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A. J. TURGEON

NINTH EDITION

TURFGRASS MANAGEMENT

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ABOUT THIS BOOK

Turfgrass Management, Ninth Edition is regarded for its thorough coverage of turfgrass science and technology. While covering the important features of turfgrass systems, interactions, and management, this book attempts to unlock some of the mysteries of turf and establish the role of cultural interventions in achieving specific objectives.

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To numerous mentors I've been fortunate to have who shaped my life;
and to my students who have taught me so much

Preface

This book has been designed as a basic text for beginning students of turfgrass science and management. In covering the important features of turfgrass systems, interactions between and among system components, and principles of turfgrass management, it attempts to unlock some of the mysteries of turf and establish the role of cultural interventions for achieving specific objectives. Illustrations are used generously throughout the text to help students grasp concepts, processes, and relationships of importance in turfgrass systems. Each chapter concludes with a series of questions to test the reader's comprehension of the material.

The ninth edition of *Turfgrass Management* employs the same organization as earlier editions. Chapter 1 includes an introduction to turf quality, and it characterizes turfgrass management as the means by which turf quality can be sustained. Chapter 2 focuses on the turfgrass plant and how it grows and develops into a sustainable turfgrass community. An expanded treatment of turfgrass physiology and biochemistry has been included in this edition. Chapter 3 provides updated information on botanic descriptions, environmental adaptations, cultural requirements, and uses of turfgrass species, along with a climatic classification system helpful in determining where turfgrass species are adapted and a taxonomic scheme useful in determining where specific turfgrasses fit in relation to other members of the grass family. Chapter 4 deals with the components of the environment—atmospheric, edaphic, and biotic—in which turfgrasses must grow, compete, and survive. New information on how environmental stress tolerance can be improved has been added to this chapter. Chapters 5 and 6 cover the broad array of primary and supplementary cultural practices, respectively, for sustaining turf at desired levels of quality. The section on cultivation has been expanded to reflect new methods for alleviating soil compaction and improving drainage. Chapter 7 covers important aspects of turfgrass pest management, including those involved in the management of weeds, diseases, nematodes, insects, and large-animal pests. While the role of pesticides is emphasized in this chapter, the entire text is concerned with pest management to the extent that pest problems can be reduced or, in some cases, essentially eliminated by providing conditions that favor healthy turfgrass growth. Turfgrass propagation is covered in Chapter 8. As many problems encountered in the management of existing turfs are directly attributable to improper establishment, the previous chapters set the stage for an enlightened discussion of propagation and its importance throughout the life of a turf. Finally, Chapter 9 attempts to bring it all together into integrated cultural systems for sustaining specific types of turf. Where appropriate, the information has been updated and expanded.

As with earlier editions, the ninth edition contains updated information and specific improvements based, in part, on feedback from many users of the text who were kind enough to share their thoughts and constructive criticisms with the author. I am especially indebted to those individuals who have made contributions to the first and subsequent editions. These include Floyd Giles for his painstaking drawing and redrawing of the many illustrations in the text; April Pahl, Trudy Zohn, and Jennifer Cooney who also contributed illustrations; Judy Verbeke, who provided some of the leaf cross-section pictures from which illustrations in Figure 3.2 were drawn; and the reviewers of portions of the manuscript, including B.J. Augustin, R. Bacon, J.B. Beard, R. Boufford, P. Busey, A.E. Dudeck, R.E. Engel, T.A. Gaskin, V.A. Gibeault, R.L. Goss, G. Hamilton, M. Hendricks, D. Henley, D. Huff, K. Killian, David Livingston, R.B. Malek, C. Mancino, L. Marty, A. McNitt, W.A. Meyer, H.G. Myers,

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Finally, the assistance of my wife, Jean, in editing the manuscript is gratefully acknowledged.

—A. J. Turgeon

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*1

Introduction

Turfgrasses are plants that form a more or less contiguous ground cover that persists under regular mowing and traffic. An interconnecting community of turfgrasses and the soil adhering to their roots and other below-ground organs form a turf. The terms *turf* and *turfgrass* are different, in that one refers only to the plant community (**turfgrass**), while the other represents a higher level of ecological organization (**turf**) by including a portion of the medium in which the turfgrasses are growing. When the surface layer of a turf is harvested for transplanting, it is called **sod**.

Turfgrasses are used for a variety of purposes (Figure 1–1). A utility turf exists primarily for soil stabilization. The binding effect of an interconnecting system of fibrous roots prevents erosion from wind and water. The protective cover of aerial shoots further stabilizes the soil while improving recharge and quality of ground water. The absorption of water from the soil by turfgrasses and its subsequent movement into the atmosphere as water vapor—a process called transpiration—provides a cooling effect during warm weather. Along roadsides, turfgrasses absorb many toxic emissions from vehicles and, thus, have a cleansing effect on the air. Along airport runways, turfgrasses reduce dust to prolong engine life; at small airports, the runways themselves are often turfed.

Lawn turfs serve a decorative function: their uniform green appearance enhances the beauty of a landscape. Lawns also provide inviting arenas for recreational activities and relaxation and offer relief from heat-absorbing roadways, buildings, and other structures.

Sports turfs provide enjoyment for participants and observers alike. Football, baseball, and soccer are just a few of the many sports played, for the most part, on turf. Player safety is substantially enhanced by the soft cushion provided by turfgrasses on a soil base that can be hard when dry and slippery when wet. The cultural requirements of an athletic field turf are unique because of the intense traffic that compacts the soil and causes considerable wear of the turfgrass.

Among sports, golf enjoys the longest and closest association with professional turfgrass managers. The evolution of turfgrass science and technology is largely the result of efforts by golf course superintendents to

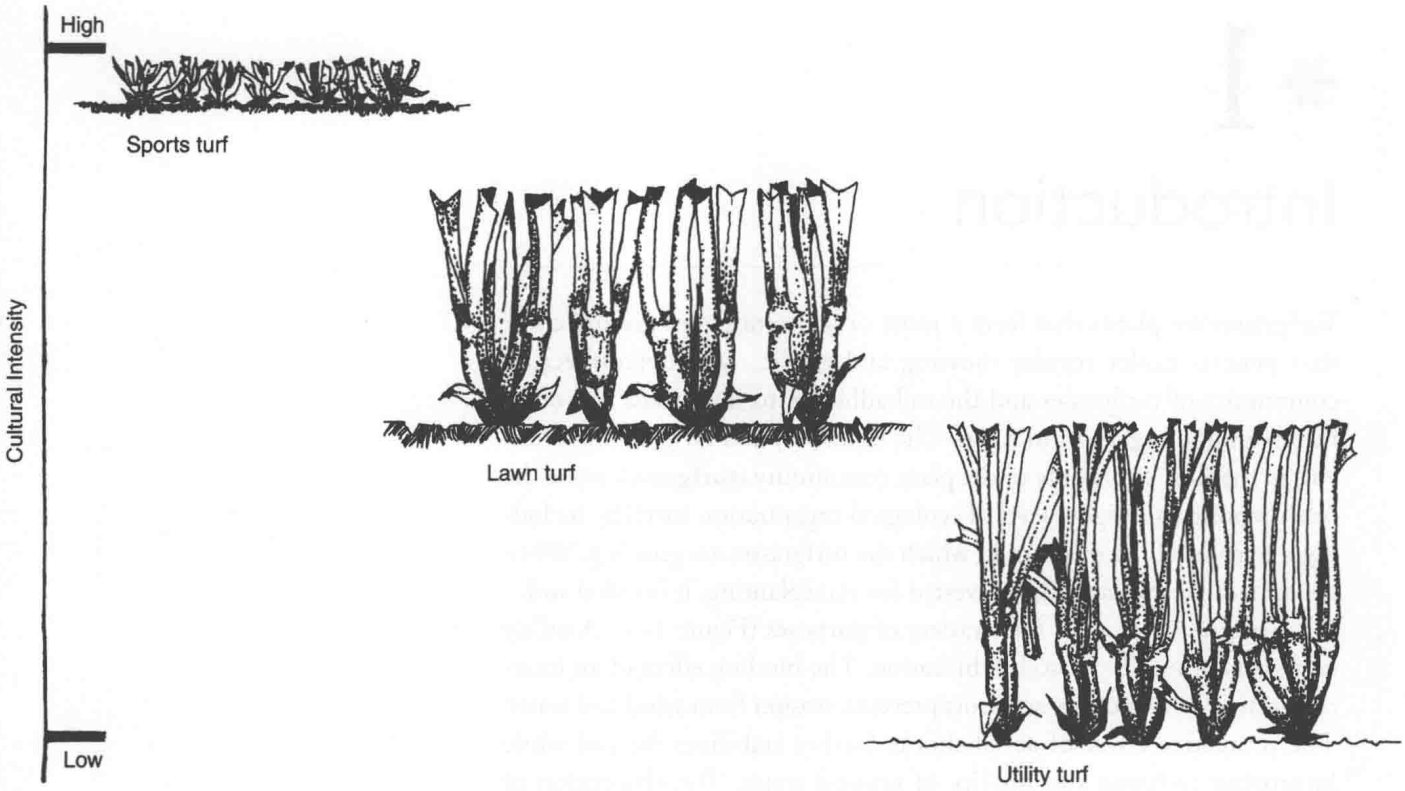

Figure 1–1
Turf types. Sports turfs are cultured intensively to provide playable surfaces; lawn turfs serve primarily a decorative function, and utility turfs are established primarily for soil stabilization.

improve techniques and solve problems. Local, state, and national organizations of golf course superintendents have, for decades, sponsored turfgrass research and encouraged academic institutions to develop turfgrass programs. Golf greens represent the highest intensity of turfgrass culture; they also present the greatest challenge.

HISTORY OF TURF

In ancient times, men grazed livestock close to their dwellings to protect the animals from wild beasts. The closely cropped grass provided an unobstructed view of any dangers lurking in—or emerging from—nearby forests. The grass also framed the dwelling and created a favorable environment for human activity. Extensive pastures sometimes served as arenas for sports and recreational activities, including early ball-and-stick games conducted on foot or on horseback. Thus, pasture grasses also served as *turf* grasses where both livestock grazing and human recreation occurred at the same site.

Lawn Turf

The purposeful use of turf as an integral part of the landscape probably dates back to the early Persian gardens, developed many centuries before the birth of Christ. The botanic features of these gardens were captured in the construction of Persian garden carpets; they included rectangular beds of low-growing flowering plants—the forerunners of contemporary lawns. The conquests of Alexander of Macedonia (356–323 BC) spread the use of Persian gardens throughout the Hellenistic world. While the gardens of Greece were limited to schools and other public meeting places, those introduced later to other parts of Europe by the Romans were used as an extension of the house, primarily for relaxation and entertainment.

During the medieval period, gardens expanded throughout Europe, largely due to the activities of monks who created elaborate gardens within their monasteries. Monastic gardens were built not only for the production of food and medicinal herbs, but also for privacy, study, contemplation, and recreation, and as a burial place for the dead. Included within these gardens, at the heart of the monastery, was the "cloister garth" alongside the church; it was a lawn—composed primarily of low-growing grasses and some broadleaved plants—around which the monks processed (i.e., walked and read prayers or studied lessons) at regular intervals throughout the day and evening. The turf was usually kept short and green; according to Hugh of Fouilloy, "the green turf . . . refreshes encloistered eyes and their desire to study returns. It is truly the nature of the color green that it nourishes the eyes and preserves their vision" (Landsberg, 1995). According to Hugh of St. Victor, the color green was "a metaphysical symbol of both rebirth and everlasting life." William of Auvergne, bishop of Paris in the 13th century, attributed its tranquilizing nature to "being half way between black which dilates the eyes and white which contracts it" (Eco, 1986).

In Queen Eleanor's thirteenth-century garden, the center was "filled with turf, because the expanse of green in a garden serves the same purpose as space in art, silence in music, or a pause in speech." A green lawn was admired in the fifteenth century by an anonymous poet in *The Floure and the Leafe:*

> freshly turved, whereof the green grass
> so small, so thick, so short, so fresh of hew
> that most like unto green velvet it was.

While European gardens were private and walled, their Colonial American counterparts tended to be open, so settlers could keep a lookout for hostile Indians. These expansive "homestead meadows" were regarded by the British and others as an American idiosyncrasy (Madison, 1971). Some believe that the American lawn, as it is known today, was actually born in the 1870s when several developments combined to make them possible (Pollan, 1989). The first was the creation of the suburbs—then known as the borderlands—to which city dwellers began to move in large numbers. The newly built commuter railroad system enabled those who were part of the rapidly expanding middle class to commute to work and thus "keep one foot in the city and the other in the countryside." In developing the grounds surrounding their homes, they attempted to emulate the estate lawns in England by "cutting the vast manorial greenswards into quarter-acre slices everyone could afford." Another essential factor favoring the growing popularity of the American lawn was the availability of lightweight affordable lawn mowers. And, the man who did the most to advance the cause of the American front lawn in the post–civil war era was Frank J. Scott, who wrote in 1870, "A smooth, closely shaven surface of grass is by far the most essential element of beauty on the grounds of a suburban house."

Sports Turf

Grassed sites have always been preferred for sports and recreation. In cool, moist climates where grass is plentiful, outdoor sports are almost always played on the grass. Kept short by grazing—usually by sheep and cows, sometimes by rabbits—the grassed surface is relatively cool, free of dust and mud, and provides stable footing for man and animals.

The ancient sport of chogân—today called polo—was first played on extensive meadows in Persia. As the use of light cavalry spread throughout the Iranian plateau and elsewhere, this rugged game played on horseback did as well. It became a popular sport throughout Asia among nobles and mounted warriors for many centuries, but

nearly disappeared as the great eastern empires collapsed. The British were introduced to polo in the mid-nineteenth century when military officers and tea planters in India witnessed the game played by Manipuri tribesmen. The British are credited with spreading polo worldwide in the late nineteenth and early twentieth centuries.

Lacrosse evolved centuries ago from ball-and-stick games played by Native Americans on open meadows or prairies. It was called *baggataway* by the Algonquin and *tewaarathon* by the Iroquois—meaning *the little brother of war*, as it was sometimes used to settle tribal disputes. As the stick reminded early French missionaries of a Bishop's crozier—*la cross* in French, *lacrosse* soon emerged as the generally accepted name for this sport.

Football (called *soccer* in the United States) is another ancient sport that is preferably played on grass fields. According to legend, rugby evolved in the early 1800s from football when a student at the Rugby boys school in England "with a fine disregard for the rules of football first took the ball in his arms and ran with it." However, some have argued that the legend is probably mythical, as games that involved running with the ball had existed for centuries. American football derived from rugby. While the first intercollegiate *running* game (kicking was not allowed) was played between Rutgers and Princeton in 1869, the rules establishing the game as it is played today were proposed by Yale University coach Walter Camp—considered the "father" of American football—in 1880.

Cricket is believed to have originated sometime in the twelfth or thirteenth century in England and it became a popular sport throughout the British Empire. Its principal playing surface, called the pitch, is maintained by close and frequent mowing and rolling to create and maintain a firm surface that supports the unique requirements of the game. While cricket may be considered England's national summer sport, baseball—characterized as America's pastime—has been its counterpart in the United States. Alexander Cartwright, known as the "father of baseball," devised the first rules for the modern game and invented the modern baseball field.

An early version of croquet was played by thirteenth-century French peasants, who used crudely fashioned mallets to whack wooden balls through hoops made of willow branches. In 1867, Walter Whitmore developed the modern game in England and is considered its inventor. After lawn tennis was introduced, the popularity of croquet declined considerably. Lawn tennis can be traced back to 1858 when British Army Major Henry Gem marked out the first court on a lawn in Edgbaston; however, the true inventor of the modern game may actually be Major Walter Wingfield, a retired cavalry officer who, in 1874, published his rules, developed a rubber ball that would bounce on grass, and patented the game under the Greek name *Sphairistike.* The first Wimbledon championships were held in 1877, and the Lawn Tennis Association was launched 11 years later in 1888. Today, the All England Lawn Tennis and Croquet Club at Wimbledon features 19 (excluding practice courts) exquisitely maintained perennial ryegrass (*Lolium perenne*) courts, including the historic Centre Court, which usually hosts the finals of the main singles and doubles events at the annual championships and seats about 14,000 people, and Court 1, which holds about 11,500 people and occasionally plays host to the Davis Cup matches.

The game of bowls may have originated with the ancient Egyptians, as artifacts found in tombs dating back to around 5000 BC suggest. As the sport spread, it took on a variety of forms, including bocce (Italian), bolla (Saxon), bolle (Danish), boules (French), and ula miaka (Polynesian); however, not all were played on grass. The oldest bowling green—located in Southampton, England—has been in operation since AD 1299. According to legend, Sir Frances Drake was involved in a game of bowls when he was notified of the approach of the Spanish Armada in 1588. He allegedly responded, "We still have time to finish the game and to thrash the Spaniards, too." Lawn bowls

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