

A STUDY OF NATIVE PLANT  
ASSOCIATIONS ADAPTABLE TO  
HIGHWAY PLANTING

Thesis for the Degree of M. S.  
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Charles W. Barr  
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THESIS

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A STUDY OF NATIVE PLANT ASSOCIATIONS  
ADAPTABLE TO HIGHWAY PLANTING

by

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A THESIS

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## THESIS

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A STUDY OF NATIVE PLANT ASSOCIATIONS  
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DEFINITIONS

Along with the exceedingly rapid growth of America's network of public ways for automobile transportation there came the knowledge that all were not of the same importance. So today the term "road" is not satisfactory for all public ways, but has been supplemented by others such as highway, freeway, street, parkway and boulevard. For the purpose of this thesis the word highway will mean any public way for automobile traffic on whose right-of-way long stretches of planting can be used and the character of which should be rural.

The word association is applied to the woody plant community growing along the fence which divides a farmer's field.

THE PROBLEM

Interest in beautiful highway right-of-ways has been increasing at such a tremendous rate that it is now an important factor to be considered in budgeting and aligning new roadways in the majority of the States. Civic organizations, garden clubs and various other clubs have stimulated this interest because of the aesthetic beauty of a tree and shrub lined highway, as a source of food and protection for birds, and as an attraction for tourists. After some work was done in response to this demand, engineers and other technical men interested in highway design began studying highway planting as a vital factor in the permanence and safe use of the highway. Today it might be said that the value of highway planting is becoming more apparent to all groups of technical

workers and the problem is no longer one of selling the merits of a tree and shrub lined highway, but one of finding the proper type of planting to use.

The desire for beautifully landscaped highways has created not only a new field of thought and work, but also a series of new problems. On the aesthetic side there are such considerations as what trees would be desirable, should shrubs be used, how continuous should the plantings be if they are to enhance and at the same time harmonize with the character of rural scenery, how should the trees be arranged or spaced, and where should these plantings be used. Hand in hand with these problems are such practical ones as what trees and shrubs can be transplanted without too much loss, where the plants may be obtained, how the planting can be adapted to a very narrow planting strip, maintenance costs, cooperation between the abutting land owners and those in charge of the planting program, snow control, erosion control, and safety.

It would seem that the growth that springs up along rural fences would be a logical source of information for many of the above mentioned problems. The fence has prevented the cultivation of a narrow strip of land which acts as a natural seed bed for many trees and shrubs. If the resulting growth is allowed to grow without interference from man it will provide a natural and beautiful example for artificial highway plantings. These linear associations are generally narrow, bounded by cultivated fields or pasture lands, receive no cultivation or care, have a pleasing and varied appearance, and, since they are indigenous, they are in harmony with their surroundings. For these reasons many rural fence associations were selected, plotted and studied for the following conclusions.



The present study will not attempt to discuss the many phases of the problem previously mentioned, but has been limited to a study of the kind of plants and their distribution within these native linear plantings with the idea of finding fundamental factors upon which to base artificial plantings. There has been no attempt made to analyse the evolution of these associations, or the causes of the plant distribution, such as soil, means of reproduction, means of seed dispersal and so forth. It is not a scientific botanical study of a phase of plant ecology, although the basic material may be used in that way, but a generalized study to find practical ways of obtaining in artificial highway plantings the freedom, informality, variety and interest of nature.

At this time it might be well to state that before the field work was begun library sources were searched for information pertaining to the plant growth found along rural fences. No published articles covering the subject were found and, as a result, this entire thesis is composed of original data, conclusions and thoughts.

#### THE PROCEEDURE FOLLOWED IN OBTAINING DATA

In an effort to obtain as many data and as accurate information as possible of each association, two measuring tapes were used and the information was plotted in the field. The plants were located according to their position in the association from an established baseline running the length of the association. One tape recorded the distance from the starting point and the second tape stretched at right angles to the baseline would give the location of the plant in relation to the width of the association. Each tree was so located and designated upon cross-section paper by a small x. Then the spread of the crown of that tree was also

measured and drawn upon the paper in an effort to find what reaction there might be from crowding and to see if it had any influence upon the number of plants within the denser sections of the planting, as well as, the appearance of the association. The heights were estimated. The shrub masses were accurately located by their spread, or crowns, but the individual shrubs within the masses were not located. Perennials and dwarf native roses were not recorded.

The individual associations were later broken down into charts of linear spacing between individual plants or masses of the same species. These chart studies made it easier to see the distribution of each species and its relationship to the whole. By studying these charts it was also possible to see how the various species associated and merged with one another to give the general effect of the association.

#### GENERAL CONDITIONS PERTAINING TO THE ASSOCIATIONS STUDIED

Eleven fence-line associations were selected that varied in length from 250 feet to 2400 feet and from approximately ten years to fifty years in age. Most of the associations, however, were over 1500 feet in length and seemed to have been undisturbed for many years. They were all located within a fifteen mile radius of Lansing. The soil, for the most part, was of a sandy-loam nature with good drainage and the topography varied from rolling to flat.

Association one: The planting was bordered on both sides by hay-fields and the ground sloped slightly downward to the north toward a wooded tract. The soil was a clay loam and the area seemed to be well drained. A fence had been built about fifty years ago where the association was located, but there is no trace of it visible today.

Association two: The field to the north had at one time been cultivated but when the data was obtained it was covered with herbaceous plants, such as, golden rod, daisies, asters, and so forth. The field to the south was an unused grass area dotted with native hawthorns averaging three feet in height. The soil was a clay loam and the land sloped approximately one and one-half per cent upward toward the east. Like the preceeding, a fence built about fifty years ago had since disappeared. The planting was dotted with dead hickory trees.

Association three: Alfalfa fields bordered the planting on each side. The land sloped gradually upward toward the north for two hundred feet and then rose sharply for a change in elevation of approximately six feet. The crest of the hill came about three hundred and fifty feet from the starting point. From there the land continued to rise gradually to the north.

Association four: A rail fence that passed through the planting had been removed a year ago and replaced by a wire one erected to one side of the planting. When the rail fence was removed all shrub growth was cut down. However the young planting offered an interesting study on tree distribution.

Association five: A corn field bordered the association to the west, a pasture to the east. A wire fence passed through the planting. The soil was a loam and the land was level for 1320 feet when it sloped sharply downward toward the south.

Association six: There was a wheat field to the west, a clover field to the east. Only remanents of what was once a continuous barb-wire fence remained. The land sloped gently to the south and a shallow drainage ditch was located in the center of the association for the first 600 feet.

There were old stumps of large trees that had been cut down sometime in the past and many of the trees charted between the stations of 500 and 520 feet were the second growth from stumps.

Association seven: There was a hay field on both sides. The land was practically level with a slight rise in the center of the stretch studied. The fence was in poor condition and had been moved a few feet to the east sometime in the past.

Association eight: A snake rail fence ran through the association and, in addition, it was flanked to the west and sometimes on both sides with a barb-wire fence. The rail fence broke up many of the plantings and without doubt the shrubs had been cleaned out several times during the lifetime of the trees. The planting began with the fence of a cattle lane and ended in a wooded section. The fields on both sides were used for alfalfa.

Association nine: There were cultivated fields to the north and east, but on the west the area was overgrown with weeds. The land had approximately a two per cent slope to a low spot at 650 feet and from there it rose at a rate of about one-half of one per cent. The soil on the lowest level was of a hard-baking peaty type.

Association ten: There were cultivated fields on both sides of the association to a fence which crossed at the 980 foot station. From the fence onward old pastures bordered the association. The soil varied from a muck type in the low areas to one of a dry sandy character on the high areas. Much of the land to the west of the first 800 feet was used for growing potatoes.

Association eleven: For the first 1800 feet the soil was a sandy loam, when it changed to a clay loam for approximately 500 feet, and this in turn changed to a muck for the last 100 feet. Most of the planting was not over ten years old and some of the trees after the 1500 foot station

TABLE OF COMPARATIVE FACTORS

| Associa-<br>tion | Character of the association                                                                                                                                                  | When the association be-<br>gins or ends in the open,<br>shrubs or vines, or both<br>dominate that end of the<br>association. |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| 1.               | A matured plantation, but only 240' long.                                                                                                                                     | Yes                                                                                                                           |
| 2.               | A dense, matured plantation 400' long.                                                                                                                                        | Prominent but not dominant.                                                                                                   |
| 3.               | A very young plantation 245' long.                                                                                                                                            | ?                                                                                                                             |
| 4.               | A very young plantation that has just had its small growth removed. Plantation 380' long.                                                                                     | ?                                                                                                                             |
| 5.               | The wild grape destroyed the balance between the shrubs and trees. 1600' stretch, quite old.                                                                                  | Yes                                                                                                                           |
| 6.               | A well balanced plantation. Species climax is of minor importance in such a plantation. 1100' stretch. Quite old.                                                             | Yes                                                                                                                           |
| 7.               | The tree and shrub colonies seem to alternate in dominancy. Most of the large colonies are separated by mixed plantings. 600' stretch.                                        | Yes (shrub-like trees)                                                                                                        |
| 8.               | Snake-rail fence and brush cutting of owner eliminates adequate shrub studies. 600' stretch, young.                                                                           | No                                                                                                                            |
| 9.               | The grape has already stopped the further development of the association beyond this study and will soon destroy the present pleasing effect. 1200' stretch nearing maturity. | Yes                                                                                                                           |
| 10.              | A rolling stretch of 2100' on a light sandy loam soil. The shrubs give the effect of being dominant. It has an interesting skyline.                                           | Yes                                                                                                                           |
| 11.              | A 2400' stretch that was cut out 10 years ago. Most of the growth after 1500' is from stumps and there were very few shrubs.                                                  | Yes on one end.<br>No on one end.                                                                                             |

TABLE OF COMPARATIVE FACTORS

| Associa-<br>tion | When the associa-<br>tion enters a<br>wooded area trees<br>dominate that end. | The association<br>progresses to a<br>tree climax.             | When trees occur in<br>groups the groups vary<br>in size and spacing. |
|------------------|-------------------------------------------------------------------------------|----------------------------------------------------------------|-----------------------------------------------------------------------|
| 1.               | Yes                                                                           | Yes                                                            | Yes                                                                   |
| 2.               | ---                                                                           | Yes                                                            | Yes                                                                   |
| 3.               | ---                                                                           | ---                                                            | Yes                                                                   |
| 4.               | Yes                                                                           | ---                                                            | Yes                                                                   |
| 5.               | ---                                                                           | Yes                                                            | Yes                                                                   |
| 6.               | Yes                                                                           | Yes, but shrubs<br>are minor for $\frac{1}{2}$<br>of planting. | Yes                                                                   |
| 7.               | Yes                                                                           | Yes                                                            | Yes                                                                   |
| 8.               | Yes                                                                           | Yes                                                            | Yes                                                                   |
| 9.               | ---                                                                           | No                                                             | Yes                                                                   |
| 10.              | Yes                                                                           | No                                                             | Yes                                                                   |
| 11.              | ---                                                                           | Yes                                                            | Yes                                                                   |

TABLE OF COMPARATIVE FACTORS

| Associa-<br>tion | There is only one<br>dominant tree<br>species carried<br>through the associa-<br>tion. | Each secondary<br>tree species is<br>distributed through<br>most of the associa-<br>tion. | When a single repre-<br>sentative of a tree<br>species appears it is<br>not in an area composed<br>of many species, but<br>is isolated, or a stray<br>in a group of some<br>minor species. |
|------------------|----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.               | Yes                                                                                    | No                                                                                        | No                                                                                                                                                                                         |
| 2.               | No                                                                                     | Yes                                                                                       | Yes                                                                                                                                                                                        |
| 3.               | Yes                                                                                    | Yes                                                                                       | Yes                                                                                                                                                                                        |
| 4.               | ---                                                                                    | Yes                                                                                       | ---                                                                                                                                                                                        |
| 5.               | Yes                                                                                    | No but they are<br>well spaced                                                            | Yes                                                                                                                                                                                        |
| 6.               | No                                                                                     | Yes                                                                                       | No                                                                                                                                                                                         |
| 7.               | Yes (not very<br>strong in one<br>half)                                                | No                                                                                        | Yes                                                                                                                                                                                        |
| 8.               | No                                                                                     | Yes                                                                                       | No                                                                                                                                                                                         |
| 9.               | Yes                                                                                    | Yes                                                                                       | Yes                                                                                                                                                                                        |
| 10.              | Yes                                                                                    | Yes for major<br>species. No for<br>minor                                                 | No, for the most<br>part                                                                                                                                                                   |
| 11.              | No                                                                                     | Yes                                                                                       | Yes                                                                                                                                                                                        |

TABLE OF COMPARATIVE FACTORS

| Associa-<br>tion | Specimens, or very<br>minor tree species<br>are very young, or<br>old for the associa-<br>tion. | Shrubs* are found<br>in colony units<br>(Hawthorns excep-<br>tion at times). | Do two or more shrubs<br>intermingle in equal<br>proportions to form a<br>large unit. (see items<br>on page 14) |
|------------------|-------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| 1.               | Yes                                                                                             | Yes                                                                          | No                                                                                                              |
| 2.               | Old or average                                                                                  | Yes                                                                          | No                                                                                                              |
| 3.               | No                                                                                              | Yes                                                                          | No                                                                                                              |
| 4.               | Yes                                                                                             | ---                                                                          | ---                                                                                                             |
| 5.               | Yes                                                                                             | Yes                                                                          | No                                                                                                              |
| 6.               | Average                                                                                         | Yes                                                                          | No                                                                                                              |
| 7.               | Yes                                                                                             | Yes                                                                          | No                                                                                                              |
| 8.               | Yes                                                                                             | Yes                                                                          | No                                                                                                              |
| 9.               | Average                                                                                         | Yes                                                                          | No                                                                                                              |
| 10.              | Average                                                                                         | Yes                                                                          | No                                                                                                              |
| 11.              | Yes                                                                                             | Yes                                                                          | One bed                                                                                                         |

\*Shrub-like trees such as Hawthorns and chokecherry are included as they form a part of the under growth.



TABLE OF COMPARATIVE FACTORS

| Associa-<br>tion | The longest shrub*<br>units.                                                     | One or two shrubs<br>dominate the associ-<br>ation by having<br>their units well<br>distributed. | Minor shrub species<br>appear as small or<br>medium sized, well<br>distributed units. |
|------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 1.               | Plum 55'                                                                         | Yes                                                                                              | ---                                                                                   |
| 2.               | Gray dogwood 45'<br>Prickly Ash 60'                                              | Yes                                                                                              | ---                                                                                   |
| 3.               | ---                                                                              | ---                                                                                              | Yes                                                                                   |
| 4.               | ---                                                                              | Yes                                                                                              | ---                                                                                   |
| 5.               | Hazelnut 30' Gray<br>Dogwood 50' Choke-<br>cherry 45' Grape<br>190' Plum 40'     | Yes until grape<br>dominated one<br>half                                                         | Yes                                                                                   |
| 6.               | Gray dogwood 85'<br>Sumac 35' Sweet crab<br>50' Bladder nut 45'<br>Spirea 35'    | Yes Chokecherry<br>Gray dogwood                                                                  | Yes                                                                                   |
| 7.               | Sassafras 60' Gray<br>dogwood 50' Sumac<br>40' Sweet crab 30'<br>Chokecherry 50' | No                                                                                               | No                                                                                    |
| 8.               | ---                                                                              | Yes Chokecherry<br>Hazelnut                                                                      | ---                                                                                   |
| 9.               | Prickly Ash 60'<br>Plum 65' Gray dog-<br>wood 50' Chokecherry<br>105'            | Yes. Chokecherry<br>Gray dogwood,<br>Grape                                                       | Yes                                                                                   |
| 10.              | Plum 70' Elder 60'<br>Sassafras 100' Gray<br>dogwood 45' Hazel 30'               | Yes. Plum, Hazel-<br>nut, Sassafras                                                              | Yes                                                                                   |
| 11.              | Gray Dogwood 42'<br>Prickly Ash 40'<br>Sassafras 80'                             | Yes. Chokecherry                                                                                 | Yes                                                                                   |

\*Shrub-like trees such as Hawthorns and chokecherry are included as they form part of the under growth.

TABLE OF COMPARATIVE FACTORS

| Associa-<br>tion | Very minor shrub<br>species appear in<br>one or two large<br>masses. | Very minor shrub<br>species appear as<br>strays, or in groups<br>generally less than<br>15 ft. long. . | Do the dominating<br>shrubs progress to<br>a noticeable climax? |
|------------------|----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| 1.               | One species                                                          | Yes                                                                                                    | Yes                                                             |
| 2.               | No.                                                                  | Yes                                                                                                    | No                                                              |
| 3.               | ---                                                                  | ---                                                                                                    | ---                                                             |
| 4.               | ---                                                                  | ---                                                                                                    | ---                                                             |
| 5.               | Yes                                                                  | No                                                                                                     | Yes                                                             |
| 6.               | Some                                                                 | Some                                                                                                   | Chokecherry, No.<br>Gray Dogwood, Yes.                          |
| 7.               | Yes                                                                  | A few                                                                                                  | ---                                                             |
| 8.               | ---                                                                  | ---                                                                                                    | ---                                                             |
| 9.               | Yes                                                                  | No                                                                                                     | Chokecherry Yes.<br>Gray Dogwood, No.                           |
| 10.              | No                                                                   | Yes                                                                                                    | Plum, Yes. Hazel,<br>No. Sassafras, Yes.                        |
| 11.              | Yes (two)<br>No (two)                                                | Yes (two)<br>No (two)                                                                                  | Yes                                                             |

TABLE OF COMPARATIVE FACTORS

| Associa-<br>tion | Does the dominat-<br>ing tree species<br>progress to a not-<br>iceable climax?<br>(Check with items<br>on pages 8 & 9) | When the shrubs are<br>in a large colony,<br>trees are absent with-<br>in it, or present as<br>a mixture of species,<br>or as specimens. | When one species of<br>tree dominates a long<br>stretch, shrubs are<br>absent or represented<br>by small units. |
|------------------|------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| 1.               | Yes                                                                                                                    | Yes                                                                                                                                      | ---                                                                                                             |
| 2.               | ---                                                                                                                    | Yes                                                                                                                                      | Yes                                                                                                             |
| 3.               | No                                                                                                                     | ---                                                                                                                                      | ---                                                                                                             |
| 4.               | ---                                                                                                                    | ---                                                                                                                                      | ---                                                                                                             |
| 5.               | Yes                                                                                                                    | Yes, except for a<br>40' colony of<br>chokecherry under<br>a colony of slip-<br>pery elm.                                                | Yes                                                                                                             |
| 6.               | ---                                                                                                                    | Yes                                                                                                                                      | Yes                                                                                                             |
| 7.               | Yes                                                                                                                    | Yes                                                                                                                                      | Yes                                                                                                             |
| 8.               | ---                                                                                                                    | ---                                                                                                                                      | ---                                                                                                             |
| 9.               | No                                                                                                                     | Yes                                                                                                                                      | Yes                                                                                                             |
| 10.              | No                                                                                                                     | Yes                                                                                                                                      | ---                                                                                                             |
| 11.              | Yes                                                                                                                    | Yes                                                                                                                                      | Yes                                                                                                             |

TABLE OF COMPARATIVE FACTORS

| Association | Are most of the shrub colonies homogeneous? | Do different shrub species appear within a shrub colony as very minor variants. |
|-------------|---------------------------------------------|---------------------------------------------------------------------------------|
| 1.          | Yes                                         | No                                                                              |
| 2.          | Yes                                         | No                                                                              |
| 3.          | Yes                                         | No                                                                              |
| 4.          | ---                                         | ---                                                                             |
| 5.          | Yes                                         | No                                                                              |
| 6.          | Yes                                         | Yes, in a few. Generally the shrub-trees are variants.                          |
| 7.          | Yes                                         | Occasional shrub-like tree variant.                                             |
| 8.          | Yes                                         | ---                                                                             |
| 9.          | Yes                                         | No                                                                              |
| 10.         | Yes                                         | Occasionally                                                                    |
| 11.         | Yes                                         | No                                                                              |

TABLE OF COMPARATIVE FACTORS

| Association | Species study                                                                                                                            |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------|
| 1.          | 3 major trees, 3 minor trees, 1 very minor tree. 2 shrub-trees. 2 shrubs.                                                                |
| 2.          | 2 major trees. 6 minor trees. 4 very minor trees. 1 shrub-tree. 2 major shrubs. 1 very minor shrub.                                      |
| 3.          | 2 major trees, 3 very minor trees. 1 shrub-tree. 2 shrubs.                                                                               |
| 4.          | 6 trees. 3 shrub-trees                                                                                                                   |
| 5.          | 5 major trees, 3 minor trees, 4 very minor trees. 4 shrub-trees. 3 major shrubs, 1 minor shrub. 2 vines.                                 |
| 6.          | 5 major trees, 3 minor trees, 2 very minor trees. 5 shrub-trees, 2 major shrubs, 4 minor shrubs. 1 vine.                                 |
| 7.          | 3 major trees, 4 minor trees, 1 very minor tree. 6 shrub-trees. 5 minor shrubs. no vines.                                                |
| 8.          | 5 major trees, 2 minor trees, 4 very minor trees. 3 shrub-trees. 2 shrubs. 1 vine.                                                       |
| 9.          | 3 major trees, 7 minor trees, 4 shrub-trees. 2 major shrubs. 1 minor shrub. 1 vine.                                                      |
| 10.         | 3 major trees, 2 minor trees, 6 very minor trees. 1 major shrub-tree, 2 minor shrub-trees. 5 major shrubs. 2 minor shrubs. 2 vines.      |
| 11.         | 3 major trees, 4 minor trees, 5 very minor trees. 1 major shrub-tree, 5 minor shrub-trees, 3 minor shrubs, 4 very minor shrubs. 2 vines. |

## CONCLUSIONS

The source or starting point of a linear association plays an important part in shaping its character. If it projects outward from even a small woodlot there is a noticeable decline in the presence of shrubs. In fact, the planting is generally composed of trees for two hundred and fifty or three hundred feet from the wooded area, and if shrubs are present they are generally in very small colonies or of that intermediate type of woody growth that is usually called a shrub-like tree, or tree-like shrub.

If the linear association starts in an open field or even with a large specimen tree that has been left to mark a corner, the shrubs and shrub-like trees will generally dominate the beginning of the planting. As to how far the shrubs are found playing a major role seems to depend upon two things; the age of the association, and the number of times the farmer has interfered. Since the artificial highway plantings can seldom be created with matured plants it may be best to consider the younger linear associations. In them shrubs play a dominant role for a distance of from one to four hundred feet, the younger the association the more important shrubs become. In most young associations, shrubs, such as, the american elder and gray dogwood, will appear in several small isolated groups before they combine with other shrubs, or trees to form a continuous planting. These first groups give a pleasant tapering effect. Whenever the farmer cuts down the shrubs and small trees periodically, leaving only larger plants, there will be a shorter stretch dominated by shrubs, and for this reason, the artificial plantings can vary considerably in the quantity of shrubs used and still harmonize with the surrounding farm land.

With the foregoing observations in mind it is not surprising to note that the majority of linear associations will progress to one or more segments composed entirely, or nearly so, of trees. It is a natural progression when the association begins in a sun-lit meadow and ends in a wooded section, but it is also found in associations located in an isolated position. However, those linear associations surrounded by open fields have better growing conditions for shrubs, and as a result, there are more shrubs present and they play an important part in most of the planting. Whenever a section is dominated by trees in these isolated associations it is generally short, but acts as an effective change in the silhouette beauty of the association. These tree composed segments are seldom in the center of the association.

When associations of varying ages are casually observed there seems to be no natural rule of spacing, or placement of the various trees and shrubs. To a certain degree that is true, but upon closer study it is found that the plants within these linear associations tend toward some general rules. For instance, the major reason why these native plantings give an harmonious, but not a monotonous impression is due to one or more species of trees and one or more species of shrubs being carried through all, or the greatest portion of the association. Half of the associations studied have one tree species carried through the planting as specimens, or in various sized groups so that its character dominates the association. In the other associations two or three trees are carried through in a similar manner. In almost all cases one or two shrubs are carried through the areas within the association occupied by such a growth.

In many of the associations studied, the dominating tree and shrub species tend to arrange themselves into groups that grow progressively larger to a climax. The distance between these groups also tends to grow

progressively smaller as they approach their largest group, or climax, in particularly dominating species. This is very noticeable in the case of about half of the dominating shrubs. Between these groups, specimens may be found intermingled with other species of trees or shrubs.

The space interval between individual trees within groups show some interesting facts. Two trees of the same species grouped closely together (within two or three feet) present a more common combination, even in young plantings, than the isolated specimen. Within large groups the trees are never equidistant from each other, nor on a straight line. There is generally a nucleus of three or more trees very closely spaced in the center of all large groups.

This natural filtration of certain species throughout the association instead of limiting them to one or two locations as they are in so many artificial plantings, gives character and harmony to the planting, yet variety and interest is given by the secondary and minor species.

Some species seem to grow in groups more readily than others. For example, the following are more frequently found in groups than as individuals: the various species of cherry, large toothed aspen, hawthorns, crab, white ash, linden or basswood, elms, and sassafras. The following trees may be found in small groups, but tend to grow as individuals throughout the planting: the hickories, black walnut, red oak, green ash, sugar maple and scarlet oak.

There seems to be no particular logic in the appearance of individual specimens of certain tree species within the linear association. For the most part they appear as very young plants struggling to establish themselves, or as individuals that are older than the other plants growing about them.



Since the dominant plants tend to group themselves, as stated above, it makes the skyline of the planting very irregular. This irregularity will remain for many years, if not permanently, because of the varying mature heights of the different dominant groups combined with their spacing. In young associations the horizon picture is made interesting by the variation in the age and size of even the same dominating species. The variation due to age will remain in many cases until the long-lived plants near maturity, when the differences in height will disappear.

Spacing, as well as height, helps to make the elevation view of the planting interesting, as the variation from dense to open planting permits an intriguing play of light to reach the motorist. Spacing controls the scenic effect of the association by alternately closing and opening views of the land beyond, or offering an enticing picture through a partially screened opening.

The shrub-like tree species are also well distributed within the association, but do not always appear in all portions of it. Sometimes these trees will act as a general filler, sometimes a sudden change in soil conditions will permit them to dominate the association for a short time and then they will taper away into the general mass, and sometimes they are short-lived species being replaced. Whatever the reason may be for the variation in quantity of these shrub-like tree species they are not limited to one short segment of the association.

The linear associations studied vary as to the number of shrub-like trees between three and six. However, there is seldom more than two species playing a prominent part in the planting and more often only one shrub-like tree is carried through the planting.

All of the shrubs and many of the shrub-like trees grow in colonies or colonial units and the units are homogeneous as to species in the greater proportion of the time. That is, only one bed of twenty feet in three miles of study was found that had an equal mixture of two shrubs, and only a few units that had other minor colonies of shrubs incorporated within them or at their margin. Generally, the shrub masses are composed of only one kind and there is a sharp line of demarcation between adjoining masses. If the shrub colonies are not homogeneous as to species, the variant is generally one of the shrub-like trees and even they do not occur in many cases.

It will surprise few to hear that when shrubs occur in a large colony that trees are generally absent, but may appear within it as a specimen, or as a mixture of species. However, it may be more of a surprise to reverse the outlook by stating that when one species of tree forms a large colony or unit within the association, shrubs are absent or represented by units less than fifteen feet in spread. There was one exception found, a forty foot colony of chokecherry beneath a colony of slippery elm.

The botanist claims that the plants within a forest are constantly changing, through the influence of a diminishing amount of light, until a forest climax is reached. This means that the species whose seedlings endure the lowest light intensity will finally dominate. It is doubtful if this influence of light will play such an important part in the establishment of highway plantings, since they are so narrow, but it does have some influence upon the shrub growths and the encouragement of seedlings.

The natural succession of plants seen along rural fences seems to depend more upon the speed of growth, ultimate height and age limits of the various plants than upon the factor of light. The most admired trees in the plantings are generally the tallest, yet there are many cases where old trees are growing under their branches with plenty of light. These lower, but matured trees, are ones that do not grow tall, such as the shadblow, hawthorn, and chokecherry. On the other hand, trees such as the chokecherry and aspen are frequently seen dying along the edges of older plantings from no other discernable cause than that of age. These factors contribute to forest successions, but seem to be the main causes of change in these narrow plantings.

Light does play an important part in these plantings, however, as a factor in the beauty of the association. Plants will adapt the shape of their crowns to the light openings, even in a narrow planting, and this forms a denser, wider mass of foliage where the plants are crowded than is generally obtained in artificial plantings. This growing for light permits a great number and variety of plants to be crowded upon a small area of ground which results in a greater amount of interest, due to their variation of foliage, color and size, than would be had from a group of one species. This is one factor that seems to be too frequently overlooked when highway plantings are being made.

#### RECOMMENDATIONS FOR FUTURE HIGHWAY PLANTINGS

In the final analysis, the basic objective of a modern roadside development program is to adapt the engineering and landscape efforts of men to the forces of nature. In this way a proper and permanent balance of natural forces will be economically obtained. Therefore, it is important that future plantings along the highways shall play their roles as

snow breaks, soil binders and wild life sanctuaries in such a way that they seem part of the native surroundings and will need little attention. There should be no attempt to develop a ribbon-like garden of iris, day lilies, lilacs, and the like, but a definite ecological succession of woody plants native to the area and arranged in a natural manner.

The native associations are not composed, as previously shown, by trees arranged to form a formal avenue. Whenever trees are seen in any arrangement approaching such an avenue they have the mark of artificiality. This is especially true when the trees are of the same approximate size and unaccompanied by shrubs and intermediate sized trees.

There are few plantings more inspiring than a well developed avenue, but even avenues can be overdone on highways. They become monotonous and tend to drowse the senses after miles of travel. The eye is directed in a certain fixed way and is not allowed to wander from one side to the other and, if the trees are not accompanied by lower growing plants, the flickering of the light between the trees increases the fatigue of the eyes. The present style of specimen planting, practiced by some highway departments, has the tendency to develop such avenue effects. A string of individual trees along a highway unsupported by its natural associates, shrub-like trees and shrubs, is artificial and not very convincing, no matter whether the spacing is irregular and varied by small groups or not. It is the road that permits passing from open views to those closed with a wall of varied green foliage and sunlight to those that give momentary combinations of both that has the greatest amount of interest and naturalness.

Fatigue as a source of danger to the motorist has been overlooked too long. Monotonous driving conditions add considerably to the mental

and physical fatigue acquired just from driving a car for many hours. Motorists drive under conditions which are not only bad, but which, with the increase of traffic, are tending to become more and more trying. To relieve some of this monotony of driving it is imperative that plantings containing the variation, interest, and restfulness of the natural plant association be introduced onto the highway right-of-way.

It would seem as though better results could be obtained if more species of plants were used in the highway plantings. These species should include long-lived trees, like the elms and oaks; quick growing trees, like the cherries; shrub-like trees, such as the hawthorns; and native shrubs that form thickets, such as the gray dogwood and prickly ash. Such a mixture of plants would give quicker and more natural results, if some of the foregoing principles of grouping were observed.

Continuous mixed plantings of trees and shrubs for five hundred feet, or more, with long open stretches broken only by a few, if any, specimen trees, should be the goal of a highway beautification project, if an appearance of naturalness is to be obtained.

The natural linear association is composed of three types of woody vegetation, trees, shrub-like trees, and shrubs. Each of these types plays an important role, but that of the shrub-like trees has been sadly overlooked, or under-estimated. This intermediary group includes such attractive and important plants as the hawthorns, native crabs, chokecherry, sassafras, flowering dogwood, and wild plum. No matter whether the planting is young or old it is this group that extends upward the dense foliage mass of the shrubs, covers many tree trunks to prevent

the dizzy, unpleasant sensation of passing a lot of high fence posts, and provides most of the floral display that encourages so many people to travel the rural highways in the spring and early summer.

It is not possible to create a "woods" in the ten or twenty feet allotted for highway plantings, but it is possible to give the mental rest gained by passing through a wooded area by using tall, overhanging trees interplanted with a dense mass of shrub-like trees and a few shrubs.

For new plantings made with a limited budget, the shrub-like trees could be used as natural nurse trees. When used in large groups they offer a possible seed bed for naturally introduced seedlings, or protection to newly transplanted saplings. They will shade the ground enough to discourage weeds and the rapidly drying out of the soil and prevent mowing machine damage to the saplings. Such a natural combination would permit the planting of smaller sized stock with a great saving for those working with small appropriations. These practical considerations should be compared with the present system of scattered tree plantings and the high maintenance cost of mowing and cultivating around the young trees. The latter system prevents natural seeding and the maintenance costs increase with every isolated tree.

Another financial saving could be obtained if more rapid growing trees such as the cherries were used. At the present time these trees are ignored because they are classed as short-lived and require high maintenance. Because they are short-lived they grow fast, cost less to raise in the nursery and could be used in greater quantities. In addition they would add a pleasant attractiveness to the roadside within a shorter period than a series of specimen long-lived trees would and at the same time act as a natural nursery for a more permanent effect. The maintenance cost

of these trees is high when they are used as specimens, but when used in masses the wind causes less damage and the increased bird life reduces the insect population to such a point that it is no longer a major worry.

Shrubs have been used in a very minor way in most artificial plantings but in the natural associations they are very important, especially in young associations. Shrubs play the role of a refiner. They taper the trees and shrub-like trees down to the meadow; they mix their smaller leaves in with the coarser ones of the larger plants and reduce the whole association down from a possible large scale that dwarfs man to one that is more intimate and restful. They also add a floral interest to the whole that most people enjoy and a trimness that helps the maintenance crews in their mowing operations. The secret of their successful use is to limit the number of species and to use large masses. The number of shrub species ranges from two to seven within the various associations studied, but, with one exception, there are no more than two outstanding shrubs in one association. Then too, nature doesn't use a half dozen shrubs of one species in a group and then use another kind for the next group. The length of shrub masses varies, but the dominant species frequently forms a group fifty feet long and masses seventy to one hundred feet are not exceptional for many species. It would seem that designers of artificial plantings should overcome the fault of using many species in small beds if they wish restfulness and naturalness in the planting.

If the artificial highway planting is for the purpose of covering a fence, vines might be used, but if the beauty of a tree and shrub planting is desired, vines should not be used among the shrubs. The native

grape vines especially will smother shrubs, shrub-like trees and even specimens of high growing trees that are twenty feet high and convert them into a skeleton of dead branches clothed with the swaying foliage of the vine. To be sure, a grape vine is attractive during the summer, especially when it is on a large tree, but it is a death warrant for small plants.

The bittersweet is generally found on open stretches of the fence or sprawled on the ground, but does very little damage to the shrubs. Its fruit is very attractive and is admired by many people, so the bittersweet might be used on the boundary fence at the ends of an association where the shrubs stop.

The Virginia creeper is also found and holds an intermediate position between that of the grape and the bittersweet. It climbs up into the trees and over the shrubs, spoiling parts of them, but doesn't seem to completely smother a plant like the grape. Its main contributions are fall color and bird food. In most cases it would seem better to dispense with the Virginia creeper in highway plantings.



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