20 (or more) years of change: Analysis of patterns in the BNZ long-term vegetation data

Joy Klein, Teresa Hollingsworth, & Andi Lloyd
October 5, 2006

http://www.lter.uaf.edu/bnz_map_bcef_static.cfm
QuickTime™ and a TIFF (LZW) decompressor are needed to see this picture.

Sturm et al. 2001, Nature
From Goetz and Bunn, PNAS
Research Questions

• What are the effects of climate variation on the structure and composition of boreal forest ecosystems in non-marginal sites?

• Which species/types of sites are likely to be most sensitive to future warming?
Upland white spruce

Floodplain black spruce

floodplain white spruce

http://www.lter.uaf.edu/bnz_map_bcef_static.cfm
### Results: Abundance

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| SPAN | 15 | 14 | 14 | 11 | 20 | 11 | 8  | 28 | 15 | 5  |

### Results: Growth

- FP4
- FP5
- UP3

For more details, visit [http://www.lter.uaf.edu/bnz_map_bcef_static.cfm](http://www.lter.uaf.edu/bnz_map_bcef_static.cfm)

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Welcome to the Introduction. This document covers Methods, Results: Abundance, Results: Growth, and Conclusions. Each section delves into specific aspects of the study, providing comprehensive insights and conclusions.

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### Methods

- Description of experimental setup
- Data collection procedures
- Analysis methods

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### Results: Abundance

- Observations from 1975 to 2003
- Data classification by sites
- Analysis of abundance trends

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### Results: Growth

- Growth metrics for FP4, FP5, and UP3
- Comparative analysis of growth rates
- Insights into growth patterns over the years

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### Conclusions

- Summary of findings
- Implications of the results
- Recommendations for future research

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For a detailed understanding of the study, please refer to the supplementary materials available online.
Data issues:

- Limited methods/metadata available
- Lack of precision
- Species not classified according to what we now recognize as functional groups.
- Sampling design may not have captured clumpy distribution of tall shrubs.
1. Trend differs than expected successional trajectory.
2. Trend is synchronous among sites.
3. Trend is consistent with known climate variation.
Analysis methods:

• Calculated abundance at each sampling time for each species per replicate site.
  – % cover (all species)
  – # stems (tall shrubs & trees; usually aggregated across size classes)

• Calculated diameter growth (from tree-band data) for each species
  – Mean annual growth per site
  – Annual growth per individual tree

• Analyzed trends in abundance/growth
  – Qualitative analysis of trends (consistency among sites, consistency over time)
  – Correlations with Fairbanks climate data (winter, summer, and annual temperature and precipitation)
Patterns of change over time are correlated among sites for <50% of species.

Alnus crispa
Results: Species abundance

- Patterns of change over time are uncorrelated among sites for many species.
- Deciduous shrub abundance has declined over time at some sites.

![Graph showing changes in deciduous shrub abundance over time for White Spruce and Black Spruce.]
Results: Species abundance

**Introduction**

**Methods**

Results: **Abundance**

Results: **Growth**

**Conclusions**
Results: Species abundance

Viburnum edulis

Year


FP4A
FP4B
FP4C
UP3A
UP3B
UP3C

Results: Abundance

Introduction
Methods

Results: Growth

Conclusions
Results: Species abundance

*Rosa acicularis*

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**Methods**

**Results:**

- Growth

**Conclusions**
Results: Species abundance

Alnus crispa: FP4A

Alnus tenufolia: FP4B

Alnus crispa: UP3B

Alnus crispa: UP3C

Stem size class

Introduction | Methods | Results: Abundance | Results: Growth | Conclusions
Results: Species abundance

- Patterns of change over time are uncorrelated among sites for many species.
- Deciduous shrub abundance has declined over time at most sites.
- Total canopy cover declined at FP5; no black spruce recruitment at FP5B (the “turning point” site).
Results: Species abundance

- Patterns of change over time are uncorrelated among sites for many species.
- Deciduous shrub abundance has declined over time at most sites.
- Total canopy cover declined at FP5.

- **Seedlings of deciduous trees have become less abundant over time at most sites.**
Results: Species abundance

- Patterns of change over time are uncorrelated among sites for many species.
- Deciduous shrub abundance has declined over time at most sites.
- Total canopy cover declined at FP5.
- Seedlings of deciduous trees have become less abundant over time at most sites.

- Abundance of moss (especially *Hylocomium*) and *Peltigera* lichens have declined over time.
Results: Species abundance

% cover

Introduction  Methods  Results: Abundance  Results: Growth  Conclusions
Patterns of change over time are uncorrelated among sites for many species. Deciduous shrub abundance has declined over time at most sites. Seedlings of deciduous trees have become less abundant over time at most sites. Total canopy cover declined at FP5. Moss abundance has declined over time.

- *Salix glauca* abundance spiked in 1993...
Only 1/3 of possible correlations were significant; 11 of those with 5-year mean of summer precipitation, which itself has a linear trend.
• Abundance of the remaining species was correlated with various measures of temperature.

Black spruce seedlings

**FP5C**

- Abundance of the remaining species was correlated with various measures of temperature.
Results: Species abundance & climate

- Only 1/3 of possible correlations were significant; 11 of those with summer precipitation.
- Tree abundance correlated with temperature:
  - Black spruce (+summer, +fall)
  - White spruce (+summer)
  - Poplar (+annual, +fall)
  - Aspen (-annual, +winter, -fall)
  - Willow (+annual)
Results: Growth

- RGR was highly variable among sites.
Results: Growth

- RGR was highly variable among sites.

- Climate response varied among sites.

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![Graph showing relationship between summer precipitation and average summer temperature for Black spruce (FP5C) and White spruce (FP3C).]
Results: Growth

- RGR was highly variable among sites.
- Climate response varied among sites.
- Climate response varied among individual trees.

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Conclusions

- Fine-scale heterogeneity is important
  - Site to site
  - Tree to tree
- Largest changes in composition occurred between late 1990s and early 2000s:
  - Reduction in deciduous shrubs & tree seedlings
  - Reduction in bryophytes, esp. *Hylocomium*, and *Peltigera* lichens
  - Reduction in *Linnea borealis*
  - Reduction in overall tree cover
- Time series still too short to fully document relationship with climate.
- Growth response to climate highly variable.