Validating site and soil impact assessments

Debbie Page-Dumroese
Research Soil Scientist
Rocky Mountain Research Station
ddumroese@fs.fed.us

Why are soils issues a big deal?

- Soil management underpins sustainable forest management
- Affects of soil disturbance on sustainable productivity varies
- NFMA (1976) and related legislation required research and monitoring to protect the permanent productivity of national forests

Current status

- “Land productivity” was never defined in NFMA
  - Timber, wildlife, watershed, fisheries, aestheics...
- US Office of General Council: productivity is the carrying capacity of a site for vegetative growth
  - i.e. can you capture carbon and grow vegetation?

Measuring growth

- Trying to measure the productive potential of a site with tree or stand growth is hard.
  - Growth trends vary with stand age, structure, stocking, and treatment history and often lack controls
- Soil-based indices are a more objective method to measure a sites' capacity for vegetative growth.

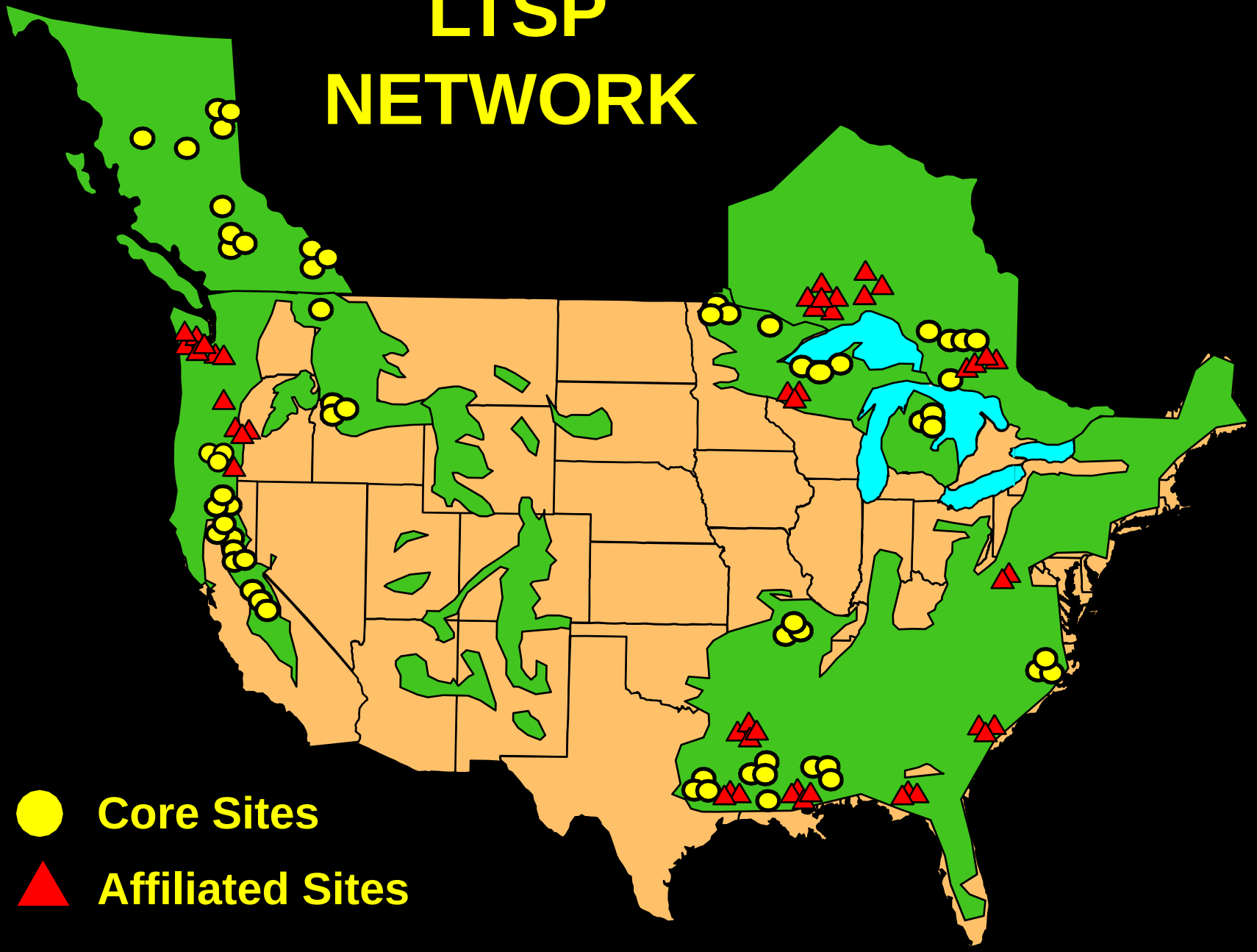
Soil quality standards

- The FS has adopted the FIRST approximation of soil-based indices
  - USFS Regional soil quality standards and guidelines
- Lack of consistent soil quality measurements
- Thresholds in the early standards were based on best professional judgment and were intended as “early warnings” – not absolute limits

Research to validate the SQS

- LTSP – a North America wide research study with a common experimental design.
- New Region 1 monitoring protocol using visual classes to assess soil disturbance

LTSP NETWORK



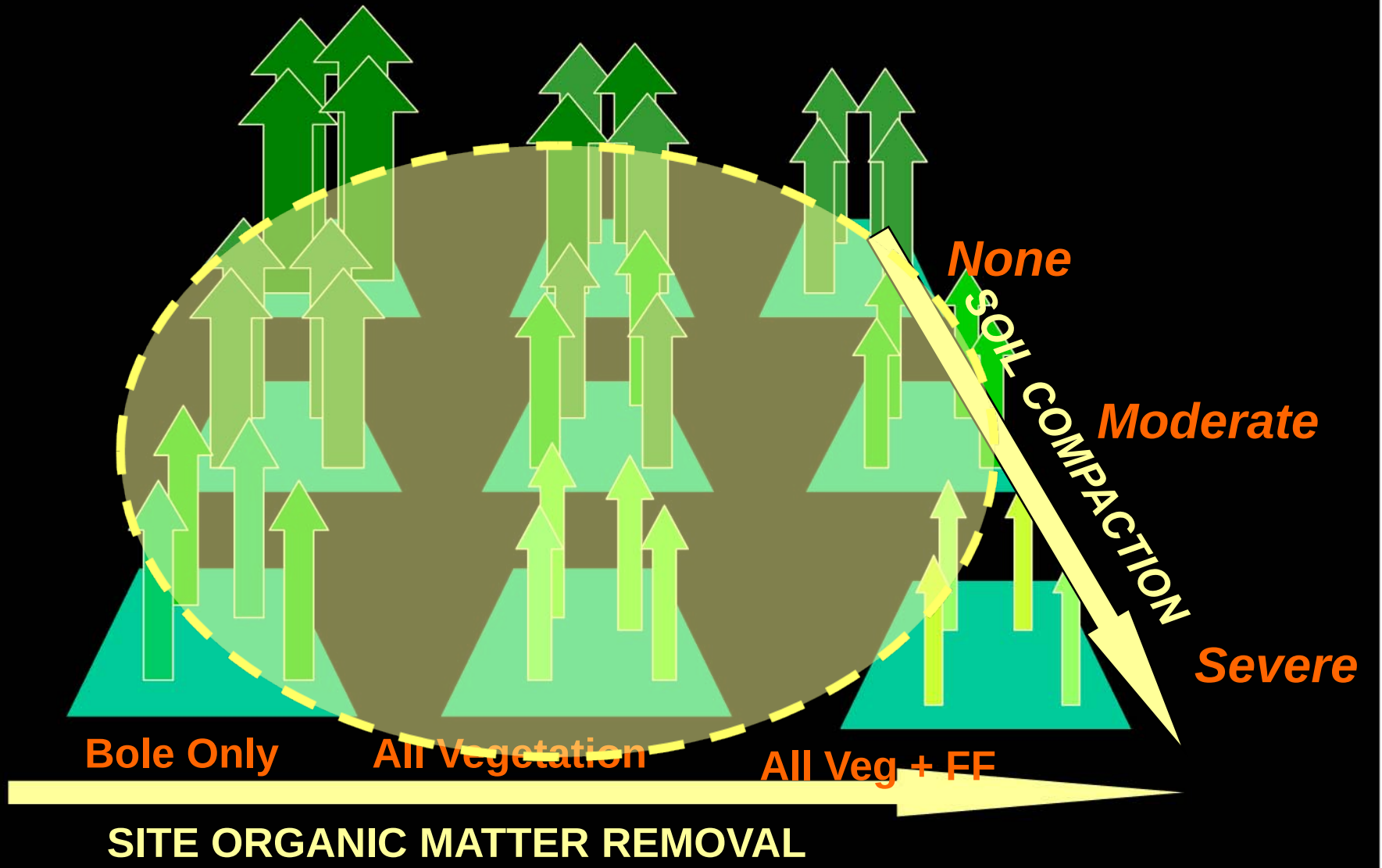
LTSP GOALS

- Know a site's productive carrying capacity
- Understand how OM, soil porosity changes affect this
- Validate soil-based indices Improve if needed
- Construct/validate a comprehensive model

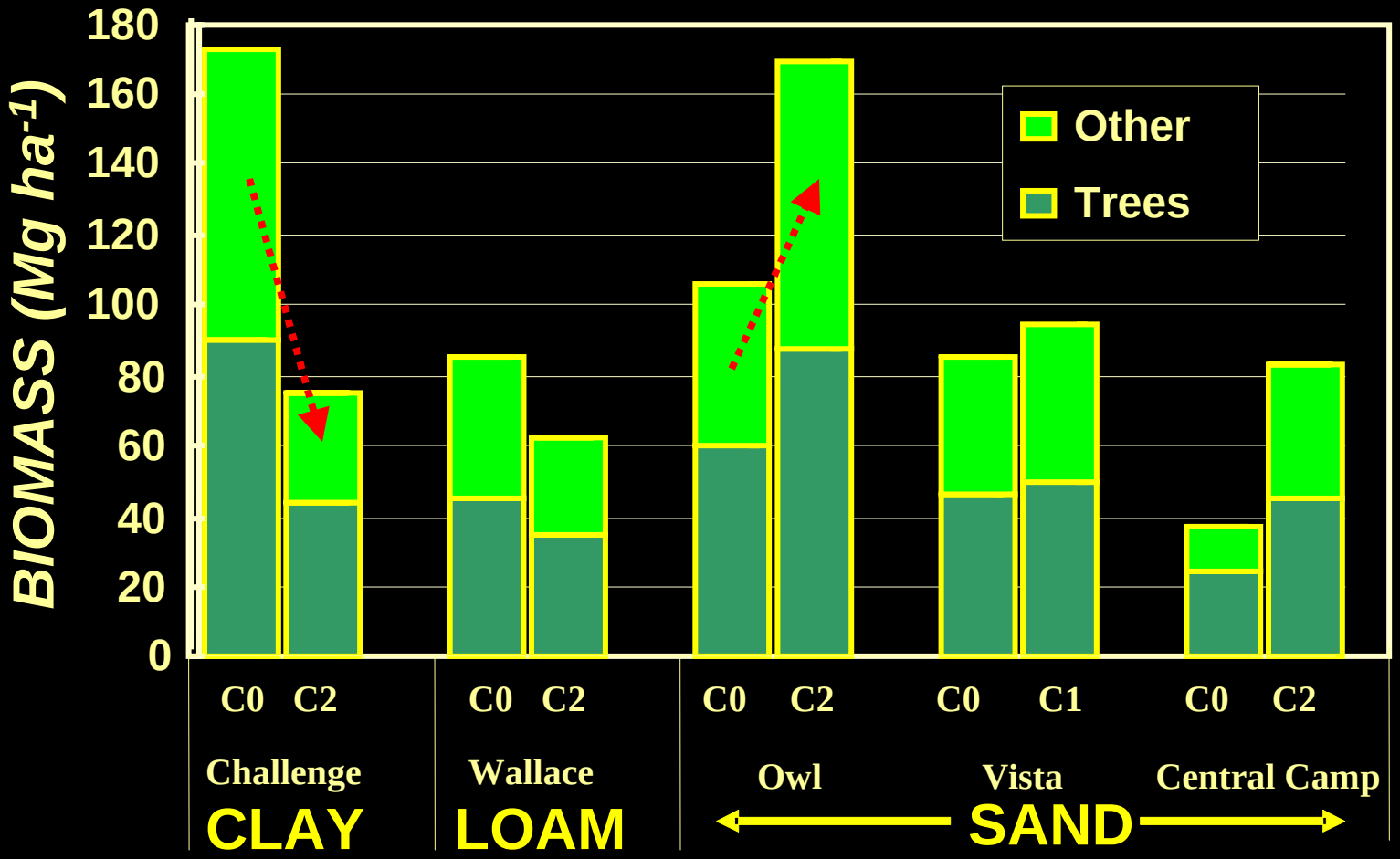
STANDARDIZED EXPERIMENTS TO TEST THE FOLLOWING NULL HYPOTHESES:

- **Pulse changes in site OM or soil porosity will not affect a site's long-term productivity.**
- **If impacts do occur, they are universal.**
- **If impacts occur, they are irreversible.**
- **Plant community diversity has no impact on long-term productivity.**

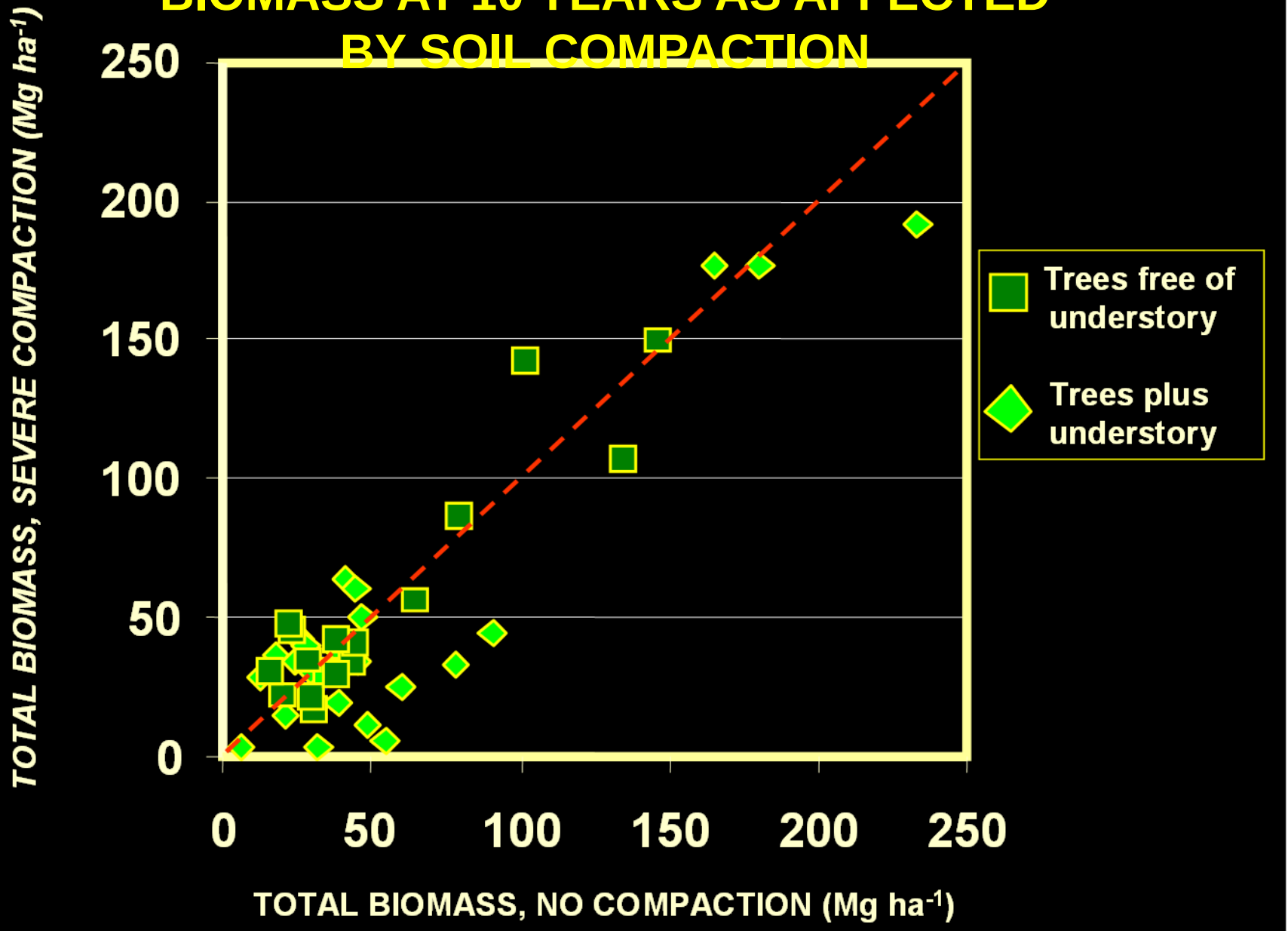
LTSP TREATMENTS ENCOMPASS THE OPERATIONAL ENVIRONMENT



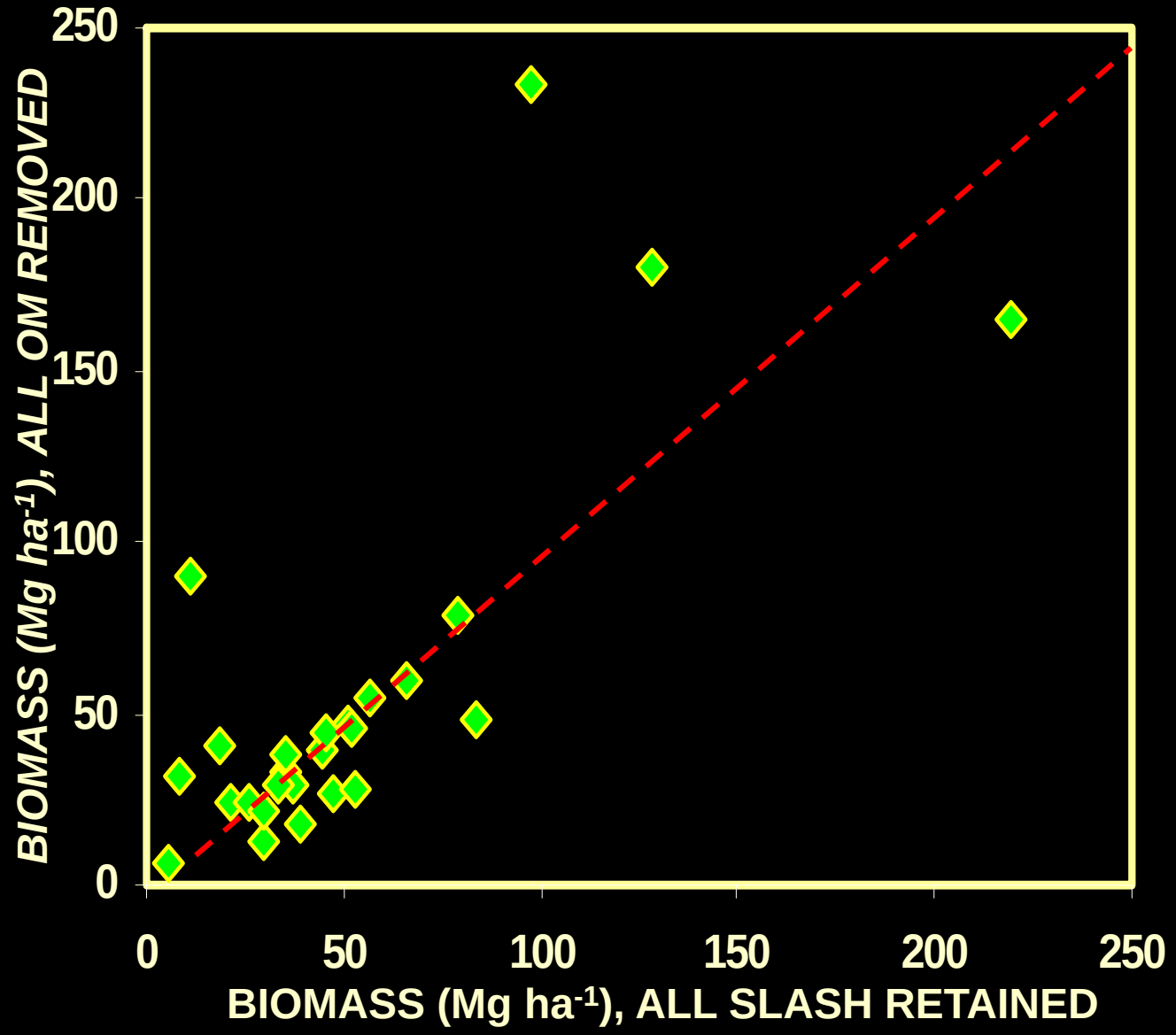
10-YR BIOMASS RELATIVE TO COMPACTION ON FIVE LTSP SITES IN CALIFORNIA



BIOMASS AT 10 YEARS AS AFFECTED BY SOIL COMPACTION



BIOMASS AT 10 YEARS AS AFFECTED BY ORGANIC MATTER REMOVAL



Research to validate the SQS

- LTSP – a North America wide research study with a common experimental design.

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Legal Challenges
Court Decisions

- "I am reluctantly compelled, because of the *absence of sufficient soil productivity analysis*, to comply with Ninth Circuit precedent and find that the Forest Service has run afoul of both NEPA and NFMA in approving Basin Creek Hazardous Fuels Reduction Project. This means that until the law is complied with in at least this one area, the project cannot move forward."

» *US District Court Judge Donald Malloy, June 9, 2006*

Adaptive Management Process Forest Soil Conservation

- A common language for soil disturbance
- Visually-based soil disturbance monitoring and classification systems
- Reliable, site specific methods to rate soils for their risk of incurring detrimental soil disturbance
- Validation
- Soil Inventory

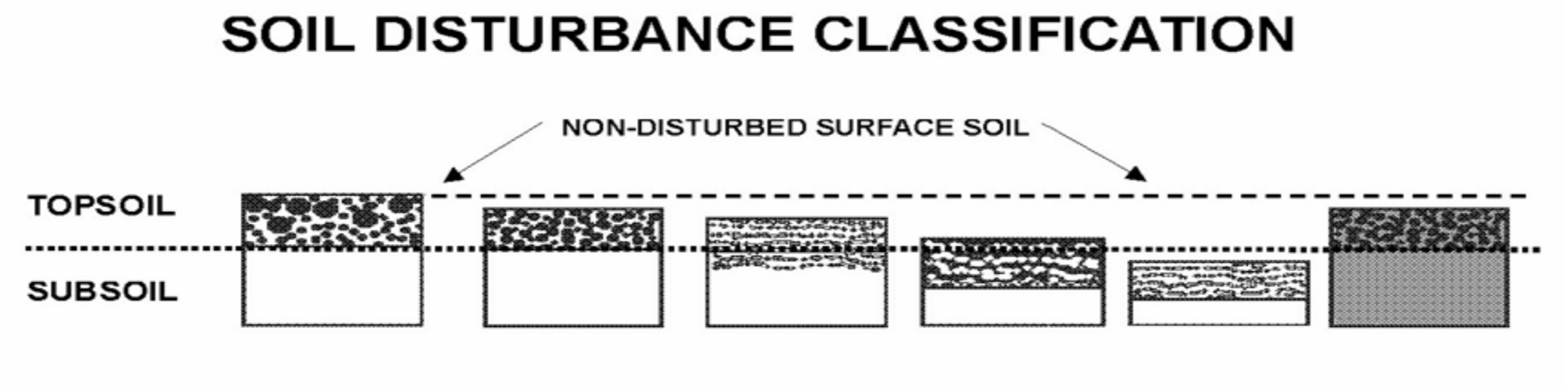
Uniform Assessments

- Common terms and comparable guidelines
- Cost-effective techniques for monitoring
- Improved methods to rate soils for risk of detrimental soil disturbance

(see Curran et al. 2005)

Visual classifications

Weyerhaeuser Company Classification System



- **Easy to understand**
- **Readily classified in the field**
- **Linked to strategic database - impacts on tree growth**

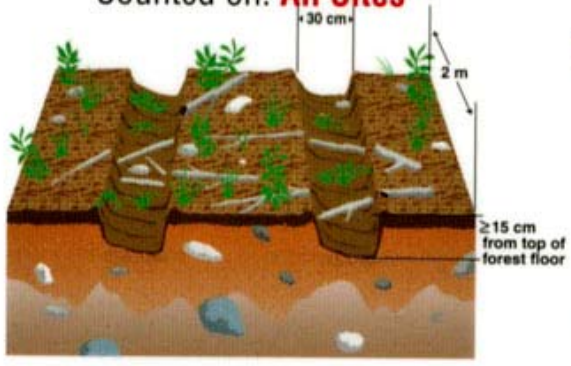
Forester / Equipment Operator Training

After Scott et al. 1979

British Columbia Ministry of Forests System

Wheel/Track Rut

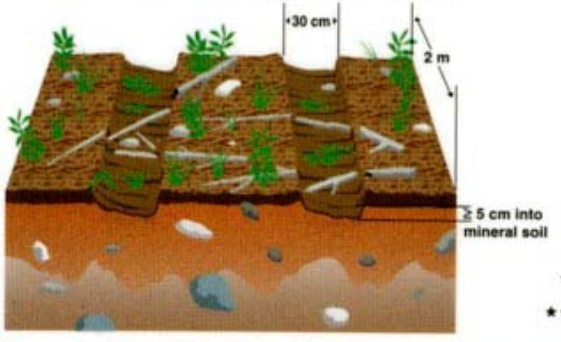
Counted on: **All Sites**



Wheel/Track Rut

Counted on: **Very High and High Compaction Hazard Sites**

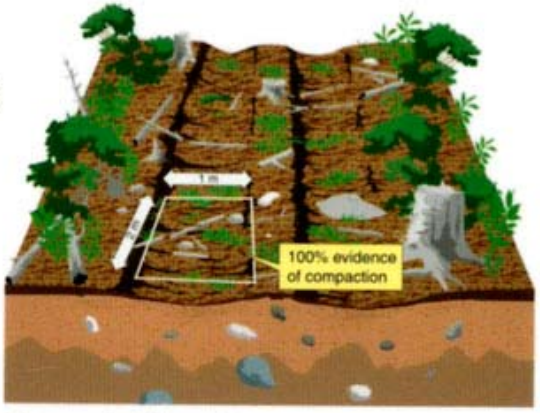
or where soil hazards have not been documented in an operational plan.



Repeated Machine Traffic

Counted on: **Very High, High and Moderate Compaction Hazard Sites**

or where soil hazards have not been documented in an operational plan.



Compacted Areas*: counted on same sites as "repeated machine traffic," illustrated above, but compacted areas are larger (i.e., must be >100 m² and > 5 m wide).

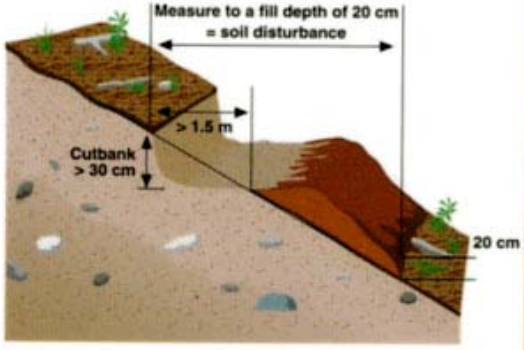
Corduroyed Trail*: logs and woody debris placed side-by-side to form a surface > 2 m long capable of supporting machine traffic.

*Must be rehabilitated unless exempted by district manager.

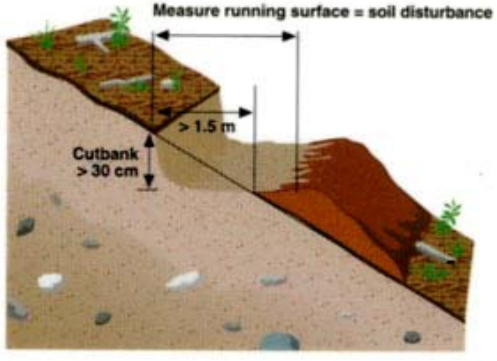
**Must be preapproved and may require rehabilitation.

Temporary Excavated/BladedTrails**

Unfavorable Fill Slope Material (won't support tree growth)



Favorable Fill Slope Material

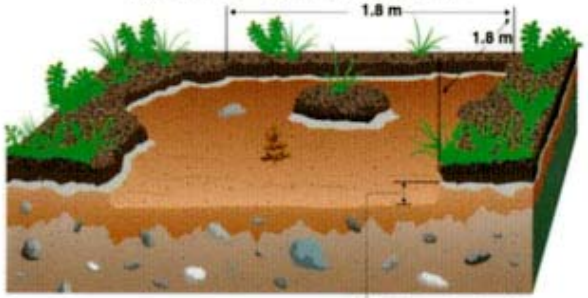


Always Counted

Deep Gouge

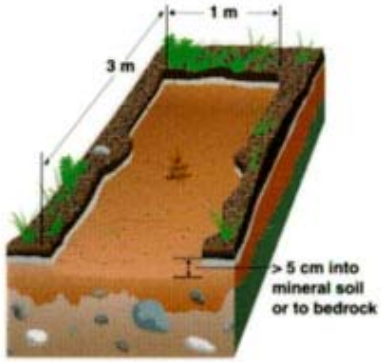
> 30 cm into mineral soil or to bedrock

Wide Gouge
(80% of 1.8 m x 1.8 m)

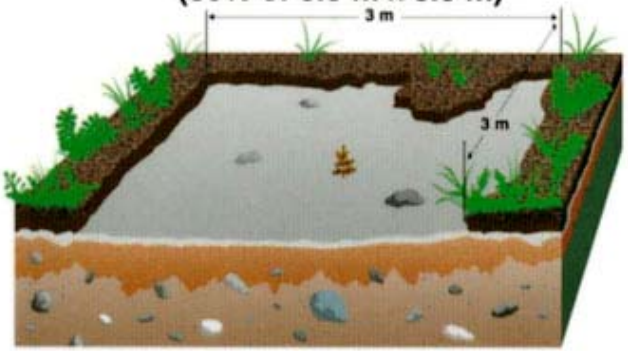


> 5 cm into mineral soil or to bedrock

Long Gouge
(100% of 1.0 m x 3.0 m)



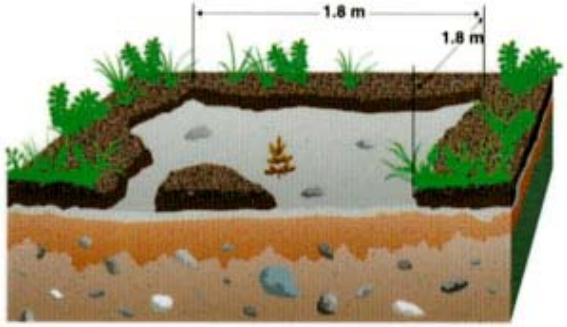
Very Wide Scalp♦
(80% of 3.0 m x 3.0 m)



♦ Scalp means the forest floor has been removed.

Wide Scalp♦
(80% of 1.8 m x 1.8 m)

Counted when: VH soil displacement, compaction or erosion; **or** moderate or high likelihood of landslides; **or** the soil hazards have not been documented in an operational plan.



Forest Practices Branch
B.C. Ministry of Forests
Soil Disturbance Card Feb/99

Disturbance classes

- Disturbance types are defined primarily by morphological attributes (not quantitative measures)
- Disturbance types are easy to communicate
- Disturbance types are correlated with soil variables that affect tree growth and hydrological and ecological function
- Disturbance classes can be used by a wide range of personnel

Forest Service Visual Class Descriptions

Class 0 – Undisturbed **Soil surface:** •No evidence of past equipment operation. •No depressions or wheel tracks evident •Forest floor layers present and intact •No soil displacement evident •No management-generated soil erosion •Litter and duff layers not burned. No soil char. Water repellency may be present.	

	Class 1 **Soil surface:** •Faint wheel tracks or slight depressions evident and are <5 cm (2”) deep. •Forest floor layers present and intact •Surface soil has not been displaced and shows minimal mixing with subsoil. •Burning light: Litter charred, or consumed. Duff largely intact. Water repellency is similar to pre-burn conditions. Depth of char < 1 cm (1/2”). Soil compaction: •Compaction in the surface soil is slightly greater than observed under natural conditions. Concentrated from 0-10 cm (0-4”) in depth. Observations of soil physical conditions: •Change in soil structure from crumb or granular structure to massive or platy structure, restricted to the surface 0-10 cm (0-4”). •Platy structure is non-continuous

Class 2 **Soil surface:** •Wheel tracks or depressions are 5-10 cm (2-4”) deep. •Forest floor layers partially intact or missing •Surface soil partially intact and may be mixed with subsoil •Burning moderate: Duff deeply charred or consumed. Surface-soil water repellency increased compared to the pre-burn condition. Depth of char 1-5 cm (1/2-2”). Soil compaction: •Increased compaction is present from 10-30 cm (4-12”) in depth. Observation of soil physical condition: •Change in soil structure from crumb or granular structure to massive or platy structure, restricted to the surface 10-30 cm (4-12”). •Platy structure is generally continuous •Large roots may penetrate the platy structure, but fine and medium roots may not.	

	Class 3 **Soil surface:** •Wheel tracks and depressions highly evident with depth >10 cm (4”). •Forest floor layers are missing •Evidence of surface soil removal, gouging, and piling •The majority of surface soil has been displaced. Surface soil may be mixed with subsoil. Subsoil partially or totally exposed. •Duff and litter layer completely consumed. Surface soil is water repellent. Depth of char > 5 cm (2”). Surface reddish or orange in places. Soil compaction: •Increased compaction is deep in the soil profile (> 30 cm in depth (>12”)). Observations of soil physical conditions •Change in soil structure from granular structure to massive or platy structure extends beyond 30 cm (12”) in depth. •Platy structure is continuous. •Roots do not penetrate the platy structure.


Class 0
Class 2
Class 3
(?)
Class 1


Class 2 or maybe 3?
Class 3

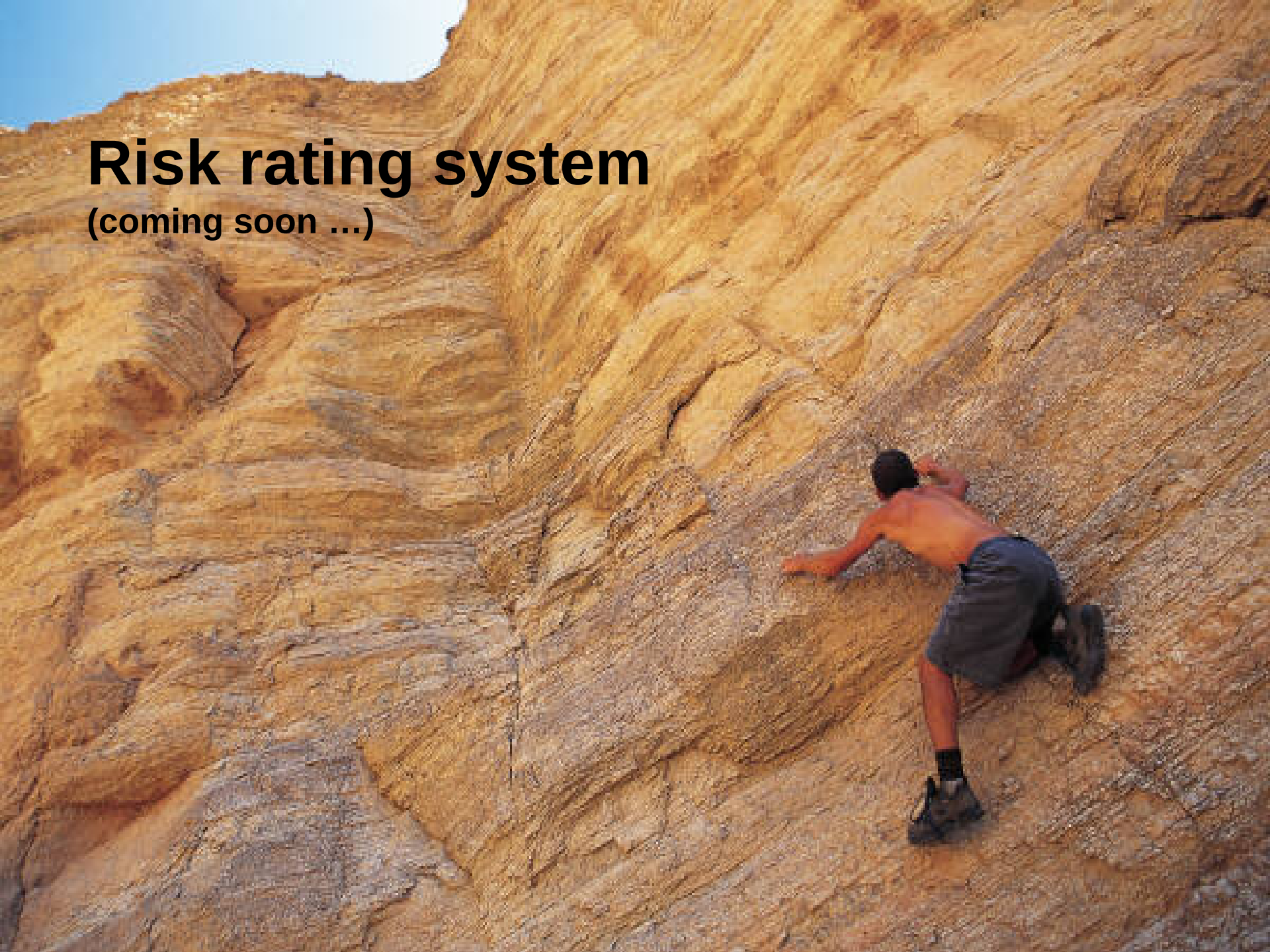
Condition Class Examples

Why a visual classification?

- Visual classes provide information about soil condition in an efficient and consistent way.
- Enables all participants to “speak the same language” when describing soil conditions.
- Incorporates repeatable measurements found in the R-1 protocol.
- Based on direct observations of visual attributes in the field.

Risk rating system

(coming soon ...)



Equipment Risk Rating Assumptions

- Small impacts on deep, fertile soil have small effects.
- Extensive impacts on shallow, infertile soil have large consequences.
- Soils that already support vigorous plant growth are assumed to be less affected by compaction or displacement than less favorable soils.
- Impacts are more likely to reduce tree growth in stressful climatic conditions.

Data Sources for the Equipment Risk Ratings

- NASIS soil properties data and SSURGO soil polygon spatial data
- Official series descriptions (OSD's)
- Spatial data for Potential Vegetation Type from the Forest Service Interior Columbia Basin Project
- Slope and aspect derived from Digital Elevation Models (DEM's)

Factors in the Risk Rating for Logging Equipment

- Combined thickness of A and B horizons
- Depth to which common or many fine and very roots are described in the official series description
- Rock fragment content in the A and B horizons
- Thickness and type of tephra (ash mantle, mixed ash, pumice mantle, etc.)
- Texture of A or AB horizon (sandy, loamy, or clayey)
- Texture of B horizon (sandy, loamy, or clayey)
- Aspect
- Slope class – same as fire hazard classes
- Potential vegetation

Finding a common language for soil assessments – a picture guide to soil disturbance classes

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How the field guide was developed

- Field visits to every region to capture photographs of mechanical equipment effects to soils.
- Gathered information on equipment type, treatment prescription and objective, time since activity.

Condition Class Examples

Validating the condition classes

What do the visual classes mean?

- Current efforts involve linking visual classes to changes in soil chemical, physical, and biological properties
- Linking condition classes to vegetative production
- Developing BMP’s

Summary of Soil Assessment Effort