Why the Grass Isn't Always Greener

In the United States in the eighteenth century, lawns were a novelty, green carpets grown by the wealthy as part of a new European, "naturalistic" fashion in gardening. As farming diminished and cities grew, lawns grew with them, naturalizing into U.S. culture to such a degree that the month of April is known not only for its showers and Earth Day, but also for being National Lawn Care Month.

In the United States, some 46.5 million acres of roadsides, lawns, golf courses, cemeteries, parks, and sports fields are blanketed with turf—more than the total U.S. acreage of cotton, sorghum, barley, and oats, according to the EPA. The green carpet has spread past U.S. borders into Canada and Europe, while booming new turf markets have opened in Southeast Asia and Australia. With the growth of lawns has come a host of concerns about human and environmental health.

Today, some see a velvety lawn as an ideal, others as a plague. Environmentalists and communities accuse the golf and turf industries of misuse or overuse of pesticides and water, destruction of ecosystems, and threats to biodiversity; turf proponents see lawns as a functionally useful and beautiful feature of a developing world. Sorting fact from falsehood involves sifting through a tangle of influencing factors, including the paucity of data on grass and turf, differences in scientific views, and clashes among the cultures of science, business, environmentalism, and recreation.

"This is a very complex field," says James B Beard, a turf grass stress physiologist, professor emeritus at Texas A&M University in College Station, and president of the International Sports Turf Institute. "You can't just focus on a single issue. You need to take a balanced view, and consider the interacting impacts together."

A History of Grass

The grass family Poaceae is among the most abundant of the vascular and flowering plants. Grasses are quick to colonize barren territory, spreading by means of an extensive fibrous root system. Only about 50 of the estimated 7,500 grass species are cultivated for turf. All 50 of these species are naturalized. Colonists imported them to the United States (along with clover, dandelions, and other "weeds") to feed their livestock—also imported—because the native grasses were so low in nutrition.

Beard says there is an ecological reason why low-growing grasses were superior for this purpose. "Native grasses of North America evolved in concert with bison, antelope, and deer, [whose] mouthparts are adapted to grazing tall grasses. Most of the turf grasses evolved 40 million years ago in Central Europe, along with ungulates like cows and sheep. The basal growth of the European grasses allows them to survive grazing—and mowing. Evolution favors their present function."

The popularization of lawns ran parallel to urbanization, technological advances, and the expansion of national distribution networks. The first U.S. lawn mower patents were filed in 1868, the first sprinkler patents in 1871. By 1987, an agrostologist at the U.S. Department of Agriculture (USDA) publicly advocated single-species lawns for all suburban homes, the grooming of which would "bespeak the character of the owner." And in her book *The Lawn: A History of an American Obsession*, author Virginia Scott Jenkins cites numerous quotes and advertisements implying that well-tended lawns and high moral fiber are inextricably linked. Golf, a game that may have originated in Julius Caesar's day, made its U.S. debut in 1888 in a New York cow pasture; by 1902, there were 1,000 golf courses in the United States. By 1912, the USDA and the U.S. Golf Association (USGA) were collaborating on turf studies.

Today, the lawn and turf industry, including machinery, sod farms, and private and commercial lawn care, generates approximately $25 billion annually and employs over 500,000 people. The U.S. golf industry, with an estimated 16,000 courses covering some 2.4 million acres, 25 million U.S. players, construction, maintenance, club dues, and employment, generates $64 billion each year, and spends $8 billion in chemicals and equipment, according to the Golf Course Superintendants Association of America (GCSAA). Overseas turf sales, though hard to track, are growing; Toro, a Minnesota-based lawn maintenance and irrigation company, earned $152 million in overseas revenues in 1995 alone.

Golf is an international sport. A 1996 survey by the renowned Scottish golf club St. Andrews, though incomplete, tallied over 25 million golfers from respondents at 11,600 golf clubs in Europe, Australia, and parts of South America, Africa, the Middle East, and the Far East.

The Pros and Cons of Lawns

There's no doubt that a "perfect," weed-free green lawn takes effort to maintain. "I don't think you'd find an ecologist who would say that a treated lawn is not a high-energy, unstable system," says Sam Droege, a wildlife biologist with the U.S. Geological Survey's (USGS) Wildlife Research Center in Patuxent, Maryland.

The roar of lawn machinery contributes to noise pollution, with machines such as leaf blowers reaching 120 decibels, a potentially damaging level. Lawn equipment also contributes to air pollution: according to the EPA, 90 million lawn and garden machines emit 6 million tons of pollutants—5% of total annual emissions—including hydrocarbons, particulates, nitrogen oxides, carbon monoxide, and carbon dioxide. The EPA also reports that lawn clippings constitute almost 21%, or 31 million tons, of material added to municipal dumps annually—an unnecessary use of space, as clippings can benefit lawns if left to decay.

Opponents say that the spread of lawns and golf courses has destroyed native plants and ecosystems in favor of an artificial, "chemically addicted," unsustainable monoculture. In *The Lawn: A History of an American Obsession*, Jenkins describes how forests and marshes have vanished before the "front-lawn aesthetic," creating "a savannah from coast to coast."

The Chemicals Question

During the post-World War II boom years, a new breed of chemical weapons was trained at the Japanese beetles, crabgrass, grubs, earthworms, and other "pest" organisms that threatened U.S. lawns. Environmental awareness was virtually absent, and DDT (called "the atomic bomb of the insect world") and other pesticides were heavily marketed. Protests against the demands and environmental effects of lawn care surfaced in the mid-1950s and gained momentum with the 1962 publication of *Silent Spring*. In this book, author Rachel Carson pointed out the dangers of lawn care "super poisons" such as arsenic, 2,4-D, chlordane, and DDT. These chemicals, she wrote, "give a giddy sense of power over nature to those who wield them." Arsenic, chlordane, and DDT were eventually banned for most uses, but 2,4-D and other chemicals, some of them highly toxic, are still on the market. Their use and alleged abuse constitute the most complex and controversial issues in the turf wars.

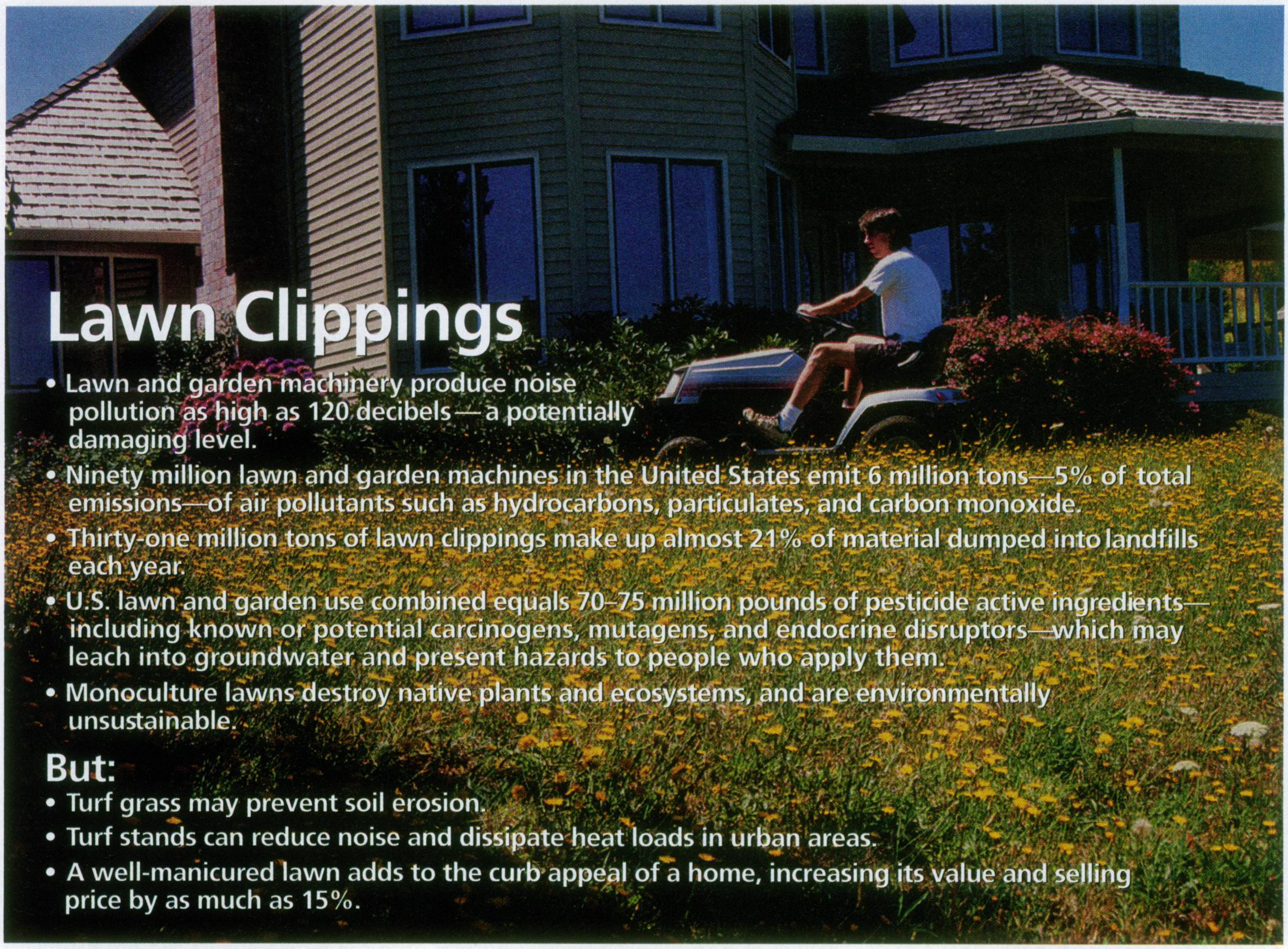
According to the EPA, in 1996 U.S. citizens used an estimated 70 million tons of fertilizer (lawn and garden use combined) and 70–75 million pounds of pesticide active ingredients (12 million pounds of insecticides, 45 million pounds of herbicides, and 5.4 million pounds of fungicides), valued at a total of $1.13 billion. The EPA's 1996 *Fact Sheet on Lawn Care Pesticide Use* reports that approximately 55 pounds of pesticide active ingredients per acre were applied annually to the average golf course. Homeowners rank above lawn care organizations (LCOs) in insecticide and herbicide use, while golf courses lead in fungicide use, employing more than six times more fungicide than homeowners, and nearly 15 times more than LCOs. (Putting greens receive the most intensive doses; roughs may receive little or no pesticides.) This pesticide use has generated outcries among the environmental community against the turf and golf industries, and against lawn cultivation in general.

The EPA is responsible for regulating lawn pesticides under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). FIFRA establishes a tolerance, or allowable residue, in raw and processed foods, animal feeds, and food additives, based on the Federal Food, Drug, and Cosmetic Act. All registered chemicals undergo extensive mandatory testing that includes determination of residues in food, environmental fate, degradation rate, accumulation, acute and subchronic hazards from oral and dermal absorption, metabolism if absorbed, teratogenicity and mutagenicity, spray drift, nontarget exposure, and exposure of employees. Registration does not imply that a product is safe, only that it will perform its intended function without "undue adverse effects on the environment." Under the latest modification to FIFRA, the 1996 Food Quality Protection Act, the EPA has also added testing to address risk to vulnerable populations such as children and the elderly, endocrine-disrupting potential, and aggregate risks posed by multiple chemicals with a common mode of action whose synergistic effects must now be examined.

The EPA has been subject to criticism because pesticide reregistration, originally scheduled to be completed in 1976, is still incomplete (with 170 active ingredients reregistered in a 1995 count). Additionally, some groups claim that labeling regulations prevent consumers from assessing potential risks not only from active ingredients, but also from inactive ingredients that are not always listed, though they can also be highly toxic.

One objection to lawn pesticides is their effect on nontarget organisms. In 1986, the EPA banned diazinon for use on golf courses and sod farms because of frequent incidents of bird kills (ranging from 1 to 800 birds at a time) related to its use. However, diazinon is still approved for household use. An insecticide, it is also toxic to beneficial animals such as bees. Chlorpyrifos, used in agriculture and also to control mosquitoes and turf-destroying insects on golf courses, has been shown to cause harm or death to nontarget organisms such as fish, aquatic invertebrates, birds, and humans. In his 1987 book *Pesticide Use and Toxicology in Relation to Wildlife*, Gregory Smith stated that, though there is little evidence that organophosphates and carbamates are causing significant population changes in wildlife species, pesticide users should understand that following label instructions does not ensure wildlife will not be killed—weather conditions, the season, and mating and migratory habits of local fauna should also be considered.

Other concerns center on the level of risk to human health from chemicals that the EPA considers acceptable. In the United States, organochlorines such as DDT, which persist in the environment and in human tissue, have largely been replaced by organophosphates and carbamates. Although these chemicals usually degrade quickly in the environment (though tests of the herbicide glyphosphate showed that the pesticide lingered as long as 140 days in the environment), many can



also be extremely toxic. Of the nine most commonly used home and garden pesticides, two (2,4-D and carbaryl) are suspected endocrine disruptors and possible human carcinogens. These chemicals inhibit the action of cholinesterase, an enzyme essential to neurological function; low-level poisoning can cause flulike symptoms, while high doses can cause convulsions and death.

At present, the links between lawn and garden pesticides and human cancers, endocrine disruption, and birth defects are unclear and there is a need for more research. "We have a lot of toxicity data, but little information on exposure, including exposure through behavioral means," says Christopher J. Borgert, a consultant at Applied Pharmacology and Toxicology in Alachua, Florida. Borgert worries that people may misinterpret scientific data on risk and exaggerate the hazards of pesticides. "Pesticide applicators are not at [greater] risk of cancer or birth defects, though common sense would tell me that they're more exposed than other groups," he says. "But my common sense is not data. We need to do good exposure studies for activities other than pesticide application, and get those questions answered."

The absence of clear human health impacts does not imply an absence of hazards, according to Droege. "I find the lack of proof of hazards somewhat specious," he says. "Another way to look at risk is to look at the cost of making a mistake. What are the consequences if these chemicals have a big effect? The risk could be hidden in the noise of outdoor variables like time, weather, and soil. Look at what happened with DDT, and the reason: not to have fruit and vegetables for Biafra [but rather] to have a beautiful lawn."

The trend in pesticides is to seek more impact with lower use. Eventually, Beard predicts, chemical pest control will be replaced with biological controls, growth regulators, and plants modified by biotechnology. Until that time, given present development strategies, pesticide use on lawns and turf is expected to continue. "Pesticides are essential tools if we're going to manage the planet the way we're doing," says Carol DiSalvo, a biologist and integrated pest management (IPM) specialist with the National Park Service's Washington, DC, office. "But you can't call them safe. People need to understand the risks associated with pesticides before consenting to have them on their lawns."

Turf and Water: Quality and Quantity

Concerns about pesticides and turf cultivation are not confined to terrestrial effects. A 1996 USGS fact sheet, *Pesticides in Ground Water*, stated that a variety of pesticides were detected in wells. Less than 2% of wells studied (mostly in agricultural areas) had concentrations exceeding EPA maximum contaminant limits, but water quality criteria have not been established for many pesticides. Furthermore, the fact sheet said, little is known about pesticides in urban areas, though residues have been detected in waterways adjacent to nonagricultural areas including golf courses, commercial and residential areas, and public gardens.

The USGS is now preparing a report about pesticide runoff in urban areas.

"We're clueless about how many chemicals are being used in urban areas and how much is applied. When and what is applied is often constrained by local [agricultural] extension agencies. We're only now getting the national picture, and there are huge information gaps," says Daniel J. Hippe, a supervisory hydrologist at the USGS in Atlanta, Georgia. The transience of urban life contributes to these gaps, he says, making cause-and-effect relationships difficult to determine and providing few people with a personal stake in protecting or restoring local streams. "The average person didn't grow up playing in the streams here. Talk about not having a tie to the land," says Hippe.

Hippe says that turf chemicals appear year-round in streams. "In Atlanta, diazinon, chlorpyrifos, and carbaryls have exceeded aquatic guidelines," he says. "I think that a small percentage is escaping, mainly from storm drainage, and if that's so, the problem could be serious. If we were seeing 30–40% of [total use of a given pesticide] in a stream, then we could get a management plan. But if a tiny amount is coming off at unpredictable times, there are few tools to control it."

Many pesticides are toxic to aquatic organisms in concentrations much lower than permitted levels for human consumption. And although numerous studies using models and test plots show minimal leaching when pesticides are applied in appropriate quantities in accordance with soil conditions and with proper irrigation, Hippe isn't convinced. "A test plot is interesting, but in urban areas there's so much artificial drainage," he says, "and modeling is done on a limited scale [so] does that represent the watershed? The best way is to combine data collection and modeling with monitoring." However, in a complex urban setting, the cost of monitoring the movement of a broad array of chemicals would be enormous.

Human error by both homeowners and turf professionals may be contributing to nutrient overloading. In the 1993 publication *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*, the EPA cites a study showing that over 50% of nitrogen leaches from a lawn when improperly applied. In the Chesapeake Bay watershed, urban areas (including lawns, gardens, and golf courses) account for about 10% of land use, and contribute about 14% of the phosphorus and 11% of the nitrogen entering local waterways, according to a 1993 white paper produced by the Alliance for the Chesapeake Bay. A 1989 paper by the Natural Resources Defense Council titled *Poison Runoff: A Guide to State and Local Control of Nonpoint Source Water Pollution* estimated that between January and October, around 1 million pounds of phosphorus was flushed from the streets of Washington, DC, nine times the amount released from the city's Blue Plains sewage treatment plant, which serves 4 million people. Excess phosphorus in water encourages algal blooms, which can lead to oxygen depletion and suffocation of other aquatic life. Agriculture still overshadows development as a source of watershed nutrients—but studies on urban development are sparse.

Pesticide and nutrient runoff can have serious effects on aquatic ecosystems. "The nitrate standard for drinking water is 1,800 times higher than the safety level for estuaries," says Todd Miller, executive director of the North Carolina Coastal Federation, a nonprofit environmental advocacy organization. Miller says the proliferation of golf courses, often located on the coastline to take advantage of the ocean view, may harm fragile coastal ecosystems and hurt the shellfish industry. "The water has to be pristine for the shellfish harvest," he says.

In 1993, JoAnn Burkholder, an associate professor of botany at North Carolina State University in Raleigh, conducted research establishing that even low levels of nitrogen (10–100 times lower than the milligram-per-liter levels referenced in turf grass studies) can be lethal to eelgrass, which shelters and nourishes fish, waterfowl, and shellfish. According to a paper presented by Burkholder at a 1993 golf industry symposium, both agriculture and development have contributed to increased turbidity and nutrient loading, resulting in large-scale destruction of eelgrass meadows—85% in the waters off New Hampshire, 40% in the Chesapeake Bay, and nearly 100% in the Delaware Bay have been destroyed. Increased nutrients have also been associated with the recent outbreaks of the toxic dinoflagellate *Pfiesteria piscicida* in rivers of the mid-Atlantic states and a global increase in the incidence of algal blooms that poison shellfish as well as the fish and humans who eat them.

In her paper, Burkholder said that environmental issues associated with golf course management and construction called for "essential research" on runoff and sediment in golf watersheds (not the test plots that are commonly used), characterization of site-specific hydrologies, and assessment of the impacts of golf course construction and maintenance on surface water quality.

Besides water quality, another water issue related to lawns and turf is quantity. The USGS *National Water-quality Report, 1995*, which was based on a U.S. population of 267 million, shows that the domestic sector uses 26.1 billion gallons per day (compared to 134 billion gallons per day for agricultural irrigation). The average household uses about 100 gallons of water per day, with about 13% of that going to lawn watering annually, although that figure varies with climate, and may be distorted by leakage and seepage in old water supply systems. Lawn opponents accuse turf stands of gobbling up scarce water resources, and suggest planting shrubs and trees. However, what little comparative research exists shows that trees and shrubs actually use more water than grass—up to 80 times more in some species. The water needs of turf stands vary according to grass variety, season, soil, and climate.

Determining golf course water use is more problematic because, as one golf professional said, "golf courses are like snowflakes—every one is different." Two golf courses only a few miles apart can vary dramatically in terms of moisture levels, temperature, and soil composition, and variations also exist from state to state. Few states have disaggregated statistics on golf course water use. But according to the USGS, some 530 golf courses in North Carolina (one of the few states for which water use numbers are available) consume 144 million gallons per day in irrigation—60% of total irrigation withdrawals, and over twice the water consumption of the 579,500 people living in Mecklenburg County, the state's largest county. "A lot of [golf courses] have automatic irrigation systems—you'll see the sprinklers running in the rain," says Douglas Walters, a hydrologist and water use specialist at the USGS in Raleigh, North Carolina.

Golf course managers have become increasingly aware of the economic benefits of proper watering, which may also lead to environmental benefits. Along with environmental representatives, the golf industry developed a handbook, *Environmental Principles*, that includes recommendations for minimizing water use including planting species according to availability of water and irrigating at appropriate times to minimize disease potential. In a recent survey, 86% of GCSAA members reported that they were practicing a variety of conservation measures, primarily for economic reasons, and were seeing an average decline in costs of 21%.

The Human Factor

Many questions on lawns and turf are inseparably tied to the costs and benefits of development. And attacks against the so-called

The Environmental FOREfront

Planning and Siting

- Site selection is a critical determinant of the environmental impact of golf courses. For every site, there will be local environmental issues and conditions that need to be addressed. A thorough analysis of the site or sites under consideration should be completed to evaluate environmental suitability. Developers, designers, and others involved in golf course development are encouraged to work closely with local community groups and regulatory/permitting bodies during planning and siting and throughout the development process.

Design

- Courses should be designed with sustainable maintenance in mind. The design should incorporate Integrated Pest Management (IPM; see below) and resource consideration strategies that are environmentally responsible, efficient, and cost-effective. The design of the course should enhance and protect special environmental resource areas, and improve or revive previously degraded areas within the site, when present, through the use of plants that are well adapted to the region. Native and naturalized vegetation should be retained or replanted when appropriate in areas that are not in play. Emphasis should be placed upon the design of irrigation, drainage, and retention systems that provide for efficient use of water and the protection of water quality. Designers should seek opportunities to create and preserve habitat areas that enhance the area's ecosystem.

Construction

- Designers should develop and implement strategies to effectively control sediment, minimize the loss of top-soil, protect water resources, and reduce disruption to wildlife, plant species, and designated environmental resource areas.

Plant Protection and Nutrition

- Course managers should employ the principles of IPM, a system that relies on a combination of commonsense practices of preventing and controlling pests (e.g., weed, diseases, insects). In IPM, pests are identified through regular monitoring, damage thresholds are considered, all possible management options are evaluated, and selected control(s) are implemented.
- Course managers also should store and handle all pest control and nutrient products in a manner that minimizes worker exposure and the potential for point or nonpoint source pollution. Groundskeepers should use nutrient products and practices that reduce the potential for contamination of ground and surface water, such as slow-release fertilizer, selected organic products, and fertigation. Soil conditions must be tested and monitored regularly, and practices modified accordingly. Selected nutrient products and time applications should meet, not exceed, the needs of the turf grass.

Water Usage

- Designers should use native naturalized or specialized drought-tolerant plant materials wherever possible. Irrigation patterns should be planned and irrigation control systems programmed to meet the needs of the plant materials in order to minimize overwatering. Groundskeepers should water at appropriate times to minimize evaporation and reduce the potential for disease, and, when feasible, use modern irrigation technologies that provide highly efficient water usage.

Waste Management

- Groundskeepers should leave grass clippings and other organic materials in place whenever agronomically possible, or compost and, if possible, recycle them. Chemical rinsate should be discarded in a manner that will not increase the potential for point or nonpoint source pollution (methods include recycling the rinsate or spraying out diluted compound in previously untreated areas.)

Wildlife Management

- Habitats for wildlife species that help control pests (e.g., bats, bluebirds, purple martins, etc.) should be protected, and managed to maintain healthy populations of wildlife and aquatic species. Additional accommodations for these beneficial species should be created whenever feasible and environmentally desirable.

Facility Operations

- Facilities should adopt practices and technologies that conserve natural resources, including water and energy. Facilities should develop and initiate comprehensive programs for recycling, reuse, and waste reduction. Facilities should properly store and dispose of solvents, cleaning materials, paints, and other potentially hazardous substances.

What Golfers Can Do to Help

- Golfers should respect designated environmentally sensitive areas within the course, and accept the natural limitations and variations of turf grass plants growing under conditions that protect environmental resources (e.g., brown patches, thinning, loss of color). They also should support golf course management decisions that protect or enhance the environment, and commit to long-term conservation efforts on the golf course and at home.

Adapted from: United States Golf Association. *Environmental Principles for Golf Courses in the United States.* http://www.usga.org/green/download/environmental_principals.html lawn culture may obscure the benefits that turf grass gives today's altered landscapes. "In terms of what turf can contribute functionally, I'd say it's one of the better friends of environmentalists," says Beard. "If we eliminated turf grasses, with development expanding, we'd be in a sorry state."

Since 1980, the USGA has funded over $12 million in valuable research on many aspects of turf grasses, contributing to increased understanding of the nature of turf and pointing to improvements in turf management. But research on turf in urban areas is almost absent. Beard and other experts stress the need for research to fill the many gaps in understanding how turf grasses function, and where they can be used in urban and recreational landscapes.

Lawns, turf, and golf courses, as well as their positive or negative environmental impacts, are part of a long-held set of assumptions about development—assumptions that don't always factor in the natural history of soil and plants. "For crop and horticulture plants, one would select a favorable climate and soil to provide maximum yield," Beard says. "But for landscaping and ornamentals, soils are turned upside down in building site construction, leaving the nutrient-deficient subsoil on top. Grasses, trees, and shrubs are planted outside their normal environmental adaptation, and expected to grow. And we wonder why we need fertilizer."

Human behavior and culture, and ignorance of the nature of grasses, play a strong role in the lawn culture. Michael Raupp and John Davidson, extension entomologists at the University of Maryland in College Park, wrote in the 1997 pamphlet *Landscape IPM: Guidelines for Integrated Pest Management of Insect and Mite Pests on Landscape Trees and Shrubs* that lawns can generally withstand some infestation—up to 20 grubs per square foot, for example—without significant damage. But when weed or insect damage is considered ugly or unsightly, homeowners often apply pesticides.

Public perception also favors a dark green grass, though Beard says that dark green grass achieved by fertilization is not the healthiest grass. "A moderately green grass is healthier," he says. When grasses enter their natural dormancy, often in the summer, many homeowners apply water to "green up" their lawns, even though it is considered acceptable for deciduous trees to go dormant in the fall. The custom of raking dead leaves robs urban soils of a potential source of nourishment. Sending lawn clippings to the dump, rather than leaving them to decompose on the lawn, deprives the soil of an additional source of nutrients. This nutrient depletion is an even more serious problem in public areas, such as the National Mall in Washington, DC, where crowds gather in the hundreds of thousands, compacting the soil, killing its flora, and impairing the health of trees and turf.

According to the Turf Resource Center in Rolling Meadows, Illinois, a dense lawn is planted with six plants per square inch, with as much as 387 miles of root per plant. The narrow-bladed leaves of turf grasses, plus their network of fibrous roots, result in a dense surface (up to 66 billion shoots per hectare, with 1,000–32,000 kg/ha of biomass) that provides valuable soil erosion prevention. In a survey of the scientific literature published in the May–June 1994 issue of the *Journal of Environmental Quality*, Beard and Robert L. Green, an agronomist in the department of botany and plant sciences at the University of California at Riverside, cite studies showing that "quality" turf grass stands modify storm water flows on land "so that runoff is insignificant in all but the most intense rainfall events."

Beard and Green's paper also documents that properly cultivated turf grasses can improve and restore soils. Based on 1976 data of a 42% annual turnover of a lawn root system (which includes decay and consumption by animals), Beard projected a conversion of 6,761 kg/ha of root biomass into soil annually. Claims that turf grasses are "thirstier" than shrubs and trees have been disproved; rather, many grasses evolved to withstand drought. Turf stands are effective in reducing noise, and have been shown to dissipate the radiant heat loads typical of urban areas, with positive implications for savings on home cooling.

Research is scanty, and some of it is decades old, but there are strong suggestions that turf grass stands provide benefits in terms of filtration of polluted runoff. Lawns have a perceived economic value, too. Homeowners responding to a 1986 Gallup survey said that landscaping (including lawns) added almost 15% to the value or selling price of their homes. And the "curb appeal"—a pleasing first view of a landscaped home—is said to reduce the time a house stays on the market.

Golf Courses and the Environment

The picture-perfect vistas to which golfers are accustomed may exact an environmental toll. The grandfather of golf courses, St. Andrews in Scotland, originally was maintained by nature itself, with the putting greens kept in trim by grazing rabbits. But in the United States, golfers have come to expect a more uniform, manicured look.

"There's something I call the 'television effect,'" says Michael Alexander, chair of the Sierra Club's Presidio Task Force in San Francisco, California. "Golfers watch the U.S. National Tournament at the Augusta [Georgia] golf course, one of the world's great courses. The course has been styled to appear perfect for a TV show, although it doesn't look that good for the rest of the year. But golfers around the country see that magnificent-looking course, and then pressure their local golf course managers to replicate the Augusta course even though the local climate, soils, and native plants may not be at all like those in the Southeast."

Golf course fairways and greens are subject to assaults from diseases and other plants and pests, including brown patch, dollar spot, pink snow mold, daisies, kikuyu grass, chickweed, beetles, borers, and nematodes, that can mar the aesthetics of the course. Golfers who do not understand the nature of grass may see pesticides as a preferable first line of defense.

Another human factor has been the traditional schism between turf professionals and environmentalists. The two groups had virtually no interactions until 1995, when a meeting of 25 golf industry representatives, environmentalists, citizens' group representatives, and the EPA was convened in Monterey, California, at the Pebble Beach Resort. "Before this meeting, the golf course community thought they were good environmental stewards, and the environmental community thought golf courses were a blight on the face of the earth," says Phil Oshida, chief of the EPA's Wetlands Strategy and State Programs Branch. "But both sides saw that they had many similar concerns."

Meeting participants formed a golf and environment steering committee and worked together to produce a document that outlines principles for environmentally sound golf course design, and addresses planning, siting, design, construction, operation, and maintenance (including plant protection, IPM, proper water use, waste management, and wildlife management). The document also outlines the environmental responsibility of golfers. The principles are voluntary, but their guidance assumes that golf course managers will comply with federal and state environmental regulations.

The coalition has continued its activities with a pilot project to set up a method of tracking environmental performance by golf courses in issues such as water management, pesticide and fertilizer use, and wildlife habitat conservation. Participating golf courses report to the coalition for purposes of gathering data; there are currently no penalties in place for noncompliance. Some 50 golf courses are participating in the project, which will be completed in early 1999.

Golf courses differ not just from site to site, but from culture to culture, and this has important implications for the environment. Regulations protect the environment surrounding golf course sites in the United States, Europe, Japan, Australia, and Canada. But in the developing world, particularly in the Far East, where 6,000 golf courses are operating and an estimated 350 new courses are opened annually, the growth of the turf and golf industries is worrisome to environmentalists. "There are not as many, sometimes hardly any regulations requiring public participation, environmental impact statements, or environmental protection," says Ron Dodson, executive director of the Audubon International, a nonprofit environmental organization based in New York City.

In the United States, the continuing development of golf courses strains the new alliance between golfers and environmentalists. Golf course architects say they must spend as long as two years ensuring that courses meet environmental standards, only to have environmentalists bring in new demands at the eleventh hour. Critics of the golf industry claim that complying with current regulations isn't enough. "The regulations are location-dependent, and some states do more than others," says Miller. "In North Carolina, [no regulations are] specifically geared to golf course development, but it's a major land use." Miller continues that, although siting is a crucial environmental issue, North Carolina regulations do not address the fact that many courses are built in fragile coastal areas, accompanied by the construction of adjacent homes—and once the construction has been completed, it is difficult to address the resulting environmental problems.

To many golf course professionals, siting is still a zoning issue, and golf course development is a matter of entrepreneurial skills. Environmentalists tend to view siting in terms of endangered wildlife and habitats. "But there are many factors involved in siting, and some of them overlap," says Oshida. "You have to consider water conservation, soils, and topography. It's possible for golfers and environmentalists to find common ground. You can't just say you shouldn't build a golf course in a certain kind of environment. Not all wetlands are the same, for example. And you can say you shouldn't build in coastal areas, but Pebble Beach is probably one of the best managed courses in the United States. But there are some places where a golf course shouldn't go."

Golfers and environmentalists have agreed on a new trend: building courses on abandoned or no longer useful industrial sites. Widow's Walk Golf Course was constructed in collaboration with environmentalists on a quarry near the landfill in Scituate, Massachusetts. Construction of the $2.4 million course involved both filling and preserving specific wetland areas, installing a radio-controlled irrigation system, using bacteria to control nutrient intake and fungal invasions, and planting a new strain of low-water-use grass. The $12 million Harborside International Golf complex in Chicago, Illinois, was created atop a 220-acre former industrial site. The Coyote Hills course near Fullerton, California, features badlands and streams winding through a working oil field. And the Fairwinds Golf Course in Fort Pierce, Florida, was constructed on a landfill and irrigates using recycled wastewater that is purified as it moves through the system. Other golf courses have been built on former sites of limestone quarries, coal mines, sand and gravel pits, and concrete factories.

"The dialogue between [the] golf and environmental communities is a positive step, and we've found common ground. But there are many issues that are not addressed," says Jay Feldman, executive director of the National Coalition against the Misuse of Pesticides. "The basic problem is not the management or construction of a site," he says. "Are 16,000 golf courses enough? Pure development is the issue."

It may be some years before the golf and turf industries become environmentally correct. Jim Fazio, the same designer whose golf course at Fairwinds rejuvenated a landfill, also designed the $60 million golf course at Shadow Creek, near Las Vegas, importing mature trees, water, "wildlife," and synthetic rocks to superimpose a Carolina-type landscape atop the flat Nevada desert. "There's a disjuncture between [the environmentalist/golf collaboration] and current practices," says Feldman. "It's a natural transition. We won't change the industry overnight. But we've made an important breakthrough."

Still, a recent trend toward environmentally sound golf courses may offer new opportunities for richer wildlife communities. Environmentalists stress that golf courses are no substitute for wilderness. "But there's no question that golf courses have the potential to be some of the last wildlife refuges in urban and suburban landscapes," says Sharon Newsome, director of environmental programs at the Washington, DC-based Physicians for Social Responsibility. A number of golf courses cultivate native plants as part of their roughs, reducing maintenance costs and increasing available wildlife habitat. The Firethorn Golf Club in Lincoln, Nebraska, features prairie-style roughs. The golf course at Prairie Dunes Country Club in Hutchinson, Kansas, supports a higher (though less diverse) population of birds than the nearby, much larger Sand Hills State Park.

Turf and Biodiversity

Only a few of the many species of grass are suitable for turf culture. These include bluegrass, fescue, and ryegrass in the North, and saint augustine grass, Bermuda grass, and centipede grass in the South. Turf for colder climates generally consists of a mixture of four or five species or varieties; in the warmer South, turf is usually a single variety.

Many environmentalists and scientists criticize the turf industry as a destroyer of biodiversity. "The goal of the lawn care industry is to decrease biodiversity," says Droege. "They want to get rid of diseases or weeds that compete—what are those but biodiversity? A chemically controlled lawn is an artificial state, a monoculture; it wants to change, so you have to treat it, and spend a lot of time on it. With complexity, there are many fail-safes. But with a monoculture, you always have to address diseases. Disease organisms are affected by other plants and animals. The more complexity there is, the more opportunities to combat disease."

Craig Tufts, chief naturalist at the National Wildlife Federation (NWF), adds that biodiversity is of particular concern in urban landscapes. "Urban growth is probably the largest destroyer of habitat, and most of the growth goes into residential development—homes and landscapes," he says. "A predominant theme of those landscapes is turf grass. Our concern is that we're substituting diverse ecosystems—including about 1,400 native plants in Virginia, for example—with about 300 plants, shrubs, and trees, mostly nonnative. The landscape once provided food and cover for a large diversity of birds and mammals, and we're replacing that—as we've done with agriculture—with just a few hundred species of plants across hundreds of thousands of acres."

Environmentalists have expressed similar concerns regarding the biodiversity of the soil ecosystems beneath turf growth. Yet, a 1970 study by F.E. Clark and E.A. Paul that was published in volume 22 of *Advances in Agronomy*, cited in Beard and

Green's literature summary, showed a high microbial population (approximately 109 organisms per cm-2) in the litter, clippings, and thatch (the accumulation of organic matter in the layer between soil and vegetation) of turf. A 1973 study of a New Jersey stand of red fescue and Kentucky bluegrass by entomologist Herbert T. Streu that was published in the June 1973 issue of the *Bulletin of the Entomological Society of America* revealed 83 taxa of invertebrates including insects, mites, nematodes, annelids, and gastropods. Some studies have shown that, though chemical applications can kill microfauna in the short term, populations can recover once a pesticide decomposes and irrigation or rain brings water back into the system.

It is often human ignorance, Beard says, that leads to the problems typically blamed on turf grasses. Meanwhile, the potential benefits of turf, particularly to urban areas, have yet to be fully researched and appreciated. "We need more research on how to use grasses and trees to abate noise," Beard says. "Do we need the [noise-barrier walls] used on highways now, or could we use properly designed landscapes? We need research on the ability of plants, including grasses, to remove [pollutant] gases; there's been research on houseplants, but little on outdoor plants. We need to understand the ecosystem of the total plant community for cooling [around homes]. What are the best materials, and what are the trade-offs for cooling? When is it cheaper to use succulents and pay for energy, or use water to irrigate, and save electricity costs? In the long term," Beard concludes, "we need to understand the physiology of nutrient stress in plants in order to reduce nutrient use in turf and ornamentals."

In the United States, increasing consciousness of the economic and environmental costs of poor lawn and pesticide management has led to numerous changes. Many homeowners have switched to organic gardening using drought-resistant plants. The NWF's Backyard Wildlife Habitat program has fostered increased biodiversity in some 21,000 yards over the past 25 years. The EPA has tightened emission controls for small-engine machinery such as lawn mowers, and sales of low-noise and manual lawn equipment have grown.

Since 1994, federal agencies have been required to move from chemical turf management to IPM, favoring appropriate cultivation, improved pest identification, and spot treatment over pesticides, which are generally used as a last resort. The National Park Service, which has implemented IPM on 80 million acres since 1979, has reduced its annual pesticide use from 240,000 pounds to 25,000–40,000 pounds of active ingredients. The Government Services Administration, which contracts out landscaping for over 100 government facilities in and around Washington, DC, reports a 33% reduction in fertilizer use, 89% less insecticide use, a 10% reduction in small-engine emissions, and reductions in water use since switching to IPM.

It is likely that, despite changes that promote practices that are friendlier to the environment, society will continue to need and use turf grass for some time to come, because in the world we've created, they work. "Grass is an amazing plant," says Beard. "We mow off most of its leaves, stomp on it, drive over it, subject it to extreme temperature and water stress. And still it survives."

Stephanie Joyce