CEDAR - HEMLOCK REHABILITATION STUDY

Hetherington, J.C.

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Blaeberry River: Phase II 1968

Phase III 1969

J.C. Hetherington,

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Introduction

This is a general plan which describes, amongst other things, the proposed treatments to be used in Phases II and III of the cedar - hemlock rehabilitation study in the Blaeberry River; the basis for their selection; the principles used in the allocation of treatments to areas; the choice of areas; and the sampling methods. No attempt has been made to prepare a detailed plan of operations since there are too many unknown factors. The final allocation of treatments and determination of boundaries can only be done on the site and sometimes must await the completion of the preceding phase of the work.

It must be borne in mind throughout this study that we are attempting to determine the least cost combination in the rehabilitation of decadent stands and this object is not necessarily achieved by minimising costs in any phase of the operation without due consideration of subsequent phases.

Objects of the Study

To determine some of the relationships between stand conditions, method of clearing, cost of clearing, type of burn, and the method and cost of obtaining satisfactory regeneration in the upper Blaeberry River Valley.

It is the purpose of this study to develop a hypothesis not to prove one. To do this, each phase of each operation must be done as efficiently as possible subject to certain practical constraints on the application of the method and with due regard to co-operation and co-ordination with other phases.

Definition of terms used in the study

clearing — Clearing refers to the process of downing the residual stand and all succeeding treatment up to the burning stage but excluding the preparation of fire guards.

burning — This is the whole process of burning from the preparation of fire guards, through light up to the end of mop up procedures.

regeneration — The restocking of the land by any means to satisfactory standards.

satisfactory regeneration standards — Satisfactory regeneration will be defined as 450 established trees of spruce, Douglas fir or western hemlock, per acre at the end of a five year period after clearing and burning.

treatment class — There are three treatment classes.

(1) Clearing Treatment Class — A single clearing treatment

(2) Burning Treatment Class — A single burning treatment.

(3) Regeneration Treatment Class — A single regeneration method.

Basis for the Experimental Design ("A mighty maze! but not without a plan." Alexander Pope.)

Basically the experimental design is a split-plot design. In essence, a split-plot design is one in which the plots of one experiment are used as the blocks of another. Due, however, to topography-treatment class and treatment class-scale interactions, to practical economic constraints on the acreage involved and other factors, no such orthodox plan can be followed. In spite of this, it would help if it could be determined that certain treatment classes represented plots, others sub-plots and others sub^2-plots. However, it can be readily seen by reference to Fig. 1, that burning or clearing treatment classes could both be plots or sub-plots under different circumstances. All that is certain is that regeneration treatment classes will always be sub^2-plots.

Treatments considered for trial

(a)	Clearing	(i) Chaining
		(ii) Hand falling
		(iii) Shearing
		(iv) Single machine downing and windrowing to three standards.
(b)	Burning	(i) Broadcast burning
		(ii) Burning of windrows
(c)	Regeneration	(i) Planting
		(ii) Direct seeding
		(iii) Bullets
		(iv) Natural regeneration
		(v) Stand treatment

Discussion of treatments considered

Throughout this study it will be assumed that the optimum equipment is used for each phase of the operation. It is the responsibility of the Division conducting the phase to determine the requirements and to carry them out with optimum efficiency within the limitations of the programme.

(a) Clearing

(i) Chaining — Considerable thought was given to the question of strip width and direction in relation to slope. No good reason could be found to specify strip width but it was felt that chaining across the contour was undesirable. There are definite limitations on the use of the chain. It does not appear satisfactory in stands with a preponderance of small diameter material which is bent over, rather than broken or uprooted. It is also limited by a maximum slope of about 30% for efficient working along the contour and by certain ground conditions. Large trees and snags which the equipment cannot handle also present a problem.

(ii) Hand falling — There are no limitations on the use of hand falling but it is likely to be expensive where there is a large amount of small material.

(iii) Shearing — This method has at present a very limited use. Problems arise where the stand is irregular in size or where exceptionally large trees occur. Large numbers of snags, windfalls, hollow and rotten stems are a problem. It is also limited by slope, ground conditions and large amounts of slash. It is not likely to find much use in the Blaeberry but should be considered.

(iv) Single machine downing and windrowing — This method can be expensive but has some very considerable advantages. The usual limitations on slope and ground conditions apply.

It is necessary to determine the relative costs and ease of subsequent regeneration in relation to the width of cleared strip and windrowed material. Too wide a strip means too much pushing around of debris; too narrow a strip makes working the machine difficult. Brush blades should be used by the machines piling the debris to avoid mixing too much soil with the material to be burned. Strip widths must be some function of the planting distance. Overcrowding of trees in narrow strips is pointless; conversely, too wide spacing is inefficient in the utilisation of ground cleared at considerable expense. Crossing contours at or near right angles should be avoided on steep ground.

In general, clearing work should be pre-planned as much as possible as to direction of machine travel, width of strips, etc., and discussed with those responsible for burning and with the Project Co-ordinator.

(b) Burning — Burning will follow all clearing treatments. The main purposes of burning will be to reduce the accumulation of debris in order to permit satisfactory regeneration at a reasonable cost and to reduce fire hazard. Reduction of the depth of the organic layer would be advantageous but should not be an over-riding factor. The feasibility of burning at different times throughout the Spring and Summer was considered but rejected on the basis of possible "mop-up" costs in relation to the value of the information obtained. We know so little, as yet, on how to reproduce burns of a given type that the knowledge that a burn under specific conditions gave certain specific results is of academic interest only.

(c) Regeneration

(i) Planting — This will be the basic method of regeneration used. The purpose of planting will be to provide the basis for the next stand rather than to establish a stand per saltum; that is, to establish the nucleus of the next stand in anticipation of gradual, natural fill-in. This purpose indicates two things. The restriction of planting to species known to be of rapid growth and high potential value and the trial of at least two levels of initial establishment density. This latter conclusion is strengthened by the fact that if heavy debris remains after burning, planting costs can soar at high planting densities. Two densities will be adequate to illustrate this point.

(ii) Direct seeding — Direct seeding is a contentious issue. It is sometimes unreliable and can be expensive where the seed is difficult and costly to obtain. There does, however, appear to be a good case for its trial in work such as this, where heavy slash cover makes planting difficult. I feel that there are limitations to its use, however, which, if ignored, can produce disillusionment. It is unlikely to succeed on potential brush sites; we cannot expect spruce to be successful on exposed south slopes and the sowing should be timed in relation to the climactic conditions of the area to be seeded, particularly if rodents and seed eating birds are numerous in the area. In implementing this technique, the species in relation to aspect and time of sowing must be considered. One limiting factor is that we must not use seed for direct seeding at the expense of seed to supply planting stock. This, for the present, rules out the use of helicopters for broadcast seeding. There are, broadly speaking, two approaches to direct seeding: broadcast and shot seeding. Of the two I favour broadcast seeding for reasons which I am prepared to explain if required. The use of Lodgepole pine and Douglas fir mixtures is suggested for use on south-facing slopes. Lodgepole pine is easier to establish than Douglas fir and will provide some cover in the event of failure of the fir. Moreover, it is not a dense shade-casting species and so will not prevent natural fill in from augmenting the stand in the future.

(iii) Bullets — Bulleted seedlings could be a very convenient way to plant an area which presents a problem to conventional planting methods, due to heavy slash accumulations. That there will be problems to face in this method is certain; frost heaving could be a trouble in Fall planted seedlings; since the seedlings are small, rapid re-invasion of brush species might be troublesome. It is felt to be worthwhile to try this method on a limited scale.

(iv) Natural regeneration — Due to its unreliability and because the composition of the final stand is unpredictable, it is not proposed to leave any area solely to natural regeneration, except within 100 feet of a seed source satisfactory as to species composition and potential seed production. This is, of course, on the assumption that we have adequate stock and seed for artificial regeneration. Natural regeneration will, however, be hoped for to increase stocking in the artificially regenerated areas.

(v) Stand treatment — By this is meant improving the spacing and species composition of areas which have regenerated but contain a large quantity of unsatisfactory stems providing competition to worthwhile trees but which will make little contribution to the final stand. Cutting or poisoning of unwanted stems provides the means of doing this. There are few (if any) areas in the Blaeberry Valley where the stand is sufficiently uniform in size for the method to be satisfactory. In an irregular stand, removal of the larger trees is indicated. If this is done by poisoning, dead trees will be left standing, which is undesirable; if they are cut, they damage the understorey and provide a protection problem because of the slash accumulation, which is equally undesirable. Furthermore, if suitable areas are available, then unless they are large or present an easily protected unit, the cost per acre of protection from adjacent slash burns or the hindrance they present to the simple clearing of surrounding areas, could be unrealistic. This method will, however, be tried should a suitable area present itself but it is feared that it has an extremely limited application.

Treatments suggested for trial

(a) Clearing — Chaining along the contour, hand falling, shearing and single machine downing with windrowing, are all suggested for trial or further trial in selected areas. The selection will be based on known facts as to the limitation of the method as discussed above. It will probably be necessary to fall the snags in the area intentionally burned in 1966. Shearing will be done if enough suitable area can be found to attract a machine and operator.

Three standards of windrowing are suggested for trial; e.g., 1, 2 and either 3, 4 or 5, as follows:

Table 1

Treatment No.	CLEARING		PLANTING		
	Width of cleared strip ft.	Width of Windrow ft.	Lines per strip	Distance apart in rows ft.	No. trees per acre
1	8	16	2	8	500
2	13	20	2	8	330
3	30	36	4	8	330
4[y]	32	34	5	10	330
5[y]	32	34	5	8	410

y same clearing treatment class

The most suitable equipment should be provided in all cases. It is suggested that the windrowing should be done with a brush blade to avoid piling too much soil in among the windrowed material.

Informed and constructive comment would be welcomed on this aspect. Preparation of detailed clearing plans will be the responsibility of Engineering Services Division, as discussed elsewhere.

(b) Burning — Burning will follow all clearing treatments except "stand treatment" and will be carried out as feasible from late Summer on. The actual timing will, of course, depend on the type of summer weather experienced, the nature of the terrain, slash, type of fire guard, etc., but will be varied as appropriate. The burning technique most suited to the type of slash accumulation will be used in all cases. Preparation of detailed plans will be the responsibility of the Protection Division.

(c) Regeneration — In some respects the regeneration phase appears to require more detailed consideration than the two earlier phases, possibly because I am more conversant with this aspect of the problem.

(i) Planting — Available for use in the planting programme will be approximately 64,000 2+1 spruce, 40,000 2+1 Douglas fir and an unspecified quantity in excess of 100,000 2+0 spruce and fir in equal proportions.

Basically there are two types of area to be planted; downed only areas and windrowed areas.

(1) Downed only areas The following treatments are suggested:

Species - Pure fir
- Pure spruce
Row by row mixture of fir and spruce.

Stock - 2+0, 2+1 of both species

Spacing - 8' x 8', 10' x 10' (in practice 450-500 and 300-350 trees per acre, respectively)

This gives a total of twelve treatments but it may not be feasible to apply them all as it is not intended to contravene the basic silvicultural requirements of the species. This will be discussed further below.

(2) Windrowed areas

Species - Pure fir
- Pure spruce
- Line by line mixture of fir and spruce as follows:

No. of lines per strip	Method
2	Pure spruce, pure fir, in alternate strips
4	Fir, spruce, spruce, fir, by lines
5	Fir, spruce, fir, spruce, fir, by lines

Stock - 2+0, 2+1 of both species

Spacing- This has been illustrated in Table 1. The outside rows will be planted as close as possible to the edge of the windrow.

This gives a possibility of the following treatment:

Pure fir in two widths of strip
Pure spruce in two widths of strip
Mixtures in two widths of strip
Two ages of stock

This also gives twelve possible treatments.

(ii) Direct Seeding

At present the size of the direct seeding programme is limited by the amount of seed available. It would be pointless to jeopardize the planting programme by using seed which could be used to greater advantage for raising planting stock. However, during the summer the location of cone-bearing fir, spruce and lodgepole pine will be noted and cones collected, if possible, to help alleviate this famine.

Direct seeding will not be carried out on potential brush sites. Apart from this, following treatments will be used.

(1) South facing slopes

Broadcast seeding of treated, stratified Douglas fir and Lodgepole pine in a 2:1 ratio, as early as possible in the Spring, using a Cyclone type of seeder. An application rate of approximately $\frac{1}{2}$ pound per acre will be used but this may be amended later on the basis of viability, etc. This treatment will be used only in areas difficult to plant and costs should only be compared with other methods on similar areas.

(2) North Facing slopes

Broadcast seeding of treated, stratified Douglas fir and spruce in a 1:1 ratio by number of seeds, as late as possible in the Spring, using a cyclone type seeder. An application rate of $\frac{1}{2}$ pound per acre in total will be used, subject to viability tests, etc.

(iii) Bullets

Approximately 10,000 bulleted seedlings (5,000 spruce and 5,000 fir) are expected to be available. These will be used in areas of heavy slash accumulation, if possible. Potential brush areas will be avoided. They will be confined to one block, if possible and planted pure and in mixture as follows:

2,500 pure fir
2,500 pure spruce
5,000 line by line mixture of spruce and fir.

(iv) Natural regeneration

Artificial regeneration will proceed to within 100 feet of any suitable seed source. The remaining 100 feet will be left to natural regeneration. No other areas will be left intentionally for natural regeneration.

(v) Stand Treatment

If a suitable area is found for this purpose, the regeneration will be spaced to an approximate spacing of 8' x 8'. Every attempt will be made to retain spruce and fir. Methods to be used will be entirely dependent upon the conditions and cannot be anticipated.

Principles to be followed in the Allocation of Treatments

(a) Clearing and Burning Only general principles can be given to guide the allocation of clearing and burning treatments. Most methods used have their limitations, as discussed above. Since the object in clearing is least combined cost, there is little point in using a method totally unsuited to a given area purely for the purpose of replication. In any case, the number of possible treatment/site combinations alone would be too large to accommodate and still engage in an efficient operation. Certain subjective eliminations of treatments must, therefore, be made in advance. Following this the remaining treatments will be allocated to specific areas in order to obtain the maximum amount of information. All attempts must be made to compromise in the definition of area boundaries in order to strike a compromise between the clearing and burning requirements. Neat clearing packages could present a burning problem. However, if the convenience of one operation must be relegated, it should be remembered that burning is normally less expensive than clearing. Preliminary allocation of treatments will be done from maps and air photos when the general area has been determined. Final definition of boundaries must be done on the ground.

(b) Regeneration The cleared area will be subdivided on the basis of the silvicultural requirements of the species and the suitability of the regeneration method in relation to brush invasion, etc. Within this framework, all treatments considered feasible on any unit will be replicated as often as possible within the limitations of block size and crew efficiency. It is probable that a minimum replication area will be in the order of five acres but this will probably not apply in the windrowed areas. The boundaries of each treatment will be marked on the ground and identified so that it can be mapped later. Specific treatments will be allocated following burning in Autumn, 1968.

Since there is insufficient planting stock, seed and bullets to artificially regenerate all the cleared area by the Spring of 1969, the following order will be followed. First, those areas likely to suffer from heavy brush invasion, then the remaining area which should be regenerated first from the northernmost limits of the clearing work and then southwards until supplies are exhausted.

It is customary, but not essential to plant 2+1 stock in the Fall and 2+0 in the Spring. Bullets will probably be more satisfactory if planted in the Spring. Direct seeding should be done in the Spring. For convenience, therefore, all regeneration will be done starting in the Spring of 1969 unless, due to unforseen circumstances, this is not possible.

Data to be collected and Method of Collection

(a) Costing

(i) Pre-operational survey It will be necessary to conduct an intensive survey of the area to be cleared during 1968 to obtain the basic data required for the costing programme of Engineering Services. This data will provide provisional estimates of cost prior to initiation of the clearing programme and additional controlled data for use in future cost predictions.

The size of the samples required to obtain this data will depend upon the factors which normally influence sample size. Since the area will have been pre-typed and provisional treatment class boundaries defined on aerial photographs, samples will be placed randomly within each treatment class (clearing treatment class or burning treatment class, whichever is smaller). These samples will later be aggregated as required, subject to the constraint that number of samples in any unit is commensurate with the variation within that unit. Information on the sampling intensity will be more readily available when the results of the 1967 survey are available. Rapid processing of data should serve to identify any anomalies and enable sampling to be increased if necessary. This work should be done by the crew hired for additional survey work, prior to starting work in other areas. Access may present a problem however.

(ii) Operational phases All phases of the clearing, burning and regeneration operations will be costed. Details of the costing techniques will be worked out later. Basically, the method will be to break the area down into units which are homogeneous for purposes of the particular phase of the operation being costed without hindering economic working. The unit's boundaries may be actual or hypothetical for this purpose. This phase of the costing operations will require the attention of several persons for the duration of the rehabilitation operations.

(b) Regeneration Apart from cost data, the data to be collected on regeneration will, at the present, be confined to stocking and survival. The sampling method used to collect the data will depend on the clearing treatment and the regeneration method. The purpose of the surveys will be:

(1) To assess initial stocking and subsequent mortality in the downed only areas.

(2) To assess subsequent mortality in the windrowed areas.

(3) To assess the amount and value of natural regeneration in the area.

(i) Plantations (including bullets)

(1) Downed only areas Two 1/100 acre circular plots per acre on a random line traverse with a minimum number of twenty plots per regeneration treatment class. The centre of each plot will be marked with a numbered stake (approx. 2% sample). At the time the plots are established, planted trees will be recorded in the manner developed for F.S. 707. Surveys will be conducted for two years following establishment; i.e., late Summer 1969 and 1970.

(2) Windrowed areas One line plot per acre, located randomly, consisting of ten trees each line, the minimum number per regeneration treatment class will be ten lines. The first and last tree in each line will be marked with a numbered stake (2% sample approx.). Survival will be measured in the late Summer of 1969 and 1970.

(ii) Direct seeding A systematic strip sampling system will be used to sample the results of direct seeding. Semi-permanent four 1 mil-acre plot clusters will be established on parallel lines two chains apart at intervals of two chains. For each mil-acre plot the location and species of each seedling will be marked on the form provided. These plots will be assessed in 1969 and re-measured for survival for two years following the year of germination. Assessments will be made in late Summer.

(iii) Natural regeneration A four 1 mil-acre plot cluster, centred on each stake used in the plantation survey, will provide the sample required for the assessment of natural regeneration (0.8% sample). The plots will be assessed and recorded to show the distribution and species of natural seedlings and the location of any planted trees. Assessments will be made in the late Summer of 1969 and 1970 and, after this, as deemed necessary.

In areas left entirely to natural regeneration, the usual systematic stock regeneration cruise will be carried out but data on species and distribution also collected.

Programme Timing

(a) Layout of clearing programme Details of clearing operations for 1968 should be determined on the ground as early as possible in 1968. Preliminary plans will be based on the cost-benefit analysis results of 1967 and provisional boundaries sketched on air photos and/or maps prior to the field visits. These provisional boundaries will be confirmed in the field and marked as and when convenient. The layout of fire guards, etc., will also be done at this time.

(b) Pre-operational cost survey The intensive pre-clearing cost data survey of stand conditions will be carried out in conjunction with the actual marking of treatment class boundaries on the ground.

(c) Clearing This work should start as soon as possible after stages (a) and (b) have been completed in any area.

(d) Burning Preparation of areas for burning should proceed concomitant with clearing. Timing of the burning will be the responsibility of those in charge of this aspect.

Personnel Requirements

(a) 1968 Apart from those involved in the study in a supervisory capacity, i.e., personnel from Inventory, Research, Protection and Engineering and excluding those required for the survey, clearing and burning work, I estimate that two men will be required for costing work. Alternatively, these men could be supplied and directed by Engineering Services but paid for by the Cedar-Hemlock Project.

Provided the programme is laid out beforehand with detailed maps and specifications, no full time supervisor other than the one responsible for the project will be required.

A total of about two man-weeks will be required for cone crop estimation, location of seed supplies, etc. Further help will be required from mid-September on fir cone collection. The amount of assistance will depend on the cone crop size.

(b) 1969 Hiring of planting crews, bullet planting crews, seeding crews, etc., will be the responsibility of the Reforestation Division. Three man-months of appropriately qualified labour will be required for regeneration and survival surveys.

The Selection of Areas for the 1968 Clearing Programme

Two questions are involved here.

(1) The size of the area.
(2) The location of the area.

These two are inter-dependent to a certain extent because, if the area is inaccessible, money, which might otherwise be spent on clearing, will need to be spent on securing access.

The following financial statement for 1968 provides a rough basis on which to work.

Already committed for 1968

Slashing contracts	$ 6,000
Snag falling on 100 acres of 1966 burn	5,000
Salaries and expenses survey and costing teams, etc.	20,000
Equipment (chain, etc.)	10,000
Burning of 600 acres cleared in 1967	10,000
	$51,000

This leaves $49,000 for additional clearing and burning in 1968. Since

(1) Some road repairing or construction may be needed, and
(2) More expensive clearing methods used,

I estimate an average of $60 per acre for clearing. Thus,

600 acres of clearing	$36,000
600 acres of burning	10,000
	$46,000
already committed	51,000
Extras	3,000
	$100,000

A clearing programme of an additional 600 acres, more or less, is thus proposed for 1968. It will be noted that no allowance is made for planting because, since Spring planting is involved, this will be covered by the 1969 fiscal year.

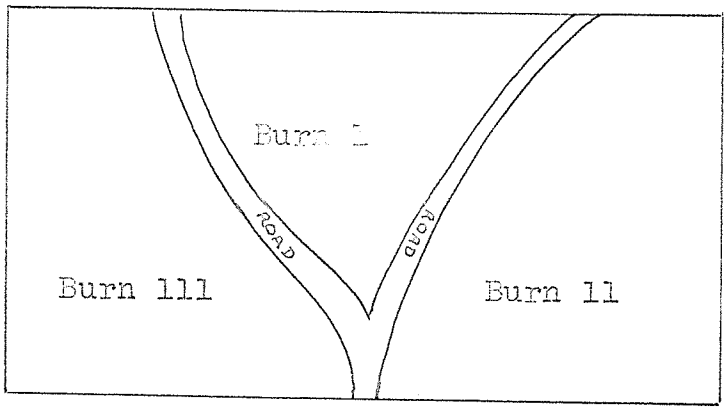
The 600 acres cleared in 1967 have, in general, a south-east aspect. The unalienated land on the south-east side of the river is in general of a higher site quality than that on the north-west side, as the following comparison indicates:

Capability Classes	Area in acres	
	North-west side	South-west side
1 & 2	246.0	466.4
3 & 4	554.8	769.6
4	779.2	308.0
4 & 5	0	464.4
	1,580.0	2,008.4

To accommodate this quality factor, to expend our resources on better-site lands and to introduce the variable of aspect into the study, it is proposed that this 600 acres of clearing for 1968 be concentrated on the south-east side of the river, if this is at all possible. The general area suggested is outlined on the accompanying map.

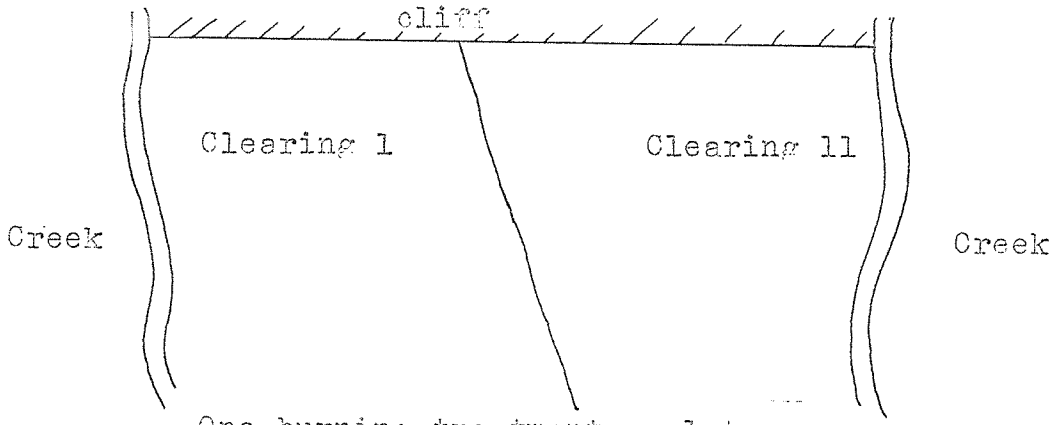
Figure 1

Case No. 1



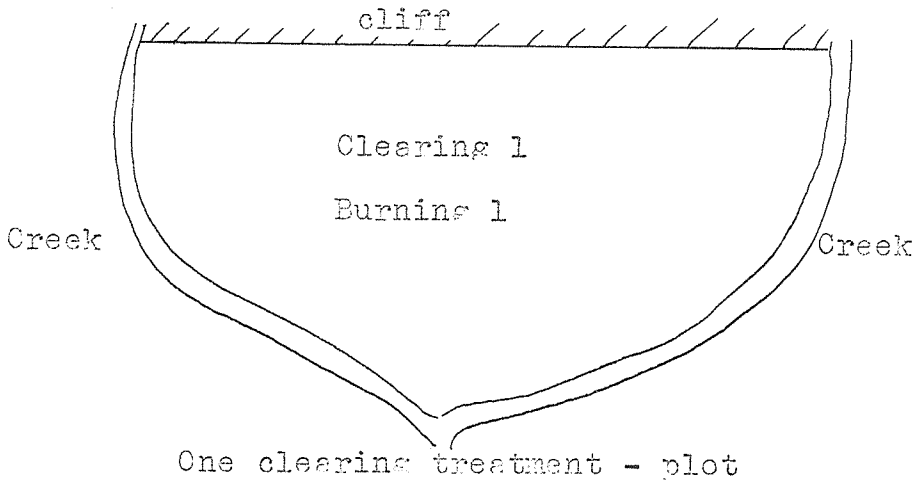
One clearing treatment - plot
Three burning treatments - sub-plots

Case No. 2



One burning treatment - plot
Two clearing treatments - sub-plots

Case No. 3



One clearing treatment - plot
One burning treatment - plot