

THE

VEGETATION

OF

THE

CITY

The Urban Ecosystem

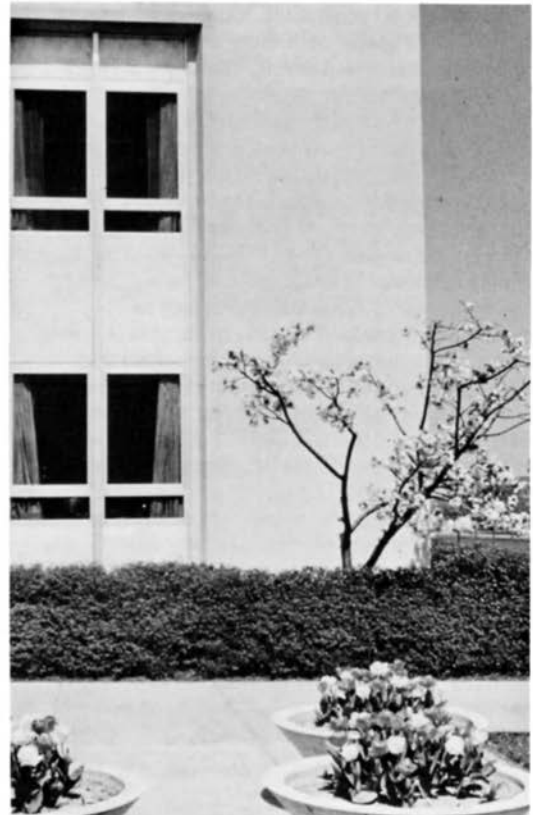


Introduction

For most people the vegetation of the city is for ornamentation. We like it because it is beautiful, pleasing, and aesthetic. The vegetation of the city gives us a feeling of well-being, a feeling that we are in harmony with our environment. Amid the engineering wonders of air-conditioned buildings, bridges, and roads, dominated by plastic, steel, and glass, city dwellers nurture living plants with loving care. Plants are grown in window-boxes, on balconies, on patios, and on rooftops. They are grown against the walls of buildings, in the foyers of buildings, and even in individual apartments and offices. In short, plants are grown wherever it is possible to do so.

One myth should be laid to rest. The city vegetation is not necessary to ensure a supply of oxygen. The supply of oxygen in the air is derived from the whole earth's photosynthetic activity including that of the oceans, which comprises three-fourths of the total area. Oxygen supply is not dependent upon a single collection or grouping of green plants such as those found in a city.

City dwellers spend a great deal of time and effort in growing city plants, often under hostile conditions. They do not make the effort in order to purify the air, but in order to purify their spirits.



What is the Vegetation of the City?

The term vegetation is usually reserved for the natural plant communities that cover undeveloped landscapes. Agricultural lands and land enclosed within cities have generally been excluded from the term. This has led to narrow and restricted thinking about the plants of the city and has contributed to the notion that only plantings and ornamentals that require cultivation by man are nurtured in the city. The word vegetation implies a growth and maintenance unaided by man, and it can be demonstrated that the biological resources of the city can maintain themselves if the environmental circumstances are appropriate.

The concept of the vegetation of the city should not be limited to parks and playgrounds that are within the city limits, nor to the occasional open space found between city and suburb. Vegetation encompasses all of the plants of the city, including those in private yards, streetside plantings, boulevards, parks, potted trees and flowers, grass, and weeds on vacant lots. In sum, the entire vegetable component of the living environment of the city.

Plants are an important element in a city. For many cities the landscaped gardens, boulevards, and streets are their most distinguished characteristics. Although roads, bridges, buildings, and other construction make the city functional and hence workable, the plants and their arrangements, together with the arrangement of space, contribute an aesthetic value for which there is no substitute. The city is a direct effort by man to modify his environment through technology, but he has generally taken care to maintain as much of the plant life as possible, and where appropriate, to introduce new material.

In the first cities, plants were almost certainly a part of the natural environment in which the city was built. Since the maintenance of life in the city depended upon adequate supplies of food and water, no doubt considerable agricultural activity, as well as commerce, took place in the first cities. In fact, it was not long ago in the history of American cities that livestock was banned in the interest of public health, and, where the price of land does not prohibit them, one can still see kitchen gardens in cities. The well-manicured lawns and flower gardens of suburbia are the lineal descendents of pastoral antecedents.

Much of the area of the city should be capable of supporting the growth of natural elements of the city vegetation, with minimal environmental improvement. Greenbelts, parks, recreation areas, picnic grounds, city forest, and wildlife gardens and arboretums, and most street plantings in residential areas provide suitable environmental conditions to support the growth of trees, shrubs, and turf, as well as wild and cultivated flowers. Hostile environments, if they exist in these areas, can be adjusted by design elements,

such as the use of permeable paving materials and strategically located plantings. As one moves closer to its center, however, the engineering demands of the modern city diminish the prospect of plants growing as they once did. The heights of buildings, underground sewage pipes, paving, overhead utility lines, and many other structures create a hostile environment for many species.

To consider the vegetation of the city community rationally, one must begin by recognizing that whatever the origin of the plants found in the city, they are all regulated by the same life and death processes that regulate their natural community relatives. And though sometimes truncated, plants of the city form a community that, to some extent, is capable of self-regeneration, and whose vigor and vitality are dependent upon the same parameters as natural biological communities.

Among biological communities, those in equilibrium with the climate, that is to say mature biological communities, are the most desirable because they are able to maintain themselves with minimum outside maintenance, and are the most productive. It follows, therefore, that if the characteristics of the mature biological community are developed in the plants of the city, similar maintenance benefits will be enjoyed. But if we are to accomplish these goals, it is essential that we understand some of the ecological parameters of the biological community and how these apply to the plant community of the city.



Plant Communities

Biologically, the mature plant community is characterized by diversity. It has diversity of species, diversity of ages, diversity of niches and habitats, and a diversity of life forms.

Life forms can generally be associated with the structure of the plant at the time of its maturity. For instance, herbs and grasses have a typical life form; shrubs have another that is typical for their growth habit; trees have an arboreal life form; and vines constitute yet another. Many herbs and flowering plants of the prairies differ significantly from grasses of the prairie in that prairie grasses have a great deal of underground structure in the form of roots and rhizomes, which make them particularly well adapted to fire and drought. Each life form has a different requirement for growth and maturation. Similarly, among life forms of a different type, some are very tolerant of low light intensity, while others require high light intensity. Based on two characteristics then, size and shape at maturity and ability to grow in light of varying intensities, plant species segregate themselves. Those that are capable of living in the habitats and environments provided by others tend to congregate together to form communities.

The mature plant community is dynamic in the sense that it is self-regenerating and is able to compete for and hold a site against all competition. Moreover, mature plant communities usually occupy the best sites and are able to maintain and/or extend their boundaries. The mature plant community develops as the result of the growth and development of many individuals, and is replaced, renewed, and regenerated by the growth, development, and replacement of these same individuals.

The mature plant community is clearly demonstrated by the deciduous temperate forest. In its most fully developed form, the deciduous temperate forest may include several species of large trees which, because of the nature of their growth habits, protrude above the general canopy level to form an overstory. The main structural formation of the deciduous temperate forest, however, is determined primarily by the canopy trees, and these are the dominant species which grow to 40-80 feet. They include the familiar forest trees such as oaks, maples, elms, etc. Their interlocking and overlapping leafed branches produce a continuous cover over the landscape, and they reproduce themselves at the site. Dominant canopy species are very versatile; they thrive in the shade of the canopy when they are young and ultimately prosper in full sunlight when full-grown.

The creation of shade or screening of light by the canopy produces a habitat which normally would not occur without it, and in the shade of the canopy grow





trees of lesser structure; that is to say, trees of the same species as the canopy but which have not grown into the canopy. Their growth rate is perhaps reduced by low light intensity or inhibited by competition. In addition, other species of deciduous trees which never attain the stature or the height of the canopy trees are a part of this second layer. These are species such as ironwood, bluebeech, dogwood, and redbud which, even under optimal conditions, would not attain the size of the dominant canopy trees.

Lower still on the deciduous totem pole is the shrub layer, usually consisting of such things as mountain laurel, rhododendron, and similar types of plants. Finally, there is an herbaceous layer of grasses and flowering plants on the forest floor, and perhaps some vines and vine-like materials such as trailing arbutus or winterberry. In considering this remarkable combination of life forms—arboreal, shrub, herb, grass, and vine—each with its different requirement for light intensity, it is easy to see that there is a measure of interdependency between and among species. Due to the incredibly efficient fashion in which a fully developed plant community utilizes energy, little is wasted. Sunlight is first intercepted at the canopy level and photosynthesis, growth, and development occur there. Next, sunlight of lesser intensity filters through to the secondary layer, and more photosynthesis, growth, and development occur there. And the process continues through the stages until the reduced sunlight energy reaches the herbs of the forest floor.

Not only do plants have differing life forms, but in a sense they have differing life styles. Plants can be classified as annuals, i.e., those plants which complete their life cycle in one year; biennials, i.e., those plants which complete their life cycle in two years; or perennials, i.e., those plants with a very long life span. Not only are there differences in the life forms of plants with respect to the completion and development of their life spans, but there are great differences in the reaction of plants to climatic conditions. The factor of adaptation to climate is as important as any other factor in determining which plants will grow in any given place. Plants native to a tropical rainforest will not grow in a temperate deciduous forest because they cannot survive the winter. Conversely, the trees of the temperate deciduous forest have adapted to the cold, and such plants will not flourish in hot, humid, nontemperate climates. Winter dormancy, which is essential to survival in a temperate winter, does not allow for the continuous growth that warmer climates permit. Life forms and the ability to survive the prevailing climatic conditions are the compelling forces in community structures, and must be fully understood when the city is considered ecologically.

If we look at the development of the forest community, of the grassland community, or of any community, we see that it proceeds through stages. There are many plants which are not capable of living except in high light intensity, yet whose life forms do not enable them to persist into the mature community. Consequently, as communities develop these species are eliminated. For example, the grasses that are found in a city lawn are plants that require relatively high light intensity. These grasses could not form the herb layer of a mature forest community because, when the forest community is fully matured, there is not enough light at the forest floor to support their growth. These plants must live in an area which, for whatever reason, has few trees. Many of the weeds, flowers, and herbs of open fields similarly require high light intensity, and are not capable of sustaining themselves in a mature forest community.

The structure of a city lawn is quite simple. The full intensity of the sun strikes a single photosynthetic layer, passes through it, and strikes the ground. A tremendous amount of energy, the same amount that can support the full growth of the forest, is absorbed by these grassy areas. It is this enormous amount of sunlight energy, capable of completely sustaining the growth of the mature forest, that must be overcome when grasses, lawns, meadows, and other nonforest community structures are to be maintained in a city that was built in a climate capable of supporting a deciduous forest.

As a community develops through pioneer stages, through herb, shrub, and secondary layer stages, and finally into a mature community with a closed canopy, many factors change. In an open community, where a great deal of light reaches the floor of the community, high evaporation rates and higher soil temperatures are likely to occur. Conversely, as a cover is formed over the soil, the temperature of the soil surface is likely to be reduced, and the rate of evaporation is likely to be less. Moreover, the climate at the center of a mature plant community is noticeably different from that at its fringes. Consequently, the structure of the mature plant community deep in the deciduous forest differs from the more open, pioneer community that lies at its edges.

The most complicated community structure to be found in terrestrial vegetation is that of the tropical rainforest. In addition to all of the layers described for the deciduous temperate forest, a tropical rainforest has great numbers of epiphytes which grow not only in the canopy species, but in the secondary species. Spanish moss is the epiphyte most common in the United States, particularly in Louisiana, Mississippi, Florida, and other southern States. Spanish moss is quite capable of sustaining its entire life cycle merely

from the nutrients and water that it gets from the air. In recent years, acres of forest in southeastern Georgia, which normally abound in Spanish moss, have suffered a loss of this plant and air pollution is suspected as the culprit.

The changing factors in community development, then, proceed as the community progresses from its pioneer stage to its mature stage. As the community increases in complexity, with numbers of different kinds of species, representing different life forms, occupying different niches in the community, the photosynthetic efficiency of life processes for a given parcel of ground also increases. This increase in the complexity of the community provides a greater number of habitats for plants, as well as a greater number of habitats for animals.

The ecological niche which the mature community provides for animals is significant not only because of the great variety of habitats and niches but also because the greater increase and efficiency of the photosynthetic process make the community more likely to be able to support an animal population. Of course, a great abundance of wildlife is found at the perimeter of the forest. Here plants which are good for forage for ungulates such as deer and game birds such as pheasant, quail, and grouse are more plentiful than they are closer to the center of the forest.

The photosynthetic apparatus of green plants is particularly well adapted to harness the energy of the sun, and very little can stop, hinder, or slow down the process of capturing sunlight energy and its utilization in the living system.



The stability of the mature plant community has enormous significance for the overall maintenance and management of cities because the mature plant community requires little outside maintenance.

This is an ecological principle of the first magnitude, and one which must be comprehended before we can understand the vegetation of the city. To maintain pioneer communities, that is to say, to arrest their development at a particular stage of maturation, requires inputs of outside energy in order to change their natural development (e.g., mowing the grass of a power right-of-way). The mature plant community, on the other hand, proceeds to a stage of development where it can maintain itself. In terms of dollars, a backyard maintained as a segment of the original forest needs no maintenance, as a segment of the original forest needs no maintenance; a backyard which is a lawn must be mowed regularly. This is not only a fact of plant life, but it is a universal principle. It applies to the maintenance of human communities, animal communities, or any situation governed by ecological principles.



The individuals of the natural community are ecotypes. As such, they are interchangeable with any member of the same species, or with a member of another species having similar life form and climatic needs. The area will enjoy greater stability if it is occupied by a variety of individual organisms which require similar climatic conditions, but which have a broad spectrum of genetic characteristics.

If all the street plantings of the city come from the same source of seed or the same clone of plants, thus being as genetically uniform as possible, and are planted at the same time, the aspect might be one of horticultural neatness. However, all of the plants will have passed through all of the stages of their life development at the same time, and all will be susceptible to any disease, to any insect attack, or to any physiological disorder for which any one of them is susceptible. In other words, the range of stresses, climatic changes, insect or disease attacks that a genetically uniform population can withstand is considerably narrower than that which can be tolerated by a genetically broad-based community derived from different clones and seeds.

For example, trees grown from a single clone, propagated vegetatively, will have the same genes for resistance or susceptibility to, say, Dutch elm disease. If any one of the trees becomes infected, and if the insect vector is uniformly distributed (and it usually is in an American elm stand), the consequences will be serious. If those cuttings have been used to plant the whole city or a large area of it, the result will be catastrophic, as has been demonstrated in Columbus, Ohio, Champaign, Illinois, and elsewhere. On the other hand, if in addition to American elms, the area includes other species of elms or other forest trees, it is unlikely that any one disease could affect them all.

The city of Washington, D.C., loses some elm trees each year to Dutch elm disease, but its elm population comes from a great many seed and clone sources. As a result, Washington has never suffered a Dutch elm disease epiphytotic of the kind experienced by other sections of the country.

This same strategy that avoids monotypic specimens in street plantings should be applied to shrubs and herbs, to ornamentals, to turf (turf plantings are comprised of a mixture of seeds), and to every use man makes of plants in the city.



As we have seen, the plants that survive best in the city are those of the natural environment, because, in general, the plants of the city are expected to maintain themselves. Even in the modern practice of horticultural plantings in pots around public buildings, the assumption is that the plant can survive on its own.

For the most part, the requirements of plants are simple. They require a few minerals (the amount in relation to the weight of the mature plant is a mere 3/10ths of 10), they need water, they require light in varying intensities, and they need carbon dioxide and the atmospheric water of the soil. Plants have a requirement for oxygen, but it is much less than that required by animals. The mature plants of the city probably do not depend very much upon surface water for their survival. In order to survive, those plants which are surrounded by concrete paving must receive their water supply from a permanent water table. It is almost certain, therefore, that a seedling will not survive unless its taproot reaches a permanent water supply, or at least a reliable water supply.

In paving cities and installing sewer lines, we have drastically altered the water table, run-off, and percolation from rainfall. The trees that we see along the main streets of our cities and admire so much probably gained access to a permanent water table before the streets were paved, since most of this paving occurred after the advent of the automobile. Street trees that are planted now, after all the concrete is in place, may never make it to a permanent water table. The ultimate goal for engineering plants into the city in those areas where a natural water table has been eliminated by the intrusion of subways, powerlines, cables, and the foundations of buildings may well be to install hydroponic facilities.

Meanwhile, American cities are discharging great quantities of nutrient-rich water into rivers and lakes. This material from the sewage system of cities is polluting our rivers and lakes when it could be fertilizing our city vegetation. Many experts believe that in the next 30-35 years the shortage of fresh drinking water will reach a crisis for many American cities. Yet we continue to pollute the streams and fresh water sources that are adjacent to our great cities. It should be possible to recycle great quantities of this nutrient-rich water into a second water system which could be used to nurture the growth and development of city vegetation.

Nor is it unreasonable to suggest piping such materials into agricultural areas to fertilize and enrich the soil for agricultural crops. The real obstacle to be overcome is not one of engineering but of public health. The public's fear that such a process might foster disease epidemics in heavily populated areas is well founded. But we should remember that we are not without expertise in the field of infectious diseases, their causes, and the principles underlying epidemics. The present state of our knowledge suggests that the public health aspect is easily surmountable. In fact, we have the technology to engineer a system that could safely utilize the waste water now being dumped into our freshwater streams and lakes, causing their pollution.



In the downtown sections of cities, where large buildings dominate the scene, and where the streets are covered with concrete to facilitate the movement of pedestrians and automobiles, the needs of trees, bushes, and grass have been engineered *out* of the city. The genius that builds a city can, with a little extra ingenuity, engineer *into* the city conditions that allow these plants to grow.

The native plants of the prairies are tall grasses. If residents of cities built in prairie regions desire something other than tall grasses for their city vegetation, they will have to engineer into their city those elements necessary for whatever plants they have chosen. In desert regions, only those species acclimatized to intense heat, solar radiation, high winds, and other extreme conditions will thrive, unless the environmental requirements of other species, particularly water, are engineered into the city to accommodate them. Palm Springs, California, is so engineered. Cities in deciduous forest regions, with trees surrounded by pavement, their roots cut by sewer and water lines, must also learn to accommodate city vegetation in their engineering plans.

In applying the strategy of the mature plant community to the public areas of the city, the underlying assumption is that, because of the natural processes of selection, genetic adaptation, and ecological adaptation, mature plant communities present the most stable configuration of the vegetation and hence require the least amount of maintenance for their upkeep.

If more elements of the mature community are incorporated into the city not only will the city become more livable in the sense of providing habitats for more different species of living things, but the city will be less expensive to maintain and more desirable aesthetically and culturally.

In order to maintain and enhance the street plantings in our cities, we need to plan ahead. We need to plant seeds or saplings next to the mature trees so that our street vegetation is at many stages of growth. When an older tree dies, is struck by lightning, or is blown down in a high wind, its replacement should be at the site, ready to fill the gap in the community. In considering the street plantings in our cities, there is no need to accept a monotypic culture in which trees are spaced uniformly in a single file down the street. We could be more adventurous and follow the design of nature, where the vegetation is at varying stages of growth and the design more haphazard. Should the street trees be in a single file? Should they be staggered? On wide boulevards, should there be as many as three or four trunks between street and sidewalk? This last, for instance, could reduce noise pollution for the pedestrian.



Vacant lots do not have to be the ugly scars they are now. Wild berry seeds scattered on a vacant lot and wetted down with a firehose, for instance, would provide a flower with a pleasing odor in the spring and wholesome fruit in the summer. Wild blackberries and wild raspberries will grow in very poor conditions and need no attention. Sumac, a weed which turns a beautiful red in the spring and fall, would grow very quickly on a vacant lot. It would provide a pleasing aspect, a sanctuary for birds, and would hide the litter with which vacant lots abound.

Trees do not have to be removed from building sites, except those actually on the spot where the building is to go. Nor is it necessary to remove all the trees along a new highway. The argument that it is too expensive to build around trees is a fallacious one. North of Helsinki, Finland, a new city, Tapiola, is under construction. Clauses have been written into the building contracts which place a monetary value on each tree at the site. Except for those trees which the plans specify must be removed in order to accommodate the building, the contractors are fined for any tree damaged or destroyed. How much is a tree worth? Perhaps nobody knows, but it is worth at least what it would cost to replace it. To dig, ball, and transplant a fully grown tree that took decades to grow would probably cost several thousand dollars.

If we want plants in our lives, if we want the natural vegetation of the city to thrive in streets and public parks, engineering plans for the city must include the needs of the plants. If a homeowner wants a thriving lawn, he must provide soil and fertility conditions that support the vigorous growth of grass, and he must buy and use a lawnmower. Similarly, if elm or sycamore trees are to shade the residential streets of the community, those conditions that favor the growth of elm or sycamore trees must be provided.

Let us relate the problem to the space age. If we wished to send a full-grown elm tree to the moon, we would have to provide a space capsule into which we had engineered the climatic and environmental conditions necessary for the well-being of an elm tree. Precisely the same conditions that prevail in that space capsule are necessary for the survival of the elm tree on earth. The survival of the elm is contingent upon those conditions no matter where it is grown.

One day, it may be possible to look down from the Empire State Building and see a canopy of green below, or from the street near the Empire State Building it may be necessary to go to an opening in the trees in order to see the top. All that is necessary to bring this about is our desire to do it.

—Theodore W. Sudia

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Richard Nixon
President of the United States

Rogers C. B. Morton, Secretary
U. S. Department of the Interior

Ronald H. Walker, Director
National Park Service

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