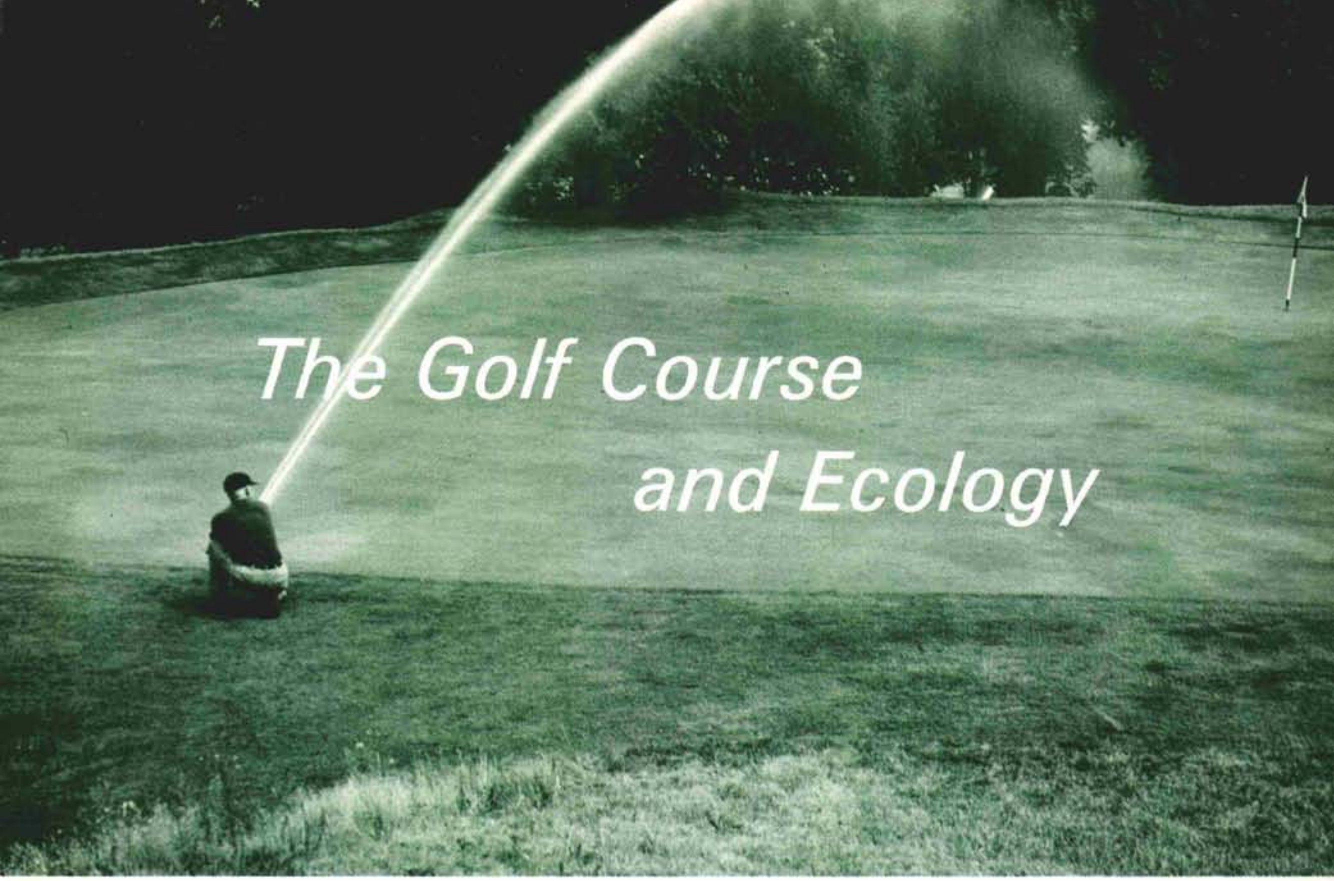
The Golf Course and Ecology



Syringing—a management practice that modifies the microclimate.

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Ecology is a word often used but seldom understood. With the attention focused on the harmful effects of pollution, ecology is fast becoming our greatest problem. But, as one noted conservationist put it, people have only a vague idea of what ecology is all about. The same can be said for turfgrasses. Do we, as turf managers, really understand turfgrass ecology?

Classically, ecology has become known as the interaction of organisms and their environment. This means that any environmental factor—climatic, soil, and biotic—whether natural or imposed, and their interplay take on meaning as an ecological aspect of turfgrass management. However, to successfully manage turf under golf course conditions requires the employment of many management practices, such as mowing, irrigation, fertilization, etc., that grasses growing naturally would not be subjected to. From this standpoint, turfgrass ecology then encompasses environmental and management interrelationships.

Adaptation and Ecology

Adaptation of turfgrasses to a particular region depends upon all environmental factors that affect growth. The more dominant ones are climatic, soil, biological, and geographical. These factors are interrelated, and the plant's ability to survive is governed by how well it can tolerate the many forces these factors exert individually or in combination. Each turfgrass specie has tolerance limits, and if these limits are exceeded it will not persist.

The most influential factor in determining adaptation to a region is climate. It embodies temperature, moisture, light, and wind. Based on their growth habit, turfgrasses have been grouped as either cool-season or warm-season grasses. Furthermore, these are broadly classified as adapted to one of four general climatic regions: cool-moist, warm-moist, cool-arid, and warm-arid regions. However, differences in geography and employment of different management practices may render certain grasses adaptable to a region where otherwise they would not persist. As an example, grasses of cool-humid or warm-humid regions may grow quite well in arid regions if irrigation is available.

Usage and Ecology

While environmental factors determine to a large degree what grasses are adaptable to a region, golf courses must be considered as an independent ecosystem within that region. As such, how various varieties of grasses are used on golf courses is a primary ecological consideration. They must be able to tolerate conditions they are subjected to. Grasses used for greens, tees, and fairways must withstand close and frequent clipping, tolerate heavy traffic, and recover rapidly from injury. Only certain varieties of bluegrasses, bentgrasses, and bermudagrasses have these qualities. Grasses for roughs, while not clipped as close or as often, must still tolerate traffic and usually more shade and less water. Varieties of bluegrass, fescue, and bermudagrass meet these requirements.

Climate and Ecology

We have already seen that climate is responsible for the grasses adaptable for golf courses. However, the four aspects of climate—temperature, light, moisture, and air—also have seasonal environmental effects on the grasses within a region that determine their performance under golf course conditions. While not much can be done about the weather, certain management practices can modify its effects. Furthermore, it must be remembered that no aspect of climate acts upon the plant alone. It acts in combination with other aspects, and as a result it is modified by the other factors.

Temperature—All turfgrasses have three critical temperatures: minimum, maximum, and optimum. Obviously, if the minimum or maximum temperature is exceeded for any length of time the plant will die. But these temperatures are often hard to determine because the wind, soil moisture, humidity, light intensity, age of plant, and management practices all will affect the survival temperature.

Attempts, however, have been made to determine limits and optimum temperatures. Research to date shows optimum temperatures for cool-season grasses to be from 60° to 80°F. Growth slows to a minimum above 90° to 100°F, with root and reserve carbohydrates being depleted. Death due to cold weather is a combination of the effects of low temperature, moisture within the plant tissue, and degree of plant hardiness. Optimum temperature for bermudagrass is reported as 95°F, with growth slowing at 59°F and 105°F.

Soil temperatures are also critical to growth, but often it is difficult to separate the effect of soil temperature from air temperature as an ecological influence.

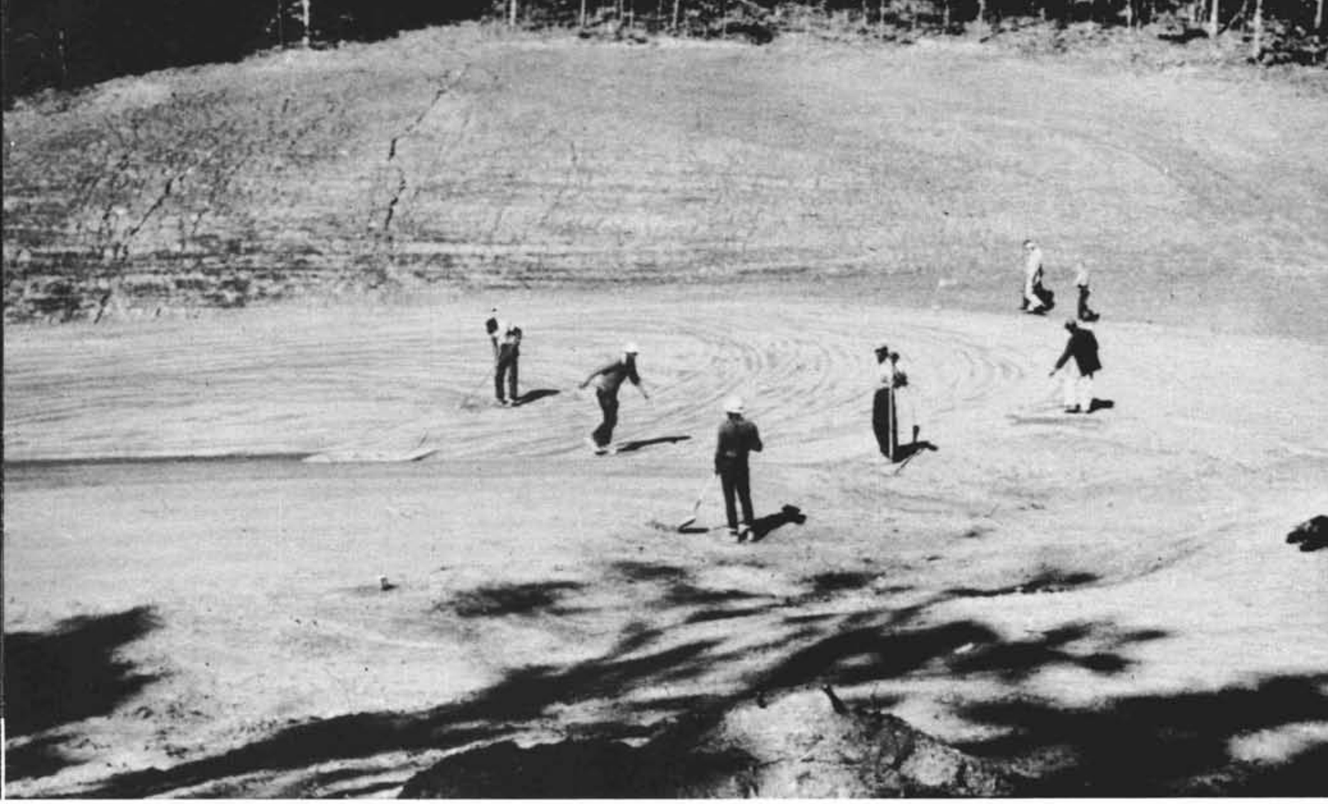
Light—In considering the influence of light on the ecology of turfgrasses, several factors must be considered—the light intensity, duration of light period, and quality of light. Light enables turfgrasses to carry on photosynthesis and respiration. These two physiological processes provide the means of obtaining energy for growth and survival. Furthermore, both of these processes are affected by temperature. At moderate temperatures, photosynthesis occurs faster than respiration with a resultant accumulation of food reserves. As the temperature rises, photosynthesis reaches a point where it levels off and it begins to fall. Respiration also increases with increasing temperature, but to a much higher point than photosynthesis. Eventually the plant uses food reserves faster than they are produced and draws upon those synthesized at the optimum temperature. If this condition prevails for a period of time the plant will suffer.

It has been difficult to determine the light requirements of turfgrasses, although the major turf species have been ranked as to their ability to grow in reduced light. However, one ecological relationship emerges: the light requirement of a turfgrass beyond that needed to keep it alive is largely determined by turf usage. Grasses subjected to heavy play usually need more light to survive. Shaded tees generally have a lower turf density than sunny tees. Reduced light intensity results in longer internodes, smaller leaves, and a more yellow color because of less chlorophyll. Moreover, grasses grown under low light have restricted roots, become more succulent and more susceptible to disease.

Moisture—Except for temperature, moisture is the most important climatic factor influencing turfgrass growth. Water is essential because it composes roughly 90% of the growing tissue, transports nutrients throughout the plant, is an important part of photosynthesis, maintains turgidity in leaves, and helps regulate plant temperature.

Due to the development of irrigation systems for golf courses, water is not a restrictive factor for survival. Water management, however, is a prime ecological factor. The judicious use of water many times is responsible for preventing wilt. Courses with automatic systems now can syringe greens and fairways more effectively, thus reducing wilt, especially that of *Poa annua.*

Overwatering, on the other hand, either from excessive rainfall or by irrigation, results in a soft and succulent plant more susceptible to wilt and disease. In this respect, research has shown that *Poa annua* watered six times as opposed to two times a week exhibited twice as many stomates (pores in leaf) to a given area.



Soils—ecologically important to good turf culture.

Another part of moisture influence is humidity, which refers to the amount of water vapor in the air. It is important ecologically because it influences water loss from soil and plants, and its association with dew and disease. Most turfgrass diseases need a moist environment to germinate and grow, and disease incidence is higher when humidity remains high.

Snow is also ecologically important in the northern states. It serves as a source of moisture in the winter and insulates and protects the turf from low temperatures and desiccation.

Air—Wind and air are the last part of climate that influences the ecology of turfgrasses. Air surrounding the earth contains carbon dioxide that plants use for photosynthesis. Wind is beneficial because it replenishes the carbon dioxide supply to the turf. On calm, bright, sunny days it has been shown that carbon dioxide concentration can become suboptimum for maximum photosynthesis.

While air turbulence is beneficial by increasing carbon dioxide supply, it can be harmful by increasing transpiration. Moving air reduces humidity which in turn increases water loss from plants and the chance for wilting. During the winter high winds result in desiccated turf if unprotected by snow.

Air pollution has recently been shown to be harmful to turf in certain industrial areas. The injury is due to the phototoxic components of smog such as ozone, and to reduced light intensity. *Poa annua* seems especially sensitive to smog components.

Microclimate—Just as climatic relationships affect the ecology of turfgrasses, so does the microclimate. It is considered to be the climate near the ground as opposed to the general climate of a region. It encompasses plant material living above ground, the thatch, and to some extent the roots. Microclimate is important because differences in environmental factors may be greater nearer the surface than farther above. Temperature and humidity are usually higher within a few inches of the soil than three to five feet above.

Thatch is a very important part of the microenvironment and influences the microclimate. A small amount is beneficial because it provides shade and lowers soil temperatures. It also provides some protection from drying winds and from frost and low temperatures. Thatch may reduce water loss and aid in the reduction of weeds.

Adverse effects of a thick thatch layer include: retention of water in the thatch layer, increases disease and insect incidence, reduces air infiltration into the soil, reduces the amount of nutrients that reach the soil, and reduces pesticide effectiveness.

Modifying the microclimate many times saves turf during periods of stress. Syringing during high temperatures cools the leaf surface and raises the relative humidity near the grass plant, alleviating moisture stress. This has been shown to be more effective if accompanied by air movement. Covering greens with artificial screens or other type mulches during the winter, and topdressing heavy in the late fall has been effective in preventing serious injury from low winter temperatures and desiccation.

Soil and Ecology

Soil plays one of the major roles in supporting turfgrass growth and therefore is a key aspect of turfgrass ecology. It is composed of mineral matter, organic matter, air, and water. The functions of soil are to provide an environment for the development of roots and to supply the necessary mineral nutrients, water and oxygen. The basis for sound turf culture begins with the soil-root environment. Roots require nutrients, water, oxygen, a suitable soil temperature, and a favorable pH range for growth. Anything which affects these variables ultimately determines the health and survival of the plant.

Roots need oxygen to grow. This is supplied by the soil air, which is composed of oxygen and carbon dioxide. The amount of air present is dependent on the nature of the soil pores. The percentage of oxygen and carbon dioxide is governed by the respiration of plant roots and microorganisms, which use oxygen and produce carbon dioxide, and by the exchange of air between the soil and the atmosphere. Soil aeration refers to the process of replacing soil air by atmospheric air and is brought about mainly by diffusion. Air in well aerated soils is similar to atmospheric air, whereas poorly aerated soils contain higher carbon dioxide levels and lower oxygen levels. Plant growth under poorly aerated soil is probably limited by low oxygen rather than high carbon dioxide levels.

So far it has been difficult to determine optimum soil air levels for turfgrass growth. However, uptake of water and nutrients is often decreased by poor aeration. Fortunately, grasses appear to be more tolerant of poor soil aeration than many other plant species.

Poor aeration also affects microbial activity. Rapid decomposition of organic matter, organic fertilizer, and thatch is slowed. The bacteria that convert ammonia and organic forms of nitrogen to the nitrite form which the plant absorbs is also inhibited.

Adequate soil water is needed for healthy turf. Like soil air, soil water is dependent on the nature of the pore space. When water is lacking the turf will obviously wilt. Too much water limits air diffusion and plant roots suffer from lack of oxygen. Plant growth is usually characterized by a yellowish-green color due to the leaching of nitrogen or reduced availability of iron. Excessive water in the soil also enhances disease activity, since most turfgrass disease fungi are favored by moisture. Compaction too is more severe when soils are overly wet.

Controlling water in the soil then becomes important to turfgrass ecology. Irrigation and drainage are generally the principle means used to control soil water. An irrigation system designed and installed properly, and managed intelligently is a must. Good surface and internal drainage should be incorporated into all portions of the golf course wherever possible. Where this cannot be accomplished artificial drainage should be installed.

Since soil under golf course conditions receives heavy traffic, compaction affects soil-root ecology. Soil compaction is detrimental because it decreases pore space and destroys aggregation. This in turn restricts the amount of air and water available to plant roots and slows internal drainage. Relieving compaction by aeration and incorporating soil amendments that resist compaction will help alleviate conditions caused by heavy traffic.

Soil temperature is also ecologically important. Minimum, maximum, and optimum soil temperatures for turfgrass growth follow closely that of atmospheric temperature. Many microbial processes in the soil are influenced and controlled by soil temperature. Again, organic matter decomposition and nitrogen transformation are critical ones affected.

Management and Ecology

Maintaining turfgrasses used on golf courses to meet the demands of today's players requires the use of many management practices. Since these practices influence the environment of turfgrass greatly, they become an essential part of turfgrass ecology. Indeed, some management techniques are so critical that an individual turf specie could not be used for golf turf without them.

We have already seen that syringing, control of thatch, and relieving compaction are all management practices that improve the environment of the grass plant. The following are others that influence good quality turf.

Heights and frequencies of mowing affect the vigor of turfgrasses. However, it is the size and morphology of a grass specie that determines mowing practices. Turfgrasses that produce stolons and rhizomes will tolerate closer mowing than will a bunch type grass. Furthermore, grasses that produce an upright growth habit cannot be clipped as low as grasses that produce many leaves near the soil surface.

Clipping upright grasses such as Kentucky bluegrasses, fescues, and ryegrasses, especially during hot weather, causes a depression of roots, rhizomes, and top growth. This weakens the turf, lowers resistance to drought, increases susceptibility to disease, and encourages thinning of turf. Also, close mowing brings more light to the soil surface and encourages weed encroachment. Mowing management of upright grasses should be based on climatic conditions. During the summer they should be clipped higher to improve vigor, reduce weeds, and increase wear resistance.

Small stoloniferous grasses such as bentgrass and bermudagrass can tolerate close clipping because many leaves remain after mowing. These will also benefit from raising the height of cut, but clipping too high will encourage a faster thatch buildup.

Frequency is also important. Allowing top growth to become tall and then mowing short is damaging. A rest from mowing greens one or two days a week will increase bentgrass vigor.

Turfgrasses need adequate nutrients to grow and recover from injury inflicted by the golfer. Nitrogen, which is the key growth regulating agent, should be used with care. Too much nitrogen causes turf to be soft and succulent and more susceptible to wilt and disease. Too little will not allow for rapid recovery from injury.

Nutrients should be supplied in adequate amounts and balance. Growth may be disrupted by an imbalance of the key nutrients, nitrogen, phosphorus, and potassium. A lack of certain minor elements, such as iron, can also affect metabolism.

Irrigation practices are critical to turfgrass ecology. Heavy, infrequent irrigation encourages root development and penetration. Light, infrequent watering results in the roots remaining near the surface where the moisture is supplied. Heavy, frequent watering is injurious because of changes in the air-water ratios of the soil pores.

The use of pesticides to control weeds, insects, and disease is certainly beneficial in improving the environment. Overuse or indiscriminate use, however, can be harmful. Residual effects or metabolic disruptions are responsible for turf injury.

The ecology of a golf course then is the interaction of natural and imposed environmental and management conditions affecting growth. The employment of the various combinations of management practices must be related to the environmental factors. Careful manipulation of these management practices can save turf in periods of stress.

SUPER SAM by Paprocki

Super Sam says, "change tee markers often."