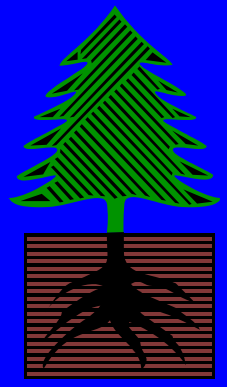
Nutrient Dynamics of the Mallory Creek IFTNC Site



By:
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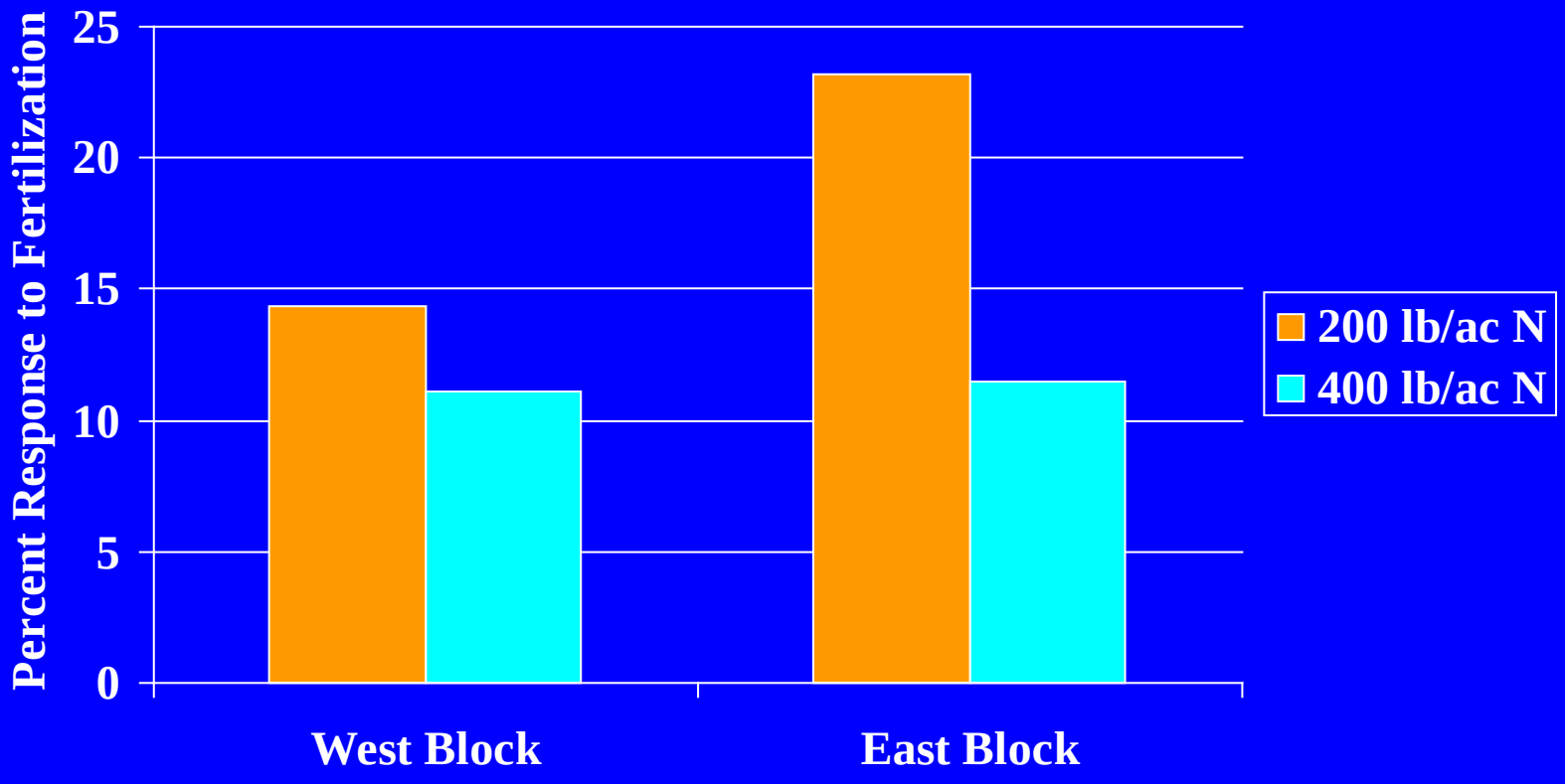
Mallory Creek:
A Case Study

Mallory Creek Douglas-fir Trial Site

- Cedar-ginger habitat type
- Schist rock type
- 1999 Stand Characteristics:
  - Stand age 50 years
  - 320 trees per acre
  - 72 ft average height
  - 12 in average dbh
  - 240 ft^2/ac average BA
  - Average species composition
    - 85.0% Douglas-fir
    - 10.0% grand fir
    - 3.5% western white pine
    - 1.5% western larch

Six-Year Volume Response (%) to Nitrogen Fertilization



Activities at Mallory Creek

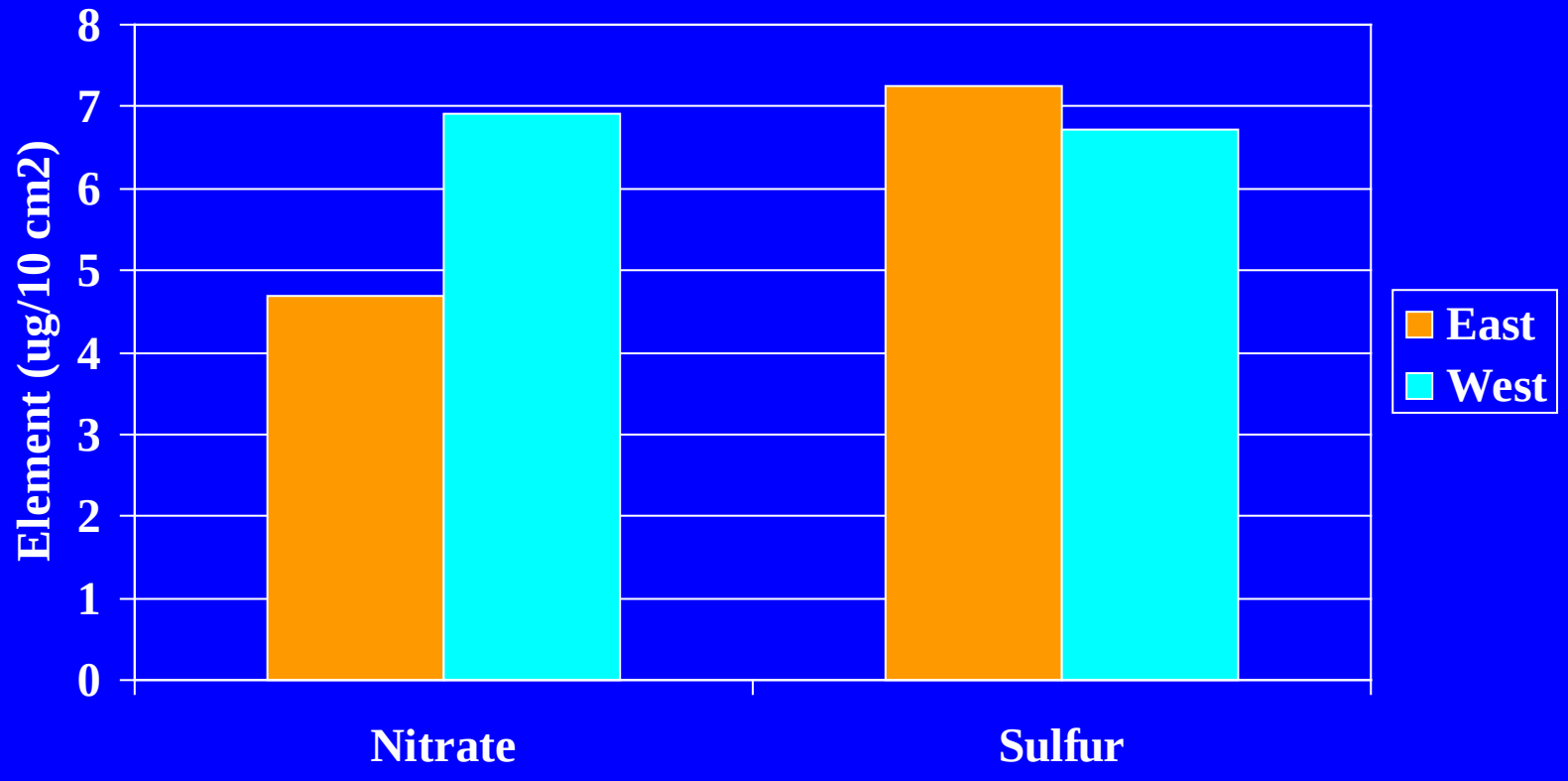
- **Soil Nutrient Availability Testing**
  - Three soil pits with ion exchange resin membranes were established in each block in June of 1999
  - Membranes were replaced every two weeks through October
- **Nutrient Model Data Collection**
  - Fifteen years of growth data available from IFTNC records
  - Foliar nutrient sampling of 16 trees periodically during 1999 growing season
  - Clip plots, woody debris surveys, and forest floor sampled during 1999 growing season
  - Litter collected periodically during growing season
  - Soil and rock samples taken

Soil Nutrient Availability Results

Soil Nutrient Assessment

- Six soil pits were established across the study area
  - Organic horizon
  - Ash cap
  - Mixed horizon
  - Residual soil

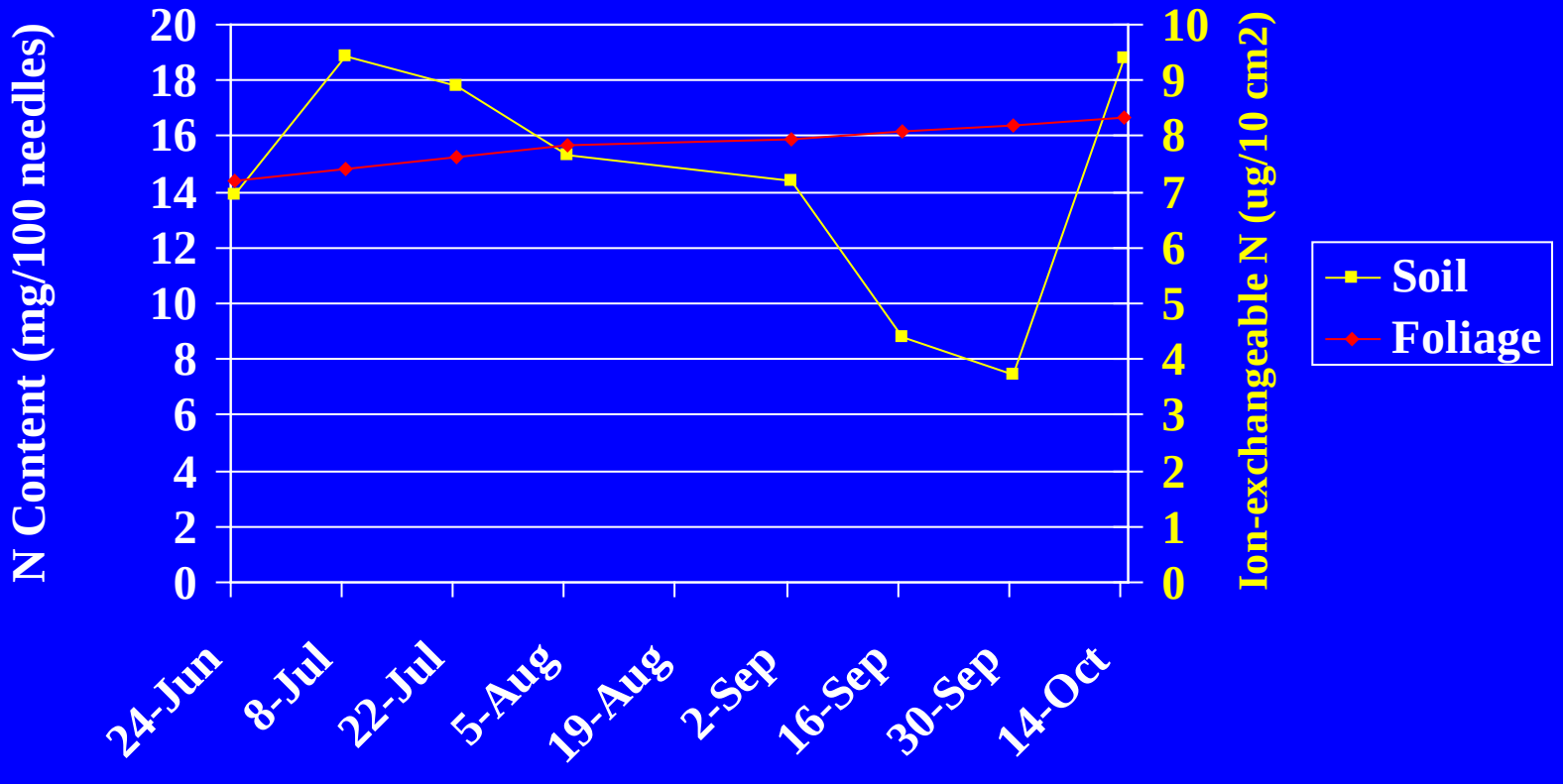
Ion Exchangers: Differences Between East and West blocks for Nitrate and Sulfur



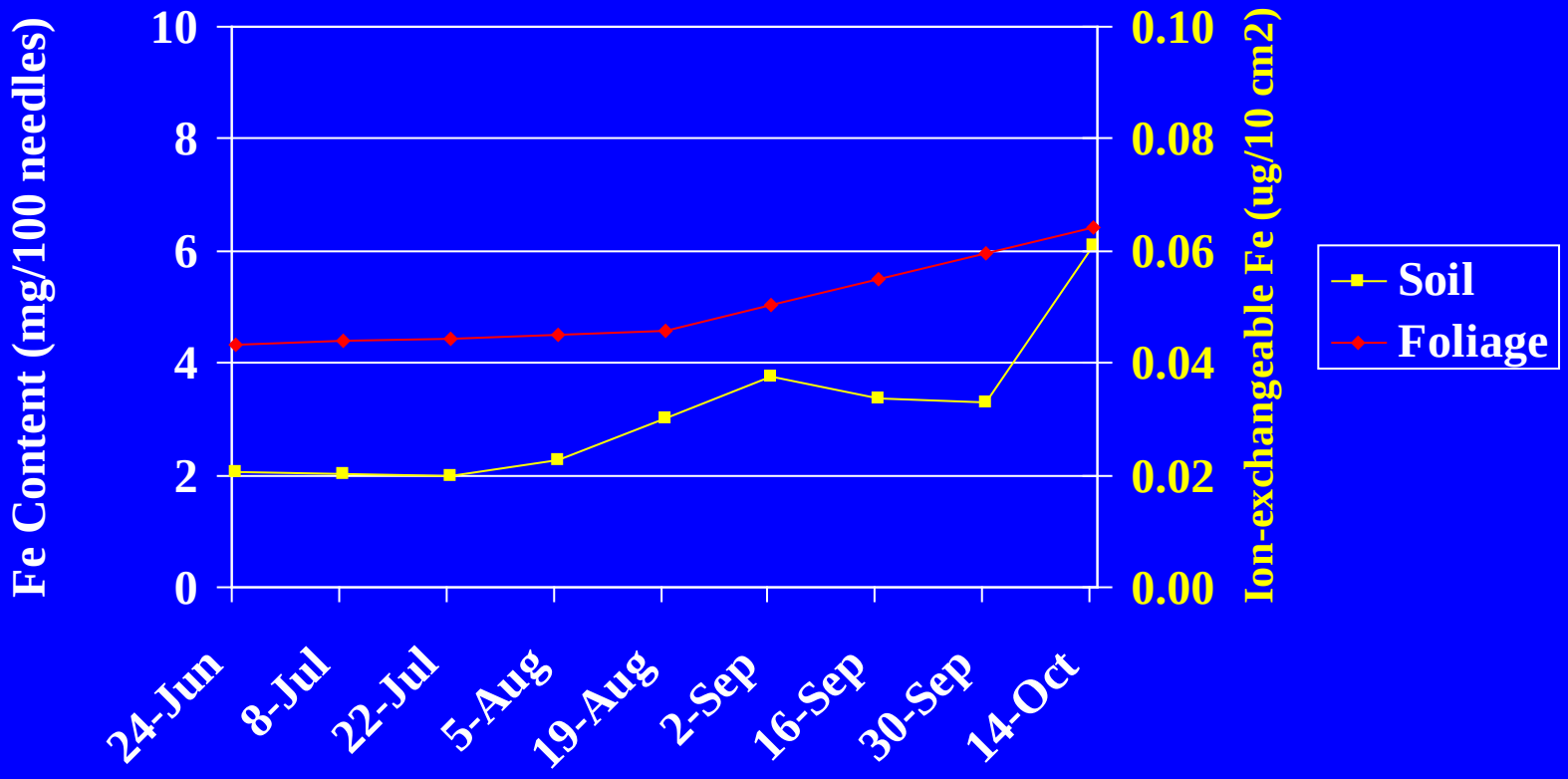
Forms of Nutrient Uptake

- Mass Flow: Evapotransporation of vegetation drives the movement of nutrients through soil to roots in soil solution
- Diffusion: As elements are taken up by plant roots, a concentration gradient develops and elements move from an area of higher concentration (soil) to an area of lower concentration (rhizosphere)
- Ion exchangers can probably simulate diffusion, but not mass flow

Foliar Nitrogen Content and Soil Ion Exchange Values: Opposite Pattern



Foliar Iron Content and Soil Ion Exchange Values: Similar Pattern

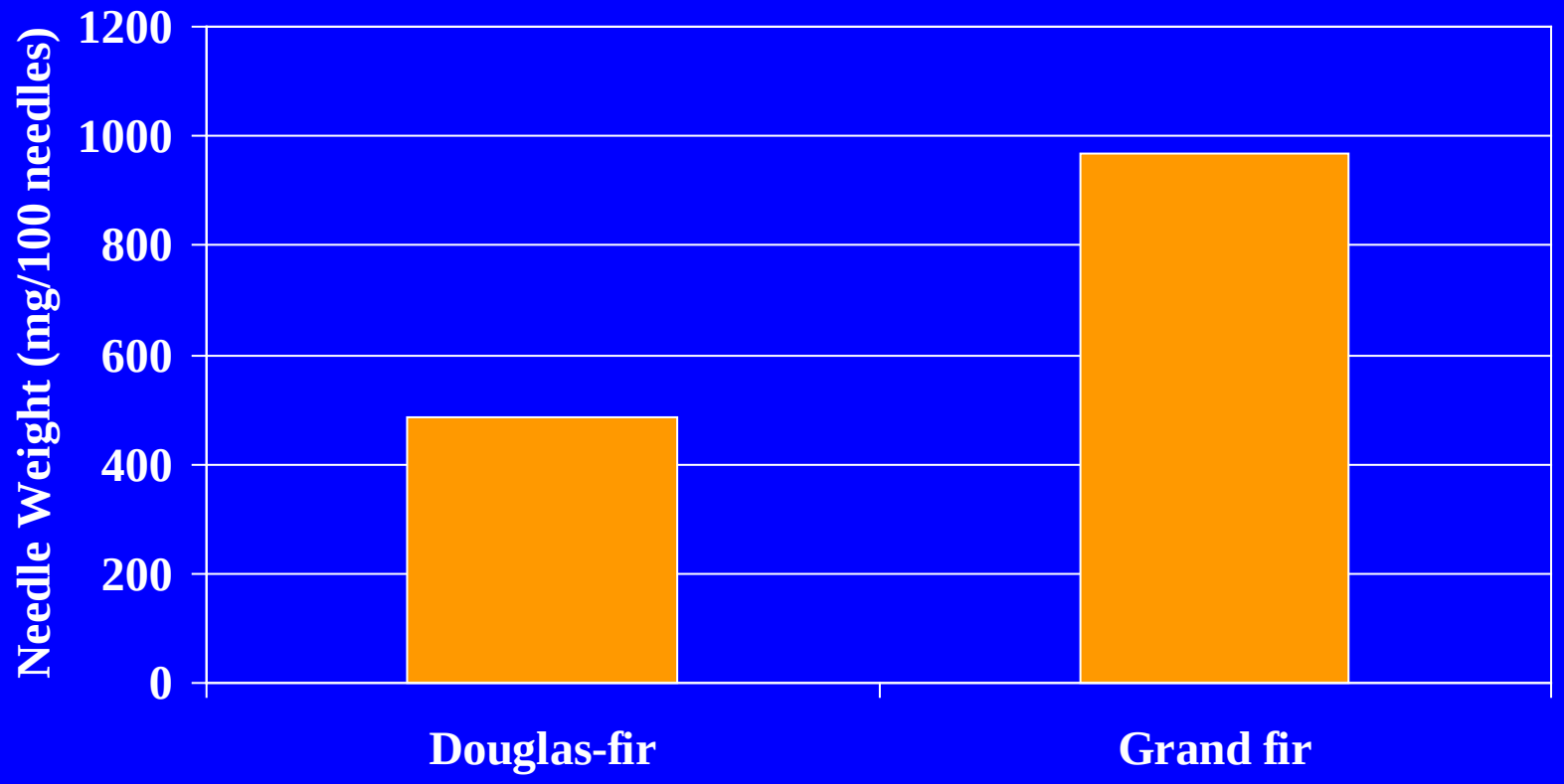


Summary: Findings Regarding Soil Ion Exchange Resins

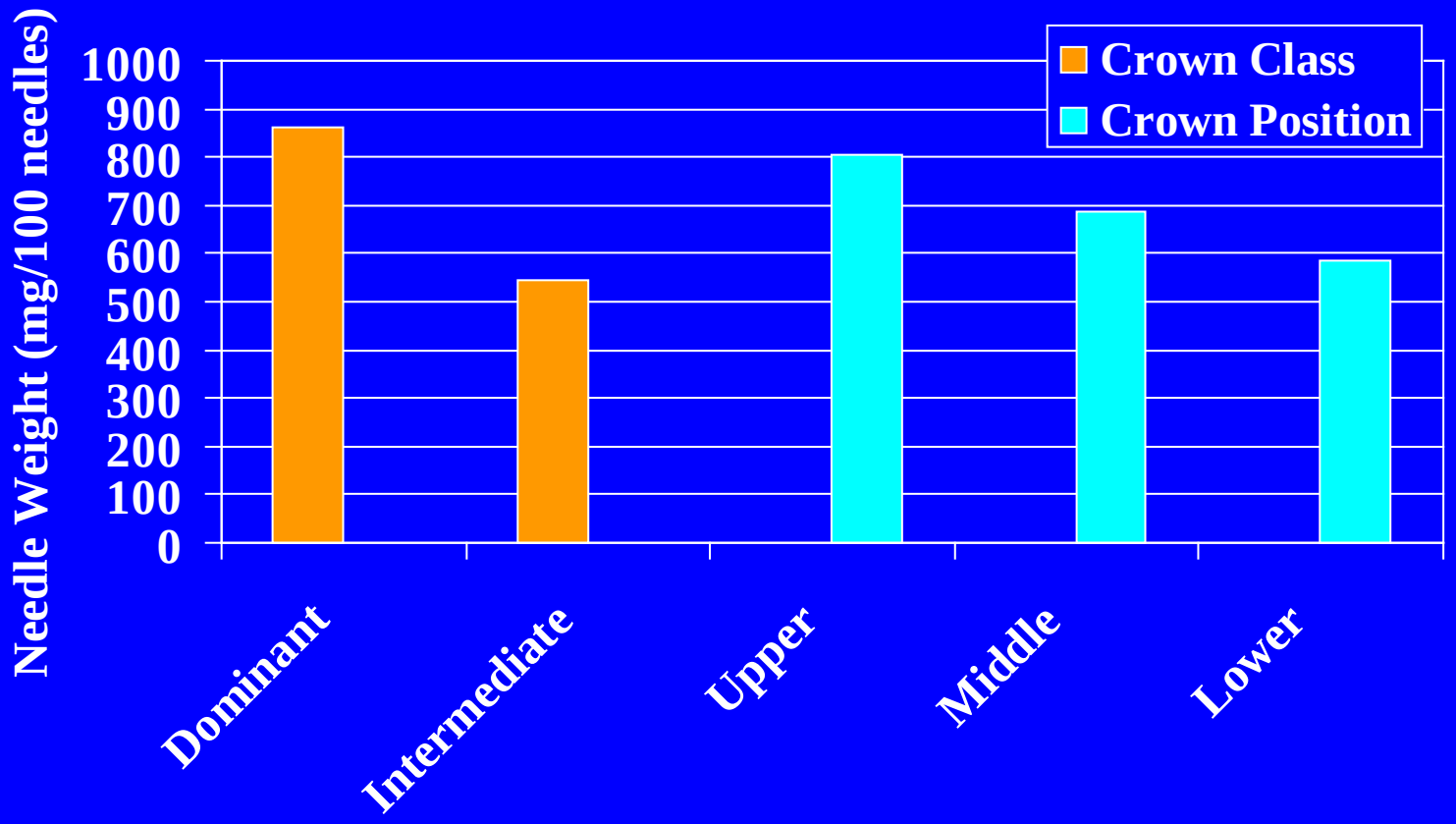
- Block effects were significant for nitrate, with less NO_3^- available on the east block.
- Soil horizon effects were significant for N, Mg, K, P, Fe, Mn and B. Findings were consistent with expectations based on mineralogical and biological soil characteristics.
- Time effects were significant for all elements. N, K, Ca, Mg and Mn adsorption rates decreased over the course of the season. P and Fe adsorption rates increased over the course of the season. Cu, S and B adsorption rates were variable.
- Findings were consistent with expectations based on seasonal moisture and temperature fluxes and plant uptake patterns.

Foliar Nutrient Content Results

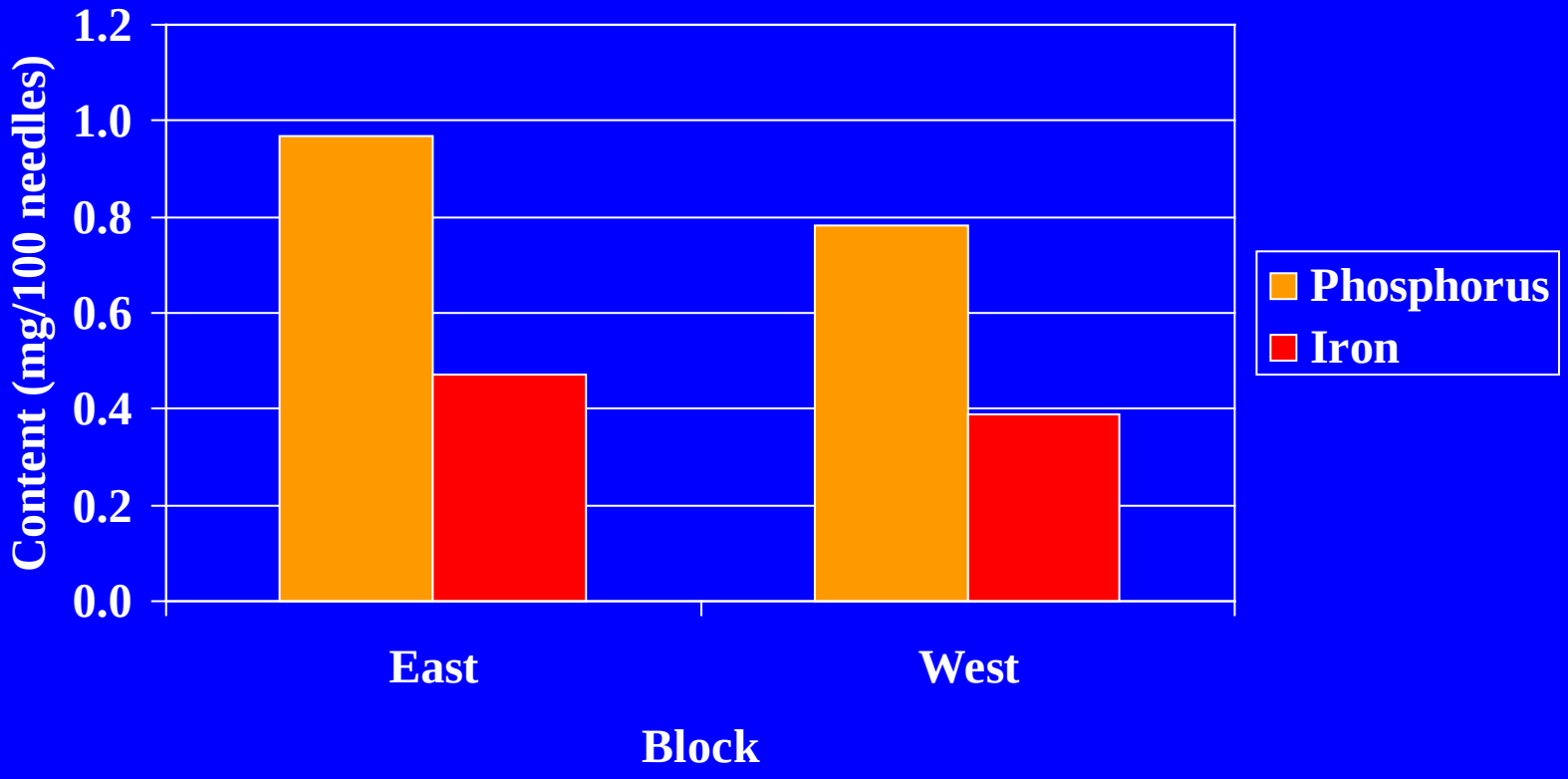
Overstory Foliage: Needle Weights By Species



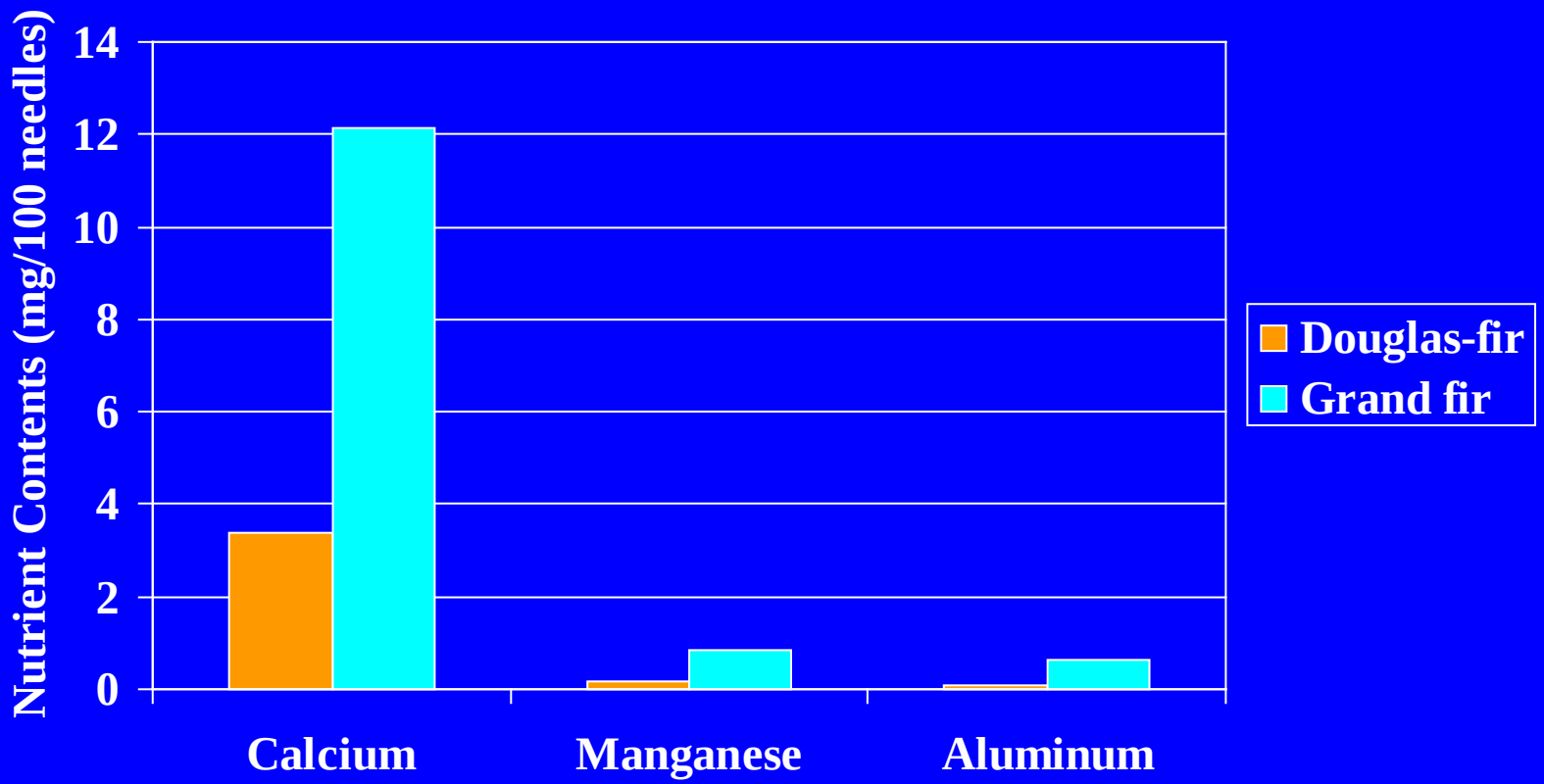
Overstory Foliage: Needle Weights by Crown Class and Crown Position



Overstory Foliage: Block Effects for Phosphorus Content



Overstory Foliage: Species Effects for Ca, Mn and Al Content



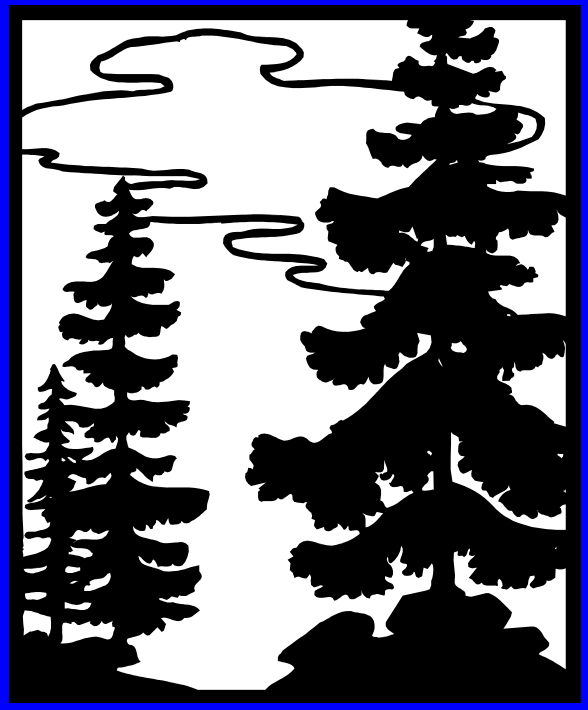
Findings Related to Crown Class, Crown Position, Time and Needle Age Class

- Crown Class: N, P, K, Mg, S, Zn, Mn, B and Al contents were significantly greater in dominant than subordinate trees
- Crown Position: N, P, K, Mg, S, Zn, Mn, B and Al contents increased from lower to upper crown
- Time and Needle Age: N, Mg, Ca, S, Mn, Fe, B and Al contents were lower in current than older foliage. P, K, Zn and Cu in current foliage were either greater or not different.
- Most findings generally reflected needle weights.

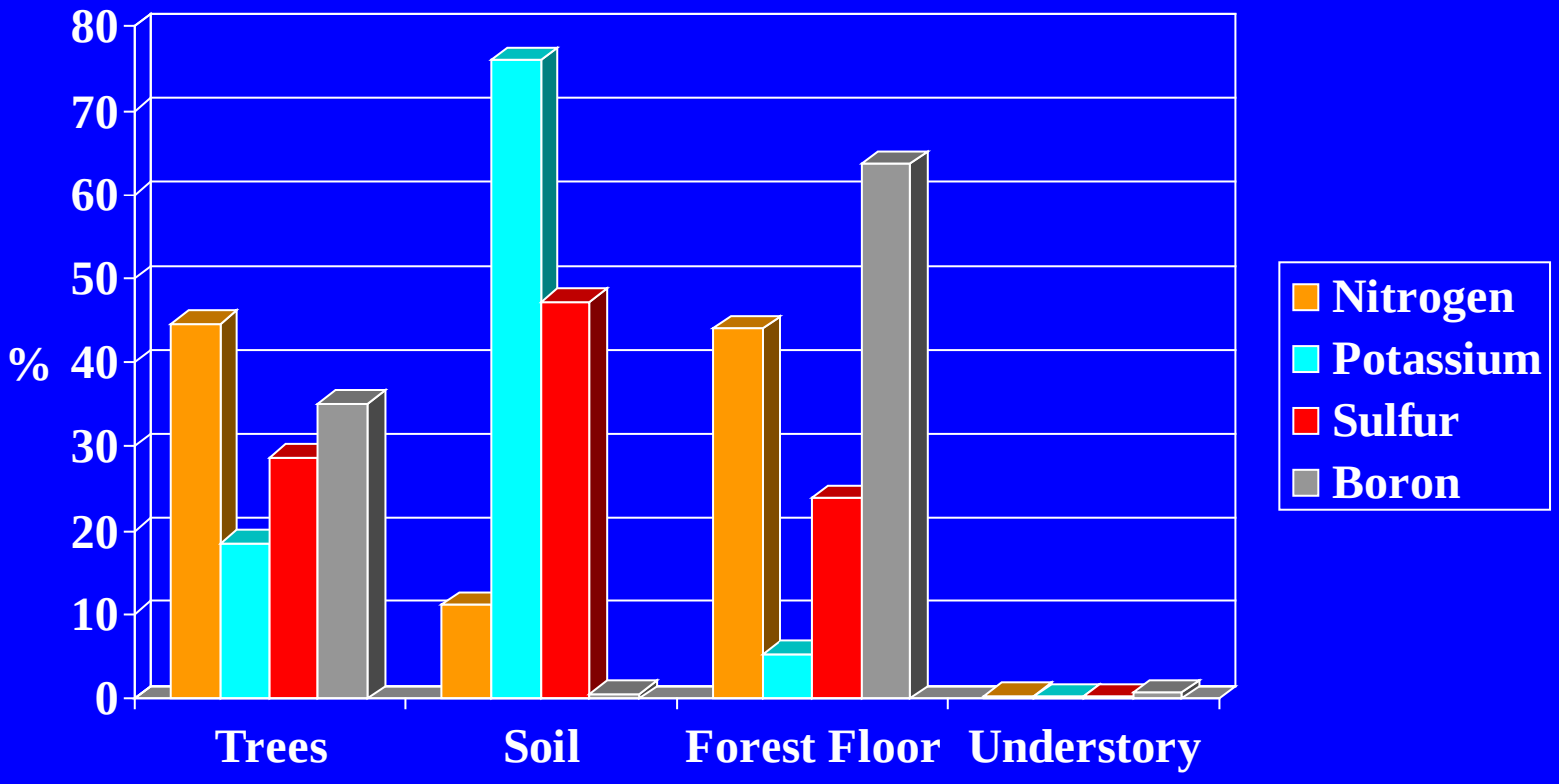
Summary: Findings Related to Past Fertilization Response

- During previous fertilization trials, the east block at the Mallory Creek site responded better than the west block.
- Soil NO_3^- availability was lower on the east block, and S tended to be greater. Foliar P, Fe, B and Cu contents were greater on the east block.
- Foliar diagnostics indicated an S-deficiency in Douglas-fir on both blocks.
- All results could help explain the past response to fertilization at the Mallory Creek site

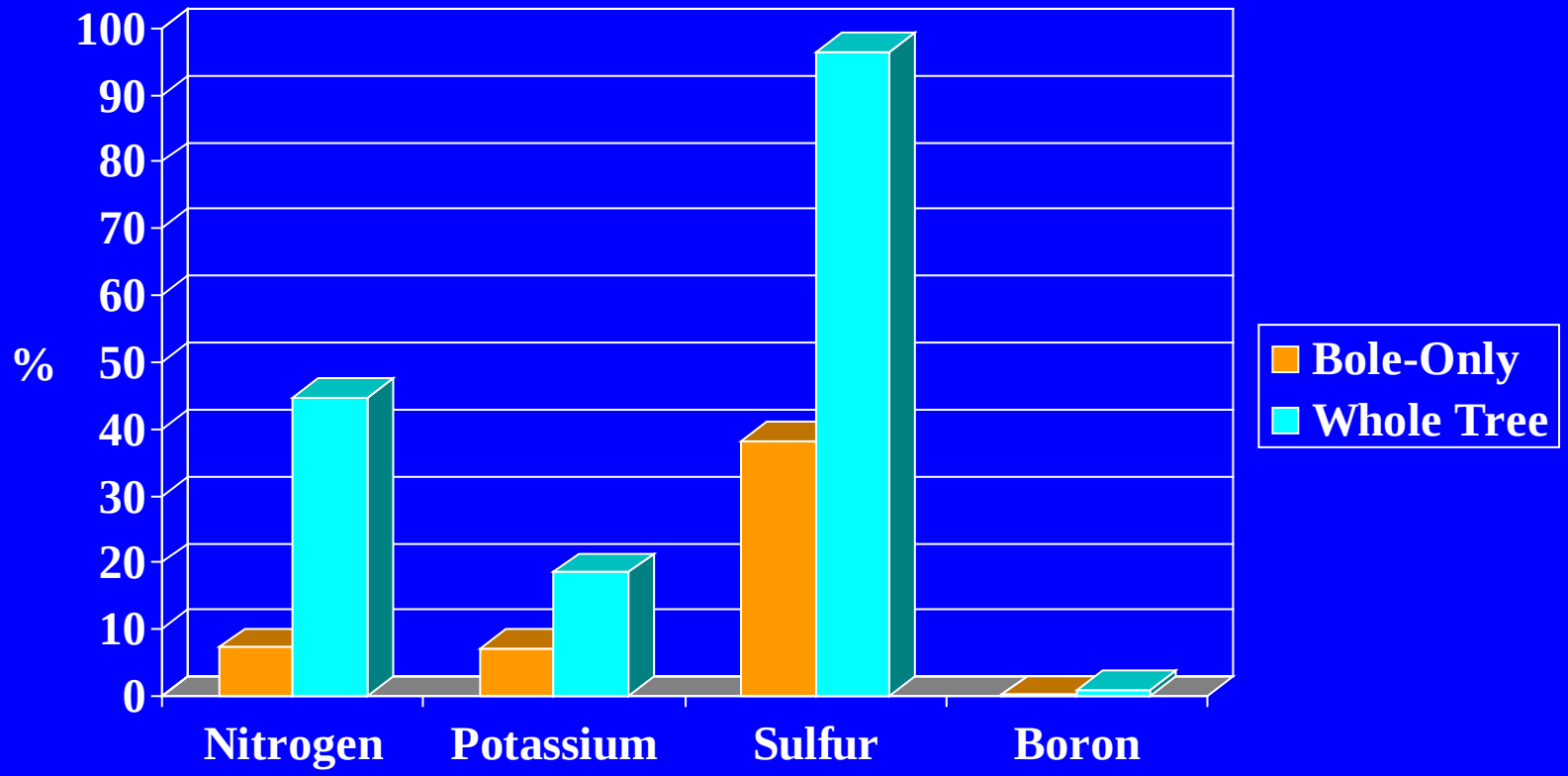
Ecosystem Components



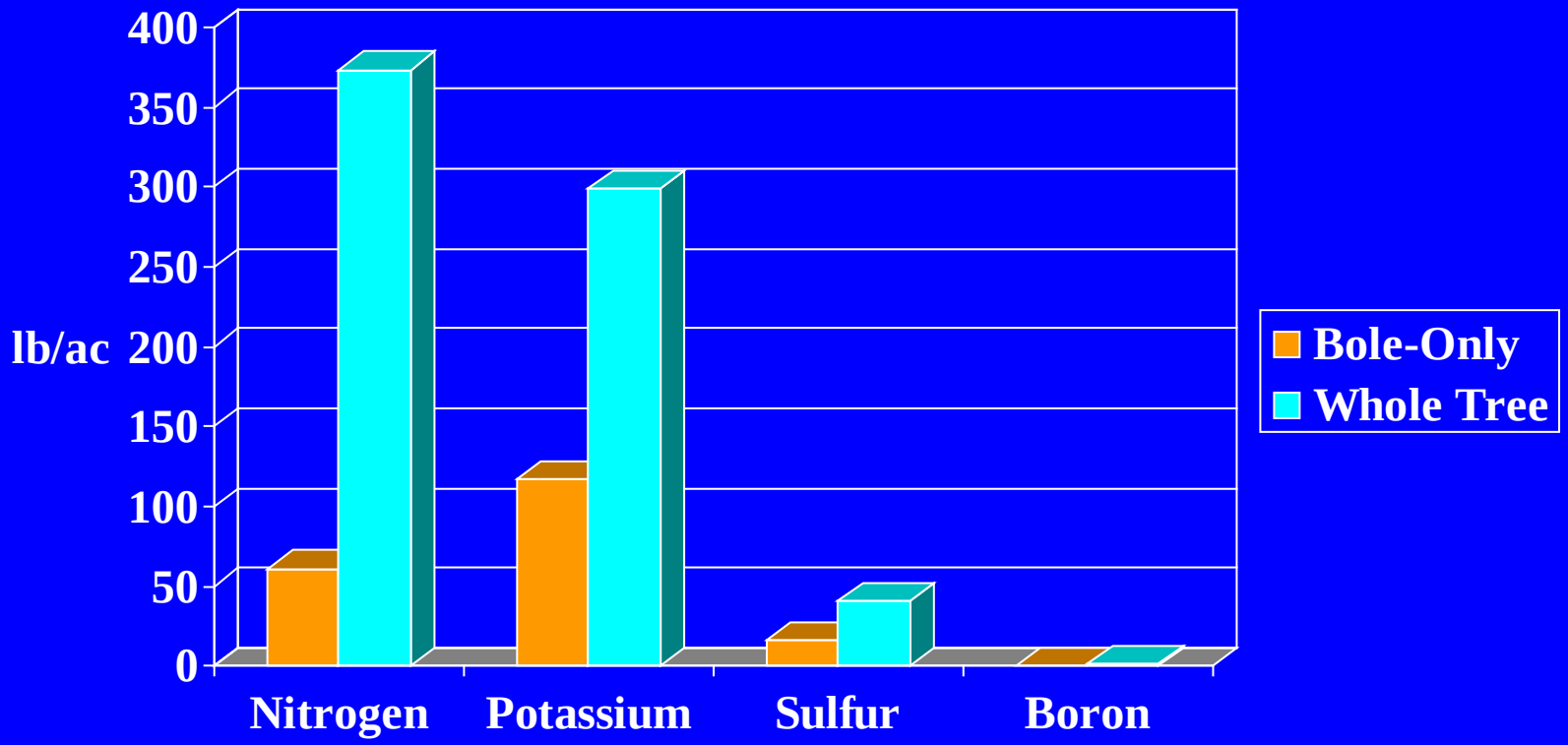
Relative Nutrient Distribution in Forest Ecosystem Components



Relative Percent Nutrient Removals for Whole Tree and Bole Only Harvest at Mallory Creek



Estimated Nutrient Removals for Whole Tree versus Bole Only Harvest at Mallory Creek



Summary : Nutrient Distribution

- Most of the nitrogen and boron was in trees and forest floor. Most of the potassium was in the soil. Sulfur was distributed between trees, soil and forest floor.
- Whole tree removal would remove approximately 6 times more N, 2.5 times more K, 3 times more S and 5 times more B than bole-only removal.

Ion Exchangers: A Comparison

Ion Exchange Membranes

- + Easy to use and process (probes are sent from Canada ready to use, and returned to them for analysis).
- + Two week intervals were useful for Mallory Creek Study
- - Two week replacement intervals may not be feasible for longer-term nutrient studies
- - Membranes are recycled, which may introduce error

Ion Exchange Capsules

- + Can be buried for long periods, some studies have gone 2-3 years.
- + We process them ourselves, giving us better quality control
- - We process them ourselves, which is lots of work

Practicality of Using Ion Exchange Resins to Predict Forest Nutrient Status and Availability

- Costs end up being about the same for both membranes and capsules
- The use of ion exchanger resins to develop a soil nutrient availability index would involve placing the resins across a variety of sites of known site quality according to a strict protocol, and developing a reference database with which to predict site quality of other sites.