Can Growth Potential Models be Used for Planning Turf Fertilization in Florida?

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Abstract

Concern about non-point source pollution and impairment of surface and ground water is common place throughout the United States. In Florida, measures to mitigate these pollutants are promulgated and enforced at the local municipality or county level. Florida's commercial fertilizer applicators must now follow Best Management Practices (BMPs) for the Green Industries in Florida and possess a state fertilizer license issued by Florida Department of Agriculture and Consumer Services. However, more restrictive local ordinances which exceed the BMPs continue to be implemented throughout Florida – many of which are not based on sound science.

Growth Potential (GP) models are being developed to predict turfgrass growth at specified temperatures and then assigning a numerical value to that prediction. The GP value can then be linked to nutrient demands of turf and the predicted amount of nutrient that a grass will use during a specific period of time can be determined. In an effort to refine fertilization practices across Florida, GP was calculated for various Florida cities across the climatically diverse state.

One outcome resulting from the GP modelling is a proposed rule change in Florida fertilizer labeling laws allowing for higher rates of slow release nitrogen (N) on a per application basis. Florida law currently restricts the use of slow release N to rates $\leq$ 49 kg N ha^{-1} (1.0 lb. N 1,000 ft^{-2}). The GP model coupled with nutrient fate research demonstrated that rates $\leq$ 98 kg N ha^{-1} (2.0 lbs. N 1,000 ft^{-2}) from certain slow release N sources have limited leaching when applied to healthy turf prior to the peak of GP.

Introduction

The U.S. Clean Water Act (CWA), Section 303(d), requires states to submit lists of polluted or impaired water bodies and to develop estimated loads that the water bodies could receive of each pollutant while meeting water quality standards. These estimated loads are called Total Maximum Daily Loads (TMDLs). TMDLs are defined as the maximum amount of a pollutant that a water body can receive and still meet the water quality standards as established by the 1972 Clean Water Act.

In 1999, the Florida Watershed Restoration Act (FWRA) (s. 403.067 F.S.) was passed. This act identified the methods that the Florida Department of Environmental Protection (FDEP) would use to develop and implement TMDLs (Fig. 1).

Specifically, the FWRA requires that TMDLs include all pollutant sources (agriculture and urban). Furthermore, the FWRA:

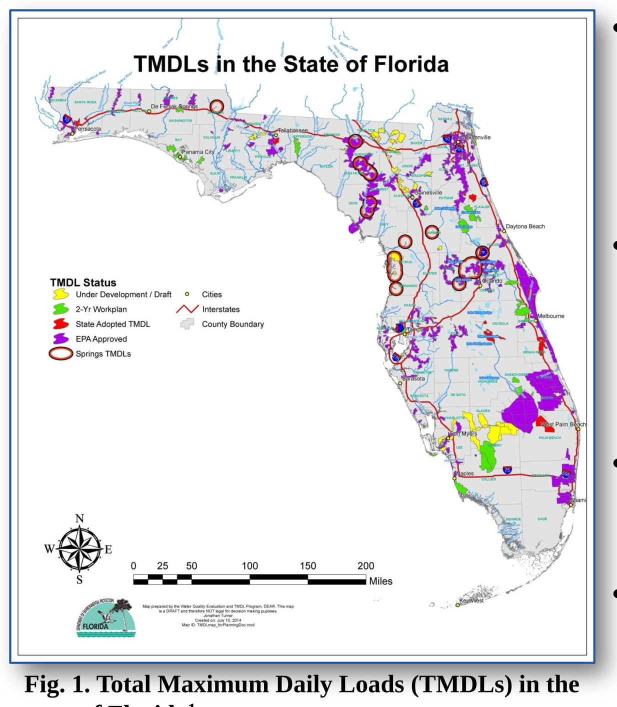


Fig. 1. Total Maximum Daily Loads (TMDLs) in the state of Florida[1].

- Directs Florida Department of Agriculture and Consumer Services (FDACS) to develop Interim Measures and Best Management Practices (BMPs) to address agricultural nonpoint pollution sources,
- Provides growers implementing BMPs that are adopted by Rule (by FDACS) and verified by FDEP as effective with a "Presumption of Compliance" with applicable state water quality standards,
- Directs FDEP to allocate pollutant loads between point, nonpoint, and background sources, and
- Allows cost-share of BMPs, with funds to support the program for agriculture originating from the Florida Forever Act Amendments.

The legislature through the Florida Right to Farm Act (s. 823.14 F.S.) provides that a local government may not adopt any ordinance, regulation, rule, or policy to prohibit, restrict, regulate, or otherwise limit an activity of a bona fide farm operation where growers are utilizing best-management practices or interim measures developed by FDACS. *This legislation, however, does not pertain to Florida's Landscape and Golf Course Industries because they are not considered farm operations.* Consequently, the Florida turf industry has been the focal point of numerous task forces, public hearings, fertilizer ordinances, mandatory regulations, and anti-green industry media campaigns (Fig. 2).

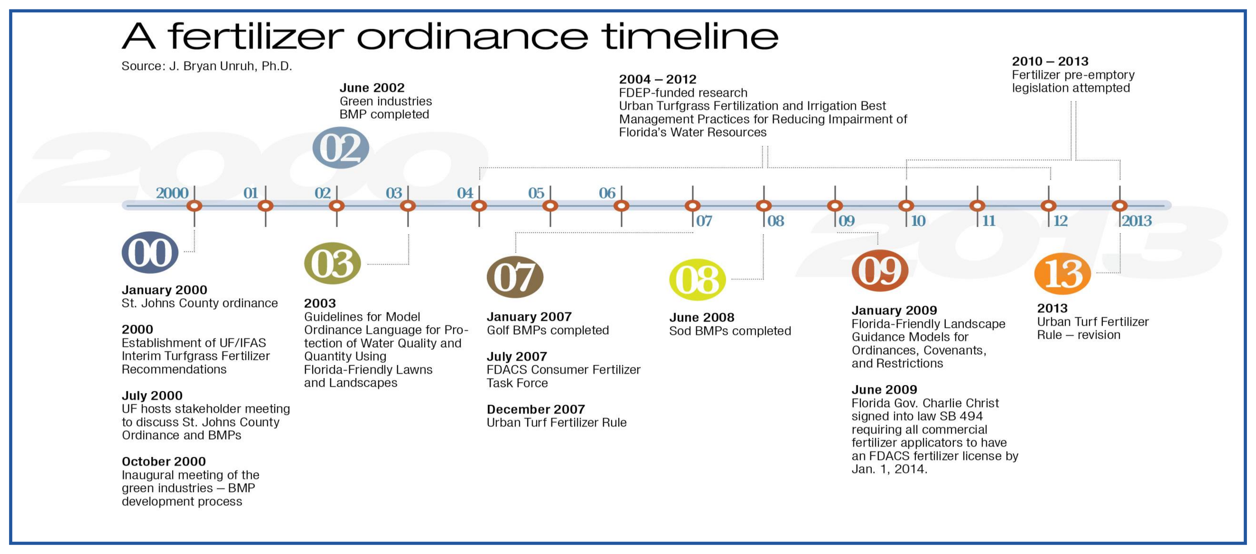


Fig. 2. A timeline depicting significant events related to fertilizer use by the Green Industry in Florida. (Source: *Golf Course Management*)

Concerns Over Turf Fertilization

Turf fertilization is under increasing scrutiny due to concerns of potential non-point source pollution – particularly from nitrogen (N) and phosphorus (P) applications. In Florida, these concerns have become heightened in recent years due to several confounding factors. First, population growth in Florida has increased sharply over past decades and continued growth is expected (Fig. 3). Second, Florida's climate is characterized by regions of abundant rainfall (Fig. 4) though it may be received sporadically over the year and often via very intense rainfall events. Third, much of Florida's soil – especially in the high density population areas – is characterized as spodosols (Fig. 5) which are typically sandy and excessively drained. Additionally, the state of Florida has Karst geology making it vulnerable to groundwater pollution.

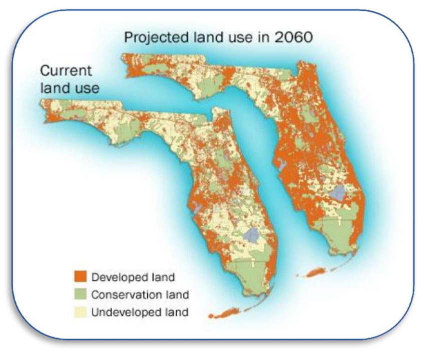


Fig. 3. Current and projected land use in 2060[2].

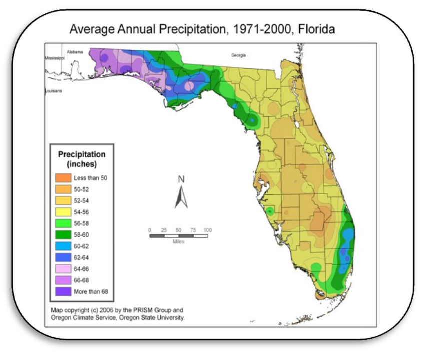


Fig. 4. Average annual precipitation across Florida – 1971 – 2000[3].

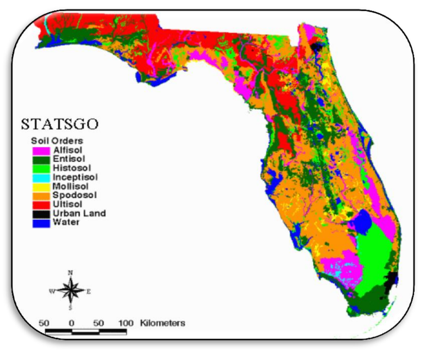
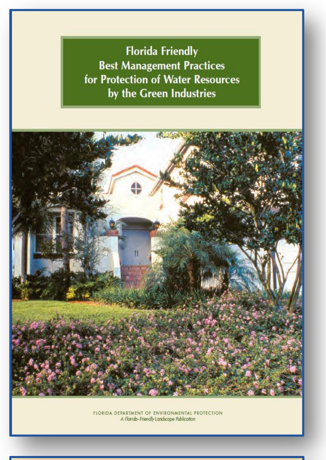
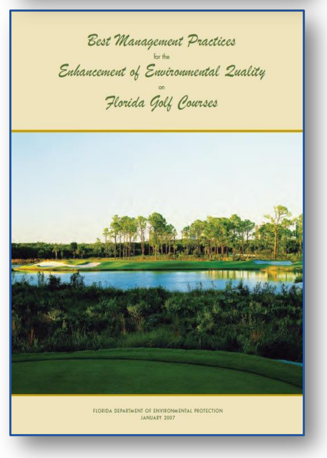
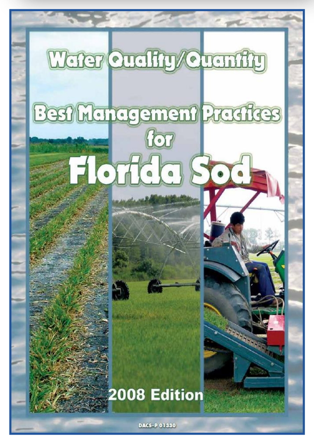


Fig. 5. Typical soil orders found throughout Florida[4].







Many Floridians – especially newcomers – are not familiar with its plants, unique growing conditions, climatic constraints, and geological features. Consequently, improper landscape management practices could lead to environmental problems. To meet the legislative mandates and to abate concerns over turf fertilization, three turf industry Best Management Practices publications have been developed. These include the *Florida Friendly Best Management Practices for the Protection of Water Resources by the Green Industry* (i.e., lawn care), the *Best Management Practices for the Enhancement of Environmental Quality on Florida Golf Courses*, and *Water Quality/Quantity Best Management Practices for Florida Sod*. These three manuals were written by a broad-based consortium of green industry practitioners, local and state officials, regulatory agencies, environmental advocacy groups, and university scientists. Since January 2014, Florida law requires all commercial fertilizer applicators to be certified and licensed in a manner similar to pesticide licensing.

Because Florida does not have state preemptory laws pertaining to nutrient use (other than Florida Right to Farm Act), 91 local government jurisdictions in Florida (10 counties and 81 municipalities), have imposed stricter rules regulating and impacting the green industry – despite the extensive BMP education efforts, state fertilizer labeling restrictions, and applicator licensing requirements. Nutrient use, irrigation, and vegetation selection are targeted and most regulations are contrary to research-based plant management recommendations. The potential unintended consequences of these restrictive rules and regulations are high (Hochmuth et al., 2012).

Growth Potential Models

PACE Turfgrass Research Institute developed predictive models (Fig. 6) used to estimate growth potential of cool- and warm-season turfgrasses by comparing actual temperature to the optimum temperature [cool-season = 20 °C (68 °F); warm-season = 31 °C (88 °F)] (Gelernter and Stowell, 2005). These models were originally developed to aid turf managers with overseeding and transitioning between cool-season and warm-season turf during winter months (Gelernter and Stowell, 2005; High, 2006). More recently, these models have been used to estimate turfgrass N use (Woods, 2012; Woods, 2013).

$$GP = 100\left[\frac{1}{e^{\left[\frac{1}{2}\left[\frac{obsT - optT}{sd}\right]^{2}\right]}}\right]$$

GP = growth potential
obsT = observed temperature (F)
optT = optimum turf growth temperature (F)
sd = standard deviation of the distribution
(warm-season = 12; sd cool-season = 10)
e = natural logarithm base 2.718282

Fig. 6. Growth potential model used to describe the relationship between turfgrass growth and temperature.

Our objective was to investigate the value of using a predictive model of growth potential for the major metropolitan areas of Florida to: 1.) compare predictive N needs with current University of Florida, Institute of Food and Agricultural Sciences (UF/IFAS) turf nutrition recommendations; and 2.) demonstrate to turf managers ways to better refine their nutrient application timings to coincide with optimal turfgrass assimilation of applied nutrients.

Growth Potential / Turf Nutrition Recommendations

UF/IFAS recommendations for annual N fertilization rates are based on turfgrass species and location in the state (Fig. 7). The three regions – north, central, and south – are delineated by orange lines in Fig. 8 along with growth potential estimate curves calculated from 30 year historical temperature data for 13 Florida cities.

Nitrogen recommendations (lbs. N / 1000 ft^2 / year)*			
Species	North	Central	South
Bahiagrass	2-3	2-4	2-4
Bermudagrass	3-5	4-6	5-7
Centipedegrass	1-2	2-3	2-3
St. Augustinegrass	2-4	2-5	4-6
Zoysiagrass	2-3	2-4	2.5-4.5

* North Florida is north of Ocala. Central Florida is defined as south of Ocala to a line extending from Vero Beach to Tampa. South Florida includes the remaining southern portion of the state.

Fig. 7. UF/IFAS Nitrogen Recommendations for Lawn Grasses Grown in Florida.

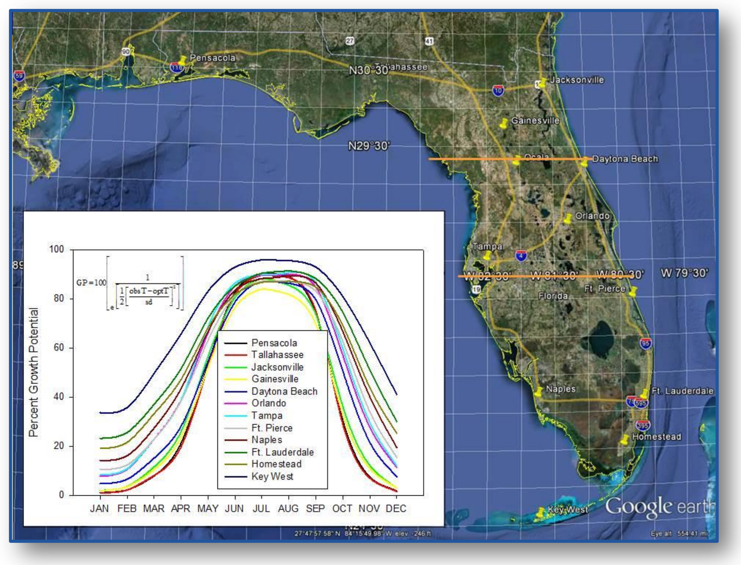
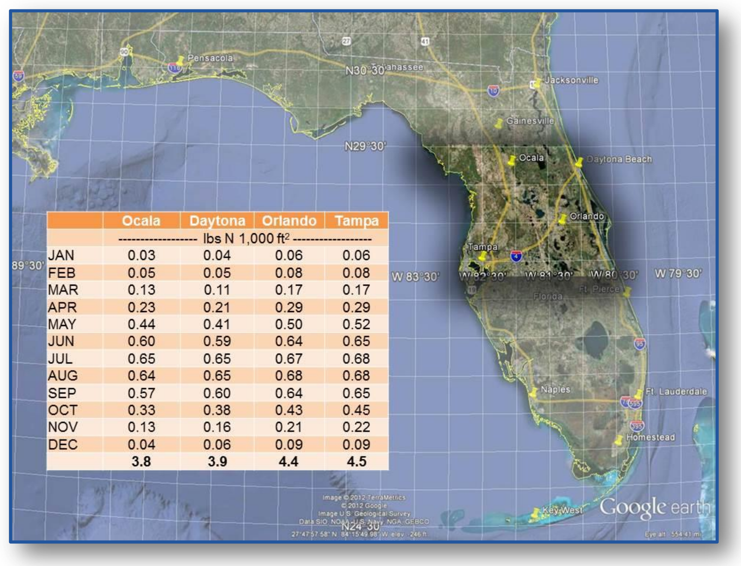


Fig. 8. Monthly Growth Potential Estimates for Various Cities in Florida.

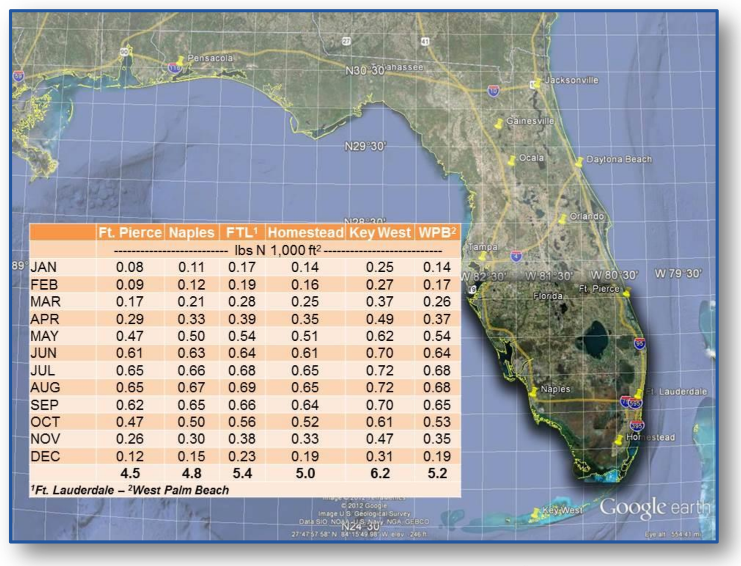
	Pensacola	Tallahassee	Jacksonville	Gainesville
	lbs N 1,000 ft^2			
JAN	0.01	0.01	0.02	0.01
FEB	0.02	0.02	0.03	0.03
MAR	0.06	0.06	0.09	0.08
APR	0.16	0.15	0.19	0.18
MAY	0.40	0.39	0.42	0.39
JUN	0.62	0.61	0.60	0.57
JUL	0.68	0.67	0.66	0.63
AUG	0.67	0.66	0.64	0.61
SEP	0.56	0.56	0.55	0.52
OCT	0.23	0.22	0.27	0.25
NOV	0.06	0.05	0.09	0.08
DEC	0.01	0.01	0.02	0.02
	3.5	**3.4**	**3.6**	**3.4**

Fig. 9. Monthly Nitrogen Rates (lbs N 1,000 ft^2) for St. Augustinegrass Determined by Growth Potential Estimates for Various Cities in North Florida.



	Ocala	Daytona	Orlando	Tampa
	lbs N 1,000 ft^2			
JAN	0.03	0.04	0.06	0.06
FEB	0.05	0.05	0.08	0.08
MAR	0.13	0.11	0.17	0.17
APR	0.23	0.21	0.29	0.29
MAY	0.44	0.41	0.50	0.52
JUN	0.60	0.59	0.64	0.65
JUL	0.65	0.65	0.67	0.68
AUG	0.64	0.65	0.68	0.68
SEP	0.57	0.60	0.64	0.65
OCT	0.33	0.38	0.43	0.45
NOV	0.13	0.16	0.21	0.22
DEC	0.04	0.06	0.09	0.09
	3.8	**3.9**	**4.4**	**4.5**

Fig. 10. Monthly Nitrogen Rates (lbs N 1,000 ft^2) for St. Augustinegrass Determined by Growth Potential Estimates for Various Cities in Central Florida.



	Ft. Pierce	Naples	FTL[1]	Homestead	Key West	WPB[2]
	lbs N 1,000 ft^2					
JAN	0.08	0.11	0.17	0.14	0.25	0.14
FEB	0.09	0.12	0.19	0.16	0.27	0.17
MAR	0.17	0.21	0.28	0.25	0.37	0.26
APR	0.29	0.33	0.39	0.35	0.49	0.37
MAY	0.47	0.50	0.54	0.51	0.62	0.54
JUN	0.61	0.63	0.64	0.61	0.70	0.64
JUL	0.65	0.66	0.68	0.65	0.72	0.68
AUG	0.65	0.67	0.69	0.65	0.72	0.68
SEP	0.62	0.65	0.66	0.64	0.70	0.65
OCT	0.47	0.50	0.56	0.52	0.61	0.53
NOV	0.26	0.30	0.38	0.33	0.47	0.35
DEC	0.12	0.15	0.23	0.19	0.31	0.19
	4.5	**4.8**	**5.4**	**5.0**	**6.2**	**5.2**

[1]Ft. Lauderdale – [2]West Palm Beach

Fig. 10. Monthly Nitrogen Rates (lbs N 1,000 ft^2) for St. Augustinegrass Determined by Growth Potential Estimates for Various Cities in South Florida.

St. Augustinegrass Nitrogen Estimates

Maximum monthly N use by St. Augustine-grass is estimated to be 0.75 lbs N (3.7 g N m^{-2}). This N value was multiplied by the monthly GP estimate derived from the model to yield the monthly N rate. These calculations were made for 13 Florida cities.

Predicted N rates for St. Augustinegrass grown in each of the three regions in Florida (Figs. 9, 10, and 11) are generally within the UF/IFAS recommended rates as denoted in Fig. 7. The average rate estimates in North and Central Florida are approximately 17% greater than the average UF/IFAS recommended rate.

Of particular importance is the observation that predicted N use in Nov – Mar (North Florida) and Dec – Feb (Central Florida) is very low. These estimations are being used to inform turf managers about the importance of applying nutrients when the turf is mostly likely to assimilate them. Furthermore, these data were used in the proposed revision to the Florida Urban Turf Rule (5E-1.003) allowing rates of not more than 2 lbs. of total N (0.7 lb. soluble/1.3 lbs. insoluble) 1,000 ft^{-2} per application to be applied during the spring or summer (onset of maximum GP but not in the fall (reduced GP).

Model Refinement and Application

- The maximum monthly N use for the warm-season grasses needs to be determined in order to strengthen the prediction value of the model.
- Similarly, the optimum temperature for each species likely differs and could impact the model's predictive strength.
- Enhanced efficiency fertilizer release patterns could be linked with GP derived N rate estimates to effectively provide for the turf's sustained nutrition.
- Additional model parameters (e.g., solar radiation, rain) should be considered.

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