# THE ORNAMENTAL LANDSCAPE AS AN ECOSYSTEM: IMPLICATIONS FOR PEST MANAGEMENT[1]

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Tansley (1935) first coined the term "ecosystem" to imply a holistic approach to understanding the ecological relationships between plants, animals, and the abiotic environment. Initially designed to describe natural systems such as a forest, the ecosystem concept has been applied to agricultural systems (Spedding 1971, Loucks 1977, Cox 1979) and is applicable to the ornamental landscape. Understanding the ecological interactions between the biotic and abiotic factors within a landscape enables more effective management of pest problems.

Any ecosystem, including the ornamental landscape, consists of four basic components 1) primary producers (plants); 2) consumers (herbivores and predators); 3) decomposers (earthworms, microorganisms, and other detritovores); 4) the abiotic environment (e.g., temperature, moisture, nutrients, wind, sunlight, soil). These components operate within set boundaries (e.g., a homeowner's yard) with specific inputs and outputs (e.g., fertilizer for trees; shade for patios) (Fig. 1).

The components of an ornamental ecosystem are structurally complex. Primary producers are represented by a large variety of taxonomically distinct plants. These can be classified broadly as evergreen and deciduous trees, woody and herbaceous perennials, annuals, turf, and "weed" species. Consumers are also diverse. Phytophagous and predatory arthropods, birds, wild and domesticated mammals, and man form the primary portion of this component. Little effort has been directed towards understanding the decomposer component in the urban ecosystem, undoubtedly because decomposer effects are not readily apparent. An example of the importance of decomposers in the system is earthworms aerating the soil and cycling organic matter and nutrients. Abiotic factors are tied closely with the other three components, and help determine which plant species will survive and prosper.

Trees and shrubs planted in harsh environments to which they are not adapted are likely to be stressed and predisposed to serious disease and insect problems. Cultural modifications can help alleviate the problem but often require considerable inputs from landscape managers.

Inputs and outputs influence the interactions between the four components of the ornamental ecosystem. Inputs are influenced by desired outputs as they are perceived by property owners and managers. Inputs include landscape design and planning, plant material, fertilizer, pesticides, and abiotic factors such as water and light. Outputs include such items as grass clippings, fallen leaves, and pesticide runoff and drift. There are also many less tangible and more general outputs. It is widely recognized that quality landscapes offer aesthetic enhancement and increase property values. Other outputs include space definition and screening, erosion control, and sun, wind, precipitation, and temperature management (Robinette 1972).

Although all ecosystems share basic attributes, there is a major difference distinguishing natural from ornamental ecosystems: intervention by man. Natural ecosystems have evolved inherent checks and balances which keep the system in dynamic "equilibrium." Leaves fall in the autumn returning nutrients and organic matter to the soil, and insect populations are restrained by forces such as climate and natural enemies.

Competition and the abiotic environment deter-

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mine plant species composition in undisturbed systems. In an ornamental ecosystem, however, species composition is initially determined by landscape designers and homeowners. Fertilizers and peat moss replace recycled leaves, insecticides substitute for predators and parasites, and man further influences the natural environment by controlling weeds. These contrived ecosystems require intensive maintenance inputs. A better understanding of the ecosystem components and interactions can reduce the detrimental effects of these inputs and increase their efficiency.

The ecosystem concept addresses the inherent complexity of natural and managed systems. Gates (1968) described an ecosystem as the sum of all the organisms, their environment, and all the interactions between and within all parts of the system. These interactions are complex and often difficult to fully discern without considerable interdisciplinary study. Spedding (1971) noted that the components have received much attention from researchers, but at some point the systems themselves must be subject to study.

Understanding ornamental ecosystems through scientific investigation of the components and interactions can provide a basis for the development of sound pest management strategies. As the widespread use of pesticides in the urban environment becomes more socially unacceptable and highly regulated, arborists will need to rely on other techniques to achieve satisfactory pest management.

With the advent of synthetic organic insecticides following World War II, arborists began to ignore tree requirements and rely heavily on insecticides to minimize pest problems (Nielsen 1982). A holistic ecosystem approach strives to understand the interactions among and between components of the ornamental landscape. With this knowledge, the components and their interactions could be manipulated to minimize pest problems and reduce the need for pesticide applications, while moving closer to a "self-regulating" ecosystem with dramatically different human inputs. This holistic approach has been suggested (Nielsen 1975, 1981; Olkowski et al 1982;

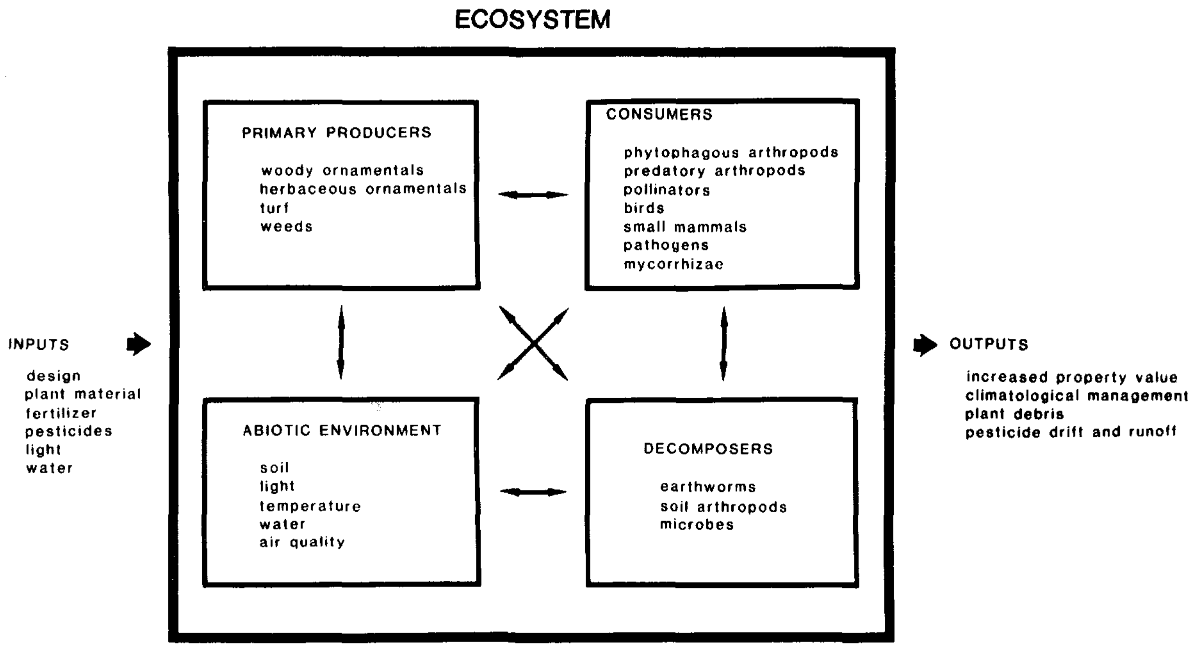


**Figure 1. Basic landscape ecosystem model illustrating components and interactions that need to be investigated.**

Shigo 1982) and is now receiving limited acceptance by arborists. Scientific investigation at component and ecosystem levels is necessay to provide sound ecological management practices in the urban environment.

Researchers are beginning to study the landscape as a system of interrelated ecosystem components. Abiotic stress such as drought, low temperature, sudden chilling, and transplanting predispose woody plants to attack by some disease organisms (Schoeneweiss 1975). Primary consumption (defoliation) also induces changes in trees, predisposing them to attack by organisms to which they are normally resistant. Oaks defoliated by gypsy moth, *Lymantria dispar,* are more susceptible to attack by the twolined chestnut borer, *Agrilus bilineatus,* and colonization by the shoestring root rot fungus, *Armillaria mellea* (Wargo 1981). Houston (1981) reported that diebacks and declines of some trees (e.g. ash, maple, and beech) are initiated by adverse environmental factors, followed by attack of opportunistic organisms that otherwise are insignificant. Recognizing true cause and effect relationships in dieback syndromes and other tree health problems is critical for optimizing pest management strategies.

An interaction often neglected by tree care specialists is the role of mycorrhizal fungi in the ecosystem. The presence of mycorrhizae is necessary for development of a vigorous fine root system on trees and other ornamental plants. Mycorrhizae enhance the water and mineral absorption ability of the fine roots. When soil conditions are altered, mycorrhizae may die. Critical factors such as soil pH, oxygen tension, and fluctuations in soil moisture and temperature influence mycorrhizae, and thus movement of water and nutrients to the tree canopy. Inhibiting the interaction between mycorrhizae and the fine root system stresses trees, and dieback or death may occur (Howe 1979), but a symbiotic relationship could be encouraged by manipulating the abiotic environment to promote this interaction.

Understanding how stress factors interact with primary producers may explain how and why plants become susceptible to pest attack. Kozlowski (1969) stated that the physiological impact of a localized stress usually is transmitted to distant organs and tissues in a complex manner and eventually affects the whole tree. Reduction in stored root starch is one of many physiological changes in defoliated trees. Corresponding to this decrease in starch is an increase in glucose. Glucose stimulates *A. mellea* and enables it to grow in the presence of inhibitory phenolic compounds and to overcome the adverse effect of gallic acid released when bark tannins are metabolized (Wargo 1981). The reduced water and mineral absorption by a root system attacked by a pathogenic fungus results in overall decrease in primary production (photosynthesis) and growth.

Plants vary in sensitivity to different stresses. Knowing which stresses are important in reducing a tree's ability to tolerate or resist a pest is essential if pest management is to include measures that minimize stress predisposition (Schoeneweiss 1981).

Utilizing the ecosystem approach through foresight can be an important management strategy. By choosing disease and insect resistant cultivars and selecting plants ecologically adapted for the intended site, the need for pesticide applications can be reduced. Soil characteristics (pH, fertility, structure, etc.), moisture availability, temperature, and exposure to contaminants (e.g., road salt) are among factors that should influence plant selections. Trees like birch are adapted to cool forest soils, and are adversely affected by extreme environmental conditions in the urban environment. Choosing plants adapted to specific sites promotes establishment and survival and results in fewer pest problems.

By understanding the influence of abiotic factors on primary producers (trees) we can manipulate water, soil, nutrients, and other factors to minimize susceptibility to pests. Pest problems can be avoided if component interactions are anticipated. Potter and Timmons (1981) demonstrated that two factors contribute most to the susceptibility of flowering dogwood, *Cornus florida,* to the dogwood borer, *Synanthedon scitula,* injury to the trunk and exposure to full sun. The risk of dogwood borer problems can be reduced by planting dogwoods in at least partial shade and preventing trunk injury. In some cases, subtle changes in landscape management practices may reduce the need for pest control. Fertilizer formulations have been shown to affect populations of the balsam woolly adelgid, *Adelges piceae.* Ammonium nitrate fertilizer has an adverse affect, while urea and potassium ammonium nitrate fertilizers are beneficial to the insect (Carrow and Betts 1973).

Increasing the diversity of plant species used in the landscape can indirectly reduce pesticide application by decreasing the risk of catastrophic diseases and insect outbreaks. During the late 1800's and early 1900's American elm, *Ulmus americana,* was planted extensively in the northeastern and midwestern United States. Because of this, the impact of Dutch elm disease in North America was much greater than it should have been (Karnosky 1979). London planetree, *Platanus* X *acerifolia,* comprises over 50% of the street trees growing in New York City's borough of Manhattan. A decline problem among these trees accentuates the vulnerability of a monoculture design (Glickstein et al., 1982). Honeylocust, *Gleditsia triacanthos,* touted as a replacement for the American elm, has become a common component of the urban forest. Once considered free from insect injury (Wheeler and Henry 1976), honeylocust is now one of the most pestiferous trees used in the landscape. Important pests include the honeylocust plant bug *(Diaphnocoris chlorionis),* mimosa webworm *(Homadaula anisocentra),* honeylocust pod gall midge *(Dasineura gleditschiae),* spider mites and wood boring beetles.

Diversity is thought to promote stability (Price and Waldbaur 1975). This concept is often ignored in the landscape. Incorporating the ecological concept of diversity into the landscape will reduce devastation by insects and pathogens. A diverse community contains more buffers against environmental change, and a change in the status of one species is less likely to have a severe impact on another.

The ornamental landscape needs to be addressed as an ecosystem by both researchers and landscape managers. This approach takes advantage of basic ecological principles and in time will lead to the development of management strategies that will reduce the need for pesticides in the urban environment. By understanding the components and interactions within the system, the effects of pesticides can be optimized while decreasing their potential detrimental side effects. By utilizing ecological principles in plant selection and pest management, an increasingly self regulating or "low maintenance" landscape can be developed.

In the future, arborists and landscape managers will need to adopt this holistic approach to pest management implied in the ecosystem concept. Before this concept is widely applied, more research will have to be conducted. The ornamental landscape is an ecosystem that warrants further study.

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# STEM DECAY IN CENTRAL PARK[1]

**by Robert L. Tate**

**Abstract.** Increment cores were taken from a random sample of 617 trees in Central Park in 1983-84. On the average just over 16 percent of the trees cored had stem decay. The percentage of trees with stem decay varied by species and increased by diameter class. There is a high degree of association in the sample between trees with stem decay and trunk abnormalities such as bark wounds and longitudinal cracks.

As part of a study to determine the growth and longevity of New York City Central Park trees, increment cores were taken in 1983-1984 from a stratified random sample of 617 trees greater than 6 inches dbh. As increment cores were being taken, it became apparent that a substantial number of the trees had stem decay. Because of the increased potential for hazard due to decay and the lack of information on its extent in urban trees, we are presenting these preliminary results.

The number of trees with stem decay varied by species (Table 1). On the average over 16 percent of the trees cored appeared to have decay. One species, London planetree *(Platanus X acerifolia)* was free of apparent decay. Forty percent of the Asiatic Turkey oaks *(Quercus cerris)*, were seriously affected with decay.

While it may be premature at this time to make statements about large trees and decay, because additional data will be collected on large diameter trees, it is important to note that all of the trees in

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