



Monitoring Vegetation

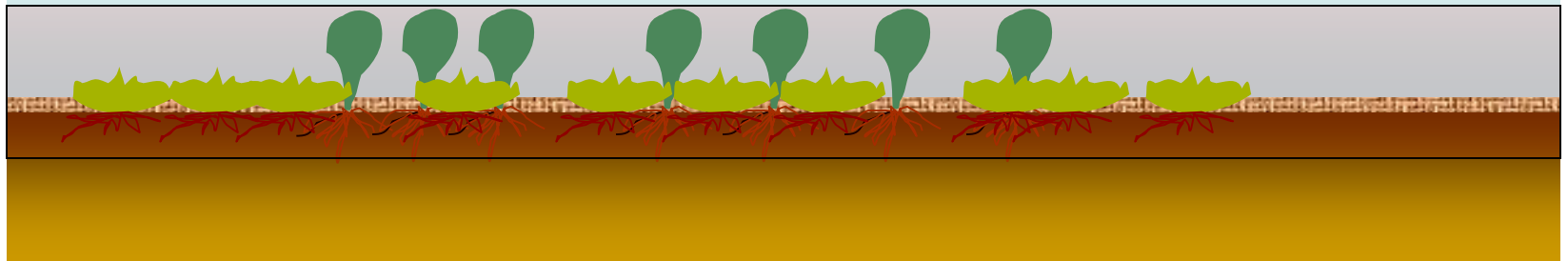
Today's Agenda

“Introduction to monitoring soil/vegetation systems”

Introduction = superficial

Monitoring = to watch, keep track of, for a purpose

Soil/vegetation systems = the living skin of the earth



Today's Agenda

- 1. Monitoring motives**
- 2. Qualitative Monitoring**
- 3. Goals, Objectives, Questions**
- 4. Estimating Parameters**

The background of the slide is a photograph of a pond. The water is dark and reflects the surrounding environment. Numerous brown, fallen leaves are scattered across the water's surface. A white, mesh-like net trap is partially submerged in the water, with its handle visible. The overall scene suggests a natural, outdoor setting, possibly related to environmental monitoring or research.

Monitoring Motives

Form Follows Function

Why we measure drives how we measure

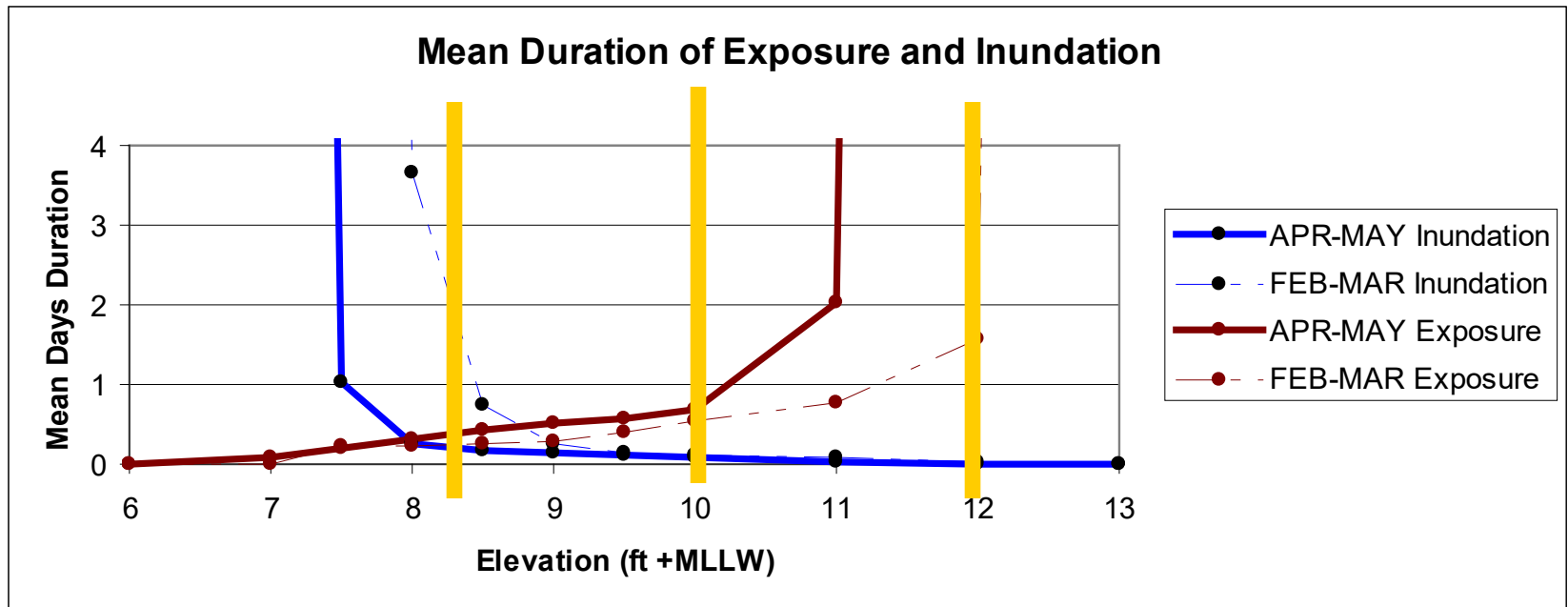
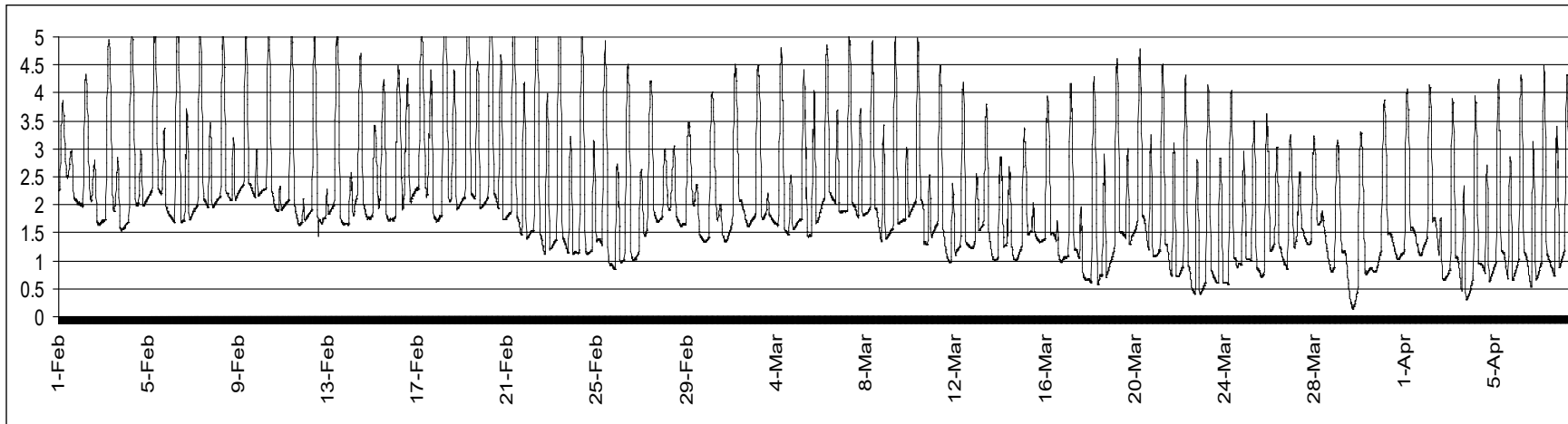
- **Desired Outcome**
 - **Knowledge and Skills**
 - **Equipment**
 - **Budget**
-
1. **SUPPORT DESIGN** – To measure the nature of intact systems
 2. **AS BUILTS** – To document on-the-ground treatments
 3. **SHOW CHANGE** – To demonstrate that things are different
 4. **LEARN LESSONS** – To understand why things are different

Support Design

How do you know if a natural site can serve as a reference state for your degraded site?

- **Soil series**
- **'Biological legacies' in the soil system**
- **Canopy conditions**
- **What did the reference site look like when it first established?**
 - Tree age and density
 - Dead trees (self-thinning)
 - Senescent early succession species
- **Local seed sources** – vegetation is driven by neighborhood
- **Hydrology** – frequency, depth, duration
- **Salinity** – landscape position, seasonality of freshwater

Support Design



Support Design

MOTIVES



Support Design

MOTIVES



As-Builts

TREATMENT ZONES

Baseline conditions

Site prep

Imported materials

After care

PROPAGATION

Species

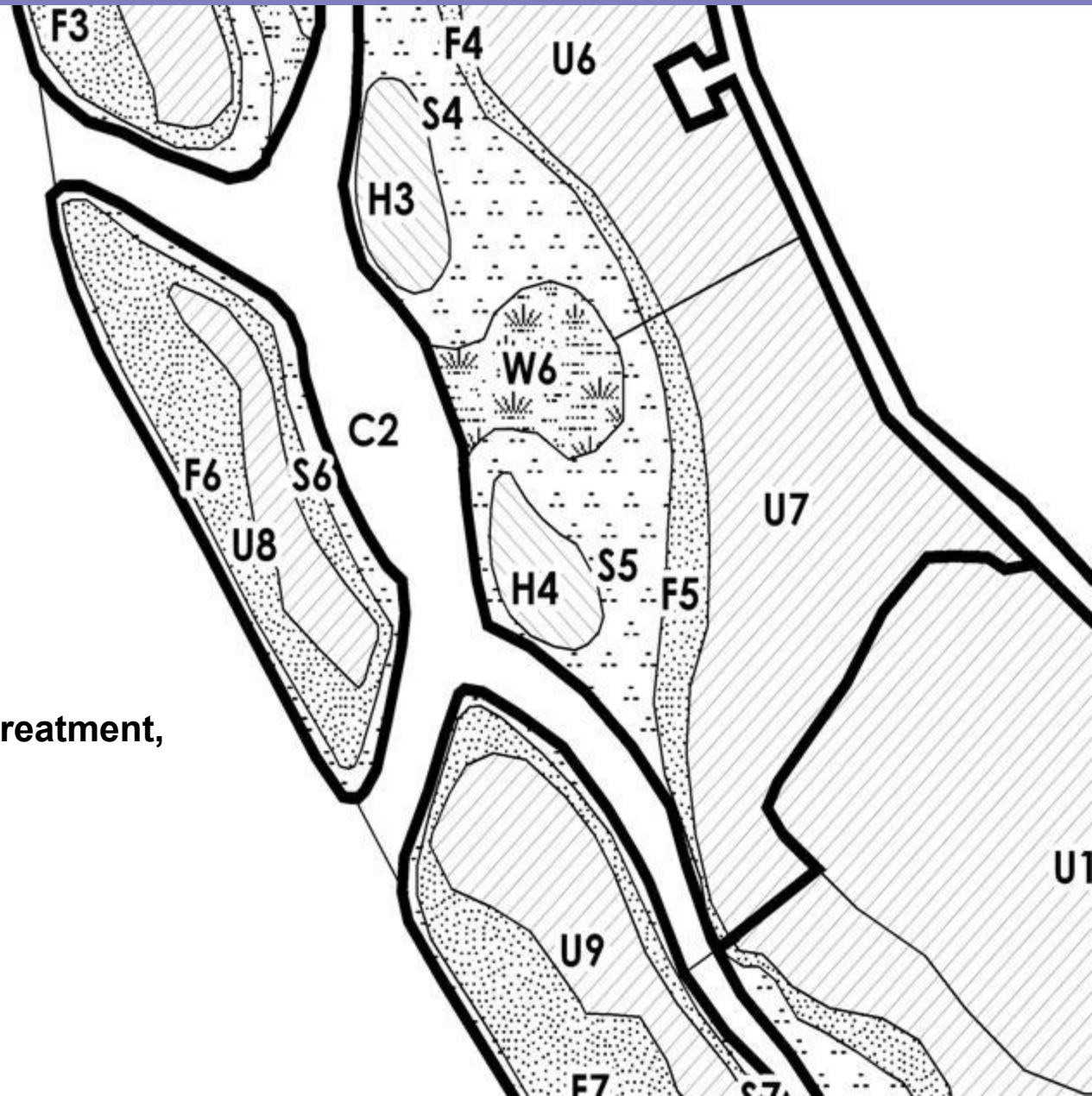
Stock type

Quantity by zone

Planting date

Installing crew

Planting specs – pre-treatment,
fertilization, etc.



As-Builts

409 units : 6710 square feet : 4.4 ft o.c. (mean)

S West Upland - [U10]

30% Dry Mixed Forest

coarse mosaic - 2013 square feet - 3.8ft o.c. (mean)

☐	15	1g	Abies grandis
☐	4	B1-0	Prunus emarginata
☐	6	1g	Lonicera ciliosa
☐	12	1g	Rosa gymnocarpa
☐	11	B1-0	Alnus rubra
☐	37	B2-0	Symphoricarpos albus
☐	11	B1-1	Pseudotsuga menziesii
☐	26	B2-1	Holodiscus discolor
☐	29	B2-0	Rubus ursinus
☐	14	1g	Polystichum munitum

Grand Fir	Random	WBF	5 ft o.c.
Bitter Cherry	Random	WGW	6 ft o.c.
Orange Honeysuckle	Random	JCN	3 ft o.c.
Baldhip Rose	Random	SNP	3 ft o.c.
Red Alder	Small drifts	FCN	6 ft o.c.
Snowberry	Small drifts	FCN	3 ft o.c.
Douglas-fir	Grouped	FRN	6 ft o.c.
Oceanspray	Grouped	FCN	4 ft o.c.
Evergreen Trailing Black	Matrix	FCN	3 ft o.c.
Sword Fern	Matrix	SNP	3 ft o.c.

25% Conifer Thicket

fine mosaic - 1678 square feet - 4.3ft o.c. (mean)

☐	22	B2-0	Rubus ursinus
☐	12	B2-0	Symphoricarpos albus
☐	12	1g	Symphoricarpos albus
☐	12	L1.5	Symphoricarpos albus
☐	45	B1-1	Pseudotsuga menziesii

Evergreen Trailing Black	Random	FCN	3 ft o.c.
Snowberry	Small drifts	FCN	3 ft o.c.
Snowberry	Small drifts	SNP	3 ft o.c.
Snowberry	Small drifts	SNP	3 ft o.c.
Douglas-fir	Matrix	FRN	6 ft o.c.

45% Alder Thicket

matrix - 3020 square feet - 5ft o.c. (mean)

☐	22	B2-0	Rubus ursinus
☐	22	1g	Polystichum munitum
☐	97	B1-0	Alnus rubra

Evergreen Trailing Black	Random	FCN	3 ft o.c.
Sword Fern	Random	SNP	3 ft o.c.
Red Alder	Matrix	FCN	6 ft o.c.

Show Change

What part of change do you want to show?

Change in number of canopy trees?

Change in community composition?

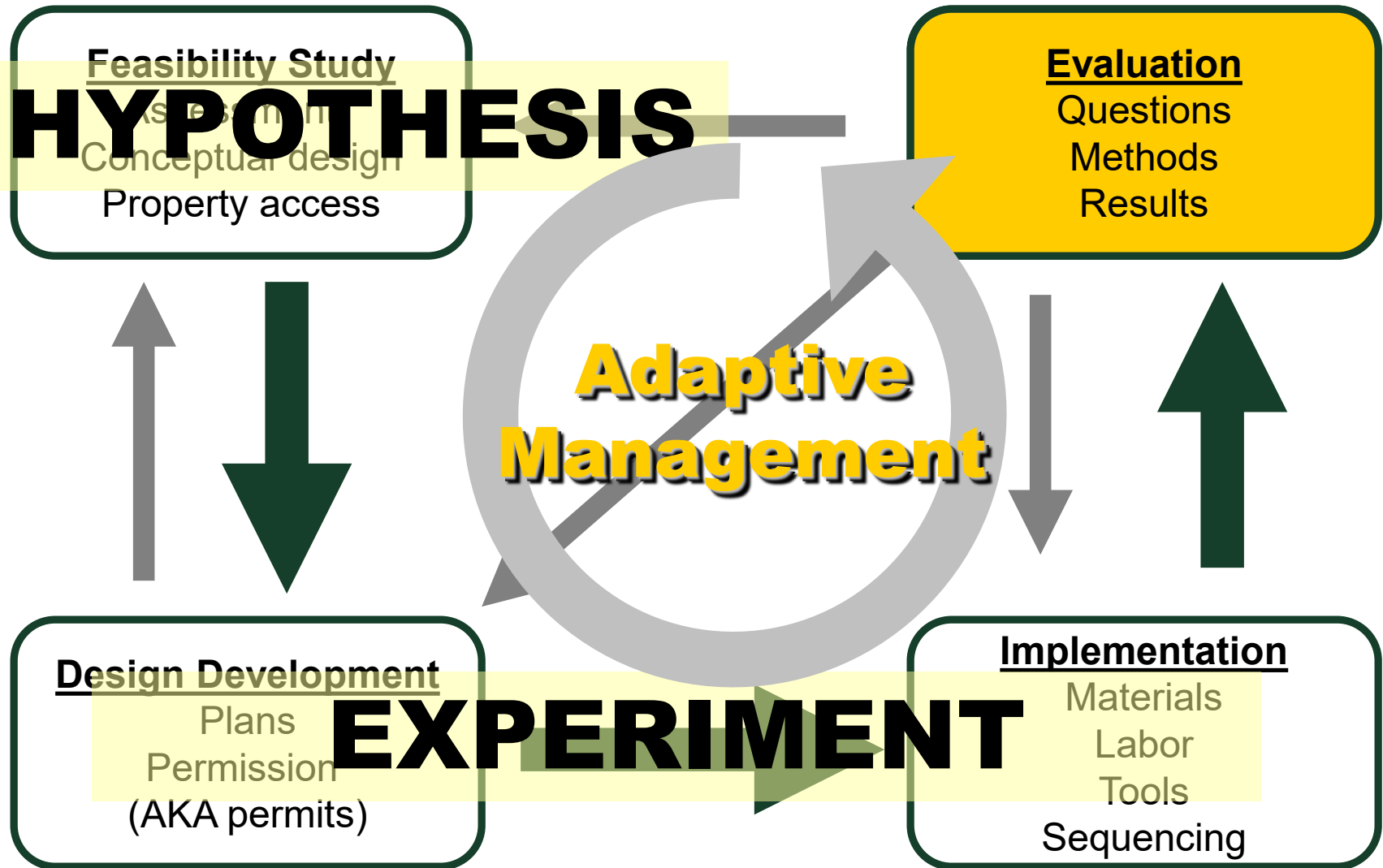
Change in soil organic matter in the top 8 inches?

Do you really need to count or measure things to show change?

What period of time is appropriate for detecting that change?

How does the magnitude of change compare to the variability of the parameter?

Learn Lessons



Learn Lessons

How does variation in treatment affect outcome?
How does environmental variation affect outcome?
How does site compare to reference over time?
Where is our greatest uncertainty

What should we do next time?
What should we do at this site now?

Lessons learned improve our ability to predict the outcome of future actions and evaluate alternatives.

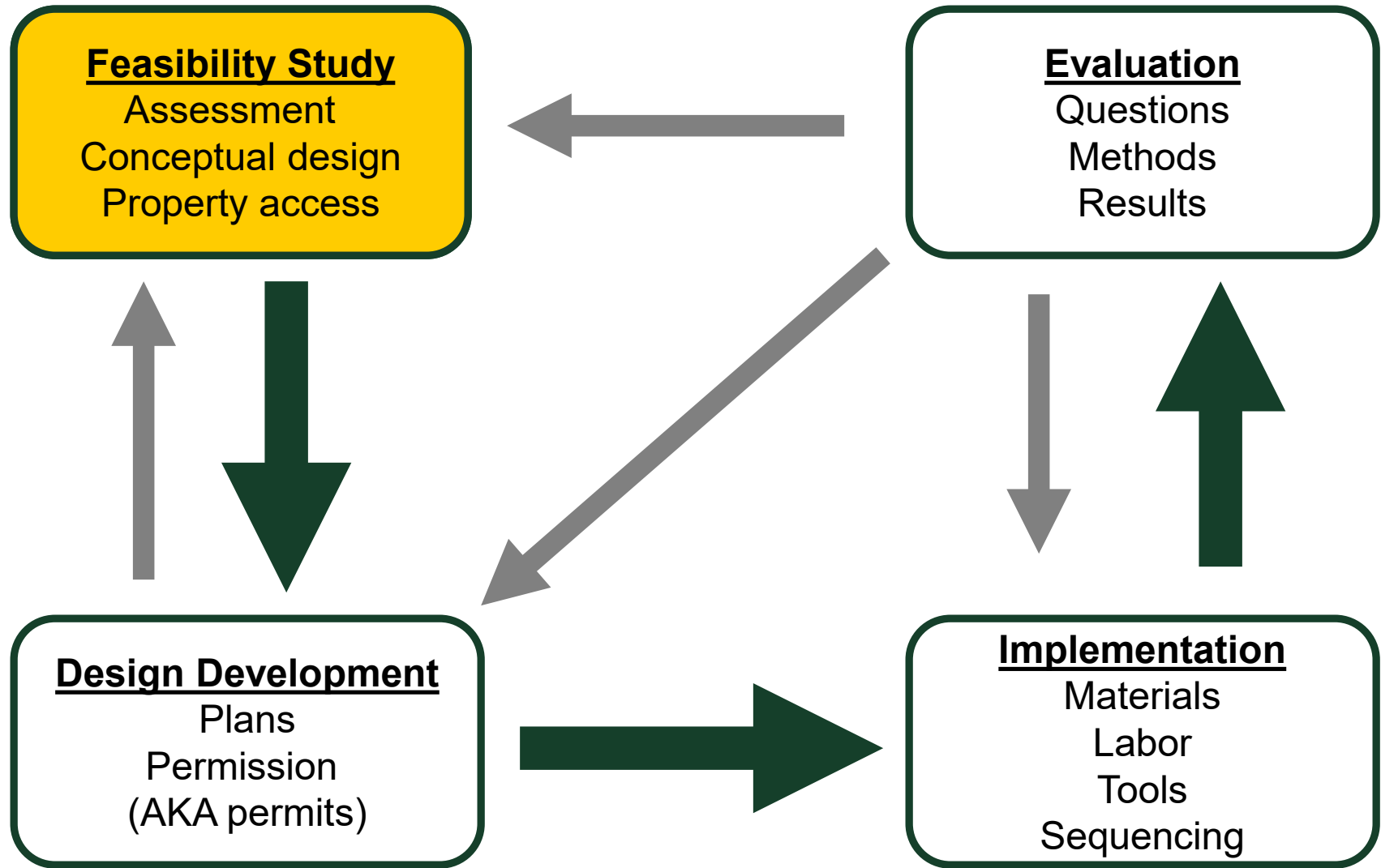
Empty motives

1. the grant application asked for a monitoring plan
2. monitoring is a good way to keep volunteers busy
3. a manual said to monitor this way
4. we need to document 'success'
5. monitoring makes us scientific
6. we have some extra money in the budget
7. we are legally required to do so
8. quantification is more accurate

Qualitative Monitoring
(AKA being a good naturalist)

Do One Thing Right

QUALITATIVE



Spatial/Temporal Context

To understand a phenomena in science you also need to understanding one level above and one level below the phenomena you are interested in. - Linda Brubaker

TIME: 1-10 years

SPACE: This site, i.e. 1-50 acres, a reach

How do biological communities function?

What will be the effect of our actions?

	TIME	SPACE
SMALLER SCALE	Daily/Seasonal Variation	Individual organisms/events
LARGER SCALE	Generations, over 10-100 years	Basin

Complex Environments

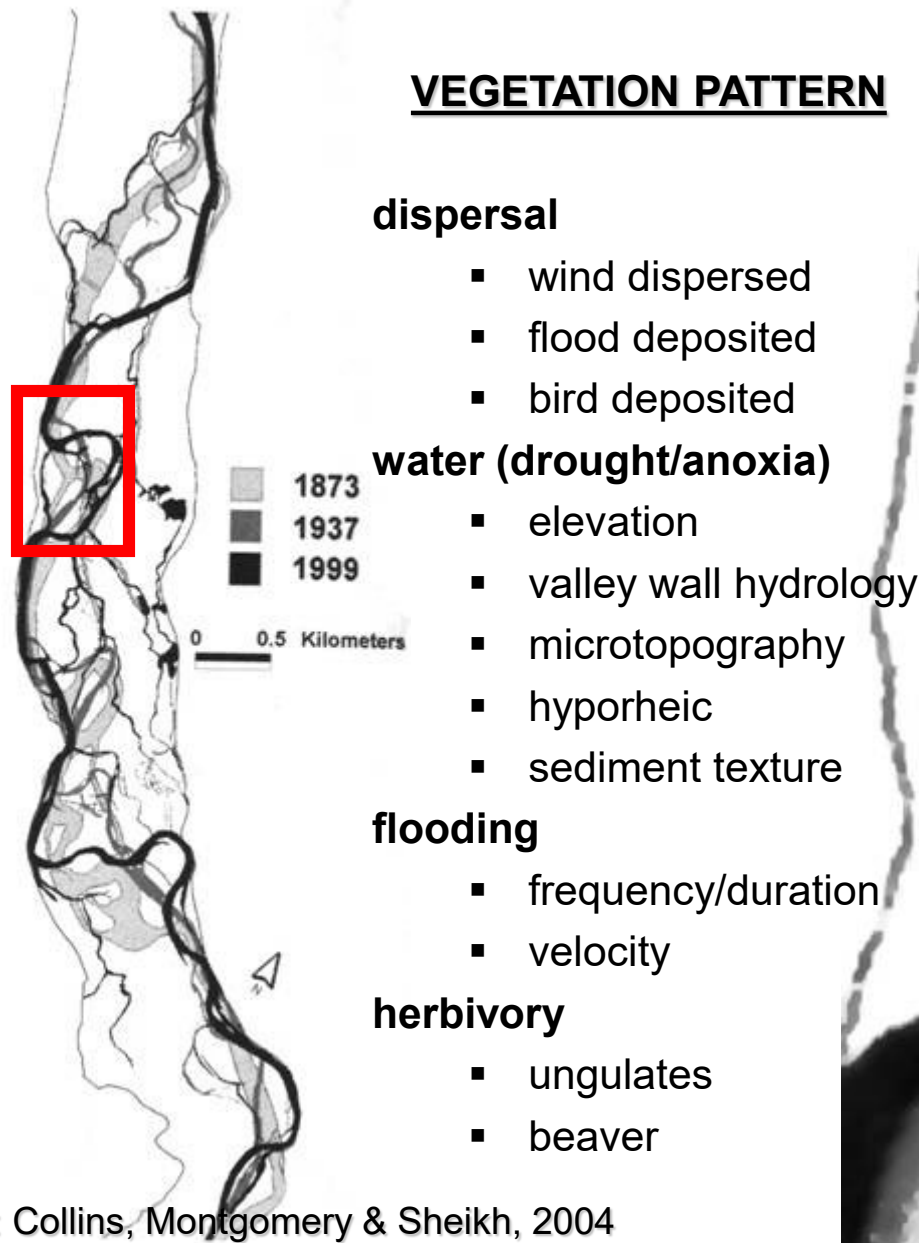


Figure : Collins, Montgomery & Sheikh, 2004

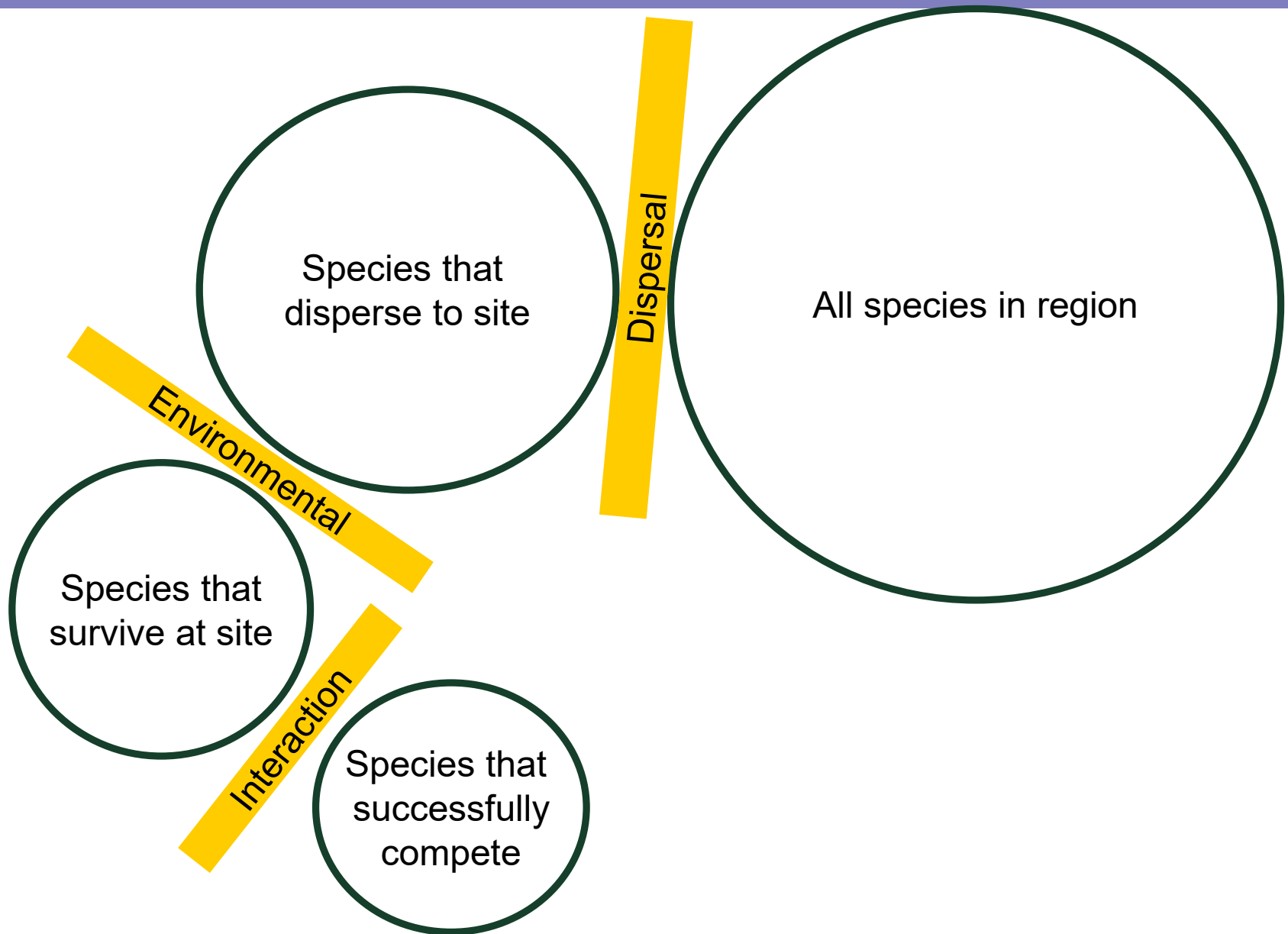
Complex Environments

QUALITATIVE



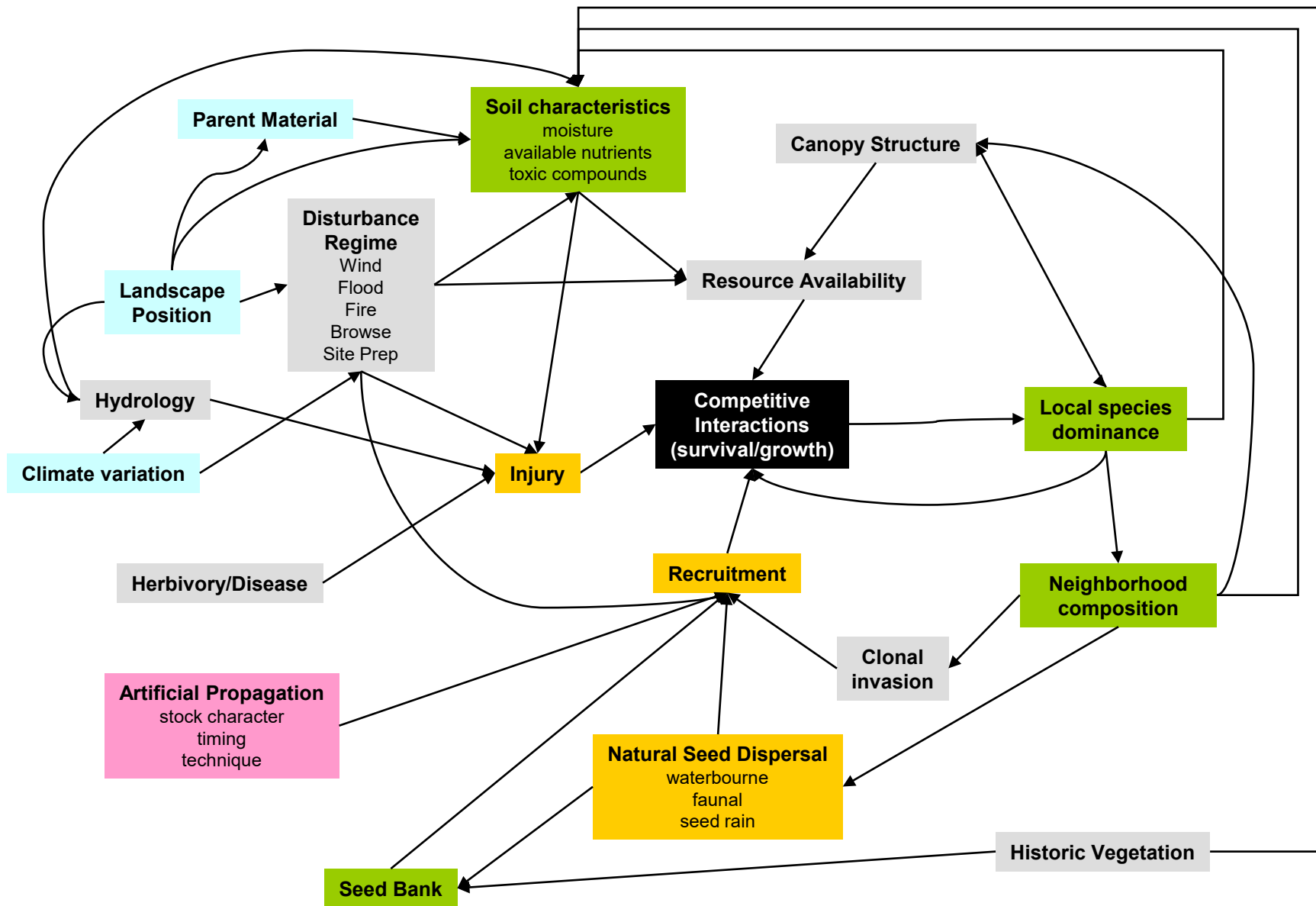
Conceptual Models

QUALITATIVE



Conceptual Models

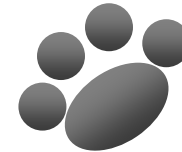
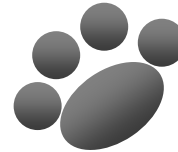
QUALITATIVE



Vegetation Indicators

Most stories can be told and management decisions made without data!!

**Redox
Drought
Sedimentation
Scour event
Elevation patterns
Local wetness patterns
Forest structure and regeneration
Fire sign
Browse sign**



- 1. Dig Holes**
- 2. Focus on understory more than overstory for indicators**
- 3. Focus on patterns more than individuals**
- 4. Rely on multiple observations, observers, sources**
- 5. HUMBLE - admit the limits of extrapolation**

Qualitative Monitoring

Photographs:

- Document location and date (treatment zones?)
- Include objects for scale
- Include reference objects for location and perspective
- Find interesting things to look at
- Consider future canopy obfuscation



Qualitative Monitoring

Systematic Observation

Use simple database structure

This allows fields for sorting

Date

Observer

Site/Sector/Zone

Type (observation, work)

Topics (plants, animals, fencing...)

Observation

Estimated response recommendation

Follow-up required

Follow-up achieved

Observation

Assessments are completed quarterly using the following schedule. A data sheet is provided for each observation category.

Installation Period (Years 1-3)

Winter	Spring	Summer	Fall
Photo monitoring Erosion Weed control Mulch Human impacts Fencing	Weed control Plant vigor Fencing Human impacts	Weed control Photo Monitoring Plant vigor Human impacts Supplemental planting areas Fencing	Erosion Human impacts Fencing

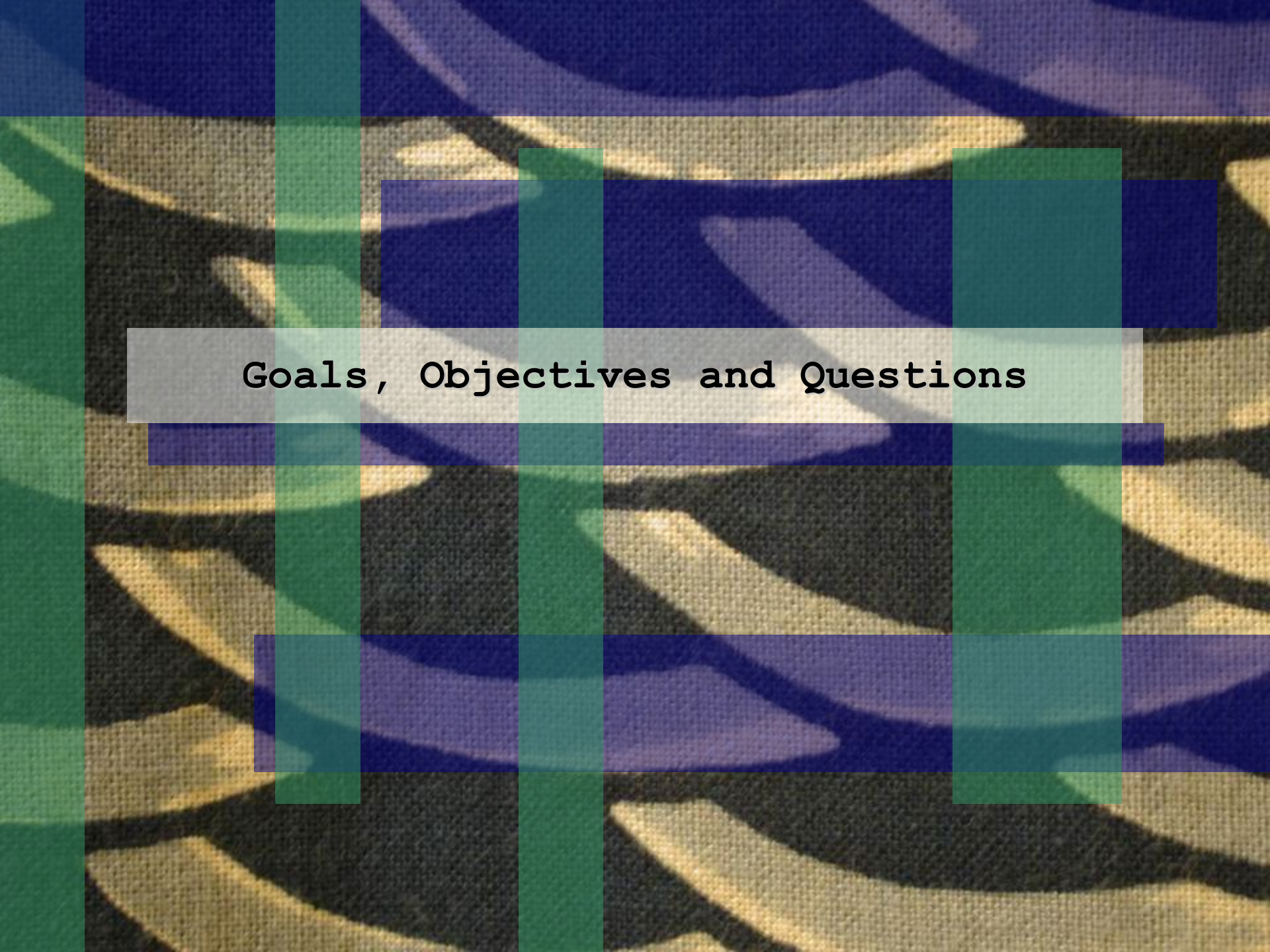
DATE	SITE	TYPE	SUBTYPE	ZONE	TIME	MATERIAL EST	LABOR EST	NOTES	PLAN FOR ACTION (CHB RESPONSE)
4/15/2006	SQUALLY	MONITOR	HUMAN	ALL	0.25	N/A	N/A	noticed a sheen in creeks (may be bacteria)	N/A
4/15/2006	SQUALLY	MONITOR	WEED	ALL	0.25		50	blackberry! Along with Pepperweed, J Knotweed, Scotch broom, and Reed Canary Grass	Restoration Day planned for June 10th with volunteers and Earthcorps
4/15/2006	SQUALLY	WORK	HUMAN	ALL	1.50	0	2	picked up 1.5 bags of garbage	AAWA Stewards will continue to take care of this ongoing problem
4/15/2006	SQUALLY	MONITOR	RESEARCH	ALL	1.00	N/A	N/A	photo point monitoring	N/A
4/15/2006	MIDDLE	WORK	HUMAN	ALL	1.25	0	5	picked up 2 bags of trash	AAWA Stewards will continue to take care of this ongoing problem
4/15/2006	MIDDLE	MONITOR	PLANT	ALL	0.25	N/A	N/A	native plant cover is increasing: salt grass, pickleweed, tufted hairgrass, saltmarsh bullrush, spike rush, douglas fir, western hemlock, western red cedar, big leaf maple, red alder, madrone, shore pine, hazelnut, oceanspray, nodka rose, hooker's willow, dogwood, oregon grape (flowering), salal, snowberry, elderberry, red-flowering currant (flowering), and kinnickinnick (flowering)	N/A
4/15/2006	MIDDLE	MONITOR	WEED	ALL	0.25		20	invasive cover is increasing: himalyan blackberry, white sweet clover, reed canary grass	Restoration Day planned for July 1st to tackle invasive plants - with Earthcorps
4/15/2006	MIDDLE	MONITOR	RESEARCH	ALL	1.00	N/A	N/A	photo point monitoring	N/A
4/16/2006	SKOOKUM WULGE	WORK	HUMAN	ALL	1.00	0	0.25	picked up 1 bag of garbage which is half the usual amount	AAWA Stewards will continue to take care of this ongoing problem
4/16/2006	SKOOKUM WULGE	MONITOR	WEED	ALL	0.50		80	present: pepperweed, japanese knotweed not leafing out yet, himalayan blackberry is all upland, scotch broom located scattered to entrance path for pp#5, and english ivy along the embankment E of pp#3	Restoration Day planned for May 20th with volunteers
4/16/2006	SKOOKUM WULGE	MONITOR	NATURE	ALL	0.00	N/A	N/A	dead harbor seal near pp#1 in early stages of decay	N/A
4/16/2006	SKOOKUM WULGE	MONITOR	RESEARCH	ALL	1.00	N/A	N/A	photo point monitoring	N/A

Observation Data

High Quality Observations

- Precise language
- Quantify wherever possible
- Observe then infer
- Consider end user
 - Future steward
 - Reporting
 - Researcher

SITE	TYPE	SUBTYPE	NOTES	PLAN FOR ACTION (CHB RESPONSE)
MIDDLE	MONITOR	FENCE	again, some goose exclusion fencing is deteriorating and no longer effective	Planned restoration day for spring 2006 to repair and extend goose exclusion fencing
			some goose exclusion fencing is deteriorating and no longer effective	Planned restoration day in Spring of 2006 to repair and extend goose exclusion fencing
		NATURE	saw a peregrine falcon	N/A
		PLANT	native plant cover is increasing	N/A
			native plant cover is increasing: salt grass, pickleweed, tufted	
			shore pine, hazelnut, oceanspray, nodka rose, hooker's willow,	N/A
		RESEARCH	photo point monitoring	N/A
			blackberry, white sweet clover, scott's broom, reed canary grass, along road	Planned restoration day for July 1 to tackle invasive cover
		WEED	blackberry, white sweet clover, scott's broom, reed canary grass,	
			invasive cover is increasing: himalyan blackberry, white sweet clover, reed canary grass	Planned restoration day for July 1 to tackle invasive cover
MOWITCH	MONITOR	WORK	picked up 2 bags of trash	AAWA Stewards will continue to take care of this ongoing problem
			pulled sweet pea, blackberry, butterfly bush, white sweet clover,	AAWA Stewards will continue to take care of this ongoing problem
				AAWA Stewards will continue to take care of this ongoing problem
			native plant cover is increasing: pickelweed, douglas fir, nodka rose, hooker's willow. Common snowberry looks dehydrated	continue to monitor, stewards are trained to handle this on a monthly basis.
			Look into the irrigation system, is it running all the time?	
		PLANT	native plant cover is increasing: pickelweed, douglas fir, nodka rose, hooker's willow. Common snowberry looks dehydrated	N/A
		RESEARCH	himalayan blackberry, white sweet clover, pepperweed, and reed canary grass present	N/A
		WEED	himalayan blackberry, white sweet clover, pepperweed, and reed canary grass present	Restoration Day planned for July 1st to tackle invasive plants - with Earthcorps
			native plant cover is increasing: himalyan blackberry, tansy ragwort, pepperweed	Restoration event planned for June 3rd and July 22 with volunteers
			native plant cover is increasing	N/A
	WORK	HUMAN	located on end of site; cannot carry out at	take care of this ongoing problem
			picked up one very full bag of garbage, hot lamp and 5 gallon bucket left on site	take care of this ongoing problem
		WEED	pulled blackberry and thistle	continue to monitor growth, planned day for removal on July 22



Goals, Objectives and Questions

Characteristics of a good question

Goal	Reason for doing work
Objective	Finite 'do-able' milestones that direct your labor, based on your conceptual model.
Parameter	Something important to measure
Criterion	A measuring stick to interpret a parameter

Vegetation Parameters

Quantitative monitoring is primarily driven by:

1. Mitigation requirements
2. Grantor requirements

...as opposed to learning

Characteristics of a good question

Does your question have a clear time span?

Does your question refer to an explicit population?

Can you define what each word means?

Does the question fits your project or program goals?

Does the question identify specific parameters?

Characteristics of a good question

GOAL

To restore riparian forests

OBJ 1

Increase healthy conifer stem density to 200 stems per acre

OBJ 2

Close tree canopy on open sites within 10 years

OBJ 3

Establish five shrub species with greater than 5% cover

Characteristics of a good question

QUESTION 1

Is there a difference in **estimated density** of **healthy conifer stems** on the **riparian zone** of the site between **pre-installation, post-installation, and 5 years following installation.**

ESTIMATED DENSITY – count per sample/sample area

HEALTHY CONIFER STEM – health criteria (growth, % live, species list)

RIPARIAN ZONE – defined area (is the whole area potential conifer habitat?)

FREQUENCY – 3 samples, baseline, as-built, and success.

Characteristics of a good question

The 'so what' factor:

- What do you do if after the 1st year you notice that your trees are dying?
- Do you care why your trees are dying?
- Do you care which species are dying?
- Do you care where your trees are dying?
- Does 5 years insure continued stand development?
- Does your definition of healthy ensure continued stand development?
- Was there any variability in the quality of planting method, stock, or site prep that may affect planting?
- Is the site really adapted to conifer forest?

**CAREFULLY DEFINING YOUR GOALS AND OBJECTIVES
IS AS IMPORTANT AS MEASURING THEM!!**

Vegetation Parameters

There are lots of ways to look at vegetation:

- **Species**
- **Functional Groups**
- **Absolute cover vs. Relative “dominance”**
- **Vegetation structure (vertical/horizontal)**
- **Cover estimate**
- **Stand age structure**
- **Gradient analysis**
- **Biomass measurement**
- **Demographics**

Elzinga Ph.D., C.L., Salzer, D.W., and Willoughby, J.W. 1998. Measuring and monitoring plant populations. BLM Technical Reference 1730-1. Bureau of Land Management, National Business Center, Denver, CO.



Estimating Parameters

Vegetation Sampling

Frequency (measure of “presentness” may not capture dominance)

Density (what is an individual)

- Total Counts (inventory)

- Quadrats (AKA plots...)

- Distance measures

Cover (aerial, basal)

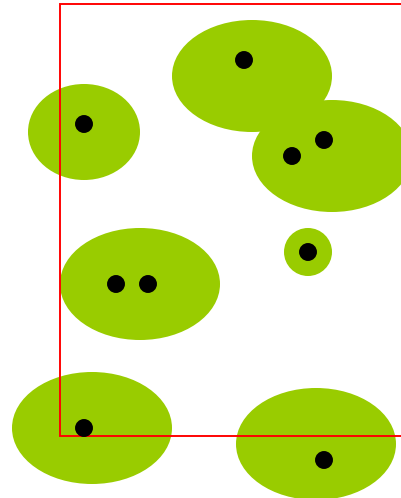
- Point

- Line

- Quadrat

Production and vigor measures

Permanent vs. Temporary Plots



Vegetation Sampling

What is the population?

you cannot describe more than you sample

How do you get a **representative sample**?

The samples provide an unbiased summary view of the entire population

How do you get a **independent sample**?

the location of the sample does not adversely affect the location of successive samples.

Does the scale of observation match the scale of variability?

pick a shape and size of sample that captures the scale of patchiness to reduce variation between samples

Do you want to describe variation or minimize it?

if you are trying to isolate variation then you may want to stratify the sample

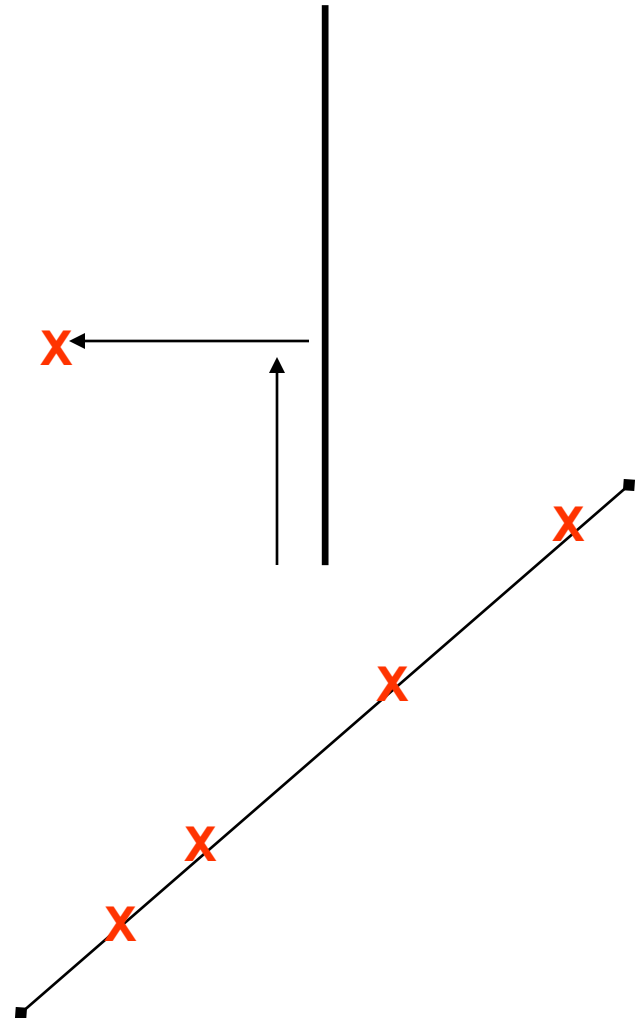
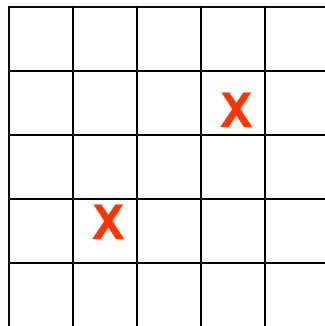
Randomization

1. Haphazard (throw quadrat over shoulder)

2. Random off of baseline

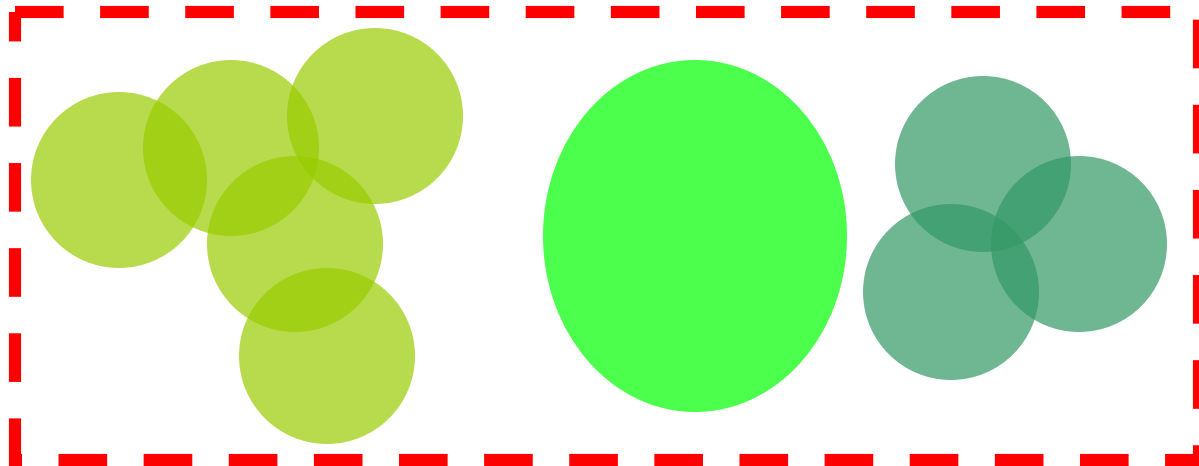
3. Random within grid

4. Random on transect



Patchiness

Patchiness + Gradients + Planting = High variance



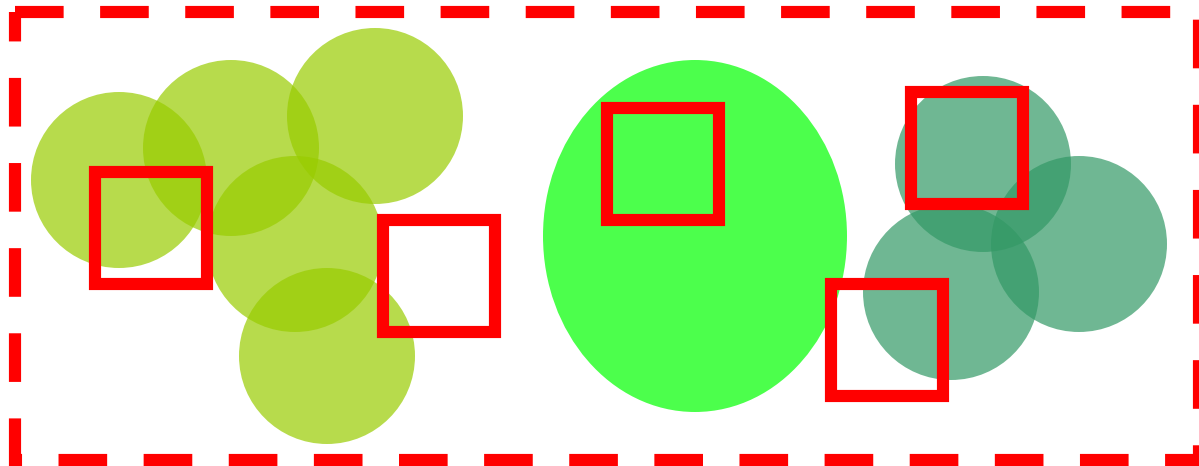
Stratify sample - divide up site into homogenous units

Fixed plot - compare change year to year for each plot

Change sample to match patchiness

Patchiness

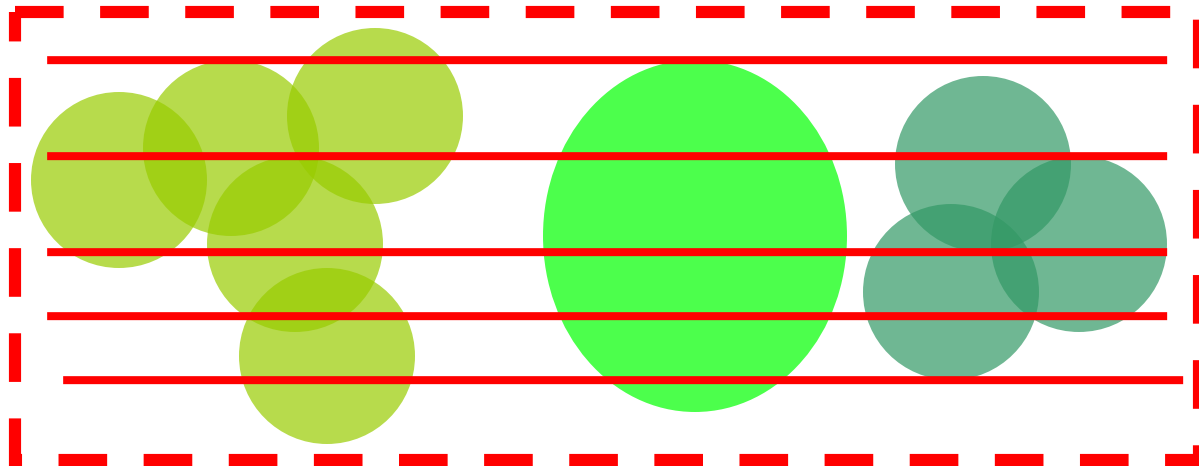
Patchiness + Gradients + Planting = High variance



	80	5	0	0	0	17 +/- 31
	0	0	100	0	0	20 +/- 39
	0	0	0	40	100	28 +/- 38

Patchiness

Patchiness + Gradients + Planting = High variance



10	25	18	10	10	14.6 +/-6
5	20	23	20	15	16.6 +/- 6.2
0	10	19	17	3	9.8 +/- 7.3

Vegetation Sampling

- Clearly identify the analysis before you start sampling
- Think about how you could introduce bias
- Take representative, independent samples of your population
- Stay efficient to maximize the number of samples
- Reduce variance by stratification or sampling at the appropriate scale