

Progress Towards a Common Approach to Assess and Report Soil Disturbance in Relation to Forestry Practices

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**IEA Bioenergy Workshop
Vancouver BC Canada
Aug 28, 2006**

Agency Collaborators

- **British Columbia Forest Service**
- **USDA Forest Service**
- **Weyerhaeuser Company**
- **University of Saskatchewan**
- **Alberta Forest Management Branch**
- **Canadian Forest Service**

Outline

- Sustainability
- Indicators
- The Need for a Common Approach
 - ◆ A. Common Terms
 - ◆ B. Monitoring
 - ◆ C. Risk (Hazard) ratings
- Developing consensus
- Summary



“Sustainable Forest Soils”

“Ensuring that the biological, chemical and physical integrity of the soil remains for future generations”

- ‘Everyone’ wants it
- Governments, 3rd parties, and Industry address the need for it through systems and processes
 - Protocols, standards and operations
- To achieve sustainability, efforts are needed at local, regional, national and international levels

“Sustainability Protocols”

- Criteria and Indicators (C&I) of sustainable forestry:
 - ◆ Montreal Process (MP) (1995)
 - ◆ Canadian Council of Forest Ministers (1995, 2003)
- Encourage countries to report on the status of the Indicators.
- States and provinces have reporting systems based on the international protocols:
 - ◆ Oregon (2000), California (2003), Ontario..
 - ◆ The State of B.C.'s Forests (2004...)

“Sustainability Process”

- Progress towards sustainability is often tracked in terms of indicators...
- Achieving sustainability is a continuous process
 - ◆ Data collection (indicators)
 - ◆ Evaluation / identifying problems
 - ◆ ‘Fixing problems’
 - policies
 - management approach
 - operating techniques
 - ◆ Creating / responding to new knowledge
- Process is sometimes called *Adaptive Management*

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“Soil productivity and hydrologic condition”

- Productivity.. a number of factors could be considered:
 - ◆ Tree growth, (or other forest products ?)
 - ◆ ‘Support ecosystem processes’
 - ◆ ‘Stability’ / ‘Resistance’ / ‘Resilience’ in the face of disturbance, disease and pests’
- Hydrologic Function of soil
 - ◆ Properties or processes affecting water quantity, quality, and distribution

Desirable Attributes for Indicators (CCFM C&I):

- Relevant (related / sensitive / responsive)
- Measurable (scientifically valid, practical)
- Understandable (forest managers, public)
- Can be Forecast (expected future condition)
- Have Reference Values (performance check)

“Soil productivity and hydrologic condition”

- In many NA ecosystems, we need at least 10 to 20 years of growth data to draw conclusions about the effects of various practices
- Therefore, soil disturbance at the time of harvest is used as a proxy that can be measured.



Soil Disturbance (a Proxy)

- Any physical, biological, or chemical disturbance to the soil caused by ground-based equipment (operations)
- May be detrimental, inconsequential, or beneficial, depending on growth limiting factors and hydrologic properties



Main concern has been disturbance leading to soil degradation

- Compaction
- Displacement (mineral soil; forest floor)
- Erosion
- Mass Wasting (cut/fill failures)

Additional concerns may arise...

- Organic matter... coarse / fine woody debris
- Biological features
- *These may be* of particular interest to bioenergy

Soil Indicators.. *more work needed*

- MP indicators are “b-type” indicators –
 - ◆ require “new or additional data and/or a new program of systematic sampling or basic research.”
- Therefore, **compliance with standards has been used instead**, e.g., CCFM C&I (2003)
- **NOT WORKING VERY WELL...**
 - standards vary too much
 - no validation yet that this approach leads to sustainability

MP talks about area with “significant compaction”



BUT, what does compaction mean on a given forest site?

We Must Strive for Clarity in Operational Use of Terms:

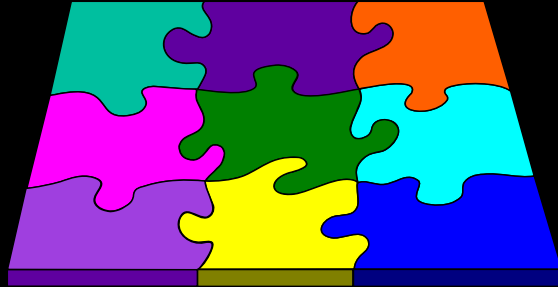
- “Compacted” “Heavily Compacted”
- “Sensitive soil” “High Compaction Hazard”
- When we refer to a “Rut”
 - ◆ Depth? Length? Compacted or Puddled?
- or “Displacement”
 - ◆ Individual Micro-sites? Cumulative area?

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“Pedology”



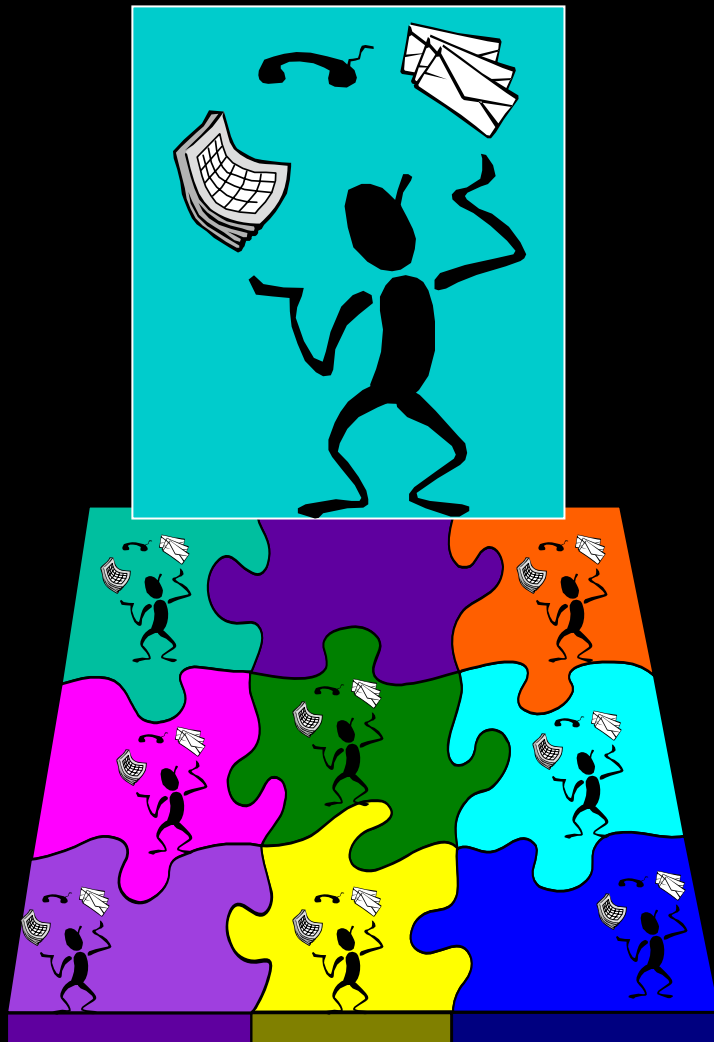
- Framework for organizing sites / results
- Based on correlating mapped soils, etc.
- Use to identify “representative” and “gaps”
- Use for communication and roll-up to higher levels (e.g. stand to National level)
- WE MISSED SOIL DISTURBANCE(!):

We can improve..

- Work together
- Follow a Reliable, Adaptive Process
- Have comparable approaches
 - ◆ Disturbance Categories
 - ◆ Monitoring Approaches
 - ◆ Risk / Hazard Ratings
 - ◆ Reporting
 - ◆ Regional databases



Starts at the Regional Level

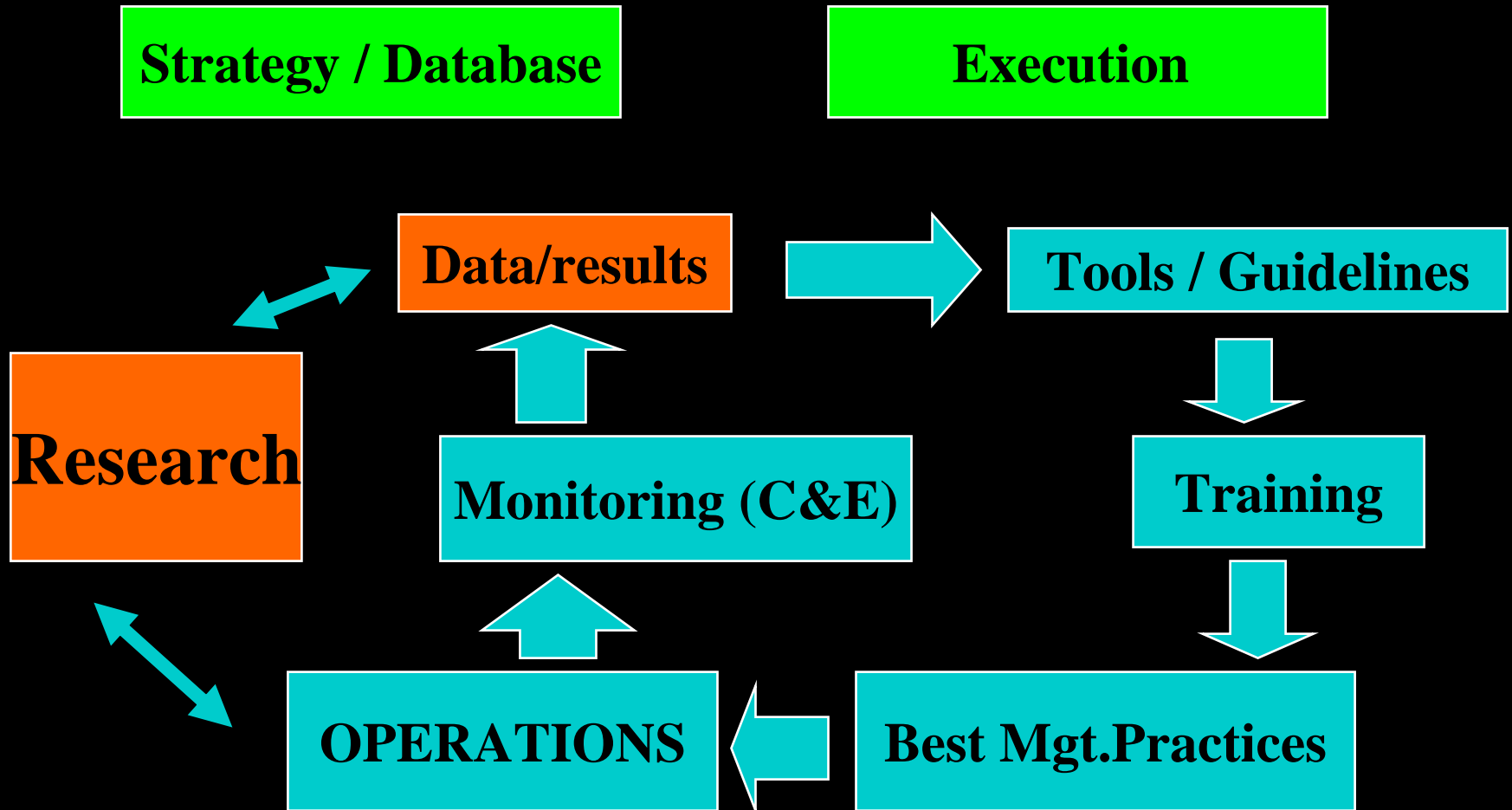


- Different History
- Different Approaches
- Stuck in our work
- But, Similar issues and Similar Soils
- Therefore, Network

Approach for Regional Integration

- Need a “Common language and database” that is tied to adaptive management process
- Work together within a region...
 - ◆ Database → Tools → Best Mgmt Practices
- Public Agencies/ Industry / Universities

Adaptive Management Process



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Common Terms and Standards

■ Currently:

- ◆ Each jurisdiction/landowner may have different definitions and criteria
- ◆ Research may use different definitions and criteria
- ◆ Difficult to compare results/standards

■ **Some legal challenges now, more expected**

- Disturbance is a proxy that must be validated, so comparability is more important now...

Criteria for consistent soil disturbance classes

1. mostly defined by visual (morphologic) attributes rather than quantitative physical properties,
2. easy to communicate, and
3. correlated with soil variables that affect tree growth and hydrological or ecological function



Always Counted

Deep Gouge



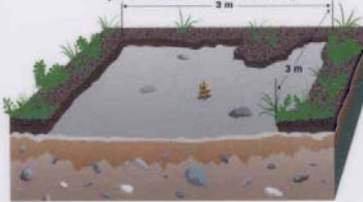
Wide Gouge (80% of 1.8 m x 1.8 m)



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



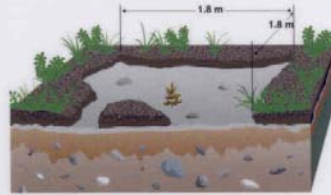
Very Wide Scalp* (80% of 3.0 m x 3.0 m)



* 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

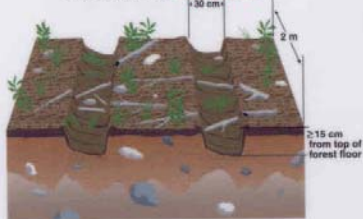
Example: BC Disturbance types

Recognized by equipment operators, contractors, inspectors, public, researchers, etc.

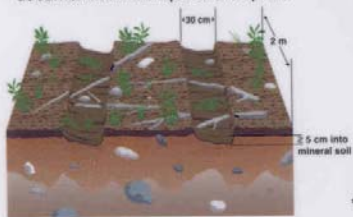
“Counted” varies with site condition

Simple “objects” defined mainly by visual criteria

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.



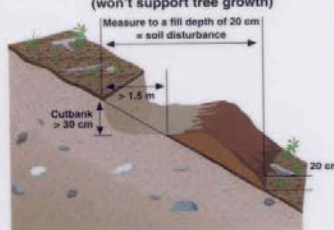
Compacted Areas*: counted on same sites as “repeated machine traffic,” illustrated above, but compacted areas are larger (i.e., must be > 100 m² and > 5 m wide).

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

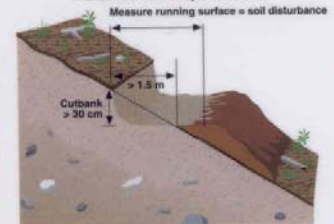
* Must be rehabilitated unless exempted by district manager.
** Must be preapproved and may require rehabilitation.

Temporary Excavated/Bladed Trails**

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



Favorable Fill Slope Material

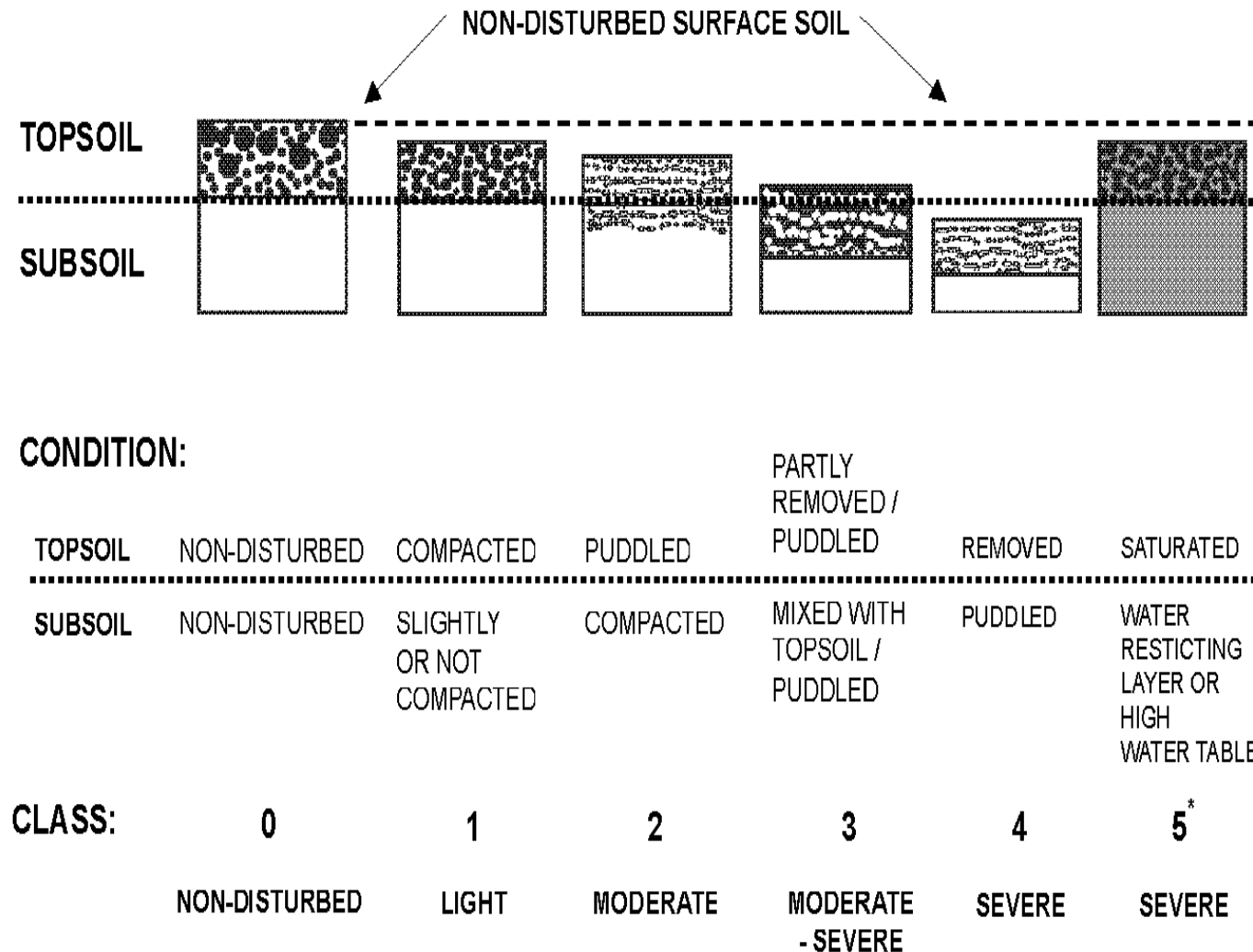


SOIL DISTURBANCE CLASSIFICATION

Weyerhaeuser
Disturbance
types

Mainly machine
traffic types
- less displaced

Varies with site
condition
(topsoil)



* CLASS 5 SATURATION APPLIES TO ANY DISTURBANCE THAT CAUSES THE SOIL TO BE SATURATED FOR TEN (10) OR MORE DAYS.

USDA FS Wallowa-Whitman

(older key had 7 classes)

■ **Class 0: Undisturbed Natural State.**

■ **Class 1: Low Soil Disturbance**


- Faint wheel tracks or slight depressions evident and are <6 inches deep.
- Litter and duff layers present and intact.
- Resistance of surface soils may be slightly greater than observed under natural conditions. Concentrated in top 0-4 inch depth.
- Change in soil structure from crumb or granular structure to massive or platy structure, restricted to the surface 0-4 inches.

■ **Class 2: Moderate Disturbance**

- Wheel tracks or depressions >6 inches
- Forest floor / surface soil partially intact
- > resistance throughout top 4-12 inches
- Platy structure is generally continuous.

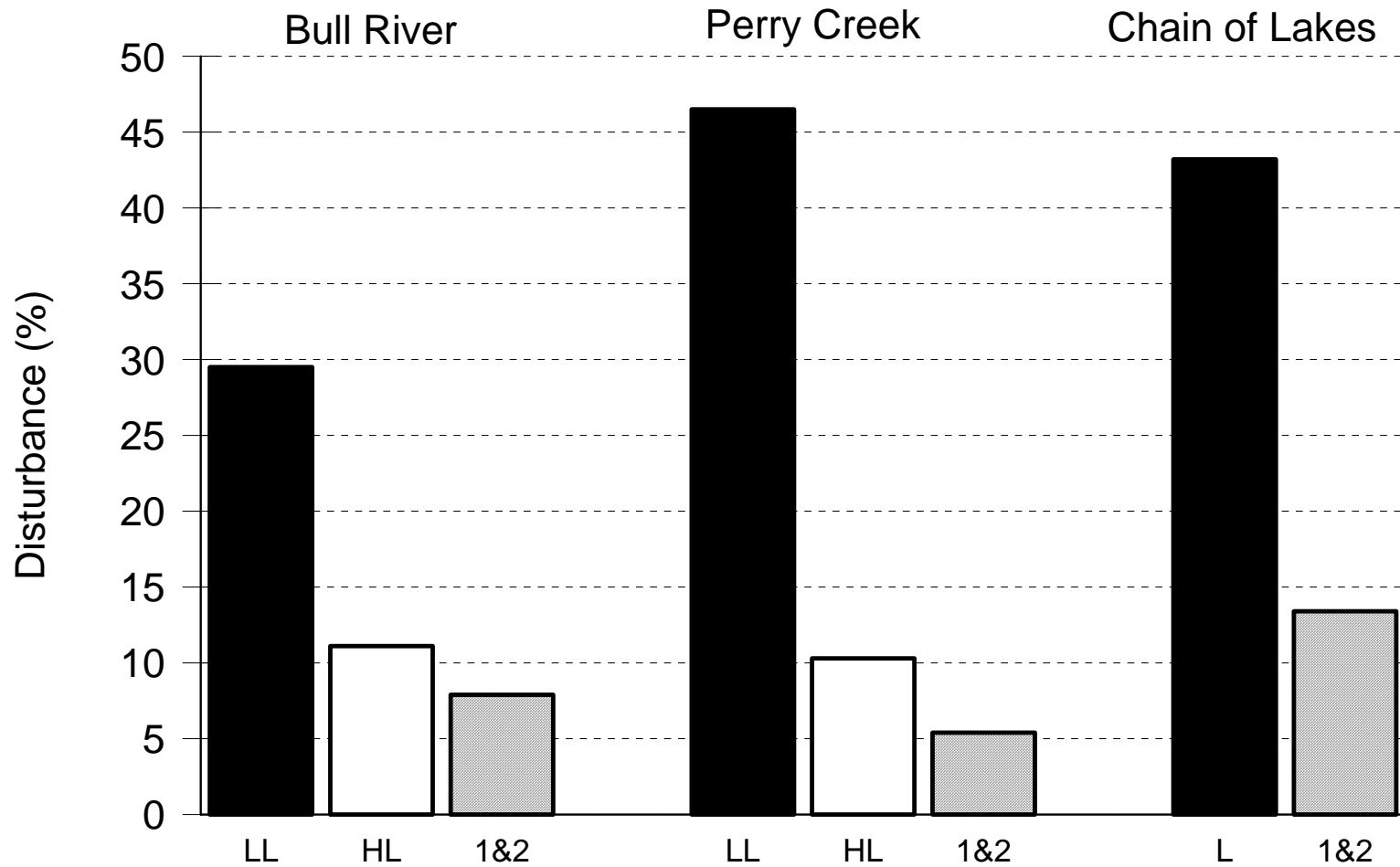
■ **Class 3: High Disturbance**

- Wheel tracks or depressions >12 inches
- Litter and duff layers are missing.
- Evidence of topsoil removal, and piling.
- Soil displacement has removed the *majority* of the surface soil.
- Subsoil partially or totally exposed.
- Increased resistance (>12 inches).
- Massive or platy structure extends beyond the top 12 inches of soil.

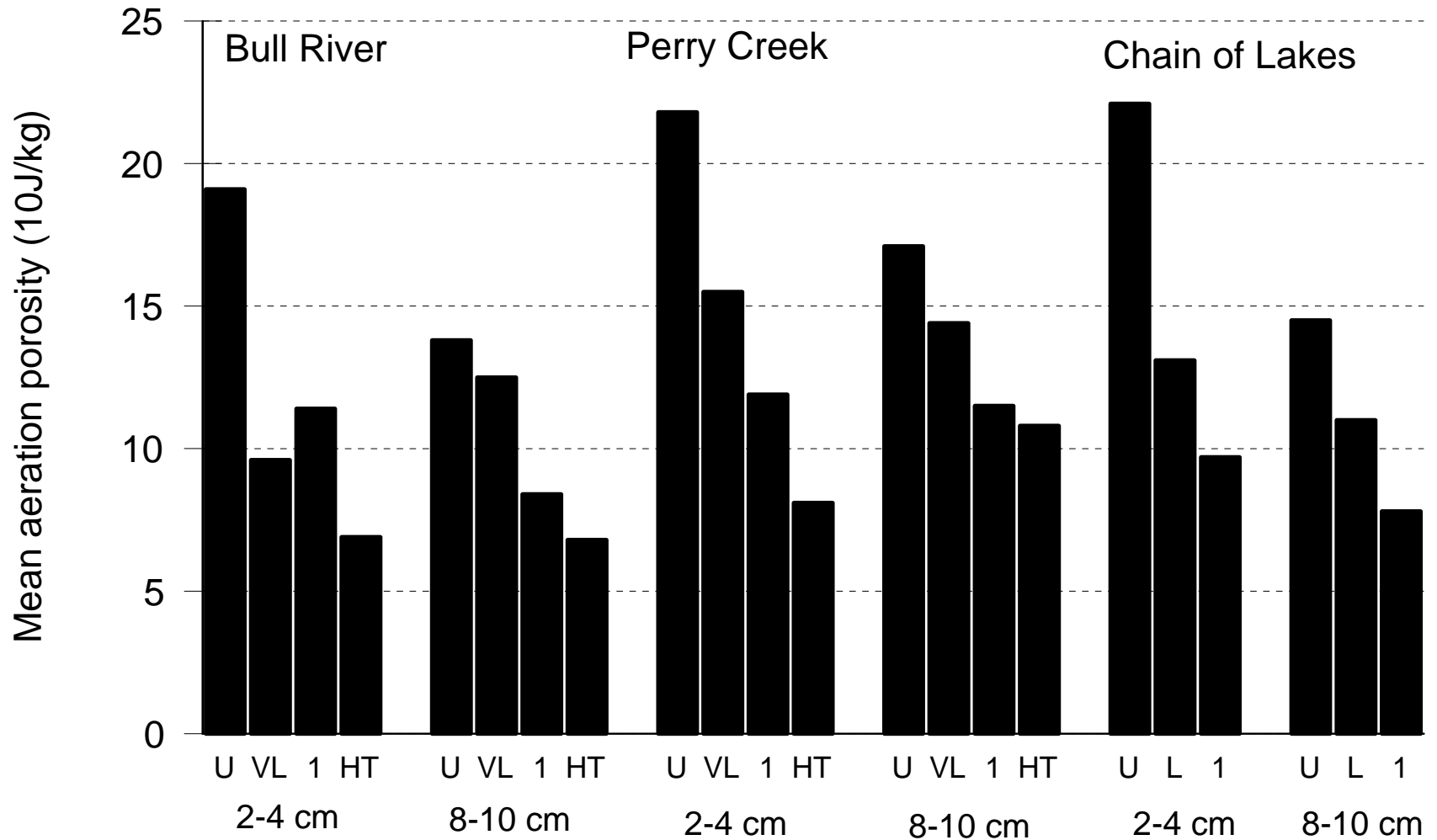
A photograph of a forest clearing, likely a logging site. The ground is covered with a dense layer of fallen logs, branches, and tree stumps. A person is standing in the center of the clearing, providing a sense of scale. The background shows a dense forest of tall, thin trees. The text "COMPACTION IS OFTEN A CONCERN ON TRAILS" is overlaid on the right side of the image.

**COMPACTION
IS OFTEN A
CONCERN ON
TRAILS**

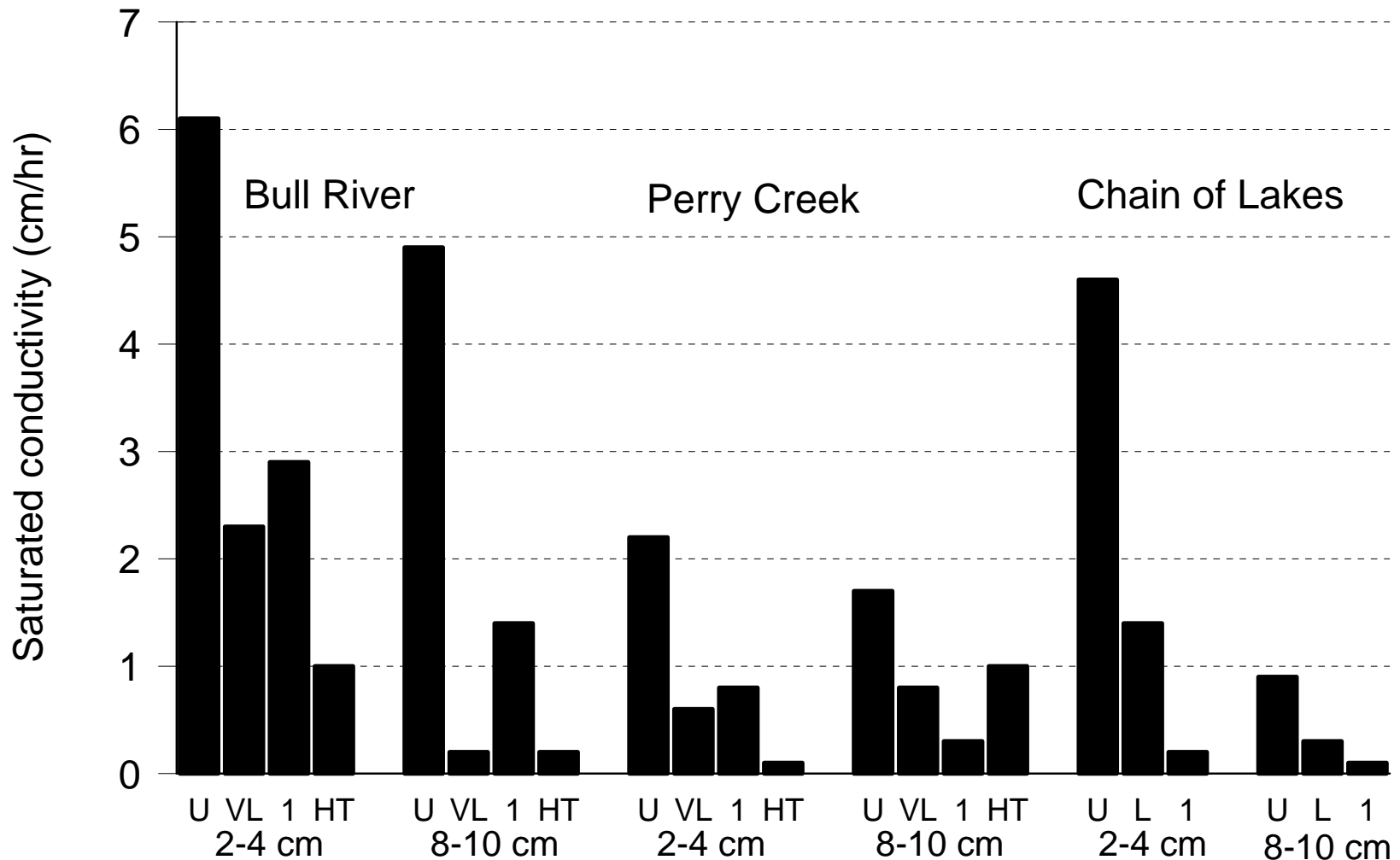
Soil Disturbance



Aeration porosity – fully mechanized harvest



Decreased saturated conductivity :



Tree growth related to bladed trail location





RATIONALE NEEDED (AND VALIDATION)

e.g. Erosion,
sedimentation and
drainage disruption
can be the main
concerns for some
disturbance types like
bladed structures
= off site effects

Examples of Common Terms

■ Permanent versus temporary access

- ◆ including trails in partial cuts

■ Machine traffic types

- ◆ ruts, puddling, repeated traffic

■ Displacement types

- ◆ gouges and scalps

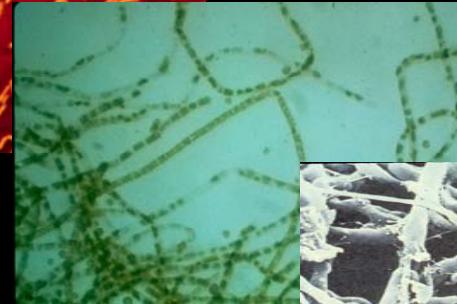
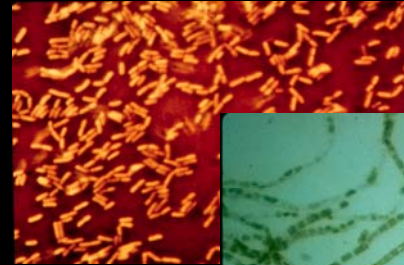


Comparable Standards

- **Limit for Permanent Access Network**
 - ◆ e.g. BC is 7 % which seems high
- Limits on Temporary Access
- Standards for Rehabilitation of above
- **Cumulative Limit for Dispersed Disturbance** within area to be reforested
 - ◆ e.g. BC it is 10 or 5 % based on sensitivity
- **These may vary with soil sensitivity**

Other soil disturbance concerns

- Organic matter
- Biological function
 - ◆ Green tree retention
- Invasive plants
- Other invaders (eg, Armillaria?)
- Aesthetics (social license)



'96 6 27

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Cost-effective Monitoring:

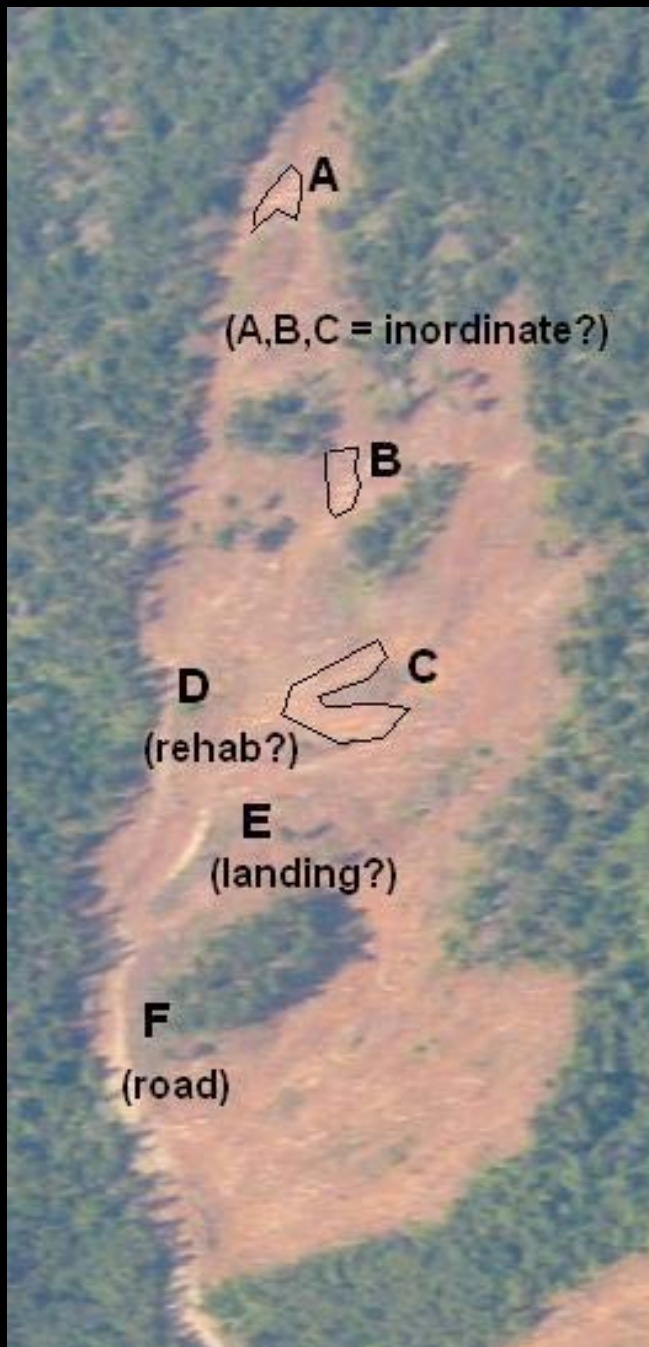
- Monitoring variables same as those used in Standards
- Intensive sampling was required for some old criteria (too costly, time consuming)
- Extensive sampling possible with visual criteria, but must be calibrated / validated
- Validation and Effectiveness monitoring are very important

Criteria for cost-effective monitoring:

1. It must provide
 - scientifically and technically sound information,
 - reliable results with acceptable costs,
2. Results need to be clearly communicated and understood by all parties affected, and
3. Process must be consistently and efficiently implemented.
4. Statistically valid (get help !)

Types of monitoring

1. **Implementation (Compliance)**
 - Did they meet the contract?
2. **Effectiveness**
 - Contract and practices effective?
3. **Validation (research)**
 - Underlying assumptions correct?

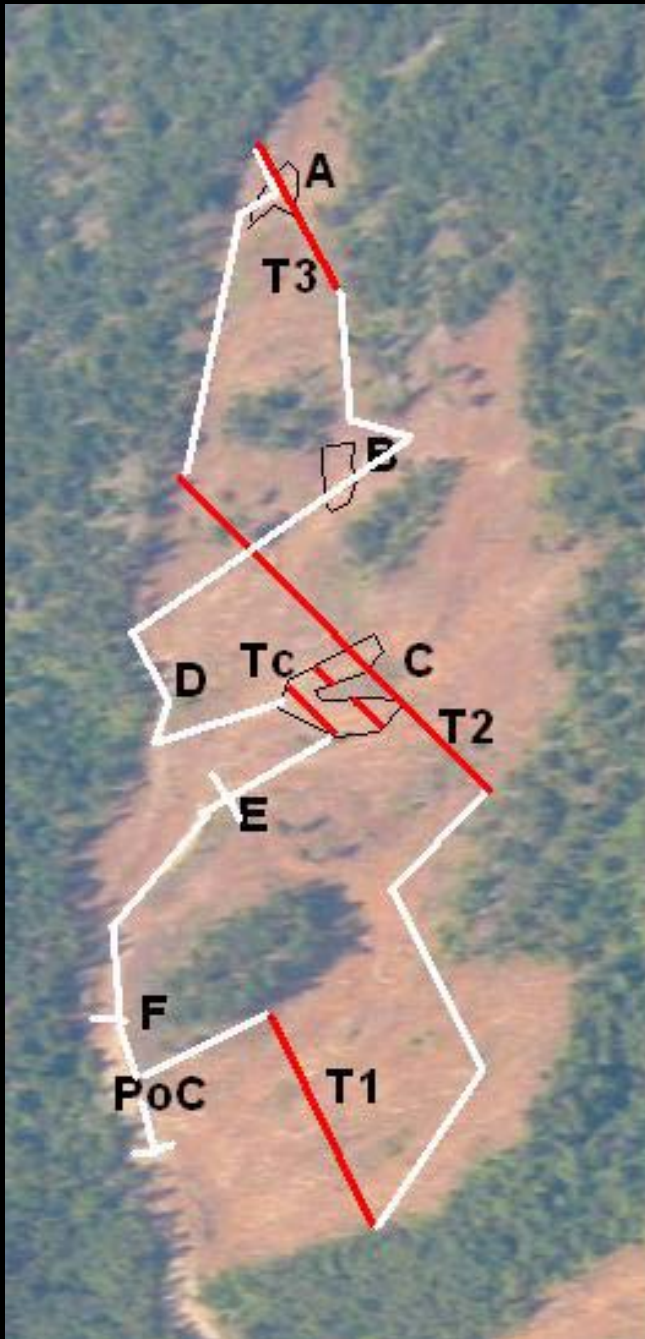


Example:

Air photo used for compliance monitoring

Low resolution image taken from conventional digital camera

Suitable for reconnaissance before routine monitoring



Example:

Air photo use for compliance monitoring

Identify features of interest and lay out transects

(proposed methods in BC may see transects replaced with random points)

Effectiveness Monitoring

1. Policy being adequately implemented?
2. Does the policy address the goal?
3. Sites being adequately described?
4. Establish benchmarks over time
5. Advise policy / research through adaptive process

**** NEW FOR BC**

BC's Forest Resource Evaluation Program (FREP)

FREP

FRPA RESOURCE EVALUATION PROGRAM


Scientifically Valid Evaluations of Forest Practices under the Forest and Range Practices Act


Protocol for Soil Resource Stewardship Monitoring: Cutblock Level


For the most current version of this document, please consult the
FREP web site http://www.for.gov.bc.ca/hfp/frep/7_rm.html

For other FREP information, please go to
<http://www.for.gov.bc.ca/hfp/frep/>

Version 1.0
September 6, 2005

 **BRITISH COLUMBIA**
Ministry of Forests
Ministry of Water, Land and Air Protection
Ministry of Sustainable Resource Management

 Resource
Stewardship
Monitoring

 <div style="display: inline-block; vertical-align: middle;"> BRITISH COLUMBIA <small>FRPA Resource Evaluation Program</small> </div> <div style="display: inline-block; vertical-align: middle; margin-left: 20px;"> Soils Effectiveness Evaluation Resource Stewardship Monitoring <small>Opening Information - Form A Side 1</small> </div>			
Opening Identification			
Opening # _____ Licence # _____ CP# _____ Block _____ Evaluator _____			
Licensee _____			
District _____ Year of Harvest _____			
Location Description _____			
Net area to be reforested (ha) _____ Gross area (ha) _____			
1. Estimating lost soil productivity due to access construction.			
1.1 Delineate and measure outblock area in un-rehabilitated roads, landings, and borrow pits			
Structure ID	Area (length x width) m ²	Description	% of Outblock 100 % x (area of structure/ total outblock area)
1.2 Delineate and measure outblock area in rehabilitated access and effectiveness of rehabilitation treatments			
Structure ID	Area (length x width) m ²	Description	ER ¹ % of Outblock 100 % x (area of structure/ total outblock area)
¹ Effectiveness of rehabilitation treatments on access. ER (effectiveness of rehab) ranges from 0 (unproductive ground) to 1 (fully restored soil conditions), and is determined according to the following method (partial scores are possible), where: ER = arbnc			
a) Vite the rehabilitated area decomposed as necessary? Determine this by digging. Look for uncompacted turning surface which may appear as a remaining "mudroad ridge" along a road or trail. Assign a score from 0 to 0.5 max and make any comments here, noting which feature the comment refers to:			
b) Vite topsoil and/or bumble debris, and woody debris re-spread with minimal mixing of subsoil? Dig to determine if the texture and organic matter content are similar to undisturbed soils on similar sites in the area, or if it is good rooting medium that is organic rich but free of voids and buried coarse woody debris. Assign a score from 0 to 0.5 max and make any comments here, noting which feature the comment refers to:			

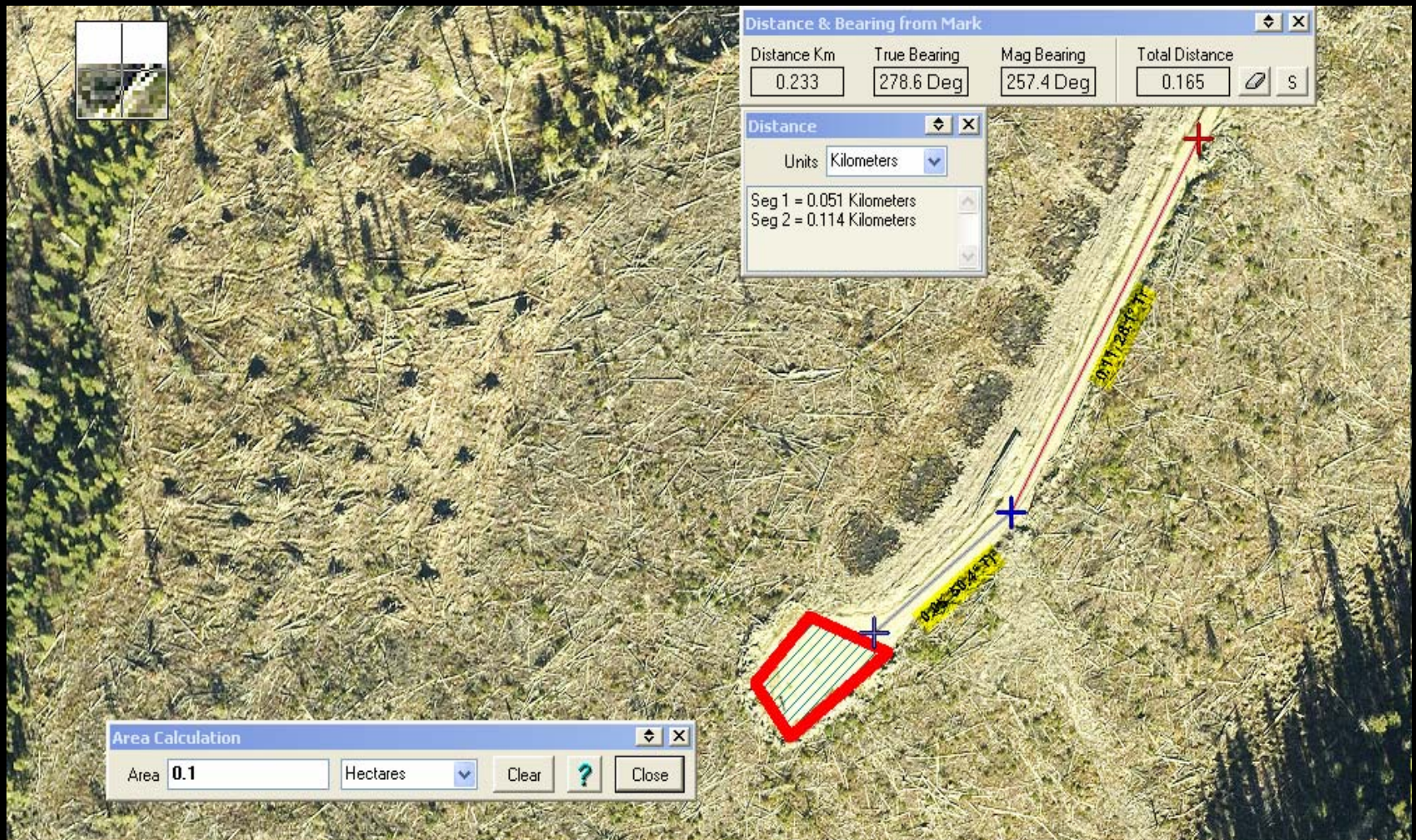
FS1246 HFP 200506
PAGE 1

FREP Indicators:

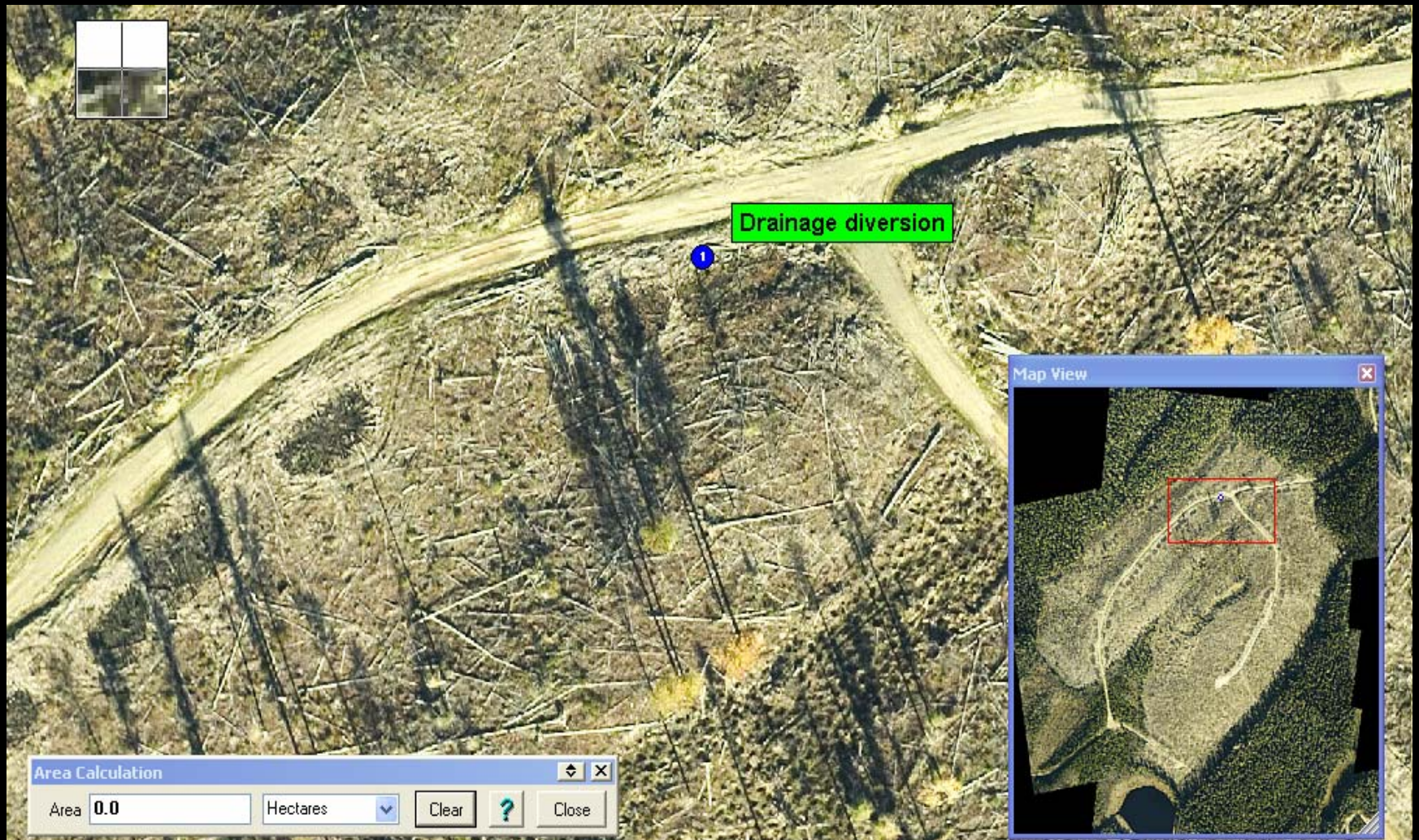
[illegible]

1. Lost productivity due to access
2. Area affected by landslides and significant erosion
3. Area affected by disturbance to natural drainage patterns
4. Area affected by dispersed soil disturbance to growing sites
5. Green tree retention
6. Organic matter

Features: Permanent Access



Features: Drainage Patterns



Field Map: Planned transects for soil disturbance monitoring



Features: Green Tree Retention and Coarse Woody debris



Features: Green Tree Retention and Coarse Woody debris

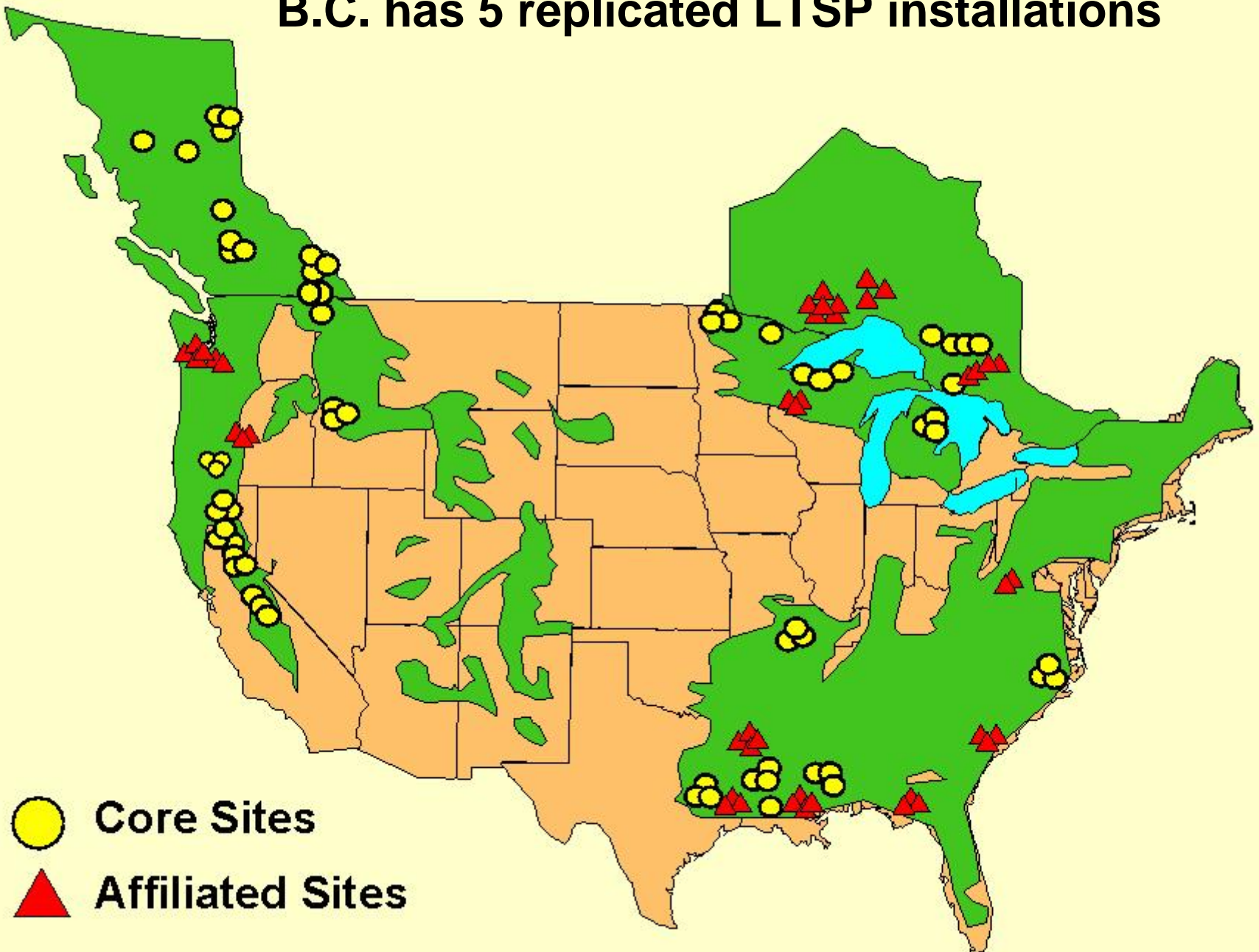


CWD
arrangement

Validation Monitoring

1. Test underlying assumptions behind the goals / objectives in policy
2. Validate indicators based on Best Available Information
3. Demonstrate long-term data trends
4. Advise policy through adaptive process

B.C. has 5 replicated LTSP installations

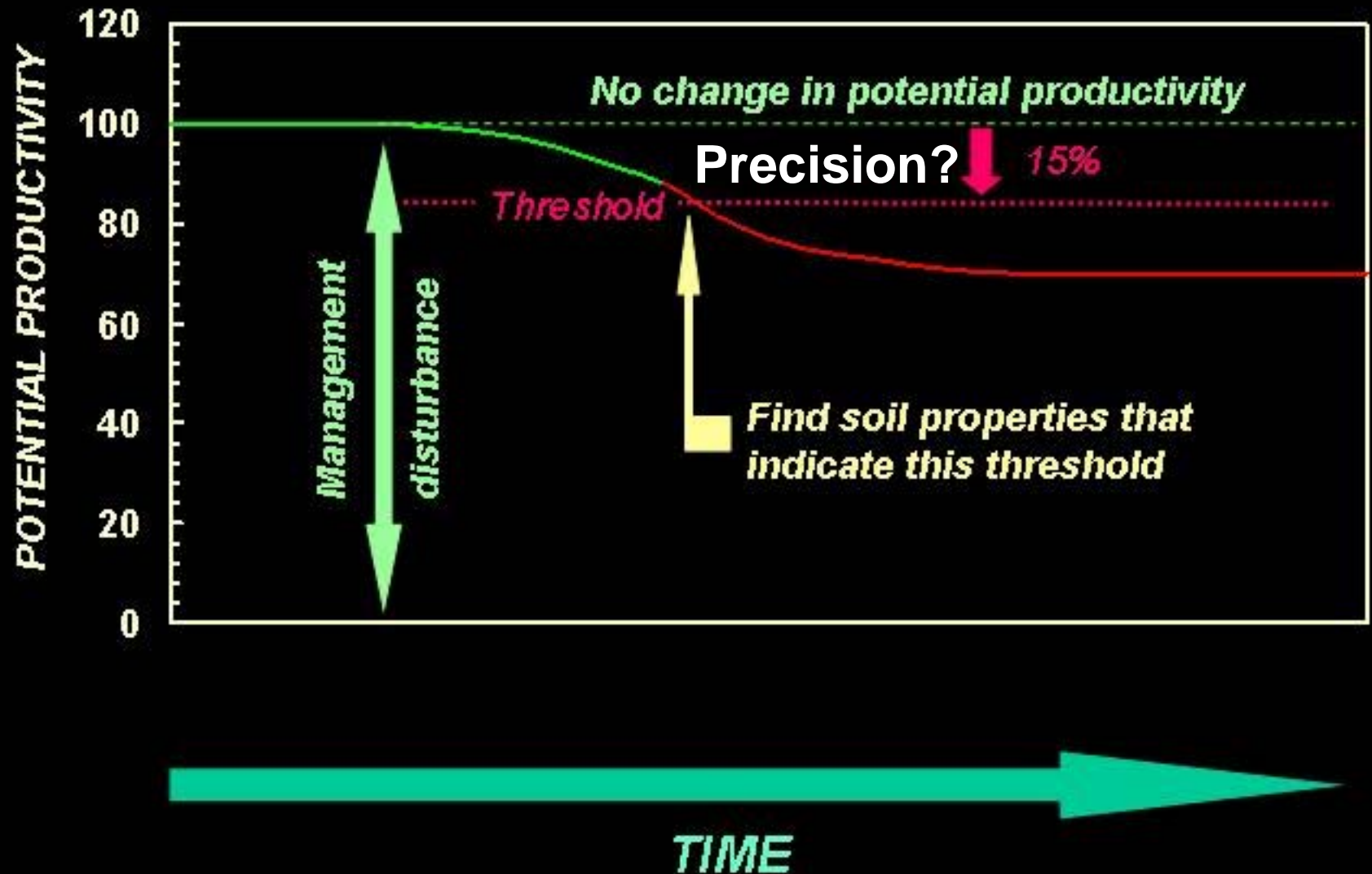






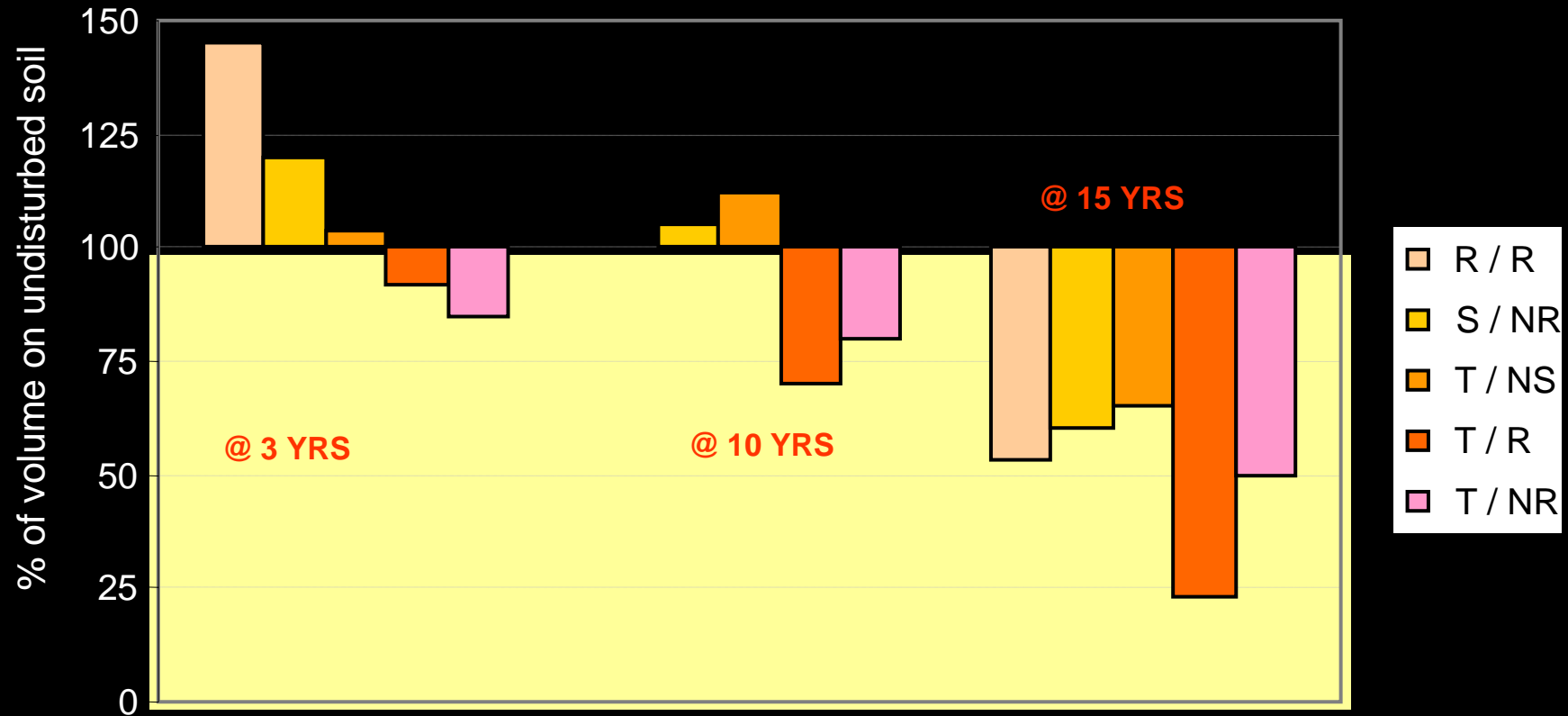


PRINCIPLE OF SOIL QUALITY MONITORING



Mean Douglas-fir volume - Gates Creek

(Smith & Wass, 1991; Wass & Senyk, 1999)



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Reliable Methods for Soil Risk Rating (productivity / hydrology)

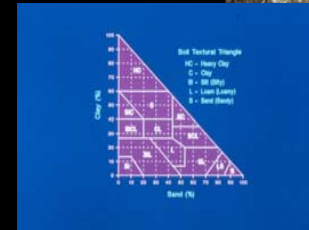
- Interpretations of risk for detrimental soil disturbance
- Risk = Hazard x Consequence
- Like disturbance standards, need validation
 - ◆ Long-term growth / hydrologic data needed

Environmental Framework

(Social and Economic are the others)

■ Inherent Soil Sensitivity: (HAZARD)

- ◆ Compaction
- ◆ Displacement
- ◆ Erosion and Mass Wasting

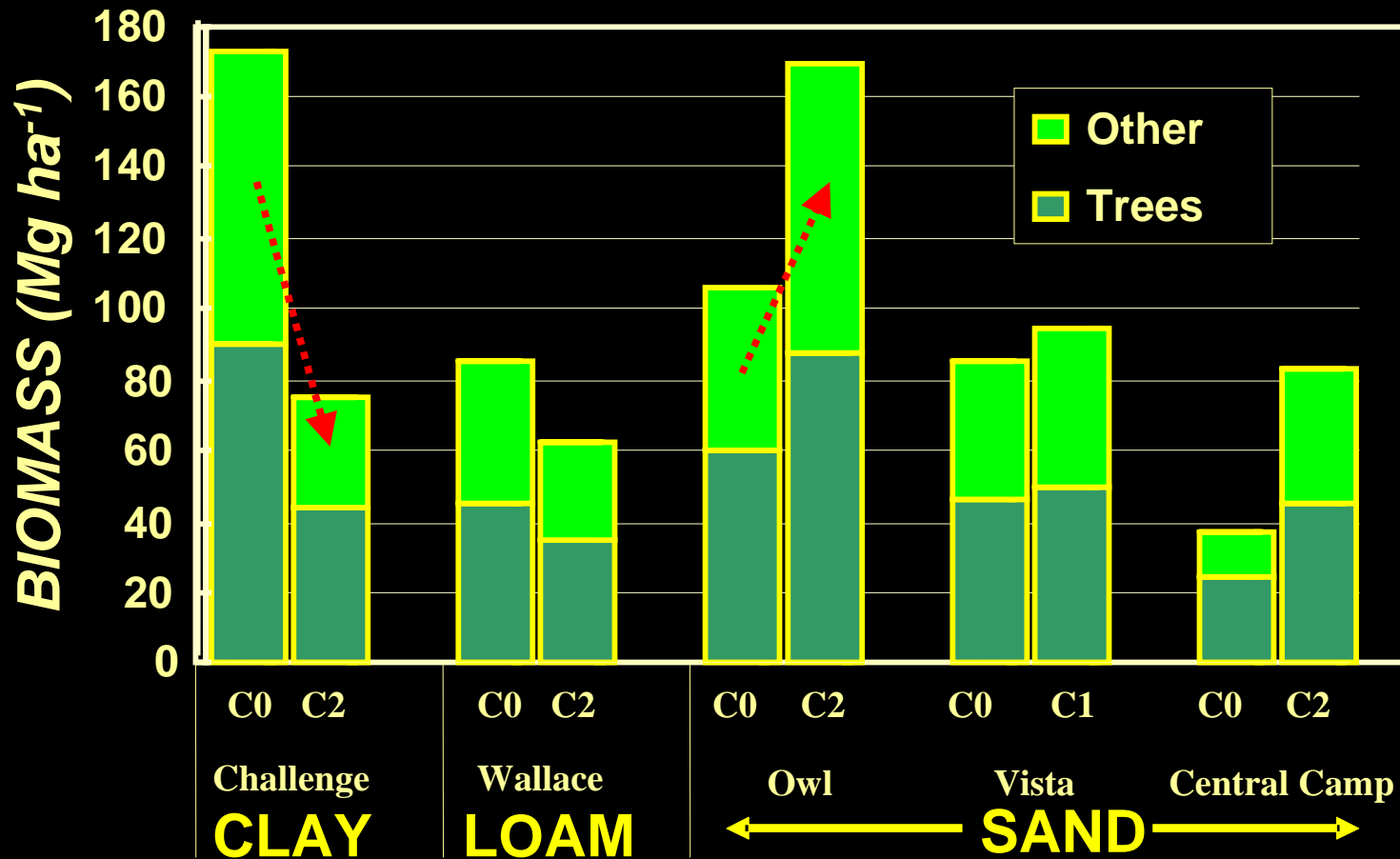


■ Potential Effects: (CONSEQUENCE)

- ◆ On-site (forest productivity)
- ◆ Off-site (fish, water, property, life)
- ◆ View - aesthetics (amelioration)



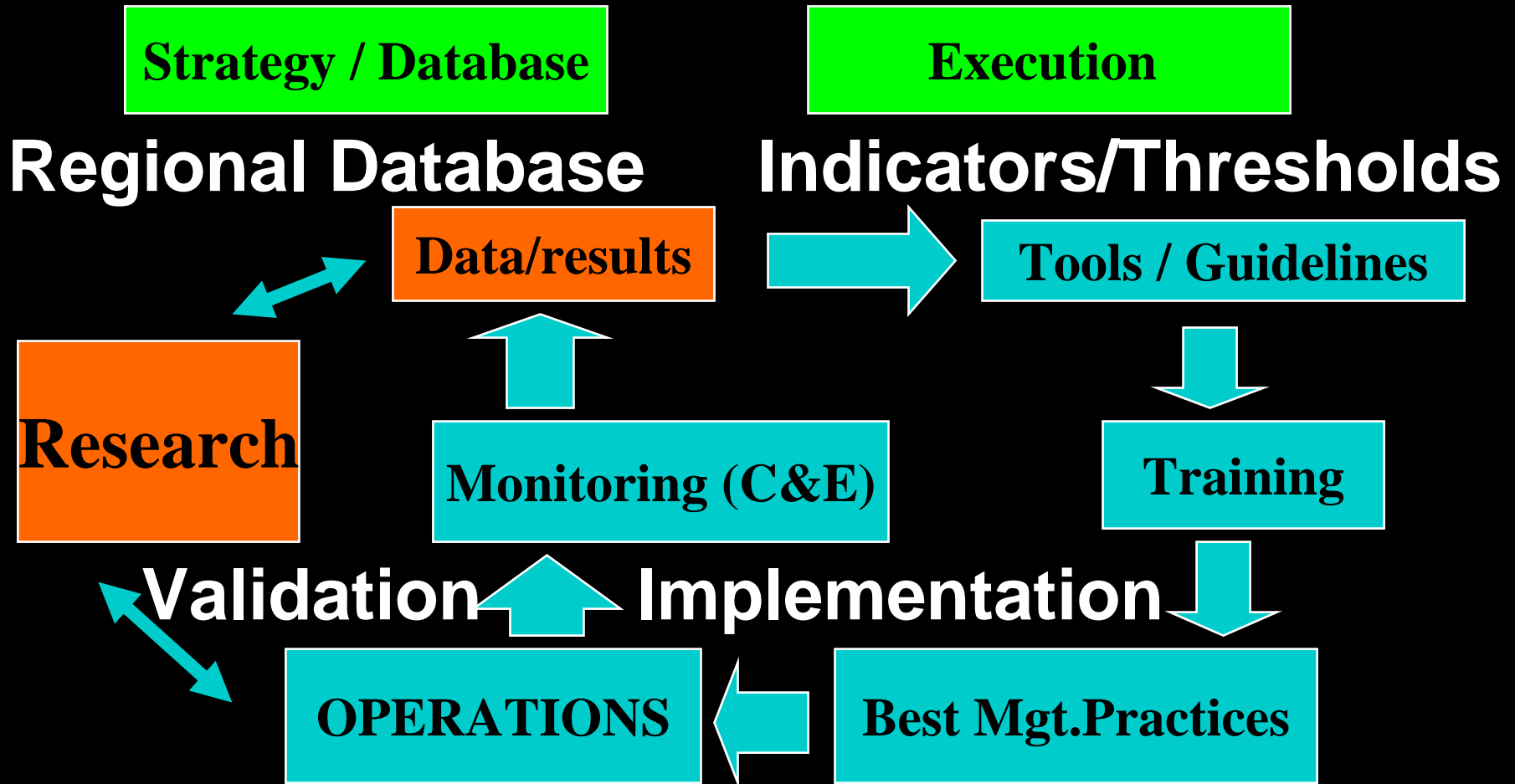
10-YR BIOMASS RELATIVE TO COMPACTION ON FIVE LTSP SITES IN CALIFORNIA



The path to “Pedo-righteousness”

- Know your soil
- Know what you are doing to it
- **Know the effects of this** (on- and off-site)
- **Adapt your practices (reliable process) over time** as more knowledge becomes available
- “Science-based” management
- None of this is new, but integration might be...

Work Together in an Adaptive Management Process



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Developing Consensus (Framework)

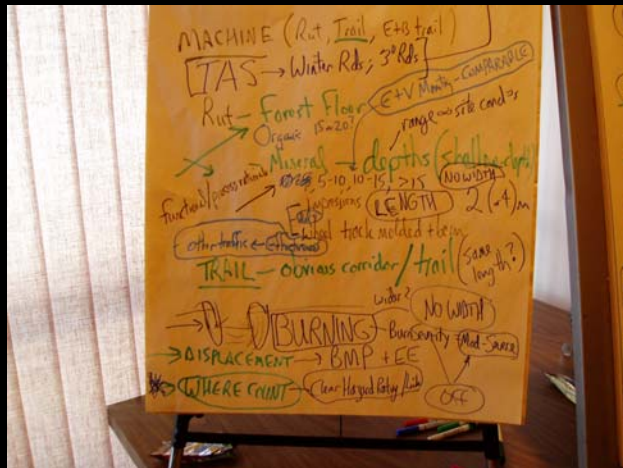
1. NWFSC Soil Dist. Working Group

- Northwest Forest Soils Council
(soil scientists from northwest US and western Canada)
- Soil Disturbance Group active since 2000
- Working towards a common approach
- 2 papers published
 - ◆ Curran et al. 2005. For. Ecol. Manage 220:17
 - ◆ Curran et al. 2005. For. Chron. 81:717
- Future directions
 - ◆ Continued meetings
 - ◆ Website

Developing Consensus (Framework)

2. Ontario Ministry Natural Resources

- Reviewing standards
- Eastern Working Group:
 - ◆ a regional level meeting
- Had BC, Alberta, Minnesota, USDA-FS FERIC
- Field tour / office session



Developing Consensus

3. CSSS MEETING (2006):

- Canadian Society of Soil Science: a variety of issues were discussed in a workshop setting:
 - ◆ Goals (definitions)
 - ◆ Hazards
 - ◆ Disturbance types
 - ◆ Cumulative limits
 - ◆ Survey methods
 - ◆ Adaptive management approach

Future workshops...

- USDA Forest Service Region 1 project October (ongoing discussions for SQS committee)
- Ongoing collaboration of all groups
- Your location here ??

Summary...

- Many agencies recognize the need for a better approach
- We can work together to provide better tools for sustainable management of our soil
- Please contact us if you are interested in more information, or would like to participate