STATE OF MICHIGAN

ENVIRONMENTAL IMPACT STATEMENT

prepared by
the

Forest Fire Division

Department of Natural Resources

for

Prescribed Burning - Class Action

A. Gene Gazlay
Director

Jan. 18, 1974
Date

C O N T E N T S

INTRODUCTION

The burning of forests and grasslands in Michigan has been going on for possibly thousands of years.[15] This can be inferred from the evolutionary adaptations to fire of many plants (for example, the closed-cone habit of jack pine), and from records of ancient charcoal in peat bogs, lake sediments, and glacial deposits[20]; also, in later times, the fire scars on large, old, fire-resistant trees. The Michigan Indians were known to have made wide use of fire in their hunting techniques, as well as to improve their environment to one more conducive to human existence. Lightning fires were probably no more numerous in early times than they are today; however, large areas underwent extensive burning due to the existence of only natural barriers to control the spread of these fires, and those started by man. As a result of the repeated burning, it is believed that several of the virgin forests were probably fire types, or were influenced in their establishment and perpetuation by fire. The same can be said of many of Michigan's wildlife species.

We have assumed that preservation of our forest areas containing related wildlife is assured by protecting them from fire, insects, and disease. Sometimes this is so, where a climax ecosystem exists (maple-beech forest); but as modern biology and ecology reveal the life histories of plants and animals, and the intricate inter-reactions between environmental factors and plant and animal communities, we find more and more that additional efforts are necessary to preserve our natural ecosystems.

An ecosystem is composed of the plants and animals living in an environment of air, soil, and water. Each organism is interrelated either directly or indirectly with virtually every other organism in the system. An ecosystem is constantly changing.[33] Change is difficult to determine from minute to minute or day to day, but given a longer period of time, it is more evident. For example, a corn field, over a 60-second period, does not show any change in growth, but as the seconds build to minutes, weeks, etc., a great deal of change is apparent. First, there is the bare ground with the planted seed in it. Very few birds and animals frequent such an area except to pass over on their way to a more productive site. After the corn sprouts and the weeds come in between the rows, insects, mice, rabbits, birds, and other animals will inhabit the field for food and cover. As the corn growth progresses, the interaction of plants and animals continues. The corn, although a very intolerant plant, remains dominant over the other plants in the field during the first year. However, in the second year the unharvested corn will produce only a few corn plants which will not maintain the first year dominance. The more tolerant weed plants will dominate the field. In a few years, trees and shrubs will inhabit the area, forcing out the less tolerant plants. As the changes in the plant life occur, the wildlife will change also. The change in plant growth from the intolerant to the tolerant species on any site is called "natural succession."

In short, succession is a continuing process marked by myriads of changes in the vegetation, the fauna, the soil, and the micro-climate of an area with the passage of time. A corn field in one year changes drastically but in a jack pine or aspen forest, years would pass before a drastic tree and smaller plant change would occur. In order to hold or set back plant succession, a disturbance on the site must occur. To assure himself a corn crop each year, man would disturb the area by plowing and planting. Nature does this in a forest with wind, fire, and flood disturbance. Man sets back or holds forest succession with fire, logging, and land clearing activities.

The reduction of wildfire is perhaps the single most important environmental change in today's forests. Michigan's fire acreage loss has been reduced considerably since the turn of the century due to improved fire suppression and prevention expertise, advanced technology in fire fighting equipment, and improved land accessibility. Records dating back to 1911 show nearly six million acres burned over the past 62 years. Earlier, fragmentary data shows 2,369,070 acres burned in 1908; one million acres in 1881; two million acres in 1871, and so on.[25] The acreage burned by wildfire in 1972 was near 6,000 acres. The lack of fire in many of the subclimax areas of Michigan (i.e., grass plains, aspen and jack pine stands, blueberry bogs, etc.), created an artificial or unnatural situation. As a result, serious changes or loss to wildlife and forest products has occurred. Much of this reduced burning has been due to a lack of understanding of Prescribed Burning and its effects.

A limited amount of burning has been done on subclimax areas by the Department of Natural Resources (formerly, the Department of Conservation) for over 30 years. Until recently, the burns were called "controlled burns." Twenty-five thousand acres were fired during this "controlled burning" period. Much of this acreage was burned to maintain openings for the Sharptailed Grouse and Prairie Chicken. Fire properly applied stimulates the growth of grasses and herbs, and kills or deters the growth of the encroaching woody vegetation. This necessary treatment favors habitat required by these birds and encourages perpetuation. To the Sharptailed Grouse and Prairie Chicken enthusiasts, this program has been a very worth-while venture.

Many more new demands and requests are now being imposed upon the Department of Natural Resources than ever before. To fulfill some of these requests, a specific type of land treatment is often necessary. In some instances, the most natural, complete, and effective land treatment is fire by prescription, better known as "prescribed burning."

Prescribed burning can best be described as the skillful application of fire to natural fuels under conditions of weather, fuel moisture, and soil moisture that will attain confinement of the fire to a predetermined area and at the same time produce the intensity of heat and rate of spread required to accomplish certain planned benefits to one or more objectives of silviculture, wildlife management, hazard reduction, or special requests such as the Kirtland Warbler habitat improvements and blueberry reproduction.

Prescribed fire knowledge has grown steadily over the last two decades. Most of the states in the nation and in Canada have used or advocated prescribed fire to meet one or more of the above objectives. Prescribed fire research ranges from R. W. Sando and R. C. Dobbs in Manitoba and Saskatchewan, Canada, to E. V. Komarek in Tallahassee, Florida, to W. R. Beaufait in Missoula, Montana, back to C. E. Ahlgren in Duluth, Minnesota, with many others in between.

Michigan's prescribed burning program is taking on a totally new dimension due to the new state-owned land management program being drawn up by the Wildlife and Forestry Divisions. Greater emphasis is being applied to individual areas for a particular treatment to form a composite of a total multiple-use land concept. Where prescribed fire is advocated, the latest research and collective fire knowledge is being applied to the areas being treated to achieve the best results with the least possible damage to the environment. This report is an attempt to clear up misunderstandings about prescribed burning and relate the beneficial and deleterious aspects.

O B J E C T I V E S

Michigan lands, from repeated burns in the past, produce many fire resultant trees and smaller plant species. Two of these tree species (jack pine and aspen) cover five million acres and produce over 800,000 cords of wood per year in Michigan. The fire-related plant communities of Michigan attract and sustain a wide variety of wildlife species. To maintain an abundant supply of forest products and wildlife, these plant communities must be productively managed, just as a farm crop is. Prescribed fire is one tool available to the wildlife and forest manager for maintaining the intolerant fire types.

A prescribed burn treatment always serves more than one purpose or objective. The objectives listed are the major justifications for using prescribed fire on a management area.

A. The silvicultural objectives are:

1. <u>Seedbed Preparation</u> (jack pine and red pine)[1,2,4,5,6,10,12,15,[illegible]]

   After a forest area has been cut over for commercial use, [illegible] in the form of tree branches and tops (slash) as well as the non-merchantable trees and brush remain. These trees consist of large trees which have been damaged in some way by nature or man, rendering them a useless product, and the trees too small for any commercial use. Pine regeneration through seeding is successful only if the slash, ground litter, and competitive live trees and brush are reduced to allow the seeds the necessary sunlight, moisture, and nutrients to sprout and grow during the early months, to produce an area well stocked with 1600-1600 seedlings per acre. A prescribed fire kills the standing trees and removes enough of the slash and litter on the ground to prepare an ideal seedbed.

2. Seed Tree Method of Regeneration[1,2,4,5,7,9,10,11,15,3]

On good jack pine sites, 8-12 seed trees are selected and marked to remain after the commercial cut to provide a viable seed source for the area. The cones on these seed trees then after burning, will provide enough seed to restock the area. Jack pine cones are highly serotinous (i.e., remain closed for years) and require the heat from fire to open them. This is why jack pine is considered a fire species and can be regenerated with prescribed fire.

3. Aspen Regeneration[6,13,32]

Fire treatment for aspen is somewhat similar to that of jack pine. Slash removal or reduction is important for optimum stocking. The blackened surface absorbs more sunlight, which aids in stimulating "suckering" or sprouting from the underground mat of aspen roots. The nutrients released from the burned slash and litter give the young aspen shoots a much needed boost in growth. This is highly beneficial to these young plants due to the sandy soils on which much of [illegible] aspen is found.

4. Insect and Disease Control[6]

No burning by the Department of Natural Resources has been done to this time strictly for this objective. However, prescribed fire could become effective if applied to combat a localized outbreak.

B. The wildlife management objectives are:

1. Aspen Regeneration[5,13,35]

The aspen and its associated plant life are highly favorable to many forms of wildlife, particularly the game species. The ground cover and aspen sprouting which comes back after burning is lush, vigorously growing and very nutritious. Young aspen twigs and leaves are highly palatable to white-tailed deer, and terminal aspen buds are the primary diet of the Ruffed Grouse over the winter.

2. <u>Maintain Grassland Openings</u>[6,7,15,18,37]

   Repeated fire every 5 to 10 years over a designated grassland area controls the encroaching woody vegetation and preserves the grasses and herbs. These openings are vital to the management of the Sharptailed Grouse and Prairie Chicken. They are also beneficial to many other species of wildlife, including deer, woodcock, hares, and a variety of song birds and small mammals. Burning is not done during the nesting period.

3. <u>Manage Marshland Habitat</u>[17,36,38]

   Marshlands also have to be treated, to relieve the overcrowding of unwanted woody vegetation. Water openings and water plants are gradually overridden, greatly reducing the productivity of the area, of and for the neighboring waterfowl and furbearers. Like other subclimax types, marshes are a temporary stage of succession and to maintain them, we must do so by slowing down or stopping their progress toward later (drier) stages. Burning is about the only safe way of alleviating this overcrowded condition.

4. <u>Stimulate the Sprouting of Scrub Oak and Red Maple on Poorer Growing Sites.</u>

   After maple-oak areas are treated with fire, prolific sprouting occurs. This regeneration on poor sites replaces insect-riddled and/or diseased trees which are of no great value as a forest product or to wildlife. The nutritious food source (i.e., the young tender growth) is again returned to an area closer to the ground, making it more readily available to wildlife.

C. Forest fire prevention objective:

1. Hazard Reduction[15,26]

Excessive accumulations of slash located in or near heavy-use areas can be a serious fire hazard, especially if the fuels surrounding these slash areas are conducive to explosive conditions on high fire-danger days.[34] (If a fire "crowns" or "blows up," control becomes very difficult, if not impossible.) A change in timber type or some other natural barrier is usually necessary before control is possible. Such areas can be burned out on a low fire-danger day, to safely reduce hazardous conditions.

D. Kirtland's Warbler Objective:[22]

1. Perpetuation Through Habitat Improvement

The "jack pine bird," as referred to by many people, nests only in Michigan on the jack pine plains in the northern half of the Lower Peninsula. These birds favor open jack pine stands of 80 acres or larger in size, with trees 6 to 18 feet tall, and 8 to 20 years old, for nesting. Prescribed fire is a successful management tool in creating acceptable nesting habitat for this prized and endangered bird.

E. Recreational Objective:

1. Blueberry Reproduction

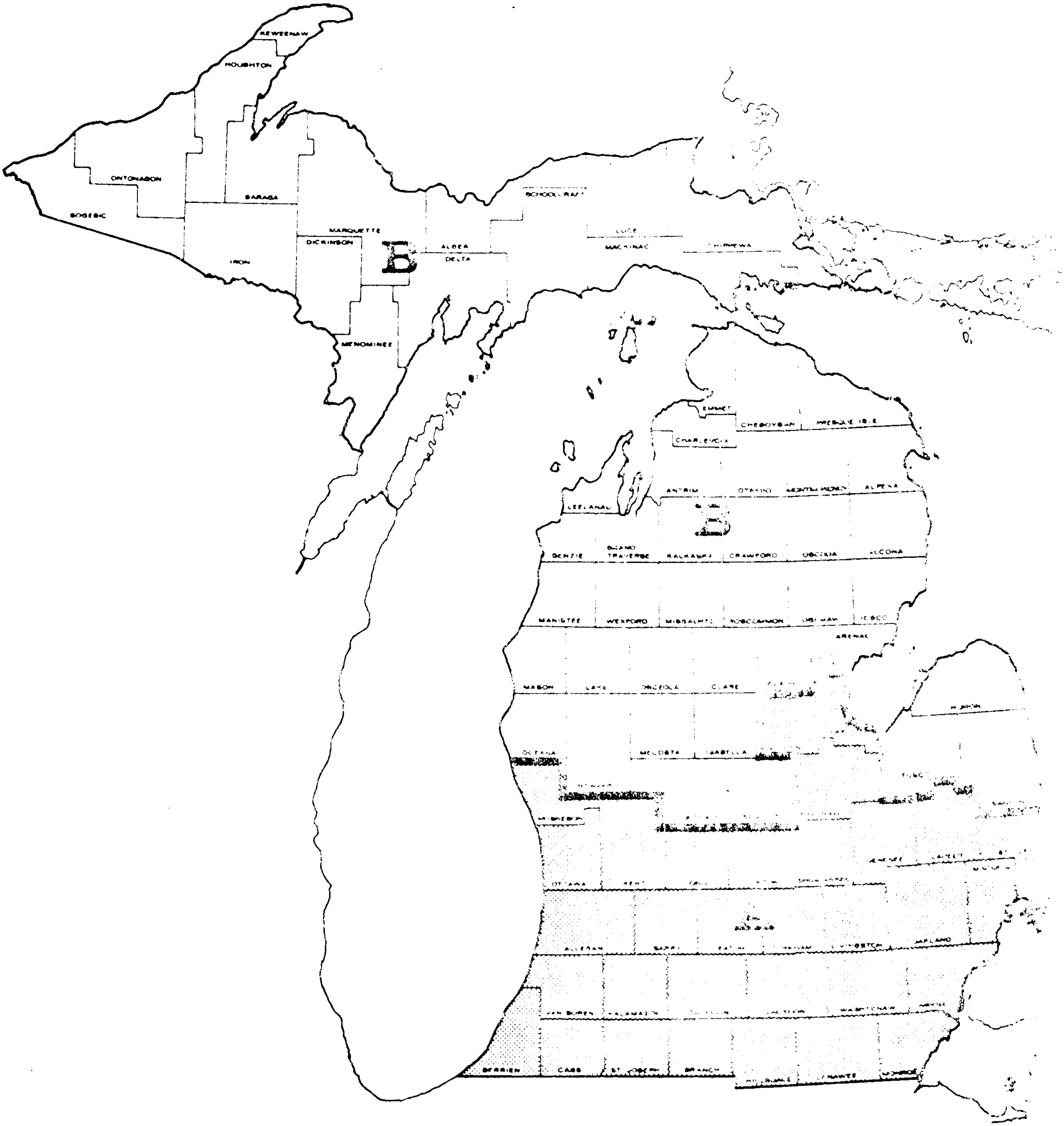
"Berry pickin' " is enjoyed by more people every year. High productivity is possible if a blueberry area is burned every 5 to 10 years. When blueberry plants become less productive, they can be rejuvenated through pruning. Pruning with fire removes the old, woody, unproductive stems or branches, releases nutrients to the soil, and kills competitive vegetation. This stimulates vigorous new growth which will produce abundant berry crops after the first full growing season Wildlife also benefits from this objective.

ACHIEVEMENT OF OBJECTIVES

To accomplish a successful burn and meet the requested objective, certain natural requirements are necessary. Some of these are, the proper blend of weather conditions, specific moisture contents of surface fuels, litter, and soil, and the proper time of day and year. Quickly one realizes that the prescribed burning program is very dependent upon weather conditions. These prescribed conditions or recommendations are necessary to assure a "cool" burn as well as burn control, proper burning intensity, as well as burn success. The burning days are few each year but, unlike other land treatments, large acreages can be treated in a single day. During 1975, almost 3600 acres were treated in 12 burning days. Future projections are to treat 12,000 acres per year as the program expands. The days prescribed fire can be effectively used during a normal weather year will range from 20 to 40. These effective or "ideal" burning days are also the days when good atmospheric mixing occurs. Fuel combustion is enhanced by entrained air moving along the ground into the fire. The smoke emitted is forced upward by this air movement and the heat generated to form a chimney-like effect. This process is called thermal lift. These smoke plumes reach 5 to 10 thousand feet in the air before being dispersed by the winds aloft. The burning time, regardless of the size of the area being treated, lasts from one to three hours.

Possible Burning Areas

All of the burns, with very few exceptions, will be conducted on state-owned land north of a line between Oceana and Muskegon Counties on the west, and Sanilac and Saint Clair Counties on the east side of the state (see map). There is a possibility that some requests will be written for areas south of that line. All of these requests must also be approved by the Department of Health before the burn can be carried out.[24]



A-23 1M 12/66 MICHIGAN DEPARTMENT OF PUBLIC HEALTH

PROBABLE ENVIRONMENTAL EFFECTS

It is inescapable that fire has an impact on each of the three aspects of the environment defined by Webster -- the climatic, the edaphic, and the biotic. Prescribed fire differs from wildfire in that it is employed only when and where it is needed. It is controlled and managed so that its beneficial effects outweigh any of its detrimental effects. Questions arise, however, when different people attempt to evaluate these plus and minus effects. A prescribed burn that removes the unwanted non-forageable brush and induces aspen-sprouting for deer browse and other wildlife habitat may rate a big PLUS from the wildlife manager and deer hunter; but the bird watcher may rate this same fire with an equally big MINUS. The housewife, whose laundry may have been soiled by particulates falling from the resultant smoke, may be the first one to write and say, "This burning has got to stop!"

Due to recent research, plus our own studies on burns conducted within the state, we know something of the effects of prescribed fire on esthetic and recreational values; on the maintenance of wildlife habitat; on the physical, chemical, and biological properties of forest soils; on the net growth of timber, and the reduction in numbers and intensity of wildfires Very little is known about forest burning effects on air quality.

Air quality is largely what people think it is. Even the information gathered by air pollution control experts is limited by their sampling networks, which usually do not cover the remote country outside of population centers; nor do they extend very far above the surface. Very little is known about the quality of air which moves into and over our cities and towns. Most of the air pollution control efforts are spent on the air quality in the cities, consequently their natural inclination is to make an educated guess

About the contribution from such outside sources as prescribed burning.

The air pollution from prescribed burning in Michigan is largely a localized problem. Most of the major population centers are not associated with forest lands where large burning programs might be conducted. There are, however, smaller population centers--highways, airports, etc.--that are being considered when burning.

Smoke management is now a part of all prescribed burning operations. Most of the localized effects occur within two miles of a fire.[29] Steps are being taken to avoid creating problems within that limit.

Our decisions to burn are based on intensive meteorological management of burning activities that will lean heavily on current and predicted weather. Some of the considerations are:

a. Burn only when the atmospheric temperature structure and the winds aloft permit the smoke column to rise to a layer that will not come in contact with the surface.

b. Do not burn when plume trajectory will be directly into an area where smoke will be an aggravation.

c. Do not burn into an airmass that is already heavily loaded.

d. Do not burn into a stagnant airmass where the concentration may build up.

e. Burn during the peak of the day when the most complete combustion will occur and the least smoke will be produced.

Prescribed fire smoke does affect visibility. This may well be its most important influence on air quality. Thus, favorable weather conditions are very important.

A. Prescribed burning--its effect as an air pollutant. 8,14,16,19,26,27,32

The principal products of forest fuel combustion are carbon dioxide, water vapor, hydrocarbons, carbon monoxide, and particulate matter.

Carbon Dioxide

Carbon dioxide is not considered a pollutant, and it is not included in the National Emission Inventory. It is significant to note that there are currently no programs to control the amount of CO_2 released into the air, nor are there plans for such programs.

Water Vapor

Water vapor is certainly visible in forest fuel combustion, but it is not harmful.

Hydrocarbons

Hydrocarbons are another combustion product emitted in significant amounts from burning forest fuels. It is interesting to note, however, that these products are generally quite different from the hydrocarbons released by internal combustion engines.

Hydrocarbons are extremely widespread in the plant world in volatile oils, waxes, and resins. Their close relations, hydrocarbons partially oxidized, are familiar to us in thousands of plant odors. A few of these are: turpentine, pine oil, peppermint oil, citronella oils, oils of lemon and orange, and a host of others. So it comes as a surprise to a chemist that "hydrocarbons" are reported in various tables of publications on emission factors and inventories as all lumped together and carrying the implied label of being generally harmful.

There are thousands of hydrocarbon compounds produced when wood fuels burn, but only a few of these are considered to be contributors to the problem of photochemical smog. In comparison, when burned, dry brush produces 4.7 pounds of hydrocarbons per ton of fuel to approximately 130 pounds of hydrocarbons in one ton of gasoline.

It is expected that the hotter fires yield fewer total hydrocarbons than the cooler ones. Composition samples of hydrocarbons collected from active fires indicate that very small quantities of a number of potentially photochemically reactive hydrocarbons are present. Whether hotter fires produce more of the unsaturated hydrocarbons, even though totally a smaller amount is produced, is not known.

Carbon Monoxide

Carbon monoxide is a serious air pollutant and is highly toxic. The estimated annual production from natural and man-made sources is 200 million tons of the gas. Yet the background levels of C.O. in the atmosphere remain fairly constant at 0.05 to 0.02 parts per million. The C.O. concentrations found close to burning forest fuels also diminished very rapidly to the low levels normally found in the rural areas as they are mixed with the outside air. In one fire, samples taken showed C.O. concentrations as high as 8000 p.p.m.; but at 5000 feet in the smoke plume, the gas was diluted to ambient conditions. On a hot slash fire, samples were taken at ground level. The C.O. levels 30 feet from the edge of the fire were 40 p.p.m., while the concentrations at 150 feet decreased to 10 p.p.m. As a basis of comparison, industrial health standards allow human exposure to average levels of 50 p.p.m. over an 8-hour day.

A ton of forest fuel produces about 50 pounds of C.O.; in contrast, 900 pounds of C.O. are produced per ton of gasoline. Carbon monoxide plays no part in the formation of photochemical smog. It may, however, be important in photochemical reactions both as a product and a reactant.

The annual effluent from automobiles in the Minneapolis-Saint Paul metropolitan area releases about 700,000 tons of carbon monoxide and about 120,000 tons of hydrocarbons into the air. Prescribed burning contributes about three-fourths of one percent of that amount. In other words, the total effluent from all the prescribed burning done in one year in the Lake States is approximately equal to the effluent from the gasoline burned in a 3-day period in the Twin Cities.

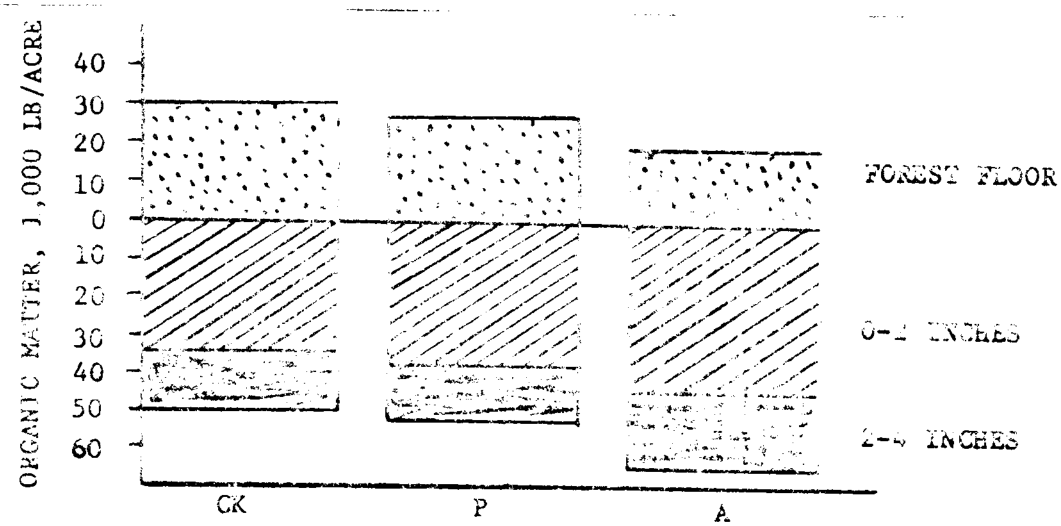
Particulate Matter

Particulate matter, or smoke, is one of the most important products of combustion. This material, either solid or liquid, and ranging in size from 0.001 to 10.0 microns, can be measured and estimates made of the amount produced per unit of fuel consumed. A simulation of open burning of one ton of woody fuel produces nine pounds of particulate. When particulates are present in large quantities, they can cause a drastic reduction in visibility and create locally hazardous conditions for movement of surface and air transportation. Particulates may be important from a health standpoint if they combine with other pollutants to form harmful chemical products. This synergistic effect--the condition whereby two or more chemical products combine to produce a compound that may be more toxic or damaging than any of the individual products--makes it extremely difficult to analyze products of combustion individually and conclude that they are, or are not, damaging to plants, animals, or humans. In comparison with other sources, prescribed burning, nationally, produces less than two percent of the particulate produced by all urban-industrial and rural-agricultural sources.

B. The effects from burning on soil chemical properties and nutrient availability.[3,6,19,38]

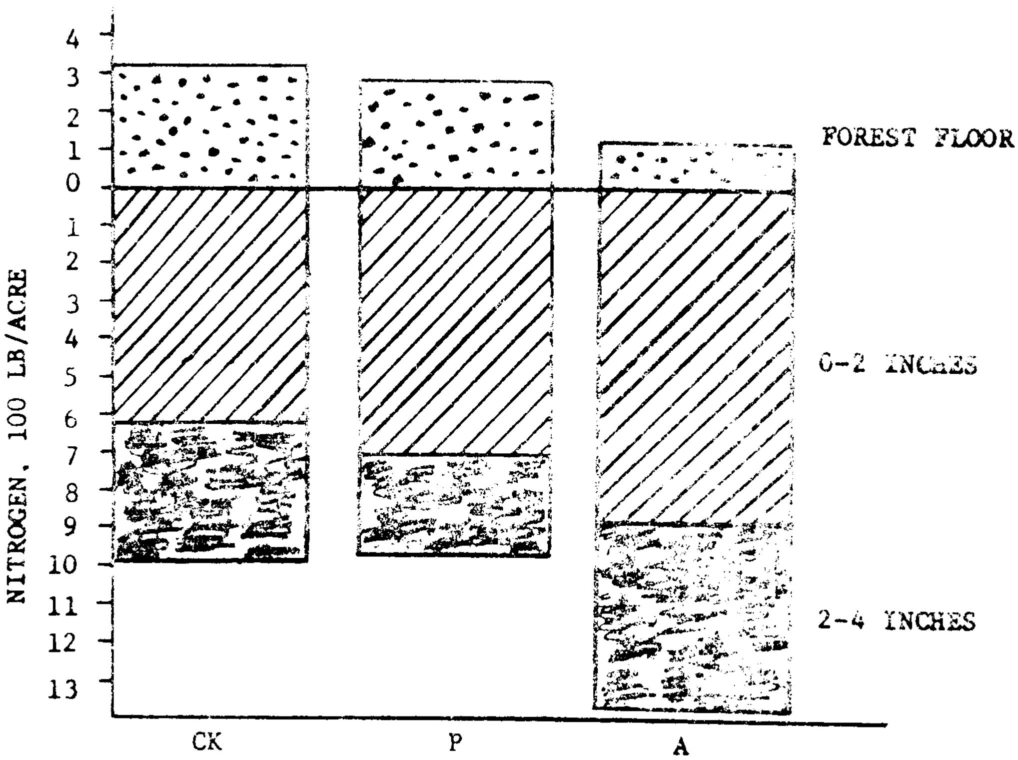
The influence of burning on soil organic matter and nitrogen are of particular importance because these two factors have a strong influence on soil fertility and productivity.

Discerning the effects of prescribed burning on soil chemical properties is complicated by the kind of soil, the climate, the vegetation, and the intensity of burn. Both burning and natural biological decomposition release mineral elements from organic matter to the soil. Burning is a much faster method. The most obvious effect of burning on the soil is the reduction of the forest floor (organic matter), mostly in weight loss. Prescribed burning does not remove all of the forest floor, and the first year or two after burning there is little visible change. Very little change takes place in the 2- to 4-inch depth. If burning were to continue periodically, there would be no great reduction in the organic matter. The organic matter would be redistributed, however, from the forest floor to the first 4 inches of mineral soil.



Organic matter in the forest floor, 0-2, and 2-4 inches of mineral soil for check (CK), periodic (P), and annual (A), treatments after 20 years.

In forest soils, nitrogen is highly correlated with organic matter. The nitrogen supply in the forest floor decreases in the same order as burn severity increases. As nitrogen decreases in the forest floor, however, it is accumulated at about the same rate in the 0 to 2-inch layer of mineral soil.



Nitrogen in the forest floor, 0-2, and 2-4 inches of mineral soil for check (CK), periodic (P), annual (A), treatments after 20 years.

Sampling before and after a periodic burn showed that the single burn caused a loss of 100 pounds of nitrogen per acre. Four of these burns in 20 years would have volatilized 400 pounds of nitrogen. More severe burning over the 20-year study period would have destroyed a larger portion of the forest floor and produced even greater nitrogen losses; yet when total nitrogen was summed up through the 4 inches of mineral soil, losses were not detectable.

There is no question that both organic matter and nitrogen are lost by volatilization during burning. Estimates are that as much as 20 pounds of nitrogen per acre and four to five thousand pounds of organic matter per acre are lost in a prescribed burn. So how can a gain be accounted for in organic matter and nitrogen in the mineral soil? It is rather difficult to understand how there can be little or no change in the organic matter and nitrogen when the forest floor and mineral soil are added together. Apparently the rapid oxidation by burning removes that part of the forest floor that is most rapidly oxidized by micro-organisms. This means that even without burning it, part of the organic matter will be fairly rapidly oxidized, but the part that is left after the burn does not oxidize, or does not decompose at a very rapid rate.

Smokes produced by burning pine litter, green needles, and fuels of lower nitrogen content were analyzed; 62 percent of the nitrogen source was released. No ammonia was detected in the gases. Most nitrogen in organic matter is volatilized as nitrogen gas, but little is known as to what form this nitrogen gas is in. It is possible that a considerable amount of soluble nitrogen returns to the earth from precipitation in the form of ammonia, nitrogen oxides, nitrates, and nitrate ions. In 1911, an unusually large amount of nitrogen returned to the soil in Ottawa, Canada, from rain abnormally enriched in ammonia (NH_3) from forest fires.

Burning the forest floor of low nitrogen soil releases more nitrogen for seedling uptake and affects plant growth more than would a burn in a more fertile soil.

Legumes, nitrogen-fixing plants, are found five times more numerously in burned areas than in unburned areas.

Phosphorus, potassium, calcium, and magnesium, like nitrogen, were not significantly changed by prescribed burning.

Weight of phosphorus, potassium, calcium and magnesium in the forest floor (F.F.), 0 to 2 and 2 to 4 inches of mineral soil.

PHOSPHORUS			
Layer	Annual	Periodic	Check
		lb.per acre	
F.F.	8.0	14.8	16.2
0 to 2	4.1	2.9	2.9
2 to 4	1.8	1.4	1.4
0 to 4	5.9	4.3	4.3

POTASSIUM			
Layer	Annual	Periodic	Check
		lb.per acre	
F.F.	13.1	23.7	24.7
0 to 2	18.9	15.5	15.6
2 to 4	11.3	8.4	8.9
0 to 4	30.2	23.9	24.5

CALCIUM			
Layer	Annual	Periodic	Check
F.F.	77	134	140
0 to 2	74	51	29
2 to 4	27	23	16
0 to 4	101	74	45

MAGNESIUM			
Layer	Annual	Periodic	Check
F.F.	13.9	24.3	27.5
0 to 2	16.8	11.1	9.5
2 to 4	10.0	6.6	6.6
0 to 4	26.8	17.7	16.1

Quantities are not comparable between forest floor and 4 inches of mineral soil because only extractable quantities were measured in the mineral soil and total analysis was made of the forest floor.

Prescribed burning more readily releases the stored-up organic matter, nitrogen, phosphorus, potassium, calcium, and magnesium to the plants and soil. The new growth on the burned area immediately begins to rebuild the forest floor which was burned away.

The soil, as a natural body, has been formed over thousands of years. Over 85 percent of our soils have been subjected to burning time and time again. The wide distribution of fire scars on old fire-resistant trees throughout the state bears this out. Soils tend to reach a state of equilibrium under conditions of frequent stress. This has been proven in areas where the land has been burned for years, as in the south, or farmed for years, as in the prairie states. Today, annual burning or yearly farming in the respective areas has done little to change the soil properties. Major changes in soil do not occur unless there is very drastic action taking place.

Burning raises the pH of soils, from the bases in the burned ash, at the 0-2 inch area below the mineral soil. This may have an influence on such things as the production of legumes or in nonsymbiotic fixation of nitrogen by micro-organisms.

C. <u>The effects of prescribed burning on physical properties</u>[3,5,6,15,28]

If the duff or forest floor was completely burned off, the mineral soil should have:

a. An increase in raindrop impact.

b. An increase in soil splattering and plugging of soil macropores, reducing infiltration.

c. An increase in soil temperature.

Otherwise, mineral soils are not greatly affected by the heat generated.

Soil samples were heated in a furnace to check for major temperature-dependent stages of ignition:

a. 200°-400° F --nondestructive distillation of volatile organic compounds.

b. 400°-600° F --destructive distillation of up to 85 percent of organic substances.

c. Greater than 600° F --ignition of carbonaceous residues.

If these results are compared with most prescribed burns, it is most unlikely that temperatures, even in hot spots, would exceed 400°F two inches below the surface. Thus, light cool burns cause no detectable change in total amount of organic matter in surface soils.

The main impact of fire on the physical environment is the extent to which it removes surface cover and thus alters the partitioning of incident precipitation into surface run-off and infiltrating components, thereby increasing the potential of soil loss by erosion.

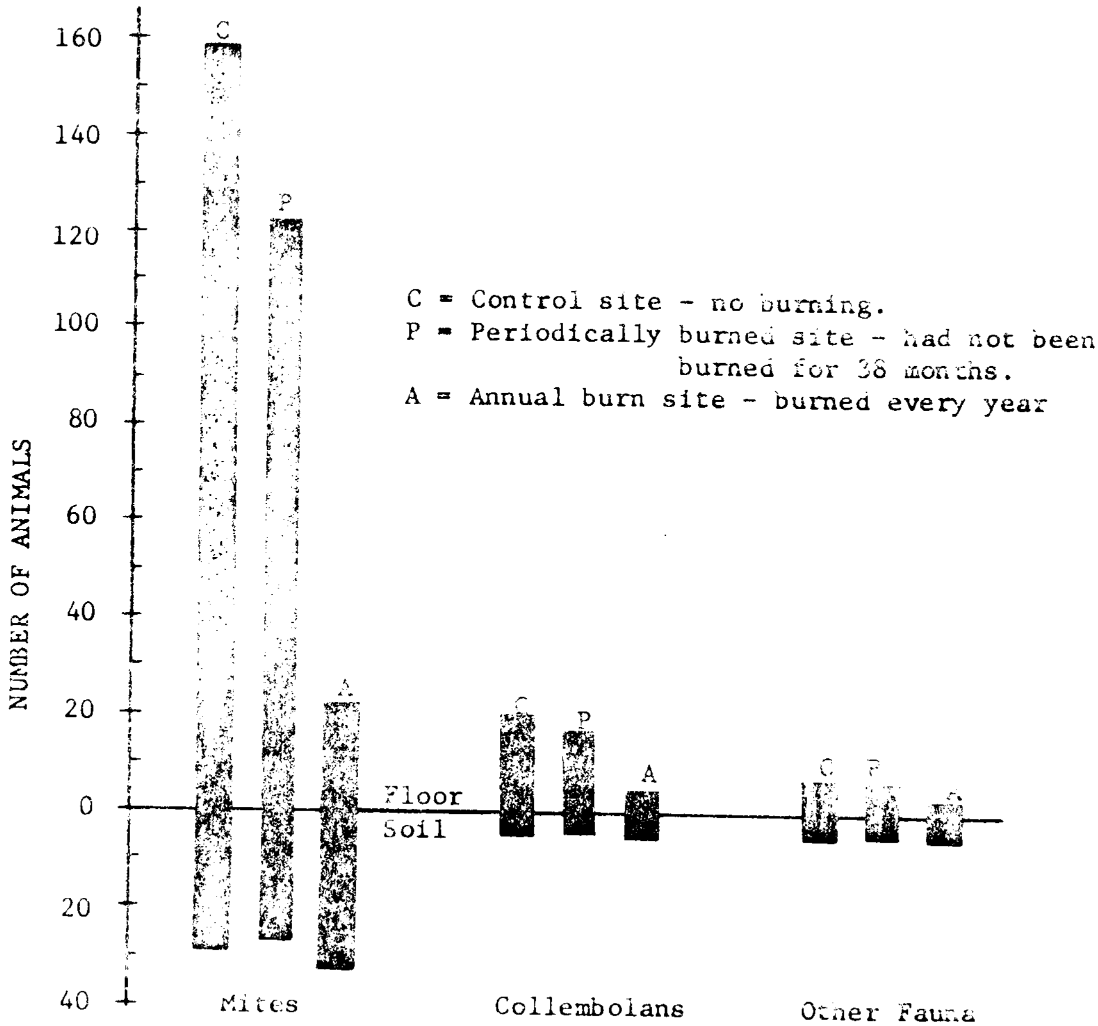
Studies show that (1) forest litter greatly reduced run-off; (2) destruction of litter and exposure of bare soil greatly increased soil erosion and reduced the water absorption rate; (3) sealing of pores by particules suspended in run-off accounted for marked differences in infiltration between bare and litter-covered soils; and (4) water absorption capacity of litter is insignificant in comparison with its role in protecting maximum percolating capacity of soils.

It is reasonable to suppose that reduction in erosion rates after burning depends on how quickly surface cover is re-established. Studies show complete stabilization from regrowth occurs by the end of the first full growing season. The total ground cover must equal or exceed 60 percent density for minimum tolerable control of run-off and erosion.

There is a tendency to over-emphasize the unfavorable effects of fire on mineral soil by stressing extreme situations in frequency and intensity of burning. There should be no minimizing of the destructive and undesirable results of wildfires, but it must be recognized that many fires have little total soil effect one way or another, and some are beneficial. This fact permits a fairly wide range of choice in using fire in particular situations as a tool in forest management without risking significant soil damage.

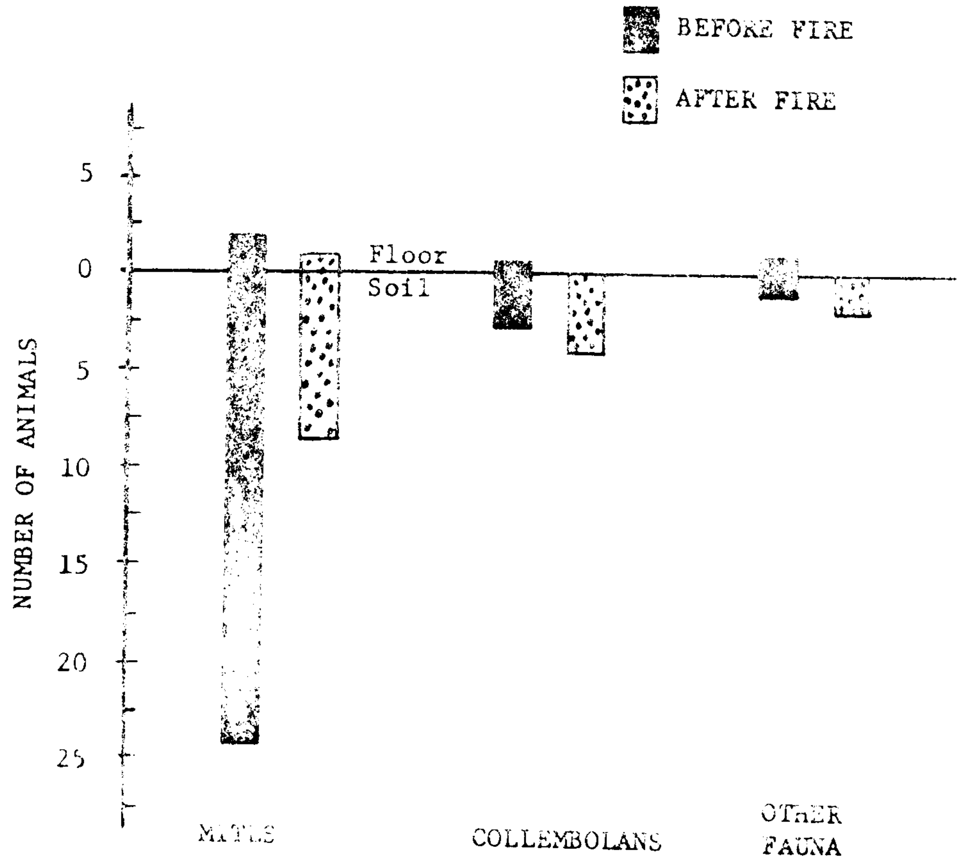
D. The effects of prescribed burning on the soil mesofauna[23]

Mesofauna are those animals who live in the forest floor and in the soil or both, and are larger than the very small microfauna and smaller than the macrofauna. The mesofaunal group consists of mites, collembolans, and small insects. Mesofauna play a big part in the decomposition process by breaking organic tissue into smaller and smaller pieces. The smaller these particules become, the more susceptible they are to action by other organisms involved in the decomposition. Most mesofauna live in the forest floor and in the mineral soil to a depth of 3 cm. Sampling was restricted to these depths.



Average number of animals extracted per 20-sq.-cm. sample on the three treatments for the 10 sampling days between February and November, 1970.

Recovery time for periodic burns is 43 months or less to reach pre-burn conditions.



Average number of animals extracted per 20 sq.-cm. sample immediately before and 24 hours after an annual burn.

E. <u>The effects of prescribed burning on the microbial characteristics of soil.</u>[5,6,21]

The soil microflora (fungi and bacteria) are responsible for the decomposition of nutrient-containing organic residues and the resulting re-use or recycling of many nutrients during a rotation.

Number of fungi and bacteria + actinomycetes in soil, by burn treatment and soil layer.

Soil Layer	Burn Treatment	Fungi per g.	Fungi per cm.	Bacteria + Actinomycetes per g.	Bacteria + Actinomycetes per cm.
		- - - - -	millions	- - - - -	- - - - -
F.F.	No burn	1.51	0.64	51.1	21.53
	Periodic burn	3.28	1.16	70.8	25.19
	Annual burn	1.18	0.16	28.2	3.88
0-5 cm.	No burn	0.12		4.1	
	Periodic burn	0.14		3.0	
	Annual burn	0.13		6.5	
13-18 cm.	No burn	0.03		1.3	
	Periodic burn	0.02		1.1	
	Annual burn	0.02		1.1	

In millions per gram

No burn - area not burned for 20 years
Periodic burn - area not burned for 8 years
Annual burn - area burned every year.

The greatest effects of burning are in the upper portion of the soil and only when the soil is severely burned is there any influence of fire below 1.5 inches. Where light burns were applied, however, there were no changes in bacteria or actinomycete populations, but severe burns resulted in an increase in the number of these organisms. Apparently a number of common soil organisms are stimulated by fire and rise to a very high level after the first rainfall following burning. There is a possibility that other organisms are reduced by fire. The testing of individual organisms has not been attempted yet.

Interesting research work has come out of Australia recently on the influence of "hot" fires on the soil microflora and on soil nutrients. Nutrients released from a slash fire were measured, similar amounts of nutrients were applied to an unburned soil, and a growth response was measured. There was much greater response on the burned plots than could be attributed to simply the increased availability of nutrients. As a consequence, a detailed study of the response of the soil microflora to the burns was made. This resulted in the conclusion that influence of the fire on stimulated growth of reproduction was attributed to changes in the composition of microflora as much as, or more so, than to the release of the nutrients.

F. The conservative nature of soils.[3,6,30,38]

Many forested soils lose fertility rapidly when first cleared and cultivated. The fertilizer responses in forests are visible within months. The run-off and erosion from cultivated lands are enormously sensitive to changes in soil treatment and cover.

Barring active erosion, developed soils tend to behave as rather conservative bodies. The impact of a new treatment or environmental feature typically shows as a more or less rapid change followed by stabilization around a new "steady state" rather than as a continuous drift. The best documented instance of this is the change in organic matter and nitrogen in soils used for agriculture. Therefore, periodic burning of Michigan lands, as a management practice, will not have a detrimental effect on the soil.

For example, the virgin prairie soils lost organic matter rapidly when placed under continuous cultivation. However, after 60 years, a new level was reached, with the content of surface organic matter stabilizing at about 50 to 60 percent of the original value.

Stability of total nitrogen in old, arable soils under 60 to 80 years of continuous cultivation:

Type of Cultivation	Date	Nitrogen in Surface-9 Inches	Type of Cultivation	Date	Nitrogen in Topsoil - No Fertilization
		Percent			Percent
Continuous wheat	1865	0.105	4-year rotation with fallow	1867	0.127
	1944	.106		1953	.119
Continuous barley	1882	.098	With clover	1867	.130
	1946	.103		1953	.152

The lack of change indicates that these soils have reached an equilibrium of sorts with treatment and the environment.

EVALUATION OF ALTERNATIVES

The prescribed burn technique is unique in that it cannot be compared totally with any other forest or grassland treatment. Prescribed fire brings about physical and chemical changes in the [illegible] in a way which cannot be accomplished with any other method, be it mechanical, chemical, or a combination of both.

Fire is a natural phenomenon which removes forest litter, grasses and woody fuels in varying degrees, depending upon the intensity. It will open serotinous pine cones, neutralize and fertilize soils, accelerate the decomposition of larger fuels and kill unwanted plant species with very little effect on the soil if applied properly.

Of the estimated 100,000 state-owned acres needing forest and wildlife management treatment annually, prescribed fire could be applied to from ten to twelve thousand acres. The average cost per acre will range from $2 to $[illegible]. The size of the area treated, area location, type of tree species and the amount of ground fuel, type of soil, time of year, weather conditions and objective requested for burning all affect the cost per acre.

Prescribed fire may be used in conjunction with other treatments to more effectively treat an area.

The ALTERNATIVES are: (A) Do nothing at all, (B) Mechanical treatment and (C) Chemical treatment.

A. Do Nothing

Of the 4 million acres of state-owned land, over 100,000 acres are set aside as "do nothing" lands, and more is predicted for the future. These "do nothing" lands are a necessary part of the total land management program but all state lands could not be managed [illegible].