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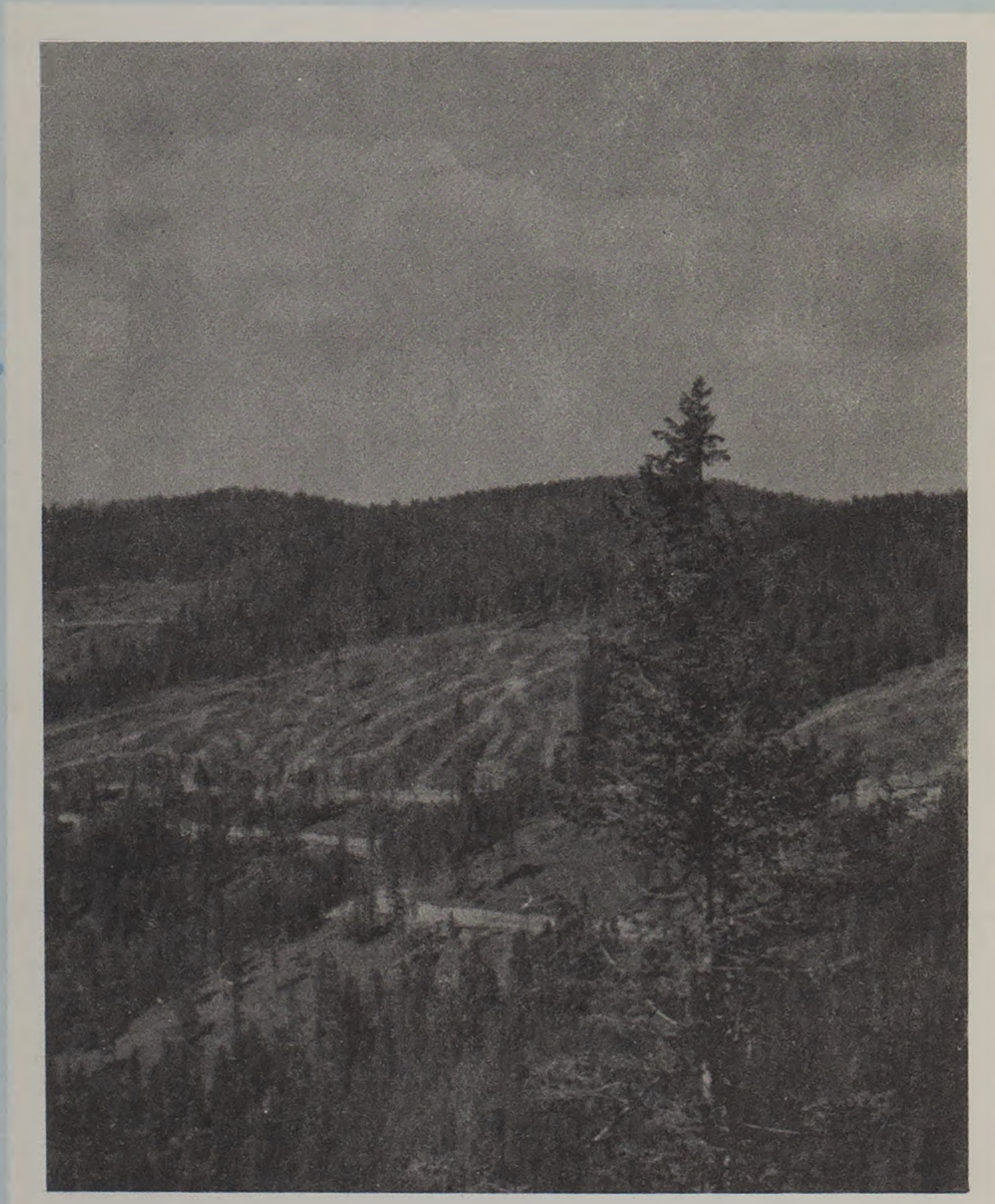

Bulletin No. 33 February, 1968

Montana Forest and Conservation Experiment Station

University of Montana ● Missoula ● School of Forestry

The Montana Forest and Conservation Experiment Station

The Montana Forest and Conservation Experiment Station was established in 1937 to study the forests and forest lands of Montana. The Dean of the School of Forestry at the University of Montana is the ex-officio Director of the Station.

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Timber stands of larch and Douglas fir in western Montana usually are harvested by clearcutting, which requires that all trees on a given block be cut. Continuous cutting of timber necessitates providing for reforestation so the area may be harvested again when the trees reach maturity.

In theory, the clearcutting system provides the essential ingredients for the regeneration of a new forest in a few years. New forests are started from seed supplied by trees around the perimeter of the clearcut and from whatever seed trees may be left on the cut area. Clearcut areas, however, do not show equal response to natural seeding. Some remain treeless for a decade or so, some fill in rapidly with grass and brush and others produce a dense stand of tree seedlings within a few years.

The object of this study is to determine the relative importance of some of the factors that influence natural regeneration on clearcuts where slash has been burned, where the seedbed has been prepared by scarifying with a bulldozer, or where no particular treatment has been used. The information obtained by examining clearcuts also helps to determine which of the areas have adequate regeneration.

The harvested areas studied ranged in size from 20 to 400 acres. They were logged with tractors or jammers and slash, if it created a fire hazard, was either piled and burned or broadcast burned. The trees which were too small to be merchantable were burned with the debris from the logging operation.

Burning reduces the fire hazard and is effective in preparing for a new forest by reducing the depth of the duff—the layer of organic material that collects on the ground under the standing forest. Coniferous tree seeds germinate adequately without any particular treatment of the duff, but during the summer the duff dries out before the seedling roots can penetrate the mineral soil. Slash burning removes much of this organic material. The more severe the fire and the drier the duff, the more the depth will be reduced, giving seedlings a better chance of surviving the dry weather during their first summer of growth.

Earlier findings by Issac (1) indicate that slash fires may produce micro-site conditions that are unfavorable to seedling survival. Through consumption of slash and duff and the blackening of the surface soil, the fires can increase surface temperatures and evaporation, thereby increasing seedling losses. Some clearcutting operations result in such heavy slash that fire protection without slash burning is out of the question. When this condition exists, the sheer preponderance of slash material may be a hindrance to seedling establishment and survival. In such cases, slash burning is likely to result in a greater number of established seedlings per acre, although it causes greater seedling mortality than would have occurred in the absence of fire.

Where slash is less abundant, protection needs may be satisfied by lighter fires that cover only parts of the surface and cause less increase in the severity of site conditions. Slash should be left on southerly exposures whenever practicable.

Issac (1) concludes with the recommendation that slash be broadcast burned on the average Douglas fir cutover in the spots where the slash is excessively heavy. This should be supplemented with some piling and burning along routes of travel, in other places of high hazard and on southerly exposures where it is undesirable to broadcast burn.

RESEARCH METHODS

To carry out the objective of this study 21 factors were recognized as having a possible influence upon the amount of regeneration that became established in a given clearcut area. Information was recorded on Porta-Punch cards for the age of the clearcut, elevation, aspect, position on slope, amount of slope, amount of shade, timber type before cutting, regeneration system used, volume per acre left on the area, status of non-commercial residual timber, age of seed source, whether the area was seeded or planted, direction of nearest seed source, vertical displacement or position of the nearest seed source, the distance and species of the nearest seed source, amount of animal grazing, original and present duff depth, type of seed bed preparation method applied to the entire area, and the micro-site condition on the plot resulting from the seed bed preparation. More detailed information about the measurement of these variables is given in the appendix.

The study was conducted during the summers of 1964 and 1965 and was limited to areas cut prior to 1962 in the larch-Douglas fir and ponderosa pine-Douglas fir forests within a 100-mile radius of Missoula, Montana. Areas cut after 1962 were not considered because insufficient time had elapsed since logging and burning for natural regeneration to have occurred. The criterion of stocked or unstocked was based on whether any coniferous seedlings were found alive on a circular plot 1/500 acre in size (radius 5.26 feet).

Three first-year seedlings were considered to be the equivalent of an established seedling a year or more old. The measure of stocking was made on 1,184 plots taken from 50 clearcut areas.

Five lines of sample plots were arranged on every area in order to obtain a representative sample. Lines of plots were run north and south with the beginning point on the south boundary of the clearcut, one sixth of the east-west dimension away from the western edge. The sample plots were spaced at two-chain intervals along these lines. The first 20 were on the first line, the next 20 on the next line to the east, and so on until the last line of plots was positioned a sixth of the east-west dimension away from the east edge of the clearcut.

The location of stocked plots can be shown graphically for any given clearcut area. The "mapping" of the distribution of stocked plots was done on an IBM 1620 computer. The Fortran II program for this work is in the appendix. Figure 1 is a sample map made by the computer to show the location, species and the amount of regeneration within a given clear-cut block.

FIGURE 1

REGENERATION SURVEY MAP

AREA NO. 29

3 DF	ONO	0	0	0	
ONO	ONO	0	0	0	
3 S	ONO	0	0	0	
3 S	ONO	0	0	0	
ONO	ONO	0	0	0	N
ONO	3 S	0	0	0	
ONO	3 S	0	0	0	↑
ONO	3 S	0	0	0	
3 L	ONO	0	0	0	
3 S	ONO	0	0	0	
3DF	3 L	0	0	0	
3 S	ONO	ONO	0	0	
3 L	3 L	ONO	0	0	
3 L	3 S	3 S	3GF	0	
3 L	3 S	ONO	ONO	ONO	
3GF	12 L	ONO	3 S	ONO	
3GF	3GF	ONO	ONO	3 S	
ONO	3GF	ONO	ONO	ONO	
ONO	3 S	3GF	ONO	ONO	
12 L	12LP	3 L	3GF	12 L	

The computer map shows location of plots and the number and species of the seedlings tallied. The area is 40 chains deep on the west side. Zeros indicate parts of strips on which no plots were taken, because the clear-cut was less than 40 chains deep at those points, and ONO indicates plots with no reproduction. The straight line at the bottom of the map represents the south boundary of the clear-cut unit regardless of the actual shape of the boundary. *Legend:* 0—no plots; ONO—no seedlings; 3S—three spruce; 3L—three larch; 3GF—three grand fir; 3LP—three lodgepole pine; 3DF—three Douglas fir.

The effect of the recognized variables on the presence of coniferous reproduction was determined by the application of a chi-square statistical test. Each of the variables, with several subdivisions was divided into two parts to form contingency tables indicating the number of stocked and unstocked plots. The values found in each cell of these tables were compared to a computed value which resulted from the distribution of all plots according to the ratios calculated from the column and line totals in the table. Before the frequencies were computed, any subdivision of a variable with a sum of zero was eliminated, and any subdivision of a variable with an expected frequency of less than five was combined with its closest neighbor so that all frequencies were at least five. The statistical test was applied to as many variables as possible from the data available.

The influence of timber type on the area before cutting, the present duff depth, the volume per acre of timber left on the area after cutting, the status of the non-commercial residual stand left on the area after cutting, and the stand reestablishment method were not included in the statistical test because of insufficient samples in more than one level or subdivision.

The variables of age of clear cut, elevation, aspect, position on slope, steepness of slope, age of leave stand, position of and distance to seed source, and effect of grazing, were all tested for each of the three microsite conditions encountered on the plots. The three microsite conditions were burned, unburned, or scarified.

The significant chi-square test value indicates dependence of the ratio of stocked and unstocked plots upon the variable that is being tested, but it indicates nothing of the amount or direction of the dependency. Collection of data from many more plots in the future could provide more detailed information. Tables No. 1 through 13 indicate the percentage of plots stocked for the variables which were found statistically significant.

RESULTS OF THE STUDY

The effect of time since cutting on stocking was significant for the scarified microsites, but became highly significant for the burned ones. Generally, the longer the time since cutting, the better the stocking was on all microsites.

TABLE 1

AGE EFFECT OF CLEAR-CUT ON STOCKING

No. Years Since Cutting	Percent of Plots Stocked			
	Unburned Only	Burned Only	Scarified Only	All Plots Together
2	----	----	77	68
3	32	9	53	23
4	26	36	71	44
5	22	42	61	47
6	39	39	63	56
7	----	----	----	58
10	----	39	72	38
11	----	----	----	76
13	34	62	93	60
All plots	28	39	66	50

TABLE 2

EFFECT OF ELEVATION ON STOCKING

Elevation Above Sea Level	Percent of Plots Stocked			
	Unburned Only	Burned Only	Scarified Only	All Plots Together
2000-3999	41	35	62	63
4000-4999	33	44	69	51
5000-5999	21	37	69	56
6000-7000	19	30	43	32
All plots	28	39	66	50

Elevation had a highly significant effect on stocking when all plots were considered together, but a breakdown of this variable into the three microsite condition classes did not show any significant effect.

TABLE 3

EFFECT OF ASPECT ON STOCKING

Aspect	Percent of Plots Stocked			
	Unburned Only	Burned Only	Scarified Only	All Plots Together
North	45	49	78	62
East	27	43	68	50
South	18	26	59	41
West	22	39	61	46
All plots	28	39	66	50

The effect of aspect was highly significant for each microsite condition as well as for all plots considered together, but the effect of aspect on stocking was not as striking as might be expected. At forty-six degrees north latitude, considerable differences in micro-climate exist between northerly aspects and southerly aspects, and it would appear that stocking advantage should be even greater on the more moist north aspects.

The authors observed that where wildfires have burned over large areas, south aspects are extremely slow to regenerate. This may be due to the severity of summer burns, to shallow soil, to the large areas involved without any source of seed, or to a combination of these factors. Intentional fires on clear-cuts are not quite as severe as accidental summer fires even under the most favorable conditions. Nevertheless, the south and west exposures need special consideration in determining the cutting method to be employed as well as in treatment of the resulting slash. Larsen (5) points out the difficulty of obtaining regeneration on south aspects due to extremes in temperatures and drought. He suggests a method of cutting which would provide smaller openings and partial shade or shelter. A cutting method such as the shelterwood system, which provides the exposure of mineral soil and some shade for the young trees, is recommended for the more sensitive south and west aspects.

TABLE 4

EFFECT OF POSITION ON SLOPE ON STOCKING

Position on Slope	Percent of Plots Stocked			
	Unburned Only	Burned Only	Scarified Only	All Plots Together
Lower Third	33	44	68	57
Middle Third	32	35	65	46
Upper Third	13	35	57	38
All plots	28	39	66	50

The position on the slope occupied by a particular clear-cut had a significant influence on stocking for unburned plots and for all treatments together. The trend indicates that the farther up the slope that a clear-cut was located, the more difficult it was to establish regeneration.

TABLE 5

EFFECT OF STEEPNESS OF SLOPE ON STOCKING

Percent of Slope	Percent of Plots Stocked			
	Unburned Only	Burned Only	Scarified Only	All Plots Together
0-9	31	40	69	56
10-19	31	34	68	53
20-29	34	48	57	48
30-39	18	39	71	46
40-49	19	31	47	32
50-59	28	40	56	40
60-69	....	44	36	45
All plots	28	39	66	50

The effect of slope steepness was significant only when the plots are considered together. Slopes under 70 percent seemed to have little effect on restocking.

TABLE 6

EFFECT OF SEED SOURCE AGE ON STOCKING

Age of the Leave Stand in Years	Percent of Plots Stocked with Coniferous Regeneration
1-50	64
50-100	60
100-300	50
Over 300	28
All plots	50

The seed source age had a highly significant effect on the amount of reproduction when all treatments were considered together.

TABLE 7

EFFECT OF DIRECTION TO SEED SOURCE ON STOCKING

Direction to Seed Source	Percent of Plots Stocked
North	45
East	42
South	57
West	53
All plots	50

Direction to the seed source from the plots was significant at the 99 percent level of confidence. There was no significance when the three microsites were considered separately.

TABLE 8

EFFECT OF DISTANCE AND POSITION OF SEED SOURCE ON STOCKING

Distance to Seed Source in Feet	Percent of Plots Stocked			
	Upslope to Seed	Downslope to Seed	Across Slope to Seed	All Slope Positions Together
0-49	58	65	75	67
50-99	42	54	49	48
100-149	41	50	55	48
150-199	45	37	44	42
200-249	38	32	46	39
250-299	52	31	55	49
300-399	30	67	44	41
400-499	67	30	40	48
500-699	58	60	47	55
Over 700	56	20	54	50
All plots	46	47	56	50

The distance from the plot to the seed source had a highly significant effect when all plots were considered together, but it made little difference whether the position of the seed was upslope, downslope, or across the slope from the plots. The data showed significance for across the slope only.

There was no significant reduction in the number of stocked

TABLE 9

EFFECT OF SPECIES IN SEED SOURCE ON STOCKING

Species Most Common in the Seed Source	Percent of Plots Stocked
Western larch	53
Douglas fir	38
Englemann spruce	62
Western white pine	54
Lodgepole pine	53
Ponderosa pine	44
Grand fir	65
Alpine fir	40
Western redcedar	35
All species together	50

plots when the distance from the seed source increased beyond the first fifty feet.

The seed of larch and Douglas fir will travel 800 to 1,000 feet when borne by drafts of warm air which exist in clearcut forest areas during the fall. The air during the day generally moves upslope, therefore seeding of the area from a seed source at the bottom was as probable as seeding from a seed source at the top or sides (Issac 2). Seeds from trees on the top side often fall onto the area and are dispersed at distances up to 100 feet even without wind.

Species in the seed source was highly significant.

TABLE 10

EFFECT OF GRAZING ON STOCKING

Degree of Livestock Grazing	Percent of Plots Stocked			
	Unburned Only	Burned Only	Scarified Only	All Plots Together
None	31	41	64	53
Light	32	44	80	56
Heavy	14	21	39	25
All plots	28	39	66	50

Grazing significantly hindered regeneration on burned and scarified plots as well as all plots taken together. There was very little difference between areas where no grazing was observed and areas where grazing was light. On areas designated as receiving heavy grazing there was a considerable reduction in the percentage of stocked plots.

TABLE 11

EFFECT OF ORIGINAL DUFF DEPTH ON STOCKING

Depth of Duff Before Any Treatment in Inches	Percent of Plots Stocked
0-0.9	39
1.0-1.9	45
2.0-2.9	58
3.0-3.9	53
4.0 and over	23

The original duff depth had a significant effect on stocking, but the effect of increasing amounts of duff is not consistent.

Duff depths in excess of five inches were seldom found in the areas used for this study, but at the four-inch depth there is a reduction in stocking.

TABLE 12

EFFECT OF MICROSITE CONDITION ON STOCKING

Microsite Condition	Percent of Plots Stocked
Unburned	28
Burned	39
Scarified	65
All Conditions together	50

The effect of microsite condition on stocking was highly significant. The type of the microsite found at the plots was the direct result of the particular treatment during the logging and post-logging operations.

TABLE 13

EFFECT OF AREA SEEDBED TREATMENT METHOD ON STOCKING

Treatment Applied to the Entire Clear Cut	Percent of Plots Stocked
No treatment	19
Broadcast burn	40
Dozer pile, burn (also windrow)	59
Mechanical scarification	68
All treatments	50

When we examined the effect of the seed bed preparation method it appeared that the preparation method was responsible for many differences in stocking. These differences resulted in highly significant chi-square values. To obtain better tests of the effect of the other variables, their resulting values were separated by microsite condition. Such condition is the one factor over which man has complete control. Roe (3) emphasizes the importance of mineral soil seed bed for the regeneration of larch and says "To single out any one cutting method as the best for all conditions is exceedingly difficult. . . . When a favorable seedbed does not occur naturally or is not provided by the logging operation (and it rarely is, in sufficient quantity), other means must be employed to improve the seedbed, irrespective of the cutting method." (Roe 4)

TABLE 14

STOCKING PERCENT COMPARISONS BY GENERAL AREAS

Area	Percent of Plots Stocked
North end of Swan Valley	58
South end of Swan Valley and Seeley Lake area	58
Lolo Creek	35
Blackfoot Valley	32
East side of Bitterroot Valley	17
All areas combined	50

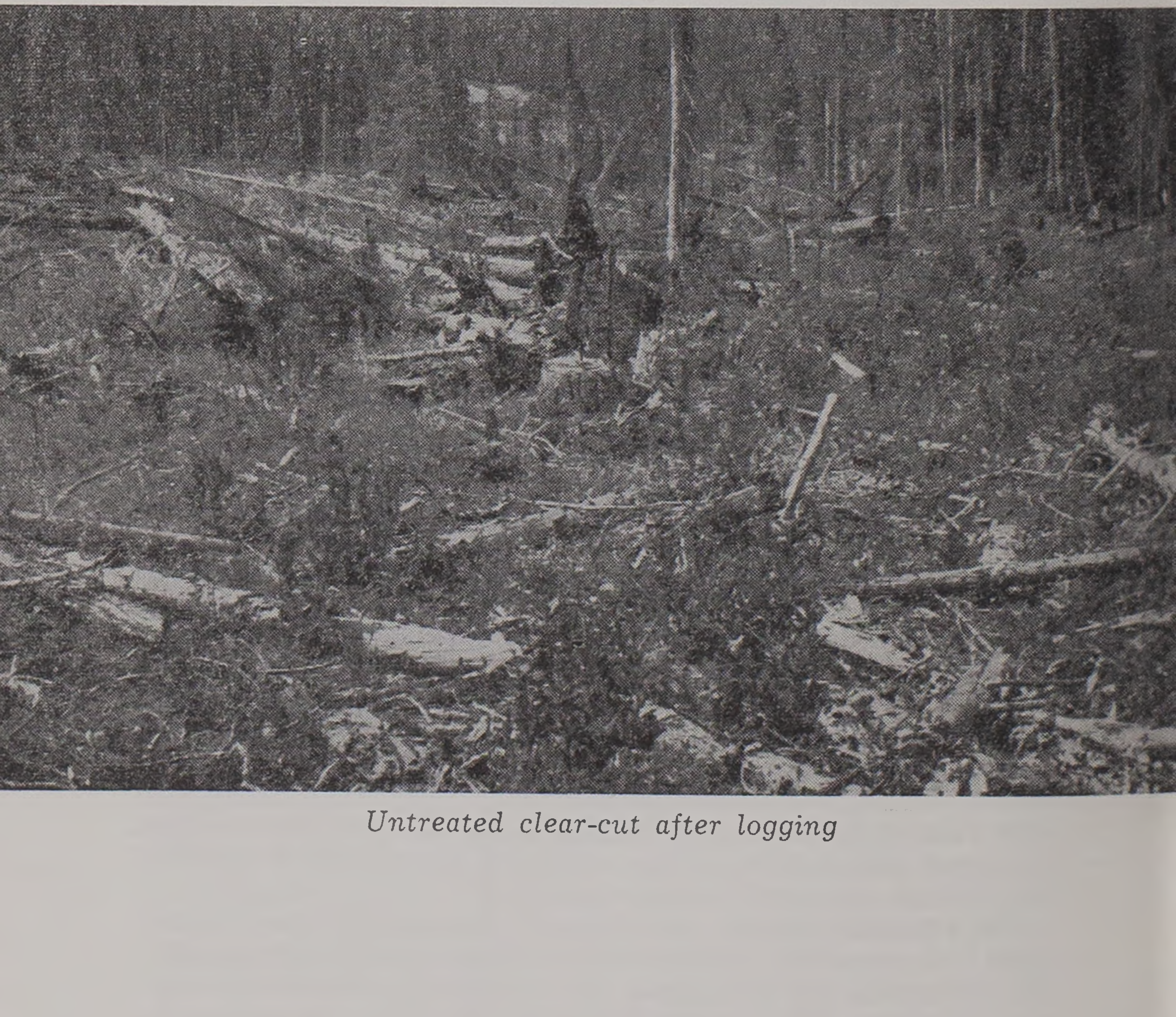
The Swan Valley area showed the highest percent of plots stocked. Much of this regeneration was larch. The Lolo Creek area and the Blackfoot Valley area were fairly similar as far as timber type was concerned. Most of this area was in the larch-Douglas fir type. The areas sampled on the east side of the Bitterroot Valley were in the ponderosa pine-Douglas fir timber type.

Regeneration of Abandoned Logging Roads Within Clear-Cuts[1]

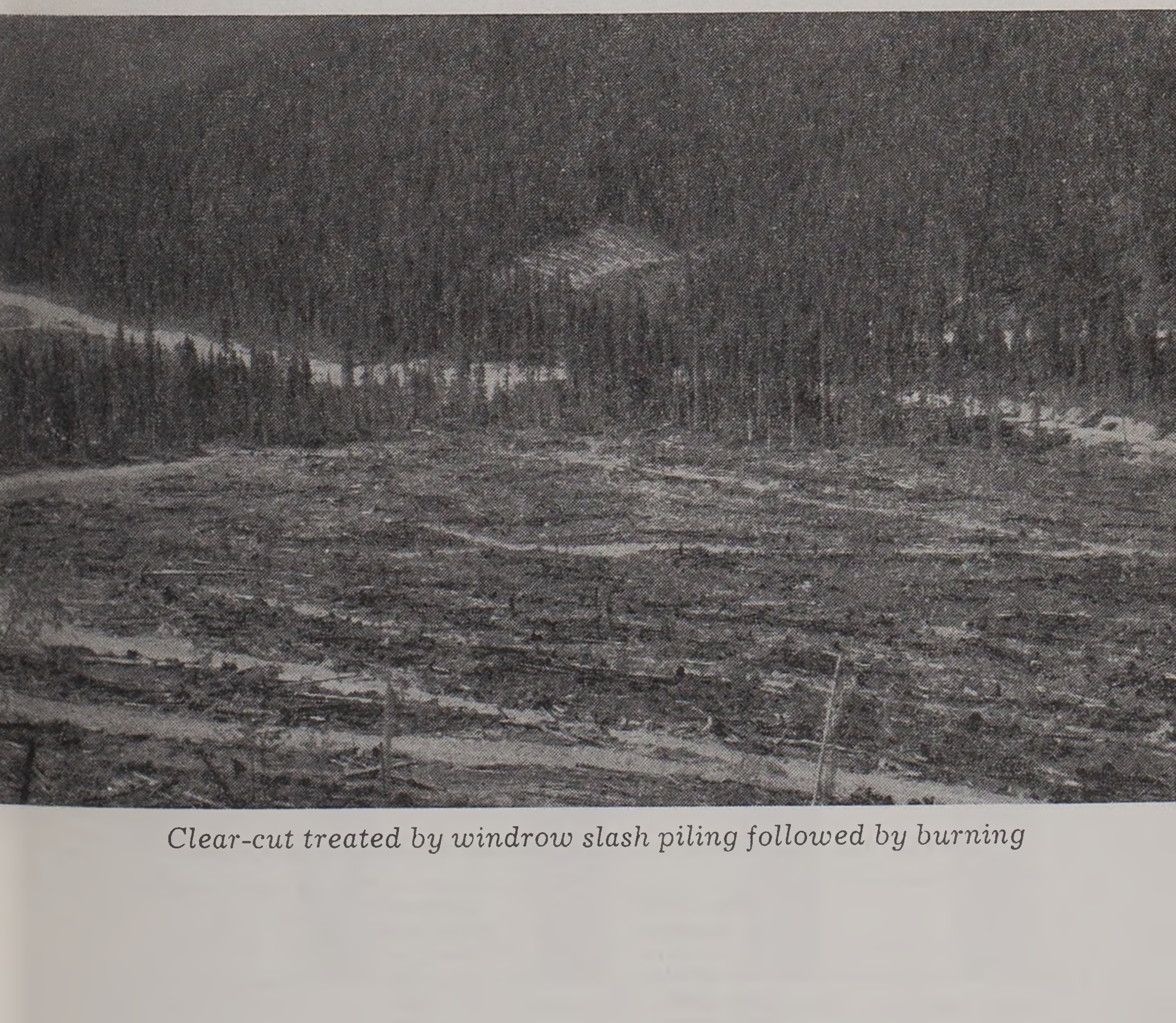
Harvesting timber by clear-cutting in mountainous country necessitates the construction of many log-hauling roads which are used only during the logging operation and are abandoned subsequently. Generally, one or two such roads through a clear-cut will be maintained as a part of the permanent transportation system for the entire management unit, but the remainder of the road network used in the logging operation is abandoned. About one-tenth of the total area on an average clear-cut is devoted to roads (Silen 6) which represents a worthwhile area supposedly capable of growing trees. The road bed represents a different microsite than that created by logging and burning. Therefore, it was decided to observe separately the regeneration that was occurring on the abandoned logging roads. The data for the logging road regeneration portion of this report was taken on 24 of the 50 clear cuts used for the entire study.

The sampling scheme consisted of examining ten-foot square plots laid out on flat portions of the logging roads. The cut-and-fill portions of the roads were not considered. Six factors were considered in addition to those used for the clear cuts previously discussed. The factors were (1) steepness of the road; (2) steep-

[1]This section was written by a senior forestry student, Robert Semrad, while he was on the National Science Foundation Research Participant program at the University of Montana, Missoula.



Untreated clear-cut after logging



Clear-cut treated by windrow slash piling followed by burning ness of the hill above the road; (3) depth of the road cut; (4) material forming shade competition to seedlings; (5) amount of erosion present on the logging road; and (6) depth of the erosion on the logging road.

In the examination of regeneration on logging roads, the only factors that showed statistical significance above 95 percent level for 556 samples were age of the clear cut and elevation. The abandoned logging road, however, compares favorably with the scarified surface as a seed bed. Once the compaction from log hauling has ceased and the soil has had a chance to stabilize, these abandoned roads form a suitable seed bed and do not need to be considered land wasted for the production of timber.

TABLE 15

CLEAR-CUT AGE EFFECT ON LOGGING ROAD RESTOCKING

Number of Years Since Logging	Percent of Plots Stocked
5	88
6	74
9-13	94
All plots	85

The regeneration that appeared on the abandoned logging roads was adequate in clear-cuts that were at least five years old. The values in Table 15 are highly significant. The logging roads were compacted during the logging operation, but soon after the truck travel ceased the soil became loose enough through the action of the weather to form a satisfactory seedbed for coniferous regeneration.

TABLE 16

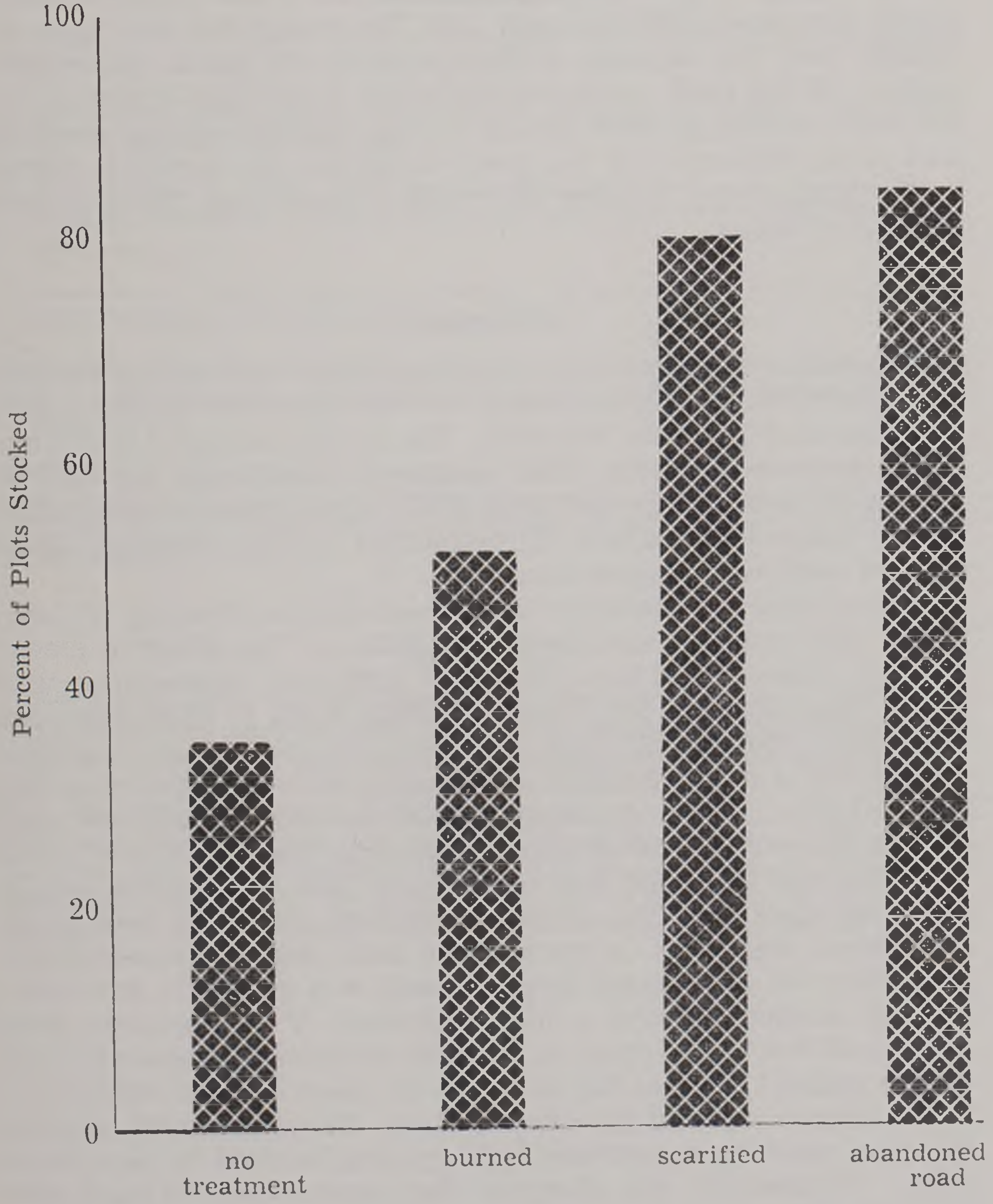
EFFECT OF ELEVATION ON LOGGING ROAD RESTOCKING

Elevation Above Sea Leavel	Percent of Plots Stocked
2000-3999	78
4000-4999	100
5000-6000	91
All plots	85

The effect of elevation on logging road restocking was highly significant. The greatest percentage of stocked plots was found between the elevations of 4,000 and 6,000 feet. This may be due to the more severe diurnal temperature differences found at the lower elevations.

FIGURE 2

MICO-SITE CONDITION



The logging roads examined in this study were on clear-cuts of all aspects, at various positions on the slope, at elevations between 3,000 and 6,000 feet, and from five to thirteen-years-old.

Comparisons shown in Figure 2 of stocking on logging roads to stocking on various other types of seedbeds showed the logging roads to be slightly more productive. This increase in productivity may have been caused by several factors. (1) The competion was decreased by removing the previous plant growth. (2) Less cover was provided for rodents, so that the seeds had a better chance of germinating. (3) The duff was removed, providing a mineral soil seedbed. (4) The water did not move so rapidly over the exposed surface because the roads follow the contour of the land, consequently, more water was absorbed by the soil. Seedlings were found in the "tracks" of the road as well as in the center of the road; however, the seedlings found in the tracks were smaller and farther apart than those in less compacted areas.

SUMMARY

The status of regeneration following clear-cutting was studied during 1964-65, on approximately 50 clear-cut areas within a 100-mile radius of Missoula, Montana. The study revealed a minimum of six years was needed after cutting in most cases for half of the areas to be restocked with coniferous regeneration. After eleven years had elapsed, three-fourths of the clear-cut areas showed sufficient regeneration.

Several of the statistically significant factors affecting restocking of clear-cuts are summarized as follows: The effect of elevation was rather broad for areas below 3,000 feet; regeneration was better than average for elevations from 3,000 to 6,000 feet; for clear cuts above 6,000 feet, regeneration was below average. Aspect had a definite effect on stocking, but the effect was not as great as might be expected for this latitude. North and east aspects showed somewhat greater stocking than south and west.

We believe that seed bed preparation had the greatest single effect on stocking. The seedbeds scarified, either by logging or intentional treatment, contained the most regeneration and regeneration on abandoned logging roads was generally adequate. Burned surfaces showed a higher percent of regeneration than unburned, but not as great as scarified surfaces. Distance to seed source under 1,000 feet did not seem to make as much difference in stocking as some of the other factors. Heavy livestock grazing retarded stocking somewhat; light grazing seemed to have little effect. It generally was observed that regeneration of larch was more abundant and appeared sooner after logging than did Douglas fir or ponderosa pine. The area covered in the study was not as fully stocked as one might like for perfect conditions of forest management, but it was stocked to the extent that with some artificial regeneration by planting on the severe sites and on places over 1,000 feet from seed, adequate stocking could be achieved.

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APPENDIX

When this study was commenced, we realized that there were many factors affecting seedling establishment on clear cuts. We attempted to recognize as many of these factors as possible and to collect enough information so that their relative importance could be assessed by statistical test. The data gathered included 23 variables, the code for which follows. This code was applied to the standard "Porta-Punch" data card with 40 columns. The "item" number refers to the column number as shown on the sample template for the Porta-Punch; the "code" refers to the number punched in the appropriate column, number 9 being the last or bottom number in each column.

AREA	PLOT	YEAR									TIMBER TYPE								SEED SOURCE					DUFF			STOCKING			
CODE	NO.	CUT	TREATMENT	RECORDED	ELEV.	ASPECT	POSITION	SLOPE	SOIL	SHADE	BEFORE	AFTER	REGEN.	VOL. LEFT	NON COMM.	LEAVE	SEED BED	TREATMET	DIR.	POS.	DIST.	SPEC.	GRAZING	ORIG.	NOW	CENT.	SP.	NO.	SP.	NO.

Template for Porta Punch Data Collection

CODE

Regeneration Surveys
1/500 acre plots, radius 5.26′

Item	Code
1. Area code—3 digits	1 to 499 used in this study
2. Plot number—2 digits	
3. Year of timber cut—2 digits	
4. Year of area treatment—2 digits	
5. Year data recorded—2 digits	

6. Elevation—1 digit

0'-999'	0
1000'-1999'	1
2000'-2999'	2
3000'-3999'	3
4000'-4999'	4
5000'-5999'	5
6000'-6999'	6
7000'-7999'	7
8000'-8999'	8
9000' and over	9

Determined by use of aneroid barometer.

7. Aspect—1 digit

north, 315 to 45 degrees	0
east, 45 to 135 degrees	1
south, 135 to 225 degrees	2
west, 225 to 315 degrees	3

8. Position on slope—1 digit

valley bottom	0
lower third	1
middle third	2
upper third	3
ridge top	4

9. Slope steepness in percent—1 digit

0-09	0
10-19	1
20-29	2
30-39	3
40-49	4
50-59	5
60-69	6
70-79	7
80-89	8
90 and over	9

This is the slope as measured on the plot with an Abney level.

10. Shade (permanent shade on the plot by 10 percent classes)—1 digit

0-9	0
10-19	1
20-29	2
30-39	3
40-49	4
50-59	5
60-69	6
70-79	7
80-89	8
90-100	9

The percentage of shade was found by determining the amount that the circular plot was shaded at any given time between the hours of 10 a.m. and 3 p.m. by herbaceous vegetation or dead material such as logs and branches.

11. Timber type on area before cut—2 digits

Douglas fir	01
ponderosa pine	11
western white pine	14
lodgepole pine	15
grand fir	33
alpine fir	36
Englemann spruce	41
western hemlock	48
western redcedar	54
western larch	55
hardwoods	70
larch, Douglas-fir	91
ponderosa pine, Douglas-fir	92
cedar, hemlock	93
cedar, grand fir	94

This information was determined by observing the leave stand adjacent to the clear cut if the same timber type prevailed. If not, records of the timber sale were consulted.

12. Regeneration system used—1 digit

clear cut	0
individual seed tree	1
group seed tree	2
shelterwood	3
tree selection	4
group selection	5
accidental fire	6

This refers to the regeneration system used on the particular area as a whole, rather than the situation on a plot.

13. Volume per acre left on the area—1 digit

none	0
1 MBM	1
2 MBM	2
3 MBM	3
4 MBM	4
5, 6 MBM	5
7-9 MBM	6

10-14 MBM 7
15-19 MBM 8
20 and over MBM 9

14. Basal area of residual stand under 9.1 inches d.b.h.

0-10 sq. ft. 0
11-20 sq. ft. 1
21-30 sq. ft. 2
over 30 sq. ft. 3

This item was obtained by measuring basal area with a 10 factor prism at each plot center.

15. Age of the leave stand—1 digit

1- 50 years 0
50-100 years 1
100-300 years 2
over 300 years 3

This was determined by examining stumps near the timber edge if the cutting was done in the same timber type as the leave stand. If the leave stand was a different timber type, increment borings were made in several dominant trees to determine age.

16. Type of seed bed preparation—1 digit

none 0
broadcast burn 1
windrow, burn 2
lop and scatter (no burn) 3
handpile and burn 4
dozer pile and burn 5

This refers to the treatment given the area as a whole following the logging operation.

17. Stand re-establishment method—1 digit

no treatment 0
planted (no seeding) 1
seeded (no seed treatment) 2
seeded (treated seed only) 3
seeded (rodent poison only) 4
seeded (treated seed and rodent poison) 5
planted and seeded (no seed treatment) 6
planted and seeded (treated seed only) 7
planted and seeded (roden poison only) 8
planted and seeded (treated seed and rodent poison) 9

This information had to be obtained from timber sale records of the land owners.

18. Plot seed source—direction—1 digit

north (315 to 45 degrees) 0
east (45 to 135 degrees) 1
south (135 to 225 degrees) 2
west (225 to 315 degrees) 3

Plot seed source—position from the plot—1 digit

up slope	0
across slope	1
down slope	2

Plot seed source—distance to seed source—1 digit

0- 49 feet	0
50- 99 feet	1
100-149 feet	2
150-199 feet	3
200-249 feet	4
250-299 feet	5
300-399 feet	6
400-499 feet	7
500-699 feet	8
700 feet and over	9

Plot seed source—species of seed source—(list one or two)—2 digits

western white pine	0
ponderosa pine	1
lodgepole pine	2
western larch	3
Douglas-fir	4
western redcedar	5
grand fir	6
alpine fir	7
western hemlock	8
Englemann spruce	9

The direction of the seed source refers to the direction that the closest seed source bears *from* the plot. The distance to seed source was either an estimated or paced distance, measured in feet, to the nearest adequate seed source. A group of seed trees was considered to be adequate; one seed tree was not considered adequate. When the seed source contains more than one species, list first (at left) the most promising species from the seed production standpoint and list next (at right) the second most promising seed producer.

19. Grazing use—1 digit

wildlife	**domestic**	
none	none	0
none	light	1
none	heavy	2
light	none	3
light	light	4
light	heavy	5
heavy	none	6
heavy	light	7
heavy	heavy	8

Though not one of the "environmental" factors as such, wildlife and domestic grazing were considered important in the establishment of regeneration. Grazing pressure was arbitrarily considered as none, light, or heavy, depending on the estimated use of the area by deer, elk, and cattle. This determination was made by observing tracks, droppings, and clipping of the plants. Observing animals in or adjacent to the areas during the summer helped to ascertain grazing pressure. Areas where animals spent several weeks were considered heavily grazed, while areas used by animals in passing from one range to another were considered lightly grazed.

20. Original duff depth from undisturbed duff near plot center—1 digit

0.0-0.9 inches	0
1.0-1.9 inches	1
2.0-2.9 inches	2
3.0-3.9 inches	3
4.0-4.9 inches	4
5.0-5.9 inches	5
6.0-6.9 inches	6
7.0-7.9 inches	7
8.0-8.9 inches	8
9.0 inches and over	9

There were generally enough places left undisturbed by fire or machinery in clear cuts where a measure of the original duff depth could be made by opening a small slit and inserting a ruler.

21. Present duff depth at plot center—1 digit
The same applies as for item No. 20

22. Duff condition on plot—called microsite condition—1 digit

no treatment	0
burned	1
scarified	2

23. Stocking: List each of the two most numerous species of seedlings within the plot followed by the number code. If no stocking exists, punch 8—4 digits

western white pine	0
ponderosa pine	1
lodgepole pine	2
western larch	3
Douglas-fir	4
western redcedar	5
grand fir	6
alpine fir	7
no stocking	8
Englemann spruce	9

number of seedlings code

1 to 5 seedlings	0
6 to 15 seedlings	1
over 15 seedlings	2

Fortran II Program

```
C       REGENERATION SURVEY MAP PROGRAM
C       FIRST CARD IS LIBRARY OF SPECIES
C       SECOND CARD IS AREA NUMBER. FORMAT I3
C       LAST CARD FOR EACH AREA SHOULD BE BLANK
        DIMENSION K(20,5),M(20,5),ISP(10)
        READ 50,ISP
     50 FORMAT (10A2)
     43 DO 1 I=1,20
        DO 2 J=1,5
        K(I,J)=0
      2 M(I,J)=0
      1 CONTINUE
        READ 5,NA
      5 FORMAT (I3)
        N1=20
        J=1
        I=20
     16 READ 4,LA,NP,IS,N
      4 FORMAT(2I3,57X,2I2)
        IF(NA-LA)14,12,14
     12 IF(NP-N1)13,13,15
     13 K(I,J)=IS+1
        M(I,J)=N+1
        I=I-1
        GO TO 16
     15 N1=N1+20
        J=J+1
        I=20
        GO TO 13
     14 DO 6J=1,5
        DO 7 I=1,20
        IF(K(I,J)-1) 7,32,32
     32 IF(M(I,J)-2)33,34,35
     33 M(I,J)=3
        GO TO 41
     34 M(I,J)=12
        GO TO 41
     35 IF(M(I,J)-3)36,36,46
     36 M(I,J)=20
        GO TO 41
     46 M(I,J)=0
     41 JI=K(I,J)
        K(I,J)=ISP(JI)
      7 CONTINUE
      6 CONTINUE
        PUNCH 40,NA
     40 FORMAT (30X.23HREGENERATION SURVEY
            MAP//36X8HAREA NO.I4)
        DO 52 I=1,20
     52 PUNCH 42,(M(I,J),K(I,J),J=1,5)
     42 FORMAT (10X,5(I2,A2,10X))
     44 PAUSE
        GO TO 43
        END
```

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of the
Montana Forest and Conservation Experiment Station
School of Forestry
University of Montana
Missoula, Montana 59801

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