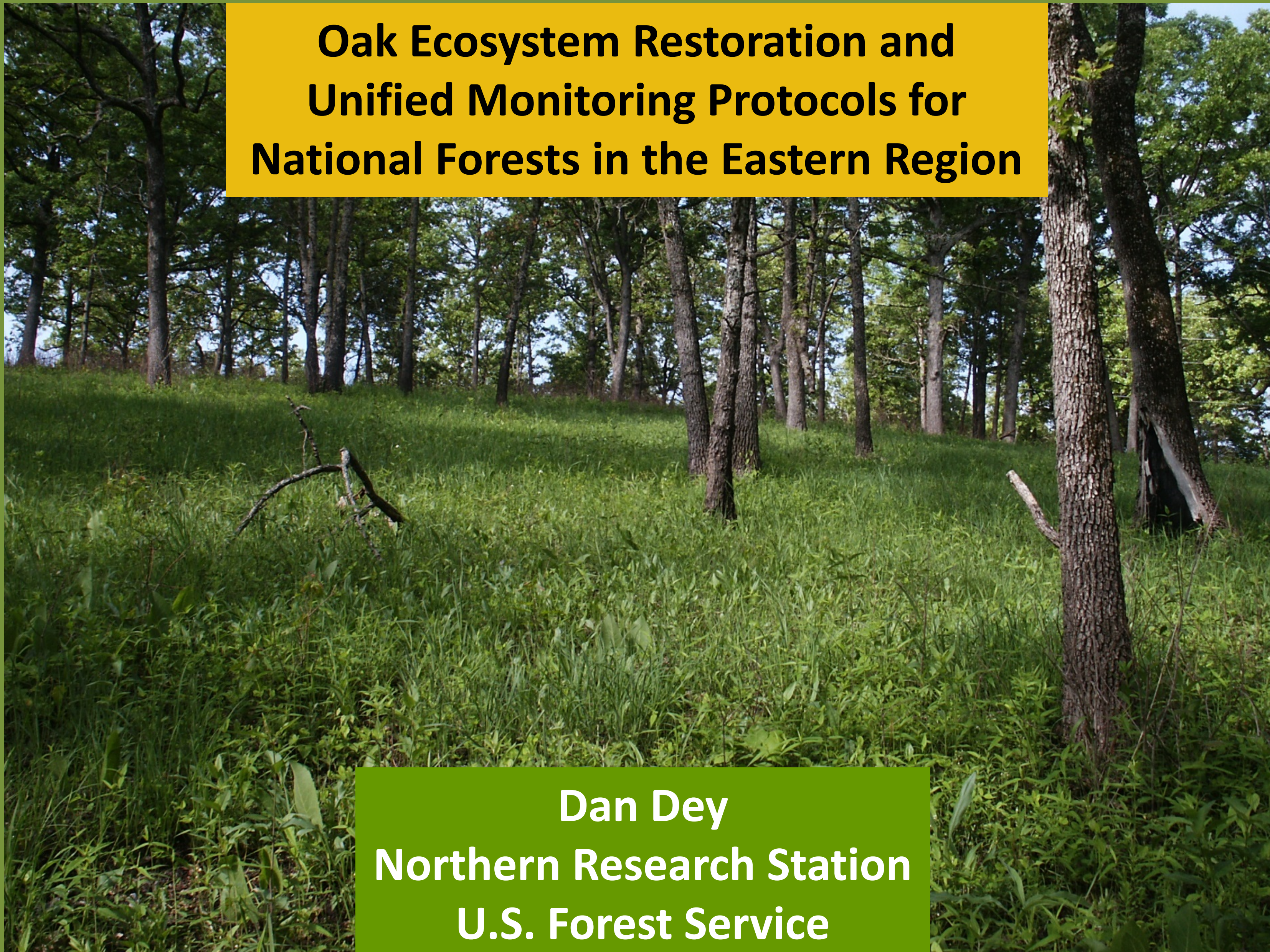

Oak Ecosystem Restoration and Unified Monitoring Protocols for National Forests in the Eastern Region

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http://www.oakfirescience.com/

Monitoring





The process of collecting and analyzing data periodically/repeatedly to determine whether a project or program is meeting its goals and achieving target conditions

It can include multidisciplines & be multi scale: landscape, watershed, stand, species


The development of the oak ecosystem restoration and monitoring guide focuses on site or stand level variables and indicators of success for projects that intend to sustain oak forests or restore oak savannas and woodlands

Reasons for Monitoring

- To measure progress and success of implementing the planned or prescribed mgmt action and to determine if the action achieved its objective, or desired future condition
- To evaluate the impact of mgmt. on ecosystem attributes: diversity indices, forest/stand metrics, socioeconomics, wildlife habitat quality, etc
- To establish baseline conditions of ecosystems for detecting change
- To understand changes & trends in key variables
- To compare condition or change in response variables to key thresholds that trigger mgmt action or modification
- To discover unintended ecological consequences of mgmt action – early alert system that triggers adaptive mgmt
- To identify drivers, causes of desired or undesirable effects
- To determine if monitoring needs to be adapted to better address original goals or new questions and information
- To communicate internally and with the public

Reasons for Monitoring

- ❑ Research is not always available or directly relevant:
  - ➢ To the locale, region, ecosystem – differences in soils, climates, topography
  - ➢ To the management practices and systems being used
  - ➢ To local management objectives
  - ➢ To the different array of drivers of vegetation response to management
    - Deer, gypsy moth, invasive species problems, presence of interference species

- ❑ You can't control all the drivers of vegetation change
  - ➢ Resulting in a large range in variation in vegetation response
  - ➢ Monitoring can help calibrate research from other regions or ecosystems

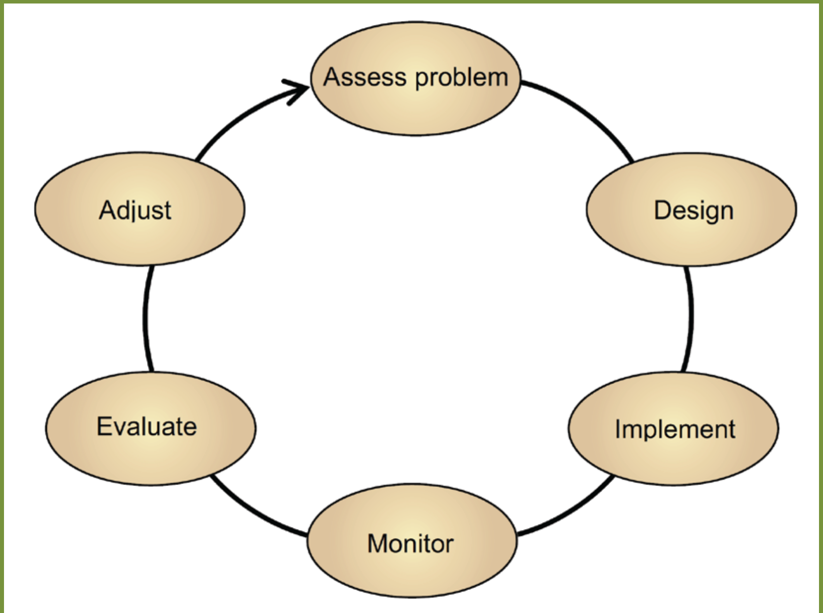
- ❑ Uncertain futures may lessen the relevance to existing research results
  - ➢ Changes in climate
  - ➢ Outbreak of invasive species
  - ➢ Changes in socio-economic-political constraints

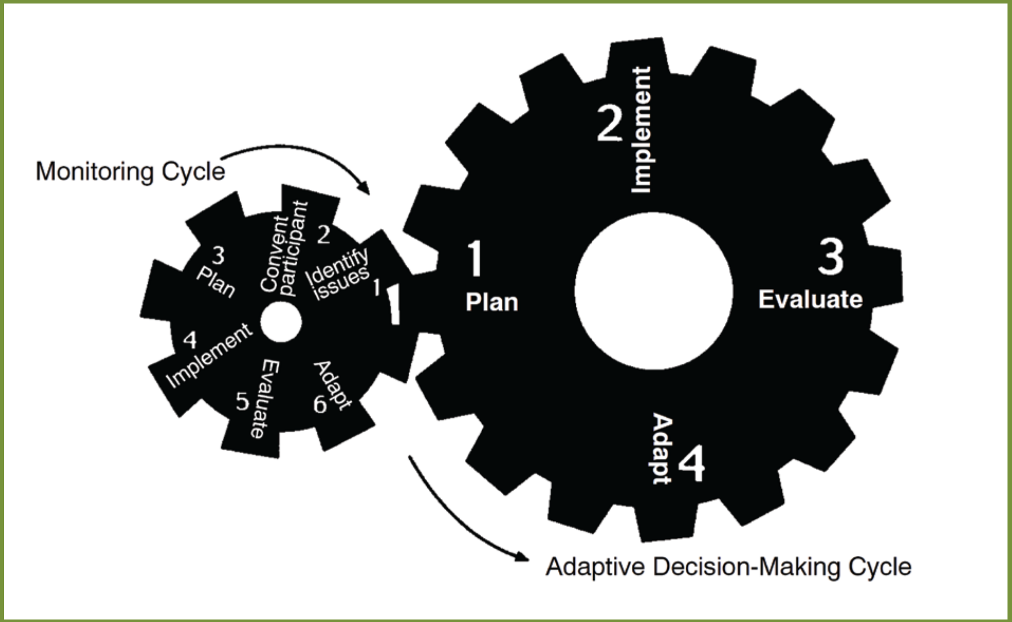
- ❑ To establish your credibility with the public and special interest groups
  - ➢ In your forest plan you said you would do x, y, and z – so, did you do it?

- ❑ It is key to the practice of sustainable forest management, good stewardship & conservation

- ❑ It is not a luxury, after thought, or first thing to be cut in a budget crisis

Adaptive Management
Aka: Good Forest Management – Stewardship





Learning by doing –

Adapt by:

- **Changing treatments – practices - prescriptions**
- **Modifing mgmt goals/objectives**
- **Modify monitoring – variables, indicators, methods**

What does monitoring look like?

Walk about reconnaissance
qualitative observation
or temporary plots

Trees per acre
Basal area
Stocking
Species
Presence-absence

Measurement of permanent plots
case study

Measurement of permanent plots
replicated study with treatments & control

Evaluation by a team of experts

Floral quality index
Habitat quality index
Habitat use
Coverage of indicator species

Increasing complexity, data collection, variables observed, costs, ability to use stats, ability to make inferences, ability to detect change, or infer cause-effect

Not everything needs to be monitored

- ❑ Implementation of traditional objectives by application of standard management practices with predictable results based on available science and experience does not need monitoring
  - ✓ Unless something new has developed such as outbreak of invasive species, occurrence of extreme weather events, epidemic of some insect or disease

- ❑ New resource objectives such as ecosystem restoration, emphasis on new variables or ecosystem attributes, or use of new tools such as prescribed fire may necessitate monitoring

- ❑ The need for monitoring may be determined by the risk of undesirable outcomes and the resulting:
  - ✓ Irreversible environmental damage
  - ✓ Threat to human health, life and safety
  - ✓ Threat to your career
  - ✓ Negative public relations

Resources for monitoring are often limiting

The decision of what, where, when, how to monitor is crucial

Chose wisely and be efficient & effective

Good management objectives are the foundation of good monitoring

- Intermediate and final desired future conditions are defined quantitatively in clear and concise objectives
- enables better comparison between current condition and desired
- establishes more definitive triggers for adaptive management
- Intermediate targets are set at key stages of stand/community development when mgmt activity is most likely to occur

Selecting good indicators of ecosystem condition, change, function and production is important

Good indicators are easy to measure, inexpensive, are standard practices, require average skill levels, directly related to ecosystem processes, function & production, linked to plan goals & objectives, grounded in science, useful in communicating among professionals & public

Following sound sampling principles, methods and practices can make monitoring more efficient, inexpensive & effective

Monitoring is objective driven

Objectives for Sustaining Oak Forests
&
Restoring Oak Savannas & Woodlands

Increase abundance & size of oak regeneration
Develop large oak advance reproduction
Promote oak recruitment into overstory
Oak stocking >30% at maturity
Manage invasive species

Increase abundance and condition
of savannas & woodlands
Increase native species richness
Restore role of fire – reduce Fire Regime Condition Class
Create heterogeneous habitats
Emulate range of natural variation in disturbance
and vegetation
Manage invasive species

Structural & Compositional Targets
Mark Twain National Forest Plan 2005

Table A-1. Range of Ecological Parameters for respective natural communities in Management Prescriptions 1.1 and 1.2

Natural Community Types	% canopy	Basal area	Canopy Gap Size	Understory	Aspect, slope, roughness	Shrub layer	Structural age/ growth stages per decade	Ground organic layer	% ground cover	Patch Size
Prairie	< 10	NA	NA	NA	All aspects; gentle slopes; plains	Sparse	Grassland with few scattered shrubs and trees	Grass, sedge and forb cover	90 – 100	10 to 200 acres
Savanna	10 – 30	<30	5-20 acres with 2 per 100 acres	scattered oaks and shrubs	Broad ridges; all aspects; gentle sloping	Dense; mostly scattered oaks and other shrubs	Shrub oak/pine covering 10-25% of area	Grassland, sedge and forb cover	90 – 100 grasses dominant	50 to over 1,000 acres
Open Woodland	30 - 50	30 - 50	10 acres with 1-3 per 100 acres	mixed shrubs, early-mid seral	southwest facing to upper ridges; gentle to steep; gentle plains and hills	dense; mostly scattered oaks and various shrubs	Shrub oak/pine covering 10-25% of area; even age stands	Grass, sedge and forb cover; little accumulated leaf litter	60 – 80 grasses dominant	10 to 100 acres
Closed woodland	50 – 80	50 - 90	3 acres with 1-5 per 100 acres	early-mid seral trees	Some upper ridges to base of north-facing slopes; gentle to steep; hills and breaks	sparse; mostly scattered oak and various shrubs	Shrub oak/pine in 5-10% of area; even age stands	Shallow leaf litter; mixed grasses, sedges and herbs	80 - 100	100 to over 1,000 acres
Upland forest	80 – 100	80 - 100	1% per year	shade tolerant shrubs and small trees	Generally north-facing slopes; steep to very steep; hills and breaks	Sparse; scattered; vines present	Oak/mixed species of variable age; small isolated gaps 1-5 acres	Moderately deep leaf litter	50 - 70	10 to 100 acres
Bottomland forest	80 - 100	90 - 100	1% per year	shade tolerant shrubs and small trees	North-facing slopes; very steep or broad-level floodplains; hills and breaks	Sparse; vines present	Multi-layered; uneven age; few gaps	Deep leaf litter; ephemeral herbs	50 - 70	10 to 500 acres
Fen	<10	NA	NA	NA	Toe slopes, ravines and floodplains	Dense to sparse or none; variable	Vary from shrub thickets to open herb/sedge meadows	Shallow marly to deep muck	90-100	<100 sq ft. to 15 acres
All glade types	<10	NA	NA	Small shrubs and trees restricted to rock outcrops and borders	Generally southwest-facing but all aspects on igneous and White River; steep to very steep; hills and breaks	Variable	Primarily grass or mixed herb cover with scattered shrubs	Sparse to dense cover of grasses; mineral soil often exposed	30 – 90 grasses dominant	½ to 300 acres

Monitoring Design is also influenced by Ecological Drivers of Regeneration and Stand or Community Development

- Regeneration potential is determined by density & size of seedlings, saplings and overstory trees by species
  - Importance of advance reproduction
  - Capacity of cut trees to stump sprout
  - Capacity of overstory trees to produce seed
  - Seed viability in forest litter
- Site factors
  - Site productivity/index affects growth of desired and competing vegetation
  - Aspect, slope & topog position influence regeneration dynamics & competition
  - Soil type/series
  - Limiting site conditions: poor drainage, rocky, thin soils, thick duff
  - Ecological land classification unit
- Competing vegetation –
  - native & invasive – woody & herbaceous
  - Stand structure, number of canopy layers, overstory density
- Browsing – white-tailed deer, animal damage

So sample design and methods should account for many of these factors

Selection of Treatments
for
Sustaining Oak Forests or Restoring Oak Natural Communities

Harvesting

Thinning

Prescribed Fire

Herbicides

Fencing

Application of treatments may vary
Combinations of treatments may vary

- Frequency
- Seasonality
- Intensity
- Extent
- Severity

Treatments need to be monitored

Monitoring treatments

Harvesting – thinning:

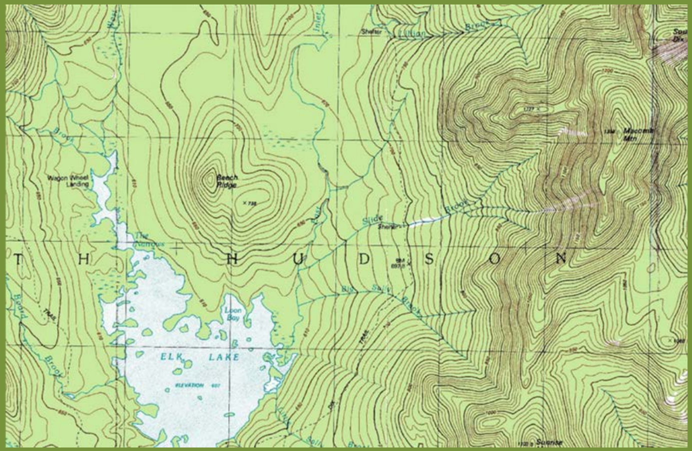
- location, area treated, date initiated & completed
- portion of diameter distribution treated
- basal area, density, stocking, crown cover, species removed
- herbicide type and method of application
- weather
- was the regeneration method, marking guidelines, prescription actually implemented

Prescribed burning:

- location, area treated, date
- fuel loading pre and post, fuel model
- weather – RH, windspeed, temperature,
- fire behavior – ground, surface, crown fire, head, back, flanking fire
- fire intensity – rate of spread, flame length, duration, extent
- ignition pattern
- fire severity - scorch height, bole char, crown scorch, litter reduction, % area burned

Site Information

Location description: Township/Range
Management unit, compartment, stand number
Soil type
Geology
% surface rock
Slope
Aspect
Slope – terrain position
Landform – concave, convex
Terrain shape index
Site index
Ecological classification unit
Topographic moisture index



Monitoring Response Variables

Seedling, sapling, tree species, density, basal area, stocking, size, age
Tree dominance – relative density, relative basal area, importance value, crown class
Species presence - absence
Species richness, Shannon Weiner Index, eveness,
Percent coverage
Floristic quality index
Mean coefficient of conservatism
Plant density & size
Fuel loading, litter depth



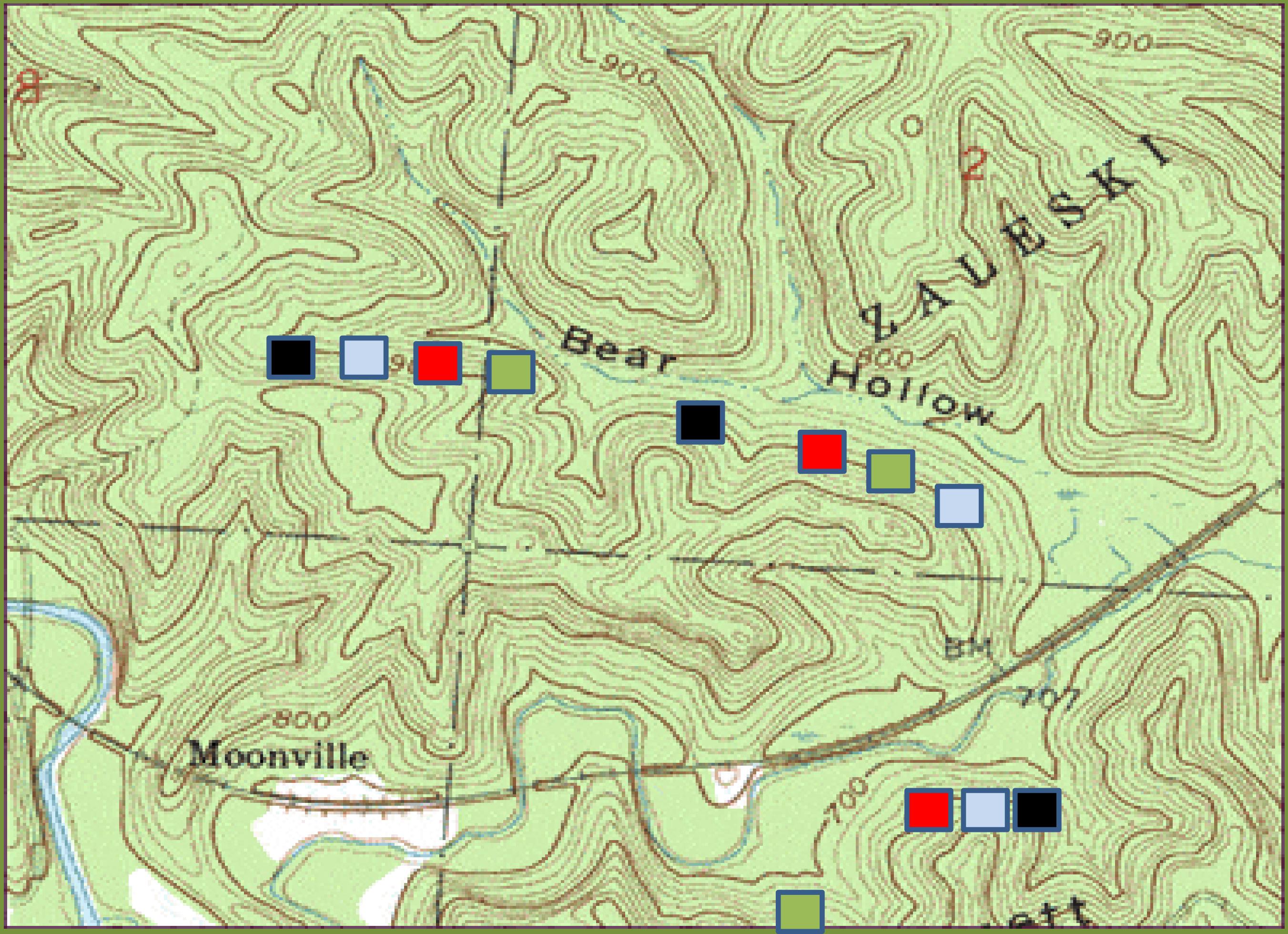






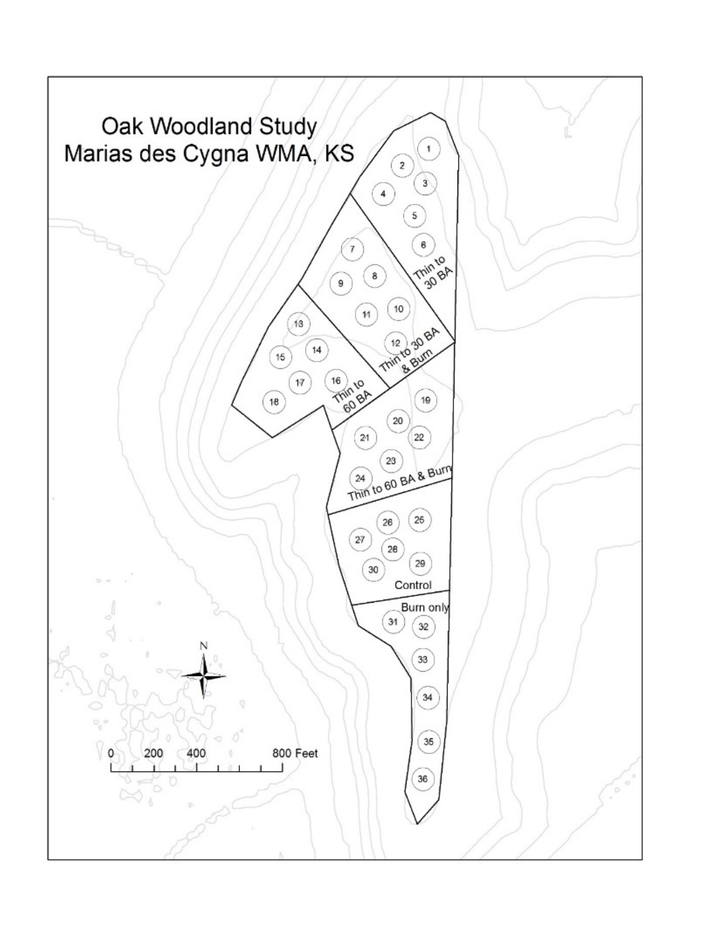
Considerations in Monitoring

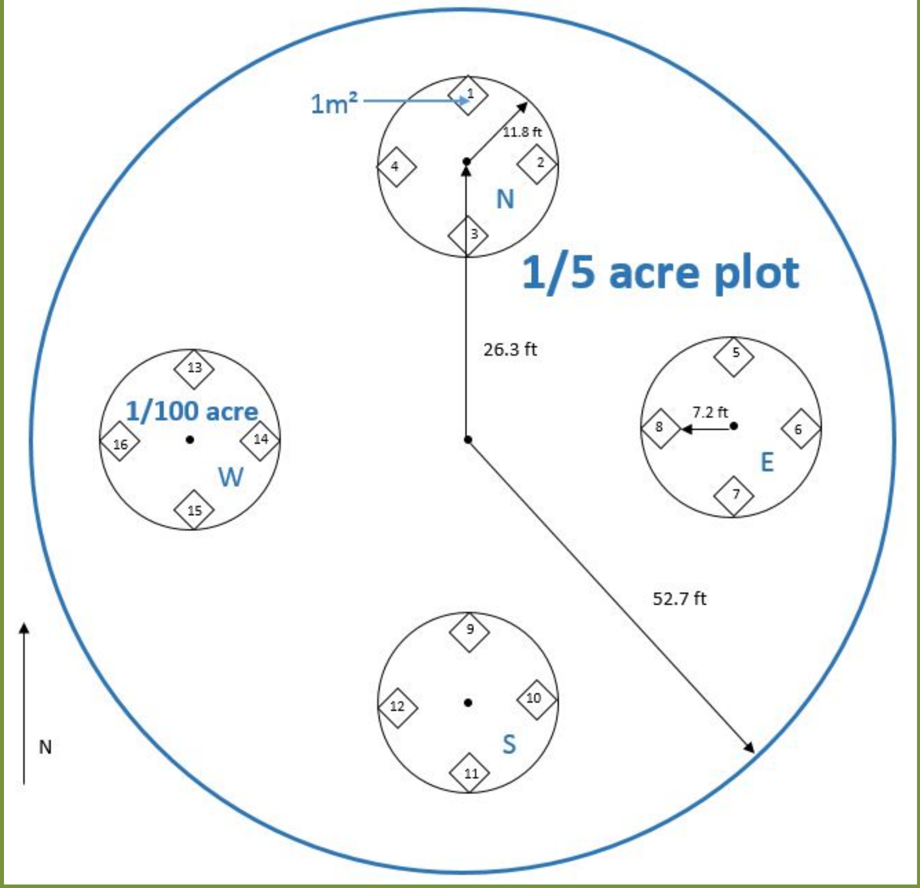
Case vs Replicated Study
The importance of randomization
Replications and treatments should be independent
The importance of having a control treatment



Considerations in Monitoring

Permanent vs temporary plots
The chonosequence approach





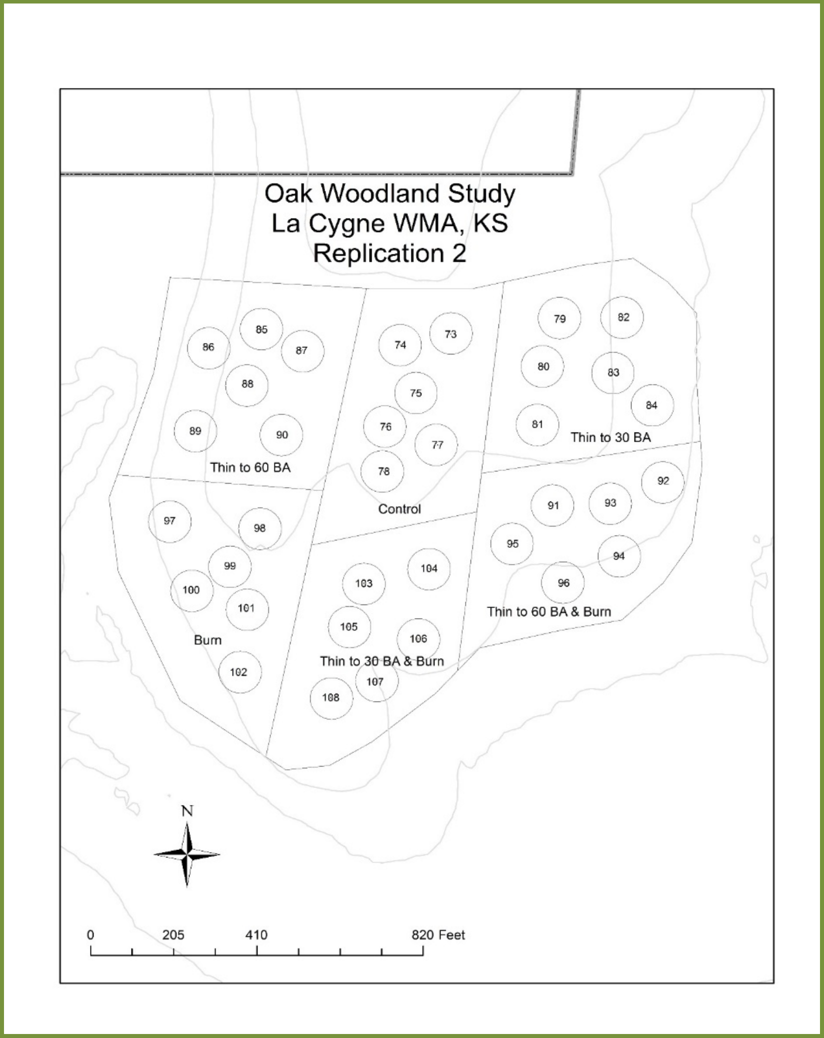
When the objective is to detect change

Considerations in Monitoring

Statistical Power

The certainty of detecting real change

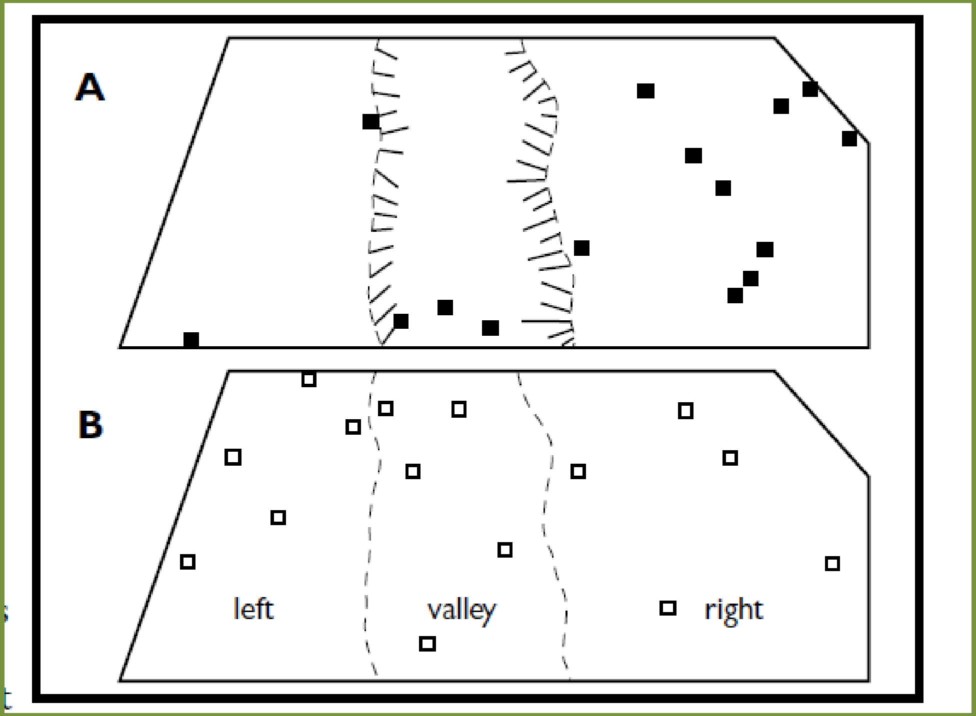
Standard deviation
Sample size
Minimum detectable change
α = Type I error rate (5-20%)
(accepting the Ha: when it is false)



Sample size

Standard deviation
Confidence level desired (80-99%)
Desired precision level
(confidence interval width about the mean)

Methods for Locating Plots

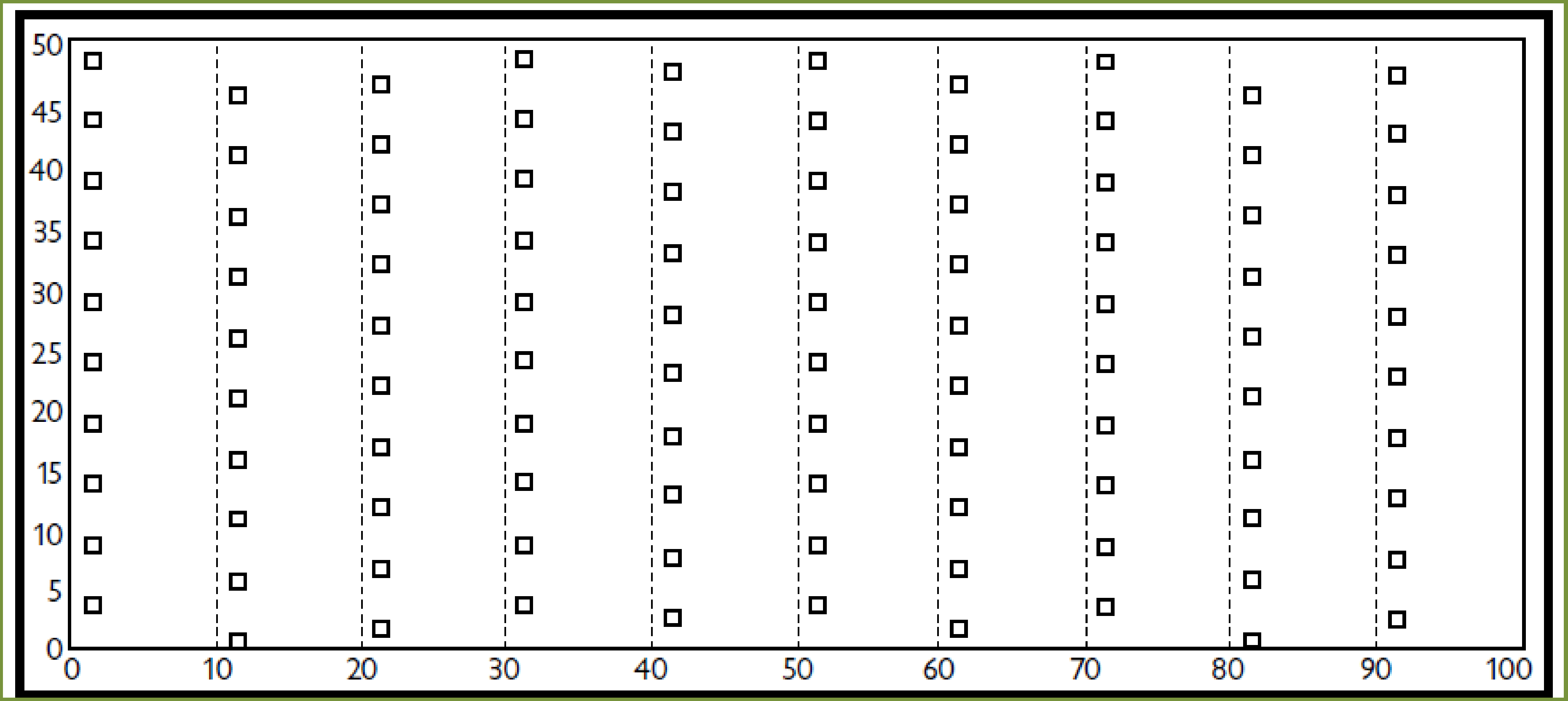


simple random

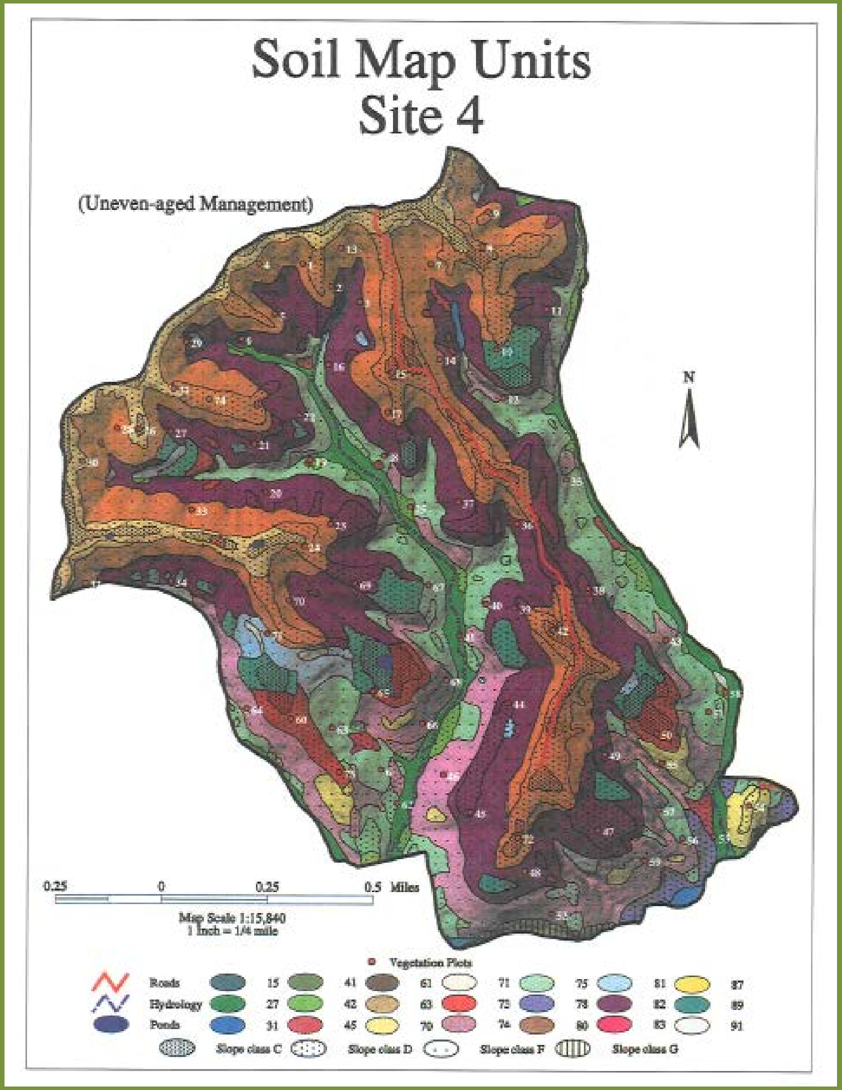
stratified random

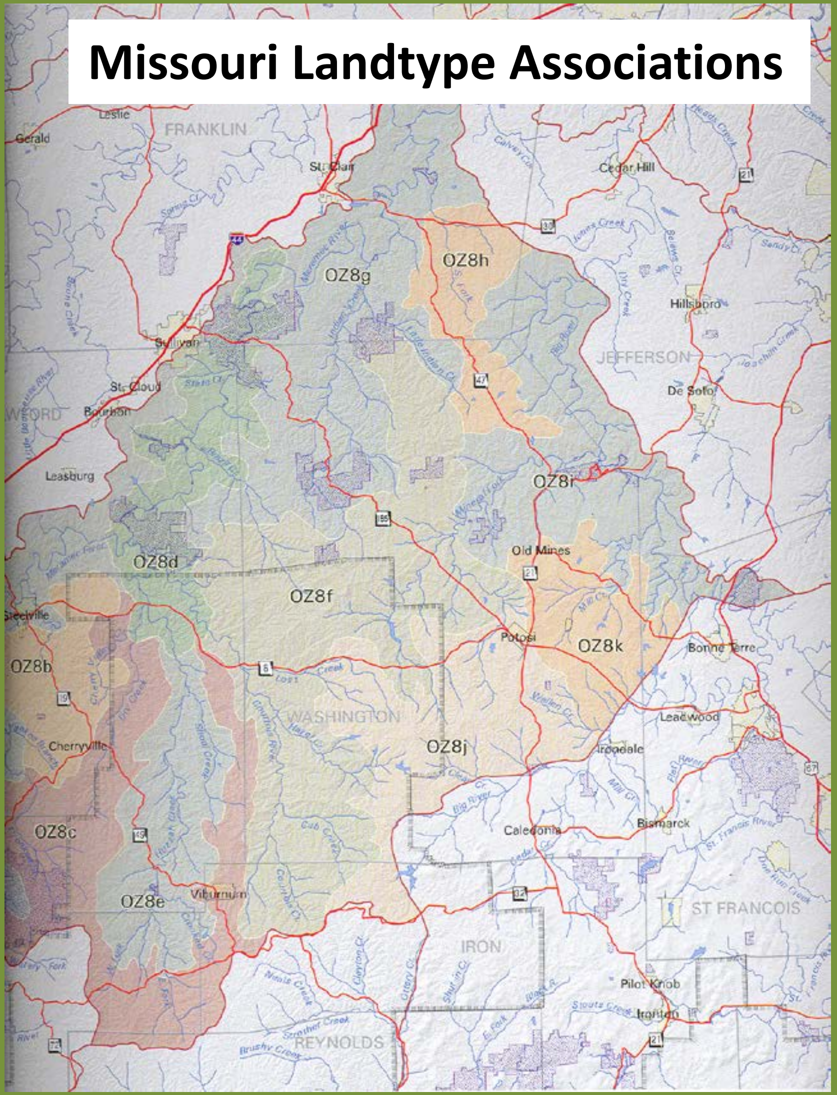
Methods for Locating Plots

systematic random
stratified random systematic



Stratify by Environmental or Ecological Gradients and Boundaries





Importance of site selection

Sites should be initially the same in condition:

in the major factors that are known to affect response variables

soils, topography, mgmt history, disturbance history

vegetation composition and structure

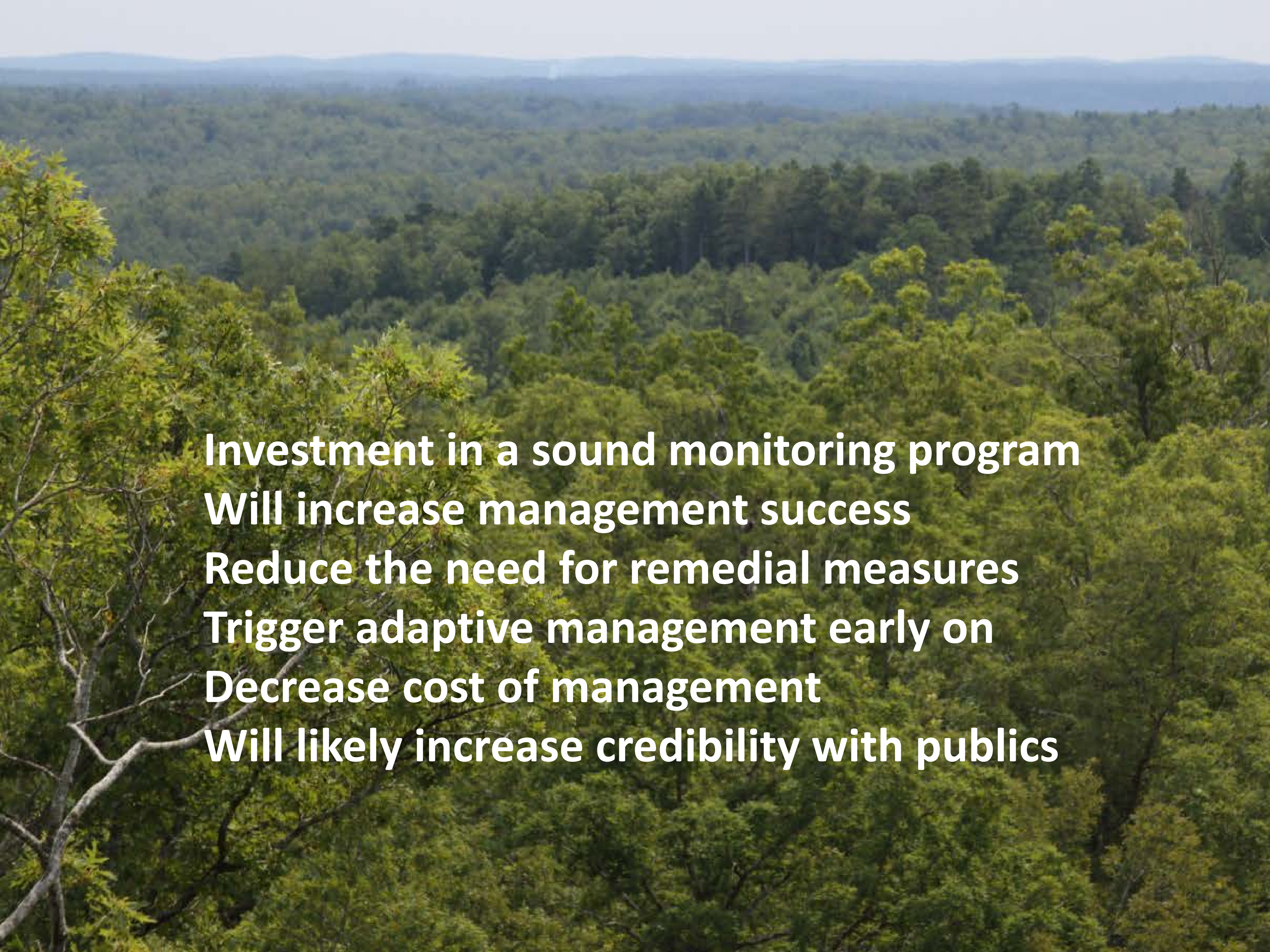
Sites should be representative of the larger area and management concern

Analysis of Monitoring Data

Work with research scientists, university faculty, FIA analyst, regional and national Forest staff, etc

Collaborate with them from the beginning

Common methods include ANOVA, Regression, paired t-tests



Investment in a sound monitoring program
Will increase management success
Reduce the need for remedial measures
Trigger adaptive management early on
Decrease cost of management
Will likely increase credibility with publics