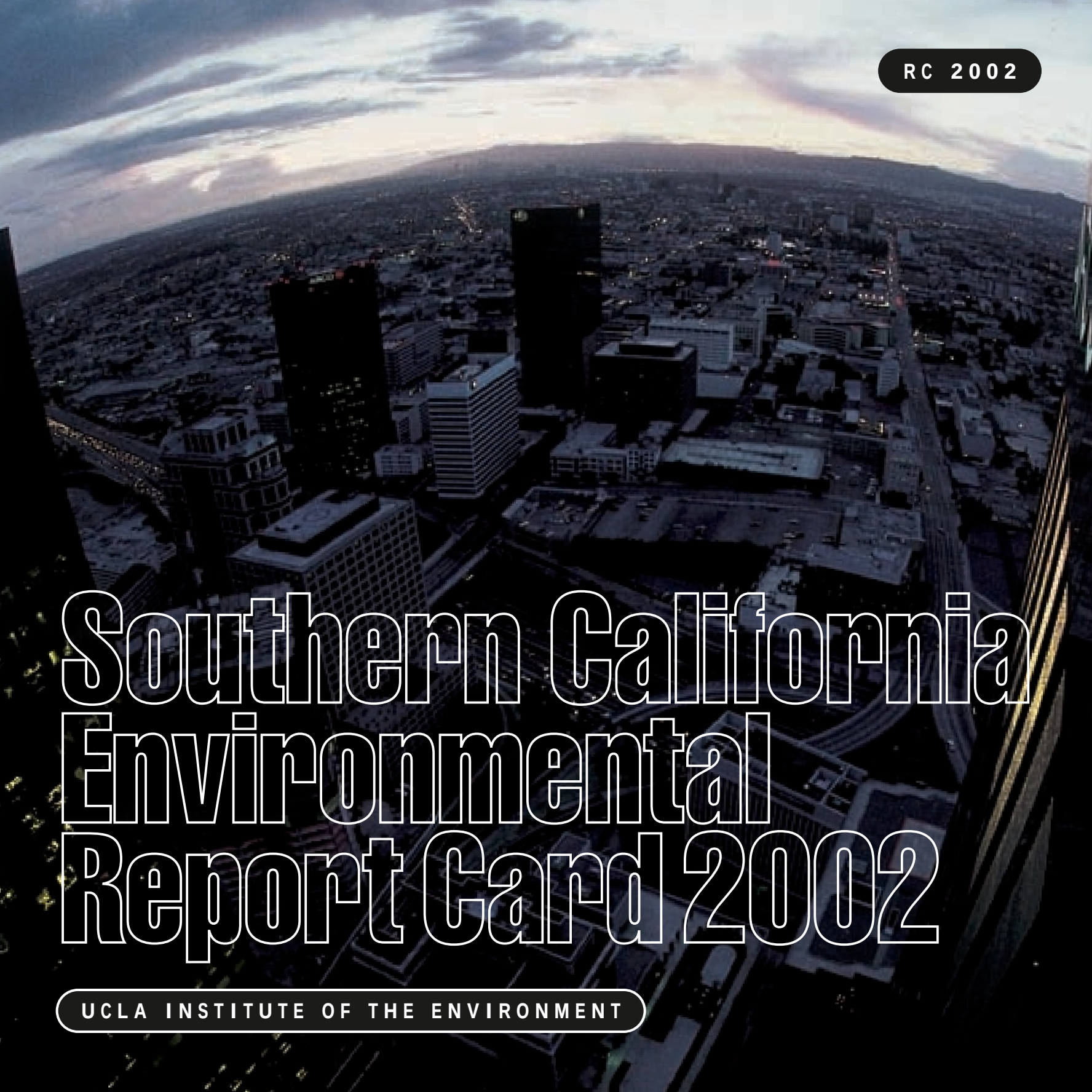
RC 2002



Southern California Environmental Report Card 2002

UCLA INSTITUTE OF THE ENVIRONMENT

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From the Editors

Written by UCLA faculty experts, the Southern California Environmental Report Card is produced under the sponsorship of the UCLA Institute of the Environment. Now in its fifth year, the Report Card is a well-established mechanism for examining critical environmental problems facing the region, and for grading how well or how poorly agencies, the private sector and the public are addressing these concerns.

While past editions have covered topics as diverse as environmental education, wildfires, the status of coastal wetlands, greenhouse gas emissions, household pollution, and environmental justice, the current RC 2002 addresses such topical issues as sustainable building, solid waste, water reclamation and biodiversity.

We emphasize that topics and authors are selected without regard for the conclusions that may be reached. As editors we "let the chips fall where they may." We require only that sufficient scientific facts are presented to support the assessments made, and that policy positions taken are also supportable and even-handed. Each article submitted for the Report Card is carefully and independently reviewed by both of us and revisions of draft articles typically follow. Since the inception of the Report Card, our goal has been to produce articles that are both scientifically defensible and accessible to non-specialists.

Next year, and in the issues to follow, we plan to cover additional environmental challenges facing the Southern California region. It is worth noting, however, that current and past articles in the Report Card have been based on assembling research that was already completed by UCLA faculty for other purposes. We hope that sufficient resources can be found so that future RC articles will be based increasingly on new research conducted specifically to monitor environmental issues in Southern California on an ongoing basis. One example would be an annual survey of Southern California residents to obtain information on environmentally relevant behavior and attitudes.

With each new edition of the Report Card, we hope to provoke informed dialogue from different points of view and appropriate self-evaluation by the relevant agencies, the public and the business community. In that spirit, we always welcome constructive responses from any readers or organizations who wish to share their views.

We continue to believe all of us in the region have a stake in working together to find cost-effective, multi-disciplinary and societally acceptable approaches to solving the most critical environmental problems we face.

Richard Berk, Ph.D.
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Department of Environmental
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Editors
Southern California
Environmental Report Card

From the Director

NEW CENTERS PROVIDE A FOUNDATION FOR SUSTAINABLE PLANNING

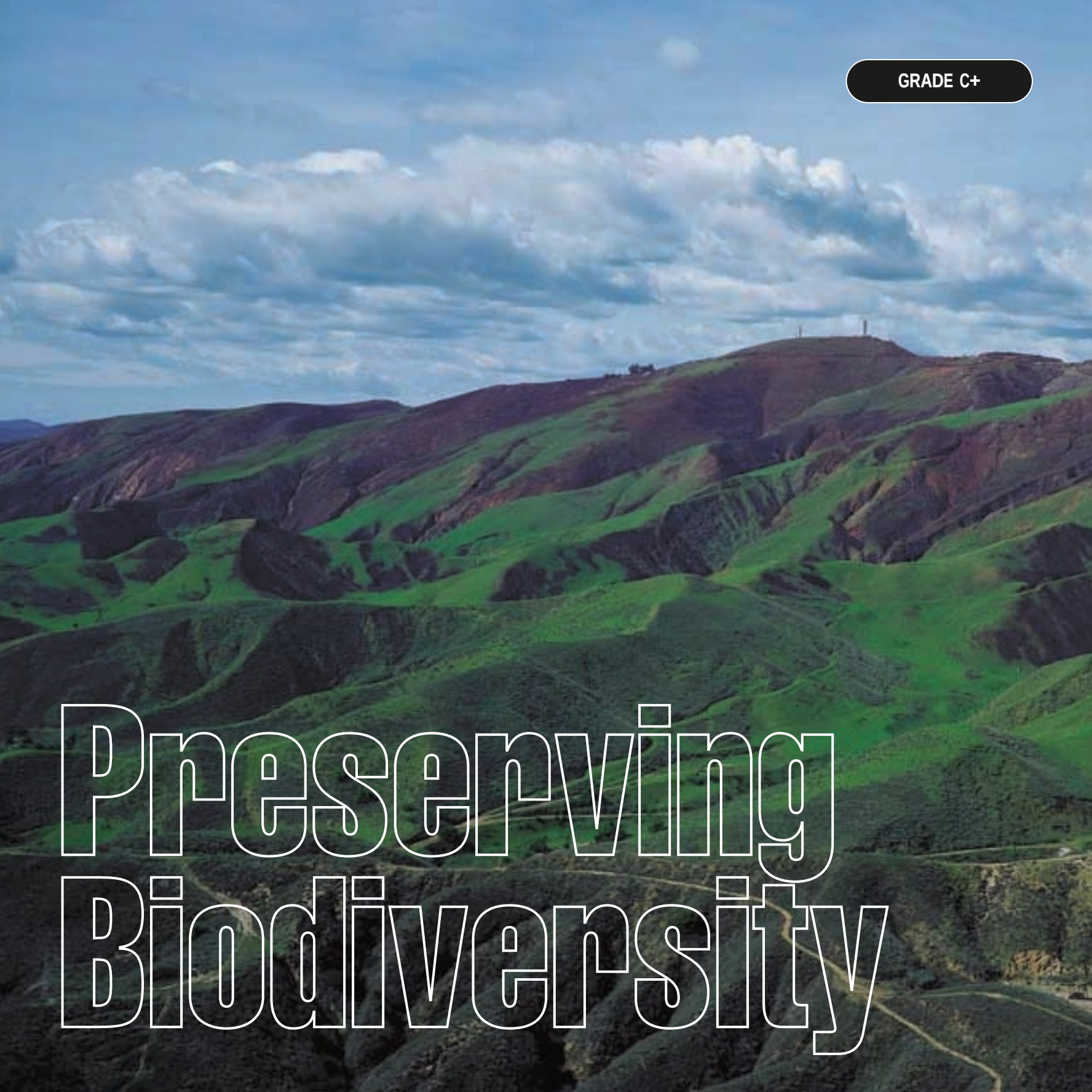
In cities throughout the world, problems associated with growth, waste, and pollution are steadily increasing. The articles in this release of the Environmental Report Card address a number of these problems as they are manifested in Southern California. The UCLA Institute of the Environment (IoE), and centers at other major institutions, are struggling to define the complex concept of urban "sustainability" within an environmental context. Sustainability may be thought of as the practical maintenance of an acceptable quality of life for all citizens into the foreseeable future. Of course, a consensus on the definition of an "acceptable" lifestyle has not yet been reached. But regardless of its precise definition, the goal of sustainability implies the preservation of natural habitats, protection of air and water quality, and access to a variety of social services.

At the IoE, we are launching centers of activity focusing on key elements of urban sustainability. The expectation is that, as we learn more about our regional environment, we will be in a better position to integrate such knowledge into workable plans to achieve sustainability. Our actions are motivated by the fact that general environmental problems cannot usually be solved on local scales in urban settings when the broader social and scientific contexts are missing. Hence, our approach is regional in scale and multidisciplinary, to capture relationships and interactions between environmental and social problems for an entire community. Projecting these interactions into the future can lead to new insights and solutions, and eventually, sustainability.

The IoE has new centers focusing on biodiversity and habitat preservation, on coastal and marine resources and management, and on air quality forecasting and mitigation. Additional centers will be identified to complement these. Teams of disciplinary experts will carry out their work at the boundaries and crossing points of more traditional fields. At a higher level of interdisciplinarity, center activities will be integrated through programs that span the interests of the individual centers. The Institute's regional watershed analysis project is an example of such an overarching program. Ultimately, Institute centers, in partnership with local governments and agencies, will cooperatively address the question of Los Angeles' long-term sustainability.

The Report Card's timely articles will hopefully sharpen understanding of such problems and help in forming a civic response. In this regard, we invite our readers to support the Institute's activities. Please contact us for more information.

Richard P. Turco, Ph.D.
Director
UCLA Institute of the Environment



GRADE C+

Preserving Biodiversity

by Philip W. Rundel, Ph.D.

Department of Organismic Biology, Ecology and Evolution

INTRODUCTION

California represents one of only five small regions of the world characterized by a mediterranean-climate regime of mild wet winters and dry summer conditions. Such conditions are also found in central Chile, around the Mediterranean Basin of southern Europe and northern Africa, the Cape Region of South Africa, and Southwestern and South Australia. These mediterranean climatic conditions are highly unusual over the surface of the earth, accounting for only a tiny portion of the world's land area. Such conditions only occur with geographic positions on the western margins of continental landmasses between about 30 and 40° latitude. The unique climatic regimes of the five Mediterranean-climate regions have led through past millennia to the evolution of a remarkable and globally significant degree of biological evolution and speciation among both plants and animals.

International conservation organizations have recently developed the concept of ecological *hotspots*, or areas of irreplaceable biodiversity, whose protection is of critical global importance. Twenty-five such hotspots have been identified worldwide on the basis of both a large and unique diversity of organisms occurring nowhere else and on the extreme threat to these regions from human activities. Although these 25 hotspots cover only 12% of the earth's surface, they are home to 65-70% of the worlds higher plant species. Moreover, 44% of the world's higher plant species are endemic to these areas, meaning they occur nowhere else. Thus, the hotspots are proposed as the key areas in which to focus conservation efforts.

To no great surprise, most of these hotspots lie in tropical forest regions of the world. However, the unusual biodiversity of California and the other four mediterranean-climate regions have led to their inclusion in this select group. Together these five regions comprise only 2% of the earth's land area but account for nearly 20% of the world's higher plant species. Proportionally to their area then, these Mediterranean-climate regions have a greater significance in protecting global biodiversity than do the Amazon Basin and other tropical rainforests. Moreover, all five regions face far greater immediate threats to their biodiversity, both faunal and floral, than any rainforest area.

The most critical area within California that has contributed to the state's designation as one of the select group of 25 global hotspots of biodiversity is the coastal area of Southern California. Whether one measures biodiversity in terms of numbers of plant and animal species present or by conservation significance as measured by numbers of designated rare and endangered species, coastal Southern California rates higher than any other part of California or the continental United States. It is here in Southern California that the impacts of the Mediterranean-climate regime combine with a diverse topography and dynamic fire cycles to produce mosaics of a wide variety of habitat types including chaparral, oak woodlands and savannas, coastal sage shrub, grasslands, riparian woodlands, wetlands, and coastal marshes.

Both the spatial and temporal scales of habitat occurrence and dynamics have been critical factors in the evolution of our biodiversity. Remarkably as well, this biodiversity exists adjacent to the second largest urban center in the nation. Yet as our urban core expands and suburban outlying areas are developed, enormous threats to biodiversity arise. Six of the ten counties in the continental United States with the largest numbers of threatened and endangered plant and animal species are in California, including Los Angeles, Santa Barbara, San Diego and San Bernardino Counties.

Biodiversity and ecosystem structure provide intangible benefits in terms of recreational, aesthetic, and spiritual values. Every organism contributes in its own way to the collective sum of ecosystem processes.

WHY PROTECT BIODIVERSITY?

The earth's living organisms contribute to human welfare in a variety ways. Some of these are very direct and can be quantified in economic terms. These include: a) natural goods and products for food, medicine and industrial products; b) genetic resources for crop breeding; and c) natural biological control agents for pests. Less easy to quantify in economic terms but no less important are a myriad of interlinked ecosystem services to society that accrue from intact natural communities of plants, animals and microorganisms. These services include regulation of hydrologic flow, biogeochemical cycling of critical elements such as nitrogen and phosphorus, photosynthetic fixation of atmospheric carbon critical for food chains, greenhouse gas regulation, water treatment, erosion control, and soil decomposition processes. Finally, biodiversity and ecosystem structure provide intangible benefits in terms of recreational, aesthetic, and spiritual values. Every organism contributes in its own way to the collective sum of ecosystem processes.

Will loss of a few or even many species really affect us? One way of looking at the ecosystem role of individual species is to consider them analogous to rivets on the wing of an airplane. The loss of one or two or scattered wing rivets would probably not cause a major change in the airworthiness of a jetliner. If rivets continue to be lost, however, at some point the damage will expand and there will be a catastrophic loss of function. It is the same way with natural ecosystems.

THREATS TO BIODIVERSITY

Threats to biodiversity in California are real. We know of at least 21 animal species and 34 plant species that have become extinct in recent decades. Another 17 animal species once common in California have been extirpated from the state, although they survive elsewhere. These include charismatic species such as the California grizzly bear, our state animal, as well as the gray wolf. The California condor teeters on the edge of extinction. Aquatic ecosystems are not immune from this problem. Nearly two-thirds of California's native fish species are extinct, endangered or in significant decline.

The problem of threats to biodiversity is particularly acute in Southern California, and more specifically the Los Angeles Basin which represents one of the most rapidly developing urban areas in the United States. A robust economy fed by broadly based industries of aerospace, entertainment, biotechnology, electronics, and import-export offers a magnet for economic growth and immigration to the region. A critical component of this urban expansion of the greater Los Angeles area has been the multiple nodes of development and home construction that have produced increasing fragmentation of existing natural areas. This can be seen very well in the Santa Monica Mountains to the west of the Los Angeles Basin. Here, many small watersheds or habitat islands have become separated from other natural areas by surrounding developments. The natural areas that do remain in the region, therefore, are becoming increasingly subdivided into smaller patches. As this occurs, biological connections between these patches are blocked. Such small pockets of remaining habitats restrict migration and gene flow between remaining populations of plants and animals.

Continued habitat loss and fragmentation threatens the long-term existence of many native species and comprise the greatest threats facing biodiversity protection in this area. Larger mammals, such as mountain lions, bobcats and badgers, and species with less mobility such as amphibians and some

Island fox.

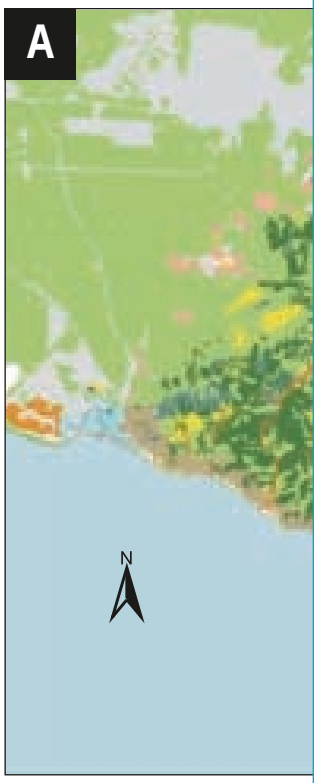
reptiles are particularly at risk and may be vulnerable to extinction by chance demographic, environmental and genetic events in fragmented areas. Moreover, fragmentation not only jeopardizes wildlife populations, but also provides expanded points of entry for invasive non-native plant and animal species (a topic we hope to cover in next year's Environmental Report Card).

The complexity of ecological interactions is such that unexpected problems invariably arise from unique circumstances. One example of such complexities is the recent catastrophic decline of the endemic island fox (*Urocyon littoralis*) on the California Channel Islands. This decline, originally thought to be due to perhaps disease, has now been related in large part to the changing food chains on the islands brought on by interactions resulting from several aspects of human impacts. Bald eagles were native to the islands and fed largely on fish. Their territorial behavior and a lack of large mammal food source traditionally kept golden eagles on the mainland from colonizing the islands.

In the 1950s, however, two events set in motion dramatic changes that were to ultimately affect the island foxes. DDT buildup in fish populations eliminated bald eagles, while at the same time feral pigs introduced to the islands increased dramatically in numbers. With these two events, golden eagles were able to establish populations on the islands, with young pigs as their primary food source. Once pig populations were eliminated in an active program of natural resource management on the islands over the last few years, golden eagles facing a dwindling food supply began to prey heavily on the island fox, drastically reducing their population size. Without the island fox, populations of small rodents that are their prey, including feral rats and mice introduced by man, have increased rapidly in number. Active management efforts today are underway to relocate golden eagles off of the islands, reintroduce bald eagles, eliminate large feral rodent populations, and use captive breeding programs on each island to rebuild island fox populations.

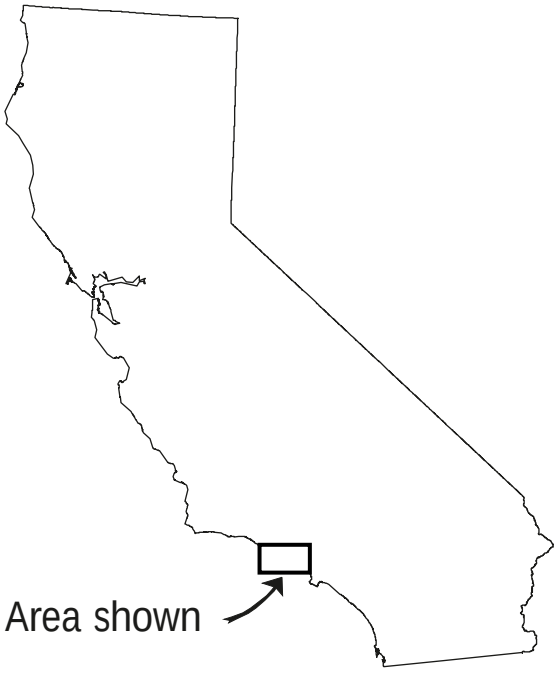
The survival of many endangered species lies at a narrow critical level of stability. This can be seen well with the history of the rare Palos Verdes blue butterfly (*Glaucopsyche lygdamus palosverdesensis*), which was federally listed as endangered in 1980. Three years later, the well intended but misguided construction of a baseball diamond on the Palos Verdes Peninsula elimi-

A Current vegetation and land cover in the Santa Monica Mountains and surrounding area.



Vegetation/Land Cover

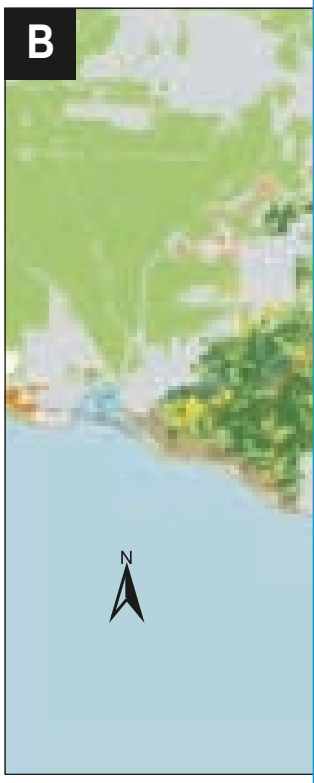
- Coastal Strand
- Grassland
- Coastal Dune/Bluff Scrub
- Coastal Cactus Scrub
- Coastal Sage Scrub
- Scrub-Chaparral Transition
- Chamise Chaparral
- Northern Mixed Chaparral
- Red Shank Chaparral
- Riparian
- Coast Live Oak
- Valley Oak
- Walnut
- Non-native Conifer/Hardwood
- Salt Marsh
- Water
- Rock Outcrops
- Agriculture
- Development
- Ocean

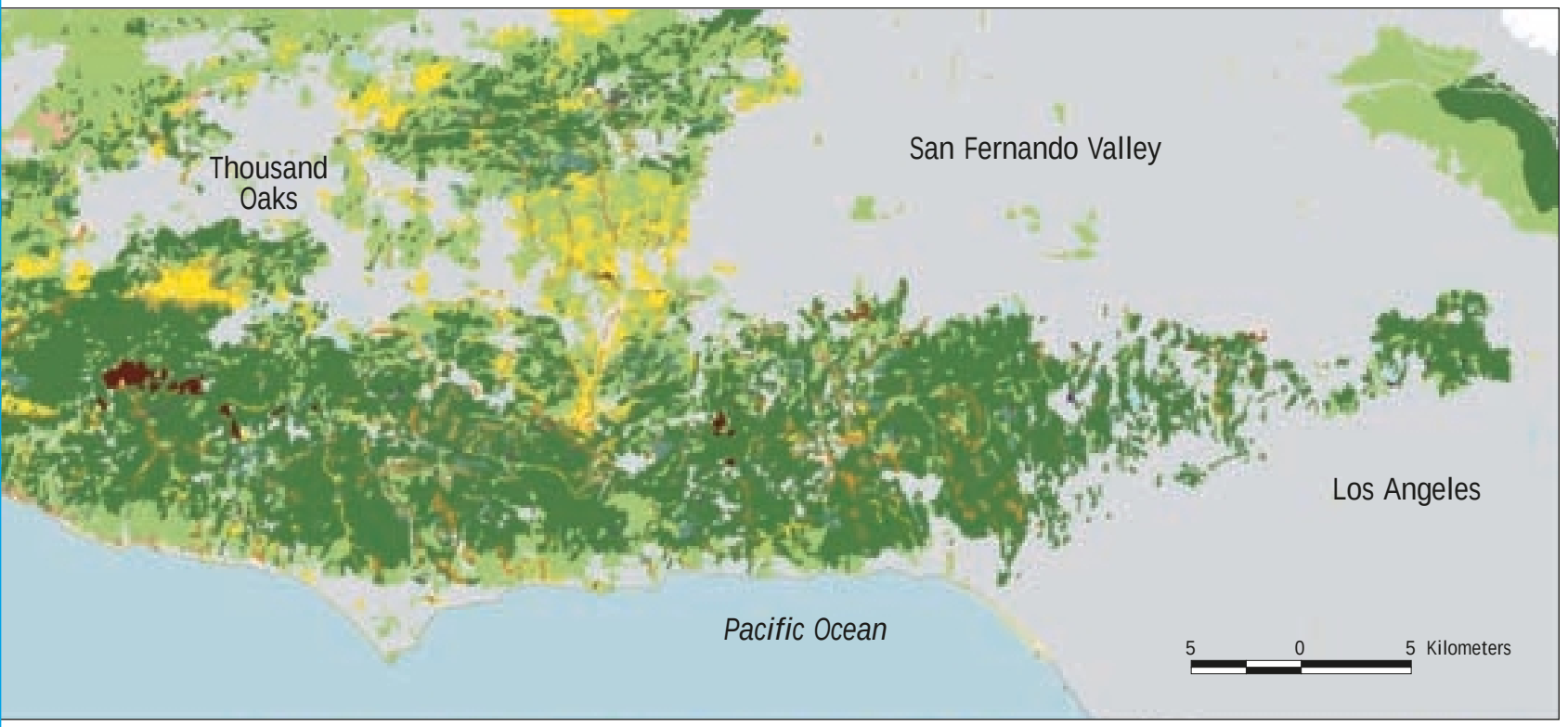


B Future development scenario showing expansion of development in the Santa Monica Mountains and surrounding region.

Development expansion in future scenario was created using a simple model based on slope and development rates consistent with observed rates between 1983 and 1990 extrapolated over 50 years.

Data sources: National Park Service, Southern California Association of Governments (SCAG), California Gap Analysis.




Thousand
Oaks
San Fernando Valley
Los Angeles
Pacific Ocean
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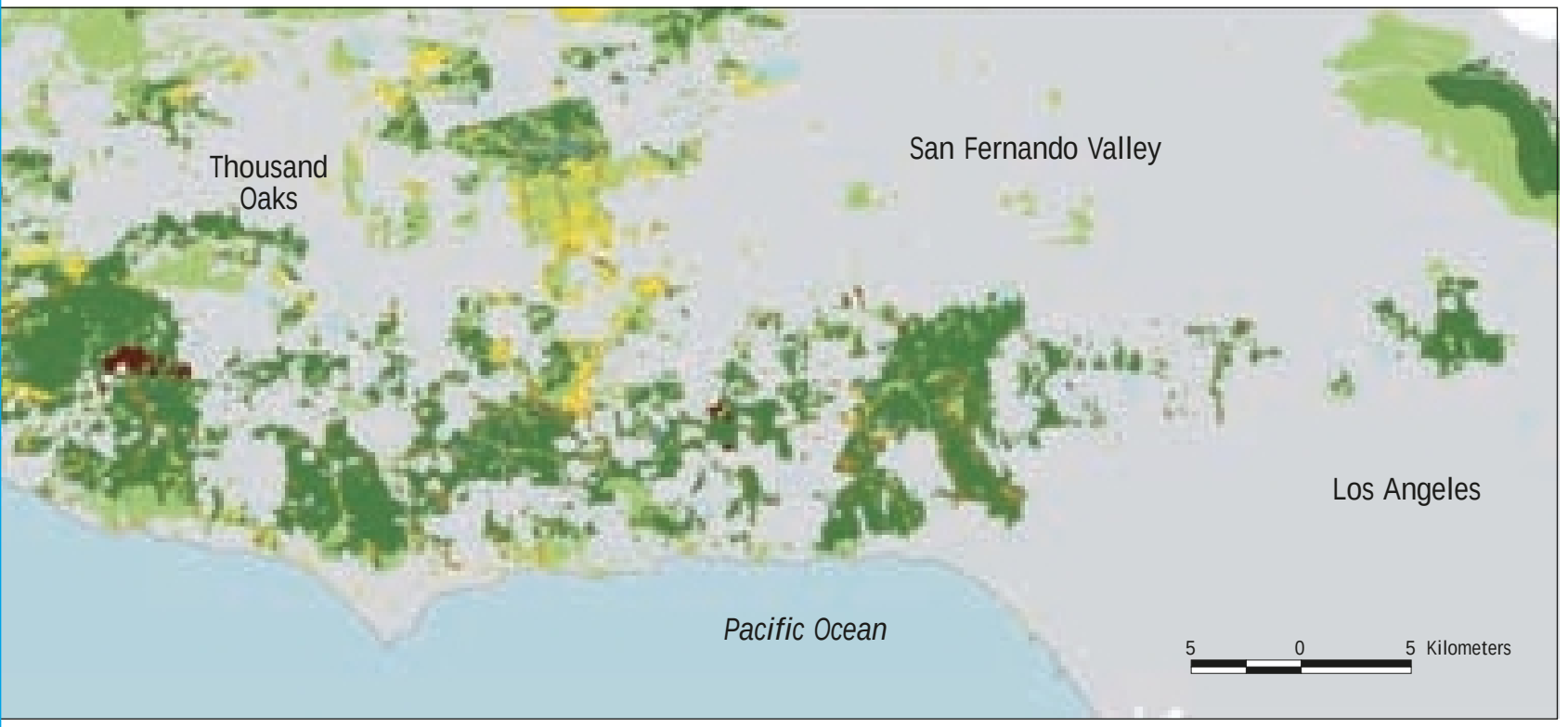
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Palos Verdes blue butterflies.

Threats to biodiversity in California are real. We know of at least 21 animal species and 34 plant species that have become extinct in recent decades.

nated the last significant stand of a rare food plant critical for the butterfly's survival. Eleven years passed without sightings of the butterfly producing fears that it had become extinct. Fortunately, a small surviving population and its associated host plant was rediscovered in 1994, giving hope that it is not too late to provide a future for the Palos Verdes blue butterfly.

Invasions of non-native plant and animal species into mediterranean-climate regions throughout the world have become a problem of increasing environmental focus and concern. Large-scale disturbance from urbanization and high impact recreational use facilitates the introduction and spread of alien plants. Alien plants, in turn, present a profound threat to the integrity of native communities. Numerous examples of severe changes to natural ecosystem structure and function have occurred with invasive species in Southern California. Annual grasses of European origin form the major ground cover of our oak woodland and grassland communities today, crowding out native species and altering natural hydrologic cycles and fire patterns and thereby restricting establishment of oak seedlings. Canyon bottoms and riparian (streamside) habitats throughout Southern California are threatened by the giant cane (*Arundo donax*) which has heavily invaded such sites throughout Southern California. Huge thickets of this bamboo-like grass choke out native species, change streamflow patterns, and allow fire to enter habitats that might otherwise not burn. These riparian habitats in the Santa Monica Mountains cover less than 1% of the land area yet are the primary habitat of occurrence for 20% of the higher plant species.

Non-native animal species have also become widely established in Southern California and are presenting a significant problem for the survival of many native species. In many creeks and streams in the region, for example, non-native species such as crayfish, mosquito fish, largemouth bass, bluegill and other fish species have dramatically altered the composition of the stream biota. Salamanders and newts quickly are eliminated from many of the streams where these invaders become established. The red-legged frogs, once common throughout California, and made famous by Mark Twain in his *The Celebrated Jumping Frog of*

Riparian woodlands are important habitats in maintaining biodiversity.

Calaveras County, is now endangered because of habitat loss and predation by non-native bullfrogs and fish.

PUBLIC POLICY AND BIODIVERSITY

Numerous Federal and State laws assist in protecting biodiversity in California. The California Endangered Species Act (CESA) largely parallels the Federal Endangered Species Act. An important difference, however, is that the California law provides an additional official category of candidate species in which public notice is given that a species is under consideration for inclusion as *endangered* or *threatened*. Additionally, the administrative policy of placing species under protected status is much more flexible and less political in California compared with the Federal level, and thus far more species are included. However, there is a major weakness in the California law compared with the Federal law in that invertebrates are excluded and protection is afforded only to *rare* and *endangered* vertebrates and plants. Both programs suffer, however, in their focus on single species with relatively little attention to habitat protection beyond these species.

The Natural Community Conservation Planning (NCCP) program of the California Department of Fish and Game, created in 1991 and recently amended, has become an important tool in preserving regional biodiversity through proactive involvement of stakeholders. Under this program, plans are developed cooperatively to preserve natural habitats at the ecosystem scale to protect highly threatened species, while still accommodating controlled growth and development. By engaging developers, landowners, federal wildlife experts and the environmental community in dialog at an early stage in the planning process, gridlock and controversies can be avoided.

An effective use of the NCCP program has occurred recently with the Southern California Coastal Sage Scrub Region of Orange, San Diego, Riverside and small parts of Los Angeles and San Bernardino Counties. The focus of this effort has been to protect the threatened coastal sage scrub habitat that serves as home to the rare California gnatcatcher and approximately 100 other potentially endangered or threatened species, including the Stephen's kangaroo rat. Compromises achieved through planning have allowed for a proactive approach in which both developers and environmentalist can achieve a win.

Stephen's kangaroo rat.

Non-native animal species have also become widely established in Southern California and are presenting a significant problem for the survival of many native species.

PRESERVING BIODIVERSITY

Viewed in a broad context, a relatively large portion of the land area of California enjoys protected status and thus enhanced preservation of biodiversity. Including multiple-use recreation areas where preservation is not the only goal, 12% of the state falls within such parks and reserves. While this statewide figure is excellent, it tells only part of the story. More than 80% of the area of high mountain conifer forests and alpine areas of California are protected, but threats from urbanization and other human impacts are very small for these regions. Wetlands, riparian woodlands, coastal ecosystems, native perennial grasslands, and vernal pools all face a different reality. Despite the keystone significance of wetland, for example, less than 5% of the original area of these ecosystems remains in natural conditions today in Southern California (see RC 1998). Nearly 25% of all of the endangered plant and animal species in California live in these wetland habitats where threats of development continue. Less than 2% of the original extent of riparian forests and less than 1% of perennial grasslands in the state remain in natural conditions and yet few of these remaining areas are protected.

The preservation of coastal ecosystems in Southern California is uneven. The National Park Service (NPS) is an important component of preserving these habitats and their biodiversity. NPS plays an important role in their administration of the Santa Monica Mountains National Recreation Area. The mountains exist today as a mosaic of different land ownerships and land uses extending over approximately 150,000 acres. Of that amount, roughly half is in protected status through public ownership as federal and state parklands, but the other half are privately owned. Management and the degree of future development on these private lands will be critical to the preservation of natural ecosystem functions and biodiversity in the Santa Monica Mountains.

Channel Islands National Park, established in 1980 and increased in size in 1986, has had major accomplishments in preserving and restoring natural ecological communities on five islands which were once heavily impacted by grazing and other human activities. Particularly important has been success in removing goats, pigs, and other feral animals that have been introduced deliberately or accidentally by man. This removal has provided a dramatic positive stimulation for the recovery of rare native plant species.

South of Los Angeles there have been few natural areas of protected coastal lands. Beach areas owned by the California Department of Parks and Recreation are extensive, but these are managed for recreation and generally have only poor remnants of natural communities. Many unique coastal habitats have largely been eliminated. The El Segundo dunes, for example, once covered more than 3,000 acres on the ocean margin of Los Angeles, but less than 10% of this habitat remains today. The large Camp

Effective programs to preserve and enhance biodiversity in Southern California must rely not just on public agencies but on public/private partnerships as well.

Pendleton Marine Corps Base along the coast between Los Angeles and San Diego provides a greenbelt between urban areas, but only limited areas of this base remain in pristine condition. Recent agreements reached through NCCP program efforts in Orange and San Diego counties are providing promising results in protecting coastal sage scrub habitats and associated biodiversity in the coastal hills.

CONCLUSIONS

Effective programs to preserve and enhance biodiversity in Southern California must rely not just on public agencies but on public/private partnerships as well. The prospects for real progress to achieve such goals are excellent. Popular interest in the environment is strong in California, and nowhere in the world is there greater activity of grass-root citizen groups and non-government organizations working to enhance preservation goals. The strength of the California economy is a mixed blessing in this respect. The state represents the sixth largest economy in the world today, and Los Angeles County alone is positioned as the twelfth largest world economy. The resource generated by this level of economic activity and popular interest in the environment should allow the region to be at the forefront of worldwide conservation efforts. At the same time, economic growth and urban expansion involves strong and continuing threats to regional biodiversity.

The prioritization of economic development over preservation in the past century, particularly in coastal Southern California, has led to extensive losses of key habitats and biodiversity. An overall grade for activities to preserve biodiversity over the past century would be no more than a **D**, or barely passing. Efforts in the last decade to focus on issues of biodiversity by state and federal agencies, and the new proactive planning processes involving both developers and the environmental community, provide hope that progress in preserving biodiversity can still be accomplished. These ongoing efforts deserve a grade of **C+**, with hope for continued improvement.

Philip Rundel is Professor of Biology in the Department of Organismic Biology, Ecology and Evolution at UCLA. He has been a faculty member in the University of California since completing his Ph.D. at Duke University in 1969. He has worked on a variety of studies of fire ecology and fire management in chaparral ecosystems and in mixed conifer forests in the Sierra Nevada. More broadly, his field of research investigates aspects of the adaptations of plants to environmental stress in Mediterranean-climate regions. He has actively worked with ecological studies of chaparral and related shrublands and woodlands in California, central Chile and the Cape Region of South Africa. Expanding beyond chaparral systems, he has also worked on a variety of programs related to the ecology and conservation biology of tropical regions around the world. This work has involved projects in Thailand and Indochina, Costa Rica, Brazil, Zimbabwe and the high Andean Altiplano region of Peru and northern Chile. In addition to his regular faculty duties, he is the manager of the UCLA Stunt Ranch Reserve, a field station for education and research in the Santa Monica Mountains.

GRADES A to D

Water Reclamation

by Michael K. Stenstrom, Ph.D., P.E., Professor, Department of Civil and Environmental Engineering and
Richard Berk, Ph.D., Professor, Departments of Statistics and Sociology

INTRODUCTION

Previous editions of the Southern California Environmental Report Card discussed various aspects of Southern California's water. RC 1998 and RC 1999 discussed wastewater treatment and stormwater management. RC 2000 described our drinking water supply. We reported generally favorable grades for these activities, although there were some negative findings with respect to the time it has taken to comply with the 1972 amendments to the Clean Water Act. The present report discusses water reclamation, which completes the cycle between wastewater or stormwater and water supply. This article relies on information presented in the earlier Report Cards.

Southern California receives its water from several sources. We are lucky that visionary pioneers developed the systems to transport water from the Colorado River, the Sierras and northern California. The presence of these water supplies enabled growth and created the California we live in. All major California cities except Sacramento depend on imported water. The sparse 15 inch yearly average rainfall is insufficient to meet Los Angeles' needs, and water must be brought to the region from far away places. You may have heard that Los Angeles would be a desert without these water supplies. This is true not only for Los Angeles but also for Fresno, San Diego, San Francisco, and San Jose; we would not have large coastal cities in California without imported water. This situation is not unique to California, and many other American cities rely upon imported water. What is different about California is the extensive reliance on imported water to support the majority of the population, which prefers to live along the coast.

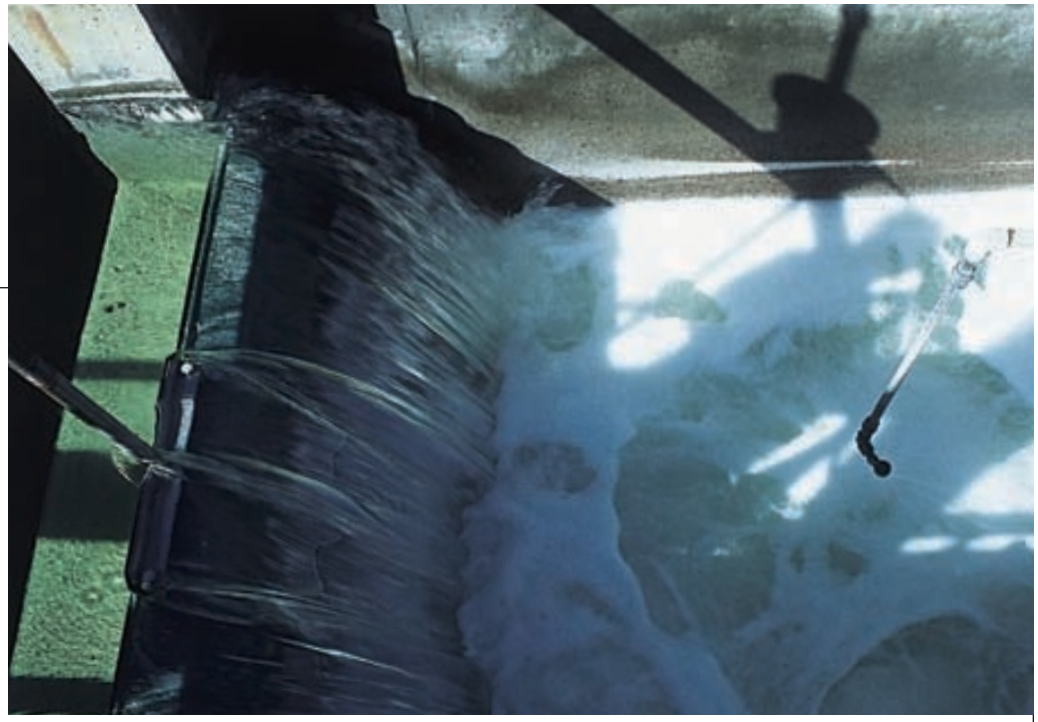
Unfortunately, Southern California is gradually losing its imported water supplies. The demand for water in other locations, along with environmental needs, are reducing our imported water supplies. The most significant example is the loss of a large portion of the Colorado River. California lost its case in the US Supreme Court, and Arizona was awarded its share of the Colorado River—water we have previously used. More recently the City of Los Angeles lost additional supplies to preserve Mono Lake and other areas in the Sierras. California cities can expect continued decline of imported water supplies.

In order to meet the challenges, new sources must be found. Unfortunately there are no rivers left to dam and even if there were, our enlightened environmental polices would allow us to do so only in rare instances. Agriculture still uses 85% of the fresh water in California. Water transfers from agricultural users to municipal users are possible and a good source of water, but transfers take planning and a long time to affect. Agricultural lands must be purchased and taken out of service, which many farmers and corporations are loath to do.

Technologies such as saline water conversion are possible, but only at great expense and extensive energy consumption. Conservation should be viewed as a new water source, but has only limited potential. Water reclamation—reusing wastewaters—is an important source, and can potentially provide new supplies equal to approximately 50% of our water consumption.

Water reclamation is already happening in California and several of our agencies have made important progress. However much more can be done. This article describes current reclamation practice, some of the technologies that exist, and how we must better utilize these technologies to meet our future water needs.

Southern California receives its water from several sources. We are lucky that visionary pioneers developed the systems to transport water.



Reclaimed water flowing over a weir in a treatment plant.

TOILET-TO-TAP

"Flush twice, LA needs the water." This was a statement made by a Department of Water Resources Director in a keynote address in California in 1979. Our water supplies originate in many places and some of those places are wastewater treatment plants, whether we like it or not. State project and Colorado River waters receive the treated wastewaters from hundreds of treatment plants. Just where do the treated wastewaters from Denver and Sacramento go? They are discharged into rivers that make up our drinking water supplies.

We occasionally read a headline "Toilet-to-Tap" and are amazed that such a concept would even be proposed. Even in the recent Los Angeles mayoral race, one candidate solicited votes by opposing one of Los Angeles' planned reclamation programs. An informed view of water reclamation programs shows that nothing is farther from the truth than "Toilet-to-Tap."

Figure 1 shows our existing situation, where a wastewater treatment plant discharges treated wastewaters into a river or lake that supplies drinking water for downstream users. A good example is the Sacramento Regional Wastewater Treatment Plant. This plant is about 1/3 the size of the City of Los Angeles' Hyperion treatment plant, and uses similar technology. Fortunately there is lots of dilution as it flows south, but some of the Sacramento discharge makes it to our drinking water treatment plants. Drinking water treatment plants provide treatment, including disinfection, before the water is supplied to users (see RC 1998 and 2000 for a description of the plants). Whether we like it or not, we are already using reclaimed waters as part of our drinking supply.

RECLAMATION TECHNOLOGIES

Water reclamation takes many forms, but all use wastewaters for another purpose. A common example is "gray water." Gray waters are wastewaters from clothes washing and showers, which can be reused to flush toilets or to water lawns. In this way, high quality potable water is reserved for applications requiring high quality; low quality water is used for other applications, and a net reduction in water use is obtained.

Another example is using treated wastewaters for irrigation or industry. In many areas of California, freeways and golf courses are watered with treated wastewaters. Oil refineries and other industries can often use treated wastewaters within their processes (some industries, such as semi-conductor manufacturing, require water purity far greater than drinking water). The Los

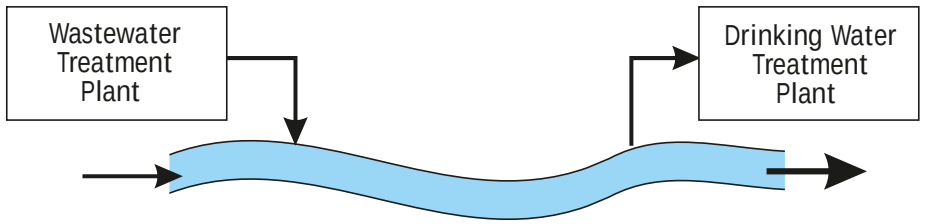


Figure 1. Relationship between water and wastewater treatment plants.

Angeles County Sanitation Districts and its predecessors began reclaiming wastewaters in this way in 1927. California developed rules to govern this type of reclamation in 1978, generally called "Title 22" waters, in reference to the rule number in the administrative code. Title 22 waters can be easily produced by modern wastewater treatment plants, such as the "inland plants" described in RC 1998. A well-designed secondary treatment plant with final filtration and disinfection can produce Title 22 waters

More advanced reclamation techniques produce higher quality water and in some cases these waters are potable. Figure 2 shows technologies called "indirect potable" reclamation. Treated wastewaters are further purified by advanced treatment and are discharged to a reservoir (top) or aquifer (bottom). The reclaimed water has a residence time of one or more years. During this time any remaining bacteria or viruses decay. Indirect potable reclamation has been practiced in California for almost 40 years. Epidemiological studies have found no evidence of any harmful effects.

Indirect potable reclamation is one method for meeting part of our future water needs. Orange County Water District's Water Factory 21 has practiced indirect potable reclamation for more than 20 years, using the direct injection method of Figure 2. Advanced reclamation treatment plants provide treatment far in excess of the treatment provided by water treatment plants.

The heart of indirect potable reclamation is a process called reverse osmosis (RO). Reverse osmosis uses semi-permeable membranes that pass water molecules but reject most other elements and compounds, generally in relation to their size. Large molecules, such as pesticides, are rejected more efficiently. Bacteria, viruses, and protozoan pathogens such as Giardia are 100% rejected based upon their size differences. A size analogy is useful; if a water molecule were represented by a golf ball, a virus diameter would be as large as the combined length of

"Flush twice, LA needs the water."

the two longest golf clubs, and a bacteria would be larger in diameter than the length of Tiger Woods' best tee shot.

Figure 3 shows an example of a water reclamation pilot plant. This plant was used to demonstrate the technical feasibility of indirect potable reclamation at Lake Arrowhead (Arrowhead bottled waters are unrelated to Lake Arrowhead). The small

Pressure tubes that hold reverse osmosis membranes at a water reclamation plant.

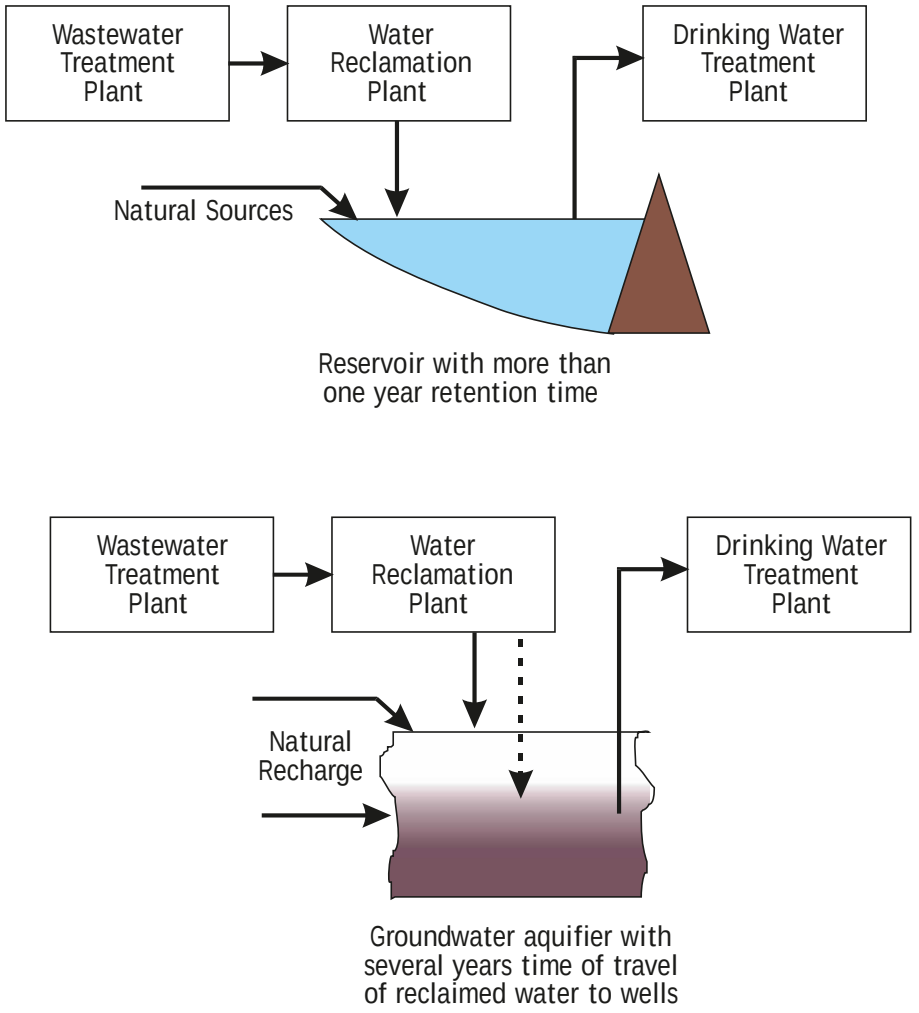


Figure 2. Two examples of indirect potable water reclamation using a drinking water reservoir (top figure) or groundwater aquifer (bottom figure). When using a ground water aquifer, reclaimed water can percolate through the soil, or be can be directly injected (dashed line).

mountain community has no water supply other than the Lake, which is inadequate to meet water needs in drought years. Lake water quality is exceptional, and the treatment goals were much more ambitious than drinking water standards. In many cases the water quality needed to protect the Lake is 10 to 100 times more stringent than drinking water standards. Figure 3 shows the concept of multiple barriers. If one process fails, either due to technology failure or human error, a second process provides the needed treatment. The most redundancy is provided for pathogen control. Pathogens are inactivated by the first and second stage ozonation, and both membrane processes also remove them. Similar multiple barriers exist for other contaminants. Lake Arrowhead has not constructed any reclamation facilities and the end of the 1985-91 drought reduced their incentive.

BARRIERS

There are barriers to water reclamation. Technology barriers are less formidable than before, but still exist. Often the cost of reclaimed water is greater than fresh water. This occurs because reclamation facilities need to be constructed, while existing water supplies and treatment systems have been amortized over the past 30 years. Fresh water prices are sometimes controlled, and in some cases, much of the cost is paid in indirect ways, such as tax incentives. A simple concept such as parallel pipe lines to transport fresh and reclaimed waters seems to be an obvious alternative but in practice has limited application. It is more expensive than the other alternatives, and finds application only

Table 1: Percentage of Respondents Who Would Use Reclaimed Water (N=501)

Type of Water Use	Percentage Who Would Find Reclaimed Water Acceptable
Median Strips	91%
Watering Lawn	89%
Washing Your Car	85%
Washing Clothes	57%
Washing Dishes	40%
Showering and Bathing	38%
Cooking	25%
Drinking	18%

Southern California is gradually losing its imported water supplies.

for high volume users, such as industries. There is also an inherit danger; it is easy to inadvertently connect the two systems together, so that reclaimed water flows into the potable system. These accidents already occur with existing sewer pipes, and are known as cross connections. They are one of the leading causes in the United States of water born diseases. Parallel distribution systems have some important applications, and our local agencies have built several. Freeway medians and shoulders are good candidates for a dedicated reclaimed water distribution system.

PUBLIC ACCEPTANCE

The greatest barrier to water reclamation is public perception and acceptance. In a recent survey of Los Angeles Area home owners (See Berk, RC2000), a question was asked about the potential acceptance of reclaimed water: "*Technology now exists to make reclaimed water at least a pure as regular water from the tap. If reclaimed water this pure were available at the same price as water from the tap, would you use it for...*". As can be seen in Table 1, the percentage that say they would use reclaimed water varies from a high of 91% (for watering median strips) to a low of 18% (for drinking). Clearly, acceptance depends on use. There is widespread acceptance of reclaimed water for outdoor use. For use in the home, a majority would find reclaimed water acceptable for washing clothes, but that majority disappears for use in washing dishes, showering and bathing, and as drinking water.

One might infer that there are health-related concerns despite the wording of the question, which stated that the reclaimed water would be as pure as tap water. Of course, some of the respondents might not choose to use tap water for cooking or drinking either (See RC 2000 for information on the quality of tap water). Still in absolute terms, the level of acceptance for these uses is quite low. Perhaps many respondents did not interpret the word "pure" as free of health risks, or perhaps they would in general not believe such claims.

The survey also explored whether acceptance of reclaimed water varied by a respondent's education, income, or occupation. No importance differences were found. For example, respondents with a college degree were no more or less willing to use reclaimed water than respondents who had only graduated from high school.

PROGRESS

Despite the previously cited difficulties, we have made important progress in water reclamation. The Los Angeles County Sanitation Districts publishes a yearly update on their reclamation activities and they report increasing reclamation. In 2000 they produced more than 520 million gallons per day (MGD) of treated wastewater, and 190 MGD was suitable for Title 22 reclamation. Approximately 60 MGD were used in reclamation projects that used special distribution systems or watering trucks. Another 25 MGD was used for groundwater recharge (Figure 2, bottom). The Districts

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In 1977 he joined UCLA and since that time has performed research and teaching in environmental engineering with an emphasis on biological treatment systems, computer methodologies, aeration systems and waster reclamation. He is the author of over 200 technical publications. He has held several administrative positions, including Chair of Civil and Environmental Engineering, Director of the Institute of the Environment, and Associate Dean of the School of Engineering and Applied Science. He is a board member of Heal-the-Bay and co-chaired their Scientific Advisory Board.

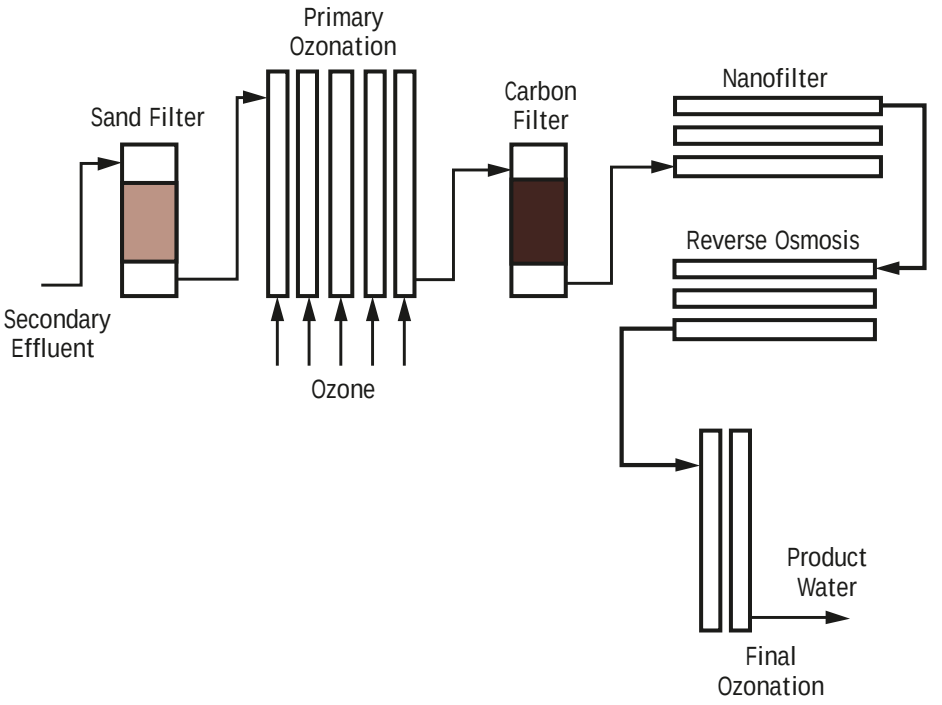


Figure 3. Example of an advanced reclamation plant (this plant was used in a UCLA demonstration study at Lake Arrowhead).

reports increasing trends depending upon rainfall; less reclamation occurs in wet years, like 1998. The number of reclamation sites increased from 100 in 1990 to 418 in 2000.

The Orange County Water District has also made good progress. They are recognized as the leader in reclamation and especially in indirect potable reclamation. The City of San Diego has an aggressive non-potable reclamation program.

OUTLOOK

As with many other topics examined by the Southern California Environmental Report Card, the outlook is mixed. We have agencies such as the Los Angeles County Sanitation Districts and the Orange County Water District who are showing leadership and wisely directing public investment.

There is a lesson to be learned from the recent energy crisis in California. We did not

Water reclamation—reusing wastewaters—is an important source, and can potentially provide new supplies equal to approximately 50% of our water consumption.

construct the needed electricity generating infrastructure or implement the necessary conservation to provide for the future. The same thing is occurring with water supply. Water reclamation plants take just as long to construct as electricity generating plants, and water is much less transportable than electricity.

Global warming is an acknowledged fact according to reputable scientists (see Report Card 2001). We do not know all the potential impacts, but extremes in weather are expected to increase, which means longer droughts and greater floods. Tree ring records suggest the droughts in the past century have been fewer and shorter than the long-term average. The next drought could be more severe and longer than any we can remember, and the problems it creates could make our electricity shortage seem trivial by comparison.

Our real problem is a lack of public interest and incorrect perceptions of water reclamation. We read newspaper headlines of "Toilet-to-tap." No agency has ever proposed or will propose a toilet-to-tap reclamation program. The proposed projects use advanced treatment technologies that provide treatment well in excess of that provided for normal drinking water. When you read such a headline, know that the writer is making an appeal to your emotions, rather than relying on facts or good science.

GRADES

Agencies: **A**. The rest of us: **D**.

Richard A. Berk is a Professor of Statistics and Sociology at UCLA. He is also Director of the UCLA Statistical Consulting Center, which provides technical assistance to individuals and organizations in need of statistical expertise.

He is an elected fellow of the American Association for the Advancement of Science and the American Statistical Association, and a former member of the National Research Council's Committee on Applied and Theoretical Statistics.

Professor Berk has published a dozen books and over 150 journal articles and book chapters, many on environmental issues. His current work addresses the links between climate change, water resources, and water quality in large urban areas. In addition to his research on Southern California, he is undertaking related work in several large Asia Pacific Cities. He also collaborates with statisticians and scientists at UCLA and the Los Alamos National laboratories on statistical tools for evaluating large-scale computer simulation models, such as those used in climate research, and on new statistical tools to permit sound generalizations from environmental case studies. His recent work is funded by the National Science Foundation and the Environmental Protection Agency.

Solid Waste

GRADE B+

by Ann E. Carlson, J.D.

Professor of Law, UCLA School of Law

INTRODUCTION

Americans generate an enormous amount of garbage and southern Californians are no exception. In 1999 the average American generated 4.6 pounds of waste every single day, requiring us to deal with and dispose of 230 million tons of trash. And our rate of garbage generation has increased: in 1960 we produced just 2.6 pounds a day per person and in 1980 just 3.0. Affluence seems to breed more garbage and when combined with population growth the trash problem will only get worse.

Trash generation creates a number of issues, not the least of which is how to handle our garbage and where to put it. We've come a long way from colonial days when city dwellers heaved trash out of their windows onto city streets and alleys, but the disposal of garbage remains a real problem. Our dominant mode of garbage disposal, burying trash in enormous landfills, has numerous problems. Landfills take space and in heavily urbanized areas like Los Angeles land is at a premium. Old landfills developed prior to more stringent federal environmental laws can create serious environmental concerns like groundwater contamination and air pollution. New landfills are increasingly expensive to operate given the more stringent regulatory regime, and often face strenuous community opposition to their siting. And both old and new landfills generate methane, a greenhouse gas that contributes to global warming (The 2001 IOE Report Card examined Southern California's contribution to greenhouse gas emissions.) Moreover, the population pressures California faces—the state's population is expected to increase by a third over the next two decades—will result in even more trash and make vacant land increasingly scarce.

In 1991, California responded to the garbage problem by passing legislation mandating that its cities and counties divert 25 percent of the their garbage out of landfills by 1995 and 50 percent by the year 2000. Local jurisdictions could achieve these diversion rates in three ways. They could reduce the overall amount of garbage produced. They could encourage the reuse of solid waste. And they could promote recycling. How have Southern California jurisdictions performed in meeting the 25 and 50 percent diversion rates, and how have they done in reducing, reusing and recycling solid waste?

DIVERSION RATES

The State's Integrated Waste Management Board is charged with providing guidelines and assistance to cities and counties in calculating and meeting their diversion goals. The Board works to ensure accuracy and consistency in the calculation of diversion rates and has only reviewed and approved data for most jurisdictions through 1998. Given the preliminary nature of later data the 1998 data are the most recent accurate numbers available. As Table 1, indicates, as of four years ago most Los Angeles County jurisdictions had made impressive strides in meeting their diversion goals.

By 1998, only two jurisdictions had yet to meet the 1995 goal of a 25 percent diversion of solid waste; 64 had exceeded the 25 percent rate and many were well on their way or had even exceeded the 50 percent rate required by the year 2000 (though a number of jurisdictions lacked the data needed to calculate a rate).

Preliminary 2000 data indicate that statewide, the diversion rate will equal about 42 percent. The news may be less rosy than it appears, however. Only 24 of L.A. county's 88 cities and the unincorporated portion of the county will meet the 50 percent diversion goal. Moreover the two largest jurisdictions, the City of Los Angeles and the County's unincorporated portions, are not likely to meet the goal. Furthermore, as explained below, some of the diverted material is not

Table 1: County of Los Angeles Solid Waste Diversion Rates, 1998

Jurisdiction	Diversion Rate %	Jurisdiction	Diversion Rate %
Agoura Hills	28	Long Beach	33
Arcadia	31	Los Angeles	46
Artesia	30	Los Angeles-Unincorp.	40
Avalon	13	Lynwood	28
Azusa	35	Malibu	29
Bell	44	Manhattan Beach	32
Bellflower	46	Maywood	41
Beverly Hills	50	Monrovia	31
Burbank	62	Monterey Park	36
Calabasas	21	Palmdale	58
Carson	56	Paramount	37
Cerritos	44	Pasadena	41
Commerce	57	Pomona	56
Cudahy	47	Rancho Palos Verdes	44
Culver City	37	Redondo Beach	37
Diamond Bar	34	Rolling Hills	43
Downey	42	Rolling Hills Estates	47
El Segundo	76	San Dimas	43
Glendale	43	San Gabriel	28
Hawaiian Gardens	47	San Marino	41
Hawthorne	48	Santa Clarita	51
Hermosa Beach	45	Santa Fe Springs	62
Hidden Hills	35	Santa Monica	38
Huntington Park	46	Signal Hill	51
Industry	48	South El Monte	63
Inglewood	34	South Pasadena	38
Irwindale	40	Temple City	38
La Habra Heights	35	Vernon	43
La Mirada	42	West Covina	29
Lancaster	51	West Hollywood	53
Lawndale	47	Westlake Village	28
Lomita	32	Whittier	35

* Excludes Alhambra, Baldwin Park, Bell Gardens, Bradbury, Claremont, Compton, Duarte, El Monte, Gardena, La Canada-Flintridge, La Puente, La Verne, Lakewood, Montebello, Norwalk, Palos Verdes Estates, Pico Rivera, Rosemead, San Fernando, Sierra Madre, Torrance and Walnut. These cities' data are incomplete or cannot be accurately calculated.

Source: California Integrated Waste Management Board.

really diverted at all and thus the numbers may be somewhat inflated. Finally, the success in diversion rates is masked by increases in population and economic growth. Localities are allowed to adjust their diversion rates to reflect increases for both population and economic growth. The result is that the total amount of material going into landfills has actually been rising, not falling, since 1996. Figure 1 illustrates the trend.

As Figure 1 shows, the amount of waste disposed in 2000 is approaching the 1991

We've come a long way from colonial days when city dwellers heaved trash out of their windows onto...

rate. So while we've made significant progress in diverting a relatively large amount of material out of landfills, our population pressures and economic growth will require significant changes in the way we view and handle garbage if we're to continue making progress in reducing the amount of materials landfilled.

RECYCLING

Of the three specified methods to achieve diversion, source reduction, reuse and recycling, localities have placed the highest premium on, and invested the most resources in, recycling. Though the state does not collect information on individual jurisdiction recycling rates, national data show that recycling has increased dramatically over the last two decades from 9.6% in 1980 to 28% in 1998. Many California localities, including the vast majority of cities in Los Angeles County, responded to the diversion rate requirements imposed in 1991 by adopting curbside recycling programs. The programs vary in design so that some programs include greenwaste pick up, others allow residents to commingle all their recyclable materials, some include commercial recycling pick up and others charge consumers

...city streets and alleys, but the disposal of garbage remains a real problem.

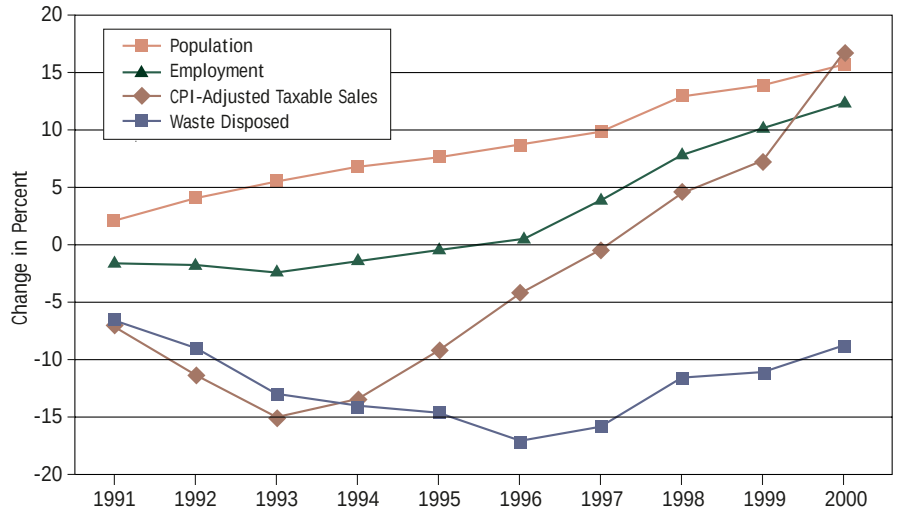


Figure 1: Trends in population, employment, taxable sales and waste disposed in California.

Source: California Integrated Waste Management Board.

by the container for trash pickup in order to encourage more recycling.

It should be noted that this move toward widespread curbside recycling is not without its critics. Some observers question whether recycling, particularly curbside recycling, costs more than the benefits it produces. They suggest instead that localities continue to rely on landfills or turn to incineration as an alternative to landfilling (a highly controversial proposition that is fraught with political and environmental controversy). Given Southern California's population growth, air quality problems and the legislature's determination that solid waste diversion is an appropriate policy goal, however, recycling seems destined to play a central role in the way we handle garbage. Moreover many critics of the critics have strongly and persuasively defended the benefits of recycling.

Curbside recycling programs combined with other statewide efforts to encourage recycling have been most successful in encouraging the recycling of those components of the waste stream that are most valuable and for which the state has provided the most significant financial incentives. For example, the state's bottle bill, which imposes a 2.5 cent deposit on specified glass, plastic and aluminum beverage containers, has led to a recycling rate of close to 80 percent for aluminum containers and a bit over 60 percent for glass. Extensive state regulation and research subsidies have led to a 65 percent recycling rate for the 31 million tires Californians discard each year.

Many plastics, by contrast, have a recycling rate of only 18 percent or much lower and paper is recycled at about a 30 percent rate. And Californians throw away 5 million tons of food scraps each year, comprising 16 percent of the solid waste stream. Construction debris, too, constitutes a substantial portion of the waste stream, 12 percent. Plastic, paper, food and other organic materials, and construction debris make up by far the largest percentage of the trash we throw out, as Figure 2 shows. These materials continue to pose real problems for jurisdictions in meeting the 50 percent diversion goal.

Finally, the diversion rates for most jurisdictions in the County (though notably not the City of Los Angeles) include what is known as "alternative daily cover." ADC, as it is known, is used as a barrier to cover waste disposed of in land fills. ADC is supposed to lessen problems with rats and other animals, fires and odor. ADC can be made of any number of materials but increasingly jurisdictions provide green material (leaves, grass, etc.) from their recycling pick up as ADC. This green material, which is placed in landfills to serve as a cover, actually counts toward the overall diversion rate even though the material is not diverted from landfills at all. Ten to twenty percent of all green waste is now used as ADC yet counted toward diversion rates.

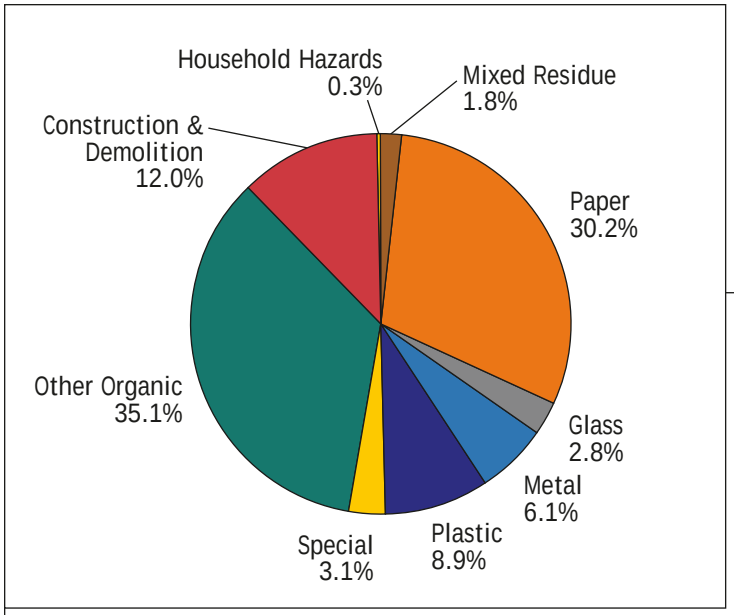


Figure 2: Composition of waste stream in California.
Source: California Integrated Waste Management Board.

In order to improve upon overall diversion rates, we will need to adopt imaginative, potentially expensive and politically controversial programs, many of which will require action by the state legislature, not municipalities.

REUSE

Municipalities can also reduce the amount of waste material going into landfills by encouraging the reuse of materials that would otherwise be discarded. Using both sides of a sheet of paper, reusing bags, donating old appliances, clothes, toys and other items all constitute reuse. Most municipalities appear to have spent little effort encouraging the reuse of materials that would otherwise be disposed of in landfills. Municipalities could, for example, adopt or expand education programs to encourage material reuse, or subsidize door to door charity pickups. Given that the overall amounts disposed of in landfills are on the rise, reuse of solid waste appears to be an area waiting to be exploited.

SOURCE REDUCTION

Reducing the amount of garbage produced in the first instance, called source reduction, is the Integrated Waste Management Board's top priority. Source reduction eliminates the need to haul materials anywhere, either for recycling or land disposal, and many source reduction efforts produce additional environmental benefits such as lower energy and natural resource usage. Certain source reduction efforts are well beyond the control of local governments—requiring manufacturers to reduce the packaging materials they use, for example—but localities can encourage the use of other measures that can achieve significant reductions in the waste stream.

The most common source reduction methods involve reducing or eliminating green and food waste through changes in landscaping, grasscycling and composting. Water-saving landscaping reduces the amount of green material produced in the first place. Grasscycling involves leaving grass clippings on the lawn to decompose, resulting in healthier lawns, lower water and fertilizer usage, and much less green waste. Composting involves turning food and green products into usable fertilizer, a process that can be done at home and therefore eliminates the need for green waste pickup. (The Solid Waste Board considers these processes source reduction though they could just as easily be categorized as recycling).

Unfortunately, Southern California jurisdictions have made little progress in encouraging the widespread practice of these source reduction measures even though virtually all the cities and the county have composting and xeriscaping/grass recycling programs. Los Angeles County, for example, which has an office dedicated to the promotion of so-called "smart gardening" techniques, estimates that only a very small percentage of county households participate in composting. The County has very recently put significant resources into trying to improve this participation rate but it is too early to predict how successful it will be.

Outside of smart gardening programs, few jurisdictions appear to encourage source reduction activities in other significant ways. It may be that many source reduction and reuse programs, such as advertising campaigns to encourage the reduction and

Our population pressures and economic growth will require significant changes in the way we view and handle garbage if we're to continue making progress in reducing the amount of materials landfilled.

reuse of paper products or requirements mandating a reduction in packaging materials, are simply beyond the capacity of localities to promote or require. The state may need to play a much more active role in source reduction and reuse if these strategies are to play a meaningful role in overall trash reduction.

CONCLUSION

In many ways, Southern California's progress over the last decade in diverting solid waste out of landfills is admirable. Many local jurisdictions have diverted more than half of their garbage away from landfills by implementing extensive and sophisticated recycling programs, market-based pricing for garbage pickup, and other programs designed to encourage source reduction and reuse. Yet the overall state diversion rate in the year 2000 (approximately 42 percent) will be significantly below the state-mandated rate of 50 percent. Los Angeles County's two largest jurisdictions, the City of L.A. and the unincorporated portions of the County, appear unlikely to meet the 50 percent goal. Moreover population pressures and economic growth are quickly pushing our trash disposal rates up to 1991 rates and will make continued success in diverting trash out of landfills quite difficult. Additionally jurisdictions have taken the easiest and least controversial steps to reduce trash disposal.

In order to improve upon the diversion rates and to reverse the growth in overall trash disposal rates we will need to adopt imaginative, potentially expensive and politically controversial programs, many of which will require action by the state legislature, not municipalities. For example, absent financial incentives for certain types of recyclable material (including robust markets for certain recyclable goods like plastic) the recycling rates for products such as plastic and paper are likely to remain significantly lower than rates for more financially valuable materials. Without serious statewide involvement in the promotion of material reuse and source reduction, localities appear handicapped in their efforts to promote reuse and source reduction. In short, the past successes in garbage diversion rates, while impressive, may be quite difficult to improve upon without fundamental changes in the way we produce and handle trash.

GRADE: B+

Ann E. Carlson is Professor of Law at UCLA's School of Law, where she also serves as co-director of the Frank G. Wells Environmental Law Clinic and UCLA's new Environmental Law Center. Her article *Recycling Norms*, an examination of the role social norms play in promoting environmentally responsible behaviors, including the recycling of solid waste, was recently published in the *California Law Review*. Her scholarly interests also include the role U.S. Supreme Court doctrine plays in altering the behavior of environmental lawyers and policy makers.

Before joining the UCLA faculty, Carlson practiced public interest law for a Los Angeles based law firm, specializing in environmental and land use issues. Her work included a challenge to the constitutionality of Proposition 13, which was heard by the U.S. Supreme Court in 1991, representation of the South Coast Air Quality Management District hearing board and work for the Sierra Club on land use issues. She also served as a senior consultant to the California State Legislature prior to attending law school.

Professor Carlson received her B.A. *magna cum laude* from U.C. Santa Barbara in1982 and her J.D. *magna cum laude* from Harvard Law School in 1989.

GRADES A+ to D

Sustainable Building

Richard Schoen, F.A.I.A.

Professor Emeritus, UCLA Department of Architecture and Urban Design

INTRODUCTION

Over the past thirty years, environmentally responsive design and construction have been of great interest to those who create, construct, and operate the built environment. Beginning with the oil embargoes of the 1970's, energy efficient design and construction has been central in efforts to reduce the nation's energy consumption. Since then, concerns have expanded to include the use of environmentally benign building materials, and more generally reducing waste when buildings are built and occupied.

In the late eighties, a report from the UN Commission on Environment and Development, *Our Common Future*, defined sustainable development as "meeting the needs of the current generation without compromising the ability of future generations to meet their own needs." This definition led to a number of principles (See sidebar, the *Hannover Principles*) later transformed into specific guidelines for designers and builders.

Among the prescriptions was that the architect, design team, builder, and eventual user(s) of a building, look beyond the property line of their projects to examine the potential impacts of that development on the community, the region, the biome and the world environment. Comprehensive planning and design concepts evolved which considered the total economic, social, and environmental costs of materials and design processes, as well as building operation, and even the eventual recycling of construction materials when a building's useful life has ended.

LEADERSHIP IN ENERGY AND ENVIRONMENTAL DESIGN (LEED)

As the number and type of principles and guidelines grew, it became increasingly difficult to judge how thoroughly particular buildings were complying with the aspirations of sustainability. In response, various strategies were developed permitting quantitative evaluations of structures, taking into account different building types, climatic regions, and socio-economic factors. In particular, the Leadership in Energy and Environmental Design (LEED) system of evaluation became the effective standard. Much more than a "building code," LEED provided a set of deceptively simple environmental design strategies linked to a rating system. Buildings could earn, in ascending order, a simple LEED Certification, or a LEED Silver, Gold, or Platinum grade. The LEED system is managed by the U.S. Green Building Council, which counts among its members governmental entities such as the GSA, the military services, entire counties

THE HANNOVER PRINCIPLES (EXCERPTED)

1. Insist on the rights of humanity and nature to coexist in a healthy, supportive, diverse and sustainable condition.
2. Recognize interdependence.
3. Respect relationships between spirit and matter.
4. Accept responsibility for the consequences of design decisions.
5. Create safe objects of long-term value.
6. Eliminate the concept of waste.
7. Rely on natural energy flows.
8. Understand the limitations of design.
9. Seek constant improvement by the sharing of knowledge.

and cities, design and construction firms, universities, academic departments, and individuals.

SUSTAINABLE DEVELOPMENT AND CONSTRUCTION IN LOS ANGELES

In Los Angeles, and more generally in Southern California, there are many kinds of buildings constructed for varying purposes. We will focus on policies and projects within the City of Los Angeles that reflect best the current situation, that are important for their impact on the city and perhaps the region, and that raise a number of broader issues. Application for, or award of, LEED certification will be noted. The underlying question is how well Los Angles is living up to the goals of sustainable built environments.

THE PUBLIC SECTOR

Unlike "Sustainable Seattle" or similar programs in Austin, Boulder, and Santa Monica, there had not been until very recently, anything close to a comprehensive, "top down" commitment to sustainable development in the public, institutional, or private sectors of the City of Los Angeles. Rather, initial efforts stemmed from volunteer participation, in cooperation with specific city departments. In particular, the *Sustainable Design Task Force* was established in 1995, with the City Architect as chair, to serve as the volunteer organization committed to the goals of first institutionalizing "Green Building" within city planning and development projects, and second overcoming financial, regulatory, political, and institutional barriers to such planning and development. In July 2000, the City Engineer was approved to hire three permanent staff members to carry out the Sustainable Design Implementation Program.

Around the same time, the Integrated Solid Waste Management Office (ISWMO) had been working to respond to AB 939, which required that all cities in the state reduce their input to landfill waste dumps by fifty percent by the year 2000. The city's ISWMO became famous beyond city hall in its enormously successful effort to recycle over 100 million tons of Northridge Earthquake debris, primarily broken concrete. The department was more recently renamed to better reflect a broader mandate. Now known as the Los Angeles Bureau of Sanitation, long-time senior manager, Lupe Vela created the *AB939 Sustainability Partnership*. With the Bureau of Engineering and Deborah Weintraub, the City Architect, as well as input from a number of other stakeholders, a concensus document was produced, *The City of Los Angeles Sustainable Building Initiative (SBI): An Action Plan for Advancing Sustainable Design Practices*.

Specific Building Programs That Will Eventually Come Under the SBI Purview

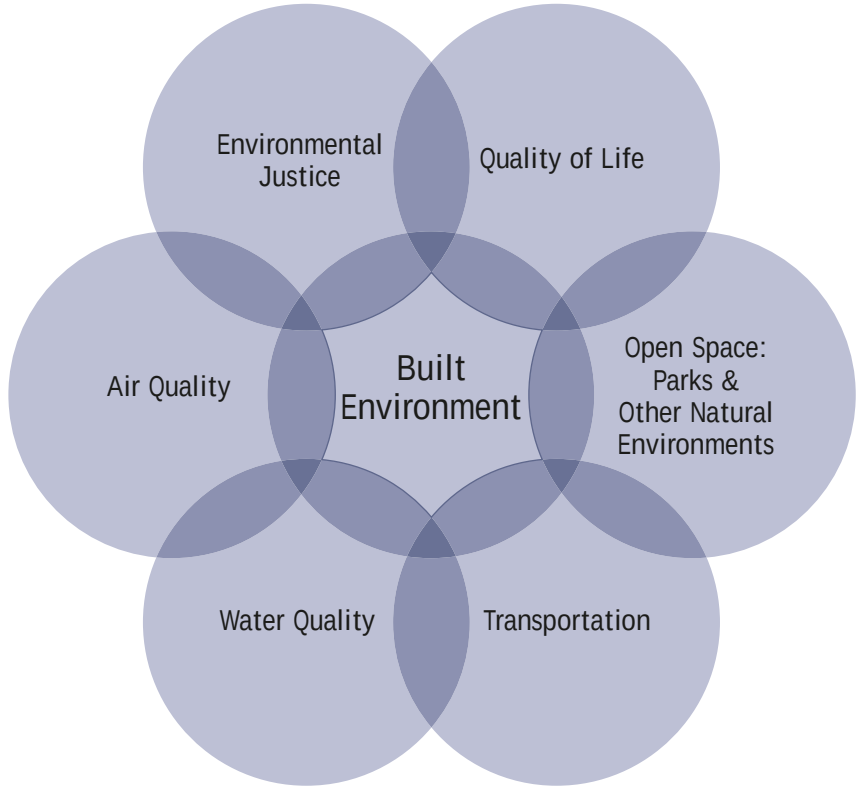
- Library Bond Program ($183.8 million through Nov 2004)—32 branch libraries.
- Animal Shelter Bond Program (154.1 million through Dec 2006)—8 LEED certified facilities.
- Fire Facilities Bond Program ($378.5 million through Dec 2006)—19 LEED certified stations.
- City parks, recreation facilities, child care, open space land acquisition ($25 million through 2026).
- Propositions 12 & 13 (estimated $300 million)—city portion of state approved bond to protect land/natural resources, drinking water, water quality and supply.
- Los Angeles Community College District new construction (approximately $525 million through 2005)—LEED Certified new construction on all 9 LACCD campuses.
- Other Projects—Griffith Park Observatory rehabilitation, California Zoo, Cabrillo Aquarium & Museum, Children's Museum, LA Riverfront.

Unlike "Sustainable Seattle" or similar programs in Austin, Boulder, and Santa Monica, there had not been until very recently, anything close to sustainable development in the public, institutional, or private sectors of the City of Los Angeles. Rather, initial efforts stemmed from volunteer participation in cooperation with specific city departments.

The recommendations of the document have been increasingly supported by the City Council of Los Angeles which voted to initiate the SBI by requiring that all city construction projects over 7500 sq. feet achieve at least LEED Certification, a first step towards the broader objective of LEED Silver certification throughout all city building programs. The SBI mandates a bottom-up process for the development and implementation of sustainable building practices and has sought to impact the over $1 billion now programmed for the design, renovation, and construction of municipal projects for the year 2002.

Concurrent efforts by the Los Angeles Community College District (LACCD) board demonstrate a growing awareness of the sustainable building practices advocated by the SBI and other local community and environmental organizations. The community college board similarly adopted a new sustainable building plan requiring that all new 7500 square feet and larger structures built using at least 50 percent of Proposition A funds meet LEED Certification standards.

Perhaps the most interesting of the upcoming municipal projects is the develop-



The built environment both affects and is affected by other environmental concerns, several of which have been treated in past Southern California Environmental Report Cards.

The Sustainable Design team at Fields Devereaux Architects & Engineers designed this new public library to meet the highest level of sustainability as rated by the U.S. Green Building Council's LEED system.

ment of six new animal shelters under Bond Measure Q. There are several unique aspects of this program which are exemplars. These include:

- Selection and education of non-green design experienced architects with built-in fees for an on-the-job type of learning experience.
- Hiring of a consultant team to create guidelines from LEED specific to this project.
- A determination that all buildings in the program shall achieve at least LEED Silver status.
- A view of the program as a prototype for both the new police facilities and the $750 million dollar fire station upgrade and expansion program.

Further evidence of a bottom up commitment to sustainable planning, and parallel to the efforts of the Bureau of Engineering and Bureau of Sanitation in creating the SBI, has been efforts by the Department of City Planning. The Department has worked within its sphere of influence to encourage infill in downtown Los Angeles, to increase housing along transit lines, and to facilitate mixed-use development by creating a Densification Incentives program. Although a host of details still remain to be worked out, the innovative approach and substantial resources being invested suggests a genuine commitment.

For these reasons, the City's overall effort in sustainable development and construction is awarded an **A**.

MUNICIPAL AND INVESTOR-OWNED UTILITIES

California is served by both investor-owned electric and gas utilities (e.g. Southern California Edison, Southern California Gas Company) and municipally-owned utilities which serve customers primarily within a city (e.g. Los Angeles Dept of Water—LADWP). As a group, all have had various energy conservation programs over the past three decades, many of which were the result of incentives by the California Public Utilities Commission, and more recently by the California Energy Commission. Recent programs have included:

- "Cool Roofs," encouraging installation of light-colored, heat reflecting roof surfaces;
- Replacement of old and energy- or water-inefficient appliances and plumbing fixtures;
- Energy efficiency rebates; and

Los Angeles has fewer urban parks than any similar city in its size range in the country. Only now is this being recognized and several creative efforts to remedy that deficiency are underway.

- State or utility rebate programs for installation of pre-certified on-site solar photovoltaic (PV) electrical generation systems.

The rebate program appears especially well-conceived. With rebates of up to 50%, PV systems are projected to pay for themselves in energy savings in under ten years. This program is the most visible effort by the state and utilities. The LADWP has established a clear leadership position in the rebate process by becoming the only utility in the state that added its own incentive—a job-creating additional rebate of $1.50/peak watt for photovoltaic modules manufactured within the city limits, onto their own $4.50/peak watt for systems under 35kW. Moreover, the LADWP Solar Team that is managing the rebate program appears to have been instrumental in changing the persona of the utility itself, as reflected by the substantial *Green Power for a Green LA* program, operated by the LADWP and supported by most city departments.

For these and related programs, the LADWP, Gas Company, and SCE all earn an **A**, notwithstanding the larger complexities of the state's now infamous deregulation program and current concerns for power

Before and after images of two former railroad yards along the Los Angeles River which were slated for industrial development but are now set to become new additions to the California State Park system.

Greening the LA River—Reclamation at Bosque Rio Hondo.

marketing practices by the state's utilities, public and private.

PRIVATE SECTOR

In the "early days" of sustainable development (a decade ago) totally mixed use developments in the inner city seemed to be more the stuff of urban critics than reality. Traditional zoning laws that rigorously separated land-use types were one of the many obstacles. Not surprisingly the first tentative efforts combined only two or three elements of what we now understand to be mixed use. For example, Village Homes near Sylmar was an infill project that developed one of the last parcels of cropland within the inner suburbs of Los Angeles. Within the development are highly energy efficient single-family homes with two kilowatts of photovoltaics on each house. In fact, then President Clinton came by rail to the site to introduce the HUD PATH (Partnership to Advance Technology in Housing) program nationally. Village Homes earns an **A-** grade, both for the energy and resource efficiency of its home construction and for the use of an inner suburb infill site as well as its location across from an AMTRAC Metro link at which a childcare center was created.

URBAN PARKS INITIATIVES

Los Angeles has fewer urban parks than any similar city in its size range in the country. Only now is this being recognized and several creative efforts to remedy that deficiency are underway.

An Inner Urban Park for the Eastern Part of Downtown Los Angeles Parts of two former railroad yards along the Los Angeles River are set to become new additions to the State Park system. The $33.5 million purchase of the 32-acre Cornfields and the $30 million purchase of the 40-acre Taylor Yards, two miles to the north, constitute the first open space and recreation complex ever developed by the state's Parks and Recreation department in downtown Los Angeles.

A Twelve Acre Park in the Arroyo Seco, Pasadena CA This 12-acre park now in development is the result of the acquisition of four separate industrial parcels along the Arroyo Seco, the Los Angeles River's largest tributary, which runs from the San Gabriel Mountains above the Rose Bowl and empties into the Los Angeles River just north of

An inordinately promising form of renewal that has multiple sustainable development benefits is the emerging market of rehabilitating fifties, sixties, and seventies office buildings that have outlived their useful lives.

downtown L.A. The first parcel is fully funded and site control is imminent. The assemblage of the parcels will create a new 12 acre park adjacent to the historic Pasadena Freeway. The park adds additional recreational fields to three schools located immediately near the proposed site and rids the neighborhood of properties that are considered crime-ridden eyesores. It creates additional open space in a highly urbanized, distressed, park-poor area which serves both surrounding neighborhoods and a local business district.

A park visitor center run by the Audubon Society, intended to be a prototype for other urban parks, is sited over a mile from the nearest power line and will depend on its building-integrated, solar photovoltaic array and battery backup for 24-hour electrical power.

The urban parks initiatives earn an **A+**.

RECLAMATION AND REHABILITATION PROJECTS

The Belmont Learning Center The Belmont Learning Center is an example of seeking to serve the broader community not only with a state-of-the-art high school, but also with ancillary mixed-use functions that were to be community-oriented and income-generating at the same time. Belmont has been the focus of intense environmental, political, and community controversy. This is a case where environmentally sound ambitions were thwarted by failure "one level down," at the scale of the project within the property line. While it is beyond the scope of this report to describe all of the original good intentions, the subsequent failure of intent, or the enormous amount of finger pointing and recriminations since, at least the following can be stated.

The Belmont Learning Center was originally created as perhaps the most ambitious effort in the region to date, to combine a wide variety of mixed uses—commercial, institutional, and educational—in a facility developed on a contaminated "brownfield." Those responsible for determining the extent to which the site was contaminated and the appropriate strategies for remediation somehow did not do their job. Serious defects with the site were discovered and made public about two-thirds of the way through construction. Initial indications were that no fully safe yet cost-effective remediation existed. As a result, construction was halted, and the $250 million dollar project was abandoned for over a year. Recent pressures by the community to have a new school in a neighborhood of overcrowded and somewhat rundown schools have caused the LAUSD School Board to reverse its stand and resume construction. However, it is not clear what remediation has been proposed that will make the site usable and safe.

Perhaps the most serious long term casualty is the idea of reclaiming contaminated sites at a time when the National EPA is working with communities across the country to rehabilitate and reuse an estimated 300,00 to 450,000 similar brown fields throughout the country. The project earns a grade of **D**.

Playa Vista The Playa Vista redevelopment of the former Howard Hughes/Hughes Aircraft Plant and runway is an intensely controversial development, large enough and containing so many mixed uses as to earn the title, "a city within a city." The project certainly exhibits a broad variety of sustainable planning and design strategies, including a set of development guidelines so environmentally demanding as to have caused at least one Los Angeles City Council member to propose they be the

The old Monty's building in Westwood Village has been reborn as the new Wilshire Center building. Once 40% vacant, the building has been renovated into a Class A real estate property and is now fully rented.

model for city-wide sustainable development standards.

A key strength of the development is the reuse of a former industrial site (Hughes Airport) within West Los Angeles that was perhaps the largest continuous unused or abandoned site within the city limits. Eventually, a large number of housing units of varying types will be provided to an area desperately in need, although at the cost of precious wetlands. Moreover, despite the promise of many opportunities for "live-work" arrangements, it appears certain the load put on surrounding streets will lead to near grid-lock traffic conditions.

The level of sustainable design exhibited by strong guidelines within the development have the potential to earn the project a **B**. However, the unresolved wetland and traffic problems earn the development only a **C** grade.

Rehabilitation and Reuse of Older Inner City Office Buildings Downtown Los Angeles has begun to share in a trend already widespread in other urban centers: the rehabilitation and conversion of old, often historic office buildings and warehouses in the center of the city into artists lofts, related live/work uses, and downtown condominiums. Developer Gilmore Associates has converted the Old Bank District buildings, including the historic San Fernando Building, the Hellman Building, and the Continental Building, into 240 units of loft housing, including street level commercial tenants such as a coffee shop, a restaurant and bar, a photo gallery/studio, and a community arts group gallery and workshop. In addition to the Old Bank District, other notable Gilmore Associates targeted projects include the reuse of the Hollywood Equitable Building, St. Vibiana's Cathedral and the Broadway Palace Theater.

These projects each earn an **A+**, both within the property line and beyond it, because they take the risky step of rescuing under-used, often decaying structures, repairing, restoring, and upgrading them in order to create new housing and live-work accommodations within the inner city.

Rehabilitation of Sixties Era Commercial Office Buildings A similarly risky but inordinately promising form of renewal that has multiple sustainable development benefits is the emerging market of rehabilitating fifties, sixties, and seventies office buildings that have outlived their useful lives. These reno-

Old, tired, energy inefficient office buildings can be converted into highly desirable tenant space for half the price of a new building.

vations focus on replacing and improving various amenities such as exterior elevations, main entry lobbies, elevator lobbies on the tenant floors, and elevator interiors. Early examples in Beverly Hills and Westwood suggest that old, tired, energy inefficient office buildings can be converted into highly desirable tenant space for half the price of a new building, in many instances occupying a site and zoning envelope that would not be permitted today.

The embodied energy savings represented by the reuse of so much existing structure and architecture puts the effort well ahead of any of its new development counterparts. The new jobs, and higher occupancy rates made possible, promise in-town rental square footage rates more competitive than those offered by low-rise speculative office buildings in the suburbs.

An excellent example of renovating a frumpy, half empty, even literally "smelly" sixties office building is the "Monty's Building" in Westwood. The design efforts by Nadel Architects for Arden Realty are exemplary. The project earns an **A+** both for its own rehabilitation and for bringing existing underused office space back into full occupancy.

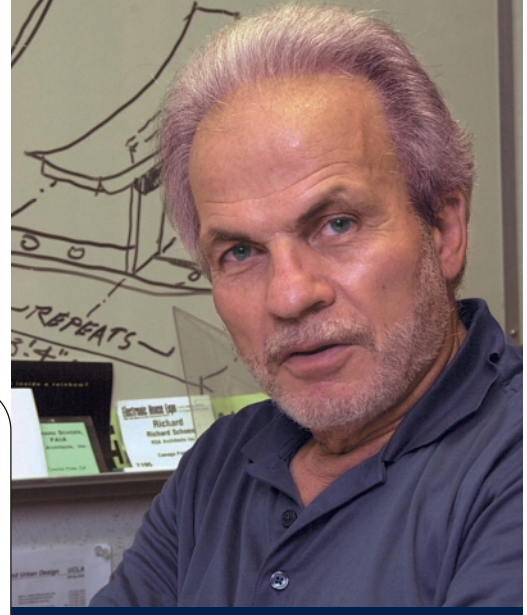
SUMMARY

Initially at least, it is apparent that sustainability in design and construction of the built environment in Los Angeles has been a highly individualized endeavor born out of the initiative of committed individuals and organizations in and out of government, as well as the private sector. A serious program of sustainable building is clearly underway in the City of Los Angeles government itself, although it took five years to reach this point and, even at that, the program is being implemented by stages rather than in a comprehensive manner.

ADDITIONAL INFORMATION

Information about public and private efforts in sustainable building in Southern California can be accessed through E-Flash, the City of Los Angeles's electronic newsletter on sustainable development, www.lacity.org/san/lasp, maintained not by the City of Los Angeles, but by the AB939 Sustainability Partnership.

The author wishes to thank Joanna Hankamer for her extensive and valuable contributions to the preparation of this article.



Richard Schoen's research, teaching, and professional work focuses on sustainable architecture and community planning with watershed issues; innovative materials and systems; and diffusion of innovation. He co-authored *New Energy Technology for Buildings: Institutional Problems and Solutions*. His sustainable architecture studio produced the student-designed Pt. Mugu Wetlands Visitors Environmental Learning Center, now in development for the Navy, National Park Service and the local community. Schoen invented the ARCO Solar-electric Batten and Seam Roof described by JPL as "the world's first architecturally-integrated photovoltaic roof system". His firm, RSA Architects, Inc. created the award-winning 2.5 acre solar-photovoltaic electricity-lighted space-frame parking shade structure at the Jeddah Airport in Saudi Arabia. Schoen works with photovoltaic manufacturers on production models as electric vehicle shade/solar-charging station structures. He designed a 62 foot rail-flatcar bridge that was fabricated entirely from recycled materials. It won the architecture prize in the International Design Resource Awards. Schoen was founding co-chair of the AIA/LA Committee on the Environment.

About the UCLA Institute of the Environment

MISSION

The UCLA Institute of the Environment (IoE) is an academic program devoted to interdisciplinary research and teaching focusing on key problems of the environment. The Institute is composed of faculty from a broad range of disciplines—the physical, life and social sciences, public policy, engineering, law, architecture and urban design, business, and public health and health sciences—working together to understand the nature of complex environmental systems, and to provide information for policy development and implementation.

GOALS

The principal goals of the Institute of the Environment, simply stated, are to:

1. Develop a world-class, broadly interdisciplinary environmental research and teaching program that addresses interrelated science and policy issues creatively and in-depth.
2. Support and extend continuing environment-oriented activities at UCLA, and in the community at large, by providing access to expert advisors, resources, and infrastructure.
3. Provide unparalleled leadership in environmental problem solving that is based on science and technology with social consciousness and sensitivity.

TEACHING

The Institute of the Environment enhances the experience of undergraduate students by introducing them to many aspects of the environment within a broad yet consistent framework. Classroom work is augmented by student contact with the Institute's diverse research programs, including fieldwork at remote UCLA facilities such as the Stunt Ranch Natural Reserve in the Santa Monica Mountains and the Ocean Discovery Center on Santa Monica Bay. Graduate students participate directly in a wide range of ongoing research projects, both in the field—at Point Mugu Lagoon, for example—and in the laboratory—including "wet" experimentation, computer modeling, and geographic information systems applications.

The Institute is currently developing a series of multidisciplinary courses at all academic levels. An undergraduate minor in environmental systems and policy has been organized. A plan to implement a multidisciplinary graduate degree program is under development.

RESEARCH

Institute of the Environment faculty, research scientists and students conduct a broad range of interdisciplinary investigations, all of which have an environmental theme, and many of which focus on Los Angeles and Southern California. For example, the Institute's Los Angeles "watershed" project involves more than a dozen faculty from eight campus units. A similar "airshed" project, housed in the Southern California Particle

Center and Supersite, is currently the largest university-based air quality research program in Los Angeles. The Institute's new Center for Tropical Research addresses a wide range of issues concerning habitat, biodiversity and conservation. Other research initiatives include:

- An Intel-sponsored Regional Environmental Assessment Laboratory and Geographic Information System (REAL/GIS) laboratory, in which integrated analyses of regional environmental problems are carried out.
- An EPA-funded project to identify the airborne sources and patterns of deposition of pollutants to Santa Monica Bay for water quality management purposes.
- A number of research projects focused on wetland characterization and remediation in Lower Malibu Creek and Lagoon, at Mugu Lagoon, and in Newport Bay.
- An Integrated Coastal Ocean Science and Management project, including the international Reef Check program, as well as coupled ocean circulation and biogeochemical modeling of coastal California.

OUTREACH

The Institute of the Environment is reaching out to the community in a variety of ways. This *Southern California Environmental Report Card* provides an annual assessment of the state of the local environment. Through the *GLOBE in the City* program, the Institute brings environmental science directly to K-12 classrooms across Los Angeles. This project recently teamed with the California Air Resources Board to set up air quality learning sites at local schools. Sponsored seminars and colloquia have covered topics as diverse as "Environment, Commerce and Opportunity," "California's Biodiversity Crisis: The Loss of Nature in an Urbanizing World," "The Electric Vehicle: Retrospect and Prospect," "Chimpanzees, Our Next of Kin: Language, Ethics, Conservation," and the "Galapagos: Paradise Lost?" A major international conference on "Experimental Approaches to Conservation Biology" was organized by the IoE last fall.

LOOKING AHEAD

Over the next few years, the Institute of the Environment will organize its interdisciplinary teaching and research activities within a series of centers of excellence, with the goal of expanding the boundaries of interdisciplinary environmental analysis. Four new faculty will be resident at the Institute by the end of this year. They, along with current faculty, will launch major projects in areas broadly related to environmental sustainability, focusing on the Southern California region. A new graduate program will be proposed this year—the first of its kind to link the spectrum of environmental disciplines at UCLA. The Institute also plans to continue its outreach programs, including the *Environmental Report Card* and *GLOBE in the City*, and to build community partnerships. Finally, the IoE is initiating a development program to support its educational and research activities, and we encourage those interested in our work to contact the Institute's new Development Officer, Ms. Sarah Burns (sburns@support.ucla.edu).

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