seasonal interpreter

therapeutic recreation

MECHANIC

specialist

RECREATION SUPERINTENDENT

ROVING LEADER

MAINTENANCE WORKER

COMMUNITY SERVICES DIRECTOR

RECREA

urban park interpreter

STATE LIAISON OFFICER

FACILITY MANAGER

NATIONAL RECREATIO
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U S Department of the Interior
Heritage Conservation and Recreation Service

Trends

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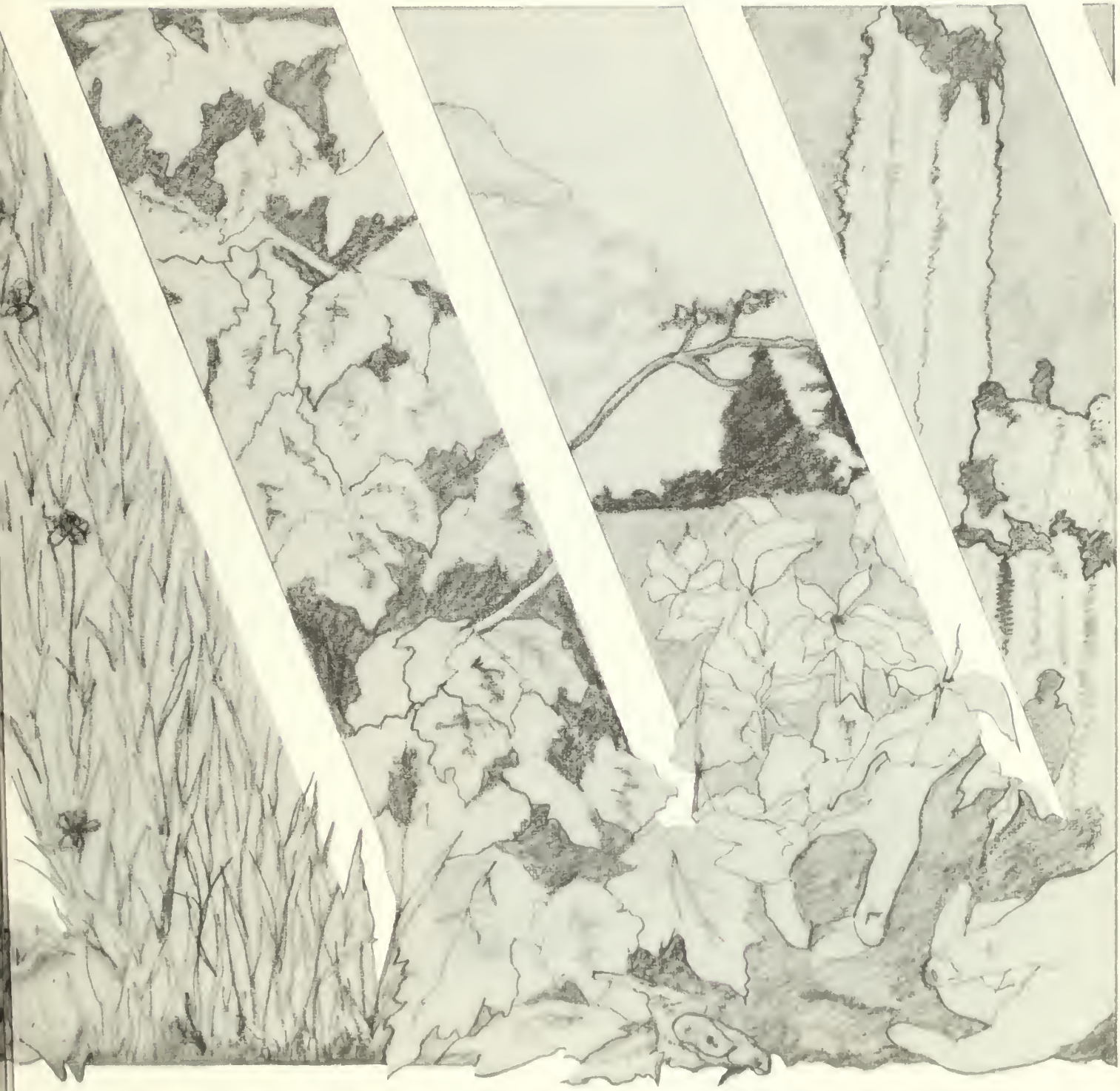
Vegetation Management



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Trends in Vegetation Management

PARK • PRACTICE • PROGRAM

A publication of Park Practice

Park Practice is a cooperative effort of the Heritage Conservation and Recreation Service and the National Recreation and Park Association

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Introduction

by Mai Liis Bartling

The challenges to park management come from many sides. Each year brings sudden or cyclic environmental stresses to complicate the already complex job of protecting both the natural resource and the taxpayer investment while responding to the day-to-day needs of the park visitor.

Today's park manager is faced with additional uncertainties. State and local taxing and spending limitations have imposed a fiscal drought. Even where park agency budgets have not taken actual cuts, the ever higher costs of energy, water, and labor have made fewer real dollars available. In many agencies, experienced staff have left out of frustration, and morale sags among those who remain (who may have time for little more than picking up litter or scrubbing graffiti off walls). And all this at a time when many park agencies should be reinvesting in the rehabilitation of a deteriorated physical plant.

Whether the current challenge comes from the environment or from the budget, the park manager remains on the frontlines, sometimes wholly preoccupied with smoothing over the immediate, short-term impacts on agency operations.

Too often, we view management as happening behind the desk, as somehow separate from what happens in the field. Those agencies that manage change with expertise know that when this separation occurs, opportunities for innovation will be missed. Time in the field will be spent on tasks that have no public benefit and bring the agency no closer to its long-term goals.

We miss a crucial point, too, if we view management as merely the day-to-day reacting to situations. Amidst today's rapid change, only an active and well-focused management strategy can succeed.

There are good reasons to focus on the management of park vegetation during the present cutback era. We can be sure that despite the reduced funding to public agencies, the public will continue to look to parks not only as a place to actively recreate, but as a place to seek refuge from the visual blight of so many urban areas.

Just as important, the cutback process itself needs to be thoughtfully modified to suit a living and biologically sensitive system. While clearly part of overall park operations, vegetation management raises additional issues.

The last few years have seen the development of a body of literature—directed primarily at the public agency administrator—to deal with overall *organizational* impacts under revenue reductions. For a more practical form of advice on managing *vegetation* during adversity we need to turn to other sources, for example, to the experience gained by California's drought-stricken agencies. (That 3-year drought put landscape managers on a "water budget"; they learned to stop overwatering, plant less thirsty vegetation, and change their irrigation practices.) However, neither of the above two sources of information, by itself, adequately frames the cutback process for today's park manager.

The manager's challenge is to draw on *all* available information and develop a vegetation management strategy that recognizes the impact of agency-wide cuts in staffing, new equipment purchases, and other key resources. Any cutback management strategy will need to come to grips, too, with such intangibles as a changed organization and unsettled staff.

Sobering Challenges Present Soaring Opportunities

Three components seem essential to formulating an active management strategy capable of dealing with revenue and resource reductions:

1) Look at the total picture.
2) Set priorities and clear goals.
3) Devise effective plans of action for reaching those goals.

If we think in these terms, we are sure to spot opportunities for cost-saving innovation, while avoiding such serious mistakes as unplanned or indiscriminate service cuts, false economies (and down-the-road costs), and inefficient, across-the-board measures.

Step 1: See the Total Picture

When we focus on park vegetation, the "total picture" is complex. Just as the "whole is more than the sum of the parts," no physical inventory of the facilities to be maintained or the tasks to be done tells the whole story. The management of park vegetation is intertwined with at least three interactive systems.

To make intelligent, balanced cuts means coming to grips with these three perspectives:

1) The park as a natural resource and habitat for wildlife, with its own internal workings.
2) The park as a site for recreation, where recreator needs and ease of maintenance do not always coincide.
3) The park as a city or county property and investment, its health inseparable from the workings of local government.

Agencies need to plan ahead for a service cut or transfer of responsibility. Indiscriminately made cuts quickly will bring the agency to the realization that every action has a reaction against which the action must be weighed. *Both* the addition and the subtraction of services have their costs and benefits. Many agencies have observed, for example, that a visible decline in park maintenance often leads to increased litter and vandalism. Other agencies have found that replacing traditional vegetation with low maintenance plantings impacts user perceptions of a park and, therefore, the kind of use it receives.

Even if we consider only those economy measures that involve no service cut to the public, the picture is complex. For example, substituting equipment for labor raises energy costs and may require the agency to expand its repair capability. To avoid false economies, the agency needs to examine the *total* cost configuration when decisions are made to save money. The agency which is already able to accurately track its labor, energy, supply, and service costs has the advantage.

To see the whole picture means also to see the impact of decisions *over time*. Agencies should not mistake short-term transitions for long-term solutions, nor fail to make a necessary investment in their long-term health. While remote today, the cost of deferred maintenance will drain the agency in the years ahead. Already the deferred maintenance tab for the nation's campus grounds approaches one quarter of their current book value. Parks cannot be far behind.

Step 2: Set Priorities and Goals

Public agencies typically begin a cutback process with across-the-board cuts in programs and services. While politically safe, such a strategy often is inefficient. When resources are limited, it is more critical than ever to spend them where they count.

Setting priorities requires weighing the benefits of providing a service against the costs—both dollar and non-dollar—of not providing it. Budget cuts in California led one county park agency to reorder its priorities to:

1) risk management,
2) resource management (such as erosion control),
3) visitor services, and
4) facility maintenance (such as shrubs, turf).

Another smaller agency uses a set of criteria including safety, intensity of use, and interference with other needed operations, to classify specific tasks as to whether critical or discretionary. Discretionary work does get done, but less frequently and never at the expense of critical work.

Still another agency has combined its criteria for critically needed maintenance with community recreation priorities. The latter agency now has a rational framework for system-wide decisions which also provides the opportunity to "stop doing those things we never should have been doing in the first place." (Intensive shrub bed maintenance is one example of a discontinued task from which the public derived no benefit.)

Carefully thought out priorities are basic to any management strategy, regardless of whether or not the park agency faces revenue reductions. Clearly thought out priorities provide a framework for rational allocation of resources. When dollars are scarce, however, simply setting priorities cannot guarantee that all necessary work will get done. The park manager also will need to set the positive goal of identifying alternative means to achieve desired ends. The park manager should make it his or her *job* to tap outside resources while seeking new internal efficiencies.

In some agencies, only a *complete* rethinking of the current management strategy will do. This rethinking should ask some hard questions about the organization itself: Why do some organizations fare so well under the pressure of change, finding opportunities for cost-saving innovations everywhere? What processes and procedures can the agency establish to foster and support the innovative individual, thereby becoming an *innovative agency?*

The fostering of cost-saving innovations should become an *organizational goal.* One place to begin is to require a full maintenance assessment prior to assuming a new maintenance responsibility. With full cost information available while a project is still in the design stage, the agency has a basic tool for evaluating less than traditional alternatives. Ideally, a maintenance assessment will be based upon life-cycle costs, averaging the cost of routine maintenance with the cyclical costs of replacement and major work.

Today's challenge is to draw on all available information and develop a vegetation management strategy that maximizes your return on every dollar spent.

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There are other places to build institutional support for cost-saving innovation. In some communities, management salary increases are based on performance targets, which include percent reductions achieved in the use of water, natural gas, electricity, or gasoline. A periodic status report keeps the manager informed on his or her progress toward the target reduction. In this way, the manager has both the incentive and the information to innovate.

Step 3: Develop an Effective Plan of Action

There is at least one advantage to working within a complex subject area such as a park. Problems often can be tackled from a number of angles. While simple solutions are rare, opportunities for creative and comprehensive problem solving are many.

Asking the right questions is the first step in effective strategizing. With practice, we learn to fine tune our questions so that even when a particular cost-cutting idea does not appear directly transferable, we can learn the underlying lessons. Overall, our goal remains the best possible use of existing resources with a continuous tapping of new community resources to help meet critical needs.

What are some of the pieces of a comprehensive strategy for low-cost vegetation management? Two of the many questions that landscape managers should begin to ask themselves are:

1) When will our dollars go further by contracting with a private sector provider?
2) How can we best tap community-based groups?

Contract Landscape Maintenance

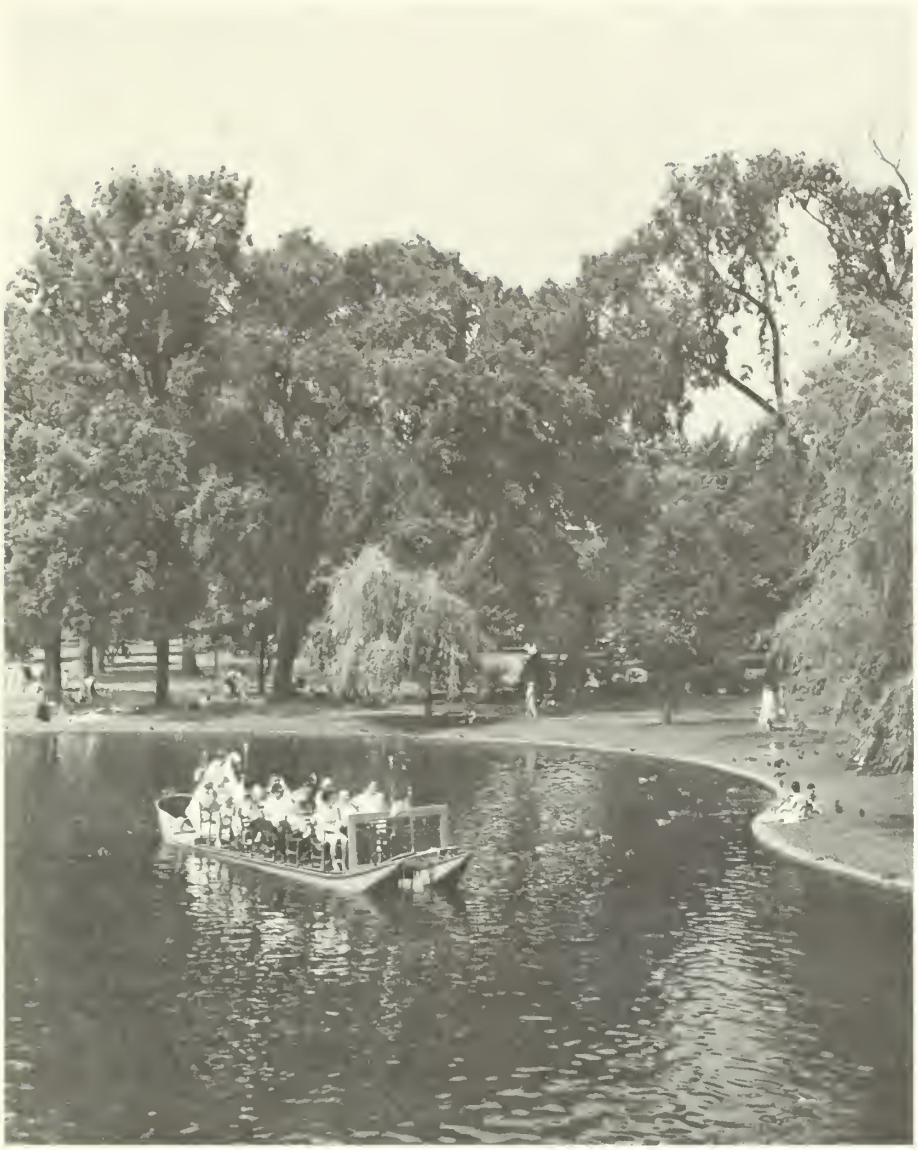
Talking about contract landscape maintenance is a little like talking about the weather. Much is said, but little is resolved. Recently, the focus has moved away from "should we or shouldn't we?" Managers today are asking: *When* is contracting cost effective? *What* specific measures can we take to minimize the risks and maximize the benefits?

There is little argument that successful contract agreements have many benefits. These may include costs savings, better budget control, minimum capital outlay, reduced personnel problems, superior equipment, greater flexibility to handle seasonal overloads, and so forth. However, when contract agreements are poorly conceived and not well monitored, there are risks: inferior workmanship, down-the-road costs, or loss of in-house backup capability. Even a genuinely satisfying contract relationship involves both staff time and paperwork to draw up, administer, and enforce.

If there is a single underlying lesson to be learned from the diversity of contract experiences, it is: Contracting is *not* a transfer of responsibility. From the start, the park manager must take an active role in managing the contract, identifying those contract opportunities where benefits are likely to outweigh risks.

Some rules of thumb include using landscape maintenance contractors:

1) To perform routine work that is easily measurable and has few unknowns, such as routine mowing.
2) To fill short-term needs or heavy seasonal requirements.
3) To cut travel and time costs for agency staff street tree trimming.
4) To assist where public contact is minimal.
5) To provide special skills and equipment or new technology where necessary.



Managers must consider parks both as a natural resource that provides wildlife habitat and as a site for recreation.

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Maintaining a highly manicured landscape is both expensive and time-consuming. ◀

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Tapping Community Group Resources

Community groups also can be partners in a low-cost vegetation management program. The agency, however, must recognize and understand both the strengths *and* the limits of voluntary and community group assistance. Since a group's long-term stability or interest cannot be guaranteed, the agency and group together should set attainable goals. These goals should be mutually agreeable and preferably set out in writing.

Many agencies have found that the job of overseeing community group involvement is much easier if the community partner already shares agency goals. Soccer and other sports teams have a clear interest in turf maintenance, and some agencies have begun to tap that interest for assistance with routine tasks. In other communities, garden clubs have become enthusiastically involved in the more skilled aspects of landscape maintenance.

Finding a stable and interested community group is a first step. The park agency also must be willing and able to support such groups through:

1) Providing clear performance standards.
2) Agreeing to itself perform certain heavy work.
3) Making expertise and training available.

In New York City, for example, the parks department has been involved in a "citizen care" program, which tests and certifies private citizens to help maintain street trees. New York City recognizes that community involvement is *not* cost effective if the agency must come in and pick up the pieces.

Contract landscape maintenance and community involvement are but two components in an overall strategy to lower the cost of vegetation management. During this era of budget cuts, it is more important than ever that the manager actively seek out still other approaches. The agency that survives—even thrives—in this cutback era will emerge a model of carefully orchestrated imagination, sound management practices, and well deserved credit for wisely spent public tax dollars.

Mai Liis Bartling is an Outdoor Recreation Planner in the HCRS Pacific Southwest Regional Office, Division of Planning and Technical Assistance.

Choosing Appropriate Vegetation

by Charles M. Sacamano, Ph.D.

A systematic approach to plant selection for park and recreation area landscapes begins with the function plants are to perform. Trees, shrubs, and vines may be very striking or "low" maintenance, but if they aren't selected to do a specific job such as define space, provide shade or privacy, direct traffic, or integrate structure and site, the landscape can never achieve its purpose. Too often those of us who have a strong horticultural background tend to ignore this functional aspect of plant selection. We develop a personal fondness for certain trees and shrubs and neglect others that might be more effective in a given situation.

After the intended function or use of the plant is correlated with the design requirements, attention should be directed to the site's particular microclimate and soil. Air drainage, wind patterns, temperature extremes, rainfall, and light exposure may all influence plant selection. Topography and soil characteristics are equally important site considerations. Bottomland areas need trees and shrubs that are adapted to periodic flooding and poor soil aeration. In upland locations, plants that require fast soil drainage perform well.

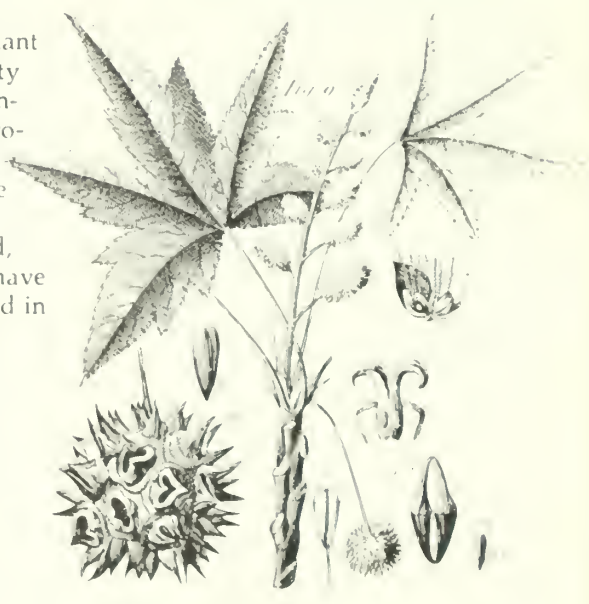
Soil pH cannot be overlooked if acid-loving plants or those species sensitive to iron chlorosis are possible landscape selections. Some plants actually look their best on poor, dry, infertile soils while others require a moist, organic, nutrient-rich soil environment. It's true that soil pH, drainage, and nutrient status can be modified to some extent, but in many parks and recreation areas it is far more practical to match plants with existing site conditions.

Mature size and shape seem obvious and very important considerations in the plant selection process. Still, it takes planning and foresight to project 10, 20, or 30 years into the future for a glimpse of how trees and shrubs will relate to one another and to the landscape as a whole. Avoid trees, shrubs, and conifers that are genetically destined to grow too large, assume the wrong shape, or look mutilated if they must be restrained. Slow growing, dwarf, and compact species and cultivars are preferable in many landscape locations.

Life span under local conditions is a key consideration in selecting landscape plants for parks and recreation areas. Everyone has seen attractive but poorly adapted trees or shrubs that struggle to survive for a few years and then must be removed and replaced. This can be costly in terms of time, budget, and energy. A good basic plant that is adapted and performing well is usually more satisfying than a plant that has potential for great beauty but, because it is in the wrong environment, ends up a sad and grotesque sight. This often happens when aesthetic decisions override functional use. Where a specific flowering tree or shrub is desired, select species and cultivars that have been proven hardy and long-lived in the area.

Plant litter is another area of concern. Cleanup of fruit, seedpods, flowers, nuts, twigs, and leaves makes large demands on manpower and equipment, especially when the litter is dropped over a long period of weeks or months. Most conifers do not require fall leaf removal, while some broadleaf evergreen trees shed leaves all year long.

In some parts of the country there is a real advantage to using deciduous trees which give summer shade and allow winter sunlight in. The ideal deciduous shade tree is one that drops its leaves quickly in autumn. Fall leaf cleanup then can be completed in one or two operations. When litter-producing trees are used and where space permits, retaining lower branches helps hide fallen debris. Another solution for some situations is to plant litter-absorbing groundcovers or shrubs under or in front of the trees.



Before planting such care-intensive features as rose gardens, flower beds, and clipped hedges, give careful thought to their maintenance requirements. To plant a rose, probably the most popular flowering plant in America, is to sign up for an exacting program of insect and disease control as well as pruning and fertilization. Concentrate such plantings in key areas where they can be managed efficiently rather than scattering them throughout the landscape. This fits well with the concept of zoning parks into areas of high and low maintenance based on function and location. The experienced landscape manager then takes care not to place plants needing high maintenance requirements in areas that are zoned for low maintenance.

Insect pests and diseases create high maintenance situations that can be avoided to some extent by careful plant selection. Avoid using large numbers of plants susceptible to the same insect or disease. All plants also should be evaluated for such undesirable characteristics as poor branching habit, dense shade in turf areas, thorns, brittle wood, self-seeding, invasive roots, poisonous parts, and in some areas, allergy producing pollen.

Landscape use of native trees and shrubs is on the increase throughout the country, especially in the desert southwest. The reasons are not difficult to uncover. Native trees and shrubs and those from similar parts of the world require less maintenance because they are adapted to local climates and soils. Once established, their irrigation requirements are greatly reduced or entirely eliminated. Growing public interest in water conservation will give added emphasis to this point in the future. Generally speaking, the natives also have fewer insect and disease problems than introduced species of trees and shrubs.

Finally, native and non-native arid land plants have a special landscape charm and beauty. They may appear a bit sparse and open in a nursery compared to traditional high water-use plants, but once placed in the landscape they grow and flourish with far less care. Some examples of arid land trees and shrubs for landscape use in the desert southwest are shown on the accompanying chart. The lists are based primarily on availability from nursery sources.

MESQUITE, CHILEAN

PALO VERDE, BLUE

Arid Land Plants for Landscape Use in the Desert Southwest

Photos provided by Charles M. Sacamano

Shade Trees

Over 30 feet	
Ash, Arizona*	*Fraxinus velutina*
Sycamore, Arizona*	*Platanus wrightii*
Cottonwood, Fremont*	*Populus fremontii*
20-30 feet	
Acacia, Sweet	*Acacia smallii and farnesiana*
Hackberry, Netleaf	*Celtis reticulata*
Palo Verde, Blue	*Cercidium floridum*
Palo Verde, Mexican	*Parkinsonia aculeata*
Mesquite, Chilean	*Prosopis chilensis*
Ironwood	*Olneya tesota*

Windbreaks and Screens

Palo Verde, Blue	*Cercidium floridum*
Cypress, Arizona*	*Cupressus arizonica*
Ironwood	*Olneya tesota*
Ebony, Texas*	*Pithecelobium flexicaula*
Mesquite, Chilean	*Prosopis chilensis*
Sugarbush*	*Rhus ovata*
Mountain Laurel, Texas*	*Sophora secundiflora*
Rosewood, Arizona*	*Vauquelinia californica*

Background and Space Definers

Above Eye Level	
Willow, Desert	*Chilopsis linearis*
Cypress, Arizona	*Cupressus arizonica*
Feather Bush*	*Lysiloma thornberi*
Ebony, Texas*	*Pithecelobium flexicaula*
Sugarbush	*Rhus ovata*
Rosewood, Arizona*	*Vauquelinia californica*
Waist to Eye Level	
Manzanita, Point-leaf*	*Arctostaphylos pungens*
Saltbush, Brewer	*Atriplex lentiformis 'breweri*
Desert Broom	*Baccharis sarothroides*
Creosote Bush	*Larrea divaricata*
Texas Ranger	*Leucophyllum frutescens*
Hopbush*	*Dodonaea viscosa*
Jojoba	*Simmondsia chinensis*
Trumpet Bush, Yellow*	*Tecoma stans*
Knee to Waist Level	
Turpentine-bush	*Aplopapus laricifolius*
Fairy Duster	*Calliandra eriophylla*
Indigo-bush*	*Dalea wislizeni*
Brittle-bush	*Encilia farinosa*

JOJOBA

Groundcovers

Saltbush, Four-wing	*Atriplex canescens*
Saltbush, Australian	*Atriplex semibaccata*
Indigo-bush, Trailing*	*Dalea greggi*
Fairy Duster	*Calliandra eriophylla*
Daisy, Blackfoot*	*Melampodium leacanthum*
Evening Primrose, Mexican*	*Oenothera speciosa childsii*
Baja Primrose*	*Oenothera drummondii var. thalassaphila*
Rosemary, Dwarf*	*Rosemarinus officinalis 'Prostratus'*
Verbena	*Verbena sp.*
Trumpet, Hummingbird*	*Zauschneria latifolia*

Erosion Control

Saltbush, Australian	*Atriplex semibaccata*
Desert Broom	*Baccharis sarothroides*
Brittlebush	*Encilia farinosa*
Lovegrass, Lehmann	*Eragrostis lehmanniana*
Bursage, Triangle-leaf	*Franseria deltoidea*
Tree Tobacco	*Nicotiana flauca*
Fountain Grass	*Pennisetum setaceum*
Globe-Mallow	*Sphaeralcea spp.*

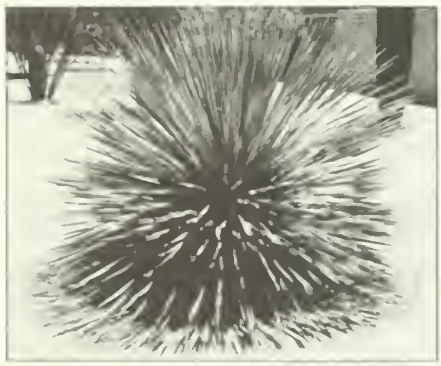
BIRD OF PARADISE, RED

FAIRY DUSTER

Specimen and Accent Plants

Floral Effects—Yellow	
Acacia, Sweet	*Acacia smallii and farnesiana*
Bird of Paradise, Yellow*	*Caesalpinia gilliesii*
Cassia*	*Cassia sp.*
Palo Verde, Blue	*Cercidium floridum*
Brittlebush	*Encilia farinosa*
Palo Verde, Mexican	*Parkinsonia aculeata*
Floral Effects—Red	
Bird of Paradise, Red*	*Caesalpinia pulcherima*
Fairy Duster	*Calliandra eriophylla*
Coral-bean, Western	*Erythrina flabeliformis*
Ocotillo	*Fouquieria splendens*
Chuparosa*	*Justicia spicigera (Anisacanthus thurberi)*
Salvia, Gregg's*	*Salvia gregii*

CASSIA



DESERT SPOON

Floral Effects—Purple

Willow, Desert	*Chilopsis linearis*
Smoketree	*Dalea spinosa*
Texas Ranger	*Leucophyllum frutescens*
Ironwood	*Olneya tesota*
Penstemon*	*Penstemon sp.*
Mountain Laurel, Texas*	*Sophora secundiflora*
Verbena*	*Verbena sp.*

Floral Effects—White

Featherbush*	*Lysiloma thornberi*
Daisy, Blackfoot*	*Melampodium leucanthum*

Foliage Texture or Color

Cassia*	*Cassia sp.*
Cypress, Arizona*	*Cupressus arizonica*
Hopbush, Purple*	*Dodonaea viscosa 'Purpurea*
Texas Ranger	*Leucophyllum frutescens*
Featherbush*	*Lysiloma thornberi*
Sugarbush*	*Rhus ovata*
Jojoba	*Simmondsia chinensis*
Rosewood, Arizona*	*Vauquelinia californica*

Growth Habit, Distinctive Branching Characteristics

Manzanita, Point-Leaf*	*Arctostaphylos pungens*
Willow, Desert	*Chilopsis linearis*
Desert Spoon	*Dasylirion wheeleri*
Ocotillo	*Fouquieria splendens*
Hesperaloe	*Hesperaloe parviflora*
Fountain Grass	*Pennisetum setaceum*
Jojoba	*Simmondsia chinensis*
Yucca	*Yucca sp.*
Cactus	*numerous genera and species*

* *require occasional deep irrigation during growing season for best landscape appearance.*

In summary, the process of selecting a landscape plant for a park or recreation area should begin with an understanding of its function as required by the design concept. The plant must not only perform that function but it must do so in the environment of a specific site and with the level of maintenance committed to the project. Following these basic steps will result in an attractive landscape that "works" without undue strain on budget or maintenance resources.

Charles M. Sacamano, Ph.D., is an Extension Horticulturist at the University of Arizona in Tucson.

Managing Urban Forests for Recreation

by John F. Dwyer

Tree-lined corridors provide a forest setting for popular linear activities such as walking and bicycling.

U.S. Forest Service

City dwellers have responded to skyrocketing gasoline prices and high inflation by spending more leisure time close to home. Urban recreation also has grown with the resurgence of interest in enhancing the quality of city life. The result is an expanding effort to provide opportunities for high quality recreation in urban areas, but the resources available for the job have been reduced by the same inflationary forces that make the effort so urgent.

Urban recreation resource managers face the challenge of trying to expand their future services without the corresponding increases in available resources. This challenge calls for more effective urban recreation programs, including the management of urban forest recreation resources.

Urban Forest Resources

As urbanites seek more and more of their forest recreation experiences close to home, urban forests will probably continue to receive rapid increases in recreation use. The urban forest is a highly diverse ecosystem characterized mainly by trees but including other plants, animals, climatic and soil conditions, and man and his works. It provides a broad spectrum of recreation opportunities that range from hiking in the "wild" parts of forest preserves to studying nature in arboreta, conservatories, or zoological gardens.

The diversity and complexity of the urban forest ecosystem and the wide range of recreation opportunities that it can provide add greatly to the intricacy of urban forest recreation resource management. The complex interactions among components of the forest ecosystem are not well understood. City dwellers' recreation preferences change over short periods, necessitating flexible and highly responsive management programs.

The urban forest is an intricate network of corridors linking tracts of various sizes and shapes, along city streets and sidewalks, river banks and transportation corridors, powerlines and pipelines, in forest preserves, cemeteries, golf courses, nature centers, vacant lots and fields, arboreta, conservatories, yards and estates, and municipal watersheds. Each forest ecosystem provides its own distinct set of opportunities for recreation.

Notable Development Projects

Some cities are developing their forests in new ways. Seattle has a park built over a freeway. Calgary, Alberta recently completed a 2.6-acre (1.06 ha) park-under-glass that is linked to other small glass enclosed gardens and malls in the heart of downtown. Saskatoon, Saskatchewan, also has plans for glass enclosed parks and walkways with a strong emphasis on cultural development.

The Chicago metropolitan area includes perhaps the most extensive urban forest under a single management agency: the 65,000 acres (26,455 ha) of forest that comprise the Forest Preserve District of Cook County (Illinois). Covering 10 percent of a county that has 5.5 million residents, the forest preserves are managed for resource preservation, environmental education, and outdoor recreation. They provide the setting for more than 31 million recreation visits per year.

Forest environments throughout the urban system complement each other in a synergistic fashion to furnish opportunities for recreation. Tree-lined corridors linking larger tracts provide a forest setting for increasingly popular "linear activities" such as walking, jogging, bicycling, and hiking. These same corridors facilitate the movement of wildlife throughout the system and aid seed dispersal from trees and related plants. The combination of open spaces and woodsy areas creates "niches" for recreation—places for observing unique plants and wildlife, picnic sites with a mixture of sun and shade, and choice fishing spots along stream banks. The urban forest influences recreation in the neighborhood where most leisure time is spent by adding to the character of the local landscape and microclimate; screening out sights, sounds, smells, and substances; moderating sun and wind; and enhancing wildlife.

Tree Planting and Care

Tree planting will continue to be an important management activity because of the strong need for establishing or restoring urban forest environments, particularly along transportation routes, around dwellings, in urban redevelopment projects, and in parks and other open spaces. These efforts will place strong demands on nurseries to introduce new and genetically improved species that are well adapted to the urban environment. Use of such plant materials will lower replacement costs and outlays for maintenance.

The Forest Preserve District of Cook County reduced tree damage by concentrating picnic facilities in open grassy areas with scattered trees rather than in dense forest.

U.S. Forest Service

Healthy, well cared for trees enhance user benefits and improve the cost effectiveness of urban forest management programs. Tree care should be complete. It should involve trimming, watering, and fertilization, as well as protection from insects, disease, pollution, mechanical damage, and vandalism. The "plant it and forget it" approach to urban trees is too expensive for most managers. They should be committed to a management system when selecting individual trees for planting sites. Avoiding or delaying tree maintenance incurs risks of high maintenance, replacement, and liability costs in the future.

Siting and Spacing

Planning the context in which trees are planted requires increasingly critical attention. Managers should strongly resist attempts to cover all urban green space with a tree canopy. In many places users do not want an unbroken tree canopy; they prefer clusters or corridors of trees intermingled with grass and other groundcover, roads and parking lots, buildings, recreation facilities, and other developments. Heavy demands for athletic fields, urban gardens, prairies, and other treeless green space should be considered in urban tree planting. Improperly positioned trees may disrupt these important uses.

The proximity of trees to other resources is a key determinant of subsequent tree loss and damage, as well as of maintenance costs. In many cases, managers can save money with no loss of benefits by maintaining appropriate spacings between trees and facilities. The Forest Preserve District of Cook County concentrates picnic facilities in relatively open grassy areas with scattered trees rather than in densely forested areas. The result is less tree damage and a better place for picnicking and many other uses. Damage to trees and related resources is also reduced by the placement of roads and parking lots and the creation of traffic barriers.

Tree planting has important implications for other components of the urban forest and the associated benefits to city people. Managers are beginning to look at the forest not as a collection of trees but as an ecosystem characterized by trees and including plants, animals, climate and soil, and man and his works. To do otherwise is to risk the creation of such undesirable conditions as damage to nearby homes and gardens from wildlife brought by an extensive tree planting effort, or loss of understory vegetation when many trees are planted close together in a particular area.

Managing the Urban Forest

Urban forest management is getting more attention for many reasons besides the rapid increases in recreation use. Diseases have killed many urban trees, requiring massive tree removal and planting programs and new pest management strategies. Large-scale suburbanization has extended residential developments into farmland and other open-space areas that have been cleared of forest, thus creating the need for establishing and managing the urban forest in new neighborhoods. Urban redevelopment has created similar needs in the inner city. The environmental movement of the 1970s focused more attention than ever before on improving the quality of the urban environment.

The management of urban forests is complicated by the high stress levels imposed on the vegetation by 1) the character of the urban environment and 2) high levels of use. Urban soils often have been disturbed, compacted, or filled, hindering root development. Root problems are particularly critical for the urban forest located in flood plains and subject to periodic flooding and drought. Salt spray, toxic runoff from streets, air pollution, and mechanical damage often pose problems for urban forests. Heavy use by city people has compacted soil; damaged trees, other plants, and facilities; and disrupted wildlife populations.

Pest Management

Because urban trees and associated plants under stress are highly susceptible to insects and diseases, pest management probably will grow more important and complex. Close public scrutiny of urban vegetation usually leads to early detection of pest damage. City dwellers generally have a low tolerance for such damage and often engage in or call for highly intensive pest management and heavy use of pesticides. The impact of pesticides on urbanites and their environment is leading to some significant rethinking of urban pest management strategies.

The squirrels, deer, birds, and other wildlife of the urban forest add to the recreation experience, but they also may become troublesome pests by damaging gardens, homes,

Enlist the support of citizen action groups in implementing urban forestry programs.
U.S. Forest Service

and recreation facilities. The control of animal damage often is complicated by strong public sentiment against actions that may harm animals. The development of management strategies that maximize the benefits of wildlife but minimize the damage is a major challenge.

Development Challenges

Creating urban forest environments through tree planting and subsequent care is one aspect of management; other efforts involve changing the existing urban forest to accommodate new uses. Prominent changes include the development of homes, transportation routes, and recreation facilities. Urban forests are highly prized sites for homes because much recreation takes place near the home. Managers face a major challenge in maintaining a pleasing forest environment while providing for the construction of homes and associated utility and transportation developments. In most instances, managers try to minimize damage to tree roots and stems during construction and subsequent maintenance, soil compaction and disturbance, disruption of soil drainage patterns, and exposure of the remaining trees and related vegetation to sunscald and wind damage.

Vandalism and other depreciative behavior may create problems for plants, animals, and facilities, as well as for users. At the same time, trees and related vegetation may influence the extent or location of some forms of depreciative behavior. Some urbanites perceive areas with a heavy cover of trees or shrubs as high-crime areas. Dense vegetation also may restrict law enforcement patrols. Efforts to reduce antisocial behavior and its associated fears often involve many strategies, including management of vegetation and other components of the urban forest in conjunction with new rules and regulations, enforcement efforts, and educational programs.

Management Restrictions and Options

Urban forest resources are managed by many public and private organizations with various purposes, interests, and levels of expertise. Individuals responsible for these resources may have experience in diverse fields including forestry, arboriculture, landscape architecture, urban planning, parks and recreation, wildlife management, engineering, and environmental education. The diversity of objectives, managers, and managerial backgrounds complicates urban forest resource management.

Urban forest managers often have fewer and somewhat different management options than their rural counterparts. Limited use through permits, blocked roads, or other direct restrictions on access usually doesn't work with large concentrations of city people nearby. Less directly controls such as facility design, placement of vegetation and barriers for channeling traffic, design of roads and parking facilities, rules and regulations, and use of patrol personnel tend to be more effective.

Objections of urbanites often make the use of fire and the cutting of live trees unacceptable as management techniques. The harvesting of dead trees for firewood is limited by concern about the spread of insects and disease and the city residents' overwhelming demand for "do-it-yourself firewood." Most urban forest management programs lack the manpower to supervise firewood cutting.

Most activities are confined to the daylight hours to protect users and to reduce conflicts with nearby residents. Uses such as hunting, driving of off-road vehicles, and camping are often restricted or prohibited because of their incompatibility with other users or nearby urbanites.

Public Involvement

The usually high level of public interest and involvement in urban forest resource management is increasing. Neighborhood associations and conservation groups are playing a more important role in urban tree planting and care, as well as in the control of vandalism and other depreciative behavior. Examples include the Greening of Boston, the California Conservation Project (The Tree People), the Magnolia Shade Tree Commission of New Jersey, Philadelphia Green, the Magnolia Tree Earth Center in Oakland, the Street Tree Consortium in New York, the Adopt-A-Block Program in Oakland, the Adopt-A-Park Program in Detroit, the Green Guerillas, and the Oakland Tree Task Force. In many urban areas, homeowners are being given greater responsibility for selecting, planting and watering "street" trees in front of their homes as well as for sharing in the cost of the trees. Expanding citizen involvement may result in substantial cost savings.

Increasing development challenges managers to adapt urban forest land to new uses.

HCRS

The maintenance of urban forest resources, including patrol and protection, requires large amounts of increasingly costly fuel and labor. Intensive efforts are underway to reduce these costs that are becoming a major drain on urban forest management budgets. The long-term solution appears to be:

1) Redesign of tree planting and other management practices to reduce subsequent maintenance costs.
2) Increased use of volunteer assistance from urbanites.

Coordination and Integration

Substantial cost savings can be achieved by applying modern management techniques to the urban forest. One change may involve combining urban forestry efforts now fragmented under street tree, park, public housing, utility, transportation, water resource, and other programs. Such an effort would facilitate coordination among urban forestry programs, improve their effectiveness, and save money.

At the same time, urban forestry should be more closely integrated into city and regional planning for housing, utilities, recreation, land use, water resources, and transportation. Without such integration, urban developments may continue to eat away at urban forest resources, reducing user benefits and requiring large expenditures for restoration. The effectiveness of integrated planning will depend, in part, on the ability of urban forest managers to anticipate changes in the system—especially in transportation, housing, and utilities—and to develop innovative ways of responding to them.

The urban forest probably will continue to change with urban development in the years ahead. Growing concern about the effects of noise and congestion on urbanites is likely to heighten attention to the forest's role in moderating noise and in screening particular areas, including portions of recreation sites. The character of residential and "street" trees and related open spaces is likely to change as multifamily housing and new developments in mass transit become more popular.

Urban forest resource managers are receiving some help from federal and state sources. The Urban Park and Recreation Recovery Program, administered by the U.S. Department of the Interior's Heritage Conservation and Recreation Service, provides grants to upgrade urban park and recreation resources. A cooperative program of the U.S. Department of Agriculture's Forest Service and state foresters provides technical assistance in urban forestry. The Forest Service is expanding its nationwide urban forestry research program to develop new urban forest management programs and procedures.

Conclusion

Managers of urban forest resources face significant challenges in meeting the rapidly increasing demands for recreation during austere times. This calls for improved management practices and programs based on a sound understanding of 1) preferences for urban forest recreation environments, and 2) techniques for providing those environments.

Some promising ways to increase the effectiveness of these management programs include:

1) View the urban forest as an ecosystem characterized primarily by trees but including many interrelated components.
2) Recognize that the urban forest recreation resource consists of a system of interrelated, and often interconnected, corridors and tracts throughout the urban systems.
3) Give careful attention to the planting of appropriate trees.
4) Deal with the high stress levels imposed on urban forest vegetation.
5) Follow management practices that avoid pest problems involving insects, disease, or animals.
6) Undertake special efforts to make certain that homes, roads, and recreation developments are constructed to maintain or enhance the existing urban forest environment.
7) Coordinate the management and use of forest recreation resources throughout the urban system.
8) Control urban forest recreation resource use through facility design, placement of vegetation and other barriers for channeling traffic, design of roads and parking facilities, rules and regulations, and enforcement personnel.
9) Manage urban forest vegetation to minimize losses to vandalism, crime, and other antisocial behavior.
10) Make effective use of citizen action groups in generating support for and carrying out urban forestry programs.
11) Make use of modern management planning techniques.
12) Coordinate and integrate urban forestry with other urban programs and developments.

John F. Dwyer is Principal Urban Forestry Specialist at the North Central Forest Experiment Station USDA Forest Service, in Chicago, Illinois

Breeding Better Trees for People

by Frank S. Santamour, Jr., Ph.D.

The United States National Arboretum has become a leader among research institutions in developing superior trees for use in populated areas—a challenge unmatched by any other type of plant breeding.

Urban trees have a high unit cost and value, both at the time of planting and, increasingly, year after year. Thus, 100 percent survival is expected from these trees under prevailing adverse conditions. Selected trees frequently are planted in environments alien to tree growth where cultural care after planting may be minimal.

Nor is the development of improved cultivated varieties—or cultivars—the only challenge facing the arboretum in bringing better trees to people. Commercial nurseries are the main distributors of trees to the public. To disseminate the fruits of our research, we must convince the nursery profession of the superiority of our newly bred cultivars.

Current research at the National Arboretum, which is administered by the Secretary of Agriculture, emphasizes the development of pest-resistant and stress-tolerant cultivars that will thrive in metropolitan or populated areas. To assure the superiority of the cultivars we develop, our evaluation program is thorough, intensive, and demanding.

Magnolia 'Nimbus' has a "tropical" appearance and nicely scented flowers.

National Arboretum

The National Arboretum's Program of Tree Introduction

First, plant populations are produced by controlled hybridization or by progeny testing of selected provenances, species, or individual mother-trees. Mass screening against disease and insect pests or environmental stresses such as salt and air pollution, is carried out at as early an age as possible. Populations, or early selections from such populations, then are planted out for long-term testing. After growth potential, flower and fruit characteristics, and resistance or tolerance to various stresses have been determined, selections are made.

These selections are propagated vegetatively, usually by rooted cuttings, and distributed to a nationwide group of cooperating evaluators including nursery professionals, scientists, and laypersons with special knowledge and interest in a particular plant. Evaluations are requested at appropriate times from these cooperators and when such evaluations are favorable and are sufficient to judge the cold-hardiness and cultural adaptability of the plant, we move on to the next phase.

This is the stock increase phase. Our major cooperators in this endeavor are wholesale propagating nurseries, which have a strong desire to help in the production and distribution of superior plants. Only after sufficient stock is available in these nurseries to insure that sales and distribution of the plant will have a significant impact on the "green industry," do we name and release the cultivar for sales and distribution to the public.

This evaluation process is time-consuming. Just waiting for a new magnolia hybrid to flower may take up to 10 years. However, we believe that our program, while frustrating to the individual scientist, is designed to get the best possible plants to the greatest number of people in the shortest possible time.

What are some of the qualities we consider in breeding and selecting new cultivars?

Provenance

Climatic adaptability is obviously an important characteristic, and winter- or cold-hardiness is the most frequently cited criterion. Data given in most tree lists on the northernmost "Hardiness Zone" are based on *species* performance. A nursery professional growing red maple seedlings of local origin in Tennessee may advertise the product as being hardy to Zone 3 (say, St. Paul, Minnesota). While it is true that *Acer rubrum* has a native range encompassing Zone 3, and even parts of Zone 2, there is no guarantee, and little likelihood, that the Tennessee maples will be completely adapted to the colder climates.

One of the most neglected aspects of tree adaptability in the nursery trade is the matter of provenance, or geographic origin of the genetic material. Our native tree species frequently occupy a wide latitudinal and elevational range. Particular populations grow where they do because they are acclimated to the natural environment. Movement of this germ plasm too far north or south, may result in less than optimum growth and survival.

For non-native species, there is frequently much less information available. We may know the native *range* of the species but not the precise locality of origin of our seed or of a tree in an arboretum. Judgments as to potential hardiness are sometimes based on the coldest zone in which a tree of a particular species exists. Many mistakes have been made by using this criterion of hardiness.

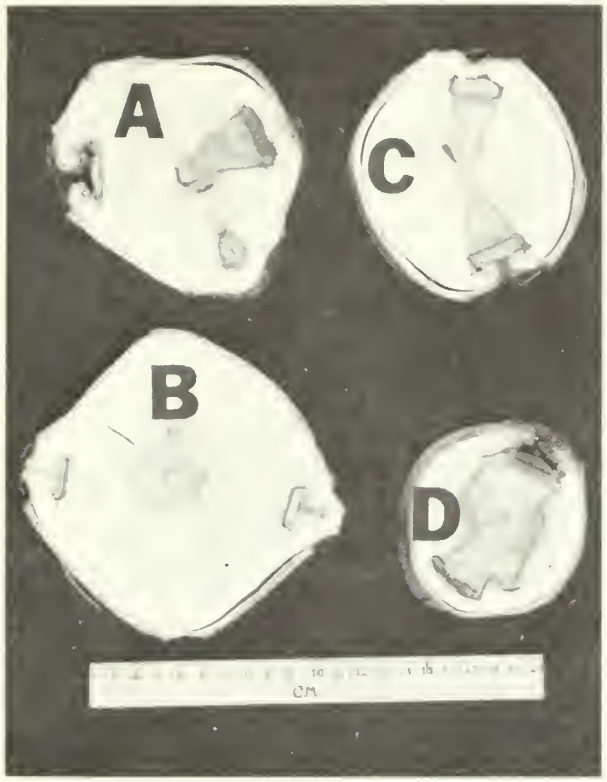
Without belaboring the point further, let me say that the provenance of a tree may well determine its utility.

Before leaving this topic, I should point out that provenance is important not only to hardiness. The movement of plant materials far south of their native or adapted range may cause less dramatic problems, but they are real ones. The long hot summers and drought are only two of the many environmental survival factors that must be considered. In addition, flowering fruiting, and autumnal leaf coloration may be altered significantly.

Pest Resistance

Neophyte researchers who consult various references listing diseases and insect pests of shade trees, might consider it just short of miraculous that any elms or poplars have survived the biological blitz. On the other hand, they will note that relatively few pests appear to plague certain tree species that are relatively rare in cultivation. It is axiomatic that the number of pests associated with a crop increases with more extensive culture—and intensive observation. There are major pests, minor pests, and unknown pests. What pests are important and how much resistance do we need?

In some genera, the ranking of priorities may be relatively easy. For elms, resistance to Dutch elm disease, phloem necrosis, and Verticillium wilt are in a reasonable order. Among elm insects, the elm leaf beetle would probably be considered the most destructive. Surely, if cultivars were developed with resistance to all the above pests, and possessed reasonable growth habits, they could find ready acceptance in the nursery trade. Yet, nectria canker might still be a problem, as might leaf spots, wetwood, borers, cankerworms, and aphids. Where do we stop?



Cultivars vary in their ability to compartmentalize, or wall off, wounds. National Arboretum

The elms are a special case. Standard references will show a large number of genera and species with only a few serious pests, or none at all. Wouldn't it make good sense to work with these genera and species?

Maximum improvement of our metropolitan environments will come when we seek to improve *all* genera and species that are available to us. The need for diversity is urgent and important.

Pests that are *limiting* factors in the successful culture of a tree are the obvious first choices for resistance breeding and selection. Inoculation with the most virulent or aggressive strains of the pathogen or long-term exposure to natural or enhanced insect populations will be necessary to achieve significant improvement. All tree geneticists, pathologists, and entomologists realize the problems; but each may have strong personal opinions on the relative importance of certain pests and the degree of resistance required. There are no *absolute* answers to these questions.

Stress Tolerance

There is no doubt that certain humanmade stresses imposed on trees in metropolitan environments are major factors in tree growth and survival. Any reduction below optimum growing conditions may make the tree more susceptible to insect, disease, and nematode pests that might otherwise not be problems.

We are fortunate that we can duplicate—under laboratory or controlled field conditions—most of these stress situations. Tolerance of salty and compacted soil is amenable to field and greenhouse experimentation. The effects of gaseous air pollutants may be tested in special chambers. The response of trees to certain sources of artificial illumination can be determined. Furthermore, the response of trees to injuries caused by automobiles and other mechanical agents can be assessed by observing healing patterns of pruning cuts or deliberate trunk wounds during the testing period.

Screening procedures against stress factors may be applied to populations or individual selections and at different stages in the improvement program. For instance, tests of salt tolerance were conducted on seedlings of sycamore progenies resulting from crossing *Platanus occidentalis* and *P. orientalis* at the National Arboretum. Individuals exhibiting resistance to sycamore anthracnose disease in field tests were selected from those progenies that had demonstrated the highest salt tolerance. After further observations on anthracnose, selected clones may then be subjected to salt testing once more before final selections are made. Or the clones may be screened for ozone or sulfur dioxide tolerance.

Stress conditions are seldom the limiting factors to the successful culture of a tree. The limiting factor in *Platanus* is anthracnose. The only reason salt-tolerance testing preceded other tests was that we had an abundance of seed, more than we could possibly use in producing trees for long-term field tests.

Where the number of seed or seedlings is small, stress-tolerance testing should be postponed until after resistance to major pests has been determined. If there are no major pests, the entire improvement program may consist of stress testing.

While we can work with stress factors singly, the trees on the streets are subjected to these conditions in combination with each other, and with biological and climatic factors. We cannot hope to duplicate or even account for all of the variable conditions. Thus, the best products of our laboratory and field studies must be tested on the street. The more ruthless we are in our screening and selection procedures, the better the chances are for the survival and use of our improved trees.

Commercial Propagation

There are few, if any, trees that cannot be propagated and planted successfully if enough time, money, and effort are expended. However, if the nursery professional and the scientist are to get the greatest number of the best possible trees to the largest number of people in the shortest possible time, serious attention must be given to the biology and economics of mass production.

The cheapest and most efficient method of tree production is by seed. If an improved seed-propagated cultivar can be increased by seed, giving reliable and uniform germination, there would be little doubt about its wide acceptance and use. We should remember, however, that such a cultivar also should be uniform in desirable traits relating to survival and growth. Tree species that are heavy and consistent seed producers will be best adapted to this method of propagation.

The next most effective and least costly method of propagation is the rooting of cuttings. The development of rooting hormones and mist systems now allows cutting propagation of many species and genera that were difficult or impossible to root in the past. Still, there are many species in which rooting success is economically marginal, and much remains to be learned.

The geneticist must be the experimental propagator of such material. Juvenility may be the key to success in many species, and initial propagations may be made from sprouts after the propagations have been cut back. Perhaps there are not many nurseries that maintain stock blocks that are handled on a cut and sprout basis, but if the scientist can demonstrate that *some* method of rooting is successful, the chances of the material being mass-produced are increased.

Personality

Most popular trees are chosen for their personality, specifically for the traits that differentiate them from the norm. Weeping, fastigiate, columnar, globe, and vase-shaped forms not only are pleasing to the eye, they have distinct utilitarian functions. Autumnal leaf coloration is urban man's reminder that winter is on the way. Permanent leaf coloration may jar the sensibilities of certain beholders, but such non-green-leaved trees do have their place. Flowers are desirable, to be sure, in as wide a range of sizes and colors as nature and the breeder can conspire to develop. Fruit and seed are important too, but often more for their absence than their presence.

Present Research Directions

In these times of energy crisis and inflation, the ability of the National Arboretum staff to function effectively is tested to the utmost. But even under our present limitations of funds and personnel, the highest research standards have been maintained and new developments continue. Among our current projects are:

- *Graft incompatibility.*

Aided by funds from the Horticultural Research Institute, research on graft incompatibility has begun. Delayed problems created by scion/stock incompatibility in landscape and street plantings of improved cultivars are costly—and they are increasing as the demand for more and better cultivars grows. Rootstock selection has become a key consideration. Most of this research effort has been concentrated on maples, oaks, and elms, but preliminary work on other genera also shows promise. Related to the problem of grafting is the study of initiation and cessation of cambial activity as measured through electrical resistance; early data indicate that electrical resistance, like growth activity, is a heritable characteristic.

'September Gem' is a new evergreen holly of limited growth with large red, early-ripening berries.

National Arboretum ▶

Not all hollies are evergreen, and the new cultivar 'Sparkleberry' is very cold hardy and holds its bright red fruit through the winter.

◀ National Arboretum

• *Wound Response.*

We have shown that the compartmentalization response of trees—or the walling off and containing of a stem or trunk wound—is inherited. Now we are trying to identify the chemical responsible for this walling off.

One problem of a breeding program involving compartmentalization is the size, type, timing, and number of wounds necessary to determine whether a tree is a weak or strong compartmentalizer. In many situations, only a single tree will be available for this determination, not several members of a clone or cultivar. An accurate assessment of the compartmentalization potential of parent trees is absolutely necessary before valid judgments on inheritance can be made.

Recently, we attempted to perform similar experiments on the response of trees to root wounding. We found that the situation in roots is either more complex or simply requires more time for expression. Therefore, we have initiated another root wounding study—the results to be available in 1982.

• *Root Hardiness.*

The increased landscape use of trees and shrubs in large, aboveground, outdoor planters has focused increased attention on cold-hardiness of the root system as a limiting factor in these situations. We have shown that root hardiness of green ash, like stem or bud hardiness, depends to a large extent on the native geographic origin of the plant material. If enough large-capacity planters can be obtained by donation or purchase, we plan to extend these studies into a comprehensive investigation of the selection and culture of trees in tubs.

• *Hollies and Elms.*

The holly breeding project at the National Arboretum, which began in 1956, may be the most extensive in the world. Testing continues on the nature and incidence of and resistance to holly leaf miner, with additional hybrid combinations being used. Likewise, a number of Chinese hybrid elm varieties continue to be tested for resistance to Dutch elm disease.

• *Anthracnose-Resistant Sycamores.*

The major problem in the cultivation of sycamore or planetrees is sycamore anthracnose disease. In the past we have recreated the highly resistant "London" plane hybrid and are currently evaluating four clones of this variety. Since this will take a long time, we decided to produce, *en masse*, a seed-propagated progeny with high anthracnose resistance and fairly uniform growth characteristics. Therefore, in 1979, we repeated a cross whose progeny has shown good growth and that had no trees with more than 5 percent wilt during our severe anthracnose years. We have harvested more than 150,000 seeds from this cross and will make the seeds available to nursery professionals.

Frank S. Santamour, Jr., Ph.D., a Research Geneticist, is Director of the U.S. National Arboretum. For further information about the Arboretum's research projects involving trees, shrubs, herbaceous plants, and taxonomy, contact Dr. Santamour at the U.S. National Arboretum, Washington, DC 20002.

Plan Before You Plant

by Monty L. Christiansen

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1. Unnecessary grass strips require mowing.
2. "Mower's blight" afflicts many young trees.
3. Park users seek the most direct route
4. Drinking fountain areas should be surfaced
5. Trimming grass under benches can be expensive and time-consuming

Monty Christiansen

The ultimate objective in park planning is creating a recreational experience for park visitors. An extremely important element of this experience is its setting. Park management consists of protecting and preserving the park setting, with vegetation management constituting a major component of this process.

Vegetation management describes the pre-planning and process of planting, cultivating, fostering, preserving, and maintaining desirable vegetation in a park. With the special exceptions of the national wilderness areas and a few others, the bulk of our parklands are not self-maintaining; they are resources in need of management. For most park agencies, the concern is not whether to manage a new parksite, including its vegetation, but is how to manage it most effectively. This management must be initiated in the pre-design phase of park planning, long before actual development of the park facilities.

There are several fundamental procedures within effective low-cost vegetation management that should be incorporated into the park planning process.

Establish a park vegetation management policy before design and incorporate specific objectives into the designing criteria.

One policy consideration for managing park vegetation is cost effectiveness—which is not to be misinterpreted as trying to do the job cheaply.

One approach to cost-effective management in the park is through zoning particular areas according to both the vegetation and activities occurring there. The development norm and degree of use for each area can be classified in chronological order designating the extent, frequency, and type of husbandry to be provided.

A simple example of such a management zoning plan is a golf course, with its greens, trees, and roughs all needing distinctive and different vegetation management. Municipal parks may have one set of criteria to manage exhibition gardens, arboreta, and floral displays; another for intensely used activity areas such as sportsfields, picnic groves, grass beaches, and playgrounds; another for nonintensive or off-season activity areas such as general purpose playfields and winter sports slopes; possibly a separate set of criteria for park landscape forms and support facilities such as earthen dams, embankments, swales, and dikes; and still another for special wildlife preserves.

Cost effectiveness also relates to the sophistication of planning energy control. The careful use of deciduous and evergreen trees, mass plantings, and groundcovers can save energy by reducing maintenance. For example, evergreens if planted in a linear pattern can actually serve as a living snowfence, and keep large deposits of snow off park roads and parking lots. Living windscreens can reduce leaf cleanup from tennis, handball, or basketball courts. Such examples of energy planning save both fuels and manpower.

Plants can provide natural air conditioning by reducing or permitting solar exposure for heat and light control. They can reduce humidity, direct the air movement in the summer, provide windbreaks, and reduce heat loss in the winter by natural insulation. These management objectives are obviously cost effective for areas where vegetation exists adjacent to park structures such as community buildings, shelters, comfort stations, lodges, cabins, information centers, nature centers, and others.

A fine case study of establishing a district-wide vegetation management policy, written by John Nicoles, appears in this issue of *Trends*.

Identify and change improper plant material specifications in preliminary plan reviews.

First, note the existing vegetation, proposed vegetation, and the functions of these as related to the area. Plant materials have attributes just like people and, like people, should be employed to utilize their best features.

Coaches prefer tall shooters for basketball, strong tacklers for football, fast runners for track. Park planners should select vegetation with the same care. If this is not done, corrective and often costly alternatives must be substituted. This can be compared to putting a short basketball player on stilts, or providing a weak football player with a club, or a slow runner with a motorcycle. It's better to meet your needs through effective recruiting and trading.

Significant characteristics of plant materials that should be considered

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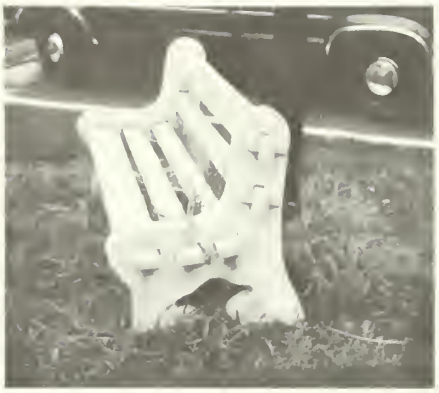

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in the planning process include plant scale, form, habit, foliage color and density, canopy, flowers and fruit, root structure, vigor, and tolerance. The following examples illustrate the effect plant characteristics have on vegetation management.

Many park agencies invest extra labor, equipment, and fuel to trim and prune trees, hedges, and shrubs because their plants are either too tall, too wide, or not shaped as desired. (Examples include forsythia, hemlock, and bridalwreath spirea.) Instead, park planners should specify plants with the natural height and shape—compact and full or loose and open—that are needed for a particular site.

Plant habit refers to the structural pattern of a species. Some plants are single trunked, others are multiple stemmed; some have limbs that grow upright and ascend, others descend or weep, and still others branch horizontally. Some plants have a high overhead canopy while others branch low to the ground.

An all-too-common problem has been the use of trees with low branching or descending habits adjacent to park walks, parking lots, and roadways, or in dense activity areas such as picnic groves and playgrounds. Pruning and trimming lower branches from trees such as pin oaks, willows, and spruces to provide clearance and space for people, automobiles, and mowers is acknowledgment of poor plant selection.

Foliage density affects visual screening, sound masking, and degree of shade. It is often desirable to contain the "perceptual park landscape" in a natural, nonarchitectural manner with plants and land forms. Also, research has indicated that park visitors have shade preferences depending upon activity, time of day, and season.

For example, campers generally prefer light shade or full sun in the spring and fall as well as in the summer mornings, but prefer a moderately dense shade during summer afternoons. Picnickers, swimmers, and others have similarly noted shade preferences, which should be considered when planning these activity areas.

Plant fruits can be an attractive asset or they can cause extra maintenance and problems. Those plants that produce large, heavy fruits or nuts (such as walnuts, hickories, osage oranges, or buckeyes) or fleshy, juicy fruits (such as flowering crabapples, cherries, ginkgoes, or mountain ashes) should not be located near parking lots or walkways or in dense activity areas. If they are, these fruits and nuts may fall on automobiles, equipment, and individuals. After falling, they may cause someone to suffer a dangerous slip or fall, or may be tracked into cars and buildings—and increase maintenance.

The roots of some trees (such as locusts, maples, and beeches) are strong and shallow. These have been known to lift and break asphalt or concrete if planted too close to walks, surface courts, parking lots, and roads. Other trees, such as willows and alders, seek moisture and have clogged sewer lines and damaged drainage fields, earthen dams, and levees.

Plant tolerance and vigor are also significant characteristics to consider in managing park vegetation. For example, plants tolerant of droughts require less watering; some plants grow well in acid soils; some in alkaline soils; some plants are tolerant of auto exhaust fumes, salt, wind, or heat. In planning, consideration needs to be given to those special microclimates near masonry buildings, ventilation fans and exhausts, air-conditioning compressors, and other park support appurtances.

Landscape architects are well trained to select plant materials suitable for these conditions. Dr. Charles Sacamono gives additional information and guidelines in his article on choosing appropriate vegetation in parks.

Review plans for possible design related vegetation management problems.

There are four common "problem zones" that may become apparent only after plantings mature: circulation routes, areas around buildings, spaces under and adjacent to park furniture, and landscaping over buried utilities.

Pedestrian and bicycle routes must provide logical and convenient traffic flow for users. A gracefully sweeping curved walk may look pleasing on a two-dimensional plan of the park but could really lead people out of their way. This only encourages shortcuts or new paths—usually through turf areas, groundcovers, shrub beds, or hedges. The repair of these areas and revision of circulation routes after development is costly.

Another frequent vegetation management problem that can be solved in the planning stage is unnecessary plantings which require extra maintenance. Examples include grass strips between a walkway and an adjacent parallel building wall or fence, on traffic islands, intersections, or walkway junctions; group plantings of shrubs at the start or end of a walk in a building, parking lot, or road; and plantings intended to hide or "soften" the appearance of the utility appurtenances such as manholes, transformers, gate and valve boxes, meters, and hydrants.

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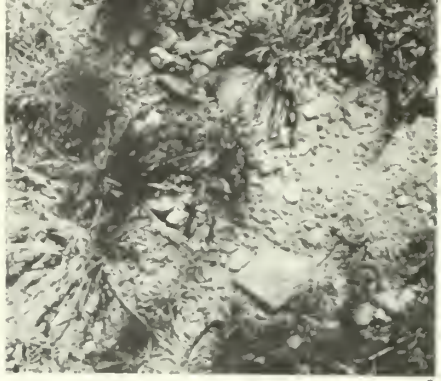


3

1. Fallen fruit can be hazardous and messy.
2. Plant steep banks with ground cover
3. Remove small stones and rocks before placing turf.

Monty Christiansen

These plantings usually are incongruous with their surroundings. Thus they actually draw attention to the equipment and make servicing or access to these items inconvenient.

Turf is an excellent park surfacing and can be very cost effective if used to maximize mechanical maintenance. Mowing considerations include such factors as spacing between obstacles (trees, pools, walls, and so forth) and gradients of turf slopes appropriate for mowing machines. Costly trimming, edging or clipping can be minimized by careful placement of park furniture such as benches, lamp posts, fences, gates, drinking fountains, and grills—and by substituting surfacing, paving, or mulch instead of grass under or around these. Mulch beds around young trees also may prevent an infestation of "common mower blight" caused by power mowers bumping, scraping, or rubbing against young tree trunks.

In many cases, careful grading of a park with proper contouring, diversion swales, runoff retention basins, and groundwater recharge areas along with proper vegetation planning and management for these landforms can replace costly underground storm water drainlines, help prevent erosion, and reduce runoff contamination of park streams and lakes.

The edge of any body of water poses a potential management problem. The abrupt change from the terrestrial plant domain to the aquatic plant domain creates an ecologically delicate and often unstable zone. Because people are naturally attracted to water, this edge may become a heavy impact area as well requiring special planting and management considerations.

Chlorinated water from swimming pools is another special concern. For example, a buckbrush hedge that screened and separated a toddlers' wading pool from the main swimming pool, died after several seasons because of the treated water from the pool splashing on it.

Identify the specific management requirements for the existing and proposed vegetation in the park and review the plans for necessary support facilities.

Vegetation management entails selecting appropriate materials, labor, equipment, timing, and task frequency in an efficient manner. For example, on one park plan the availability and placement of water outlets were examined with regard to vegetation management. Additional hosebibbs were desired adjacent to vegetation that would receive routine watering or irrigation. For areas infrequently watered, occasional hoselines or portable water tanks were considered more cost-efficient than permanent lines, which had to be installed below a deep frostline and in a very rocky soil. Water hydrants were planned at several points in the park to permit convenient recharging of sprayers and other maintenance equipment and eliminate time lost from returning to the maintenance center to refill empty tanks. The plan examined width of gates and service routes to make sure sprayers, mowers, and other maintenance equipment could have direct access to work areas.

Snow removal procedures were reviewed for parking lots, roads, and snow deposition sites. Projected amounts from plows and snow blowers were examined and their impact upon the effective vegetation studied.

Identify processes or phases of park construction that require careful treatment or supervision to prevent or reduce future maintenance problems.

Of particular concern is the preparation of the soil, be it a seedbed for a turf sportsfield, a bed for mass planting, or bedding next to the foundation of buildings or other structures. Careful soil treatment and preparation should be noted in the construction specifications.

A poorly prepared, stone-filled seedbed for a turf field will cause vegetation management problems after development. The rocks and stones will work to the surface and cause havoc with effective management and safe use of the field.

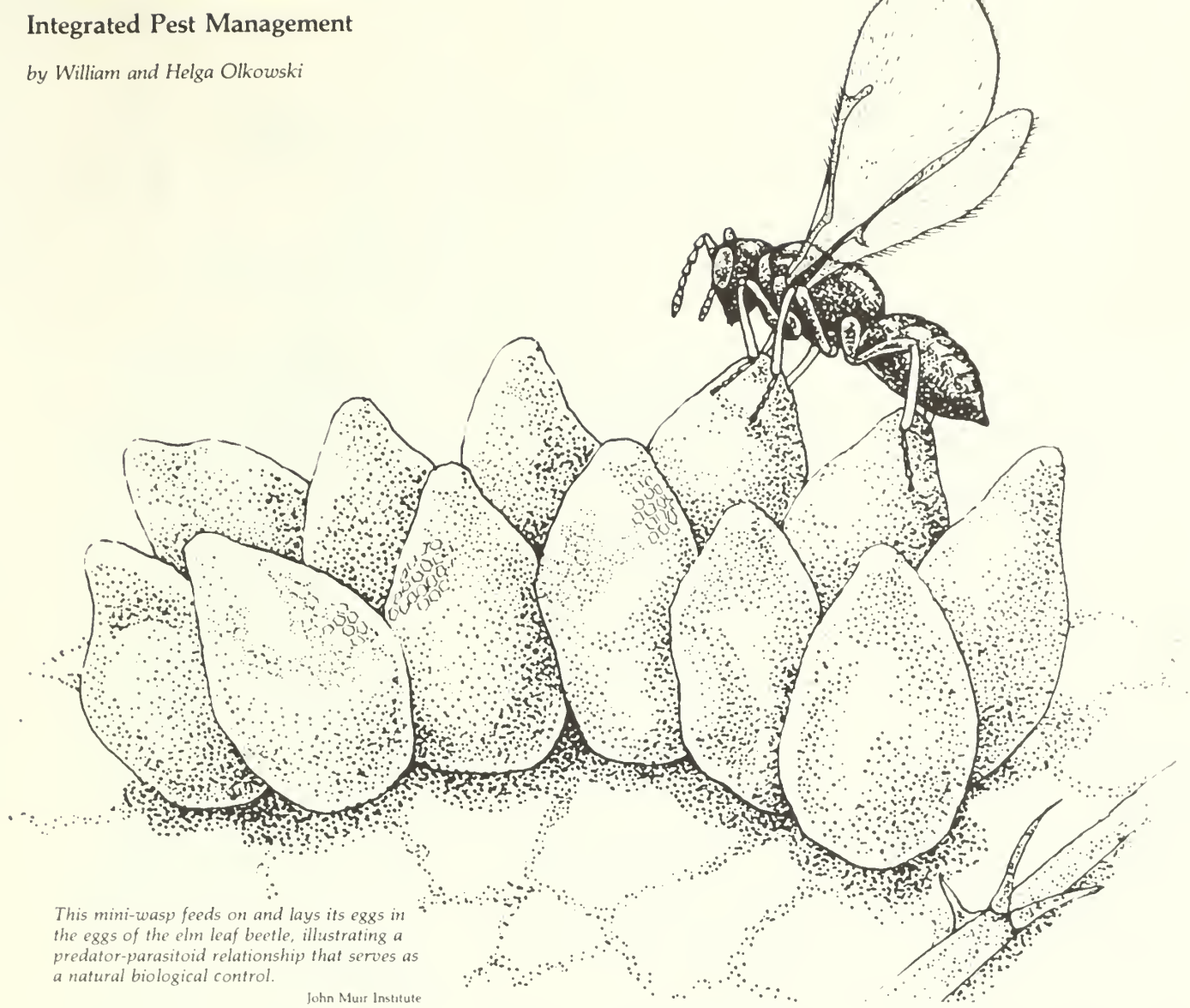
Backfill of raised planting beds and areas around buildings and wall foundations often provides a handy dump for a variety of construction wastes and debris, which may contain toxic chemicals or excesses of acidic (or alkaline) materials. This eventually causes problems for any vegetation planted over it.

By incorporating pre-design procedures similar to those mentioned here into vegetation management in parks, many potential problems can be eliminated and the efforts can become more cost-effective.

Monty L. Christiansen is Associate Professor of Recreation and Parks at The Pennsylvania State University University Park, Pennsylvania.

Integrated Pest Management

by William and Helga Olkowski



This mini-wasp feeds on and lays its eggs in the eggs of the elm leaf beetle, illustrating a predator-parasitoid relationship that serves as a natural biological control.

John Muir Institute

"When you kill off the natural enemies of the pests, you inherit their work," Carl Huffaker, noted scientist, once said. But killing off pests has been the goal of millions of people for hundreds of years.

Now, one approach has been devised to reduce pest populations without wiping them out and thereby creating further problems like those suggested by Huffaker. The approach, known as integrated pest management (IPM), is a technical decisionmaking process that combines all available pest control techniques into a program for suppressing pest populations below a level at which they pose a threat. The process is based on the understanding that insects and other animal populations are normally under natural control.

While IPM first was developed to control insects harmful to agriculture, its problem solving approach now is being used successfully in a variety of situations involving forest management, urban pest control, water resources management, wildlife management on rangelands and rights-of-way, and parklands management.

For example, IPM has been successfully adapted in Berkeley, California. The goal of the program, developed in the early 1970s by the local Recreation and Parks Department, was to control insects on the city's 30,000 street trees.

In 3 years the program virtually eliminated synthetic chemical insecticides as regular management tools for the city's 123 species of shade trees. This resulted in lower pest management costs, fewer citizen complaints, elimination of secondary pest outbreaks, and a reduction in environmental contamination. A 1974 estimate showed that the city then was saving about $22,500 each year in labor and pesticide costs by employing the IPM process.

Any integrated pest management program seeks to make maximum use of naturally occurring pest controls, including weather, disease agents, predators and parasites, and availability of food and habitat. In addition to such natural controls, IPM may employ various biological, physical, and chemical controls.

Whatever the resource under management—whether primitive forest, urban recreation area, or wetland—it is viewed as a functioning ecosystem where everything is related. Thus, actions are taken to restore, preserve, or augment the checks and balances of nature.

How IPM Works

The IPM process is based on four basic questions. *If* pest suppression treatments are needed. *When* they are needed. *Where* they are needed. And *what* the treatment strategy should be.

Answers are obtained through six process steps, or components. These are:

1) Monitoring populations of potential pests and their natural enemies.
2) Determining aesthetic or economic injury levels.
3) Developing and integrating strategies that affect potential pest populations.
4) Timing and spot treatment with pest suppression strategies.
5) Evaluating results.
6) Educating maintenance personnel and citizens about natural enemies of insect pests and strategy combinations for environmentally sound pest control.

Monitoring—the Key

The key component of any IPM program is its monitoring system. Regular observation is made of present and potential pest populations and their natural enemies, of human activities that directly or indirectly affect pest or natural enemy populations, and of weather factors such as temperature, humidity, rainfall, and flooding.

A monitoring program can be designed to determine the amount of injury caused by the pest, when the best time for pesticide treatments occurs, whether the release of beneficial insects would help, the relationship of the pest population size to weather, specific information about the biology or ecology of the pest or its natural enemies, or some combination of these. Each monitoring program is tailored to the particular problem situation requiring management.

Monitoring is used to identify the problem, and to determine the most effective way of dealing with it. Regular observation also provides a margin of safety by gathering facts that will spot at an early stage any new problems that might arise.

At the same time when present and potential pest populations are monitored, account is taken of various factors that affect them. These can include horticultural practices such as fertilizing, watering, pruning, mowing, and mulching; management of garbage and waste; and human behaviors that range from storing food to walking household pets in urban parks.

Grasping the Problem

Proper monitoring helps the management team assess the full extent of a problem. One example of this can be seen in a current IPM maintenance project for flood control levees in California.

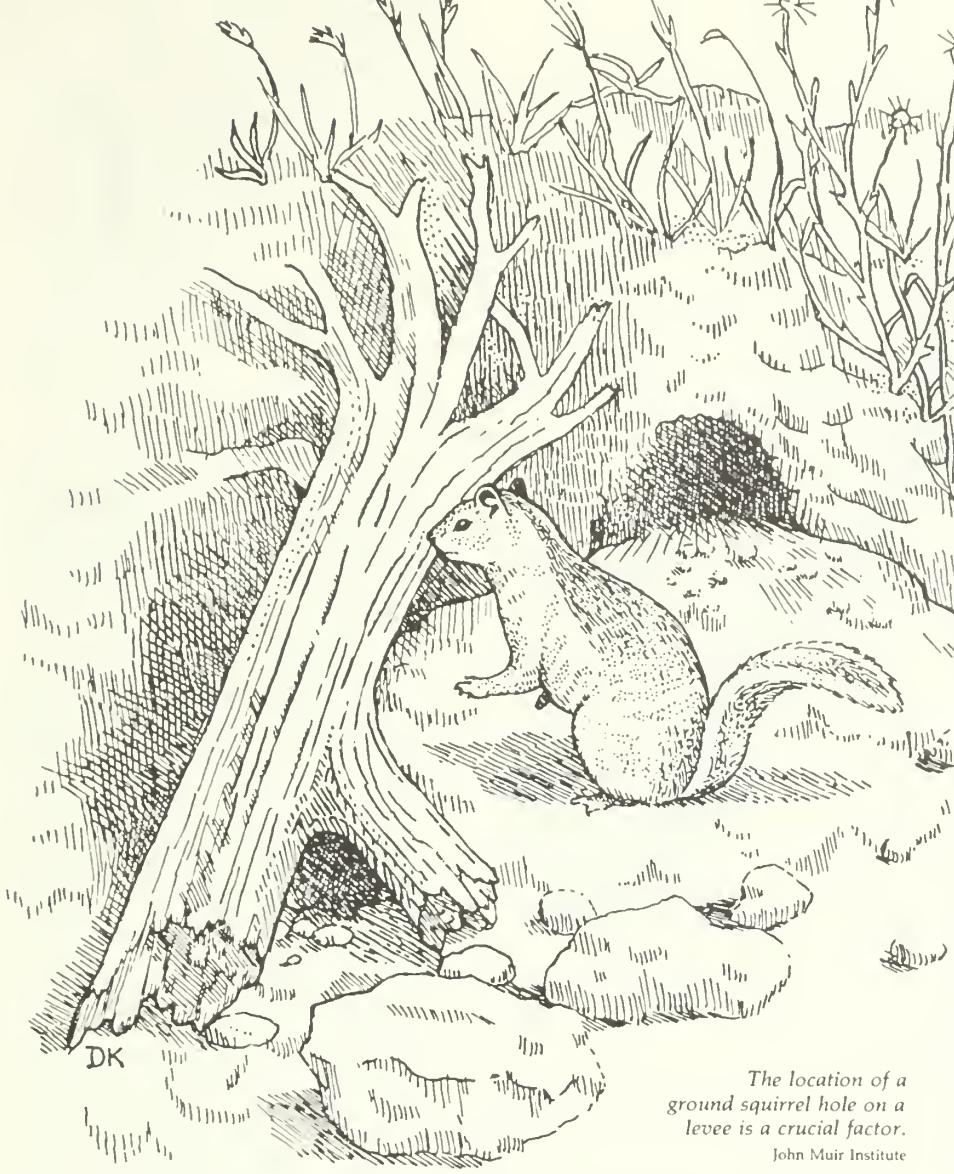
On flood control levees, ground squirrels, gophers, and a variety of agricultural weeds are major pests. Other challenges to the integrity of the levees include cracking and erosion caused by water and human activities such as the use of motorcycles and off-road vehicles.

In the case of the ground squirrel, any one squirrel hole can provide a channel through which flood water could breach the levee. But location of the hole—whether on the land or water side—and the width of the levee at the site of the hole are crucial factors. Top priority is given to areas that have the largest ground squirrel populations on the water side.

Monitoring studies show that wide strips of riparian vegetation are beneficial for a number of reasons, but that undesirable weeds can infest nearby agricultural areas. The studies further indicate that burning of plant cover and other activities that lower plant height encourage the ground squirrels, since the creatures need to see their predators to avoid them and to see each other to maintain their social system. Removal of the vegetation also encourages quicker and more uneven drying of the interior of the levees, which results in more cracking and settling.

Through monitoring, the red-tailed hawk was found to be a primary predator of the ground squirrel. A pair of these hawks may take more than 500 ground squirrels during the period when they are feeding their young. Other known predators noted were marsh hawks, white-tailed kites, owls, gopher snakes, and a wide variety of wild and domestic cats.

Threats to these predators, including secondary poisoning from consuming poisoned prey and vegetation destruction by maintenance workers, were other factors that needed alteration. The prey were being poisoned primarily by adjacent farmers. The vegetation destruction resulted from the annual burning of levees, justified on the grounds that the practice facilitated levee inspections.



The location of a ground squirrel hole on a levee is a crucial factor.
John Muir Institute

The monitoring and other studies showed that all these predators of the ground squirrel could be encouraged through the conservation and augmentation of a diverse riparian vegetation on and adjacent to the levees.

The IPM program for the levees thus indicates the need for more permanent, diverse, and climatically suitable plantings on the levees to create a low-maintenance system that will protect the integrity of the area. Plants on which ground squirrels feed will be avoided on land directly adjacent to the levee. (Adjacent walnut orchards were found to be a major food source for the squirrels.) Finally, an educational program for both landowners and the general public has been implemented to ensure a successful, long-term regional approach to the pest problem.

How Much Is Bad?

Pest management through an IPM program aims at reducing the size of the pest population to a point where no intolerable economic or aesthetic damage occurs. The cost of the treatment always should be less than or equal to the cost of the damage caused by the pest. *The aim is not to eliminate the pest* from the area; that also would eliminate its natural enemies and make the situation even more unstable.

Essential to the program is determining how many potential pests can survive without causing serious damage and without pest population resurgence. This population size is called the injury level. Once this information is obtained, the goal is to maintain the pest population at or below that level.

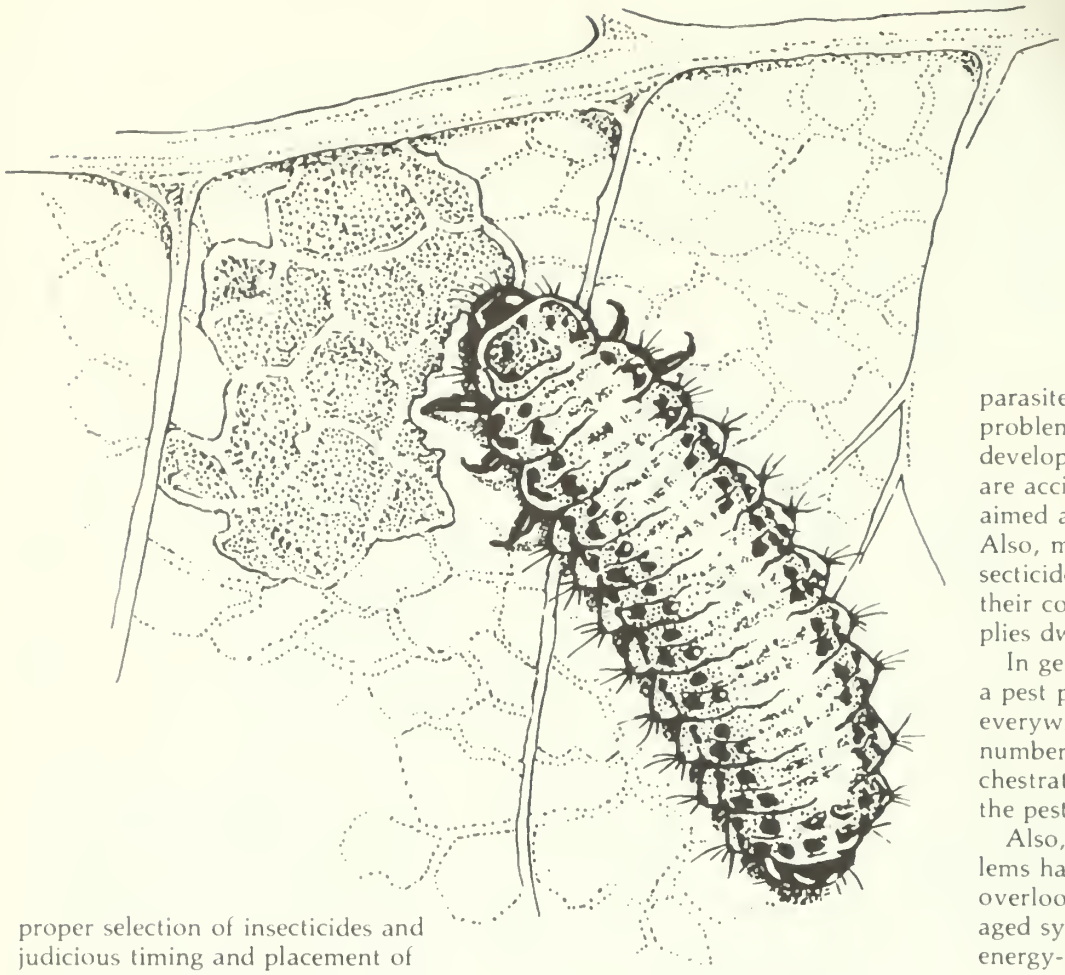
Treatment Options

By taking the IPM program step-by-step, many treatment options become apparent through an ecosystem view of the pest problem. Interactions between the pest and its natural enemies such as predators, parasites, and diseases; other natural controls such as weather; and human behaviors such as maintenance activities, then become obvious.

Many treatment options exist under an integrated pest management system. Habitats can be modified to reduce pest harborage, food, or other requirements. The environment can be enhanced for the pest's predators, parasites, and diseases.

Treatment can be as simple as modifying such human behavior as watering, fertilizing, pruning, mowing, mulching, cultivating, waste management, and food storage. In some cases, education, not suppression, may be needed. Public demand for manicured landscapes or fewer of certain insects can be reduced through educational programs in schools, exhibits on the ecosystem, slide presentations, and the use of the news media.

Biological controls frequently are the most effective and enduring form of treatment under an IPM program. Successful conservation of the pest's natural enemies through



Adult elm leaf beetle feeds only on elm trees.
John Muir Institute

proper selection of insecticides and judicious timing and placement of these and other treatments has been demonstrated repeatedly.

In other situations, the pest's natural enemies may have to be augmented or imported. For example, the Berkeley insect problem referred to earlier, stemmed from the fact that most of the trees were not native to the area. Therefore, they were vulnerable to occasional invasion by tree-feeding insects that belonged to an exotic ecosystem. The city lacked populations of those beneficial insects that serve as natural controls on the exotic pests. After determining what insects were causing the problem, Berkeley researchers identified the native area of the pests and imported their natural enemies. Once this was done, classical biological control proved successful on the three species of aphids which were attacking Berkeley's linden, elm, and English oak trees.

An IPM program does not rule out the use of chemical controls; it merely puts the use in perspective as one of many options. Chemical controls include the use of pheromones and other attractants to lure or confuse the pest; juvenile hormones that arrest pest development; sterilants or "contraceptives" to reduce breeding of future generations; and contact, stomach, and other poisons.

Since the end of World War II and the growth of the agri-chemical industry, modern insecticides have formed the backbone of pest management programs in this country. Unfortunately, a number of problems with these materials have begun to emerge. Their effects on human health and wildlife survival are increasingly well publicized.

Not so obvious, and thus less understood, is the way in which the unwise use of insecticides actually may cause more pest problems than it cures. Insect pest populations can rebound when an insecticide kills off the beneficial insect predators and parasites. Entirely new species of problem insects and mites may develop when their natural controls are accidently destroyed by poisons aimed at the original target pests. Also, most commercial synthetic insecticides are made from fossil fuels; their cost rises as our fossil fuel supplies dwindle.

In general, no single approach to a pest problem is likely to succeed everywhere and at all times. Often a number of strategies need to be orchestrated to achieve suppression of the pest below damaging levels.

Also, in large measure, pest problems have been designed into, or overlooked, in many human managed systems. By far, the most energy- and cost-efficient pest management strategy is to design the pests out of the system in the beginning. Through the selection and mix of plant species, the design or remodeling of structures and interiors, the contouring of sites, the design of organic waste and other resource management processes, the extent that preferred harborage, food, water, and other requirements of the life cycle are provided, these measures all can contain the population of existing or possible pests.

Or, in the words of another scientist, Mike Dover, "Use of a pesticide is no substitute for prevention."

William Olkowski, Ph.D., and Helga Olkowski are co-directors of the Center for the Integration of Applied Sciences, a project of the John Muir Institute for Environmental Studies. For more specific information and a list of publications on integrated pest management, contact the Olkowskis at. CIAS, 1307 Acton Street, Berkeley, California 94706.

IPM in Modesto

The Parks and Recreation Department of the city of Modesto, California, developed an integrated pest management program for the city-owned streetside shade trees in 1976.

The program began with a weekly monitoring where key pests were determined. Studies revealed their local life cycles, natural enemies, habitat preferences, and population peaks during the season.

A quantitative sampling determined injury levels in order to plan the timing of treatments. For example, the 320 city maintained elm trees had been treated twice each season with Metasystox-R to reduce elm leaf beetle populations. Monitoring showed that only 59 elms needed one treatment in 1978. This reduced treatment 91 percent. While the number of trees requiring treatments varies from year to year, continued monitoring is expected to keep pesticide use below pre-IPM levels.

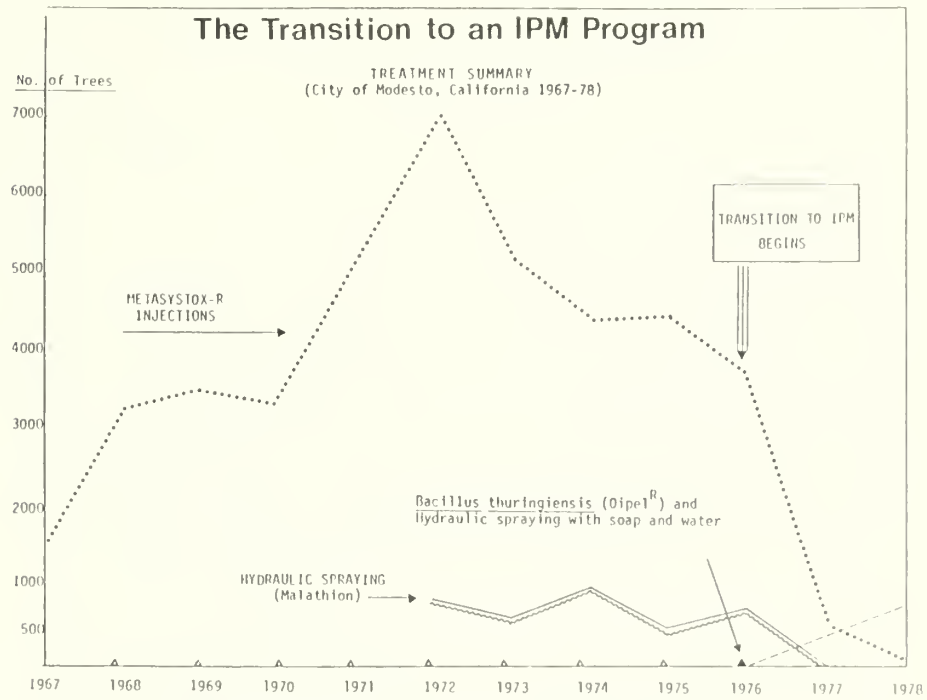
A management strategy for each key pest was developed. Over the 3-year implementation period, pesticide treatments were reduced overall approximately 99 percent, from 4,530 trees in 1976 to 59 in 1978. At the same time, citizen complaints or requests also were gradually reduced. For example, 33 percent fewer insect related service requests were received by the department in 1978 than in 1977. Repeat requests also were reduced.

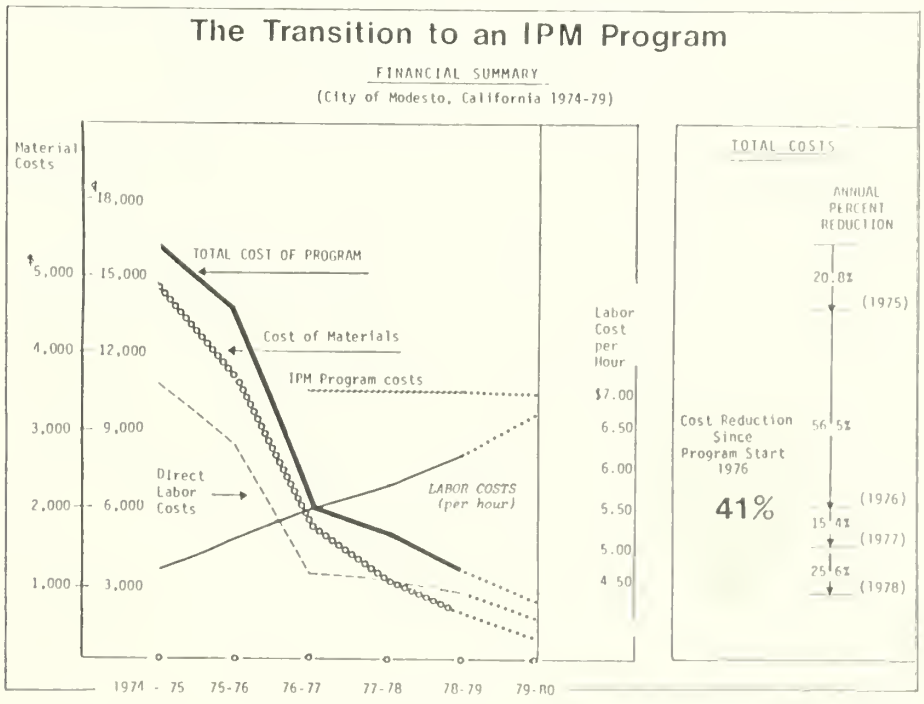
During the 3-year initiation period, although labor costs per hour were rising, total costs of the pest management decreased 41 percent.

The same pattern has been repeated in a number of cities through the use of IPM. The accompanying chart shows results of using IPM in some California cities.

TREATMENT SUMMARY

	Berkeley	San Jose	Palo Alto	Modesto	Davis
Tree population	35,000	250,000	80,000	85,000	12,000
Pre-IPM Treatments (annual average)	11,500	42,000	1,600	8,000	2,000
IPM Treatments 1977	144	3,714	314	1,115	200
Percent Reduction	99%	88%	80%	86%	90%





Recreation Opportunity Spectrum: A New Management Concept

by Thomas A. Hoots and Leon J. Buist

Primitive	Semi-Primitive Non-Motorized	Semi-Primitive Motorized
Roaded Natural	Rural	Urban

Figure 1. The Recreation Opportunity Spectrum Classes

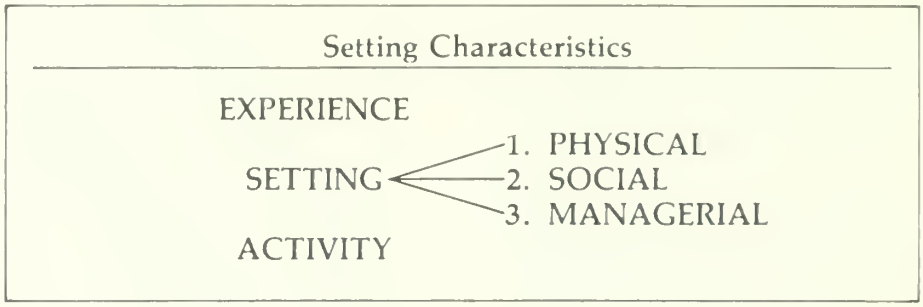


Figure 2. Components of Recreation Opportunity Classes

"Managing for recreation requires different kinds of data and management concepts than do most other activities. While recreation must have a physical base of land or water, the product—recreation experience—is a personal or social phenomenon. Although the management is resource based, the actual recreational activities are a result of people, their perceptions, wants, and behavior."

The complexity of recreation planning is well expressed in the above excerpt from the February 1979 Committee of Scientists' Report to the Secretary of Agriculture on the Forest Service Land and Resource Management Planning Regulations. Now a new concept, the Recreation Opportunity Spectrum (ROS) helps recreation managers deal with this complexity by incorporating physical, social, and managerial elements into their planning process.

Recent cooperative efforts among researchers and land managers with the Forest Service, Department of Agriculture; the Bureau of Land Management, Department of the Interior; Colorado State University; and Oregon State University have developed the ROS concepts. These concepts, a part of a total recreation opportunity planning system, provide a framework wherein the opportunities for recreation experiences can be inventoried and demand may be expressed. At the same time, these ROS concepts can make significant contributions to the land and resource management planning process, including the process of vegetation management being addressed in this issue of *Trends*.

ROS defines a range or spectrum of recreation opportunities, which the public and private sectors can provide to meet a diversity of visitor preferences. The spectrum is based on the logic that people prefer to participate in specific types of recreation activities, within certain preferred environmental settings, in order to attain those kinds of experiences that yield satisfaction. ROS incorporates this reasoning into an operational inventory system by combining all probable experience outcomes into six identifiable spectrum classes (figure 1).

The Recreation Opportunity Spectrum

The goal of all recreationists is to realize a satisfying experience. This is done by participating in a preferred activity in a preferred setting. The goal of recreation managers is to provide specific, identifiable settings within which recreationists may participate in suitable activities. The recreationists' and managers' goals, therefore, are expressed in terms of three interrelated components of recreation opportunity—an activity, a setting, and an experience opportunity.

Since the goal of recreation managers is to provide settings, they must be able to inventory and manage the setting component. To facilitate this ability to manage settings, three subcomponents are identified—the physical, the social, and the managerial (figure 2).

Composition of Recreation Opportunity Spectrum Class

The physical setting is that condition on the ground which relates to the amount of environmental modification from human activity. It is influenced largely by the degree of remoteness, the evidence of humans, and the size of the basically undisturbed areas.

The social setting reflects that condition which indicates the amount of use and social interaction—the amount of contact between individuals or groups. The social setting generally is identified by the evidence of user impact and user density.

The managerial setting provides an indication of the amount and type of administrative action taken to manage current recreation use. This is indicated by the number of user controls and their visibility.

By identifying and applying these setting characteristics, all land and

Table 1*

ROS Setting Opportunities

Primitive	Semi-Primitive Non-Motorized	Semi-Primitive Motorized
Area is characterized by essentially unmodified natural environment of fairly large size. Interaction among users is very low and evidence of other users is minimal. The area is managed to be essentially free from evidence of man-induced restrictions and controls. Motorized use within the area is not permitted. Large mammals and wildlife species which are not too tolerant of man's presence.	Area is characterized by a predominately natural or natural-appearing environment of moderate to large size. Interaction among users is low, but there often is evidence of other users. The area is managed in such a way that minimum on-site controls and restrictions may be present, but are subtle. Motorized use is not permitted. Large mammals which are not too tolerant of man's presence.	Area is characterized by a predominately natural or natural-appearing environment of moderate to large size. Concentration of users is low, but there is often evidence of other users. The area is managed in such a way that minimum on-site controls and restrictions may be present, but are subtle. Motorized use is permitted. Wildlife species mid-range between those tolerant of man's presence and those not.
Roaded Natural	**Rural**	**Urban**
Area is characterized by predominately natural-appearing environment with moderate evidence of the sights and sounds of man. Such evidence usually harmonizes with the natural environment. Interaction among users may be low to moderate, but with evidence of other users prevalent. Resource modification and utilization practices are evident, but harmonize with the natural environment. Conventional motorized use is provided for in construction standards and design of facilities. Large mammals tolerant of man's presence; those not tolerant present infrequently. Prevalence of smaller wildlife species.	Area is characterized by substantially modified natural environment. Resource modification and utilization practices are primarily to enhance specific recreation activities and to maintain vegetative cover and soil. Sights and sounds of man are readily evident, and the interaction among users is often moderate to high. Many of the facilities are designed for use by a large number of people. Facilities often are provided for special activities. Moderate densities are provided far away from developed sites. Facilities for intensified motorized use and parking are available. Wildlife species limited mostly to those tolerant of man's presence.	Area is characterized by a substantially urbanized environment, although the background may have natural-appearing elements. Renewable resource modification and utilization practices are to enhance specific recreation activities. Vegetative cover is often exotic and manicured. Sights and sounds of man, on site, are predominant. Large numbers of users can be expected, both on site and in nearby areas. Facilities for highly intensified motor use and parking are available with forms of mass transit often available to carry people throughout the site. Wildlife species restricted to those highly tolerant of man's presence.

** This table is for descriptive purposes only. Use the five specific ROS class delineation criteria to identify the actual areas to which these descriptions apply*

water in the planning area can be classified into one of the six ROS classes described in table 1. The physical, social, and managerial characteristics of the setting are used as indicators of the kinds of experiences the recreationists probably will obtain in each of the classes.

As an integral part of recreation opportunity planning, ROS enables management agencies and the private sector to manage areas for specific experience opportunity objectives. Both the Forest Service and the Bureau of Land Management have developed guidelines for using ROS in their land and resource management planning. As these federal land management agencies move forward with a uniform planning system, the public will be the benefactor because it will receive consistent information about recreation opportunity settings on the major portion of federal lands.

Table 2

ROS Activity Opportunities*

Primitive Semi-Primitive Non-Motorized	Semi-Primitive Motorized	Roaded Natural	Rural	Urban
Viewing outstanding scenery	Viewing outstanding scenery	Viewing outstanding scenery	Viewing outstanding scenery	
Enjoying unique and/or unusual environments	Enjoying unique and/or unusual environments	Enjoying unique and/or unusual environments	Enjoying unique and/or unusual environments	
Hiking	Hiking	Hiking	Hiking	
Cross-country ski touring and snowshoeing	Cross-country ski touring and snowshoeing	Cross-country ski touring and snowshoeing	Cross-country ski touring and snowshoeing	
Horseback riding	Horseback riding	Horseback riding	Horseback riding	
Canoeing	Canoeing	Canoeing	Canoeing	
Sailing	Sailing	Sailing	Sailing	
Other non-motorized watercraft use	Other non-motorized watercraft use	Other non-motorized watercraft use	Other non-motorized watercraft use	
Swimming	Swimming	Swimming	Swimming	
Diving (skin or scuba)	Diving (skin or scuba)	Diving (skin or scuba)	Diving (skin or scuba)	
Fishing	Fishing	Fishing	Fishing	
Photography	Photography	Photography	Photography	
Camping	Camping	Camping	Camping	
Snowplay	Snowplay	Snowplay	Snowplay	
Hunting (big, small game; Upland birds and waterfowl)	Hunting (big, small game; Upland birds and waterfowl)	Hunting (big, small game; Upland birds and waterfowl)	Hunting (big, small game; Upland birds and waterfowl)	
Nature study	Nature study	Nature study	Nature study	
Acquiring general knowledge/understanding	Acquiring general knowledge/understanding	Acquiring general knowledge/understanding	Acquiring general knowledge understanding	
Unguided hiking	Unguided hiking	Unguided hiking	Unguided hiking	
General information	General information	General information	General information	
		Motor-driven ice and snowcraft	Motor-driven ice and snowcraft	
	Motor-driven ice and snowcraft	ORV touring	ORV touring	
	ORV touring	Power boating	Power boating	
	Power boating		Picnicking	
		Picnicking	Gathering forest products	
		Gathering forest products	Auto touring	
		Auto touring	Downhill skiing	
		Downhill skiing	Water skiing and other water sports	
		Water skiing and other water sports	Automobile camping	
		Automobile camping	Trailer camping	
		Trailer camping	Viewing interpretive signs	
		Viewing interpretive signs	Organization camping	
		Organization camping	Lodges	
		Lodges	Resort-commercial public services	
		Resort-commercial public services	Resort lodging	
		Resort lodging		
			Competition games	
			Ice skating	
			Scooter-motorcycle use	
			Bicycling	
			Spectator sports	
			Jogging	
			Passive use of developed parks and open space	
			Outdoor concerts	

* *These activity opportunities are illustrative only. Specific additions or exceptions may occur depending upon local forest conditions.*

By using the ROS, managers can predict levels and intensity of use within particular areas.

U.S. Forest Service

Table 3
ROS Experience Opportunities*

Primitive	Semi-Primitive Non-Motorized	Semi-Primitive Motorized
Extremely high probability of experiencing considerable isolation from the sights and sounds of man, independence, closeness to nature, tranquility, and self-reliance through the application of woodsman skills in an environment that offers a high degree of challenge and risk.	High, but not extremely high, probability of experiencing the above listed primitive natural environment elements.	Moderate probability of experiencing the above listed primitive natural environment elements, except that there is a high degree of interaction with the natural environment. Opportunity is available to use motorized equipment while in the area.
Roaded Natural	**Rural**	**Urban**
About equal probability of experiencing affiliation with other user groups and isolation from sights and sounds of man. Opportunity to have a high degree of interaction with the natural environment. Challenge and risk opportunities associated with more primitive type of recreation are not very important. Practice and testing of outdoor skills might be important. Opportunities for both motorized and non-motorized forms of recreation are possible.	Probability for experiencing affiliation with individuals and groups is prevalent, as is the convenience of sites and opportunities. These factors are generally more important than the physical setting. Opportunities for wildland challenges, risk-taking, and testing of outdoor skills are generally unimportant except for specific activities like downhill skiing, for which challenge and risk-taking are important elements.	Probability for experiencing affiliation with individuals and groups is prevalent, as is the convenience of sites and opportunities. Experiencing natural environments, having challenges and risks afforded by the natural environment, and the use of outdoor skills are relatively unimportant. Opportunities for competitive and spectator sports and for passive uses of highly man-influenced parks and open spaces are common.

* *These experience opportunities are highly probable outcomes of participating in recreation activities in specific recreation settings.*

Obviously, ROS has significant implications for vegetation management. Different types of vegetation will predominate in the different spectrum classes. By using a system such as this, a manager can predict levels and intensity of visitor use within particular areas. From these predictions, appropriate levels of vegetation management and site modification, likewise, can be planned.

Thomas A. Hoots is Leader, Planning and Inventory, USDA Forest Service, Recreation Management Staff, Washington, DC; Leon J. Buist is Associate Professor of Outdoor Recreation, Division of Renewable Natural Resources, College of Agriculture, University of Nevada, Reno. This article was written while Buist was on an Intergovernmental Personnel Act appointment with the Recreation Management Staff.

How to Start a Street Tree Program

by Richard D. Marling

Community involvement and city council action preserved this heritage tree, Umbellularia Californica, by stopping construction and purchasing the tree and lot.

City of San Mateo

For over 15 years the city of San Mateo, California, has had an active street tree management program. Even Proposition 13 did not adversely affect the tree program because of its ability to meet documented needs and maintain high production and work standards.

This article summarizes how to start a similar program. The steps outlined should be used as a general guide only; each agency will have to adapt them somewhat to accommodate local climate, soil conditions, terrain, and citizen needs.

1. Establish Needs

First, assess your area to determine needs and identify particular problems. For instance, virtually every city has sections that lack trees. Many localities have old, potentially hazardous trees that require special care and training. Other places need to protect their trees from the stresses of new construction or redevelopment.

Some old trees have historical value and merit special consideration. Others may be creating problems where their roots have uplifted sidewalks, curbs, gutters, and driveways. Still others may cause traffic hazards due to improper siting or planting.

2. Develop Public Interest

The key to your success is to establish an aura of tree concern within your community. You may wish, as did San Mateo, to set up a community beautification committee to work with the Park and Recreation Commission or directly with your agency. Perhaps an arboretum society, formed with the intention of protecting and furthering knowledge about trees through education of the public, would be beneficial.

Get involved with homeowners' associations. Prepare newspaper articles on special plantings and homeowner hints. Give special talks on tree care at community gatherings. Plan Arbor Day festivities. Organize tours of treeless areas and those with good trees. Distribute handouts on arboreal beautification. All are important in building public awareness.

3. Take an Inventory

Before you can know what to do, you first must know what you have. A tree inventory ideally can be handled as part of your winter program.

Be sure that you train your personnel to record and file data properly. A system that employs block cards that note facts about the trees—such as genus, species, size, condition, location, size of rights-of-way, and obstacles like telephone poles, sidewalks, or curbs—seems to work well. Perhaps even historical analyses of the trees might be included. San Mateo has done considerable preliminary work on computerizing its tree maintenance program, but all other preliminary work outlined here first must be achieved to ensure a successful program.

4. Establish Planting and Maintenance Policies

Your inventory will pinpoint such factors as trees that are hazardous, trees that need training, damage to rights-of-way, and areas that lack trees. Once you have these details, you can begin to develop a planting and maintenance policy or program.

Again, involve local citizens' groups—the arboretum society, the beautification committee, various homeowners' organizations—to intensify the aura you are trying to establish. Input from horticulture schools can provide updated information on planting methods. Your farm advisor can give you valuable field consultation on species availability, new local varieties, and final tree selection. Check, also, with local nurseries for information on locally successful plantings.

Continual training ensures high standards of workmanship. City of San Mateo

In setting up your planting program, keep in mind that when you have a neighborhood planting program, you are developing friends of trees—although, in some cases, a neighborhood program may be more costly than planting under contract. Work out the details of your spraying system to keep your trees clean and free from pests and disease. Also, have a system of removal ready so you can quickly replant, when necessary, with younger and better trees.

5. Enact a Comprehensive and Legal Ordinance

Special expertise is needed to enact a legal ordinance. Seek professional help if you need it. Involve your staff in this step and be sure to consult with other concerned departments such as Public Works or the city attorney's office.

This comprehensive and legal ordinance is only as good as its acceptance within the community. Therefore, make sure that it is acceptable to as many people in the community as possible.

The International Society of Arboriculture has model ordinances that you can use as guidelines. Also, in my opinion, the city of San Mateo has outstanding heritage and street tree ordinances.

6. Develop a Cost Analysis

If you lack information on cost analysis, you can consult other agencies. The information you will need includes the costs of manpower, equipment operation, supporting staff, amortization, replacement of plants, and so forth. As you develop these costs, involve local tree companies and various arborists' associations, as well as interested citizens.

7. Formulate a Street Tree Master Plan

Involve as many municipal departments and local groups as possible. Analyze your city's weather, soil conditions, terrain, obstacles, and types of citizens. Make sure you consider existing trees and other plant life.

At this point, develop your master plan. You might include both an *official* list—tree species to be planted on each block—and a *pending* list of trees that exist now but which you hopefully will remove and replace. The official list should include suitable street trees. Selection of the genus, species, and variety is crucial.

The size of the available planting space becomes important, as does how the trees are to be planted. Be sure to analyze how small, medium, and large trees affect the areas in which they are planted. In some areas, linear planting is desirable; in others, impact and mass plantings may be better considering scenic views and the type of development. In congested areas, cutouts may be better than planting strips.

Gracefully spreading trees can soften and complement many structures. Tall, slender trees may be chosen for areas where view is a prime consideration, while spreading trees may be better suited for flat ranchlands.

Consistency of tree species is helpful as far as maintenance is concerned. However, be sure to use more than one kind of tree in your community to safeguard against potential disasters such as Dutch Elm Disease.

When considering flowering trees, remember that certain people have allergies to some varieties, including the acacias. Also, in selecting trees keep in mind such factors as overhead power lines, wind, sight distances, and other traffic considerations.

8. Implement the Program

As you implement your program, it helps to anticipate some of the problems and details you may en-

Special arboriculture crews maintain the street trees on public rights-of-way.
City of San Mateo

Proper training of young trees establishes future growth habits.
City of San Mateo

counter. Probably your greatest number of calls will concern routine pruning. You also will receive emergency calls. Provide a method of documenting these calls. For routine pruning, you might start in one area, then move on throughout the city, area by area, ideally within a 3-4-year pruning cycle.

Citizen requests in regard to the tree program must be considered because of their immediate need; these requests may conflict with your routine pruning program. It is important that personnel in the office know what has been done and where. A block card system that is accessible to office personnel is one of the best systems available.

You may need to have various applications which can be submitted to the department for removals, trimming, planting permits, even the designation of heritage trees. Heritage trees are those which are special because of their size and/or age. They may stand on private property.

The city of San Mateo has a Board of Zoning Adjustments—with one member from the Park and Recreation Department. This board establishes standard landscape requirements for street trees, and the planting of parking lots and public use areas. The same board also requires landscaping for all developments, except for single family, individual residences. These requirements include landscape installation and maintenance bonds for 18 months.

When considering subdivisions, weigh the desirability of monolithic sidewalks versus separate sidewalks. Also, establish a system of training personnel and inspectors in other departments on the basics regarding trees and ordinances.

Work with the developers regarding the selection, siting, and size of trees. The International Society of Arboriculture has a book on tree evaluations that you might find useful.

9. Give Your Staff Proper Training

It is essential that your staff be well trained. High standards of work must be maintained at all times for tree preservation and cost reduction.

You need to have qualified, trained office staff who can monitor a budget, keep accurate records of work accomplishments, prepare various reports, sensitively handle citizen requests (or demands), and post on block cards various information relative to street trees.

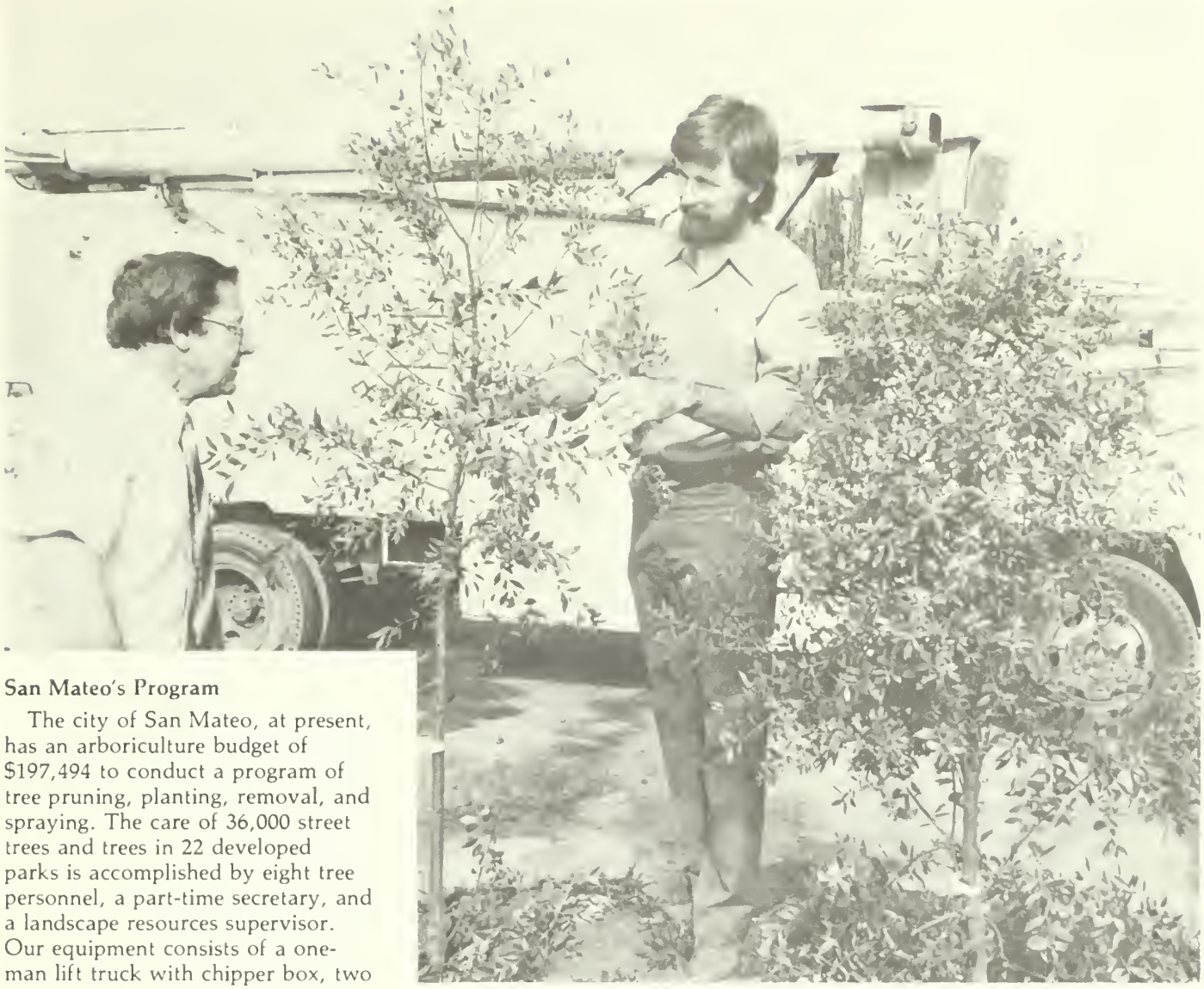
In the field operation, again the key to success is qualified, properly trained personnel. The lead person must be prepared to develop daily reports, schedule and route crews, and deal with the public. The crews must be able to handle such things as special problems, emergencies, and hazards, while keeping up their routine pruning. They must be able to handle special situations, such as trimming sycamores in the winter, and must be able to implement spraying and removal programs as well as do planting as needed.

10. Review and Analyze Your Program

Determine how the costs of your program compare to those of 1) the private sector, and 2) other agencies. Reports and cost analyses of other cities can be helpful. Second, assess your success in attaining the goals you have established.

Third, try to develop some innovation. For example, in new areas, plan to have tree planting easements farther back from the sidewalks, allowing for more root area.

Finally, analyze the possibilities and impact of various federally sponsored programs. You'll particularly want to check CETA, conservation corps, and urban forestry grant programs.



San Mateo's Program

The city of San Mateo, at present, has an arboriculture budget of $197,494 to conduct a program of tree pruning, planting, removal, and spraying. The care of 36,000 street trees and trees in 22 developed parks is accomplished by eight tree personnel, a part-time secretary, and a landscape resources supervisor. Our equipment consists of a one-man lift truck with chipper box, two 1½-ton (1.35 t) dump trucks for chips, two chippers, a stump machine, and one 400-gallon (1514 l) sprayer. We have established a policy of spraying only under heavy infestation, or for elm bark beetle in selected areas.

Major concerns of our arboriculture subprogram are:

1) *Dutch Elm Disease:* Several years ago we initiated a sanitation pruning program for our 1,300 elm trees on public rights-of-way. At the present rate of losing an average of four trees a year to Dutch Elm Disease, the impact on our budget was very light. This type of forward-looking approach has saved our taxpayers money.
2) *Street tree/sidewalk repair program* was started last year. This program consists of removal, replacement, or root pruning trees and relocating broken sidewalks to better accommodate tree roots. Poor trees, or those with poor root systems, are removed and replaced. Large or historical trees are saved if at all possible.
3) *Cost* is a major concern for us as it is for all municipalities. Three years ago a two-block-long area was put out to bid. After establishing an hourly cost for men and equipment (plus overhead), the city, along with private tree companies, bid on the job. The city of San Mateo was low bidder, and completed the project ahead of schedule, saving the taxpayers considerable money.

The above illustrates the importance of having well-trained personnel equal to or better than that of the private sector, to keep budgets low. Citizens seeing high standards of work also tend to keep their private trees cared for accordingly. The end results are better, bigger, and healthier trees for the entire community.

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Managing Recreational Fields of Turfgrass

by John R. Street

A major difference in maintaining turfgrasses for functional and ornamental purposes as opposed to recreational or sport purposes is the degree of traffic. Recreational and sport sites are people oriented. People oriented activities on turfgrass areas imply traffic.

Two major problems associated with traffic on turfgrass sites are wear injury and soil compaction. As traffic intensity increases on sport facilities, there is usually a corresponding increase in both wear injury and soil compaction. Sport facilities are becoming overused as school enrollments increase and as young people and adults of all ages become more interested in athletics and physical fitness.

Turfgrass selection for sport facilities must be based on several key factors including environmental adaptation, intensity of culture, wear tolerance, and recuperative potential. The principal cool-season turfgrasses used on sport turf in the Midwest include Kentucky bluegrass, perennial ryegrass, and tall fescue. Bermudagrass is used to some extent in the South and the southern portion of the Midwest. Whichever type is chosen, soil compaction problems can be minimized by insuring good surface and subsurface drainage and by using various cultivation techniques.

TURFGRASS SELECTION

- Kentucky bluegrass.

Adapted to a wide range of environmental conditions, Kentucky bluegrass provides an attractive turf under proper cultural conditions. Kentucky bluegrass exhibits good wear tolerance and recuperative potential. It forms a strong sod that does not tear, slip, or lift easily under the twisting and turning action of foot traffic. Kentucky bluegrass also provides a resilient surface that aids in reducing injury in contact sports.

Many cultivars of Kentucky bluegrass are available. They differ widely in characteristics such as the shade of green, texture, density, environmental and cultural adaptation, and disease susceptibility. The cultivars of Kentucky bluegrass fall into two general groups, those susceptible to Helminthosporium leafspot and those resistant to it.

Cultivars susceptible to leafspot include Park, Kenblue, Delta, and Newport. Helminthosporium organisms cause leafspot and melting-out, both of which are serious disease problems of Kentucky bluegrass in the Midwest. These diseases tend to occur more readily on heavily fertilized turf that is closely mowed.

Good performance can be expected from these cultivars if they are not overfertilized, particularly in the spring, and if they are mowed at a height of 2-2½ inches (5-6.35 cm). Close mowing, high fertilization, and supplemental irrigation are considered advantageous in maintaining good sport turfs. Thus, a dichotomy exists between the use of these latter Kentucky bluegrass cultivars and maintenance regimes to sustain high quality sport turf. In addition, these latter cultivars are not as inherently aggressive or vigorous as some of the newer, improved Kentucky bluegrass cultivars.

Cultivars resistant to leafspot include most of the newer or improved strains such as A-20, A-34, Adelphi, Baron, Bonnieblue, Cheri, Glade, Majestic, Parade, Touchdown, and Victa. These resistant cultivars perform best under a medium to high cultural intensity. Some can tolerate mowing heights of less than 1 inch (2.5 cm). These cultivars are recommended for sport turf areas where medium to high quality is desired or aggressiveness and recuperative potential are essential.

Blending of varieties is a recommended practice when seeding Kentucky bluegrass. A blend is a combination of several cultivars within a species. A combination of 2-4 cultivars is suggested. Unlike a single cultivar, blends provide greater genetic variability, which improves disease resistance and the general adaptation of the turf under differing environmental conditions. Blending superior cultivars allows the desired features of each component to be incorporated while reducing the effects of specific weaknesses on general turfgrass quality.

The performance of any cultivar or blend of cultivars will depend to a large extent on how intensive the culture is. Many cultivars of Kentucky bluegrass perform well when cultured at a moderate intensity. However, as the cultural intensity is increased or decreased, fewer cultivars are well-adapted.

Cultural studies at the University of Illinois using A-20, Fylking, Kenblue, Merion, Nugget, Pennstar, and Windsor indicate that the quality of turfgrass is largely effected by disease incidence, which is related to the mowing height and fertilization rate. For example, low nitrogen rates, especially on closely clipped turf, increase the tendency for the infestation of dollar spot. High nitrogen rates and close mowing, especially during the spring, favor the incidence of Fusarium blight and Helminthosporium leafspot on susceptible cultivars.

In 1975, a study was initiated at Illinois to evaluate the performance of 21 cultivars of Kentucky bluegrass under different cultural intensities (Table 1). After four years, the results of this study indicate that the cultivars vary widely in their adaptation to different cultural regimes. The amount of annual bluegrass invasion is a good indicator of the adaptability of a cultivar to a particular cultural intensity. Brunswick, A-34, and Touchdown are superior at the highest cultural intensity. These cultivars had less than 10 percent annual bluegrass. Most of the cultivars performed well at the intermediate cultural intensities. For example, Glade and Parade had 78 and 47 percent annual bluegrass, respectively, at the highest cultural intensity; whereas, annual bluegrass was only 7 and 8 percent, respectively, at a more moderate cultural intensity (Table 1). Aquilla, Vantage, Birka, and Code 95 provided fair quality and appeared to be better adapted to the lowest cultural intensity. This information suggests that the selection of specific cultivars for blends should take into account the relative performance of Kentucky bluegrass cultivars at the specific cultural intensity intended on the planting site.

Table 1. Annual bluegrass infestation of several Kentucky bluegrass cultivars under several cultural intensities.[1]

Cultivar	Cultural Intensity[2] A	B	C	D
	— % Annual bluegrass —			
A-20	83	21	13	0
A-34	8	0	6	1
Adelphi	47	22	22	12
Aquilla	88	23	12	12
Baron	90	20	15	9
Birka	93	14	18	0
Bonnieblue	63	22	11	4
Brunswick	7	1	1	0
Cheri	82	5	10	5
Glade	78	9	7	0
Majestic	82	33	20	5
Merion	70	9	13	3
Nugget	83	13	22	10
Touchdown	10	4	1	0
Parade	47	2	8	0
Pennstar	92	35	23	18
Sydsport	48	8	7	0
Vantage	88	32	22	18
Victa	57	18	22	8

[1]*Annual bluegrass percentage was determined 4 years after the initiation of treatments.*

[2]*Cultural intensities: A — mowing height at ¼ in. and 8 lb N 1000 sq. ft*
B — mowing height 1½ in. and 8 lb N 1000 sq. ft
C — mowing height ¼ in. and 4 lb N 1000 sq. ft
D — mowing height 1½ in. and 4 lb N 1000 sq. ft

• **Perennial ryegrass** *(Lolium perenne).*

The cultivars of perennial ryegrass available prior to the late 1960s were not compatible in mixtures with Kentucky bluegrass or acceptable alone for high quality turf. These older cultivars exhibited an upright growth habit, low density, coarse texture, poor mowing quality, short persistence, and light green color.

During the late 1960s, cultivars referred to as improved, turf-type, fine-leaved perennial ryegrasses were released. Manhattan and Pennfine were two of the first cultivars described as turf-type perennial ryegrass. Additional turf-type perennial ryegrasses on the market today include Birdie, Blazer, Citation, Caravelle, Dasher, Derby, Diplomat, Fiesta, Loretta, Omega, Pennant, Regal, Yorktown, and Yorktown II.

These new cultivars are referred to as "turf-type" because of their higher turf density, improved mowing quality, longer persistence, better disease resistance, slower rate of vertical shoot growth, darker color of green, and finer leaf texture than the older perennial ryegrass cultivars like common and Linn perennial ryegrasses. These turf-type perennial ryegrasses have challenged the traditional image and use considerations of perennial ryegrass and increased its acceptability.

A traditional advantage of perennial ryegrass is its quick germination and establishment rate. Perennial ryegrass can germinate within 5 days with favorable moisture and temperature. A good turfgrass cover should develop within 3-4 weeks under optimum weather and maintenance conditions.

The rapid establishment characteristics have made the perennial ryegrasses extremely desirable where quick cover is needed for soil stabilization, repair of damaged athletic fields and golf course tees, temporary cover during unfavorable growing weather, and customer satisfaction. Perennial ryegrass commonly is used for annual overseeding on sport turf, such as tees and athletic fields, where heavy traffic and continual use limit the time needed to establish other cool-season turfgrasses.

In addition, the plant vigor of the turf-type perennial ryegrasses enhances their establishment success under adverse moisture conditions, within thatch, and in moderately compacted soils that normally result in failure for other species. Under these less than optimum growing conditions, perennial ryegrass sometimes is used as an annual or semi-permanent turfgrass. The improved characteristics and rapid establishment also make the turf-type ryegrasses good competitors against annual bluegrass in overseeding programs. Indeed, the turf-type perennial ryegrasses commonly are confused with Kentucky bluegrass.

The rapid germination and vigorous seedling growth of perennial ryegrass is a concern in species mixtures due to ryegrasses' potential domination if it is seeded too heavily or comprises too high a weight percentage of the mixture. In Illinois studies, combinations of Kentucky bluegrass and perennial ryegrass at different percentages by seed weight (such as 5, 10, 15, 20, 25, or 50 percent perennial ryegrass) yielded different proportions of the two species, varying with cultivars selected. For example, A-34 Kentucky bluegrass was more competitive than Fylking. Pennfine perennial ryegrass was more competitive than Citation. The differences were most striking at the 5-percent level of perennial ryegrass in the seed mixture. After 3 years, the Pennfine-Fylking mixture was nearly 50 percent perennial ryegrass, while the A-34 Citation mixture was less than 5 percent perennial ryegrass. Less than 20 percent perennial ryegrass occurred in stands resulting from 50:50 mixtures of A-34 and Citation by seed weight. Thus, where Kentucky bluegrass predominance is desired, the selection of less aggressive perennial ryegrass cultivars and more aggressive Kentucky bluegrass cultivars should be considered.

A general standard has been to include 10-20 percent ryegrass in Kentucky bluegrass mixtures for establishment. The final percentage of perennial ryegrass, however, will vary depending on both the perennial ryegrass and Kentucky bluegrass cultivars selected. In contrast, the more aggressive perennial ryegrass cultivars may be a better choice for overseeding programs on established turfgrass sites.

Wear tolerance of the turf-type perennial ryegrasses is considered good to excellent. Mixed with Kentucky bluegrass, these cultivars are performing satisfactorily on sport turfs and other areas of heavy traffic and in overseeding programs on sport turfs. The recuperative potential and surface-matting characteristics of perennial ryegrass, however, fall below that of Kentucky bluegrass. Recent research indicates that perennial ryegrass does not exhibit the lateral healing potential of Kentucky bluegrass (Table 2).

Table 2. The 50-day lateral growth recovery of several Kentucky bluegrass and perennial ryegrass cultivars during the summer of 1975.

Cultivar	Portion of Artificial Divot Healed
	— % —
Merion	89
Baron	82
Kenblue	75
Derby	30
Manhattan	27
NK-200	13

Hall, J. R. 1978. The Perennial Ryegrasses—Understanding Their Capabilities and Limitations. 1978 Ohio Turfgrass Conference Proceedings.

The tillers of the turf-type perennial ryegrasses grow in a semiprostrate fashion. Several cultivars have been observed to produce subsurface tillers that emerge from the soil several inches from the parent plant. This semiprostrate growth habit is one characteristic that enables perennial ryegrass to tolerate somewhat lower mowing heights than Kentucky bluegrass. They appear to tolerate mowing heights of ½ inch (1.27 cm) during the cooler periods of spring and fall and ¾-1 inch (1.9-2.5 cm) during the summer. The mowing quality of the turf-type perennial ryegrasses, however, is not quite equal to Kentucky bluegrass, especially during the months of June, July, and August. Loretta appears to exhibit the best mowing quality characteristics during cool weather.

Additional disadvantages of perennial ryegrass that have been observed under research and field evaluations are: Disease susceptibility, poorer summer and winter hardiness relative to Kentucky bluegrass, and lack of long-term drought tolerance. These latter factors are considered the major drawbacks to the use of perennial ryegrass monostands.

The perennial ryegrasses are inherently weak against the *Pythium* and *Rhizoctonia* diseases. Pythium blight is a serious threat to seedling stands of perennial ryegrass and established stands during hot weather, especially in low or wet areas. The Rhizoctonia brown patch disease, favored by warm, humid weather and high nitrogen fertility, can frequently cause serious damage to perennial ryegrass. Brown patch has been observed to cause serious thinning of perennial ryegrass stands in southern Illinois. Information from Rutgers University indicates that some perennial ryegrass cultivars are less susceptible to brown patch than others. The turf-type perennial ryegrasses also are susceptible to dollar spot, snow mold, red thread, rust, and leafspot.

The summer heat tolerance, drought tolerance, and winter hardiness of the turf-type perennial ryegrasses are considered to be below that of Kentucky bluegrass. In general, the newer perennial ryegrasses have exhibited good short-term drought tolerance. Initial evaluations suggest that they have less ability to withstand a prolonged drought than Kentucky bluegrass.

Some of the turf-type ryegrasses showing significant improvements in heat tolerance and summer performance are Pennant, Citation, Pennfine, Birdie, Yorktown II, Diplomat, Omega, Fiesta, Dasher, Blazer, Derby, and Regal. Those ryegrasses exhibiting significant improvements in winter performance include Manhattan, Yorktown II, Yorktown, Omega, Loretta, and Diplomat (1, 3). In Illinois trials, Manhattan has performed best during the cool periods, and Pennfine has performed best during the warm periods.

• **Tall fescue** *(Festuca arundinacea).*

Tall fescue traditionally has been used as a low maintenance turfgrass in the Midwest. It tolerates soils of low fertility and has excellent resistance to summer heat and drought. Tall fescue's ability to tolerate low maintenance regimes and its excellent wear tolerance make it a possible choice for low maintenance athletic fields and other recreational sites.

For acceptable turf quality, a heavy seeding rate of 6-8 pounds (2.72-3.63 kg) per 1,000 square feet (9 m^2) is recommended. This will produce a dense turf that helps to compensate for the lack of rhizomatous and stoloniferous growth. Tall fescue is prone to low temperature injury, which is a major drawback to its use in the cooler portions of the cool humid region. "Kentucky 31" tall fescue is the most widely available and acceptable tall fescue cultivar presently available.

• **Bermudagrass** (*Cynodon* spp.).

Bermudagrass is a warm-season turfgrass used frequently for sport facilities in the southern United States. Bermudagrass provides a good playing surface for athletic fields because of its excellent wear tolerance and recuperative potential. Bermudagrass dormancy in the fall and early spring can result in thinning of athletic turfs subject to concentrated traffic at these times. The heat and drought tolerance of the bermudagrasses are excellent, but poor cold tolerance has severely limited its widespread use in the southern portions of the Midwest. Midiron is the cultivar with the best winter hardiness. Tiflown, Tifway, and Tufcate are bermudagrass cultivars that are utilized on athletic fields in the southern United States.

MAINTENANCE OF TURFGRASS

Whatever type of turfgrass is selected, certain maintenance procedures will help preserve its quality and prevent common problems.

Overseeding of New Grasses

Football fields commonly are overseeded with new grasses in the fall after play has been completed or in the early spring. Planting methods presently used for overseeding or introducing new grasses onto sport facilities include broadcast seeding following vertical mowing and/or core cultivation, and slit or disc seeding. Whichever overseeding method is chosen, in the site preparation it is critical to expose sufficient soil to provide a good seedbed for germination and maximum seedling survival.

A common mistake in renovation operations is seeding on or within the thatch layer. Thatch—organic matter layer at the soil surface—is a poor growing medium not only for established turf but also for young turfgrass seedlings; it has poor moisture-retention characteristics compared with soil, and repels water readily once it becomes dry. Thus, the moisture characteristics of thatch are undesirable for seedling survival. Seeds distributed on or within thatch may germinate, but they commonly die during the initial seedling stage because of inadequate moisture availability. *Thus a cardinal principle in renovation is to reduce and penetrate the thatch layer to expose the underlying soil for seed or vegetative materials.*

- *Vertical mowing and core cultivation.*

Vertical mowing (dethatching)—cutting into the turf and physically removing excess vegetation and organic debris—may require several passes over an area before sufficient dead vegetation and thatch are removed to ensure proper seed-soil contact. Thatching machines should be adjusted to cut through the thatch and loosen or penetrate the underlying soil to a depth of ¼-½ inch (0.635-1.27 cm) or more. The best solution to serious thatch problems may be to remove the turf with a sod cutter and reestablish grass on the bare soil.

PERENNIAL RYE GRASS

GIANT RYE GRASS

Vertical mowing is commonly preceded or followed by core cultivation. Spoons or tines are inserted into the soil, and soil cores 2-4 inches (5-10.16 cm) long are brought to the soil surface. The soil cores are broken up by a light dragging or vertical mowing of the area. The loosened soil material is distributed across the soil surface and introduced into any remaining organic debris that might be present at the surface. It acts as a light topdressing, further enhancing seed-soil contact. Core cultivation alone usually requires at least 8-10 passes over an area to disturb the soil sufficiently before overseeding.

- *Slit or disc seeding.*

Seeders that provide for vertical mowing and seeding in one operation now are available. These devices have vertical slicing knives in front to remove excess vegetation and loosen the soil surface. Next, free-rotation coulters cut slits into the existing sod. Seed then is dropped into the slits through seed distribution tubes.

This method, referred to commonly as slit or disc seeding, is an excellent method of assuring good seed-soil contact and is very efficient in terms of labor and seed requirements. An obvious advantage is that overseeding can be accomplished with minimal disturbance to the turfgrass area. The success of this method is reduced where too much thatch exists or where soil compaction is severe.

The best time for turfgrass overseeding in the Midwest is during the late summer to early fall. Temperature, moisture, and water loss rates are highly favorable for germination and seedling survival at this time. Sport and recreational turfs that are under intensive use during the fall period should be overseeded as early in the spring as possible. Late fall overseeding of cool-season grasses has proven successful on most midwestern athletic fields.

Suggested seeding rates for broadcast and disc seeding of Kentucky bluegrass blends are 2-3 and ½-1 pounds (0.9-1.36 and 0.23-0.45 kg) of seed per 1,000 square feet (92.9 sq cm), respectively. Dragging or raking the area following seeding is

recommended to cover seeds and to try to carry seeds into slits or holes produced by vertical mowing or coring. The area then should be thoroughly irrigated to a depth of 6 inches (15.24 cm) and surface moisture maintained during the germination and establishment periods. Nitrogen fertilizer can be applied lightly 3-5 weeks after seeding to enhance the establishment rate. Activity should be limited on the renovated area for at least 4-6 weeks after overseeding.

Soil Compaction

Compaction is one of the main problems of athletic field turf. Compacted soils are characterized by poor aeration and drainage, low water-infiltration capacity, shallow root growth, and reduced turf quality. Such soils are typically dense clay that has been subjected to concentrated traffic.

Soil compaction can be reduced by mechanical cultivators that create openings into the underlying soil, thus facilitating the movement of air, water, and nutrients. Cultivation should be practiced during cool weather, when an extended period of active growth follows. Two principal types of mechanical cultivators are coring machines (aerators) and spikers.

Coring machines remove small soil cores, ¼-1 inch (.635-2.5 cm) in diameter, and deposit them on the surface of the turf. The cores then are broken up and distributed uniformly over the turf by a heavy steel mat or section of chain-link fence. The soil should be moist, but not wet, during the coring operation, so that the hollow tines can penetrate the soil to their maximum depth of 2-4 inches (5-100 cm).

Spikers and slicers employ solid knives, which create narrow openings in the lawn. While not as effective as coring machines for reducing soil compaction, they may improve turf quality.

Soil Drainage

The accumulation of excess water on athletic fields increases the tendency for soil compaction, reduces field playability, and increases the possibility of serious player injury. Proper surface and subsurface drainage will reduce maintenance problems and maintenance costs. On sand fields, drainage of excess surface water will usually be sufficient. On heavy soils such as silt and clay, surface (contouring) and subsurface (tiling) drainage techniques are usually necessary.

Effective surface drainage is most important on athletic fields constructed on heavy soils. Good contouring of the surface will aid substantially in reducing compaction by providing rapid removal of excess surface water. Football fields should be designed to provide a 12-18-inch (30-45-cm) crown sloping uniformly from the center of the field to the sidelines. Tile lines should be placed along the sidelines with catch basins appropriately located to remove water rapidly. Soccer and baseball fields should be constructed with a crown having a maximum of 1 percent slope to sidelines. Tile lines and catch basins also can be used to ensure rapid water movement. Baseball outfields should be graded to a 1 percent slope from the center in all directions.

Subsurface drainage consists of installing tile lines below the soil surface to aid in percolation or movement of water to deeper soil levels. On heavy soils, tiling may be of little value because the surface compaction impedes water movement into the tile lines. Heavy soils must be modified with sand or other coarse material if subsurface tile drainage is to work properly.

Inadequate drainage on existing fields built on heavy soils may be improved by placing vertical trench drains within the field and along the sidelines. The slit trench technique involves a trench 2-3 inches (5 to 7.5 cm) wide and 2-4 feet (61-122 cm) deep. A vertical column of gravel or coarse sand is placed in the trench and filled to the soil surface, which is left open. Tile lines can be placed at the base of the slit trench to insure rapid water movement. Skinned baseball fields also can be sanded to enhance surface drying; apply the sand lightly to the soil surface. On low maintenance fields, trenching and sanding will be more economic alternatives to reconstruction.

In conclusion, the degree of maintenance on athletic fields is dependent to a large extent on proper turfgrass selection, cultivation, and adequate drainage. Properly adapted turfgrasses will better withstand player traffic and therefore persist for a longer period of time. Overseeding periodically will help to strengthen the stand. Timely cultivation and good drainage will ensure an adequate soil environment for healthy grass growth and maximum quality.

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Evolution of a Policy for Vegetation Management

by John Nicoles

The East Bay Regional Park District is an independent, property-tax-supported, special purpose government, which provides generally large-scale parks to Alameda and Contra Costa counties on the eastern shore of San Francisco Bay. Today the park district's political boundaries encompass close to 1,000 square miles (2,600 sq km) in which the district operates over 50,000 acres (20,350 ha) of parkland in 42 separate units ranging in size from just under 50 to nearly 6,000 acres (20 to 2,400 ha). In addition, a number of interpark trails serve to stitch the parks together.

The topography of the park district is generally aligned on a northeast/southwest axis. Along the western edge is the San Francisco Bay shoreline. To the east lies a strip of gradually rising piedmont ranging in width up to 2 miles (3.2 km). From the east of the piedmont rises a ridge of hills, generally to about 1,200 feet (365 m) in elevation, but with individual peaks in excess of 2,000 feet (609 m). In its midportion, this ridge is referred to as the "Berkeley-Oakland Hills," after the cities that occupy its western slopes and the majority of the piedmont below.

East of the Berkeley-Oakland Hills lies a series of north-south ridges and intervening valleys of various sizes, which shelter a number of interior towns and cities. East of these ridges, and beyond the park district's eastern boundary, lies California's famous central valley.

Early Efforts

Even before the park district existed, rudiments of a vegetation management policy for the area could be seen in a document known as the "Olmstead-Hall Report."

Prepared in 1930 by Ansel Hall, then chief naturalist for the National Park Service, and Frederick Law Olmstead, Jr., the report recommended that some 10,000-11,000 acres (4,000-4,400 ha) of surplus public watershed lands in the Berkeley-Oakland Hills be used for parks, and that:

> the greater part of the proposed park be retained in its present attractive 'natural' condition. By carefully planning the management of its forests and open grasslands the area can year-by-year be made more attractive for park purposes at comparatively low costs, provided the vegetation native to the region is protected or re-established where necessary.

One of the administrative possibilities suggested in the report was the establishment of a special purpose agency to acquire this surplus land and administer it as parkland. Thus, the East Bay Regional Park District was born.

In 1940, the park district prepared a master plan—its first formal effort to define its directions and, among other things, establish a vegetation management policy. The technical staff employed on the plan included a landscape architect, an engineer, a draftsman, and a forester. This technical staff was assisted by representatives from the National Park Service and the Civilian Conservation Corps. Evidently there were no public hearings.

The 1940 master plan consisted of five segments: a generalized development outline and four specific plans, one for each of the district's four parks—Tilden, Temescal, Roundtop, and Redwood. A General Fire Plan, prepared by the Park Service in 1936, was included, as was the Olmstead-Hall Report.

The development outline established that Tilden Park and Temescal Park were to be developed for intensive recreational use, while Redwood Park and Roundtop Park were to be retained in a more primitive state. Under the heading "land status," the outline stated:

> The Master Plan contemplates the preservation of typical California landscape, the natural park values, and the protection of the flora and fauna which are so commonly destroyed by the advance of civilization.

Freeze-damaged eucalyptus 18 months after freeze. Sprouting has occurred on some trunks; others are dead to ground level.

John Nicoles

Aerial view of Robert Sibley Regional Preserve 5 months following freeze. Cleared "fuel break" in mid-ground. Damaged eucalyptus in background is a serious fire hazard.

◀ John Nicoles

Regarding Redwood Park, the plan noted:

> In the northeasterly or upper end of the valley there are about 300 acres (120 ha) which were planted some years ago to eucalyptus. The variety used is quite tender and many of the original trees have been killed by frost and snow. In their place have sprung up dense second and third growth which in its present state creates a fire hazard. It is proposed to gradually eliminate these trees and replant with Monterey Pines and Redwoods in the canyons, and Live Oaks.

The 1940 master plan appears to have contained no provisions for updating. In retrospect, this was an interesting omission, for the plan stood as the only official park district master plan until the end of 1973.

During the 1960s, substantial acquisitions and annexations more than doubled the park district's land. In spite of dramatic increases in property tax income, the costs of new acquisitions, necessary development, additional staff, and general inflation threatened to surpass the park district's income. By the end of the decade, a tax levy increase was clearly necessary. In authorizing the levy, the California State Legislature withheld a portion of the requested increase pending the district's submission of a new master plan that "spelled out its acquisition and development goals."

Master Plan

Although the resulting 1973 master plan is oriented primarily toward land acquisition and development, certain acquisition policies affect vegetation management. The plan recognized that the park district must categorize parks to ensure acquisition of an appropriate mix of park types.

In defining the categories, reference is made to the vegetation of the parklands and the objectives for vegetation management. Regional parks, wildernesses, and preserves are to have a high percentage of "natural" open space (extensive use areas), while regional recreation areas and shorelines are candidates for more intensive recreational development.

In addition, the 1973 master plan establishes the following park planning sequence:

1) *A (pre) Acquisition Analysis*—to ensure compliance with acquisition guidelines.
2) *A Resource Analysis*—in which significant natural resources are identified and "a potential plan for vegetation and wildlife management" is prepared.
3) *A Land Use-Development Plan*—in which the general land uses and the boundaries between intensive and extensive use areas are established.
4) *A Capital Improvement Plan.*

Thus, the master plan provides for identification of and planning for significant natural resources before capital improvements are made. The general guidelines for extensive use areas remain similar to those of 1940, emphasizing "natural" vegetation, with associated intensive use areas blending into their natural surroundings.

Sharper Focus on Vegetation

The 1973 master plan was the product of 3 years' work from 1971 to 1973. During December 1972, in the middle of the planning process, the Bay Area experienced a natural event which forced the park district to focus more closely on its vegetation policies. A severe week-long freeze left considerable vegetation damage. Many desert and tropical landscape plants were destroyed, and throughout the Berkeley-Oakland Hills the eucalyptus crowns all turned brown.

In light of California's "Mediterranean" climate, this destruction took on ominous significance. Summer drought and hot, dry, east winds that blow in the late summer and fall, traditionally leave the area vulnerable to wildfires.

Understandably, both official and popular concern grew about the magnitude of the fire hazard which the apparently dead eucalyptus crowns would represent when the late summer fire season arrived. After considerable political discussion, the federal government agreed to fund the removal of a 300-foot wide (90 m) band of eucalyptus from the crest of the Berkeley-Oakland Hills. This created a "fuel break" between the residential areas on the western slope and the forested lands to the east.

Power Wagon 6—a typical Park District off-road fire truck. Dependence on off-road equipment can be reduced by a vegetation mosaic and a fire control support system that anticipates and mitigates the spread of fire.
John Nicoles

Sprouting has occurred on trunks and main limbs of both trees. Larger tree represents a serious limb fall hazard along the road.
John Nicoles

For practical purposes, the project virtually cleared 300 acres (127 ha) of parkland. Subsequently, the park district elected to make further removals from interior areas to break up the continuity of the eucalyptus forests, and to create protective zones around park facilities. Thus, massive vegetation changes were made in a significant portion of the park district. Accordingly, in September 1974, the Park District Board of Directors requested that vegetation management plans be prepared for the four parks effected by these changes. A planning team of 12 staff members was formed, representing the fields of interpretation, landscape architecture, forestry, fire control, and park operations. The team was assisted by six individual consultants representing the same general disciplines.

By the time the planning team started work, the 1973 master plan had been completed, adopted, and published. Review by both team members and consultants made it clear that more detailed policy regarding vegetation management objectives would have to be developed to supplement the master plan's broad references to "natural" conditions.

To What Extent "Natural"?

The concept of a "natural landscape" has both popular and scientific definitions. Both definitions attempt to describe a landscape that has not been disturbed by man. The scientific approach is to identify the biotic community which actually would occur on a given site without man's influence. The popular approach is less concerned with biological correctness than with the appearance of an undisturbed condition; a popular natural landscape typically would be described as the absence of symbols (such as structures, roads, or machinery) of human presence.

While the scientific and popular concepts of "natural" may be complementary, they often conflict. One source of conflict arises from the fact that some level of human activity must be accepted as natural, but the appropriate bounds on that activity are quite subjective.

A second, and perhaps major, source of conflict between the popular and scientific viewpoints arises when the existing vegetation is not the agreed upon natural landscape, and re-creation is necessary. This occurs frequently due to such human influences as introduction of plant species, reduction of native wildlife habitat, and fire suppression policies. The re-creation process disrupts the existing, apparently undisturbed condition, and upsets proponents of the popular view.

In spite of these problems, a biologically correct landscape does offer a major benefit: it is composed of indigenous species; that is, plant varieties which have evolved in association with the local climate, diseases, and pests. Indigenous plants are more resistant than introduced ones to occasional local peculiarities such as weather extremes. Therefore they are less susceptible to large-scale damage. The eucalyptus damage resulting from the 1972 freeze is a case in point.

In preparing the vegetation management policy, the park district planning team attempted to integrate both biological and popular considerations within the overall concept of "natural" as suggested by the 1973 master plan. The effort was made to emphasize scientifically based decisions, while recognizing the realities of a public agency functioning in a popularly oriented society.

Underlying Philosophy

It is the park district's philosophy to provide front-line managers with necessary resources (including information) and allow them to make the decisions in running their assigned parks. Therefore, few of the policies are written as strict rules. In most cases room is left to apply local judgment. To assist that judgment, the biologic principles behind the policies are discussed at considerable length, so that the policy document can serve as a vegetation management text—hence, the document's title: "Vegetation Management *Principles* and *Policies*" (emphasis added) for the East Bay Regional Park District.

added). The chapter on fire control is included here to illustrate the principles/policies format used.

The major objectives of the vegetation management policies are to create and maintain natural or naturally appearing vegetation, to minimize buildups of vegetation that would constitute undue fire hazards or maintenance problems, to provide animal habitat, and to support recreational use of the land.

One section is devoted to a biologically sound definition of indigenous vegetation and establishes a policy of favoring indigenous vegetation in both planting and removal projects. While the park district may engage in some large-scale conversion work, it is recognized that gradual changes are less disruptive, both biologically and popularly. In deference to this principle, as well as to economics, it is anticipated that most vegetation changes will be made on an opportunity basis when some other circumstance demands that plants be removed or added. The purpose of the vegetation policy is to direct the district toward a biologically sound landscape whenever an opportunity arises.

Evaluation

Has the adoption of "Vegetation Management Principles and Policies" been effective? Yes, no, and it's too early to tell. By the time the policies were adopted in November 1976, the park district's planning department had initiated use of the planning sequence established in the 1973 master plan. The sequence (except for the acquisition analysis) was to be applied to existing, as well as new, parks. Overall resource management planning thus was incorporated into the larger planning process, and no vegetation management plans for individual parks were ever completed by the planning team. The policies that the team developed, however, have become an integral part of the district's planning process. In this regard, the policy has been effective.

In the field, where the day-to-day decisions are made, there is evidence that the document has not been widely read or understood. It is apparent that employee awareness and understanding could be improved by instituting some form of training sessions. In this regard, the policy appears less effective than desired.

Finally, the kinds of changes the district would like to effect will require decades (at least) to accomplish. For this reason, the final analysis cannot be made for a long time.

John Nicoles is a registered professional forester in the state of California and Land Management Specialist for the East Bay Regional Park District. He was coordinator and the principal author of "Vegetation Management Principles and Policies." Copies of "Vegetation Management Principles and Policies" are available for $2 each from the East Bay Regional Park District, 11500 Skyline Boulevard, Oakland, CA 94619.

Vegetation Fire Control at East Bay

From "Vegetation Management Principles and Policies," East Bay Regional Park District.

1. **Background and General Principles.**

   Although a prime visual, habitat, and recreational resource, vegetation is also a prime fire hazard. While this hazard cannot be eliminated (short of eliminating most of the vegetation), proper design of the vegetation mosaic can simplify wild fire suppression and minimize the probability of a major wild fire developing. The principles involved relate to well-understood fire behavior and established suppression techniques.

   a. *Heat rises; the heat rising from a fire dries out and preheats the fuels located above (uphill from) the fire.* For this reason, fire moves much more rapidly up a hill than it does across or down a hill. Often it is nearly impossible to suppress a fire on its uphill edge until it reaches the top of the hill and the terrain flattens out. It is a common firefighting practice to stage fire suppression efforts along ridge lines, without attempting to suppress the fire on the hillside.

   b. *Fuel (vegetation) type influences the character of a fire.* Light fuels (grass, leaves, small twigs) are more easily ignited and burn faster than heavier fuels (large limbs, tree trunks); however, they generally generate less heat. A fire in ground level fuels is more accessible for suppression efforts than a fire in high brush or treetops. Although fire can spread

from airborne burning particles, it most commonly spreads (either vertically or horizontally) through continuous fuel.

c. *Fuel moisture influences the character of a fire.* Vegetation which requires little moisture is generally dryer and more flammable than species which are green and moist all year round. The relationship between vegetation and topography means that south- and west-facing slopes are generally the most flammable.

d. *Winds influence fire behavior.* Wind can drastically increase the intensity of a fire by force-feeding oxygen to the combustion process just as a bellows does. Wind also carries heat from the fire to non-burning fuel, drying it out, and preheating it so that it ignites and burns more easily when the fire reaches it.

When a wind develops which blows into an already burned area, it becomes a major aid in extinguishing the fire. A strong wind can overcome a fire's tendency to progress uphill. Due to diurnal temperature changes, local winds can be expected to blow up canyon during the day and early evening, and down canyon during the night and early morning. Local winds are sometimes overpowered by more general prevailing winds.

During most of the fire season in the East Bay area, prevailing winds are from the west (tending to push fires eastward); however, during late summer, strong east winds are common. The significance of the east winds is that during the most intense period of the fire season, from a temperature and moisture standpoint, fire hazard is magnified by a wind pattern which could bring fire into the District lands from the watershed areas to the east, or drive a fire from parkland into the heavy residential areas to the west.

e. *Fire suppression is dependent upon eliminating at least one of the elements essential for fire: fuel, oxygen, and heat.* Traditional suppression techniques employ water to reduce heat and cut off oxygen, and roads and firebreaks (strips of bare earth surface) to eliminate fuel. Fuelbreaks, which are strategically located zones in which fuel (vegetation) is controlled (not eliminated) and access provided in order to simplify suppression, are of significant value in containing and extinguishing wild fires.

2. Policies.

a. *Wild fire is both dangerous and destructive, and the occurrence and magnitude of wild fires must be minimized within the Regional Parks.*

b. *Planning (both Land Use-Development and Vegetation Management Planning) must recognize the principles of fire behavior and control to minimize the impact of wild fire.*

c. *Specific control and suppression measures which should be considered and may be recommended include:*

1) Vegetation-type conversion to reduce difficulty of suppression.
2) Break-up of horizontal fuel continuity through:
   a) Thinning or removal of forest stands.
   b) Construction of access roads, firebreaks, or fuelbreaks.
3) Break-up of vertical fuel continuity through removal of fuel between ground level and crown level, i.e., pruning of lower tree limbs and removal of brush, vines, or young trees as necessary and appropriate.
4) Regularly reduce or eliminate ground fuel build-up through:
   a) Recreational development.
   b) Grazing.
   c) Prescribed burning.
   d) Chemical treatment.
   e) Mechanical removal.
5) Provide access suitable for fire-fighting equipment.
6) Maximize water availability through:
   a) Formal distribution systems.
   b) Development of natural water sources.
   c) Installation of static storage (cisterns).

d. *Because construction of fire control systems tends to be disruptive to both vegetation and animals, such systems should be carefully designed to minimize the amount of area receiving heavy treatment.*

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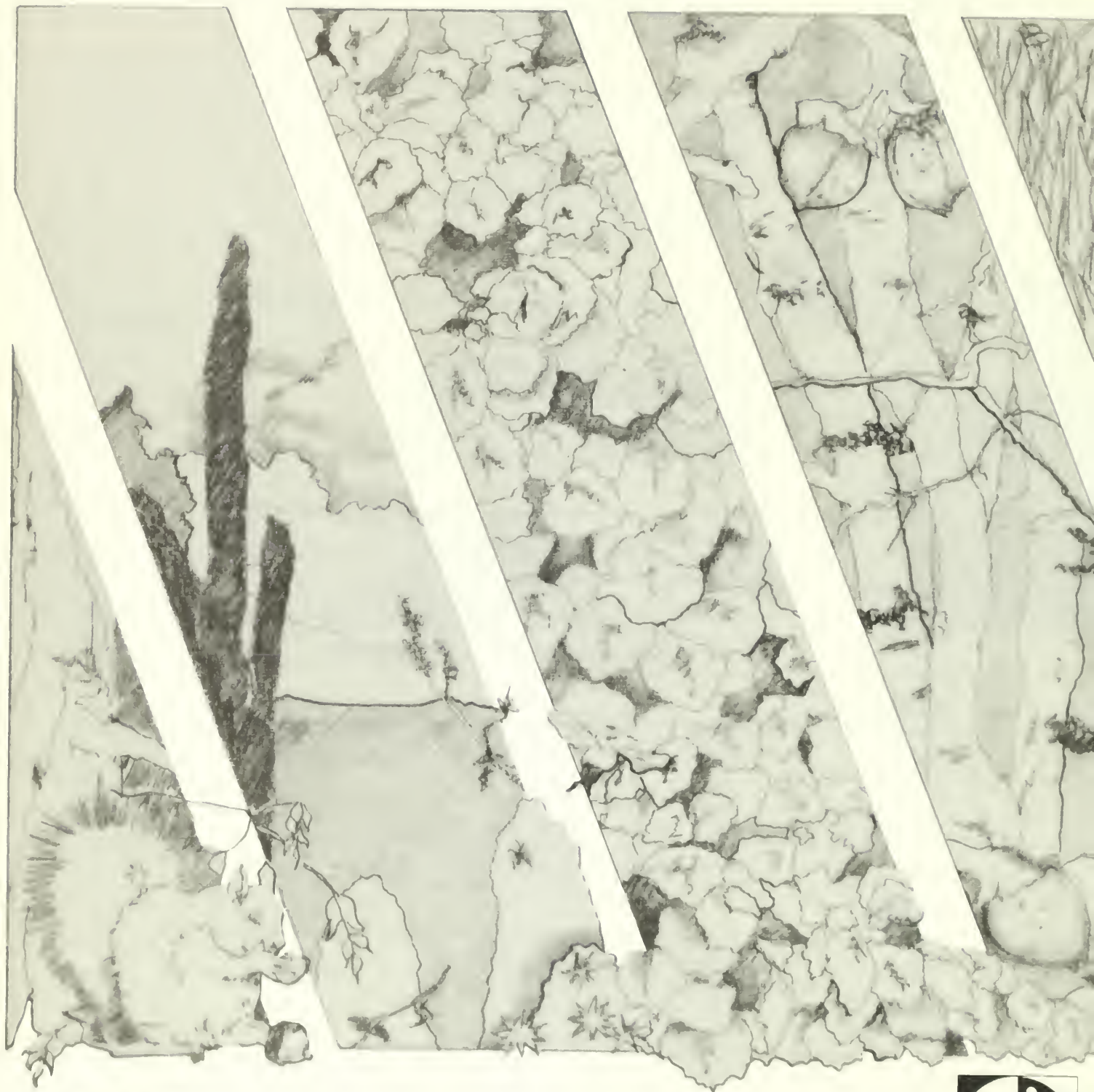

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