Fire Effects Assessment Using FIA Data in the Northern and Central Rocky Mountains

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Collaborative Effort

Strong Commitment

- Forest Health and Monitoring – Dave Atkins, Greg DeNito, Ralph Thier
- RMRS – Theresa Jain, Deb Page-Dumroese, Mike Amacher
- IWFIA – Mike Wilson, Renee O’Brien, Larry DeBlander, FIA staff

Theoretical Foundation of Fire Effects

Fire Severity Concept and Conceptual Model

Fire Severity Concept

- It is a continuum

Erosion

Environment | **Fire Intensity** | **Fire Severity** | **"Burn Severity"**

Heat → **Consumption** → **What is left** → **Response**

1st order fire effect **2nd order fire effect**

← Process Perspective → Environment Perspective

Disturbance (process) is the cause

Environment created by the disturbance is the cause

Cause and effect relationship

Conceptual Model

Physical Setting

Weather

Forest Structure

↓

Fire Behavior

↓

Fire Severity
(heat/consumption)

↓

"Burn Severity"
What is left

↓

Response

Objectives

- Estimate of consumption
  - Quantify change in forest structure, surface fuels, and soils
- What is left
  - Quantify the variation of fire effects (severity)
  - Describe residual soil and vegetation environment

Objectives

- Response
  - Follow post-wildfire tree mortality for 3 years
  - Vegetation response
  - CWD input
- Placed within the context of weather and physical setting

Fire Year Occurrence & Visitation Rules

- Idaho & Montana 2000 & 2001
- Utah & Arizona 2002
- All burn plots are visited first year.
- Plots with live trees visited for 2nd and 3rd year
- Just finished 3rd year of data collection on 2000 fires, 2nd year on 2001 fires, and first year on 2002 fires
- Visited 170+ locations on 51 fires in cold, dry, and moist forests in northern and central Rocky Mountains

Analysis

- All data will be summarized to the location
  - Use FFE-FVS Model for tree summaries
  - Summarize to an average burn severity
- Link pre-wildfire forest structure to
  - Post-wildfire environment (what is left)
  - Post-wildfire response from trees and vegetation

Defining Burn Severity

Burn Severity - Trees

Dominant **black** crown– no needle input for nutrients or erosion effects

Dominant **brown** needles (scorched) – needle input

Dominant **green** needles

Dominant Green Crowned Trees

Probability of mortality – 3 year data

- Crown scorch (% of original crown ratio)
- Low and high stem scorch height, % of base
- Diameter (bark thickness), height, crown ratio, species
- Insect infestation

Soils
Traditional Classification

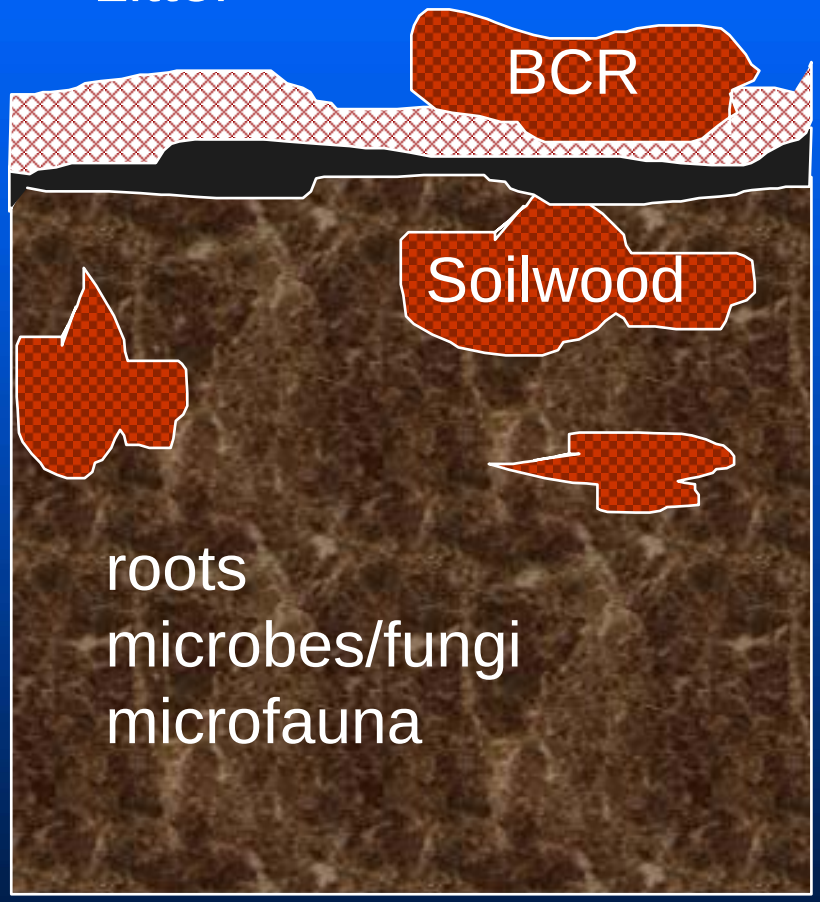
High Severity
Soil visibly altered
10% deep char
>80% moderate char

Moderate Severity
Mineral soil not altered
Litter largely consumed
<10% deep char
>15% moderate char

Light severity: litter present
< 2% deep char soil
< 15% moderate char soil

Wells et al. 1979 Ryan and Noste 1985

Forest Soil

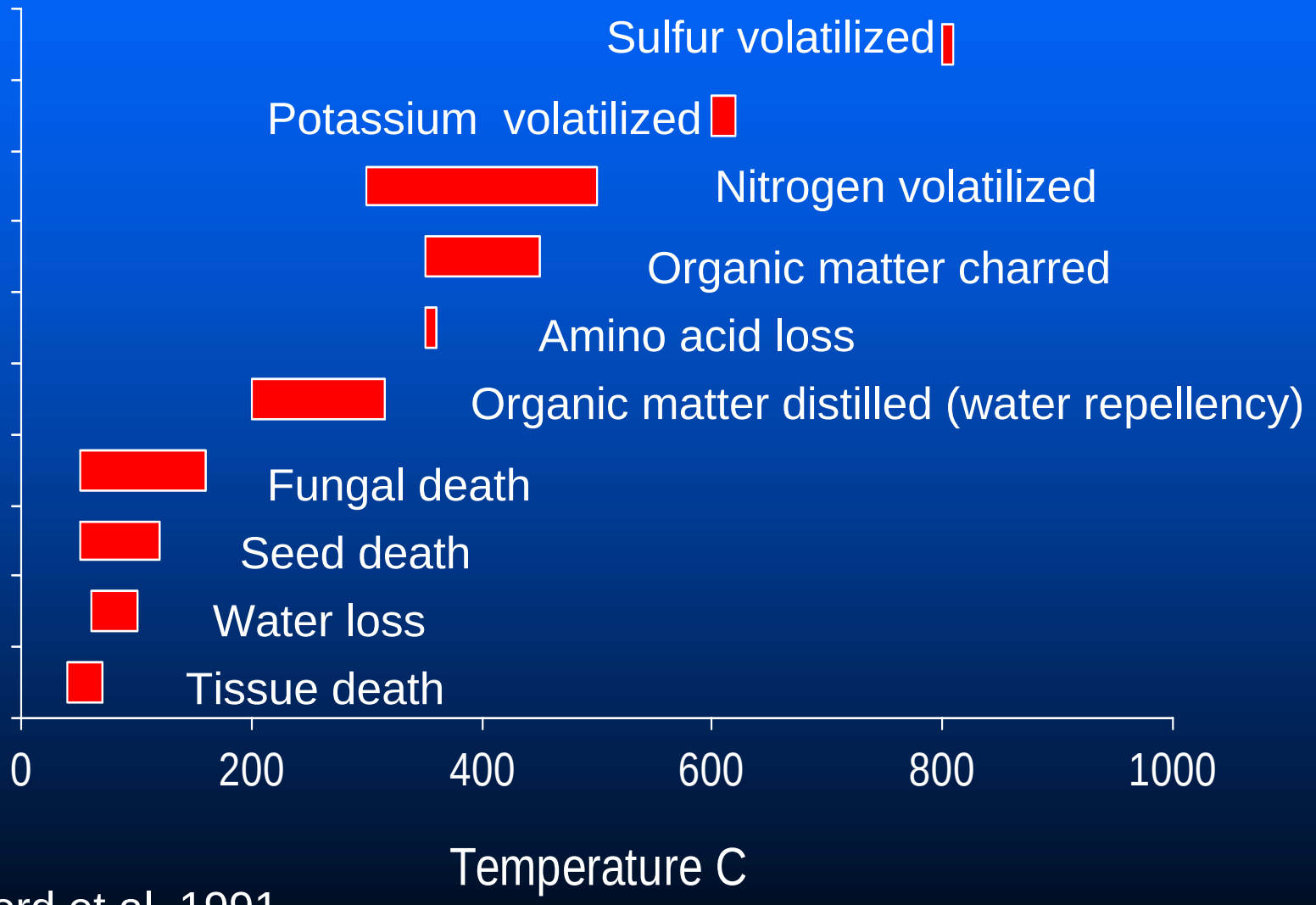


> 50% of Nitrogen
> 70% of ectomycorrhizae
> 50% Nitrogen fixation

(1980's – 1990's Harvey, Jurgenson, Dumroese, Graham, etc.)

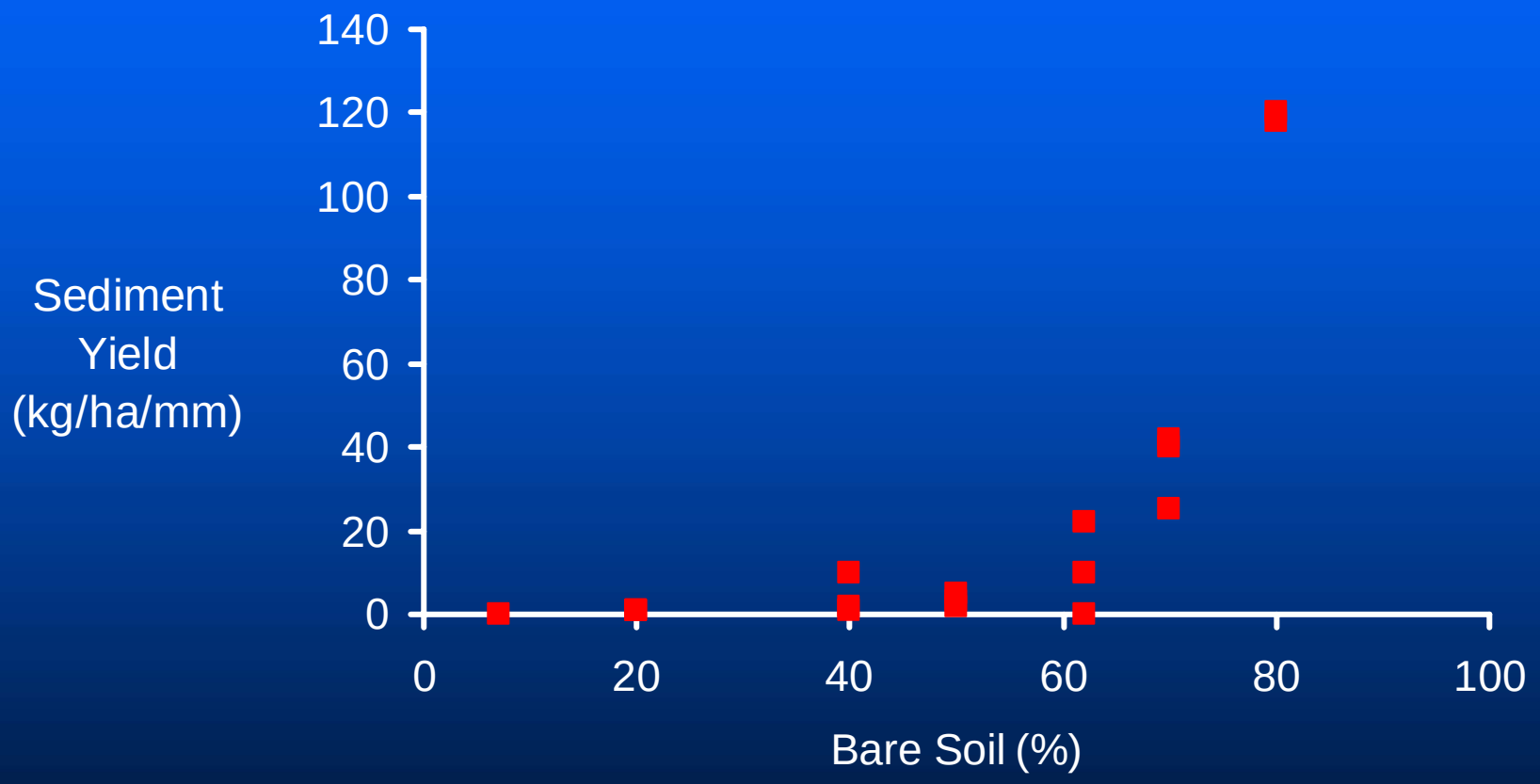
Critical Soil Temperatures

Nutrient, Physical, & Vegetation Impacts



Hungerford et al. 1991

Erosion



Johansen et al. 2001, Huffman et al 2001, Benavidez-Solorio 2001, Robichaud and Waldrop 1994

Degree of Surface change Heat/What is Left

Litter unburned → 100% mineral Soil

Arthropods
Seed Source
Little or no heat

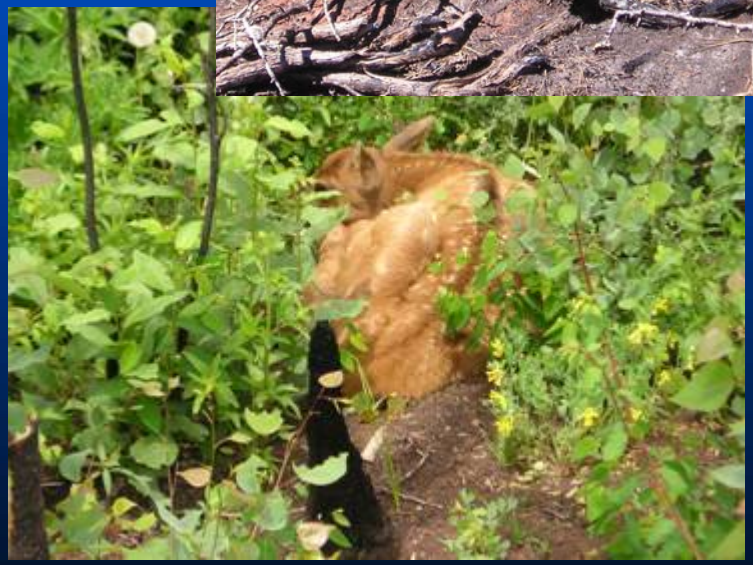
Nutrient dynamics
Erosion
Understory vegetation
> 50 to 400^{0} C

Soil OM present
Change in soils
Moderate to deep char soil
> 700^{0} C

Soil Severity Defined in This Study

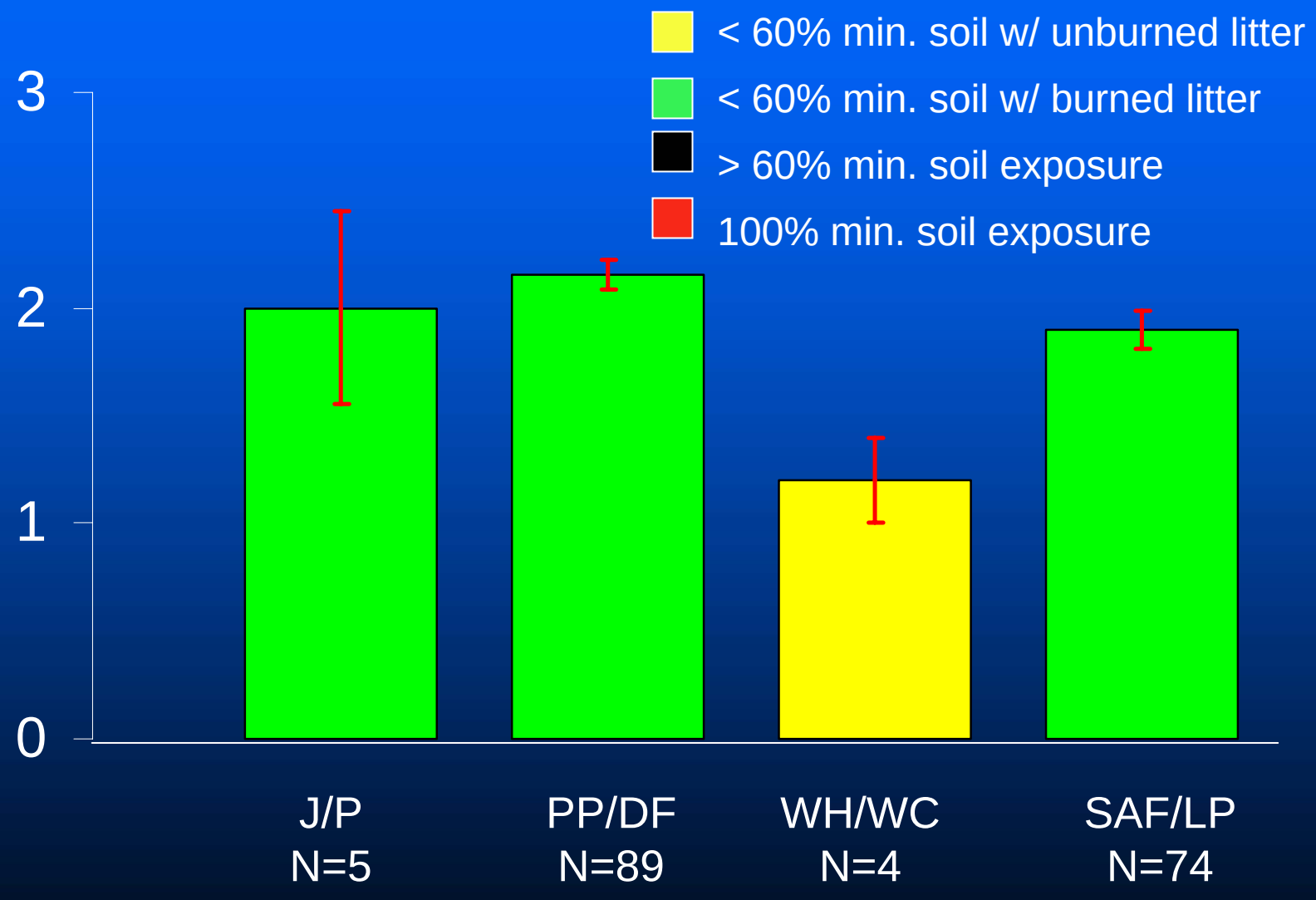
- < 60% Mineral Soil (w/ rock) exposure with unburned litter present
- < 60 % mineral soil (w/ rock) exposure with burned litter present
- > 60 % mineral soil (w/ rock) exposure
- 100% mineral soil (w/ rock) exposure w/ < 50% moderate and deep char
- 100% mineral soil (w/rock) exposure w/ > 50% moderate and deep char

An Investigation of Fire Severity

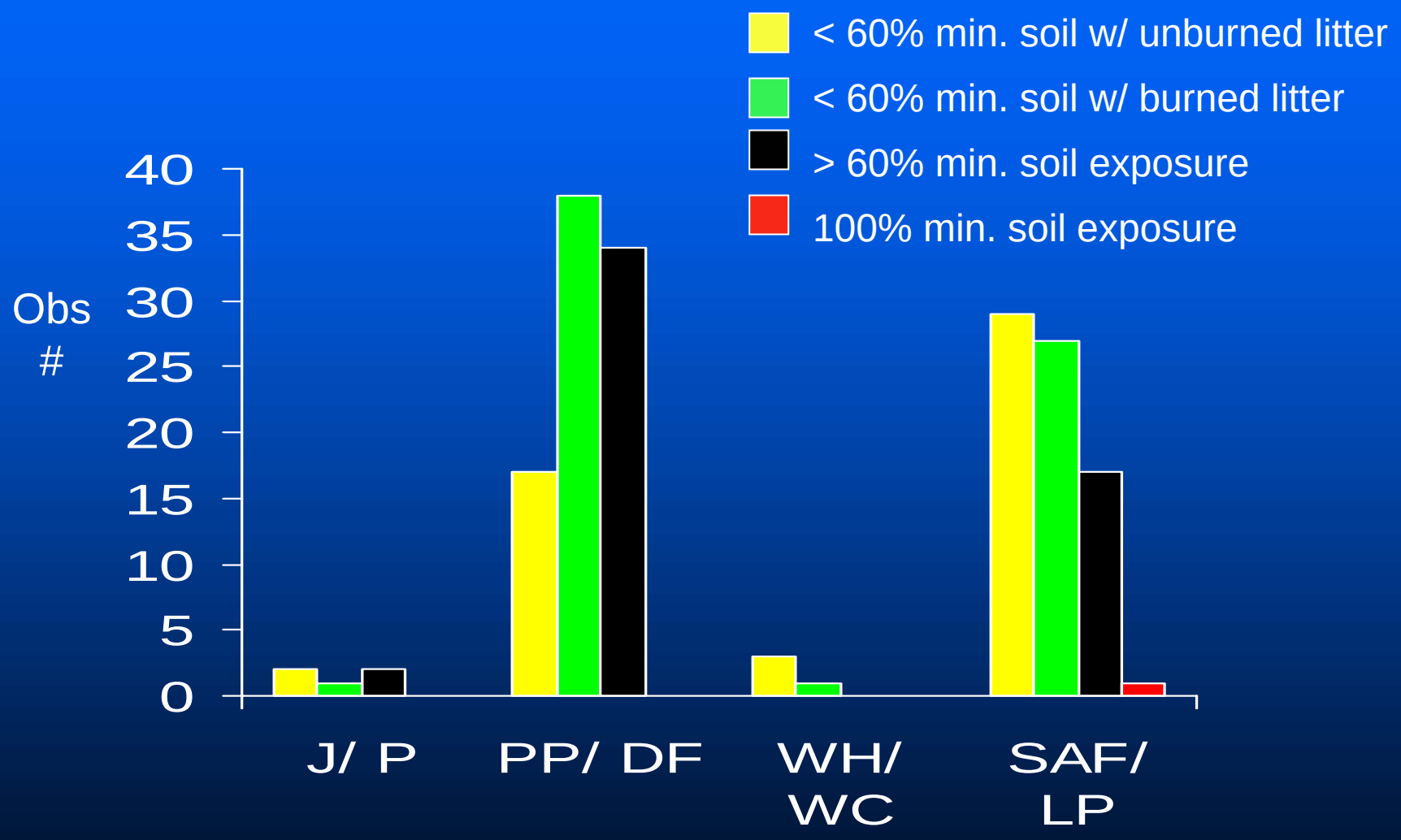


Soil Severity

172 Observations

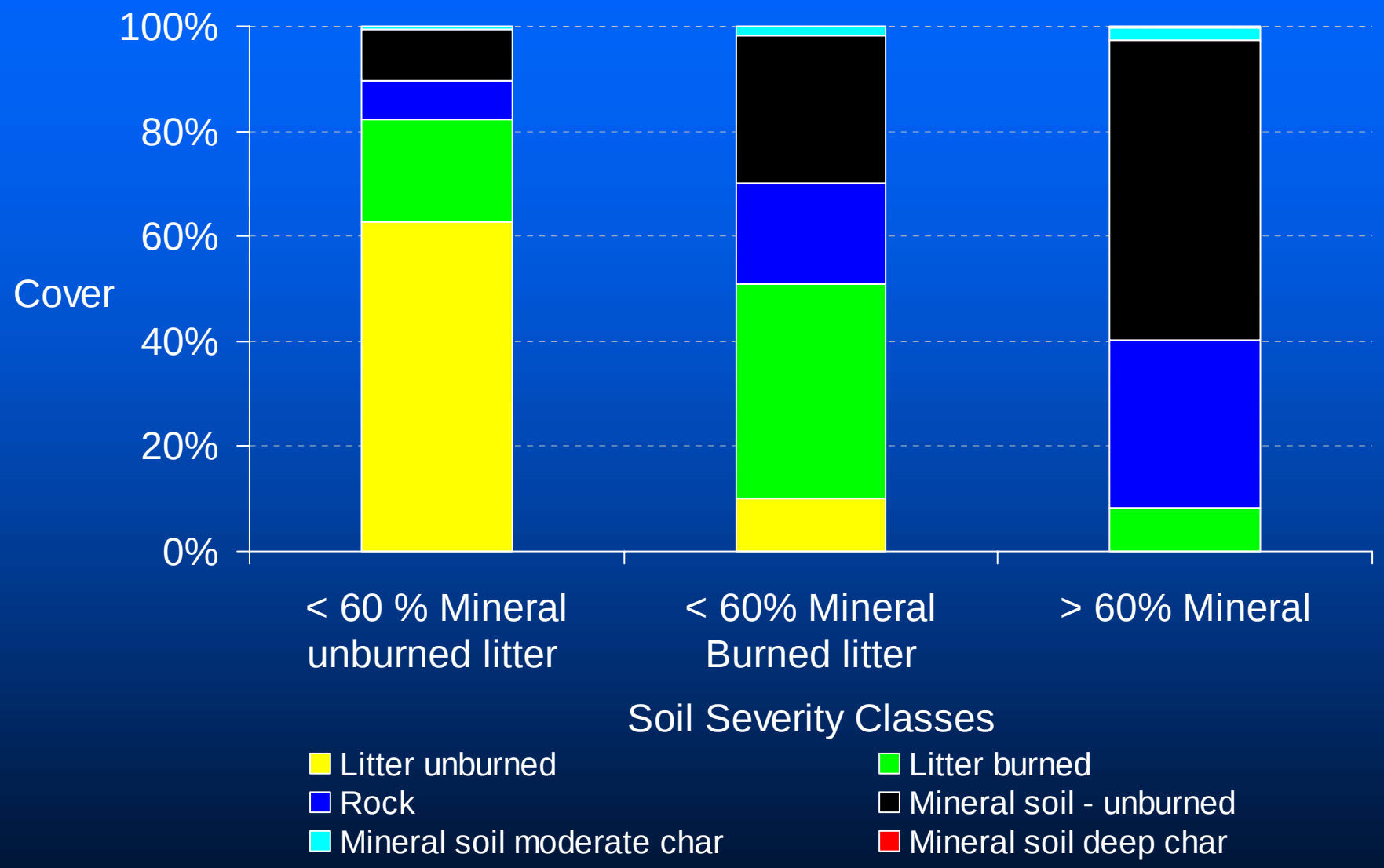


Soil Severity-Distribution of the Observations

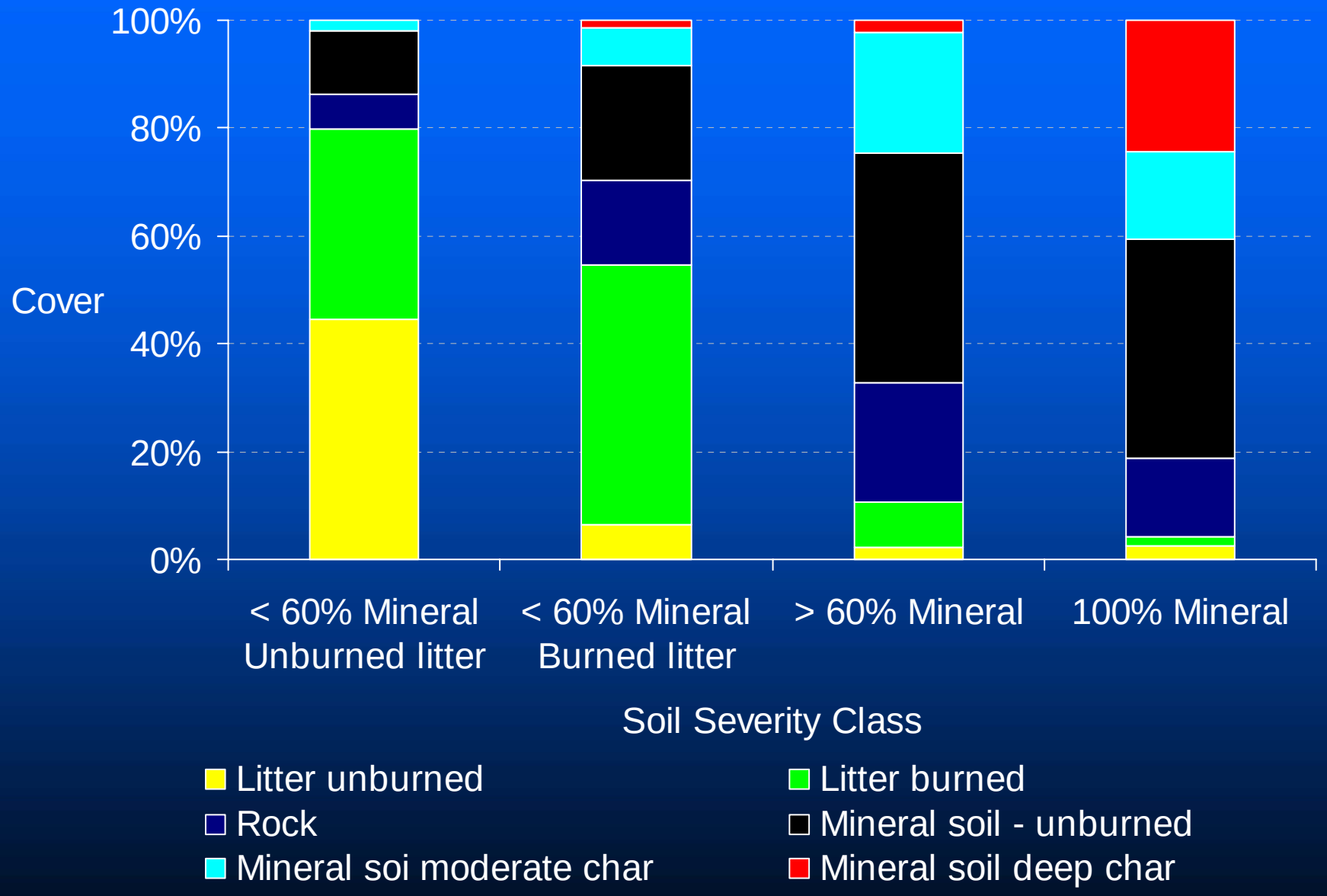


Distribution of Surface Floor Components

Ponderosa Pine/Douglas Fir Forests



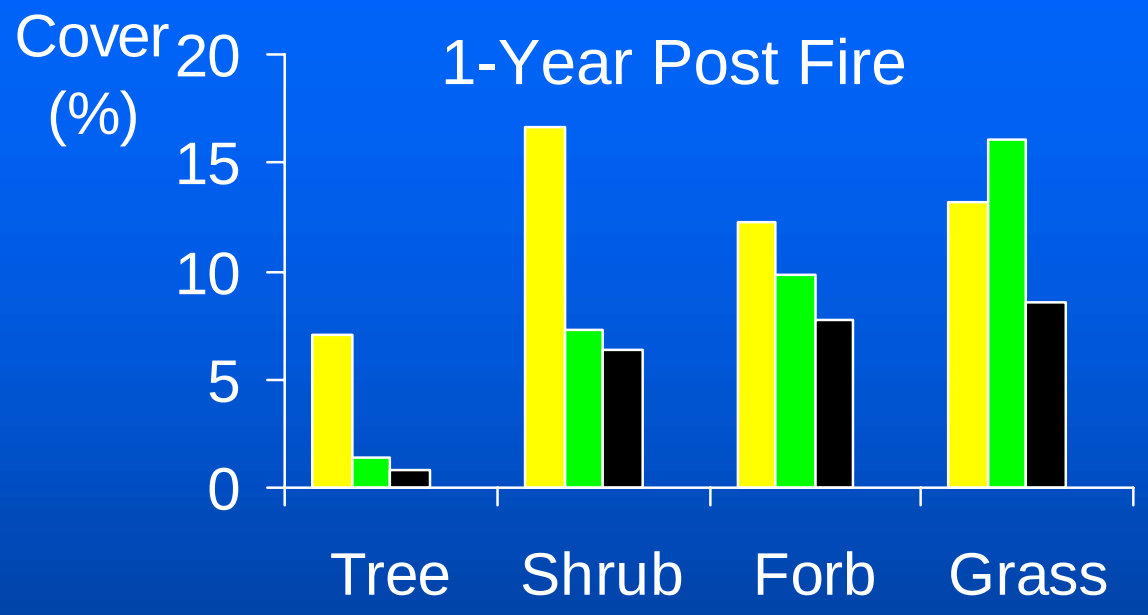
Subalpine Fir/Lodgepole Pine

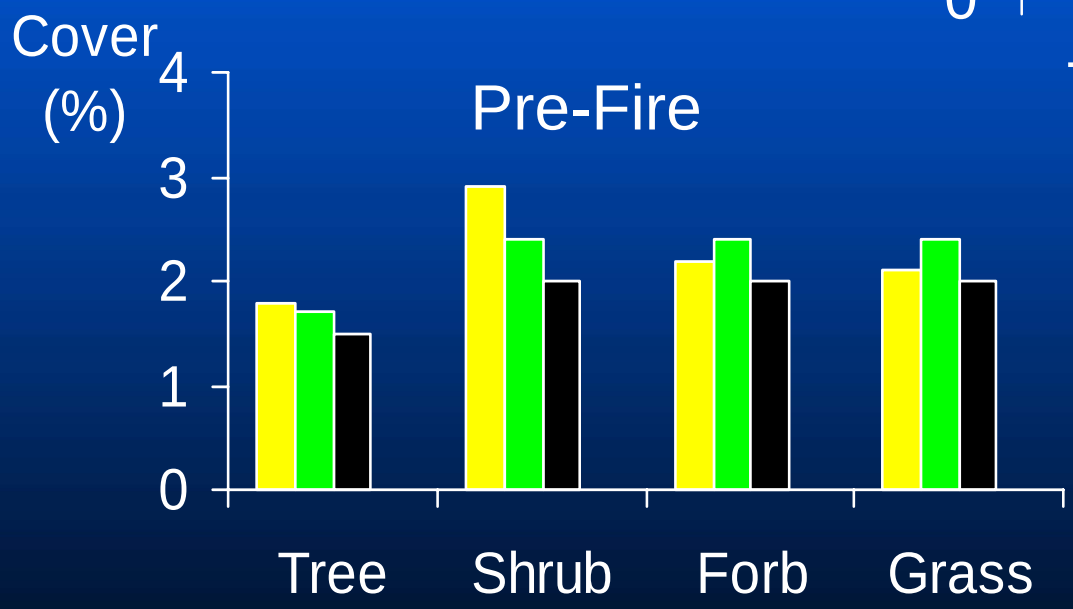


Understory Vegetation

Pre-Fire vs Post Fire Understory Vegetation

Ponderosa Pine
Douglas Fir

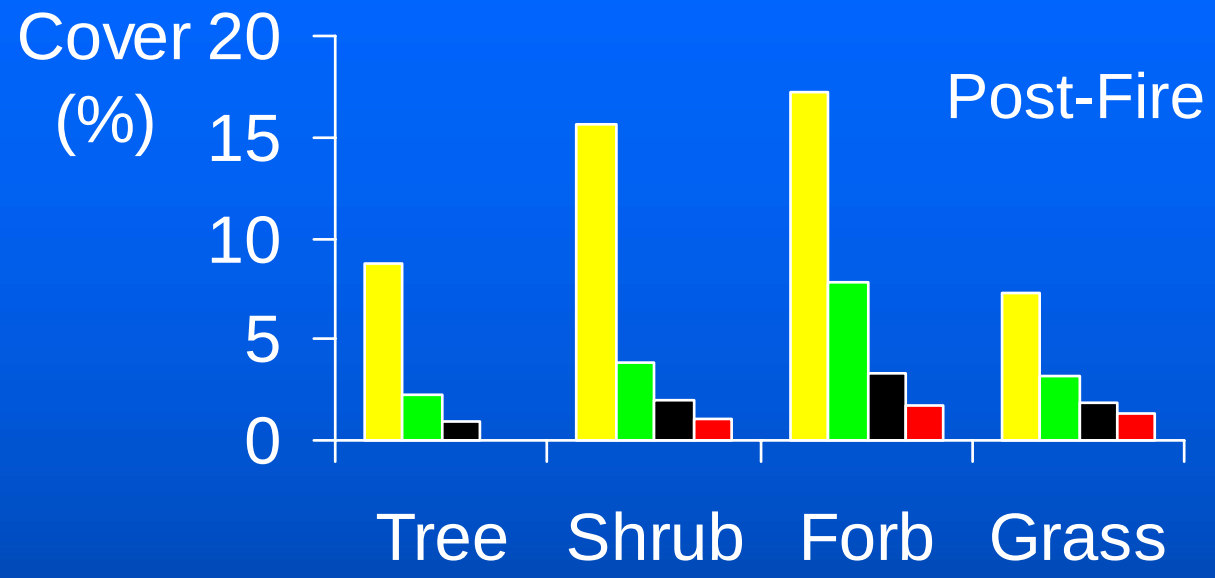


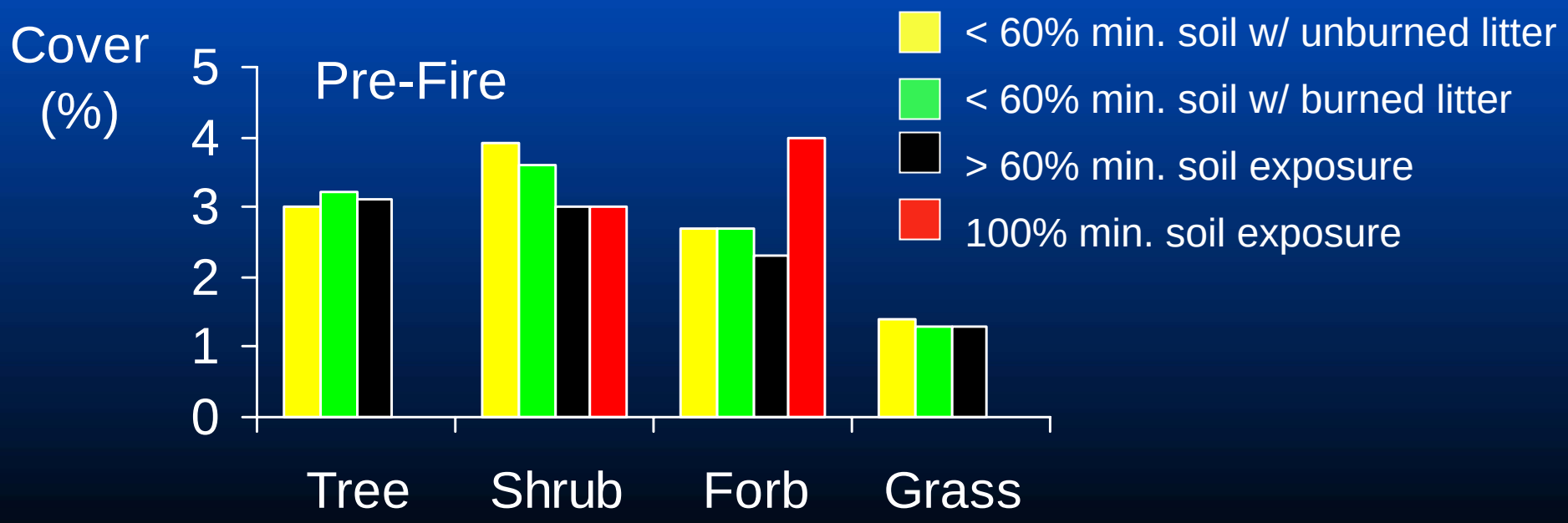


- < 60% min. soil w/ unburned litter
- < 60% min. soil w/o unburned litter
- > 60% min. soil exposure
- 100% min. soil exposure

Pre-Fire vs Post Fire Understory Vegetation

Subalpine Fir
Lodgepole Pine





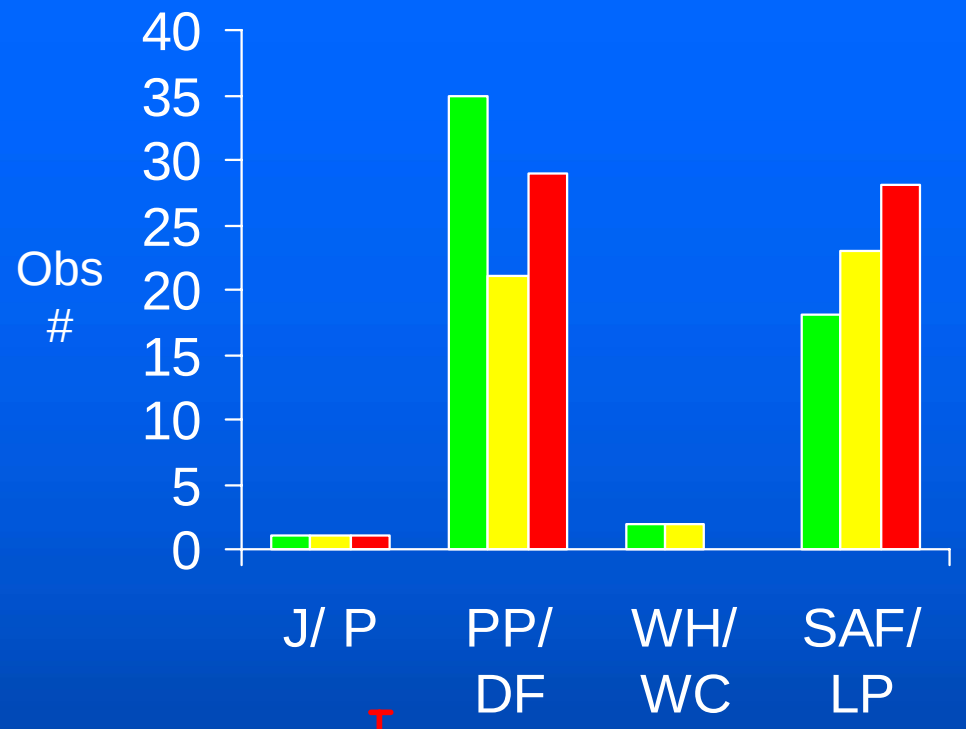
Trees

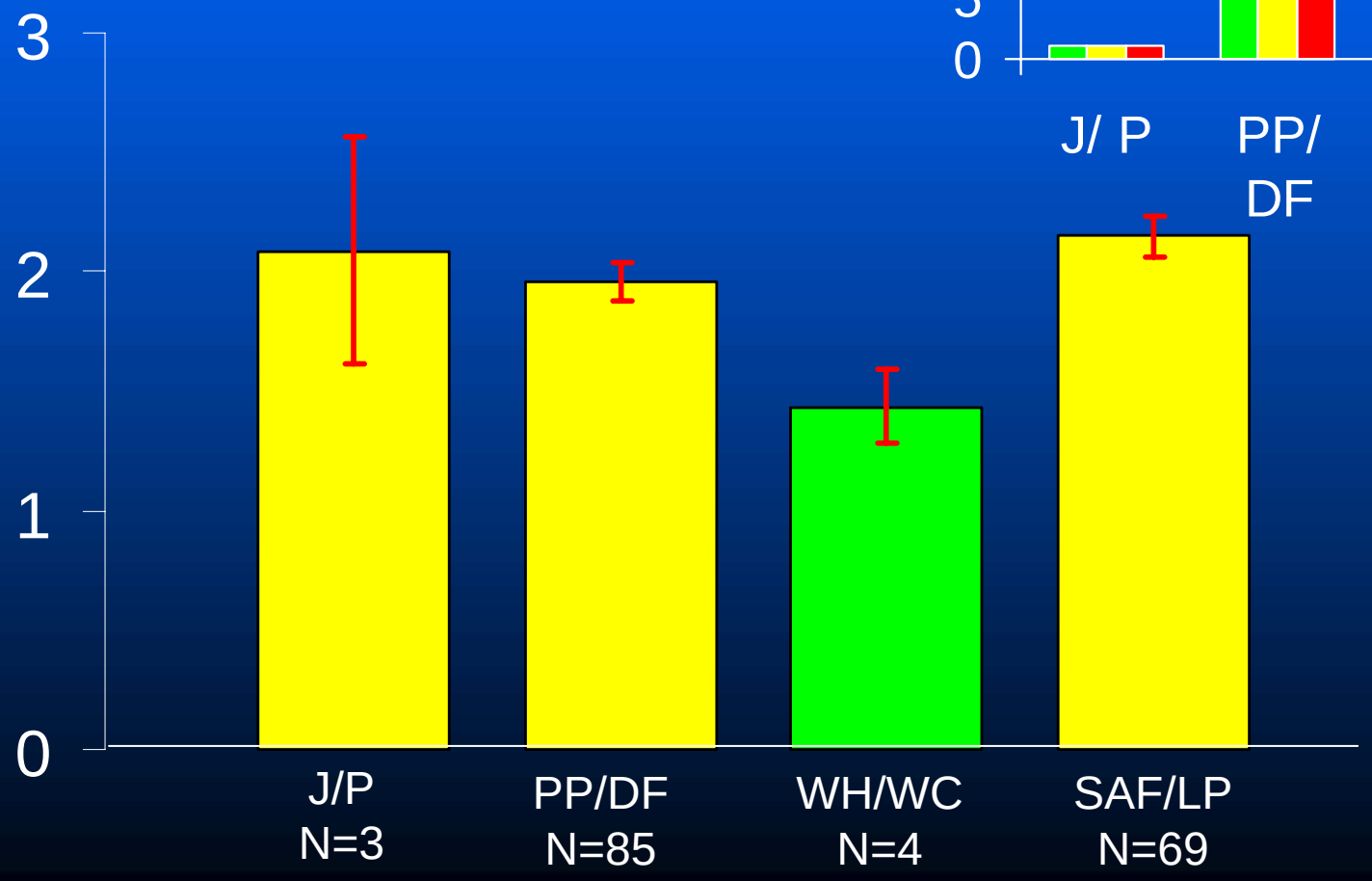
Crown Severity

1 = Green needles

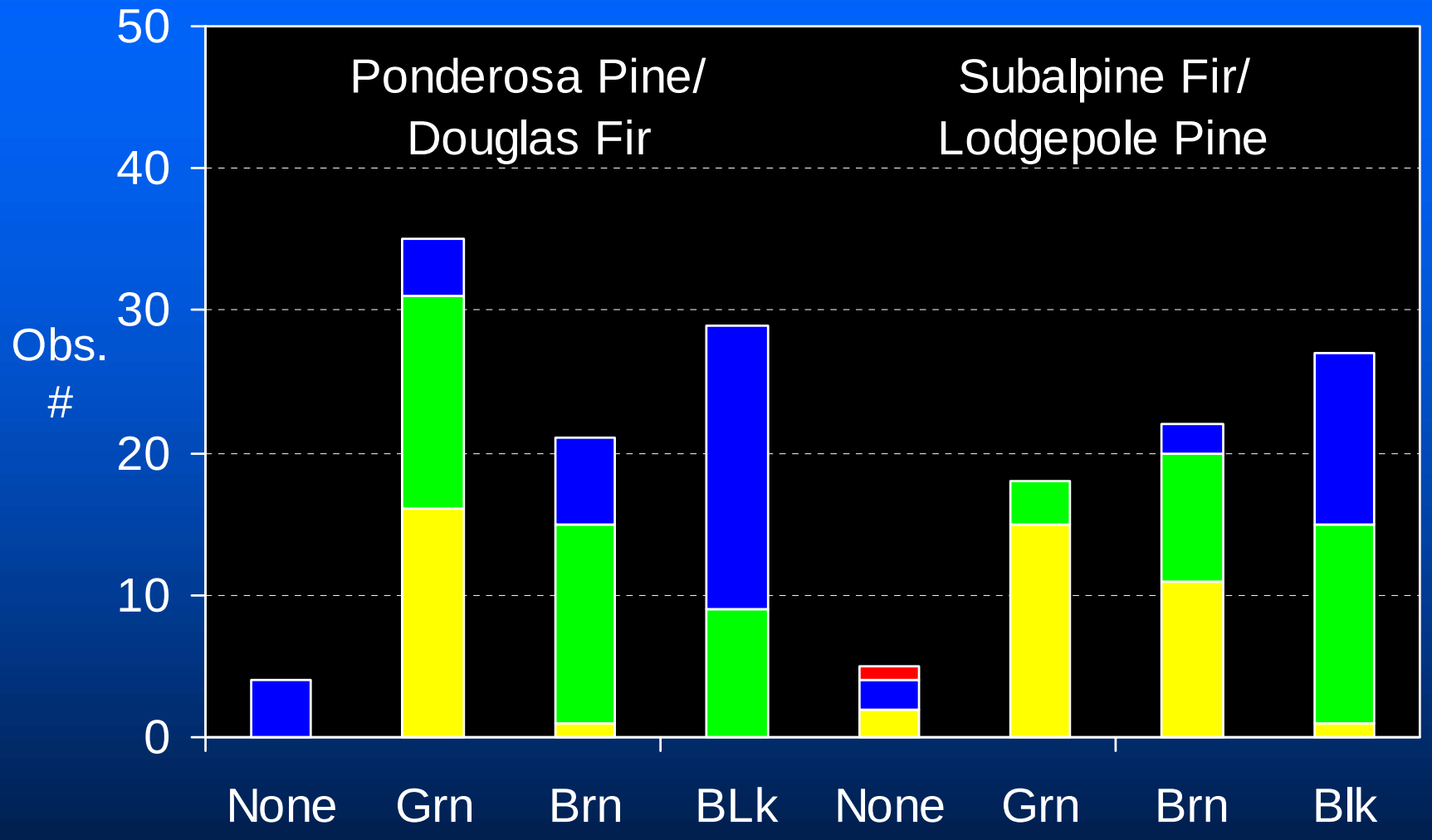
2 = Brown needles

3 = Black crowns – no needles



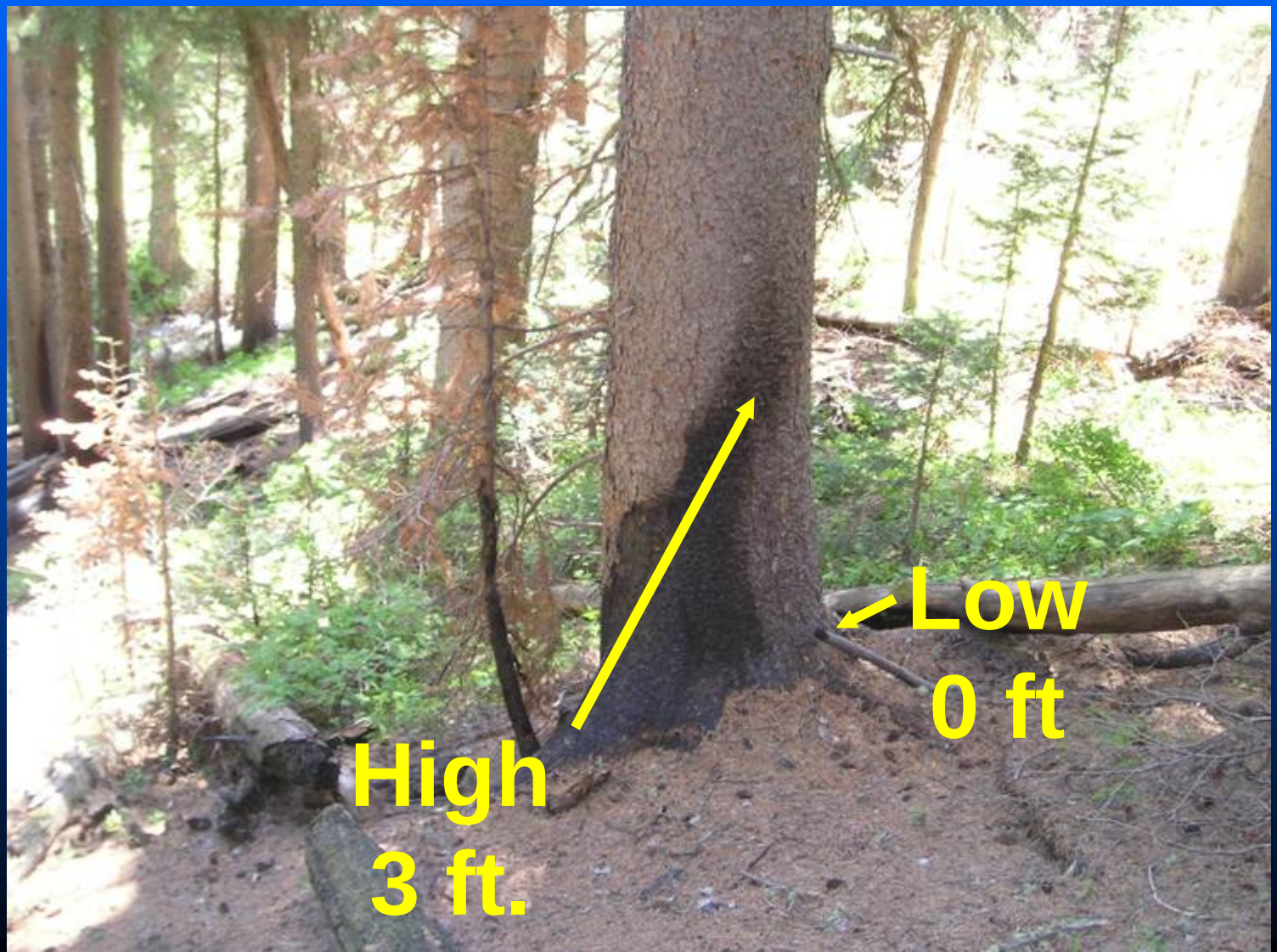


Crown Severity Versus Soil Severity

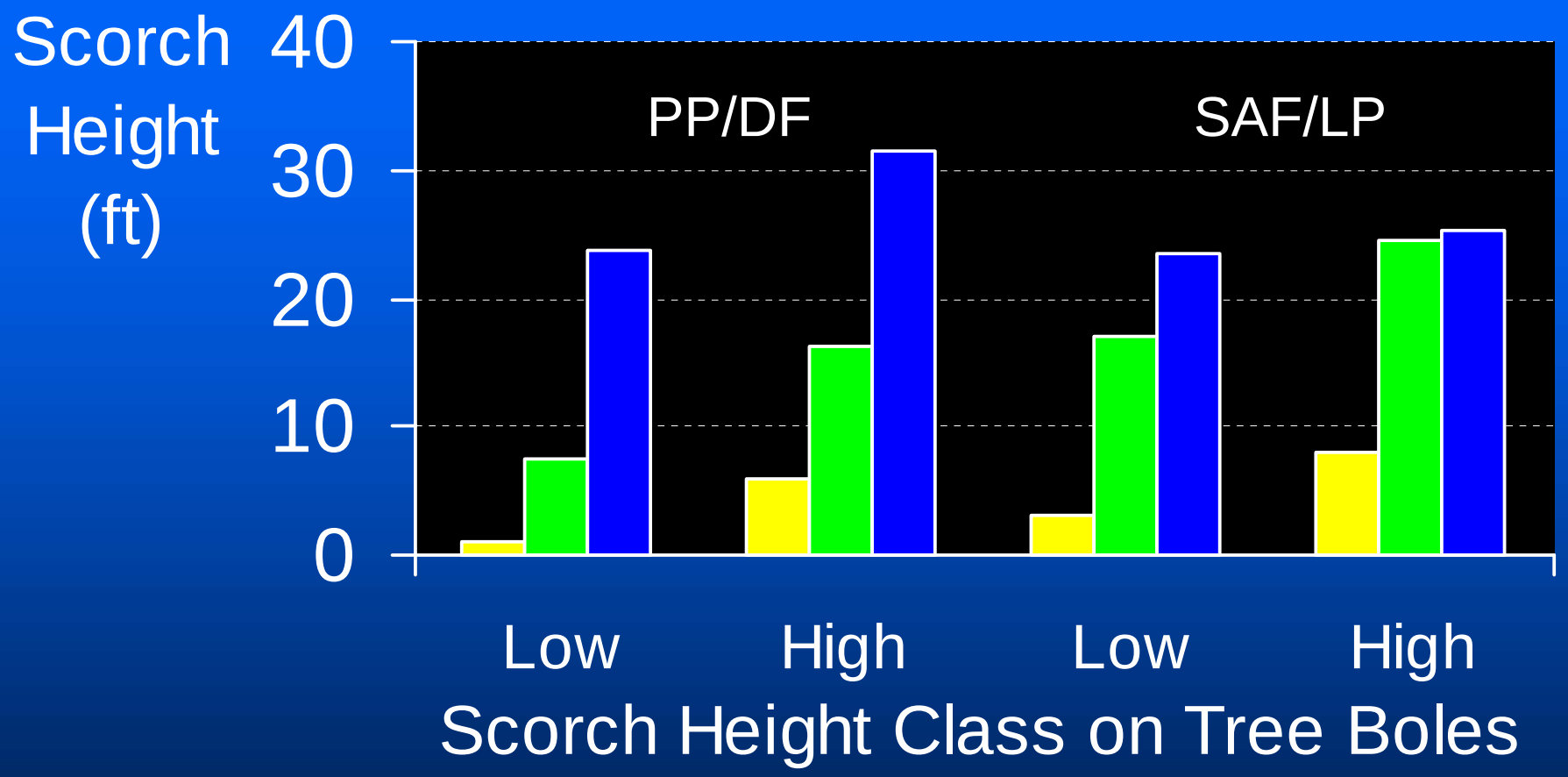


- < 60% Min. soil w/ unb litter
- < 60% Min. w/ burned Litter
- > 60% Min. soil
- 100% Min soil

Scorch Height on Tree Poles



Soil Severity Versus Scorch Height



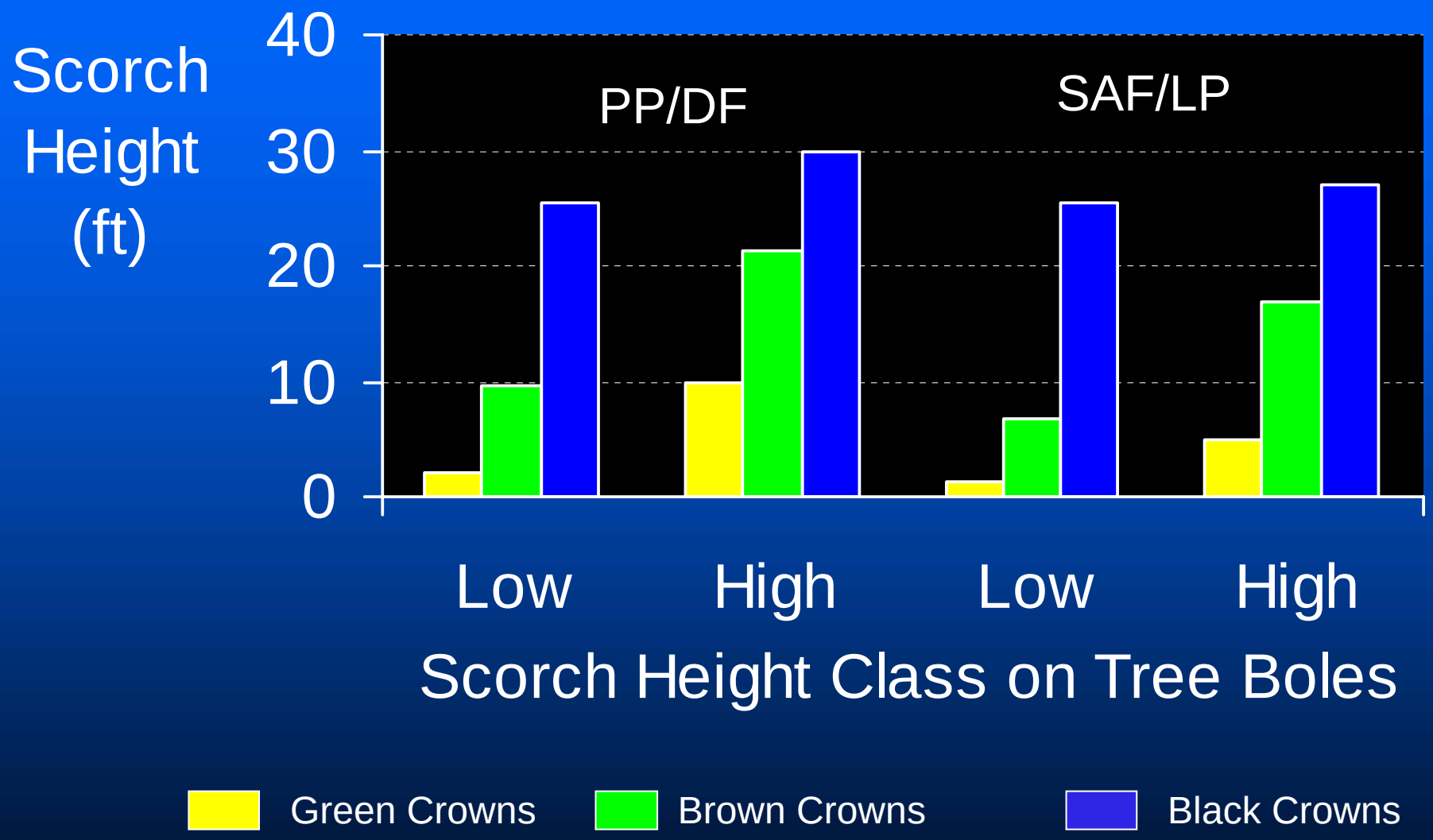
< 60% min. soil w/ unburned litter

< 60% min. soil w/ burned litter

> 60% min. soil exposure

100% min. soil exposure

Crown Severity Versus Scorch Height



Main Points

- Soil fire severity as defined appears to be representing the variation in response (vegetation) and intensity (scorch height/flame length).
- Appears there is a weak relation between crown severity and soil severity
- Scorch height appears to be related to both average crown and soil severity

Study Implementation Process

Developed Sampling Protocol

- Integrate established FIA designs
- Quantify burn severity on different vegetation strata within FIA protocol
- Visited for 3 consecutive years – what information taken on each visit
- Worked with FIA, FHM crews and staff in protocol development and training

Field Manual

- Interior West FIA fire study field manual (Bill Dunning, Juliet Wilhelm, Theresa Jain, Ralph Thier, Dave Herwig)
  - Field location
  - Plot layout – 4 designs
  - Location reference and description
  - Data collection protocol
    - » Trees, understory vegetation, ground surface burn severity
    - » Soil and erosion
    - » Down woody debris

Incorporating Collaborative Efforts

FHM ⟷ FIA ⟷ Scientific Investigation

Dave
Greg
Ralph

Mike Wilson
And Staff

Terrie
Deb

FHM ← FIA → Scientific Investigation

Understory vegetation (shrubs)

- Average cover versus Biomass
- Fire models use biomass based on other algorithms besides cover

- Data is location sensitive

FHM ← FIA → Scientific Investigation

- Past Designs
  - Multiple designs depending when originally established (1988-1999)
  - Locating all the data – National Forest Systems and FIA in Ogden
  - Data preparation
  - Immense amount of data – organization is challenging

FHM → FIA ← Scientific Investigation

- Sampling protocol was evolving so could not use PDR's
- Needed to write a manual
- Teach collaborators FIA process – who does what, when, and where
- Logistically adding the project to the annual inventory requirements

Unique Opportunity

- Exact pre-wildfire locations and measurements - wide range of data
- It was educational
- It was different work
- Challenging but fun
- We are still learning
- Variety of products
  - Publications
  - Presentations/workshops
  - Integration across Stations
  - Identify strengths and weaknesses in conducting fire effect assessments

Estimate of Consumption

Quantify Change

- Pre-wildfire forest structure-original plot data (1988-1999)
- Post-fire- revisit previously established plots
  - Tree: species, tree status, height, etc.
  - Surface fuels
  - Soils
- Consumption-difference between pre-fire and post-fire

What is Left-all plots

Trees >5” DBH

- Tree remeasurement-species, tree status, height, etc.
- Uncompacted crown ratio
- Crown percent colors
- Bole scorch height
- Fire Direction
- Base stem damage

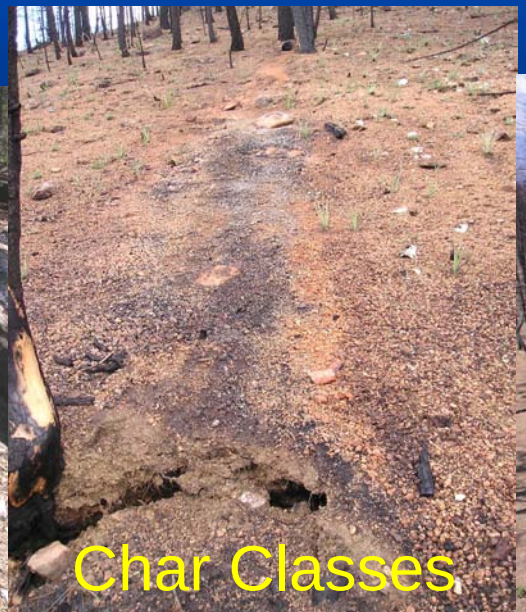
What is Left – All Plots

- Understory vegetation - shrubs, grasses, forbs, tree seedlings/sapling
- Vegetation part 1
  - % cover by species and layer
- Vegetation part 2
  - % cover by life form and layer
  - Total % cover (aerial) by life form

What is Left- All Plots

- Soils
  - Proportion in each char class and total cover of litter, humus, mineral soil, woody debris, new litter
  - Collect soil samples, bulk density
  - Erosion potential, organic matter thickness

Litter cover


Char Classes

Mineral soil exposure

Site Response

Only plots with live trees

- Vegetation response
  - Measure vegetation part 1 and part 2
  - Noxious weeds
- CWD - > 3” diameter
  - Proportion buried over time

Site Response

Only plots with live trees

- Tree response
  - Evidence of beetle infestation
  - Changes in vigor (crown ratio)
  - Fire tree status (only dead)
    - CWD input
    - Snag retention
  - Tree mortality
  - Cause of death