Unintended Consequences Associated With Certain Urban Turf and Landscape Ordinances

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Introduction

Nutrient runoff and leaching to groundwater, particularly of nitrogen and phosphorus, have been implicated with degradation of water bodies in urban coastal Florida. Red tide and other problems in coastal waters have sometimes been thought to be related to nutrient runoff from land (Anderson et al., 2002). Total Maximum Daily Loads (TMDLs) have been established by the Florida Department of Environmental Protection (FDEP) for several areas in the state. Where TMDLs have been established, a Basin Management Action Plan (BMAP) guides fertilizer use to achieve the TMDL goal. Counties and local municipalities in Florida are taking several approaches, including voluntary and non-voluntary means, to comply with the TMDLs. Fertilizer ordinances are being used as a regulatory approach in several counties. Some early ordinances were adopted in the Town of Wellington, St Johns County, and Sarasota County (see reference list). A recent proposed model ordinance, for potential adoption by counties and municipalities in the Tampa Bay Region, was developed by the Tampa Bay Estuary Program (Tampa Bay Estuary Program, 2008). A good coverage of the development of ordinances in Florida can be found in Hartman et al. (2008). These ordinances include many logical and science-based aspects, such as applying fertilizer at recommended rates, using appropriate fertilizer sources including controlled-release fertilizers, soil testing for phosphorus (P), removing fertilizer, turf clippings, and plant materials from impervious surfaces, and using appropriate irrigation practices. A regulatory approach that is gaining popularity in the ordinances of some counties and municipalities is a restricted period (also called a “black-out” period) where nitrogen (N) and P fertilization of turf and landscape plants is prohibited during the summer rainy period, typically June 1 through September 30. The underlying reasoning behind the fertilizer black-out is that there is concern over fertilizer runoff and leaching during frequent and heavy rainfall events in the summer. The black-out component of an ordinance is very controversial for several reasons. The research on this subject points to possible unintended consequences of restricting fertilizers on turf and landscape plants during their most active growing period. In addition, a black-out could place financial burdens on the turf and landscape industries. This paper discusses the research behind turf growth, biology, and ecology, and describes unintended consequences of fertilizer ordinance “black-out” periods. We understand the need to properly manage nutrients in the environment and we understand the need to apply well thought-out and science guided controls on fertilizer use to prevent negative impacts to our environment. We offer science-based alternatives to the strict fertilizer black-out period for encouraging new habits for managing nutrients in the landscape and for achieving everyone’s improved water quality goals.

Unintended consequences of a rainy-season fertilization black-out:

A full blackout of fertilizer applications in the rainy season might appear on the surface to be a logical reaction to the problem of excessive amounts of nutrient in the water bodies in this state. However, there are several aspects of the biology of turf growth and the ecology of the landscape that may lead to un-intended consequences of a black-out.

- Turfgrass needs adequate and consistent nutrition for optimal health, and healthy, actively growing turf is excellent at absorbing nutrients. The current Extension fertilizer recommendations for turf grass are summarized by Sartain (2007). Most research shows little nitrogen (N) leaching from a well-maintained turf that is fertilized (and irrigated) according to research-based recommendations. Trenholm et al., (unpublished data) and Sartain (2009) show that well-managed turf does not lead to N leaching during the rainy period in Florida (Fig. 1).
- The growth period for warm-season grasses is during the long days of spring and summer. This is the time of greatest growth and nutrient requirements for these grasses and is also the time when the grasses have the greatest ability to take up nutrients, due to a dense root and shoot system.

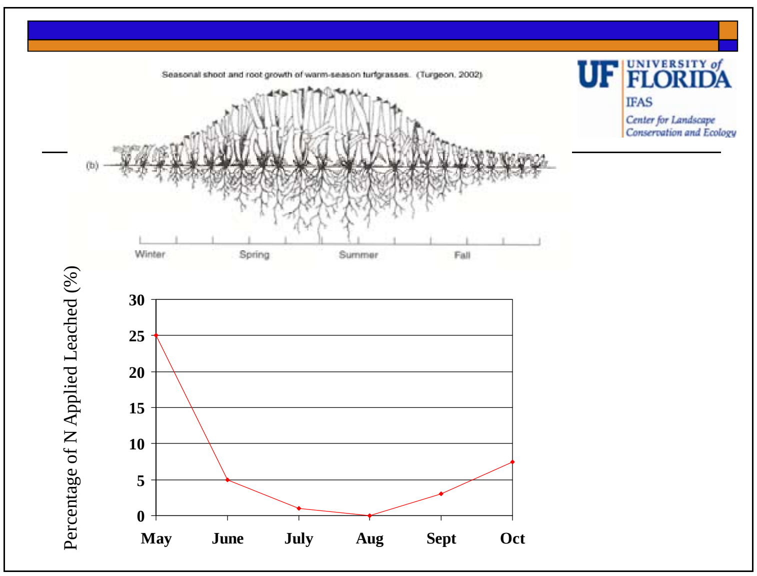

Figure 1. Growth of warm-season grass (top) and N leaching during season (bottom-after Sartain, 2009).

- Turf that does not receive adequate N will decline with time, leading to weaker turf with less dense root and shoot systems that are less capable of absorbing fertilizer rapidly. Warm-season turfgrass root growth typically declines in fall and winter months due to shorter days (Fig. 2). A grass that does not receive adequate nutrition might experience even more decline (Figs. 2 and 3). This decline might not be immediate due to residual and native nutrients in the soil.

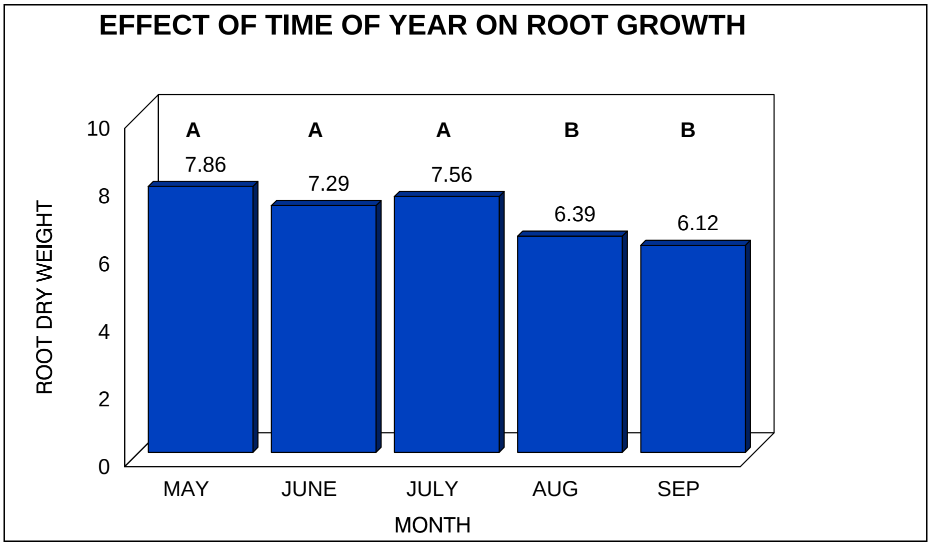

Figure 2. Effect of time of year on root growth of warm-season turf.

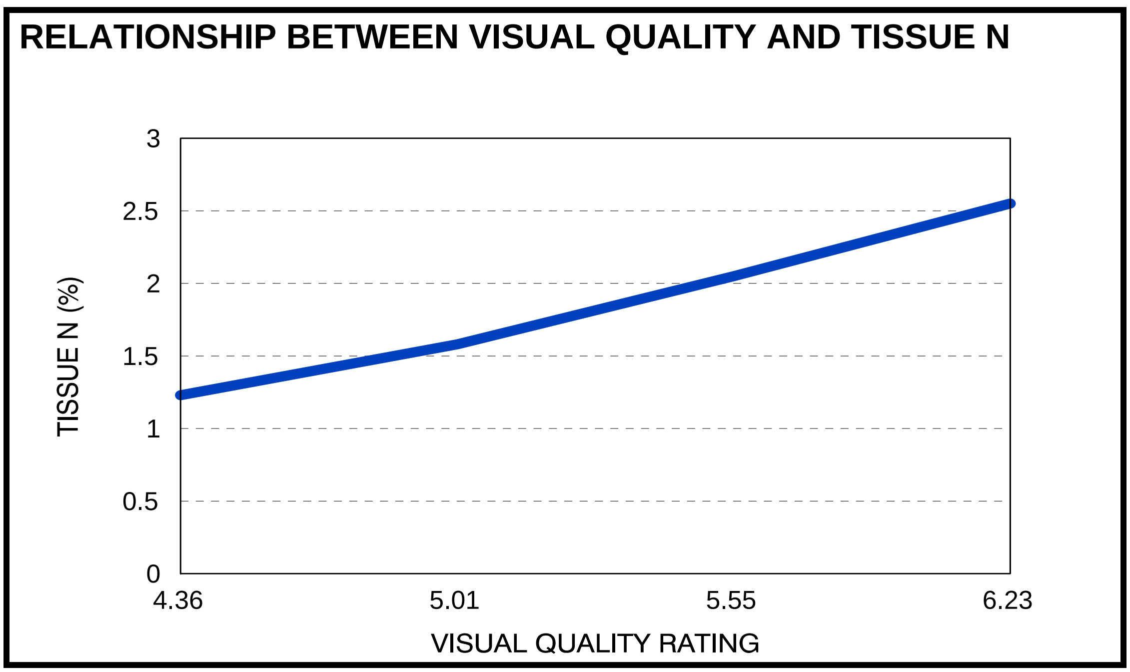

Figure 3. A turf visual rating of 5.5 corresponds to the adequate range of leaf N concentration.

- Treating N-deficient turf grass during a “blackout period” with other products, such as iron or potassium will not cure the underlying N deficiency and the shoot and root system will continue to decline.
- Weak turf will lead to bare-soil areas where weeds will likely invade, which may lead to increased need for herbicides. Bare-ground patches also could lead to more N leaching when fertilizer applications can resume following the “black-out period.” Bare areas are prone to erosion and increased runoff from the lawn. Turfgrass acts to reduce the velocity of the runoff and also filters particulates and contaminants from the water. By reducing the velocity of the water, increased infiltration can occur resulting in groundwater recharge (Blanco-Canqui, 2003).

- Homeowners may over-apply N fertilizer prior to the black-out period, thinking that the extra N will last through the black-out period. This practice could result in considerable loss of soluble N to runoff and leaching. This could also be problem with excessive amounts of either soluble or controlled-release N products.
- If homeowners experience a decline in their turf coverage and quality due to the inability to apply N during a "black-out period," then there may be unintended consequences, such as discrete fertilizer over-applications in an attempt to get the grass to recover rapidly. Severe black-out restrictions are unlikely to be effectively enforced.
- Under a black-out period of June 1 to September 30, fertilizer application could be resumed after September 30th. A possible problem here is that grass that has not been adequately fertilized will have less root and shoot system than one that has been fertilized through the growing period. As warm season grasses naturally begin to lose root and shoot system (Fig. 2) at this time due to daylength, this can result in increased potential for nutrient leaching or runoff in an inadequately fertilized system. (Fig 1.).

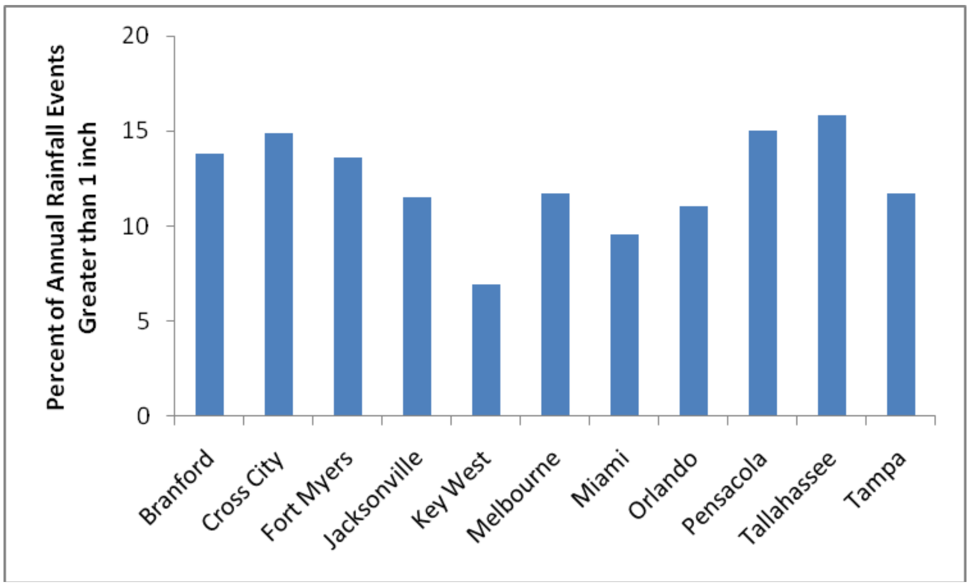

Figure 4. Percentage of annual rainfall events greater than 1 inch at select locations in Florida. Rain events separated by less than 6 hours are considered to be a single event. Period of record used: 1942-2005. The gauges analyzed contained between 28 and 64 complete years of data.

- Only about 10 to 15% of rainfall events in Florida are 1 inch or more (Figure 4). A problem with the typical summer black-out period ordinance approach is that it addresses only one-third of the year. There are other times in the year with leaching rainfall, especially in the fall (Figure 5). An unintended consequence is the uncontrolled fertilization by homeowners during the rest of the year to "get ready for" or to "recover from" the effects of the blackout period.
- Any attempt to minimize N pollution from the urban landscape will be for naught if irrigation best management practices are not included in any fertilizer guidelines. Running irrigation systems during the rainy-season period (when not needed) will intensify the leaching and runoff potential. Irrigation and fertilization practices go hand-in-hand. Properly fertilized and irrigated turf is one of the most environmentally sound plant systems available. In an early study in Florida, scheduling irrigation by a moisture sensor device led to N leaching of only 2% of the N applied (ammonium nitrate) whereas irrigation at 125% of evapotranspiration resulted in loss of 50% of the applied N (Snyder et al., 1984).

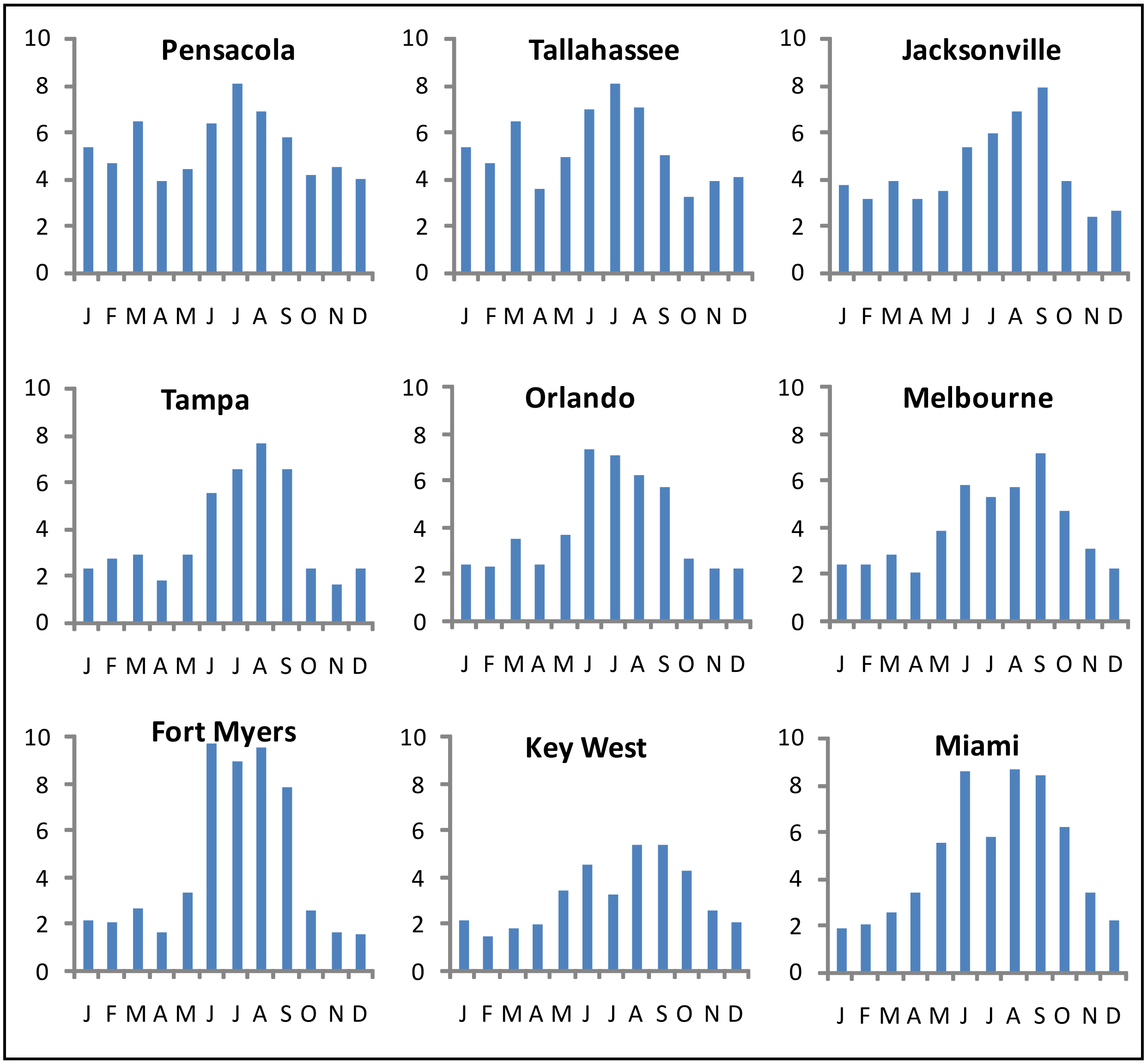

Figure 5. Monthly mean rainfall totals (inches) at select stations across Florida 1971-2000.

Considerations regarding urban turf irrigation as it relates to turf health and fertilization:

- The trend in the state points to water restrictions, even during non-drought periods. Turfgrass (and other plants) stressed due to reduced water inputs during water restriction periods (or really watered on "your" day, rather than at the right time) could be further stressed if there is a nutritional deficiency induced during blackout periods.
- Day-of-the-week watering restrictions encourage over-watering on "your day". This could compound a problem with soluble fertilizer application being lost just before the blackout period.
- Nutrient and water management are tightly linked (Dukes et al., 2009). Proper irrigation management is needed for healthy turf and for preventing nutrient losses. An urban irrigation scheduler tool is available on the Florida Automated Weather Network

(FAWN) at http://fawn.ifas.ufl.edu/urban_irrigation. This tool allows a user to determine irrigation controller runtime estimates with three clicks. Research has shown that using guidelines such as this tool can reduce irrigation water use as much as 30% (Haley et al., 2007).

- New technology is available in the irrigation arena known as "Smart Irrigation" controllers. These irrigation controllers use inputs from the irrigated area to determine or regulate irrigation. Research in Florida on soil moisture sensor controllers has shown that savings can exceed 70% with a variety of controllers under normal rainfall conditions (Cardenas-Lailhacar et al., 2008; Mcready et al., 2009). Savings during dry periods are less dramatic but are as much as 30-40% (Shedd et al., 2009 - ref being submitted for publication now). Finally, ET controllers have also been shown to result in savings of 43% during dry conditions (Davis et al., 2009 - ref being submitted for publication now).

Table 1. Amounts of N applied depend on concentration of N in the reclaimed water and the amount of reclaimed water applied during irrigation.

N conc. In reclaimed water (ppm)	1.0 inch irrig. water	5.0 inches irrig. water	10 inches irrig. water	20 inches irrig. water	30 inches irrig. water	50 inches irrig. water	100 inches irrig. water	150 inches irrig. water
	Resulting lbs N per 1000 sq ft							
1.0	0.00518	0.0259	0.0518	0.1036	0.1554	0.2590	0.518	0.777
2.0	0.01036	0.05180	0.1036	0.2072	0.3108	0.5180	1.036	1.554
3.0	0.01554	0.0777	0.1554	0.3108	0.4662	0.7770	1.554	2.331
5.0	0.02590	0.1295	0.2590	0.5180	0.7770	1.2950	2.590	3.885
10.0	0.05180	0.2590	0.5180	1.0360	1.5540	2.5900	5.180	7.770
20.0	0.1040	0.5202	1.0405	2.0809	3.1214	5.2023	1.041	15.61
30.0	0.1561	0.7803	1.5607	3.1214	4.6821	7.8035	1.561	23.41

Considerations for the use of reclaimed water as a source of nutrients:

- In terms of reclaimed water from advanced waste water treatment facilities (AWT), in most cases, the mass balance points to excessive amounts of water required to achieve even low recommended amounts of N due to the low concentration of N in reclaimed water (Table1). Reclaimed water users should be sure to understand the concentrations of nutrients in their water before determining an irrigation schedule. Concentrations of N can be greater from facilities with only secondary waste water treatment (the 20 and 30 ppm rows of data in Table 1). Although these are the calculated amounts of N applied, there may be eventual loss of N due to denitrification, volatilization, and tie-up in organic matter and soil microbes.
- Proper irrigation management with reclaimed water is required to prevent N leaching from over-application of water. Rates of reclaimed water used in irrigation should be

based on the water needs of the turfgrass. Once that amount is determined, then the amount of N applied can be determined. For example in Table 2, using 30 inches of water with 3.0 ppm N, for the year would result in the application of 0.446 lbs of N per 1000 sq. ft. for the season. This amount of N could be subtracted from the recommended amount of N, thus saving fertilizer costs. Irrigating with reclaimed water can result in leaching of the N contained in the reclaimed water as well as fertilizer N previously applied to the turfgrass.

- Proper irrigation management with reclaimed water can also prevent the over-application of P. For example in Table 2, using 30 inches of reclaimed water with 0.5 ppm P would result in the application of 0.179 lbs of P_2O_5 per 1000 sq. ft. for the season. This amount of P_2O_5 can eliminate the need to apply any additional phosphorus fertilizer, thus saving fertilizer costs. However, many of the combinations of reclaimed water P concentrations and irrigation amounts would exceed the Florida Department of Agriculture and Consumers Services "Urban Turf Fertilizer Rule" (FDACS, 2007).
- Possible build up of salt through the use of reclaimed water. But this might go either way. Salt doesn't seem to be a widely reported problem at this time.
- Unintended consequence of irrigating with reclaimed water is the contribution of nitrogen and other nutrients, not to mention other elements, during the non-growing, dormant period of landscape plants when these nutrients are not needed by the plants.
- The specific N and P concentrations in reclaimed water are not always optimal for turf requirements. For example, a homeowner may have a soil that tests high in P and does not require the P from the reclaimed water. In this case, it might not be wise to use reclaimed water.

Table 2. Amount of P_2O_5 applied as a function of the concentration of P (as P) in reclaimed water and the quantity of reclaimed water applied.

P conc. In reclaimed water (ppm)	1.0 inches irrig. water	5.0 inches irrig. water	10 inches irrig. water	20 inches irrig. water	30 inches irrig. water	50 inches irrig. water	100 inches irrig. water	150 inches irrig. water
	Resulting lbs P_2O_5 per 1000 sq ft							
0.1	0.0012	0.0060	0.0119	0.0238	0.0357	0.0596	0.119	0.179
0.25	0.0030	0.0149	0.0298	0.0596	0.0894	0.1489	0.298	0.447
0.5	0.0060	0.0298	0.0596	0.1191	0.1787	0.2979	0.596	0.894
0.75	0.0089	0.447	0.0894	0.1787	0.2681	0.4468	0.894	1.340
1.0	0.0119	0.0596	0.1191	0.2383	0.3574	0.5957	1.191	1.787
2.0	0.0238	0.1191	0.2383	0.4766	0.7149	1.1915	2.383	3.575
5.0	0.0596	0.2979	0.5957	1.1915	1.7872	2.9787	5.957	8.936

The University of Florida summer rainy-season N fertilizer management strategy for inclusion in a fertilizer ordinance:

The research shows turf to be a very good accumulator of nutrients and leaching mitigator. The unintended consequences described above should be of intense interest to those interested in preventing nutrient pollution. We therefore are proposing the following reasonable and workable strategy and best management practice as an alternative to the strict fertilizer "black-out" period:

Allow a one-time application of at least 30% controlled-release nitrogen fertilizer, not to exceed 1.0 lb total N per 1000 sq. ft., during the summer rainy-season period to correct a professionally (BMP trained county agent or BMP-trained turf professional) diagnosed nitrogen deficiency in the turf. This approach is consistent with the UF-IFAS turf fertilization recommendations (Sartain, 2007; Sartain et al., 2009; Trenholm et al., 2009), which are based on more than 20 years of research, the Green Industries Best Management Practices Guide, the FDACS Urban Turf Rule, and the FDEP Model Turf Ordinance (FDACS, 2007; FDEP, 2002; FDEP, 2009).

Nitrogen diagnosis would be by the following standard, commonly used research color/quality rating scale (Skogley and Sawyer, 1992):

A very good quality grass would be one that rated 7.0 to 8.0. One that rated a nine would be somewhat excessively fertilized. Considering economic and environmental factors, it best to manage turf in the range of 6.5 to 7.5 which would be rated a good to very good quality turfgrass.

Summary/concluding comments

- UF/IFAS strongly supports using research-based science to underpin sound guidelines for helping homeowners protect the environment, and achieve the enjoyment of their urban landscapes.
    - These goals can be achieved without a strict summer rainy-season blackout of turf/landscape fertilizers.
    - We believe research can identify those situations when fertilizers are needed and those when fertilizers are not needed.
- Minimize potential for N and P leaching or run-off from urban turf landscapes.
    - Lawn grasses require consistent nutrition to grow normally. Unfertilized turf will decline leading to reduced uptake of fertilizer when fertilization commences.
- Provide for reasonable turf growth for home owner satisfaction.
    - A strict summer rainy-season ban on N fertilization may lead homeowners to over-apply fertilizer just prior to the blackout period, leading to potentially more nutrient loss with the summer rains than properly fertilized healthy lawn grass.
- Minimize the loss of turf or decline in ground coverage
    - Lawn grasses require consistent fertilization to grow normally. Unfertilized turf will decline leading to poorer uptake of fertilizer when fertilization commences.
- Base guidelines on research to the extent possible.

- Addressing urban fertilization practices should be a year-round process, using best management practices and education. There is adequate research in Florida to support the University of Florida summer rainy-season fertilization strategy presented above.
- More education and research is needed for best management practices for homeowners and turf professionals.
  - Education and incentives (with accountability) have proven to achieve the best results in changing behavior.
  - The University of Florida has published three documents containing answers to frequently-asked questions (see reference list).
- There is a need for mandatory BMP training for fertilizer applicators, retailers, home owner associations, and others who apply fertilizers or who make recommendations for fertilizer application.
- There are several major needs for further research including:
  - An IFAS sponsored turf industry summit identified the following major research needs relating to the environment: verify current BMPs, study controlled-release fertilizers, evaluate the effectiveness of ordinance summer fertilizer black-out periods, breed nutrient and water efficient turf varieties, study irrigation efficiency.
  - We need to develop springs and watershed friendly fertilizers. These fertilizers might consist of new technologies to control nutrient release or consist of blends of specially developed controlled-release and soluble fertilizers.
  - We need studies of consumer behavior in adopting BMPs.
  - Evaluate new ways to assist homeowners in applying correct amounts of fertilizer, for example, retail fertilizers may need to be packaged in consumer-sized units, e.g., size by 1000 sq ft.
  - Identify new construction site best management practices that leave a soil and site properly conditioned for proper turf and landscape plant establishment and growth. For example soil compaction can lead to increased water and nutrient runoff.

In summary, much is known about turf grass fertilization and water quality in urban environments. Part of solving the water quality problems associated with urban fertilizer management is related to fertilizer practices and irrigation technology adoption by homeowners. Another part of solving the problem is making the solutions logical and reasonable so there is a very high likelihood of adoption. There is a strong need for all stakeholders, (scientists, environmental groups, turf and fertilizer industries, state agencies, county BOCCs, local municipalities, and others) in the issue to work together to come up with a lasting solution that everyone buys into and that future generations will benefit from.

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