Managing Our Coastal Lawns to Protect the Salt Ponds

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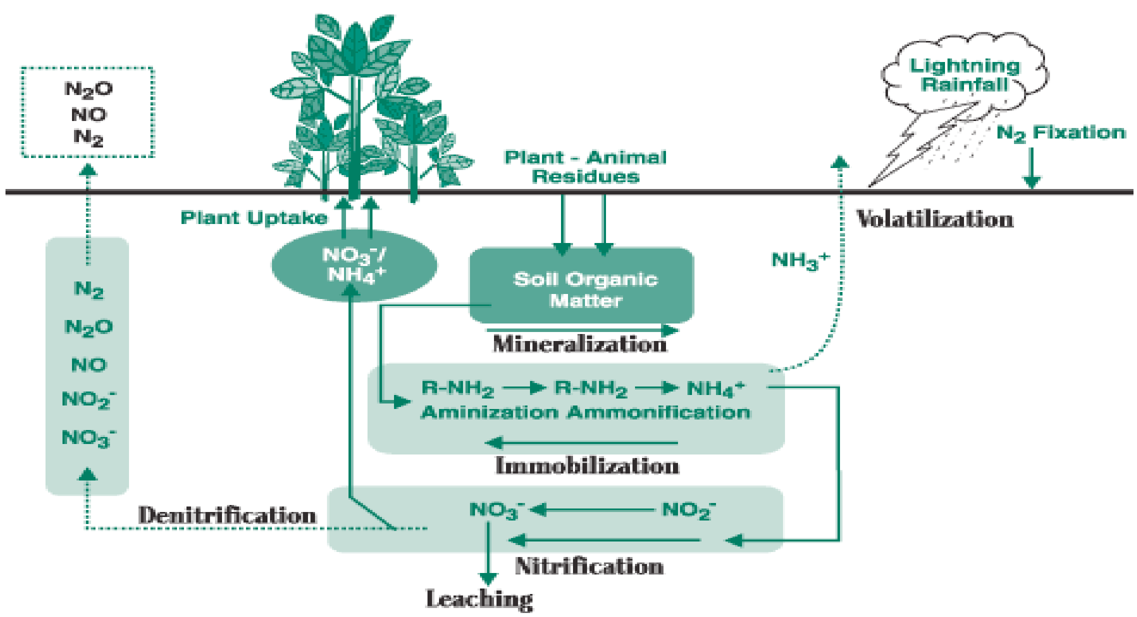
Nitrogen in our salt ponds

The nutrient of most concern that enriches or negatively affects Rhode Island's coastal salt ponds is dissolved inorganic nitrogen, notably nitrate (NO_3) and ammonia (NH_4) (Callender, 2008). Both nitrate and ammonia are important inorganic nitrogen species for the fertilization of Rhode Island's Coastal Salt Ponds (Kanda, et al., 1990) (Twomey, et al., 2005). Most of the nitrate comes from external sources (runoff, groundwater, atmospheric precipitation), while most ammonia in the ponds is internally recycled by mineralization of sinking and deposited organic matter (Billen and Lancelot, 1988).

Nitrogen is everywhere

Nitrogen (N) is part of our natural world. It cycles between the organic and inorganic forms. In the atmosphere nitrogen comprises over 78% of the major chemical constituents (Chapin, et al. 2003). In the organic form (proteins, nucleic acids, etc.) nitrogen is an important element in plants, animals, microorganisms and plant-animal residues. Nitrogen is also found, to lesser extent, in inorganic forms (NH_4, NO_2, and NO_3).



Human (anthropogenic) activity has significantly increased the availability and cycling of nitrogen throughout the world (Vitousek et al, 1997).

Lawns in the salt pond zone

Lawns have been a historically important part of our residential landscapes. The advent of the power mower combined with the widespread availability of improved grass species, formulated lawn fertilizers, the rubber hose for irrigation enhanced the role of lawns in the American landscape from the early 20^{th} Century to today.

A healthy and well-established lawn can out-compete most weeds and withstand a certain amount of stress from drought, insects, disease and foot traffic. A key to maintaining an attractive and healthy lawn is the availability of nitrogen. Nitrogen is an important element in chlorophyll which makes it possible for the plant to photosynthesize. It is the presence of chlorophyll, of course, that creates the green color of the typical lawn.

What happens when fertilizer is applied to the soil

When we add N to our local environment, oftentimes as fertilizer for plant growth, it can be transformed from the organic form to the inorganic form (mineralized), absorbed in the inorganic form by plants and microbes with transformation into a mix of organic combinations, transformed to a gas with release to the atmosphere, or it can move in solution, primarily in the inorganic form as NO_3 but also (to an extent) as dissolved organic nitrogen (DON), with surface and ground water flow; sometimes ending up in our salt ponds.

Most of the nitrogen in the soil is in organic combinations of one sort or another, with only a small proportion of the nitrogen reservoir of the soil mineralized during each growing season (Alexander, M. 1991). As with the algae in our salt ponds, the roots of grass plants absorb N from the soil primarily in the inorganic form (NO_3 and NH_4).

Lawn plants take up nitrogen through their roots; primarily in the inorganic, or nitrate (NO_3) form. Since grass plants have fairly shallow root systems, it is the top six inches or so of the soil surface that provides nitrogen to the plants. NO_3 easily moves into solution, and if water is found in excess in the root zone, any NO_3 not used by the grass plant roots, or transformed to a gas, may move with the water down below the lawn root zone area. Eventually, some of the NO_3 in this shallow groundwater may flow into the salt ponds.

Biochemical Processes

In the soil, ammonia reacts with water and is largely converted to ammonium (NH_4), which tends to be strongly adsorbed on soil particles. This adsorption inhibits the movement of ammonium through the soil. Ammonium is an energy-rich substance and certain soil bacteria can utilize this energy by nitrifying the ammonium to nitrate (NO_3). Unlike ammonium, nitrate is not adsorbed to soil particles and, therefore, moves readily with water in the soil. Nitrate that is not taken up by plant roots or soil micro-organisms can be transported to groundwater and surface water by a variety of mechanisms (McIsaac, 2003).

In addition to the mineral N (NH_4 and NO_3), dissolved organic nitrogen (DON) is increasingly recognized as a significant form of N in the solution of fertilized soils (Murphy et al., 2000) and may contribute 10 to 20% of total leaching N losses (Siemens and Kaupenjohann, 2002). The DON is composed of an array of N-bearing organic molecules (e.g. amino acids, amino sugars, peptides, humic materials) that are dissolved in and transported with the soil solution. Recent research suggested that DON was a significant component of the total N leached from golf-green profiles, and was assumed to be derived primarily from background soil and rhizoshperic N (Pare, et al., 2008).

Hydrologic Processes

Rainfall, snow melt, or irrigation water input to the soil periodically exceeds the water holding capacity of the soil in the root zone. Depending on the characteristics of the soil, this may lead to one or more of the following: 1) saturation of the root zone with water; 2) surface runoff; and 3) drainage of water through the soil profile to groundwater and/or surface water bodies. Each of these has different consequences for transport of nitrate to surface waters. If the soil becomes saturated, oxygen may become scarce and in anoxic conditions, denitrifying bacteria may convert the nitrate to nitrogen gases (NO, N_2O, and N_2) (McIsaac, 2003).

<u>Recent lawn research identifies water quality concerns for coastal zone</u>

Recent research shows that certain commonly used lawn management practices can contribute to the loss of N from lawn areas, increasing the potential for some N to eventually enter the salt ponds. Areas of concern include:

- **Late fall fertilization**. Because the late fall and winter are characterized by low temperatures, high precipitation, low evapo-transpiration and low plant uptake of water and nutrients, fertilizer applied to turf in the fall may be subject to leaching losses (Petrovic, 1990). Research at the University of Connecticut to determine the timing effects of fall fertilization on nitrate leaching found no differences in color, clipping yield, chlorophyll concentration, shoot density or root mass when nitrogen fertilizer was applied between October 15 and December 15. However, NO_3-N concentrations and mass losses in percolate water increased with these later application dates. These finding suggest that the current recommendation of applying N in mid to late November in southern New England may not be compatible with water quality goals (Mangiafico and Guillard, 2006).

- **Fertilizer amounts and frequency**. For most established lawns with clippings returned, two pounds of nitrogen per 1,000 square feet per year may be sufficient. Under this approach, one pound of nitrogen per 1,000 square feet is applied in late spring and one pound of nitrogen per 1,000 square feet in fall. If turf quality and density is acceptable before fertilization, it may be possible to reduce the nitrogen rate or eliminate entirely. With low-maintenance grasses, one pound of nitrogen per 1,000 square feet per year may be sufficient if clippings are returned (Guillard, 2008).

- **Soluble fertilizers**. Various formulations of N-based fertilizers are available for lawn turf. These products range in formulation from highly soluble, fast-release sources of N such as urea, ammonium nitrate, and ammonium sulfate to low solubility, slow-release sources such as isobutylidene diurea, coated ureas, ureaformaldehyde, or organic-based materials. Research at the University of Connecticut suggests that to reduce the threats of NO_3-N leaching in coastal environments of southern New England that lawn turf fertilizers should be formulated with a larger percentage of slow-release N than with soluble N (Guillard and Kopp, 2004).

- **Over-fertilization of older lawns**. Soil organic matter accumulation is rapid in the first ten years after lawn establishment and slowly builds to an equilibrium at 25 years when no further net N immobilization occurs. There is a rather limited capacity of the soil to store organic N and that after ten years the potential for over-fertilization is greatly increased (Porter, et al., 1980). Research at the University of Western Australia suggests that the quality of older turfgrass was maintained using less N fertilizer than was used on younger turfgrass (Barton, et al, 2008). Researchers at Michigan State University concluded that limiting fertilizer application rates on older lawns reduced the concentration of NO_3-N in the leachate (Frank, et al., 2004).

- **Use of high maintenance grass species**. Lawn grasses vary in their needs for fertilizer and water. Kentucky bluegrass and perennial ryegrass have relatively high requirements for fertilizer and water in order to perform well. Lower-maintenance grass such as turf-type tall fescues, dwarf tall fescues, and the fine-leaf fescues such as creeping rye, Chewings, sheep, and hard fescue provide good persistence and quality while requiring less fertilizer, water, and pesticides (Guillard, 2008).

- **Excessive irrigation**. Irrigation has been shown to significantly increase NO_3 leaching (Snyder, et al., 1984). Home lawns are typically watered with little regard for soil moisture status or the water-holding capacity of the soil. Excessive watering will increase antecedent soil moisture, thereby promoting additional leaching and surface water runoff from natural storm events or from supplemental (irrigation) water alone (Morton, et al., 1986).

Suggested actions to manage lawn areas

Because many residential properties in the coastal region drain to salt ponds the question for many property owners becomes: How to maintain an attractive residential landscape, yet try to do our best to protect the water quality of the ponds?

The key objective should be to manage the lawn with an eye to having nitrogen available in an amount that is needed at any given time, but not to excess. To achieve this consider the following actions:

- **Use organic fertilizer or low-soluble inorganic fertilizer**. This approach minimizes the amount of inorganic N that can become soluble in water and potentially lost from the root zone.

- **Return clippings to the lawn**. You can cut your fertilizer need in half by "recycling" the N in the grass clippings back to the soil for later use by grass plant roots.

- **Add no more than one half pound of N with each application for each 1,000 square feet of lawn area.** Most lawn fertilizer bags list the amount of square footage coverage provided by the fertilizer in that bag based on adding one pound of N per 1,000 square feet. To determine how much N is in the bag, look at the fertilizer bag label and multiply the weight of fertilizer in the bag times the percent nitrogen in the fertilizer. This will tell you how many pounds of N are in the bag.

- **Fertilize once or twice per year.** For established lawns apply fertilizer in late spring and again in the fall. If turf quality and density is acceptable before fertilization, it may be possible to reduce the fertilizer frequency to one time each year. If the lawn appears to need more fertilizer to establish suitable density and appearance, then consider adding fertilizer more frequently, but at the one-half pound rate.

- **Stop adding fertilizer after early-November.** The fertilizer N in late fall fertilizer additions is not taken up by the roots; rather it is available to become soluble in water and lost from the root zone over the fall and winter months.

- **Reduce the amount of fertilizer applied to lawns that are ten years or older.** As the lawn ages, it needs less nitrogen from fertilizer. Therefore, if the older lawn needs less fertilizer, and standard application rates are followed, the chances are increased that some of the fertilizer N will become soluble in water and may be lost below the root zone.

- **Reduce excessive irrigation of lawns**. By adding water through irrigation, there is an increased risk that some of the inorganic N in the root zone will be dissolved in the water and move below the root zone before the lawns roots have time to absorb the N.

- **Shift to fescue grasses**. These grasses require less N and water. Consider turf-type tall fescues, dwarf tall fescues, and the fine-leaf fescues (creeping red, Chewings, sheep, and hard). They provide good persistence and quality, with less fertilizer, water and pesticides than Kentucky bluegrass and perennial ryegrass. Turf-type and dwarf tall fescues also are good alternatives for high-traffic, lower-maintenance recreation areas. Although this approach is most suitable for newly-established lawns, it is possible to over-seed existing lawns with a fescue mix so that over time the lawn will see an increased mix of fescue grasses.

- **Clean up fertilizer that gets applied to roads, sidewalks, patios and other hard surfaces.** Fertilizer left on these surfaces will flow offsite with the rain water.

Additional landscape management approaches

Consider reducing the amount of lawn area and applied nitrogen by allocating areas previously in lawns to other plantings, such as perennial beds, shrubs, trees, or gardens. Allow some areas to revert to natural forested areas. Take a three-part approach that includes site design, plant selection, and landscape management.

Overall design of the property is a critical first step. From a water quality standpoint consider working with the hydrology instead of altering it. Allow off-site runoff to move across the property without damaging the site or adding pollution to the runoff. Maintain natural vegetation or riparian buffers around surface water edges and wetlands. Ensure developed areas drain to well-vegetated zones, never directly to a stream or storm sewer. Use small on-site detention basins to hold water to increase infiltration or slow runoff.

Manage runoff and pollution from impervious surfaces. Driveways, sidewalks, and gutters need not drain to the pavement - they can drain into a well-vegetated area by appropriately sloping, crowning, or redirecting water flow. Improve existing soil infiltration by incorporating organic material into lawns and planting beds.

Use buffer zones to intercept and filter pollution in runoff and enhance the diversity of plant and wildlife species. Infiltration can be increased by one-third to one-half by leaving areas in a more natural state, such as buffer zones or existing woods.

Select plants to be maintained and/or added to the property. Take particular note of existing site conditions (wet/dry areas, sunny/shady areas, etc.) as well as your long-term goals (minimize deer damage, attract birds/butterflies, enhance wildlife corridors, etc.).

Grass may not be the best choice as a vegetative cover. Excellent locations for alternative ground cover include areas with steep slopes, wet or shady areas and sites with easily erodible soils. When carefully selected and planted, ground covers can improve infiltration of water into the soil, slow storm water runoff and reduce maintenance needs.

Consider converting areas of your yard to natural looking tree and shrub borders with the trees. Utilize xeriphytic plants (requiring little water) on dry landscape sites by using drought-resistant plant varieties, and improving soils or using mulches to help retain moisture in the soil. Many varieties of native or non-invasive ornamental plants are adaptable to dry landscapes. Many ornamental grasses and herbs have low water needs.

Manage the landscape by recycling existing materials such as leaves instead of utilizing purchased bark mulch. Chop the leaves with a mulching mower and rake or blow them into the landscaping beds to use as mulch. Careful planning of your landscape beds and natural border areas will help to facilitate this process.

Web sites

There are several useful websites for further information. Two locally-oriented sites of note that address various aspects of landscape management are:
URI web site: http://www.uri.edu/ce/healthylandscapes/index.html
UConn web site: http://www.sustainability.uconn.edu/index.html

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