Presentations given at the Annual Meeting of the Intermountain Forest Tree Nutrition Cooperative

April, 1985

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Peter Mika, Data Analyst

I.F.T.N.C.

I. Review of experimental set-up

A. Distribution of installations by region and year

B. Sampling goals

1. 2nd growth, even-aged, managed stands of Df

2. Range of ages, tree sizes, densities, site conditions

<u>Conditions sampled</u>:

	Range	Mean
Age	27 to 100	65 years
BA	48 to 272	142 ft^2/A
DBH	5.8 to 15.3	10.3 inches
Site Index	37.1 to 108.0	68.7 ft @ 50 yrs
% Df		87.5%

Plot set-up

II. Results from analysis of experimental design

A. Model #1

1. Overall model statistics

2. Details on factors influencing treatment response

a. Regional differences (at BA = 150 ft^2/A)

(i) Absolute 2 year BAI by treatment and region

Good general growth in N Idaho

Poor growth in NE Oregon

General increase from control to N treatment across all regions

(ii) Difference between control and N treatment by region

Large response of N. Idaho and Central Washington

Large change from 200 to 400 in Central Washington

(iii) % change [(treatment-control/control]

Relative response about the same over all regions, except for Central Washington

b. BA differences

(i) % response decreases as initial BA increases

(ii) 400 # response seems to converge to 200# response at higher BA (200 ft^2/A)

3. Details on factors influence underlying growth rates

a. BA differences

(i) Overall, as BA increases, growth/acre also increases - effect of increased stocking level

(ii) Yearly differences

1981 - decreasing rate of BAI/BA at higher BA

1982 - linear across the range of BA's

b. Year differences - vary by region

(i) North Idaho, Central Idaho, NE Oregon, Central Washington - higher growth rates on 1982 installation

(ii) NE Washington - growth rates similar in both years

(iii) Montana - higher growth rates on 1981 installation

B. Model #2

Region x treatment and BA x treatment replaced by Min N x treatment

1. Overall model statistics
2. Factors influencing treatment response
   a. Min N differences
      (i) Convergence of treatment response to control levels as Min N increases
      (ii) Convergence of 400# to 200# on Min N increases
3. Factors influencing underlying growth rates
   a. Min N
      (i) Growth on control plots shows trend of increasing growth with increasing Min-N

(ii) Basically no trend (zero slope) for BAI versus Min N on treated plots

NUMBER OF INSTALLATIONS

Region	Year of Installment 1981	1982	Total
Northern Idaho	5	14	19
Central Idaho	8	5	13
Montana	8	8	16
NE Oregon	6	2	8
Central Washington	9	9	18
NE Washington	9	7	16
TOTAL	45	45	90

Design Model 1

LN (BAI) =

F (Year , Region , Year x Region,

Installation (Year Region)

Block (Year Region Installation)

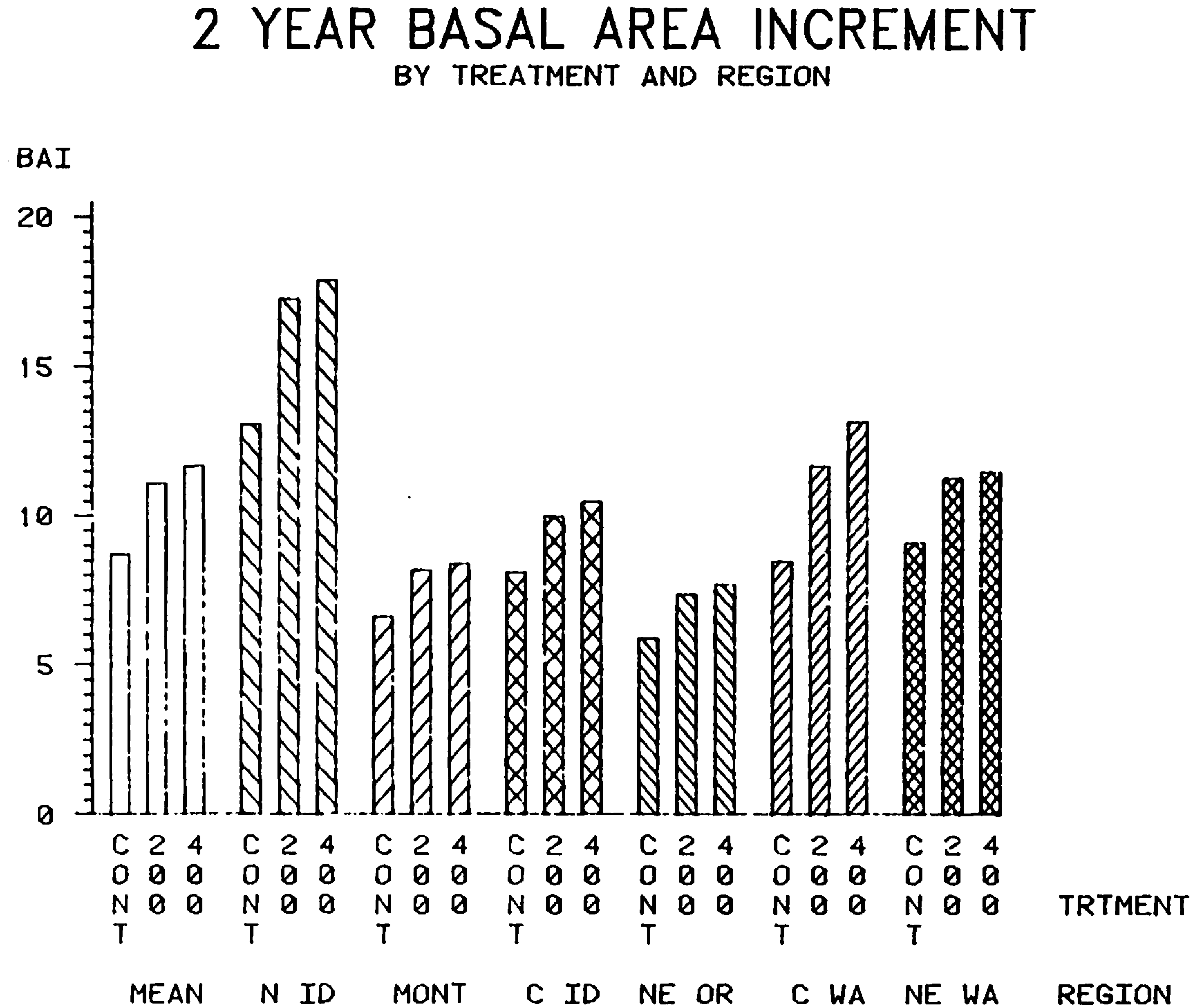
Treatment

Region x Treatment

BA BA x Treatment BA x Year

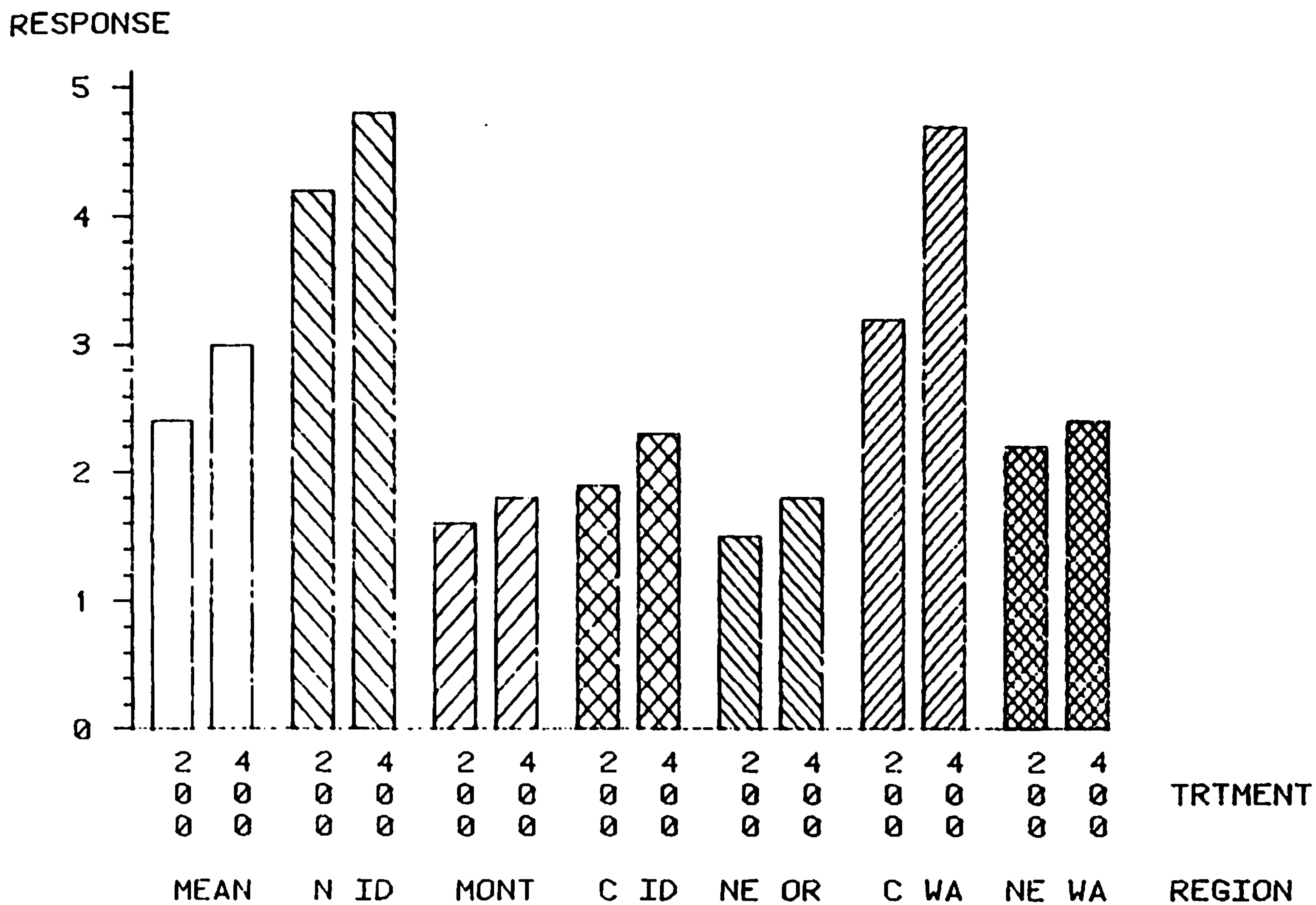
BA^2 BA^2 x Treatment BA^2 x Year)

R^2 = 0.9025 MSE = 0.0243 CV = 6.86%


2 YEAR BASAL AREA INCREMENT
BY TREATMENT AND REGION
BAI
20
15
10
5
0
CONT 200 400
TRTMENT
MEAN
N ID
MONT
C ID
NE OR
C WA
NE WA
REGION

BAI INCREASE OVER CONTROL

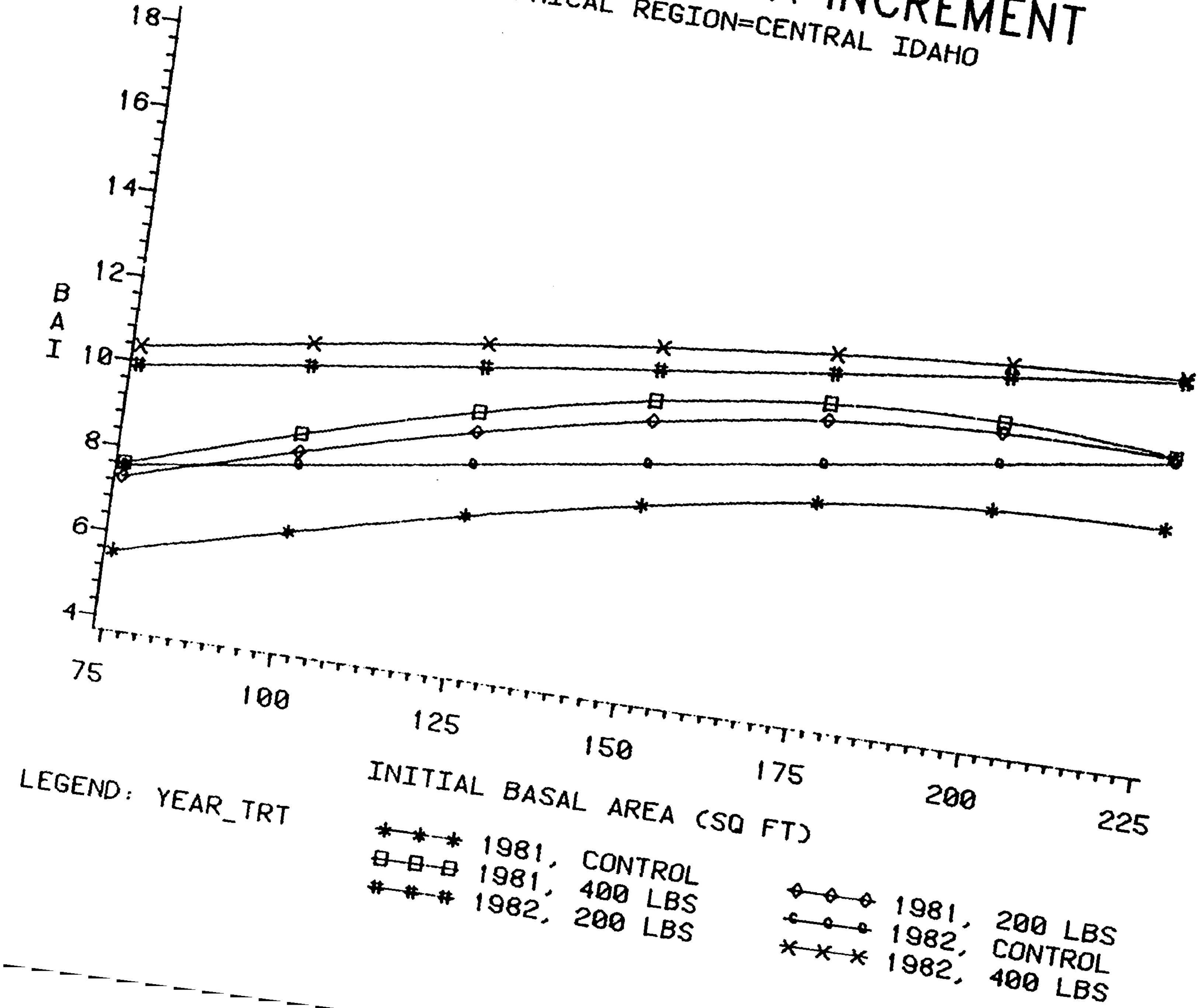
BY TREATMENT AND REGION

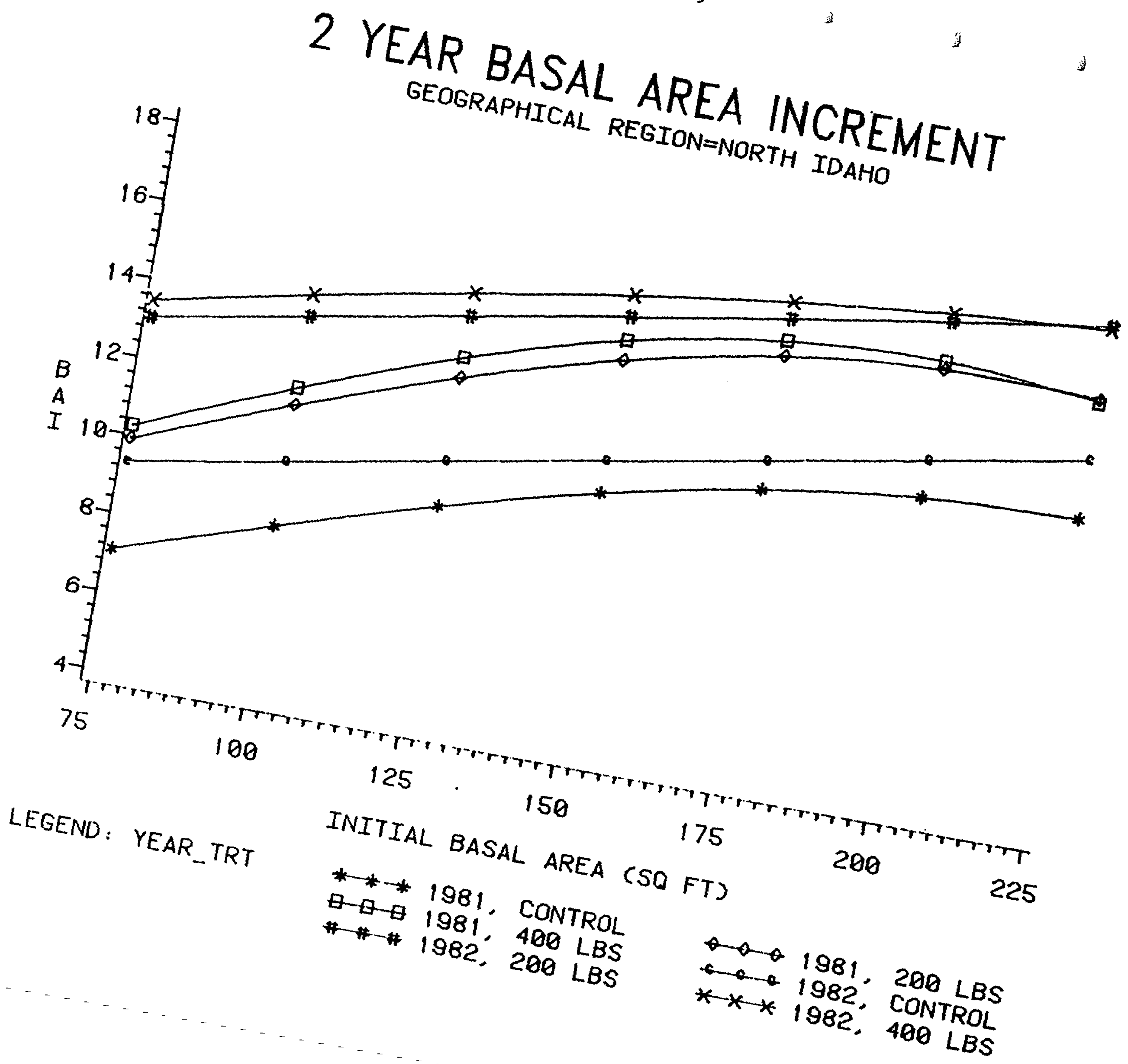


8

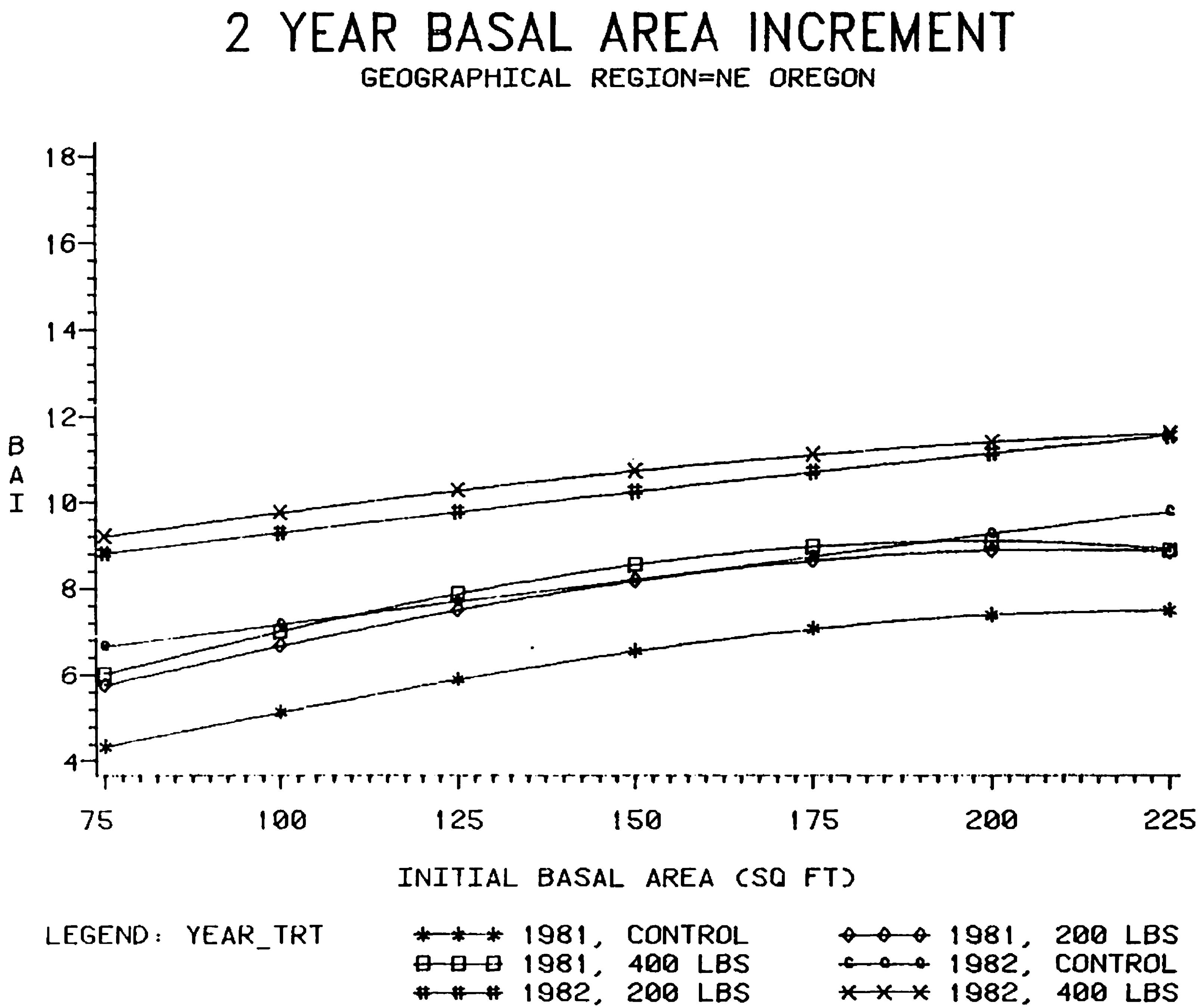
2 YEAR BASAL AREA INCREMENT

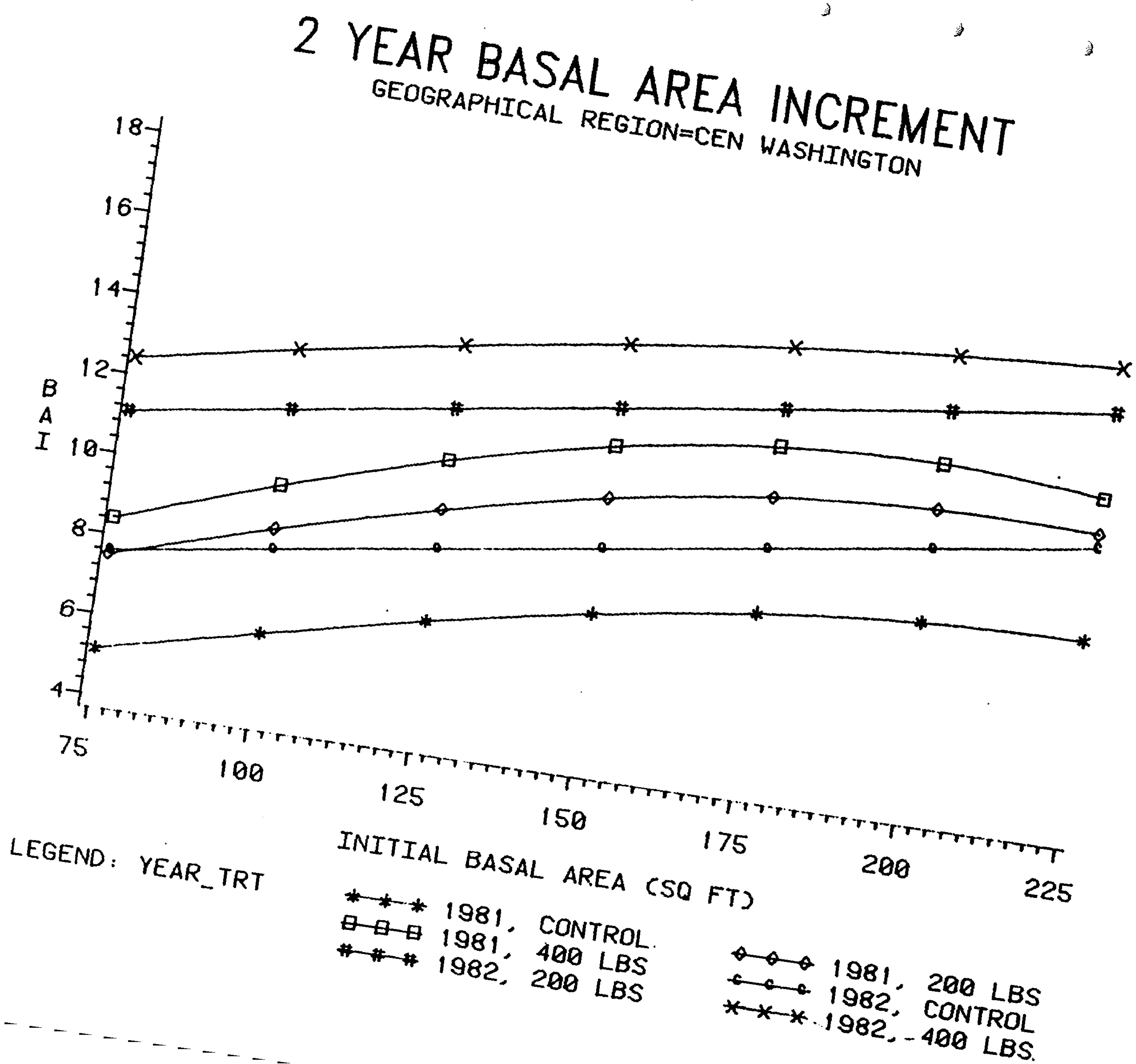
GEOGRAPHICAL REGION=CENTRAL IDAHO



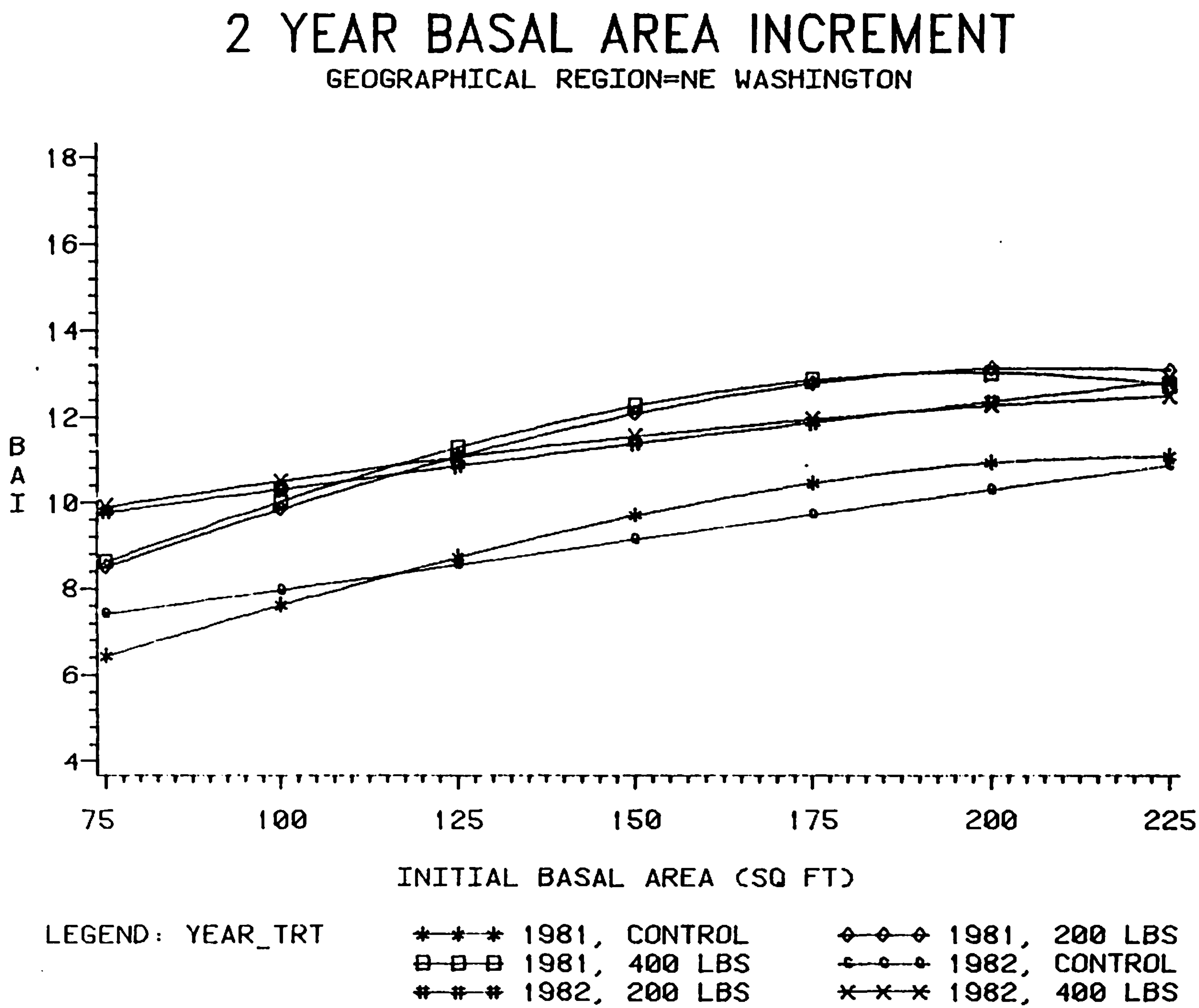


2 YEAR BASAL AREA INCREMENT
GEOGRAPHICAL REGION=NORTH IDAHO
BAI
18
16
14
12
10
8
6
4
75
100
125
150
175
200
225
INITIAL BASAL AREA (SQ FT)
LEGEND: YEAR_TRT
1981, CONTROL
1981, 400 LBS
1982, 200 LBS
1981, 200 LBS
1982, CONTROL
1982, 400 LBS


2 YEAR BASAL AREA INCREMENT
GEOGRAPHICAL REGION=NE OREGON
BAI
18
16
14
12
10
8
6
4
75
100
125
150
175
200
225
INITIAL BASAL AREA (SQ FT)
LEGEND: YEAR_TRT
1981, CONTROL
1981, 200 LBS
1981, 400 LBS
1982, CONTROL
1982, 200 LBS
1982, 400 LBS

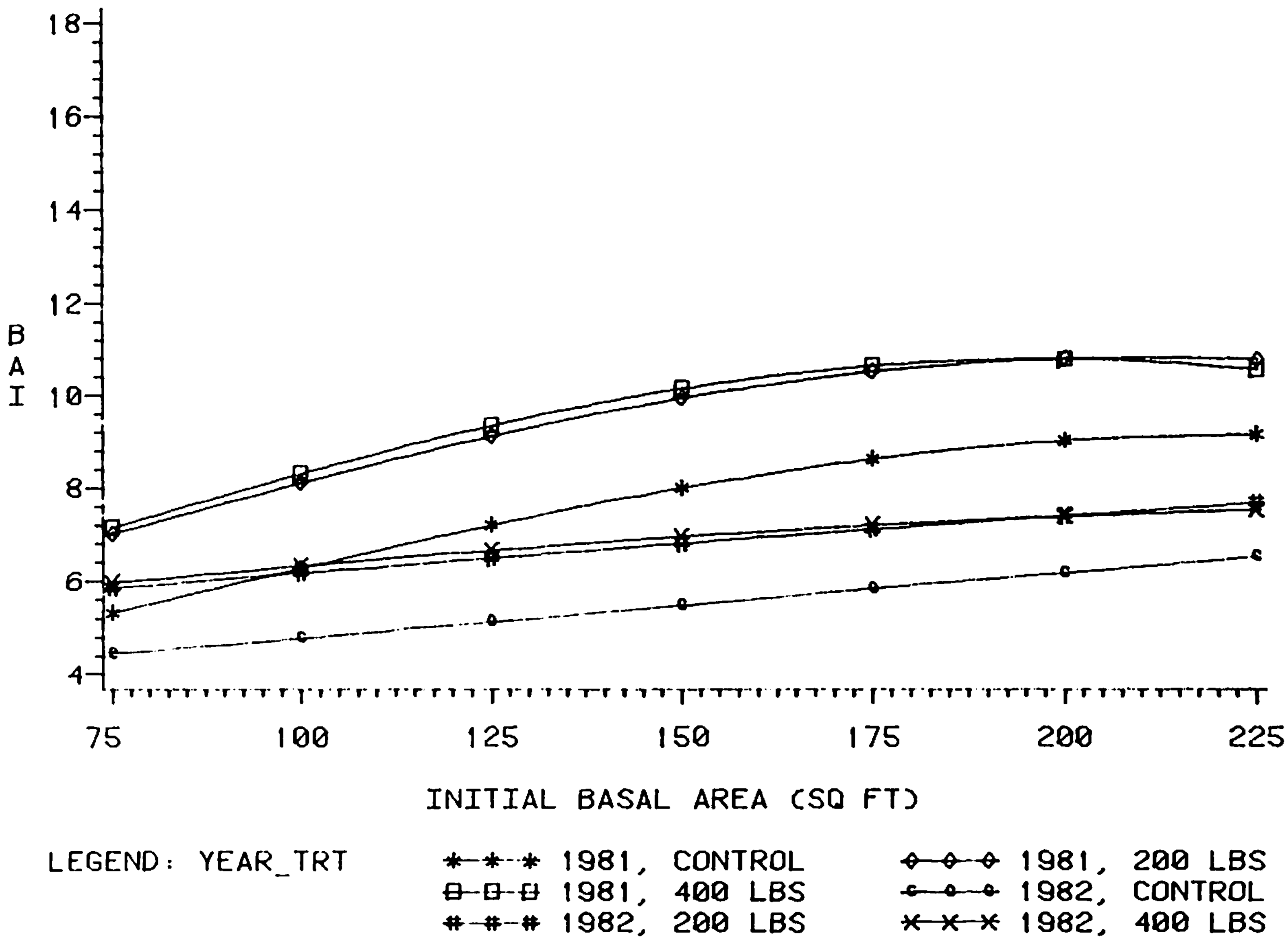


2 YEAR BASAL AREA INCREMENT
GEOGRAPHICAL REGION=CEN WASHINGTON
BAI
18
16
14
12
10
8
6
4
75
100
125
150
175
200
225
INITIAL BASAL AREA (SQ FT)
LEGEND: YEAR_TRT
1981, CONTROL
1981, 400 LBS
1982, 200 LBS
1981, 200 LBS
1982, CONTROL
1982, 400 LBS


2 YEAR BASAL AREA INCREMENT
GEOGRAPHICAL REGION=NE WASHINGTON
BAI
18
16
14
12
10
8
6
4
75
100
125
150
175
200
225
INITIAL BASAL AREA (SQ FT)
LEGEND: YEAR_TRT
1981, CONTROL
1981, 400 LBS
1982, 200 LBS
1981, 200 LBS
1982, CONTROL
1982, 400 LBS

2 YEAR BASAL AREA INCREMENT

GEOGRAPHICAL REGION=MONTANA



DESIGN MODEL 2

LN (BAI) =

F (YEAR , REGION , YEAR X REGION,

INSTALLATION (YEAR REGION)

BLOCK (YEAR REGION INSTALLATION)

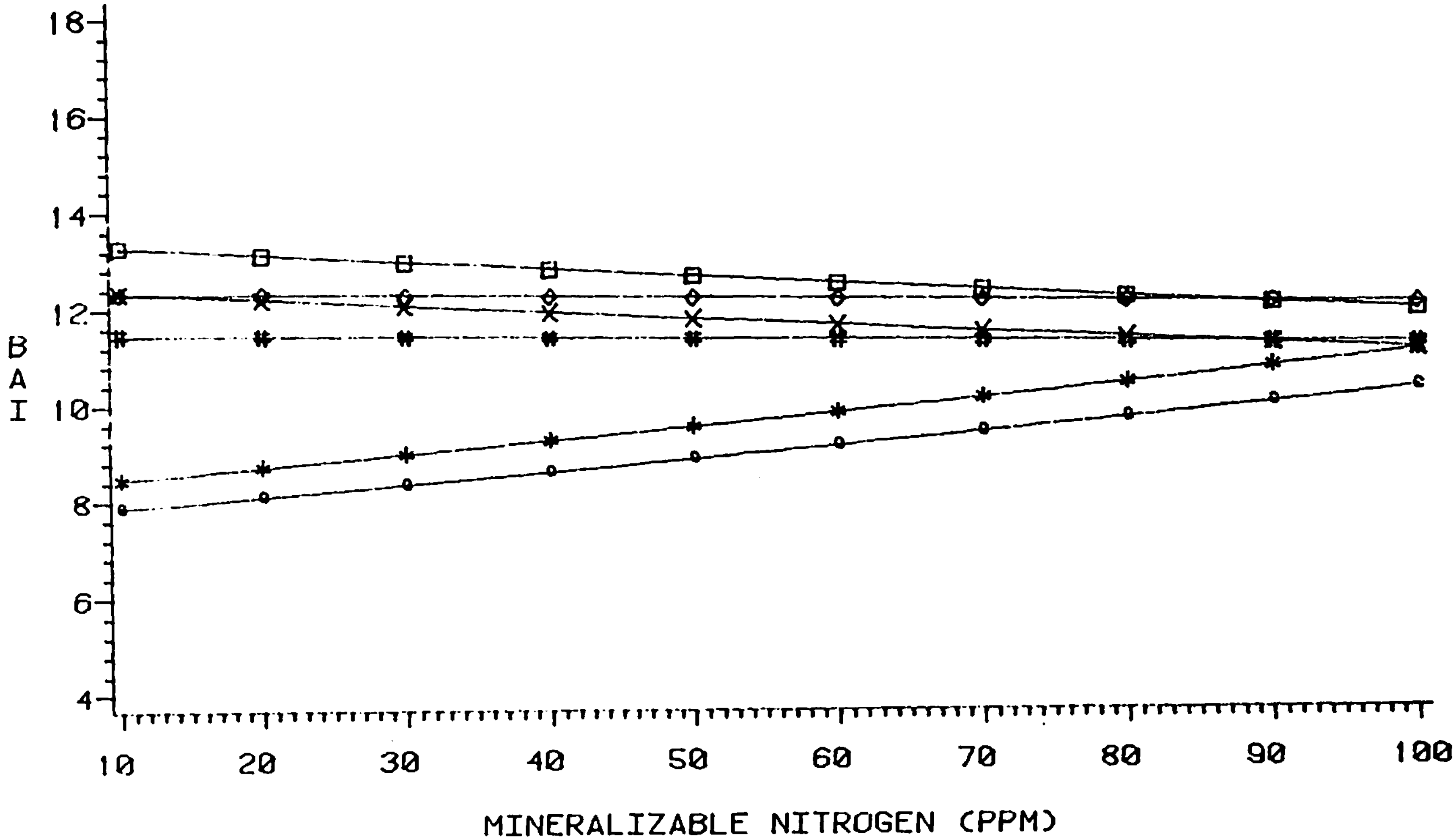
TREATMENT

BA	BA X YEAR
BA^2	BA^2 X YEAR
MIN N	MIN N X TREATMENT)

R^2 = 0.9038 MSE = 0.0232 CV = 6.71%

2 YEAR BASAL AREA INCREMENT

GEOGRAPHICAL REGION=NE WASHINGTON

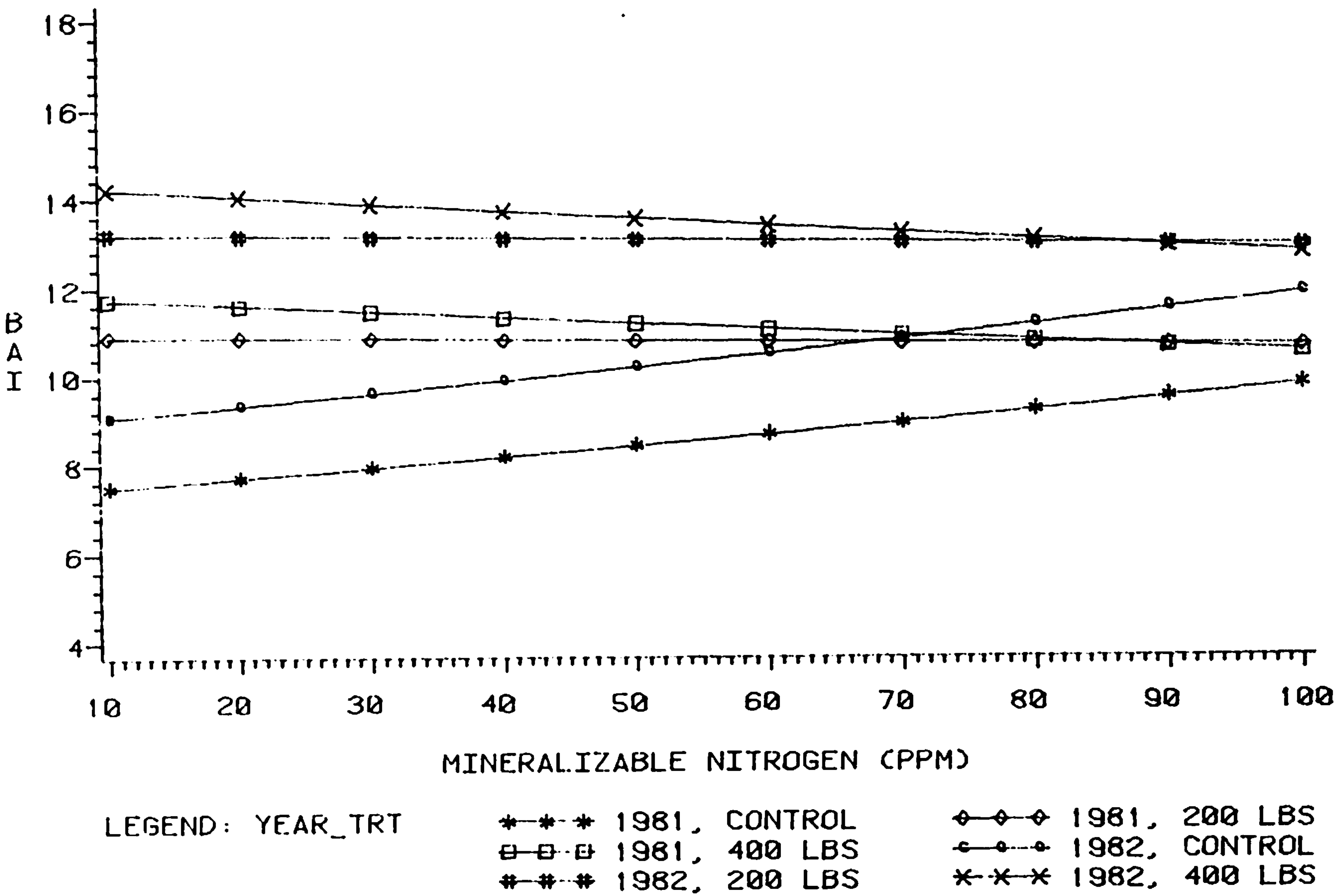


LEGEND: YEAR_TRT

- ✱—✱—✱ 1981, CONTROL
- ⊟—⊟—⊟ 1981, 400 LBS
- #—#—# 1982, 200 LBS
- ◇—◇—◇ 1981, 200 LBS
- o—o—o 1982, CONTROL
- ✕—✕—✕ 1982, 400 LBS

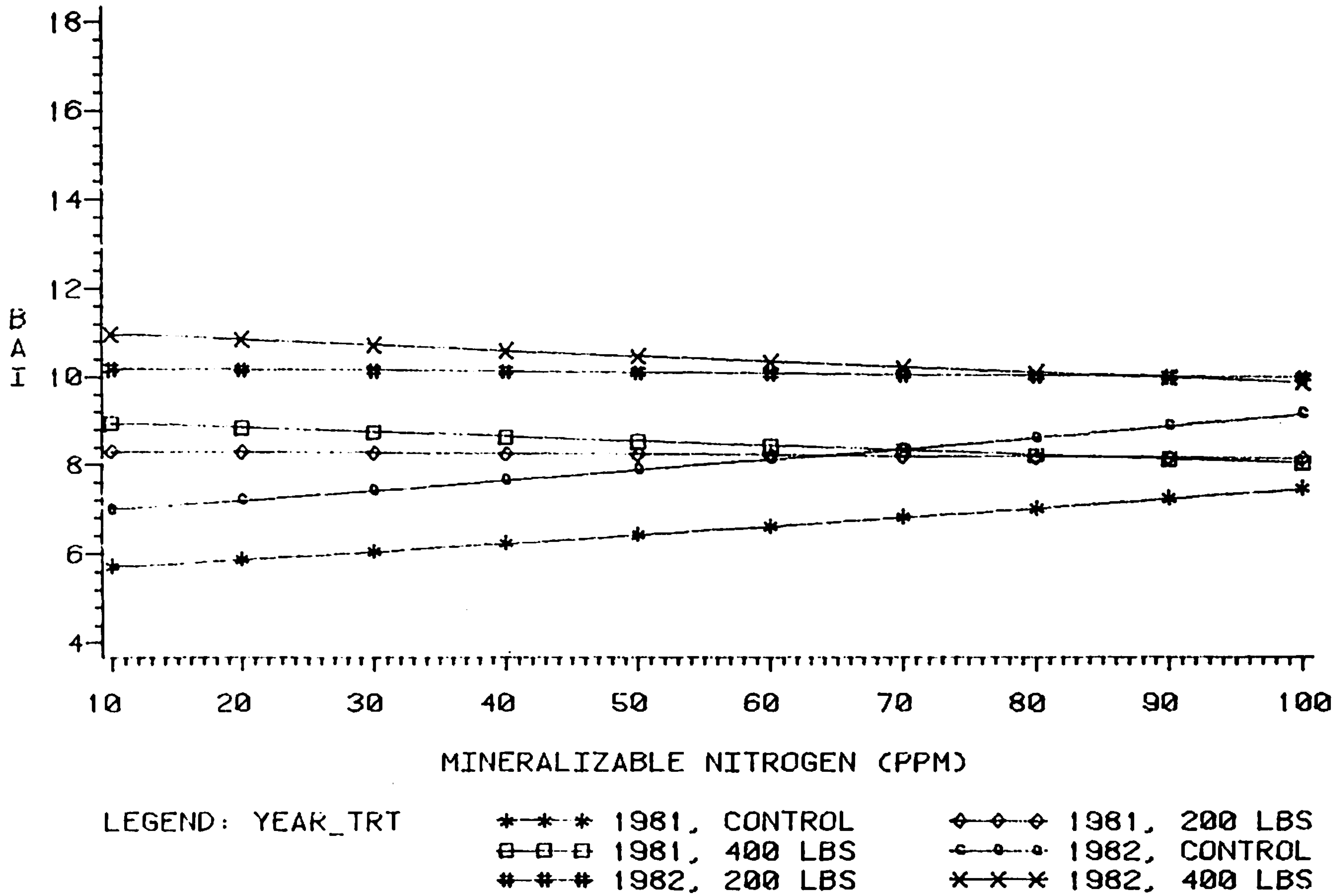
2 YEAR BASAL AREA INCREMENT

GEOGRAPHICAL REGION=CEN WASHINGTON



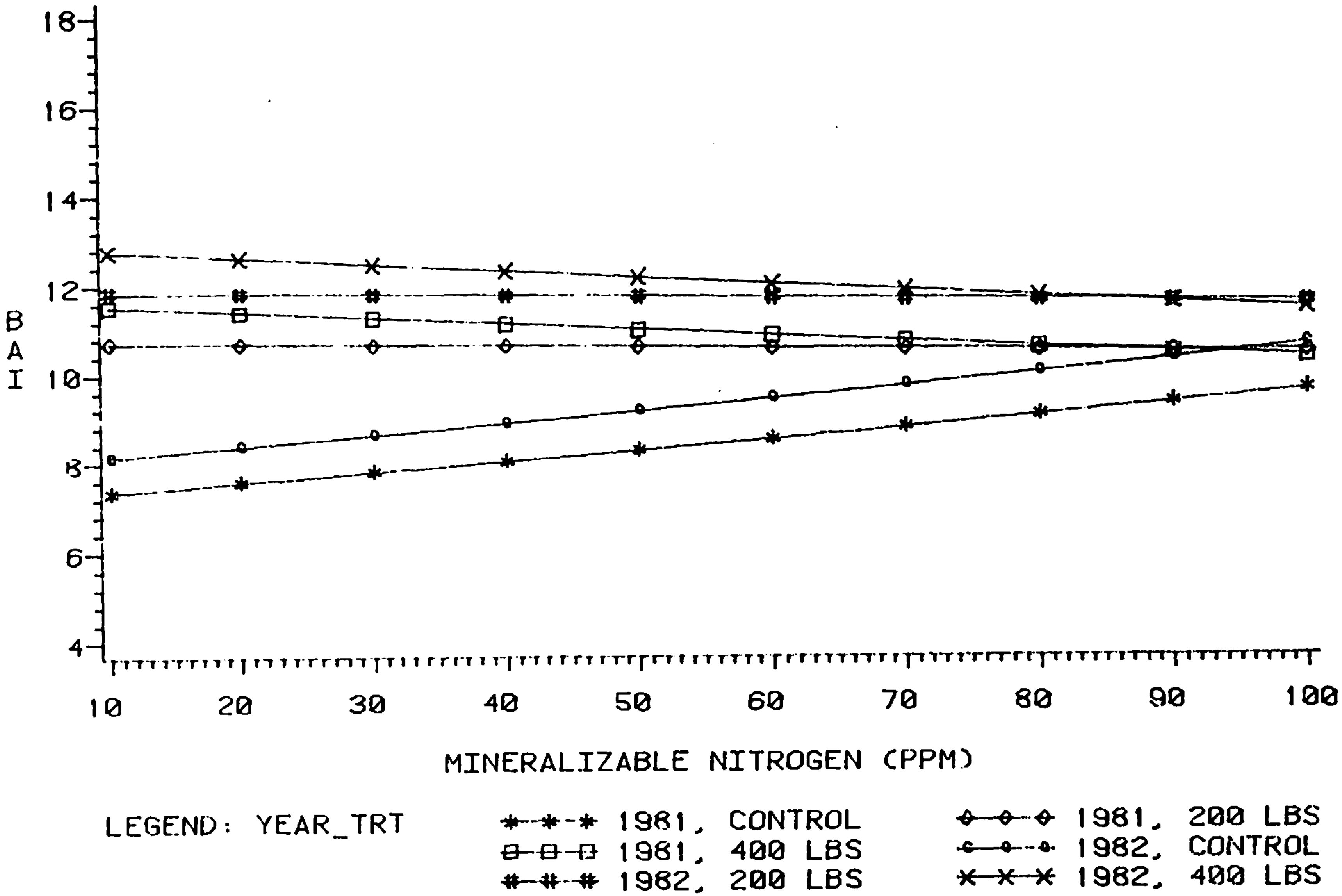
2 YEAR BASAL AREA INCREMENT

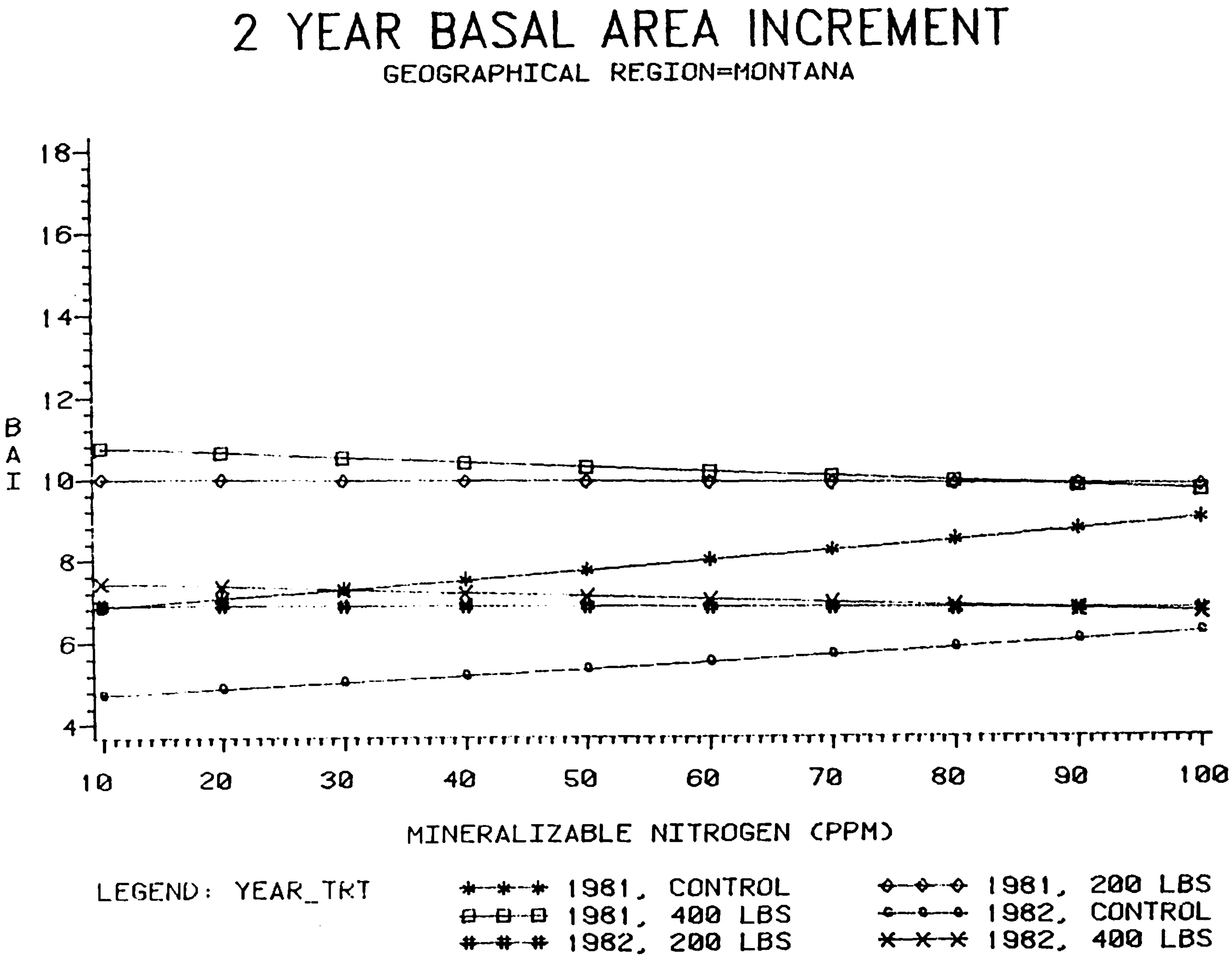
GEOGRAPHICAL REGION=NE OREGON



2 YEAR BASAL AREA INCREMENT

GEOGRAPHICAL REGION=CENTRAL IDAHO




2 YEAR BASAL AREA INCREMENT
GEOGRAPHICAL REGION=MONTANA
BAI
18
16
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12
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8
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4
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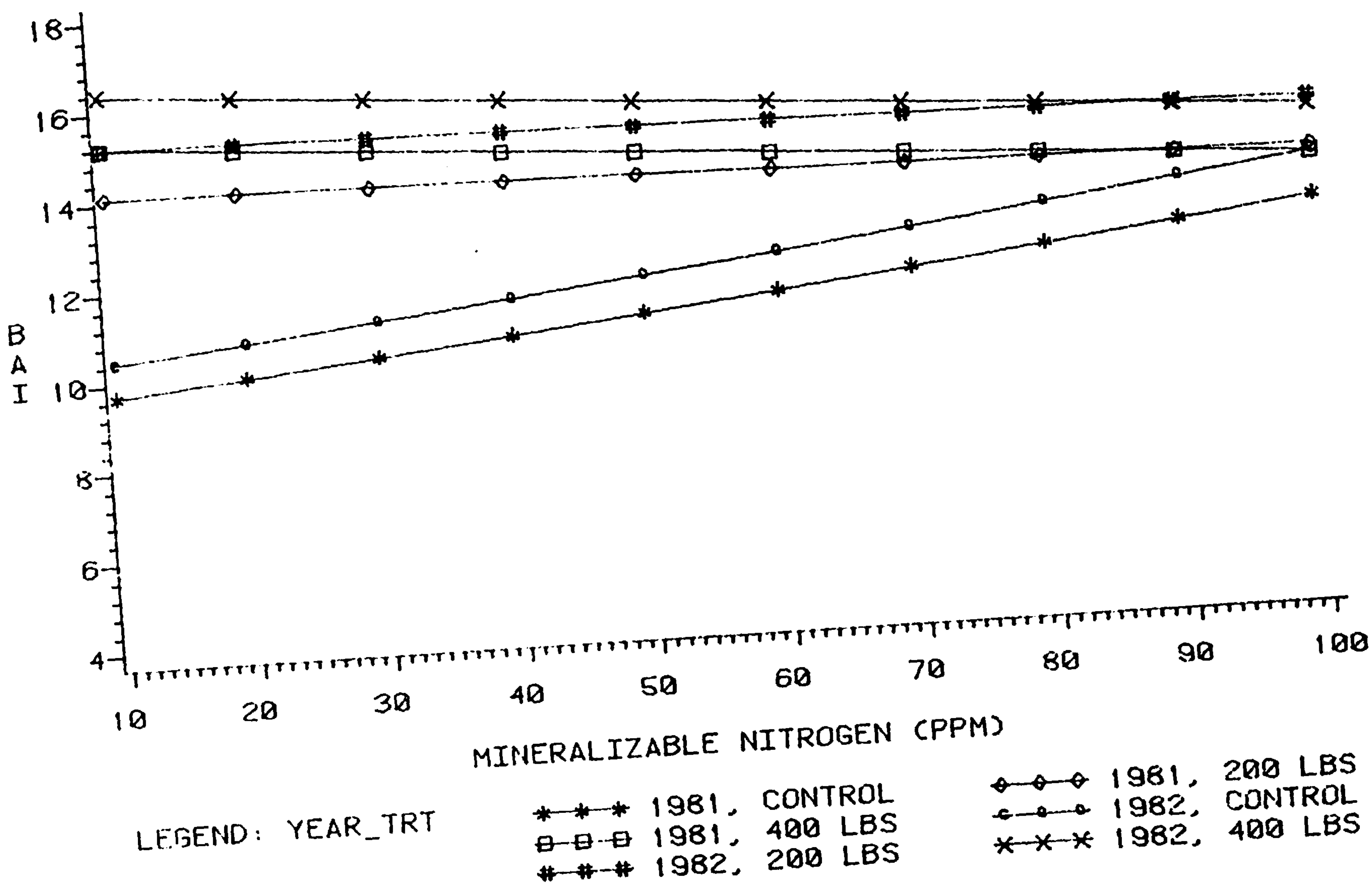
20
30
40
50
60
70
80
90
100
MINERALIZABLE NITROGEN (PPM)
LEGEND: YEAR_TRT
1981, CONTROL
1981, 400 LBS
1982, 200 LBS
1981, 200 LBS
1982, CONTROL
1982, 400 LBS

2 YEAR BASAL AREA INCREMENT

GEOGRAPHICAL REGION=NORTH IDAHO



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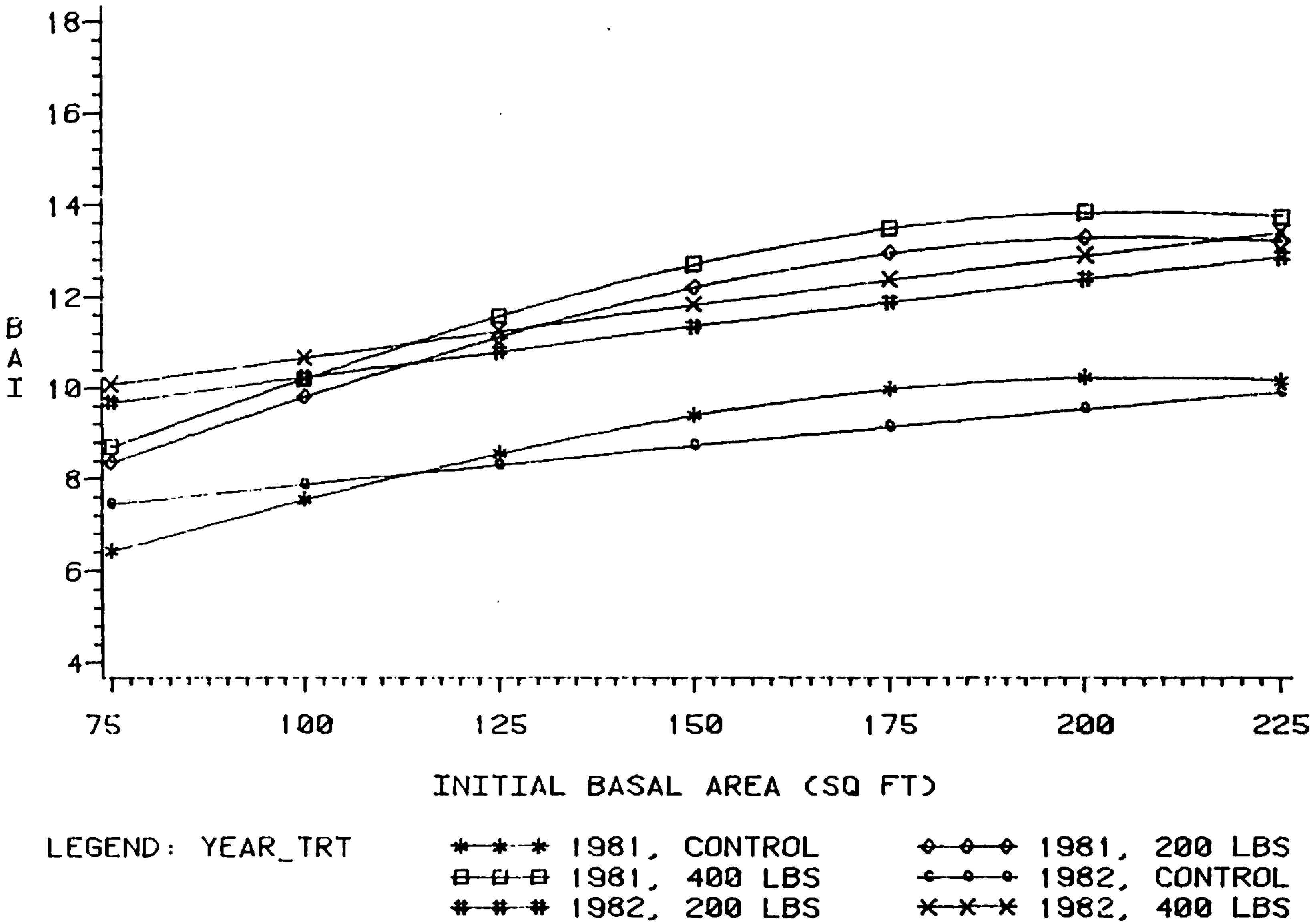
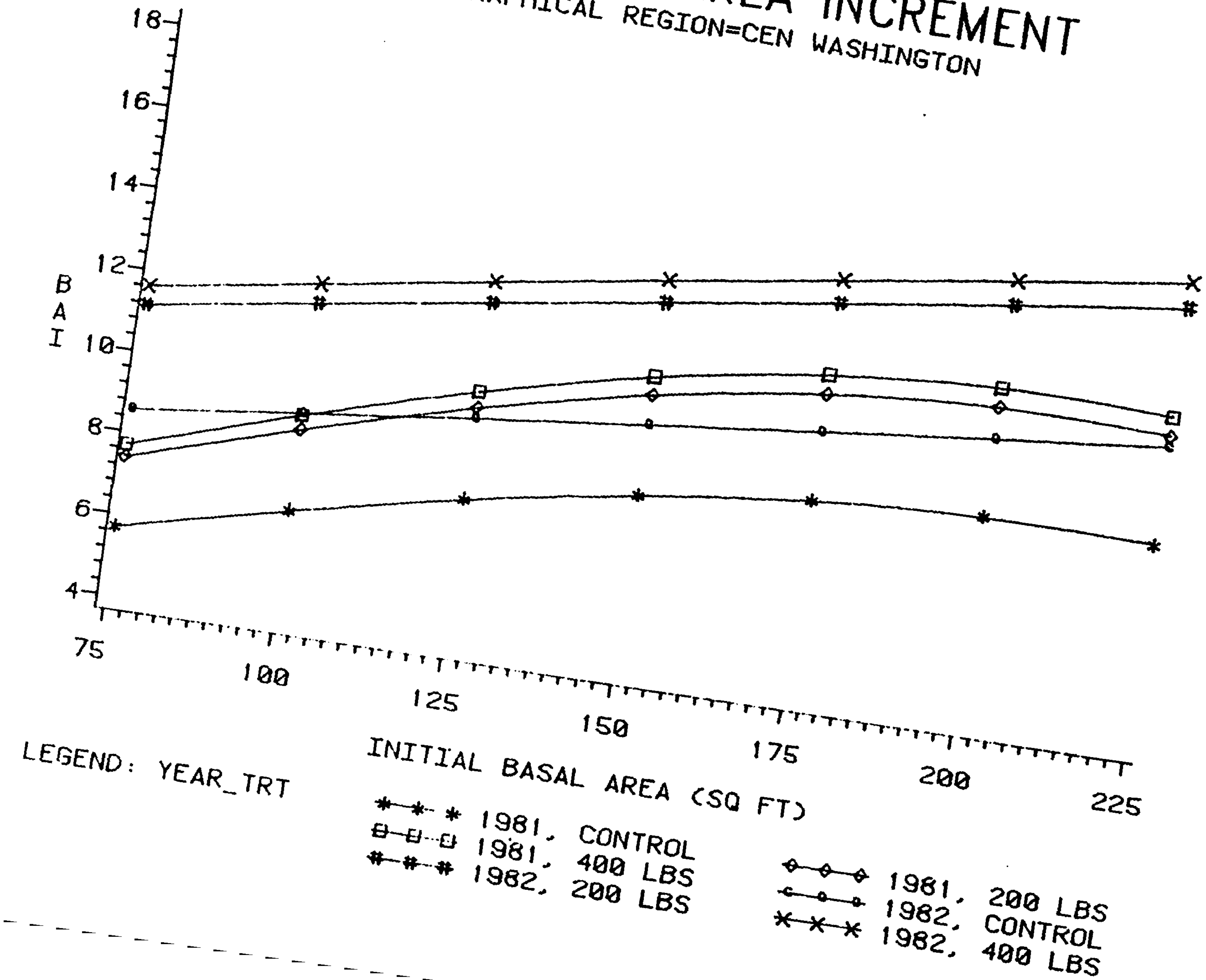
2 YEAR BASAL AREA INCREMENT

GEOGRAPHICAL REGION=NE WASHINGTON



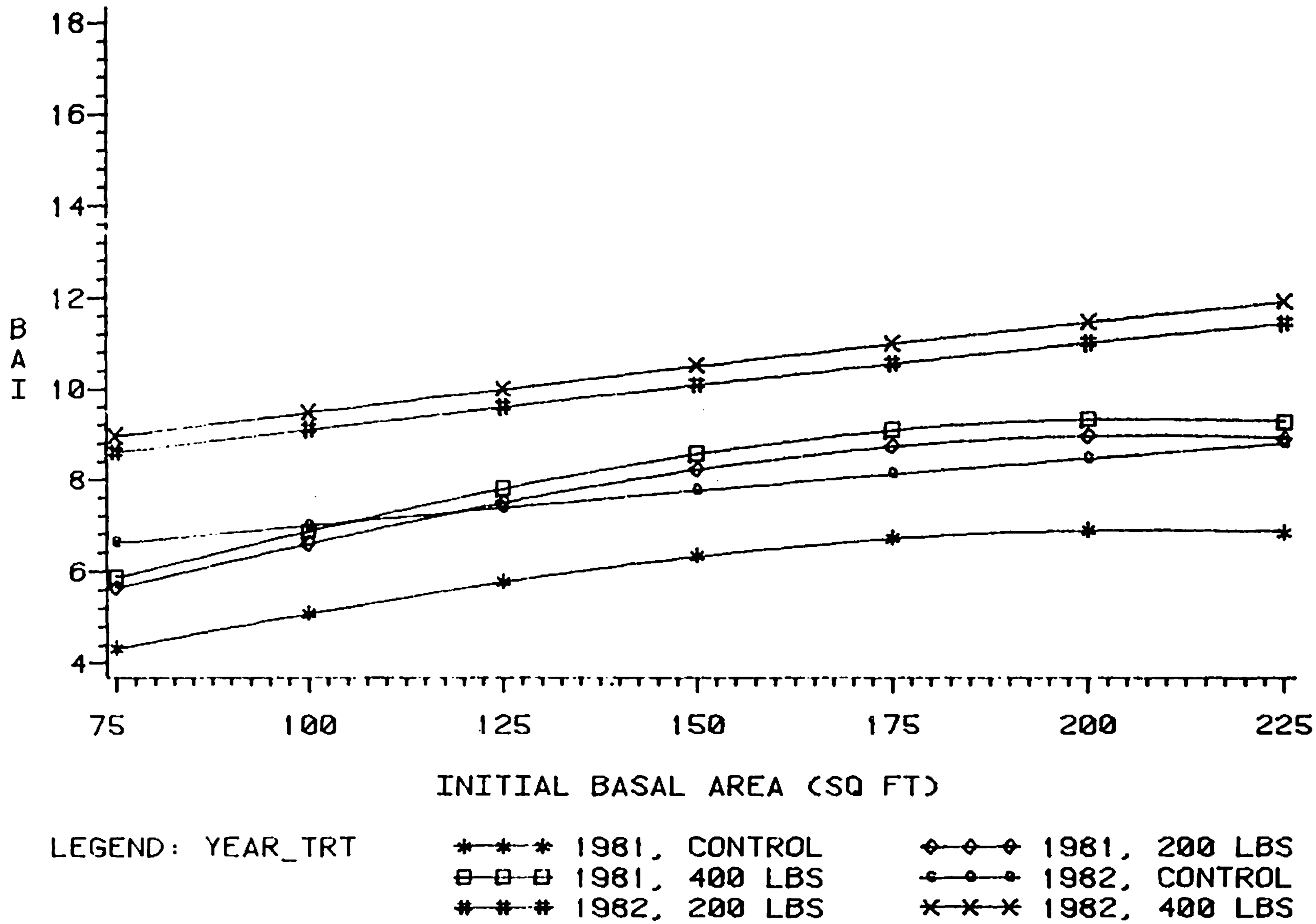
2 YEAR BASAL AREA INCREMENT

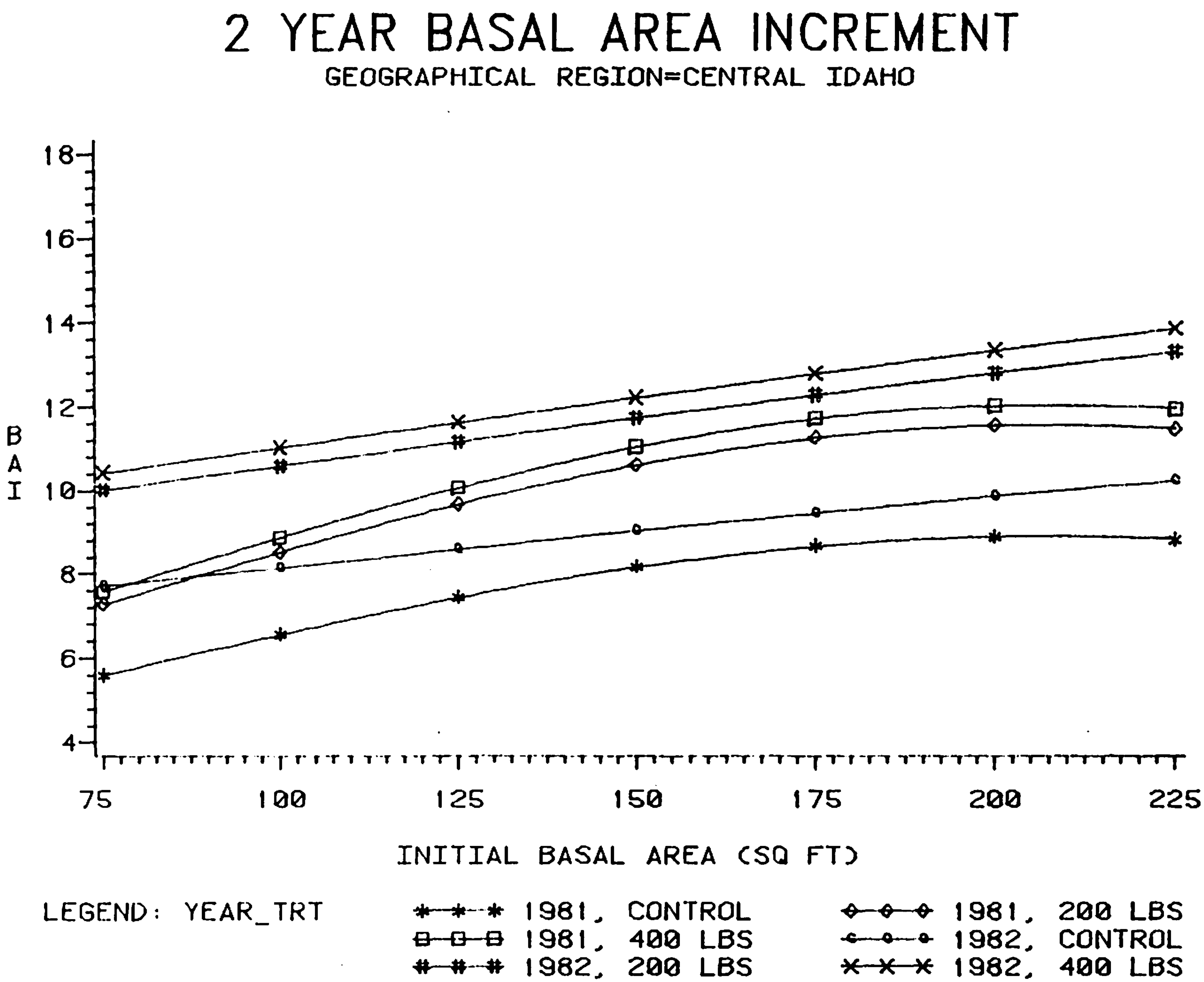
GEOGRAPHICAL REGION=CEN WASHINGTON



2 YEAR BASAL AREA INCREMENT

GEOGRAPHICAL REGION=NE OREGON





2 YEAR BASAL AREA INCREMENT
GEOGRAPHICAL REGION=CENTRAL IDAHO
BAI
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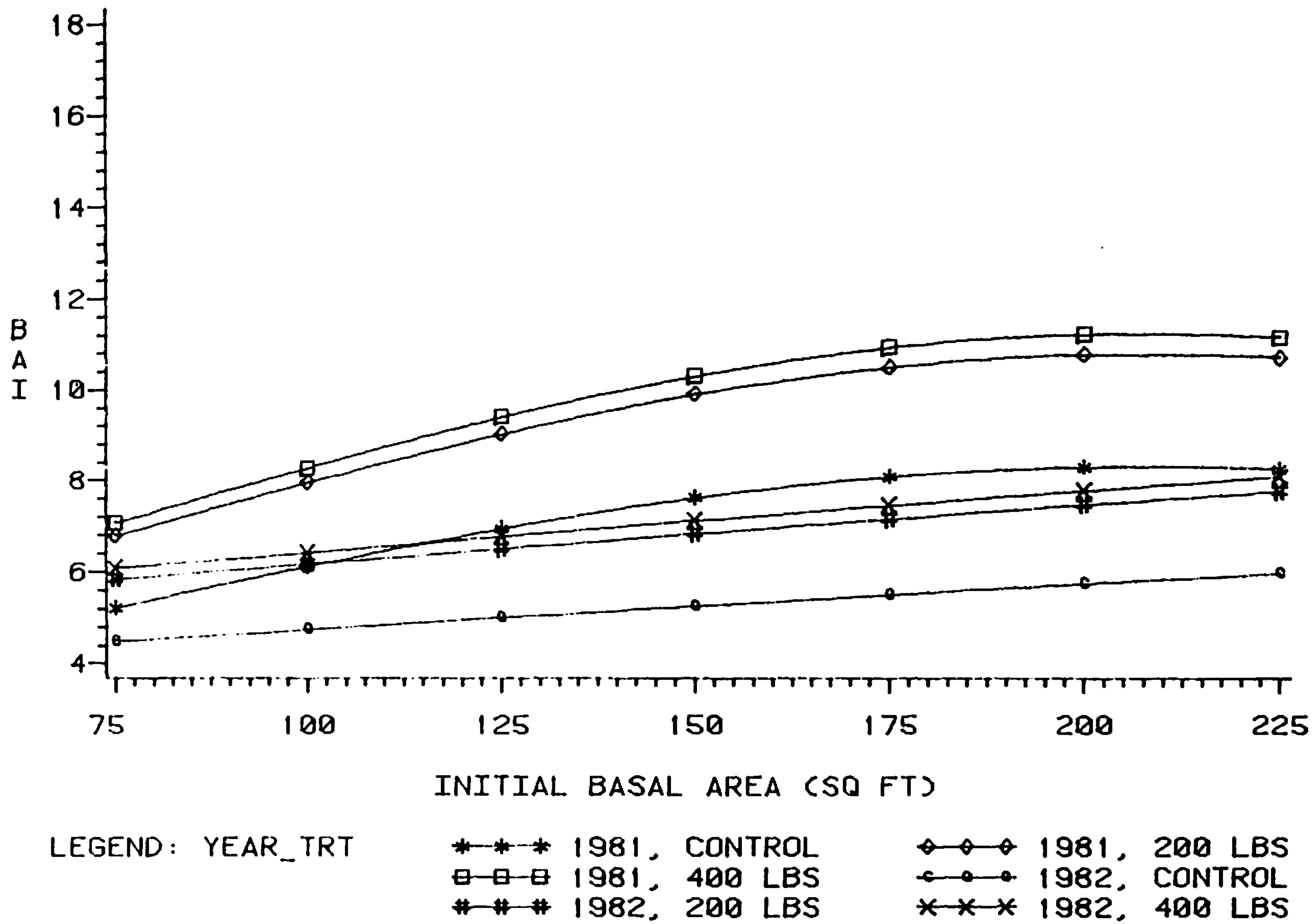
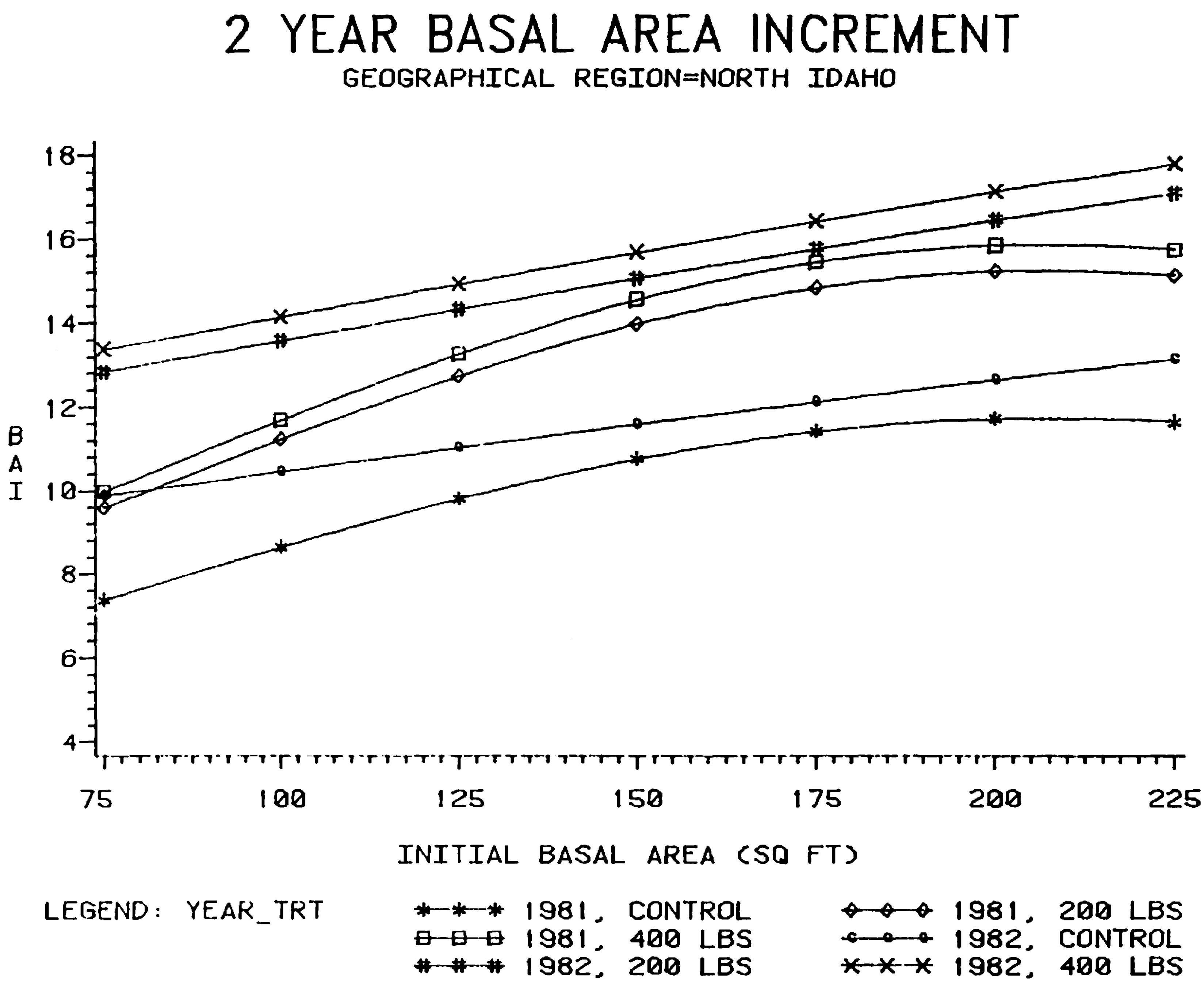
INITIAL BASAL AREA (SQ FT)
LEGEND: YEAR_TRT
1981, CONTROL
1981, 400 LBS
1982, 200 LBS
1981, 200 LBS
1982, CONTROL
1982, 400 LBS

2 YEAR BASAL AREA INCREMENT

GEOGRAPHICAL REGION=MONTANA




2 YEAR BASAL AREA INCREMENT
GEOGRAPHICAL REGION=NORTH IDAHO
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INITIAL BASAL AREA (SQ FT)
LEGEND: YEAR_TRT
1981, CONTROL
1981, 200 LBS
1981, 400 LBS
1982, CONTROL
1982, 200 LBS
1982, 400 LBS

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Predictive Model of Response to Nitrogen Fertilization

Contrast with design model = differences between installations rather than within installations.

Predictive model R^2 = .70 vs. R^2 = .90 for the Design Models.

Variables in the predictive model that account for underlying differences in growth between installations but do not interact with treatment are:

*Soil Depth - deep soils (>24") grow better than medium (12 to 24") grow better than shallow soils (≤12").

*Ash Depth - (where present) - deep ash soils (>12") grow better than shallow ash caps. This will be illustrated later.

*Douglas-fir site index (Monserud 1984) - as site index increases growth increases. See Figure 1.

*Slope and aspect - this is expressed as an interaction term (Stage 1976) in the model. The highest basal area increment occurs on Southerly aspects (other factors being equal). Similar results from other studies in Northern Hemisphere. See Figure 2.

*Soil parent material and initial stand density (basal area) - also influence the underlying differences in basal area growth rate between installations. But more importantly - they significantly interact with treatment. They both are important in predicting treatment response.

The next series of Figures illustrates the relationships between treatment growth response and initial basal area by parent material.

Figure 3. A bar graph showing differences in relative (%) response to treatment by parent materials.

Note: No response for valley fills and very large % response for sandstone.

Figure 4. The effect of initial basal area on relative response for Ash/Metasediments.

Notes: (1) This parent material is confined to North Idaho.

(2) Relative response is highest at low densities.
(3) The 400 lb. treatment is significantly more than the 200 lb. treatment.
(4) The 30% response line. For 200 lbs. = 117 Ft^2/Ac.; for 400 lbs. = 204 Ft^2/Ac.

Figure 5. The effect of initial basal area on relative response for basalts.

Notes: (1) Relative response is highest at low stand densities.
(2) There is no significant difference between the 200 and 400 lb. treatments.

Figure 6. The effect of initial basal area on relative response for granite.

Notes: (1) Relative response is highest at low stand density.
(2) There is no significant difference between the 200 and 400 lb. treatments.

Figure 7. The effect of initial basal area on relative response for Valley fill.

Notes: (1) This parent material was sampled only in Montana.
(2) There was no treatment response on this parent material.

Figure 8. The effect of initial basal area on relative response for colluvium.

Notes: (1) This parent material was sampled only in Montana.
(2) There was a significant difference between the 200 and 400 lb. treatments.
(3) There was a very high % response on this parent material, but this may not translate to as much absolute basal area response depending on the level of untreated growth. This will be illustrated in subsequent figures.

Figure 9. The effect of initial basal area on absolute basal area increment for ash/metasediments with shallow ash (≤12").

Notes: (1) Control 2-year basal area increment peaks at approximately 130 Ft^2/Ac.
(2) Absolute basal area response for the 200 lb. treatment is highest at the lowest stand

densities, but the curve is relatively flat over the range of densities sampled.

(3) Absolute response for the 400 lb. treatment peaks at about 120 Ft^2 Ac., although response is predicted to be greater than 4 Ft^2/Ac. even at an initial basal area of 175 Ft^2.

(4) Ash/metasediment soils were sampled only in North Idaho.

Figure 10. The effect of initial basal area on absolute basal area increment for <u>ash/metasediments with deep ash</u> (≥12").

Notes: (1) The contrast of this figure with figure 9 illustrates the effect of having a deep ash cap on the site. There is an increase in the amount of absolute response to treatment due to the higher baseline (normal) growth on deep ash soils.

Figure 11. The effect of initial basal area on absolute basal area increment for <u>ash/loess with a deep ash</u> (≥12").

Notes: (1) Control (untreated) growth peaks at an initial basal area of 200 Ft^2/Ac.

(2) Treatment response peaks at about 170 Ft^2/Ac.

(3) There is no significant difference between the 200 and 400 lb. treatments.

Figure 12. The effect of initial basal area on absolute basal area increment for <u>glacial till with deep ash</u>.

Notes: (1) Control (untreated) growth peaks at about 160 Ft^2/Ac. initial basal area.

(2) Response to the 200 lb. treatment is highest at the lowest initial basal area (75 Ft^2/Ac).

(3) Absolute response to the 400 lb. treatment is largest at about 100 Ft^2 initial basal area.

(4) The response curves are relatively flat over the range of basal areas sampled on this parent material.

Figure 13. The effect of initial basal area on absolute basal area increment for <u>granite</u>.

Notes: (1) Control growth is greatest at an initial basal area of about 160 Ft^2 for this parent material.

(2) Absolute basal area response to the 200 lb. treatment is greatest at the lowest initial basal area (75 Ft^2/Ac.).

(3) Response to the 400 lb. treatment peaks at an initial basal area of approximately 125 Ft^2/Ac.

(4) The response curves are relatively flat over the range of basal areas sampled. Similar to the pattern shown for glacial tills.

Figure 14. The effect of initial basal area on absolute basal area increment for colluvium.

Notes: (1) Because of the very slow normal (untreated) growth on this parent material, the "huge" percent response (shown in Figure 8) translates to only a "large" absolute response.

(2) A relatively narrow range of initial basal area was sampled on this parent material (105 to 175 Ft^2/Ac.) and the curves do not extrapolate well outside of this basal area range.

(3) This parent material was sampled only in Montana.

Figure 15. The effect of initial basal area on absolute basal area increment for alluvium.

Notes: (1) Control (untreated) growth peaks at an initial basal area of about 170 Ft^2/Ac.

(2) Absolute basal area response to the 200 lb. treatment is greatest at an initial basal of approximately 160 Ft^2/Ac. for both nitrogen treatments.

(3) The response to the 400 lb. treatment is less than for the 200 lb. treatment on this parent material. Subsequently, we discovered that the plots for the 400 lb. treatments had higher pre-treatment nitrogen mineralization rates (Min-N) than the 200 lb. treatment plots. When we statistically adjust for the differences in pre-treatment Min-N, the response to 400 lbs. becomes slightly higher than for the 200 lbs. treatment.

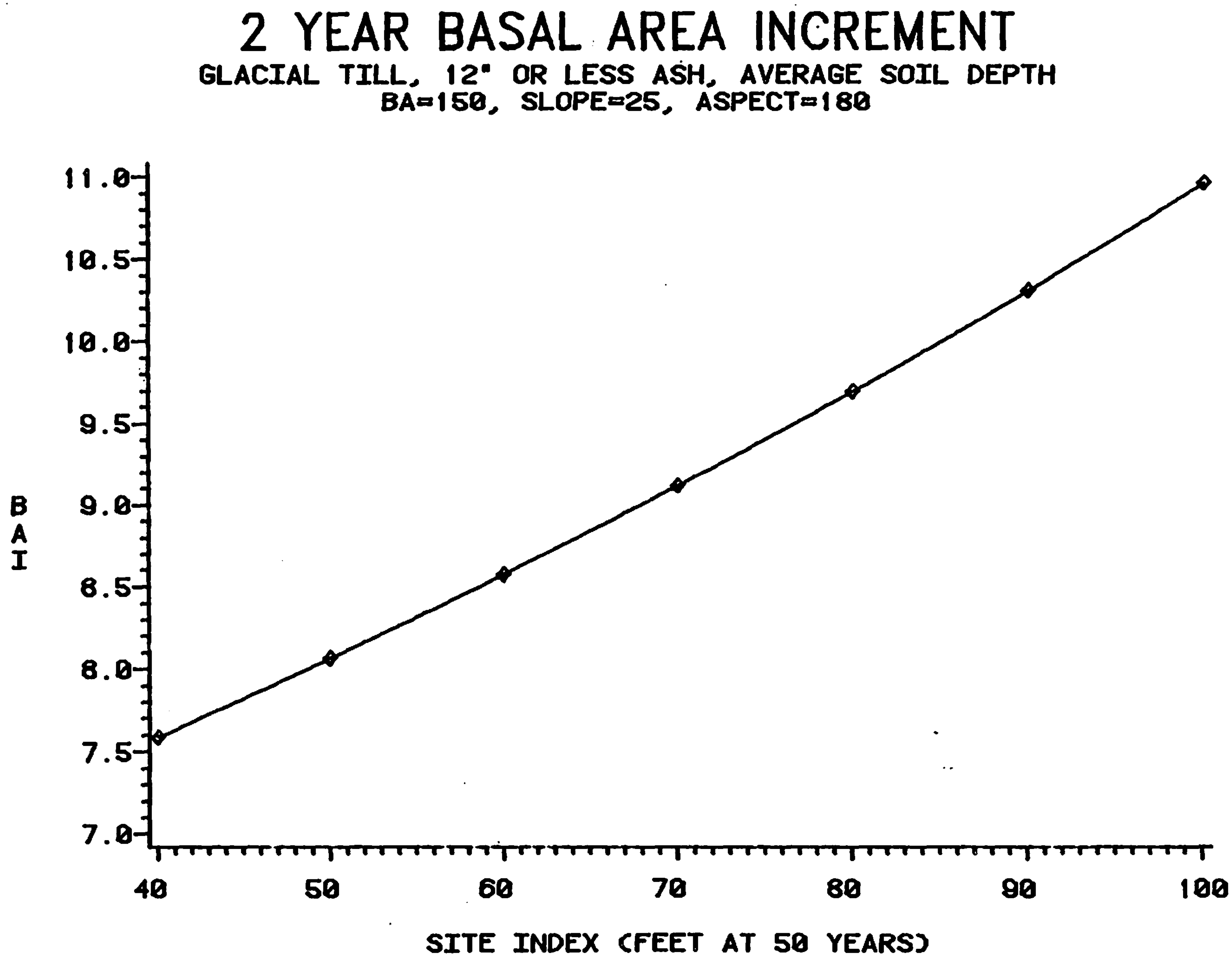


Figure 1. The relationship between untreated two-year basal area increment per acre and Douglas-fir site index.

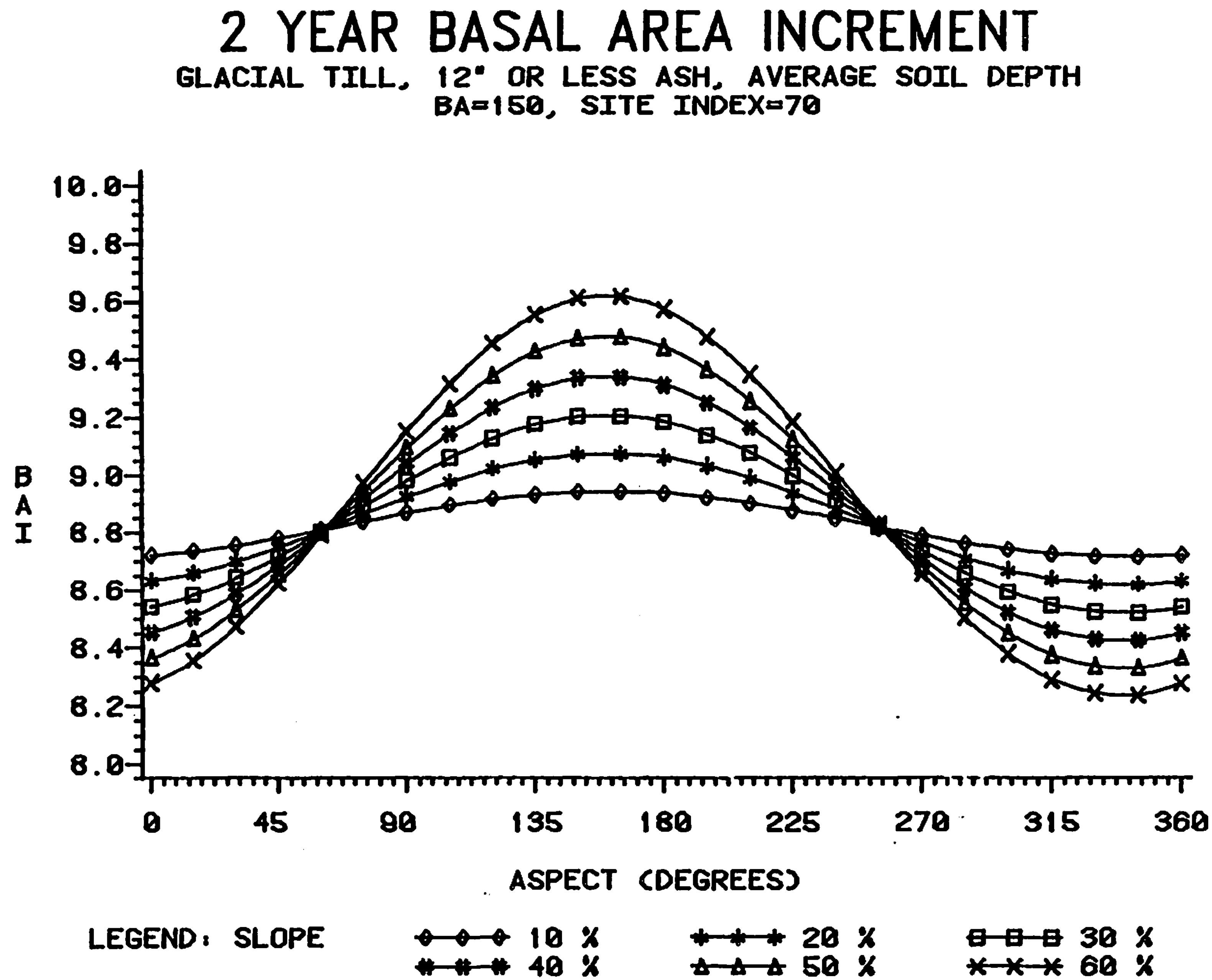


Figure 2. The relationship between untreated two-year basal area increment per acre and slope and aspect.

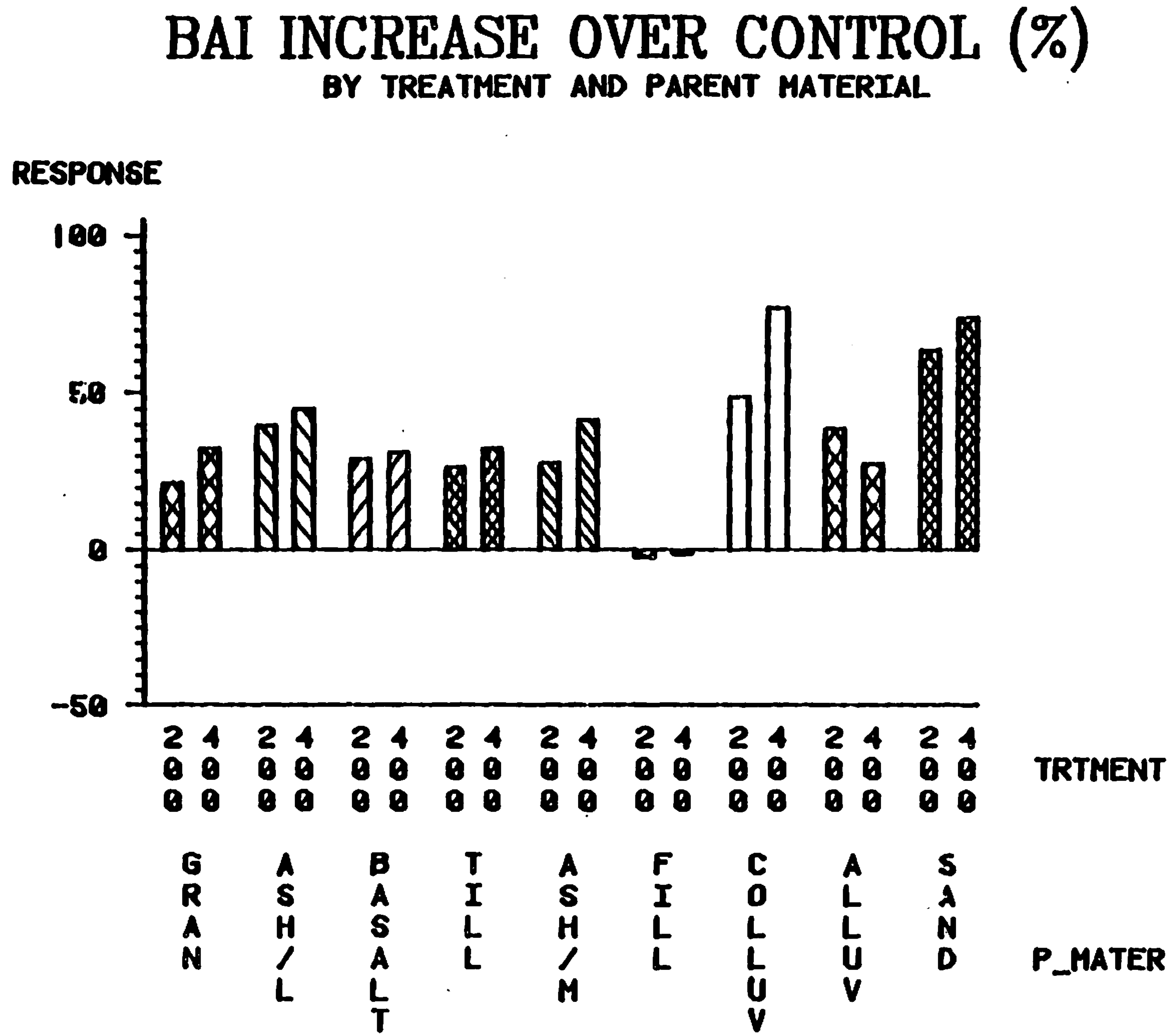


Figure 3. Two-year relative basal area response by soil parent material.

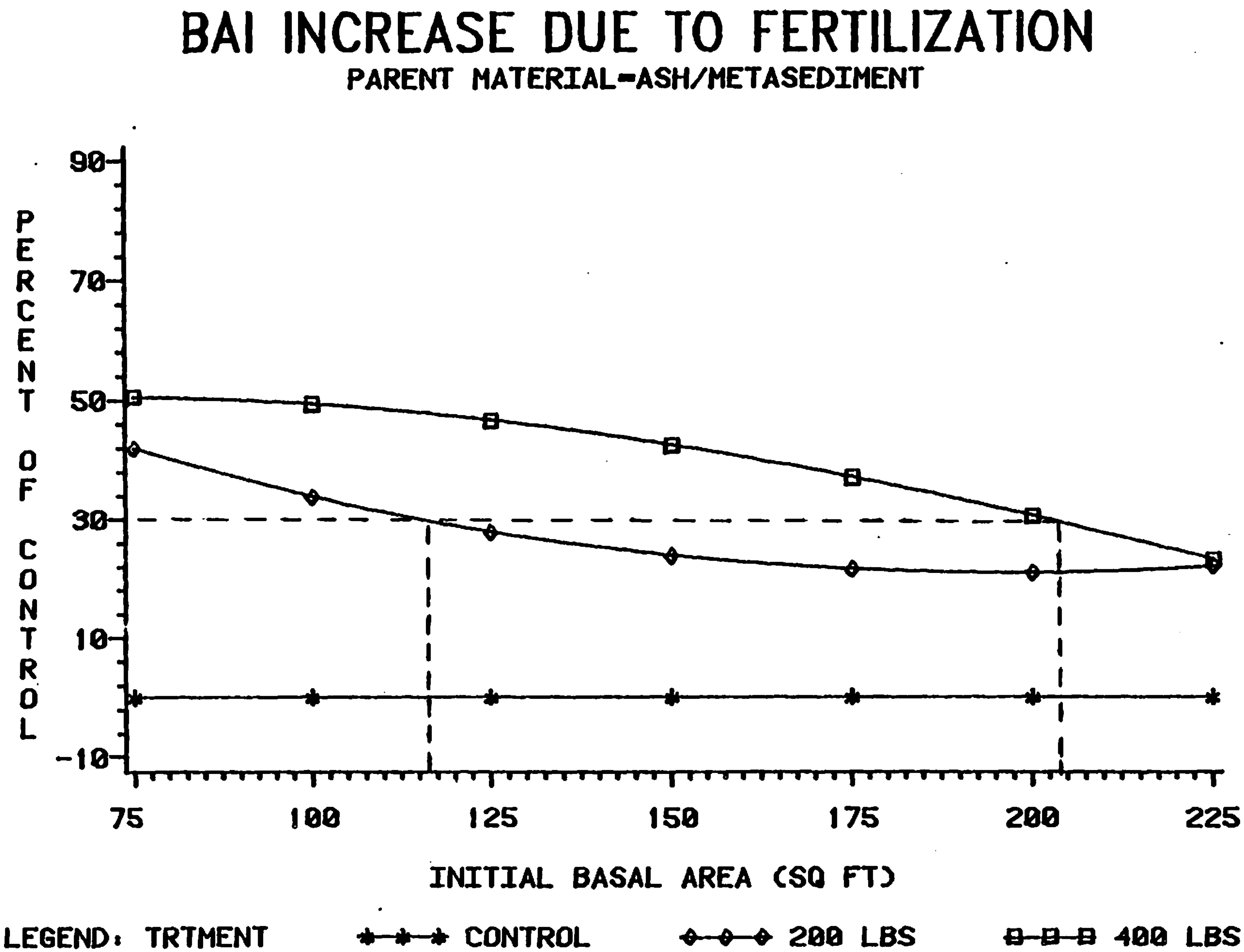


Figure 4. The effect of initial basal area on relative response for Ash/Metasediments.

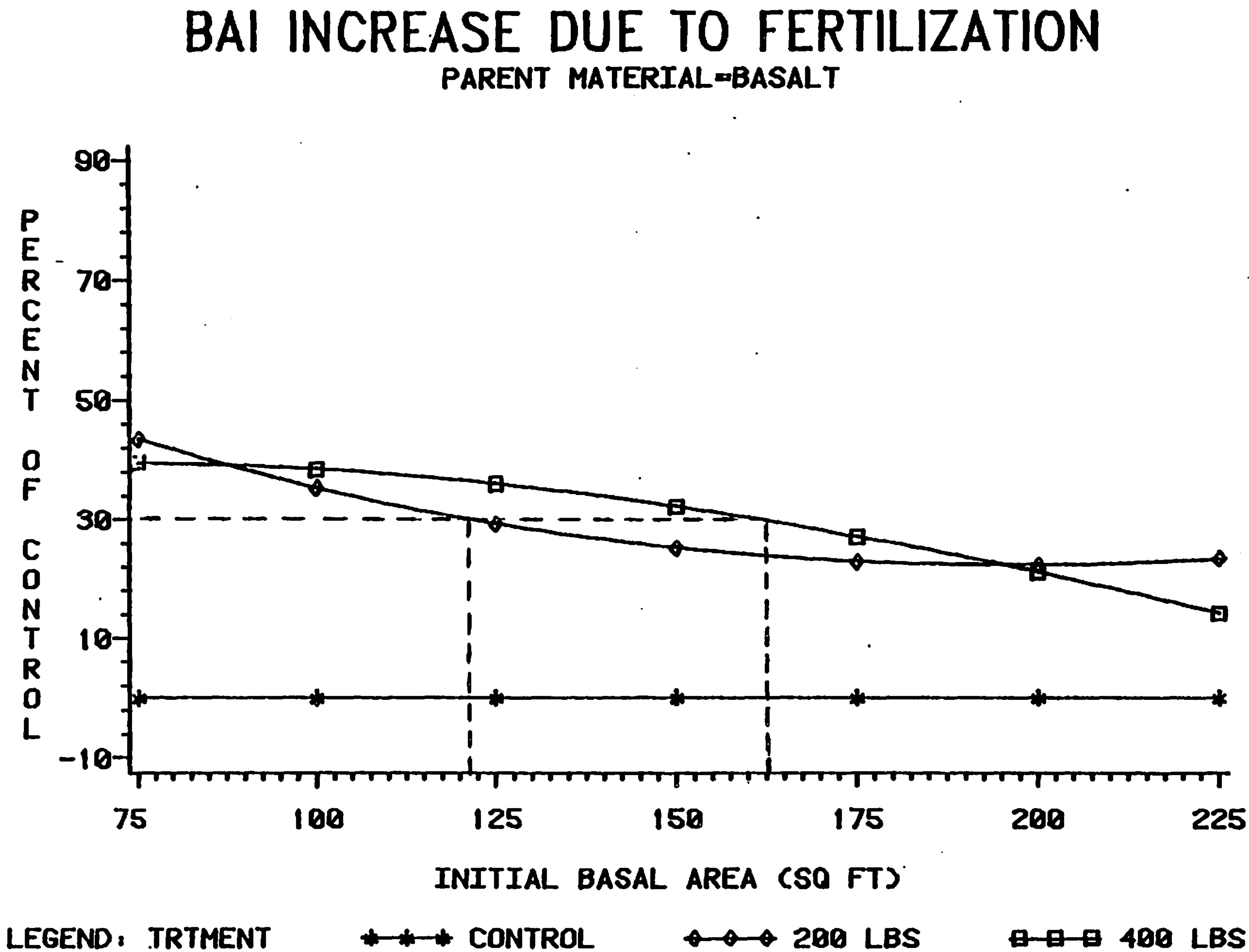


Figure 5. The effect of initial basal area on relative response for Basalt.

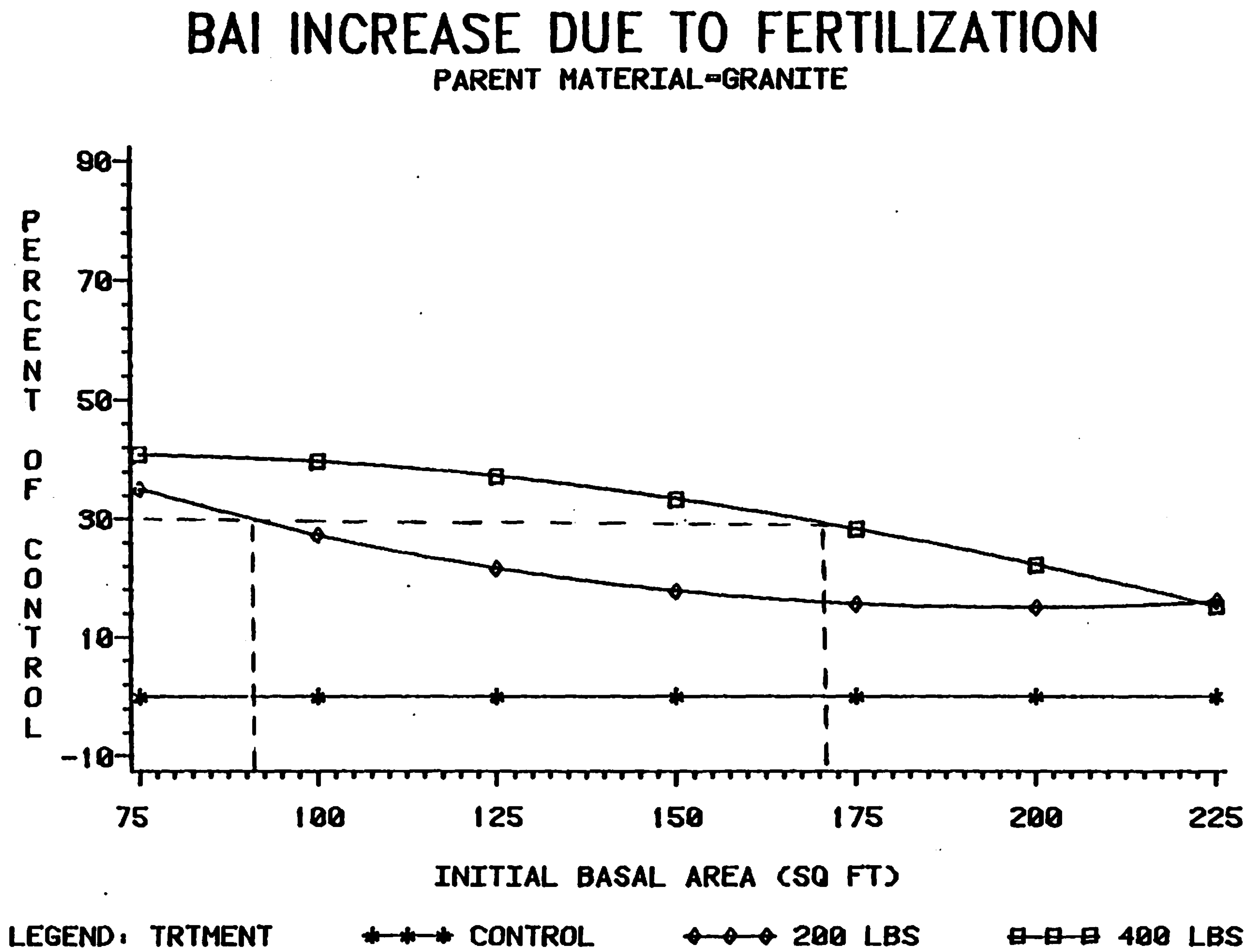


Figure 6. The effect of initial basal area on relative response for granite.

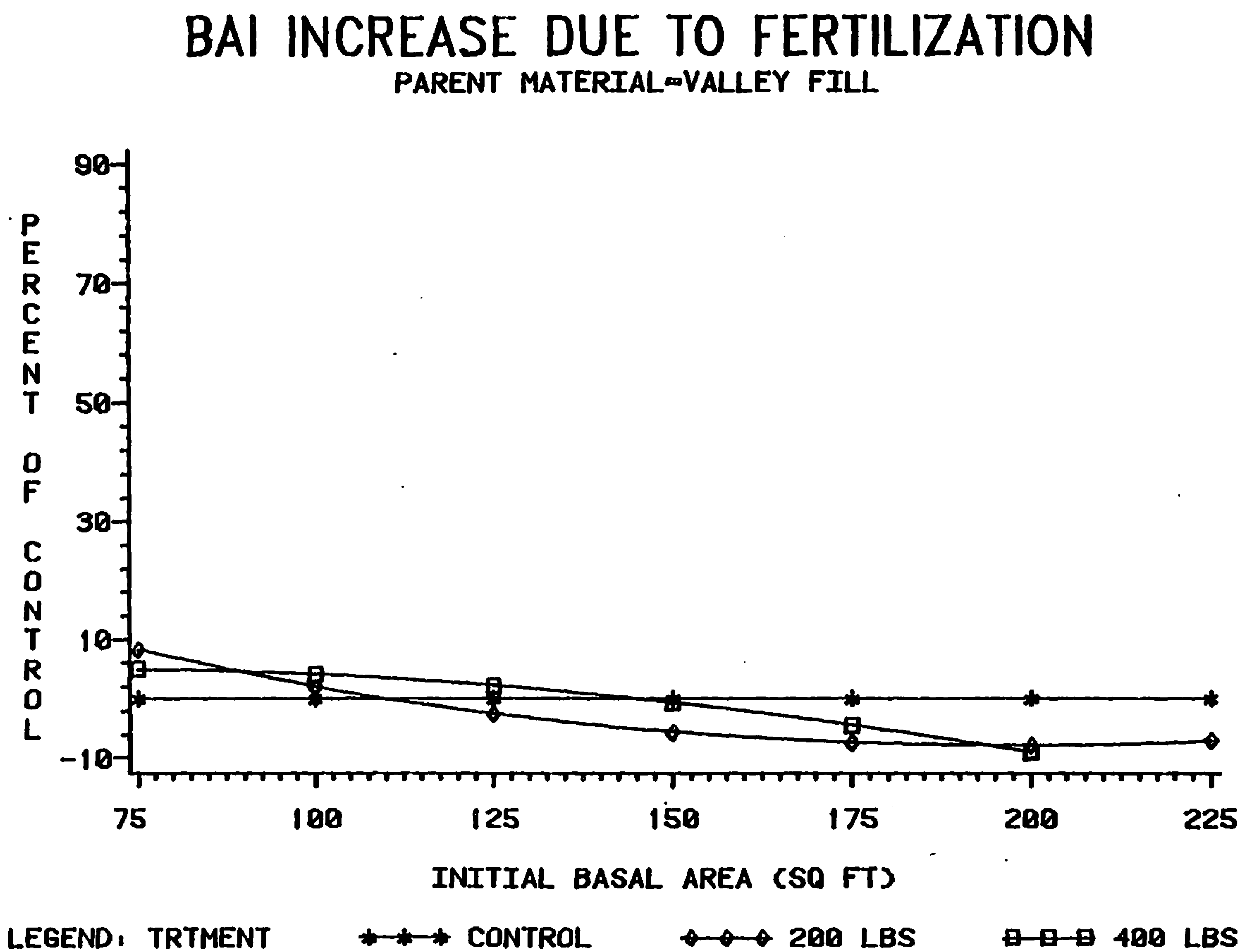


Figure 7. The effect of initial basal area on relative response for valley fill.

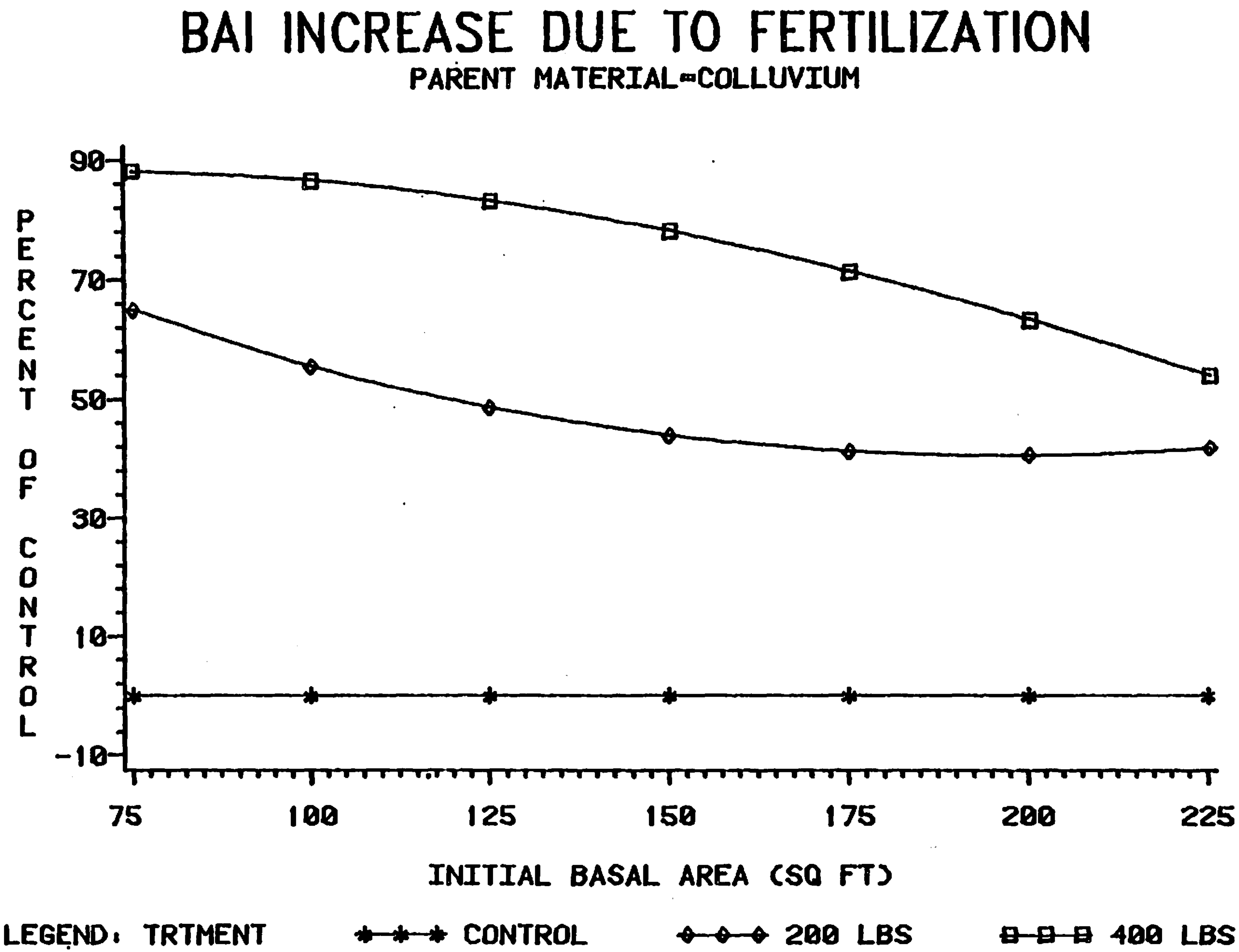


Figure 8. The effect of initial basal area on relative response for colluvium.

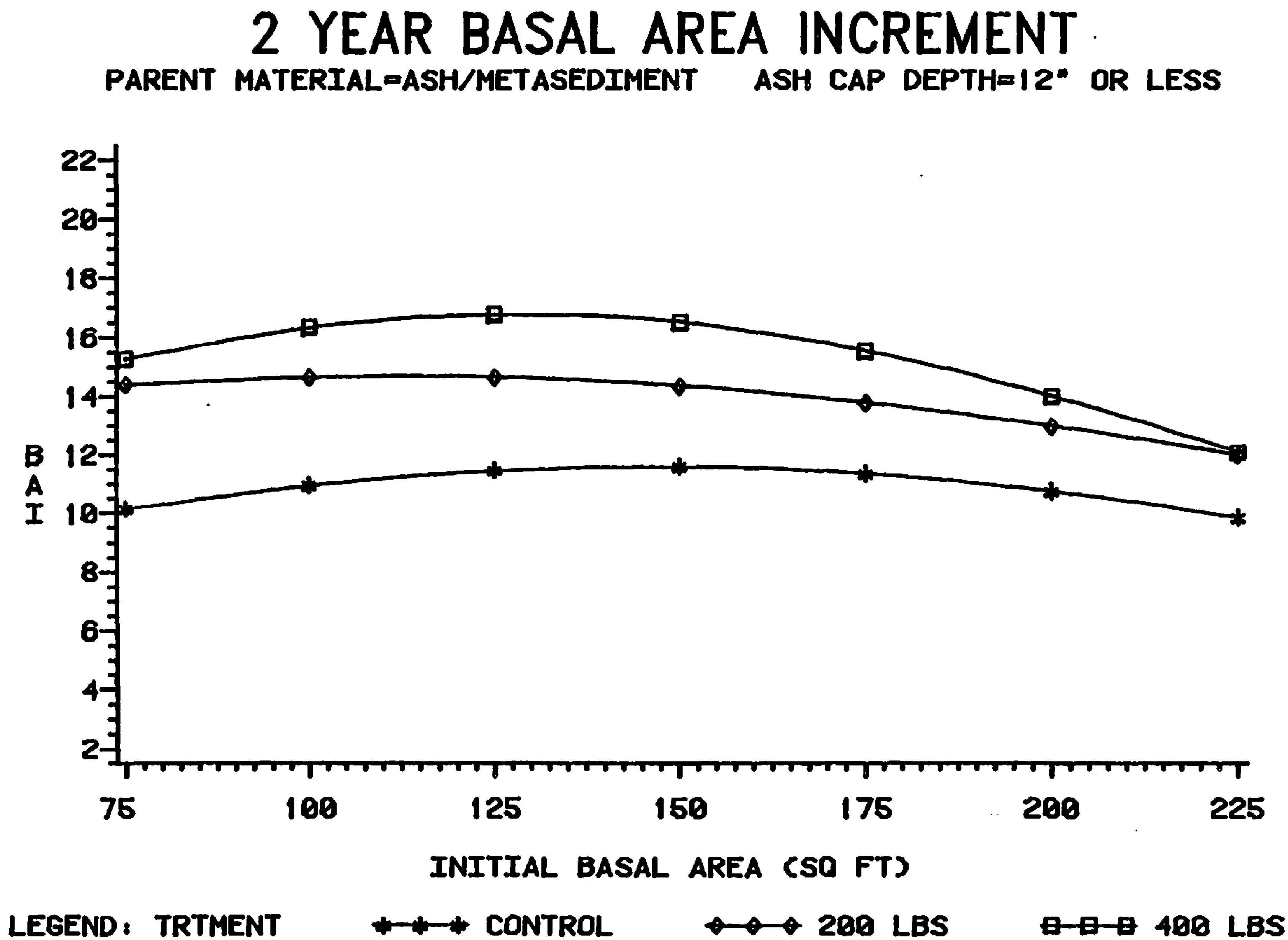


Figure 9. The effect of initial basal area on absolute basal area increment for ash/metasediments with shallow ash (≤12").

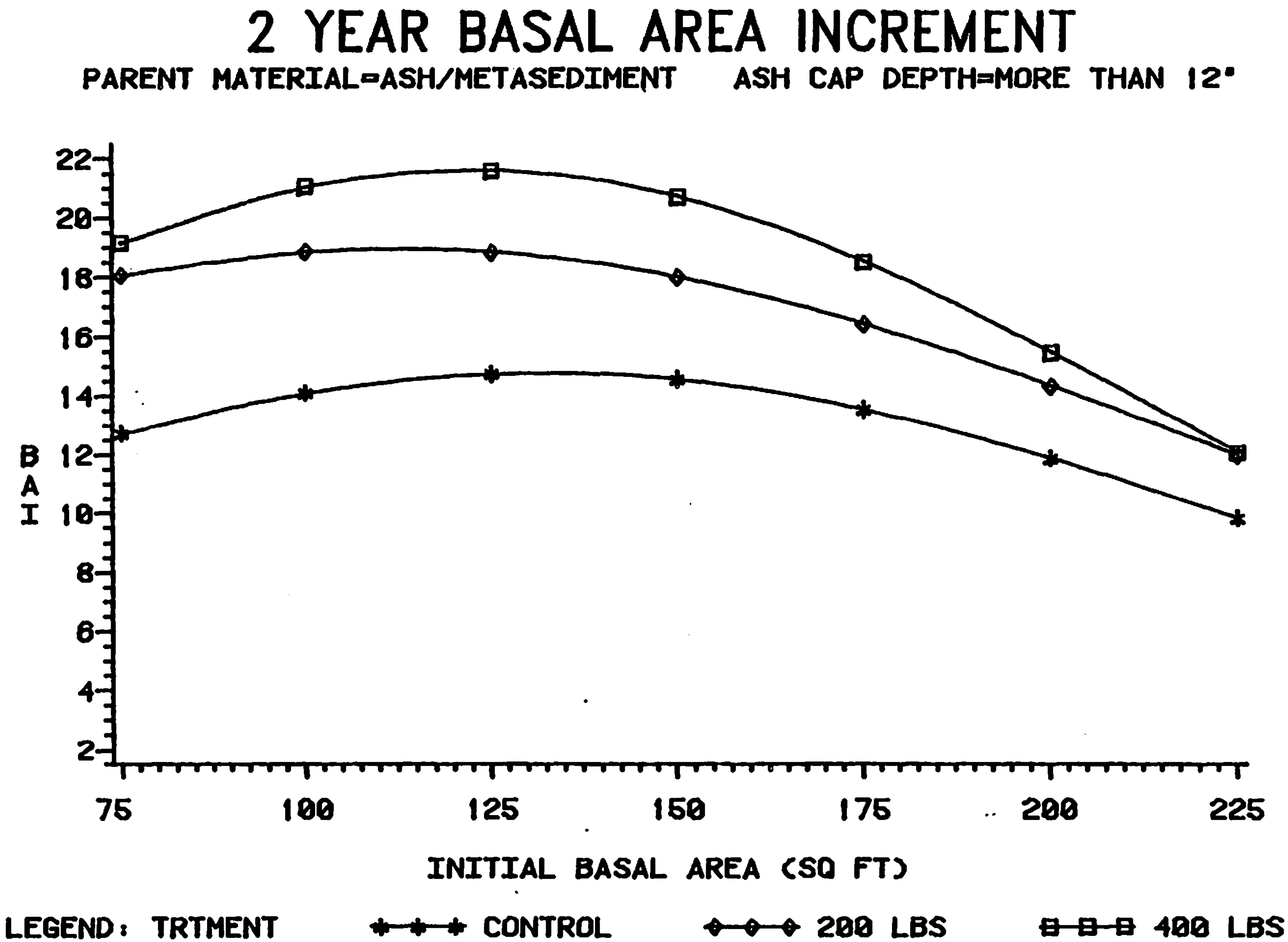


Figure 10. The effect of initial basal area on absolute basal area increment for ash/metasediments with deep ash (>12").

Figure 11. The effect of initial basal area on absolute basal area increment for ash/loess with deep ash (>12").

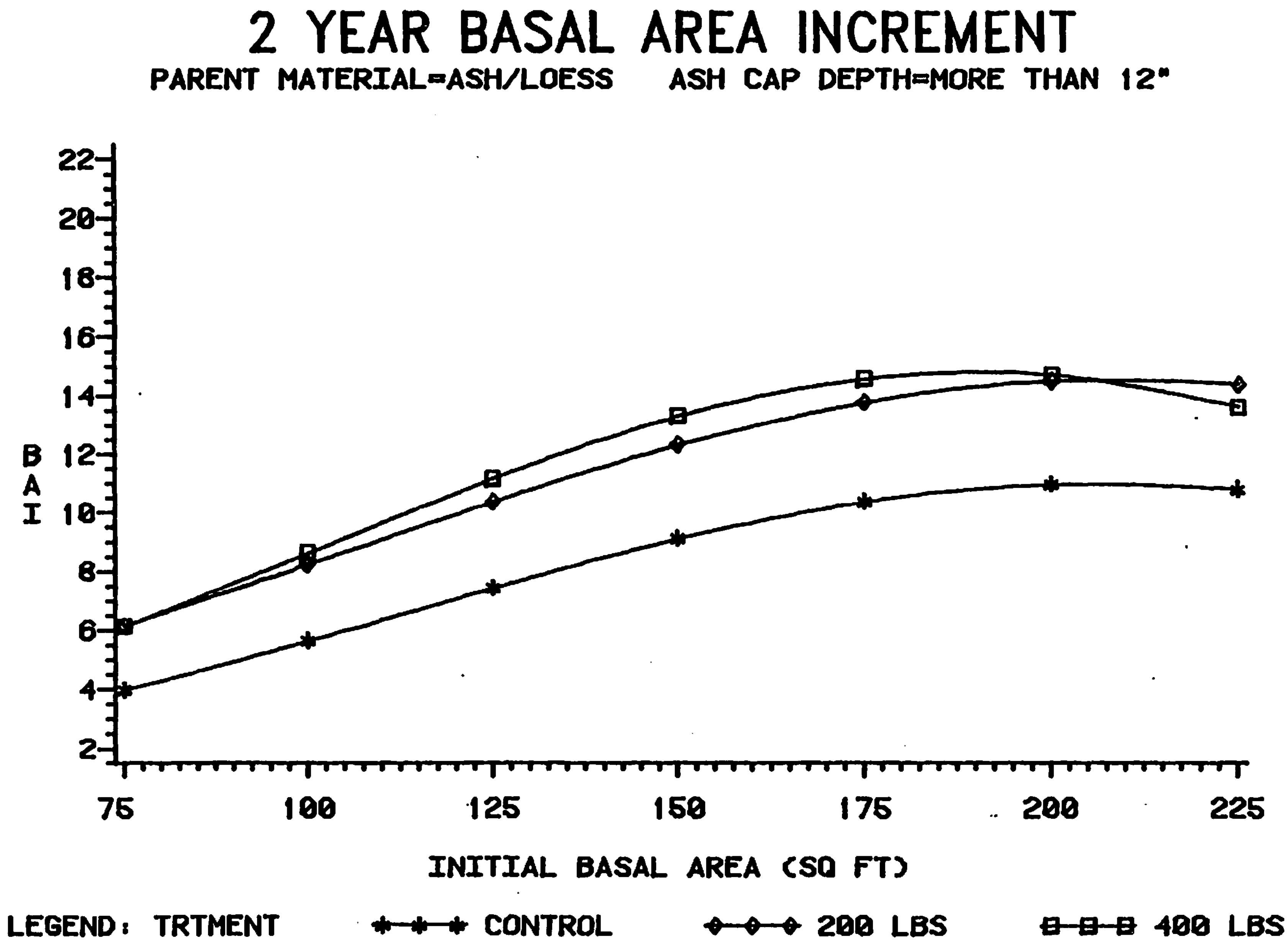


Figure 11. The effect of initial basal area on absolute basal area increment for ash/loess with deep ash (>12").

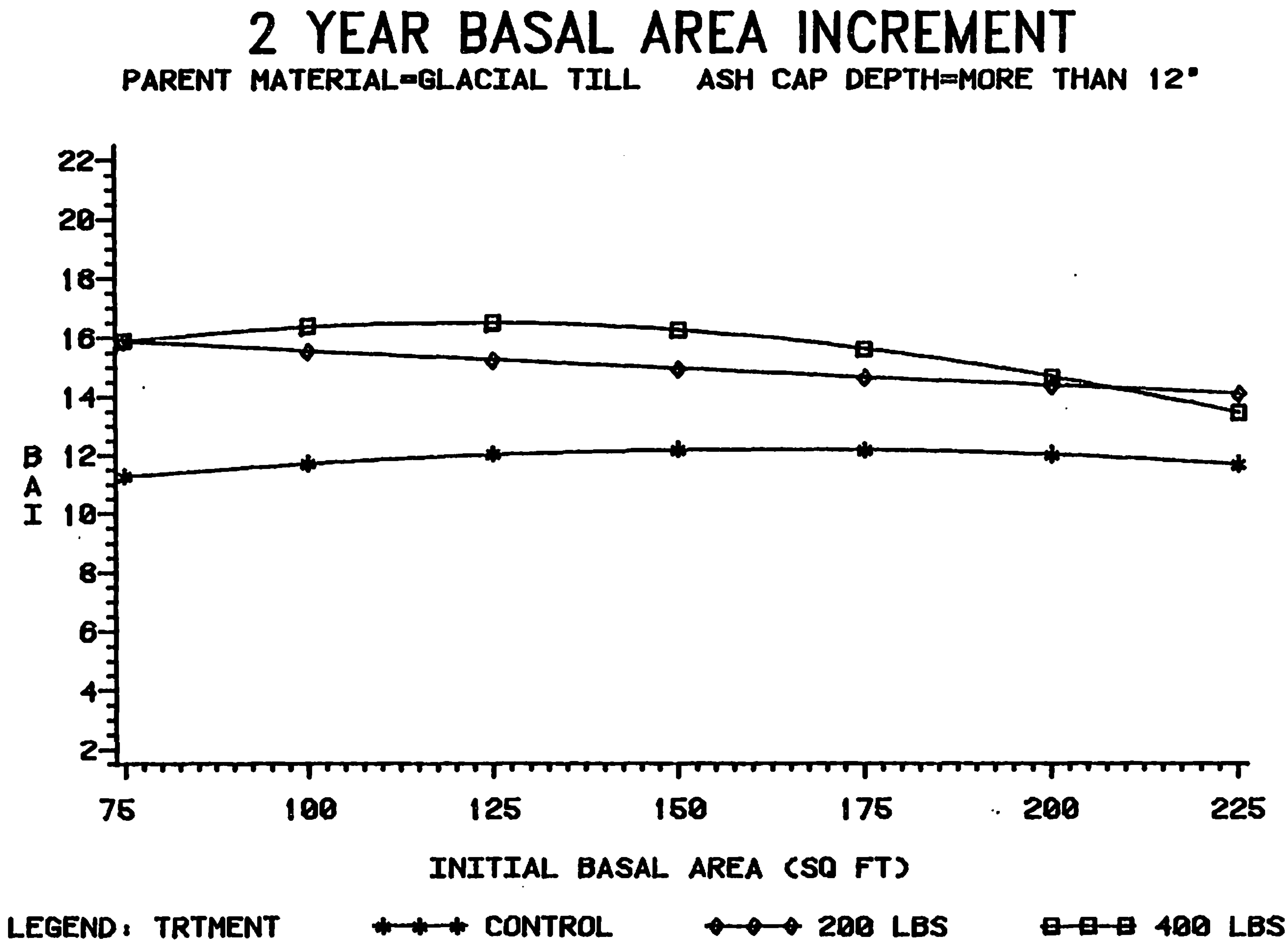


Figure 12. The effect of initial basal area on absolute basal area increment for glacial till with deep ash.

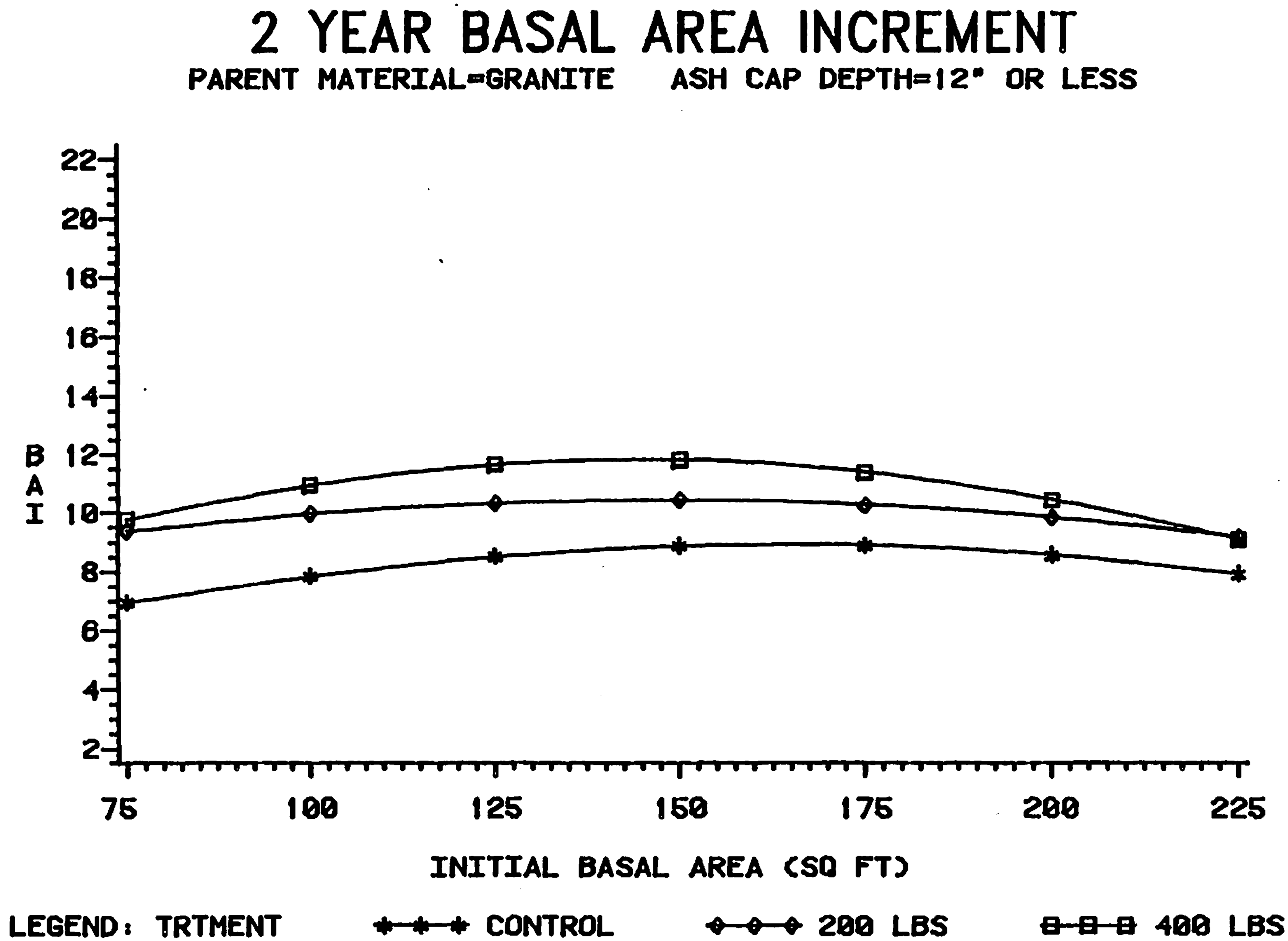


Figure 13. The effect of initial basal area on absolute basal area increment for granite.

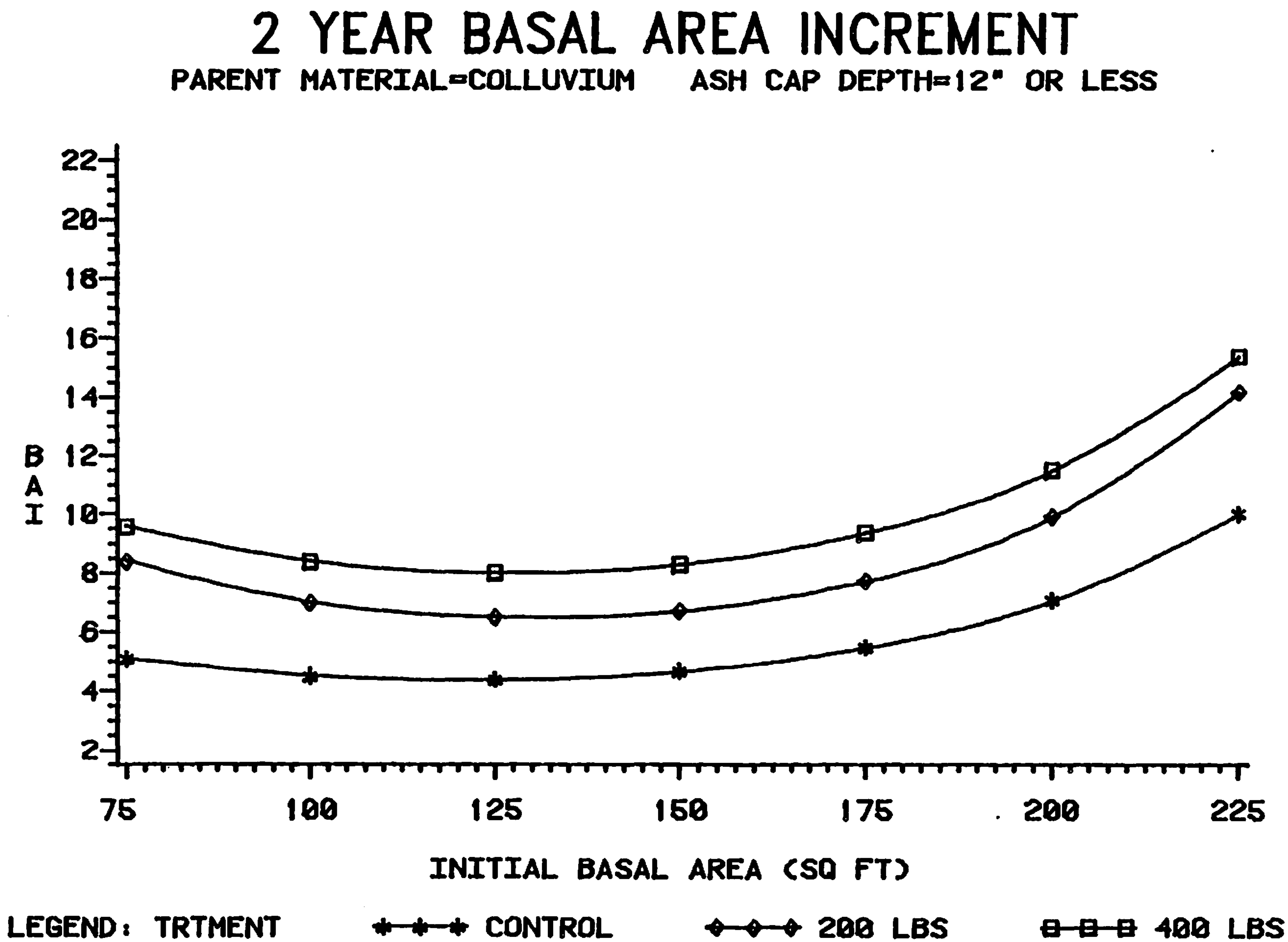


Figure 14. The effect of initial basal area on absolute basal area increment for colluvium.

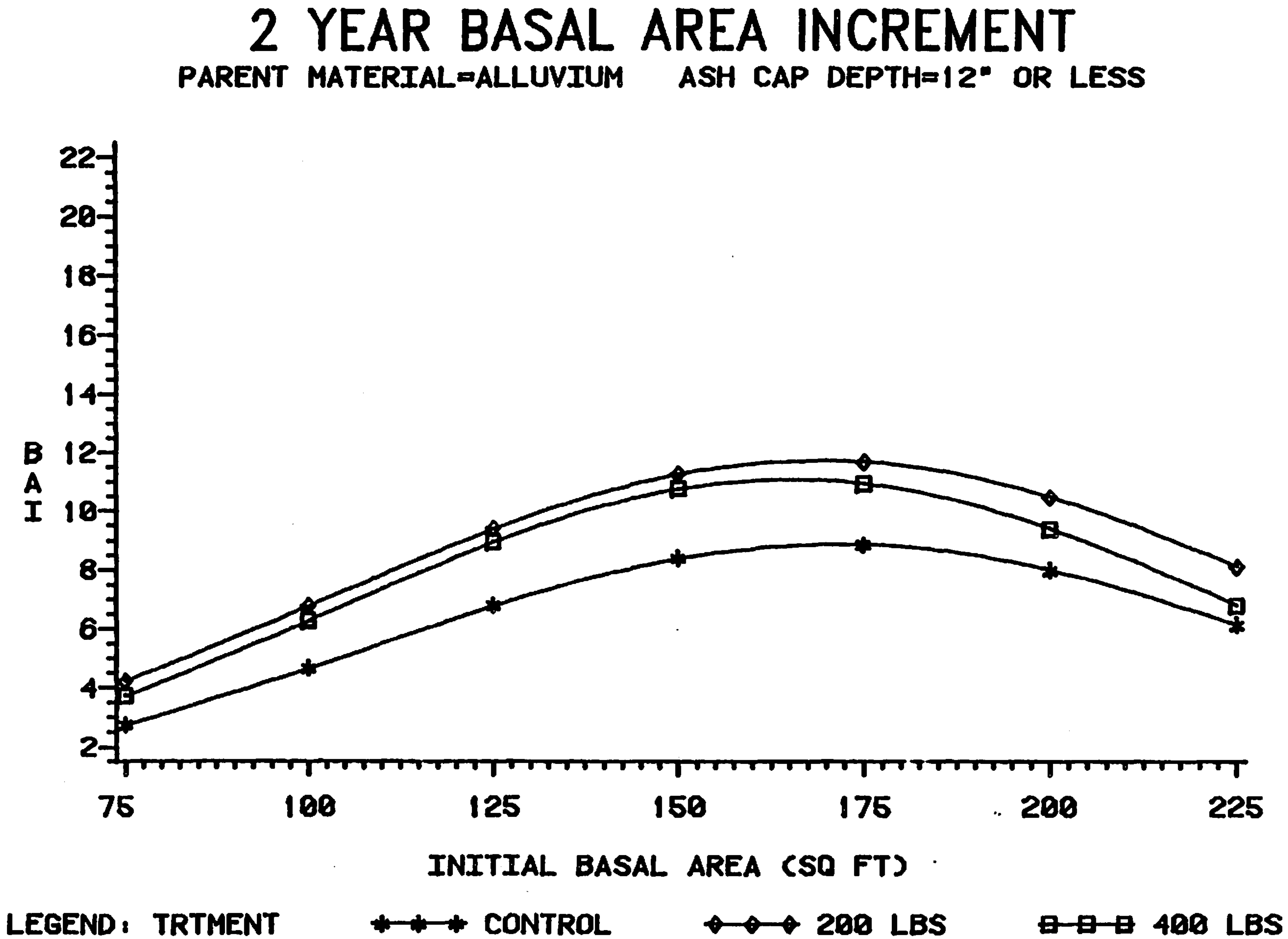


Figure 15. The effect of initial basal area on absolute basal area increment for alluvium.

Summary

What have we gained in a practical sense from the information just presented? One way to illustrate the gains from the new information is to go through the following scenarios:

> If we had applied 200 lbs. of nitrogen per acre to all the managed Douglas-fir stands in the Intermountain region as represented by our installations, we would have obtained the overall average 2-year basal area response of 2.4 Ft^2/Ac. or an average 31% increase in basal area growth. These numbers are probably higher than we expected at the beginning of the project. But if these are the averages, think what response we must be getting on the best responders!
>
> Table 1 illustrates how we can use the predictive models to eliminate the non-responders and concentrate the treatments on the better responding sites. Each contrast represents conditions that are common in each region (not the best or worst). The comparisons were selected to show the effects of parent materials and stand density on response in a useable way.
>
> These differences will determine the profitability of an operational fertilization program if they continue in the same manner over time.
>
> The evidence to date certainly indicates that nitrogen fertilization should be strongly considered as a viable silvicultural treatment on many sites in the Intermountain West. The key is to identify the best responding sites and concentrate on those that produce the highest return on the investment. We have come a long way toward identifying those sites in the last several years.

Table 1. Predicted response to 200 pounds of nitrogen per acre for various site and stand conditions in each geographic region.

Growth Response to 200 Lb. N/Ac.

	BA/Ac.	Percent
Overall	2.4	31
North Idaho		
Ash/Metasediments	5.7	40
Glacial till	1.8	20
Montana		
Colluvium	3.7	65
Valley fill	-0.5	- 8
Central Idaho		
Basalt	3.6	42
Granite	1.2	16
Northeast Oregon		
Ash/Loess	3.5	33
Basalt	1.9	22
Central Washington		
*Sandstone	6.6	71
Basalt	3.6	42
Glacial till	1.8	20
Northeast Washington		
Glacial till	3.7	39
Basalt	2.0	25

The contrasts presented in Table 1 were generated using the following values in the predictive response model.

North Idaho

Predicted response = 5.7 ft^2 (40%)

Parent material = ash/metasediments
Initial basal area = 80 ft^2
Ash depth = deep
Soil depth = deep
Site index = 85
Aspect = 180
Slope = 20%

Predicted response = 1.8 ft^2 (20%)

Parent material = glacial till
Initial basal area = 175 ft^2
Ash depth = not deep
Soil depth = medium
Site index = 75
Aspect = -
Slope = 0%

Montana

Predicted response = 3.7 ft^2 (65%)

Parent material = colluvium
Initial basal area = 75 ft^2
Ash depth = none
Soil depth = deep
Site index = 75
Aspect = 180^o
Slope = 20%

Predicted response = -0.5 ft^2 (-8%)

Parent material = valley fill
Initial basal area = 150 ft^2
Ash depth = none
Soil depth = medium
Site index = 70
Aspect = -
Slope = 0%

Central Idaho

Predicted response = 3.6 ft^2 (42%)

Parent material = basalt
Initial basal area = 80 ft^2
Ash depth = none
Soil depth = deep
Site index = 75
Aspect = 180°
Slope = 25%

Predicted response = 1.2 ft^2 (16%)

Parent material = granite
Initial basal area = 175 ft^2
Ash depth = none
Soil depth = shallow
Site index = 70
Aspect = 180°
Slope = 25%

Northeast Oregon

Predicted response = 3.5 ft^2 (33%)

Parent material = ash/loess
Initial basal area = 175 ft^2
Ash depth = deep
Soil depth = deep
Site index = 75
Aspect = 180°
Slope = 25%

Predicted response = 1.9 ft^2 (22%)

Parent material = basalt
Initial basal area = 200 ft^2
Ash depth = none
Soil depth = shallow
Site index = 65
Aspect = 180°
Slope = 25%

Central Washington

Predicted response = 6.6 ft^2 (71%)

Parent material = Sandstone
Initial basal area = 100 ft^2
Ash depth = none
Soil depth = deep
Site index = 75
Aspect 180°
Slope 25%

Predicted response = 3.6 ft^2 (42%)

Parent material = basalt
Initial basal area = 80 ft^2
Ash depth = none
Soil depth = deep
Site index = 75
Aspect = 180°
Slope = 25%

Predicted response = 1.8 ft^2 (20%)

Parent material = glacial till
Initial basal area = 175 ft^2
Ash depth - none
Soil depth = medium
Site index - 65
Aspect = 180°
Slope = 25%

Northeast Washington

Predicted response = 3.7 ft^2 (39%)

Parent material = glacial till
Initial basal area = 80 ft^2
Ash depth = none
Soil depth = deep
Site index = 80
Aspect = 180°
Slope = 25%

Predicted response = 2.0 ft^2 (23%)

Parent material = basalt
Initial basal area = 175 ft^2
Ash depth = none
Soil depth = medium
Site index = 70
Aspect = 180°
Slope = 25%

Additional Response Comparisons

by Jim Moore

The following results were not presented at the annual meeting of the IFTNC, but the information should also be of interest to cooperators. Another useful way to compare differences in response by soil parent materials is to set the values of the variables in the predictive response model so that they reflect conditions most typically sampled for each parent material. The values given in Table 1 are the averages for the predictor variables by parent material. These values were then used in the "predictive response model" (the alternative model that includes mineralizable nitrogen as a variable; pg. 54, IFTNC 1985 Technical Documentation Report) to produce the predicted treatment responses given in Table 2. Ash/loess, ash/metasediments, and glacial tills, all with deep ash caps, produced the highest absolute basal area response to both treatments.

Table 1. Average values of predictor variables by soil parent material.

Parent Material	Slope (%)	Aspect (Degrees)	Site Index (ft @ 50 yrs)	Min_N (P.P.M.)	Soil Depth (inches)	Basal Area (Ft^2/Ac)
Alluvium	10	300	55	50	12-24*	130
Ash/loess (shallow ash)	15	270	70	30	>24	165
Ash/loess (deep ash)	10	160	80	30	>24	165
Ash/metasediment (shallow ash)	35	240	85	50	>24	145
Ash/metasediment (deep ash)	30	280	90	45	>24	155
Basalt	20	60	60	50	12-24	140
Colluvium	45	160	65	45	12-24	145
Glacial till (shallow ash)	15	250	70	50	>24	135
Glacial till (deep ash)	10	360	60	20	>24	105
Granite	30	320	60	25	>24	140
Sandstone	45	320	70	35	>24	165
Valley fill	25	60	60	70	<12	120

Table 2. Predicted two-year basal area response per acre to nitrogen treatments using average values sampled for each parent material.

Parent Material	-Treatment Response-	
	200 lb/Ac (ft^2/Ac)	400 lb/Ac (ft^2/Ac)
Alluvium	1.6	2.5
Ash/loess (shallow ash)	2.8	3.6
Ash/loess (deep ash)	4.1	5.1
Ash/metasediments (shallow ash)	3.3	5.0
Ash/metasediments (deep ash)	4.5	6.3
Basalt	1.8	2.8
Colluvium	1.3	1.9
Glacial till (shallow or no ash)	2.3	3.4
Glacial till (deep ash)	4.6	5.3
Granite	3.1	3.9
Sandstone	2.8	3.6
Valley fill	0.7	1.3

Kurt Pregitzer
Department of Forestry
Michigan State University

Summary and Conclusions

1. The mineralizable nitrogen soil test is useful predictor of response to fertilization. As mineralization increases response decreases.

2. Soil parent material strongly influences. The fundamental growth of Douglas-fir and its response to fertilization.

3. Volcanic ash is a valuable soil resource. It's presence and depth significantly influence growth and response to fertilization.

4. Stand basal area plays an important role in determining fertilizer response and basal area interacts with soil parent material. As stands reach their maximum leaf area response seems, logically, to decline.

5. Soil moisture availability is strongly implicated as a factor influencing fertilizer response. Such soil properties as soil depth, parent material and ash depth all are indirect measures of moisture holding capacity.

6. We have made important headway in understanding where to apply nitrogen fertilizer. Our initial goal was to develop a method of reducing the risk of fertilizing non-responsive acres. We have accomplished a major objective.

I. INTRODUCTION

II. MINERALIZATION VS. RESPONSE

A. Nitrogen availability

B. General trends

C. Regional trends

D. Trends by parent material

E. Predictive models

III. OTHER ELEMENTS

I. Introduction

<u>Overhead</u> - "Nitrogen limits tree growth!

Nitrogen limits tree growth! This is a simple fact of life in the temperate ecosystems of the northern hemisphere. Our fertilizer studies in the Inland Empire clearly bear this fact out with significant growth responses in all geographic regions. But the evidence runs deeper.

If you become a student of nitrogen you soon realize the case for nitrogen-limited tree growth is overwhelming and stretches from Alaska to New York and on to Findland. I'm not an economist. But, from a biological perspective, there is probably no other silvicultural investment that will increase the yield of Douglas-fir as much as nitrogen fertilization.

But fertilization of mountainous forests is not simple. As we have seen in Jim's presentation response is not universal and depends upon other factors besides nitrogen availability.

Therefore, let me make the following point.

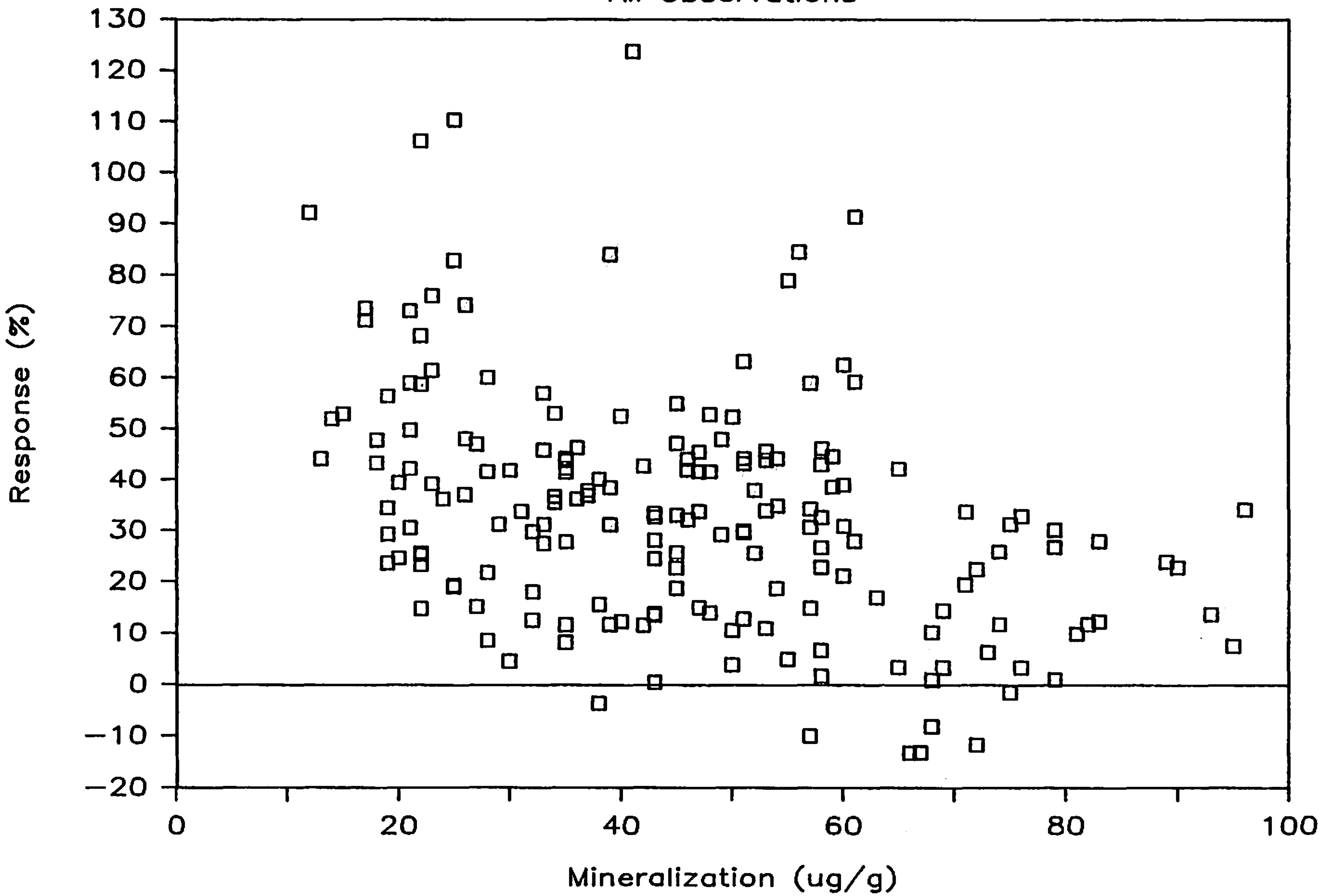
Overhead N-limited forests are usually stressed in other ways!

Many factors influence the range of nitrogen cycling and nitrogen availability. Since virtually all the nitrogen in an unfertilized ecosystem comes from or through the atmoshpere, low nitrogen sites are those which have one or more other environmental stresses limiting plant development or nitrogen fixation. Adverse climatic conditions, soils with unfavorable moisture-holding capacity or poor aeration, and geological substrates without proper supplies or combinations of other elements can result in low quantities of total and available nitrogen in an ecosystem.

As we review the relationships between mineralizable nitrogen and fertilizer response, keep in mind that all the soil-site factors that control Douglas-fir growth are interrelated. This will become more obvious shortly.

Mineralization vs. Response

All Observations

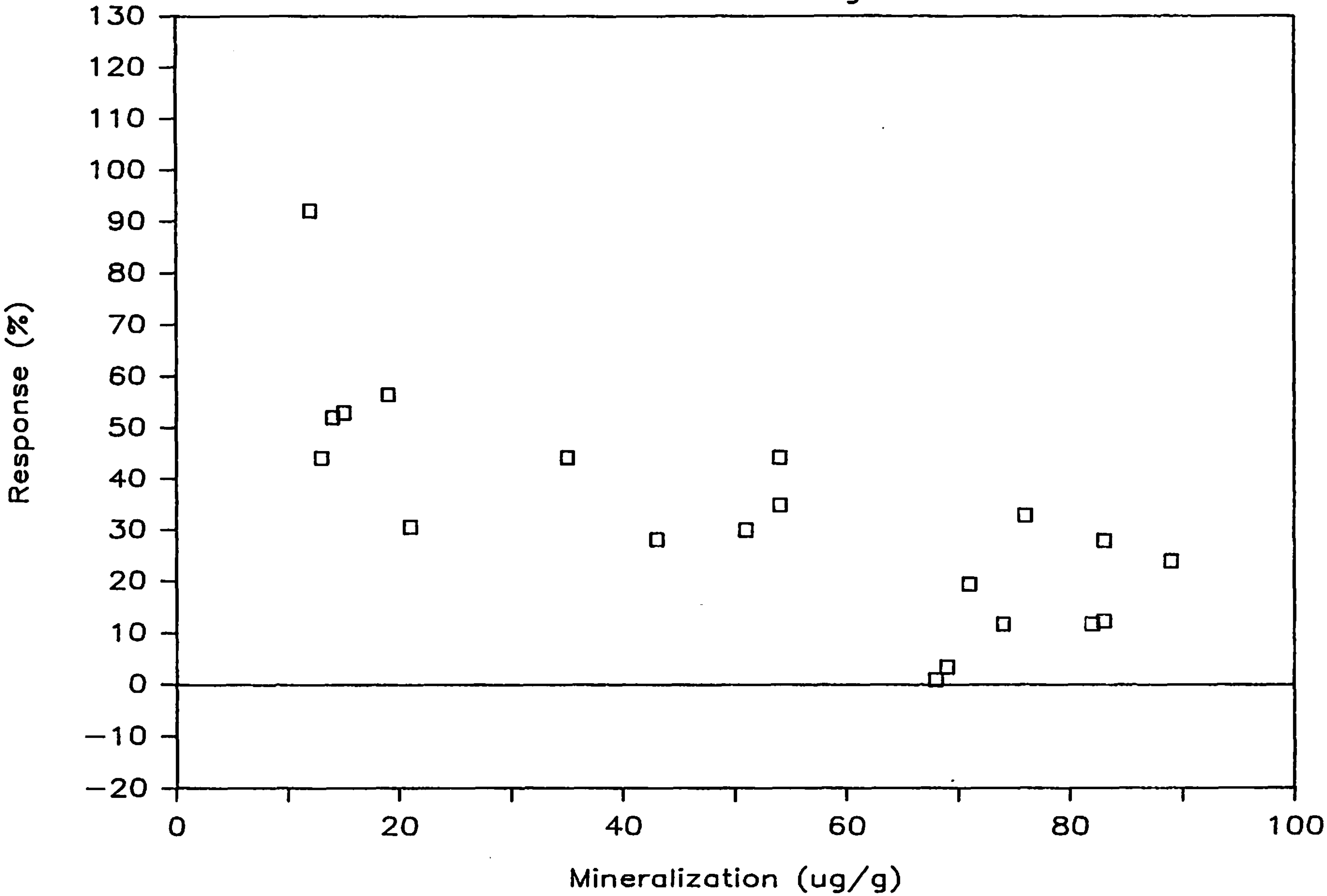


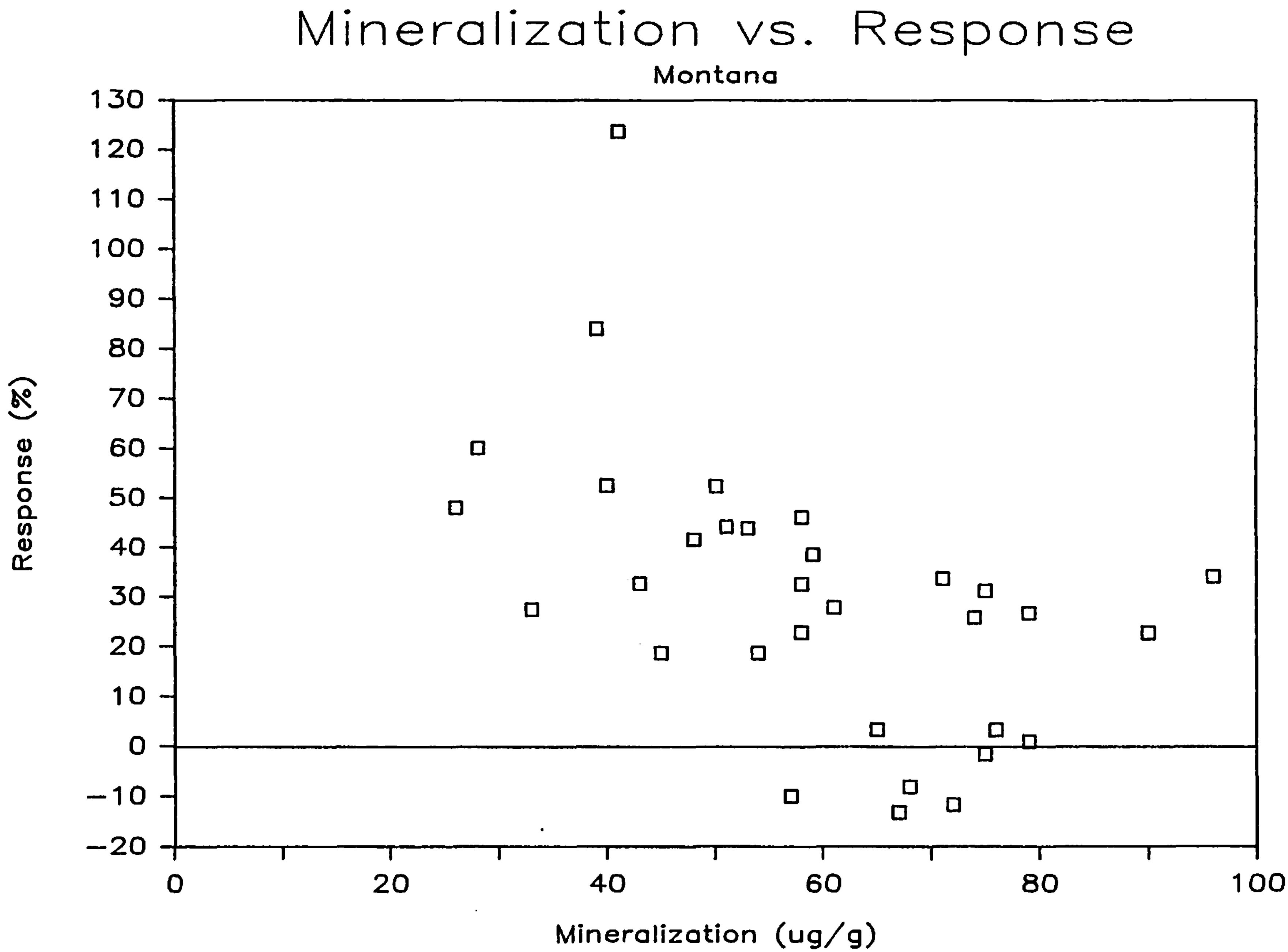
Average rate of mineralizable nitrogen and average response by geographic region for all ninety installations.

Region	Min-N (ppm)	Treatment 200 lb/ac	Response (%) 400 lb/ac
Central Washington	30	38	54
Central Idaho	35	24	30
North Idaho	46	32	37
Northeast Washington	50	25	26
Montana	61	24	27
Northeast Oregon	62	25	31

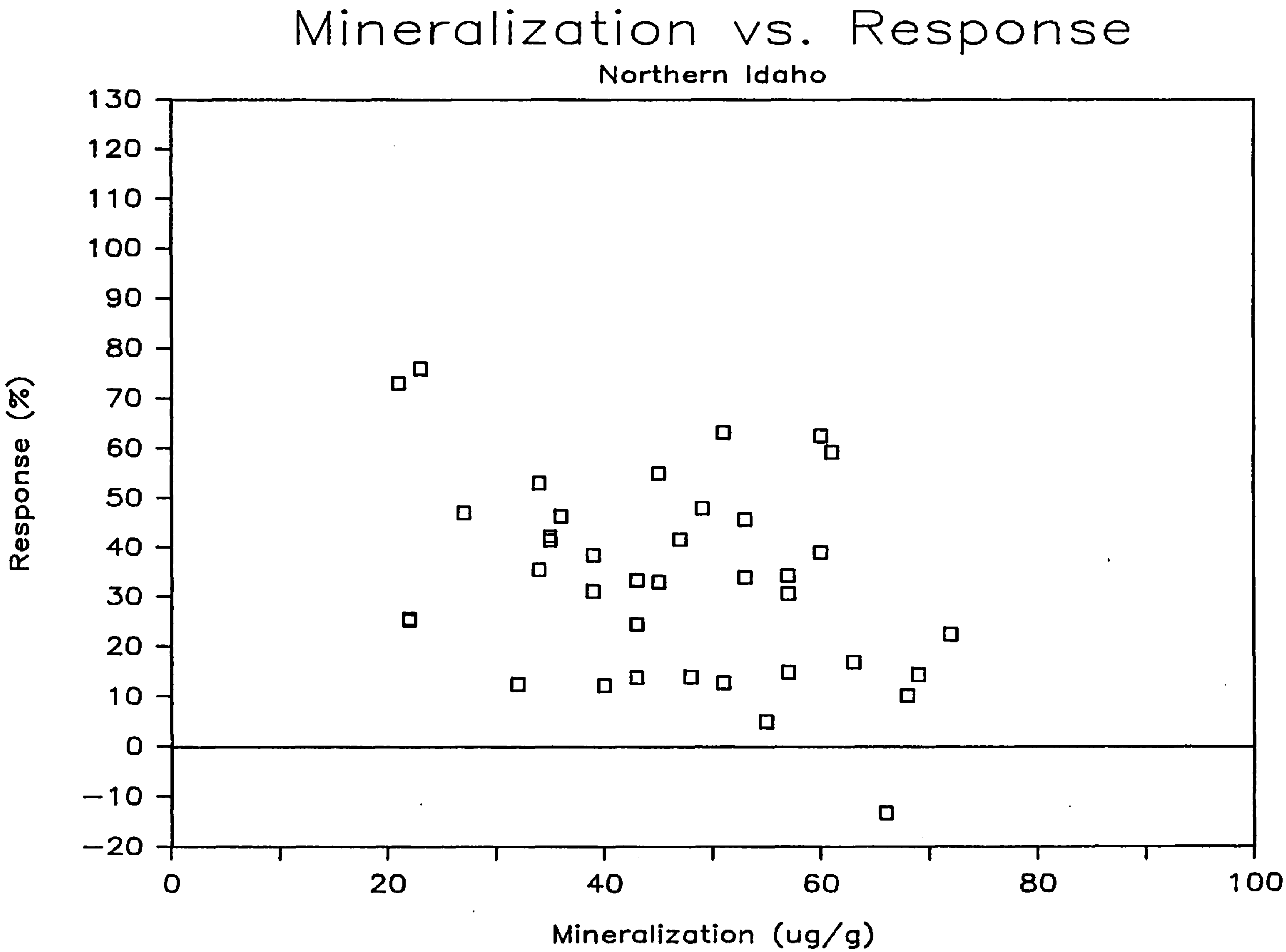
Mineralization vs. Response

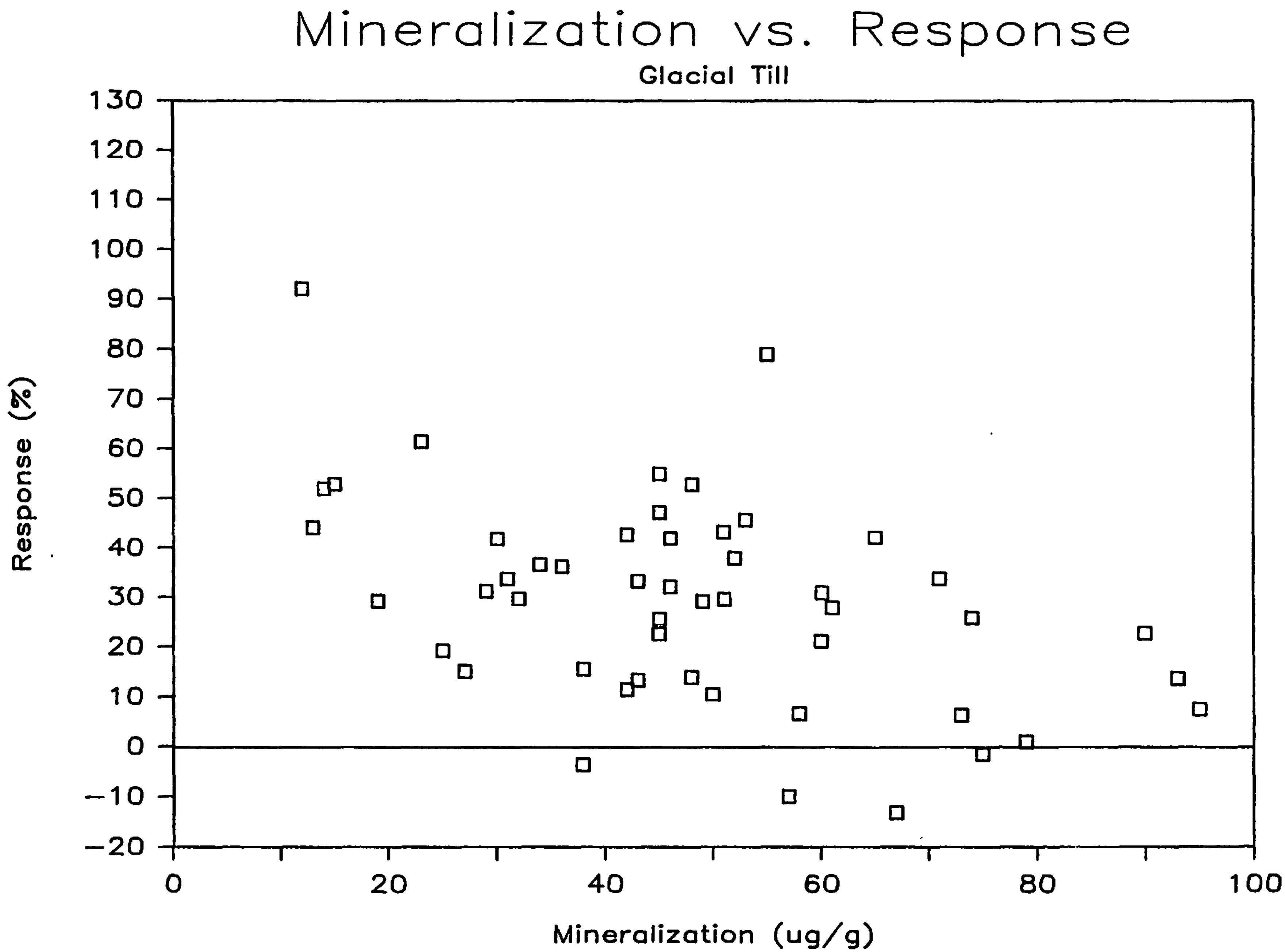
Northeastern Oregon

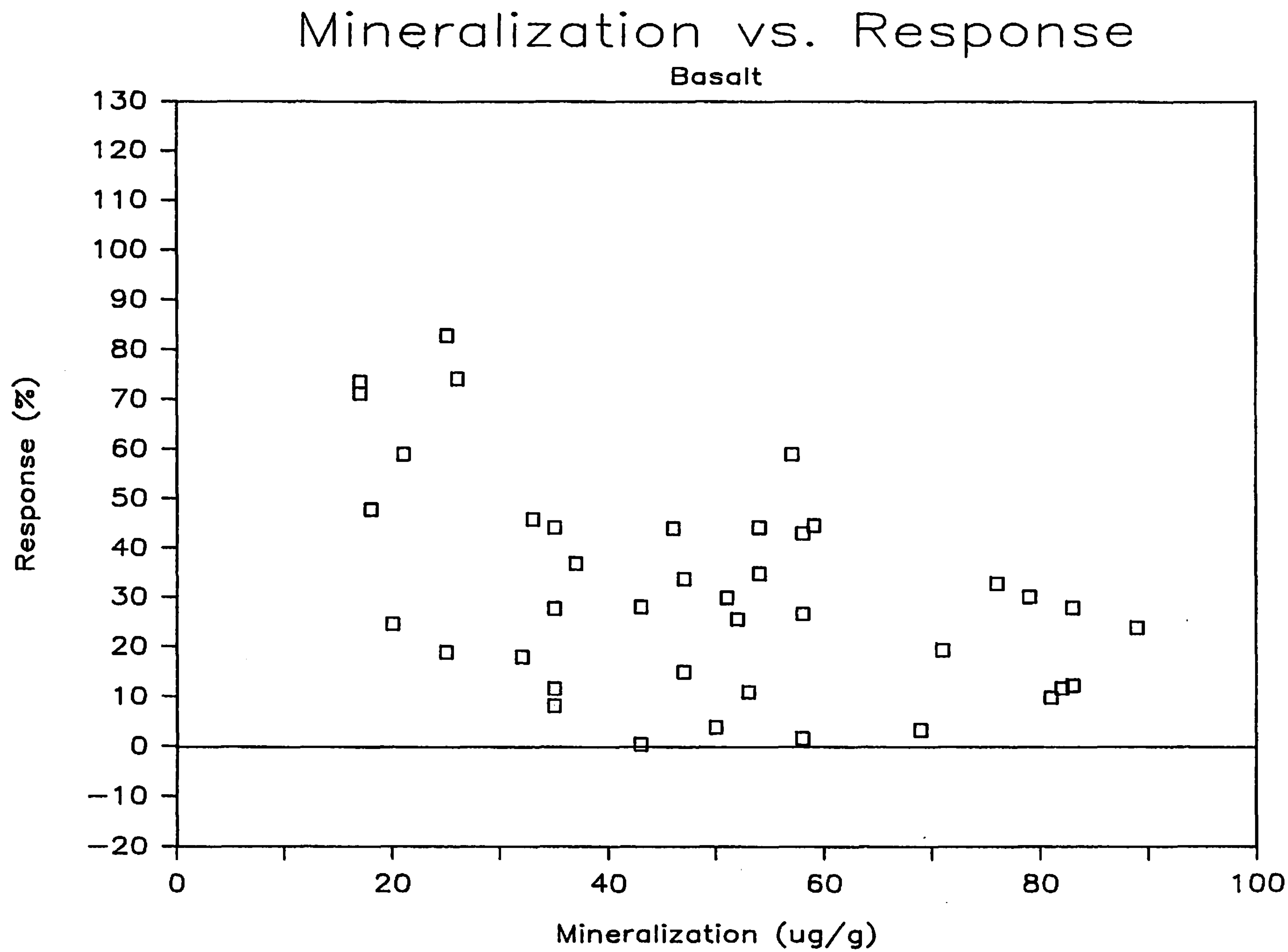




Mineralization vs. Response
Montana
Response (%)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
−20
0
20
40
60
80
100
Mineralization (ug/g)


Mineralization vs. Response
Northern Idaho
Response (%)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
−20
0
20
40
60
80
100
Mineralization (ug/g)

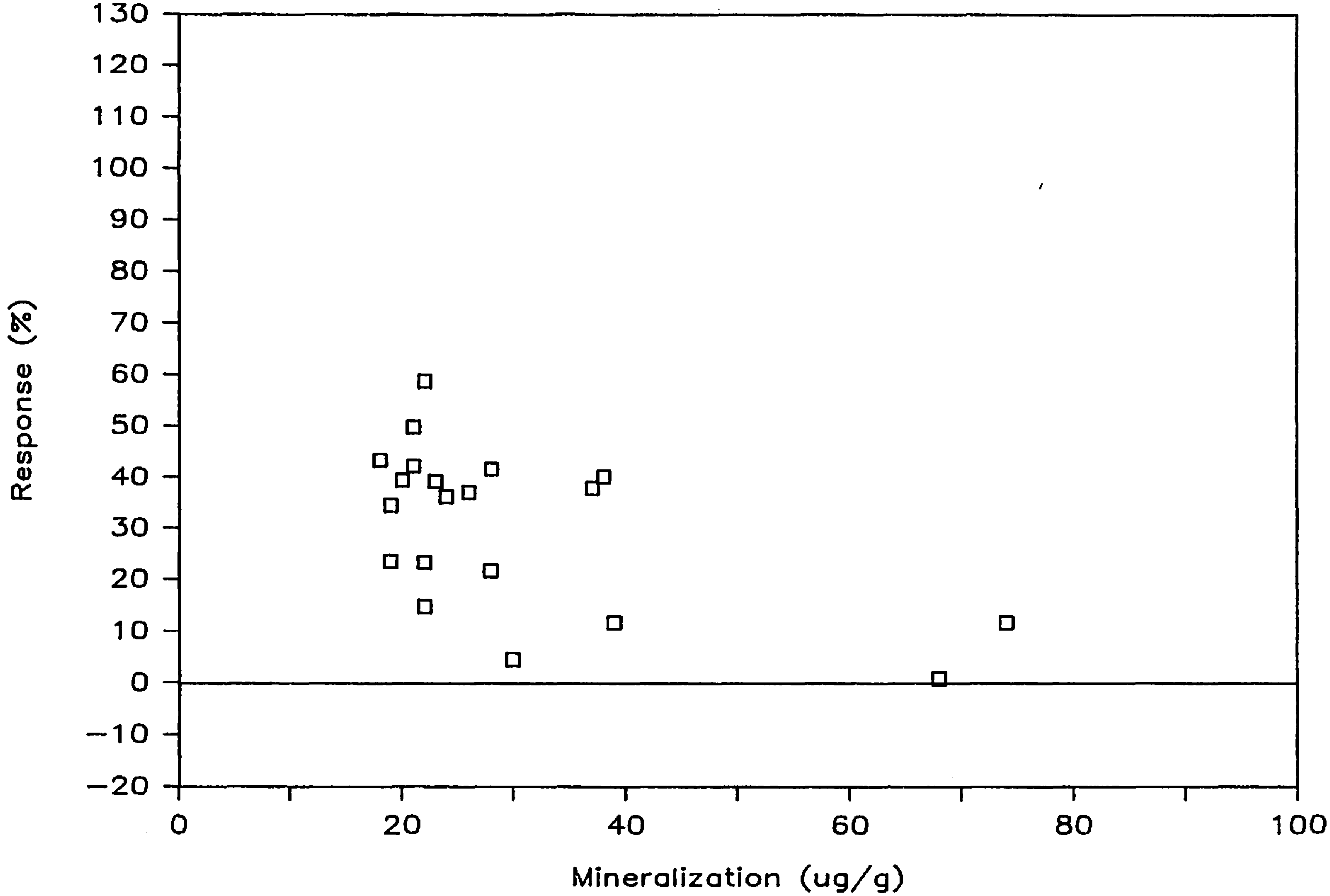

Mineralization vs. Response
Glacial Till
Response (%)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
−20
0
20
40
60
80
100
Mineralization (ug/g)



Mineralization vs. Response
Basalt
Response (%)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
−20
0
20
40
60
80
100
Mineralization (ug/g)

Mineralization vs. Response

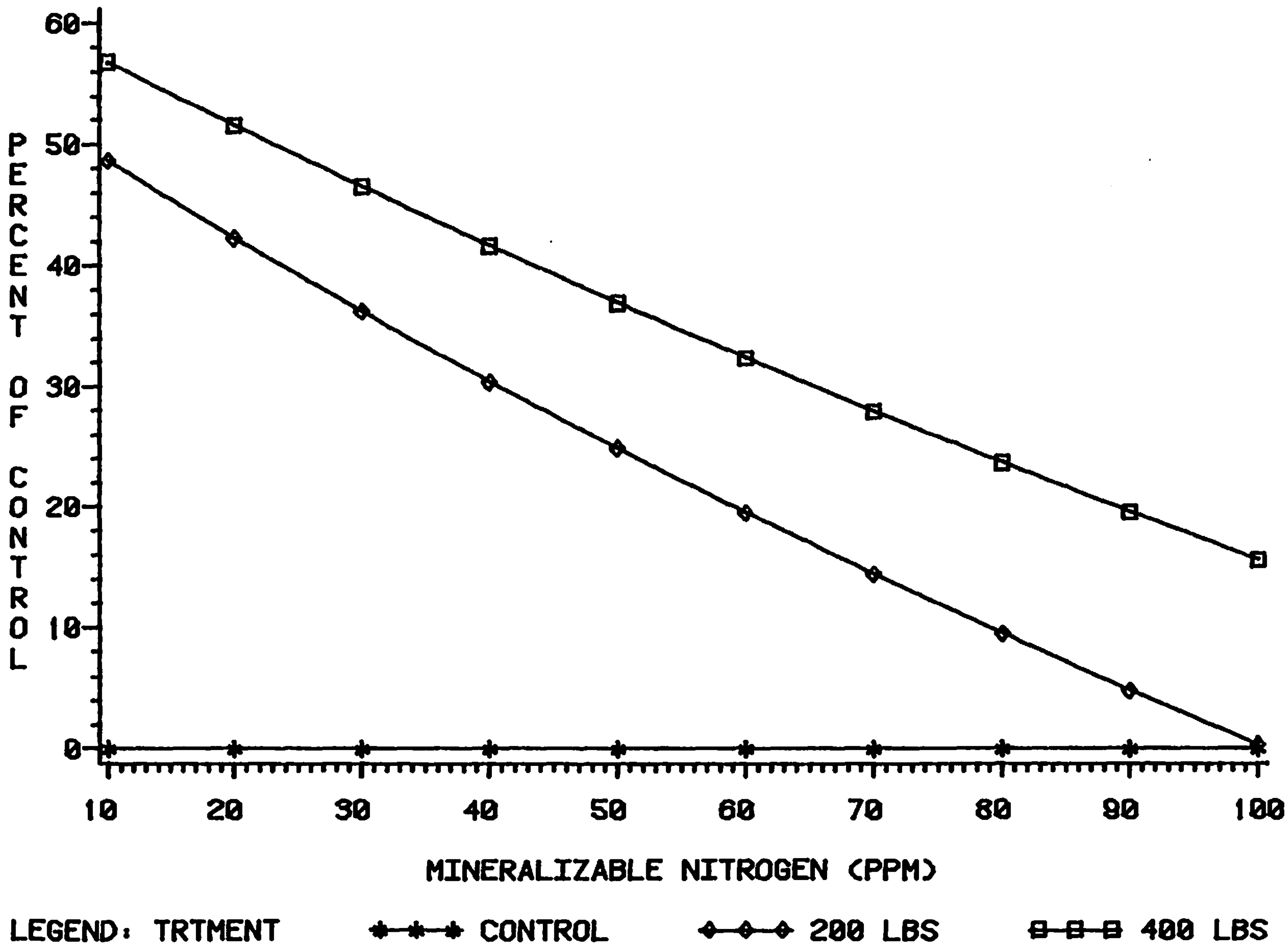
Granite

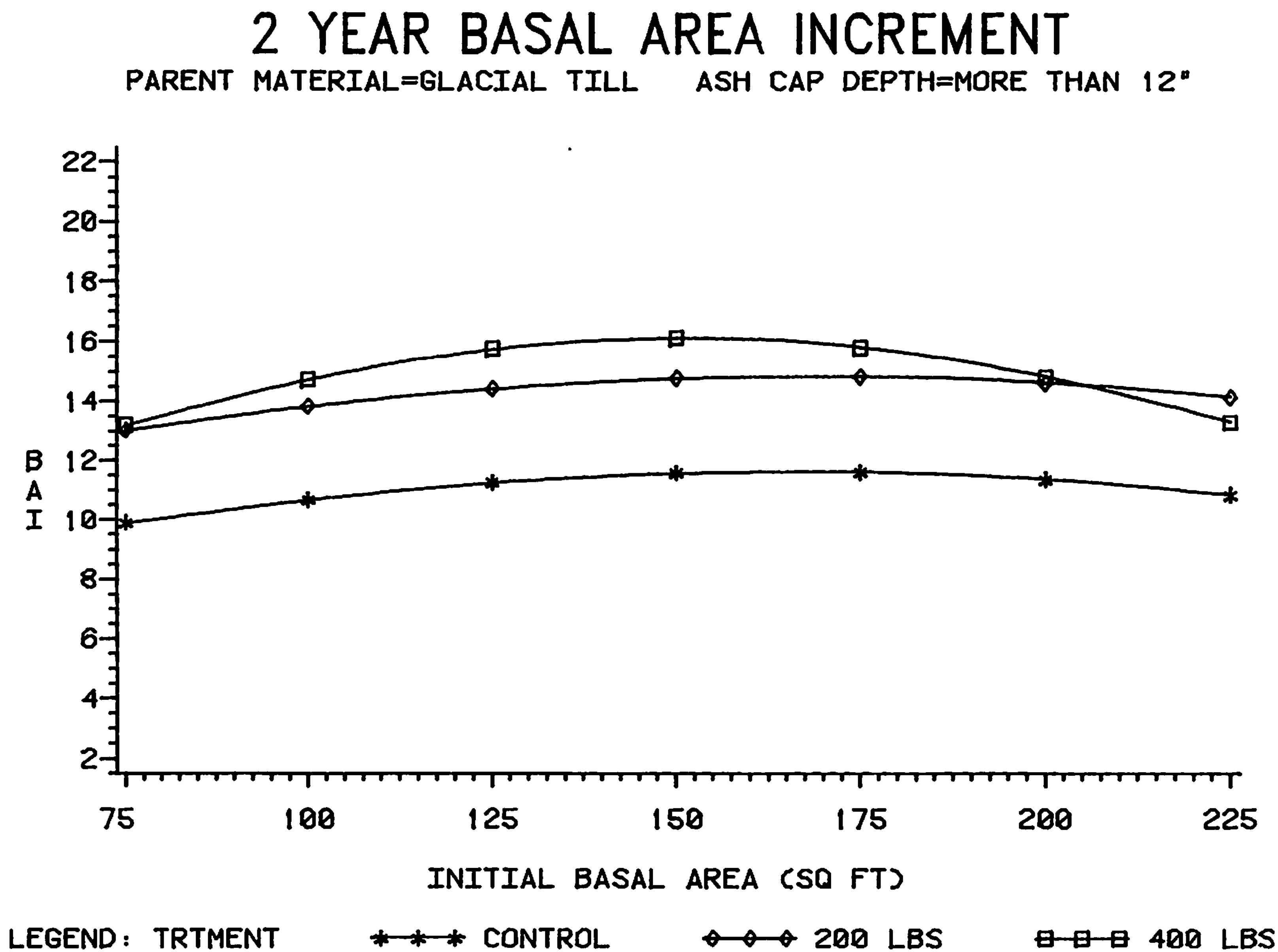


Comparison of models predicting treatment response.

Independent variable	Parent material model (r^2=.70)	Min-N model (r^2=.71)
Treatment	---------------common---------------	
Parent material	---------------common---------------	
Ash depth	---------------common---------------	
Soil depth	---------------common---------------	
Site index	---------------common---------------	
Percent slope	---------------common---------------	
Slope*sin (aspect)	---------------common---------------	
Slope*cos (aspect	---------------common---------------	
Initial BA	---------------common---------------	
BA × parent material	---------------common---------------	
BA × ash depth	---------------common---------------	
BA × treatment	---------------common---------------	
BA*BA	---------------common---------------	
BA*BA × parent material	---------------common---------------	
BA*BA × ash depth	---------------common---------------	
BA*BA × treatment	---------------common---------------	
Parent material × treatment	significant	not significant
Min_N	not in model	significant
Min_N × parent material	not in model	significant
Min_N × ash depth	not in model	significant
Min_N × treatment	not in model	significant

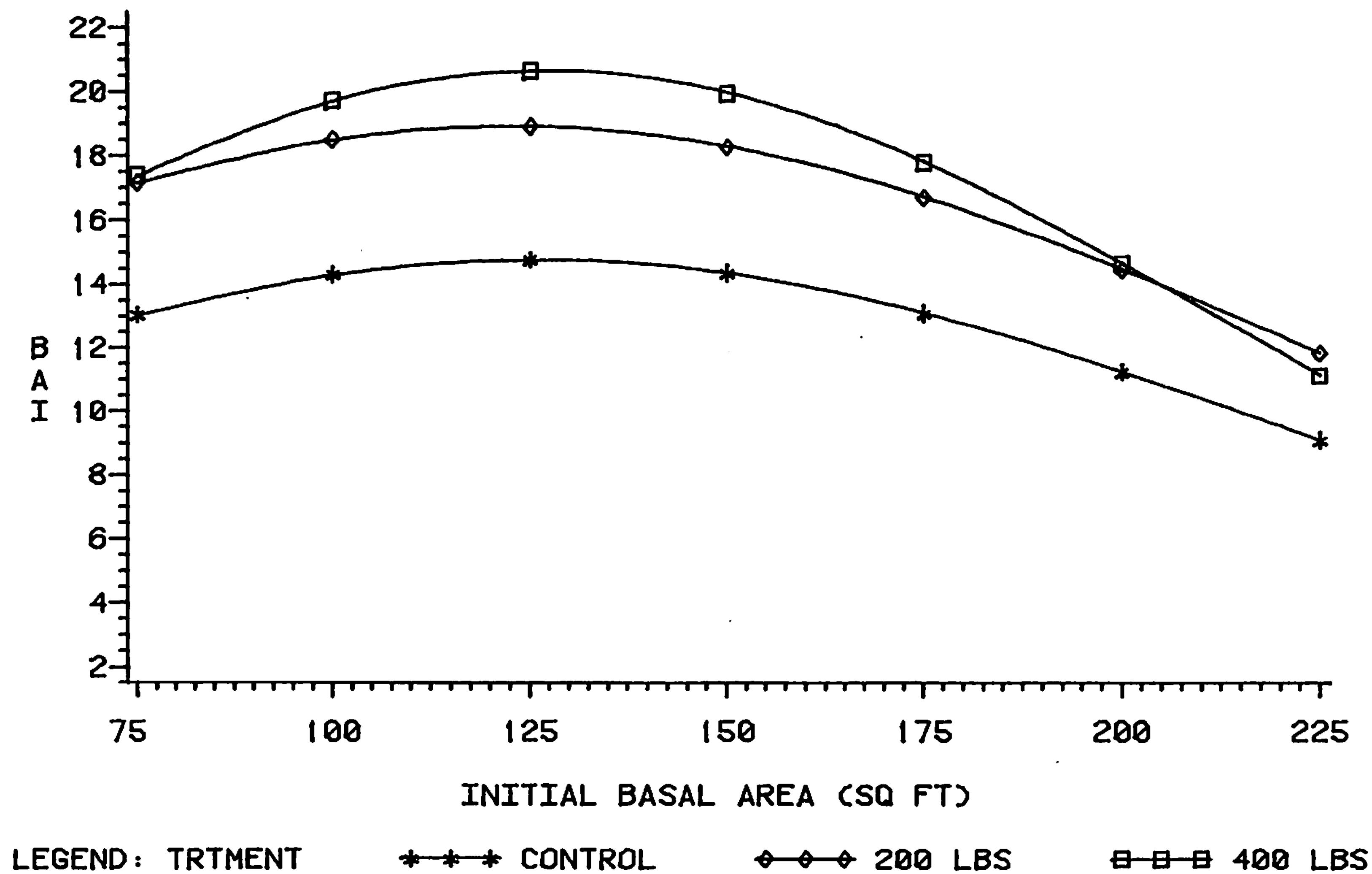
BAI INCREASE DUE TO FERTILIZATION




2 YEAR BASAL AREA INCREMENT
PARENT MATERIAL=GLACIAL TILL ASH CAP DEPTH=MORE THAN 12"
BAI
22
20
18
16
14
12
10
8
6
4
2
75
100
125
150
175
200
225
INITIAL BASAL AREA (SQ FT)
LEGEND: TRTMENT
CONTROL
200 LBS
400 LBS

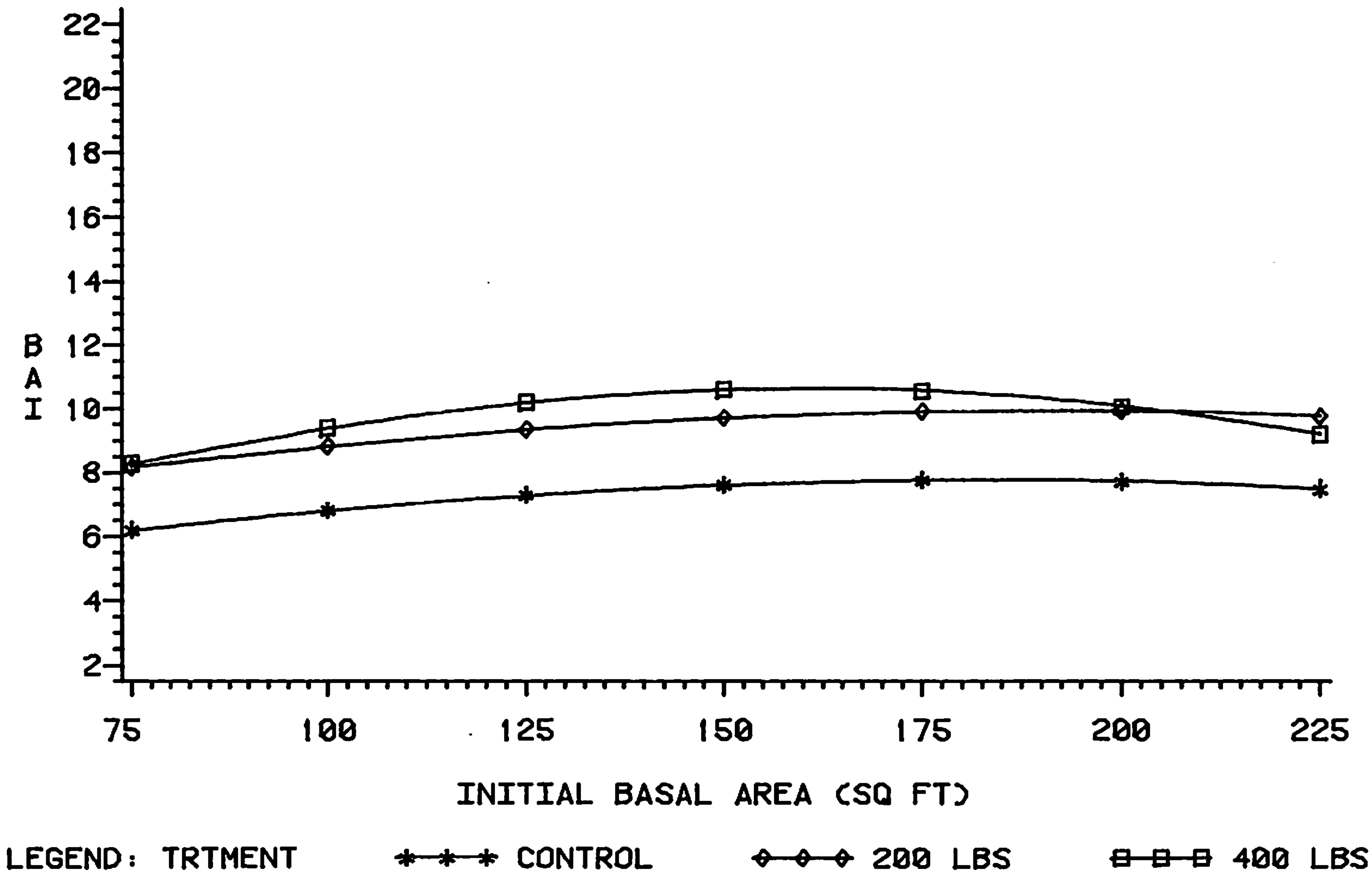
2 YEAR BASAL AREA INCREMENT

PARENT MATERIAL=ASH/METASEDIMENT   ASH CAP DEPTH=MORE THAN 12"



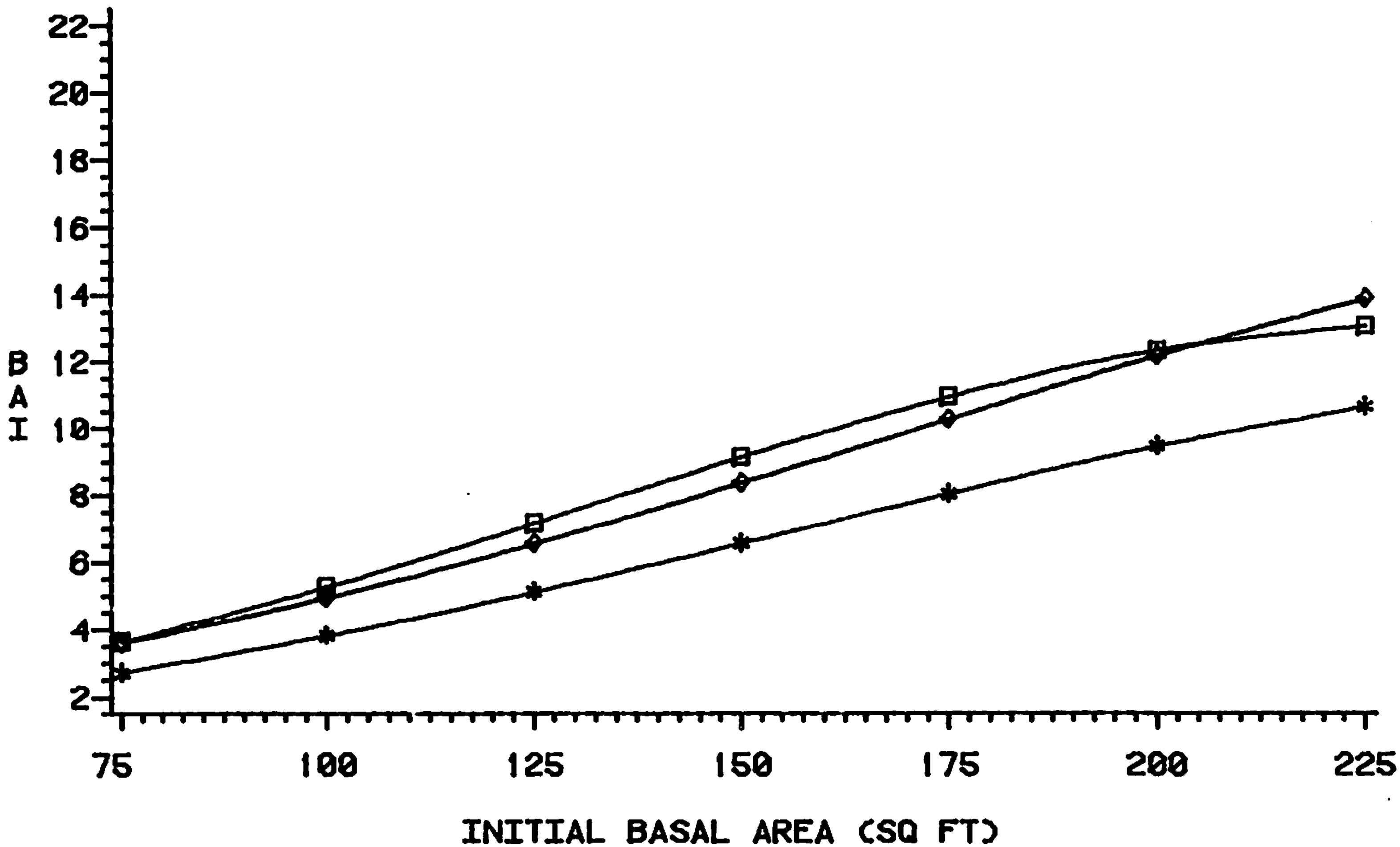
2 YEAR BASAL AREA INCREMENT

PARENT MATERIAL=GRANITE ASH CAP DEPTH=12" OR LESS



2 YEAR BASAL AREA INCREMENT

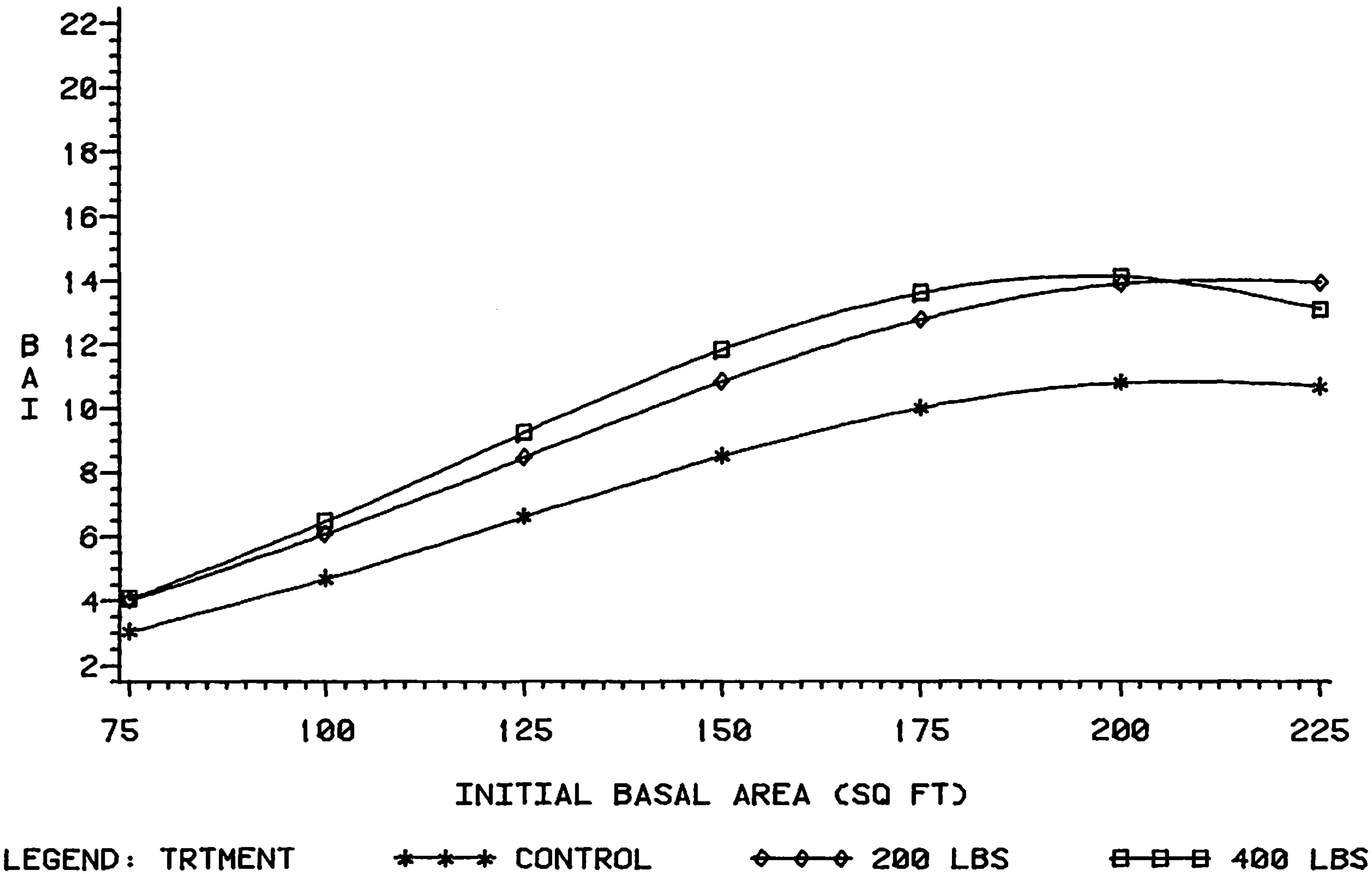
PARENT MATERIAL=ASH/LOESS   ASH CAP DEPTH=12" OR LESS



LEGEND: TRTMENT   CONTROL   200 LBS   400 LBS

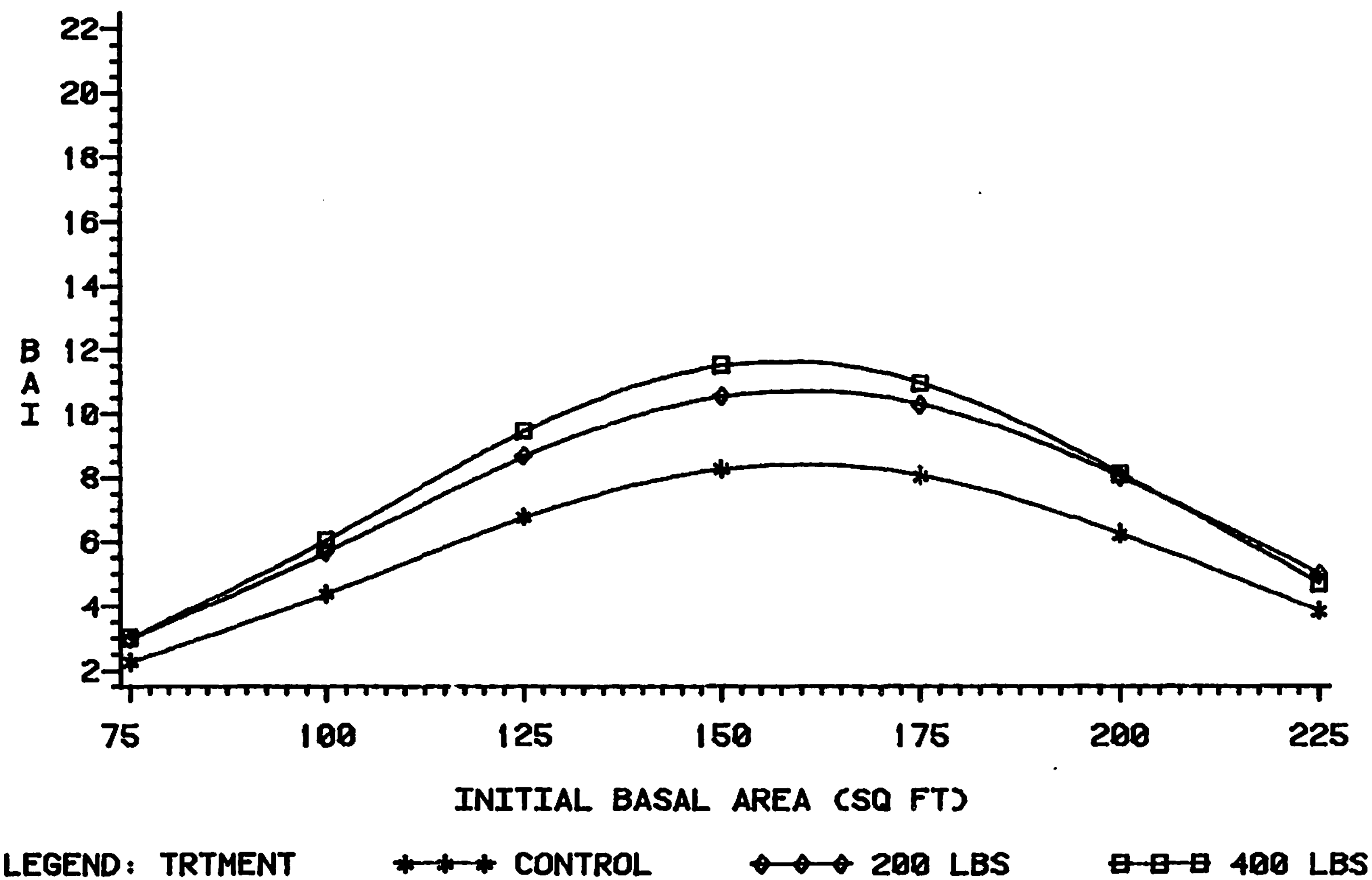
2 YEAR BASAL AREA INCREMENT

PARENT MATERIAL=ASH/LOESS   ASH CAP DEPTH=MORE THAN 12"



2 YEAR BASAL AREA INCREMENT

PARENT MATERIAL=ALLUVIUM ASH CAP DEPTH=12" OR LESS



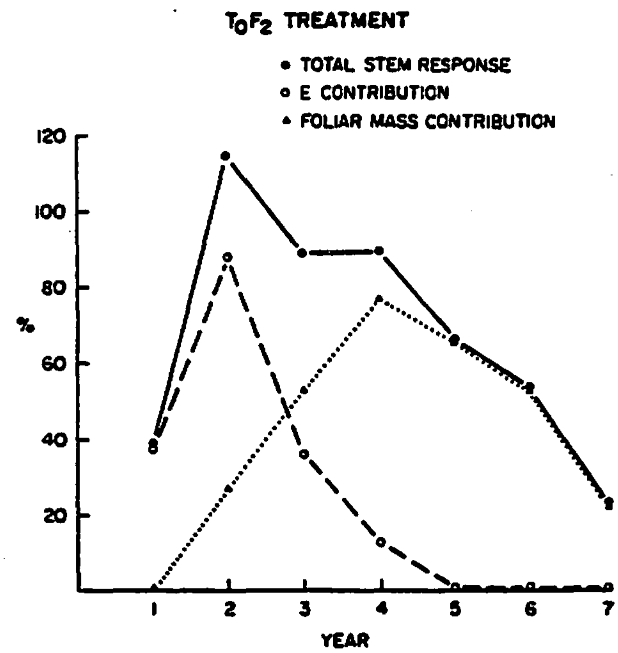


FIG. 4. Stemwood growth response to T_0F_2 treatment, percent above control, and contribution of E and foliage biomass to the response in years following treatment.

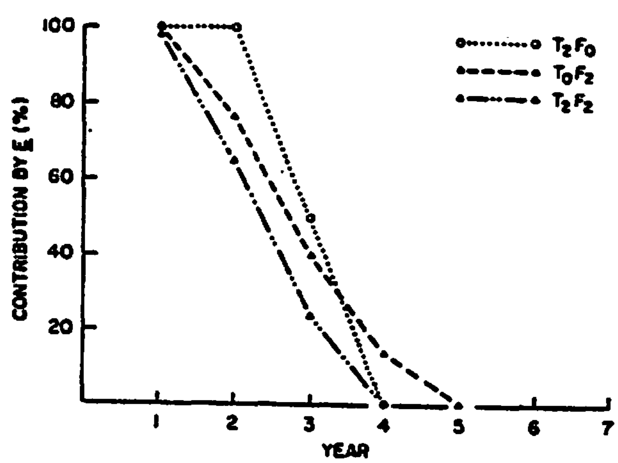


FIG. 5. The contribution of E to the stemwood growth response following treatments as a percentage of the total response.

Table 1. Foliar nutrient concentrations of Douglas-fir growing on different parent materials within the Inland Northwest.

Parent Material	N**	P	K**	Ca**	Mg**	Mn*	Fe**	Zn**	B**	Cu
	% mean (s.d.)		ug/g mean (s.d.)							
Granite n=10	1.02(0.08)	0.19(0.03)	5880(776)	4397(850)	1647(491)	343(98)	66(15)	29(7)	22(2)	4(1)
Ash/Loess n=8	1.09(0.15)	0.21(0.04)	6149(857)	3840(691)	1696(562)	404(128)	70(32)	29(4)	23(3)	4(1)
Basalt n=19	1.16(0.20)	0.22(0.05)	6917(1085)	3968(870)	1783(428)	324(100)	85(17)	29(5)	24(4)	5(1)
Glacial Till n=23	1.09(0.15)	0.23(0.05)	6619(1063)	4238(944)	1576(296)	365(109)	64(20)	32(7)	28(6)	4(1)
Ash/Meta. n=12	1.14(0.08)	0.22(0.04)	6523(1007)	3489(681)	1359(425)	338(124)	80(22)	24(6)	27(5)	4(1)
Valley Fill n=3	1.20(0.10)	0.20(0.01)	6198(601)	3358(431)	1540(693)	270(43)	66(27)	26(2)	21(6)	5(2)
Colluvium n=4	1.05(0.07)	0.19(0.02)	5984(672)	3596(379)	1029(139)	337(122)	48(10)	28(3)	26(9)	3(1)
Alluvium n=3	1.09(0.13)	0.19(0.02)	6653(530)	5045(691)	1655(8)	464(37)	59(2)	33(4)	28(7)	5(1)
Sandstone n=3	1.41(0.27)	0.27(0.04)	8127(1102)	3503(466)	1367(75)	504(84)	59(3)	33(5)	27(6)	3(1)

* F test significant at α= 0.1

** F test significant at α= 0.05

Soil Moisture Holding Capacity Determination For Five Soil Parent Materials (Installations)

By Jim Mital, Graduate Assistant, University of Idaho

Samples were collected from at least one soil pit in each of the 1982 installatins for the determination of soil moisture holding capacity. Soil bulk density was determined for each soil horizon by collecting undisturbed samples with a bulk density sampler and processing samples in the lab. Percent coarse fraction (particles > 2mm diameter) was estimated in the field.

Preliminary laboratory determination of soil moisture holding capacity was conducted using a pressure apparatus. The field capacity pressure used was 1/10 bar, while the wilting point pressure used was 15 bars. Moisture holding capacity was corrected for bulk density and coarse fraction. The preliminary results from five installations representing five different parent materials are shown in the following tables.

The ranking of the soil moisture holding capacity of the upper 24" for five parent materials (installations) is as follows:

1) Ash/Metasediment = 10.0"
2) Basalt = 6.4"
3) Valley fill = 2.3"
4) Granite = 2.2"
5) Glacial till = 1.4"

Installation 280

Parent Material: Granite

Horizon	Depth	Bulk Density	1/10 bar Water Content	15 bar Water Content	% Coarse Fraction	Available Water
A	0"-5"	1.08	16.90%	3.87%	15	0.60"
Bw1	5"-10"	1.10	19.50%	3.82%	20	0.69"
Bw2	10"-15"	0.96	19.50%	3.82%	30	0.53"
C	15"-26"	1.06	11.35%	3.27%	55	0.42"
Cr	26"-43"+	--	--	--	100	--

Moisture holding capacity--top 24" soil: 2.17" Total 2.24"

Installation 249

Parent Material: Basalt

Horizon	Depth	Bulk Density	1/10 bar Water Content	15 bar Water Content	% Coarse Fraction	Available Water
A	0"-4"	1.02	39.86%	10.95%	2	1.16"
Bw1	4"-16"	1.32	32.09%	11.27%	3	3.20"
Bw2	16"-25"	1.44	31.16%	13.10%	3	2.27"
B+	25"-39"	1.40	33.42%	13.06%	5	3.79"
C	39"-45"+	--	--	--	70	--

Moisture holding capacity--top 24" soil: 6.38" Total 10.42"

Installation 264

Parent Material: Ash/Metasediment

Horizon	Depth	Bulk Density	1/10 bar Water Content	15 bar Water Content	% Coarse Fraction	Available Water
Bw	0"-6"	0.65	79.41%	14.67%	3	2.45"
Bs	6"-21"	0.69	80.70%	14.49%	3	6.65"
2Bw	21"-36"	1.55	28.00%	3.67%	25	4.24"
2C1	36"-43"	1.39	31.62%	5.42%	45	1.40"
2C2	43"-61"+	1.39	29.32%	6.02%	25	4.37"

Moisture holding capacity--top 24" soil: 9.95" Total 19.11"

Installation 252

Parent Material: Glacial Till

Horison	Depth	Bulk Density	1/10 bar Water Content	15 bar Water Content	% Coarse Fraction	Available Water
A	0"-1 "	0.79	32.06%	6.97%	30	0.21"
Bw	1 "-8"	0.95	33.33%	7.60%	55	0.71"
C1	8"-20"	1.08	20.88%	4.43%	80	0.43"
C2	20"-40"+	--	--	--	90	--

Moisture holding capacity--top 24" soil: 1.42" Total 1.35"

Installation 269

Parent Material: Valley Fill

Horizon	Depth	Bulk Density	1/10 bar Water Content	15 bar Water Content	% Coarse Fraction	Available Water
Bw1	0"-6"	0.71	45.74%	9.71%	35	1.00"
Bw2	6"-14"	0.99	31.25%	8.62%	50	0.90"
C	14"-24"	0.87	29.41%	8.54%	80	0.36"
Cr	24"-39"+	--	--	--	90+	--

Moisture holding capacity--top 24" soil: 2.26"   Total 2.26"

A Comparison of Monserud's Douglas-fir Site Index And Height Growth Equations with Those Developed From IFTNC Stem Analysis Data for Six Geographic Regions

By

Jim VanderPloeg

Research Associate, IFTNC

Introduction

Douglas-fir site index estimates for each of the 572 research plots of the Intermountain Forest Tree Nutrition Cooperative were obtained using equations developed by Bob Monserud. Monserud's equations resulted from a study using stem analysis data from North Idaho and extreme western Montana (Figure 1). Stem analysis data collected in conjunction with the IFTNC was used to test the validity of applying Monserud's site index curves throughout the IFTNC's entire region of study (Figure 2).

A total of 1,164 dominant and codominant Douglas-fir trees from 93 IFTNC sites were destructively sampled. A series of height and age measurements along the bole of each tree provided a basis for comparing each site's observed height growth pattern to that predicted from Monserud's height growth equation. We followed essentially the same process that Monserud used in his North Idaho study. Each region was analyzed separately.

Methods

1) Screen data for unacceptable sample trees

   -evidence of suppression

   -damage

   -disease

2) Use resulting data points and for each site (installation), fit the logistic estimate parameters B_0, B_1, and B_2 using nonlinear regression.

$$\text{Total Height} = 4.5 + \frac{B_0}{(1 + e^{(B_1 - B_2 \ln A)})}$$

3) Evaluate equation at age 50 for an estimate of site index for each site.

4) Take resulting SI estimate and insert in the habitat type specific height logistic developed by Bob Monserud from stem analysis data in North Idaho.

$$\text{Total Height} = 4.5 + \frac{42.397 \text{ X } (SI - 4.5)^{0.3488}}{1 + e^{(9.7278 - 1.2934 \text{ X } \ln A - .9779 \ln (SI - 4.5))}}$$

5) Evaluate both equations for each decade to the highest decadal age found at that site.

6) Compare mean differences in height over all sites and age classes, and test for significant differences between the two equations.
7) Develop new site index equations for those regions where the height-age pattern appears significantly different.

Results

Comparing the height growth pattern in six geographic regions in the Inland Northwest to Monserud's height growth model developed from North Idaho data suggests that some regional differences may exist over the average of high and low sites. When comparing total heights thru time for each region (Figures 3a-3f) the height growth pattern appears quite similar. However, examining the mean differences of the predicted heights (Monserud) from the observed heights (IFTNC) for each region (Figures 4a-4f) revealed that there were differences.

Most of the regions showed larger differences at higher ages. This could be partially due to a smaller sample size from older stands. Except for North Idaho and Central Idaho Monserud's height equation tended to overpredict at ages over 60. For ages less than 60, North Idaho, Montana and Northeast Washington showed consistent underpredictions while Central Idaho, N.E. Oregon and Central Washington were overpredicted.

North Idaho was the only region in which all age classes were underpredicted, although not significantly. The IFTNC sites in North Idaho were generally in young stands on productive sites, which could explain the observed trend. IFTNC sites in Montana, N.E. Oregon and N.E. Washington were on the average somewhat drier than that sampled by Monserud. This could also help to explain some of the differences, especially in older stands.

Montana and Central Washington exhibited the most differences between the two models when compared across all age classes. These regions are also the farthest from the area sampled by Monserud. Therefore, site index curves for Montana and Central Washington were developed from IFTNC data and compared to Monserud's curves. Monserud's curves for Douglas-fir series habitat type were used for Montana, while both the Douglas-fir series and Grand-fir/Western redcedar series curves were used in Central Washington.

Montana (Figures 5a-5c) shows substantial differences in curve from site index curves developed in this study for low site index values. Again, this is probably due to the drier sites sampled by the IFTNC. Medium and high sites, however, show essentially no difference.

Monserud's Douglas-fir series curves in Central Washington had basically the same result as Montana (Figure 6a-6c). However, differences between the curves for low site index values are not as severe as Montana, especially in older stands. When Monserud's Grand-fir/Western redcedar series curves were used in Central Washington, the low site curves match more closely, but the differences on medium and high sites are greater (Figures 7a-7c). When the IFTNC curves were developed, all habitat types were grouped together. Montana sites were almost entirely on the Douglas-fir series habitat type; but Central Washington has more GF-WRC types incorporated in the curve development.

Summary

In general, Monserud's site index curves could be used reliably throughout the Inland Northwest. However, care must be taken when using his curves in areas outside his sample area, especially on low sites.

Analysis is continuing concerning differences in curve shape with habitat type and parent material on the IFTNC sites.

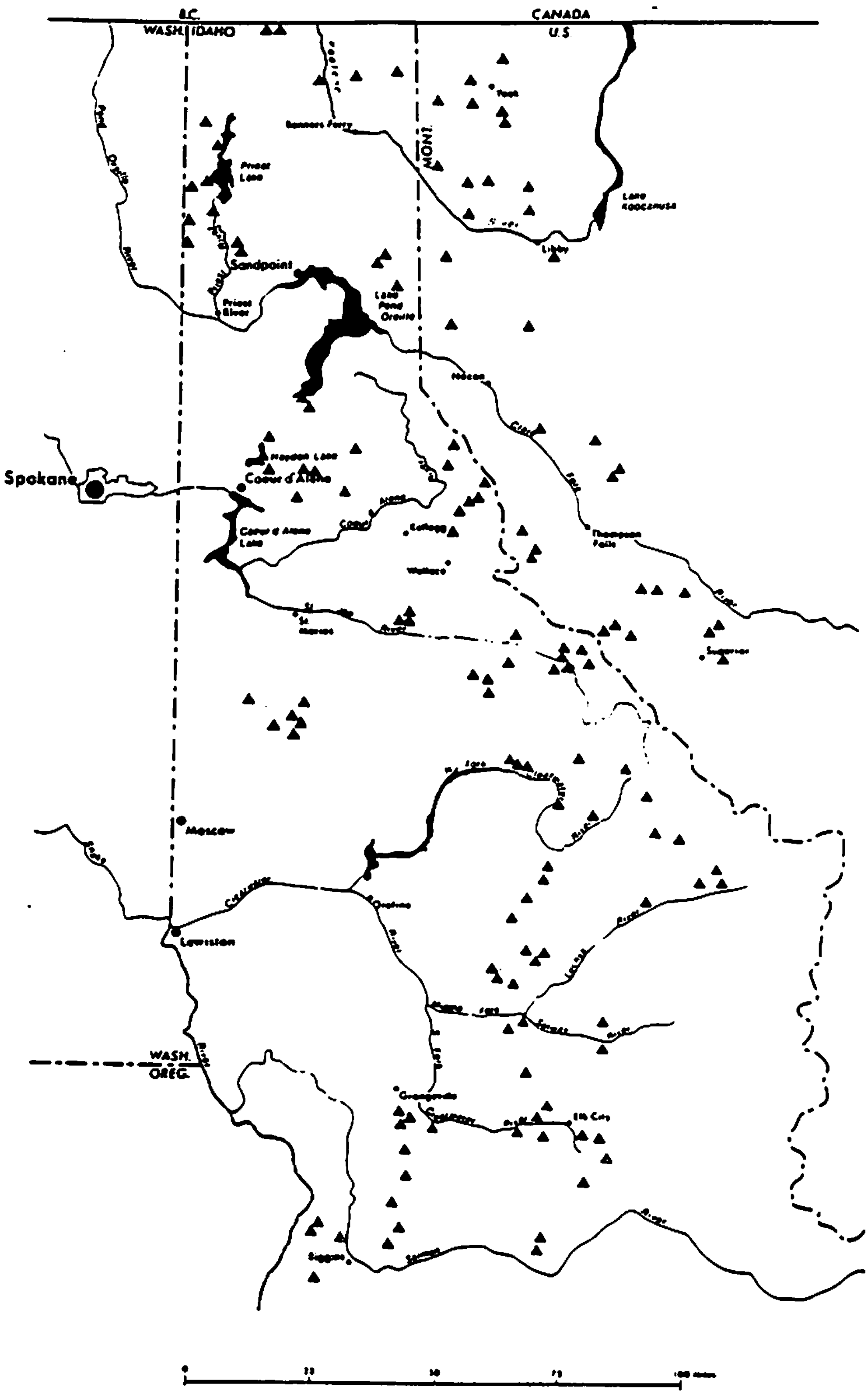


Figure 1. Douglas-fir site index study plot locations.
(used in the development of Monserud's SI curves)

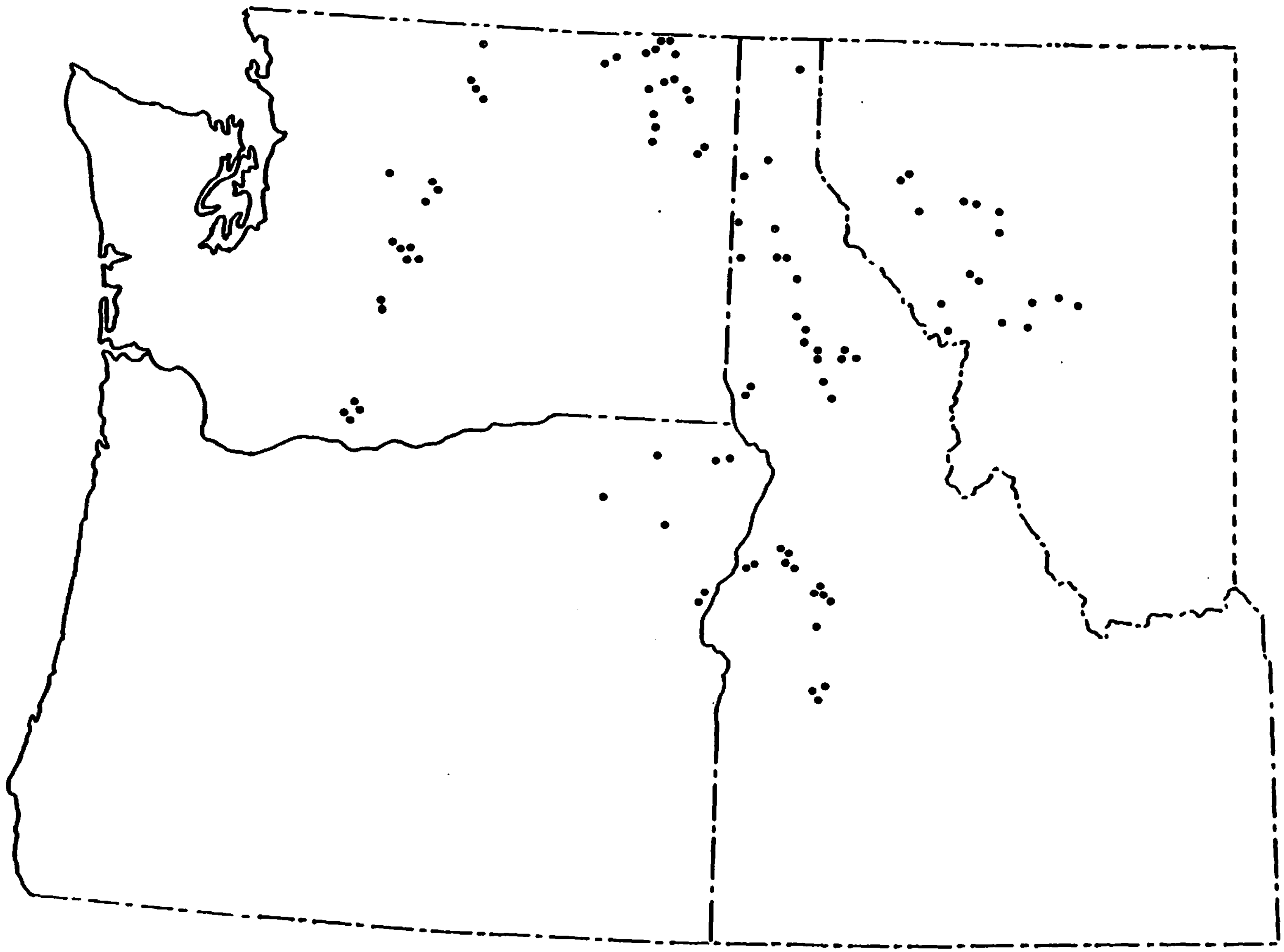


Figure 2. **SAMPLE PLOT LOCATIONS**

IFTNC Study

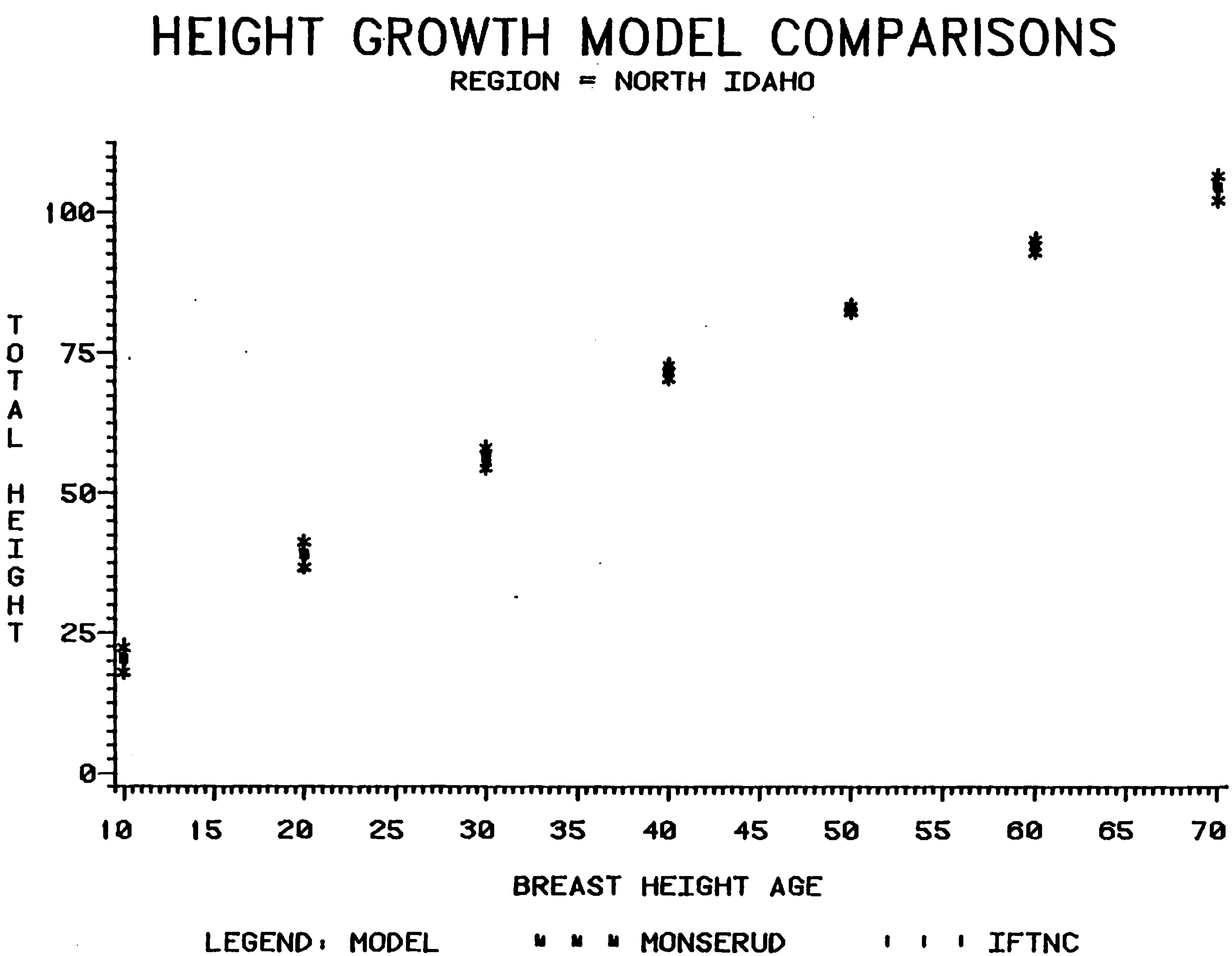


Figure 3a. Comparison of predicted heights using Monserud's height growth model with those obtained from height growth equations developed from IFTNC data for North Idaho.

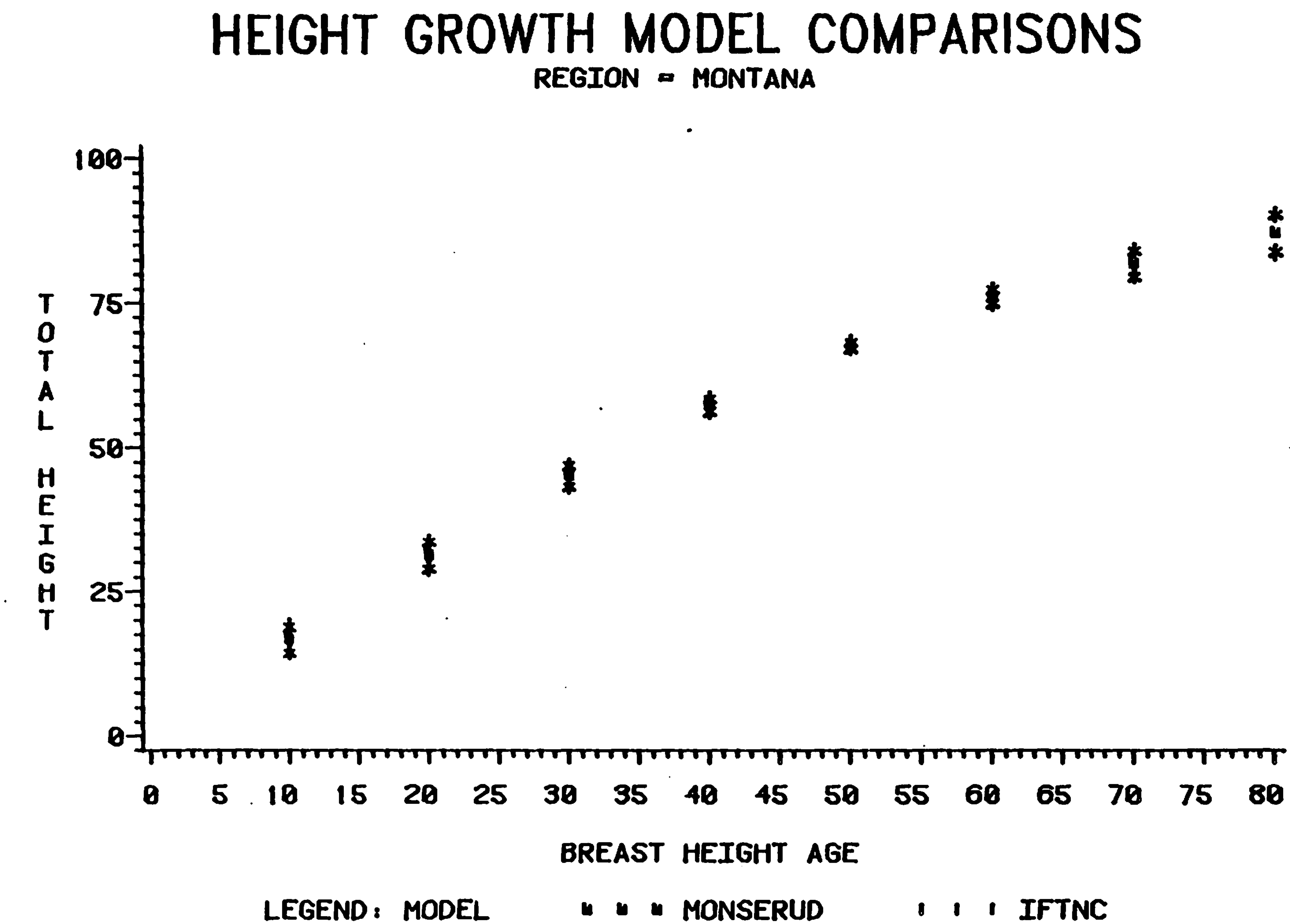


Figure 3b. Comparison of predicted heights using Monserud's height growth model with those obtained from height growth equations developed from IFTNC data for Montana.

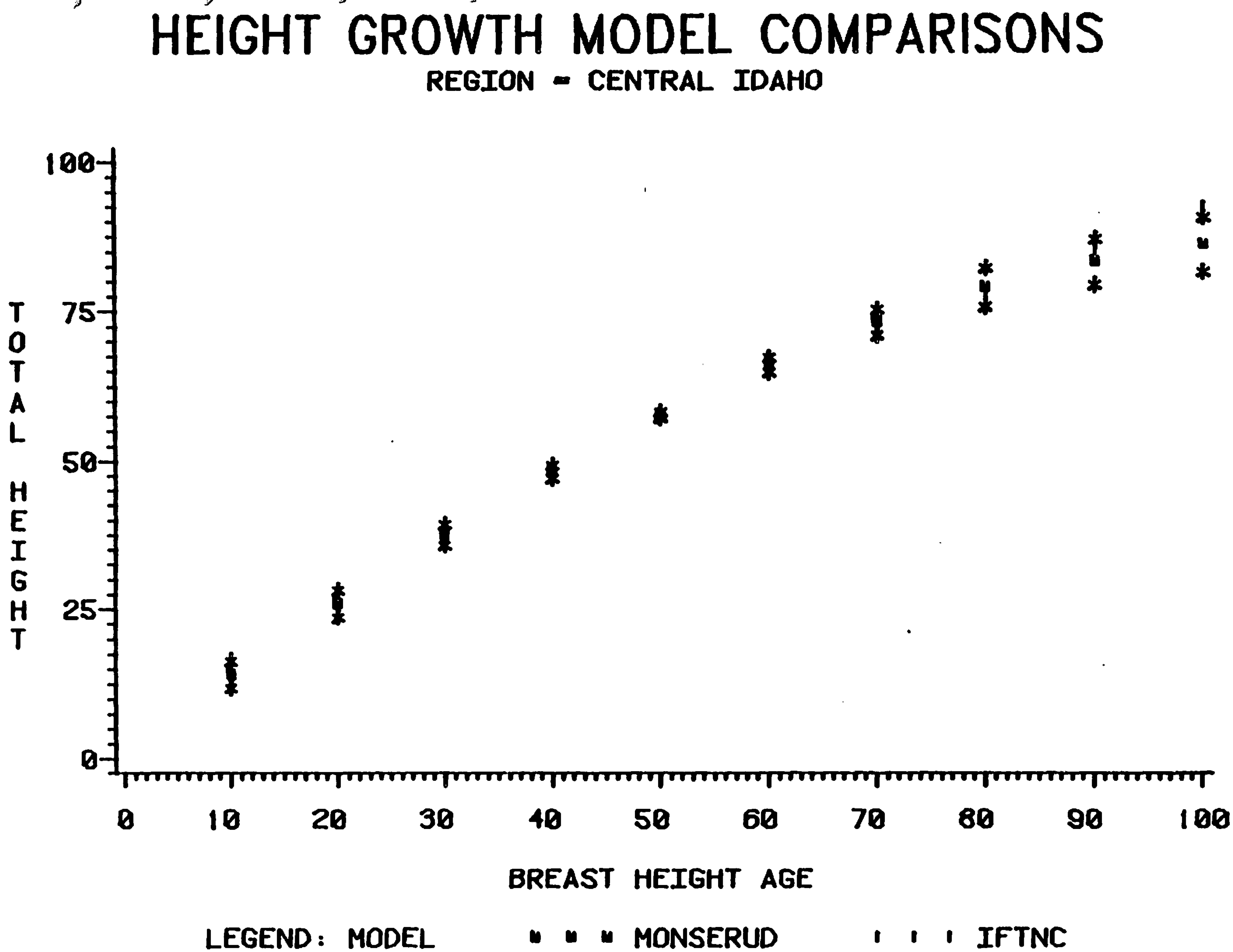


Figure 3c. Comparison of predicted heights using Monserud's height growth model with those obtained from height growth equations develped from IFTNC data for Central Idaho.

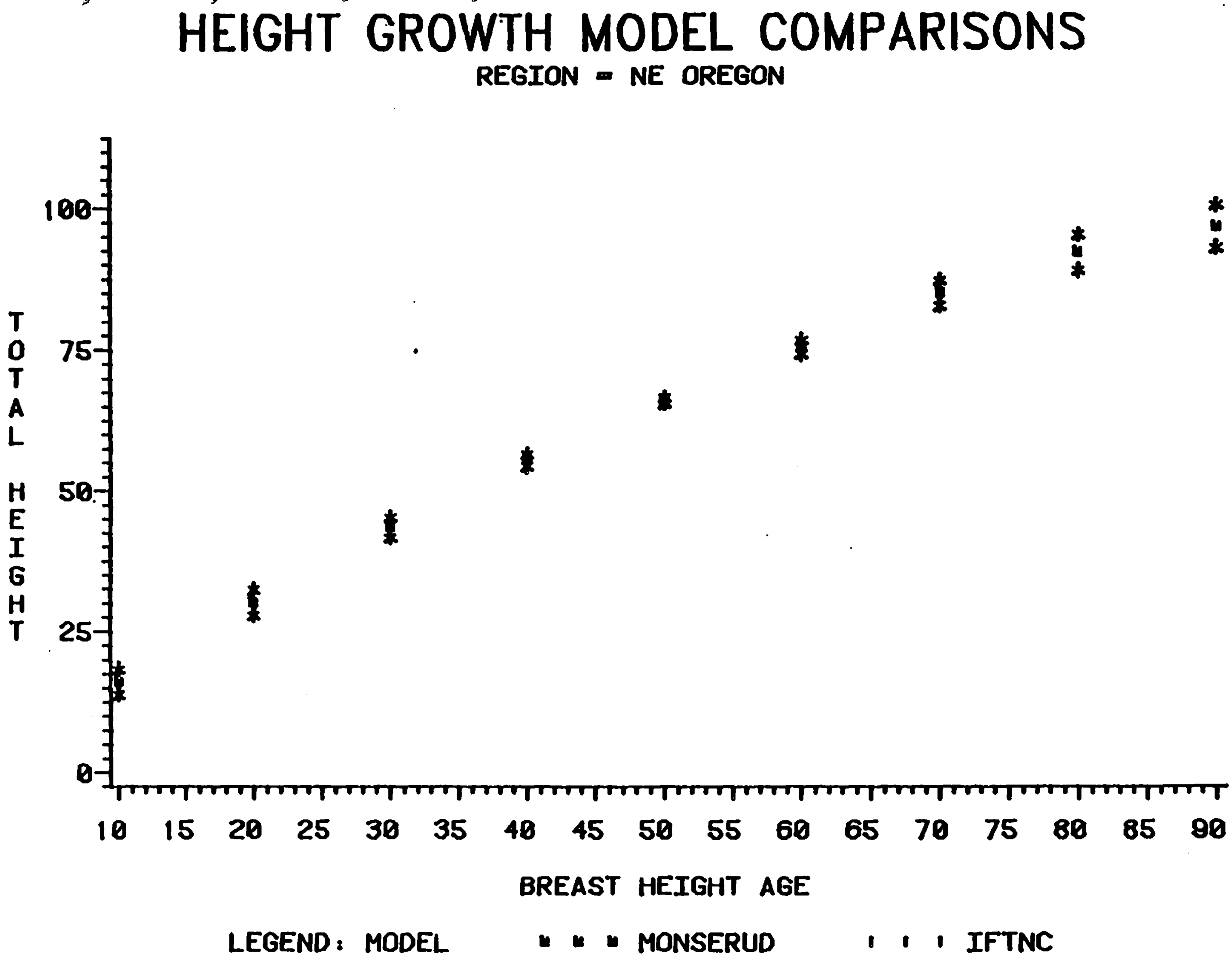


Figure 3d. Comparison of predicted heights using Monserud's height growth model with those obtained from height growth equations developed from IFTNC data for Northeast Oregon.

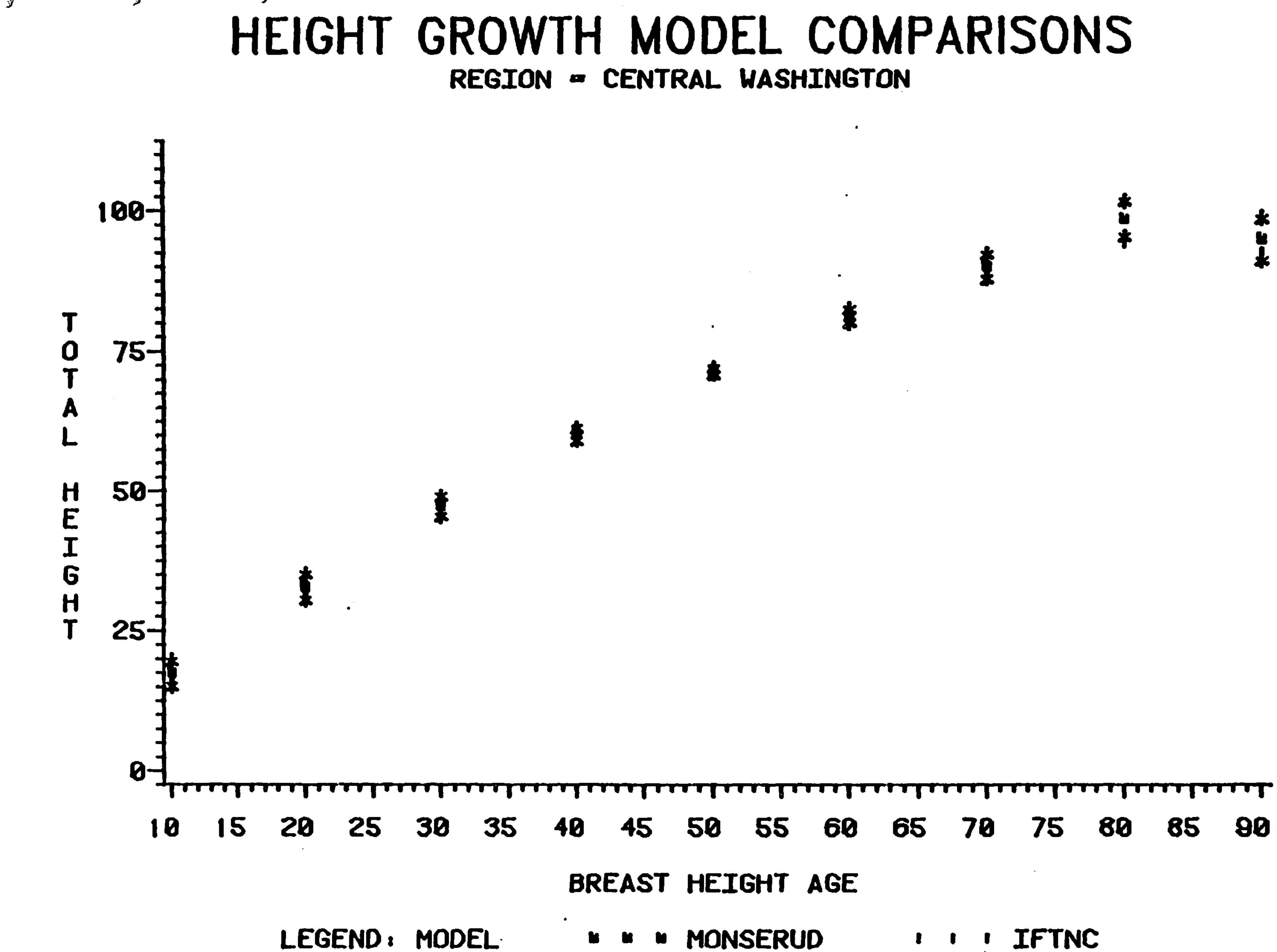


Figure 3e. Comparison of predicted heights using Monserud's height growth model with those obtained from height growth equations developed from IFTNC data for Central Washington.

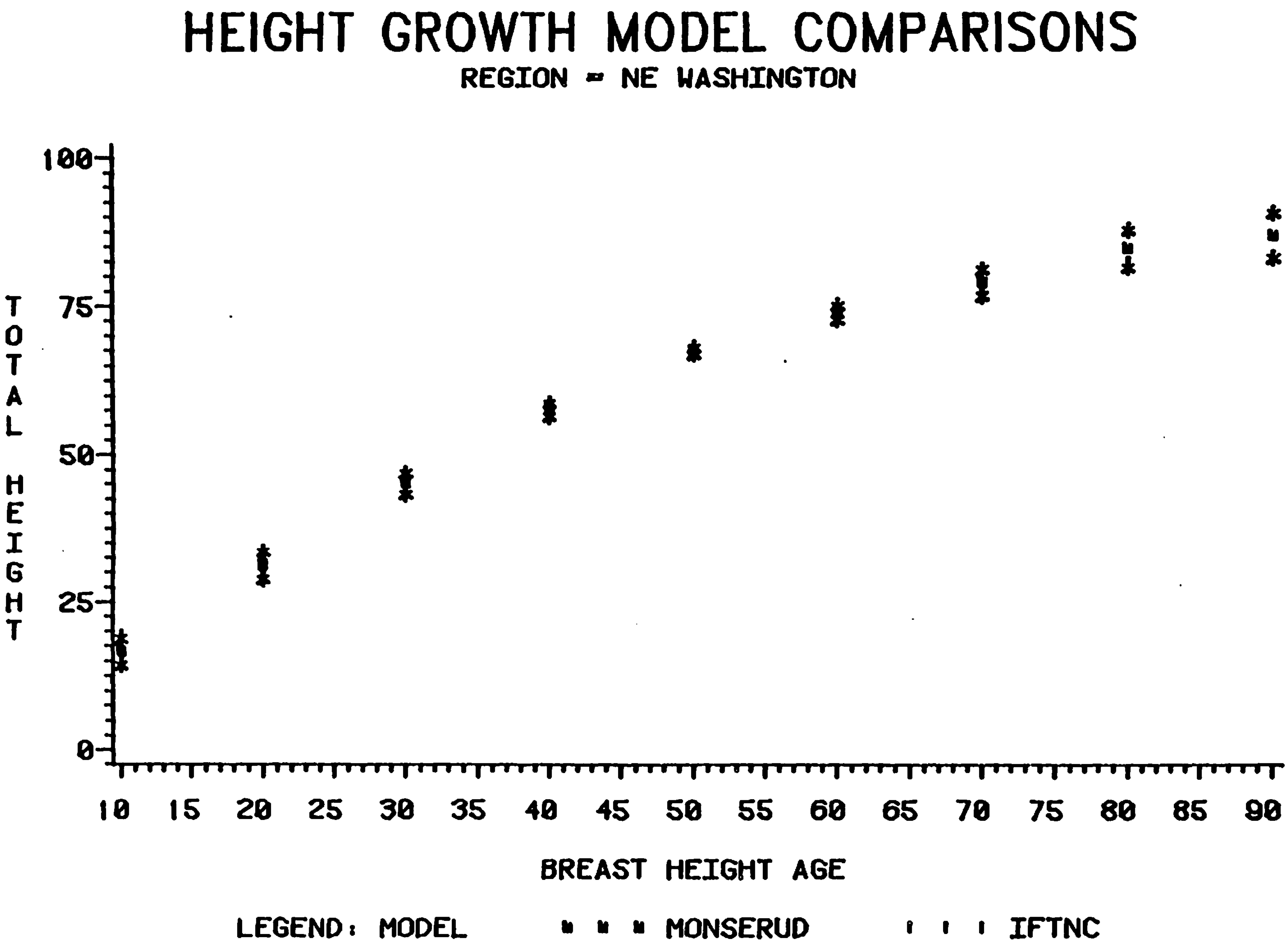


Figure 3f. Comparison of predicted heights using Monserud's height growth model with those obtained from height growth equations developed from IFTNC data for Northeast Washington.

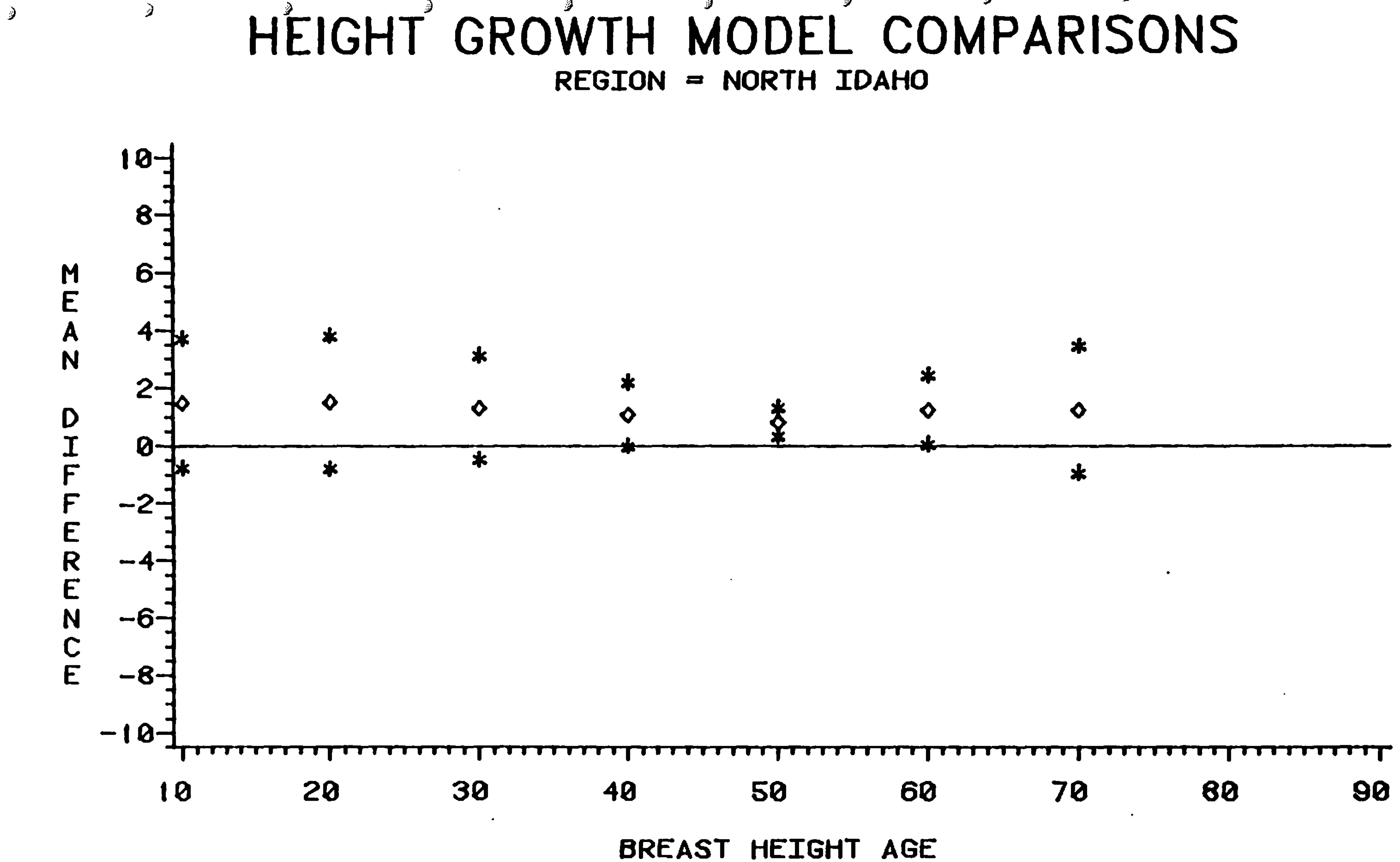


Figure 4a. Comparison of mean differences in predicted heights using Monserud's height growth model with those obtained from height growth equations developed from IFTNC data for North Idaho.

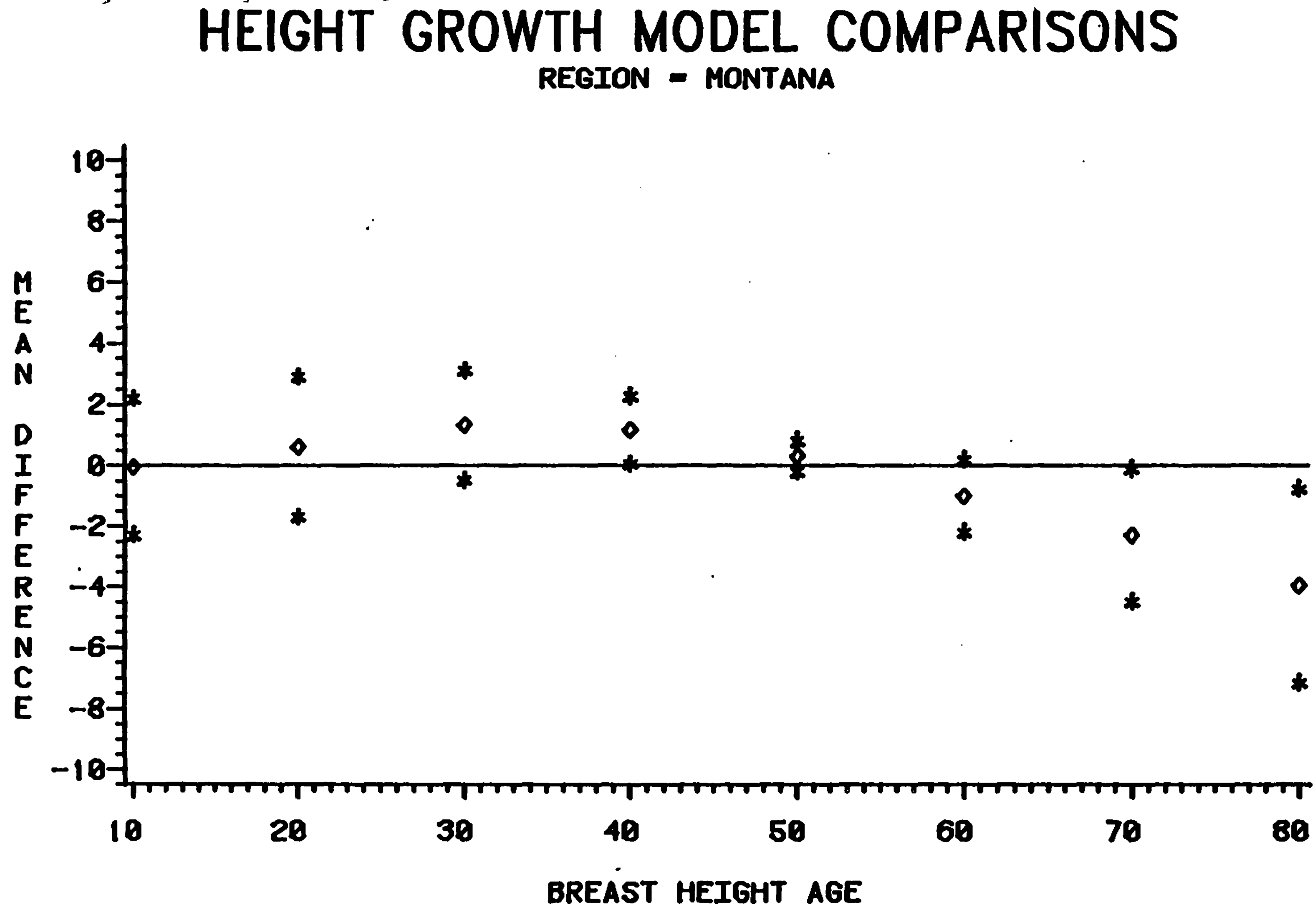


Figure 4b. Comparison of mean differences in predicted heights using Monserud's height growth model with those obtained from height growth equations developed from IFTNC data for Montana.

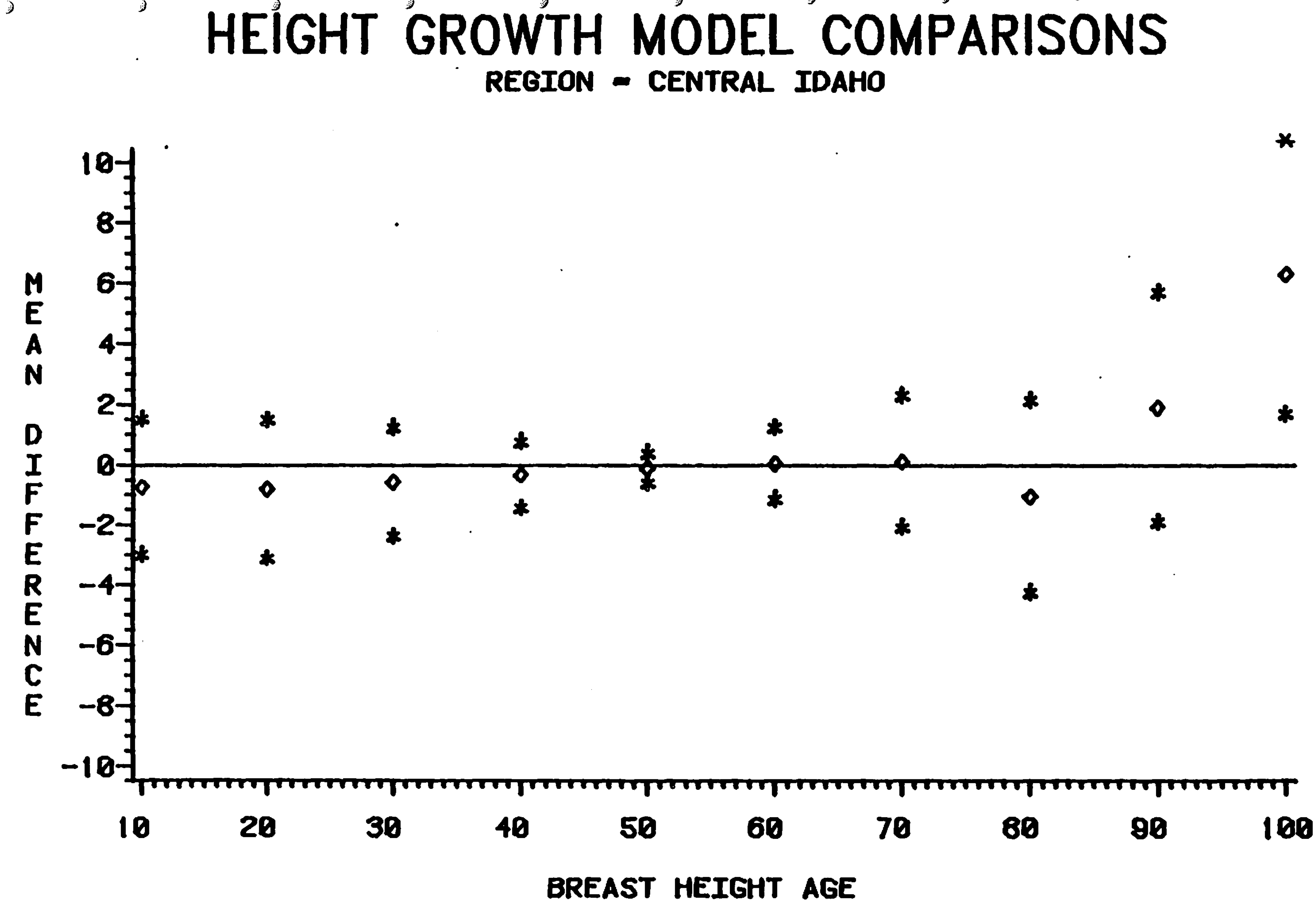


Figure 4c. Comparison of mean differences in predicted heights using Monserud's height growth model with those obtained from height growth equations developed from IFTNC data for Central Idaho.

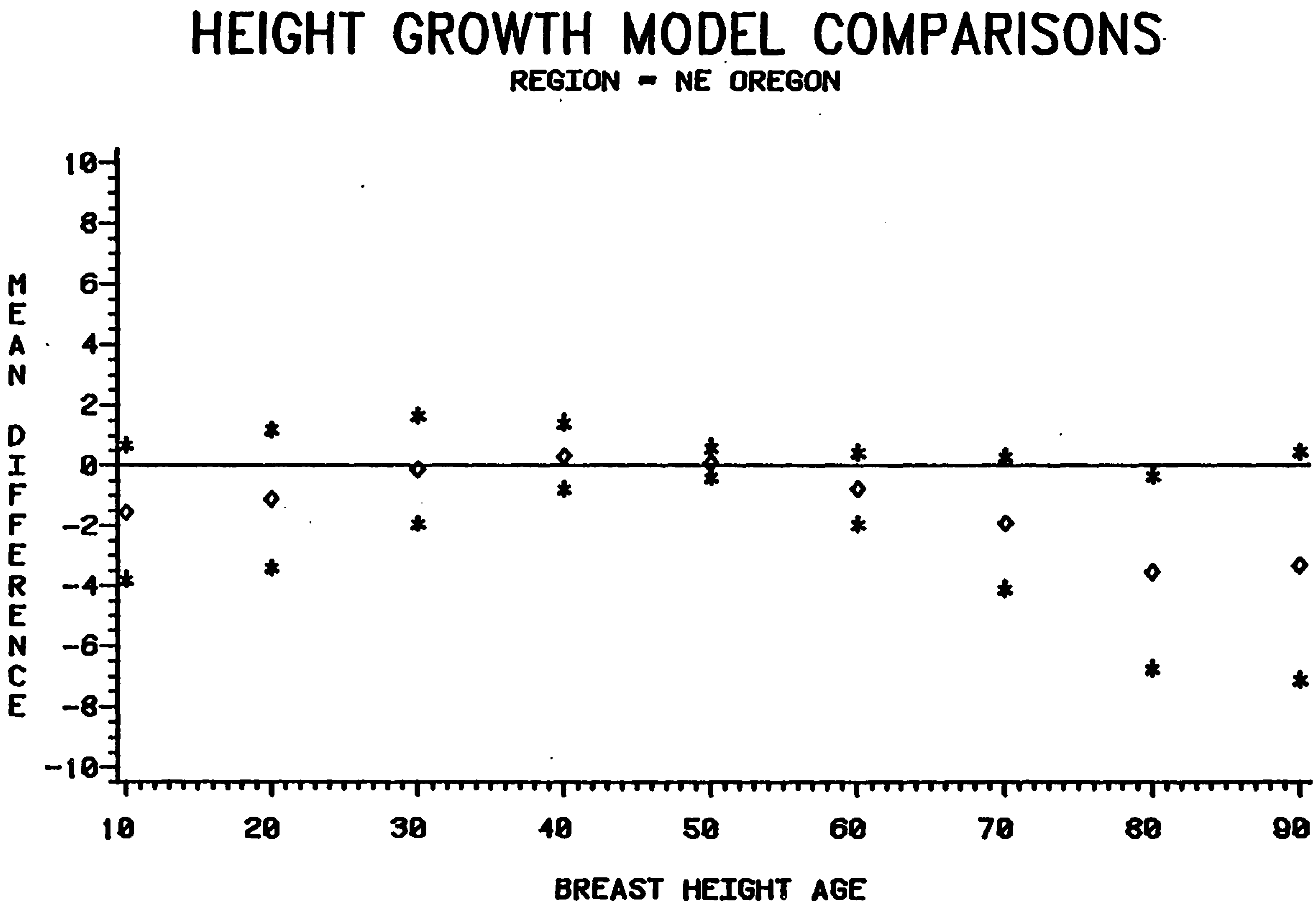


Figure 4d. Comparison of mean differences in predicted heights using Monserud's height growth model with those obtained from height growth equations developed from IFTNC data for Northeast Oregon.

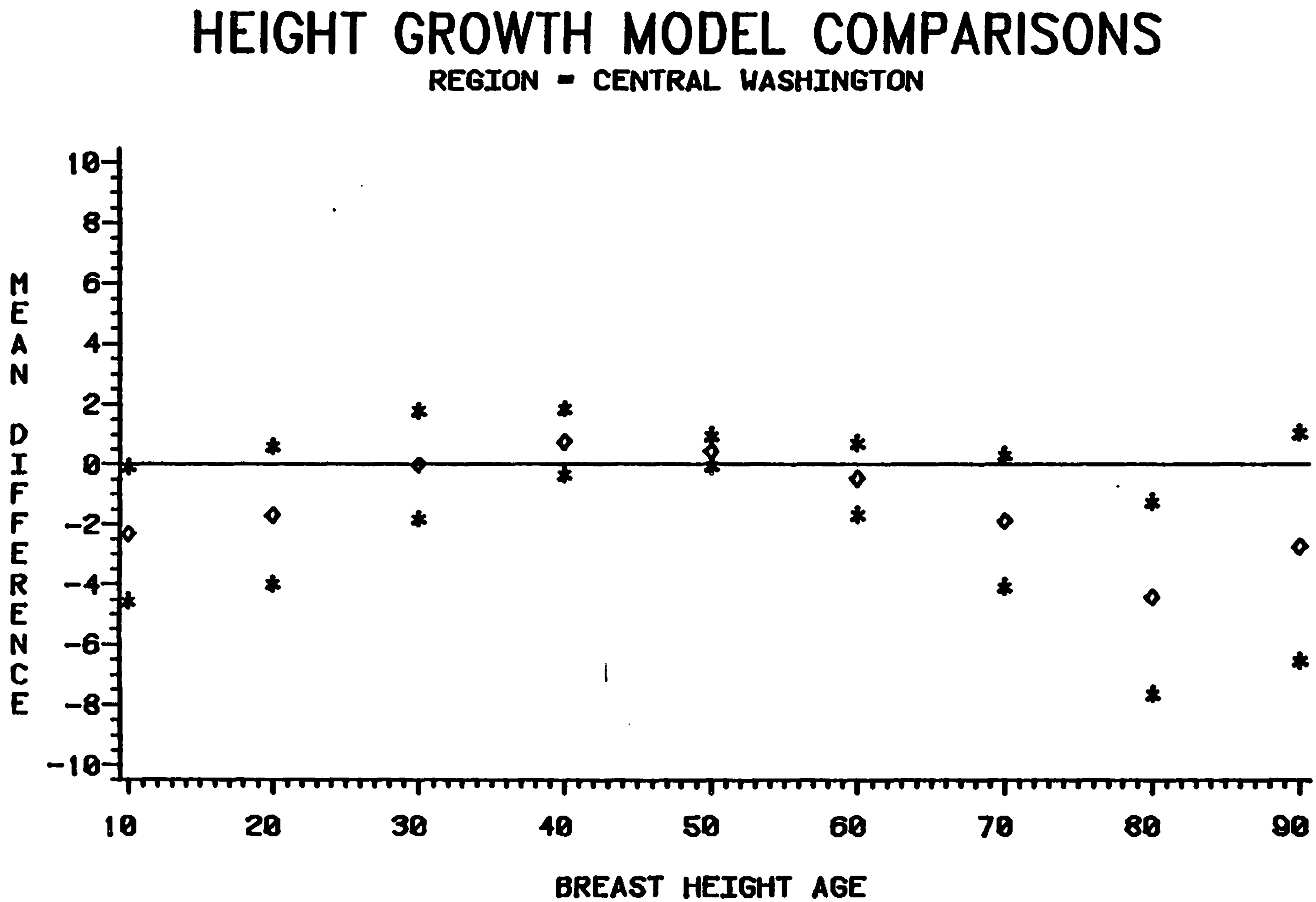


Figure 4e. Comparison of mean differences in predicted heights using Monserud's height growth model with those obtained from height growth equations developed from IFTNC data for Central Washington.

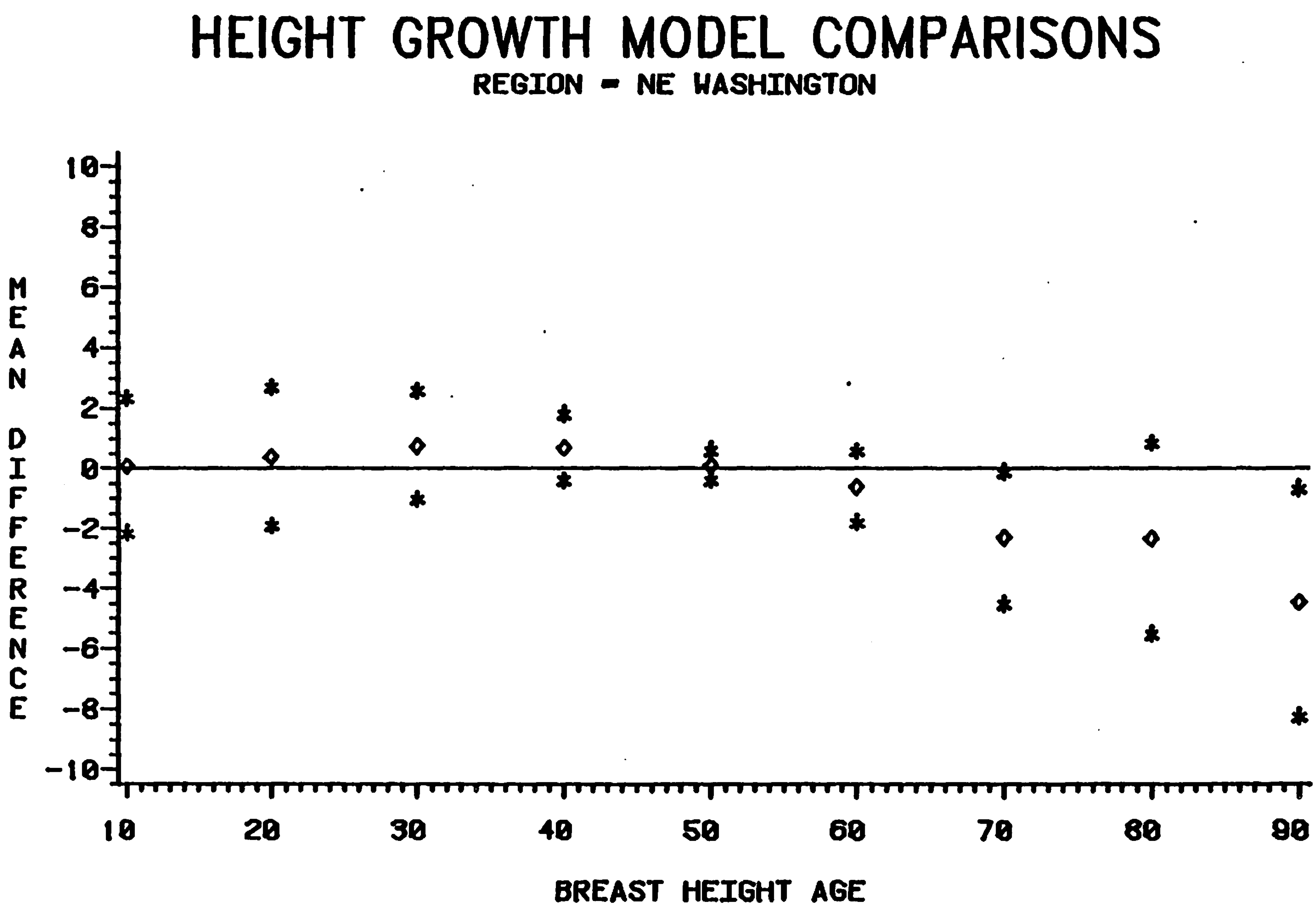


Figure 4f. Comparison of mean differences in predicted heights using Monserud's height growth model with those obtained from height growth equations developed from IFTNC data for Northeast Washington.

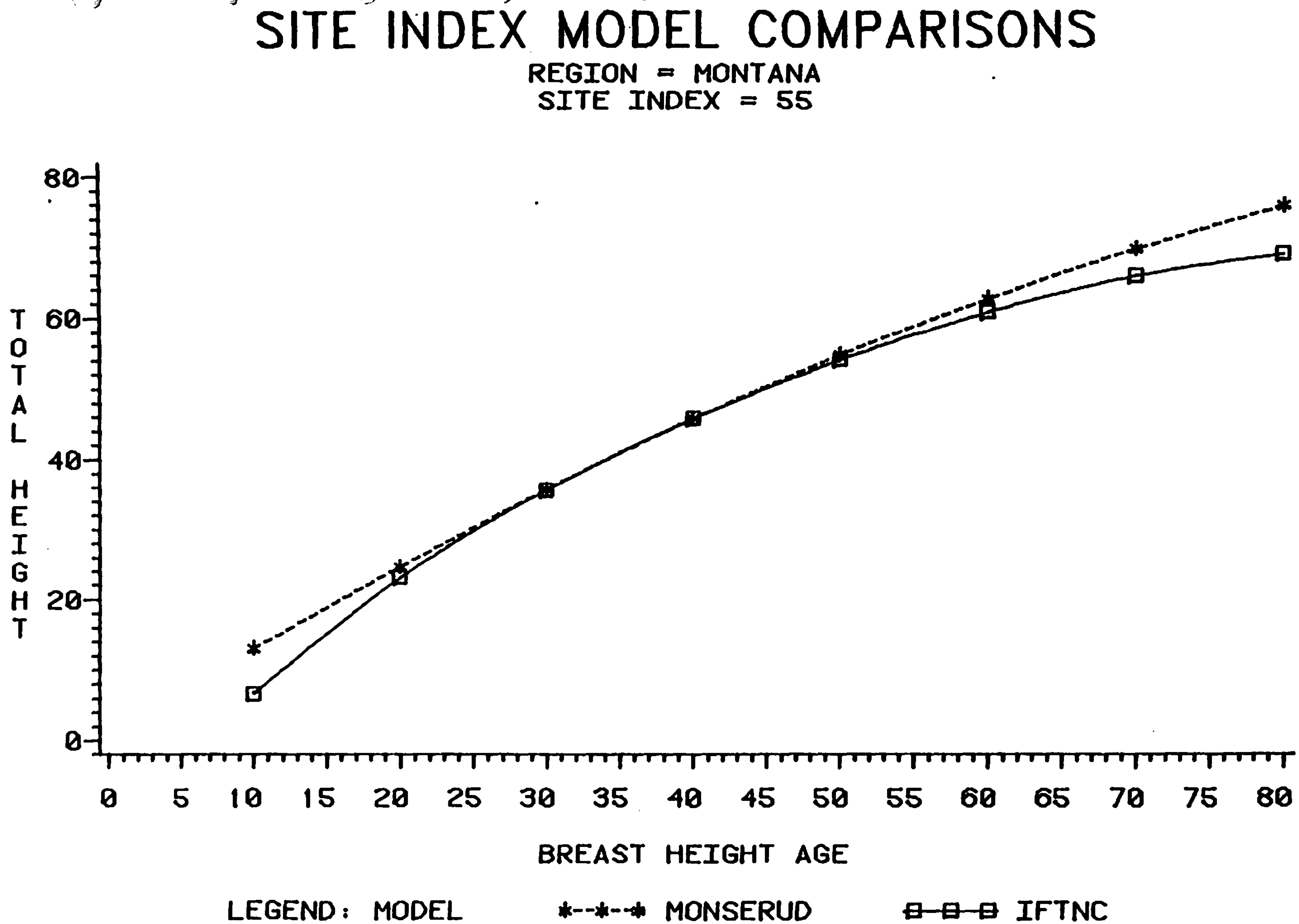


Figure 5a. Comparison of Monserud's Douglas-fir site index curve with the site index curve developed from IFTNC data for site index 55 in Montana.

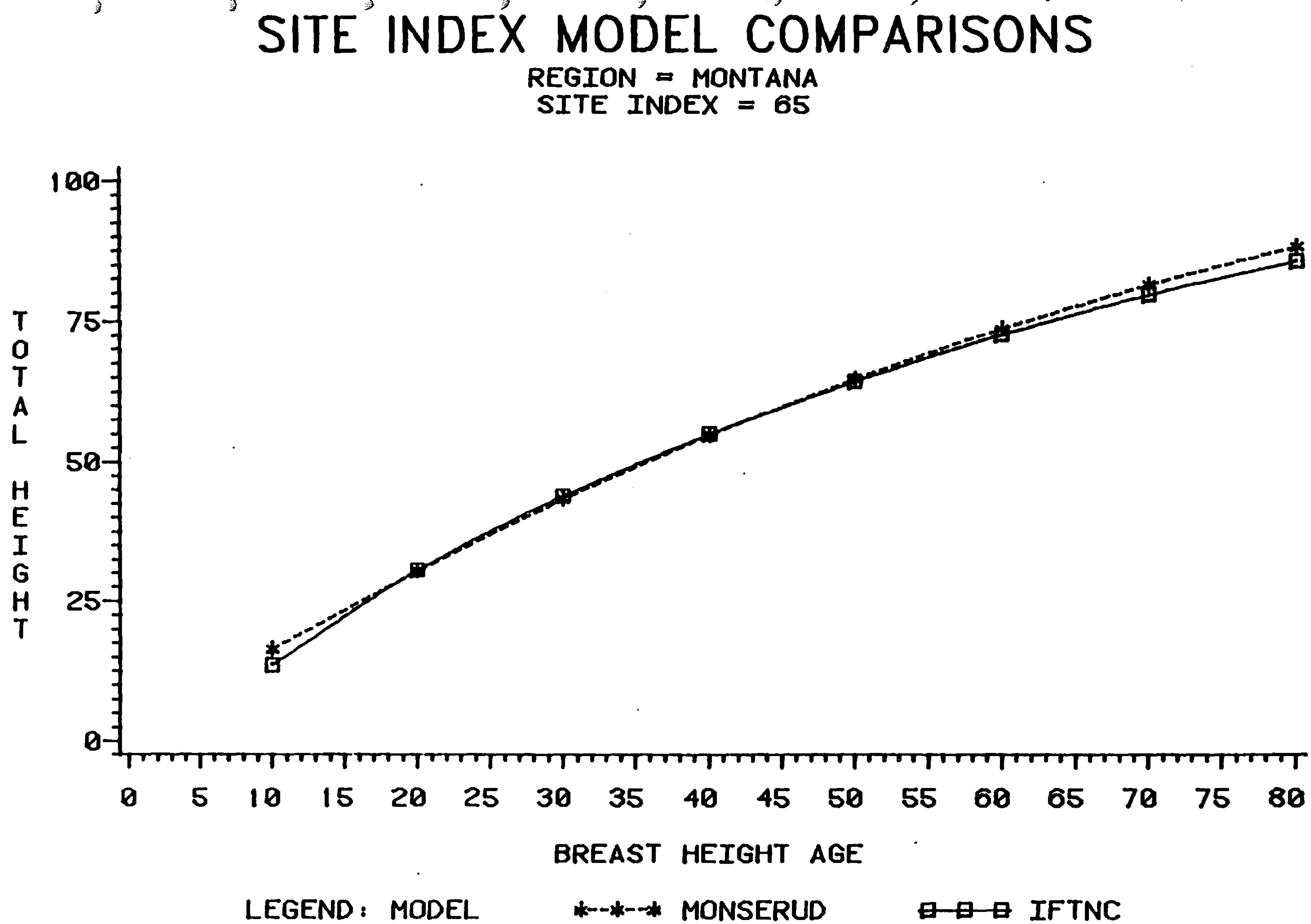


Figure 5b. Comparison of Monserud's Douglas-fir site index curve with the site index curve developed from IFTNC data for site index 65 in Montana.

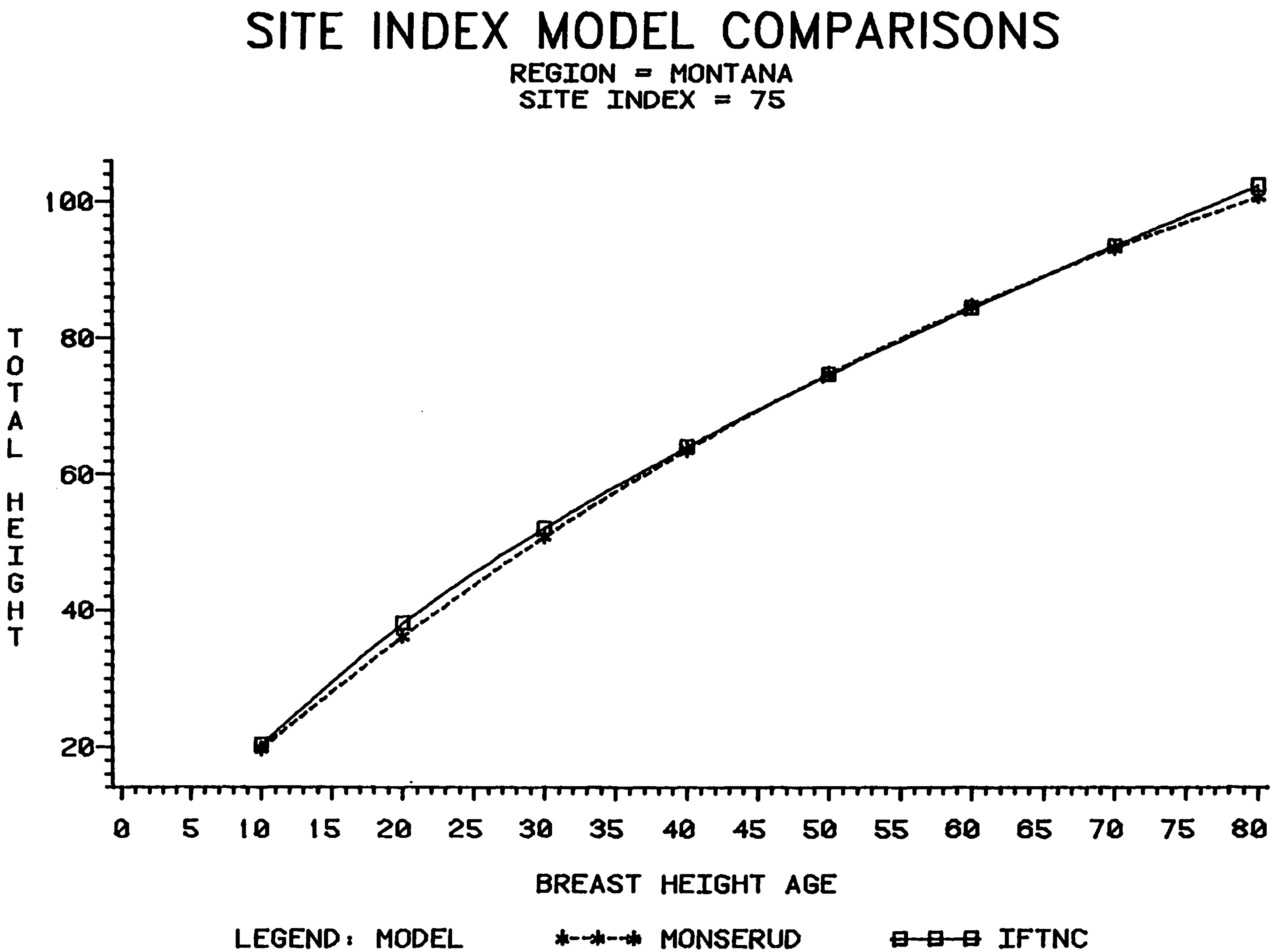


Figure 5c. Comparison of Monserud's Douglas-fir site index curve with the site index curve developed from IFTNC data for site index 75 in Montana.

SITE INDEX MODEL COMPARISONS

REGION = CENTRAL WASHINGTON
SITE INDEX = 50

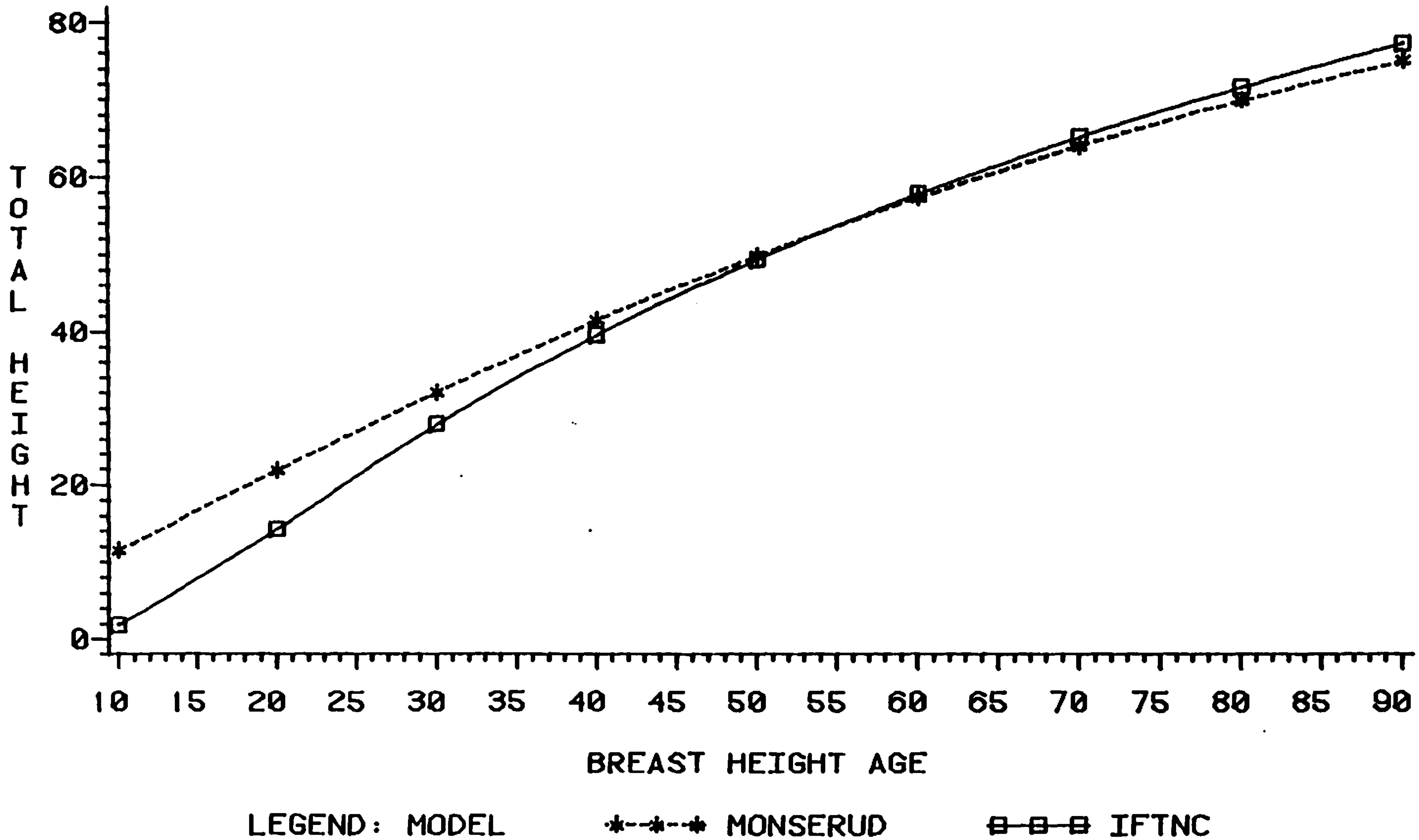


Figure 6a. Comparison of Monserud's Douglas-fir site index curve with the site index curve developed from IFTNC data for site index 50 in ~~Montana.~~ Central Washington.

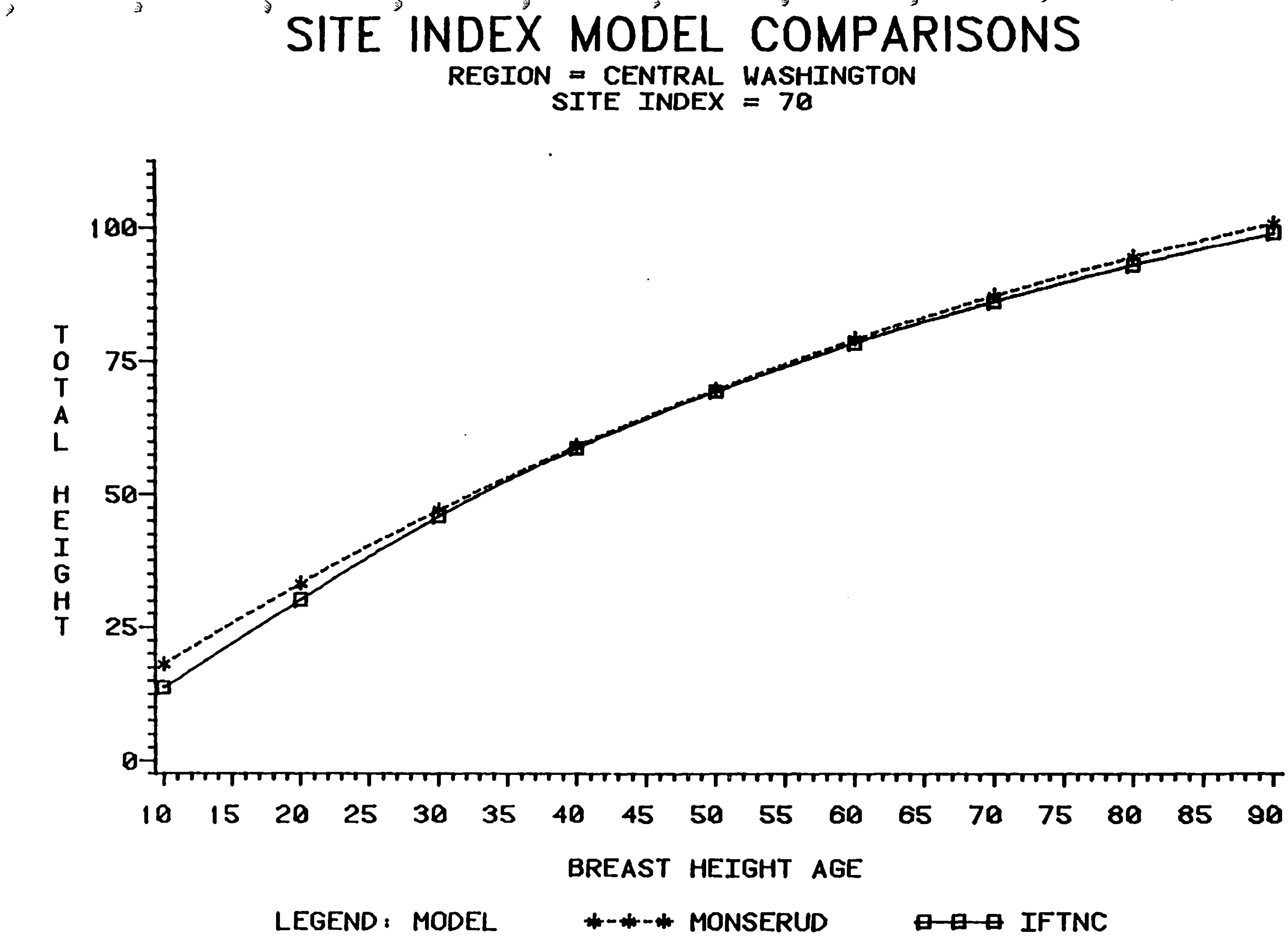


Figure 6b. Comparison of Monserud's Douglas-fir site index curve with the site index curve developed from IFTNC data for site index 70 in ~~Montana~~. Central Washington.

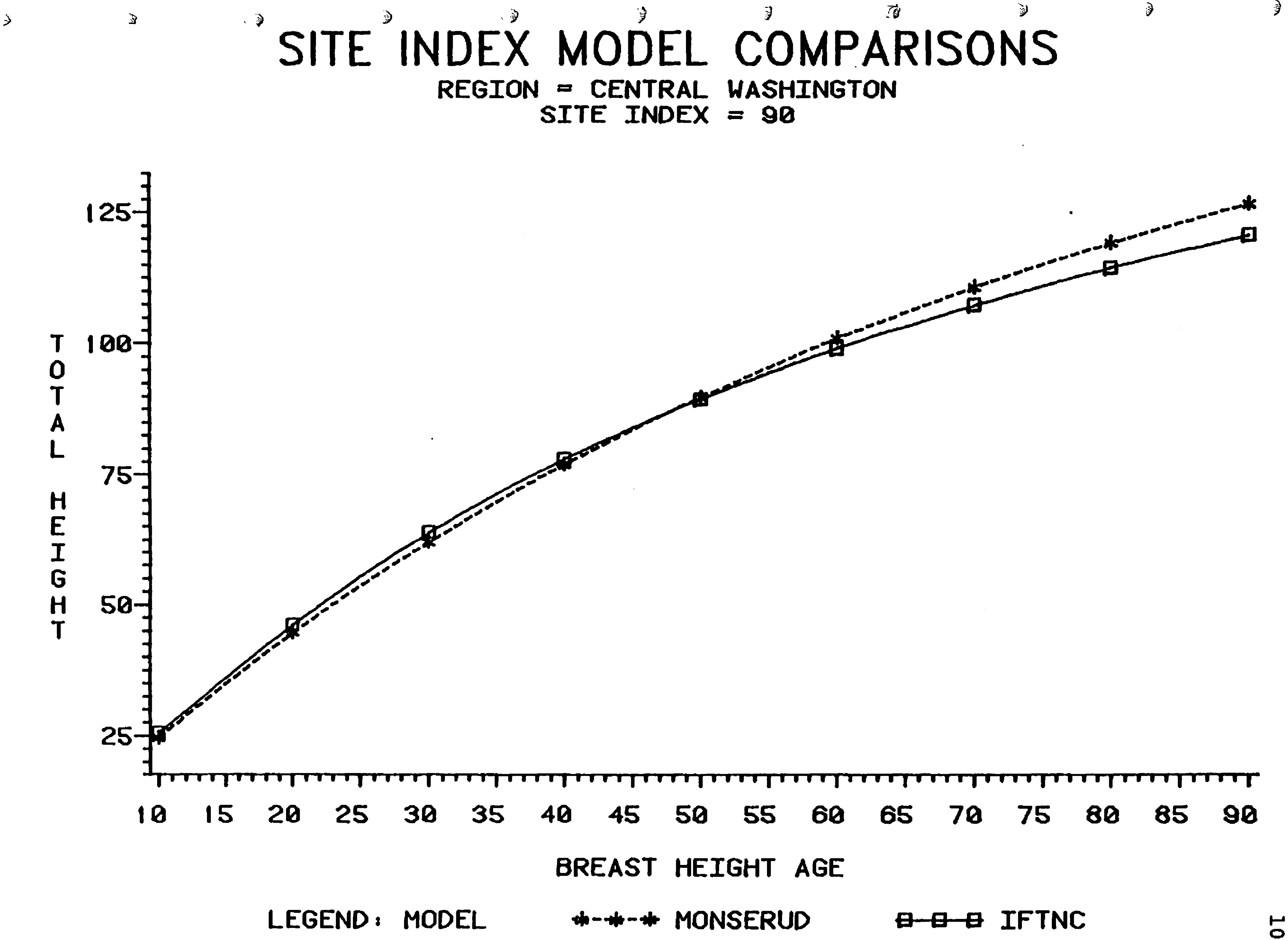


Figure 6c. Comparison of Monserud's Douglas-fir site index curve with the site index curve developed from IFTNC data for site index 90 in ~~Montana~~. Central Washington . .

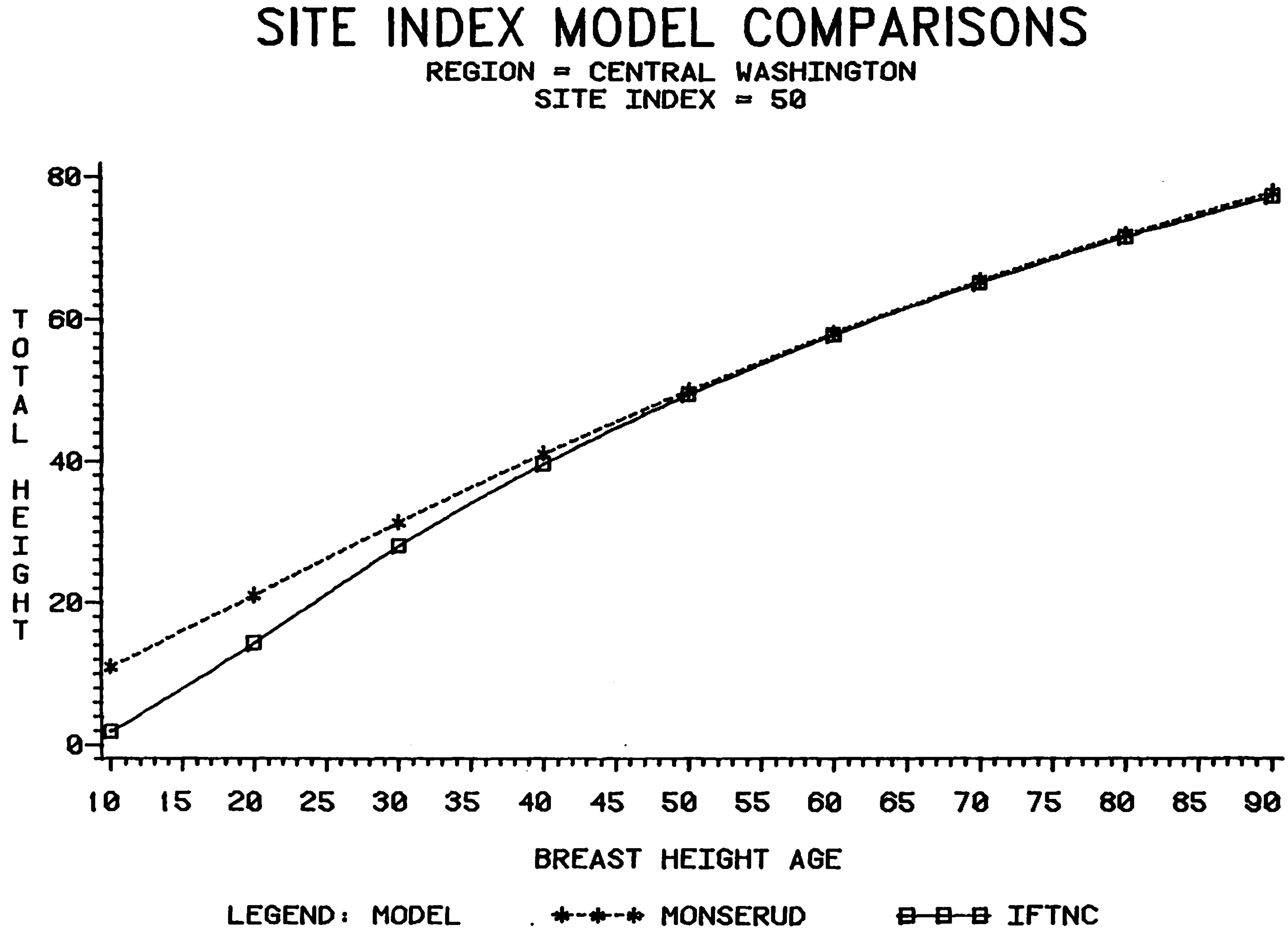


Figure 7a. Comparison of Monserud's Grand fir/cedar site index curve with the site index curve developed from IFTNC data for site index 50 in ~~Montana~~. Central Washington.

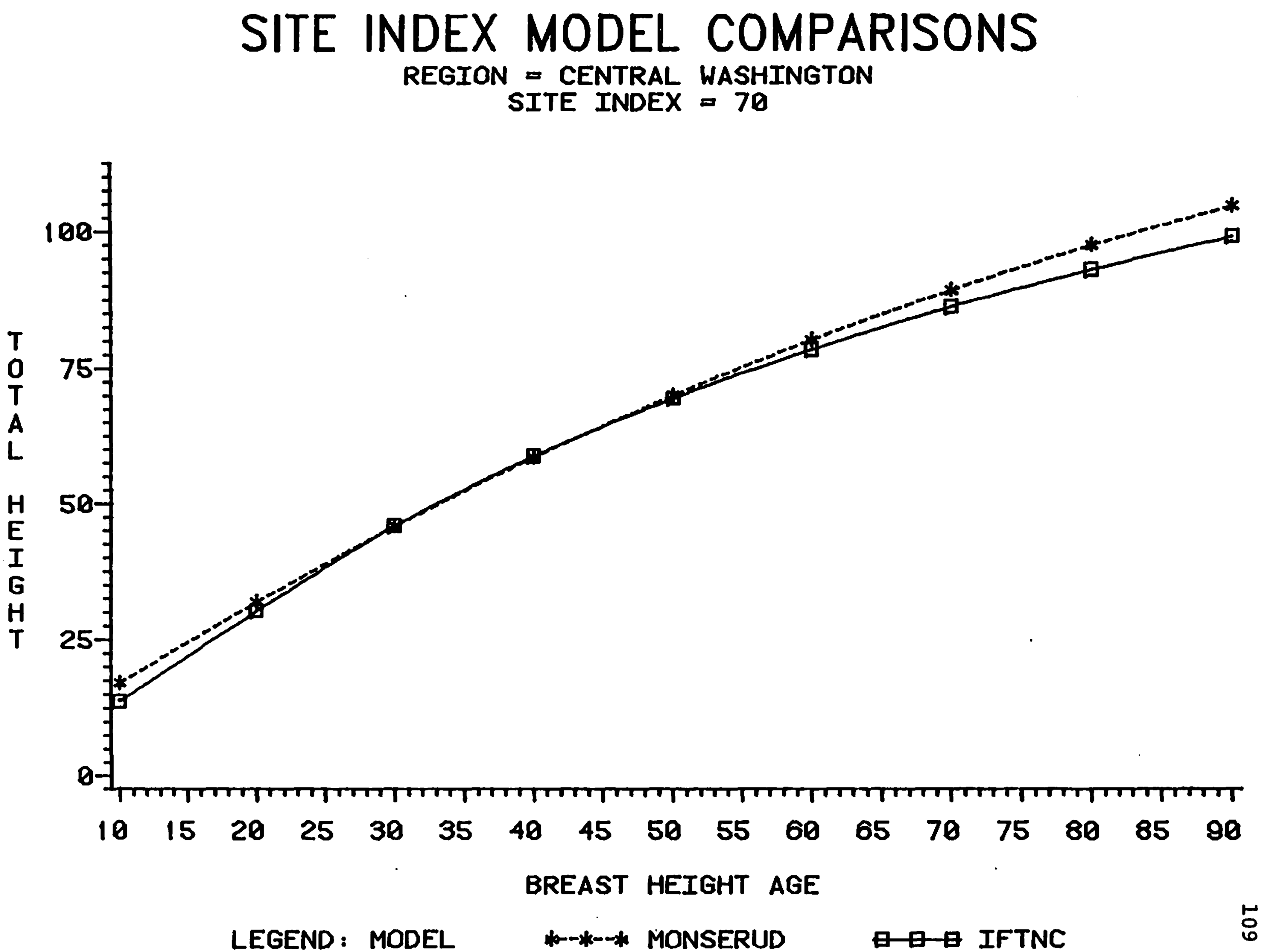


Figure 7b. Comparison of Monserud's Grand fir/cedar site index curve with the site index curve developed from IFTNC data for site index 70 in ~~Montana.~~ Central Washington.

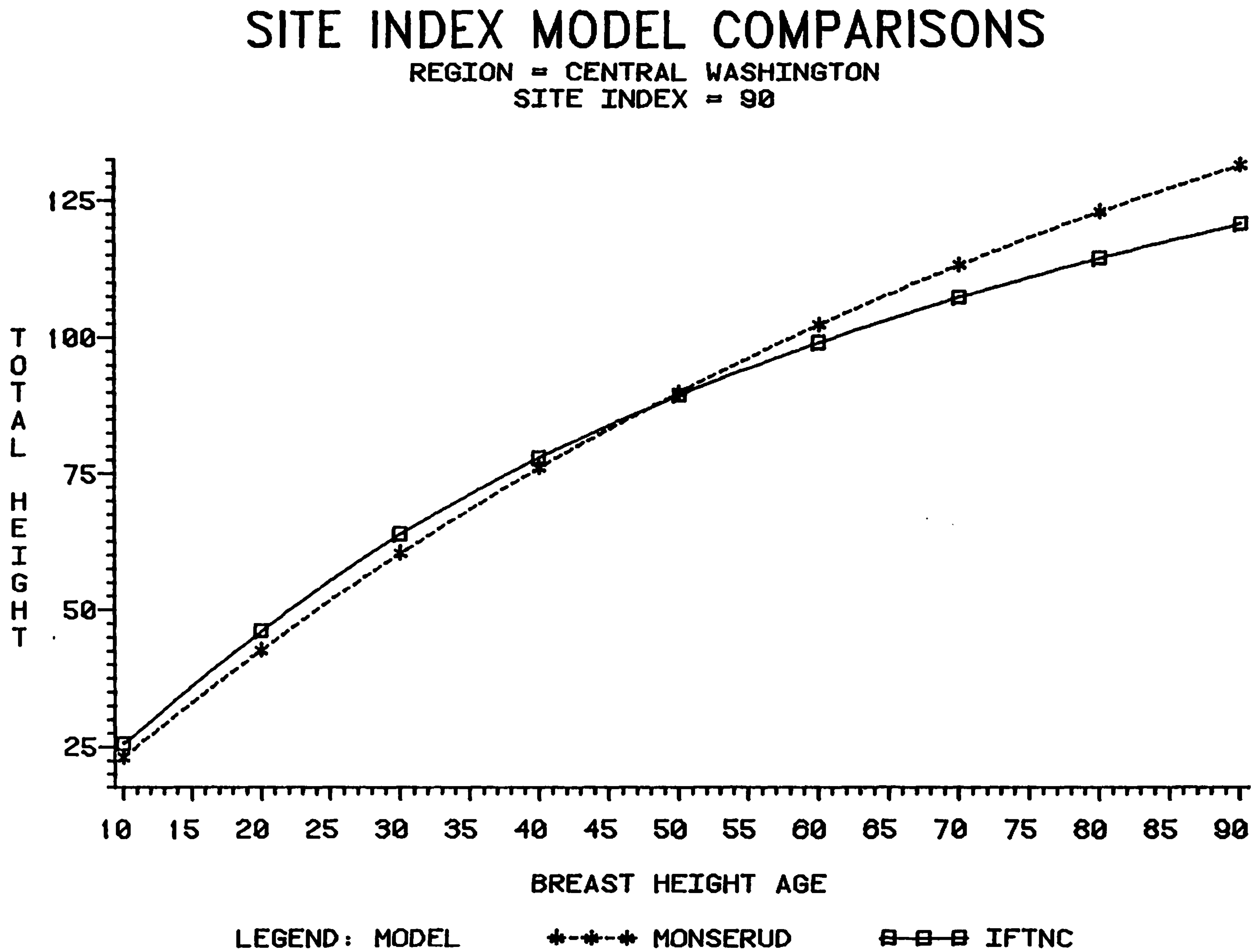


Figure 7c. Comparison of Monserud's Grand fir/cedar site index curve with the site index curve developed from IFTNC data for site index 90 in ~~Montana.~~ Central Washington

INFORMATION REQUIREMENTS FOR AN OPERATIONAL FERTILIZATION PROGRAM

By John Olson
Potlatch Corporation

PURPOSE

- REAFFIRM OBJECTIVES IN SUPPORTING CO-OP RESEARCH ON FOREST FERTILIZATION
- IDENTIFY KEY INFORMATIONAL NEEDS OF COOPERATORS
- PROVIDE DIRECTION FOR ANALYTICAL ACTIVITIES CONDUCTED BY U OF I
- DISCUSS OPTIONS FOR OPERATIONAL FERTILIZATION PROGRAM EVALUATIONS

WHY ARE WE SUPPORTING CO-OP RESEARCH IN FOREST FERTILIZATION?

- PRIMARY REASON: OBTAIN "ECONOMY OF SCALE" BENEFITS RESULTING FROM COMBINING RESOURCES AND EXPERTISE IN A RESEARCH EFFORT DESIGNED TO EVALUATE RESPONSE OF MANAGED DOUGLAS-FIR TO NITROGEN APPLICATIONS THROUGHOUT THE INLAND EMPIRE REGION.

  ▶ RESULTS OF THIS EFFORT SHOULD PROVIDE THE BIOLOGICAL BASIS FOR EACH COOPERATOR TO JUSTIFY OPERATIONAL FERTILIZATION PROGRAMS.....IF WARRANTED.....

- OTHER REASONS:

1.
2.
3.
4.
5.

QUESTION:

GIVEN THE GENERALLY "POSITIVE" RESPONSE OF CONIFEROUS FORESTS TO NITROGEN AND THE EXISTING DATA SUPPORTING THIS TREND IN THE REGION -- WHY HAVE WE NOT BEEN ABLE (OR NOT ATTEMPTED) TO INITIATE OR SUSTAIN OPERATIONAL FERTILIZER PROGRAMS?

COOPERATOR	LAND BASE (ACRES)	FERTILIZED ACRES (%)
IDAHO DEPT. LANDS	600,000	<1
CHAMPION	600,000	0
POTLATCH	615,000	3
INLAND EMPIRE PAPER	85,000	0
DEPT. NATURAL RESOURCES	400,000(?)	0
BOISE CASCADE	2,200,000	0
BIA-FLATHEAD	400,000	0
LONGVIEW FIBER	80,000	0
USFS	?	?
TOTAL	4,980.000	

RESPONSE:

WE HAVE NOT INITIATED AN OPERATIONAL FERTILIZATION PROGRAM BECAUSE:

- LACK OF SUFFICIENT RESPONSE DATA
  (WHAT IS SUFFICIENT?)

- LACK OF CAPITAL - $

OTHER REASONS:

-
-
-
-
-

CLOSER LOOK -- HOW VALID ARE THESE?

LACK OF RESPONSE DATA

- BASIS FOR INITIATING IFTNC
- VALID FOR MUCH OF REGION
- HAS AND WILL ALWAYS BE INCOMPLETE
- WILL CONTINUE TO IMPROVE - IFTNC
- MOST OFTEN POORLY DEFINED -
  - BASAL AREA, HEIGHT, DIAMETER
  - VOLUME (BD. FT. CU. FT., WHOSE EQUATION)
  - GROSS, NET
- ▶ LACK OF CORRELATION BETWEEN RESPONSE & STAND/SITE ATTRIBUTES

CAPITAL

- HAS AND ALWAYS WILL BE LIMITED!
- ALLOCATION HAS AND WILL BE BASED ON ECONOMIC CONSIDERATIONS
- FERTILIZATION HAS AND WILL CONTINUE TO COMPETE WITH OTHER ACTIVITIES

IN ADDITION

WHAT ABOUT - - - - -

EXTERNAL PRESSURES

- COMPETITION WITH HIGH FRONT END INVESTMENT ACTIVITIES - ARTIFICIAL REGENERATION

- ALLOCATION OF CAPITAL IMPACTED BY LEGAL REQUIREMENTS - FPA (REFORESTATION)

EXTRAPOLATION OF RESULTS - OFTEN OVERLOOKED OR OVERESTIMATED

- COOPERATORS' ABILITY TO INTEGRATE RESEARCH RESULTS WITH "IN-HOUSE" GROWTH FORECASTING MODELS AND MORE IMPORTANTLY INVENTORIES

  (I.E., HOW MANY ACRES OF RESPONDING STANDS DO I HAVE?)

RELEVANT QUESTION REALLY IS:

IF SILVICULTURE DOLLARS WERE AVAILABLE, COULD I "ADEQUATELY"[1/] EVALUATE THE BENEFITS OF FERTILIZATION GIVEN THE ANALYSIS RESULTS PROVIDED BY THE CO-OP?

IF NOT - WE ALL HAVE A PROBLEM!

IF NOT - WE HAD BETTER BEGIN IDENTIFYING OUR NEEDS - ASAP

IF NOT - WE CANNOT ACHIEVE OUR PRIMARY OBJECTIVE.

1/ DEFINED AS THE BEST ESTIMATE GIVEN EXISTING INFORMATION

REQUIREMENTS FOR ANSWERING THE QUESTION:

(HOW) <u>FIRST</u> - IDEA OR PLAN AS TO <u>HOW</u> FERTILIZATION MIGHT BE EVALUATED:

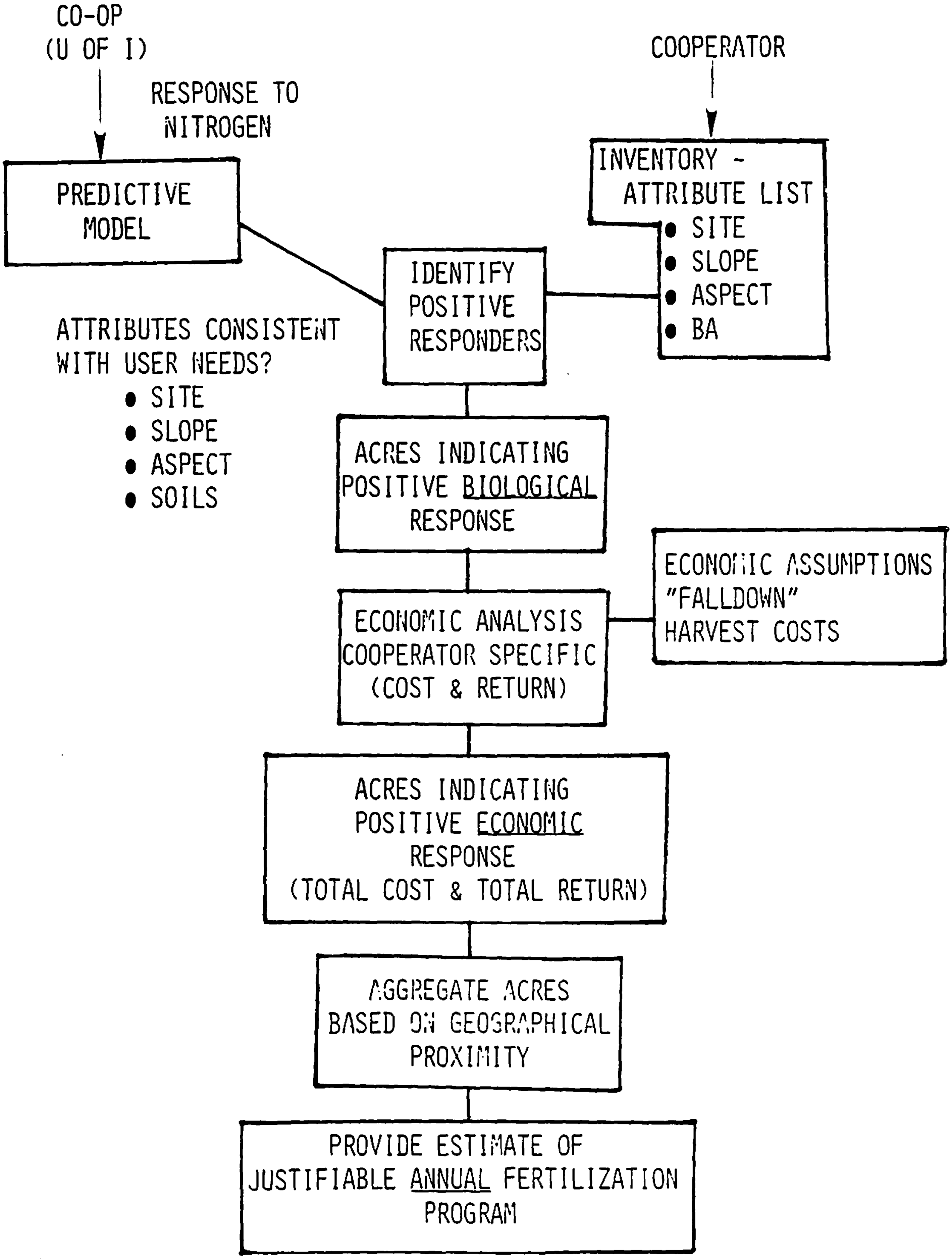
- ACTIVITY -VS- PROGRAM ANALYSIS
- PROCEDURES FOR IDENTIFYING CANDIDATES
  - INVENTORY SCREENING
- METHODS FOR PREDICTING RESPONSE
  - GROWTH MODEL
  - RESPONSE MODEL

(WHAT) <u>SECOND</u>* - IDENTIFY SPECIFIC INFORMATION REQUIREMENTS:

- RESPONSE
  - INSTALLATION -VS- REGION AVERAGE
  - HOW ANALYZED AND REPORTED (BA, BD.FT., CU.FT., HGT, DIA, ETC.)
- ATTRIBUTES OF RESPONSE
  - STAND STRUCTURE INFORMATION (SPECIES, DENSITY, AGE, SIZE, VIGOR)
  - ENVIRONMENTAL/SITE (SITE INDEX, ASPECT, SLOPE, SOILS, ETC.)
- RELATED "TOOLS"
  - PREDICTIVE MODELS

*OF PRIMARY INTEREST TO CO-OP -- ALLOWS RESULTS TO BE <u>TAILORED</u> TO THE <u>USER</u>!!

EXAMPLE - PROGRAM LEVEL



EVALUATION OPTIONS (HOW)

1/

2/

3/

SPECIFIC INFORMATION (WHAT)

MEASURES OF RESPONSE - (BASAL AREA, VOLUME, HEIGHT, ETC.)

CONDITIONS FOR RESPONSE - (SITE, ASPECT, HABITAT, SOIL, ETC.)
(OR LACK OF RESPONSE)

FORECASTING RESPONSE - (PREDICTIVE MODELS, ATTRIBUTES OF IMPORTANCE)

DURATION OF RESPONSE -

IFTNC IS CURRENTLY PROVIDING:

RESPONSE	-	BASAL AREA
CONDITIONS FOR RESPONSE	-	STAND AND SITE CHARACTERISTICS
FORECASTING RESPONSE	-	(FOR DOUGLAS-FIR)

BASAL AREA RESPONSE (SQ.FT./AC) = (TREATMENT
PARENT MATERIAL
SOIL DEPTH
ASH DEPTH
SITE INDEX
SLOPE
ASPECT
BASAL AREA)

WHAT SHOULD IFTNC FOCUS ON IN FUTURE?

1. HOW IMPORTANT IS VOLUME RESPONSE?

   UNITS - BD.FT., CU.FT., HGT., DIA.

2. FORECASTING RESPONSE - WHAT VARIABLES HAVE OPERATIONAL UTILITY?

3. HOW IMPORTANT IS DURATION OF RESPONSE?

4. HOW IMPORTANT IS INFORMATION ON OTHER SPECIES (I.E., PP, GF)?

5. DO YOU NEED RESPONSE PREDICTED ON A TREE-BY-TREE BASIS OR STAND AVERAGE?

6.

PARTING COMMENTS

1. NEARLY 1.6 MILLION ACRES FERTILIZED WEST COAST. ANTICIPATING 40% OF ALL PLANTATIONS FERTILIZED. TRENDS AND MAGNITUDES OF RESPONSE FOR I.E. DOUGLAS-FIR SIMILAR.

2. ABILITY TO UTILIZE RESEARCH RESULTS IN OPERATIONAL SETTING WILL IMPACT OPERATIONAL FERTILIZATION JUSTIFICATION.

3. BENEFITS DERIVED FROM COOPERATIVE RESEARCH CAN ONLY BE REALIZED IF USED IN THE COOPERATOR'S DECISION PROCESS.

4. CO-OP CANNOT TAILOR RESULTS TO OUR NEEDS UNLESS THESE NEEDS ARE IDENTIFIED (SPECIFICALLY).

5. PROFITABILITY OF FERTILIZATION MUST BE DETERMINED BY EACH COOPERATOR.

6. FERTILIZATION AND THINNING ARE THE ONLY TREATMENTS AVAILABLE TO INCREASE GROWTH AND/OR VALUE OF EXISTING GROWING STOCK.

APPLIED RESEARCH NEEDS

BY

JOHN SHUMWAY
WASHINGTON DNR

THE NUTRITION OF INTERMOUNTAIN CONIFERS

MEASURING N DEFICIENCY

SOIL TESTS

MINERALIZABLE N

FOLIAGE ANALYSIS

- CRITICAL LEVELS FOR N
- DRIS

OTHER NUTIRENT ELEMENTS

MOISTURE

TEMPERATURE

CO-OP OBJECTIVES

DO MY STANDS NEED NITROGEN FERTILIZER?

HOW MUCH FERTILIZER SHOULD I APPLY?

HOW OFTEN SHOULD I APPLY FERTILIZER?

HOW MUCH CAN GROWTH BE INCREASED?

HOW CAN THE MOST RESPONSIVE STANDS BE IDENTIFIED?

Basic Research Needs and Opportunities

by

John Mandzak, Champion International

Introduction

-Practice of Forestry on rough, less fertile lands unsuitable or unneeded for other uses

- -Reasons for infertility--climate
  --nutrient

-Coop members - interested in determining to what extent forest production can be economically improved by <u>nutrient management</u>--usually considered to be application of fertilizer

- -but, "nutrient management" can involve other practices
  - -control of export of nutrients due to logging or slash disposal
  - -control of competing vegetation
  - -Mgmt. of <u>N-fixers</u> or <u>other plants</u> which favor improved nutrient supplies for desirable plants

-Pragmatic inclinations - Coop was formed by individuals with <u>pragmatic inclinations</u> or <u>pragmatic marching orders</u>

-Objective - "How and when, and with what and in what quantities should I fertilize managed Df (Gf, PP, etc) so as to receive an economic return?"

Initial debate as to how to achieve the objective

-Nitrogen - was presumed to be the major limiting element

- substantiated by previous trials

-Other Nutrients - presumed to be important also

- limited resources for evaluation

Regional Design - 6 plots - 2 rates of Urea N

- $(NH_4)NO_3$ - rejected - "source of N"

Hindsight - West Coast Cooperative

- Economy of regional design

- Recollection of inabilities to explain response & non-response, led to a serious problem of inability to efficiently direct field operations - average response - avoid fertilization of non-responsive sites

Hindsight - Planned Auxiliary Investigations

- that would allow us to, if not completely understand response and non-response - still be able to direct fertilization to definitely responding sites

Examples of Auxiliary investigations

-Preparation of "ecological summary report"

-Soil total N & mineralizable soil Nitrogen tests

-Determination of soil parent materials - geomorphic landform types

-Soil typing

-Foliar Analysis - Weetman need length response test
- Weetman diagrams
- Pre and Post fertilization nutrient content analysis
- <u>"Diagnosis"</u>

<u>Current Results</u>

Substantially able to predict response in the Intermountain Region

-<u>for managed</u> DF <u>to Urea N</u>

-Duration of response - MS16 tests - N. Idaho
- Not known - rest of area - need to maintain plot remeasurement schedules

-Ability to direct capital dollars - N. Idaho
- Other areas
- Organization differences

No data developed for Gf, PP in relatively pure stands

-Unplanned budget restraints

Talk Objective

Explain Research Needs, reasons for those needs and how we might satisfy those needs - [Your Needs]

[The hat being worn] - "A technical hat"

- Advisor to the Steering committee
- Outline options w/o great detail at this point
- Further deliberation at technical committee will be required to develop research action plans
  - should be reviewed by other individuals

"Basic questions we can't quite answer"

- Most installations - low foliar
  - good N uptake
  - variable response
- Due to? - "Other Nutrients"
  - "Environmental limitations"

What is an acceptable nutrient content for Mgd Df?

- N - fairly sure
- Total content of other elements
- Nutrient ratios

"Would you know a "good" foliar analysis if you saw it? - No!

Fall vs. summer sampling - fall results only

Needle age class sampling - current needle results only

Moisture limitation of response - dry forests
- environmental limitations

Correlations of parent material with response - why?

Nutrient Ratios - Dris Indices

Ability to Cycle Nitrogen

If we do not fertilize, are there "nutrient management" strategies that can be employed in the course of forest management activities that will at least "not aggrevate" nutrient deficiencies?

Plant competition - thinning

- control of non-arborescent vegetation?

Harvest Practices - "Tree-length" vs "log" harvesting (location of nutrients)

Site Preparation - Burning (can volatilize N)

Increase mineralization rates of remaining N to benefit target plants

Reduce uptake by competing stems (weeds)

Does the thinning-fertilizer interaction occur in the Intermountain Region?

What about "weed and feed" treatments? especially with open stands?

Funding

-The "magic" of research priority lists

-Outside funding resources available to the Coop?
Ex. USFS competitive grants

-Increase in Coop fees?

Other issues to be acted upon by the Steering committee

5 year point of Cooperative

- Desire to establish more installations with other species now? Enough known for now about Df? (Budget option) (Implication for longevity of Coop)

- Desire to do a more thorough analysis of Df first?
  - "Other nutrients + soil moisture" (Budget option #2) (No implication for longevity of Coop)

- Both?