Lawn Care Best Management Practices for Protecting Water Quality

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Dept. Plant Science & Landscape Architecture, UConn

Landscaping for Water Quality in the Sunapee Area
New Hampshire Extension
Sunapee, NH
March 30, 2018
Reinforce Concept of Lawn BMP’s and Water Quality

http://www.fourseasonssir.com/community/nh/lake-sunapee/sunapee/
Common Sense Lawn Practices and Water Quality

https://whereyouareplanted.com/fertilizer-on-your-sidewalk-helps-helps-pollution-grow/

https://www.themasterslawncare.com/blog/do-i-really-need-sprinkler-rainfreeze-sensor

http://www.lakesuperiorstreams.org/understanding/impact_fertilizer.html

http://lusciouslandscapes.blogspot.com/2015/03/reviving-grass-injured-by-over.html


https://www.yelp.com/biz/chesterfield-lawns-and-landscapes-chesterfield
Water Quality Perspective

- Nutrients
  - Phosphorus
  - Nitrogen
- Sediment
- Pesticides (not so much, although they should not be ignored!)
Current New Hampshire Regulations State Statute (RSA: 431) as modified in 2013

• Lawn fertilizers sold retail shall not exceed 0.9 lbs. total N per 1,000ft\(^2\) per application.

• At least 20% N must be slow release form.

• Lawn fertilizers sold retail shall not exceed 0.7 lbs. per 1,000ft\(^2\) of soluble N per application.

• Shall not exceed annual application rate of 3.25 lbs. per 1,000ft\(^2\) total N.

• Illegal to apply any fertilizer within 25 feet of reference or high water line. Only lime can be applied within 25 feet of reference line. Beyond 25 feet but within 50 feet, only low P and slow release N (SRN) fertilizers may be used.
• P sold retail should be used only on newly established or repaired lawns, or on lawns testing deficient in P.

• Annual applications may not exceed a rate of 1 pound per 1,000ft$^2$ of available P ($P_2O_5$).

• No fertilizer sold retail intended for use on newly established or repaired lawns, or for lawns testing deficient in P shall exceed an application rate of 1 pound per 1,000ft$^2$ annually of available P ($P_2O_5$).

• Illegal to apply any fertilizer within 25 feet of reference or high water line. Only lime can be applied within 25 feet of reference line. Beyond 25 feet but within 50 feet, only low P and slow release N (SRN) fertilizers may be used.
New Hampshire’s Turf Fertilizer Law
What You Should Know

MARGARET HAGEN, Extension Field Specialist

Nitrogen and phosphorus are nutrients essential for the growth of plants. However, an overabundance of these nutrients causes pollution in waterways. In New Hampshire, more than half of the nitrogen pollution to Great Bay can be traced back to urban and suburban nonpoint source pollution, including fertilizer runoff. Nonpoint source (NPS) pollution, unlike pollution from industrial and sewage treatment plants, comes from many different sources. NPS pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and transports natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters and ground waters.

Once in our waterways, fertilizers designed to make our lawns lush and green may cause harmful algae blooms. As algae grow and then decompose, they block sunlight from reaching aquatic plants, rob the water of oxygen, and threaten underwater life. Algae blooms also reduce water clarity which can lead to fewer opportunities for fishing and swimming.

When fertilizers, either synthetic or organic, are applied in the proper amounts at appropriate times during the growing season, lawns will thrive and the risk of fertilizer nutrients entering our waterways will be reduced. Because of concerns over lawn fertilizer runoff, the New Hampshire legislature passed a bill in 2013 regulating the use of nitrogen and phosphorus in turf fertilizers that are sold at retail. The goal is to help homeowners maintain healthy lawns without applying unnecessary fertilizer.

When purchasing lawn fertilizers, the bag is labelled with a guaranteed analysis consisting of three numbers such as 22-0-3. These numbers stand for the percent, on a dry weight basis, of nitrogen, phosphorus (as phosphate), and potassium (as potash) contained in that fertilizer. These three nutrients are not available in sufficient quantities in many existing soils so we add them to the soil in

FERTILIZE RESPONSIBLY

- Nitrogen Content Reduced
  Lawn fertilizers sold at retail shall not exceed 0.9 pound of total nitrogen applied per 1,000 square feet per application when applied according to the label. At least 20% of the nitrogen must be in slow release form.

- Phosphorus-Free
  Most NH soils provide all the phosphorus that a home lawn needs. Phosphorus sold at retail should only be used on newly established or repaired lawns, or on lawns testing deficient in phosphorus. Annual applications may not exceed a rate of 1 pound per 1,000 square feet of available phosphate.

Turfgrass Nutrient Management Bulletin B-0100

New England Regional Nitrogen and Phosphorus Fertilizer and Associated Management Practice
Recommendations
For Lawns Based on Water Quality Considerations
Addressing Water Quality for Turfgrass in the Landscape

• Selection of Species – Higher vs. Lower Maintenance Requirements

• Mowing Heights and Clippings Management

• Water Management – Follow the Water

• Nutrients

• Pesticides

• Sediment
Selection of Species – Higher vs. Lower Maintenance Requirements

- Kentucky bluegrass and Perennial ryegrass vs. Fescues

[Images of Kentucky bluegrass, Perennial ryegrass, Turf-type tall fescue, Fine fescue, Creeping red, Chewings, and Sheep]

http://www.extension.umn.edu/garden/landscaping/maint/ts-selecting-cool-season.htm
Alternative Low-Input Species

• Bentgrasses (*Agrostis* spp.)
  • Colonial bent (*A. tenuis* or *capillaris*)
  • Highland bent (*A. castellana*)
  • Redtop (*A. gigantia*)
• Junegrass (*Koeleria* spp.)
• Hairgrass (*Deschampsia* spp.)
• Poverty oatgrass (*Danthonia* spp.)
• Zoysiagrass (*Zoysia japonica*)
Highland bentgrass

Colonial bentgrass

Prairie junegrass

Poverty oatgrass

Tufted hairgrass

Zoysia grass

http://www.finegolf.co.uk/what-is-fine-golf/green-keeping/fine-turf/
http://www.turfgrassproducts.com/seed.html
https://www.pinterest.com/pin/362891682452749587/
http://zoysias.com/
http://nativeson.com/annotated_catalog/grasscatalog.htm
Mowing Heights and Clippings Management

• Cut it High – Let it Lie

Higher mowing of turfgrass promotes a good root system - Sir Walter results are similar to above

http://www.casperwy.gov/residents/environment_and_waste/yardwaste_and_composting
http://www.beaverlakesmart.org/blog/2015/05/lawn-management-for-protecting-water-quality/
• Clippings back on Turf

Water Management – Follow the Water

- Water transport of Nutrients, Sediment, Pesticides
  - Leaching
  - Runoff

https://www.neponset.org/happenings/think-twice-before-irrigating-your-lawn/
### Reported range of turfgrass ET by species

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>ET[^1] (mm day[^{-1}])</th>
<th>Inch/wk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tall Fescue</td>
<td>Festuca arundinacea</td>
<td>7-13</td>
<td>2.0-3.8</td>
</tr>
<tr>
<td>Perennial Ryegrass</td>
<td>Lolium perenne</td>
<td>7-11</td>
<td>1.8-3.1</td>
</tr>
<tr>
<td>St. Augustinegrass</td>
<td>Stenotaphrum secundatum</td>
<td>6-11</td>
<td></td>
</tr>
<tr>
<td>Seashore Paspalum</td>
<td>Paspalum vaginatum</td>
<td>6-8</td>
<td></td>
</tr>
<tr>
<td>Bahiagrass</td>
<td>Paspalum notatum</td>
<td>6-8</td>
<td></td>
</tr>
<tr>
<td>Kikuyugrass</td>
<td>Pennisetum clandestinum</td>
<td>6-9</td>
<td></td>
</tr>
<tr>
<td>Creeping Bentgrass</td>
<td>Agrostis Palustris</td>
<td>6-10</td>
<td></td>
</tr>
<tr>
<td>Centipedegrass</td>
<td>Eremochloa ophiuroides</td>
<td>5-9</td>
<td>1.1-1.8</td>
</tr>
<tr>
<td>Bermudagrass</td>
<td>Cynodon spp.</td>
<td>4-9</td>
<td>1.5-2.0</td>
</tr>
<tr>
<td>Zoysiagrass</td>
<td>Zoysia spp.</td>
<td>5-8</td>
<td></td>
</tr>
<tr>
<td>Kentucky Bluegrass</td>
<td>Poa pratensis</td>
<td>4-7</td>
<td></td>
</tr>
<tr>
<td>Buffalograss</td>
<td>Buchloe dactyloides</td>
<td>3-6</td>
<td></td>
</tr>
</tbody>
</table>

[^1]: Field grown under high evaporative demand conditions
• Less Frequent and Deeper Watering
• Concept of Deficit Irrigation

Watering 1/10 inch a day supplies about 1 inch of water per week. However, applying the water in a single 1-inch or two 1/2-inch increments will actually make your lawn healthier. The root system will be healthier and deeper when more water is applied at once.
• Rain Sensor Cut Offs

http://www.rainbird.com/homeowner/products/timers/ESP-SMTe.htm
http://waterheatertimer.org/How-to-wire-Intermatic-sprinkler-timers.html
Nutrients

• Both Phosphorus (P) and Nitrogen (N) need to be managed carefully!

- **Nitrogen** enhances eutrophication caused by excess Phosphorus in fresh water lakes and ponds

- **Phosphorus** enhances eutrophication caused by excess Nitrogen in estuaries and coastal salt-waters

Phosphorus

Sources of Phosphorus Loading → Precipitation → Sediment Reflux → Discharge

Runoff

http://www.solitudelakemanagement.com/a-proven-solution-for-reducing-phosphorus-pollution-in-ponds1
Plant Response to Soil Test Phosphorus

Extractable Soil P Concentration

- Below Optimum
- Optimum
- Above Optimum
- Agronomic Critical Level
- Environmental Critical Level
# Soil Test – Don’t Guess!

## Test Data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Optimum Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH - Soil (pH)</td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>Mehlich - Lime Test (Buffer pH)</td>
<td>6.25</td>
<td></td>
</tr>
<tr>
<td>Calcium, Mehlich 3</td>
<td>1366.8 (ppm)</td>
<td>H</td>
</tr>
<tr>
<td>Magnesium, Mehlich 3 (Mg)</td>
<td>362.0 (ppm)</td>
<td>VH</td>
</tr>
<tr>
<td>Potassium, Mehlich 3 (K)</td>
<td>146.0 (ppm)</td>
<td>L</td>
</tr>
<tr>
<td>Phosphorus, Mehlich 3 (P)</td>
<td>129.0 (ppm)</td>
<td>VH</td>
</tr>
<tr>
<td>Est. CEC</td>
<td>10.2</td>
<td></td>
</tr>
<tr>
<td>Est. Base Sat.</td>
<td>100.0 %</td>
<td></td>
</tr>
<tr>
<td>Est. Ca Sat.</td>
<td>66.8 %</td>
<td></td>
</tr>
<tr>
<td>Est. Mg Sat.</td>
<td>29.5 %</td>
<td></td>
</tr>
<tr>
<td>Est. K Sat.</td>
<td>3.7 %</td>
<td></td>
</tr>
</tbody>
</table>

## Optimum Range Key

- **VL** - Very Low
- **L** - Low
- **M** - Medium
- **H** - High
- **VH** - Very High
Turf and Dissolved P in Runoff

• Increasing Soil Test P does correspond to greater amounts of Dissolved P in runoff

• High-intensity rainfall
• Over/misadjusted irrigation
• Frozen ground/snow melt
• Compacted soil

http://www.fairfaxcounty.gov/nvswcd/drainageproblem/control-runoff.htm
http://www.berkeleyside.com/2014/08/05/calgary-city-of-berkeley-take-steps-to-curb-water-use/
http://turfblog.rutgers.edu/?p=856
http://ocean.njaes.rutgers.edu/UnderstandingSoilCompaction.html
Just Because Fertilizer is Organic Doesn’t Mean No Threat to Water Quality

- Once nutrients mineralized to ionic forms, they can runoff or leach.
- Doesn’t matter if original source is synthetic or organic.
- Excess is Excess.
New England/Northeast Organic Farm Survey (Morris et al.)

- Collect soil samples for routine fertility analysis in 2002 and 2003, and for nitrate in 2002 and 2004 from organic vegetable fields
- Collect field history of nutrient management on farm from each grower
- Not a random sample of farms
- 5 states, ME, NH, MA, CT, NJ
- 34 farms (4-7 farms/state)
- 203 fields (1-9 fields/farm; most 5-6 fields/farm)
<table>
<thead>
<tr>
<th>P, lbs/ac</th>
<th># of fields (n=203)</th>
<th>% of fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 14</td>
<td>65</td>
<td>32.0</td>
</tr>
<tr>
<td>14 to 20</td>
<td>31</td>
<td>15.3</td>
</tr>
<tr>
<td>21 to 39</td>
<td>51</td>
<td><strong>25.1</strong></td>
</tr>
<tr>
<td>&gt; 40</td>
<td>56</td>
<td>27.6</td>
</tr>
</tbody>
</table>

Optimum range is 14 to 20

Mean 68.2; median 21.5; range 1 to 99
Soil P Values to Monitor
Organic Amendment Additions

- Soil Test P was significantly related to soil test K, Mg, Ca, and soil OM
- Soil OM had the greatest influence on Soil P
- Soil test P significantly related to years in organic: fields > 16.3 yrs of application much greater P
Nitrogen

http://www.sjrwmw.com/waterbodies/pollutionsources.html
http://befreshwaterfriendly.org/yard-savvy/
Nitrogen

- Application rates, timing, and formulations
- Slow vs. Fast Release forms
- Synthetic vs. Organic
- Timing – Fall Fertilization
- Fertilizer Substitution – Clovers and other legumes
- Maintain soil pH near neutral
- No- or Low-Fertilizer Buffer Strip Adjacent to Water Sources
What Guides N Fertilization for Turfgrass?

- Historical; Routine
  - Usually 0.5-1.0 lb per 1000ft$^2$, 2-4 or more times a year for *high-cut turf*
  - much lower rates and more frequently for *low-cut turf*; every 10-14 days)
- Subjective Assessment (usually based on color and density; or sports surface performance)
- Expected needs of specific grass species
- Objective Tests are not routinely used
Without Objective Guide for Nitrogen

- For older established lawns, apply \( \frac{1}{2} \) to \( \frac{1}{3} \) (or less) of that recommended on fertilizer bag label.
- Reapply only when lawn response starts to fall below acceptability.
- Slow-release formulations are more preferable than soluble, fast-release formulations.
Cumulative Nitrate-N Loss, lbs/1000ft²

But, What are Long-Term Effects Of Slow-Release N?

Soil nitrate-N concentrations (0-12-inch) in vegetable fields with various organic amendment histories in June 2002 (wet spring) and June 2004 (normal spring)

PSNT
25 ppm critical conc

Field number

Soil NO$_3^-$-N, ppm

New England/Northeast Organic Farm Survey (Morris et al.)
Fall Fertilization
Agronomic Benefits
What Risk to Water Quality?

• Agronomic benefits limited with later fall application dates.
• Higher probability of N loss with later fall application dates.
• In my opinion fall fertilization represents greatest risk to water quality other than establishment and gross over-application.
• Earlier cutoff date, lower rates, or rethinking of practice must be considered.
Mechanism of Nitrogen Uptake Related to Transpiration and Mass Flow

Water lost by transpiration

Ions absorbed with water by root hairs

Ions absorbed with water by root hairs
What is Likelihood of Sufficiently High Transpiration Rates in Late Fall to Drive Uptake of Large Volume of Soil Water?

https://www.campbellsci.com/blog/evapotranspiration-101
## Potential Evapotranspiration (average monthly; inches) 1981-2010

<table>
<thead>
<tr>
<th>Location</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concord, NH</td>
<td>0.33</td>
<td>0.53</td>
<td>1.17</td>
<td>2.2</td>
<td>3.46</td>
<td>3.97</td>
<td>4.42</td>
<td>3.84</td>
<td>2.48</td>
<td>1.42</td>
<td>0.63</td>
<td>0.35</td>
</tr>
<tr>
<td>Caribou, ME</td>
<td>0.17</td>
<td>0.3</td>
<td>0.73</td>
<td>1.51</td>
<td>2.88</td>
<td>3.39</td>
<td>3.64</td>
<td>3.07</td>
<td>1.84</td>
<td>0.89</td>
<td>0.31</td>
<td>0.16</td>
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<tr>
<td>Bangor, ME</td>
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<td>0.45</td>
<td>0.98</td>
<td>1.86</td>
<td>3.11</td>
<td>3.56</td>
<td>3.91</td>
<td>3.42</td>
<td>2.20</td>
<td>1.20</td>
<td>0.49</td>
<td>0.27</td>
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<tr>
<td>Burlington, VT</td>
<td>0.24</td>
<td>0.42</td>
<td>0.97</td>
<td>1.96</td>
<td>3.26</td>
<td>3.74</td>
<td>4.13</td>
<td>3.47</td>
<td>2.18</td>
<td>1.13</td>
<td>0.45</td>
<td>0.23</td>
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<tr>
<td>Portland, ME</td>
<td>0.33</td>
<td>0.52</td>
<td>1.08</td>
<td>1.91</td>
<td>3.09</td>
<td>3.61</td>
<td>4.08</td>
<td>3.54</td>
<td>2.30</td>
<td>1.29</td>
<td>0.58</td>
<td>0.34</td>
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<tr>
<td>Worcester, MA</td>
<td>0.33</td>
<td>0.51</td>
<td>1.12</td>
<td>2.03</td>
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<td>3.59</td>
<td>4.03</td>
<td>3.49</td>
<td>2.27</td>
<td>1.31</td>
<td>0.59</td>
<td>0.33</td>
</tr>
<tr>
<td>Boston, MA</td>
<td>0.37</td>
<td>0.57</td>
<td>1.15</td>
<td>1.95</td>
<td>3.09</td>
<td>3.58</td>
<td>4.02</td>
<td>3.49</td>
<td>2.29</td>
<td>1.36</td>
<td>0.63</td>
<td>0.37</td>
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<tr>
<td>Hartford, CT</td>
<td>0.39</td>
<td>0.61</td>
<td>1.31</td>
<td>2.28</td>
<td>3.56</td>
<td>4.02</td>
<td>4.45</td>
<td>3.74</td>
<td>2.52</td>
<td>1.54</td>
<td>0.72</td>
<td>0.41</td>
</tr>
</tbody>
</table>

http://www.nrcc.cornell.edu/wxstation/pet/pet.html
University of Connecticut

Kentucky bluegrass-Creeping red fescue mix
1 lb N 1000ft$^{-2}$

Percolate Nitrate-N loss,
lbs/1000ft$^2$/yr

Control
Sept.15
Oct.15
Nov.15
Dec.15

Date of Fall Fertilizer Application

No Fall Fertilizer

Mangiafico and Guillard
(J. Environ. Qual. 35:163-171, 2006)
Fig. 1. Effect of temperature regimen and nitrogen application rate on $^{15}$N fertilizer recovery in roots and roots + verdue (total) for (A) Run 1 and (B) Run 2. Roots and verdue were harvested 10 d after nitrogen application. Temperature regimens correspond to 15 Sept., 15 Oct., and 15 Nov. in Madison, WI.

University of Wisconsin

Lloyd et al. 2011, HORTSCIENCE
46(11):1545–1549

Nov. ~40-60% loss

Nov. ~65-85% loss
Fall lawn fertilizer applications should be complete before September 15 in northern New Hampshire and by October 1 in southern New Hampshire.
Fertilizer Substitution

• Dutch/Micro White Clover (*Trifolium repens*)

Estimated to provide 2.6 to 4.4 lbs N/1000ft²/yr

• Grazing Birdsfoot trefoil (Lotus corniculatus var. arvensis ‘Kalo’)

Estimated to provide 0.7 to 3.0 lbs N/1000ft²/yr

http://bygl.osu.edu/bygl_archive2015/content/birdsfoot-trefoil-foiling-appearance-turfgrass-0
• Return the Clippings to the Turf

Kopp and Guillard (Crop Sci. 42:1225-1231, 2002)
• When Clippings Returned, Reduce N Rates or total N Loading

Bentgrass managed as fairway

• Returning Clippings Does Not Increase Thatch

Kopp and Guillard (2004, Proceedings 4th International Crop Science Congress)
Maintain Soil pH Near Neutral

- 6.0 to 6.8 Ideal range
- Promotes soil organic matter mineralization

Pesticides and Water Quality

• Combination Fertilizer & Pesticide Products
• IPM
• Pesticide Runoff 29 Chemicals (Haith and Duffany, 2007)
  □ Turf pesticides runoff losses varying from 0 to 2% of applied chemicals.
  □ Pesticide runoff depends on the nature of the grass surfaces; greater vegetation mass produce less water runoff and also more strongly adsorb chemicals.
  □ Pesticide runoff not uniformly distributed throughout year; most occurs in brief, infrequent events.

• Maintaining dense vegetation decreases runoff
• Buffer Zones
• Most of turf pesticide leaching – sand putting greens
Sediments

• Runoff Related to Vegetative Cover and Infiltration

http://turfblog.rutgers.edu/?p=856

http://ocean.njaes.rutgers.edu/UnderstandingSoilCompaction.html
Concluding Thoughts

• Lawn BMP’s for water quality do not have to be in conflict with profitable business model.

• Common sense should guide most of your lawn-care management decisions with respect to water quality.

• Your feedback and input critical for future research.
Questions?

karl.guillard@uconn.edu

http://www.turf.uconn.edu/guillard.shtml