United States Department of Agriculture
Forest Service
Apache-Sitgreaves NFs
P.O. Box 640
Springerville, AZ 85938
520 333-4301

A/S

File Code: 2520-3/6520

Date: August 28, 1997

Subject: Cottonwood Fire Final BAER Report

To: Regional Forester, R-3

Enclosed please find the final BAER report for the Cottonwood Fire on Lakeside District, as requested. Actual unit costs of all watershed treatments are reflected as accurately as possible for future reference. A brief appendix has been added to clarify deviations from original treatment plans, and a number of captioned photographs of the burn area and treatments were added to show the results.

All BAER funds have been accounted for at this time, and additional funds spent on the area were tracked as accurately as possible.

JOHN C. BEDELL
Forest Supervisor

Enclosures

cc:
Lakeside RD
T. Subirge

USDA-FOREST SERVICE

Date of Report: August 25, 1997

BURNED-AREA REPORT
(Reference FSH 2509.13, Report FS-2500-8)

PART I - TYPE OF REQUEST

A. Type of Report

[ ] 1. Funding request for estimated WFSU-FW22 funds
[x] 2. Accomplishment Report, Final
[ ] 3. No Treatment Recommendation

B. Type of Action

[ ] 1. Initial Request (Best estimate of funds needed to complete eligible rehabilitation measures)

[ ] 2. Interim Report
[ ] Updating the initial funding request based on more accurate site data and design analysis
[ ] Status of accomplishments to-date

[x] 3. Final report - following completion of work

PART II - BURNED-AREA DESCRIPTION

A. Fire Name: Cottonwood Fire

B. Fire Number: Az-ASF-120

C. State: Arizona

D. County: Navajo

E. Region: 03 Southwestern

F. Forest: Apache-Sitgreaves N.F.

G. District: Lakeside

H. Date Fire Started: 6/23/96

I. Date Fire Controlled: July 3, 1996

J. Suppression Cost: $ 750,000.00

K. Fire Suppression Damages Repaired with WFSU-PF12 Funds:
1. Fireline waterbarred (miles) 10.0
2. Fireline seeded (miles) 10.0
3. Other (identify) Repair of rutted roads,

L. Watershed Number: 15020005105

M. NFS Acres Burned: 1440 Total Acres Burned: 1440 or 1,484?
Ownership type:
(---) State (---) BLM (---) PVT (---) ________

N. Vegetation Types: Pipo/Quga and Pipo/Jude2/Quga (source TES map)
Pipo 82%, Oak Woodland 13%, Pinyon-Juniper 5% (Veg Map)

O. Dominant Soils: Typic Eutroboralfs, fine, mixed 70%
Typic Eutroboralfs, clayey-skeletal, mixed 30%

P. Geologic Types: Surface geology and soil parent materials derived from Rim Gravels.

Q. Miles of Stream Channels by Order or Class:
Order: 1st = 3.0 miles --- --- ---

R. Transportation System:
Trails: 1.5 (miles) Roads: 10 (miles)

PART III - WATERSHED CONDITION

A. Fire Intensity (Acres): 110 (low) 455 (moderate) 874 (high)
7.7% 31.6% 60.7%

B. Water Repellant Soil (Acres): 438

C. Soil Erosion Hazard Rating (Acres):
925 (low) 360 (moderate) 155 (high)

D. Erosion Potential: 5.0 tons/acre (7,217 tons/1440 acre burn)

E. Sediment Potential: 640 cu. yds/sq. mile (@20% delivery ratio)

PART IV - HYDROLOGIC DESIGN FACTORS

A. Estimated Vegetative Recovery Period: 3 years.

B. Design Chance of Success: 80 percent.

C. Equivalent Design Recurrence Interval: 10 years.

D. Design Storm Duration: 1.0 hours. (NRCS recomended duration for watersheds of less than 10 square miles.)

E. Design Storm Magnitude: 1.6 inches. (1.9 inches for 25 year recurrence)

F. Design Flow: 22 $cfsm^2$. (Design flow for 25 year event is 66 $cfs/mile^2$.)

G. Estimated Reduction in Infiltration: 15 percent.

H. Adjusted Design Flow: 81 $cfsm^2$. (Design flow for 25 year event is 154 $cfs/mile^2$.)

PART V - SUMMARY OF ANALYSIS

The 1484 acre Cottonwood Fire apparently started on Friday June 21, 1996 by ~~lightning~~ strike. Lookouts first observed smoke at 1:00 pm on Sunday, and crews and air tankers were immediately dispatched to the scene. The fire quickly grew as winds in excess of 40 mph drove it towards Pinedale, and the situation called for evacuation of the town. Spot fires started 1/4 to 1/2 mile ahead of the flame front which had flame lengths of over 100 feet. Approximately 263 people were evacuated Sunday afternoon to Show Low High School and various other locations by the sheriffs department. Approximately 300 people were assigned to the fire, along with 13 structural fire engines. Rain recieved on Wednesday helped containment. No lives structures or property was lost in the fire. Control was estimated on July 12, 1996.

A. Describe Emergency: The results of a wildland fire basically affect two important resources; soil and water. Due to the burn intensity of nearly 900 severely burned acres, this area has lost all live vegetative overstory as well as all of its litter ground cover. This situation results in increased soil erosion due to loss of cover, and reduced water infiltration rates. Soil loss also results in loss of long-term soil fertility which affects site productivity. Infiltration rate is reduced in intense fires due to the formation of a water repellent surface from distillation of waxes and resins during combustion, which dramatically increases surface tension. Over time, this effect is lost, but it initially has significant impact. Reduced infiltration then also adds to soil erosion through sheet wash and gully erosion processes. Runoff from the burned area of the watershed also normally increases as a result of these effects. The amount of this increase is related and proportional to acres burned versus total acres in the watershed. In this case, approximately 38.4% of the Left Hand Draw watershed burned, and the expected increase in flow passes through the residential area of Pinedale. This has potential of tripling flows with an average storm durtion of only one hour with a 10 year recurrence interval. Any mitigations which can increase hydraulic roughness in the watershed and reduce peak flows will help reduce these effects. Possible mitigations are discussed below.

B. Emergency Treatment Objectives: The treatment objectives are to prevent on-site soil loss, minimize surface runoff, and protect the long-term productivity of severely burned areas. The main objectives of treatment are to reduce effects of eventual increased runoff by restoring groundcover. The area is being seeded with annuals and native grasses, and some structural work is being proposed to catch sediment in drainages before reaching culverts. Watershed treatments proposed include contour felling the small pole sized timber to add hydraulic roughness and slow surface runoff, along with straw bale structures in small side drainages to reduce sediment movement. Fencing or removing entire pasture from use is proposed to protect regrowth and establishment from livestock.

C. Probability of Completing Treatment Prior to First Major Damage Producing Storm:

Land 75 % Channel 90 % Roads 90 % Other ____ %

D. Probability of Treatment Success

	<----Years after treatment-----> 1	3	5
Land	75	85	85
Channel	90	90	90
Roads	90	95	95
Other: Stream Structures	80	90	90

E. Cost of No-Action (Including Loss): $ 228,100

F. Cost of Selected Alternative (Including Loss): $ 149,742

G. Skills Represented on Burned-Area Survey Team:

[X] Hydrology [X] Soils [X] Geology [X] Range
[ ] Timber [X] Wildlife [ ] Fire Mgmt. [X] Engineering
[ ] Contracting [X] Ecology [ ] Research [ ] Archaeology
[ ] ________ [ ] ________ [ ] ________ [ ] ________

Team Leader: Tom Subirge
Phone: 520-333-4301 DG Address: T.Subirge:R03F01A

H. Treatment Narrative:
Describe the emergency treatments, where and how they will be applied, and what they are intended to do. This information helps to determine qualifying treatments for the appropriate funding authorities. For seeding treatments, include species, application rates and species selection rationale.

#1 (+2&3)

Land Treatments:

1. Seeding: Targeted ares for seeding are those in severely burned areas and over 15% slope. Seeding will be accomplished using a seed mix containing four grasses and a legume for nitrogen fixation. The species are common to the area, and suggested application rates are defined in terms of seeds per square foot. Seeding will be accomplished via helicopter broadcasting over severely burned areas, and either hand operated Cyclone seeders or 4-wheeler mounted seeders for special areas needing extra heavy applications. Examples of heavy application areas are fire lines made with dozers or hand lines constructed in steep terrain. Seed will be applied after these areas have been drained and water barred. The fire line seeding is being accomplished as a part of suppression rehab.

fire rehab.!

Species mix and application rate as follows:

Species	Broadcasting Rate	
Sideoats grama	1.6	lbs/acre
Pubescent wheatgrass	3.4	lbs/acre
Annual ryegrass	2.0	lbs/acre
Prarie Junegrass	0.1	lbs/acre
Yellow sweetclover	1.0	lbs/acre
Total application:	8.1	lbs/acre
Seeds per square foot	42	

Replacement Seed: During the course of fire control shifting to rehabilitation, the District used their own seed stocks and that from the neighboring Heber District to initiate seeding work as long as crews were on hand. Expedience was critical as rain was expected. The work covered not only roads and firelines covered through fire suppression funds, but also progressed onto some of the severely burned acres. Seed used for the latter will need to be replaced to the District through rehabilitation funds.

#2 **2. Terracettes:** Small logs of 4 to 10 inch diameter will be used in critical areas of steep slope in the severeley burned areas Left Hand Draw only, to further impede surface runoff above Pinedale. These logs will be contour felled, limbed, topped, and then sealed to the ground with soil to create small dams or terraces which collect sediment. These structures are offset below each other to catch overflows from one end of the log to the center of the next lower one. After construction, these areas should be re-seeded. These structures are effective in reducing runoff on steep slopes up to 40%.

#3 **3. Contour Felling:** This method of watershed treatment involves felling remaining burned trees on the contour to slow overland flows, reduce sheet wash erosion, and promote infiltration. Although not quite as effective as the log terracettes above, treating whole watersheds by this method is less costly and will increase in effectiveness with time as the logs decay and contact the ground more. The decaying wood also adds organic matter lost in the fire, as well as retaining sediment similar to the terracettes above. Contour felling will be done near drainages and above culverts and in select areas on steep slopes. Further direction on leaving clumps of dead trees and larger snags is outlined below, emphasizing wildlife values.

During the implementation of emergency rehabilitation actions on the Cottonwood Fire area, consideration should be given to various management guidelines concerning Northern Goshawks. The entire burn area is included in goshawk management territories. Until it is determined whether or not the delineation of these territories should be modified because of the fire, management activities associated with the rehabilitation should follow FSM 2676.3 which encorporates the Goshawk Scientific Committee (GSC) recommendations found in the document "Management Recommendations for the Northern Goshawk in the Southwestern United States". Rehabilitation actions involving the cutting of dead or living trees need to consider the GSC recommendations:

1. Retain at least 2 large (≥18 inch DBH, ≥30 feet tall) snags per acre throughout the burn area.
2. Retain at least 3 large (≥12 inch diameter mid-point, ≥8 feet long) downed logs per acre throughout the burn area.

The intent of providing snags and downed logs is to meet the habitat requirements of various goshawk prey species (eg. cavity nesting birds, small mammals).

During directional felling of trees proposed as an emergency rehabilitation action, large trees (≥12 inch DBH, ≥30 feet tall) should be not be cut except where required for the construction of in-channel, sediment-entrapment structures.

Cavity nesting birds, however, often forage on insects inhabiting smaller diameter trees (eg. 6 to 12 inch DBH trees). Much of the tree mortality in the Cottonwood Burn area consists of dead trees in this smaller diameter class. During directional falling of trees to reduce erosion, it is recommended that clumps of these smaller diameter, burned trees be retained. The clumps may be staggered across the slope, or left in a band that follows the contour of the slope. Although no optimal clump size is known, the following recommendation may enhance areas for insectivorous birds: 0.1 acre clumps roughly configued as 40 feet by 100 feet and staggered across slopes at a rate of about 1 clump per acre. Likewise, no optimal configuration of uncut trees is known, but the following recommendation may provide suitable foraging substrate for some goshawk prey species: leave uncut bands of small diameter trees about 20 feet wide and separated from each other by a band of directionally felled trees 150 to 200 feet wide. The clump arrangement is preferred because of the greater depth and more natural appearance.

The Forest Plan (page 122) also directs the retention of all Gambel oak snags >10 inches DBH and 10 feet tall. During felling activities, snags meeting these dimensions should not be cut.

4. Trashrack: Four trashracks made of large stout logs will be installed into the Left Hand drainage, near the downstream end of the burned area to catch #2 large debris floating down the creek during high flows. Each will consist of a large diameter tree straddling the drainage, with 6 to 8 logs leaning against it from the upstream end. In essence, it will resemble a "cowcatcher" as found in front of locomotives. All logs will be notched and firmly tied together with rebar stakes and wire.

5. In-Stream Directional Felling: This treatment will only be used in the upper ends of watershed where flows are minimal and large logs are not likely to float up and become mobile. The idea is to drop whole trees of larger size into the drainages with tops pointing upstream. This becomes a barrier that catches smaller organic debris such as pine needles, which in return filter out and accumulate sediment. Many such debris dams were noted to have burned out, which will release substantial sediment downstream. Returning some large debris to smaller side drainages will help retain sediment already in the drainages. This treatment will be done to all small drainages branching off of Left Hand Canyon, and others as needed determined on site.

6. Straw Bale Check Dams: Similar to the whole tree treatment above, straw bale check dams are designed to filter sediment in small side drainages and in upper watersheds where flows are relatively small, and the bales will not be torn out. This treatment is proposed in all small side drainages over the Left Hand Draw watershed, as well as above culverts and road crossings, to reduce soil movement and help keep culverts from plugging. In upper watersheds, depending on site conditions, two or three of these structures will be installed in the same drainage. These structures, in conjunction with other types of treatments, will help retain sediment on the watershed.

7. Drainage of Roads: This treatment is recommended by the engineering staff to maintain and provide extra drainage of the road network within the burn. Work will include some straw bale work, as well as road grader work installing water lead out ditches. A total of three days work is estimated for the C & M crew. The road grading work is being accomplished as part of the suppression rehab.

See attached Burned Area Rehabilitation Plan; Transportation Report (with map) provided by Mike Wilson, Forest Engineer.

#2

8. Hogwire Stream Structures: These structures are also designed to function as trash racks, but tend to collect more fines such as pine needles, etc. which then in return filter out fine sands and silts. The structures are made of hogwire and steel t-posts, and run straight across the stream bottom no higher than approximately 3 feet. These structures are effective in collecting sediment, and are relatively cheap. They are planned to be installed in Left Hand Draw.

#16

9. Electric Fencing: SEE APPENDIX. A total of 5 miles of fencing is planned to be installed around the burned area, to help keep livestock out of newly emerging growth and allow beter establishment of plants. This will be installed to tie in with existing fencing, to reduce the amount of fencing needed. The exclosure will be kept in place a minimum of two years, depending on establishment of seed. After this time, the fence will be removed.

10. Fertilizer: A light application of a nitrogen/phosphorus fertilizer would be beneficial to establishment of ground cover. Most of the soils this fire occurred on are inherently very poor in nutrients. Although ash tends to release some nutrients, the burn intensity of this fire likely volatilized most nitrogen needed by young growth, and a supplement would likely help. Targeted application areas are the upper slopes of severely burned areas. Application to upper slopes only also minimizes the chance of fetilizer leaching into runoff in the main drainage.

PART VI - EMERGENCY REHABILITATION TREATMENTS AND SOURCE OF FUNDS BY LAND OWNERSHIP

NOTE: Emergency rehabilitation is work done promptly following a wildfire and is not to solve watershed problems that existed prior to the wildfire.

Line Items	Units	Unit Cost $	NFS Lands: Number of Units	NFS Lands: WFSU-FW22 $	NFS Lands: Other$ Wtrshd & Soil Imprvt	Other Lands: Number of Units	Other Lands: Fed $ ident.	All Total $
A. LAND TREATMENTS								114
Contour Felling	acres	150	50	7500				7500
Seeding	acres	22	700	15400				15400
Seed, replacement	acres	22	400	8800				8800
Terracettes	acres	300	65	19500				19500
Fencing: livestock & elk	miles	2077	5	10385	59478	<NFFV		69863
Fertilizer	acres	6	200	800				800
BAER Team implementation					2700	<SI		2700
				[illegible]	[illegible]			128563
B. CHANNEL TREATMENTS								
Straw Bale Check Dams	each	175	50	8750				8750
In-Strm Directnl Felling	acres	35	20	700				700
Hogwire Stream Structs.	each	105	14	1465				1465
BAER Team implementation					2500	<SI		2500
				10915	2500			13415
C. ROADS AND TRAILS								
Straw Bale Check Dams	each	175	15	2625				2625
Trash Racks	each	400	3	1600				1600
BAER Team implementation				1000				1000
								5225
E. BAER Team		* for District use						
Evaluation & Administration				* 4550	2500	<P30000		7050
Implementation				* 2000	2024	<WFPR		4024
				6550	4524			[illegible]
F. TOTALS								
Initial Request				62,400				
Interim Add-On				22,675				
Total				85,075	69202			154,277

^ Total additional funds, sources designated above.

APPENDIX: additional information regarding various treatments.

Terracettes: In addition to the initial installation, these structures needed minor maintenance to keep logs sealed to soil surface. Some developed small leaks which reduced their overall effectiveness and sediment storage capacity. These were repaired as needed at no addtional cost.

Trashracks: Four trashracks were planned to control large debris floating down the major drainages. Three were built in stategic locations and considered sucessful. The last one was not built to allow time to pass which may reveal an additional critical location after fire killed trees rot out and start to topple into stream courses, causing debris jams. This additional structure may not be built for years, or at all if no need arrises. Alotted cost was $400, which was absorbed in the total rehab effort, and if built will be absorbed by project funds.

Straw Bale Check Dams: Although these structures were relatively easy to install, they needed immediate maintenance which was unforseen. The straw consisted of wheat straw with some wheat, which attracted ungulates. Elk and livestock both did considerable damage, tearing apart the bales before they filled with silt and mud which made them unappealing. Several additional treatments were added to deter animals including spraying with dish detergent, and wrapping the bales with chicken wire. The latter method worked, but significantly added labor. The additional treatments were absorbed in the total rehab effort to keep the treatments effective.

Fencing: Early on, this treatment was opted by the District and intended to keep livestock off newly emergent growth and allow good plant establishment before significant grazing pressure occurred. The District had some once-used electric fencing materials available, which was planned to be used for this purpose, and to keep costs down. An estimated cost of 1000/mile was for labor only. It turned out the salvaged materials were not readily usable; parts were missing and wire in a tangle. New materials therefore needed to be purchased. The District also tried contracting the 5 miles of fencing; the lowest bid came in at 27,000 for materials and labor. The contract was not let. By 2/1997 a cattle guard has been installed, and the fencing materials were ordered and planned for an early spring installation. Actual total installation cost of the 5 miles of 4-wire fencing was approximately 10,000. The cost of fence maintenance and removal will be absorbed through project funds as needed.

Later, it was suggested to use part of the 4-wire fence length as a common boundary with a large electric elk and livestock exclosure. The exact dimensions of this elk fence exclosure have not been plotted yet, but it is estimated to be approximately 600 acres in size, and is entirely within the burn area. The purpose of the exclosure is to be able to compare recovery with and without large ungulate herbivory, and to protect tree plantings the District had installed. Lakeside District has also installed photo monitoring points to compare recovery over time. This exclosure is planned to be a long-term installation.

Captions for Illustrations

Figure 1: An oblique aerial photo taken from a helicopter during initial reconaisance of burn intensity. Outlined are examples of how the three burn intensities appeared immediately after the fire. Low intensity consisted of ground fire only, and crowns were not affected. Moderate intensity burns resulted in a yellowish green foliage, which indicates lethal temperatures have been reached, but ground cover can be expected in a few weeks from needlecast. High intensity left white ash on the ground and the entire tree crown is consumed, leaving nothing for immediate ground cover.

Figure 2: High intensity fire with complete consumption of crowns and ground fuels. This scenario results in very rapid erosion rates due to total lack of ground cover.

Figure 3: Extremely intense heat generated in high intensity burns radiates sufficient heat to the ground to cause spalling of exposed rocks. Surface temperatures of rocks rises so rapidly that expansion causes high internal stresses resulting in explosive fracturing. This example spalled twice during the burn and shows that the heat source came from the same direction. Note also that the relatively cool rocks condensed soot out of hot passing smoke, turning them black.

Figure 4: White ashes left by complete combustion of litter in high intensity burns may be several inches deep. These materials are of silt size and are therefore highly mobile in moving water. Complete mineralization of organics release some nutrients in water-soluble form, while most nutrients leave the site in the form of suspended sediment. Many small debris dams in drainages totally burn out leaving the drainage un-obstructed to transport sediment.

Figure 5: Example of moderate intensity burn, showing the typical yellowish green color of top-killed vegetation. Foliage is dead and will soon fall to the ground forming new ground cover.

Figure 6: Moderate intensity burn showing partial consumption of vegetation in an irregular pattern. Most shrub species will re-sprout, such as manzanita. Gambel oaks also top-kill and re-sprout from the base. Ponderosa pine which shows the yellowish color is normally killed.

Figure 7: Low intensity burns are limited to ground fires, and typically burn relatively cool. Crowns are unaffected, and no vegetation is killed.

Figure 8: The duff layer is only partially consumed in low intensity fires. This small clump of partially consumed pine needles was turned upside down and unburned fine fuels were still present. Note also that these fine fuels are only charred, and not mineralized into white ash.

Figure 9: The first rain occurred on the burned area very soon after control. This photo was taken during the first 5 minutes of rain, and water repelent soil is already apparent. The highly mobile white ash is easily transported off-site.

Figure 10: In order to counteract soil erosion, terracettes were built out of logs felled on the contour, and sealed against the ground. These structures are scattered over the entire hillside and help curb excessive runoff and ensuing erosion.

Figure 11: Terracette soon after installation catches fine soil materials, and retards runoff to allow more time for infiltration. Features of the installation include locating the limbed log on the contour, sealing any space below the log either with a small trench or light back filling, pulling the but end of the log above the stump intentionally left high, and if possible leaving branches on the downhill side to prevent rolling. Stakes can be added if necessary.

Figure 12: Terracettes often completely fill with sediment, also catching broadcast seed. The soil behind these structures is ideally suited for germination.

Figure 13: Straw bale check dams work well in low gradient drainages, where storage volume is greater and velocities are lower.

Figure 14: This example of a straw bale check dam with held a substantial flow. Note the size of the bedload which was trapped; cobbles and smaller.

Figure 15: Livestock can cause problems in burn areas, and should not be allowed entry until newly seeded and resprouting vegetation has had time for establishment.

Figure 16: Livestock, as well as wildlife, can have detrimental effects on straw bale erosion structures. In this case livestock tore apart a structure to gain access to straw containing wheat. Allowing livestock access is counter productive, and also expensive to deal with.

Figure 17: Hog wire can be used to catch sediment in moderately burned areas, as needle cast is first necessary to plug the mesh, which then catches soil fines.

Figure 18: Hogwire structures will only retain sediment until the litter plugging the mesh decays out. At that time, sediments will be released.

Figure 19: In larger drainages, trash racks can be installed to catch large debris such as logs floating down during peak flows. These structures are only designed to retain large floating debris, but as can be seen in this example, reduced velocity in the channel soon settles out smaller sediments as well.

Figure 20: Trash racks are designed for the future, after dead standing trees have had time to rot and topple into the drainage. For this reason, trash racks need to be built to last. This one utilized a large diameter tree felled across the drainage and is some 10 feet above the channel. Large poles are then spiked together to catch debris. These stuctures also prevent log jams downstream, which can plug culverts and wash them out with overflow.

Figure 21: Contour felling is another technique used to slow runoff. This is also a more long-term approach, as it is not immediately effective. Over time, the logs decay and relax, touching ground and sealing over the entire length. This then produces similar effects as terracettes. Note visible space between the logs and the ground. Felled logs are limbed to promote ground contact.

Cottonwood Fire

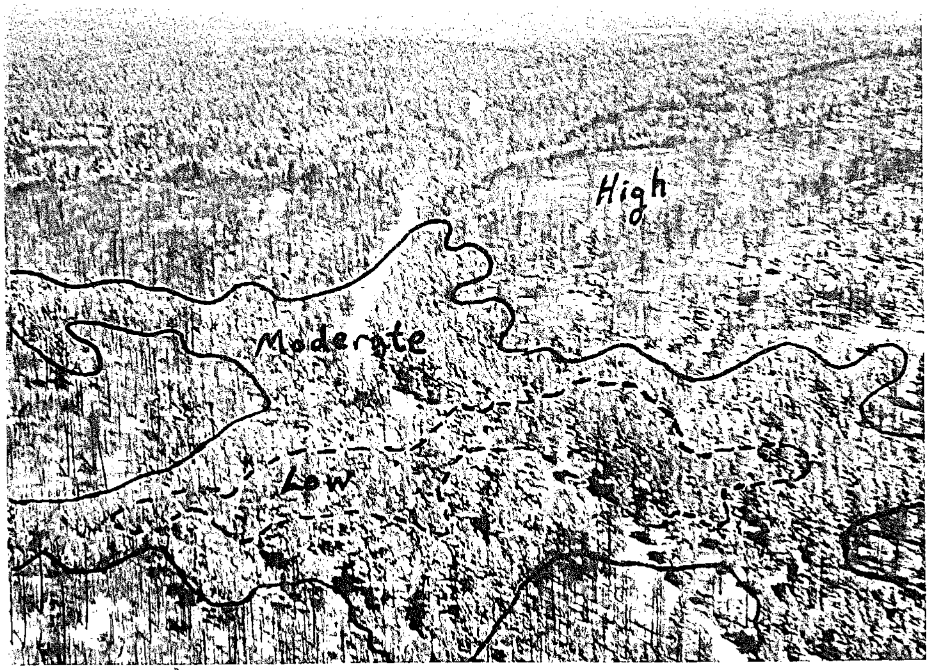

Figure 1

Figure 2

Cottonwood Fire

Figure 3

Figure 4

Cottonwood Fire

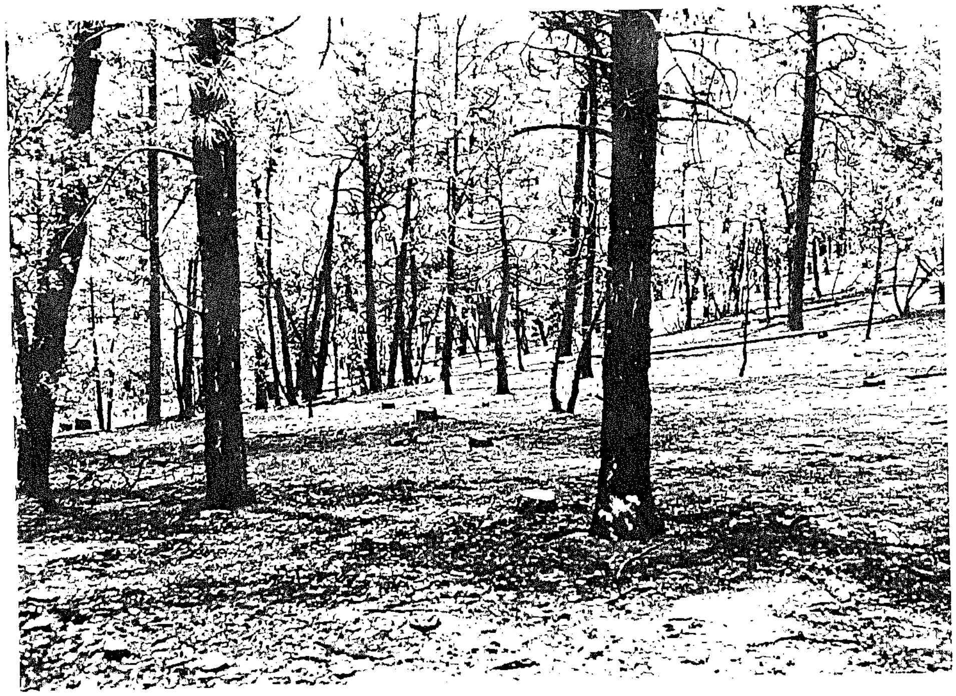

Figure 5

Figure 6

Cottonwood Fire

Figure 7

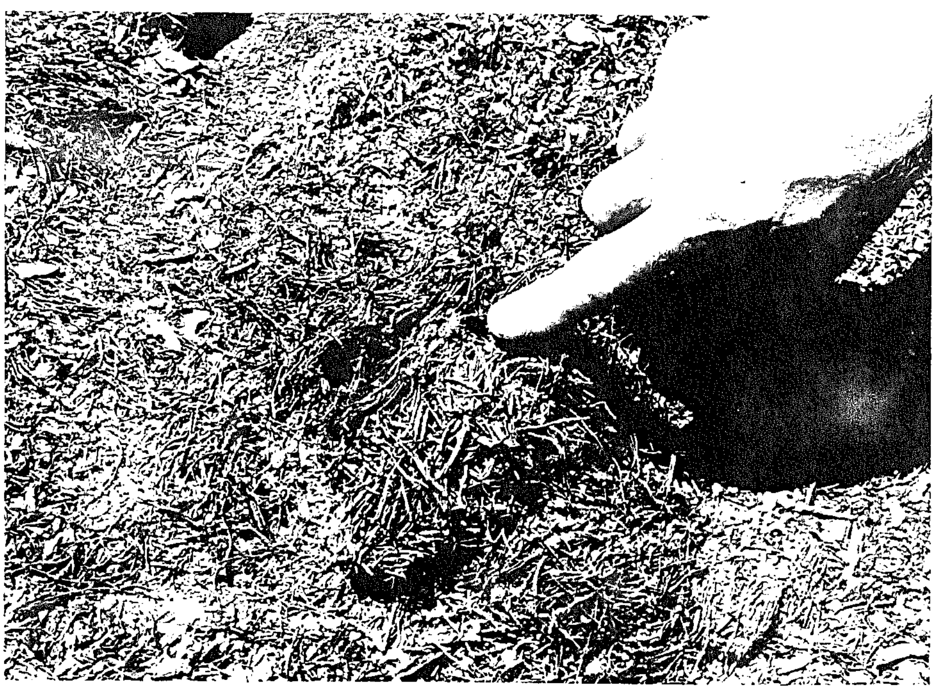

Figure 8

Cottonwood Fire

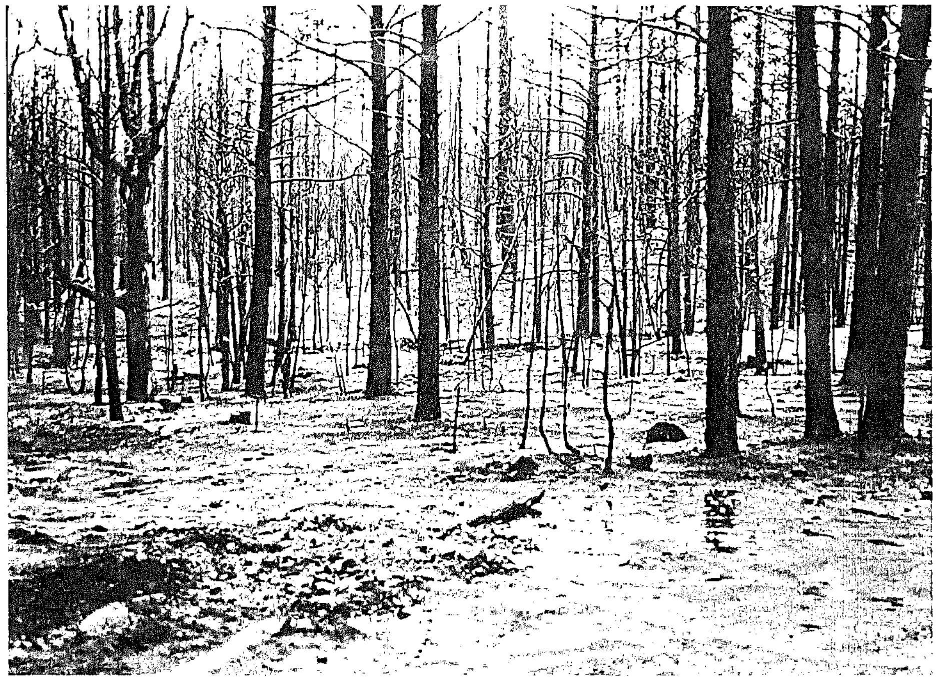

Figure 9

Figure 10

Cottonwood Fire

Figure 11

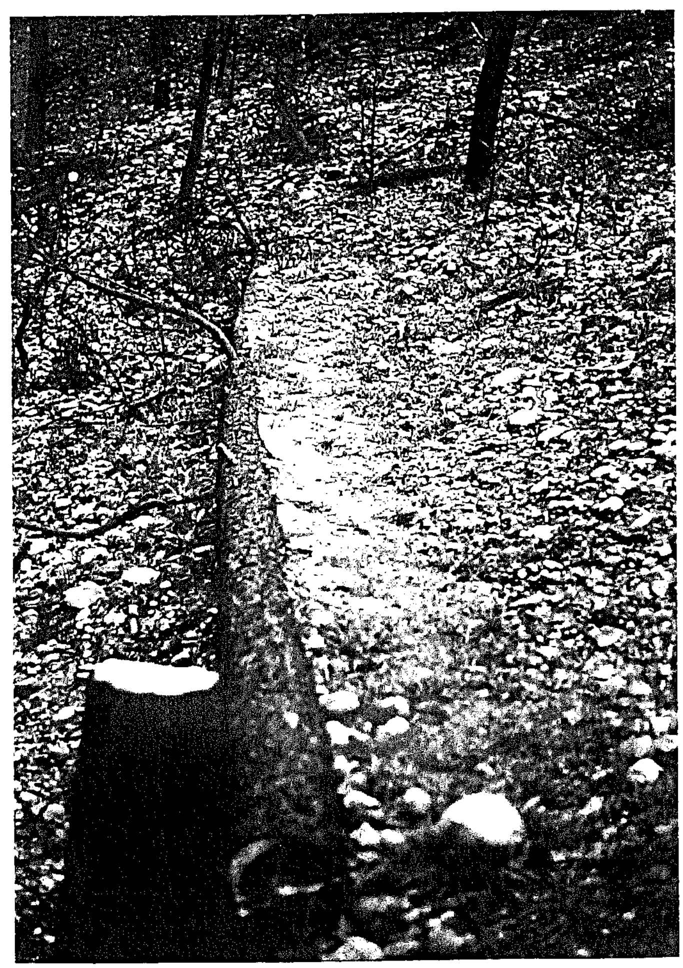

Figure 12

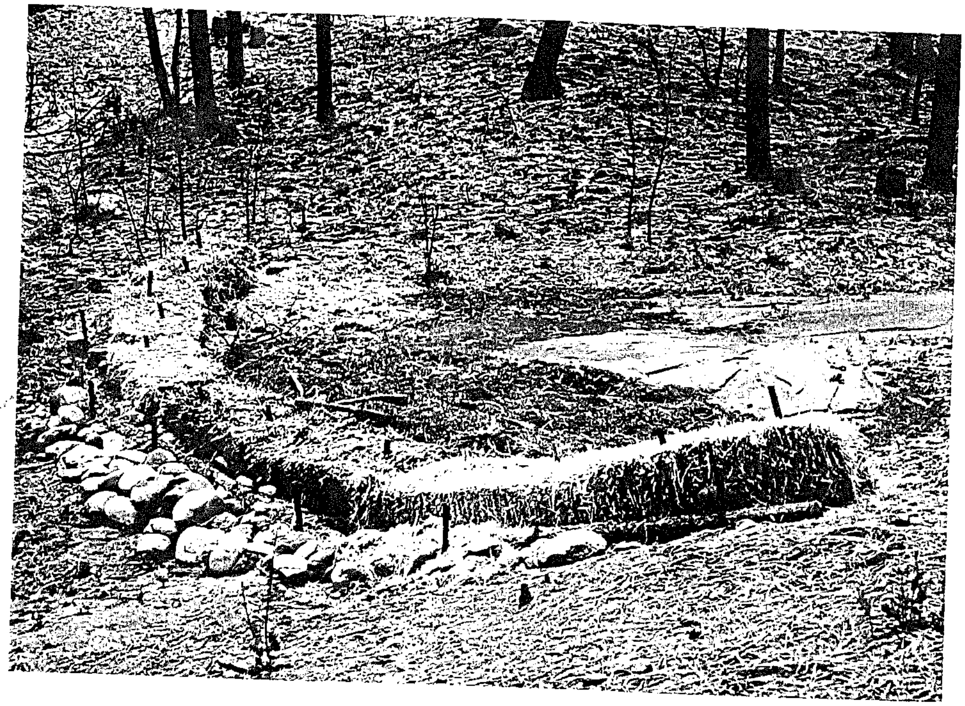

Figure 13

Figure 14

Figure 15

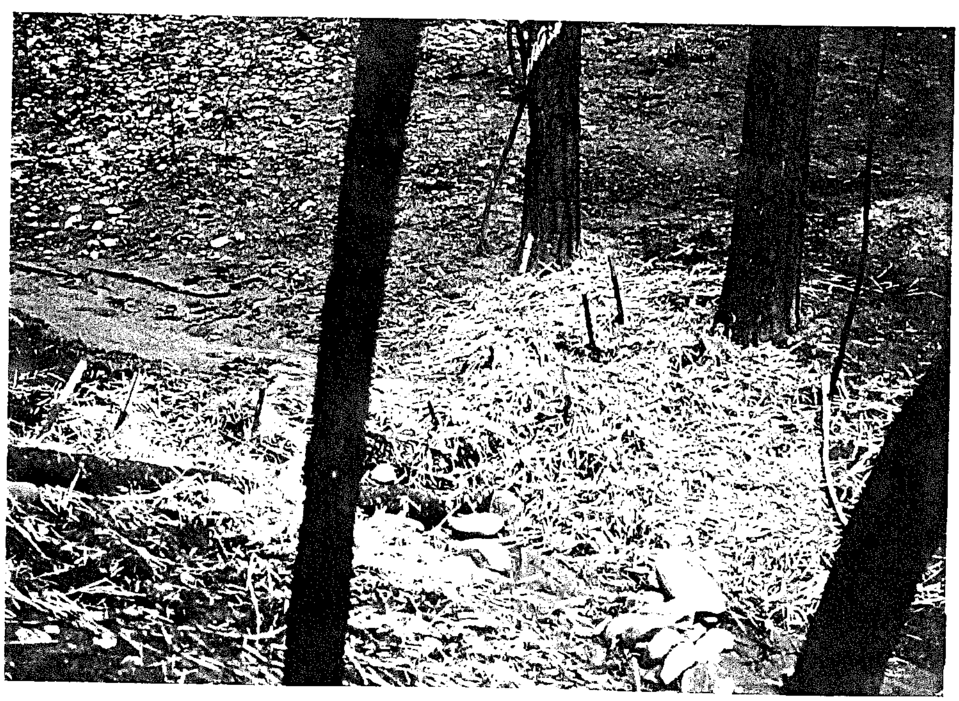

Figure 16

Cottonwood Fire

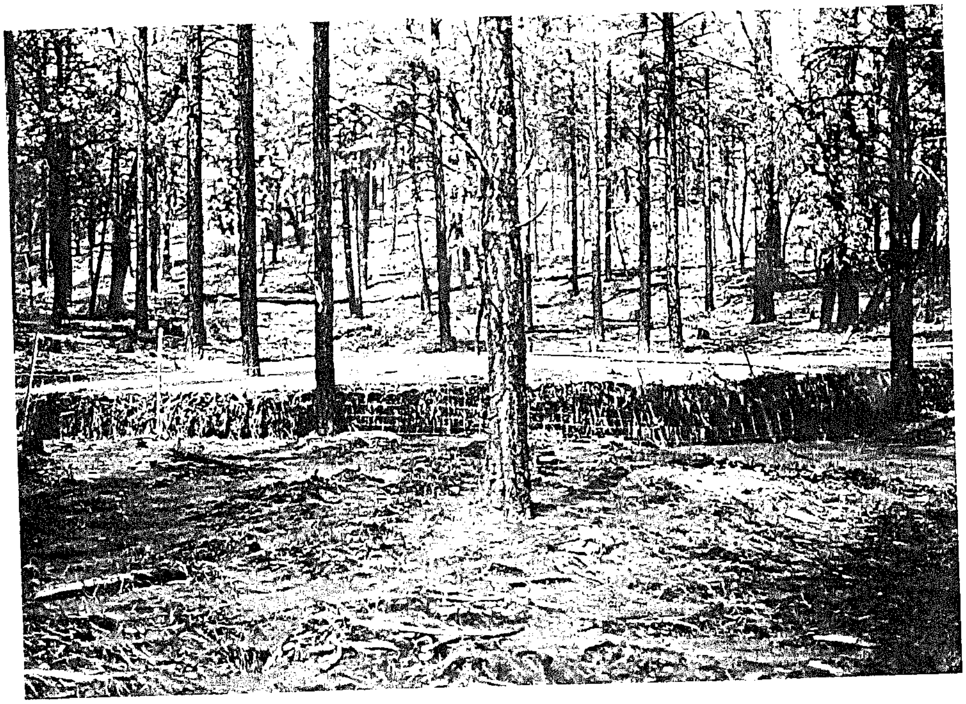

Figure 17

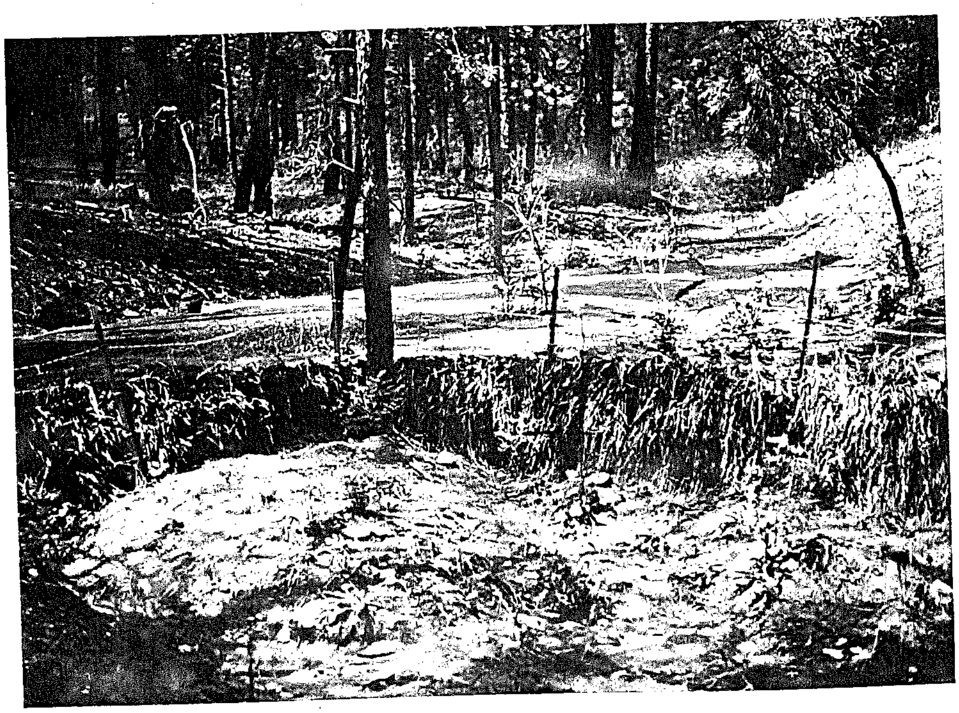

Figure 18

Cottonwood Fire

Figure 19

Figure 20

Cottonwood Fire

Figure 21