Relationship between Stand Productivity and Soil Fertility

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Introduction

- Soil fertility is closely associated with underlying parent material (rock type).
- An understanding of site soil fertility is helpful in assessing stand productivity and in determining fertilizer prescriptions.
- Soil fertility management is key to long-term sustainable stand productivity.

Materials and Methods

- Stand and soil data are from natural soils in Idaho, Montana, Oregon and Washington

  - Douglas-fir Sites: 90 stands
  - Forest Health Sites: 31
  - Seedling Sites: 10
  - Umatilla Sites: 9
  - Okanagon Sites: 8
  - Klickitat Sites: 6
  - Total stands: 154

Materials and Methods

- Rock Type as Indicator of Site Fertility
- Rock Type Distribution among Stands

  - Basalt: 48 (41 DF) stands
  - Granite: 29 (25 DF)
  - Mixed: 27 (24 DF)
  - Metasedimentary: 32 (31 DF)
  - Total stands: 136 (121 DF Stands)

Materials and Methods

- Stand Productivity Variables:
  - Annual stand BA growth (%)
  - Annual stand VOL growth (%)
  - Douglas-fir stand annual BA growth (%)
  - Douglas-fir stand annual VOL growth (%)

Materials and Methods

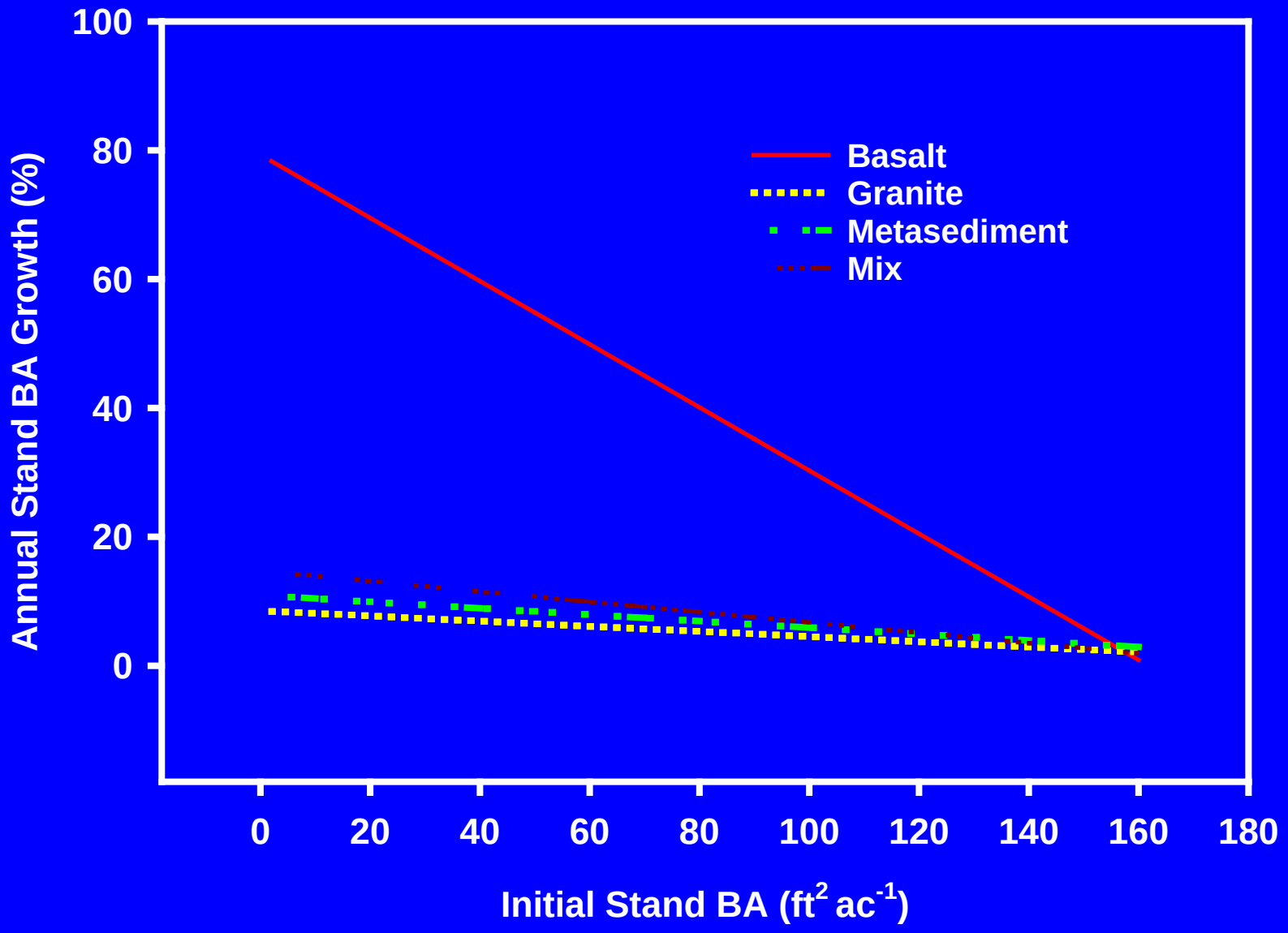
- SAS was used in statistical analyses
- ANOVA was used to test rock type differences in stand growth variables
- Stand growth was compared among rock types
- Weibull function was used to smooth relative distribution of stands over a stand productivity variable

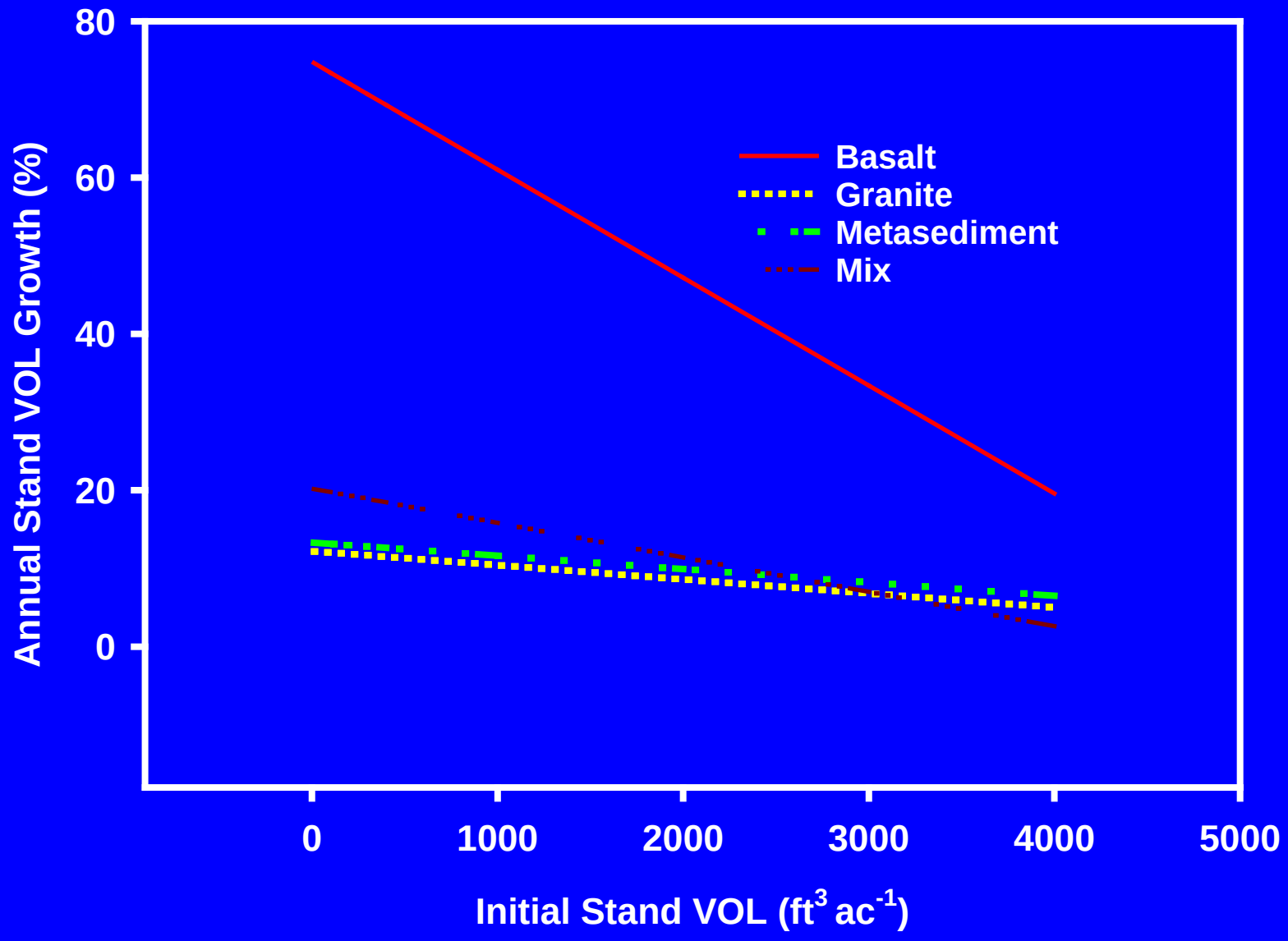
Results

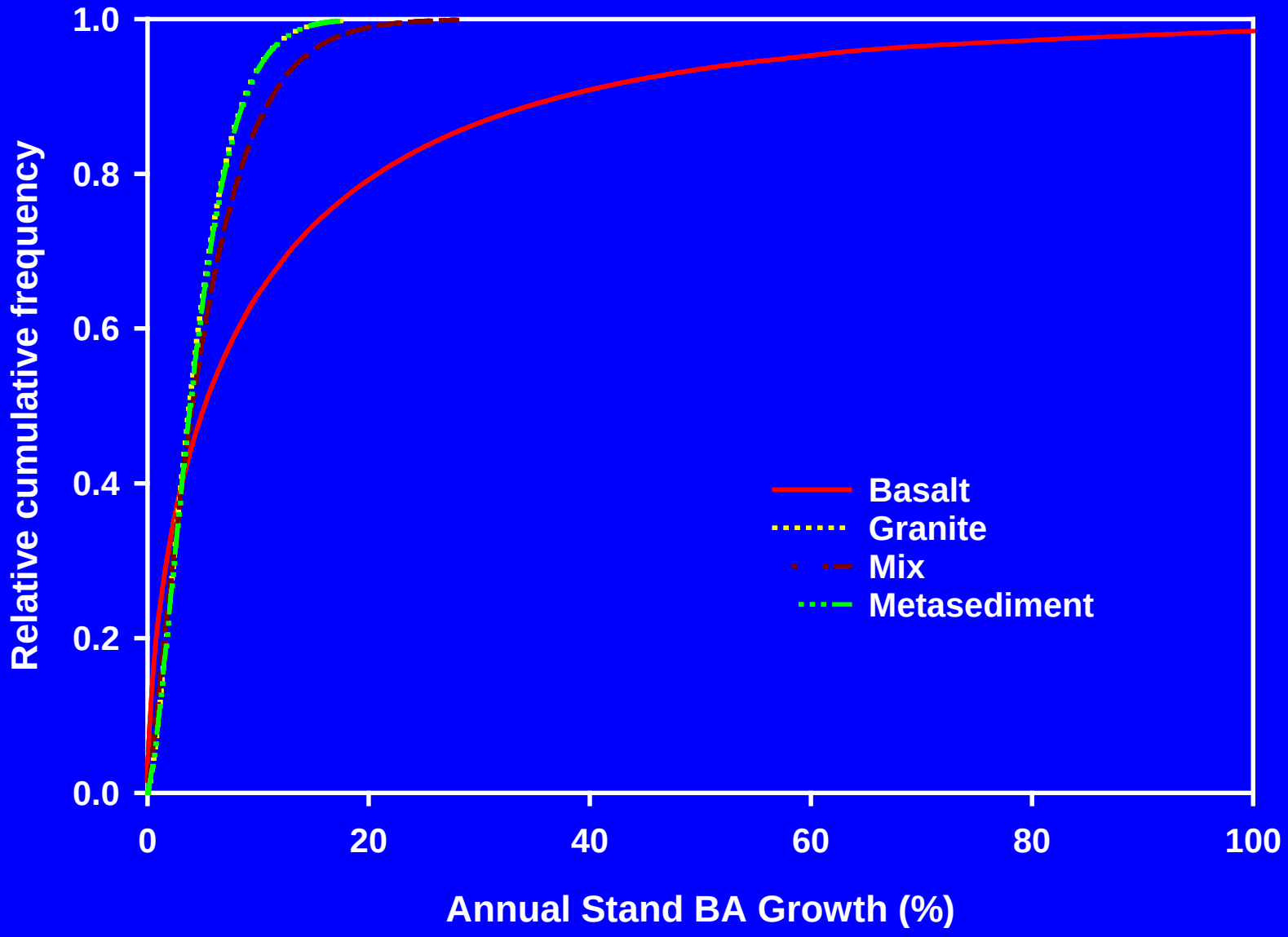
- Annual stand BA and VOL growth:
  - DF annual stand VOL growth are significantly different among rock types at the 90% level
  - No clear differences in DF annual stand BA growth among rock types

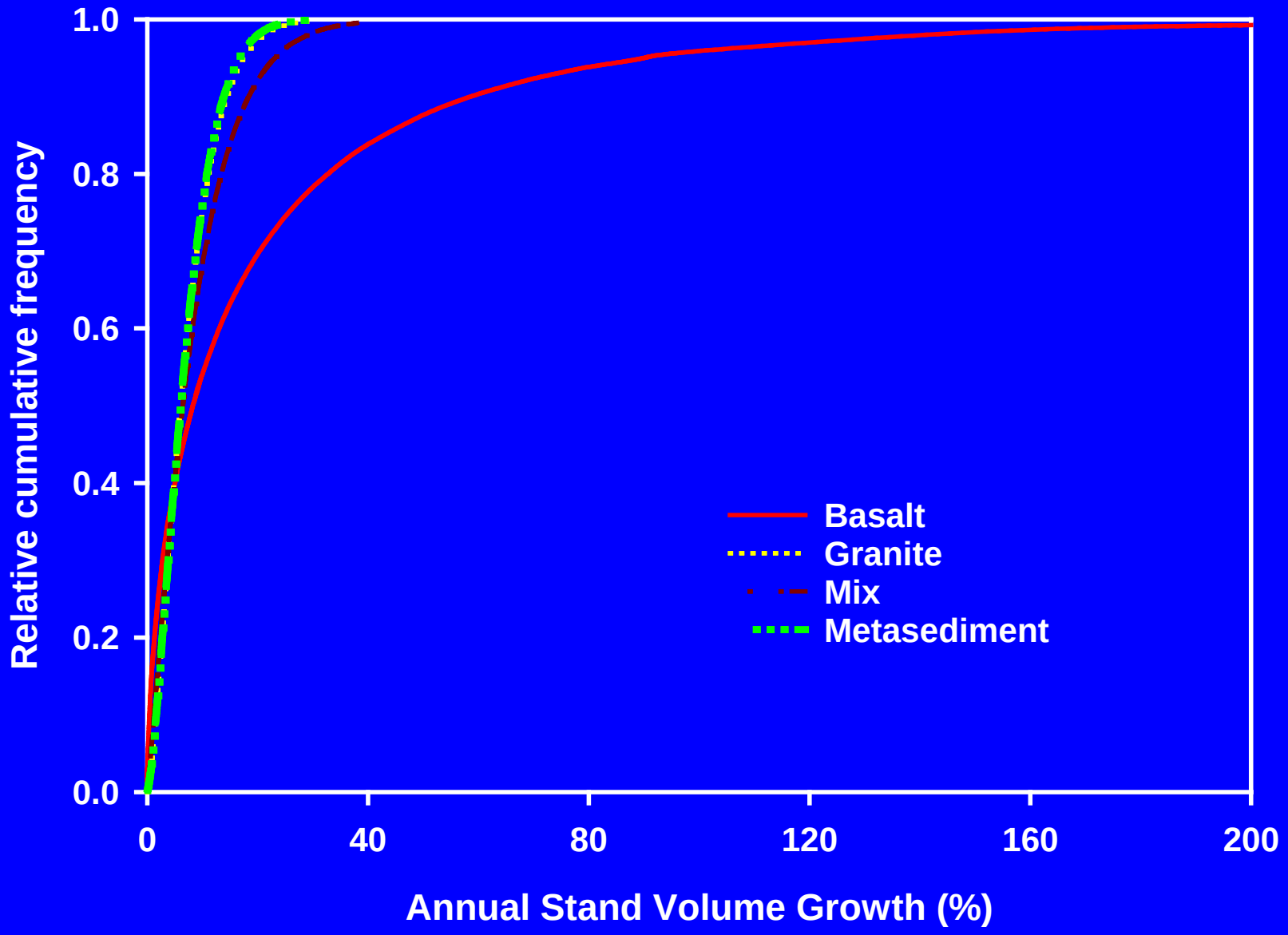
Comparison of Percentage Change (%) in Stand Growth Means Among Rock Types

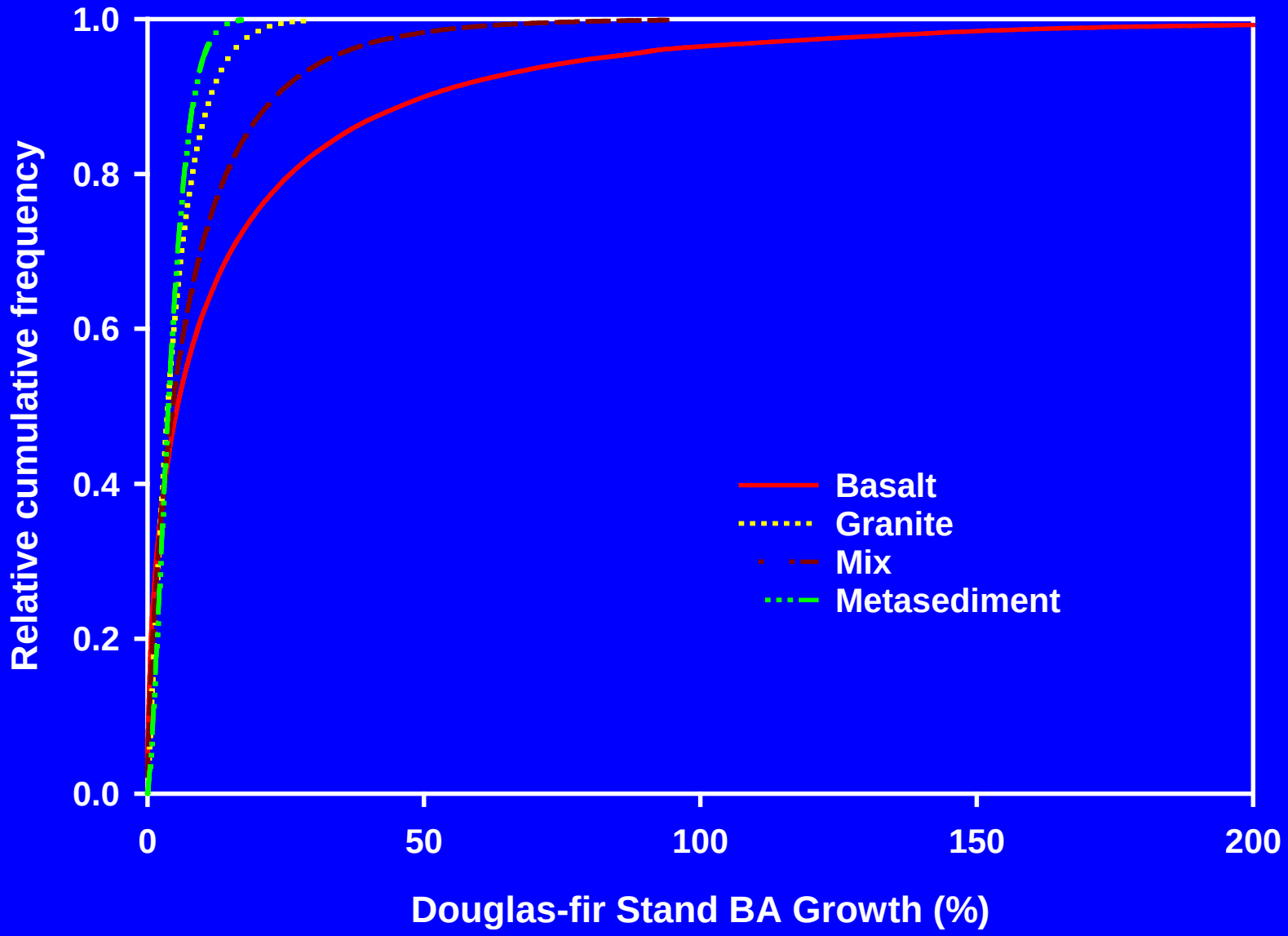
Rock type	BA	VOL	BA (DF)	VOL (DF)
Basalt	18.3a	27.8a	27.6a	33.1a
Granite	4.4b	7.1b	5.0a	7.1b
Metasediment	4.5b	7.0b	4.3a	6.7b
Mixed	5.2b	8.4b	10.1a	11.2ab

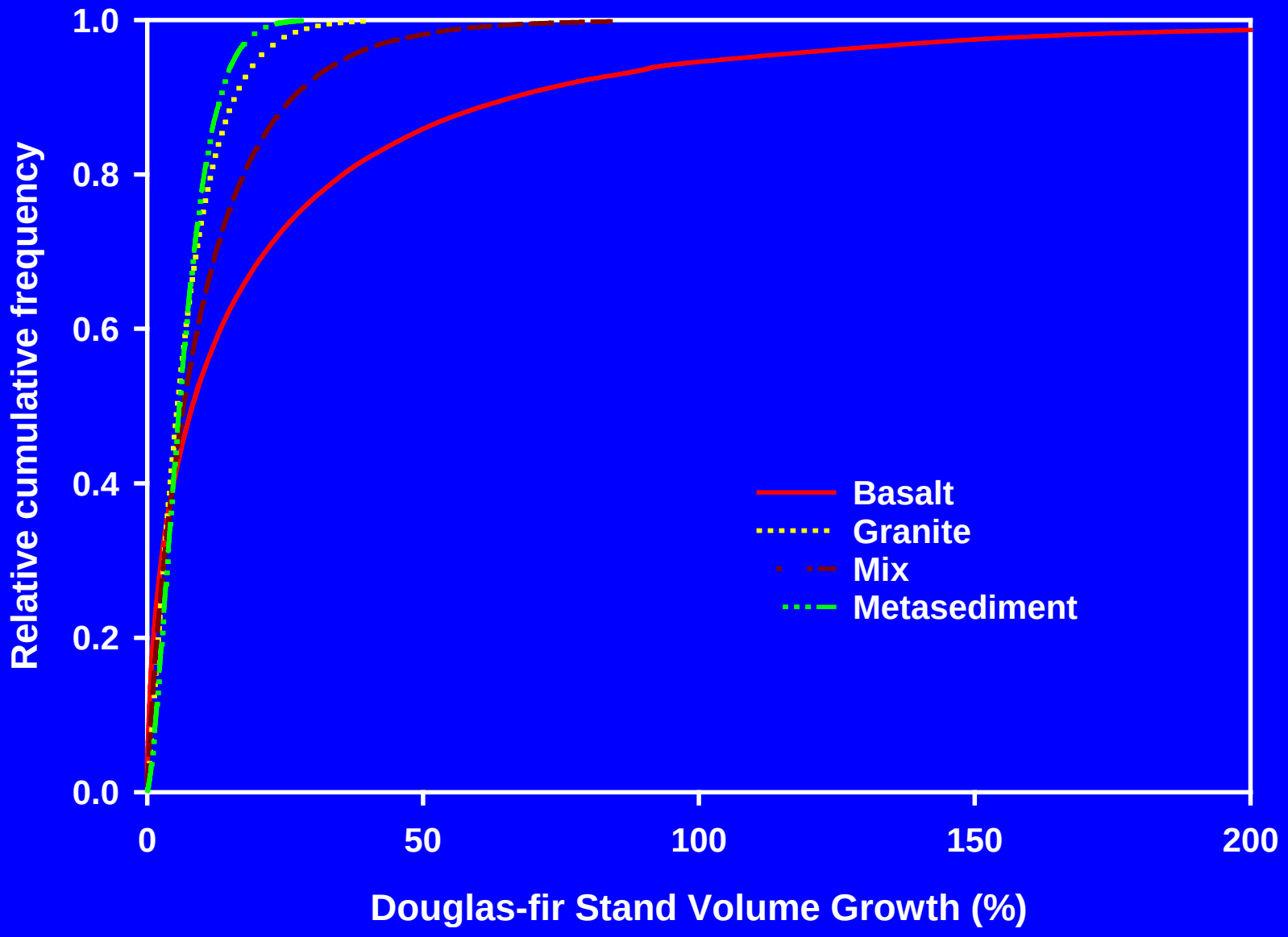

Annual Stand BA Growth (%)
100
80
60
40
20
0
Basalt
Granite
Metasediment
Mix
0
20
40
60
80
100
120
140
160
180
Initial Stand BA (ft2 ac-1)


Annual Stand VOL Growth (%)
80
60
40
20
0
Basalt
Granite
Metasediment
Mix
0
1000
2000
3000
4000
5000
Initial Stand VOL (ft3 ac-1)

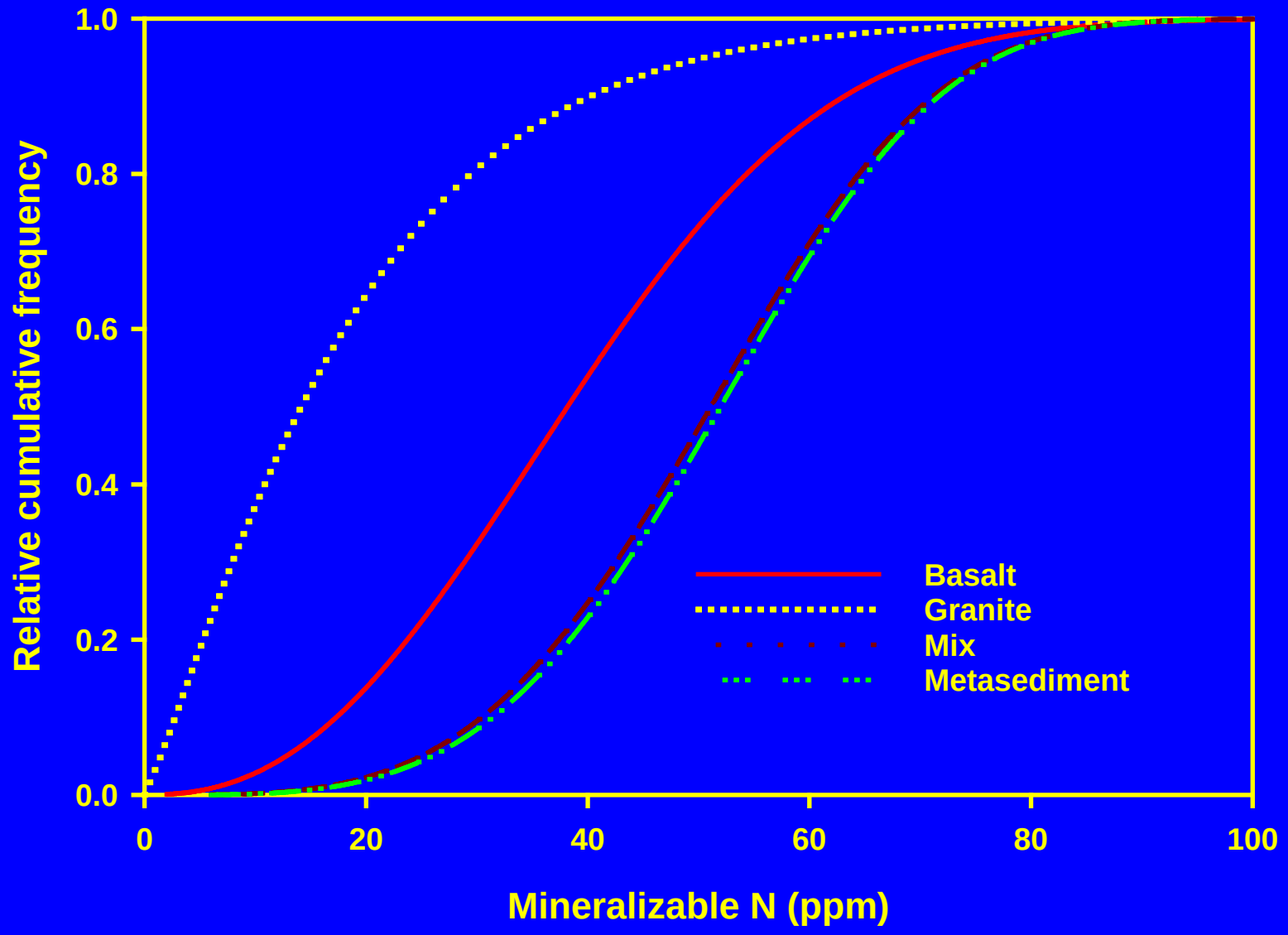

1.0
0.8
0.6
0.4
0.2
0.0
Relative cumulative frequency
0
20
40
60
80
100
Annual Stand BA Growth (%)
Basalt
Granite
Mix
Metasediment

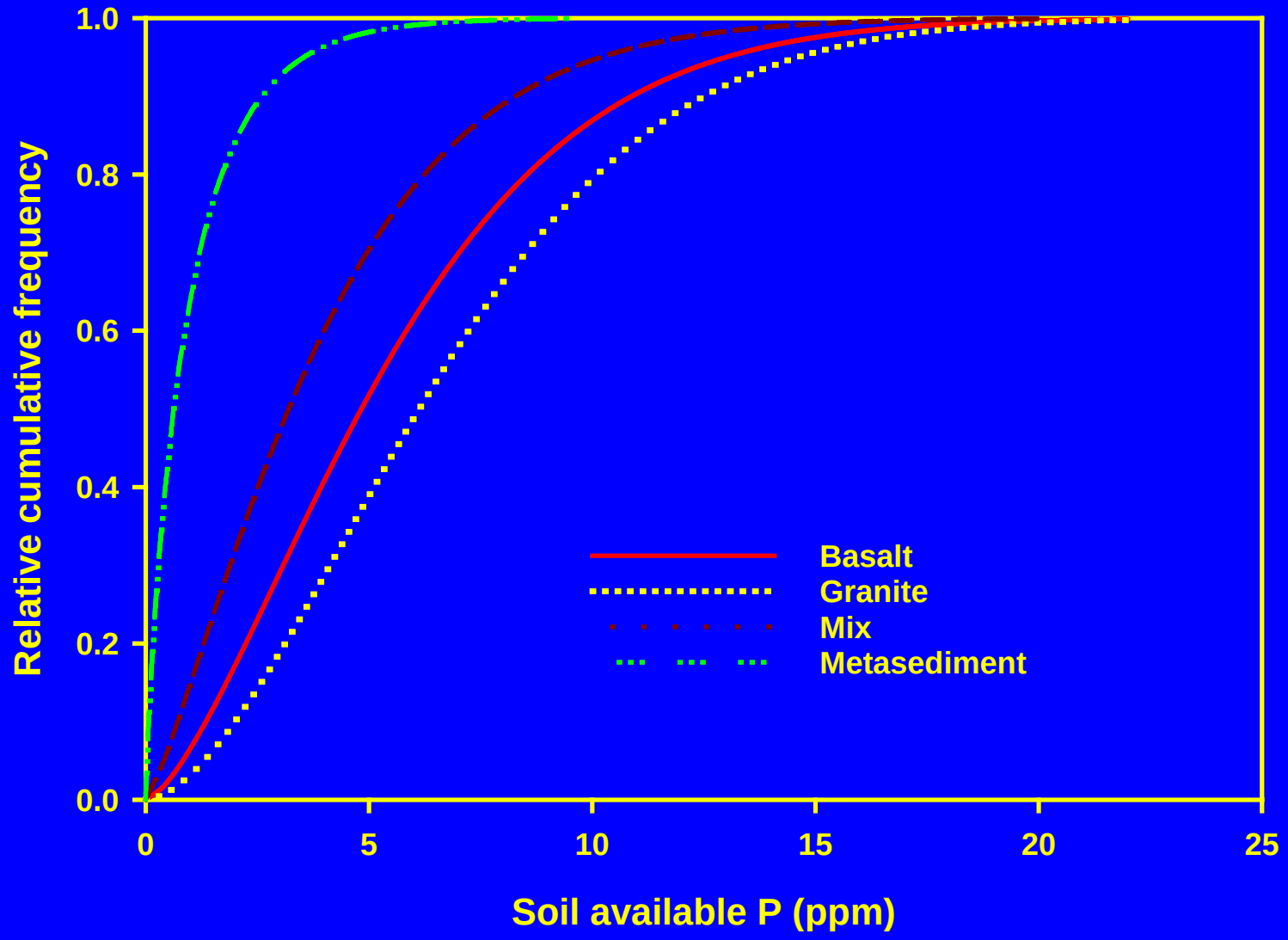

1.0
0.8
0.6
0.4
0.2
0.0
Relative cumulative frequency
0
40
80
120
160
200
Annual Stand Volume Growth (%)
Basalt
Granite
Mix
Metasediment

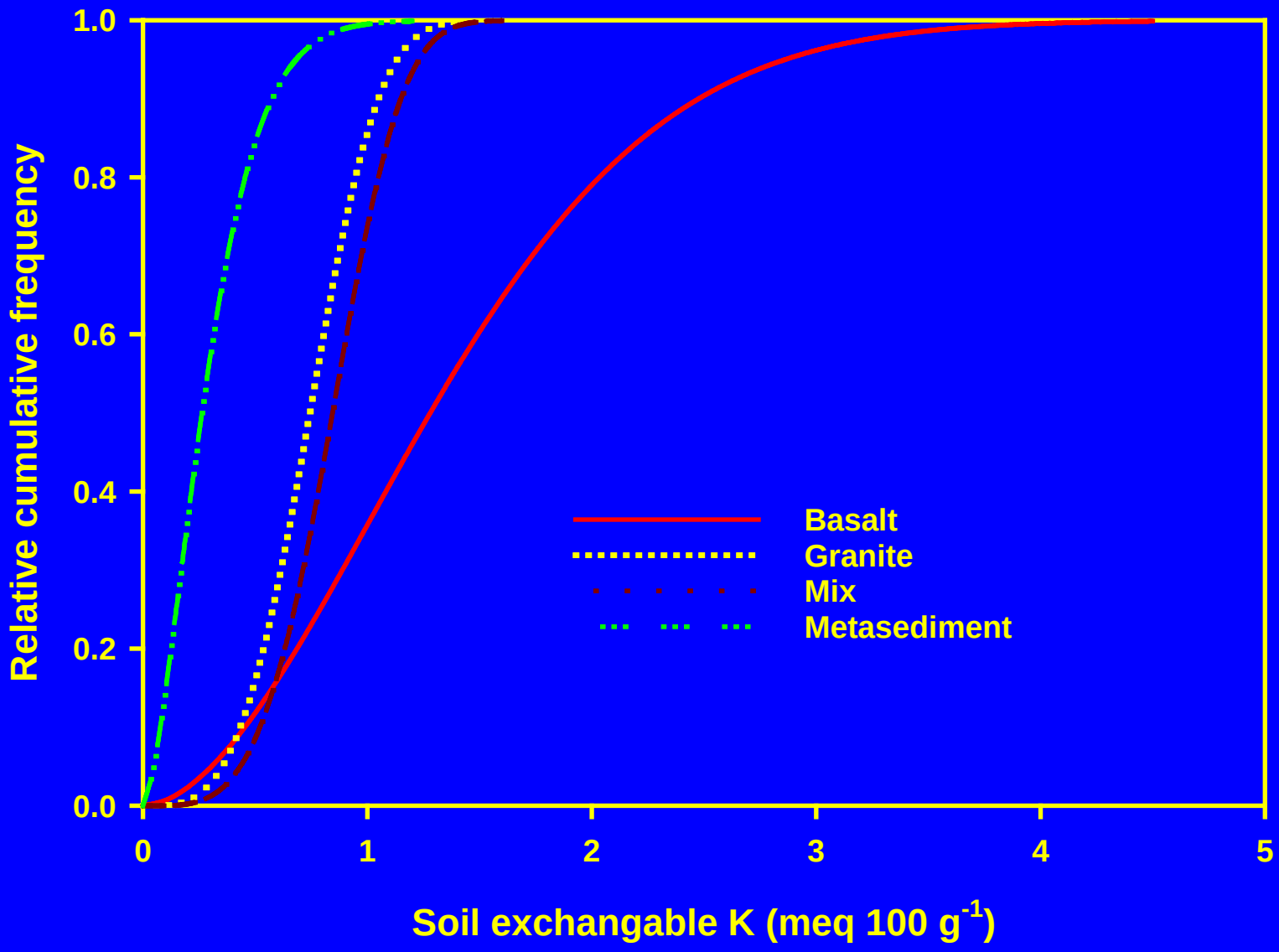

1.0
0.8
0.6
0.4
0.2
0.0
Relative cumulative frequency
0
50
100
150
200
Douglas-fir Stand BA Growth (%)
Basalt
Granite
Mix
Metasediment

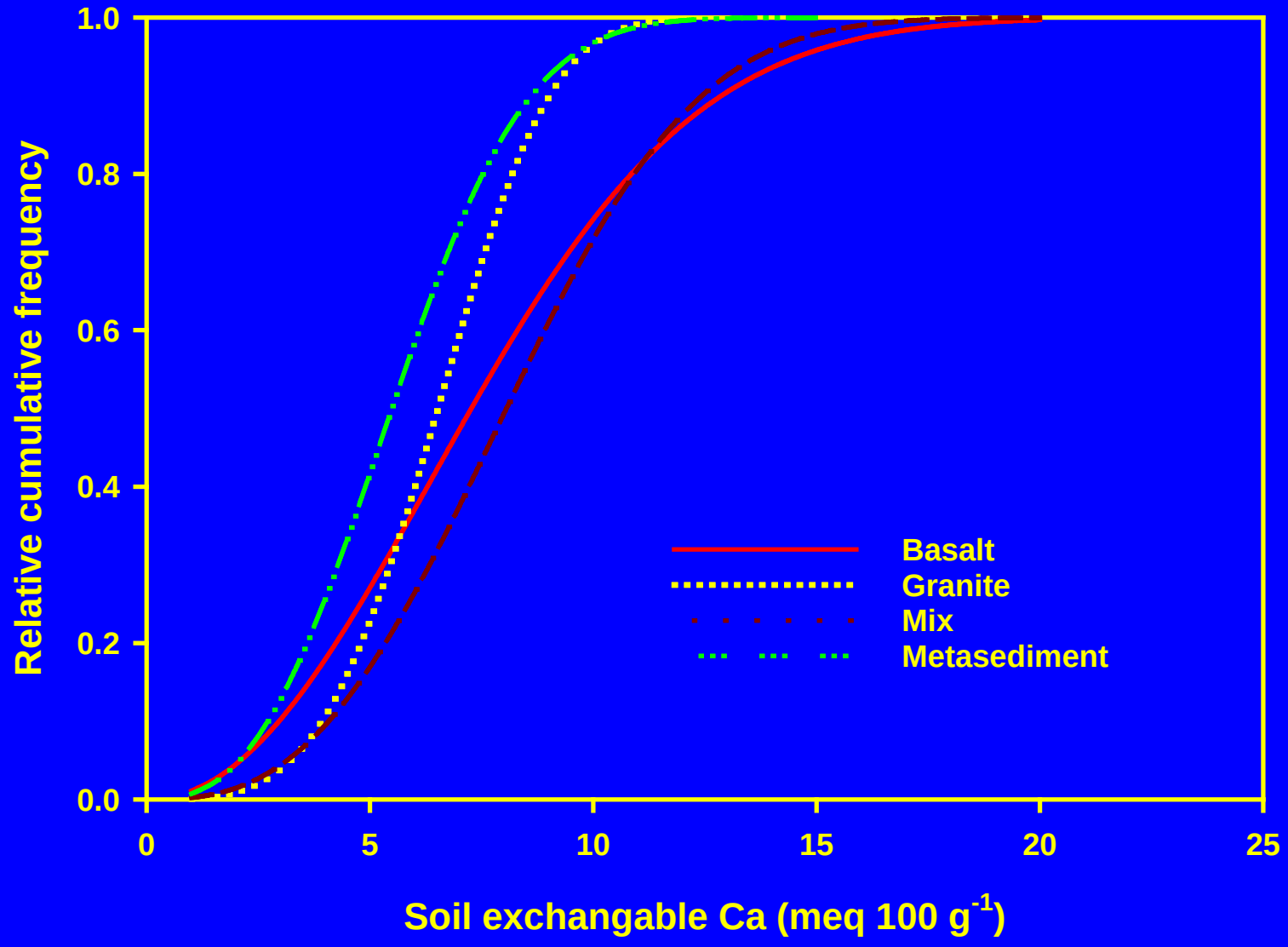

1.0
0.8
0.6
0.4
0.2
0.0
Relative cumulative frequency
0
50
100
150
200
Douglas-fir Stand Volume Growth (%)
Basalt
Granite
Mix
Metasediment

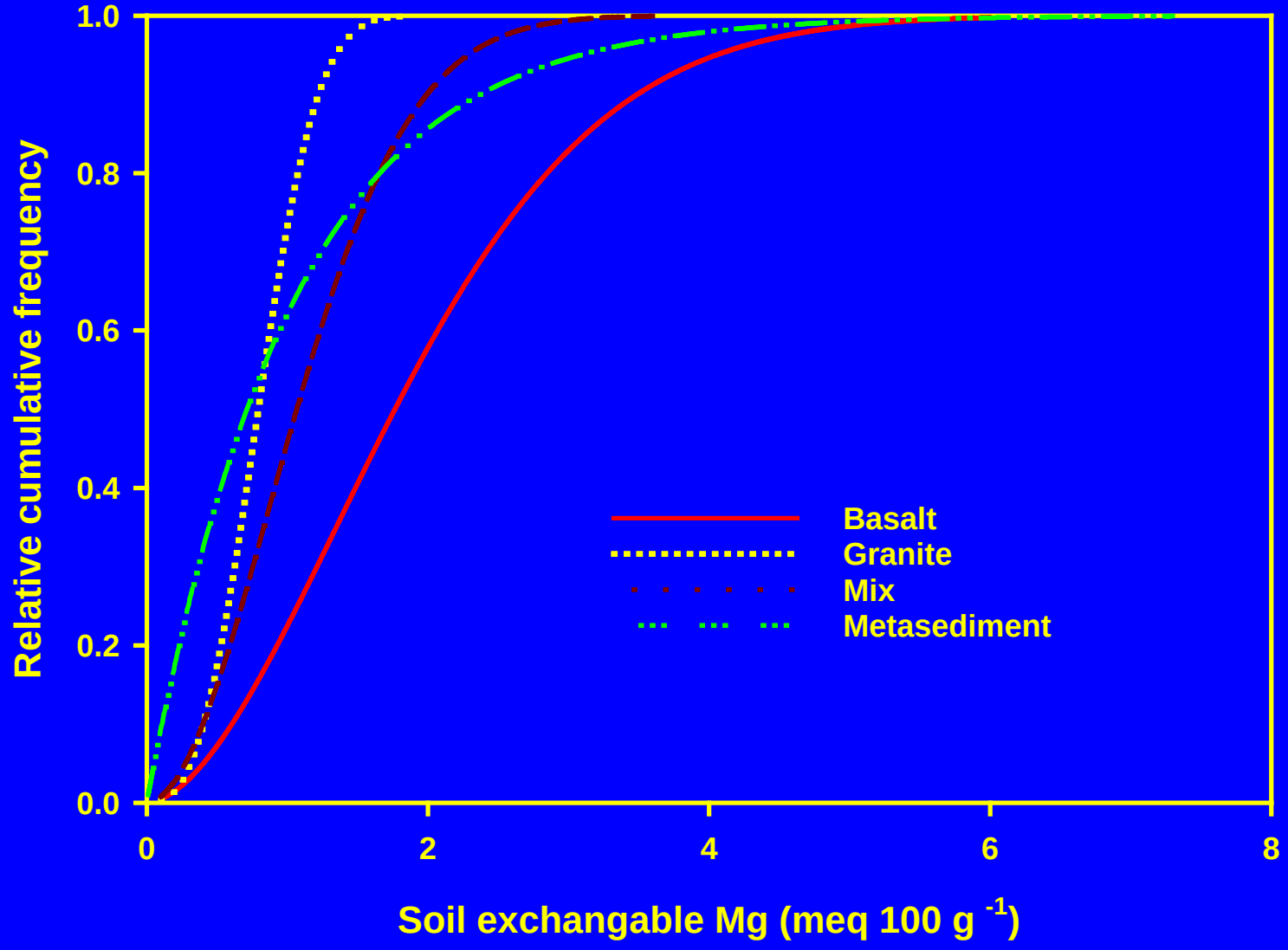
Frequency Plots Showing Distribution of Soil Nutrients

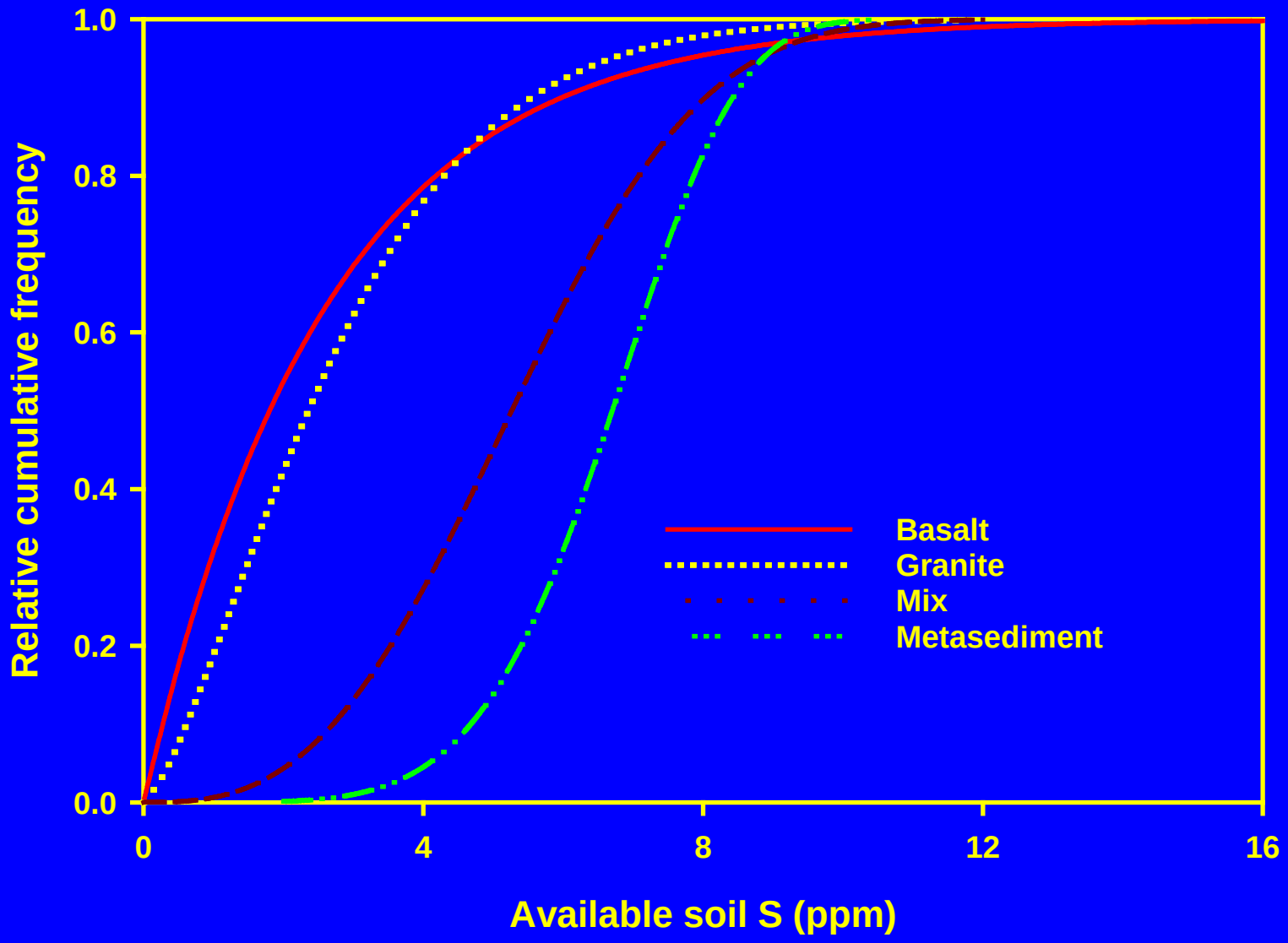

Relative cumulative frequency
1.0
0.8
0.6
0.4
0.2
0.0
0
20
40
60
80
100
Mineralizable N (ppm)
Basalt
Granite
Mix
Metasediment

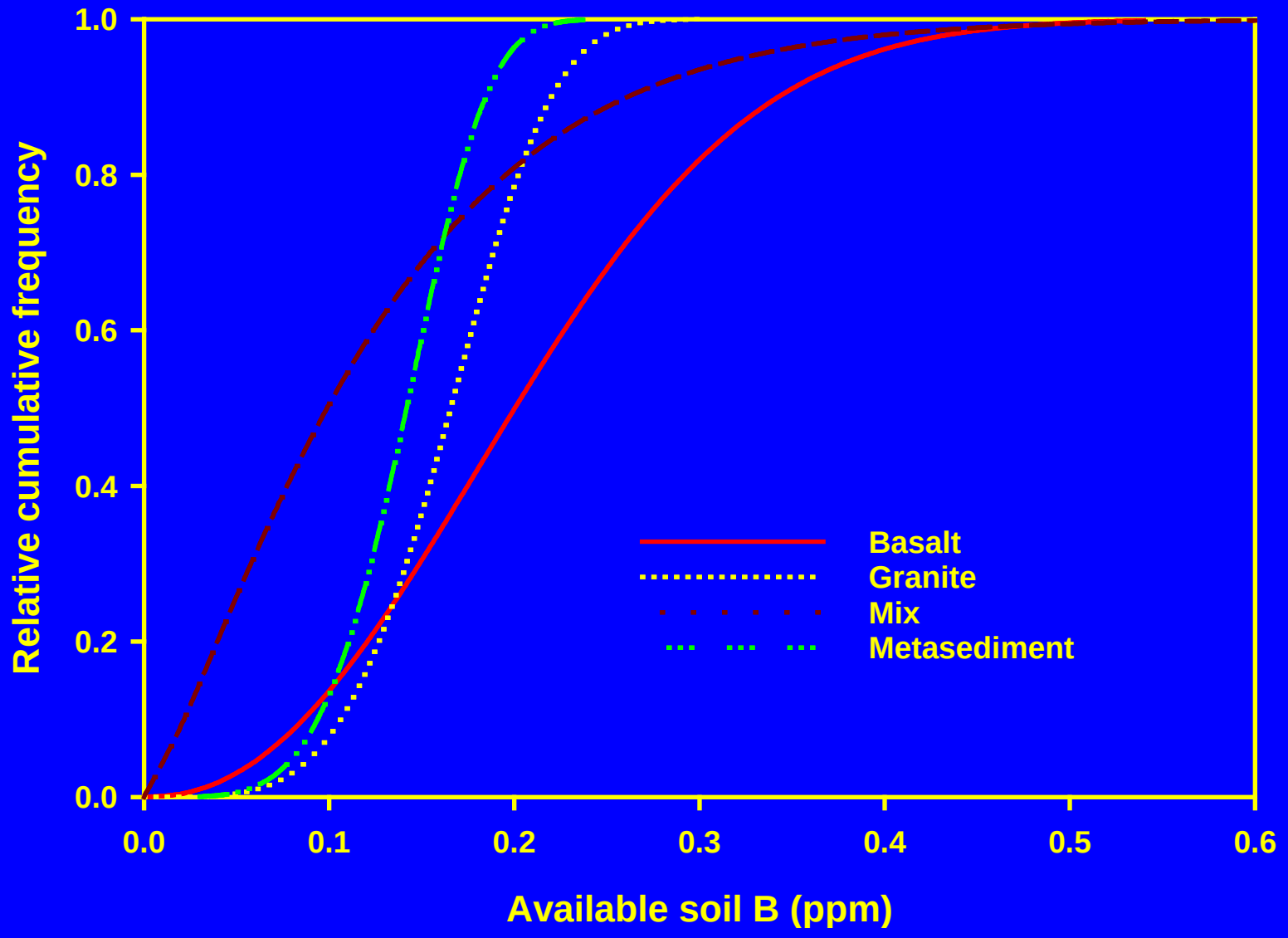

Relative cumulative frequency
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
Soil available P (ppm)
Basalt
Granite
Mix
Metasediment


1.0
0.8
0.6
0.4
0.2
0.0
Relative cumulative frequency
0
1
2
3
4
5
Soil exchangable K (meq 100 g-1)
Basalt
Granite
Mix
Metasediment


1.0
0.8
0.6
0.4
0.2
0.0
Relative cumulative frequency
0
5
10
15
20
25
Soil exchangable Ca (meq 100 g-1)
Basalt
Granite
Mix
Metasediment


1.0
0.8
0.6
0.4
0.2
0.0
Relative cumulative frequency
0
2
4
6
8
Soil exchangable Mg (meq 100 g -1)
Basalt
Granite
Mix
Metasediment


1.0
0.8
0.6
0.4
0.2
0.0
Relative cumulative frequency
0
4
8
12
16
Available soil S (ppm)
Basalt
Granite
Mix
Metasediment


1.0
0.8
0.6
0.4
0.2
0.0
Relative cumulative frequency
0.0
0.1
0.2
0.3
0.4
0.5
0.6
Available soil B (ppm)
Basalt
Granite
Mix
Metasediment

Conclusions

- Rock type contributes significant differences to stand growth (and soil nutrient levels).
- Initial tree size also determines growth potential.

- Overall, annual stand growth is in order of basalt > mix > metasediment = granite.
- Predicted stand growth showed similar trend.

Conclusions

- Ranking of soil cations (K, Ca, Mg) among rock types is the same as that for stand growth.
- Ranking of soil N, P, S, and B among rock types are slightly different from that for stand growth on different rock types.

Conclusions

- About 40% of the sites on all rock types have similar stand growth rates.
- About 60% of the sites on all rock types show growth differences due to rock type.
- Future analysis can look for other factors in these two classes that may account for similarities or differences