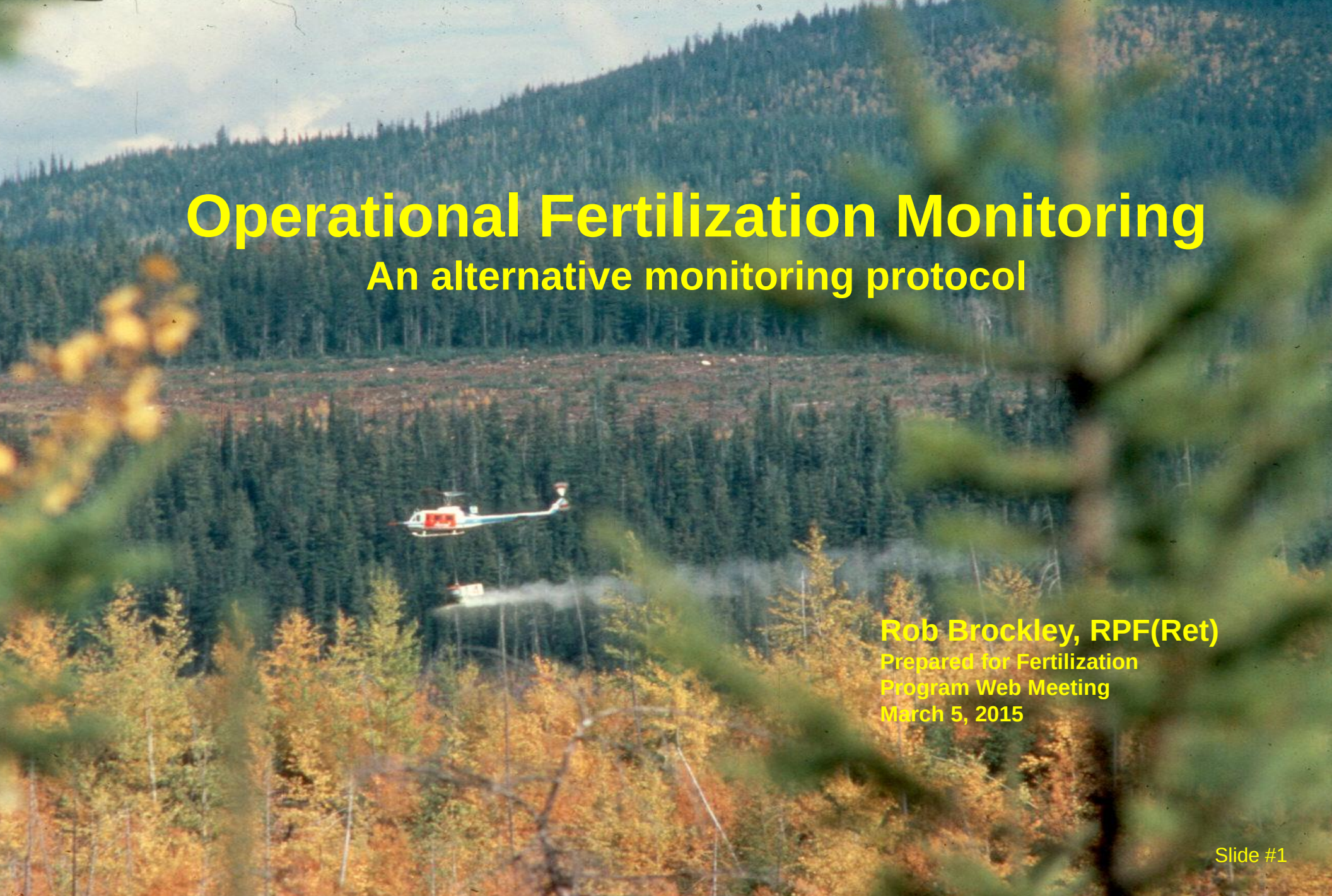

Operational Fertilization Monitoring

An alternative monitoring protocol

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Why growth response monitoring?

- Are stand growth responses from the operational fertilization program consistent with fertilization research results?

How is fertilization growth response estimated?

$$R_f = A_f - E_f$$

where:

R_f = growth response of a fertilized tree

A_f = post-fertilization growth of a fertilized tree

E_f = growth that would have occurred had tree not been fertilized

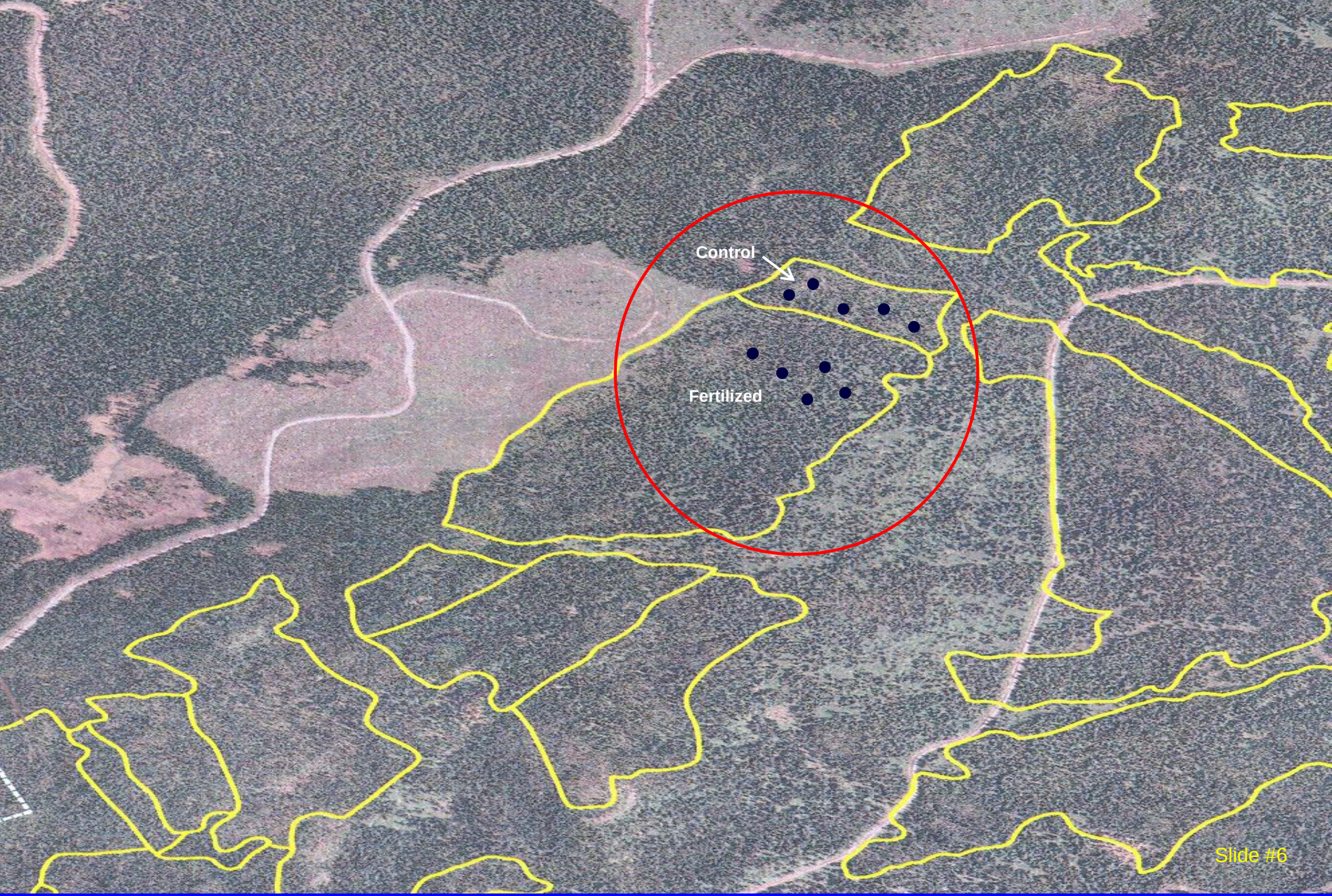
- E_f can only be estimated (i.e., cannot be measured)

Different growth monitoring objectives

- Area-based (m^3/ha) growth response estimate
- Relative (%) growth response estimate

Area-based monitoring methodology

- Establish several G&Y permanent sample plots (psp's) in fertilized and unfertilized portions of the treatment block
- Measure dbh (and height) of all trees within psp's at the time of fertilization
- Re-measure psp's at some point in the future (e.g., 5 years)


Control
Fertilized

Area-based monitoring

Advantages:

- Area-based growth response estimate (m^3/ha) is desirable

Disadvantages:

- Expensive
- No basis for statistical inference due to restriction on randomization
- Within- and between-plot stand/site variability may result in an unreliable growth response estimate

Types of stand and site variability

- Stand density
- Age
- Species composition
- Stand management history
- Site series

Common problems

- Within- or between plot variability
- Missing tags or missing trees
- Data discrepancies

Area-based fertilization monitoring program

- ~ 80 area-based operational fertilization monitoring installations have been established in the BC interior during the past several years
- Re-measurements to date have generally yielded inconclusive and unreliable results
- Estimating area-based growth response using traditional G&Y methodology may simply be an unrealistic objective for an operational fertilization monitoring program

An alternative fertilization monitoring protocol

- A new fertilization monitoring protocol has been designed to address more achievable objectives
- Instead of estimating absolute per-hectare growth gains, the new protocol estimates relative (%) fertilization response using a representative sample of individual trees as experimental units rather than area-based G&Y plots
- Reliably estimating relative growth response may be an achievable objective and may adequately demonstrate whether or not the growth benefits obtained from operational fertilization projects are broadly consistent with results from fertilization research experiments

Relative growth response monitoring methodology

- Set aside a representative control (i.e., unfertilized) area ≥ 5 ha in size prior to fertilization
- Select several (n=30?) representative individual trees in fertilized and unfertilized portions of the treatment block ~ 5 years after fertilization
- Measure and record the dbh of each selected tree
- Collect increment cores from all selected trees (2 cores/tree?)
- Measure pre- and post-fertilization radial increment on all increment cores using an automated core analysis system (e.g., WinDendro)

How is fertilization response estimated?

$$av R_f = av A_f - av[(B_f) \cdot av(A_u/B_u)]$$

where:

R_f = absolute growth response (cm) attributed to fertilization

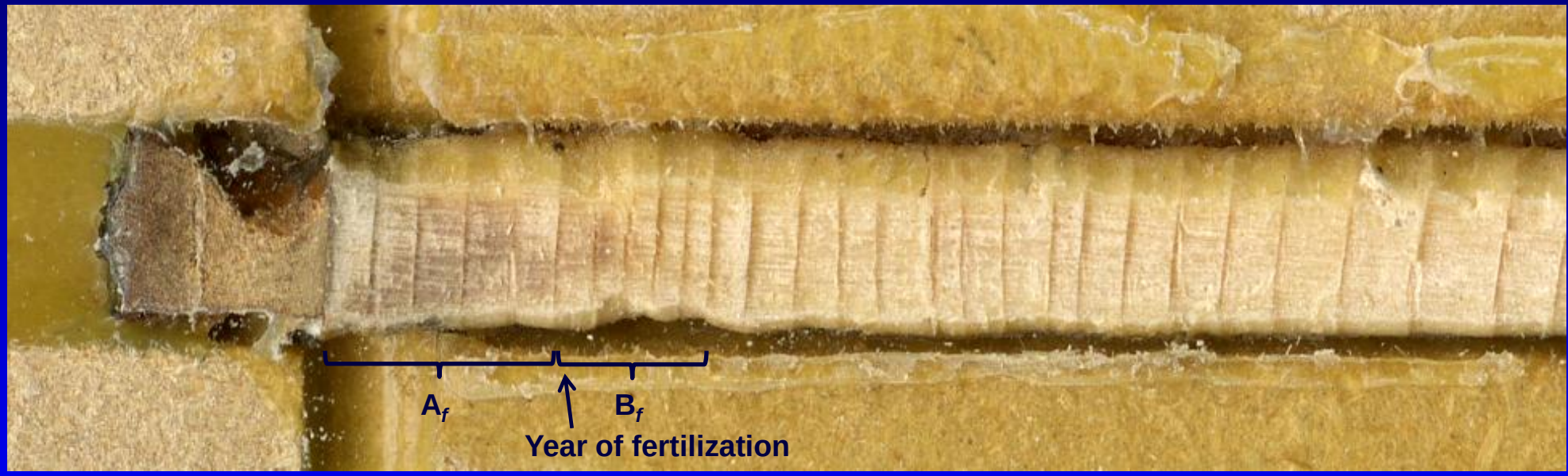
A_f = post-fertilization growth of a fertilized tree (cm)

B_f = pre-fertilization growth of a fertilized tree (cm)

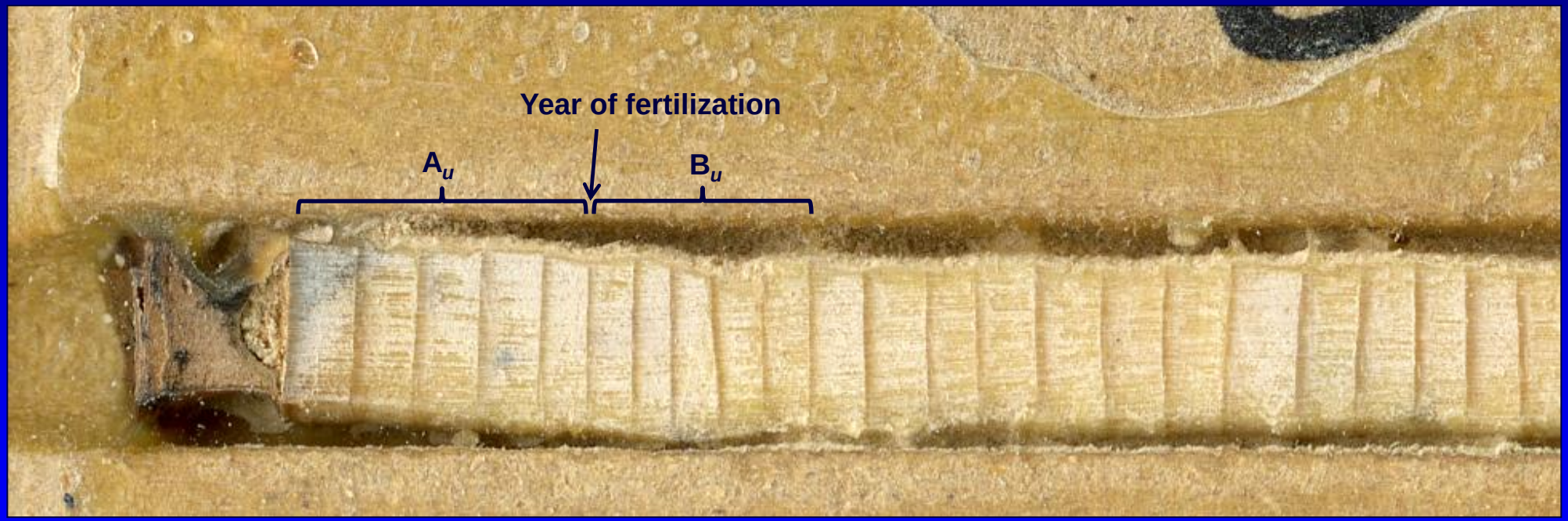
A_u = post-fertilization growth of an unfertilized tree (cm)

B_u = pre-fertilization growth of an unfertilized tree (cm)

Core measurement – fertilized



Core measurement – unfertilized



How is fertilization response estimated?

1) Relative response (%) = $av R_f$ / $av[(B_f) \cdot av(A_u/B_u)]$

2) I = $av(A_f/B_f) - av(A_u/B_u)$

where:

I = Response index (%)

Relative growth response monitoring

Disadvantages:

- No estimate of area-based growth response
- No basis for statistical inference due to restriction on randomization

Relative growth response monitoring

Advantages:

- Less expensive than area-based monitoring
- Stand and site variability can be minimized by carefully selecting individual sample trees (QMD?)
- By using increment cores, measurement of pre-fertilization growth for fertilized and unfertilized trees may improve estimation of E_f
- Reliable estimate of % growth response may be achievable
- For mixed species stands, response estimates may be obtained for different species