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GROWING Points

Department of Environmental Horticulture • University of California, Davis

Restoration Ecology: Renewing Our Disturbed Landscapes - Part I

By Truman Young, Assistant Research Ecologist

"When we experiment with planting forests,...would it not be best to consult with nature at the onset?" -Henry David Thoreau

In Thoreau's time, people were already planting trees to restore landscapes. Throughout this century, public and private organizations as well as countless landowners have worked to restore plant communities to sites that have been disturbed by natural disasters, and by human activities such as mining, road construction, clear cutting, and agriculture.

Over the last 20 years, restoration ecology—a field that draws its expertise from both ecology and horticulture—has experienced exponential growth. The growth of this field, driven by a rising environmental awareness that is often supported by legislation, has resulted in increased cooperation between these groups. While ecologists have become interested in restoring the structure, function, and biota of natural ecosystems, horticultural scientists have begun using their skills with plant materials in settings outside of traditional commercial and residential settings.

Figure 1. *Landscape disturbance resulting from road construction is common in California. This slope (center of photo) was cut for construction of Highway 299, west of Redding.*

What does each of these groups contribute to the practice of restoration ecology? Ecologists provide theoretical frameworks for the structure and stability of plant populations and communities, tools for vegetation monitoring, and a sense of the natural history of species and ecosystems. Horticulturists and landscape architects provide the skills essential for successfully establishing selected plants in a cost-effective manner that satisfies both aesthetic and socio-economic sensibilities and needs.

Scientists from the University of California at Davis are involved in all aspects of restoration research. Ecologists, soil scientists, plant materials experts, and geneticists are working with public and private institutions such as PG&E, CalTrans, the U.S. Forest Service, the Bureau of Land Management, and The Nature Conservancy, as well as with members of the private sector, on a variety of research and restoration projects.

In This Issue...

Key Questions In Restoration Ecology

By Truman Young and Frank Chan

Restoration is applied ecology. It shares many of the questions that are central to the related fields of ecology, landscape biology, and conservation. For example: How do the size, shape, and isolation of vegetation patches affect the success of individual species and of entire communities? How do the processes of succession and disturbance influence community structure? More importantly, however, restoration ecology is concerned with working out the practical details of current and future restoration activities:

What is the goal of restoration?

Most restoration projects begin with the need to meet specific practical requirements. Some examples of these requirements include: reduced soil erosion, high visibility along roadsides, decreased visibility (glare) between opposing traffic lanes, increased wildlife habitat, suppression of undesirable plants, reintroduction of extirpated species, and re-creation of the original vegetation. The goal may be to achieve one or more of these conditions.

What population/community/ecosystem characteristics do we most want to restore or create?

A first step in many restoration projects is determining the original plant community. This is not as straightforward as it may appear. In many areas, the original vegetation was devastated, so that either there are no remnants of it, or the remnants are restricted to particular site conditions or heavily influenced by surrounding land uses.

The overwhelming success of exotic annuals in California grasslands has obscured details that would help identify the vegetation that they replaced. Since much loss of natural vegetation occurred before detailed surveys of these communities could be done, historical records are only occasionally of use.

What limits our ability to achieve the desired conditions?

Often, before planting can begin, the soil must be re-created or modified, as is frequently the case on mining, road-building, and construction sites. Ideally, topsoil should be removed at the beginning of these activities and used later for site restoration.

Another problem is that plant selection is limited. Currently, those species that are commercially available represent only a fraction of the native California flora, as propagation techniques for many native and non-native species that may be desirable for restoration have not yet been worked out. Those that are available have only recently been produced on a commercial bases, so they are still expensive. In addition, they may need special care to become established. All of these considerations go into performing a cost-benefit analysis of various restoration options for a particular site.

What should be the role of native plants?

Increasingly, native plants are used in restoration and revegetation. In fact, some agencies, such as the U.S. Forest Service, have an official policy of favoring natives in their revegetation projects.

There has been considerable discussion regarding the inherent practical versus aesthetic value of using native plants. Many who favor them over non-native species do so on philosophical grounds. Others in favor of using natives point out that they have a long evolutionary and ecological “track record” of appropriate matching between environment and genetic make-up, so that, when appropriately selected, chances for survival are good. Also, native species are less likely to escape from restoration sites to cause problems elsewhere. A drawback of the use of native plant materials is that, as previously noted, many species that would be appropriate for particular sites are not yet commercially available.

In addition, there are questions about what constitutes a native plant at a particular site. For example, should a plant species native to California’s San Bernadino Mountains be considered a native planting in a Sierra Nevada watershed? Within species, how much attention should be given to the genetic source of the material? Despite these questions, it is likely that we will continue to see an increase in the use of native plants, and more attention given to matching the source of these plants to particular restoration uses.

(Truman Young is a research ecologist working with the Department of Environmental Horticulture. Frank Chan is a consulting horticulturist with Native Plant Resources.)

Restoration Ecology's Many Faces

The wide variety of activities carried out within the umbrella of restoration are associated with a bewildering array of terms. Below is a list of some of these terms and the ways in which they are commonly (though not universally) used.

Restoration: The re-establishment of plant species or communities (and their requisite environmental conditions) in areas where they have been lost or degraded. Often restricted to native species and communities.

Revegetation: The re-establishment of vegetation on sites from which it has been lost, often with a specific goal such as erosion control. Vegetation may or may not be specifically designed to replicate the indigenous vegetation of the site.

Mitigation: Generally, any action taken to correct or compensate for an environmental impact. Often, the attempt to create a community type in a site where it may or may not have occurred before to balance the loss of a similar community elsewhere (perhaps as a result of development). Usually done to fulfill a legal obligation.

Remediation: Similar to mitigation, but with fewer legal implications of one-for-one replacement. May include the use of biodiversity to increase ecosystem function or environmental quality (bioremediation).

Reclamation: Originally expressed the opposite of "reclaiming" land from nature for human use. Increasingly used to designate the more general idea of reclaiming land from a less to a more desirable state. Sometimes includes the restoration of natural vegetation.

Rehabilitation: The repairing of damage on degraded land. May include major restoration activities and/or management techniques that favor shifts in certain aspects of the plant community.

Adaptive management: Management of land and its biota in a way that allows for intervention where appropriate to maintain or develop desirable characteristics.

Soil Fertility of Decomposed Granite Cut Slopes and Adjacent Vegetated Soils

By Vic Claassen, Assistant Research Soil Scientist and
Robert Zasoski, Professor of Soil Science
Dept. of Land, Air and Water Resources, UC Davis

The disturbance of decomposed granite (DG) landscapes by logging, mining or road construction is a common occurrence in California. These activities often involve the burial or removal of the thin but nutrient rich topsoil that originally covered the sites. In addition, the exposed subsurface DG material erodes easily--a process that may contribute to poor revegetation success by preventing nutrient accumulation. Because revegetation of DG soil substrates is difficult, these sites often remain barren and unvegetated for many years.

Figure 2. *"A" site at Buckhorn Summit. Cut slope samples were composited from loose material at the slope face. Native topsoil was collected from the vegetated area to the upper left.*

Low organic matter levels can also negatively impact soil physical characteristics. Granitic parent materials typically weather to sandy textured materials with a small percentage of kaolinitic clays. The combination of sandy, noncohesive soil particles and dispersive, low charge density clays allows close packing of soil particles and filling of the voids between the sand grains. This creates a substrate with inherently poor nutrient retention capacity, low infiltration rates, and a tendency to hardset when dry. Low infiltration rates increase overland flows and surface erosion and reduce moisture retention on the site.

While mature plants with extensive root systems can extract water from deep fractures and weathered bedrock , roots of newly established plants only have access to moisture in the thin, coarse, surface soil layers. Soil organic matter and associated microbial activity can improve plant-water relations by promoting generation of water-stable soil aggregates. Once created, this state reduces close-packing and hard-setting, thereby allowing greater infiltration and root exploration.

Another potential growth-limiting nutrient in DG may be phosphorus (P). Even though granitic parent materials typically contain significant amounts of P, the amount which is actually available for plant uptake may be low.

The P in granitic materials occurs in small inclusions within the crystalline rock matrix where it may be physically isolated from plant root contact, dissolution and uptake. Despite the significant inherent P content of granitic parent materials, it has been found that large P amendments are required to maintain plant available P levels and yields of clover on soils derived from DG.

There is considerable potential for degradation of soils on DG parent materials. One illustration of this is the case of a productive coniferous forest in southern Oregon which was clearcut and subsequently subjected to repeated herbicide application to reduce brush growth. Within 20 years, this forest community was converted to a desertified site capable of supporting only a sparse cover of annual grass and scattered shrubs. The reduced ability to support plant growth was attributed to the loss of soil organic matter which previously maintained the sandy DG soil in a well structured (aggregated) state, and to the loss of soil microorganisms such as mycorrhizal fungi which assist plants in nutrient and water acquisition. Elimination of plant growth resulted in fewer organic inputs to the soil which reduced the soil's ability to store water and nutrients, further reducing plant growth.

Many barren DG sites in our study areas contain large tree stumps, suggesting that adequate growth conditions previously existed on these sites. Further, soils adjacent to these barren disturbed areas continue to support tree, shrub, and herbaceous plant communities. Since DG parent material is common to both types of sites, the unvegetated areas are viewed as being constrained by one or more factors that prevent revegetation.

The purpose of this study, funded by CalTrans, was to compare nutrient availabilities on barren DG sites to those of adjacent vegetated natural soils, and to identify soil conditions that may limit plant colonization and growth. Potentially limiting conditions will be manipulated in future field trials and lab experiments.

Materials and methods:

Site selection. Three sites along Highway 299 in the Coast Range of Northern California, about 35 km west of Redding, were sampled for comparison of plant cover and soil nutrient levels Sites were located within a total distance of 3 km east of the Buckhorn Summit between 900 and 1200 m elevation. The main soil type in this area is the Chaix series, classified as a coarse-loamy, mixed, mesic, Dystric Xerochrept. All sites are on DG parent material which is known to be difficult to revegetate after road construction.

The A site, 1.0 km (0.6 miles) east of the Shasta-Trinity county line, was located at a large, steep slump area that has not stabilized or revegetated for many years (**Figure 2**). The site poses a traffic safety hazard, in that it frequently sloughs sandy DG material onto the nearby road. Adjacent natural soils were equally steep (45° above horizontal) but support black oak (*Quercus kelloggii*), ponderosa pine (*Pinus ponderosa*), shrubs, forbs and grass cover. The B site, 1.6 km (1.0 miles) east of the county line, had a 20 to 30 year old cut slope which was naturally, though sparsely, revegetated with *Ceanothus lemmonii* and *Pinus ponderosa*. The native topsoils at this site were taken from a stable, gently sloping ridge shoulder with oak, pine, Ceanothus spp. and grass cover. A road realignment project was under construction at the C site, 4.0 km (2.5 miles) east of the county line, utilizing fill material excavated from the slump at the A site. Topsoil and subsoil samples at this site came from an annual grass community on a 27° slope with scattered oaks.

Soil sampling and analysis. For each category of soil (cut slope, native topsoil or native subsoil), three replicate 1 L volumes were sampled at 1 m intervals. Topsoil samples were taken from 0 to 10 cm depths and subsoil samples were from a 20 to 30 cm depth at the same locations. Cut slope samples were taken from the top 10 cm of the decomposed granite saprolite.

Nutrient analyses included total (Kjeldahl) nitrogen, extractable (2 M KCl) and mineralizable nitrogen (anaerobic, 40 °C, one week), total phosphorus, and plant available phosphorus (dilute hydrochloric plus sulfuric acid or bicarbonate methods). Exchangeable K, Ca, and Mg, were estimated by displacement with neutral ammonium acetate. Cation exchange capacity (CEC) was determined by barium saturation, and sulfate sulfur was extracted in a calcium phosphate solution. Soil particle size was measured by wet sieving and clay content was reasured by the pipette method. Soil acidity was measured in distilled, deionized water and also in 0.01 M $CaCl_2$. Soil organic matter was measured by wet dichromate oxidation.

Statistical differences between treatment means of all the data were determined by analysis of variance using Systat, Inc. software (Evanston, IL). Significance (0.05 probability level) was assigned by calculation of least significant difference (LSD) using rank ordered means.

Results and Discussion:

DG material on cut slopes tended to have coarser textures and lower clay content than adjacent natural soils. No consistent trend in acidity between vegetated and barren slopes was noted. All water pH levels were between 6.2 and 7.0. Measurement of pH in $CaCl_2$ solution indicated substantial H^+ displacement from the exchange--an indication that the CEC was partially filled with H^+ ions.

Topsoils had significantly higher levels of soil organic matter. This probably accounted for much of the increase in CEC in the native soils compared to the barren DG. Low organic matter levels also partly contributed to the tendency of the cut slope material to saturate and flow when wet and to pack densely and hardset when dry. Exchangeable Ca, Mg and K showed some variation between sites, but plant tissue analysis indicated that levels were above critical values for commercial forests. Extractable sulfur contents were below critical levels for commercial forests, but did not differ between cut slope and vegetated soils.

Soil characteristic	Percent decrease on DG cut slopes compared to native soil
Clay content	50%
Soil organic matter	21%
Water holding capacity	25-50%
pH	same, non-limiting
Cation exchange capacity	70% (A and B sites)
Exchangeable Ca, Mg	higher in cut slope
Exchangeable K	reduced, not deficient
Total N	29%
Available N	33%
Total P	same or higher
Available P	low to high availability
Extractable Sulfur	same, potentially limiting

Table 1. *Summary of the decrease in each soil parameter in DG cut slope samples compared to levels measured on native vegetated soil samples (averaged from topsoil and subsoil values).*

Nitrogen in total, extractable, and mineralizable pools showed significant decreases in the cut slope materials compared to the native soils. Total nitrogen in cut slopes averaged 24 % of that in the topsoils. Extractable N in cut slopes averaged 20 % of that in the topsoils. Mineralizable nitrogen in the A site cut slope was 10 % of that in the native soil, but differences in the B and C sites were not as great.

Total P contents of cut slopes and topsoils were similar for A and C sites, but the topsoil at the B site was depleted in P, for unknown reasons. Plant-available P was difficult to evaluate because different soil extracts gave opposing indications of P fertility. When measured by double acid extracts, all of the cut slope materials had higher levels than their adjacent topsoils. The B site topsoil was indicated to be deficient (< 10 μg P g^{-1} soil). The bicarbonate extract, however, indicated that the cut slope soils were low (5 - 10 μg P g^{-1} soil) while the topsoils had abundant P extracted by this method.

These conflicting results are thought to result from the different chemical forms of P in the soil. Inclusions of apatite ($Ca_{10}(PO_4)_6OH_2$) are soluble in the acid extract while soil organic matter bound P and organic P is more soluble in the bicarbonate extract. The different extraction efficiencies could also be interpreted in a soil development sequence, in which the apatite P in the fresh DG is solubilized (by acid exudates from roots or mycorrhizal fungi) and gradually accumulated in organic P in soil organic matter.

The average values of various soil characteristics on the unvegetated materials compared to adjacent vegetated topsoils are summarized in **Table 1**. (Numerical data may be obtained by contacting the authors.) Unvegetated DG cut slopes generally had lower levels of clay, soil organic matter, CEC, water holding capacity, total N, available N, and bicarbonate extractable P. Exchangeable nutrient cations (K, Ca, Mg), sulfate-S, total P and pH levels differed little between barren DG cut slopes and adjacent native topsoils.

Conclusions:

The very low level of soil organic matter is a striking feature of DG cut slopes, compared to adjacent vegetated slopes. Plant growth will be increased through amendment with plant residues and humified organic matter, which will improve soil structure, water retention, CEC, and nutrient retention.

The first choice for a source of replacement soil organic matter is usually the topsoil that existed on the site before the disturbance occurred. Where possible, this material should be stockpiled and preserved. The organic matter in this material is already stabilized, or humified, and harvested topsoil can provide biological inputs of seeds and microbial propagules as well as nutrients. Where sufficient topsoil materials are not available, applications of well stabilized composts, organic amendments or mulches may achieve many of the benefits of natural soil organic matter, although methods for evaluating the long term contributions of these materials are still being developed.

Low soil organic matter contents contribute to low plant-available N levels, both through the N content of the organic matter as well as through the improved biological activity and nutrient cycling. Comparisons of nutrient levels as measured by plant tissue analysis and bioassay tests also indicate that N is a primary limiting nutrient. Because adequate N is required for root development, N deficiency can be expected to contribute to poor uptake of available water and other nutrients.

The status of P availability is unresolved. The two chemical extraction methods used to measure plant available P indicated both adequate and deficient P levels on the same soil samples. This is thought to result from the different solubility of P in the rock matrix (P-containing apatite inclusions) compared to soil organic matter bound P. Mycorrhizal infection is expected to increase uptake from both mineral and organically bound P. However, adequate plant N availability appears to be a prerequisite for mycorrhizal function, reinforcing the importance of N availability.

Sulfur is also a potential limiting nutrient, but this possible deficiency can easily be corrected by amendment with non-leaching, elemental sulfur. While the measured levels of exchangeable cations and S may be low relative to other systems (commercial forests or agricultural systems, for example), these conditions are not expected to account for the lack of vegetation on the barren DG materials.

A broader conclusion from these analyses is that soils on DG parent materials should be viewed as fragile and easily degraded systems, especially where slopes are as steep and long as at the Buckhorn Summit study sites. In areas where damage has already occurred, correction of each of the various factors restricting plant growth must occur before the system can be stabilized and restored. Regeneration of the soil resource may be more difficult than avoiding or minimizing the initial disturbance.

(Adapted from: A Comparison of Plant Available Nutrients on Decomposed Granite Cut Slopes and Adjacent Natural Soils, in press with Land Degradation and Development.)

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For Your Information:

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Research Update

Water Use and Crop Coefficients of Woody Ornamentals in Containers

Interest in water use requirements of ornamental nursery crops continues to grow as nurseries attempt to conserve water and reduce runoff. Increasing water prices, possible allocation or availability limits, and pollution of ground and surface water through runoff are rationales to estimate the amount of water plants need as closely as possible. Once daily water use requirements are known, irrigation efficiency can be improved by grouping plants with similar irrigation demands.

Water use is a strong function of solar radiation and, therefore, fluctuates considerably on a daily basis. One possible approach is to express crop water use on the basis of reference crop evaporation. Crop coefficients were first developed to compare water use of a crop to that of a reference crop. Reference crop evapotranspiration is defined as the rate of evapotranspiration from an extensive surface of 8 to 15 cm tall, green grass cover of uniform height, actively growing, completely shading the ground, and not short of water (Doorenbos and Pruitt, 1977). In California, CIMIS weather stations collect data in different locations throughout the state and calculate evapotranspiration. While these data are of great interest for a general geographic area, they may not account for local microclimates. A potentially more accurate method is the use of an atmometer (a device installed at plant canopy height that estimates local evapotranspiration).

The present study was conducted by Ursula Schuch of the Dept. of Botany and Plant Sciences, UC Riverside and Dave Burger, Dept. of Environmental Horticulture, UC Davis. Their objectives were: (1) to determine the water use of 12 containerized woody ornamental plant species growing in two locations in California from the liner stage up to 2 years, and (2) to compare crop coefficients for these plants with evapotranspiration data obtained from CIMIS weather stations (Kc_{cim}) or atmometers (Kc_{atm}).

Results. Water use, Kc_{cim}, and Kc_{atm} differed by species, location, and month. *Rhaphiolepis*, *Pittosporum*, *Juniperus* and *Photinia* were the highest water users in Riverside while *Arctostaphylos*, *Juniperus*, *Cercis*, and *Pittosporum* used the highest amount of water in Davis, when averaged over the 20-month study period. *Rhamnus*, *Prunus*, and *Cercocarpus* were among the lowest water users in both locations. Although plant water use fluctuated considerably between individual sampling dates, the relative ranking of species' water use in each location changed very little over the study period. Kc's fluctuated seasonally from as much as 1 to 4.7 for high water users, while values were stable for low water users and also for *Buxus*, an intermediate water user. During periods of low evapotranspiration, especially in fall and winter, Kc's were artificially high and failed to correspond to plants' low water use. During periods of high winds, evapotranspiration calculated by CIMIS may not provide an accurate reference for container crops. Kc's for low water users seem to be useful to estimate water requirements over an extended period of time, whereas general Kc's have limited value for plants with high water demand and need to be developed for different growth stages and growing locations.

(Adapted from: Water Use and Crop Coefficients of Woody Ornamentals in Containers, in press with the Journal of the American Society for Horticultural Science.)

Notes From the Chair...

A merger has taken place. Beginning with this issue, Growing Points will devote a page to news formerly found in the "other" quarterly Departmental newsletter, which will no longer be published. To insure that our "other" readers continue to receive news about people and events here in the Department, we have added your names to our Growing Points mailing list. Our "Where Are They?" column will resume in the next issue.

The Department wishes to extend hearty congratulations to this year's graduates of the Environmental Horticulture and Urban Forestry major. They are: **Laurie Barley, Chris Bikle, Tami Combs, Erinn Curtiss, Ben Eggert, Ben Fish, Marilyn Gastaldi, Vance Howard, Johanna Kwan, Stephen Leas and Lindsay Yerkes**. **Ben Fish** and **Vance Howard** graduated with honors. Congratulations, also, to **Pat Thompson** and **Mark Stoutemyer**, who have earned M.S. degrees in Horticulture. Good luck in your future endeavors!

Since its inception in the fall of 1995, the new major has seen not only a steady increase in enrollment, but the addition of a new option for specialization. Along with the areas of Floriculture and Nursery, Urban Forestry, and Landscape and Turf, EHUF students may now specialize in Biodiversity and Restoration.

Congratulations to **Sy Gold**, who was recently presented the 1997 Distinguished Public Service Award "in recognition of his distinguished public service contributions to the community, State, nation and world." He has conducted pioneering playground safety studies and is one of the first park professionals to call attention to the under-use of parks. He helped develop playground safety standards adopted by the U.S. Consumer Products Safety Commission and also drafted playground safety guidelines for the State of California. This award was established by the Academic Senate (the governing body of UC Davis professors) in 1990 and is presented annually.

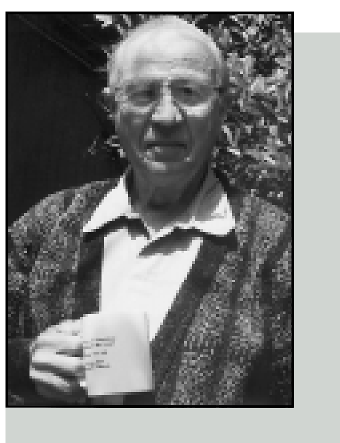
We also wish to congratulate **Lisa Brown**, Senior Word Processing Specialist in the Department who has been recognized for her contribution to the Horticulture Graduate Group. She assisted students through the application process for financial assistance, with enrollment in classes, and with finding solutions to a variety of other problems. Her efforts created a positive and workable environment for the faculty that saved them many hours.

Lisa was also recognized as a member of the College of Ag and Environmental Sciences Advisor's Homepage Committee. This is a five-member team that provided a framework which can be used by the College and the Dean's Office, and also by other campus units to design World Wide Web pages for the delivery of information to current and prospective students. The five individuals volunteered for this project and devoted many hours to the effort.

Peggy McLaughlin received the first George P. Hart Award for Faculty Leadership "for exemplifying the qualities of compassion, benevolence and intellectual curiosity which endeared George Hart to the Cal Poly Pomona community." Peggy, an alumnus of the Department from the '70s, is a professor in the Dept. of Horticulture, Plant, and Soil Science at Cal Poly. The award was presented in January of this year.

The Committee on Undergraduate Scholarships, Honors & Prizes has awarded the Ellen C. Thomason Memorial Scholarship to undergraduate **Kara Barker** for the academic year 1997-98. She was recommended by the Department for this honor in recognition of her academic accomplishments and potential for future achievement. Ellen Thomason was a Davis resident who had a love of gardening. she passed away in 1992.

The Department gratefully thanks the family of **Mildred M. Calkins** of Acampo for the donation of her outstanding orchid collection and library. This diverse collection, now maintained in Environmental Horticulture greenhouses, will enhance our teaching program immensely.



Harry S. Kohl

Members of the Department were saddened in September of last year by the loss of long time friend and colleague Harry Kohl.

Born in 1919 in St.Louis, Missouri, Harry learned the horticultural trade and the value of hard work at an early age, helping out in the family's greengrocer and butcher shop. Economic considerations always were incorporated into the work that he did throughout his long career of research, teaching and outreach for the floriculture industry.

Harry received his B.S. from the University of Illinois in 1940 and served in the cavalry during the war, rising to the rank of major. He transferred to the Army Air Corps, and served as a fighter pilot in China and India. After the war, Harry returned to the University of Illinois, where he obtained his M.S. in Floriculture in 1948. Two years later, he completed a Ph.D. in Floriculture at Cornell University with Kenneth Post. After a short period as an Extension Floriculture Specialist at Rutgers University, he was appointed in 1953 to the Department of Floriculture and Ornamental Horticulture at UCLA. In Los Angeles, Harry developed a program combining basic and applied research that responded to the needs of California's fledgling floriculture industry and ensured his nationwide recognition as a leading plant scientist and horticulturist.

In 1963, when departments from UCLA and UCD were combined, he and his family moved to Davis. Here he served as Department chair from 1966 to 1973 and was responsible not only for providing a first-class greenhouse research facility, but also for setting the future direction of the Department.

Since his retirement in 1986, Harry was an active emeritus. His ongoing research included a successful effort to return scent to large-flowered cyclamen hybrids. The campus patent office presently is evaluating the potential market for his short-crop seed-propagated Easter lilies. He continued to help the floriculture industry and the University, serving for a period as executive director of the Saratoga Horticultural Foundation, on several College and campus committees, and as an active member of the Friends of the Arboretum.

As a key member of a committee appointed by the Emeritus Association to create videotaped interviews of distinguished emeriti, he was both cameraman and editor. These activities earned him the Louie Award from Davis Community Television, an award that joins many made to him over the years by industry and professional organizations.

Harry leaves his wife Martha, daughter Carol, an empty chair at his regular lunch-time bridge session, and a host of friends and colleagues who remember him fondly for his kindness and good humor, and as a man of ideas, enthusiasm, and action.

The Department has established an endowment in Harry's name. Donations may be made to the U.C. Davis Foundation and sent to the Department of Environmental Horticulture, University of California, Davis, CA 95616.

Profiles in Environmental Horticulture

Dave Burger, Dept. Chair and Associate Professor of Environmental Horticulture

A primary question asked by growers is: Where will plants grow best? Microcalorimetry, a technology that measures the heat produced by a plant's metabolism, is a potential tool for predicting optimum environmental conditions for bedding plants. In a current study funded by the California Association of Nurserymen, Dr. Burger is measuring the heat produced bymarigold, pansy, and gerbera tissues, with the goal of determining optimum temperature ranges for growth of these plants. He speculates that this technology could eventually provide other kinds of information—water content, nutrition and salt levels, as well as the effects of chemicals and disease—that would assist growers in bedding plant cultivation.

Recently completed with funding from the Slosson Foundation and the California Association of Nurserymen, another of Dr. Burger's studies addresses the need to conserve water and reduce runoff in the nursery setting. By measuring evapotranspiration (water loss through cooling) daily water use requirements can be determined and irrigation efficiency increased. (See Research Update)

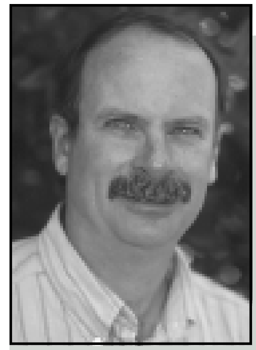
In addition to production issues, Dr. Burger's research addresses problems faced by landscape horticulturists. In urban landscapes, tree roots pose an increasing and major problem. As street trees mature, shallow roots often cause damage to nearby structures, notably sidewalks. In a study funded by the Slosson Foundation, he is attempting to identify deep-rooted varieties of trees commonly planted along California city sidewalks. In consultation with arborists from the cities of Sunnyvale, Redwood City, Palo Alto, Modesto, Sacramento, and Davis, three species were selected for this study: shamel ash, pistache, and zelkova. He is trying to identify both shallow- and deep-rooted specimens of each species (to see if root length is a stable genetic characteristic), with the idea that specimens with deep roots are good candidates for propagation as street trees.

Other recently completed landscape-related studies focused on the use of treeshelters in California. Developed in Great Britain, these polypropylene cylinders are used to protect young trees from damage by browsing animals. In a series of studies funded by the Slosson Foundation, Dr. Burger has generated data that enable the use of treeshelters for increasing transplant survival of ten trees commonly found in California landscapes.

The research and teaching interests of the Department cover a broad field. Since becoming Dept. Chair in 1995, he has sought to blend these interests by increasing possibilities for collaboration among faculty through group planning. His vision, he says, is twofold: "to build on the traditional strength in ornamental production by adding a landscape maintenance and urban forestry focus, and to continue to have the finest environmental horticulture department in the world." Perhaps foremost among his efforts to achieve this goal has been his leadership in establishing the Department's new *Environmental Horticulture and Urban Forestry* (EHUF) major. He has served as student advisor for EHUF since it's inception in the fall of 1995.

Currently, he teaches two classes: *Introduction to Environmental Horticulture and Urban Forestry* and *Physiological Principles in Horticulture.* His teaching philosophy is "to teach students to teach themselves so they can become lifelong learners." One important means toward this end, he says, is an emphasis on the development and use of computer learning aids in the classroom—instructional videotapes, multimedia tutorials, and interactive videodisc presentations, as well as electronic communications (E-mail, mailing lists and newsgroups) and the World Wide Web. Each summer he participates as a presenter and facilitator in the UCD Summer Institute on Technology in Teaching, a group of 40 campus faculty who want to increase the use of computer technology in their teaching.

He received his B.S. in Ornamental Horticulture from California State University, Fresno, an M.S. in Horticulture from West Virginia University, and completed his Ph.D. in Plant Physiology at UC Davis prior to joining the Departmental faculty in 1983. For information about his programs, contact him as follows: Telephone: (916) 752-0398; Fax: (916) 752-1819; E-mail: dwburger@ucdavis.edu.



Truman Young, Assistant Research Ecologist

Transmission line rights of way are one of the most widespread kinds of human manipulation in the California landscape. Power companies and land managers spend considerable resources to maintain these rights of way in a form that minimizes fire risk (cutting and pruning to reduce limb falls and tree falls onto the lines, and clearing of volatile underbrush), as well as providing ready access.

In collaboration with Frank Chan of Native Plant Resources, Inc., Dr. Young is investigating ways to control tree invasion of rights of way by establishing native species of plants that suppress tree recruitment. The goal is to provide an alternative to the current practices of chemical application and brush-clearing for maintaining rights of way. Funded by Pacific Gas & Electric Company, this project is a pilot study that he is working to expand into large-scale demonstration projects.

He is also the director of a long-term study in collaboration with the University of Nairobi, the National Museums of Kenya, and the Kenya Wildlife Service. This study also relates, in part, to the maintenance of treeless communities as stable components of wooded landscapes. Throughout the Laikipia ecosystem in Kenya, isolated treeless patches of nutrient rich vegetation called "glades" occur within acacia bushland and woodland communities. Use by various species of herbivores, including elephants, giraffes, zebras, oryxes, elands, buffalos, and gazelles, is several times greater inside glades than in the background savanna vegetation. Additionally, soil nutrients such as nitrogen, potassium, carbon, calcium and sodium are greatly elevated in these areas. Dr. Young is conducting experiments which exclude endemic large herbivores in varying combinations as a means of shedding light on two basic questions: Are wild herbivores responsible for the existence of glades? And, if so, which herbivores?

Another component of this project looks at the interaction among cattle, wild herbivores and the plant community. This is the first controlled exclusion experiment that factors out the separate and combined effects of competing livestock and large wild herbivores on rangeland. Data gathered from these experiments provide unique statistical power to answer a series of basic and applied questions about the sustainability of semi-arid land managed for the coexistence of livestock and biodiversity.

In California, a related study investigates the effects of large-scale grazing on biodiversity. In cooperation with several other organizations, the Bureau of Land Management has initiated a large-scale, long-term experiment in the San Joaquin Valley to examine the effects of cattle grazing on ten threatened or endangered plant and animal species. Some of the species included in the study are bluntnose lizards, antelope squirrels, and two species of kangaroo rat. As one of a team of scientists involved in this study, Dr. Young is exploring cost-effective methods of restoring the native vegetation in this ecosystem, which is currently dominated by exotic annual grasses.

In addition to conducting research, he presently teaches two courses in the Department—*Introduction to Environmental Plants* and *Ecology of Horticulture* (taught with Dr. Lin Wu). He feels strongly that “the best way to learn is to go out and do things”—a teaching philosophy that results in his incorporating as much field work as possible into his classes.

A graduate of the University of Chicago with a B.A. in Biology, he received his Ph.D. in Biology from the University of Pennsylvania in 1981 and went on to research and lecture at University of Nairobi, University of Miami, The Center for Population Biology at UC Davis, and Fordham University in New York. He has been associated with the Department since 1996.

For more information about Dr. Young’s projects, contact him as follows: Phone: (916) 754-9925; Fax: (916) 752-1819; Email: tpyoung@ucdavis.edu.

World Wide Web Site

www.gardenweb.com

Garden Web is a site produced by Karen Fletcher, Illinois Master Gardener of the Year for 1996, that provides a wealth of useful and interesting information for everyone from the casual weekend gardener to the professional.

From this site's **Gardening Tips**, you can learn how to start seeds indoors, water properly, and prepare a new garden. If you're looking for a particular seed or plant to purchase, or wish to trade plant materials, **The Garden Exchange** provides a place to post requests and offers. **The Merchant Directory** carries information on a range of products--from rare seeds and herbs, to books and pest control materials. **GreenLeaves Bookstore**, where all books are 25% off the list price, is an online source for purchasing books about gardening, wildflowers, and birding.

Gardens of the World takes a look at some of the most interesting botanical gardens from around the world. Listings for the ten gardens currently featured include both a history and description of each, along with information for contacting staff.

Other resources currently at this site include: **The Cyber-Plantsman**, **The Garden Spider's Web**, **The Garden Web Forums**, **Calendar of Events**, **The Mystery Plant Contest**, **The Association of Online Growers**, **Brooklyn Botanic Garden**, **Garden Web Europe**, and **Garden Web Australia**.

Subscription Information

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