Fall 1981

Patterns of seedling establishment in an old field

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PATTERNS OF SEEDLING ESTABLISHMENT IN AN OLD FIELD

Within 100 years after settlement began (ca. 1830), most forest land in the Milwaukee area had been influenced by agriculture. When the land was cleared for cultivation, trees were occasionally left along property boundaries, on steep slopes or in depressions. These trees served to shade the farmer and his livestock and break the wind. Beginning in the 1930's, urbanization and other changes in land use have resulted in abandonment of cultivated fields and pastures and their regrowth to forest or conversion to other uses. The isolated trees provided a continuing source of tree seed.

The presence of an isolated tree in an abandoned field provides an excellent opportunity to study seed dispersal and seedling establishment. This study, undertaken in 1977, examined the distribution of sugar maple (*Acer saccharum*), white ash (*Fraximus americana*) and basswood (*Tilia americana*) seedlings and was part of a larger study of landscape patterns in southeastern Wisconsin. Seed dispersal and soil and microclimatic effects were examined (O'Donnell 1980).

The study area consisted of an abandoned field in the northwestern corner of Milwaukee County (T8N, R21E, Sec. 4). The site lies on an Ozaukee silt loam with small areas of less well-drained Mequon silt loam.

METHODS

Several isolated, mature trees were studied. One of these, a sugar maple, will be used to illustrate the patterns observed. Transects were established extending outward from the base of each tree far enough to include all visible seedlings. Plots one meter square were located every two meters along each transect, and all woody stems were identified and counted. In several cases, stems were harvested to determine biomass and height. Seedling stems were aged by counting the rings of terminal bud scale leaf scars, while older stems were aged by counting the annual rings. Total density and density for each height class were determined for each sample plot. Soil samples were collected and soil moisture determined.

The sugar maple chosen was 17m tall and 0.6m DBH with a canopy approximately 14m in diameter. At the drip line (outer edge of the canopy), the canopy reached within 2.5m of the ground. Twelve transects were established radiating from the base of the tree (Fig. 1). Several passed near, or included one or more neighboring trees, hawthorn or ash. Seedling density was recorded in three categories: 1) 0-9 stems/m^2, 2) 10-29 stems/m^2 and 3) 50 or more stems/m^2. Distribution of tree reproduction was mapped by density.

RESULTS

Seedling establishment in the vicinity of the isolated sugar maple proved to be closely related to soil and microhabitat conditions. Seedlings were most abundant in the northeastern and southwestern quadrants being most common near and under the drip line. There was less reproduction in the western and northern quadrants (Fig. 1). Stem density varied greatly with age class; the largest age class was that of 1977, while the 1974 age class was more abundant than older ones. The 1975, 1976 and 1978 classes were not represented. Lack of reproduction in these years may be attributed to small seed crops, unfavorable weather during seed development or seed germination, or a combination of these factors. The youngest age class (1977 - 2 year-old seedlings) occurred almost entirely near the drip line and was most abundant in the southwestern and southern sectors where competition from the older well-established seedlings was not a factor. These older seedlings (5 years - 1974 and older) were concentrated under the canopy in the north to east portion (Fig. 3). Although most reproduction occurred in the immediate vicinity of the maple or under adjacent trees, some sugar maple seedlings were found 50 to 70m distant.

Scattered hawthorn and other trees 3 to 5m tall served to reduce grass cover locally and provided locations suitable for maple reproduction similar to those under the maple.

DISCUSSION

Available seed is the first prerequisite for seedling establishment. Evidence indicates that within the area surrounding this maple and other isolated trees, seed was not distributed uniformly. However, there appeared to be adequate seed in the immediate proximity of the maple.

In addition to seed, microclimate and soil conditions must be favorable if seedlings are to become established and survive. After seed reaches a site, microhabitat becomes the critical factor in seedling establishment.

Research in other areas and forest types has described specific microhabitat conditions that may occur around an individual stem. Zinke (1962) suggested that the distribution of ground vegetation is a reflection of the soil pattern produced by bark, litter and other materials dropping from the tree. Whitford and Whitford (1978) noted that, in a Hill's oak (*Quercus elipsoidalis*) stand, there was more ground vegetation under the oak canopy than in the open. They theorized that the more dense vegetation was related to higher levels of P and K in the sandy surface soil under trees than was present between trees. Others (Horn 1971) have noted that canopy shape and leaf distribution influence the amount and quality of light reaching the soil surface and thus affect seedling establishment. The amount of solar energy reaching the forest floor or the surface of the old field influences the temperature and moisture content not only of the air immediately above the soil but of the soil as well. Studies of forest edges (Bruner 1977, Levenson 1976) suggest that the forest edge affects tree regeneration primarily through differences in light, moisture and temperature.

Our findings indicate that maple reproduction has been strongly influenced by differential shading and moisture availability. Older maple seedlings are concentrated within three meters on either side of the drip line in the northern and northeastern sector of the canopy. Soil moisture in this location is favorable and the soil is protected from direct solar radiation. The tree shadow, therefore, produces a favorable microclimate. Maple seedling establishment in the vicinity of hawthorn stems was also predominantly in the area shaded by the hawthorn canopy. White ash reproduction in the vicinity of a large American elm showed a similar pattern. Although the elm was dead in 1977, most reproduction had developed earlier. Ash germination and seedling establishment occurred under and near the former elm canopy, but was more diffuse and covered a wider arc than did maple seedlings around the maple.

In contrast to ash and maple, survival of basswood seedlings was more frequent beyond the basswood canopy, and seedlings were absent under the hawthorns, implying a lower shade tolerance for basswood.

The seedling distributions noted above, highlight some of the variables that must be considered in assessing the potential for regeneration of forest stands from isolated trees and, by extension, from the northern and eastern edges of forest islands. This type of establishment appears to be one way in which forest stands in urban fringe areas are regenerated and perpetuated.

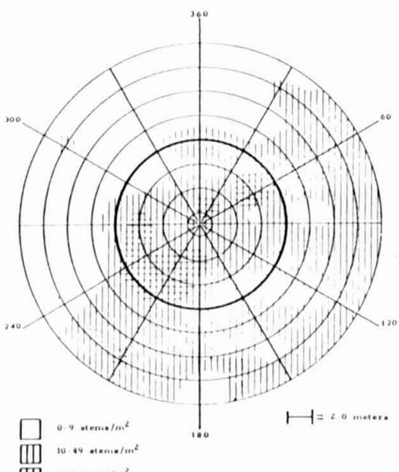

Fig. 1. Density (stems/meter^2) of sugar maple reproduction within 15 meters of maple. Approximate position of canopy dripline is indicated by heavy line.

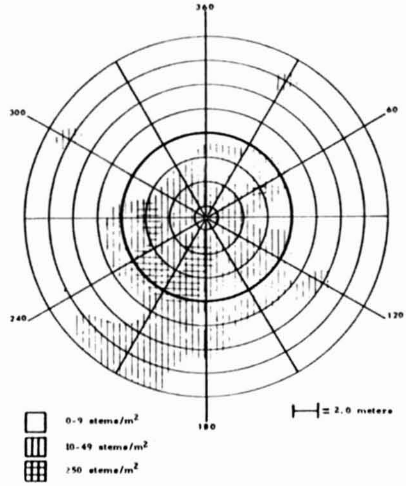

Fig. 2. Density (stem/m^2) of 2 year old sugar maple seedlings within 15 meters of maple. Approximate position of canopy dripline is indicated by heavy line.

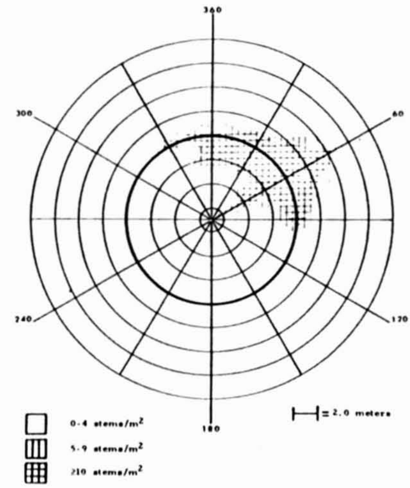

Fig. 3. Density (stems/m^2) of sugar maple reproduction older than 5 years. Approximate position of canopy dripline is indicated by heavy line.

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