Artificial Reforestation in the Ten Forest Regions of the United States and Alaska

by

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A Thesis

Presented to the Faculty

of the

School of Forestry

Oregon State College

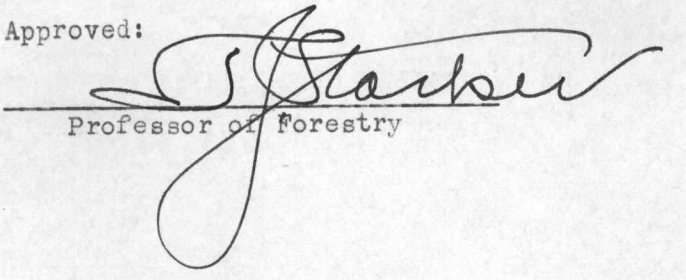
In Partial Fulfillment

of the Requirements for the Degree

Bachelor of Science

June 1938

Approved:



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INTRODUCTION

The following material is a brief, but concise resume of the artificial reforestation that has been carried on in the various regions of the United States and Alaska in the past few years. It is complete to and including 1936. In this paper I have tried to include what has been planted, where, why, and how it has been done.

The reports from some of the regions may seem rather short, but inasmuch as there is no printed material about recent artificial reforestation, I had to rely upon the letters and mimeographed material that was sent to me.

Due to the inconsistency of the various replies, the only outline I could follow was artificial reforestation by the various regions.

ARTIFICIAL REFORESTATION IN REGION ONE

I should like to quote the following analogy from a report of Forest Planting in Region One by Percy E. Melis. "Planting as a phase of forest management may be likened to skin grafting as a phase of bodily care. It is the last recourse in repairing the damage caused by accident, particularly a severe and extensive burn. As skin grafting is slow, tedious, and expensive, and the necessity therefore to be deplored; so is planting a slow, tedious, and expensive silvicultural process, and the necessity therefore should be avoided insofar as possible. Forests, even with the constant and continued improvement in fire control measures repairing the damage caused by fire, will be a major silvicultural problem for many years."

Artificial reforestation in Region One has now been in progress for over 25 years, and a total of approximately 75,000 acres have been planted. The early efforts were largely experimental, while methods of propagating and field planting the several desirable tree species were being developed and improved. Many failures were recorded in this process, but net results to date show approximately 50,000 acres successfully re-established to a half-stocked stand or better, which is the criterion of a successful plantation; and the development of a planting technique which affects the successful restocking of over 80% of the areas now being planted.

There planting operations can be logically segregated into five closely related activities, namely: seed collection and extraction, nursery production, selection of planting sites, field planting, and plantation examinations at definite periods to determine and record the degree of success obtained.

The seed harvest in Region One is an annual fall activity. For purposes of estimating the amount needed, one bushel of tight, fresh cones is expected to yield approximately the amount of seed required for sowing one standard seed bed, four by twelve feet, to either Western White pine or Ponderosa pine. With reasonable fresh seed of average viability, eight ounces per bed of White pine, and sixteen ounces of Ponderosa pine per bed are normally used. These amounts of seed are expected to produce approximately 2,000 Ponderosa pine, or 3,000 White pine seedlings per bed. The cones are gathered almost entirely from squirrel caches where they have been stored for winter food. This appears to result in no hardship to the squirrels, merely serving to stimulate them to greater activity in making further provision for their needs. Two seedplants are operated where the cones are assembled, thoroughly dried, the seed extracted, cleaned, and shipped to the Nursery. During the last fall season, 2,495 bushels of Ponderosa pine cones and 2,228 bushels of Western White pine cones were gathered. The yield of seed from the White pine cones was exceptionally low this season, netting only 808 pounds; while the yield of Ponderosa pine was "very good," totaling over 3,000 pounds.

All of the planting stock for use in Region One is produced at Savenac Nursery, which is operated as a distinct unit by the Forest Service. From this central nursery, located near Haugan, Montana, stock is shipped for planting on National Forest lands throughout Northern Idaho and Western Montana. The production plan was stabilized for many years at approximately 3,000,000 trees annually, but in connection with the recently increased emphasis on reforestation, it has been expanded to 5,000,000 trees. Further expansion is now in progress, and current sowing is being made to produce 10,000,000 seedlings and transplants each year.

Over a period of years the production will average about 50% Ponderosa pine, 30% Western White pine, and 20% Engelmann spruce, with very small quantities of other indigenous conifers--Douglas fir, Western Red cedar, and Western larch. The amount of White pine stock at the Nursery is at present quite low due to a sharp decline in sowings a few years ago when the control of the White pine blister rust appeared less assured. The control program has now advanced so that increased sowings are being made for planting on protected sites.

Survival studies of field planting show a superiority of 2-2 White pine stock and 1-2 Ponderosa pine stock in comparison with other age classed of these species and, accordingly, stock of these classes is favored in nursery production. However, since seedling stock is much less expensive to produce, requiring much less labor, space, and time; and since, in favorable planting seasons and on the best sites, entirely satisfactory survival is obtained, some seedling stock is produced for shipment each year. The distribution schedule for spring of 1936 will comprise species and age classes as follows:

Ponderosa pine-----1-2------	3,066,000
Ponderosa pine-----2-0------	2,458,000
Western White pine-2-2------	158,000
Engelmann spruce---3-0------	150,000
Total.....	5,832,000

The small trees are counted into bundles of 100 trees each at the Nursery, baled into units convenient for handling, and shipped to the planting site where they are "heeled in" until needed for planting. In all handling of nursery stock, extreme care is required to avoid damage by drying, heating, or mould.

Forest planting in different localities may be for the production of commercial timber, the control of erosion, the regulation of stream flow, the protection of wild life, or recreational and aesthetic purposes. In Region One, since the area to be planted is far greater than the present program will accomplish for many years, only the most productive soils of denuded areas within the commercial timber zone are selected for planting. This limitation assures the most advantageous combination of the bemefits listed above, since the growing of merchantable timber also results in the other desirable effects of a forest cover.

The high degree of selectivity required in determining areas to be planted is accomplished by intensive planting surveys conducted from one to five years in advance of planting, in which consideration is given to accessibility, elevation, soil, aspect, evidence of the former timber stand, and site indicators which may be recognized among the species of brush that first appear on the area. Planting type maps are prepared as a guide in field planting and to serve as a base for plantation records. The planting surveys of the past year covered somewhat over 30,000 acres and somewhat less than 11,000 acres, or approximately 35% was typed as plantable. A comparison of these figures, with due consideration to the fact that only high grade areas are surveyed, gives a clear conception of the degree of selectivity that is used in this work.

Non-reproducing burns are classed as plantable only when a combination of all factors is definitely favorable. In addition to eliminating areas on account of elevation, inaccessibility, poor soil or ruggedness of topography, brush areas of any species sufficiently dense to constitute a major problem in controlling the spread of fire. The survey crew recommends the species to

be planted on all areas classed as acceptable for planting and further rates the site into one of three quality classifications--excellent, good, and fair. Natural White pine sites outside of the blister rust protection zone are listed for planting to either Ponderosa pine or Engelmann spruce, depending on site factors. This detailed information is used in planning the field planting operations.

Field planting is carried on both in spring and fall, but a study of plantation survival indicates an advantage in spring planting. In spite of this indicated advantage, it is often desirable to plant some sites in the fall on account of availability of labor, or on account of snowdrifts or otherwise impassable roads in the spring. A planting crew consists of from 12 to 15 men, each of whom is equipped with a bag of trees and a short handled-long bladed mattock especially designed for tree planting. In good soil, a single stroke with the mattock will penetrate to the full length of the nine-inch blade and a few deft movements will open a rectangular hole about two inches square and nine inches deep. The tree is set in the hold with care to prevent curling or matting of the roots, and the earth is then very firmly tamped to eliminate any air pockets and to bring the tree roots into close contact with the moist earth.

Care is used in selecting the individual location for each tree so that it will have the best possible chance to survive and grow. When a seven by seven foot spacing is used, the planters are urged to select the best location within a radius of three feet for placing each plant. It is much more important that the trees be given the advantage of any natural shelter that the site affords, such as stumps and logs, than the planting be done according to a precise pattern. Various spacings have been used for different classes of

stock, but the present planting practice has been standardized at a spacing of seven by seven feet, or 890 trees per acre. Rock outcrops, small thickets of dense brush, occasional small areas of natural reproduction, and comparable locations are skipped in planting, so that the average number of trees actually planted per acre at this spacing is approximately 850.

At the time of planting, a small percentage of the trees are marked by the establishment of a staked row, which serves as a sample of the area. This staked row consists of the setting of painted stakes alongside of individual trees in a more or less irregular course, which can be followed in later years across the area. An attempt is made in the establishment of this sample row to cover the work of all the planters and all variations of site conditions in representative amounts.

Formal examinations of the plantations are made after the first, third, and tenth growing season. In the first two examinations the staked row is followed and all living and dead trees counted. The living trees are classified as to degree of thrift, and the dead trees are dug up and, if possible, determination of the cause of death is recorded. The information gained thereby shows where additional emphasis is most needed in improving the planting practice. Precipitation during the first few months after planting is by far the most important factor influencing survival that is not subject to some control. Sturdy nursery stock can be produced, favorable site selected, and effective technique followed throughout; yet many trees will fail to establish themselves if the area is subjected to extreme drought during the first year. For the past twenty-five years, the average survival, including total failures and losses of all kinds, has been approximately 50%. Records of survival in individual plantations of 90% are, however, not uncommon.

Under present planting practice an average survival of 80% is considered highly satisfactory and even 70%, if well distributed, will result in a fully stocked stand.

By far, the heaviest mortality in planted trees occurs during the first summer after planting, but a small loss generally continues during the two following years. The acreage of one and two year old plantations is held in abeyance with respect to the survival record, and the plantation definitely classified on the basis of the third year examination. The survival is recorded on the basis of well-distributed, living trees per acre in classifications as follows:

Failure-------- 0 to 99 trees

Part. success--100 to 249 "

Success--------250 to 499 "

Super success--500 trees and over

The tenth year examination consists of a comprehensive, silvicultural review of wide informational value. Very rarely is there sufficient loss after the third year to require a revised survival classification.

Costs of forest planting vary so greatly with differences in nursery costs, class of stock used, accessibility, and size of the area planted that averages may not be applicable to any specific area. However, costs are always important and even this brief discussion would be imcomplete without some mention of them. The average weighted cost per acre of all stock used in 1935 was $2.92, as compared with an average figure of $3.62 for the preceding five years. The average weighted cost of all planting, including cost of stock, overhead, depreciation of equipment, and nursery improvements, and all other charges, for 1935 was $10.43 per acre, as compared with the preceding five-year average of $9.65. From these based on 5,943 acres planted in

1935, and a total of 22,887 acres planted during the preceding five years, a close approximation of $10.00 per acre is used im making general calculations of cost of reforestation by planting. Appropriate adjustment factors are applied when considering any special job.

Intensive forest management is steadily becoming more necessary through the increasing economic and social demands on the wild land of the Nation; and planting, as a phase of intensive forest management is expected to play an increasingly more prominent part as an aid to nature in reforestation activities, especially in repairing the damage caused by fire.

ARTIFICIAL REFORESTATION IN REGION TWO

Under the direction of the Regional Office the Forest Service is operating three nurseries as follows: Bessey Nursery, Nebraska National Forest, Halsey, Nebraska; Monument Nursery, Pile National Forest, Monument, Colorado; Pole Mountain Nursery, Medicine Bow National Forest, Laramie, Wyoming. The capacities of these nurseries are approximately 5 to 6 million each for the Bessey and Monument Nurseries, and 280,000 for the Pole Mountain Nursery. These nurseries are growing coniferous species including Ponderosa and Lodgepole pine, Douglas fir, Engelmann and Blue spruce, Eastern and Rocky Mountain Red cedar as the principal species.

A limited portion of the output of the Bessey and Monument Nurseries is made available to the various States within this Region for Clarke-McNary planting activities. This work is handled through the State Extension Forester or other State agencies. The remainder of the nursery production is planted on the National Forests within this Region. The present annual acreage planted on the National Forests within this Region is slightly in excess of 6,000 acres which is divided between the States of Colorado, Wyoming, South Dakota, and Nebraska, with perhaps Colorado and Nebraska planting the larger acreages under normal conditions.

The reforestation program in this Region has been under way since approximately 1903 on the Nebraska Forest, while the Colorado plantations have been built up mostly within the last 25 years. In Colorado the principal objective in the forest planting has been the improvement of the watersheds of some of the larger cities, such as Denver and Colorado Springs, on which areas the natural forest cover was destroyed many years ago by fires

and early logging activities. The planting on the Nebraska Forest has been more or less of a demonstrational nature, with the idea back of it all of growing timber products which would have a sale value in a territory in which natural timber is largely lacking. Planting in South Dakota and Wyoming has been, for the most part, on burned-over areas which are inadequately restocking naturally. The results of planting in this Region have been, on the whole, successful, although during unfavorable seasons and drouth periods severe losses have been experienced.

Ponderosa pine, Douglas fir, and Englemann spruce are, from the latter standpoint, the most desirable species for planting. 3-1 Engelmann spruce, 3-0 Douglas fir seedlings have proven satisfactory for planting on the average site. The trees are usually spaced 8 x 8 feet; the planting being done in the spring of the year. The grub hoe is the most practical planting tool for use on the rocky, brushy sites characteristic of the Southern part of the Region. The bulk of these lands lie at the higher elevations in the Engelmann spruce type. Less extensive areas are scattered through the other forest types. The more recent burns are more urgently in need of planting than the older ones, because erosion is still in progress on them, whereas the older burns have a heavy grass sod developed on them to stop erosion.

ARTIFICIAL REFORESTATION IN REGION THREE

Two broad timber types are found in Region three, the woodland and the sawtimber. The former is composed of several species of juniper, pinin, and oaks, and the type is usually found on areas receiving from 12 to 20 inches of annual precipitation and between the elevations of 5,000 to 7,000 feet. The sawtimber type is made up of three sub-types; the Ponderosa pine type, which is practically pure, makes up by volume approximately 80 percent of the stand in the Region, and is found between the altitudinal ranges of 7,000 to 8,000 feet; the Douglas fir type occurs just above the pine between the elevations of 8,000 and 9,500 feet, and is composed largely of Douglas ans White fir, Mexican White and Limber pine; and the spruce type, occurring at elevations from 9,500 to timberline, which is usually found at an elevation of 11,500 feet.

The majority of the sawtimber type in Arizona and New Mexico is publicly owned, consisting of National Forests, Indian reservations, national parks, and state lands. The publicly owned lands are cut on a selection system, and there is reserved on the cutover land from 20 to 30 percent of the original volume. The private lands in both states are heavily cut, but barring fire and with reasonable management will continue in timber, but the second cut will be long deferred due to the heavy removal.

On the private and public cutover lands, natural reforestation is expected, and the natural restocking on the older public cutting areas shows that faith is well-founded. The same selection system of cutting is practiced in the woodland type, and for the most part natural restocking is taking place. Artificial reforestation in this Region in the past has been largely

on an experimental basis, and work was undertaken in the sawtimber type with stock produced in small nurseries, some of which have now been discontinued. This work shows that even under the difficult conditions encountered in this Region, it is possible to reforest artificially if good stock is produced and if careful planting is done, but the cost per acre is high.

At the present time one small nursery in the Douglas fir type is being operated by the Southwestern Forest and Range Experiment Station. This nursery produces Douglas fir stock, which is used to plant experimentally lands in the Douglas fir type. Another nursery in the Ponderosa pine type is just starting, but stock from this nursery will not be available until 1939. The stock will be used to plant heavily denuded lands, cutover before the establishment of the national forests. 2-1 stock will be planted on these areas.

According to Westveld forest, planting will never become an important project in this Region. It seems that such marked improvement in the progress of natural regeneration in the Ponderosa pine type that it now appears that, by properly controlled cutting and grazing, adequate reproduction can be secured. Getting natural reproduction with fir and spruce has met with less success, but that is not an important factor because of the low economic value of these two species.

ARTIFICIAL REFORESTATION IN REGION FOUR

There has been comparatively little planting done in Region 4 since about 1920. Previous to this time considerable work had been done on old burns throughout the Region both by seeding and planting. Some of this work was successful and some was not, due largely to drouth conditions. In any event, in 1919, due to shortage of labor and to the fact that a very small acreage was available and suitable for reforestation, such work was abandoned for the time being. Nothing was mentioned of the destructive work done by the birds and rodents when an area was seeded.

Since that time much experimental planting has been done on a small scale to determine best practices and most desirable species to plant. The following schedule of planting done during the fiscal year 1935 is as they said, "representative of the work being done in the Region at present":

Forest	Species	Acreage Planted
Cache	Pinus contorta	1.5
	Pinus ponderosa	3.5
Humboldt	Pseudotsuga taxifolia	1.0
Nevada	Pinus ponderosa	1.0
	Pseudotsuga taxifolia	2.0
Ashley	Pinus ponderosa	5.0
Dixie	Pinus ponderosa	11.5
	Pseudotsuga taxifolia	2.5
Fishlake	Pinus ponderosa	2.0
La Sal	Pseudotsuga taxifolia	3.0
Manti	Pseudotsuga taxifolia	2.0
	Pinus ponderosa	7.0

Forest	Species	Acreage Planted
Uinta	Pinus ponderosa	10.0
	Pseudotsuga taxifolia	4.0
Wasatch	Pinus ponderosa	2.5
	Pseudotsuga taxifolia	.5
	Picea pungens	.5
	Total - -	59.5

They believe that, as a result of experimental work done during the past 17 years, they are in a good position to resume planting. Also they again have large areas in need of reforestation due to the severe fire seasons of 1931, 1934, and 1935. As a result, they are now building nurseries; one of the Cache Forest with a capacity of 3,000,000, and one on the Idaho with a capacity of 1,000,000 seedlings. When these nurseries are established and operating, they expect to embark on a rather large reforestation campaign.

In as much that Region 4 has planted only 60 acres in experimental work in the last 17 years, I do not feel that their compilations of data would be as accurate if it had been done in the past 5 or 6 years. Over that period of time, with such small plantations, the surrounding site could change, climatic conditions could change, and various other factors would enter to make their data inaccurate.

ARTIFICIAL REFORESTATION IN REGION FIVE

There are a great many factors acting individually or in combination which definitely limit the extent and character of the work that may be accomplished in reforestation. In Region 5 the two factors which make it extremely difficult to conduct a successful program of reforestation are: 1. The long, dry summers with high temperatures, which limit the amount of soil moisture that is available for establishment of tree growth. 2. The prevalence on lands to be planted of a dense growth of shrubby plant species, which competes with planted stock for the limited available soil moisture, and which is a severe handicap to the mechanics of planting. This combination in the Southern part of the Region is so detrimental in its effect on planted trees, particularly because the dry season is of longer duration than in the Northern part of the Region, as to practically prohibit successful establishment of tree growth. For this reason, administrative planting was suspended in the Southern part of the Region in 1915, and has not been resumed to date. Small experimental plantings are still being made annually in this part of the Region, in an endeavor to determine the tree species best adapted for growth there, and the technique that will make possible resumption of administrative planting.

In the Northern part of the Region, the effect of the combination of factors mentioned was reflected in exceedingly high cost per acre for planting and in very poor survival. Therefore, in 1920 planting work was suspended in the Northern part of the Region for the reason that much better results could be secured in other Regions at less cost. After the disastrous fire season of 1924, three small plantings were made on areas that had been

burned over that year. This planting was a success, and indicated that restocking of recently burned over areas, before such areas were invaded by brush species, could be undertaken at a nominal cost with reasonable prospects that results would be successful. This marked the resumption of administrative planting in the Northern part of the Region.

As a result of these trials, when planting was resumed, the work was confined to planting on recently burned over areas. It was stated that the Regional objective was to plant lands within the range of commercial timber types where timber cover has been destroyed, and where restocking with tree growth could not be expected from natural regeneration, and that this principally involved planting on recently burned over areas. An administrative nursery was established at Susanville in 1928 to produce stock for planting on those East side forests, the Lassen and Plumas, which had large burned over areas as the result of recent fires. Later the program was extended to take care of such areas on the Modoc. Past experience had indicated that the best results were obtained with 1-1 planting stock, so production was confined primarily to this age class, and to the two principal timber species characteristic of East side timber types, Pinus ponderosa and Pinus jeffreyi. Production at the nursery was first planned to produce sufficient stock for an annual planting program of five hundred acres and the first allotment of stock was distributed in 1930. In 1933 the production at the nursery was increased to provide stock for an annual planting program of one thousand acres. Production at the nursery has been gradually increased since then until, at present, the annual planting program is two thousand acres, involving planting projects on seven forests.

It was recognized, from the very beginning of the resumption of reforestation work in the Region, that the policy of planting principally on

recently burned over areas offered little possibility for the development of a stable program of reforestation, and was not adequate to provide for all the needs of reforestation in the Region. The necessity of using 1-1 stock required that stock production be planned two years in advance of planting. The extent of areas denuded each year by current fires varied. This uncertainity of occurrence and extent of burns in sites made it difficult to plan the work for two years in advance of planting. No provision was made for any treatment of the enormous areas in the Region which were burned over many years ago, and definitely constitute a part of the reforestation needs of the Region. Very few of these areas have restocked with timber species, in fact, the major portion of this denuded land has restocked with brush species. Past experience in attempts to reclaim these brushfields by ordinary methods of planting have failed, as this dense brush is a serious obstacle to the mechanics of planting, and survival of plantings made in brush covered areas have been low. Therefore, any treatment of these brushfields that would permit the establishment of tree growth at reasonable cost, thus making it possible to include these areas in the reforestation program, was desirable. Clearing brush from such areas by burning, as a preparatory measure for planting, was not a success. It was a hazardous undertaking, and the results did not justify the risk involved. It destroyed the surface growth of brush, but with little or no injury to the extensive established root system. This type of clearing eliminated brush cover as a hindrance to the mechanics of planting, but contributed little toward ameliorating the condition with reference to root competition.

The development during the past few years of heavy motor-powered road building equipment placed a tool in their hands, the tractor trail-builder, which furnished a practical means of preparing these brushfield areas for planting. With this machine, cleared strips approximately six feet wide

could be made through the most dense stands of brush. Clearing strips with this machine not only removed the surface growth of brush, but also broke up, up-rooted, and scattered a large part of the root system. Trees could then be planted in these cleared strips by ordinary methods of planting. A small number of these cleared strips were first prepared and planted in 1931, and a slightly greater number in 1932. The results of these trials, although not conclusive, indicated that this method of treating brushfield areas for planting had very promising possibilities. The hindrance of brush cover to the mechanics of planting was removed. Root competition was so reduced that survival of planted trees was excellent. Indications were that this type of preparatory work could be done at a cost not greatly in excess of cost of preparatory work being done in other Regions. The technique of preparing this cleared strip appeared to be about right, but the areas that could be prepared were limited due to the mechanical performance of present day equipment in use. It was found that the work had to be confined to treatment of brush-field areas where slopes are moderate, and where there is little or no surface rock. Improvement and development of equipment better suited for this work is being made each year.

After 1932, preparation of cleared strip as a method of treating brush-field areas for planting was incorporated as regular part of the Region's program of reforestation. The annual program for work of this nature has been gradually increased since that time, until, at present, six hundred miles of cleared strip are being prepared each year. The present planting schedule now provides that the annual planting work be divided about equally between planting areas not requiring preparation and planting areas requiring preparation. Areas of relatively recent burns requiring no preparation work at present, might require preparation if permitted to go unplanted too long.

On the other hand, the physical aspects of the old burned areas requiring preparation will not change so greatly over a period of years as to increase the difficulties of the work. Therefore, the amount of this type of planting may be increased or decreased from year to year, with knowledge that such fluctuations will not materially increase the difficulties of future work. This provided a more stable planting program with sufficient flexibility to permit giving priority to planting new burns, the need for which cannot be accurately anticipated. The planting policy for the Region has been revised so as to incorporate this additional work as part of the plan for reforestation. It is now stated that the Regional objective is to plant lands within the range of commercial timber types where timber cover has been destroyed, and where restocking with tree growth cannot be expected from natural regeneration, and that this principally involves planting on recently burned over areas, and on old burns where timber cover has been replaced by brush.

ARTIFICIAL REFORESTATION IN REGION SIX in 1935

Inasmuch as Region 6 is closer to home, I feel that it should be treated more thoroughly. The following material will be a brief resume of the annual planting reports of 1935 and 1936.

An important feature of the planting work in this Region curing 1935 was the increase in planned nursery production to 3½ million trees annually. During the previous two years the output had varied from 2¼ to 2½ million and prior to that, somewhat less than 1½ million. This increase was made more adequately to meet the planting need of the Region arising not only from the acreage requiring treatment already in the national forests, but also from the expectation of the addition of considerable amounts by acquisition.

Owing to the curtailment in regular funds during the past three years, an increasing proportion of planting work has had to be carried on through emergency agencies. In 1933 some phases of nursery work, and 39% of the planting acreage was done by CCC. In 1934 the proportion was 58%, and this year it was increased to 72%, including with CCC a small amount of ERA. This has brought about several rather significant changes in the character of the work. Selection of projects has had to be contingent upon the location of CCC camps, and in some cases, could not be made on the proper basis of priority. With the tendency of the camp locations to become more fixed, and the restrictions on the number and character of spike camps, particularly when away from the roads, the selection of suitable projects is becoming more difficult.

Another effect has been to reduce the size and increase the number of individual operations, and to divide them between fall and spring in order

to utilize all of the available stock. The break in the enrollment periods comes right in the middle of both planting seasons, and usually results in a severe curtailment in available personnel for a considerable time. Because of this, it is impossible to cover a large area (800 to 1000 acres) in a single operation. This multiplicity of operations makes it difficult to supply adequate experienced supervision and inspection for each job.

A third effort resulting from the use of CCC is a distinct lowering in the quality of planting. This is particularly true when the crews are made up of new enrollees who have just arrived in camp, and many of whom have had no experience in the use of tools.

With the first trees from the increased nursery production ready for outplanting in the fiscal year 1937, it is greatly to be hoped that a larger share of the work can be financed from regular allotments. To accomplish it entirely in this manner will require an allotment of $60,000. On the basis of thus financing the major portion of the nursery, 50% of the field planting and the regional office overhead will require $40,000.

Another departure, in 1935, from former practice was the emphasis placed upon the planting of roadside protective strips as a measure of fire hazard reduction along roads which traverse burned and cut-over areas. These strips are oridinarily 300 feet wide and a close spacing of 6 x 6 feet is employed in order to establish more quickly a dense stand which will shade our vegetation underneath.

Plantations established in the calendar year 1935 totalled 2,777 acres, divided into 1,743 acres in the spring, and 1,034 acres in the fall. Although this acreage is less than half of the previous year, this fact does not mean that the planting program has actually been curtailed to this extent.

Rather it is due simply to the fact that the spring acreage was relatively small because of a heavy program the fall previous (both drawing on nursery output of the same "production year"), and that fall operations were similarly curtailed by adverse weather conditions.

As usual, Douglas fir was the chief species, comprising 94% of the total acreage. The remaining 6% was Ponderosa pine. Transplant stock still led numerically, but the proportion of 2-0 root-pruned stock increased to 40% of the total Douglas fir acreage, thus indicating the rapid progress being made in changing over to the use of this class of stock.

The spring planting season opened somewhat later than usual, but was otherwise normal, and the various operations progressed without delay. In the fall, conditions were quite the reverse. A sudden cold snap with considerable snow came at the end of October when most projects had either just gotten underway or were about to start.

Planting costs for the year, including cost of stock, averaged $9.11 per acre for all species. For ECW projects, costs were computed at the rate of $1.50 per day for wages of enrolled men, and actual expenditure for facilitating personnel and contributed time. On ERA and NIRA projects the basis was actual wages paid. This average figure of $9.11 compares favorably with the average of the previous year of $10.05. The maximum number of 1200 Douglas firs per acre occurred where the spacing of 6 x 6 feet was used to form roadside protective strips.

First year survival in spring plantations ranged from 35%-85% with a weighted average of 79% for all species. This was believed to be somewhat lower than past years, but the reason was chalked up to inexperience of the planting crews. For the first-year survival in fall plantations, reference

must be made to those of 1934 rather than 1935. For these, reports thus far submitted, covering 60% of the total acreage, indicate an average survival for all species of only 63%.

In recent years, survival in the limited Ponderosa pine planting that has been attempted has been very unsatisfactory. Rodent damage has often been held partly responsible, but drought has been usually ascribed as the chief cause. Unquestionably there has been a deficiency in precipitation for a considerably number of years, at least in contrast to that previously prevailing.

Close cooperative relations were continued during the year with A. W. Moore of the Biological Survey in the development and use of a strychnine spray for the control of rodents in new plantations. While thus far now wholly effective, evidence of some degree of control, such as the finding of dead rabbits, has been observed on a number of projects. Its use this year was considerably extended, and a very large percentage of the planting stock shipped from the nursery was thus treated.

On several Forests in this Region, notable in southern Oregon, there is a large acreage of brush field, much of which must be planted sooner or later. Except for occasional projects in the more open areas and around the fringes of the dense fields, no effort has been made heretofore to replant them, because of the cost involved in any method of opening up the brush sufficiently, either to permit planting or survival of the trees afterward. With the development of mobile power machinery, such as the trailbuilder and Killefer fire plow, and the availability of CCC personnel, the time seemed opportune to tackle the problem. Two projects were undertaken; one on the Cathill area on the Rogue River, the other on Thornx Prairie on the Umpqua.

The former consisted of clearing planting lanes, the latter both lanes and broadcast clearing. The following extracts from project reports, with explanatory comments by the writer: In the Rogue River Forest the plot under discussion contained .41 miles of lane per acre. This was done with a "Cat" with a bulldozer and a rock blade. A dirt blade was also used. It was noted that the dirt blade did not remove as many of the roots of the brush as did the rock blade. A crew of three men was needed to cut overhanging brush, and to help in surveying. A dirt blade was used for 2,824 feet of lane, and a rock blade for over 11,624 feet of land. The whole procedure required from 4 to 6 round-trips to clear a lane. Owing to the inexperience of the men on this new project, the cost does not represent a true picture of the job. With a six by six foot spacing the cost was 19 cents per tree for the dirt blade, and 14½ cents for the rock blade.

After several years of active interest, during which they contributed $2,428.97 toward the planting of 302 acres on the Columbia Forest, the Washington Chapter of DeMolay have discontinued this practice due to a change of personnel controlling state policies. Other cooperatives that have contributed trees are U. S. Indian Service; Lincoln High School, Tacoma, Washington; Roosevelt High School, Seattle, Washington; and miscellaneous small lots.

PLANTING HIGHLIGHTS OF 1936

The major features of the year may be briefly summarized as follows: the second largest annual acreage of new plantations; greater distribution among projects and forest than in any year heretofore; a new high in the proportion of acreage planted by emergency agencies; a fall planting season emphasis on the planting of close density strips along roads running through open areas as a measure of fire protection.

Planting operations during the calendar year 1936 embraced a total of 4,037 acres. Excluding early day seeding, this is the second largest acreage which has been covered in a single year, and is exceeded only by the 5,959 acres planted in 1934. 57% was planted in the spring; 43% was planted in the fall. Because of the insufficiency of regular funds, all except one operation were conducted with emergency labor, either CCC or ERA. Two of the ERA projects located on the Siuslaw Forest were financed by Resettlement funds, but the operation was conducted by Forest officers.

In line with past policy, projects were located preponderantly in the Douglas fir region. In fact, only 1% of the total acreage was in the Ponderosa pine region. This is an exceptionally low percentage for this species, and was due to the decision to hold Ponderosa pine stock for an additional year in the nursery. For the first time the use of 2-0 root-pruned Douglas fir planting stock exceeded that of Douglas fir transplants, and fall operations were entirely with this age class.

Approximately one-fifth of the total planting acreage (871 acres) was in the form of roadside protection strips. These totalled 32 miles in lenght, counting strips on each side of one mile road as two miles.

Costs of new plantations ranged from $7.84 to $16.59 per acre, with a regional average of $10.11. This is a 16% increase above the five-year average. Over three-fourths of this increase was due to a greater average density of planting arising from close spacing in roadside strips. Planting stock averaged 29% lower in cost per M, due to greater use of 2-0 stock and increased 19%.

Reports received to date indicate a first season survival for spring Douglas fir ranging from 60%-86% with a weighted average of 82%. For first

year survivals of fall plantations, reference must be made to those of 1935 rather than 1936. These averaged about 60% for Douglas fir and 46% for Ponderosa pine. Thus, for two successive years fall planting in Douglas fir has shown materially lower first-year survival than spring planting. Possibly the validity of comparisons based on first-year survival may be questioned somewhat on the ground that spring plantations have not gone through one winter period, as have those planted in the fall. From this standpoint, third-year survival figures may be a better basis for comparison; but none of these are as yet available. However, experience has shown that in spring plantations, first summer mortality is usually a larger factor than mortality for following winter. Trees which have survived the hazards of the summer dry period without great loss of vitality are fairly well established and are better able to withstand the hazards of the succeeding winter than newly planted trees. Hence, it is believed these figures indicate the relative favorableness of the two seasons quite closely. The chief reason for undertaking fall planting is to distribute the load. This is particularly necessary where the bulk of the work is performed by emergency agencies.

Progress in "brushfield planting" on the Rogue and Umpqua Forests has been curtailed, due to lack of any considerable quantity of planting stock, and waiting for the development of a brush clearing machine by Region 5.

ARTIFICIAL REFORESTATION IN REGION SEVEN

Statistics show that to date there has been 20,376 acres planted in this Region with 74,522 acres to be planted. A great portion of the planting is of 2-1 Red spruce and Red pine stock. Other species used, include White pine, Norway spruce, and White spruce. Also, at this time, they are increasing the planting of 1-0 hardwoods, using largely Black cherry, Red oak and Sugar maple.

The center hole method of planting is standard, care being taken to spread roots and cover with good soil Results obtained from experiments to date with the slit method have not justified its labor economics.

Most of the planting problem is in the Appalachians, on lands denuded, and not restocking at the time of purchase, following clear cutting and recurrent fires.

There is a nursery at Parsons, West Virginia with an authorized capacity of 7,000,000 seedlings or transplants. Present production schedule calls for 5,000,000 seedlings per annum of which 15% is hardwoods. Local seed is used by preference in this plant.

An interesting study practice is the staking of a group of 200 trees of each species in each plantation at random. The staked rows are re-examined at one, three, and five-year periods to determine the success of the project by recording survival, thrift, and height. The major hazards to survival have been frost-heaving, and damage by deer and rabbits.

ARTIFICIAL REFORESTATION IN REGION EIGHT

This region concerns itself primarily with the four Southern pines which are Pinus palustris, Pinus caribaea, Pinus taeda, and Pinus echinata. One or more of these species compose an important part of the commercial forests of each of the following 13 states: Delaware, Maryland, Virginia, N. Carolina, S. Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, Arkansas, and Oklahoma. These species are grown for structural timbers, poles, piling, railroad ties, naval stores, and Kraft paper. They are among the fastest growing species of the United States.

Forest planting began in the year of 1892 when some farm owners in the region planted small areas with wild stock. Since 1926 artificial reforestation has become rather general throughout the Southern Pine Region. Part of this progress is traceable to the activities of State forestry departments and to Federal aid extended under provisions of the Clarke-McNary Act of 1924.

The characteristics of the seed are an important factor in the process involved in artificial reforestation with the Southern pines; the behavior of the cones during extraction, amount of seed per cone greatly affect the cost of the seed. Since there are fewer seeds per pound than any other conifer, nursery and planting costs are low. Anything tending to increase the cost of the seed greatly increases the cost of planting.

Trade in the southern pine seed in comparatively undeveloped, thus necessitating the private and State foresters to collect their own seed. Four factors are considered in an area's desirability for pine-seed collection: abundance and quality of cones; presence of a logging operation or of trees that can be climbed successfully or economically, accessibility, and hereditary qualities of the parent trees. Very little is known as to the latter

item, but seed trees are selected as to form, growth, rate of growth, quality of wood, and freedom from injurious insects and disease. The cones are usually collected sometime in August. This usually depends upon the weather at that time of year.

A bushel of unopened southern pine cones weighs from 28 to 45 pounds. Of this weight 35% to 65% is water, which must be removed. Cones in this Region are dried as in any other Region by natural processes or artificial, although the natural processes are not as efficient, due to the heavy dews and frequent rains. The seeds are then cleaned, dewinged, and tested like any other conifer.

The labor required to collect cones of the southern pines varies from about one-fifth man-hour per bushel to 6 - 10 man-hours. The cost of the seed varies from $1 to $6 per pound, and at times the price of longlead pine seed has been as low as 26 cents per pound.

The most important factor in the location of a nursery in the southern pine region is the adequate supply of water, of which a deep well is the most common source of water in this Region. A loam or a sandy soil is preferable. Southern pines thrive on a slightly acid soil (pH 6.5 to 4.5). The slope should be not over 3% as the soil is too easily washed away. The nursery should be as far away from other stands of pine as possible because of pests, and disease.

The beds in the nurseries are four by fifty feet, although one State Nursery uses beds 500 feet long with paths between the beds two feet wide. A bed 4 by 50 feet is a convenient areal unit on which to base estimates as to quantities of seed or fertilizer to be used, or of stock to be grown and shipped. These beds are covered with a "Pine Straw" which is favored to

mulch and burlap, because it does not pack the seed bed as much, and it costs less. The seed beds require about one inch of water per week, and from four to seven weedings per year.

The cost for raising the various species of seedlings of Southern pines varies from $1 per M to $1.75 M. Factors that increase costs far beyond those necessary for the species and site are the following: 1. Waste of seed, particularly through oversowing or through mismanagement resulting in incompleteness of germination. 2. Usurpation by weeds--weeds must always be pulled before they attain a height of two inches. 3. Inroads by birds, or attacks by insects such as cutworms, redspider, or scale. Heat killing. Drought killing. 4. Waste of mition.

The range of Slash pine is the most limited, and that of Short leaf is the greatest. Longleaf pine is widely enough distributed to fill most of the region's planting needs, and Slash pine seems to be able to thrive considerably beyond its natural range, and hence to be almost as widely available. Several million acres of land formerly occupied by Longleaf pine appear to be incapable of restocking naturally with any useful species in less than 40 years. Other things being equal, among areas in need of planting those of highest potential productivity should be planted first. Of the millions of acres of land affected with erosion, practically all should never have been cleared, and practically all has been farmed injudiciously.

Loblolly pine should be planted on the sandy coastal plain from South Carolina north to Maryland, and in the piedmont area from Mississippi east to Georgia, and thence northward into North Carolina.

A system of "skeleton planting" has been devised whereby 200 to 300 trees of the desirable commercial species are planted per acre in natural openings or on apparently favorable patches of soil.

Other things being equal, the species chosen for planting should be that promising greatest resistance to insect or fungous enemies likely to cause trouble in the locality.

The choice of spacing is one of the most important factors in the planting of the Southern pines. With the exception of Longleaf, in even-aged pure stands, close spacing would result in stagnation of the stand as soon as the crowns closed because of the intolerance of these species. The standard spacing is usually 6 x 6 feet or 8 x 8 feet. Sometimes a 6 x 8 spacing is used.

Plowing is the universal method of preparing a site for artificial reforestation in the Southern pine Region. Hoes are used for preparing a site for Longleaf pine.

Sometimes burning the site before planting is advocated. This not only facilitates planting, but forms a firebreak for the first year that the seedlings are in the plantation.

The universal planting tool used in the southern pine Region is the planting bar or the "dibble". Under ordinary conditions two men working together can plant from 1600 to 2200 trees in an 8-hour day.

AREAS PLANTED IN REGION 8, BY CALENDAR YEARS 1/

State	On National Forests	On State and private land	Total
	Acres	Acres	Acres
Alabama			
1934	-	266	266
1935	-	2,491	2,491
1936	-	3,091	3,091
Arkansas	1,705	2/	1,705
1934	953	7	960
1935	4,814	2,180	6,994
1936			
Florida			
1934	-	2,383	2,383
1935	-	4,030	4,030
1936	-	8,371 4/	8,371
Georgia			
1934	27	544	571
1935	32	3,889	3,921
1936	-	9,838	9,838
Louisiana			
1934	473	760	1,233
1935	4,699	3,889	5,316
1936	23,278	9,838	23,597
Mississippi			
1934	22	219	241
1935	5,348	4,876	10,224
1936	22,597	1,102	23,699
North Carolina			
1934	266	527	793
1935	33	203	236
1936	144	2,097	2,241
Oklahoma			
1934	-	493	493
1935	-	819	819
1936	-	5,511 3/	5,511
Puerto Rico			
1934	-	4,040	4,040
1935	173	2,249	2,422
1936	3,890	3,024	6,914

State	On National Forests	On State and private land	Total
North Carolina			
1934	-	806	806
1935	-	6,260	6,260
1936	501	21,645	22,646
Tennessee			
1934	396	2,176	2,572
1935	623	3,388	4,011
1936	101	843	944
Texas			
1934	-	1/	-
1935	-	18	18
1936	3,623	120	3,743
Total	73,698	99,202	172,900

1/ Does not include planting by the TVA, the Prairie States Forestry Project, Soil Conservation Service, or Resettlement Administration, except as indicated.

2/ Clarke-McNary Law, Section 4, cooperative project not in effect for this year

3/ Includes 3,300 furnished by State and planted by Prairie States Forestry Project, and 1,717 by Soil Conservation Service.

4/ Includes 3,300 planted by Resettlement Administration and Soil Conservation Service.

ARTIFICIAL REFORESTATION IN REGION NINE

The broad Regional policy under which the reforestation work is guided, stated briefly, is as follows: "to grow the largest and best timber crop possible, consistent with the multiple use principle."

An intensive planting reconnaissance is done on all areas which constitute possible planting sites to determine what species and age class is best adapted to the soil and cover conditions on the area, whether it can be planted, and whether or not planting is the highest form of use for the area. This reconnaissance is to be done on sufficient area to allow the building up of a five-year planting program based on specific sites.

Only local species are to be used, grown from local seed in the local nursery. The nurseries are seeded on a basis of the requirements for the various species as shown by the intensive planting reconnaissance. Limitations are placed on the planting of the White pine and Red cedar, because of the White pine blister rust disease and the cedar apple rust.

The age class of stock used is determined by conditions on the site. On sites where vegetative competition is not severe, 1-0 Jack pine can be used, and 2-0 White and Red pine. On sites especially poor in quality or on good sites where the vegetation is especially aggressive transplant stock is used. The spruce stock is usually 2-2 age class.

Species are mixed in a plantation according to site conditions, and tolerance of the species and the rate of growth. The mixtures are made by alternate rows of two species in some cases, by alternate strips in other cases. The best results are obtained by the more complicated method of mixture which recognizes changes in site due to exposure, cover, and height

of water table. This method is called the "group mixture" where each species is placed on the site to which it is best adapted.

Spacing of trees in a plantation is based on inherent growth characteristics of the species coupled with site quality. To produce a well-formed Jack pine, spacing of 4 x 6 feet is used on poor sites, and 6 x 6 feet on medium and good sites. For other conifer species a 6 x 6 foot spacing is used on poor sites, and a 6 x 8 foor spacing on medium and good sites. Hardwood species are planted 6 x 6 feet on good sites, and 4 x 6 feet on poor to medium sites. Erosion control plantings are spaced 4 x 4 feet. Direct seeding is done on a 4 x 4 foot spacing.

In the Lake States, planting is universally done in furrows. The ground preparation is accomplished by using 35 hourse power tractors with large Killifer plows producing clean flat bottomed furrows about 20" wide and four to five inched deep. A limited amount of scalping is done on areas which it is impossible to plow.

Rigid specifications have been set up covering the minimum size of the top, caliper of the stem and length or foot systems which constitute a plantable tree. Only the premium grade stock used is sent to the field from the nurseries. It has been found that the quality of the stock has a marked influence on the survival of the plantations and comprehensive studies are now under way at serveal of the nurseries with an objective of determining the optimum sized stock to plant on various sites for the various species.

Considerable progress has been made in the care of stock from the time it leaves the nursery until it is again in the ground. Cold storage plants with artificial refrigeration have been constructed at several nurseries to keep the stock in a dormant condition during the latter part of the spring planting season, and a limit of 48 hours for stock to be our of the ground

has been set as an objective which is being met by most of the Forests. This latter objective, of course, does not apply to the stock held in storage for use at the end of the spring season.

The methods of planting used are the Michigan bar method, center hole method, and the inverted "V" method. Because of the advangages included in the inverted "V" method, it is being used to a large extent by many of the Forests where soil conditions permit.

Work is now in progress on the development of better planting plows, and two transplanting machines are being constructed after the pattern of the machine developed by Harry Turner on the Huron Forest of Region 9.

The newest developments in this Region are the practices of making a thorough site analysis of planting areas to determine the species best adapted, and the production of the best possible quality of stock grown from a local seed source. Studies are being made to determine ways and means of properly measuring site characteristics, and how to produce the best stock with highest survival.

ARTIFICIAL REFORESTATION IN REGION TEN

Conditions prevail in this region that, in all probability, are the dreams of existing regional foresters. The annual cut in only about one percent of the estimated annual growth, and so the cost of management plans, artificial reforestation, cultural thinnings, and such silvical refinements are not warranted at this time.

The forest floor in this region is heavily covered with moss and duff, and usually considerable advance reproduction of hemlock. After logging, natural restocking is usually very dense and full stocking is obtained in about five years.

After fires, or which there are very few, natural regeneration is somewhat slower; but normally satisfactory stocking is obtained in ten years or less with a much higher percentage of spruce than in the original stand.

The fact that their annual cut is only about one percent of their estimated annual growth may be explained by the fact that so much of their timber is inaccessible, and that there has not been as much exploitation of the timber in Alaska as in the United States.

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