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DIVISION OF FORESTRY EDUCATIONAL PAMPHLET NO. 4

FOREST REPRODUCTION

IN MINNESOTA

MINNESOTA
DEPARTMENT OF CONSERVATION
1950

This pamphlet is intended for the use of students and for any Minnesotans who desire to become better informed on the forestry problems and forestry programs of their State. Copies may be obtained by writing the Division of Forestry, State Office Building, St. Paul, Minnesota.

DEPARTMENT OF CONSERVATION
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Pamphlet Revised

by

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COVER PICTURE — NORWAY PINE REPRODUCTION

FOREST REPRODUCTION IN MINNESOTA

Revised

The Problem of Forest Reproduction

As logging proceeds in Minnesota the forester is concerned with getting more trees started to take their place, except in land clearing and forest thinnings. This replacement of log trees may involve three possibilities; namely, that of planting, the waiting for nature to seed in the area, or for sprout growth to appear and restore a forest on the land.

We are concerned not alone with forest reproduction to replace the trees which are being cut today but we have a tremendous job of restoring forests which have been cut and burned over in the past where nature has not replaced or insufficiently replaced tree growth.

There are many problems to solve if we are to attain satisfactory forest reproduction over the large areas in need of reforestation. Among these are technical skill and scientific knowledge of forestry. This aspect of the problem will be discussed here. More adequate forest fire protection, good forestry practices on private timber lands, adequate appropriations to the State for managing State timber, while all important, are not the subject of this pamphlet.

That we may better understand the technical and scientific side of forest reproduction, we will learn something of how trees and forests grow, following with a discussion of silviculture which is concerned with forest reproduction.

How Trees Grow

Minute cells that can be seen only under a microscope are the structural units of living things, whether they be men, cattle or trees. The cells can be likened to the bricks in a building. They are grouped together into tissues and organs. Unlike the bricks of a building, they are constantly washed and watered and fed by rich humors and liquids that are important parts of living bodies, but absent in brick buildings.

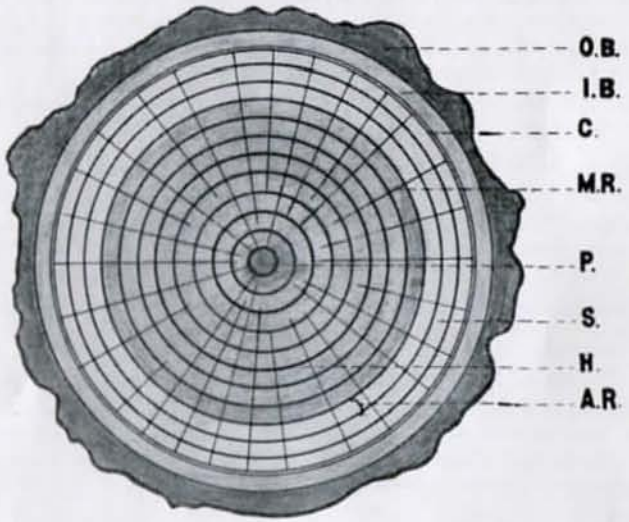
There are many variations in the way that different beings live but like men and cattle, trees breathe, eat and sleep. Unlike men and cattle, trees in common with other leafy plants, manufacture their own food. Carbon dioxide, one of the gases found in the air that we breathe, is produced by the burning or oxidizing of wood, coal, or other materials containing carbon. Carbon dioxide is absorbed by the leaves, thereby helping to purify the air as well as being an important ingredient in the metabolism of the tree. Hair-like roots reach into the soil and absorb moisture containing chemical elements in solution. This water is transported up through tube cells of the large roots, the trunk, branches, and twigs—finally reaching the leaves. Within the leaves the water is combined with the

carbon dioxide to produce starches. Starch or sugars, which is the food of plants, are formed by a process known as "photosynthesis." This production of starch depends upon the ability of the green coloring matter ("chlorophyll") of the leaves to harness the sun's energy in the manufacturing of starch.

Starches are stored in the leaves temporarily and in the cells of the sapwood and roots permanently. When the growing portions of the tree needs food, the starch is changed to various forms of sugars and sent to areas of growth.

Diameter growth of a tree takes place in the space between the bark and the wood while height growth occurs in the terminal bud. By far, the majority of all tree growth occurs in the space between the bark and the wood. This microscopic place where new cells are born is known as the "cambium." The inner portions of the cambium add cells to produce wood while the outer portion adds cells to the inner bark, a new layer of each every year.

DIAGRAM OF A CROSS-SECTION OF A TREE



O. B.—Outer bark, a protective covering.
I. B.—Inner bark, which is soft and spongy.
C.—Cambium, which is a microscopic layer of living cells where the growth takes place. These cells divide and some go to make up the sapwood and others the inner bark.
M. R.—Medullary rays which transfer food and water horizontally in the tree.
P.—Pith, a spongy tissue found in the center of the trunk and branches.
S.—Sapwood, the active portion of the tree which conducts water and chemicals from the roots to the leaves and also conducts sugars from the leaves to the growing portions of the tree.
H.—Heartwood, which is inactive but gives strength to the tree.
A. R.—Annual Ring, a layer of light and dark wood forming one year's growth. The lighter and more porous portion is formed in the spring and the darker and more compact portion is formed in the late summer and winter.

Height growth in a tree is produced only at the tip of the branches. This explains why a mark on the trunk of a tree does not move upward as is the popular conception. In the early spring the cells formed are large in order to transport the great amount of water needed for growth. Cells formed in the late summer and winter are exceedingly small and as a result cell walls are so dense as to cause a differentiation of the tissue and appear as a dark compact line.

These two periods of growth go to make up the annual ring. By counting these rings we may determine the age of the tree.

It is suggested that the student obtain a cross-section of the trunk of a tree or a cross-section of a larger branch for study. With such a specimen see if you can find the annual rings of growth. These rings appear different in various kinds of wood and may be the basis for identifying the wood after it has been manufactured into products. When boards are cut from a tree the annular rings make a wide degree of patterns adding to the variety and beauty of furniture or other manufactured items coming from the tree.

How Forests Grow

The natural growth of the forest is a continuous and relentless process of crowding. More trees start growing on an acre than can ever grow to maturity. Many must either die or be taken out as thinnings.

Some trees grow faster than others and overtop their neighbors. Some, though slower growing, can stand the shade ("tolerant" species) and eventually win out over associates that temporarily outstrip them. Others are fast growing but short lived. They dominate for awhile but finally succumb to the slower but more persistent plodders. There are those that are badly worsted on the better soils but excel all competitors on poorer land while tamarack and black spruce can hold the swamps where other trees are unable to displace them.

In a dense forest the competition between different species as well as individuals of the same species is very keen. Shrubs, herbs, and grass may enter into the more scattered stands. The trees which are best adapted to their environment survive; the others are crowded out. Starved for light and water they are usually stunted and many die while still young.

This competition frequently results in a pure stand of a single species of tree over a considerable area. This is typified in the Jack Pine and Black Spruce forests as well as the Popple and Oak forests so common in northern Minnesota.

Where the contestants are more evenly matched a number of species may survive and still struggling, form a mixed forest. This is more frequently the case with the broad-leaved trees than with the conifers.

Where death or the overthrow of old trees has produced openings or where seeds of tolerant trees have been able to establish a young growth under a thin spot in the canopy of larger trees, then we find seedlings growing in these openings to produce a varied aged forest. There may be trees from one year old to 300 years old on a comparatively small area. However, where the old forest has been cut down or destroyed by fire, the catastrophe is frequently followed by a growth of the same aged trees over the entire area. Reproduction following logging or fire is usually of one species of tree.

Silviculture

Silviculture is the science which deals with the problem of forest tree growth. It is the science which studies the way forests react to different environments. The logging off or burning over of tracts of land may so alter the problems of silviculture that considerable study is necessary if the forest is to be left in a good condition for reproduction.

Silviculturists have learned that they must depend upon many different ways of obtaining forest reproduction. Control of logging methods is the first vital step in determining and obtaining desirable forest reproduction.

Natural Reproduction

A tree must reach a certain age to produce seed. This age varies from a very few years, in the case of the Jack Pine, to several decades for Oak, White Spruce, and other species.

All trees will reproduce themselves by means of seed when conditions are right.

Some trees, including most of the evergreens, produce abundantly only once in three to five years. Most hardwoods produce seed annually. The majority of the trees native to Minnesota require but one year to produce ripe seed; however, in the case of the pines two years are necessary.

Successful natural reproduction depends upon a good seed bed. The ground must not be too hard or too thickly covered with leaves, grass or other vegetation. A hard soil will prevent the seedling roots from penetrating into the ground while dead leaves or other vegetation will prevent the roots from reaching mineral soil. The ground is usually in good condition in the forest if the stand is not too dense.

Where natural reproduction is not occurring within a forest the reason will frequently be found to be lack of sufficient light or that the seed produced fails to penetrate the undecayed leaf mold. If the forest were cleared out a little so that sunshine could get in and the leaf mold decay, little seedlings would spring up everywhere. This is the reason for the dense reproduction often appearing in

openings where old trees have fallen down or where the timber has been cut.

Other causes of failure of natural reproduction may be attributable to birds and rodents consuming the seed. (Chipmunks and squirrels are notorious tree seed eaters.) Competition for water is also a limiting factor in the establishment of natural reproduction. As a matter of fact water is the limiting factor of all tree growth. The only thing that a tree obtains in quantity from the soil is water plus a limited amount of chemicals. The water holding capacity of the soil will, in a large degree, determine the density of a forest and anything that can be done toward increasing the water holding capacity of the soil will be reflected in the greater growth of the tree.

Forest Tree Nursery

Denudation of the forest by logging operations and fires has reduced the productivity of large areas of forest land. There are between three and four million acres of so-called barren land, varying from bare rock to land growing nothing but a little brush. Possibly five million more acres are producing only a fraction of the timber they could produce. Nature, given generations of time and complete protection from fire and insect ravages, would again clothe this land with forests. It is important that man put each and every acre to its most intensive use if timber production is to keep apace with our wood needs. There is a real and large economic loss where lands are left idle or producing only part of that timber which they are capable of producing.

Man can overcome this waste and hasten the return of the forest through the planting of trees. Before the State can afford to plant on this scale, there must be a source of low-cost seedlings in vast quantities. It takes 1,210 trees to plant an acre where the spacing is 6 ft. x 6 ft.

The first State nursery to grow trees was authorized by the 1931 Legislature and it was established within the boundaries of the Foothills State Forest. The nursery is situated fifteen miles west of Backus and ten miles south of Akeley.

Since 1931 the Division of Forestry has established a nursery at Willow River, Minnesota, giving the Division two major nurseries. There are several minor nurseries which take care of local needs within some of our State Forests.

Under the present nursery law trees may be purchased for private lands planting or may be furnished gratis for public owned lands. The following paragraphs are written with the idea that the information may be helpful in the growing of nursery stock by the individual.

Choosing the Nursery Site

In the event that you are to grow conifers then the soil chosen should be of a light, sandy loam nature. In the case of hardwoods,

a much heavier soil is permissible. The seed bed area should have as little organic material as is possible and under no circumstances should barnyard manure of any kind be added. The surface of the seed bed should be level and close to a source of water so that the young growing trees may be watered generously. The seed bed should be from 36" to 48" wide permitting of easy access for weeding and care. Any convenient length is permitted. Old nursery practices indicated a 4' x 12' bed giving 48 sq. ft. Upon such an area from four to five thousand conifers can be grown if properly spaced and thinned. After spading the area of the bed, it then should be firmed with a trowel or board so that little or no settling will occur.

Seed Collection

Raising of trees in nurseries calls for seed collection. All trees do not mature their seed at the same time. For example: White elm seed ripens in May before the leaves come out; soft maple ripens in the early spring and sugar and red maples in the fall. As most of the hardwood seeds can be picked up from the ground, there is time enough to collect them after they begin to fall.

With conifers, the case is different. When the seeds have once fallen to the ground it is practically impossible to pick them up again; therefore, it is necessary to pick the cones from the trees.

Great care should be exercised in selecting the trees from which the seed is to be collected. We know from experience that the form and growth habits of the parent trees are inherited by the offspring. A scrubby tree has a tendency to produce scrubby trees. The seeds from weak, slow-growing trees are likely to produce inferior trees. Consequently, it is important to select only strong, vigorous, well-formed individuals for seed trees. The stronger the growth of the parent, the better the seeds will be.

We cannot over-emphasize the importance of the source of seed. The following simple rules will guide one in the selection of parent trees:

First—gather the seed from local sources if possible.

Second—secure seed from well-formed, mature and thrifty trees and not from stunted, diseased or deformed trees.

Third—where seed is to be purchased it is recommended that the seed originate from a colder region than the area where they are to be planted. Buy seed only from reputable dealers who are acquainted with the seed source.

With conifers the seeds are found in the cones, two at the base of each fertile scale. They mature, for the most part, the first half of September. When the squirrels begin to gather them it is time to collect the cones.

Seed Extraction

While the following method of seed extraction is not too efficient it will suffice for the individual establishing a small seed bed. (The extraction of seed at our nurseries is accomplished through the use of controlled oven heat as well as other involved operations by elaborate machinery.)

To hasten the opening of the cones they may be placed upon a cloth or canvas in full sunlight. After from one to three days they may be shaken when a goodly amount of seed will be obtained. To get rid of the seed wings they may be rolled between the palms of the hands when with the application of air currents, the broken wings can be gotten rid of.

The seeds may be sown in the ground the same fall or stored in airtight containers, placed preferably in a well ventilated cool place free from artificial heat. The seeds must be kept in tight containers to eliminate drying and to insure protection from chipmunks, squirrels, and mice.

Sowing the Seed

Hardwood seeds may be sown and cared for in exactly the same way as garden seeds. Fall sowing of evergreen tree seed is recommended. It should be sown as late in the fall as possible. Some evergreen seed will germinate very poorly if planted in the spring. This is particularly true of White Pine and to a lesser degree of White Spruce.

The quantity of seed to sow will vary with the size of the bed and the quality of the seed. The following figures are based upon a seed bed of 48 sq. ft. or 4 ft. x 12 ft. With seed of a good germinating percentage three ounces of Norway Pine seed or four ounces of White Pine or three ounces of Jack Pine or two ounces of White Spruce. An indication of the germination percentage of seed can be had by means of a cutting test. Select an average sample of 100 seeds and by the use of a sharp knife, they may be cut open. Good seed will have a firm, white kernel while poor seed will be a brownish color. This should give a fair indication as to the viability of your seed. In the case of low germination tests, the above figures for seed per bed should be increased accordingly.

The seed may be sown in drills or broadcast. If sown in drills the rows should be about 3" apart with the seed sown to a density that will give one tree per running inch of drill. If sown broadcast every effort should be made to get uniform density. It is suggested where broadcast seeding is to take place, that about one-third of the seed be used to cover the entire area to be planted taking the second third of the seed and repeating the process will permit of filling in the more sparsely seeded areas. Repeating with the last third of the seed will insure reasonable uniformity of distribution. The ground should have one viable seed on each square inch of bed.

After the seed has been scattered it should be gently pressed into the ground with a flat board or trowel. The seed should then be covered with about one-fourth inch of clean, sifted sand. (A sieve made of one-fourth inch mesh screen is very desirable for sifting the sand.) Covering the seed to a greater depth than one-fourth inch is likely to keep the smaller seeds from germinating while less dirt will permit of too rapid drying out.

With the application of the sand a mulch of some sort should be placed over the bed. Burlap makes a most desirable mulch and will help to conserve moisture as well as protect the seed from pounding rains and blowing wind. By using telephone wire cut eight to ten inches long and bent for a head, the resulting pin will hold the burlap close to the ground. The mulch, however, should be removed as soon as the trees come through the ground.

It is frequently desirable to prepare a board frame of 1 in. x 6 in. boards to go completely around the bed. This will permit of the placing of screen cloth or snow fence to give partial shade to the seedlings during the first year after germination. Conifers are usually left in the seed beds for two years, when they are taken up and transplanted giving them additional room for at least one more year of growth.

The spacing in the transplant bed should be in rows six to nine inches apart with a seedling planted every two or three inches in the row. They may be left in the transplant bed for from one to three years as desired. In the case of hardwoods if the seed bed is thinned giving more room for each tree they probably will be of desirable size for planting in the field at the end of one or two years. There is no need for transplanting hardwoods unless large specimens are desired. Both seed beds and transplant beds should be weeded, cultivated, and watered frequently for best results.

If it is intended to use the trees for ornamental purposes the transplants may be repeatedly transplanted giving more room with each successive transplanting. During any and all transplanting operations it is vital to see that the roots are kept moist.

Cuttings

Cuttings are pieces of branches from trees which when planted develop roots and grow into trees. Trees from the Willow and Popple families are the easiest from which to make cuttings. The cuttings are usually six to nine inches long and from one-fourth to one-half inch in thickness. They should have about four to six buds on each piece. Cuttings are usually made in the spring before growth starts.

They are planted by making a hole in the earth, slightly larger than the diameter of the cutting, at a forty-five degree angle and inserted in the hole. The earth would be firmly packed around the cutting leaving two to three buds above the ground. The cuttings

should not be forced into the ground as this will tend to strip the bark from the stem or break off the buds. It is well to clear a space around each plant so that other plants will not compete with the cuttings. The cuttings may also be planted in furrows. If the soil is dry, frequent watering will insure a good survival.

Sprouting

Evergreens in this section of the country do not sprout from the stump or roots as do most of the hardwoods. Willow, the Popple and Box-elder, especially, sprout luxuriantly from the stump. These sprouts grow very rapidly because they are supplied with water and chemicals by a large and well established root system.

If it is desired to reproduce a tree in this way, one or two of the most vigorous sprouts should be selected and all the others cut off. If the sprouts are not wanted the stump may be killed during the dormant period and all sprout growth stopped by mopping the top of the stump with the following preparation: (It must be remembered that this solution is deadly poison to people and animals as well as trees.) Formula: One pound arsenic, one pound washing soda, four gallons water, and one-half pound whiting.

Tree Planting

Before planting a tree the roots must be protected from the air and not allowed to dry. A hole or opening in the ground should be made large enough and deep enough to allow ample spreading of the roots and to allow the tree to be placed at the same level at which it originally grew. The tree roots should be carefully spread out and quickly covered with moist earth firmly packed. Choosing a cloudy, cool day will give best results in the planting and transplanting of trees. If possible, the area should be kept free from weeds and the trees watered occasionally.

Since the establishment of our first State nursery over 56 million trees have been shipped for planting upon public owned lands which include State forests, parks, State institutions, municipal, county and roadside forests. Coniferous trees grow very slowly the first three to five years. However, after that one foot of height growth per year is a very conservative figure to use.

In both transplanting and field planting there are two points which must be observed strictly: (1) **The roots must not be allowed to dry for an instant; (2) the dirt must be firmly packed around the roots when they are placed in the ground.**

The safest practice is not to manure trees, especially evergreens. Very well rotted manure may sometimes be used profitably as a top dressing, but it is safer never to bring it in contact with the roots of the trees.

For additional field planting information see Educational Pamphlet No. 6, entitled "Instructions for Planting Evergreens."

Continuous Production

A fundamental forestry principle is to keep the forest continually productive.

Trees in the forest may be likened to an invested capital—the annual growth of the trees represents the interest. As long as only an amount of timber equal to the annual growth is cut, the forest may continue to yield interest indefinitely without decreasing the capital stock. Proper handling will at the same time increase the growth and improve the quality of the forest.

The following would be an ideal example: Take 1,000 acres of forest, which is actually made up of 50 forests of 20 acres in size, one of them one year old and the others successively one year older up to 50 years. Each year the oldest age trees are cut and the area immediately replanted. Under this plan twenty acres of 50 year old trees could be cut every year forever.

This is the plan that forestry attempts to put into practice. Many factors such as fires, insect attacks, disease, and emergency demands for timber are continually interfering with this plan. It can never be carried out exactly yet the forester is continually striving to bring his forest as near to this ideal as possible.

Timber Cutting

When timber has been sold from State lands an experienced crew is sent into the tract from which the timber is to be cut. They designate the trees that are to be removed or those that are to be left. In most cases they indicate the trees that are to remain; especially those that are to be reserved for seed trees. The timber cutters are allowed to cut only those trees that have been selected and specified for cutting by a State forester.

FOREST TREES IN MINNESOTA

Conifers or Softwoods

Cedar, Northern white (arborvitae)	(Thuja occidentalis)
Cedar, Red (juniper)	(Juniperus virginiana)
Fir, Balsam	(Abies balsamea)
Juniper, Dwarf (a shrub form)	(Juniperus communis)
Pine, Jack	(Pinus Banksiana)
Pine, Norway (red pine)	(Pinus resinosa)
Pine, White	(Pinus strobus)
Spruce, Black	(Picea mariana)
Spruce, White	(Picea glauca)
Tamarack (American larch)	(Larix laricina)
Yew (a shrub form)	(Taxus canadensis)

Deciduous Trees or Hardwoods

Ash, Black	(Fraxinus nigra)
Ash, Elder Leafed Mountain	(Sorbus subvestita)
Ash, Green	(Fraxinus pennsylvanica)
Ash, Mountain	(Sorbus americana)
Ash, Prickly	(Xanthoxylum clava Herculis)
Ash, White	(Fraxinus americana)
Aspen, Large Tooth	(Populus grandidentata)
Aspen (Popple)	(Populus tremuloides)
Balsam, Poplar (Balm of Gilead)	(Populus balsamifera)
Basswood	(Tilia americana)
Beech, Blue (hornbeam)	(Carpinus caroliniana)
Birch, Paper	(Betula papyrifera)
Birch, River (red birch)	(Betula nigra)
Birch, Yellow	(Betula lutea)
Bladder Nut	(Staphylea trifolia)
Box Elder	(Acer Negundo)
Butternut	(Juglans cinerea)
Cherry, Black	(Prunus serotina)
Cherry, Choke	(Prunus virginiana)
Cherry, Pin	(Prunus pennsylvanica)
Coffee Tree	(Gymnocladus dioicus)
Cottonwood, Eastern	(Populus deltoides)
Crab, Wild	(Malus ioensis)
Elm, American	(Ulmus americana)
Elm, Rock (Cork Elm)	(Ulmus racemosa)
Elm, Slippery	(Ulmus fulva)
Hackberry	(Celtis occidentalis)
Haw (red)	(Crataegus mollis)
Hickory, Bitternut	(Carya cordiformis)
Hickory, Shagbark	(Carya ovata)
Hop Hornbeam (ironwood)	(Ostrya virginiana)
Locust, Black	(Robinia Pseudo-Acacia)
Locust, Honey	(Gleditsia triacanthos)
Maple, Mountain	(Acer spicatum)
Maple, Red	(Acer rubrum)

Maple, Silver (soft maple)	(Acer saccharinum)
Maple, Sugar (hard maple)	(Acer saccharum)
Mulberry, Red	(Morus rubra)
Nannyberry (sheepberry)	(Viburnum Lentago)
Oak, Burr	(Quercus macrocarpa)
Oak, Red	(Quercus borealis)
Oak, Scarlet	(Quercus coccinea)
Oak, White Swamp	(Quercus bicolor)
Oak, White	(Quercus alba)
Plum, Canada	(Prunus americana)
Serviceberry (juneberry)	(Amelanchier canadensis)
Thorn, Dotted	(Crataegus punctata)
Thorn, Long-spined	(Crataegus macracantha)
Walnut, Black	(Juglans nigra)
Willow, Babylon Weeping	(Salix Babylonica)
Willow, Bebbs	(Salix Bebbiana)
Willow, Black	(Salix nigra)
Willow, Pussy	(Salix discolor)

Note: Named according to the U. S. Forest Service check list.

Key for the Identification of Native Minnesota Conifers

A. Trees with needle-like leaves: Pine, Spruce, Balsam Fir, and Tamarack:

I. Needles in groups of two to five—Pine.

a. Needles in groups of five. Bark of young tree smooth; of older tree deeply furrowed and dark brown in color. WHITE PINE (Pinus strobus)

b. Needles in groups of two. Norway pine and Jack pine.

(1) Needles five to six inches long, semicircular in cross-section and close together; bark of young trees scaly and dark brown in color; of older tree reddish in color. NORWAY OR RED PINE (Pinus resinosa)

(2) Needles three-fourths to one and one-fourth inches long, flat in cross-section and spread apart; bark scaly and dark brown in color. JACK PINE (Pinus banksiana)

II. Needles in rosettes around a swelling on the branch. Leaves dropped in Autumn. TAMARACK (Larix laricina).

III. Needles borne singly on branch. SPRUCE, BALSAM FIR.

a. Needles four-sided; stiff pointed and sharp at the tip SPRUCE (Picea sp.)

b. Needles flat; flexible, round or blunt at the tip. BALSAM FIR (Abies Balsamea)

B. Trees with scale-like or awl-like leaves: Cedar, Juniper:

I. Trees with all scale-like leaves, branchlets flat and give off strong odor when fresh; fruit a small cone. NORTHERN WHITE CEDAR OR ARBORVITAE (Thuja occidentalis)

II. Trees with some scale-like and some awl-like leaves with a small thorn on each scale, fruit, a blue-black berry. RED JUNIPER OR RED CEDAR (Juniperus virginiana)

Questions

1. How does a tree function in the production of its food?
2. By what means do we secure the growth of new forests?
3. How are seeds secured for planting in the nursery?
4. What is meant by sprouting?
5. Outline the proper procedure in planting trees. In what ways should one be very careful?
6. What is meant by natural reproduction? How is it secured?
7. Name ten native trees of Minnesota.
8. What is meant by coniferous trees?
9. How many seedlings are usually grown in a bed four feet by twelve feet?
10. Explain two methods of sowing trees in the nursery.
11. Why are the seedlings transplanted?

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Dying Balsam Fir and Spruce in Minnesota, The—Special Btn. 68—Agricultural Extension Division, U. of Minn.—free.

Injured Trees, Repairing — Ext. Leaflet 47, A.E.S., Amherst, Mass.—free.

Insect Pests of Trees and Gardens—Circ. 42 — A.E.S., Fargo, N. D.—free.

Storm Damaged Trees, Repairing—Ext. Leaflet 47—A.E.S., Amherst, Mass.—free.

Sunscald on Shade Trees—Circ. 105—Bureau of Plant Industry, Harrisburg, Pa.—free.

How to Know the Hardwood Trees by Their Flower, Btn. 37, American National Association, Washington, D. C.—free.

Forest Leaves—USFS, Washington, D. C.—free.

Common Trees of Michigan—American Tree Association, Washington, D. C.—free.

Common Trees—Bot. Leafl. 11, Field Museum, Chicago, Ill.—25c.

Trees, Famous by Priscilla Edgerton, Asst. Editor, USDA, Forest Service, Washington, D. C.—free.

Blister Rust Control, White Pine—L. B. Ritter—USDA (U. S. Dept of Agriculture) or State Forestry—free.

Deer Damage to Forest Trees in Pennsylvania—Res. Circ. 3—Dept. of Forests and Waters—Harrisburg, Pa.—free.

Drainage of Swamps and Forest Growth—Rec. Btn. 89—A.E.S., Madison, Wisconsin—free.

"KEEP MINNESOTA GREEN"

Following are quotations from statements made by S. Rexford Black, former chairman of the "Keep Minnesota Green" executive committee:

"The Keep Minnesota Green campaign, launched in May with the wholehearted cooperation of the State Department of Conservation, is in full swing as a major addition to forces already at work for the perpetuation of Minnesota's vast forest resources.

"Sponsors of the KMG movement are forest industries, which create employment and wealth from wood and its products, and the great public and private organizations which seek preservation of forests as shelters for wildlife and factors in stabilizing water levels and preventing floods, drouth and soil erosion.

"While the KMG drive is aimed first at prevention of forest fires, merciless enemy of all woodlands, its program, to continue

through the years, has for its goal not merely the protection of Minnesota forests but their renewal and perpetuation through utilization of all methods embraced in modern forestry science. In the past ten years 12,285 fires have swept Minnesota forests and 12,087 or more than 98 per cent of them were caused by human carelessness or neglect, which is proof of the need of educational work in fire control.

"But this is only a start toward the KMG goal. The broad purpose of the campaign is complete mobilization of public support for all phases of forest perpetuation, notably proper cutting of mature trees, to protect young growth; replanting, as rapidly as possible, areas that will not reproduce trees naturally; and scientific practices for the protection of trees at all stages of development. Thus the KMG job is not only to preserve the forests of today but to insure new and greater forests for tomorrow."