

The Effect of Chaining and Burning on Soil Nutrients in Pinion/Juniper Woodlands on Twin Point, Arizona

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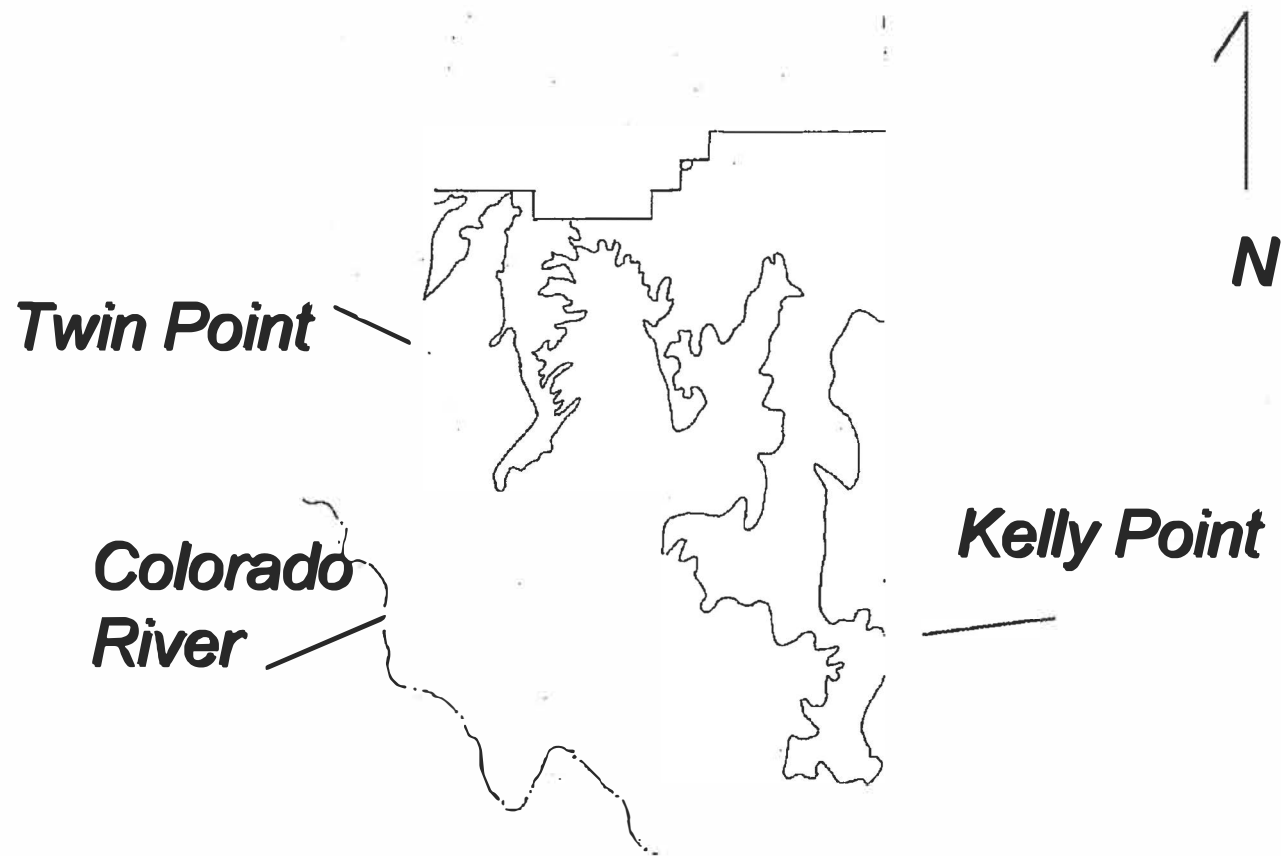
U.S.D.A. Natural Resources Conservation
Service

I. INTRODUCTION

1. Location

- ◆ **Lake Mead National Recreation Area**
- ◆ **Arizona Strip**
- ◆ **Shivwits Plateau**
- ◆ **Twin Point**

Location of Twin Point



I.

2. Context and Scope

- ◆ Soil survey started in July, 1996, of LMNRA, NPS
- ◆ NPS interested in vegetative restoration
- ◆ NPS concerned about soil nutrient status and the effect of P/J invasion on soil nutrients

I.

3. Definition of Problem

- ◆ **Determine whether chaining and burning improves availability of soil nutrients**

I.

4. Hypothesis

- ◆ Soil nutrients are not limiting in this system.
- ◆ Due to previous cover of grass providing ample organic matter and nitrogen and
- ◆ Kaibab Limestone provides adequate phosphorous.

I.

5. Physiography

- ◆ **Twin Point-flat extension of plateau at 6000 feet elevation.**
- ◆ **Uppermost formation is the Harrisburg Member of the Kaibab Formation**

I.

6. Vegetation

- ◆ **Primary vegetation is Pinion Pine and Utah Juniper**
- ◆ **Understory consists of Wyoming big sage, Blue grama, cliffrose, banana yucca, Wrights birdsbeak**

I

7. Climate

- ◆ Temperature - MAAT 48 to 54 degrees F
- ◆ Mesic temperature regime
- ◆ Precipitation - MAP 14 to 18 inches
- ◆ Aridic Ustic moisture regime
- ◆ Twin Point effected by microclimate due to Mt. Dellenbaugh and edge of plateau

I.

8. Soil Classification

- ◆ Soils are 30 to 40 inches deep to limestone bedrock
- ◆ Soils have high clay content (40-50%)
- ◆ Soils have calcic horizons in lower profile
- ◆ Soils have mollic colors
- ◆ Fine, smectitic, mesic Vertic Paleustolls

II. MATERIALS AND METHODS

1. Preliminary Mapping

- ◆ The study area comprised an area of old growth P/J, chained area and burned area in close proximity**
- ◆ Highly detailed mapping determined no variability in parent material or soil type**

II.

2. Sampling Method

- ◆ Three pits were sampled from the burned area, chained area, and the dripline and interspaces of the old growth area
- ◆ Soil sampled from each horizon of each pit
- ◆ Samples air dried, hand ground, sieved through 10 mm sieve, frozen

II.

3. Laboratory Analyses

- ◆ **Laboratory Consultants, Ltd contracted to do soil analyses in duplicate**
- ◆ **Nitrogen, phosphorous, organic matter**

II.

4. Organic Matter

- ◆ **Walkley Black wet oxidation method**
- ◆ **Loss on Ignition for samples $>5\%$**
- ◆ **Includes all organic matter regardless of degree of decomposition as well as refractory carbon**

II.

5. Nitrogen

- ◆ **Total nitrogen - includes N from all organic matter as well as NH_4 and NO_3**
- ◆ **Exchangeable Ammonium - includes only NH_4 on exchange sites of clays**
- ◆ **Total nitrate - includes mineralized nitrate**

II.

6. Phosphorous

- ◆ **Total phosphorous - includes P from primary minerals and all forms of P_2O_5**
- ◆ **Available Phosphorous - includes only plant available forms such as organic and moderately soluble P_2O_5 s**

II.

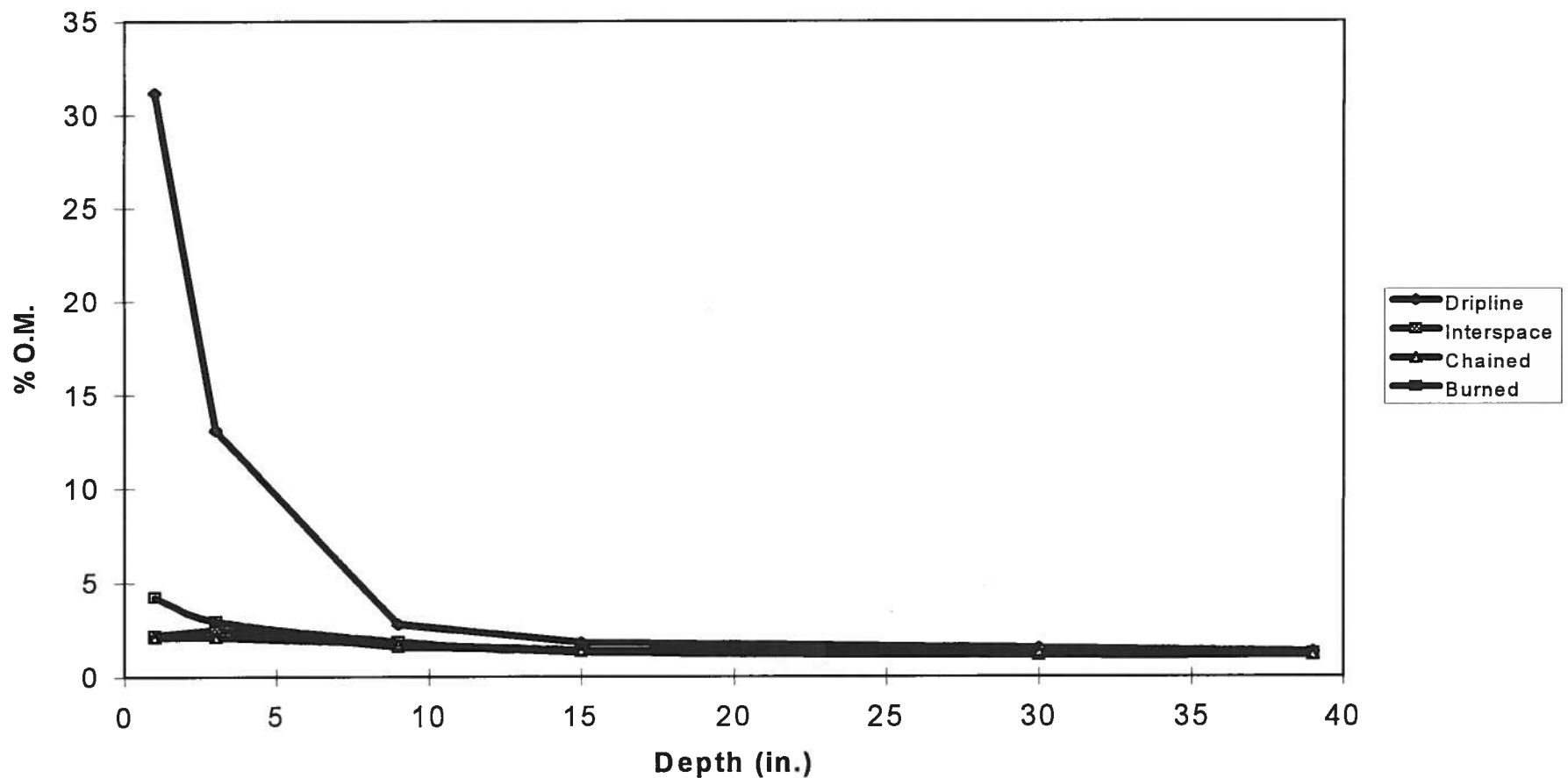
7. Statistical Analyses

- ◆ Used M.S. Excel statistics and graphing package to analyze for F & T test and analysis of variance (ANOVA)

III. RESULTS

1. Organic Matter

Percent Organic Matter - All Treatments



III. 1.Organic Matter

A. Statistical Analyses

- ◆ At 1 inch ANOVA was significantly different at 0.01 percent**
- ◆ At 1” burn vs chain and dripline vs chain were significant at 0.01 for F test**
- ◆ At 15 inches ANOVA was not significant**

III. 1. Organic Matter

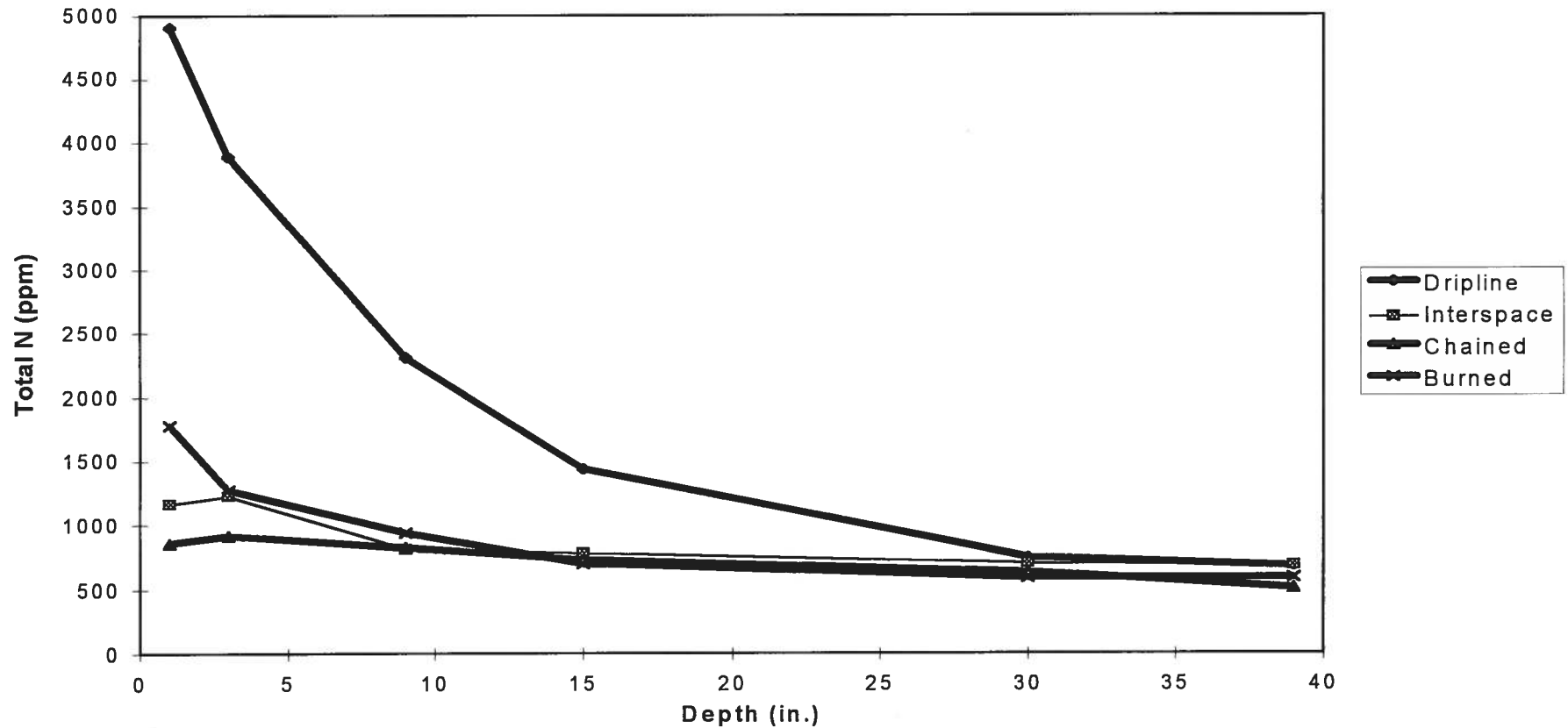
B. Discussion

- ◆ Higher in dripline because of duff layer**
- ◆ Some organic matter was incorporated down to 3 inches**
- ◆ At 9 inches no difference between treatments**
- ◆ All soils had 1 percent O.M. down to the base of the profile**

III. RESULTS

2. Total Nitrogen

Total N - All Treatments



III. 2. Total Nitrogen

A. Statistical Analyses

- ◆ Significant difference between dripline and other treatments down to 9 inches**
- ◆ No significant difference between other treatments**

II. 2. Total Nitrogen

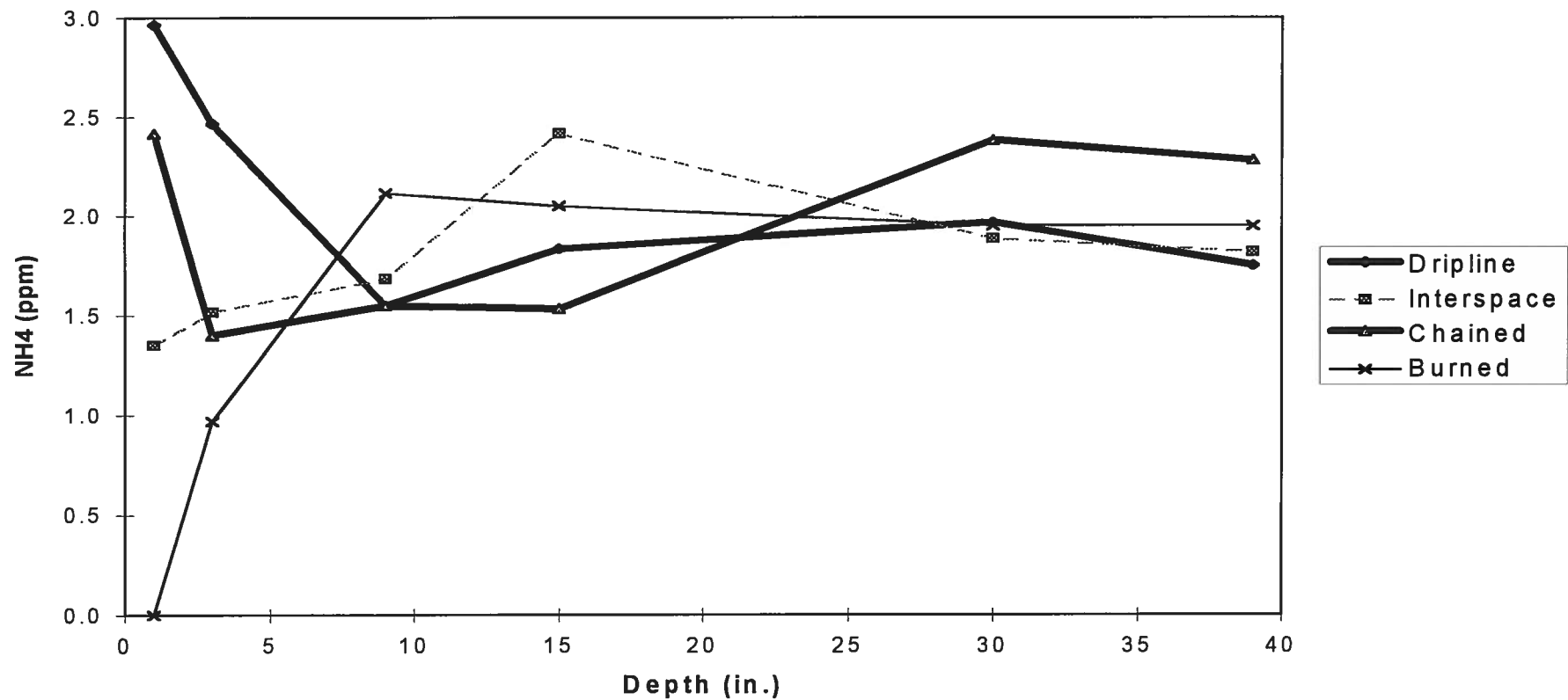
B. Discussion

- ◆ Large amount of total nitrogen in dripline due to high organic matter content.**
- ◆ Chained area had slight decrease due to heavy young juniper grow**

III. RESULTS

3. Exchangeable Ammonium

Exchangeable NH₄ - All Treatments



III. 3.Exchangeable Ammonium

A. Statistical Analyses

- ◆ At 1 inch ANOVA showed significant difference among populations. The F test showed a significant difference between burned areas and the dripline**
- ◆ At 3 inches ANOVA showed no significant differences between populations**

III. 3. Exchangeable Ammonium

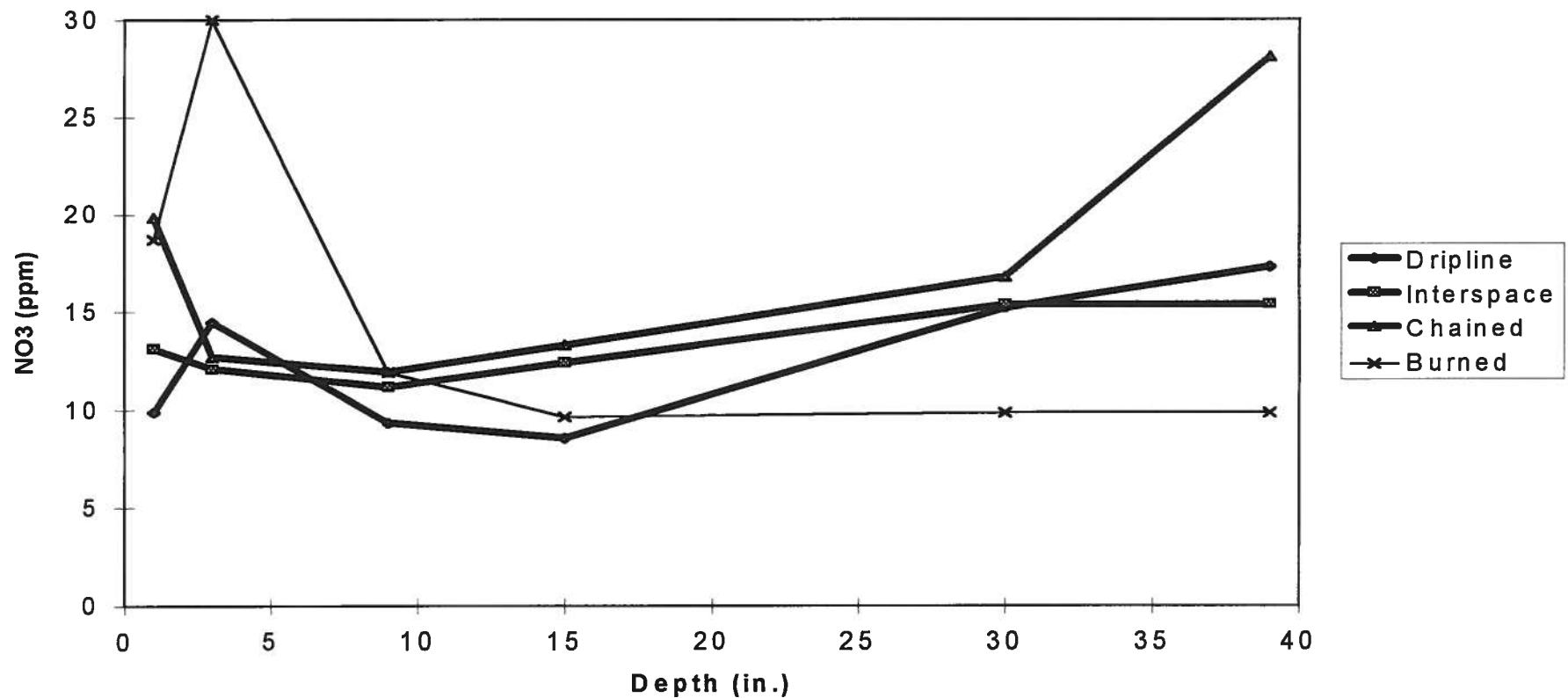
B. Discussion

- ◆ Burning oxidized NH_4 to N_2 in the upper 1 inch and after 1 year not replenished
- ◆ Burning had no effect below 1 inch

III. RESULTS

4. Total Nitrate

Total Nitrate - All Treatments



III. 4. Total Nitrate

A. Statistical Analyses

- ◆ ANOVA at 1 inch showed no significant difference between any treatments**
- ◆ At 3 inches the burned area was significantly different than the chained area**
- ◆ Below 3 inches there was no significant difference**

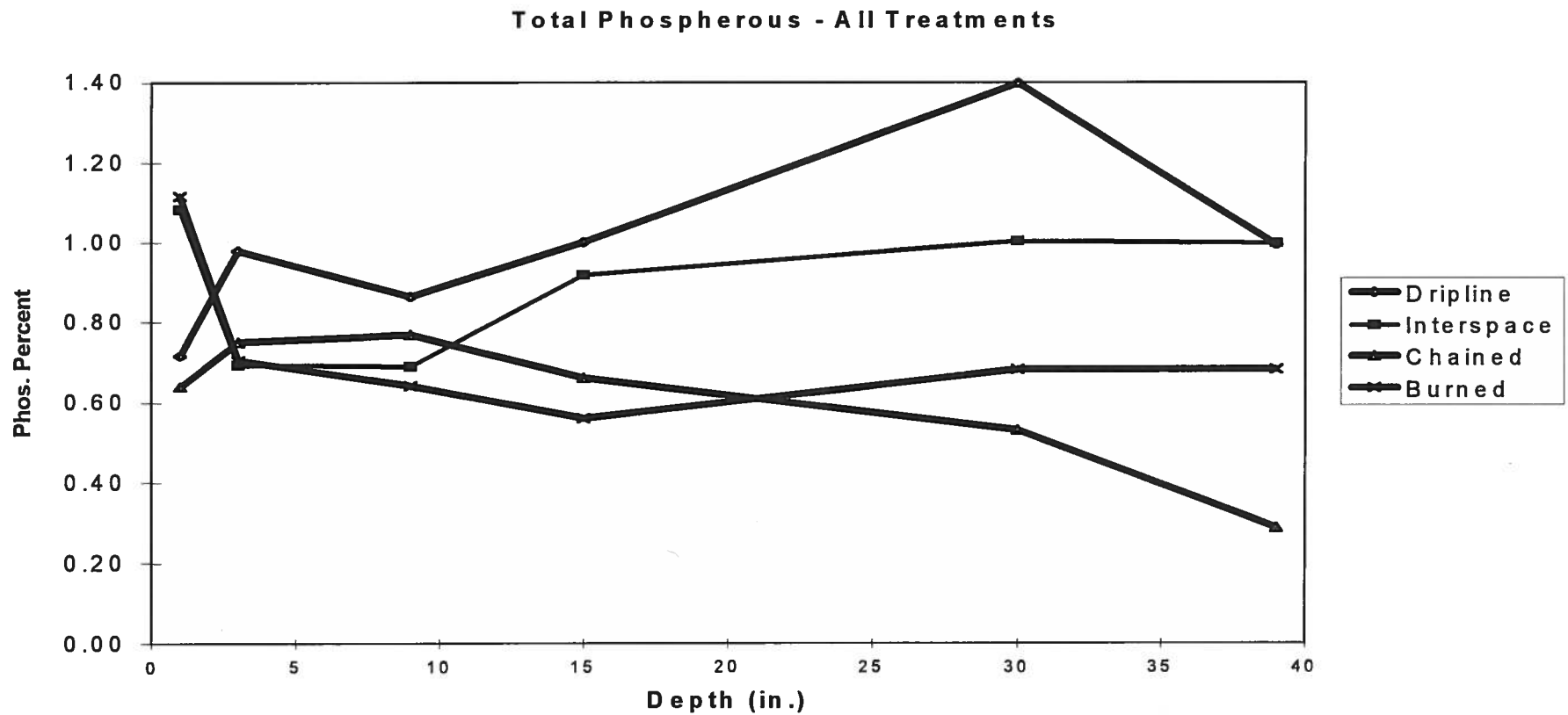
III. 4. Total Nitrate

B. Discussion

- ◆ Nitrate spike at 3 inches in burned area due to nitrification of NH_4
- ◆ There is no difference between the other treatments at any other depth
- ◆ Overall nitrate higher because of post-sampling mineralization

III. RESULTS

5. Total Phosphorous



III. 5. Total Phosphorous

A. Statistical Analyses

- ◆ There was no significant difference between any treatment above 15 inches**
- ◆ At 15 inches ANOVA and T test showed significant difference between dripline and chained area at 0.05 percent probability.**
- ◆ At 30 inches ANOVA and T test showed significant difference between dripline and chained area at 0.01 percent probability**

III. 5. Total phosphorous

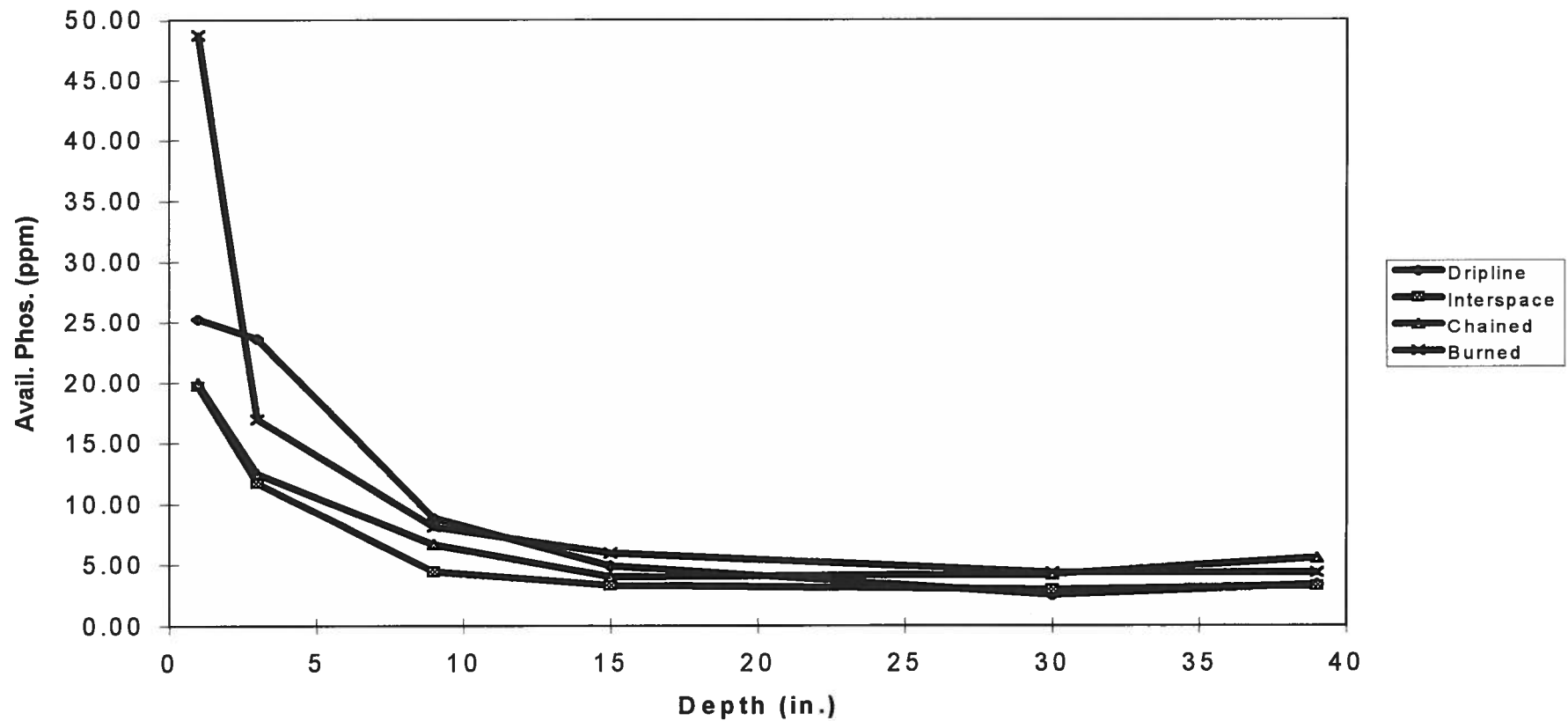
B. Discussion

- ◆ **Active roots in the dripline increase phosphorous mineralization from limestone**

III. Results

6. Available Phosphorous

Available Phosphorous - All Treatments



III. 6. Available Phosphorous

A. Statistical Analyses

- ◆ At 1 inch ANOVA showed significant difference in population at 0.01 percent**
- ◆ At 1 inch T test showed difference between burned area and dripline at 0.05 percent**
- ◆ At 3 inches ANOVA showed difference between population at 0.05 percent**
- ◆ No differences in population below 3 inches**

III. 6. Available Phosphorous

B. Discussion

- ◆ **Burning increased available phosphorous in surface almost twofold.**
- ◆ **At 3 inches dripline had more available phosphorous than other treatments.**
- ◆ **Below 3 inches burning and chaining had no effects.**

IV. SUMMARY

1.Chaining

- ◆ **Had no effects on soil nutrients except to possibly reduce total nitrogen content in the surface**

IV. SUMMARY

2. Burning

- ◆ Burning increased available phosphorous in the upper inch of soil**
- ◆ Burning totally eliminated exchangeable ammonium in the surface**
- ◆ Burned areas had much lower total nitrogen and organic matter than the dripline but about the same as chained and interspace areas.**

IV. SUMMARY

3. Driplines

- ◆ Dripline areas had the highest organic matter and total nitrogen content of all treatments. This was true down to 9 inches.**
- ◆ Driplines areas had the highest exchangeable ammonium at the surface and at 3 inches.**
- ◆ At 3 inches driplines had the highest available phosphorous**

V. CONCLUSIONS

1. Chaining

- ◆ Chained areas are not aesthetically pleasing
- ◆ do not lend themselves to recreational uses
- ◆ do not spontaneously regenerate into a more favorable understory composition
- ◆ have no effect on nutrient status

V. CONCLUSIONS

2. Burning

- ◆ **Burned areas are not aesthetically pleasing**
- ◆ **do not lend themselves to recreational uses**
- ◆ **are very difficult to revegetate**
- ◆ **have minimal effects on soil nutrients**

V. CONCLUSIONS

2. Burning

- ◆ **Controlled burns on chained areas and even old growth areas are difficult to maintain because of lack of understory growth. It does not seem economically worthwhile to control burn an area that will not burn.**

V. CONCLUSIONS

3. Old growth areas

- ◆ Old growth areas are aesthetically pleasing and lend themselves to recreational uses.
- ◆ They are the zones of highest nutrient status overall and protect the soil from erosion.
- ◆ The primary effect P/J has on understory vegetation is not nutrient uptake but most likely is moisture uptake.

V. CONCLUSIONS

4. Old Growth Areas

- ◆ These areas would be most likely to provide suitable habitat for restoration if they were allowed to burn from natural lightning strikes.
- ◆ Minimal understory vegetation would minimize fire spreading and promote a patchwork pattern that would free up soil moisture in small areas without exposing extensive surface area to erosion.