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Urban Fertilizer Ordinances in the Context of Environmental Horticulture and Water Quality Extension Programs: Frequently Asked Questions[1]

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Introduction

Excess nitrogen (N) and phosphorus (P) in water bodies are a leading cause of water quality degradation statewide. There are both natural and anthropogenic sources of N and P transport to Florida surface and groundwater; however, since 2007, urban fertilizer is one source that has been increasingly targeted for management. As a result, more than 50 Florida counties and municipalities now have formal fertilizer ordinances, which in some cases include fertilizer blackouts, or bans on the usage of N and P fertilizers during certain times of the year.

University of Florida Institute of Food and Agricultural Sciences (UF/IFAS) Extension serves a variety of stakeholders. As such, UF/IFAS has researched and developed recommendations on the use of urban fertilizers for plant health and landscape quality, as well as best management practices for water quality protection when urban fertilizers are used. Anecdotal reports suggest that stakeholders sometimes hear only one side of this message or feel that the two sides are necessarily at odds with each other, leading to a sense that UF/IFAS either promotes one side or the other, or that UF/IFAS is inconsistent in its messaging related to urban fertilizers.

The purpose of this document is to provide background information on the underlying issues of fertilizer use, with an emphasis on an urban setting, and outline the current state of the science on urban fertilizers and water quality in Florida. This information is presented in response to 12 frequently asked questions (FAQs) that also include discussion of several technological and regulatory solutions that have been adopted around the state. A summary of additional research that is needed in order to help UF/IFAS better address this critical issue in Florida follows each FAQ.

1. What is the overall nature of water quality issues in Florida with regard to nutrients?

Nutrients are a natural requirement for the proper biological function of aquatic ecosystems. Generally, most of Florida's freshwater systems are phosphorus limited, whereas our estuaries are nitrogen limited. However, the relationship between nutrient concentration and ecological

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response is often site-specific, and the management of both nutrients is essential for maintaining healthy water quality and ecosystem function. When aquatic ecosystems are healthy, primary productivity and biomass are limited by the availability of nutrients. However, when nitrogen and phosphorus are provided in excess, eutrophication can occur. The process of eutrophication includes the excessive growth of aquatic vegetation and algae due to an overabundance of available nutrients. Algal blooms can lead to reductions in water clarity, die-offs of submerged aquatic vegetation (SAV), and/or declines in the amount of oxygen available in the water. Pervasive eutrophication and harmful algal blooms can have broader health, economic, and social impacts.

Nutrient pollution from excess nitrogen and phosphorus to Florida's inland, estuarine, and coastal waters originates from either point or nonpoint sources. Point sources are identifiable, fixed sources (e.g., wastewater treatment plants), whereas nonpoint sources are sources without a single point of origin (e.g., agricultural or urban stormwater). Point sources of pollution are easier to identify and have been managed since the 1970s through the federal Clean Water Act (CWA). The CWA created the National Pollution Discharge Elimination System (NPDES), which restricts the discharge of pollutants. These pollutants include nutrients as well as a broad array of other industrial, municipal, and agricultural wastes.

The CWA also set standards for identifying impaired bodies of water (known as the 303(d) list) and for estimating loads of pollutants that would not prevent a body of water from meeting water quality standards. Bodies of water that do not meet these water quality standards for the particular pollutant are considered "impaired." The Total Maximum Daily Loads (TMDLs; see http://edis.ifas.ufl.edu/ae431 for more information) include an estimate of all sources of nutrient discharge (point source load allocation, nonpoint source load allocation, and a margin of safety). This margin of safety allows for a level of uncertainty since nonpoint sources of pollution are much harder to identify and quantify.

In Florida, the Florida Department of Environmental Protection (DEP) is responsible for developing and implementing the state's TMDLs as mandated by the 1999 Florida Watershed Restoration Act (s.403.067 F.S.; see http://edis.ifas.ufl.edu/fe608 for more information). In addition to TMDLs, Florida has a set of numeric nutrient standards for total nitrogen, total phosphorus, and/or chlorophyll a. According to the Florida Administrative Code (62-302.530(47)(b)), "in no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna." Nutrient pollution is the primary cause of water quality impairment throughout the state and is considered the single largest cause of water quality degradation in the United States (FDEP 2018).

2. How can UF/IFAS on one hand recommend fertilizer and on the other hand study water quality degradation due to excess nutrients?

As a land-grant university, the University of Florida has a mission to serve all stakeholders through UF/IFAS. Those stakeholders represent agriculture, horticulture, and natural resources. UF/IFAS develops fertilizer recommendations with the goal of using the least amount of fertilizer to elicit a desired response in plants, as do all land-grant universities. In agriculture, the goal is to use the smallest fertilizer application to produce the maximum yield. In horticulture, the objective is to apply the smallest amount of fertilizer to maintain optimal health and acceptable quality. Although the development of fertilizer recommendations described here minimizes the amount used, the primary consideration is plant response rather than environmental impact. Fertilizer recommendations are regularly reviewed to assess whether less product can be used to obtain the same response, because fertilizer is costly and the science of identifying, documenting and measuring impacts on the natural environment is ongoing. Recent research has resulted in reduced fertilization recommendations for three turfgrass species (Table 1). That said, under certain conditions, even the recommended amount could have environmental consequences.

3. What does the science say about fertilizer requirements in urban landscapes?

A range of fertilizer rates is recommended to maintain healthy turfgrass with acceptable visual quality and adequate ground cover. The ranges of recommendations are meant to account for variance in site conditions (e.g., soil compaction, pH, management practices, etc.; see Table 1). Within the range of real-world conditions, the recommendations are for the smallest amount of fertilizer for a desired response. A healthy turfgrass stand can reduce soil erosion and provide vegetative filtering of pollutants.

Research needs: Turfgrass breeding research needs to continue to produce commercially viable grasses that provide aesthetic appeal while requiring fewer inputs such as fertilizer and irrigation. More research is needed on nutrient fate and transport in turfgrass systems in real-world and non-ideal conditions such as soil compaction, sparsely covered lawns, or weedy lawns. UF/IFAS has some historic recommendations for fertilization of non-turfgrass ornamentals (Kidder et al. 2009), but research is needed to see if these recommendations can be updated.

4. What are the sources of nutrients to Florida's bodies of water?

Sources of nutrients can originate from both natural and human (anthropogenic) activities. The amount of nutrients entering a body of water is complex and dependent on a number of factors (Badruzzman et al. 2012). Three main sources are discussed below. Several others that are beginning to be studied are listed.

One of the primary sources of natural nutrient loading is through atmospheric deposition, or the transfer of atmospheric pollutants into terrestrial and aquatic ecosystems through wet (i.e., rain, snow, fog) or dry (i.e., particles or gases) pathways. In some aquatic systems, atmospheric deposition can be a significant contributor of total nitrogen (approximately 20%) and phosphorus, although phosphorus deposition is less understood.

Septic systems, also referred to as onsite wastewater treatment systems (OWTSs), are widely used in areas that lack municipal wastewater treatment systems. An estimated 30% of Florida's population uses septic systems for wastewater disposal. With an estimated 2.6 million systems in operation, Florida is responsible for 12% of the entire country's septic systems (FDOH 2018). Although septic systems are extremely efficient at removing biological waste (i.e., fecal coliform), conventional systems are not designed to remove nutrients; in addition, these systems only remove about 30% of total nitrogen input, making even well-sited and maintained conventional systems potential sources of nutrients to groundwater. See http://edis.ifas.ufl.edu/ss550 for more information about nitrogen from septic systems.

Fertilizer application in agricultural and urban environments can be a significant contributor to nutrient pollution in Florida (see Question 5). According to the Florida Department of Agriculture and Consumer Services, nearly 1.9 million tons of fertilizer were sold in FY2017–18. Nutrient loading into subsurface groundwater and surface waters from fertilizer application is dependent on numerous factors including, but not limited to, soil type, plant type and density, fertilizer type and application rate, and irrigation schedules.

Other sources of nutrients to surface and groundwater include livestock wastes, pet wastes, soil erosion, organic matter (grass clippings or leaf litter), and reclaimed water, but limited if any formal data exist on the extent to which these sources are contributing nutrients to surface and groundwater in Florida.

Stormwater runoff is a nonpoint source of nutrients to bodies of water worldwide. The concentration of nutrients in stormwater runoff has been evaluated for various land use categories in Florida. This enables a comparison of potential transport of nutrients by stormwater across land use types (Table 2). However, these numbers do not tell us the source of these nutrients.

5. Are fertilized landscapes sources of nutrients in bodies of water?

Yes. A study by Yang and Toor (2016) showed that fertilized urban landscapes were one of several sources of nitrate nitrogen to urban stormwater runoff in Florida. In that study of various neighborhoods in the Tampa Bay area, N fertilizers contributed 1–39% of nitrate in urban residential stormwater. Urban stormwater runoff can be directed to surface water, thereby conveying fertilizer nutrients to Florida bodies of water. Basin Management Action Plans (BMAPs) for surface water bodies in Florida specifically list stormwater runoff as a potential source of nutrients and call for actions that will reduce nutrient transport via stormwater. The management practices in many Florida BMAPs include public education about turfgrass fertilizers and other Florida-Friendly Landscaping™ practices that aim to minimize potential transport of excess nutrients from land to water bodies.

In BMAPs developed for Florida's nitrogen-impaired springs, contributions of N by urban turf fertilizers, agricultural fertilizers, and sports turf fertilizers have been estimated through the Nitrogen Source Inventory Loading Tool (NSILT). This modeling tool uses the best available data on land use, expected fertilizer application rates associated with each land use, and fertilizer attenuation in soils to predict N loading to each spring's watershed. For example, in the Homosassa Springshed, urban turf fertilizers are estimated to contribute 24% of total springshed N (137,637 lb N/year), while agricultural fertilizers are estimated to contribute 18% (107,844 lb N/year). Sports turf fertilizers are estimated to contribute 3% (14,786 lb N/year).

Research needs: More information on stormwater transport of fertilizer nutrients in other geographic areas of Florida is needed. We also need more information on the fate of agricultural fertilizers to both runoff and groundwater for a variety of crops, sites, and growing conditions in Florida. These studies will help improve the NSILT models and increase our ability to predict the fate and transport of fertilizer nutrients in a variety of soil and climatic conditions. We also have limited information on sports turf fertilizer usage rates and nutrient losses from those land uses.

6. What is known about nutrient losses via leaching and runoff in urban landscapes?

Extensive research on leaching of nitrogen under turfgrass systems has been conducted. When applied to actively growing, healthy turf, nitrate leaching was minimized even when treatments were applied as soluble urea at rates exceeding the current UF/IFAS recommendations (McGroary et al. 2017; Shaddox et al. 2016a; Shaddox et al. 2016b; Shaddox et al. 2017; Telenko et al. 2015; Trenholm et al. 2012). The results from these studies indicate that nitrate leaching does not increase significantly during the months of fertilizer bans in many county/municipality fertilizer ordinances (June–September 30). This is due to the increased root mass and shoot growth during this time (Telenko et al. 2015; Trenholm et al. 2012). Research from north central Florida indicates that the most nitrate leaching is likely to occur in late winter or early spring, and that nitrate leaching can increase significantly during winter months when N is applied at rates of 1 lb/1000 ft^2 or greater on a monthly schedule (Shaddox et al. 2016a). This increase in leaching is attributed to the reduced nutrient assimilation by the semi-dormant or dormant turfgrass. There were few differences in nitrate leaching due to N source, whether treatments were soluble, biosolid, or controlled-release sources if turf was actively growing and healthy (Saha et al. 2007).

Due to the sandy soils that allow for rapid water infiltration in Florida, it is often thought that runoff is not a major problem. However, local hydrology is significantly disturbed in urbanized areas. Suboptimal site conditions such as compacted soils or sparsely vegetated lawns can lead to runoff from urban lawns. Furthermore, impervious surfaces in urban areas can collect nutrient-bearing materials (fertilizer granules, pet wastes, grass clippings, etc.), which are mobilized and transported by rainfall. UF/IFAS research by Yang and Toor (2016) used stable isotope source tracking methods to identify sources of N in stormwater runoff and stormwater ponds in the Tampa area (see Question 5). These studies showed that fertilizers are indeed a source of N in urban residential runoff. In the most intensive of these studies, which investigated runoff from a variety of urban neighborhood types (multifamily, single family of different sizes), atmospheric deposition (rain) was the leading N source, followed by soil organic matter and N-bearing fertilizers. Atmospheric sources of nitrogen are local, national, and international, and atmospheric N concentrations can vary widely. However, since N is a ubiquitous part of the atmosphere, atmospheric deposition will contain some level of N. Impervious urban surfaces that limit rainfall infiltration into soils can therefore be expected to channel atmospheric N to runoff and receiving water bodies.

7. Do fertilizer bans protect water quality?

There are multiple sources of nutrients in Florida's water bodies. UF/IFAS research using stable isotope source tracking methods has shown that in addition to fertilizers, sources of nutrients in water bodies include atmospheric deposition, decaying plant material such as grass clippings left on streets, pet waste, sewage waste and leaky septic tanks, reclaimed water, and soil (Yang and Toor 2016; Lusk 2019) (see Question 5). It is important to note that nutrients are likely transported from landscapes to water bodies regardless of fertilizer use. However, fertilizers are indeed identified in UF/IFAS research as one source of nutrients in samples of stormwater, ponds, lakes, streams, springs, and coastal waters.

A study funded by the Tampa Bay Estuary Program (TBEP) reported in 2015 that at least 7 years of monitoring would be necessary to observe any statistically significant effects of fertilizer bans on local water quality. Long-term monitoring efforts have not been initiated to compare water quality in residential areas with fertilizer bans versus those without the bans.

The same TBEP study observed evidence of nitrate from fertilizer sources in lawn soils of residential neighborhoods both with and without bans. Thus, even if fertilizers are not applied, fertilizer-derived nutrients may still reside in lawn soils and potentially become mobilized and transported to water bodies for some time after the last fertilizer application. In a separate UF/IFAS study by Lusk et al. (2018), fertilizer N applied to young St. Augustinegrass during the summer rainy season was shown to accumulate in soil organic matter pools, with very little (less than 3%) leached from the soil during the season. While this fertilizer N may reside in the soil organic matter pool for years, it could potentially become mobilized at some future point, even in the absence of future fertilizer applications.

Research needs: Long-term (>7 years) studies on the relationships between fertilizer bans and water quality are needed.

8. What are the long-term effects of fertilizer bans in terms of economics, the environment, and landscape quality?

Evidence on the effect of fertilizer blackouts on landscape health does not exist formally. Anecdotal evidence from numerous landscape maintenance companies suggests landscapers are responding to fertilizer bans by changing their approach to chemical application by using enhanced-efficiency fertilizers and organic amendments such as various types of composted materials or municipal yard waste. Both of these practices increase maintenance cost, but the effect on the environment or landscape quality is unknown.

Research needs: Research is needed to quantify the economic and environmental cost of fertilizer blackouts, as well as the impact of fertilizer blackouts on long-term turfgrass and landscape quality. Further understanding on release characteristics is needed for current and developing enhanced-efficiency fertilizers. Research is also needed on the agronomic benefit and environmental impacts of soil amendments that may be used more frequently when fertilizer bans are put into place.

9. How does reclaimed water contribute to nutrient needs of turfgrasses and other plants?

Reclaimed water is former wastewater that has undergone at least secondary treatment and disinfection at a wastewater treatment plant, after which it may be piped back to communities for reuse in numerous activities, including landscape irrigation. Florida leads the nation in reclaimed water reuse, with approximately 760 million gallons/day of statewide reuse. The majority (66%) is used for landscape and agricultural irrigation (FDEP 2017). Reclaimed water contains numerous constituents of concern that are not completely removed by wastewater treatment, such as salts, nutrients, and trace organic chemicals. With the continued and increasing use of reclaimed water in the state, there is a growing need to understand the contribution of nutrient loads from lands irrigated with reclaimed water.

Reclaimed water contains both N and P in varying levels depending on the type of wastewater treatment process in a locality. While reclaimed water nutrients can help meet some of the nutritional needs of turfgrass, some of the nutrients in reclaimed water may be in forms not readily available to plants (e.g., complex nitrogen-bearing organic molecules), or they may be applied at times of the year when plants are not actively taking up soil nutrients. More information on the nutrient content of reclaimed water can be found at http://edis.ifas.ufl.edu/ss542.

Research needs: Reclaimed water contains not only nutrients but also other constituents of possible concern, such as salts and other inorganic elements (boron, fluoride, etc.). Therefore, research is needed to determine how these constituents may affect plant health and offset any benefits of nutrient additions via reclaimed water. Research is also needed on the forms of nutrients in reclaimed water and the conditions that will allow plants to use them. Data are lacking on how much irrigation overspray (i.e., watering nontarget areas such as sidewalks) contributes nutrients to urban stormwater runoff, but this may be expected to occur and should be investigated.

10. How do soil amendments affect the nutrient and irrigation needs of turfgrass and landscape plants?

Florida's sandy soils naturally have low organic matter content and water-holding capacity. The typical process of development results in extensive movement of soil to meet drainage requirements on a site. This activity often results in poor soils as the media for landscape plant growth. There is currently great interest in soil amendments to increase soil health and water-holding capacity with the objective of decreasing inorganic fertilizer requirements. However, there is little evidence quantifying the effect of different types of amendments, potentially optimal application rates, or possible duration of an amendment in urban landscapes.

Research needs: Studies are needed to quantify the physical, chemical, and biological effect of various amendment types on urban soils. Nutrient interaction and longevity studies are also needed.

11. How does human behavior fit into fertilizers and water quality?

Research from neighborhoods in Florida has detected nitrogen in stormwater and ponds originating from fertilizers, grass clippings, and yard debris (Tampa Bay Estuary Program 2015; Yang and Toor 2016; Lusk et al. 2020). Determining the exact behavioral mechanisms that lead to this stormwater pollution is difficult due to the high variation in landscape management, seasonal rainfall, and stormwater design. Social research with homeowners throughout the state indicates a high percentage of homeowners apply fertilizer themselves or hire contractors (Persaud et al. 2016; Tampa Bay Estuary Program 2015).

Among the factors that influence the application of fertilizer are the presence of a homeowner association (HOA), the age of the development, household income, and percentage of turfgrass in the landscape. Research has documented how neighbors' norms and practices influence residents' landscaping practices. There is a knowledge gap about what residents should do to limit the environmental impact of their landscapes. Those who rely on contractors have even less knowledge about what is taking place in their landscapes (Tampa Bay Estuary Program 2015). Homeowners in municipalities with a fertilizer ordinance show awareness of the ordinance itself and report that they follow the guidelines regarding the blackout period, but they are less knowledgeable about the details of nutrient management (e.g., keeping grass clippings out of stormwater structures) (Yang and Toor 2016; Persaud et al. 2016; Tampa Bay Estuary Program 2015). The Center for Public Issues Education in Agriculture and Natural Resources has conducted numerous research studies on public perception around water issues such as conservation.

The TBEP study compared fertilizer usage among residents in counties with fertilizer bans and usage by residents in counties without fertilizer bans. The study found that residents reported using significantly higher rates of fertilizer in counties without fertilizer restrictions compared to residents in counties with restrictions. For example, the study concluded that Hillsborough County communities (no fertilizer ban) were receiving 93 lb N/acre, whereas Pinellas County communities (summer fertilizer ban) were receiving 38.3 lb N/acre (Tampa Bay Estuary Program 2015). Thus, fertilizer bans may affect resident behavior and lead to reduced application of fertilizers.

12. How does UF/IFAS balance constituent needs such as fertilizer recommendations from the landscape industry with the need to protect environmental quality?

The Florida-Friendly Landscaping™ (FFL) Program was created more than two decades ago to provide education related to residential and commercial landscapes intended to conserve water, reduce waste and pollution, create wildlife habitat, and prevent erosion. This program promotes techniques such as soil testing before fertilizing, using the appropriate type and rate of fertilizer for specific plants, utilizing the most efficient irrigation practices, performing proper irrigation management, and above all, implementing landscape designs that minimize irrigation and fertilizer requirements.

The Green Industries Best Management Practices (GI-BMP) educational program was created to train lawn care and landscape maintenance professionals in FFL practices that help conserve and protect Florida's ground and surface waters. All commercial fertilizer applicators must be licensed based on GI-BMP training.

Historically, land-grant universities have developed fertilizer recommendations to elicit a plant response using the minimum amount of fertilizer. These recommendations are meant to maximize yield for food crops or plant health and quality for non-food crops. This approach results in the lowest cost for the optimum plant response. It has always been implicit that the minimal fertilizer use would also minimize the environmental impact, given the main goal of maximum yield or quality. Optimizing plant quality while minimizing water quality to meet environmental goals is not typically done.

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Table 1. Nitrogen recommendations for established turfgrass in Florida by species and region (lb N/1,000 ft²/year).

Species	2004–2015			2016–present		
	North	Central	South	North	Central	South
Bahia	2–3	2–4	2–4	1–3	1–3	1–4
Centipede	1–2	2–3	2–3	0.4–2	0.4–3	0.4–3
St. Augustine	2–4	2–5	4–6	2–4	2–5	4–6
Zoysia	3–5	3–6	4–6	2–3	2–4	2.5–4.5

Table 2. Typical nutrient concentrations in stormwater by land use category (Harper and Baker 2007).

Land Use Category	Event Mean Concentration (mg/L)	
	Total Nitrogen	Total Phosphorus
Low-Density Residential	1.61	0.91
Single-Family	2.07	0.327
Multifamily	2.32	0.520
Low-Intensity Commercial	1.18	0.179
High-Intensity Commercial	2.40	0.345
Light Industrial	1.20	0.260
Highway	1.64	0.220
Pasture	3.47	0.616
Citrus	2.24	0.183
Row Crops	2.65	0.593
Undeveloped/Rangeland/Forest	1.15	0.055
Mining/Extractive	1.18	0.150