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Report on Sanitation and Fertilization Tests in Aspen Stands on Bright Angel Point, Grand Canyon National Park

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REPORT ON SANITATION AND FERTILIZATION TESTS IN ASPEN STANDS ON BRIGHT ANGEL POINT, GRAND CANYON NATIONAL PARK

By

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In his report of a pathological inspection of the Grand Canyon National Park, August 18-21, 1941, Dr. Lake S. Gill, of this office, discussed the death of aspen at Bright Angel Point on the North Rim. He pointed out that soil compaction and erosion resulting from heavy use of certain areas have weakened many trees and made them liable to severe and frequently fatal attacks by the Valsa canker fungus (Valsa sordida), ordinarily a minor pathological factor in normal aspen stands.

While the Valsa canker (Figure 1) alone appears to be sufficiently virulent to explain a major proportion of the deaths of weakened aspen, other agencies, also normally innocuous, may be partly responsible for the high mortality. For example, the so-called "aspen canker" (Figure 2), twig and branch cankers, and a die-back of undetermined cause are common in declining stands. Laboratory studies now in progress may indicate that some of the branch die-back is caused by the Valsa canker organism, and that consequently dead branches, as well as dead trunks, constitute

ideal places for the development of spores capable of infecting nearby healthy trees. Declining stands are also characterized by tremendous insect activity. A large wood borer, Saperda calcarata, appears to be the most common insect, and it may be of considerable importance in spreading the canker disease. Insect work undoubtedly complicates the situation, for it is difficult to differentiate between insect damage alone and a combination of insect activity and disease. Mechanical injuries, particularly basal wounds, caused by deer rubbing their antlers against the trunks of small trees (Figure 3), often provide avenues of entrance for disease.

In the past few years the National Park Service has removed a considerable number of unsightly dead trees in the headquarters area, but new infections and deaths have continued at an alarming rate in the residual stands under this program of mild sanitation. Consequently, it was felt that immediate steps should be taken to test the practicability of more drastic measures not only in definitely declining stands, but also in stands showing only the earlier stages of disease and relatively no evidence of decline.

Two tests were started by the Division of Forest Pathology in cooperation with the National Park Service during September. One test was designed to determine the effect of the removal of infective trees from a diseased stand; the other test was designed to determine the effect of fertilization on tree vigor and resistance to disease. Active assistance was given Forest Pathology by Assistant Chief Ranger Arthur Brown

and his assistant, Ranger W. J. Kennedy, without whom it would have been impossible to accomplish the work planned for this year. Temporary and CCC labor was also provided by the Park Service to help in setting up both experiments.

The purpose of this report is to review the tests inaugurated this year and to present descriptions of the stands that were sampled. A map (Figure 4) showing the approximate location of the plots and a motor log are included in the report.

SANITATION TEST

Two plots, 1 for treatment and 1 for a check, were established in stands about 300 feet apart on the west side of the North Entrance Road between the roads leading to the Cafeteria and the Utah Parks Garage (see Figure 4 and the motor log). The treated plot has an area of 1.7 acres, and contained 341 (199 per acre) living trees prior to cutting. The check plot has an area of 2.3 acres, and contains 417 living trees (182 per acre). An attempt was made to secure plots of about the same age, d.b.h. distribution, composition with respect to the presence of other species, as well as comparable rates of mortality and disease. It is believed that the paved roads, telephone and sewer-line clearings, and bridal paths have exerted about the same effect on both plots.

Tables 1 and 2 may be used to compare the plots with respect to d.b.h. distribution, and proportions of dead, declining, and diseased trees. It can be seen that the plots were quite similar prior to the

sanitation treatment, although the check plot contained a higher proportion of large trees than the treated plot. Also, ponderosa pine is more generally distributed on the check plot than on the treated plot, and the somewhat lower infection on the former may be due in part to the barrier to spore dispersal offered by the dense pine foliage.

Before the dead, declining, and seriously diseased trees were removed from the treated plot, d.b.h. measurements were taken, records made of their condition with respect to vigor, disease, insect activity, miscellaneous injury, and the reasons for removal indicated. Labor furnished by the National Park Service then removed all such trees. Five man days were required for the cutting, and approximately 8.5 cords of wood were removed. Table 1 shows the proportion of trees removed in each 3-inch d.b.h. class. Although 56 percent of the trees (including those that were dead) were cut, the remaining trees are well spaced, and the stand does not appear unusually open. Figures 5 and 6 are photographs of a portion of the plot taken before and after cutting. In addition to the trees on the plot itself, nearby infective aspens also were felled in order to augment the isolation partially provided by the roads and telephone line. Five man days of CCC labor were used in hauling away the wood and slash.

After treatment all remaining trees were tagged and their d.b.h.'s measured. A record was also made of their general appearance and any evidence of possible disease or insect activity. It was impossible to remove every tree suspected of being infected without approaching clear

cutting, and these records provide a basis for further study of such suspicious cases.

All of the trees on the check plot were tagged, their d.b.h.'s measured, and notes taken on their general appearance, disease, and insect activity. The records of disease are more complete for this plot than for the treated plot, since they include information on the type and location of observed cankers. Since the notes for the check plot also indicate whether or not a tree would have been removed in a sanitation operation, it will be possible to check the marking policy used on the treated plot, as well as to compare the progress of disease in an undisturbed stand with that in a stand from which practically all infective trees were removed.

Additional measures may be necessary to clean the treated plot completely. More than likely some of the cankers that were considered to be arrested this year will appear as active infections in 1942. It is also natural to suppose that disease resulting from this year's infection will manifest itself next year. It is not anticipated that subsequent operations will have to be as drastic as the initial cleaning.

Sanitation measures thus far employed consisted of the removal of trees with trunk infections. Future operations, however, may include the removal of diseased branches from otherwise healthy trees, thereby avoiding excessive reductions in stand densities. For the same reason it may prove advisable to excise small trunk infections rather than to remove the trees.

FERTILIZATION TESTS

The two objectives of the fertilization tests are: (1) To determine the effect of various types and concentrations of fertilizer on normal aspen stands; and (2) to determine the effect of fertilizer on trees which are declining as a result of trampling and heavy infection by the Valsa canker fungus.

In a Normal Stand

Five plots, 4 designated for treatment, and 1 for a check, each with an area of 2,000 square feet, were established in a stand west of the Utah Parks Company Barn and Corral, and south of the Campground and Cafeteria (see Figure 4 and the motor log). At the time of establishment the stand appeared to be as free from disease as any observed on Bright Angel Point, although it adjoins 2 seriously infected areas, viz., the Campground area and the Utah Parks Company industrial area. The 5 plots are 20 x 100-foot strips, separated by 20-30 x 100-foot isolation strips within a rectangle 190 x 100 feet. (Figure 4, inset). Separation of the plots was considered necessary because of the likelihood that the effect of fertilizer applications might extend beyond the limits of individual plots.

All living trees on the five plots were marked at breast height with aluminum tags, their d.b.h.'s measured, and records taken on their general appearance and condition with respect to disease, insect activity, and miscellaneous injury. Notes were not taken on dead aspen. Table 3

shows the distribution of trees according to 3-inch d.b.h. classes and the proportion of declining and diseased trees in each class for all five plots combined. The table indicates that disease was light in this stand compared to that found in stands where the sanitation test was made.

On Plot 1, two dump truck loads (approximately 4 cubic yards) of stable manure were spread over the surface of the ground. The respons of the trees to this type of fertilizer may provide a clue to the feeding requirements of aspen.

On the three remaining plots designated for treatment, commercial fertilizer containing ammonium sulphate, superphosphate, and potash were applied at three different rates. The relative proportions of available nitrogen, phosphorous, and potassium in the commercial fertilizer were 7:10:6, with the exception of one plot (the one receiving 49 lbs. of fertilizer) where, because of loss in shipment, it was necessary to modify the rates to 10:9:6. Available information now indicates that 10:8:6 fertilizer is suitable for shade and ornamental trees, and it is hoped that the fertilizer prepared for the tests contained sufficient nitrogen for aspen.

Fertilizer was applied at the rate of 150 lbs. (Plot 2), 100 lbs. (Plot 3), and 49 lbs. (Plot 4), to 2,000 square feet (Table 4). Since the plots showed considerable variation in the number and sizes of trees, Table 4 also shows the applications reduced to rates per inch of d.b.h. and per foot of basal area. These data suggest that only in the case of

the plot receiving 150 lbs. does the average dosage per tree approach that generally recommended for shade and ornamental trees.

Very much significance should not be attached to the above-mentioned comparisons in the rates of application, since the trees were not uniformly spaced on the plots. Nevertheless, in view of the extensive network of roots in the soil beneath dense aspen stands, some system of applying fertilizer on an areal basis rather than on a tree basis appeared satisfactory. Consequently, all plots, including the check, were gridironed by 1-1½-inch deep trenches which were located 5 feet apart, and made parallel to both the long and short sides of the plots. The total length of trench for each plot was approximately 920 feet; and the fertilizer was sifted into the trenches at a predetermined rate per 20 feet of trench, depending on the rate of application for a given plot. The gridiron pattern was not rigidly maintained, since it was frequently necessary to detour around the bases of trees and large pieces of debris. Figure 7 is a photograph showing the trenching on a portion of one of the fertilization plots.

It is possible that the most satisfactory methods for feeding declining trees in campgrounds and other heavily used areas will be the addition of fertilizer to trenches dug about individual trees at rates based on tree size. If this is the case, records on the fertilization of single trees on the plots, as indicated by the position of the trenches, should prove valuable. Evidence of trenching should still be present next year, at which time such records could be easily secured if desirable.

Fertilization this fall should have little or no effect on tree growth until next growing season. When the fertilizers were being applied autumnal color changes of aspen leaves were approaching their height, and undoubtedly a majority of the trees were practically dormant.

In a Declining Stand

The remaining fertilization test was made in a stand in the new CCC Camp area (see Figure 4 and the motor log) which has been subjected to heavy use, and to the removal of litter in the course of camp policing for the past four years. Mortality is still low in this area, but the small leaves and serious infection of many of the trees are suggestive of a declining stand. One plot 20 x 50 feet in size which included 15 living trees was established in the area. Notes taken on the trees include the same information collected on the other fertilization plots. All of the 15 trees showed signs of decline, and 60 percent of them were diseased. The fertilizer used contained equal amounts of ammonium sulphate and the prepared fertilizer, Vigoro. It was applied by the trench method at a rate of 100 pounds to 2000 square feet. Since the formula for Vigoro is 4:12:4, the addition of the ammonium sulphate resulted in a mixture more nearly like that usually recommended for shade and ornamental trees. While this test bears little or no relation to the other fertilization tests, it may provide some information on the value of feeding trees in a definitely declining stand.

PLANS FOR FUTURE WORK

Sanitation Test

Observations should be made in 1942 on both the treated and the check plots. It is not anticipated that they will provide an immediate basis for drawing definite conclusions on the effect of sanitation measures. They will probably indicate the advisability of additional cutting in order to maintain the treated plot in a disease-free condition. This work should certainly be completed in 1942, and, in addition to tree removal, might well include the pruning of branches suspected of infection, and the excision of small infections in the trunks.

Extensive surveys of the aspen stands on Bright Angel Point may be undertaken in order to determine the probable magnitude of large scale sanitation operations should the tests indicate that this procedure effectively reduces the existing mortality rates.

Fertilization Tests

During 1942 observations will be made on the effect of fertilization on tree growth on the test plots. At the time the observations are made it will probably be advisable to plot the location of trees and trenches on large scale maps as an aid to the analysis of the reactions of individual trees to fertilization.

New fertilization tests may be undertaken, particularly if there is ample evidence to indicate that larger amounts of fertilizer are needed to stimulate growth. Tests of summer fertilization should be started.

If there is sufficient time during the 1942 field season, it may be desirable to inaugurate tests of methods designed to prevent undue soil compaction by the substitution of gravel for the finer grained materials of the upper soil horizons. Compressed air feeding methods and pressure oxygen treatments that have proved successful in restoring vigor of shade and ornamental trees may be considered measures worth testing in the near future. In fact, it is not unlikely that a complex of treatments involving sanitation, fertilization and physical modifications of the soil may be necessary in order to preserve aspen in and adjacent to heavily-used areas.

It is felt that appreciable progress has been made on the problem this year. In the future it is hoped that the tests may be enhanced by the results of fundamental research. Culture work and inoculation experiments should indicate the extent to which Valsa sordida and other canker forming fungi are associated with die-back, insect work, and miscellaneous injury, and these should result in the development of better criteria for judging highly infective trees. If information having general application develops as a by-product of the current tests, it will be made available to the National Park Service and to other interested agencies.

Table 1.- Sanitation Test. Summary of Records Taken on the Treated Plot.

D.b.h. Class In.	Distribution of trees 1/		Proportion of each d.b.h. class									
			Dead		Declining		Infective 1/		Cut 1/			
	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent		
1- 3	79	20	19	24	15	19	42	53	46	58		
4- 6	212	55	25	12	61	29	131	62	135	64		
7- 9	85	22	3	4	24	28	29	34	29	34		
10-12	11	3	0	0	7	64	6	55	7	64		
13-15	1	0	0	0	0	0	0	0	0	0		
All classes	388	100	47	12	107	28	208	54	217	56		

1/ All dead trees included.

TABLE 2.- Sanitation Test. Summary of Records Taken on the Check Plot.

D.b.h. Class In.	Distribution of trees 1/		Proportion of each d.b.h. class									
			Dead		Declining		Infective 1/		Cut 1./ 2./			
	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent		
1- 3	101	21	30	30	17	17	56	55	61	60		41
4- 6	198	40	29	15	58	29	102	52	121	61		77
7- 9	126	26	9	7	34	27	44	35	54	43		
10-12	61	12	5	8	5	8	11	18	12	20		
13-15	4	1	0	0	1	25	2	50	2	50		
All classes	490	100	73	15	115	24	215	44	250	51		$\frac{118}{240} = 49$

1./ All dead trees included.

2./ If sanitation cutting had been made.

$\frac{182}{250}$

TABLE 3.- Fertilization Test. Summary of Records taken on 5 plots in a Normal Stand.

D.b.h. Class In.	Distribution of trees		Proportion of each d.b.h. class			
			Declining		Diseased	
	No.	Percent	No.	Percent	No.	Percent
1- 3	6	5	4	67	1	17
4- 6	53	45	11	21	9	17
7- 9	50	42	4	8	6	12
10-12	10	8	0	0	1	10
All classes	119	100	19	16	17	14

TABLE 4.- Fertilization Test. Comparison of 5 Plots in a Normal Stand and 1 Plot in a Declining Stand.

Description of plots and fertilizer applications	Normal Stand 1	2	3	4	5	Declining Stand
1. Area - sq. ft.	2000	2000	2000	2000	2000	1000
2. No. of trees						
a. Total	30	17	31	18	23	15
b. Per acre	653	370	675	392	501	653
3. Average						
a. D.b.h.-inches	6.5	7.4	6.2	7.8	8.1	6.8
b. Basal Area - sq. ft.	0.253	0.319	0.229	0.334	0.382	0.279
4. Fertilizer application rate lbs.						
a. Per 2000 sq. ft.	Stable manure	150	100	49	No Treatment	100
b. Per inch d.b.h.		1.2	0.5	0.4		0.5
c. Per foot basal area		27.7	14.1	8.1		11.9

Fig. 1.- Canker considered to be caused by the fungus Valsa sordida. The perennial nature of the infection is indicated by the zonate discoloration of the bark beyond the darkened area of the canker. Copy made from 35 mm Kodachrome.

Fig. 2.- Typical "aspen canker." The perennial nature of the multiple infection is indicated by the irregular ridges of callus tissue. Copy made from 35 mm Kodachrome.

Fig. 3.- Basal wound caused by a deer rubbing its antlers against the lower trunk of a small tree. The depressed area at the lower end of the antler wound indicates the development of a canker probably caused by Valsa sordida. Copy made from 35 mm Kodachrome.

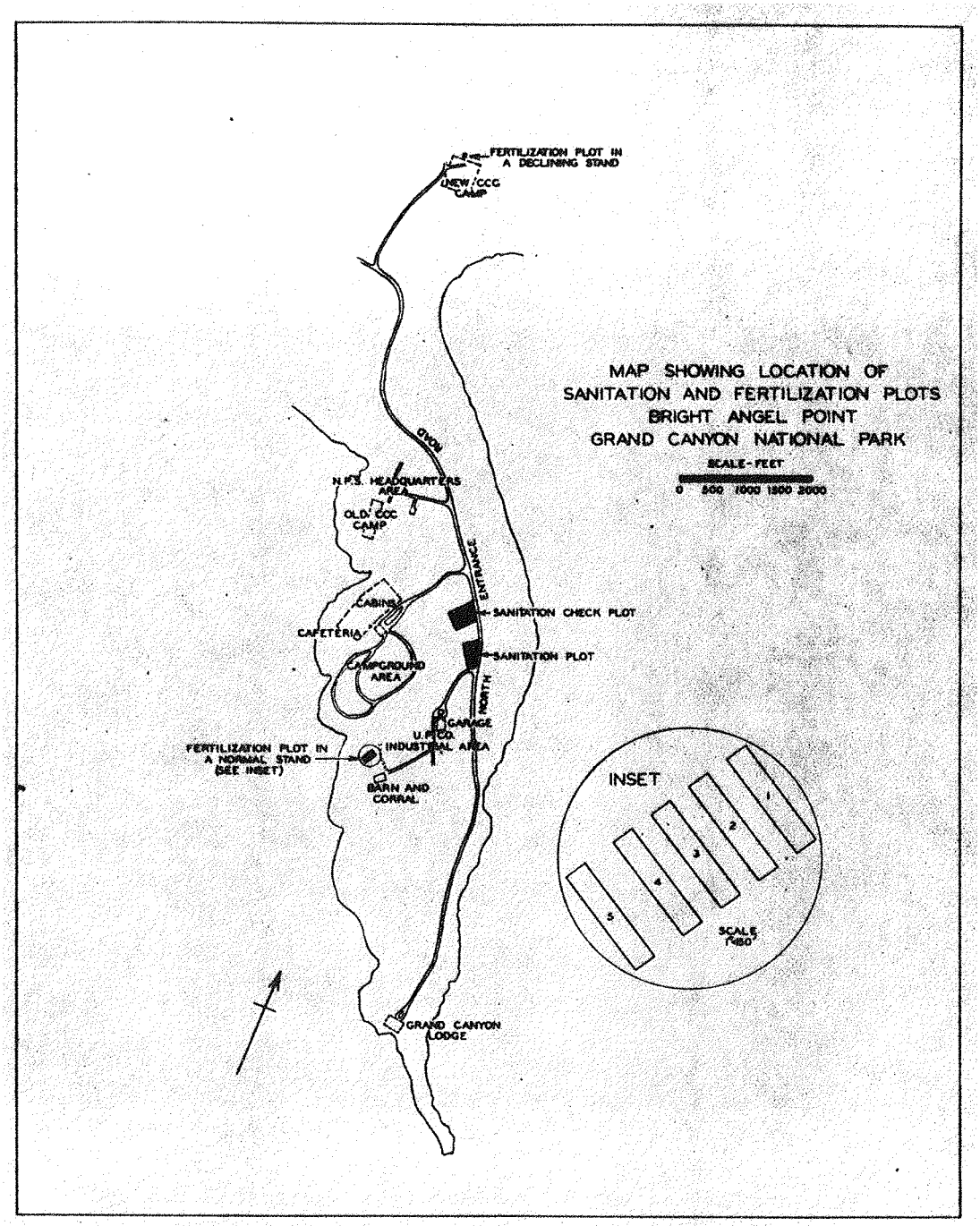

Fig. 4.- Map showing location of sanitation and fertilization plots on Bright Angel Point, North Rim, Grand Canyon National Park. The inset shows arrangement of the Fertilization Plots in a normal stand. The map was adapted from one appearing in the National Park Service booklet entitled Grand Canyon National Park --- Arizona.

Fig. 5.- Photograph of a portion of the sanitation plot before cutting showing a number of dead and declining trees in the foreground. Severe Valsa-canker infection can be seen on the trunk of the aspen nearest to the lefthand side of the photograph. Copy made from 35 mm Kodachrome.

Fig. 6.- Photograph of a portion of the sanitation plot after cutting showing that while a large number of trees were removed in eliminating all dead, declining and infective aspen, the stand does not appear unusually light. Copy made from 35 mm Kodachrome.

Fig. 7.- Photograph of a portion of the fertilization plot in a normal stand showing the density of the stand, and the gridiron-trench method of applying fertilizer. Copy made from 35 mm Kodachrome.

MOTOR LOG FOR TEST PLOTS

SANITATION TEST

Treated Plot

		Miles
1.	Junction of North Entrance Road and entrance road to National Park Service Headquarters. Go south toward Grand Canyon Lodge ----------	0.00
2.	The southeast corner of the plot is on righthand side of road. Corner is an iron pipe extending about 2 inches above ground of road shoulder ----------	0.45

Check Plot

1.	Same as for treated plot ----------	0.00
2.	The southeast corner of the plot is on righthand side of road. Corner is an iron pipe extending about 2 inches above ground of road shoulder ----------	0.30

FERTILIZATION TEST

Plots in a Normal Stand

1.	Same as for Sanitation Test treated plot ----------	0.00
2.	Turn right onto Utah Parks Garage Road ----------	0.45
3.	Keep right on circle in front of Utah Parks Garage taking road that passes close to west or righthand side of garage ----------	0.60
4.	Turn right ----------	0.70
5.	Just before reaching Utah Parks Corrals turn right onto old road ----------	0.80
6.	The northeast corner of the rectangle enclosing the 5 plots is due south about 1 chain. Corner is an iron pipe extending about 3 inches above the ground	0.85

Plot in a Declining Stand

		Miles
1.	Same as for Sanitation Test treated plot, except go north on North Entranee ----------	0.00
2.	Turn right off main road and proceed up hill past Kaibab Trail Corral ----------	0.80
3.	Take sharp right fork ----------	1.15
4.	Camp fire-tool box at end of last row of tent frames. The southwest corner of the plot is northwest about 100 feet. Corner is an iron pipe extending about 5 inches above ground ----------	1.20