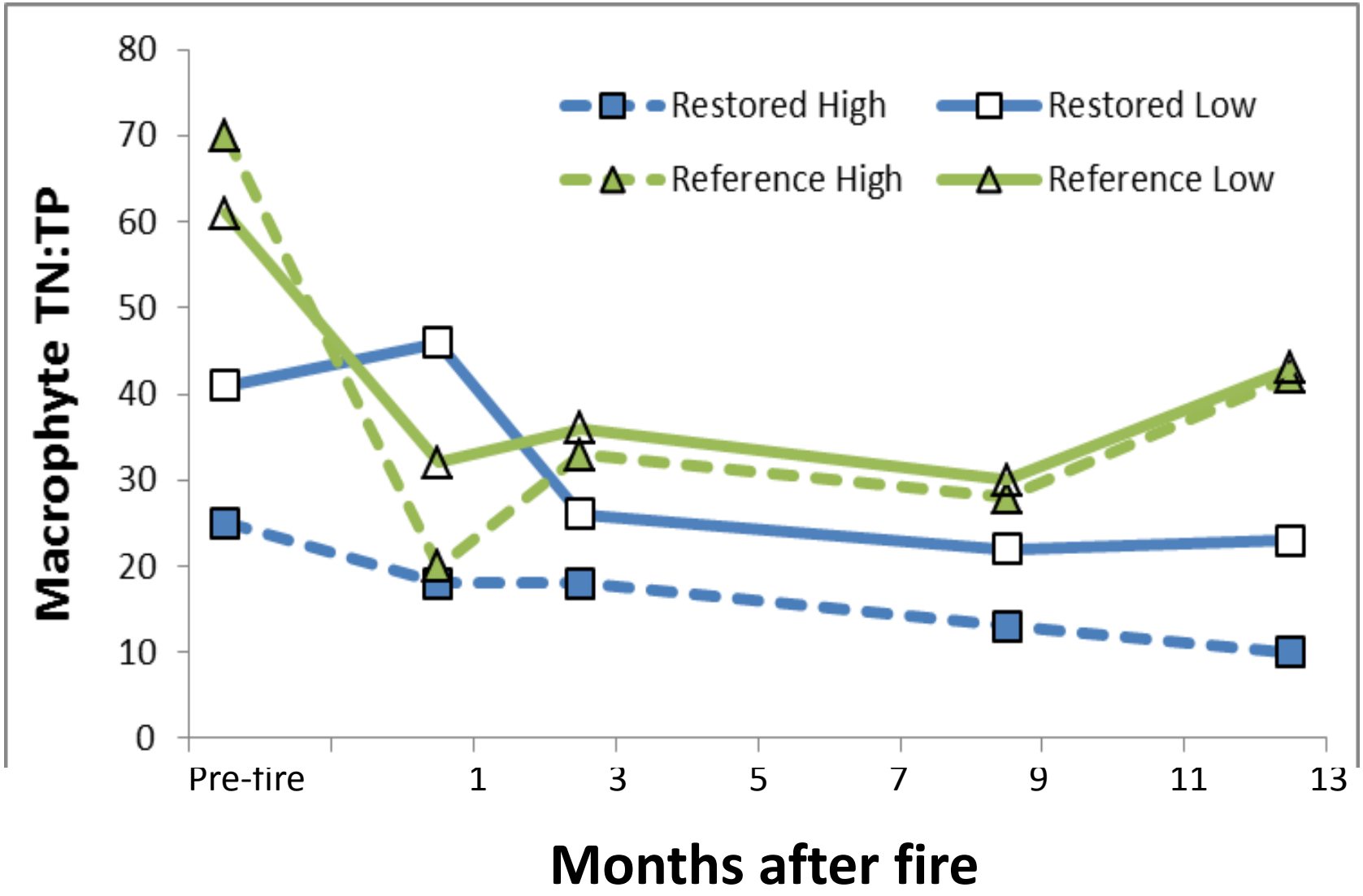
Restored



Above-Ground TP	**81**	**46**
Live Biomass	15.8	0.1
Dead Biomass	17.0	9.5
Litter	29.1	4.8
Periphyton	18.8	32.0

~48 mg P m^{-2}

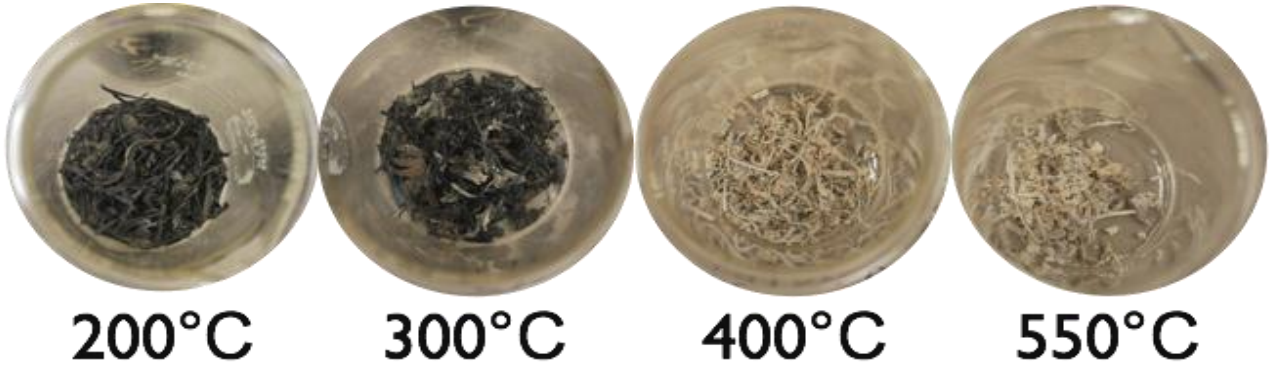
Nutrient limitation



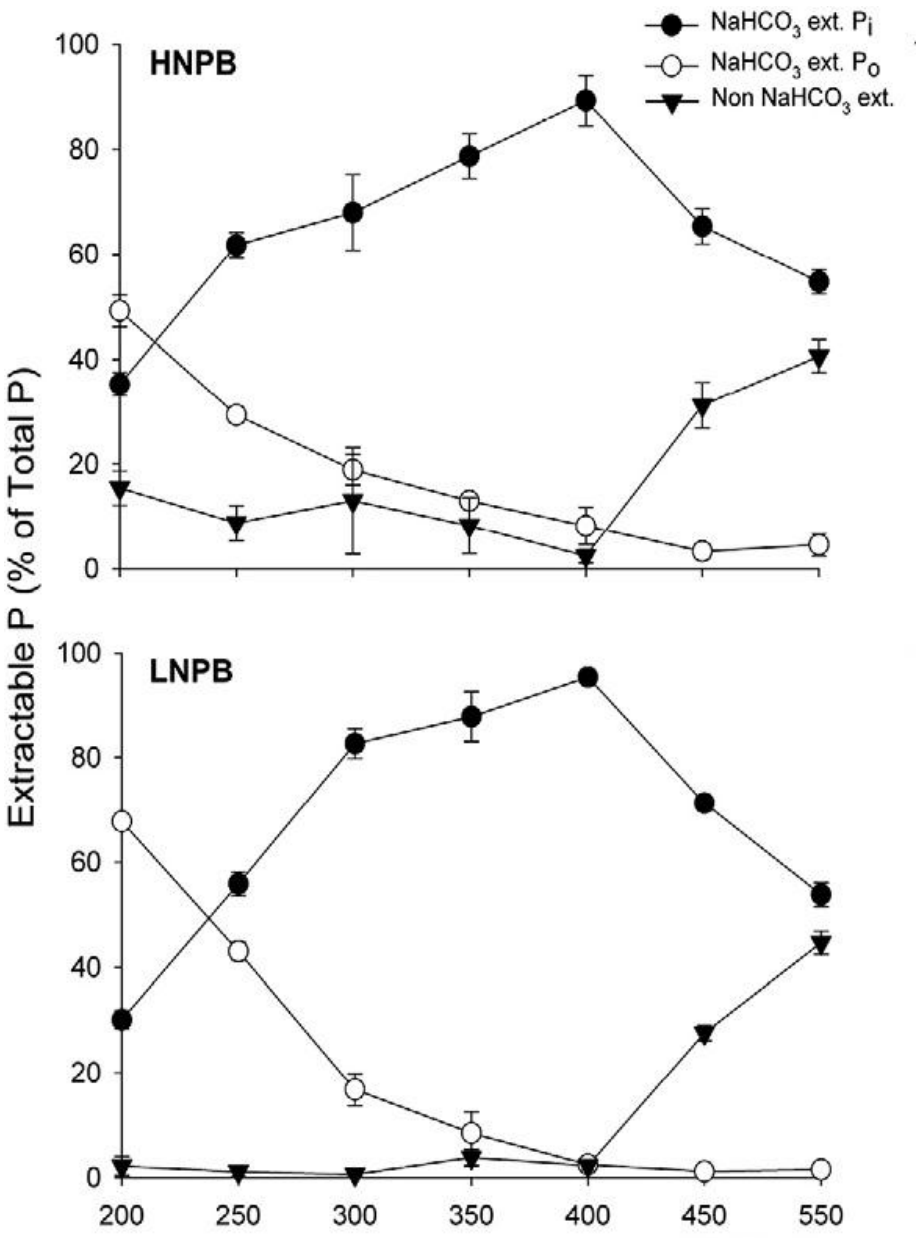
Combustion Residues

Char, Charcoal, Biochar

Ash



Residue Characterization

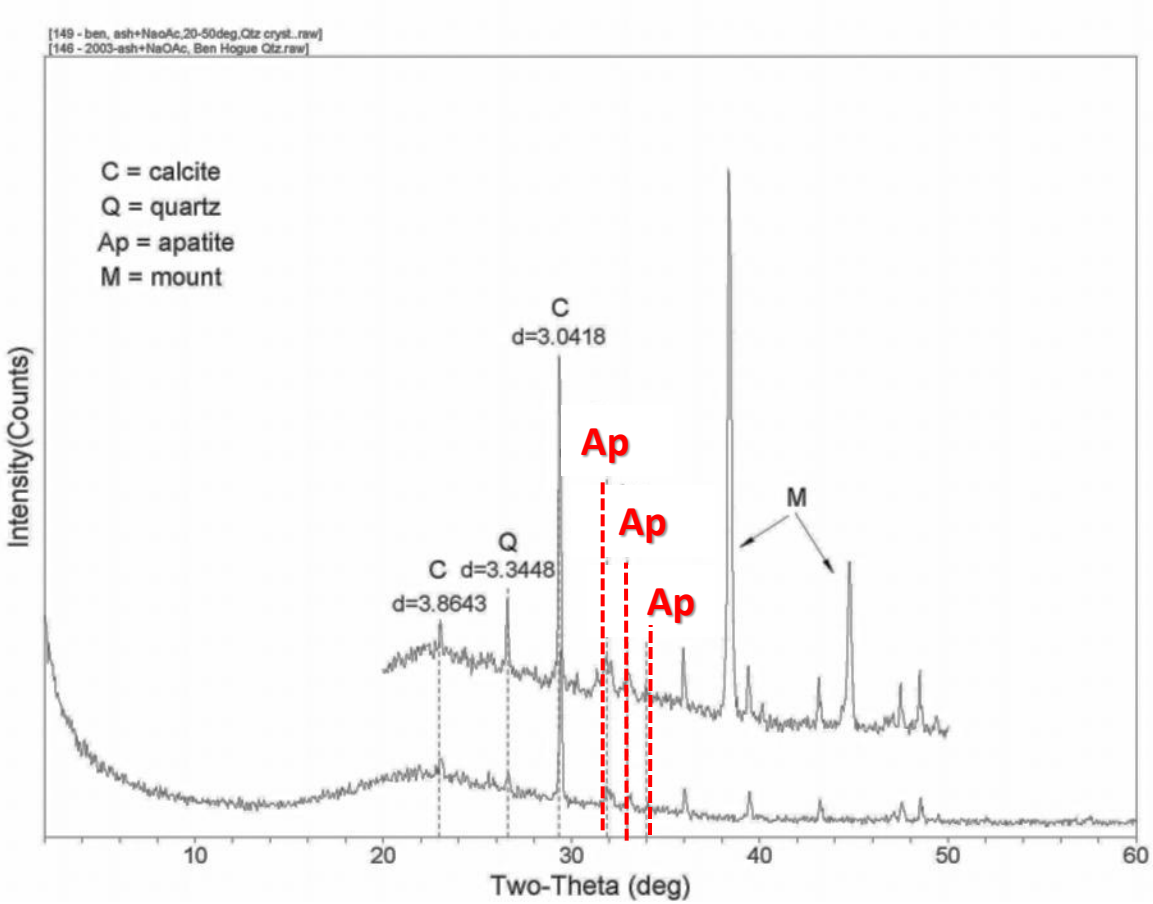


- Low temperatures enhance P availability
- High temperatures (forming ash) reduce P availability

Hogue and Inglett (*2012*)

Ash mineralogy

- Calcite, Quartz dominate
- Presence of apatite Ca-PO_4
- High temp → oxides → stable P



XRD analysis after salt and partial carbonate removal (W.H. Harris)

Conclusions/implications

- Merging soil biogeochemistry and fire ecology disciplines
  - Fire experiments are difficult!
- Differences in fire intensity are important
  - Woody vs. herbaceous, elevation
  - Nutrient transformer, residue quantity

Conclusions/implications

- Fire residues determine biogeochemical response
  - Char residues enhance P
  - High temps favor ash, increase stable P minerals
- Hotter fires promote restoration maintenance of P limitation
  - Fuel load, frequency

Thank you!

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- Wetland Biogeochemistry Laboratory
  - Y. Wang, G. Wilson,

Fire characteristics

- May 4th 2010
- Ignition: drip torch, aerial ignition
- Heading fire
- Rate of spread: 15-30 chains hr^{-1}
  (1 chain=66 ft)

Fire pictures taken by T. Osborne