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NATURAL TREE REPRODUCTION IN URBAN ENVIRONMENTS

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ABSTRACT

Three contrasting urban areas in Milwaukee County were sampled to determine the tree species reproducing and the habitats in which seedlings become established.

Habitats most favorable for seedling establishment were shrub hedges and areas along fence lines or adjacent to buildings.

Overall, elm and ash were the taxa most successful in establishing seedlings. In the Menomonee Valley, seedlings of boxelder and tree-of-heaven were most abundant with elm and ash close behind, while in Shorewood and Brown Deer, a great variety of seedlings was present. Elm, ash, boxelder, Norway maple, buckthorn, cherry and mountain ash were the most prevalent.

Successful seedling establishment depends upon availability of sites that offer exposed soil for germination and temporary protection from disturbance.

INTRODUCTION

Most urban dwellers assume that trees growing in the city were either planted there or are leftovers from some distant time, before the city developed. Despite this perception, there are many trees in the city that originate directly from seed. These wild or feral trees are those whose presence was not planned.

Trees provide many benefits in the city; they create aesthetically pleasing views, control soil erosion, provide shade and abate pollution (Landphear 1971, Grey and Deneke 1978). In addition, they help to reduce noise (Cook and VanHaverbeke 1972) and provide habitat for urban wildlife (Stearns 1975). Urban trees exist under stress. For successful survival in the city, growing space is required, as well as a modicum of resistance to and protection from the physical, chemical and biological components of the environment, i.e. "bulldozer disease", air pollution, road salting and vandalism.

Our knowledge of the development of unplanted trees within the city is limited. We know little about which species reproduce in urban areas, or in what sites reproduction is successful. This study was conducted to explore those questions and to provide groundwork for further studies on urban arboreal vegetation (Boyd 1983).

Study sites were chosen to represent three types of urban environment in which trees might become established. Sites were selected in a recently

developed suburb - Brown Deer, an older suburb - Shorewood, and an industrial area - the Menomonee River Valley in Milwaukee.

METHODS

Sampling in the three areas followed a modified stratified random pattern. Brown Deer sampling sites were selected in one-block units and additional sites were chosen at distances six blocks from the initial sites. A total of fifteen units was sampled. In the Menomonee Valley, site selection was based on three east-west transects. Each site was 161 m long and sites were separated by 300 m or more. Nineteen sites were sampled. Shorewood was divided into two habitats, alleys and front yards, and each type was sampled with 15 alley and 13 front yard sites.

At each site in Brown Deer and Shorewood seedlings were counted along both sides of the street, in front and side yards for the length of a block. Side hedges when encountered, were followed into the side yard but not into the back yard. Where density of seedlings was high, areas were subsampled. In the Menomonee Valley, areas 12 m into the site were sampled, save where a fence prevented access, in which case the fence was followed around the area. Shorewood alleys were sampled on only one side, since they had high densities of seedlings and the samples included the area from the pavement to the limit of the residential back yard, generally a fence or hedge. Vigor, height, distance from the street, distance to the nearest mature individual of that species, and location, were recorded for each seedling as were data on the nearest mature trees, including diameter at breast height (DBH) and vigor, and the nature of the seedling establishment zone. Data were coded and key punched and SPSS programs were used for analysis. In all, 3245 seedlings and 1511 mature trees were recorded.

Seed Availability and Establishment Sites

Many species of urban trees, both native and exotic, are capable of producing seed and do so. In the case of cottonwood (*Populus deltoides*) for example, heavy seed production results in this useful urban tree often being designated as a nuisance. For a tree to become established, a suitable site and opportunity must be provided. Thus, this study examines establishment and early survival of urban tree seedlings, without which the production of seed is meaningless.

Available seed is related to the number of mature trees present. The relationship is demonstrated in the three sample sites. Shorewood has a much higher density of mature trees (1.74/100 m^2) than the Menomonee industrial area (0.22/100 m^2) and also has a correspondingly greater density of seedlings (5.57/100 m^2 as compared to only 1.10/100 m^2 for the Menomonee Valley) (Table 1). However, other factors are involved, since Brown Deer, with an intermediate density of mature trees shows a far smaller seedling density than even the Menomonee Valley. Presumably, the difference lies in the relative youth of that

Table 1

Mature trees and seedlings in Brown Deer, Shorewood and the Menomonee Valley

	Brown Deer	Menomonee Industrial Valley	Shorewood Yards	Shorewood Alleys	Four Sites Combined
Number of species					
Mature trees	31	12	35	28	38
Seedlings	25	8	20	17	33
Number of seedling species that make up over 2.5% of total population	10	5	5	5	8
Individuals in sample					
Mature trees	838	72	400	201	1511
Seedlings	364	350	1277	1254	3245
Area sampled, m^2	90,220	32,918	22,921	4,580	150,639
Density (#/100m^2)					
Mature trees	0.92	0.22	1.74	4.38	1.00
Seedlings	0.40	1.10	5.57	27.40	2.15

suburb where lawns are large and hedges are not common. The species of mature trees present also affect seedling density; some species are capable of only limited reproduction and others are highly successful.

Seedlings were found in a variety of sites, under shrubs or small trees, along fence lines, in hedges, along garages and in gardens. Hedges and building sides appear to be primary locations. Where shrubs are present, i.e. in Brown Deer and Shorewood, they provided a safe site for the greatest number of seedlings (Table 2). Privit hedges (Ligustrum spp.) are common and appeared to be most frequent of all shrub sites for seedling germination and seedling development. In the Menomonee River Valley and along Shorewood alleys, fence lines and sides of buildings are the most favorable habitats. In Brown Deer and Shorewood front lots, habitat provided by Japanese yew (Taxus spp.) was second and that by spirea (Spirea spp.) and honeysuckle (Lonicera spp.) third and fourth; again these were among the most common hedge species planted. There was no correlation between the species of shrub host and the prevalence of a particular species of tree seedling. The growth form of the shrub and the amount of soil disturbance around its base are the factors that permit seedling establishment.

Successful reproducers in order of abundance were elms (Ulmus spp.), ashes (Fraxinus spp.), boxelder (Acer negundo), tree-of-heaven (Ailianthus altisima), cherries (Prunus spp.), Norway maple (Acer platinoides), and buckthorn (Rhamnus cathartica) (Table 3). Seedling species composition varied, but ash and elm were in the top four in all areas. Boxelder and Norway maple were common in Brown Deer and Shorewood and boxelder and tree-of-heaven, in the industrial area. There were also differences in the two sampling areas in Shorewood. Boxelder the most important species in the Menomonee Valley was common in Shorewood alleys, while in contrast, Norway maple and cherry, not present in the industrial area, were in front yards. Frequency data corroborate density data.

Distance from seedlings to the nearest mature trees varied considerably, ranging from those immediately under the parent tree to those many meters distant. Elms are currently the most successful species at reproducing within the city, even so the presence of elm seedlings is related to the density of mature trees and hence to the amount of seed produced. Elm seed is widely distributed; seedlings were recorded as much as 55 m from the nearest mature tree. In contrast, ash mature tree and seedling numbers show no correlation. The principle species present are the native white ash (Fraxinus americana), and the introduced green ash (F. pennsylvanica var. subintegerrima). This genus is sensitive to sulfur dioxide and ozone (Davis 1976) and does not appear to reproduce successfully in the Valley.

Boxelder reproduces effectively in the Menomonee Valley, usually within a few meters of the parent tree. It also reproduces successfuly in Brown Deer and Shorewood where, again, the relative proportion of seedlings is greater than the percentage of mature trees. Boxelder's tolerance of compacted soils, poor

Table 2

Percentages of tree seedlings and saplings rooted under shrubs or in other habitats[1]

Shrub taxa and other rooting sites [2]	Location			
	Brown Deer	Menomonee Valley	Shorewood Front Yards	Shorewood Alleys
Barberry	T	--	3.9	T
Honeysuckle	4.4	T	8.8	T
Lilac	3.8	--	T	T
Privet	23.6	--	32.1	T
Spirea	6.0	--	5.9	2.5
White Cedar	6.3	--	--	--
Yew	6.9	--	15.2	T
Juniper	6.3	--	4.5	--
Coniferous trees	4.7	--	2.6	--
Deciduous trees	4.1	--	3.2	--
Lawns and old fields	--	24.0	T	T
Planting bed	21.2	--	12.5	T
Garage or bldg. side	T	42.6	T	48.8
Fence line	--	32.0	T	26.5
Forested edge	6.6	--	--	8.5

1, T = trace, <2.5% of total population

2, other shrub and rooting sites (with less than trace amounts) include bush honeysuckle, dogwood, euonymus, forsythia, mock orange, rose, snowberry, viburnum, weigela, window wells and pavement cracks

Table 3

Relative Seedling Composition of Sampled Sites (%)

Taxa	Brown Deer	Menomonee Valley	Shorewood	Shorewood Alley
Box Elder	8.8	25.1	9.7	19.4
Norway Maple	8.0	0.0	6.3	16.0
Silver Maple	T	0.0	T	T
Sugar Maple	3.0	0.0	T	T
Horsechestnut	T	0.0	T	T
Tree-of-Heaven	0.0	35.4	T	T
Hawthorn	T	0.0	T	0.0
Ash	15.7	11.4	24.7	14.1
Honey Locust	T	T	0.0	T
Walnut	T	0.0	0.0	T
Juniper	T	0.0	T	0.0
Apple	4.1	0.0	T	0.0
Cottonwood	0.0	T	0.0	0.0
Cherry	7.7	0.0	11.6	6.9
White Oak Group	T	0.0	T	T
Red Oak Group	0.0	0.0	T	T
Buckthorn	10.2	0.0	T	T
Black Locust	0.0	3.4	0.0	0.0
Mountain Ash	7.4	0.0	T	T
Basswood	5.5	0.0	T	0.0
Elm	22.5	21.7	36.9	40.0

T=Trace, <2.5% population total.

Taxa present in smaller numbers: Acer ginnala, A. rubrum, Carya spp., Catalapa speciosa, Elaeagnus angustifolia, Morus spp., Prunus spp., Rhus typhina, Salix spp., Xanthoxylum spp.

drainage and salt and lower susceptibility to ozone and sulfur dioxide are certainly advantageous.

Many species, although common as seedlings in Shorewood and Brown Deer, did not occur in the Menomonee Valley. These included cherry, Norway maple, hawthorn (Crataegus spp.), mountain-ash (Sorbus spp.), basswood (Tilia americana), and sugar maple (Acer saccharum). Their absence may be explained by a lack of a seed source as well as unfavorable conditions. Norway maple deserves particular mention since it is planted extensively throughout the northern United States as a street tree. It is a good tree for city planting because it is tolerant of ozone and sulfur dioxide, as well as of road salt. Norway maple is capable of efficient seedling establishment, particularly in hedges and backyard gardens. Our native sugar maple and its frequent associate, American basswood, produced relatively few seedlings, presumably for species-specific reasons, i.e. lack of viable seed and seed dormancy respectively.

Seedlings of the bird-dispersed species including mountain-ash and various apples and cherries were frequent. They did not, however, make up a major part of the seedling population, and the greatest number of these seedlings were found in relatively close proximity to the parent trees, indicating limited bird dispersal. Seedling establishment by evergreens is notably unsuccessful; although spruces (Picea spp.) were the most common mature tree in Brown Deer and are also frequent in Shorewood, no seedlings were found. Juniper (Juniperus spp.) fruits also are disseminated by birds, but only one juniper seedling was encountered, likewise, no yew seedlings were found although seedlings have been observed in nearby areas.

The differences in seedling establishment depend on many factors: the availability of seed, the mode of seed dissemnination, the nature and speed of germination and early growth of the plant, seed predation and the availability of safe sites for germination and growth. Although many species have been noted to reproduce within the urban environment, only a few can be said to be truly successful. These include several ash species, maples, specifically Norway maple and boxelder, elms and cherries. In the Menomonee Valley disturbance encourages black locust (Robinia pseudo-acacia) and tree-of-heaven.

Although the large seeded dicots are present as mature trees, e.g. walnut (Juglans spp.), horsechestnut (Aesculus spp.) and several of the oaks, i.e. bur oak (Quercus macrocarpa) and white oak (Q. alba), they are generally unsuccessful in reproducing. However, all of these groups may be successful under specific conditions, i.e. where soil is disturbed at the appropriate time, burying the seed (fruits) and protecting them from predation and from dessication. In garden areas, when acorns are buried, oak seedlings can be abundant.

This study documents the successful establishment of some tree species in the urban environment and the lack of success by others. It also illustrates the potential for wild seedlings to revegetate abandoned areas, provided that adequate soil conditions and seed are available. When a well-established tree

seedling is discovered in a hedge or a garden, the landowner must choose whether the seedling is an appropriate plant with long-term potential, or a weed to be removed.

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