Soil Change and Soil Survey:
Dynamic Soil Properties

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Interpretations Staff, NSSC

Northeast Regional Cooperative Soil Survey Conference
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Narragansett, RI

Soil Change Leadership Team

- **Karl Hipple,** National Leader, Interpretations
- **Chris Smith,** National Leader, Technical Soil Services
- **Susan Andrews,** Director, Soil Quality Team
- **Larry West,** National Leader, Investigations
- **Arlene Tugel,** Soil Scientist, Interpretations
- **Jeff Herrick,** Research Soil Scientist, ARS

Outline

- Soil Change Strategic Plan
- Overall strategy
- Data collection procedures
- NCSS roles and research needs

Announcement

SSSA symposium, October 2008

S6 and S5, S3, S7

Pedology, Soil Change and Management Effects on Soil Quality

Organizers:

Susan Andrews, Arlene Tugel and Larry West

Soil Change Strategic Plan 2008 - 2010

- A 3-year plan for integrating dynamic soil properties into the National Cooperative Soil Survey.
- Presented to Mike Golden, March, 2008.
- Solicit input from NCSS cooperators at 2008 regional meetings.

Vision

Enhance NCSS data and products with information about how soils change.

Overall strategy

1. Select priority benchmark soils
2. Gather dynamic soil property and vegetation data
3. Populate a point database
4. Develop interpretations of management effects on soil function and the consequences of change
5. Use models and pedotransfer functions to populate the soil map unit data base.

Soil Survey Conventions for Soil Change

I. Taxonomic classes.

II. Phase distinctions.

III. Models of change.

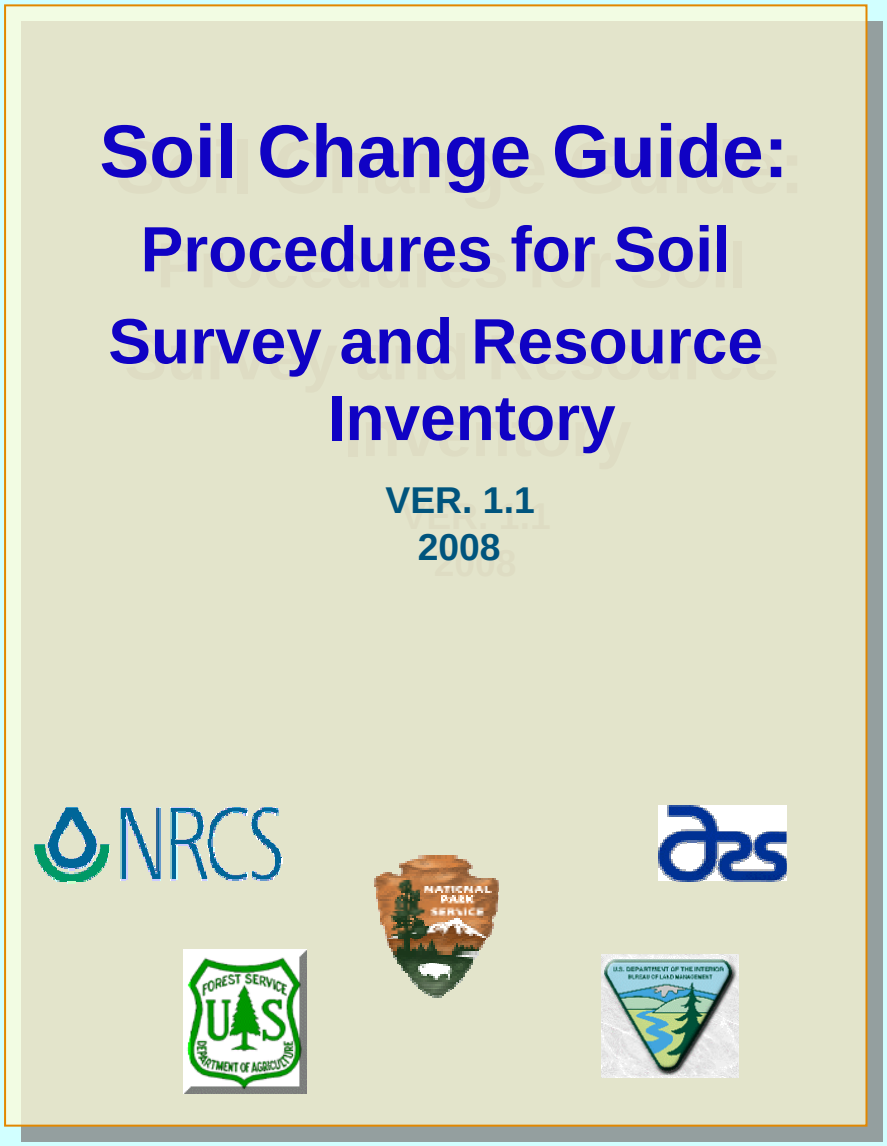
Describe management effects on soil using simple conceptual models of change.

(e.g. state and transition models)

IV. Short-interval monitoring.

(e.g. soil water table depth).

Soil Survey Procedures



Contents

1. Background on comparison studies and conceptual models
2. 6 steps to conduct a project
3. Soil and vegetation data is collected together
4. Cropland sampling design to be added

Developed by NRCS, ARS, and NPS with review by BLM and FS

How will we select benchmark soils for a comparison study project?

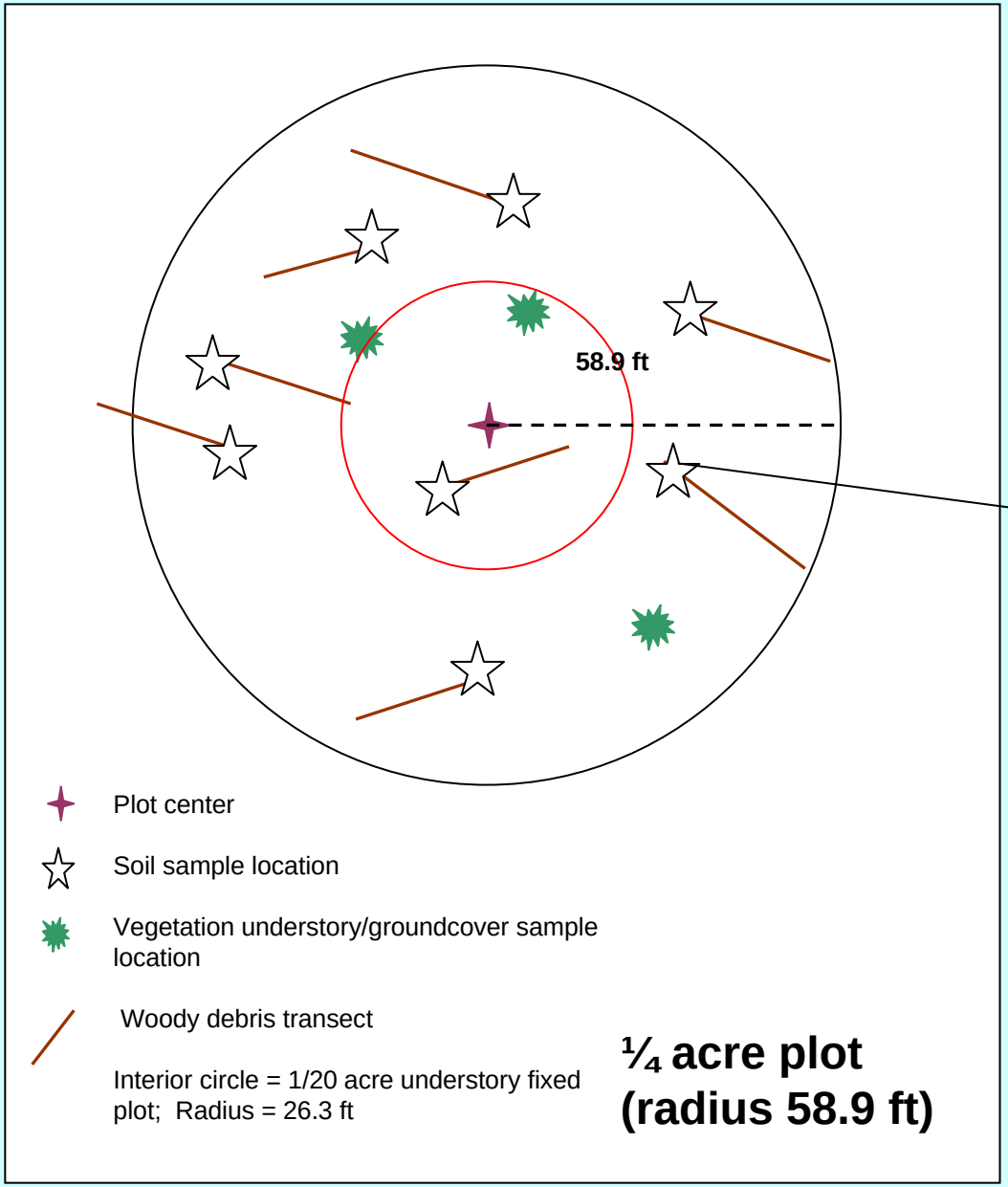
- Experiencing critical resource management problems or opportunities.
- Management history and other data available (soil and vegetation).
- Existing long-term study project underway
- Mechanisms of change represent those of other similar soils.
- Extensive.
- Benchmark Ecological Site.

How will we inventory dynamic soil properties and soil change?

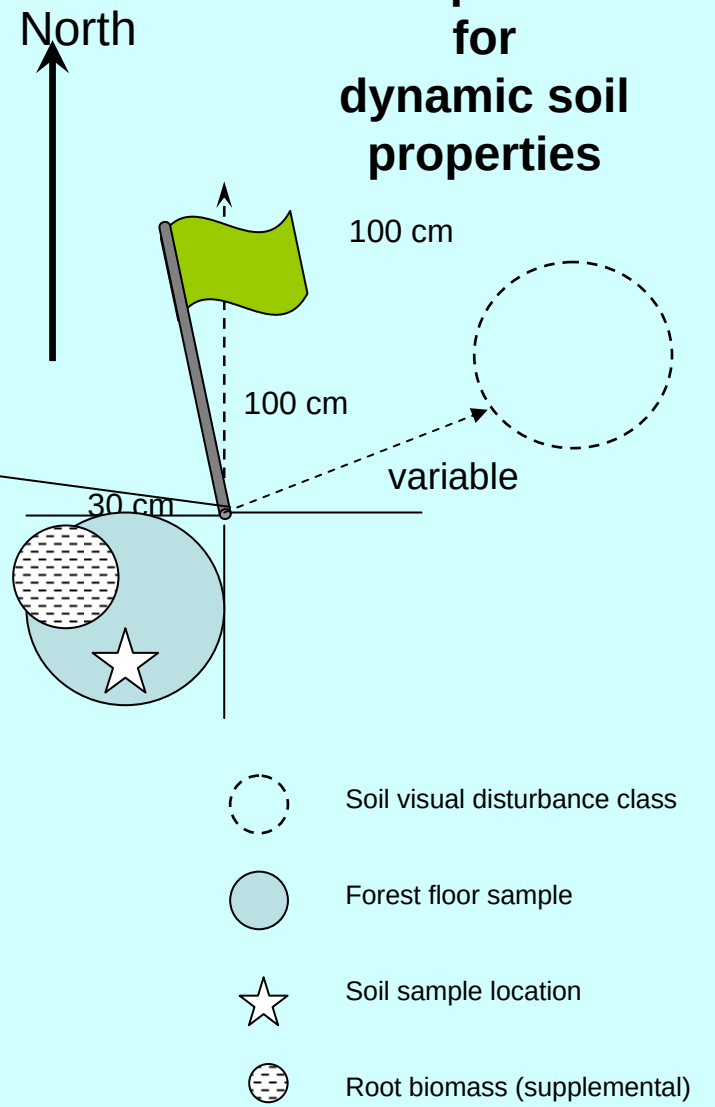
Answer: Comparison studies

- Document central tendency and range of variability for dynamic soil properties:
  - For specific management systems
  - On a specific soil map unit component phase,
  - At two scales (regional and plot scale)
- Sample at least 5 plots each management system and 5 soil replicates on each plot
  - (or use variance to determine numbers of samples)

Forestland Ecosystem Plot



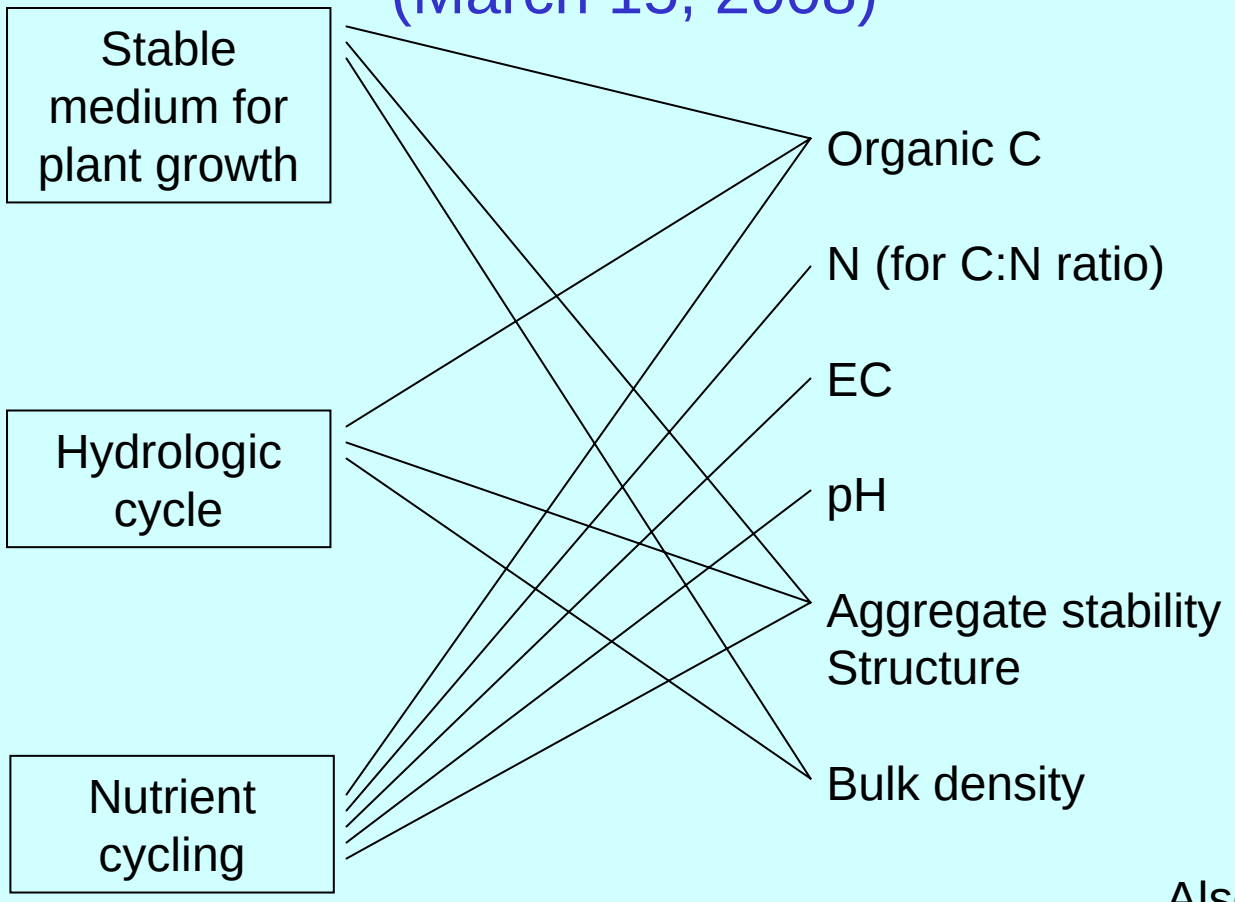
Soil sample location for dynamic soil properties



What properties do we measure?

Answer: Minimum data set

(March 15, 2008)



Also
Particle size
Rock fragments

What systems do we compare?

Winter fat, perennial grass

PGS

Cheat grass

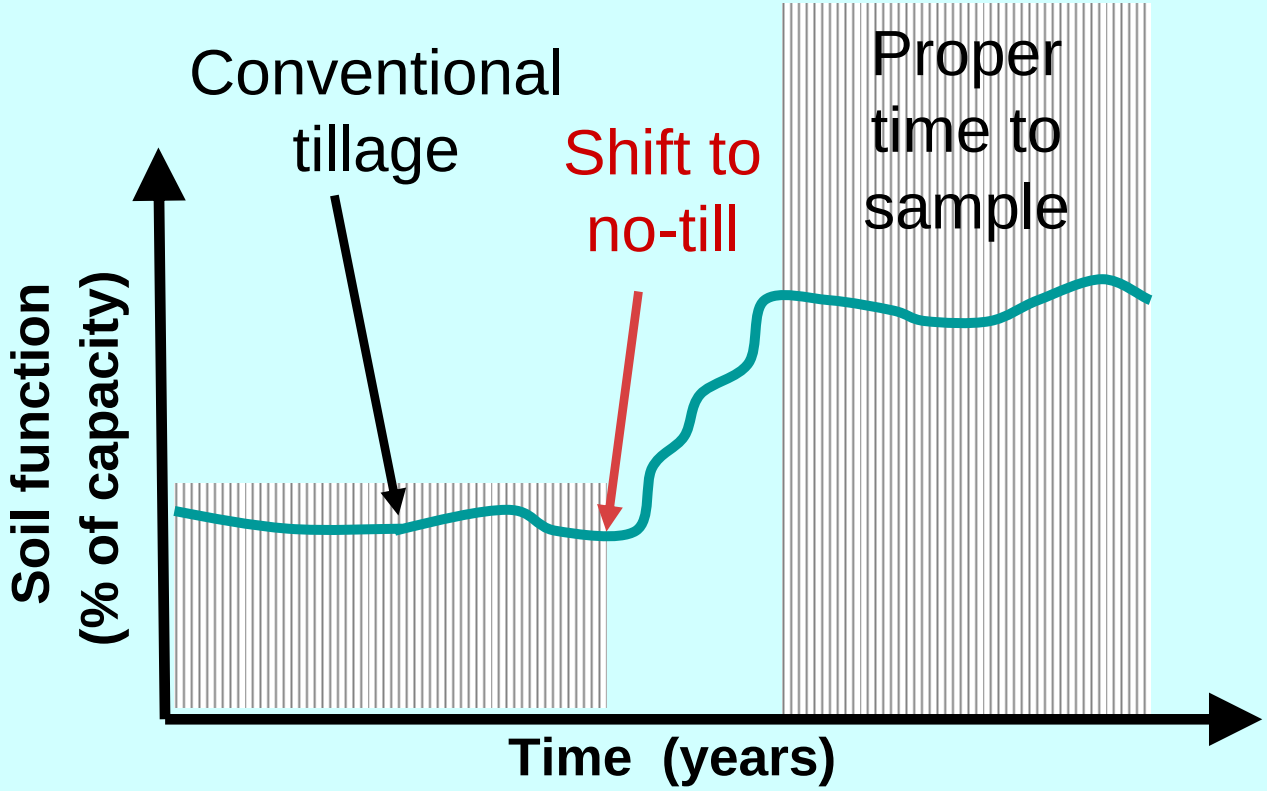
AG

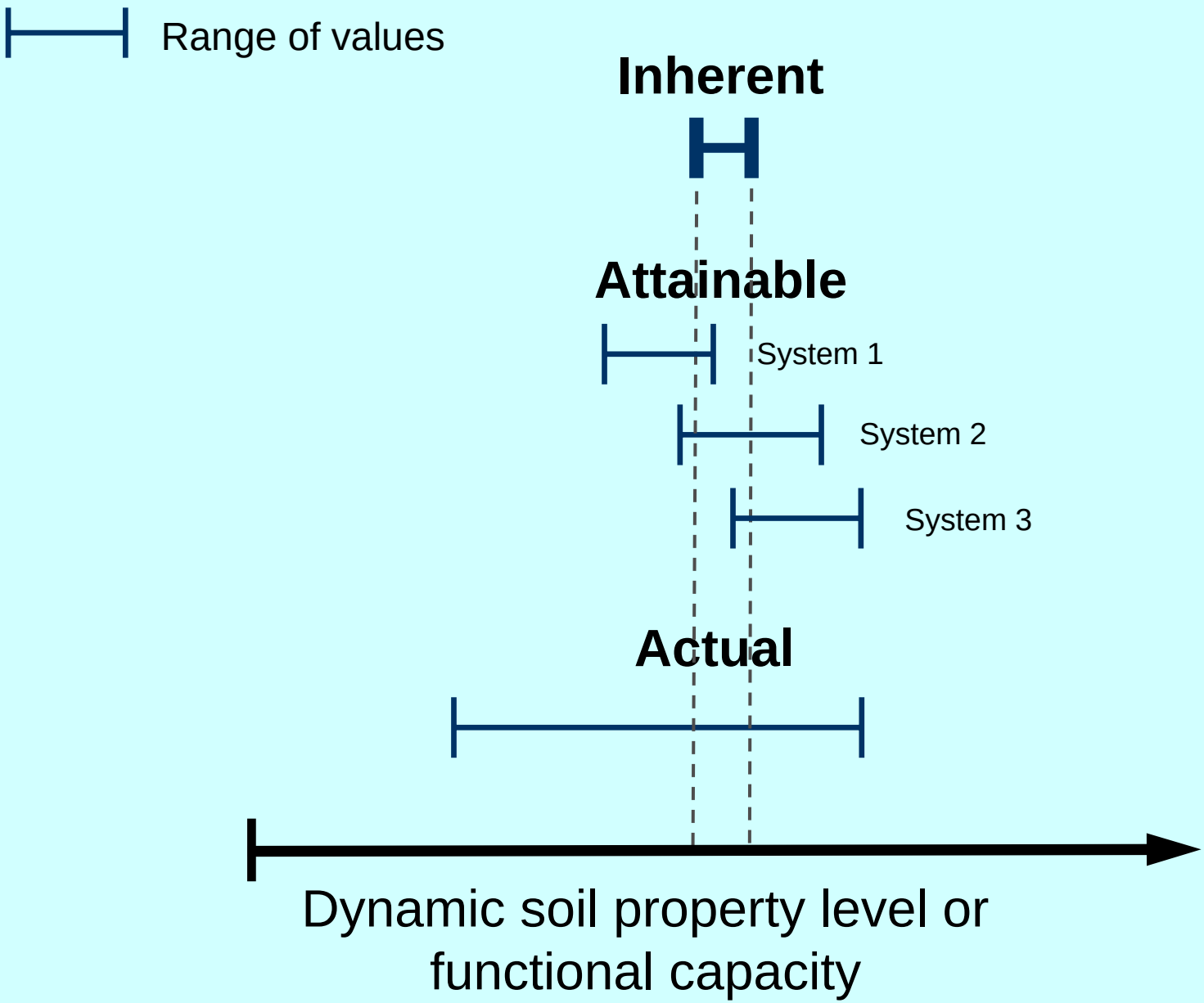
Utah Pilot

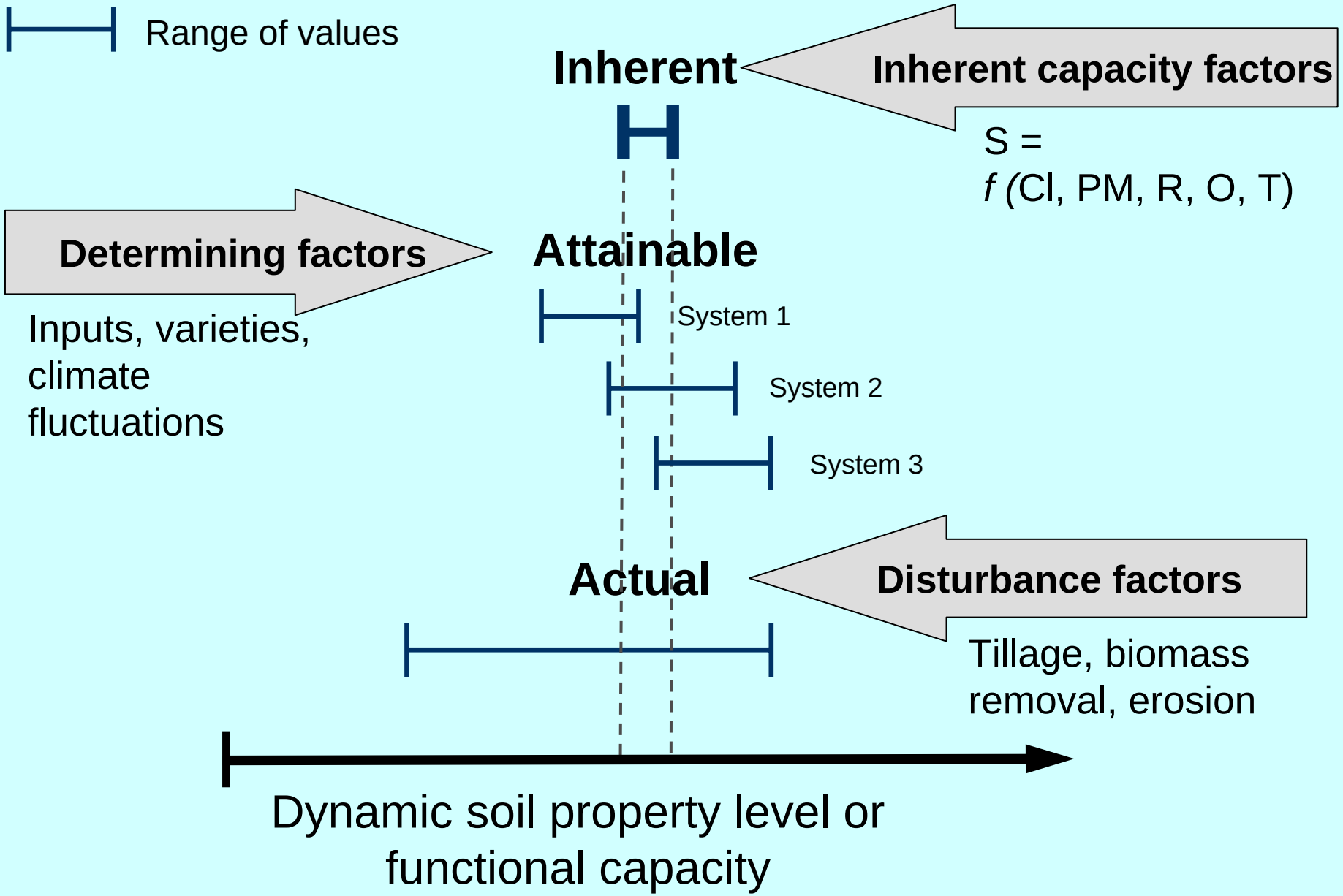
Arches National Park

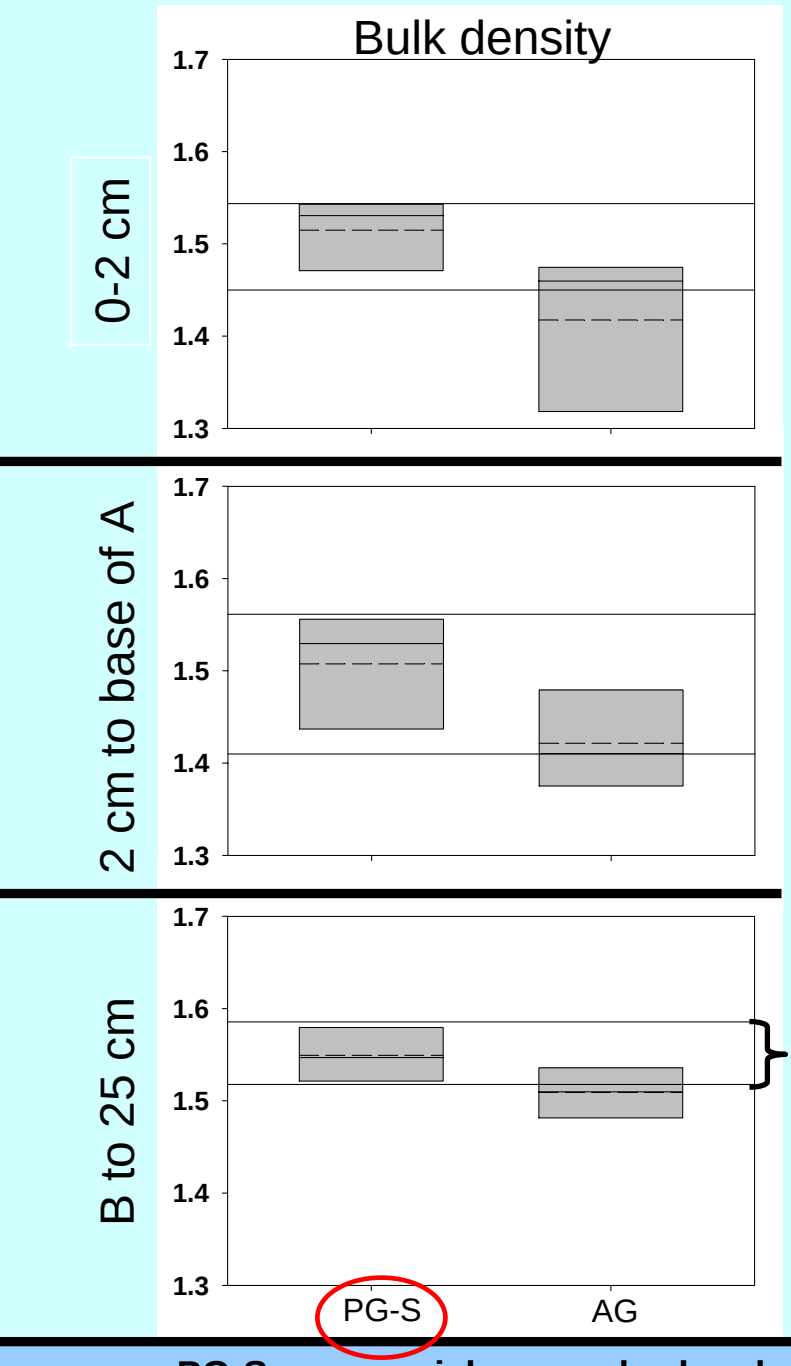
What systems (and when) do we sample?

Answer: Not during the transition period.




Range of values
Inherent
Attainable
System 1
System 2
System 3
Actual
Dynamic soil property level or functional capacity


Range of values
Inherent
Inherent capacity factors
S =
f (Cl, PM, R, O, T)
Determining factors
Inputs, varieties,
climate
fluctuations
Attainable
System 1
System 2
System 3
Actual
Disturbance factors
Tillage, biomass
removal, erosion
Dynamic soil property level or
functional capacity



How do we report differences between the inherent potential (reference state) and other management systems or land uses?

Answer: Control charts

High and low values of reference state

PG-S = perennial grass-shrub sub-state; AG = Annual grass (cheat grass) sub-state; n=4

——— = Median - - - - - = Mean

Next Steps

NCSS Roles

- Set up subcommittee on Soil Change.
- Develop a collective vision for soil change in soil survey—National Cooperative Soil Survey.
- Identify resource issues related to management-induced changes in soil properties.
- Update benchmark soil lists (and benchmark Ecological Sites).
- Conduct research to fill knowledge gaps.

Research Needs

1. What is the spatial and temporal variability of dynamic soil properties at multiple scales?
2. What are the most efficient plot designs for integrated soil and vegetation sampling?
3. What techniques can be used in data analysis to represent and compare vertical redistribution in soil profiles?

Research Needs, cont'd

4. How do we predict properties such as infiltration rate from less costly measures?
5. What pedotransfer functions and models can we use to populate the aggregate database?

6. Develop interpretations to support monitoring, assessment, and management of human impacts on soil.
   - Conceptual models of management effects on soil (state and transition models)
   - Indicators of function
   - Thresholds
   - Early warning indicators
   - Resilience

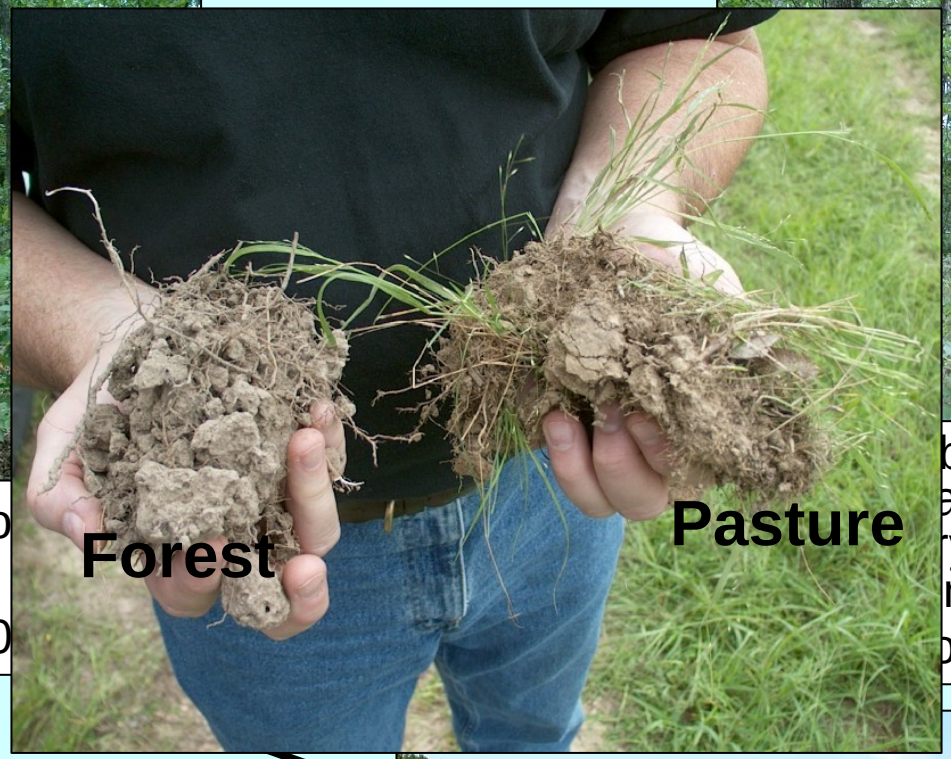
Summary

- **Populating the point database comes first.**
  - Soil and vegetation data will be collected as a part of projects
  - Conceptual models will be used to design projects and organize results.
  - Other discipline specialists need to be involved.
- **NCSS Roles**
  - Develop an NCSS vision for soil change.
  - Send suggestions for the Soil Change Strategic Plan to Karl Hipple karl.hipple@lin.usda.gov

    or Arlene Tugel atugel@nmsu.edu

Post oak/blackjack oak/little bluestem

Post oak/flowering do
tick trefoil-goldenrod.
story. Canopy: 30-90



buckbrush (or
acks mid-story.
y single species
minated
open 30-90%

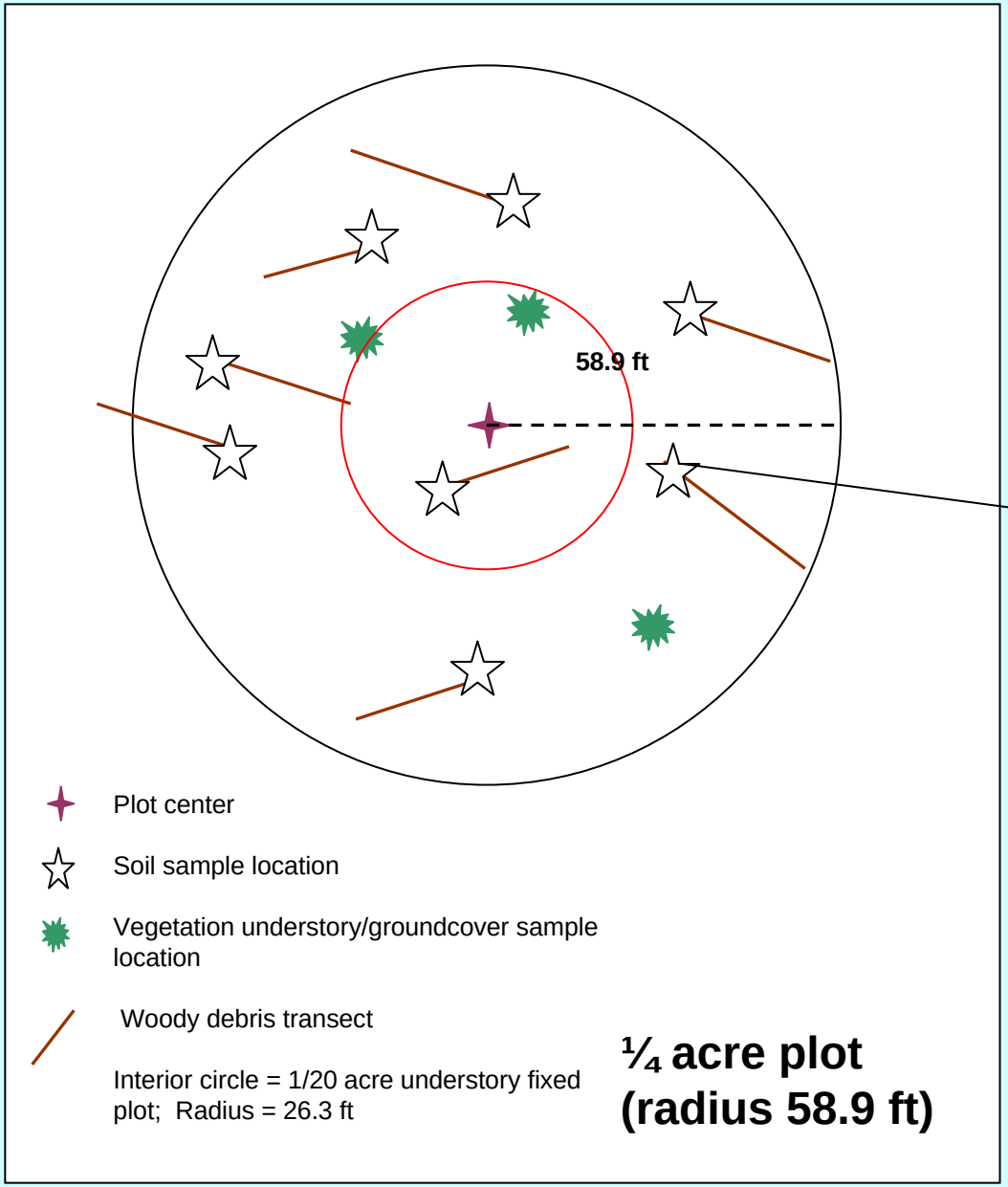
Pasture (improved)
Non-native grass sod

Abandonment for 20+ yr with recruitment of woody natives

Missouri Pilot

STM by:
D. Wallace, J. Robinson,
B. White, M. Kennedy

Forestland Ecosystem Plot



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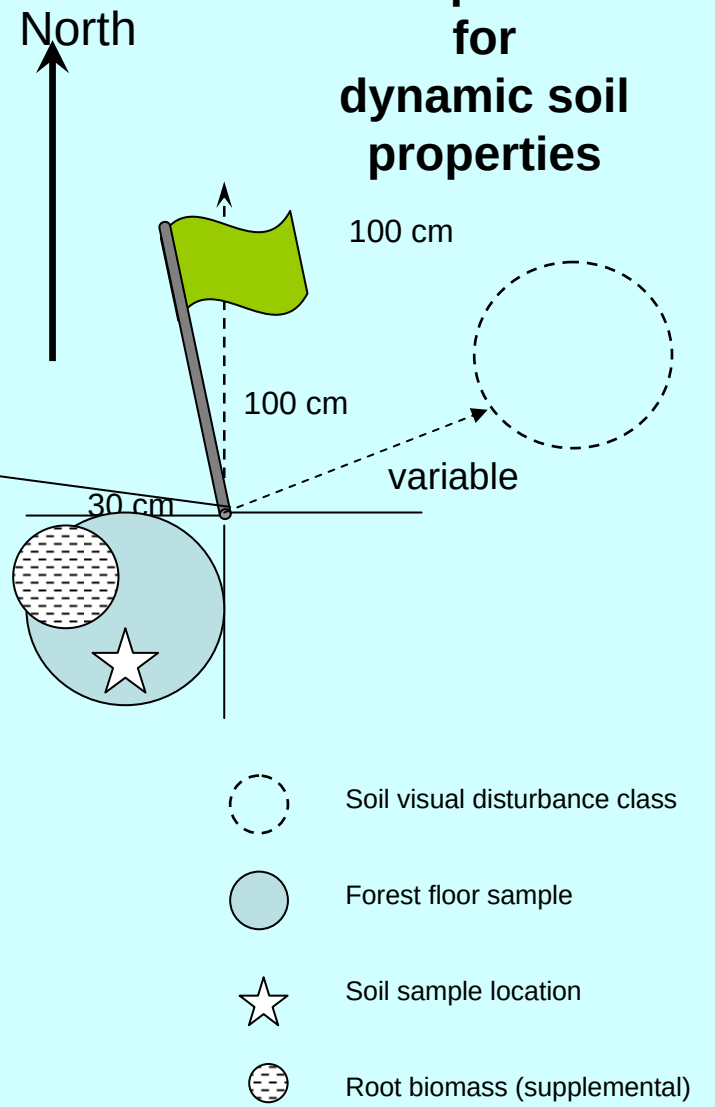
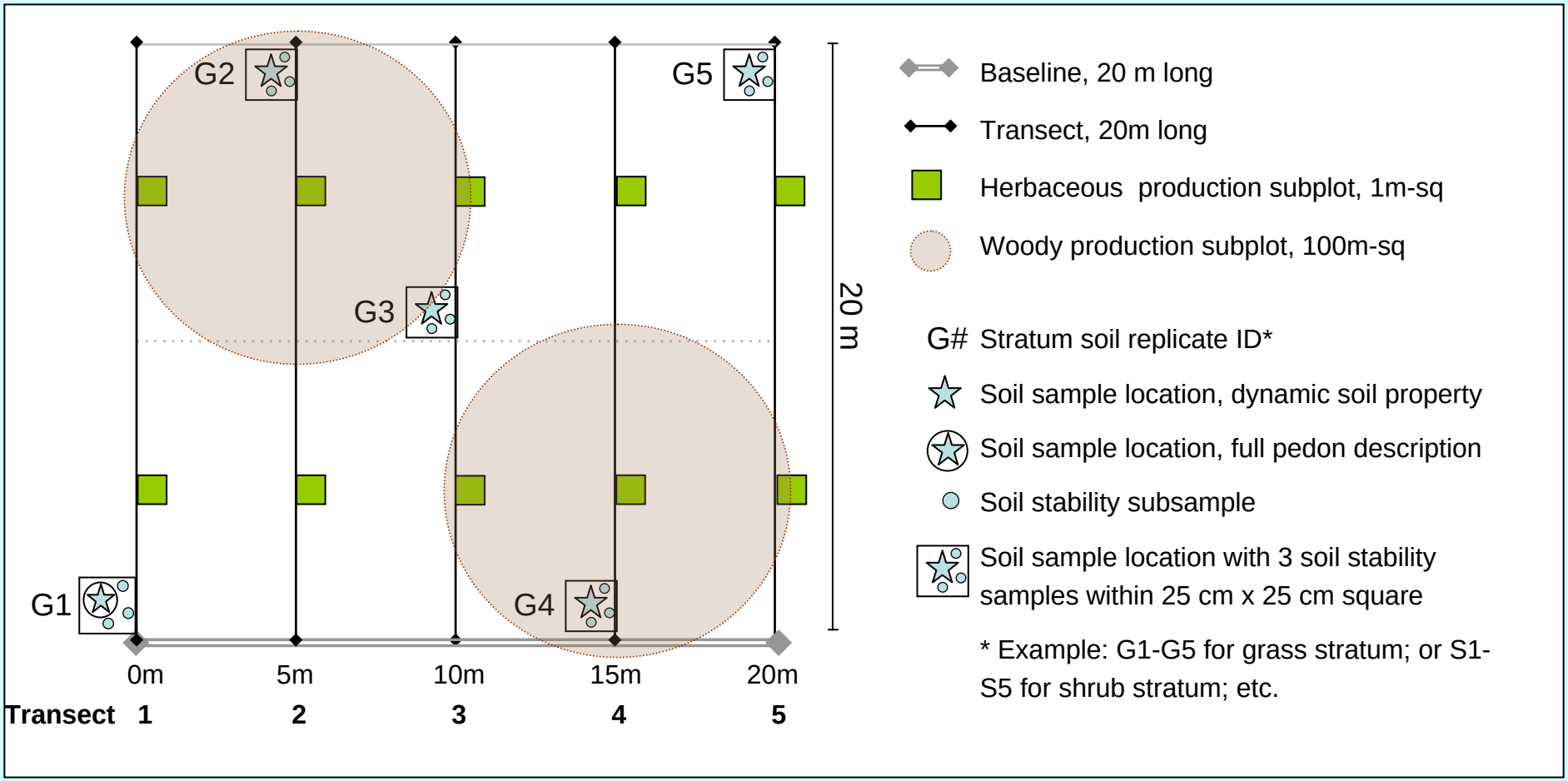


Grassland, Shrubland and Savanna Ecosystems

20m x 20m plot, one stratum, five soil sample locations



Line point intercept sampling every 1 m on five 20-m long transects resulting in 100 points. Start at 1 m. Modify to every 0.5 meter for 200 points if many finely intermingled plant species each contribute a relatively low percentage to cover. Start at 0.5 m.

November 05, 2005
rev May27, 2008

Document the central tendency and range of variation

Bulk density

				Central tendency of plot means		Central range	Variation
		Depth/ horizon	full state phase range	Mean	Median	Interquartile range of plot means	CV
Begay fsl, 0-6%	PGS	0 - 2 cm	1.27 - 1.91	1.51	1.53	1.47 - 154	2.7
		A not 0-2	1.27 - 1.68	1.51	1.53	1.44 - 1.56	4.5
		B	1.46 - 1.62	1.55	1.55	1.52 - 1.58	2.0
	AG	0 - 2 cm	1.01 - 1.68	1.42	1.46	1.32 - 1.47	6.9
		A not 0-2	1.29 - 1.54	1.42	1.41	1.38 - 1.48	3.9
		B	1.42 - 1.59	1.51	1.51	1.48 - 1.54	2.0

Interpretations

- What is the condition of my soil?
- How does it compare to what is possible?
- If degraded, can it be restored it?
- How long will it take (*and how much $*)?
- What lands are at risk of irreversible (and undesirable) change?
- How will soil changes affect future management options?

Recommended reading

- Understanding soil change (Richter and Markewitz, 2001)
- State and transition modeling (Stringham, et al, 2003, JRM)
- Soil change, soil survey and resource decision making (Tugel, et al., 2005, SSSAJ)