GROWING Points

Department of Environmental Horticulture • University of California, Davis

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California's Power Crisis Fuels Renewed Interest in Greenhouse Energy Conservation

by Linda Dodge

California's continuing energy crisis has severely affected the state's nursery and cut flower industries. Growers rely heavily on natural gas this time of year for heating greenhouse cut flower crops and potted flowering and foliage plants during production. Soaring natural gas prices have forced them to temporarily shut down part or all of their operations, pass the cost on to customers as a 3-5% energy surcharge or convert their heating systems to use cheaper, less efficient fuels. One southern California grower paid 20¢ per therm (100,000 BTUs) for natural gas in the early months of 2000, paid 63¢ per therm in September and by December was paying $1.41 per therm, a seven-fold price increase within one year. A rose grower in northern California shut down his operation before the monthly gas bill soared from $34,000 to $290,000. Lee Murphy, president and CEO of the California Cut Flower Commission, predicted that, without relief in the form of a price cap for natural gas, nearly half of the state's flower growers may go out of business.

These bleak circumstances have forced commercial growers and university researchers to reexamine strategies for conserving energy use in greenhouses. Reducing heat losses from greenhouse structures is the first step and several proven methods can be revisited and new innovations incorporated. Increasing system efficiency and modifying management practices (including more cool-growing species in the crop mix) can also contribute to lower energy bills. Investigating alternative energy sources may be necessary to ultimately gain control of this aspect of production costs.

Rolling benches occupy 20 % more space than conventional fixed benches allowing more production per energy dollar.

Reducing heat losses

Heat exchange in greenhouses is due to the forces of conduction, convection and radiation. In addition, moisture in the air plays an important role through the processes of evaporation (absorbing heat) and condensation (releasing heat). In California greenhouses, 68-75% of heat loss occurs through the roof and 21% of the loss is due to infiltration or air leakage. Growers have several options for insulation materials and methods of reducing infiltration to minimize heat losses and energy use.

Adding a single layer of polyethylene to the inside of a greenhouse roof and walls can reduce energy use by 35%. A subroof of polyethylene reduces the height to which warm air can rise and cuts energy use by 20-30%. A double layer of polyethylene, inflated to enclose an insulating layer of air, will result in energy savings of 25-45%. The benefits of insulation provided by these materials must be measured against the potential for light reduction, which should be no more than 10% to ensure optimum plant growth.

A thermal blanket system for greenhouse insulation consists of curtains pulled at night to reduce the volume of space needed to be heated and prevent heat loss through radiation from warm plants and soil. Thermal blankets can be opaque or clear and solid or porous and can account for 35-57% savings in energy use. Opaque blankets may also function as short day controls and porous blankets may serve as shade cloth when needed.

Reducing infiltration or air leakage in greenhouses costs little to implement and, therefore, pays back in a short time. Sealing strips applied to ridge vents enable them to close more tightly and can reduce energy use by 5-10%. For glass greenhouses, up to 10% savings in energy use

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Table 1. Greenhouse crops that can be grown with night temperatures of 55-60F.

Cut flower crops	Container crops	Bedding plant crops
Alstroemeria	*Calceolaria*	*Argyranthemum frutescens*
Aster (*Callistephus*)	*Campanula isophylla*	*Bacopa sutera* hybrid
Bells of Ireland	*Centaurea*	*Bracteantha*
Euphorbia fulgens	Christmas cactus	*Calibrachoa* hybrid
Freesia	*Cineraria*	*Osteospermum ecklonis*
Iceland poppy	Cyclamen	*Diascia*
Iris (bulbous)	Heather	Petunia, Supertunias
Nerine	*Pelargonium*	*Impatiens*
Snapdragon	*Streptocarpus*	*Lamium*
Sweet pea		*Lobelia*
Violet		*Nemesia*

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can be realized by applying sealants around the glass panes. Some California greenhouses have sidewalls that can be opened for loading or ventilation. Inflating polyethylene tubes over these walls at night provides insulation and up to 20% savings in energy use. Similar inflated tubes mounted inside or outside of evaporative pads can save up to 20% in energy use.

Increasing system efficiency

Natural gas is the most widely used fuel source for greenhouse heating systems, whether they consist of boilers distributing hot water through pipes or unit heaters and horizontal air flow systems blowing warm air. Now more than ever, configuration and maintenance of these systems are paramount to provide the most efficient use of valuable fuel.

For hot water systems, the current trend is root zone heating, bringing the heat distribution system under benches or to ground level to warm plants and soil more directly and reduce losses through the roof by radiation. Boilers can have on/off, two- to four-stage or fully modulated control over firing with the last type providing the least fluctuation in set point temperature and the most efficient use of fuel. Root zone heating in combination with thermal blankets can reduce energy use by 66-80%.

More suited to small operations, unit heaters burn fuel to warm the air and use various types of fans to distribute it throughout the greenhouse. These systems cost less than those using hot water but are less efficient because they heat the air above the crop and lose more through the roof. Fan-jet systems usually use an overhead polyethylene tube to distribute the warm air. Blower-type unit heaters can make use of horizontal airflow fans to distribute the warm air down the length of the greenhouse and back.

Infrared heating systems consist of units mounted in the peak of a greenhouse roof containing a gas-fired burner inside a tube with a reflector to direct the radiated heat downward to the plants and soil. These systems can have high fuel efficiency because they do not heat the air. An indirect benefit of infrared heat is lower incidence of foliar diseases because foliage and soil are kept warmer than the surrounding air. Best used for short-term crops such as cuttings or potted geraniums, fuel savings of 20-50% have been reported for infrared heating systems.

Modifying management practices

Maximum utilization of greenhouse space is an easy way to get the most out of energy expenditures. Growing plants in multiple tiers or suspending hanging baskets over walkways is possible as long as light levels are not compromised. Rolling benches (see photo) allow 86-88% of available space to be used for growing crops as opposed to 62-66% space utilization with fixed benches and walkways.

Reducing greenhouse air temperature by one degree Fahrenheit lowers heating energy use by 3.5%. With this in mind, much work is being done to develop crop cultivars that can tolerate lower temperatures and still be productive (Table 1).

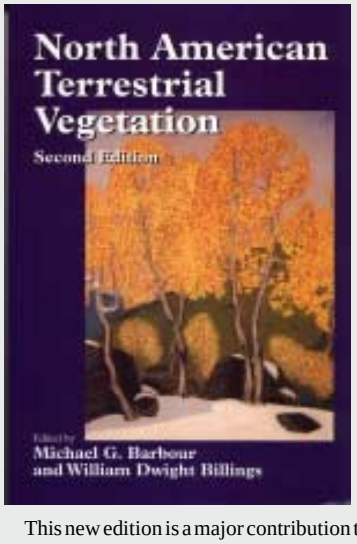
Investigating alternative energy sources

If the natural gas situation remains unresolved, many growers may look for long-term alternative fuel sources. Propane can be used with overhead unit heaters in small greenhouses but is prohibitive for larger ranges. Fuel oil and coal require on-site storage with the possibilities of leakage and environmental contamination. Recent federal programs are providing incentives to use renewable biofuels made from corn and soybeans. These are blended with diesel fuel and do not require modifications of oil-burning systems.

The development of geothermal heat pumps offers an interesting alternative energy source for heating and cooling. A closed loop of pipes, buried in the ground near the structure to be heated, circulates water which absorbs heat from the soil. A heat exchanger is used to transfer the soil heat to another fluid system which radiates it to a blower that distributes the heat into the greenhouse space. The process is reversed for cooling and the soil acts as a heat sink.

Most of the information in this article came from UC Leaflet 21411, *Reducing Energy Costs in California Greenhouses*. Although written in 1985 and now out-of-print, this publication can be found as a PDF file on the Ornamental Horticulture Research and Information Center (OHRIC) Web site (http://ohric.ucdavis.edu). **GP**

Second Edition Now Available



This new edition is a major contribution to botanical and ecological literature, and provides comprehensive coverage of the major vegetation types of North America from the arctic tundra of Alaska to the tropical forests of Central America. Each chapter describes the composition, architecture, environment, and conservation status of each ecosystem.

Available online at:
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Environmental Horticulture Classes for Winter Quarter 2001

During Winter Quarter 2001 (January-March), the Environmental Horticulture Department at UC Davis is offering a selection of classes that reflects the diverse expertise of its faculty and the diverse interests of UCD students. From production horticulture to landscape ecology and restoration, we've got it all.

Dr. Heiner Lieth is the instructor for **"Greenhouse and Nursery Crop Production"** (ENH 125), one of the department's signature courses. Covering all aspects of producing ornamental crops in greenhouses and nurseries, this course offers the student both fundamental information on plant growth and hands-on experience growing ornamental crops. An overview of the ornamental industry is presented including current cultural practices and plant materials. Dr. Lieth takes an ecosystem approach to cropping systems as he outlines the effects of temperature, light, carbon dioxide and relative humidity on plant growth. Other topics covered include propagation, growth control, soils, irrigation, fertilization, pest and disease management and postharvest physiology. The class is augmented by guest lectures from renowned faculty and field trips to cutting-edge commercial production sites.

"Woody Plants in the Landscape" (ENH 133) is one of the department's most popular classes and is taught by Dr. Alison Berry. This course focuses on principles and practices involved in the growth and management of trees and shrubs in the landscape. The practical emphasis of the course is on management of woody plants and plantings in urban landscapes, a discipline known as "arboriculture". Because of expanding human activities in the natural environment, the course seeks to broaden concepts of woody plant management to include the whole urban forest, the urban-wildland interface and other disturbed landscapes. One of the course's more popular learning activities involves pruning of deciduous trees in theory (see photo) and in practice. Bands of students brandishing loppers at unsuspecting campus trees is a familiar sight this time of year.

Dr. Tom Ledig, Senior Scientist with the Institute of Forest Genetics, is the instructor for **"Genetics and Plant Conservation: The Biodiversity Crisis"** (ENH 155). This course addresses current concerns about the accelerating rate of extinction of species and its implications for biodiversity. With examples drawn largely from forest tree species, students learn how diversity is measured, why it is threatened and why it should be protected, how it is distributed, what to save and how to save it. Extinction and its causes, historic and prehistoric, are covered. Emphasis is on genetic diversity, the basic building block of all biological diversity. How evolutionary processes have resulted in genetically structured species and how this may relate to ecosystem function is explored. Lectures address how much diversity is necessary and its value to the individual organism and the population, the nature of adaptation, and the consequences of a reduction in diversity. The population genetic consequences of small population size is a major focus.

"Fire Ecology" (ENH 198) is the "directed group study" offering for Winter Quarter. Instructors for the course are Michael Barbour and Steve Wathen of EH, Andrea Thode of the Environmental Studies Department and Neil Sugihara of the US Forest Service. Topics for study include the effects of fire on individual plants, soils, plant populations and communities, air quality and watersheds. In addition, the course uses case studies of fire in various habitats to examine historic changes in fire policy, the restoration of natural fire regimes, the use of fire by indigenous cultures and the management of fire as a tool in restoration and revegetation.

Dr. Heiner Lieth teaches **"Modeling Horticultural Systems"** (HRT 251). This course is designed for graduate students who are interested in using mathematical models of plant growth in their research or professional work, or who wish to develop software tools that can be useful for practitioners in horticulture or related fields. Using both mechanistic and empirical approaches, students learn how to go through the modeling process from conceptualization to validation. Class participants complete a modeling project related to their research interests and become familiar with several modeling tools and learn some basic computer programming.

Dr. Alison Berry demonstrates the fine art of tree pruning to eager students of ENH 133, Woody Plants in the Landscape.

The topics for Winter Quarter's graduate seminar (ENH 290) led by Dave Burger are **"Horticultural Techniques in Restoration"**. The seminar is focused on identifying and discussing important horticultural techniques used to propagate, transplant and maintain plants for restoration projects. Guest speakers include **Ann Chandler (Cornflower Farms, Elk Grove, CA)**, and **Frank Chan (Restoration Consultant, Davis, CA).** Each student identifies, researches and leads a discussion of a topic involving horticultural restoration techniques.

Malcolm North is the instructor for Winter Quarter's graduate level "directed group study" course entitled **"Experimental Design and Grant Writing for Ecological Studies"**. This course is designed for students who have selected a thesis or dissertation topic and are formulating the most appropriate experimental design, field sampling and analysis techniques for their research. Objectives include the evaluation of experimental designs and analytical

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Research Updates: Recent Publications by EH Faculty

Minnich, R. A., M. G. Barbour, J. H. Burk and J. Sosa-Ramírez, 2000. Californian mixed-conifer forests under unmanaged fire regimes in the Sierra San Pedro Mártir, Baja California, Mexico. *Journal of Biogeography*, 27:105–129.

Michael Barbour collaborated with R. A. Minnich of the Department of Earth Sciences, UC Riverside; J. H. Burk of the Department of Biology, California State University, Fullerton; and J. Sosa-Ramirez of the Universidad Autonoma de Aguascalientes, Centro de Ciencias Agropecularias in Aguascalientes, Mexico to study the patterns of fire occurrences in the Sierra San Pedro Mártir. This mountain range, located southeast of Ensenada in Baja California, was chosen because it is the last remaining mixed conifer forest along the Pacific coast subject to uncontrolled, periodic ground fire. The authors used aerial photographs taken from 1942-1991 and ground sampling to establish spatial, temporal and intensity characteristics of the region's unmanaged fires. They hoped to extend the resulting interpretation of forest stand dynamics to other areas of this vegetation type, including much of California before mandated fire suppression began in 1925.

Sequential analysis of past aerial photographs and data collected from present-day sites suggested a rotation period of 52 years for large scale, high intensity fires that removed accumulated litter, shrubs, saplings and pole-size trees (up to half the size of overstory trees), forming open forests of mature trees. Numerous spot fires due to lightning strikes also occurred but on a much smaller scale and with lower intensity. These findings contradict the 4-20 year major fire rotation periods concluded from studies using fire scar dating methods, which cannot distinguish spot burns from landscape-scale fires. Clarification of the role of small, low-intensity fires in forest dynamics may lead to the creation of a new surface fire model for forests in the western US.

Okubara, P. A., N. A. Fujishige, A. M. Hirsch, and A. M. Berry, 2000. *Dg93*, a nodule-abundant mRNA of *Datisca glomerata* with homology to a soybean early nodulin gene. *Plant Physiology*, 122:1073–1079.

Former EH post-doc, Patricia Okubara, and Alison Berry worked with N. A. Fujishige and A. M. Hirsch of the Department of Molecular, Cell, and Developmental Biology at UCLA on what is the first report of similar genes expressed during early development of root nodules in plants exhibiting different mechanisms for nitrogen fixation. *Datisca glomerata* is an actinorhizal plant, forming a symbiosis with the bacterium *Frankia* in which the plant forms root nodules in response to infection by the bacterium. The plant host supplies carbon (energy) to the bacterial endosymbiont, which in turn fixes atmospheric nitrogen and makes it available to the plant. A similar symbiotic relationship develops between legumes such as soybean and the bacterium *Rhizobium*. The legume system has been studied extensively and genes known as early nodulins have been characterized and thought to have roles in the control of nodule development.

The gene from *Datisca*, designated *Dg93*, was found as a cDNA clone during experiments involving another enzyme. It was purified and hybridized to RNA samples from nodules harvested 4,5,7 and 11 weeks after *Frankia* inoculation as well as to RNA from leaves, flowers and fruits. *Dg93* was abundant in all stages of nodules but not found in the other tissues. *In situ* hybridization with nodule tissue showed *Dg93* located in the meristem, early infection zone, periderm and cells of the vascular cylinder.

Microcalorimeter and accessory equipment used for carnation study in Dave Burger's laboratory.

Nucleotide and deduced amino acid sequences of *Dg93* were compared to other known sequences using a variety of software and Internet sites. The known early nodulin gene from soybean, *GmENOD93*, was found to have 83% of its nucleotide sequence in common with *Dg93* and the proteins encoded by both contained 105 amino acids with 74% of the sequences identical.

Stoutemyer, M.R. and D.W. Burger. 1998. Calorespirometric studies of *in vitro*-grown carnation (*Dianthus caryophyllus* L. var. 'Improved White Sim') shoot tips. *Plant Cell, Tissue and Organ Culture*, 53:189–196.

Mark Stoutemeyer (M.S., Horticulture 1997) and Dave Burger sought to develop microcalorimetry as a method for relating modifications in carnation tissue culture protocols to plant growth and for predicting plant performance beyond the tissue culture process. A microcalorimeter uses very small samples to measure metabolic heat production, oxygen utilization rate and carbon dioxide emission for respiring plant tissues. These parameters can be related to growth rate and efficiency of biomass accumulation.

Shoot tips of carnation provided stable and adequately large heat production rates making this species a good candidate for future research on the effect of culture conditions on growth and comparisons between *in vitro* and *ex vitro* responses. Metabolic heat production rate and the rate of carbon dioxide evolution correlated linearly to increased dry mass. Wounding of carnation tissue greatly increased the metabolic heat production rate. More experimentation needs to be conducted to determine if ethylene production is correlated with the wound response, and if so, how this gas affects metabolism.

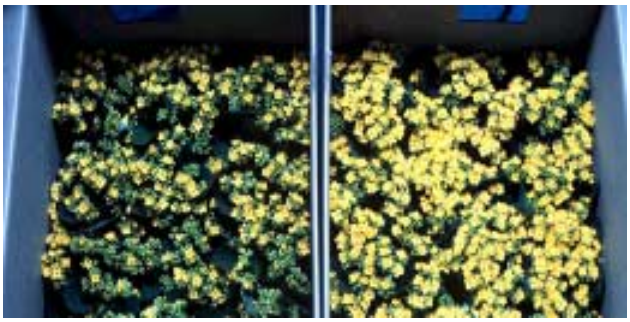
Fisher, P. R. and J. H. Lieth. 2000. Variability in flower development of Easter lily (*Lilium longiflorum* Thunb.): model and decision-support system.

***Computers and Electronics in Agriculture,* 26:53–64.**

Paul Fisher, former EH post-doc, now at the Department of Plant Biology, University of New Hampshire, and Heiner Lieth collaborated on developing a model to predict the distribution of harvest dates for an Easter lily crop in relation to air temperature. A computer decision-support system called LilyDate was developed from the model to optimize greenhouse temperature settings to ensure that the majority of a crop is ready to harvest by a target date. Sorting plants into different greenhouse temperature zones is the only current method growers have to control development but is usually not feasible as crops can number in the thousands of plants.

To implement LilyDate, the user measures the length of the largest flower bud per plant on a sample of plants in the greenhouse (100 plants maximum), and enters the frequency of plants at each flower bud length (to the nearest cm) into the program. Based on the expected temperature and sample growth data, the software predicts a cumulative and daily distribution of when plants will be in flower. LilyDate also reports when the median harvest date is predicted, and when 95% of the crop will be ready to harvest.

The model was tested using lily plants grown in UCD greenhouses, two commercial California greenhouses and one commercial greenhouse in Michigan, predicting the harvest date distributions with an accuracy of ± 2-3 days. The validation experiments indicate that the LilyDate program could be used by growers as part of their strategy for managing variability. The model can be implemented 2–3 weeks before harvest begins to provide an estimate of median and 95% harvest dates. This information can be used to decide if changing average greenhouse temperature is necessary to move the distribution back or forward in time. The general approach of the computer model could be adapted to predict the harvest distribution for other crop species that require a consistent quantity of thermal time to harvest, and that are grown for a target harvest date.



Kalanchoe plants in boxes exposed to ethylene during shipping. Plants on the right were pretreated with 1-MCP and show more open flowers than untreated plants on the left.

Serek M. and M. S. Reid, 2000. Ethylene and postharvest performance of potted kalanchoë. *Postharvest Biology and Technology,* 18:43–48.

Michael Reid recently spent a short sabbatical leave in the lab of Dr. Margrethe Serek in the Department of Agricultural Sciences, Horticulture at the Royal Veterinary and Agricultural University in Frederiksberg, Denmark. Dr. Serek has visited EH several times and she and Dr. Reid have collaborated on numerous research projects involving the effects of ethylene on the postharvest physiology of cut flowers and potted plants.

Kalanchoë blossfeldiana and its cultivars are popular as potted flowering plants due to their brilliant colors and generally long display life. The flowers are very sensitive to ethylene gas, which causes inrolling of petals and premature senescence. Because ethylene is produced by many fruits and vegetables during ripening, kalanchoë plants displayed in supermarkets often lose quality and are not salable. The authors used time-lapse videography to study the effects of ethylene on the flowers of several named kalanchoë cultivars.

Flowers of different maturities reacted similarly to ethylene exposure, beginning to inroll after about 8 hours and completely senescing by 30 hours. Flowers exposed to 1 ppm ethylene for 8 hours or less showed very little inrolling during a subsequent four-day period and those exposed for 24 hours inrolled but recovered somewhat 2 days after exposure. Those flowers exposed to ethylene for 32 hours or more experienced irreversible wilting.

There were dramatic differences in ethylene sensitivity among cultivars, one showing little response to as much as 10 ppm. These differences should be exploited in future breeding programs. Pretreatment of plants with the ethylene antagonist, 1-methylcyclopropene (1-MCP), protects flowers in the presence of ethylene but does not extend flower longevity in ethylene-free environments. This suggests that ethylene does not play any important role in the natural life of the flowers.

Young, T. P. 2000. Restoration ecology and conservation biology. *Biological Conservation* 92:73-83

Dr. Truman Young ‘s extensive survey of literature in the relatively new academic fields of conservation biology and restoration ecology serves to point out the operational and philosophical differences between these two disciplines. Conservation biology has traditionally focused more on animal species, has used descriptive techniques and modeling to answer questions and has viewed systems on the population and genetic levels. Restoration ecology, in contrast, has had a more botanical focus, used experimental methods and viewed systems on the community and ecosystem levels. Conservation biology fosters a more pessimistic mind set, viewing ecological problems in terms of imminent permanent loss and the main goal should be to slow or stop the forces of degradation and maintain remnants of original systems. Restoration ecology promotes an optimistic mind set, viewing ecosystem degradation as temporary and many habitat and population losses as recoverable given a long enough time frame.

Although conservation biology predates restoration ecology as a discipline by about 15 years, Young contends that the long-term future of conservation biology is restoration ecology. Current trends of human population stabilization, abandonment of agricultural land as people move to urban areas and public awareness of biodiversity issues present a unique opportunity for slowing the pace of habitat and species loss or even reversing these outcomes.

GP

LAIR: The Landscape Architecture Image Resource Project (www.lair.umd.edu)

The recognition of the Internet as an important educational tool for Landscape Architecture programs has led to a collaborative project involving several US universities to develop an on-line database of digital images for use in creating new instructional materials. Called the Landscape Architecture Image Resource Project (LAIR), the database is in the form of a World Wide Web site (http://www.lair.umd.edu), hosted by the University of Maryland. Other participating institutions include Cornell University, University of Georgia, University of Oregon and Virginia Polytechnic Institute and State University. Mark Francis and Steve McNeil of the Environmental Design Department are the UC Davis participants in the project.

The LAIR Web site has been designed to foster active, collaborative learning and encourage community building across a variety of campuses serving landscape architecture education. The project takes advantage of computer technology in a manner that encourages independent study and cooperative problem solving. It supports a student-centered education, both inside and outside the classroom, that will generate group discussions, student partnerships, and the development of individual research, writing and design skills. With access to a variety of instructional materials and technologies, faculty and students from around the world will develop their own multimedia presentations that integrate text, images, sound, video, and animation.

Many of the faculty affiliated with the LAIR Web site project have used these images in the preparation of teaching materials. The result is an information delivery system called the LARC Virtual Classroom which allows easy access and distribution of digital course materials related to the study of landscape architecture. It includes course syllabi, on-line lectures, tutorials, essays, design projects, and interactive multimedia textbooks. As it develops further, the LARC Virtual Classroom will enable users to establish discussion groups, chat areas, and on-line testing and assessment tools. In addition, the LAIR listserve, found on-line at "lair-l@majordomo.umd.edu", allows all users of the Landscape Architecture Image Resource to communicate with each other regarding the content, accessibility, and the future development of the image database.

Image of Villa D'Este in Tivoli, Italy available on the LAIR Web site

Participating institutions have devoted substantial resources to bringing success to this shared image bank project. They have provided staff and faculty time, computer equipment and software, and their collections of images from around the world with the corresponding data. The benefits derived from the project are the efficient use of limited resources, the reduction of course material duplication, and the ready availability of visual information.

The LAIR database may be searched using such data fields as Location (City, State or Region), Country, Project Name, Time Period, Subject, Designer/Artist Name, View Description, Spatial Locale and Ecological Locale. A further elaboration of the items included within each data field is found by clicking on the title listed. This will lead to a detailed alphabetical listing of the topics available in the database.

Search results are in the form of a list of records that matched the criteria entered. The list will display a thumbnail of the larger image and some information about the image in a table. Click the thumbnail to get more detailed information about the image including links for viewing and downloading the full size image. The downloaded images are in BinHex format and require a utility such as WinZip or Expander to decompress them.

The development of this site was supported by a Higher Education Challenge Grant from the Cooperative State Research, Education, and Extension Service (CSREES) of United States Department of Agriculture (USDA). Matching funds were provided by the Colleges and Departments of the participating Landscape Architecture programs. This partnership draws together unique resources of various institutions. It allows faculty and students at multiple sites to have access to new instructional materials. As computers become a major part of the everyday life of landscape architecture students, the LAIR Web site will have a substantial impact on the way students and faculty think, work, study, learn and communicate. GP

Notes From the Chair... By Dave Burger

Now that we are truly into the new millennium, it looks like we may realize the doomsday scenarios of the Y2K advocates, not due to bugs in our computers but to lack of energy to keep them going. I am writing this by candlelight in my darkened office using actual pencil and paper. The department as a whole is doing its part to conserve wherever possible, unplugging idle instruments and postponing long day experiments until Spring. Some of the vital services that can't be compromised, however, are 24-hour access to coffee and microwave popcorn.

The era of our EH department as a self-contained unit is coming to an inevitable close. Plans are underway for the construction of a convention center and hotel on what are now our experimental field plots and semi-famous buffalograss volleyball court. The south campus area is being developed into a showplace for the arts and major meeting facility. EH will be given a tract of land west of campus where other plant science departments also have field facilities. This is the first step in a process that may result in EH eventually moving to central campus.

Student Accomplishments

Todd Palmer (Ecology Grad Group), a student of **Truman Young**, is now a published author with the appearance of "Short-term dynamics of an acacia ant community in Laikipia, Kenya" in the journal *Oecologia* in 2000 [vol. 123(3):425-435]. **Maureen Stanton** of UCD's Evolution and Ecology section of the Divison of Biological Sciences and **Elizabeth Wenk** of UC Berkeley's Department of Integrative Biology are co-authors.

Jeanne Wirka (MS Ecology, 1997), a former student of **Michael Barbour**, and **Judy Boshoven** (BS Landscape Architecture 1987) are currently working with several Yolo County farmers and agencies such as **CalFED** and **Audubon-California** to revegetate 30 square miles of private land with native plants and grasses to control weeds, reduce soil erosion and provide wildlife habitat. Read about their accomplishments in the January-February 2001 issue of **Audubon Magazine** (online at http://magazine.audubon.org/audubonin action/action0101b.html).

Dave Barnett (Ph.D. Ecology, 1987), former student of **Jack Paul** and currently the Director of Horticulture at Mount Auburn Cemetery in Cambridge, Massachusetts, was featured on a recent segment of the **Martha Stewart Living** television program. Dave's pride in his work was evident as he related details about the cemetery. Founded in 1831 by the Massachusetts Horticultural Society, Mount Auburn was the first landscaped cemetery in America and was influential in the creation of public parks in the US. It is still an active cemetery but also serves as an arboretum, a museum of sculpture, and a wildlife sanctuary.

Visiting Scholars

Dr. Shimon Meir of the Agricultural Research Organization (ARO), The Volcani Center, Bet-Dagan, Israel continues his sabbatical leave working with **Michael Reid's** lab group. Dr. Meir is studying changes in sink-source relationships in cut flowers during senescence and tissue sensitivity to ethylene and its control by auxin in leaf abscission zones.

Researchers **Sarel Cilliers** (South Africa), **Ayzik Solomeshch** (Russia), **Jose Antonio Molina** (Spain) and **Rod McDonald** (private consultant) have arrived to work with **Michael Barbour** on the vernal pool survey project funded by the **Packard Foundation**.

Faculty Activities

The EH faculty, led by **Heiner Lieth**, are in the process of establishing a **Floriculture Postgraduate Certificate Program**. In collaboration with University Extension, the six-to-12-month program will provide current knowledge and research experience in aspects of floriculture such as production, physiology, breeding and biotechnology and postharvest biology. The program is designed to meet the needs of advanced students, researchers and technicians through specialized training and research experience. The program will also provide international students a means for obtaining necessary background coursework before beginning advanced degree studies.

Staff News

Welcome to **Konstantin Krutovskii** who has joined **Dave Neale's** forest genetics lab as a postgraduate researcher and to **Ahmet Gulcu** who has joined **Ron Lane's** greenhouse crew as our new Agricultural Technician. Ahmet came to the US from Turkey in 1995 and has impressed his fellow staff members with his work ethic.

Congratulations to **Sherryl Fawx** who received recognition for fifteen years of service to UC Davis. For most of that time, she has been an essential member of the EH office staff, but has also served in several other campus departments including Mathematics, Animal Physiology and Vet Med Radiological Sciences and has worked at UCDMC. Sherryl is a **UC Master Gardener** and fields many of the horticultural questions that come in to the department from the general public.

Ron Lane, Mitch Bunch, Jianquo Chen and **Glen Forister** recently upgraded the audio and video capabilities in the department's main classroom. On a shoestring budget of $1500, they were able to equip the room with a mixer and amplifier for tape recording lectures, speakers and wireless microphones, and easier access for audio and video input. These expanded resources will give instructors more options for presenting their teaching materials. GP

New Irrigation Publication

"A Guide to Estimating Irrigation Water Needs for Landscape Plantings in California" is a free publication now available from the California Department of Water Resources. Part 1 of this two-part guide describes the landscape coefficient method for calculating water needs. Part 2 lists the water needs for individual landscape plant species. Order copies from:

Department of Water Resources
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P.O. Box 942836
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techniques for making ecological studies more robust, and critical review of student research projects through the experience of grant writing and panel evaluation. Ecological studies have several design pitfalls due to our limited understanding of complex natural systems and because most field studies don't conform to the constraints of classic experimental design. Seminar students review the fundamentals of design such as blocking, replication and treatment, discuss complications inherent to ecological studies (pseudo-replication, covariance, small sample size, etc.) and suggest some remedies. There is a non-technical but comparative review of appropriate multivariate techniques for different designs and a brief review of recent advances in power and spatial analyses. The seminar also provides students with the opportunity to focus their research through writing a grant proposal and receiving critical feedback. In grant writing, researchers are forced to clarify their experiments, develop appropriate designs and distill their presentations into a concise, persuasive proposal. Students write up their research in the format of a National Science Foundation grant, and participate in panels which evaluate the grants. **GP**

News from the Western Center for Urban Forest Research and Education

By Greg McPherson

Scientists at the US Forest Service's Western Center for Urban Forest Research and Education received a $500,000 capacity-building grant from the National Fire Plan. They will develop a decision-support modeling tool for residents and communities to evaluate costs and risks associated with alternative prescriptions for firewise landscapes in California's urban-wildland interface.

Western Center researchers teamed with UC Cooperative Extension (**Drs. Dennis Pittenger and Donald Hodel**) and UC Davis Dept. of Land, Air, and Water Resources (**Dr. Qingfu Xiao**) to produce **"Tree Guidelines for Inland Empire Communities."** The manual quantifies benefits and costs of "green infrastructure" in a region containing 8 million people that extends from Ojai to Riverside and Escondido. The Guidelines also describe optimal configurations of trees, recommend tree species for different situations, and identify sources of funding and technical assistance. The publication is being distributed to local elected officials, planners, landscape architects, and non-profit groups throughout the Southern California region by its publisher, the Local Government Commission (LGC). Copies are available from **LGC, Attn. Steve Hoyt, 1414 K St., Suite 250, Sacramento, CA, 95814-3929 or call (916) 448-1198**.

Dr. Greg McPherson received the **L.C. Chadwick Award** for Arboricultural Research from the **International Society of Arboriculture** for research activities that have "...fundamentally altered our perception of the role of trees in cities. His Benefit Cost Analysis model demonstrated the environmental value of trees, and provided arborists with a needed tool for quantifying the benefits and costs associated with trees. Two issues of the Journal of Arboriculture were dedicated to presenting the results of an urban ecosystem study in Sacramento. He has been involved in evaluating the nature of root-pavement conflicts, in assessing the success of tree plantings in parking areas, and reviewing the success of street tree master plans."

For free subscription, contact Linda Dodge, Managing Editor
Environmental Horticulture Dept., University of California, One Shields Ave., Davis, CA 95616
Phone: (530)752-8419; Fax: (530)752-1819; E-mail: growing@ucdavis.edu
Download back issues (PDF format) of Growing Points at: http://envhort.ucdavis.edu

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