Thirteenth Annual Report

Intermountain Forest Tree Nutrition Cooperative

Part I

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Ten-year Growth Response to the Original Fertilization Treatments and Four-Year Response to the Retreatments for the Entire Douglas-fir Experiment

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SECTION I

Ten-year Growth Response to the Original Nitrogen Fertilization Treatments

This section of the report illustrates ten year growth responses to the original nitrogen treatments for the entire Douglas-fir experiment. Magnitude and duration of response are illustrated by IFTNC geographic region and by response diagnostic strata: soil parent material; habitat type series; and pre-treatment foliar potassium classes.

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10 Year Gross BA Pai Response
1980, 1981, and 1982 Douglas-fir Sites

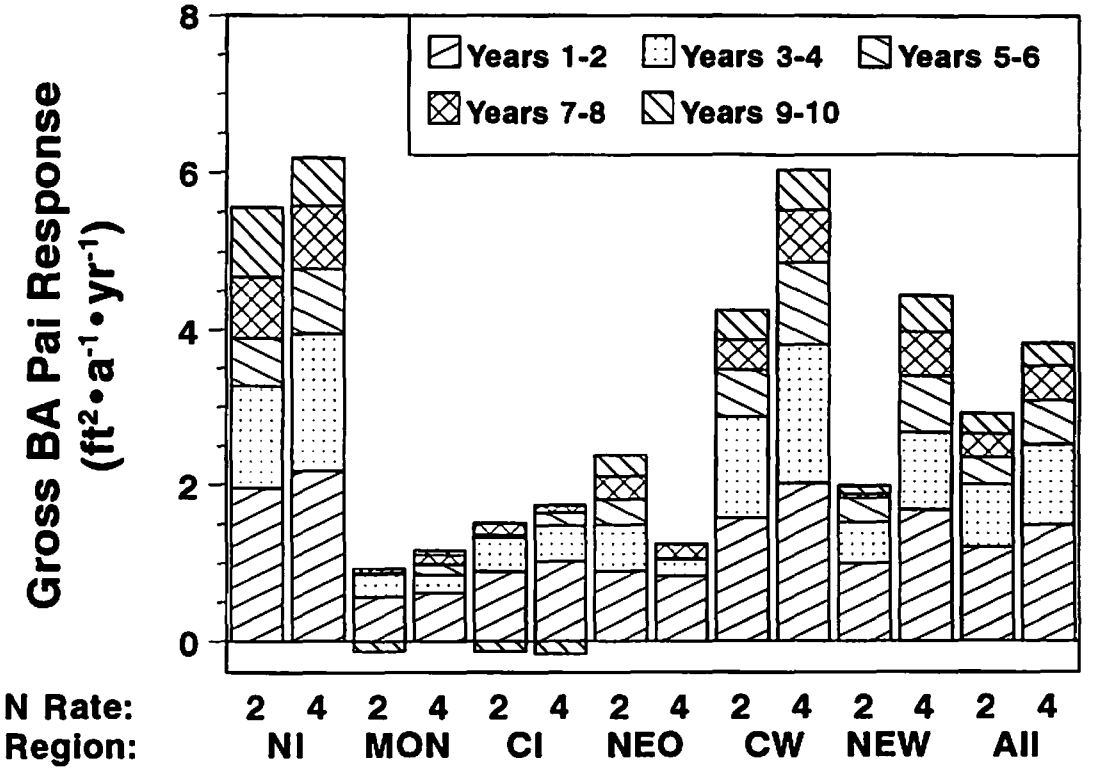

Figure 1
This graph shows magnitude and duration of response to the original nitrogen treatments for the entire Douglas-fir experiment.

Response (treated - control) declines through time, but significant responses continue to exist in the last period (years 9-10). Recall that these responses are a combination of direct fertilizer effects and indirect effects associated with increases in tree size and density accumulated in previous periods.

10 Year Gross BA Pai Relative Response
1980, 1981, and 1982 Douglas-fir Sites

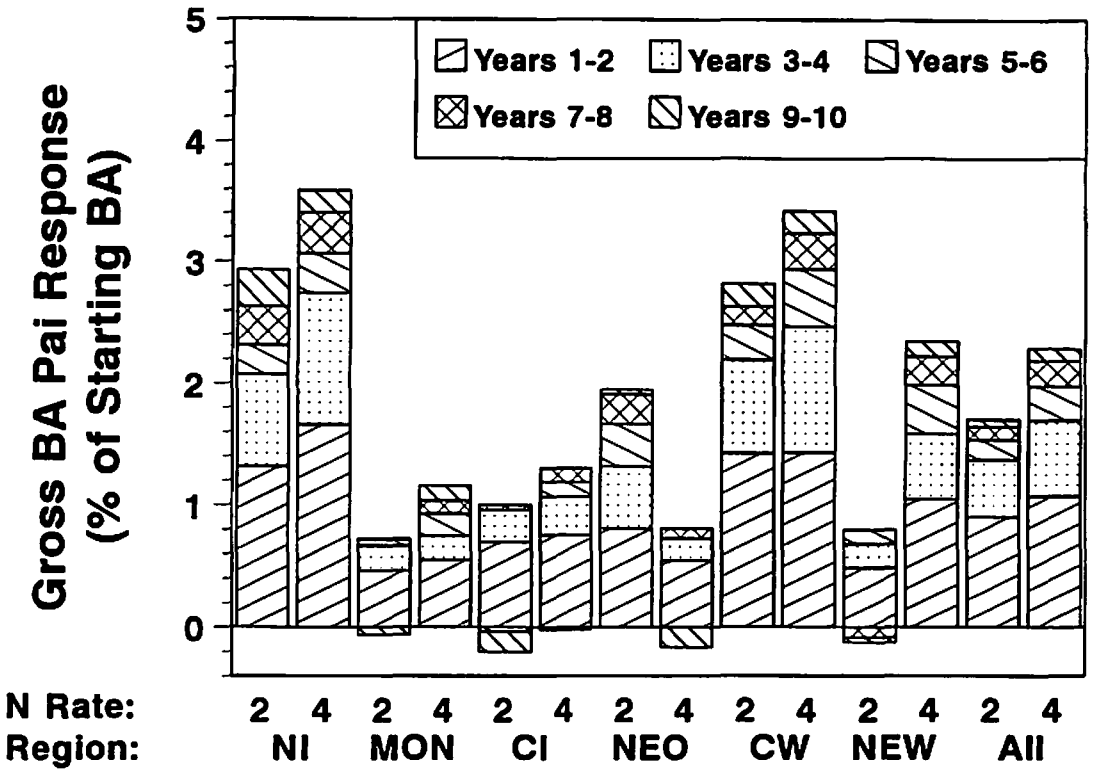

Figure 2
In contrast to Figure 1, if we focus just on direct fertilizer effects by expressing the growth in a period as a percentage of the density at the beginning of that period, we see a much sharper decline in response. By period 4 (years 7-8) there is no longer any significant differences among regions in treatment response, and in period 5 (years 9-10) the direct treatment effects are non-significant.

10 Year Gross BA Pai Response
1980, 1981, and 1982 Douglas-fir Sites
By Parent Material

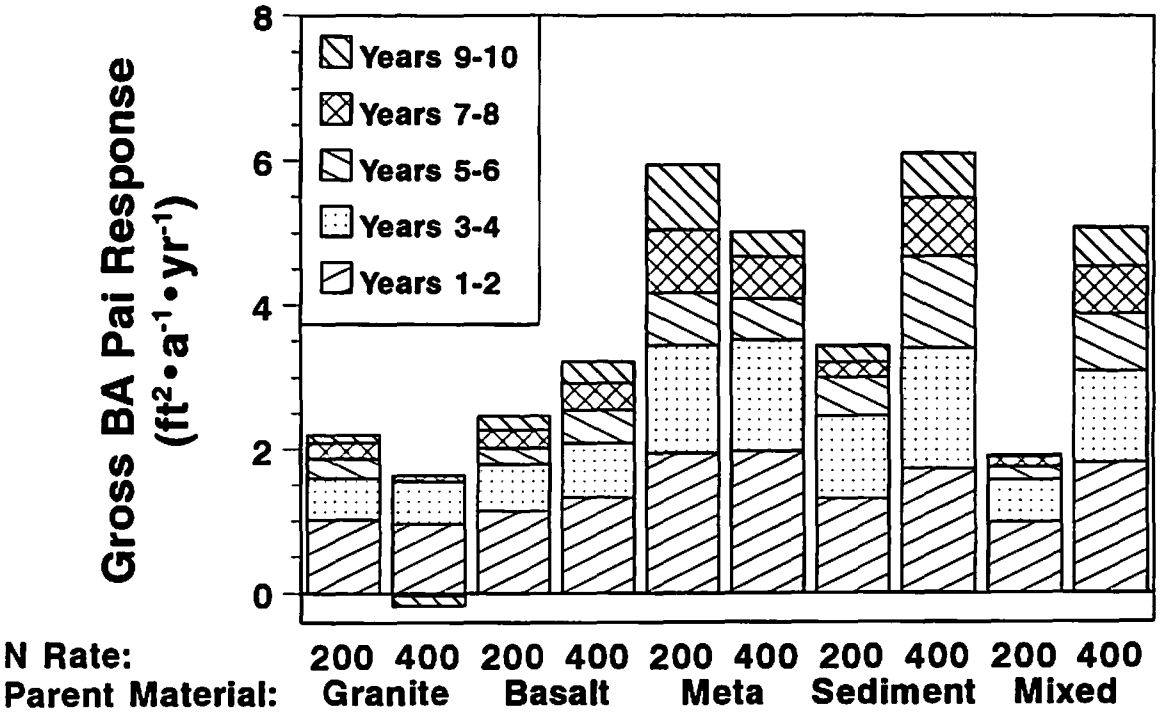

Figure 3
Soil parent material is a useful (significant) predictor of response to nitrogen treatments. Notice the higher magnitude and duration of response on meta-sedimentary, sedimentary, and mixed rock types. The 400#N treatment produced significantly more response than the 200#N treatment on sedimentary and mixed rock types.

10 Year Gross BA Pai Response
1980, 1981, and 1982 Douglas-fir Sites
By Vegetation Series

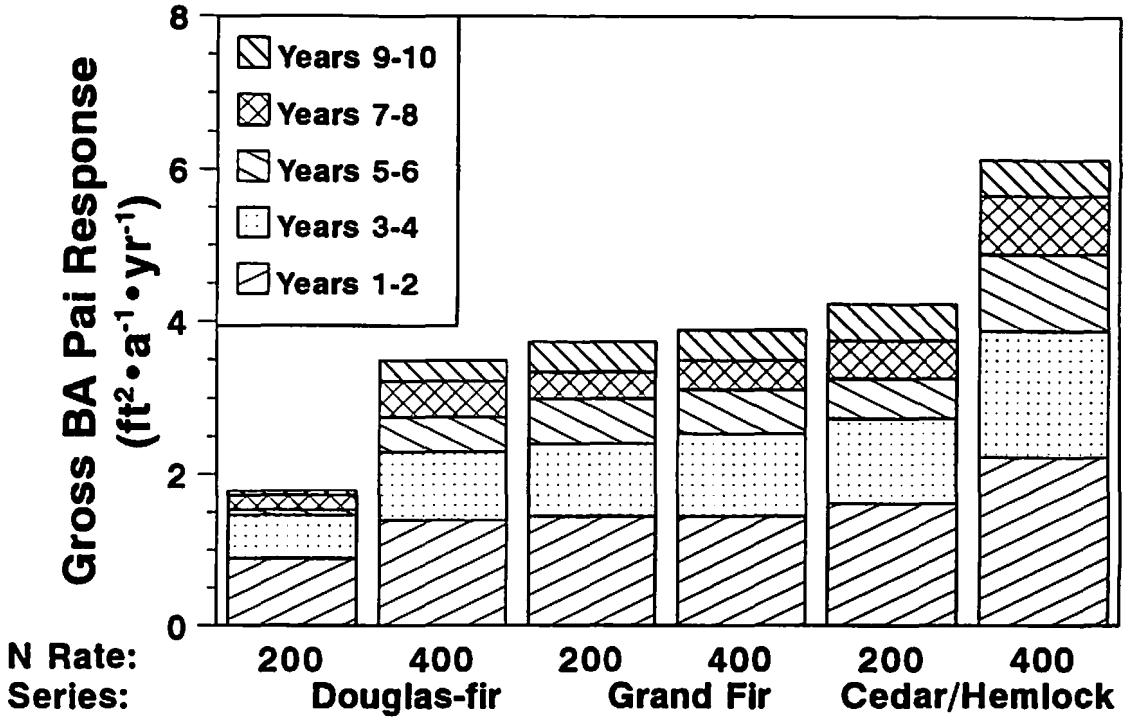

Figure 4
Habitat type series is also a useful (significant) predictor of response to nitrogen fertilization. Note the interesting stairstep appearance of average response as we move from the drier Douglas-fir types to the wetter cedar types. The 200#N treatment on grand fir types produces a bit more response than the 400#N treatment on Douglas-fir types; the comparison is similar for the respective treatments on the cedar vs. grand fir types respectively. The 400#N response on the cedar habitat types is significantly greater than the 200#N treatment.

10 Year Gross BA Pai Response
1980, 1981, and 1982 Douglas-fir Sites
By Initial Potassium Condition

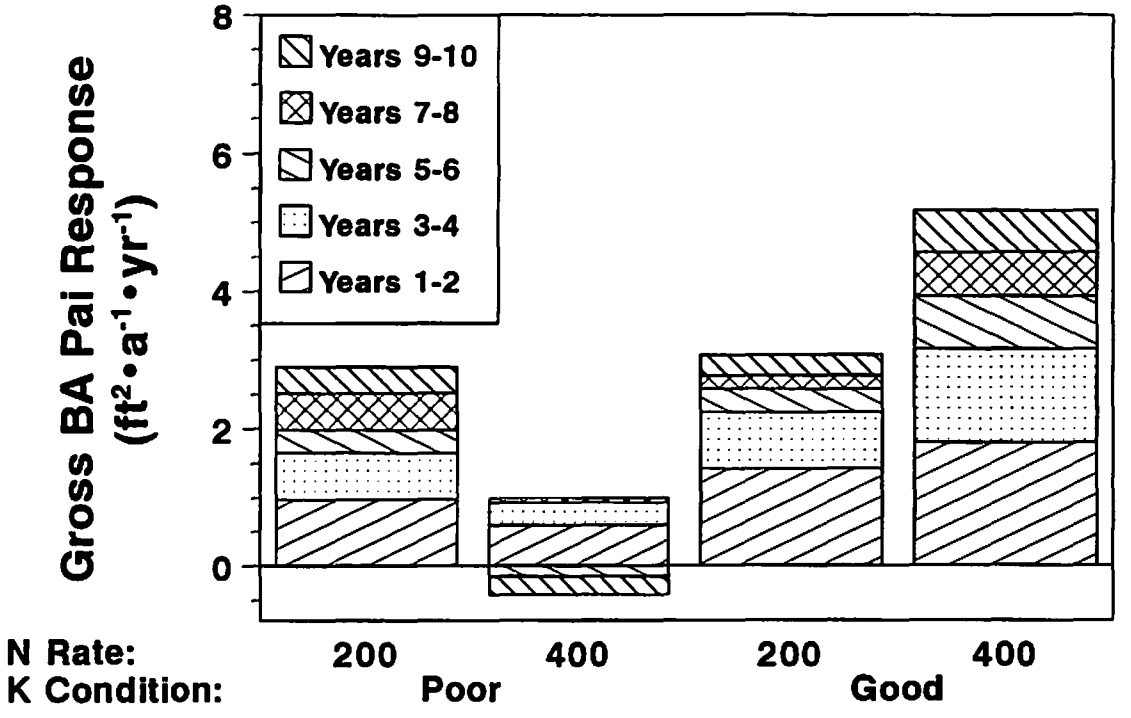

Figure 5
The differences observed after six years in response to N fertilization between stands diagnosed as having poor or good foliar potassium levels prior to treatment continue after ten years. The 200#N treatment is "safe" even in the poor K-class, and the real (significant) difference is in the response to the 400#N treatment.

SECTION II

Four-year Growth Response to Fertilization Retreatments by Significant Predictive Categorical Variables

This section of the report illustrates four-year retreatment growth responses to fertilization retreatments with 200 pounds of N alone or with 200 pounds of N plus 200 pounds of K. The results are displayed by soil parent material, habitat type series, and initial foliar potassium status. Contrasts illustrated in the following graphs include: (A) the period (climate?) effect by comparing the N+K treatment with the original 200#N treatment (assuming no K effect on growth); (B) the retreatment "falldown" (derived from retreating only six-years after the initial fertilization treatments) by comparing the N+K on previous control plots with the retreatments on those plots previously fertilized with N; (C) the K effect by comparing N alone with N+K retreatments on the previous 200#N and 400#N treatments; (D) and of course the differences in response magnitude and treatment contrasts among the various included strata.

List of Figures

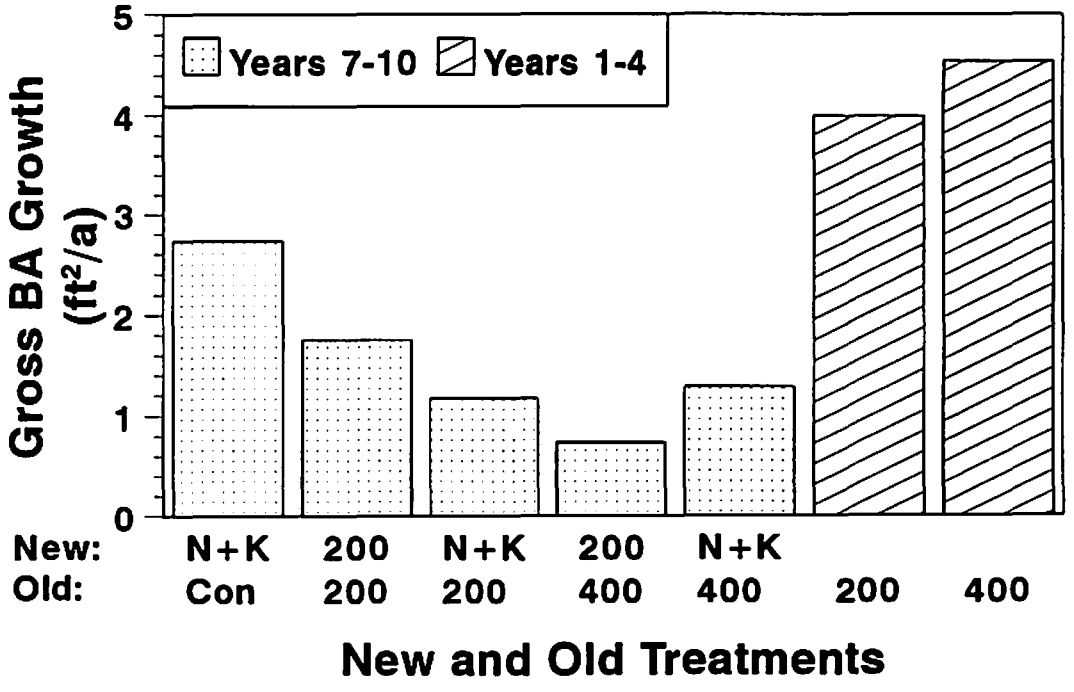

Figure 1

This figure compares retreatment response with response to the initial nitrogen treatments for the basalt parent material. Comparison of the N+K retreatment on previous control plots with the original 200#N treatment gives an idea of the period (perhaps climate) effect, while a comparison of the N+K on previous controls with 200#N on previously fertilized plots gives an idea of the "falldown" associated with retreating too soon after the first treatment. All retreatments are significant except 200#N on the old 400#N. There is no significant K effect on gross growth.

4 Year Response to Treatments
1981 and 1982 Douglas-fir Sites
Granitic Parent Materials

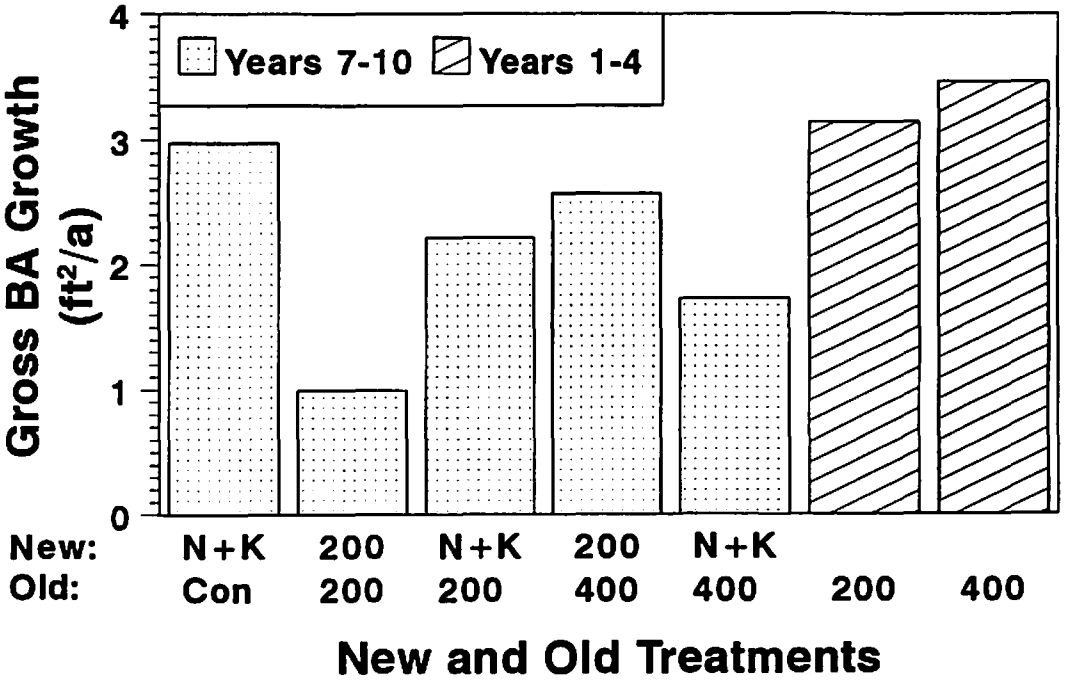

Figure 2
The same contrasts for granite soils can be made here as in Figure 1. The difference between the N+K treatments on previous control slots and the original 200#N treatments is slight indicating little "period effect" for granitics. All retreatment responses are significant except for the 200#N retreatment on the previous 200#N treatment. The K effect is non-significant for gross growth.

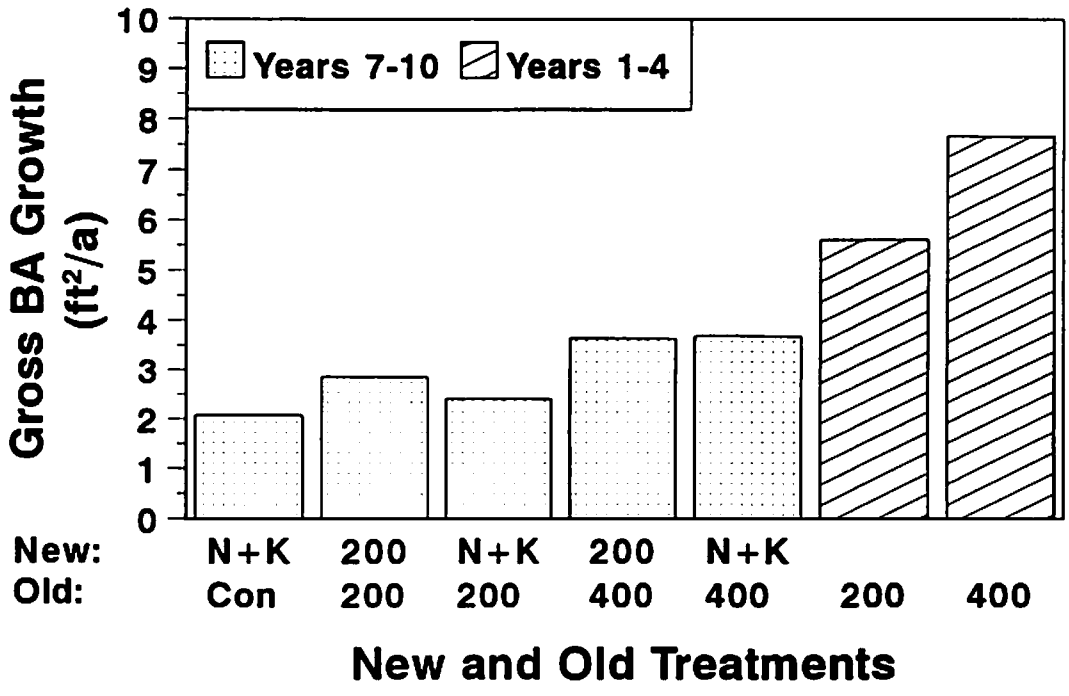

Figure 3
There is a large period effect for metamorphic soils. All retreatment responses are significant. There is no retreatment falldown effect on metamorphics, and the K effect is non-significant.

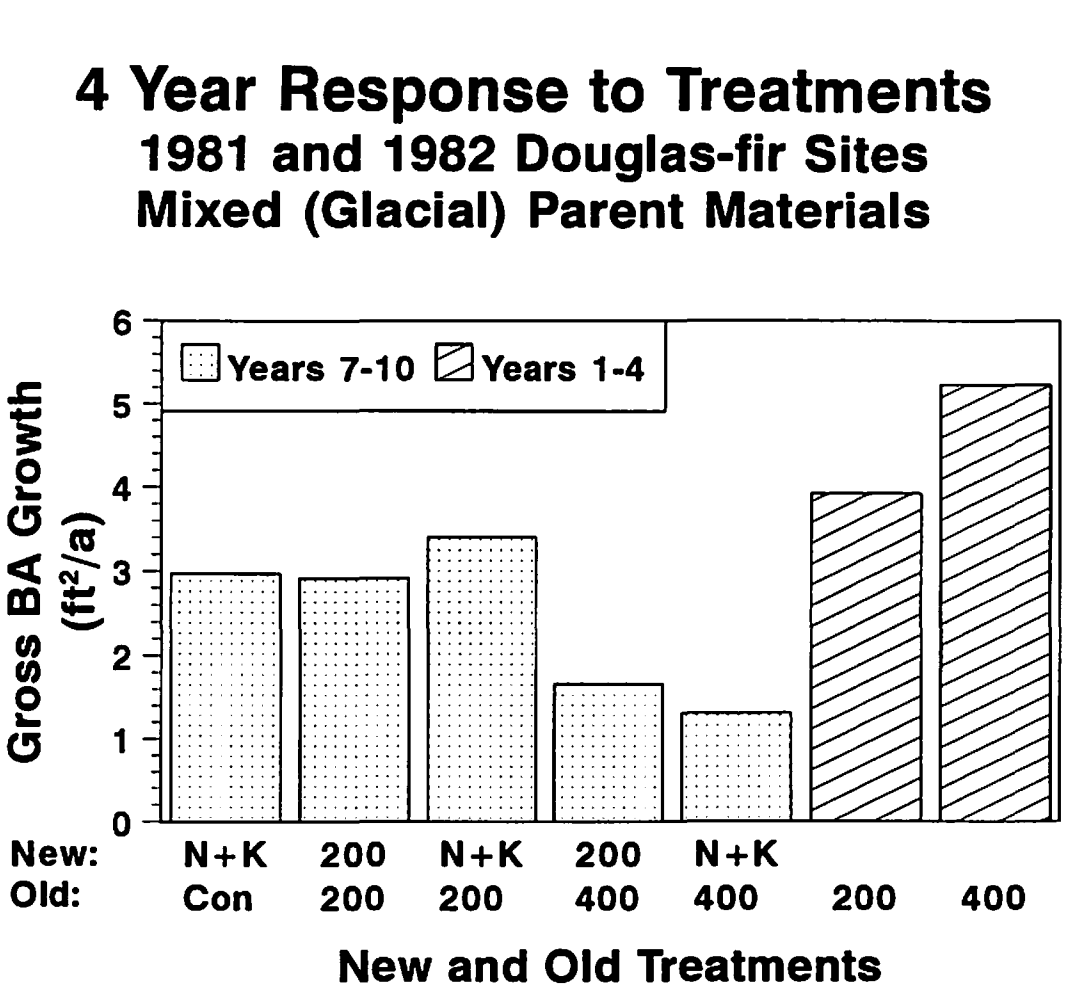

Figure 4
There is a slight period effect comparing the N+K treatment on previous control plots with the original 200#N treatment. All retreatment responses are significant, but there is a significant retreatment falldown effect on the plots previously treated with 400#N. The K-effect is non-significant for gross growth.

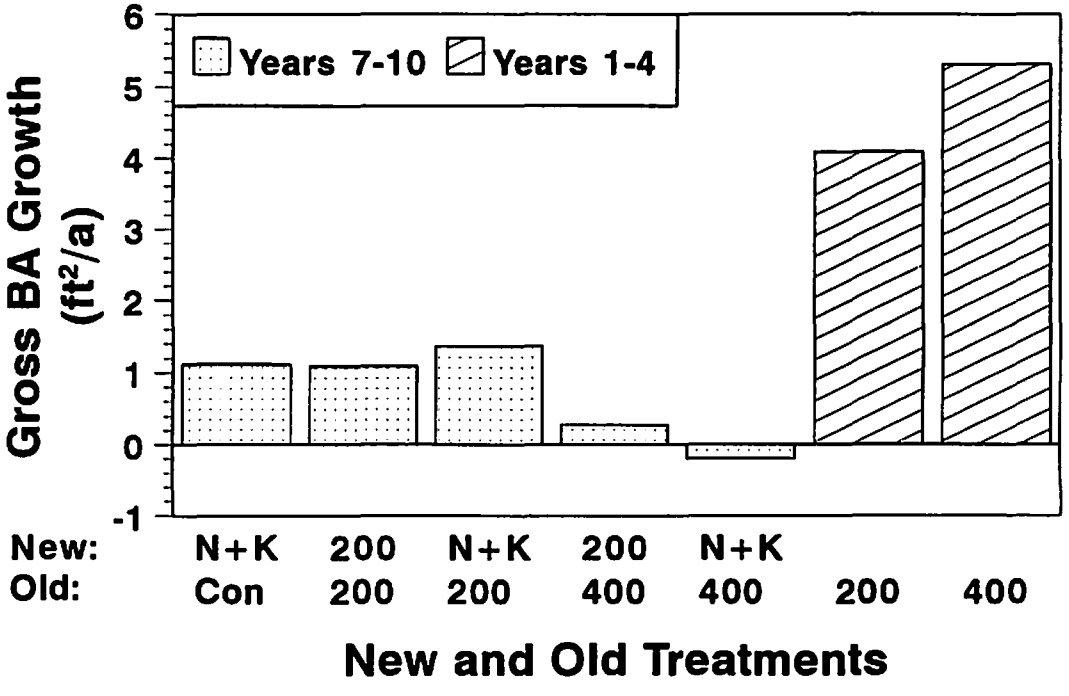

Figure 5
There is a substantial period effect for sedimentary parent materials. There are no significant retreatment responses and no K effects.

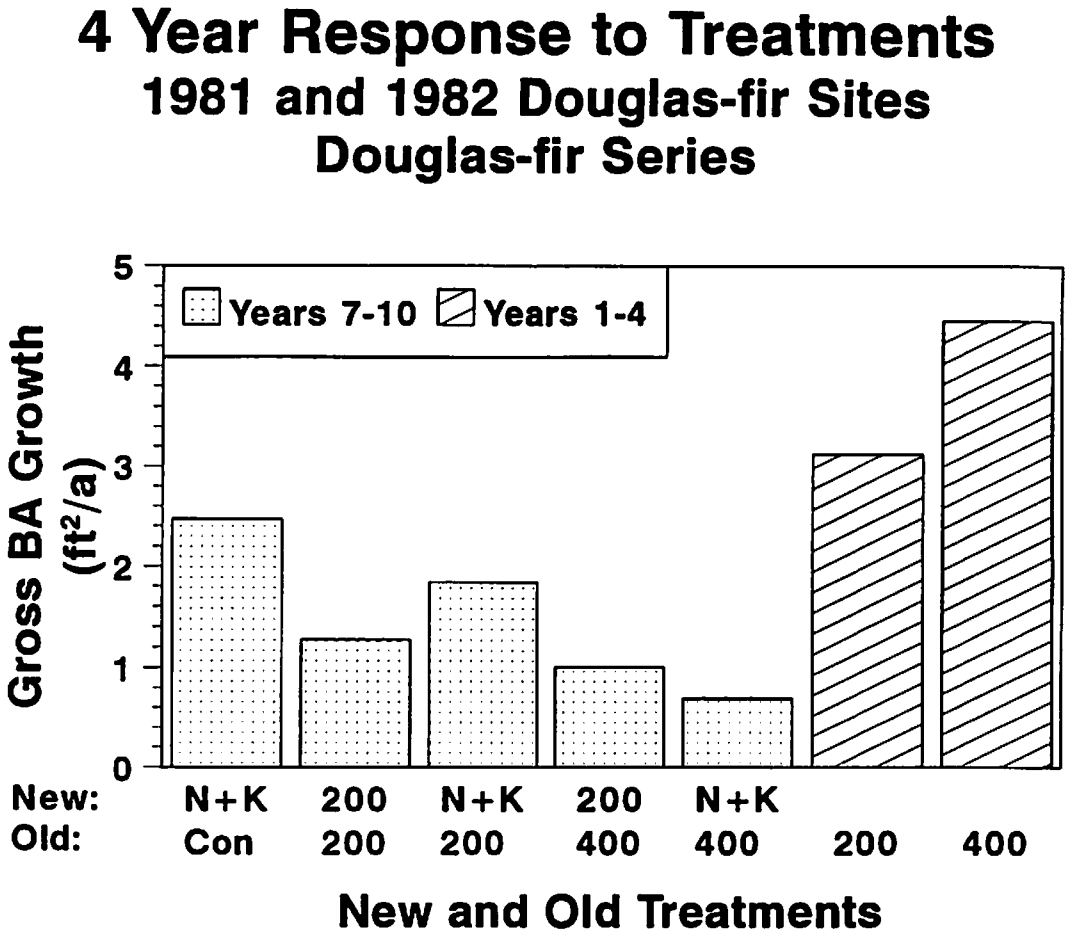

Figure 6
Comparison of the N+K retreatment on control plots with the original 200#N treatment shows a slight decline due to a "period" effect on Douglas-fir habitat types. All the retreatment responses are significant and there is no K effect on gross growth. However, there was a significant "falldown" from retreating too soon.

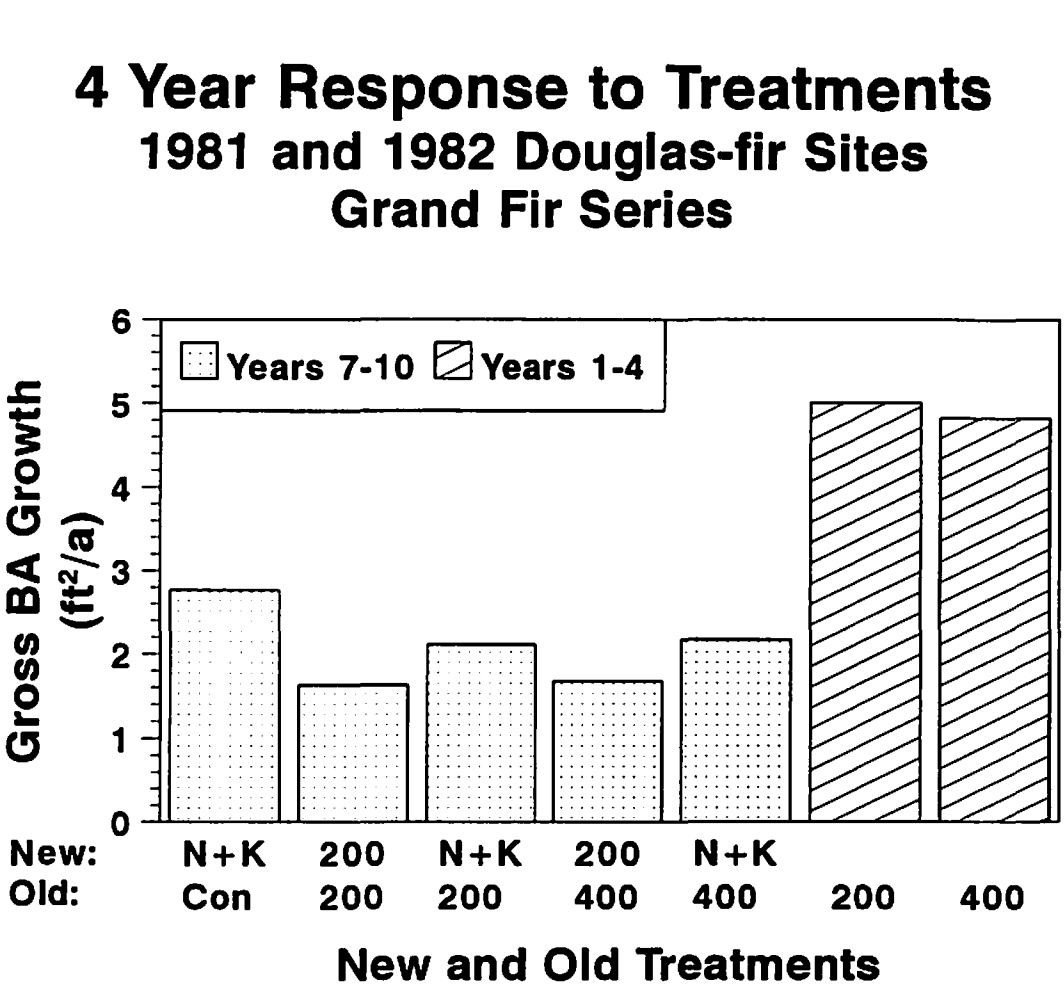

Figure 7
The N+K retreatment response on previous control plots was substantially less than the average response to the original 200#N treatment on grand fir habitat types indicating a period effect. All retreatment responses are significant; however, there was a significant "falldown" effect from retreating too soon. There was no significant K effect on grand fir habitat types, although there is a tendency for N+K retreatment responses to be higher than N alone treatments.

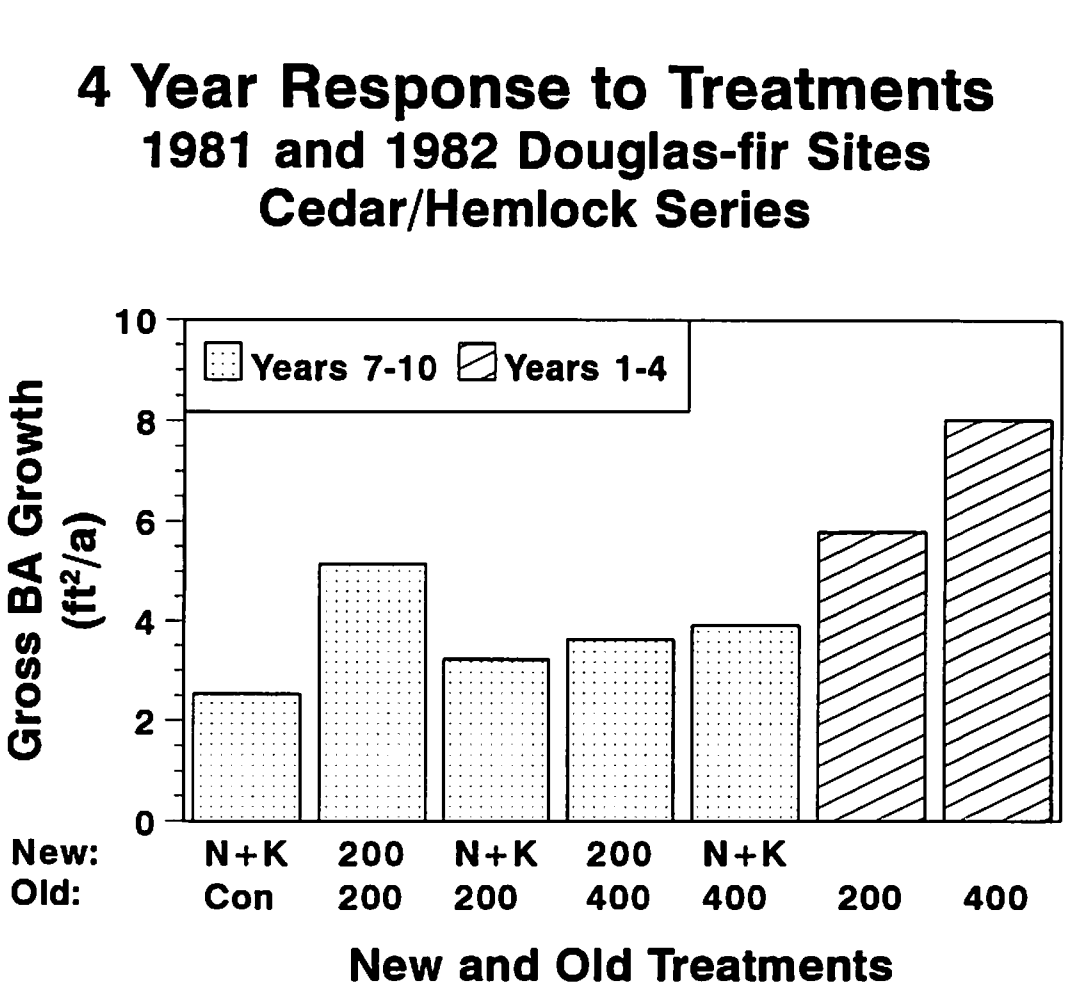

Figure 8
There seems to be a significant period effect when comparing the N+K retreatment on previous control plots with the original 200#N treatment. All retreatment responses are significant and there is no retreatment "falldown" on cedar habitats. The K-effect is non-significant.

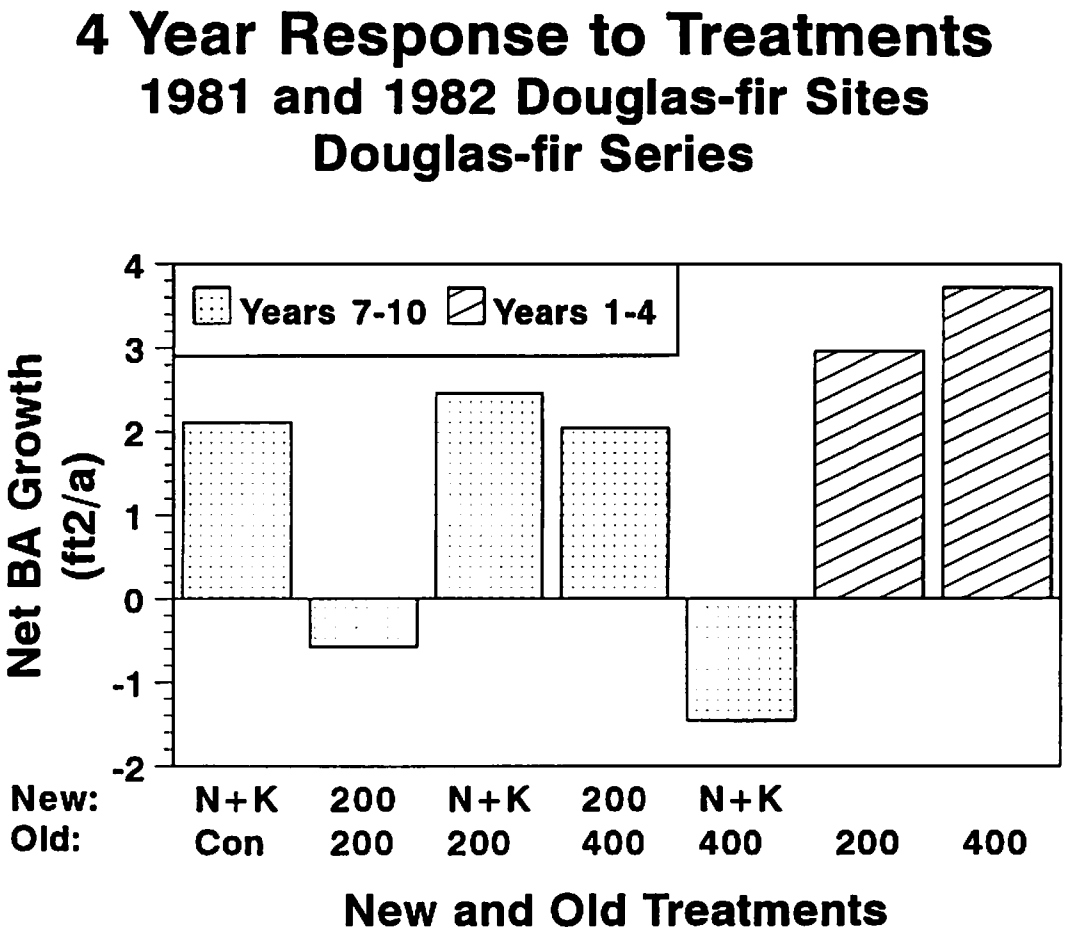

Figure 9
All net retreatment responses are non-significant on Douglas-fir habitats. The K-effects are also non-significant.

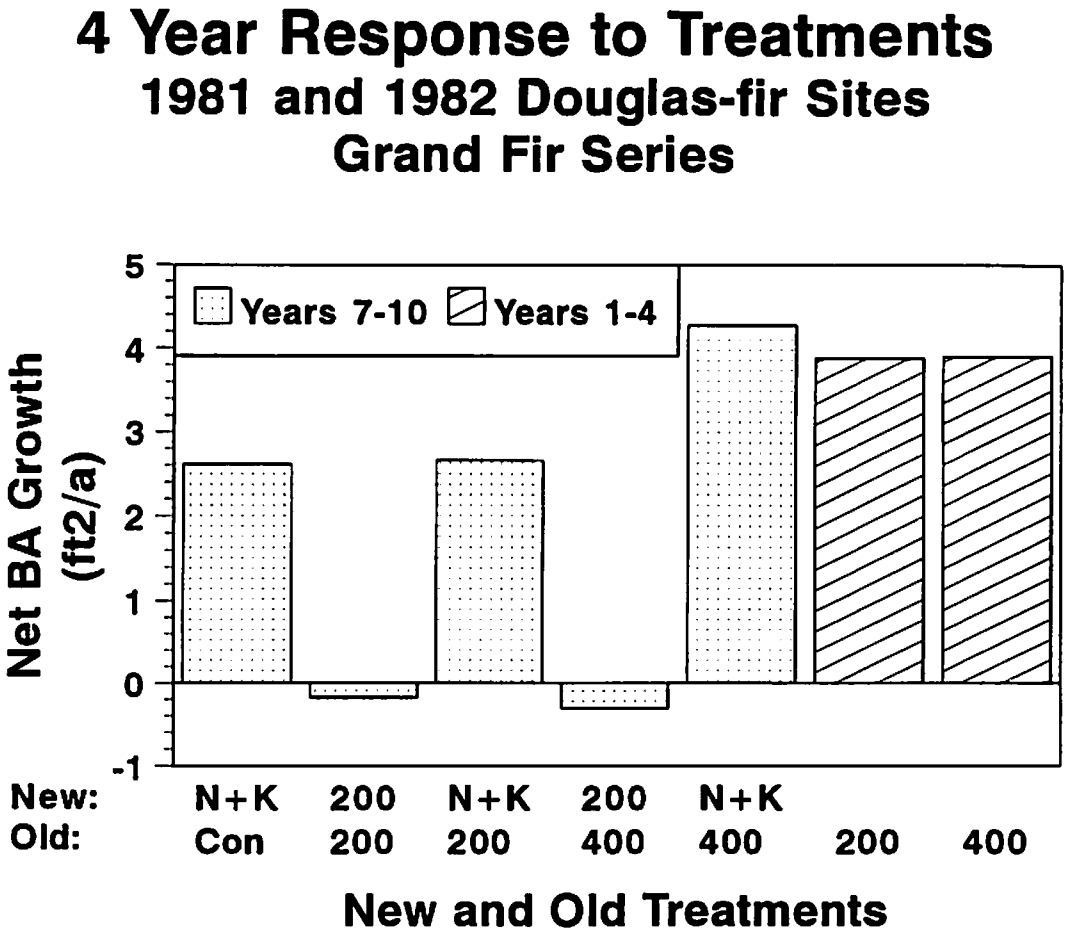

Figure 10
All net retreatment responses are non-significant on grand fir habitats. The K-effects are marginally significant, which given the amount of variation in net growth, indicates a strong trend for the N+K retreatments to have less mortality than the N only retreatments on this habitat type.

4 Year Response to Treatments
1981 and 1982 Douglas-fir Sites
Cedar/Hemlock Series

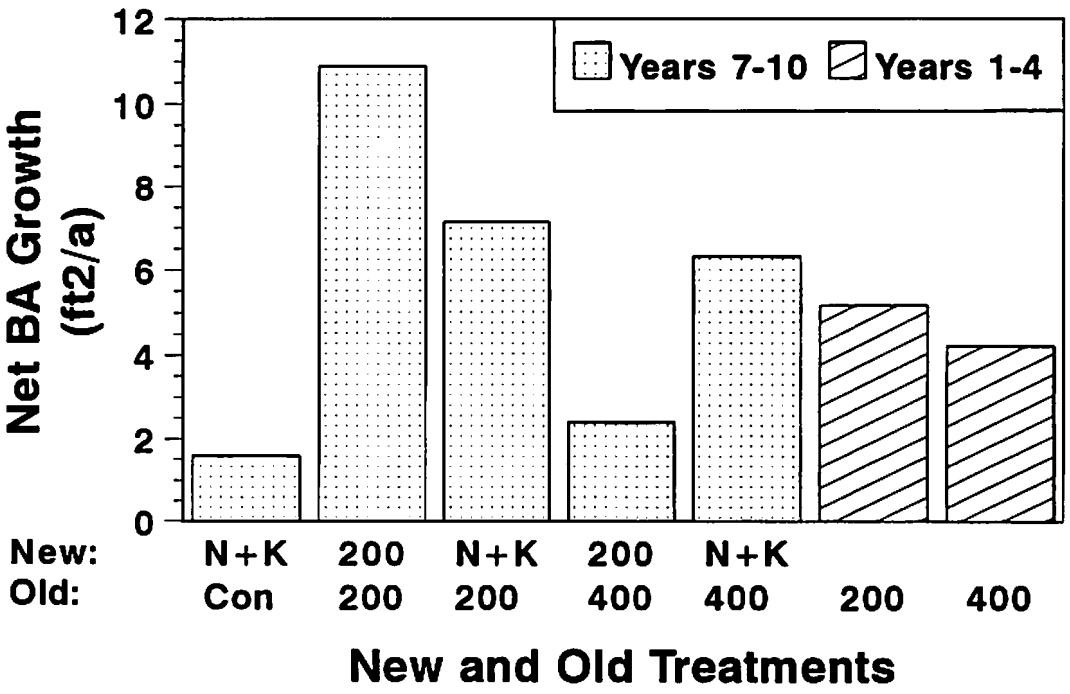

Figure 11
The net retreatment responses for N+K on previous controls and 200#N on previous 400#N treatments are not significant, all other retreatment responses are significant on cedar habitats. There is a trend (non-significant) for a K effect on the plots previously treated with 400#N.

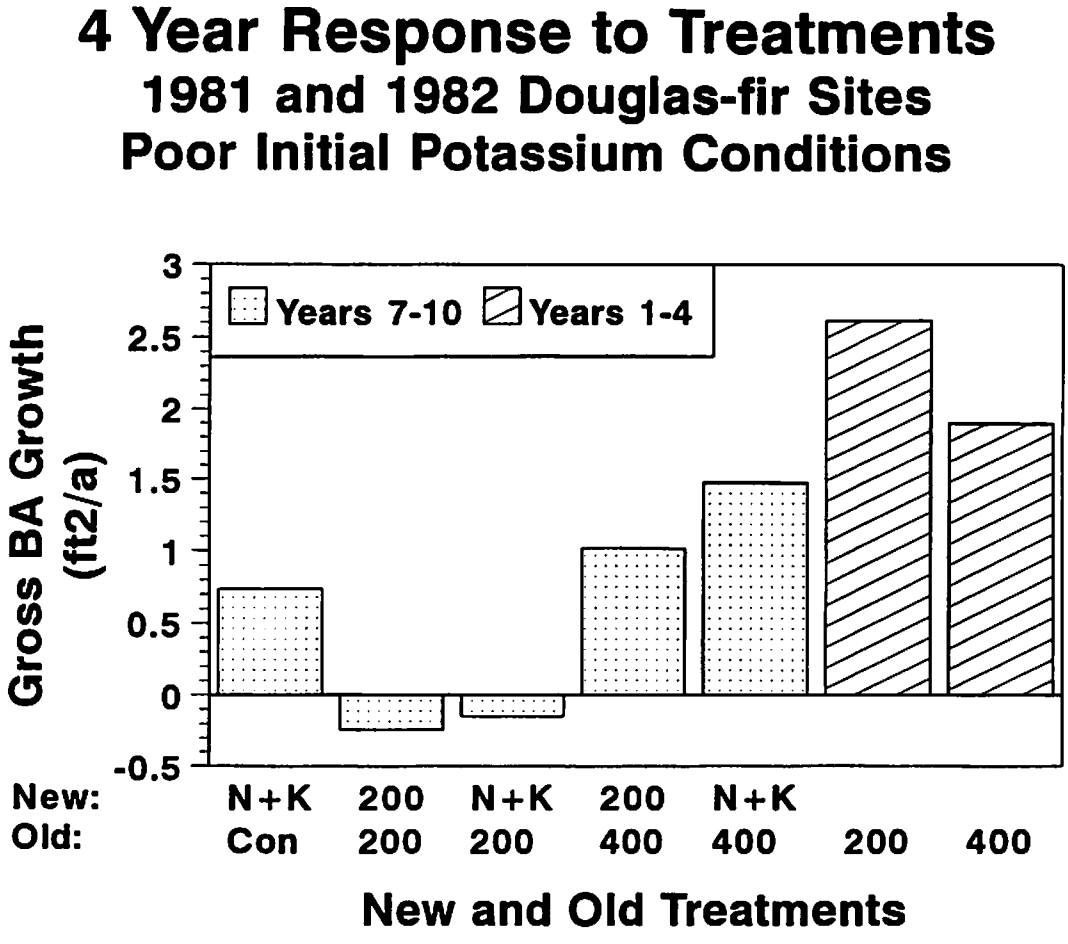

Figure 12
This figure compares retreatment gross growth response with response to the initial nitrogen treatments for the poor foliar K-class stands. All retreatment gross responses are non-significant for the poor K-class. There is a weak (non-significant) K effect.

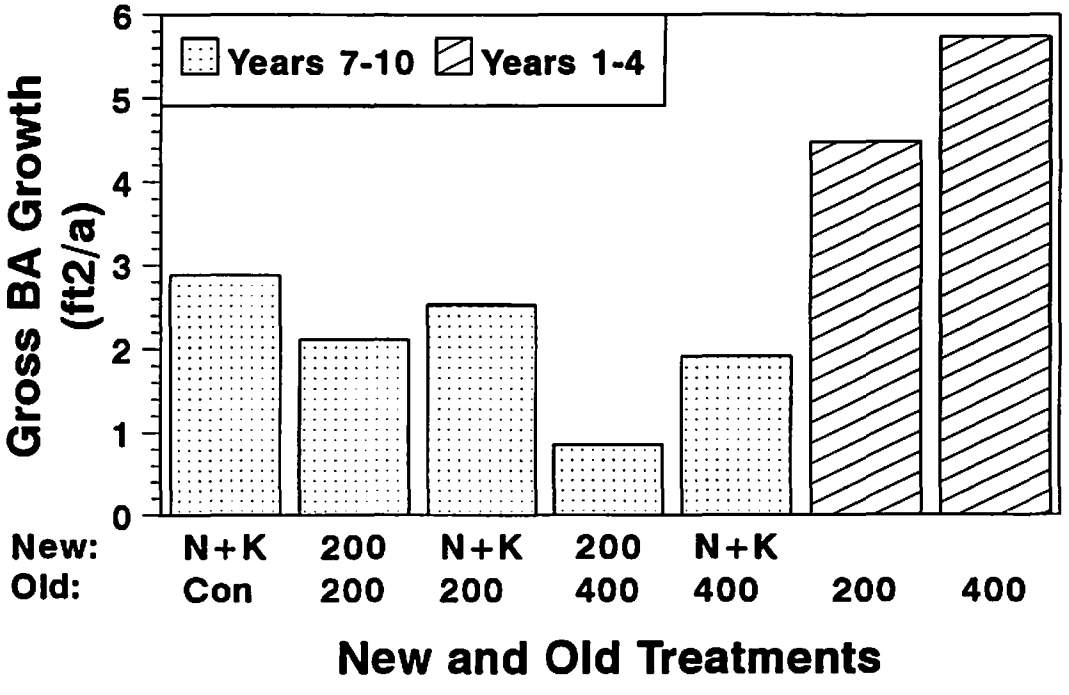

Figure 13

In contrast to the poor K-class (Figure 12), all retreatment gross growth responses (except 200#N on previous 400#N treatments) are significant on good foliar K-class stands. Interestingly there is a trend (non-significant) toward a K-effect even in these stands classed as having good K status.

4 Year Response to Treatments
1981 and 1982 Douglas-fir Sites
Poor Initial Potassium Conditions

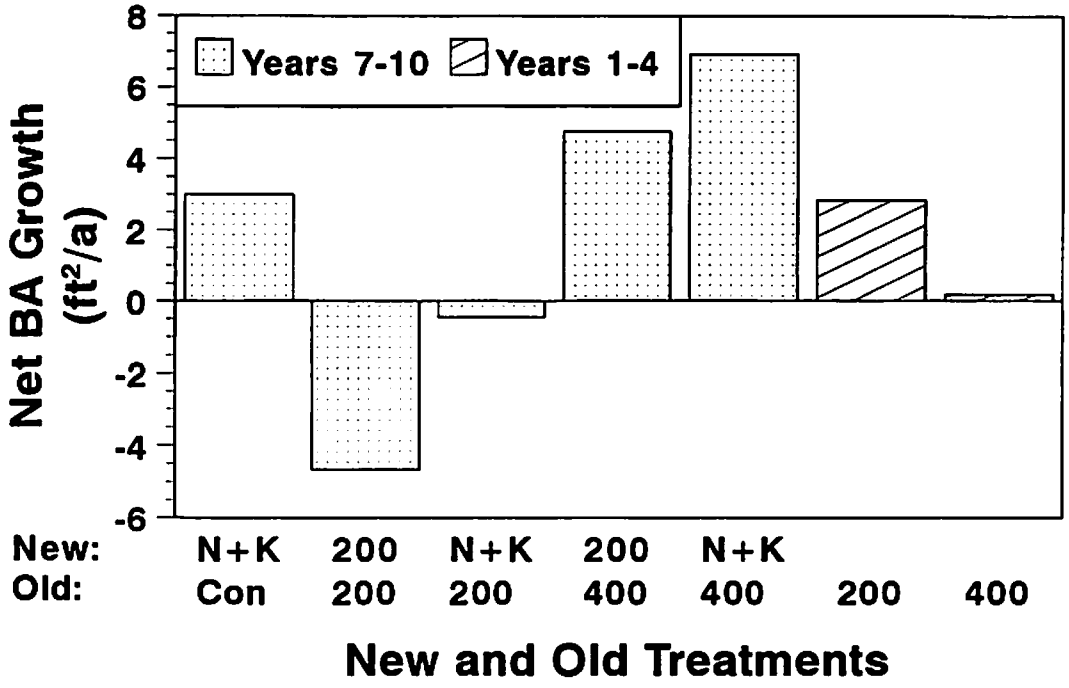

Figure 14
All retreatment and original treatment net growth responses, except the N+K retreatment on previous 400#N plots, are non-significant in the poor foliar K-class stands. There is a non-significant trend N+K retreatment responses to be higher than the N alone retreatments (a K effect).

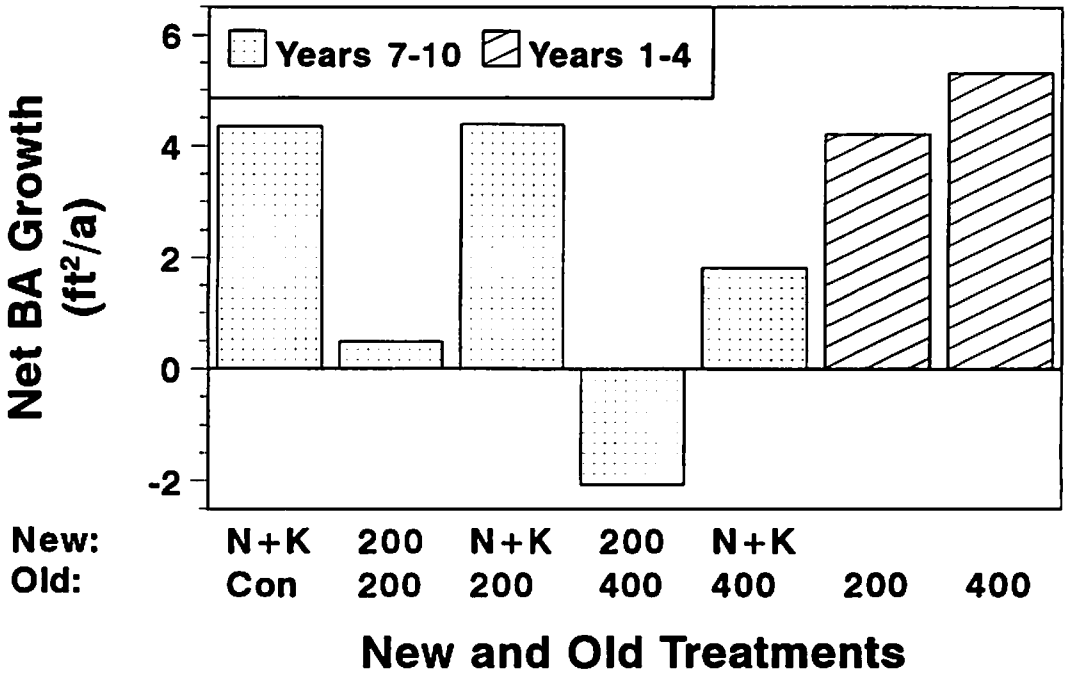

Figure 15
In contrast to the poor K-class (Figure 14), the net growth responses to the original N treatments and the N+K retreatments on the original control plots and those previously treated with 200#N are all significant. The N only retreatments did not produce a significant net response. There is a non-significant trend toward a K effect even on these stands classified as having good K status.

SECTION III

Four-year Growth Response to Fertilization Retreatments by Geographic Region

This section contains the four-year growth responses to fertilization retreatments for the entire Douglas-fir experiment by IFTNC geographic region. The contrasts of interest illustrated by the following graphs are the same as those in Section II of this report.

List of Figures

4 Year Response to New Treatments
1981 and 1982 Douglas-fir Sites
All Regions

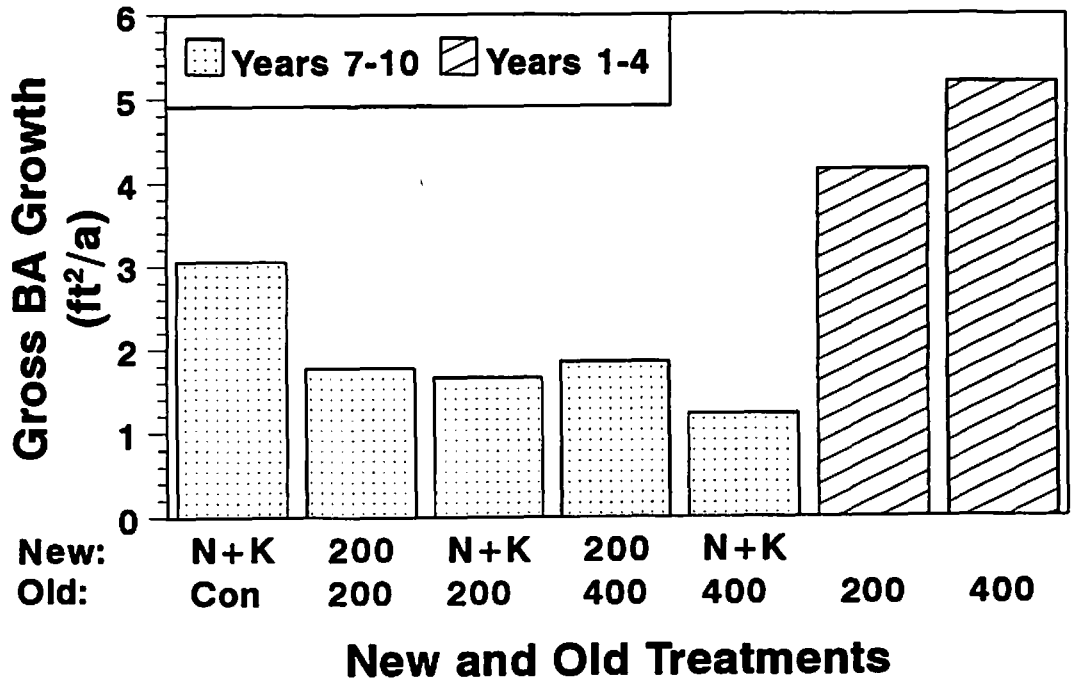

Figure 1
This graph compares retreatment basal area responses to the original four-year treatment response for the overall Douglas-fir experiment.

There was a significant response to the new N+K treatment, but not to the original N response level. A decline in overall growth rates was not sufficient to explain all of the reduced response.

However; there was significant response to the N and N+K retreatments, but no evidence of any K growth effect. The significant decline from new treatment response levels probably indicates that retreating six years after the initial treatments was too soon.

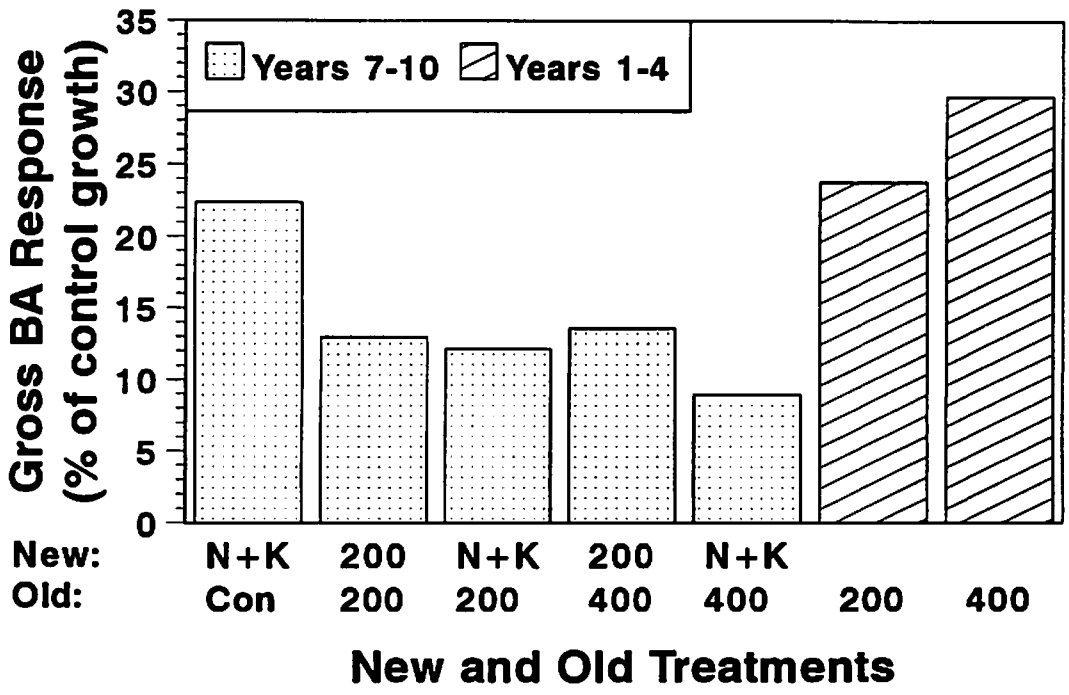

Figure 2
A decline in overall growth rates did not completely explain the decline in response to new N treatments observed across the region-wide Douglas-fir experiment (Figure 1).

4 Year Response to New Treatments
1981 and 1982 Douglas-fir Sites
North Idaho

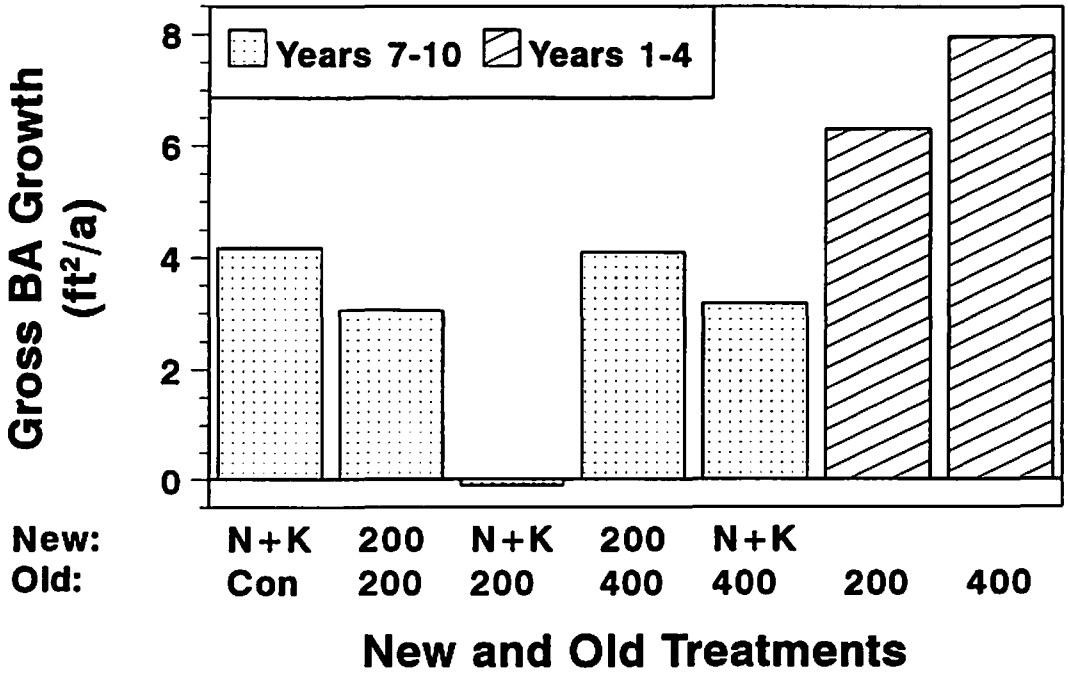

Figure 3
This graph compares retreatment basal area responses to the original treatment's four-year response in north Idaho.

There is significant response to N+K treatment and variable response on the previously treated plots: significant decline on the former 200N plot when compared with 200N on 200, but similar response on former 400N plot.

N retreatment produced a significant response (slight non-significant decrease from N+K on former control); thus, there is no reason to conclude there is any decrease in response with retreatment.

Overall there is a decline in response compared to the initial treatment responses.

4 Year Response to New Treatments
1981 and 1982 Douglas-fir Sites
North Idaho

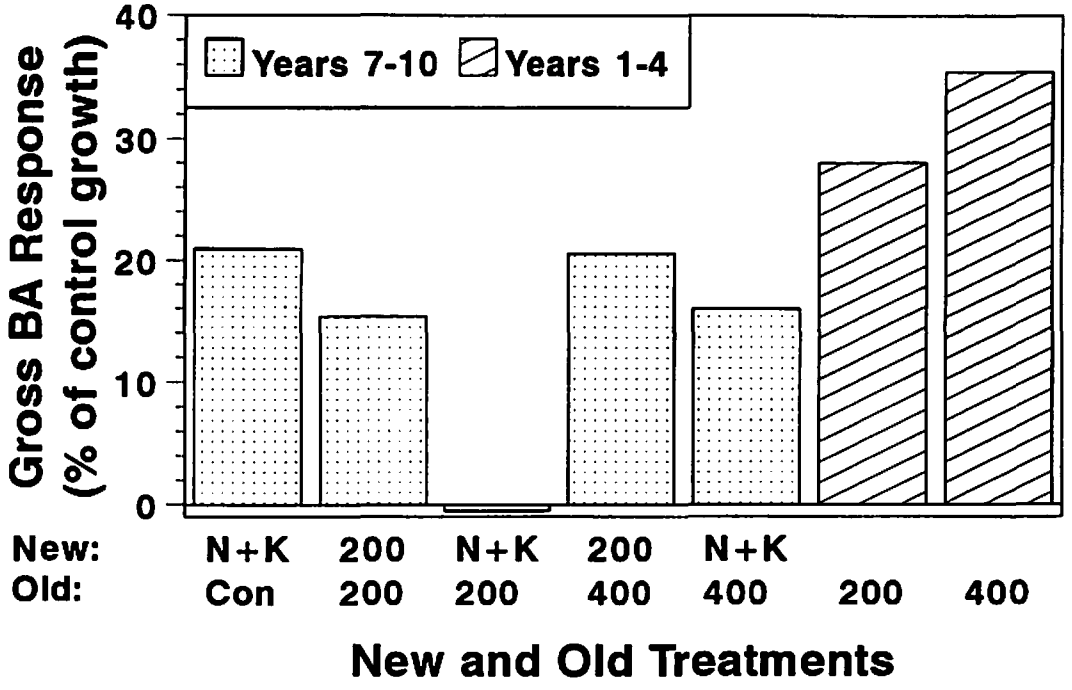

Figure 4
This graph compares retreatment relative responses to the original treatments in north Idaho.

The decline in control plot growth was insufficient to completely explain the decline in absolute response shown in Figure 1.

4 Year Response to New Treatments
1981 and 1982 Douglas-fir Sites
Montana

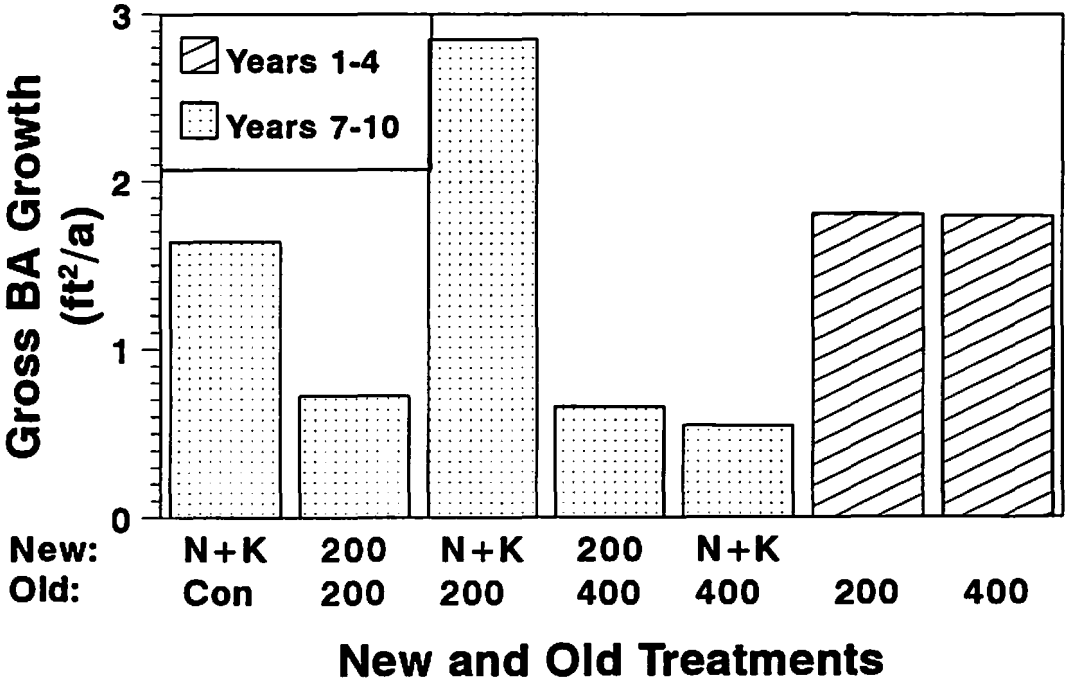

Figure 5
This graph compares retreatment basal area responses to the original four-year response in Montana.

The new treatment with N+K produced significant response nearly identical to original N response. The slight decline can be explained by proportional decline in control plot growth.

Retreatment with N did not produce a significant response. In this region retreatment does not appear to produce the equivalent response as a new treatment (although not different statistically).

There is some possibility of a K effect (it is significant on the 200N original treatment).

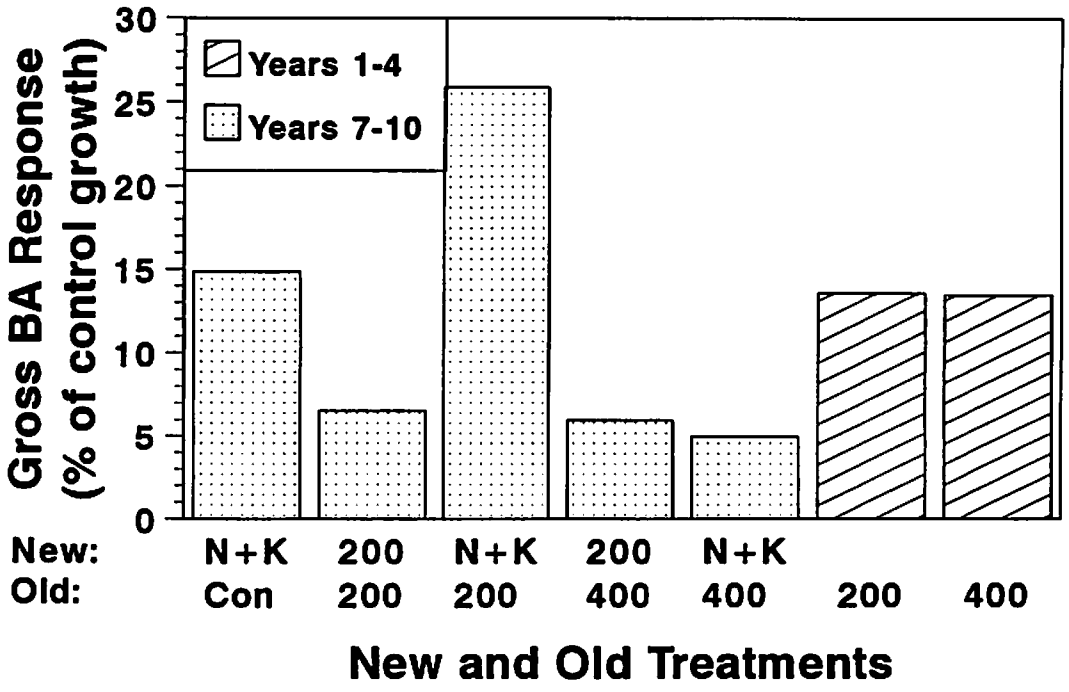

Figure 6
Relative response in Montana shows the same pattern as absolute response indicating that the results are a treatment effect rather than due to a difference in overall growth rates between the two periods.

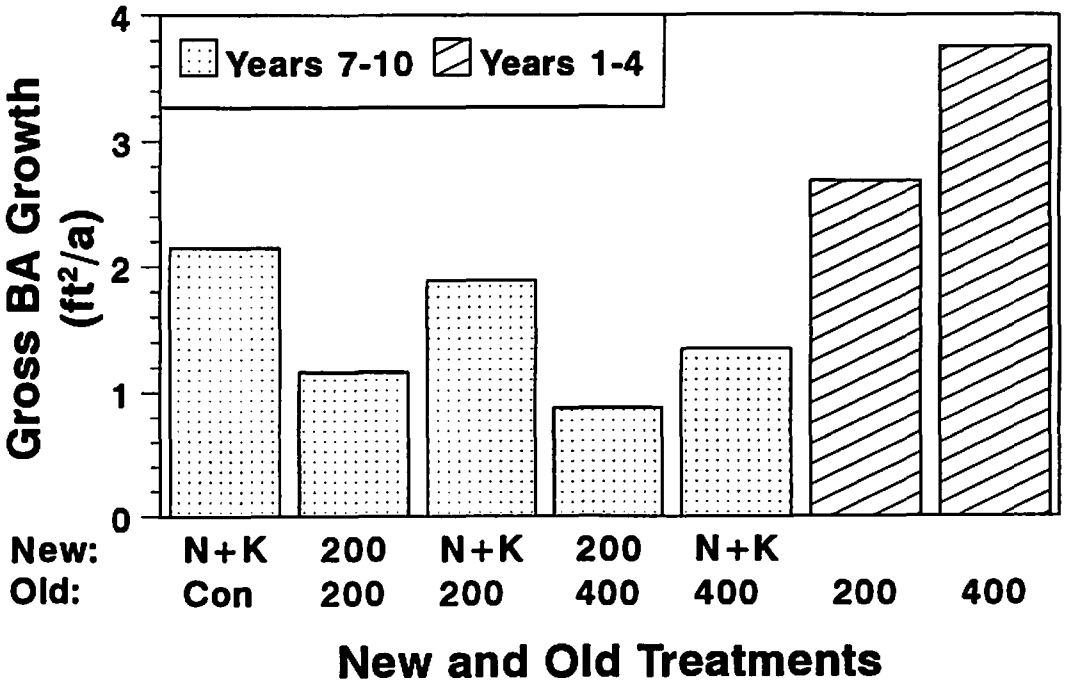

Figure 7
This graph compares retreatment basal area responses to the original four-year response in central Idaho.

There is significant response to N+K treatment, but less than the original N response--likely due to a simple decline in overall growth rates.

Response to the N retreatment is non-significant. There is a possible K effect on retreatment plots--N+K is consistently higher than N only treatments (although not significant).

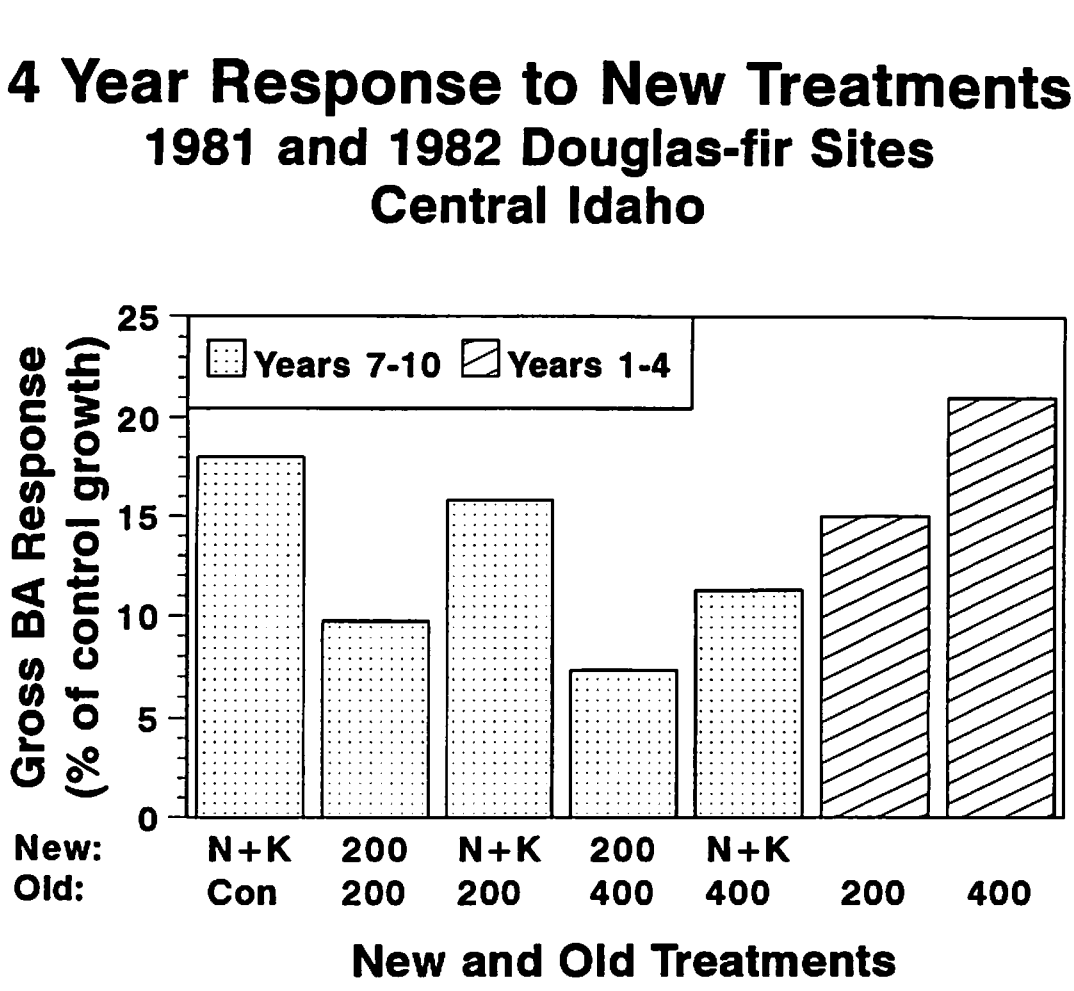

Figure 8
Relative response in central Idaho for new N+K treatment actually exceeds the original N% response as does retreatment with N+K--thus no evidence of decline in response to retreatment (conditional on K being included in the fertilizer mix).

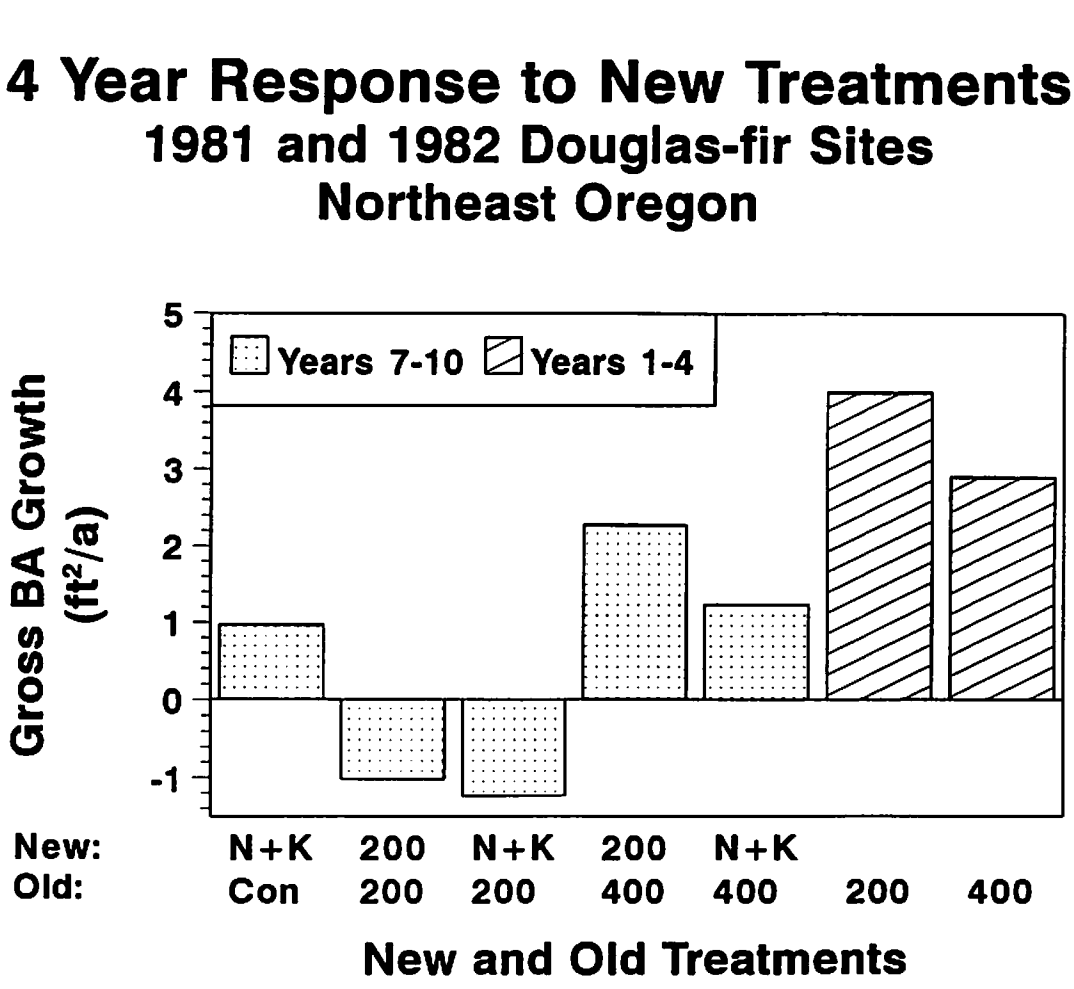

Figure 9
This graph compares retreatment basal area responses to the original four-year response in northeast Oregon.

Response to N and N+K retreatments is non-significant for all conditions. This differs from the original experiment where the 200# N treatment was highly significant. Perhaps environmental conditions during latest period (years 7-10) precluded successful response to N.

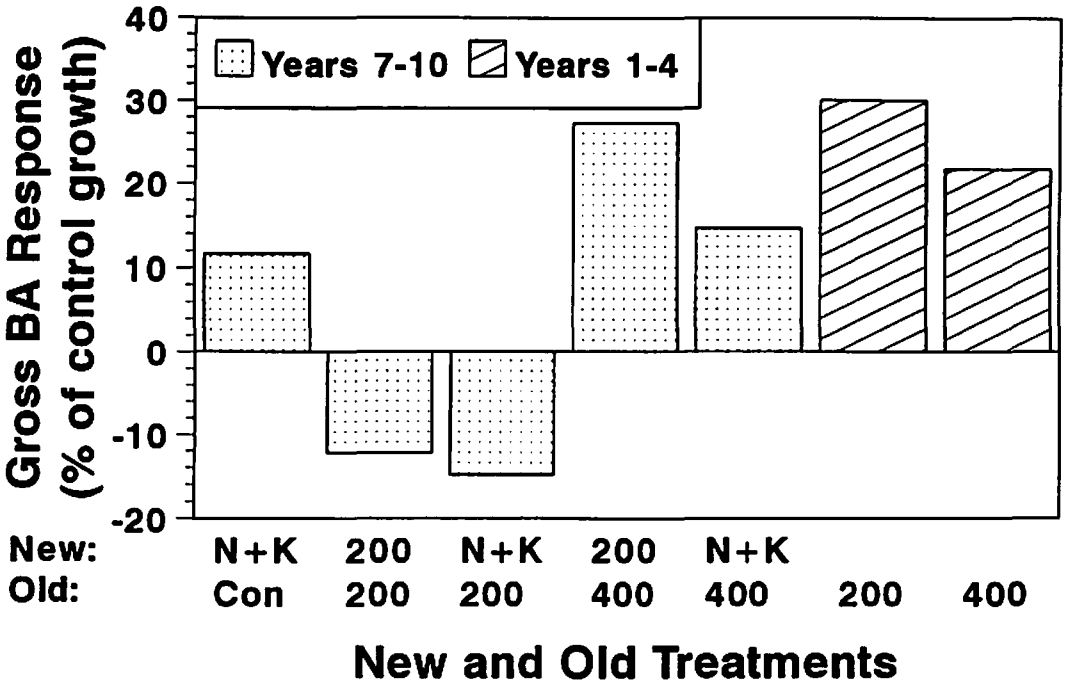

Figure 10
Decline in overall growth rates from years 1-4 to years 7-10 is not enough to account for decline in response to N or N+K treatments observed in Figure 7.

4 Year Response to New Treatments
1981 and 1982 Douglas-fir Sites
Central Washington

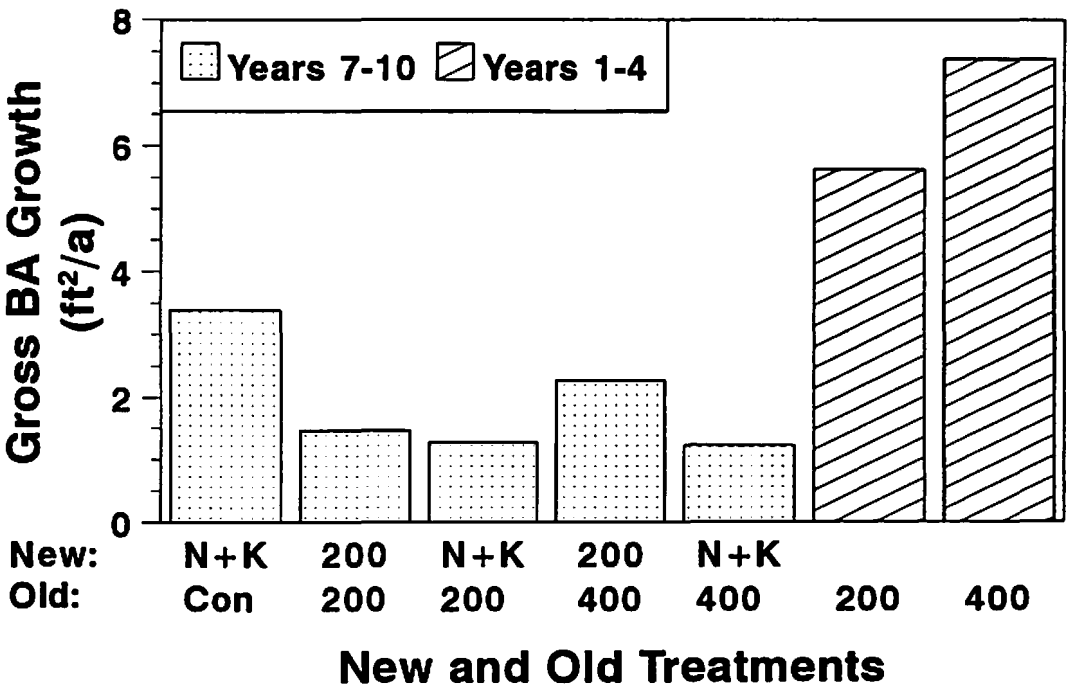

Figure 11
This graph compares retreatment basal area responses to the original four-year response in central Washington.

There was significant response to the new N+K treatment but not to N or N+K retreatments: thus, there is a decline associated with retreatment. There is no evidence of any K effect.

The decline in new response to N compared to response in years 1-4 cannot be accounted for by decline in overall growth rates (see Figure 10).

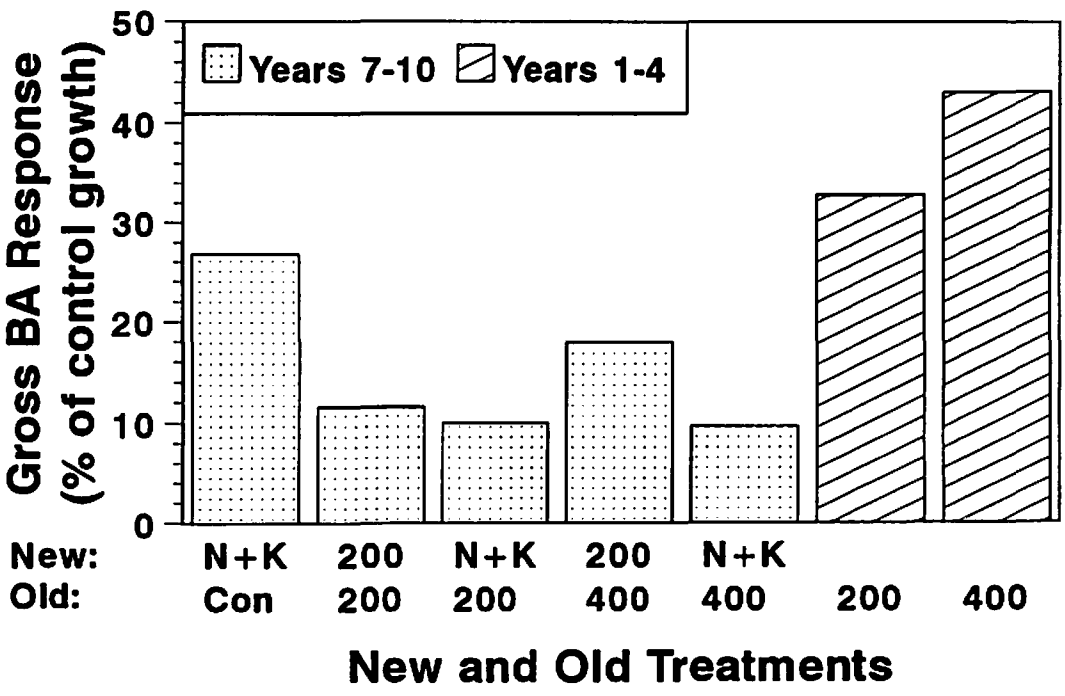

Figure 12
The decline in overall growth rates from years 1-4 to years 7-10 in central Washington is not sufficient to completely account for the decline in response to N+K on the previously untreated plots.

4 Year Response to New Treatments
1981 and 1982 Douglas-fir Sites
Northeast Washington

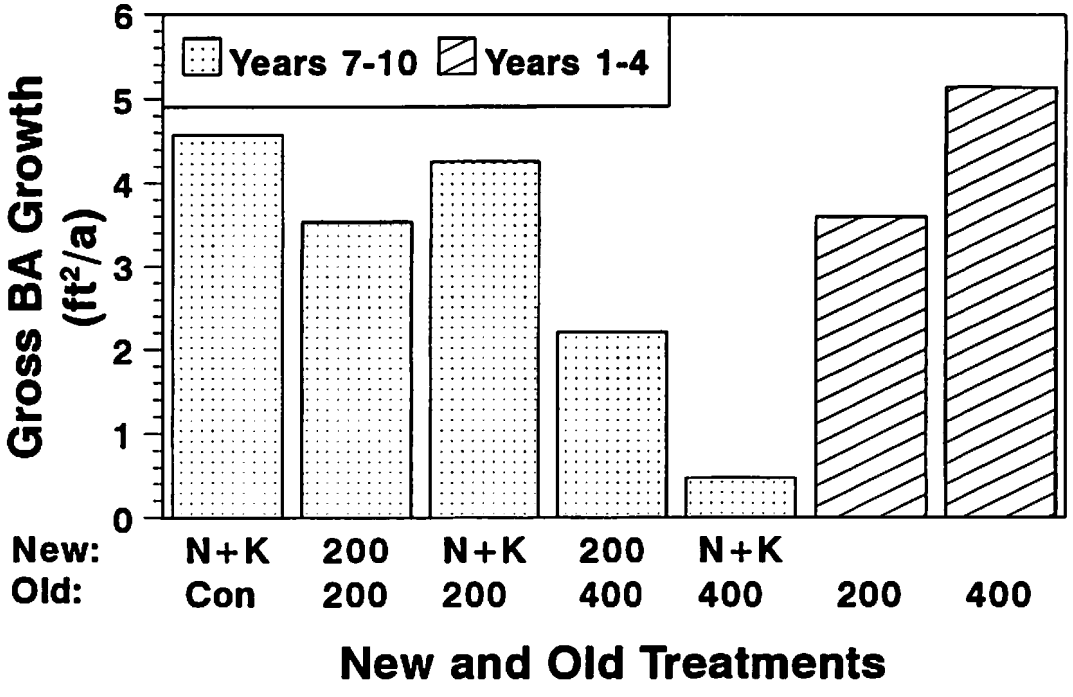

Figure 13
This graph compares retreatment basal area responses to the original four-year response in northeast Washington.

There is significant response to the new N+K treatment and N and N+K retreatments (except to N+K on 400#N). There is some decline in response associated with retreatment. New treatment response exceeds the original N treatment response, despite an overall decline in growth rates for this region.

An interesting pattern of decreased response on former 400# N plots is evident and statistically significant for N+K retreatments.

4 Year Response to New Treatments
1981 and 1982 Douglas-fir Sites
Northeast Washington

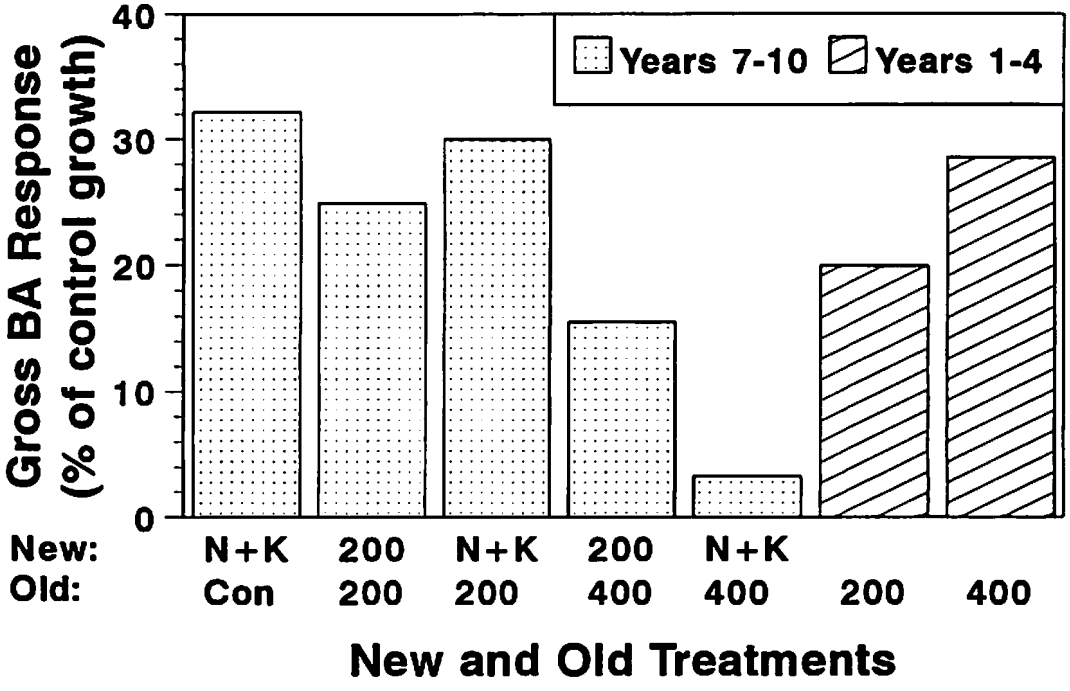

Figure 14
Relative response to the retreatments is even higher than the absolute responses (Figure 11) compared to the original treatments due to overall decreased growth rates in northeast Washington during the most recent growth period.