APPLICATION FOR A PERMIT FOR RESEARCH OR EDUCATIONAL ACTIVITIES IN THE GREAT DISMAL SWAMP NATIONAL WILDLIFE REFUGE

Office of Dismal Swamp Programs — Old Dominion University

1. TITLE OF STUDY - Viability of Chamaecyparis thyoides seed at a recently burned site on the Dismal Swamp National Wildlife Refuge (DSNWR). Plus: Possible studies of planting methods at the burn.

2. OBJECTIVE - To study seed viability at the burn site with the following variables:
   - A. Comparing burned area with unburned area.
   - B. Viability in relation to seed depth.
   - C. Viability in relation to distance from edge of burn, and therefore perhaps fire intensity.
   - D. Viability in relation to nutrients, pH, and general aspects.
   - E. If time allows, sowing of seed from a viable stand on two or more plots at the burn area.

3. JUSTIFICATION - A recently acquired portion of the DSNWR contains an area of approximately 100 acres which was burned September, 1975. Prior to burning the site consisted of both logged and unlogged tracts which had been dominated by Chamaecyparis thyoides. Since it is believed that fire or other destructive forces are required prior to regeneration of this species a knowledge of seed viability in the area would be pertinent information. Information obtained from the study of this site would be of value in the event of future burns.

4. PROCEDURE -

(1) Literature Review -

U.S. Department of Agriculture, 1967.
Forest Service
Seeds of Woody Plants in the U.S.
Agricultural Handbook #450

Korstain, C. F., and W. D. Brush, 1931.
Southern White Cedar, U.S. Dept.
Agric. Tech. Bull. #251

Toumey, J. W., and Korstain, C. F. 1931
Seeding and Planting in the Practice of Forestry
John Wiley and Sons Inc. N.Y. New York.

Further data will be referred to as required.

(2) Data Collection - Random collection of soil samples from the burned site and from unburned adjacent areas which are deemed similar to the prefire condition. Seed to be extracted from various depths and tested for viability using the Tetrazolium method. PH, nutrient and other environmental data will also be collected.

(3) Data analysis and interpretation - To apply appropriate statistical analysis to determine if significant relationships exist between seed viability in burned vs. unburned areas and to also consider factors of depth, nutrients, PH, fire intensity and general environmental factors.

5. COOPERATORS -

6. RESPONSIBILITIES - The DSNWR will provide appropriate study sites. It will also make YCC personel available to assist in preparation of seed beds.

7. COSTS - No costs to DSNWR otherthan those noted in 6 above will be req'd.

8. SCHEDULE - Starting Date June 7, 1976

Concluding Date Aug. 20, 1976

9. REPORTS - A report will be submitted to DSNWR approximately Aug. 20, 1976.

10. PUBLICATION - If appropriate, results will be presented at a professional science conference.

11. SUBMITTED BY - Date: June 14, 1976

(1) Investigator - Ronnie M. Pierce

(2) Major Advisor - Gerald F. Levy, Ph.D. Gerald F. Levy

(3) Director Dismal Swamp Programs - Gerald F. Levy

Gerald F. Levy, Ph.D.

12. APPROVED BY -

A STUDY OF FACTORS INVOLVED IN POSSIBLE REGENERATION OF *Chamaecyparis thyoides* IN A RECENTLY BURNED AREA IN THE GREAT DISMAL SWAMP

R. M. Pierce--NSF-URP Participant

August 1976

A STUDY OF FACTORS INVOLVED IN POSSIBLE REGENERATION OF *Chamaecyparis thyoides* AT A RECENTLY BURNED SITE IN THE GREAT DISMAL SWAMP

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ABSTRACT

A logged over tract of *Chamaecyparis thyoides* in the Great Dismal Swamp was burned by natural fire. An investigation to determine if any *C. thyoides* seed had survived the fire was conducted. No viable seed was found. In conjunction with the seed study a soil analysis was also conducted comparing burned areas to a control area of living cedar to determine what effects the fire had on soil nutrients. Most parameters were as to be expected following a fire, the exceptions being a significant lowering of pH and available nitrates.

Introduction

In September, 1975, a fire initiated by lightning occured in an area which was recently acquired by the Great Dismal Swamp National Wildlife Refuge (GDSNWR). The dominant species in this particular area is Atlantic white cedar (*Chamaecyparis thyoides*). However, the main portion of the burn (Approx. 60 acres) was logged one year previous to the fire. Standing cedar at the western border of this stumpage was also destroyed by fire (approx. 13 acres). Forest line ditch stopped the spread of fire on the eastern border and the cedar to the east of the road was not visibly affected by the fire. In the remainder of this paper the three environments mentioned above will be termed: "Burned stumpage," "burned standing" and the control "living cedar." (Fig. 2)

The main concern of this study was the burned stumpage area which may be further described, when first observed in June, 1976, as: Sixty acres of charred blackened stumps, extremely barren with even very little herbaceous vegetation. There are a few compacted drag trails which run in an east-west direction across the burn. Most greenery is found on these trails and it appears they were not severely affected by the fire due to compaction and lack of slash. The peat, however, which appears to have been approximately 18 inches deep before the fire, was completely burned leaving the stumps standing high on their roots above what is now ground level.

Ordinarily a slash burn in logged over <u>C. thyoides</u> system would result in regeneration of that species due to the seedling requirements for abundant sunlight and lack of competition. In the burned stumpage area in June there was no evidence of first year seedlings with the exception of a small number on the drag trails. Observations made in the 1920's (Korstain, 1924) in regard to controlled burning stated that any burn which occurred during the dry season would result in the destruction of all C. thyoides seed in such an area and prohibit regeneration. No research data was referred to. Historically white cedar has managed to regenerate without benefit of controlled burns and it seems that most wild fires occur during the dry season. It was therefore the purpose of this study to determine if any viable seed had survived the fire and if it had, what factors would aid or hinder its germination. At the same time, if natural regeneration did not seem imminent it was hoped that any information gained (i.e., from soil tests or field observations) would be of use to the GDSNWR in the event that reforestation seemed required and/or feasible. (See Fig, 1 for fire location)

Methods

Plots for obtaining samples were located by random stratified procedure (Fig. 2). In all three environments the unit of measurement for plot location was restricted to "paces" due to the terrain and amount of surface area to be considered.

In the burned stumpage area twelve samples were taken with a piston type soil borer at the center point of each plot. The samples were 2.75 inches in diameter by 9 inches, which compressed to 6" in depth. These samples were then, on the site, wrapped in plastic taking care not to disrupt the natural horizons, sealed and taken to the lab to be examined for C. thyoides seed, the process of which will be discussed later.

In each of the three major areas composite soil samples were taken at twelve locations, making a total of 36 composite samples (see Fig. 2 for approx. locations). At each of the 36 plots eight one pint samples were taken around the center point at an approximate radius of ten feet and at 45° apart. These eight portions were then thoroughly mixed at the site and a one pint sample of the mixture for each of the 36 plots was taken to the lab for analysis. Before taking these soil samples the top layer of ash was removed so as not to be included in the soil. Therefore, four strictly ash composite samples were taken from lines transecting the burned stumpage area.

Seeds for any controls necessary were collected, still in the cones, from the surface beneath the living cedar.

At the lab the core samples were sliced in two inch lengths (each section representing a three-inch field depth). One third of each of these portions was labeled (A=top horizon) as to horizon and plot location, and set aside for examination. Each sample was then strained through a #20 standard sieve using water to break up the soil.

The resulting washed and strained organic matter was then studied under a binocular microscope for the presence of C. thyoides seed. Seeds found were tested for viability using the tetrazolium method (Yearbook, 1961). The testing solution consisted of 0.5 gram of 2,3,5-triphenyltetrazolium chloride in 200 ml of distilled water. Seeds were sliced longitudinally and emersed for four hours, in darkness, before reading.

Composite soil samples were taken to the Virginia Truck and Ornamentals Research Station (VATORS) for technical assistance in soil analysis. The following procedures were employed.

Upon arrival at the station the soil samples were oven dried for ten hours. They were then passed through a 2 mm screen and thoroughly mixed. For pH and salt concentration 25 g of soil from each sample was added to 25 ml of distilled water. This mixture was allowed to stand for 30 minutes. An RC-16B Solubridge was used to test for salt concentration and pH determination was made using a Beckman Zeromatic pH meter.

For tests requiring extraction 5 g of soil from each sample was placed in an extraction flask with 250 mg of charcoal and 20 ml of extracting solution. The samples were then allowed to stand for 20 minutes, and filtered. The extracts were then tested for the following parameters:

Calcium, magnesium, and phosphorus were tested using a colorimeter; samples were tested for potassium in a Perkins-Elmer flame photometer. Separate extractions were made for the nitrate tests which were read on a Fisher Electro-photometer. All the above procedures are stated by VATORS to be in accordance with V.P.I. Bulletin No. 475, Aug., 1955.

The data obtained from the soil analysis was cross computed for significant differences in nutrients between all three areas using the significance ratio (t test) with a confidence level of 95-99%.

Results

A total of 13 seeds were found after extensive examination of all samples. They all showed negative a response to the tetrazoilum test for viability. Table 1 is a listing of plots and horizons at which they were found.

Plot No.	No. of Seed
4B	1
5A	2
6A	6
6B	1
7B	1
10A	2

Table 1--Amount and location of *C. thyoides* seed found. A, B and C refer to horizons, a being the top. See Figure 2 for plot locations.

The soil analysis results are graphically depicted in Figure 3. Amounts of nutrients graphed are averages of the 12 samples taken from each of the three areas. The t-Test indicated the following information. Calcium and Magnesium which were both in very high quantity (Table 3) showed no significant differences between burned stumpage and living cedar, burned stumpage and burned standing timber or burned standing and living cedar. (These three cross tests were run on all nutrients). The available phosphorus was found to be significantly greater in both the burned stumpage and standing burned sites when compared to the living cedar control area. Nitrates and potassium, however, were significantly lower in both burned areas as compared to the living area. In regard to salt concentration, no significant differences were found in any of the three areas. Soil acidity was significantly greater in the burned stumpage area when compared to both the standing burned and living cedar areas, but there was no significant difference between the living cedar and the standing burn. See Table 4 for a recap of the above results.

The soil analysis tests on the ash samples yielded nutrients as listed in Table 3.

When compared to the soil from the burned stumpage area the ash was: higher in regard to pH, potassium and phosphorus; lower in nitrates and salts. No differences

	Line 1	Line 2	Line 3	Line 4
pH	4.3	3.9	4.0	4.1
CaO	1960	1960	1960	1820
MgO	178	136	122	172
P_2O_5	165	69	75	134
K_2O	88	53	53	56
NO_3	63	38	38	38
Salts	223	160	183	124

Table 3--PPM of nutrients in ash
See Fig. 2 for line locations.

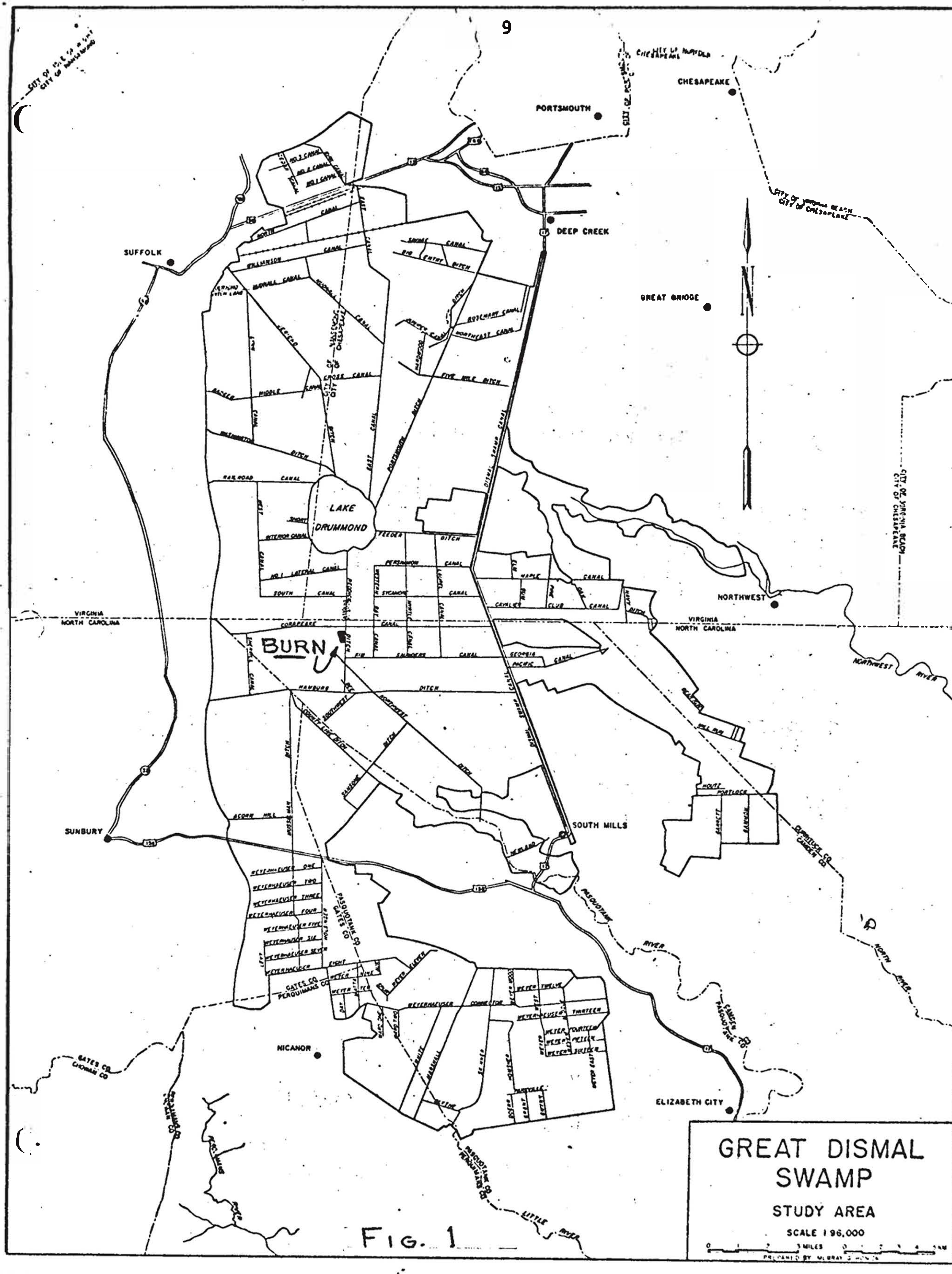
PORTSMOUTH
CHESAPEAKE
DEEP CREEK
SUFFOLK
GREAT BRIDGE
LAKE DRUMMOND
BURN
VIRGINIA
NORTH CAROLINA
NORTHWEST
NORTHWEST RIVER
SOUTH MILLS
SUNBURY
PASQUOTANK RIVER
NORTH RIVER
NICANOR
ELIZABETH CITY
LITTLE RIVER
GREAT DISMAL SWAMP
STUDY AREA
SCALE 1:96,000

FIG. 1

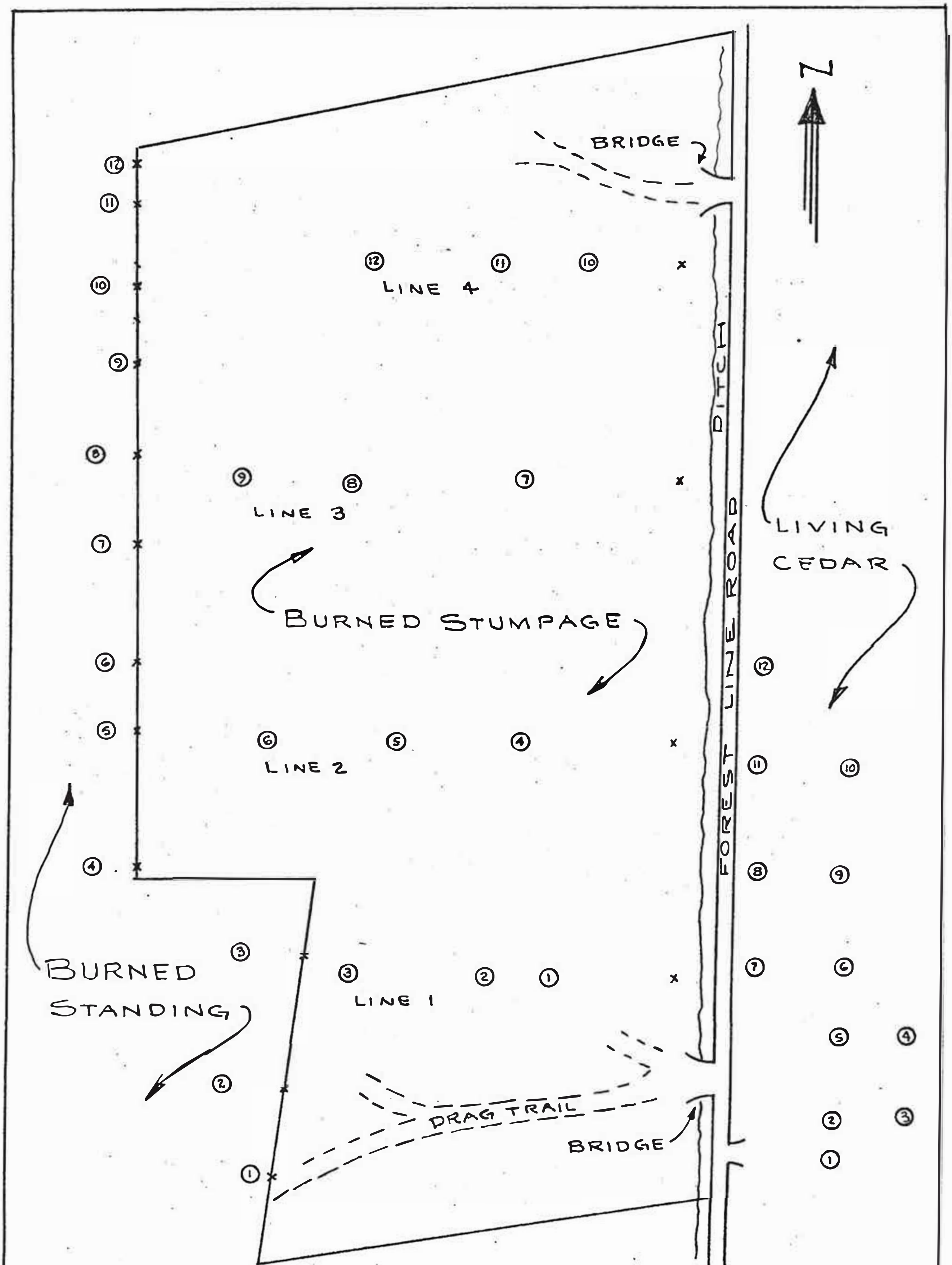

FIGURE 2.
APPROXIMATE PLOT LOCATIONS

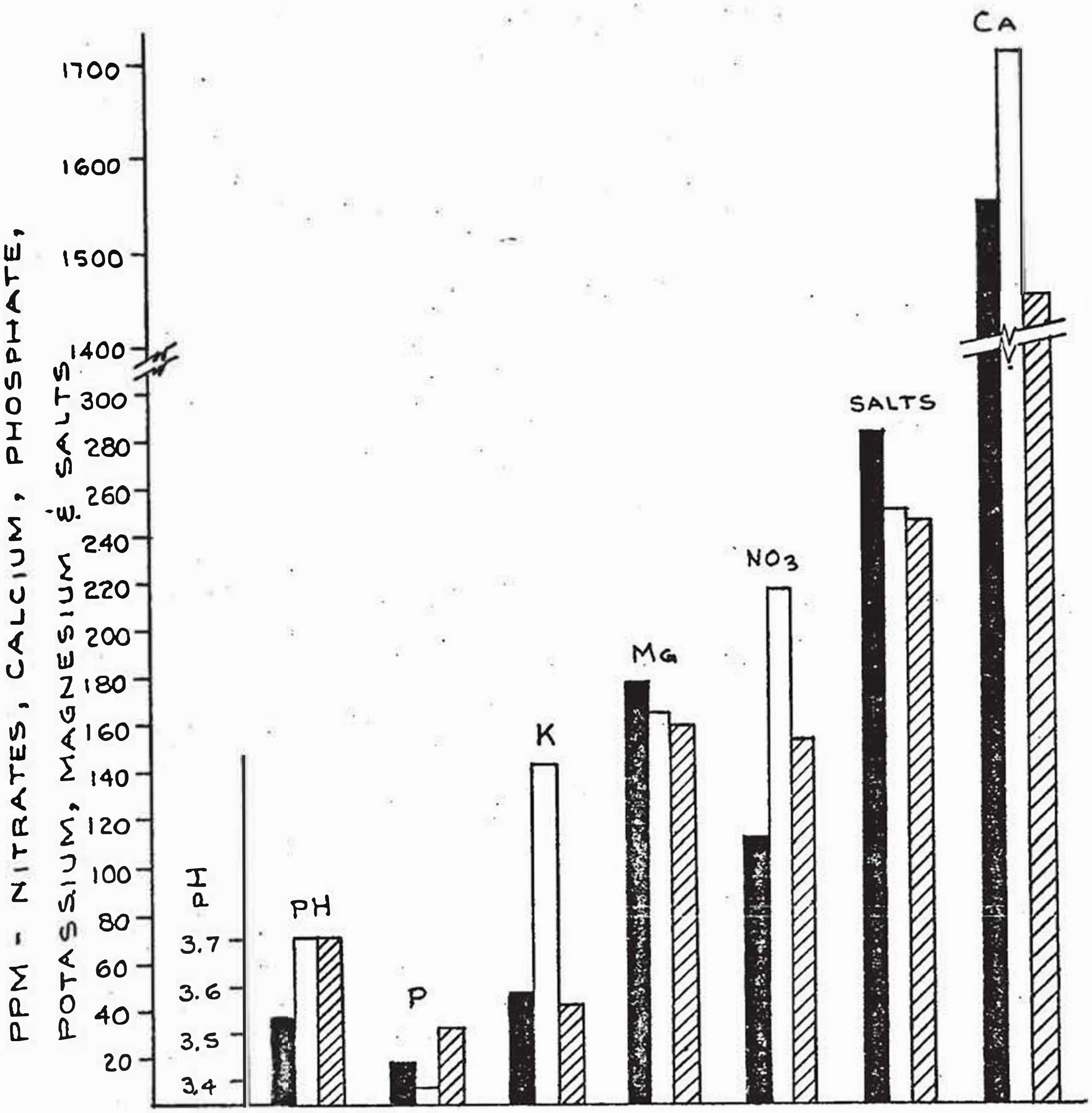

Fig. 3--Graph showing results of analysis for available nutrients in the soil from the three environments. The dark bar designates the burned stumpage area; light bars = control area; cross hatched bars = standing burn area. For areas of significant difference see Table 4.

	VL	L	M	H	VH
CaO	0	0-140	140-420	420-1400	1400+
MgO	0	0-20	20-100	100-200	200+
P_2O_5	0	0-25	25-67	67-125	125+
K_2O	0	0-47	47-106	106-188	188

Table 3

Conversion of PPM soil nutrients to readings of very low to very high. As noted by VATORS.

	Living vs Stumpage*	Living vs Standing*	Standing vs Stumpage*
pH	Lower*	--	Lower*
P_2O_5	Higher*	Higher*	--
CaO	--	--	--
NO_3	Lower*	Lower*	--
K_2)	Lower*	Lower*	--
MgO	--	--	--
Salts	--	--	--

Table 4

Areas in which significant differences were found in regard to available nutrients. *Statements are in regard to stumpage, and standing, soils.

were noted in regards to amount of calcium and magnesium.

Discussion

The available phosphorus was found to be significantly greater in the burned stumpage and standing burned sites when compared to the living control area. There was no significant difference, however, between the burned stumpage area and the burned standing area (Table 4). This addition of phosphorus can readily be attributed to the natural release of mineral nutrients immediately following a fire. In addition to release by burning, the great amounts of soluble phosphorus may be partially due to the fact that a decrease in pH (which has occured) leads to a marked increase in phosphate solubility (Stanberry, 1948). In past test burns the amount of easily soluble phosphorus (P_2O_5) was practically doubled by burning (Kozlowski, 1974). It was also mentioned in the aforementioned case that in the year after the fire the burned humus layer had lost half of the newly acquired phosphorus due to leaching in the form of potassium phosphate. It may well be that the same phenomenon has occured here, but unfortunately no immediate post fire research was conducted.

Calcium and magnesium were both in very high content in all three areas, with no significant differences being noted. Both of these cationic nutrients under ordinary conditions are slow to leach, and if slight leaching does occur, will be fixed by ion exchange in the top layer of mineral soil so any loss during burning would be negligible. This fact is indeed confirmed by the soil analysis.

All potassium compounds formed by burning are water soluble. The significantly lower amounts in the burned stumpage and burned standing areas are undoubtedly due to leaching. Some of which probably occured as they were trying to drown the fire.

In reference to the salt concentration, no significant differences in the three areas were found. In general, one may expect to find, immediately after a fire, an increase in total salts (Haines, 1926) which is probably a general feature due to the liberation of salts from burnt plant remains. The salts are then immediately leached and due to the time lapsed since this fire that would be the causative factor of the relatively lower amounts noted.

Living vegetation, needles, smaller branches of slash, portions of large slash and almost the total peat layer were all consumed by the fire. Whereas much of the mineral nutrients remain at the site in the ash, it may be assumed that most of the nitrogen is lost by burning (Kozlowski, 1974). Under ordinary circumstances this loss of nitrogen would be considered unimportant as it was bound up in living and dead vegetation and would have only slowly become available for plant utilization, and with an increase in pH as would normally occur after a fire an increase in the mineralization of the nitrogen-nitrification process would eventually increase the amount of available nitrates in the soil, despite the initial loss of the total amount of nitrogen. In this case, however, the removal of nitrogen-nitrates combined with the extreme acidity of the soil may be one of the limiting factors of future growth in the area. Under conditions of artificial fertilization plants which prefer acid soils show a favorable response to nitrate salts (Wilde, 1958), so it may well be that the fire has caused considerable damage as far as available nitrates are concerned.

As mentioned in the previous paragraph, there seems to be one distinct anomaly in regard to this fire. That being, that the acidity of the soil significantly increased in the burned stumpage area. This is the opposite of what one usually expects after a fire (Ahlgren, 1960; Barnette, 1930; Fowells, 1933; Haines, 1926). In only one case did the literature search indicate an increase in acidity after a fire (Pearsall, 1941). In a discussion of the inordinately high pH of Connemara peat being due to the lack of oxidation in water logged conditions rather than to the presence of bases, Pearsall states:

> . . . when they are allowed to dry (peat samples) out slowly in the laboratory, oxidation takes place and there is nothing to prevent the development of high hydrogen ion concentrations, akin to and even greater than those observed in acid peats.

ccompanying tables also indicate that fires in this bog also tended to increase acidity. This increase in acidity due to drying may possibly have some bearing in this instance. On the other hand, this researcher feels the high table of acidic water (water table is only ±6 inches below surface and fluctuates greatly) may have a more controlling influence on the pH differences between the burned stumpage and the living cedar area, it being noted that the water level beneath the living cedar, with peat, would be considerably lower. In any event, with pH being such an important parameter of the soil it is felt that further research by qualified persons should be undertaken, as soon as possible to resolve this matter.

As mentioned in the introduction it has been stated that any slash fire which occurs during an extremely dry season will result in the destruction of the upper layer of peat and any C. thyoides seed therein (Korstain, 1931). This is undoubtedly the case in respect to this fire as proven by the small number of seeds found and the lack of viability of those seeds. It should also be noted that the greatest number of seeds were found at plot 6 in the burned stumpage area (see Table 1 and Figure 2). The close proximity of this plot to the standing burned timber on both the south and the west sides indicate that the seed found was probably wind deposited from the standing burned trees and were not seed coats which survived the fire. It must be assumed that no seed was left alive in the burned stumpage area. Under such circumstances, succession in Virginia generally is towards pond pine (*Pinus serotina*) of which there are several still standing in the area. However, it should be noted that at the time of this writing, first year seedlings (not numerous) of *C. thyoides* have begun to appear in the burned stumpage area, particularly to the east of and in close proximity to the standing burned cedar area. The seeds from the standing burned trees which were ready to disseminate at the time of the fire apparently escaped damage and are seeding at least part of the area. There is also an area along the northern border of the burned stumpage area which was not burned and has numerous first and second year seedlings. It may be stated here that there is at least a minimal chance for *C. thyoides* to inhabit the area once more depending upon how it and other species can tolerate the post-fire conditions of: lowered nitrates, increased acidity and high water table. Further testing with viable seed and/or seedlings should be conducted regarding these factors.

Conclusions

The results obtained from this investigation permit the following conclusions:

1. There are no viable seeds remaining in the burned stumpage area due to the intensity of the fire. Therefore all first year seedlings now present are the result of seeds being blown in from other areas.

2. The available nitrogen in the soil was lowered by the fire and replenishment of nitrates by microbial action may be negligible due to lowered pH.

Works Cited

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