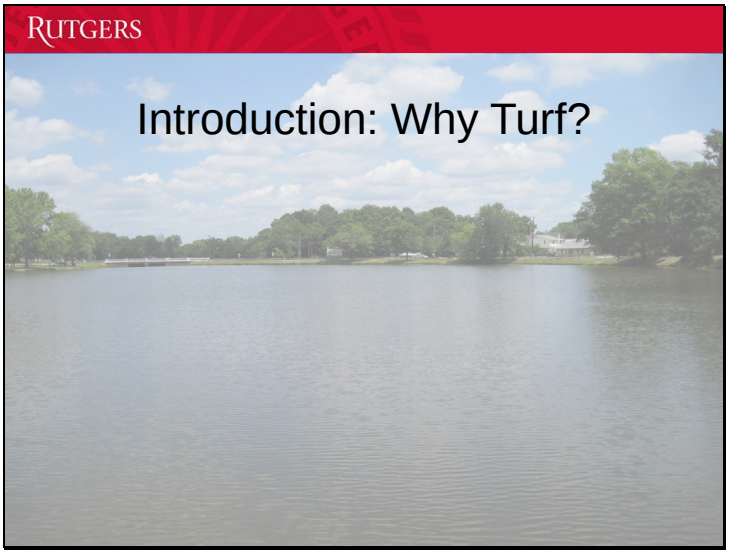
Slide 1

Today we're going to be talking about environmentally-friendly lawn care. I will talk a little about the use of turfgrass in general, some specific horticultural issues like watering and fertilizing, and finally some environmental topics associated with turfgrass.

Slide 2



Slide 3

RUTGERS

Where are turfgrasses used?

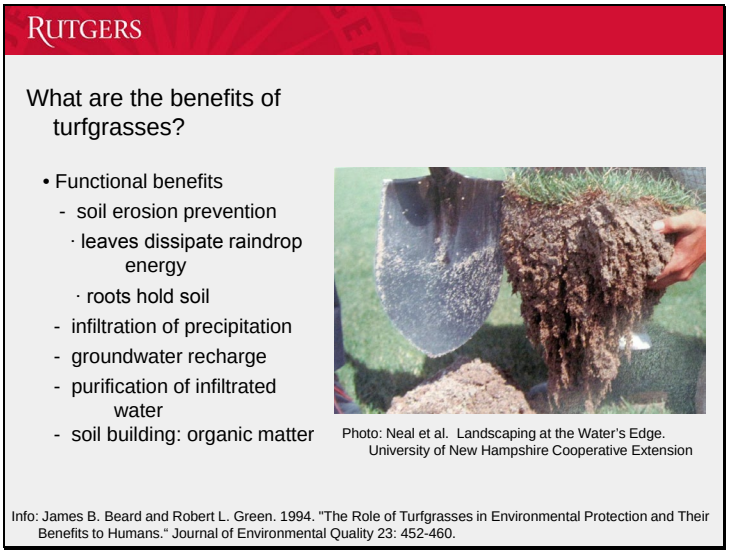
- Home lawns
- Schools and businesses
- Sports fields, golf
- Utility: Road sides, airports

Haven Sports Field, photo: Nikki Mahadevan, Creative Commons license, Wikimedia.

Info: James B. Beard and Robert L. Green. 1994. "The Role of Turfgrasses in Environmental Protection and Their Benefits to Humans." Journal of Environmental Quality 23: 452-460.

If you think about the landscapes in which we live, you realize that we use a lot of turfgrass: home lawns, turf areas around schools and businesses, sports fields, golf courses, and utility uses of turfgrass like along roadsides.

Slide 4



So why do we use turfgrass so much in our landscapes? There are several benefits to turfgrass. Thinking about ecosystem benefits, turfgrasses have dense, fibrous root systems—as you see in the photo—that are very good at holding soil in place and preventing soil erosion. They have a dense canopy of leaf blades that dissipate raindrop energy, which also helps to prevent soil erosion. This dense canopy of leaf blades slows runoff, allowing water to infiltrate into the soil, thereby removing pollutants from the water and recharging groundwater stores. Turfgrasses also tend to build soil organic matter and soil structure as roots grow into the soil and then eventually die off.

Slide 5

RUTGERS

What are the benefits of turfgrasses?

- Recreational
  - recreation
  - safety
- Aesthetic
  - aesthetics, landscaping
  - mental health

Haven Sports Field, photo: Nikki Mahadevan, Creative Commons license, Wikimedia.

Info: James B. Beard and Robert L. Green. 1994. "The Role of Turfgrasses in Environmental Protection and Their Benefits to Humans." Journal of Environmental Quality 23: 452-460.

In sports fields, turfgrass provides an appropriate playing field, whether it's a soccer field or a putting green on a golf course. But what's most important for a sports field is having a safe playing surface. For example, on a soccer field, having a dense, uniform turf is important to prevent someone's cleat from slipping and causing a sprained ankle. Also, on a soccer field, you would need a grass that recuperates from wear relatively quickly to keep the playing surface densely covered. Finally, there are the aesthetic benefits to using turfgrasses. Some research indicates that people prefer landscapes that have turf and trees—maybe with more trees than in this photo—, but often we want a municipal park, say, to have open areas and trees.

Slide 6

RUTGERS

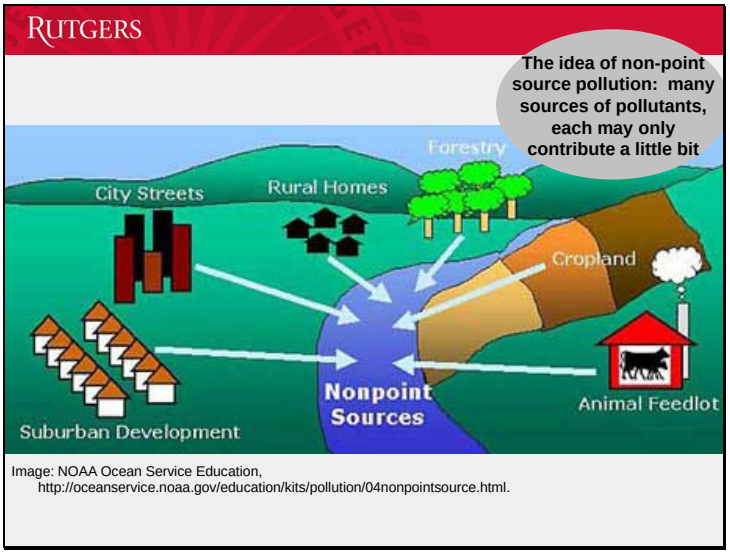
What are the potential detriments of turfgrasses?

- water inputs
- fertilizer inputs
- pesticide inputs
- energy and labor inputs:
  mowing
  and other maintenance

Haven Sports Field, photo: Nikki Mahadevan, Creative Commons license, Wikimedia.

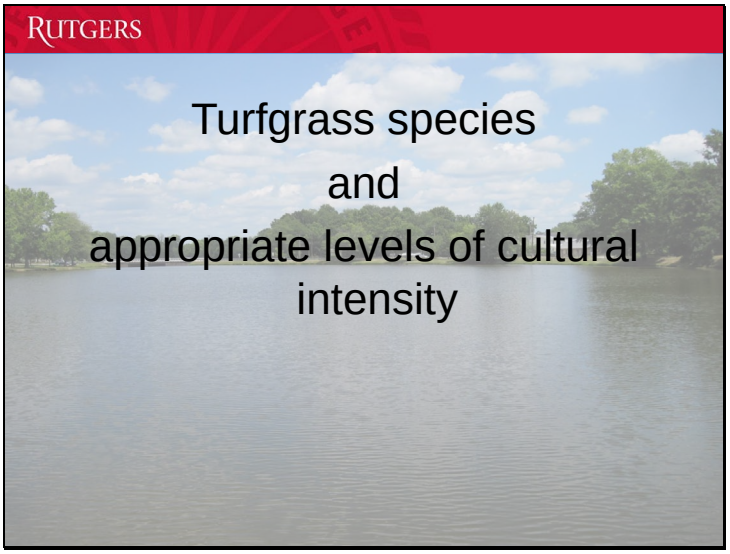
With those being the some of the reasons why we use turfgrasses so much, what are some of the potential environmental drawbacks to using turf? Depending on the maintenance, turf can require relatively high inputs relative to other land uses: inputs of water and fertilizer, in some cases inputs of pesticides—including herbicides for weeds, insecticides, and fungicides on higher-end turf—, and energy and labor inputs. If you think about all these acres of turf that need to be mowed weekly in the summer, that represents a fairly intense investment of labor and energy.

Slide 7



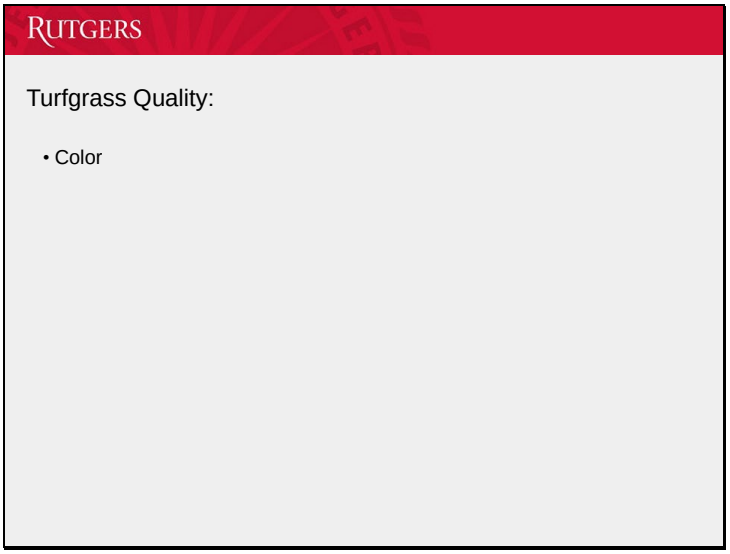
It's important to step back for a moment when we're talking about potential environmental impacts of fertilizer and pesticide use to consider the concept of non-point source pollution. Many of the pollutants we're concerned about in our rivers and lakes can come from a variety of sources in the landscape. For example, phosphorus in a lake could come from residential lawns, garbage from urban streets, wildlife droppings, or from forested areas. And it's often the case that there is no one single contributor, no single bad actor. But instead, each parcel may contribute a little bit. If there are many small sources in a watershed, and each contributes a little bit, in aggregate that may add up to an amount we're concerned about.

Slide 8



I'm going to now cover a little bit about different turfgrass species and different levels of maintenance.

Slide 9



Just quickly, I'm going to cover the idea of turfgrass "quality." If you look up scientific studies on turfgrass, the researchers are always rating the grass in terms of its "quality"—for example if using one fertilizer gives you turf of a higher quality than another fertilizer. One aspect of turf quality of lawns that we respond to is the color.

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In this photo, the grass in the red circle is the original color in the photo. So here's what the lawn looks like when it's lighter. Then a little darker. Darker, the original color in the photo. Greener and a little darker. And darker. [How does it look on the screen?] Often, what people want in their lawn is that darker green color.

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RUTGERS

Turfgrass Quality:

- Color
- Density
- Texture
- Uniformity
- Smoothness

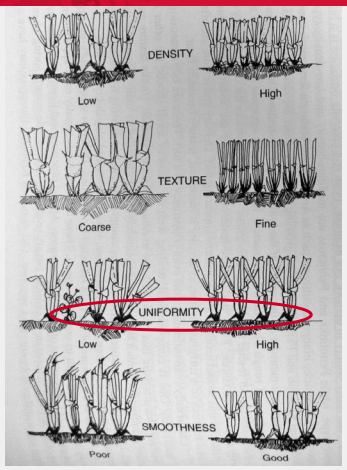
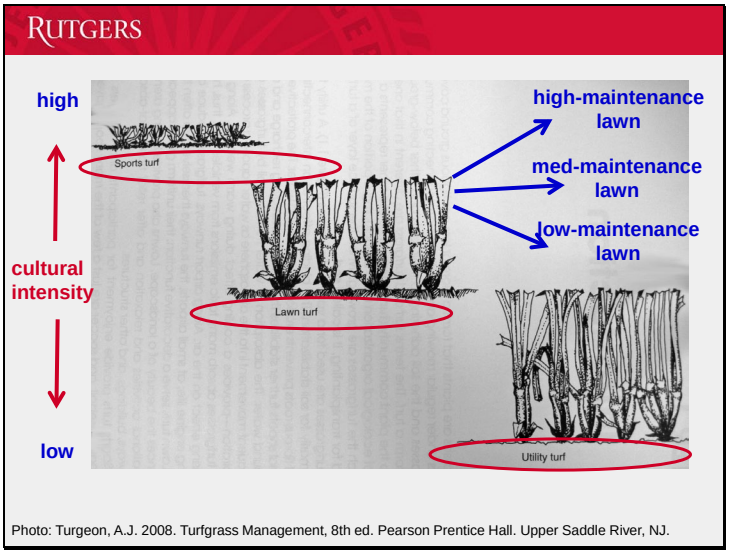


Photo: Turgeon, A.J. 2008. Turfgrass Management, 8th ed. Pearson Prentice Hall. Upper Saddle River, NJ.

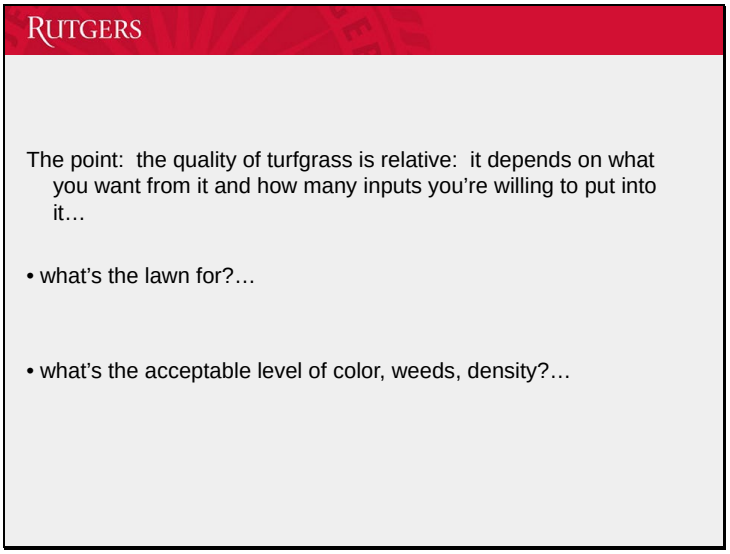
And then there are a bunch of other aspects of turf quality people think about: density of the turf, texture—people tend prefer to grass with fine leaf blades to that with larger blades—, uniformity—which really means having the grass plants look similar and not having weeds mixed in—, and the smoothness of the cut.

Slide 12



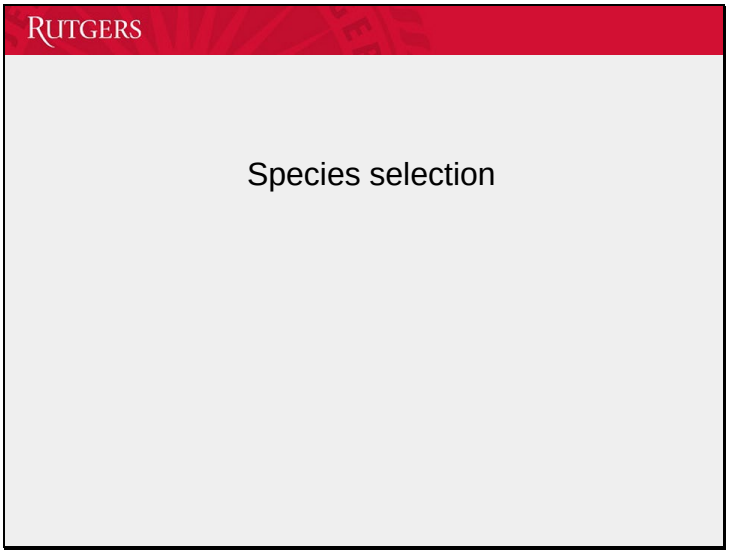
The amount of inputs we need to put into a turfgrass depend upon what kind of quality we expect from the turf, but also the intended uses of the turf. A golf course green mowed at 5/32 of an inch will require constant maintenance with frequent watering, fertilizing, mowing, and probably frequent pesticide applications. On the other hand, a road-side utility grass probably does fine being left alone if it's mowed once in a while. Home lawns tend to be somewhere in the middle. But even with home lawns, there are different options for the level of maintenance. If someone wants the darkest green lawn possible with absolutely no weeds, she may need to put in considerable inputs of fertilizer and water, probably some pesticides, and frequent mowing. But if a reasonably green lawn, with some weeds in it, and which maybe is allowed to go dormant in the summer, will satisfy the need of the owner then all that may be needed is mowing and perhaps a little water, lime, or fertilizer if required.

Slide 13



The point here is that the quality of a turf stand is relative to its intended uses and to what is expected from it. A home lawn that isn't perfectly dark green and has some weeds is perfectly good quality if its intended uses are to prevent soil erosion, infiltrate water, and serve as a host for an occasional cook out. As people want to have the more perfect, darker green, weed-free lawn, they'll need to invest more into the care and upkeep of the lawn.

Slide 14



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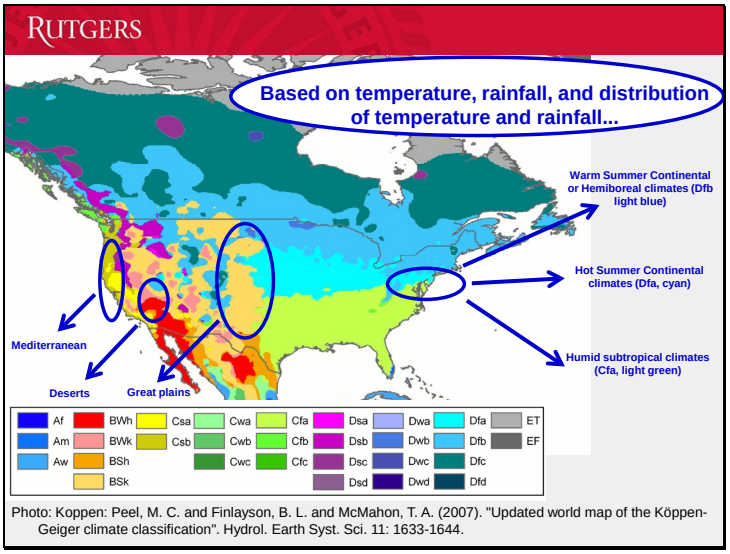
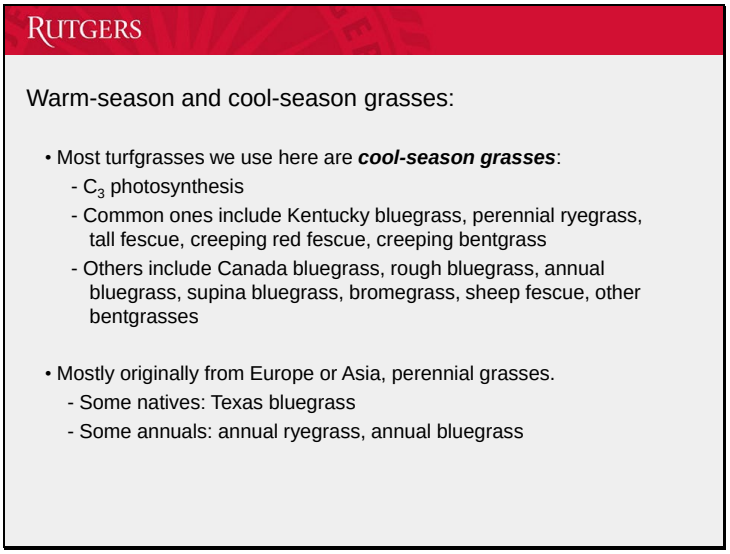


We don't often think about there being different species of turfgrass, but when we think about how variable the climate is across the United States, it becomes apparent why we use different species in different areas of the country. The climate in Maine is different from the climate in Florida, and we use very different turfgrasses in each of them. Even if we focus just on New Jersey, we see that climate changes quite a bit from the northern part of the state to the southern part of the state… Then as you move west across the United States, the climate gets drier to the Great Plains, and then deserts on the other side of the Rocky Mountains. The West Coast has a different climate, including a Mediterranean climate in Southern California, where it rains usually only during part of the year. It's clear that different turfgrass species would be adapted for different climates in this wide range.

Slide 16



Most of the turfgrasses we use in New Jersey are ***cool season*** grasses. Ones that we use include Kentucky bluegrass, perennial ryegrass, tall fescue, and some other common ones. The grasses we commonly use in New Jersey for turf are originally from Europe or Asia, and are perennials. (With the only common exceptions being Texas bluegrass which is a native used in the South, and annual ryegrass and annual bluegrass, which have limited uses.)

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RUTGERS

Warm-season and cool-season grasses:

- In hotter, drier climates ***warm-season grasses*** are better adapted:
  - C_4 photosynthesis
  - Common here: zoysiagrass
  - Others: St. Augustinegrass, bahiagrass, centipedegrass, seashore paspalum, buffalograss

Photo: St. Augustinegrass. Photo: public domain, wikimedia commons.

The one ***warm season*** turfgrass we commonly use in New Jersey is zoysiagrass, though in warmer climates you'll commonly find St. Augustine grass, centipedegrass, and some others.

Slide 18

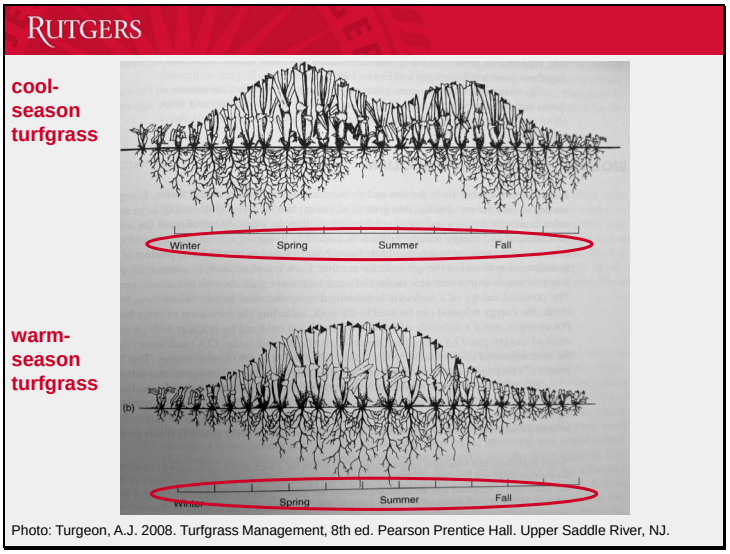

Photo: Turgeon, A.J. 2008. Turfgrass Management, 8th ed. Pearson Prentice Hall. Upper Saddle River, NJ.

This drawing shows the growth pattern of cool and warm season grasses throughout the year. Looking at the top drawing, you can see cool season grasses flourish in the spring and fall. In the summer months they are under stress from the heat: they grow less, the carbohydrate reserves in their roots become depleted, and they may go dormant—or brown out—during the summer. Warm season grasses, on the other hand, flourish in the summer months and have more limited growth during the cooler months. In New Jersey, they may not be very green during the early spring or late fall.

Slide 19

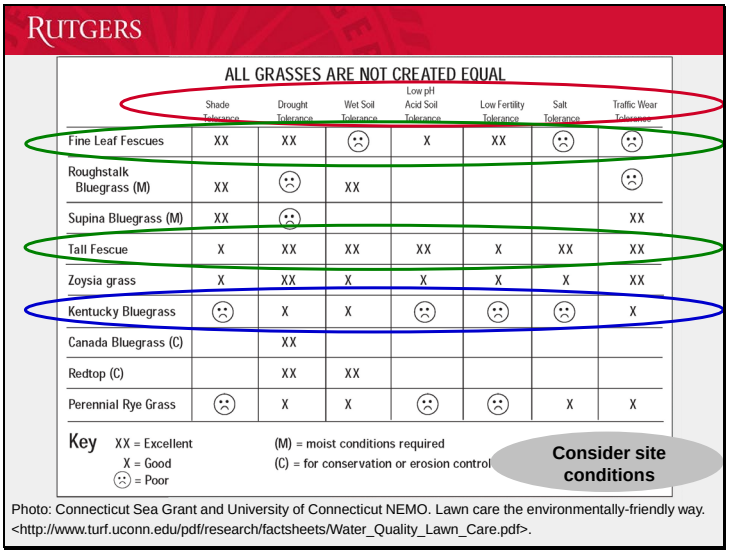

Photo: Connecticut Sea Grant and University of Connecticut NEMO. Lawn care the environmentally-friendly way. <http://www.turf.uconn.edu/pdf/research/factsheets/Water_Quality_Lawn_Care.pdf>.

In choosing an appropriate turfgrass species, it's important to consider the conditions of the specific site as well. Different species of turfgrasses have different tolerances for stresses like shade or acidic soils. This table shows how well these turf species can tolerate some of these stresses, with a double *X* meaning that the grass has excellent tolerance, a single *X* for good tolerance, and a frown for poor tolerance. If we look at Kentucky bluegrass: Kentucky bluegrass is a very beautiful grass if it is given good soils, water and fertilizer, but you can see it is not tolerant of low pH—that is, acid—soils, low fertility soils, or shade. In contrast, tall fescue is tolerant of low pH soils, low fertility soils, and shade. Similarly, the fine leaf fescues—including creeping red fescue—have tolerance for drought, low pH soils, and low fertility soils.

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RUTGERS

Low-maintenance grasses:

- Tall fescue – ***Turf type*** tall fescue has drought tolerance and is more tolerant of low fertility soils, acidic soils, and also wet sites. Once mature, it will withstand traffic well. It will keep its color and quality with less added fertilizer or water, and will stay green throughout most summers.

Photo: Connecticut Sea Grant and University of Connecticut NEMO. Lawn care the environmentally-friendly way. <http://www.turf.uconn.edu/pdf/research/factsheets/Water_Quality_Lawn_Care.pdf>.

Because of their tolerance for drought and low fertility, both tall fescue and the fine leaf fescues are often considered low-maintenance grasses. Essentially, they will perform well with fewer inputs of irrigation, fertilizer, and lime, especially in lawn settings. Tall fescue is commonly used for lawns in New Jersey and in some other parts of the nation.

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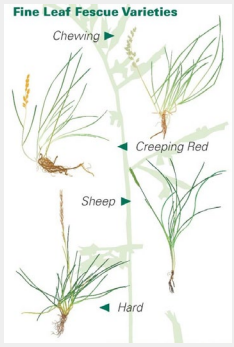
A low-maintenance lawn of tall fescue in southern New Jersey. There are a few dandelions, and some clover, but this lawn receives no irrigation and probably no fertilizer or other chemical inputs.

Slide 22

Tall fescue sod being harvested.

Slide 23

RUTGERS

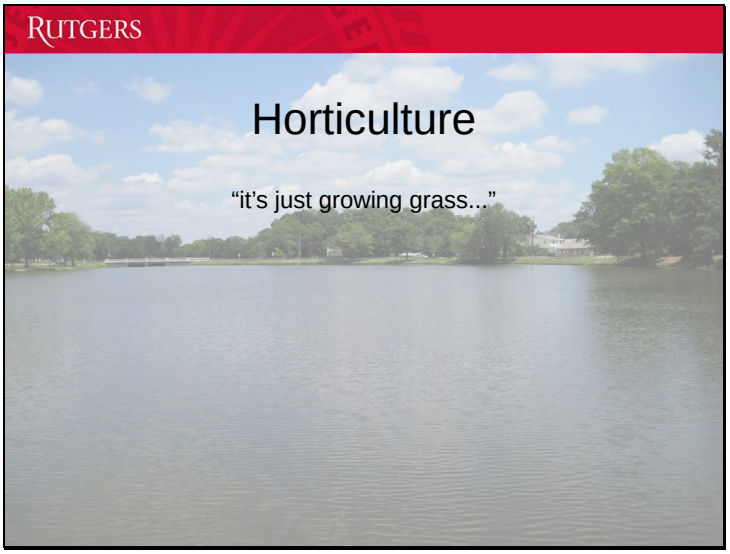


- Fine-leaf fescues – The fine-leafed fescues are also tolerant of drought and low fertility. And are particularly good for shady environments, but are less tolerant of traffic. Won't tolerate wet or salty conditions. Often used in mixes for home lawns. Ideal as a low-maintenance grass in shady areas.

Photo: Connecticut Sea Grant and University of Connecticut NEMO. Lawn care the environmentally-friendly way. <http://www.turf.uconn.edu/pdf/research/factsheets/Water_Quality_Lawn_Care.pdf>.

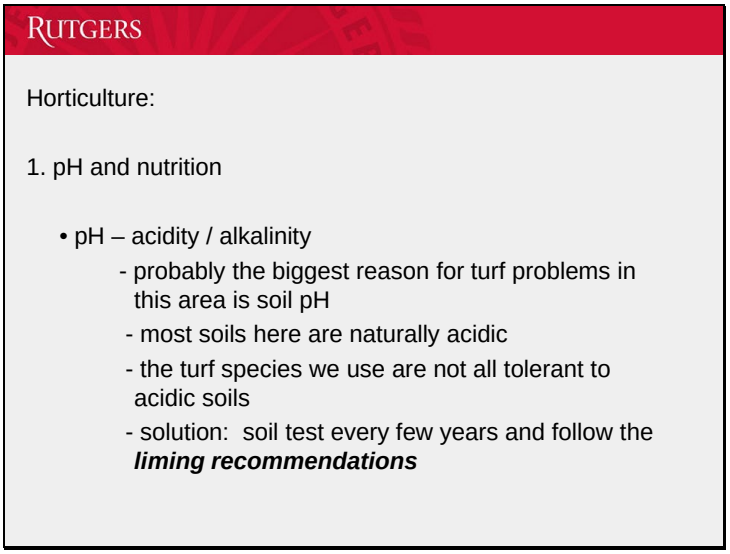
Fine leaf fescues are also considered low-maintenance grasses. They are especially good in shady spots, but don't tolerate traffic or wet soils well.

Slide 24



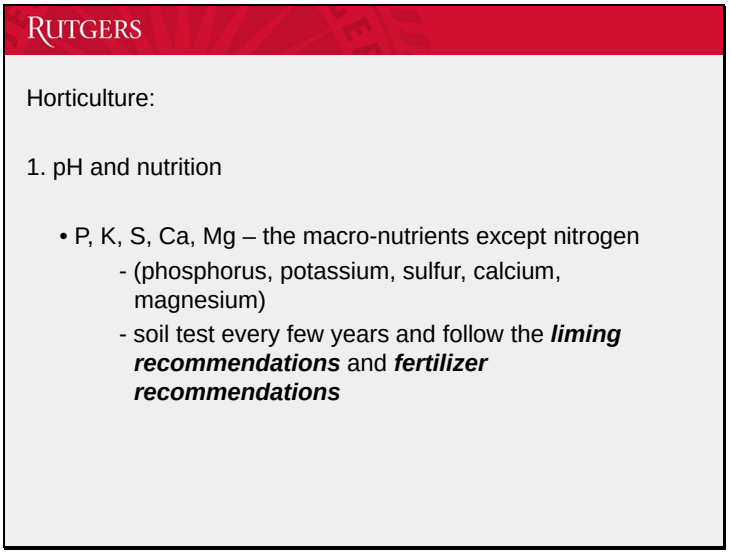
Now I’m going to just briefly cover some of the major topics in turfgrass horticulture: soil pH, fertilizer, irrigation, and mowing.

Slide 25



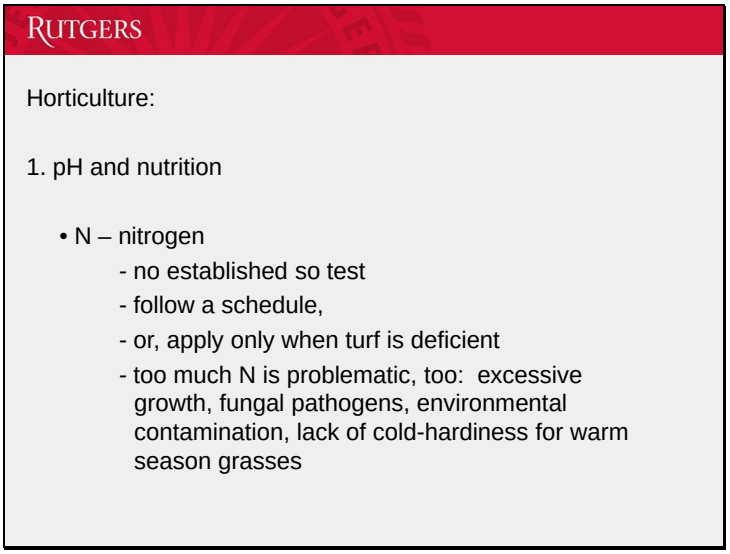
Probably the biggest cause of problems with lawns is inappropriate soil pH. Most soils in New Jersey are naturally acidic, and the problem is that when plants are not well adapted to acid soils they are unable to take up nutrients well from acid soils. No amount of fertilizer or water will help plants that are not adapted to the pH of the soil they are growing in. Luckily, the solution to dealing with acid soils is relatively easy: have the soil tested every few years, indicate the plant you are growing ("cool season turfgrass") when you send in the sample, and apply lime according the test recommendations. If the soil pH needs to be adjusted, you may want to soil test every year until the problem is corrected. Parenthetically, of course, another solution would be to grow plants that are tolerant of acidic soil conditions, such as native plants from this area. One notable exception to the generalization about New Jersey soils being naturally acidic is the Washington soil series and related soils, derived from limestone, that are found in some parts of Warren, Hunterdon, and Morris counties.

Slide 26



Most of the nutrients that turfgrasses need from the soil in large amounts—with the exception of nitrogen—can also be assessed with a soil test. These are phosphorus, potassium, sulfur, calcium, and magnesium. By submitting a soil test and reporting the plants you are growing, the soil test recommendations will let you know how much of what kind of fertilizer you should apply to correct any deficiency.

Slide 27



Applying the correct amount of nitrogen is more difficult, since there is no established test for soil nitrogen for turfgrass. A few approaches to determine how much nitrogen to put on your turf would include: 1) following a pre-determined schedule; and 2) a more conservative approach: applying nitrogen fertilizer only when the when the turf develops a chlorotic, light green or yellow-green color. It should be noted, too, that applying too much nitrogen is problematic, since it can cause excessive growth and plants with succulent tissue that are more prone to fungal diseases, leaching and runoff of nitrogen fertilizers, and of course, more frequent mowing. Warm season grasses have another problem with too much nitrogen, which is that they may lack cold hardiness if too much nitrogen is applied or if it is applied too late in the season.

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RUTGERS

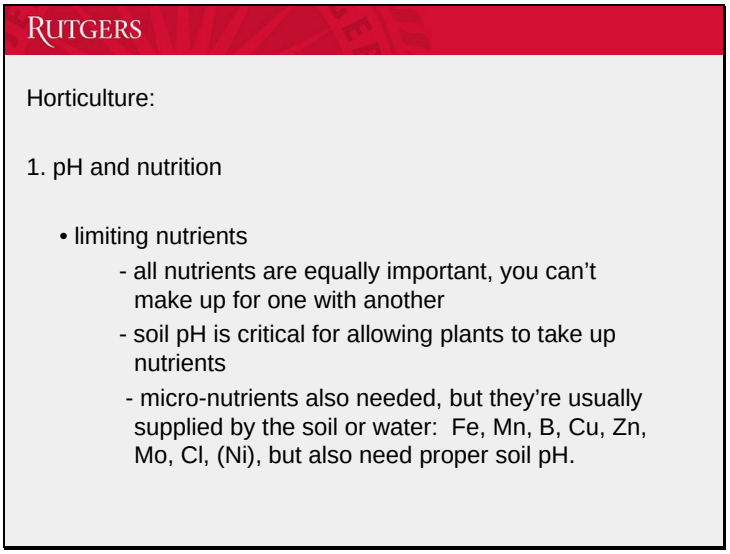
Type of Turf	Annual N[1]	Timing of Application: Mid-March to April[2]	May to mid-June[3]	Late June to early August	Mid-August to mid-September[4]	Early October to early December[5]
Management of General Turfs (mowed higher than 1-inch)	pounds of N per 1000 ft²					
Irrigated, clippings removed	3 to 5	½ to 1	½ to (1)	not required	1	1 to (2)
Irrigated, clippings not removed	2 to 4	½ to 1	½	not required	1	1 to (1½)
No irrigation, clippings not removed	0 to 2	½	not required	not required	½ to (2)	not required
Zoysiagrass	0 to 2	apply no N	½ to (1)	½ to (1)	apply no N	apply no N
Golf Course Turfs						
Putting Green	1½ to 4	0 to 1	¼ to (1¼)	¼ to (1)	¼ to 1	½ to (2)
Tee	2 to 6	0 to 1	½ to (1½)	½ to (1)	½ to (1½)	½ to 1
Fairway	1½ to 3	0 to 1	½ to (1½)	0 to (¾)	½ to 1	½ to (2)
Roughs	1 to 3	0 to 1			1 to (2)	0 to (2)
Utility	0 to 2	0 to ½			0 to (2)	

Turf systems are fairly nitrogen-efficient as long as you're not putting on *too* much fertilizer... Mature turf stands with clippings returned may need little or no fertilizer inputs.

Table: Murphy, J.A. and S.L. Murphy. 2009. Best management practices for nutrient management of turf in New Jersey. Bulletin E327. Rutgers Cooperative Extension. New Brunswick, NJ. <http://njaes.rutgers.edu/pubs/publication.asp?pid=E327>.

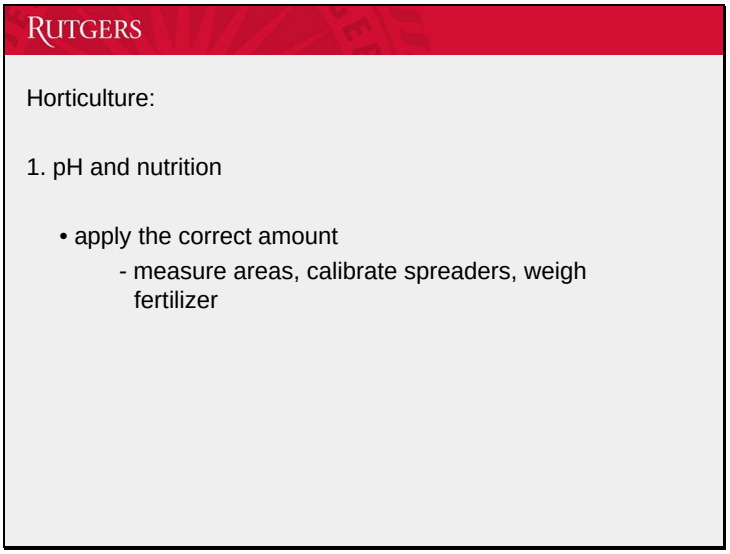
This is a table from a Rutgers bulletin on best management practices for turfgrass management. Notice that the amount of fertilizer a turfgrass area may benefit from depends upon the level of inputs and maintenance. For example a lawn without irrigation where the clippings are left in place may need up to two pounds of nitrogen per thousand square feet, or may need none at all. However, a more intensely managed area that is irrigated with the clippings removed may need more. In general, turf systems are fairly efficient with nutrients as long you don't put on too much. Turf plants have a lot of roots which are pretty good at scavenging nutrients from the soil, so once a stand is mature, if the clippings are returned, it may need little or no fertilizer inputs. The problem is that when you put on too much fertilizer, the ability of the plants to take it up is limited, so that you end up with leaching losses of nitrogen.

Slide 29



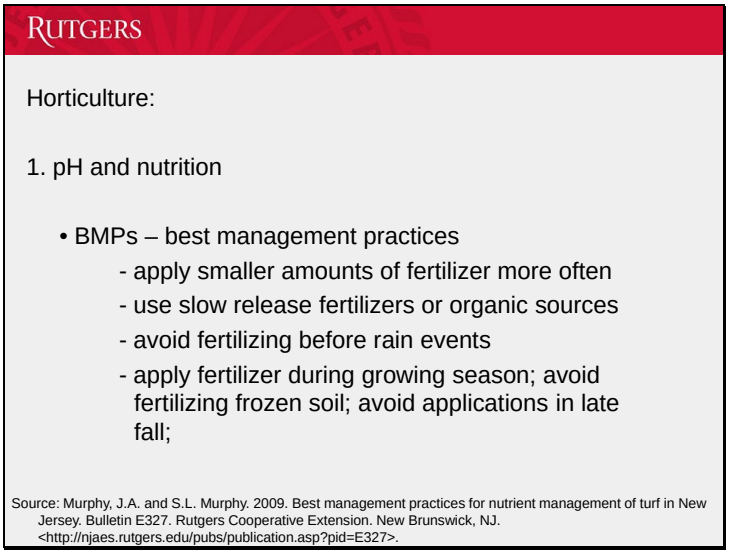
When thinking about plant nutrition, it's important to remember the concept of a limiting nutrient. Each essential nutrient is—well—essential for the plant growth and health. A deficiency in one nutrient cannot be made up for by adding more of a different nutrient. Adding more nitrogen fertilizer will not help plants that are growing in a soil deficient in magnesium. Likewise, adding more fertilizer will not make up for having inappropriate soil pH. There are also micronutrients that are essential for plants, but they are usually available in sufficient supply from the soil or water. The standard fertility test at the Rutgers Soil Testing Laboratory includes the micronutrients iron, manganese, boron, copper, and zinc. The uptake of micronutrients from the soil is also dependent on having proper soil pH.

Slide 30



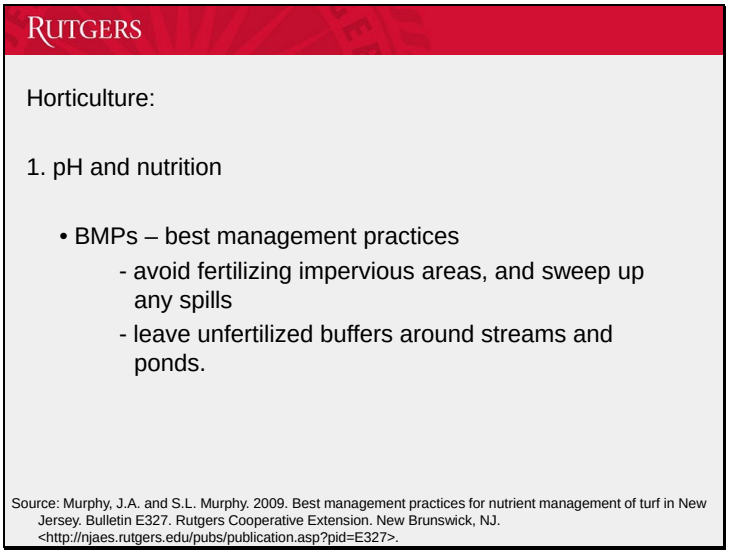
It is always good horticultural and environmental practice to know you are applying the correct amount of fertilizer by measuring the area you're applying to and weighing out the amount of fertilizer the spreader is putting out, in order to the calibrate the spreader and be sure it is delivering the correct amount.

Slide 31



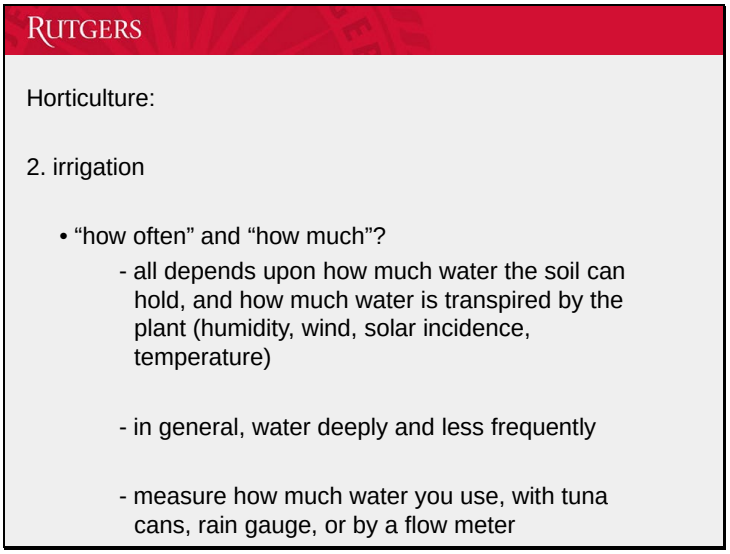
There are several best management practices, or BMPs that are recommended for fertilizing turf areas. A best management practice is something that is desirable for the health of the plants and is also more environmentally benign—or has other benefits like saving money. Some BMPs for fertilizing turf include: splitting fertilizer applications so that you are applying smaller amounts of fertilizer more often; using slow release or organic sources of fertilizer; avoiding fertilizing before large rain events; always applying fertilizer at the correct times of year: spring and fall for cool season grasses—but not too late in the fall or early in the spring;

Slide 32



avoiding getting fertilizer on impervious areas like driveways and sidewalks, and sweeping up any from those surfaces; and leaving low-mow and unfertilized buffers around streams and ponds. Many of these BMPs are codified in the new New Jersey lawn fertilizer legislation for 2011.

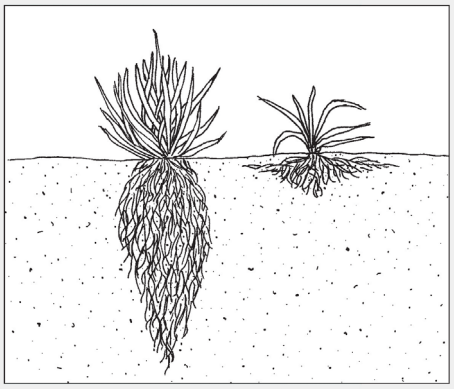
Slide 33



A second important aspect of good turfgrass horticulture is irrigation, with two important considerations being "how often" to water and "how much" to water. The answers here are not easy or universal. This is because how much water plants need depend upon many factors such as how much water the soil can hold, and the weather determines how much water a plant will transpire. A further complication is that different plants require different amounts of water for the same conditions. Some general principals to follow are: 1) as long as your soil can hold it, water deeply and less frequently, say, one or two times per week; and 2) measure how much water you are actually putting down using a set of empty tuna cans on the ground or small rain gauges on the ground, or a flow meter on your hose or irrigation system.

Slide 34

RUTGERS

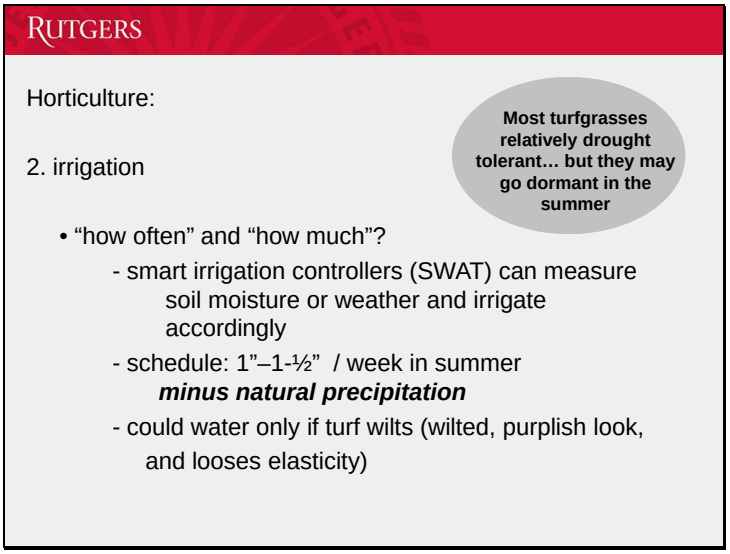


Effect of irrigation frequency on rooting depth.

Photo: Connecticut Sea Grant and University of Connecticut NEMO. Lawn care the environmentally-friendly way. <http://www.turf.uconn.edu/pdf/research/factsheets/Water_Quality_Lawn_Care.pdf>.

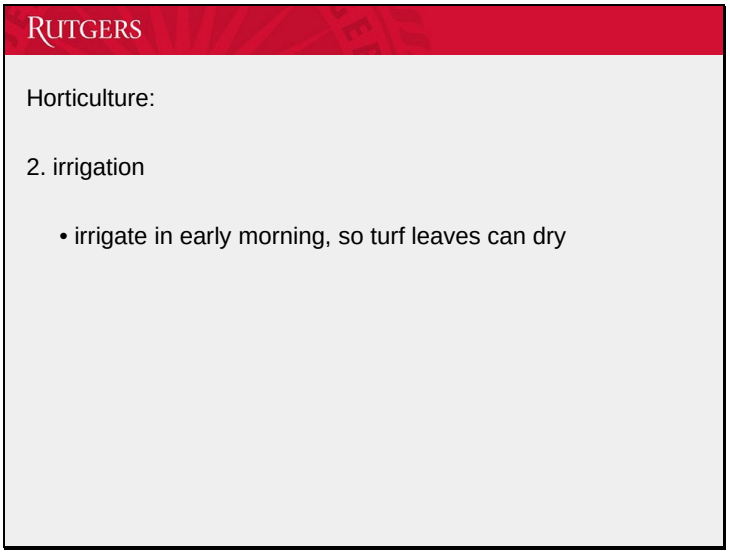
This is a generalized drawing showing the effects of irrigation frequency on root depth. In general, watering more deeply and less frequently will encourage the plant to put down deeper roots. This in turn means the plant may be more drought tolerant since it has a deeper root system.

Slide 35



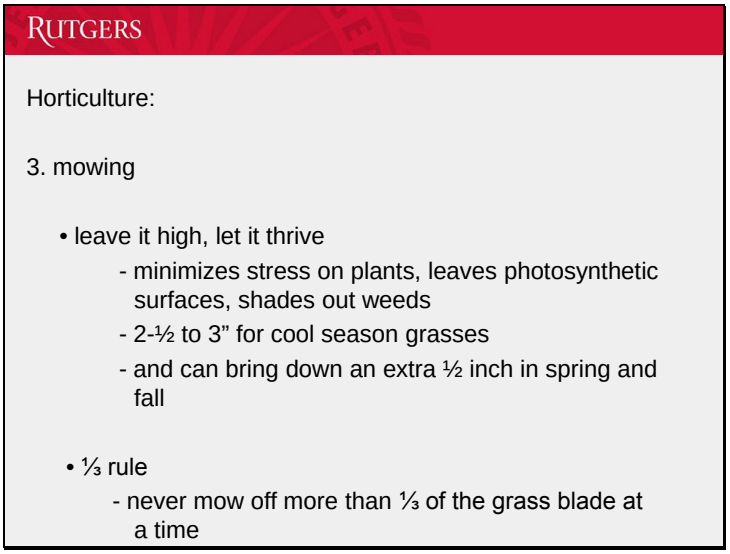
A few strategies for determining irrigation amounts include: 1) using a smart irrigation system—also called SWAT—smart irrigation application technology—that determines the amount of irrigation needed by measuring either the soil moisture or the weather; 2) watering on a schedule where you irrigate, say, one inch per week in May and one to one-and-a-half inches in July—depending on where in New Jersey you live—but subtract any natural precipitation; 3) simply wait until the turf plants look in need of water—they begin to wilt, look purplish, or lose their elasticity. There are disadvantages to each approach, in terms of cost or complexity. And no approach may be able to achieve perfect irrigation efficiency in the sense of supplying plants with sufficient water while never overwatering. It should be noted too, that most turf species are relatively drought tolerant. Those listed as particularly drought tolerant will be more forgiving of underwatering.

Slide 36



A final note: it's better to irrigate in the early morning so that not much water is lost immediately to evaporation but that leaves have a chance to dry. Avoid watering in the evening if possible since plants that stay wet all night are more susceptible to diseases. Also note that many municipalities have restrictions on watering times and days.

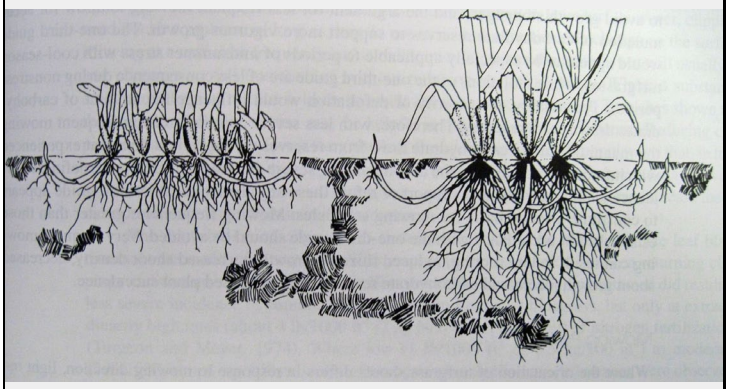
Slide 37



Properly mowing turf is important for its health and quality. One mantra is "leave it high, let it thrive," suggesting that mowing turf at a greater height minimizes stress on plants by leaving more of the turf blade intact. Also, having taller grass helps to shade out germinating weeds. A general recommendation for mowing height is 2-½ to 3 inches for cool season grasses, though you can bring it down an extra half inch in the spring and fall if you want. Also, a rule of thumb is to never mow off more than one-third of the grass blade at a time. Again, following this rule minimizes stress on the plant.

Slide 38

RUTGERS

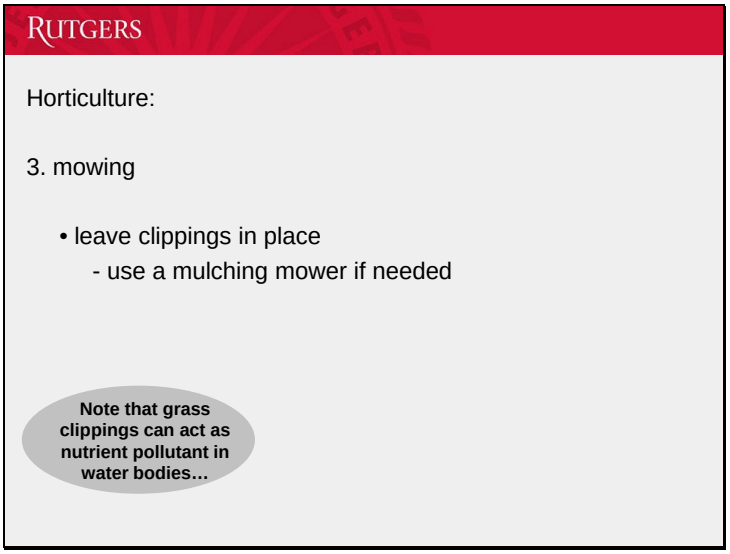


Effect of mowing height on shoot and root length.

Photo: Turgeon, A.J. 2008. Turfgrass Management, 8th ed. Pearson Prentice Hall. Upper Saddle River, NJ.

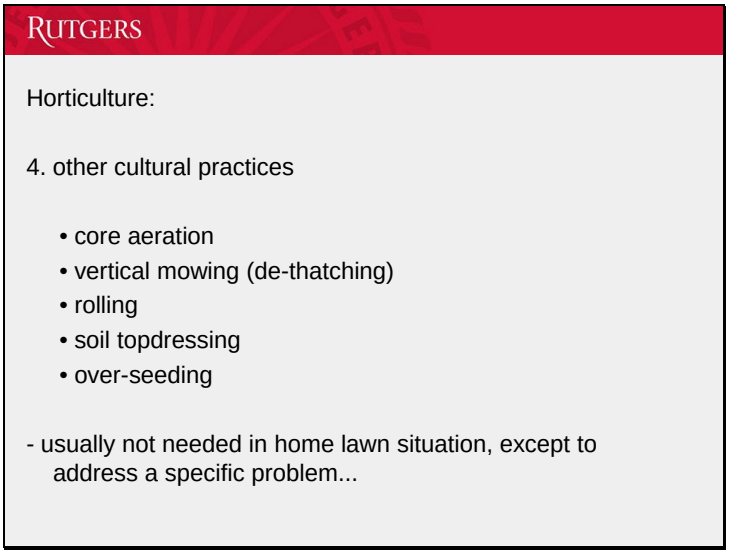
This is a generalized drawing showing the effects of mowing height. With a taller mowing height, the plants are able to devote more energy into developing deeper roots.

Slide 39



Grass clipping serve a source of fertilizer to the grass, so leaving the clippings in place continually returns all the nutrition from the plants during mowing, and decreases the need for chemical fertilizers. Using a mulching mower helps chop up the clipping more finely. Keep in mind, too, that grass clipping act a nutrient pollutant to water bodies, so keep clippings out of storm drains, streams, and ponds.

Slide 40

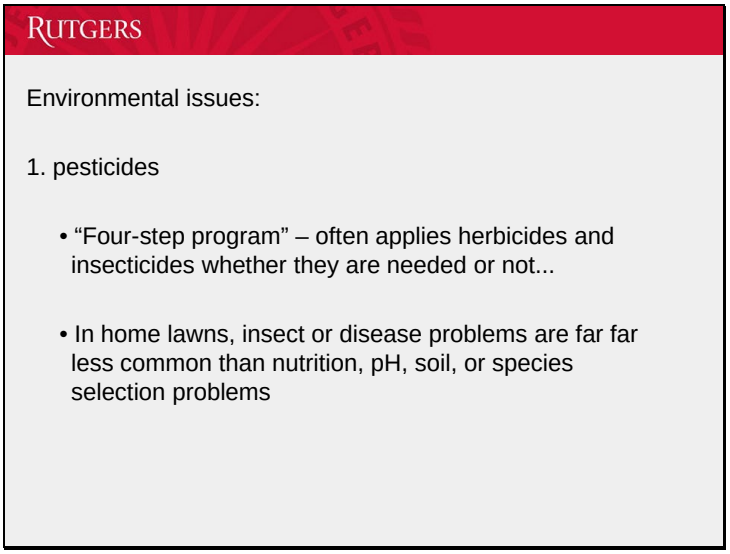


There are always questions about other cultural practices such as aerating and de-thatching. Simply, these are good practices when they are needed and not necessary when they aren't needed. Core aeration, or tine aeration, relieves compacted soil if that is a problem. Dethatching, or vertical cutting, a lawn relieves thatch problems. Mostly, these practices are not regularly needed for a home lawn, except to address a known problem.

Slide 41

This presentation was introduced by listing a few of the environmental benefits of using turfgrasses and a few of the potential environmental impacts. Many of the major consideration in keeping a low-impact lawn have been brought out throughout the presentation: maintaining a healthy lawn keeps soils in place and infiltrating water; following soil tests for phosphorus fertilizer and recommendations for nitrogen fertilizer limit runoff and leaching losses; likewise, irrigating judiciously limits runoff and leaching losses of fertilizers. The next few slides will just touch on a few other topical issues.

Slide 42



A fair amount of pesticides are used on lawns, including pre-emergent herbicides to prevent weed germination in the spring, herbicides to kill broadleaf weeds, insecticides for white grubs and other insects, and occasionally on home lawns, fungicides for fungal diseases that attack turf. One issue that is sometimes raised is that the "four-step program"-type of fertilizers that people commonly buy often include herbicides and insecticides, so that these products are being applied whether they are needed or not. In many cases the application of pesticides may not be warranted, and it should be noted that for home lawns, insects or diseases are typically less problematic than nutrition, pH, or poor species-selection.

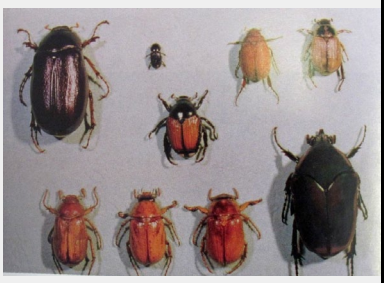
Slide 43

RUTGERS

Environmental issues:

1. pesticides

• a healthy turf resists many plagues...

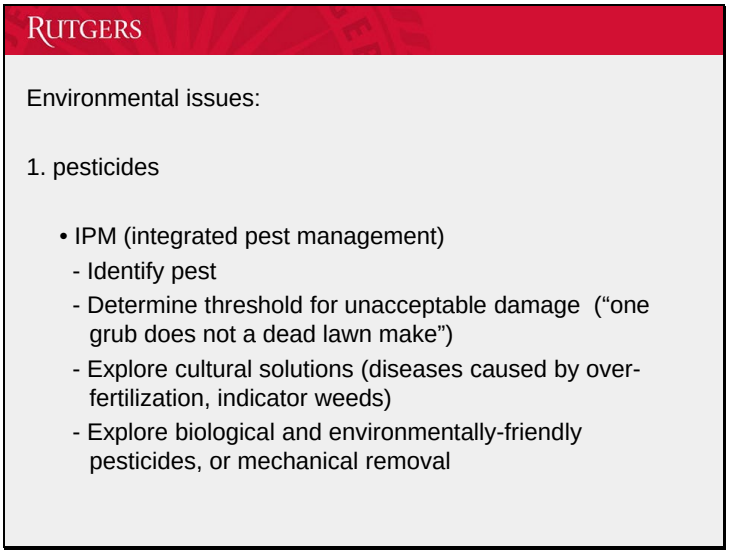


White grub beetles: May/June beetle, black turfgrass ataenius, asiatic garden beetle, oriental beetle, Japanese beetle, chafers, green June beetle

Photo: Watschke, T.L., P.H. Dernoeden, and D.J. Shetlar. 1995. Managing Turfgrass Pests. Lewis. Boca Raton, FL.

Just a slide of the adult beetles of white grubs that commonly inhabit turfgrass areas.

Slide 44



A better approach to pest control mimics an integrated pest management approach, which basically entails indentifying the pest, determining if it is actually causing significant damage, and if it is, determining if there are cultural issues—like poor soil fertility or compacted soil—that are the root of the problem.

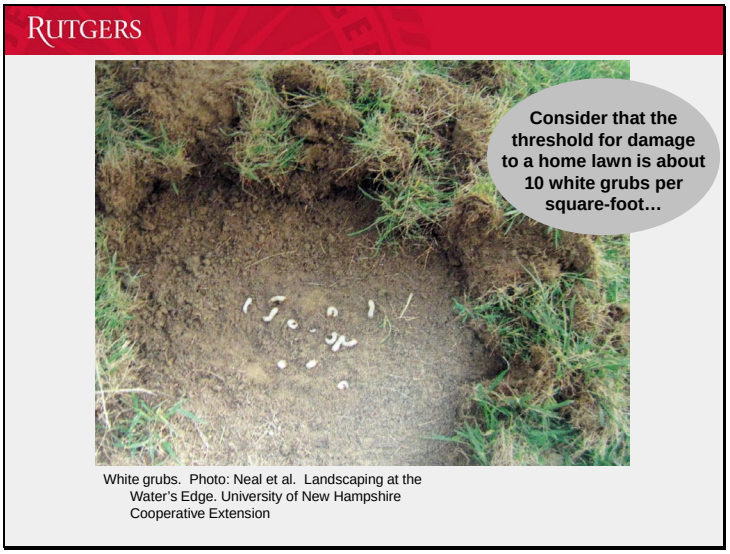
Slide 45

RUTGERS

Japanese beetle lifecycle. Photo: Neal et al. Landscaping at the Water's Edge. University of New Hampshire Cooperative Extension

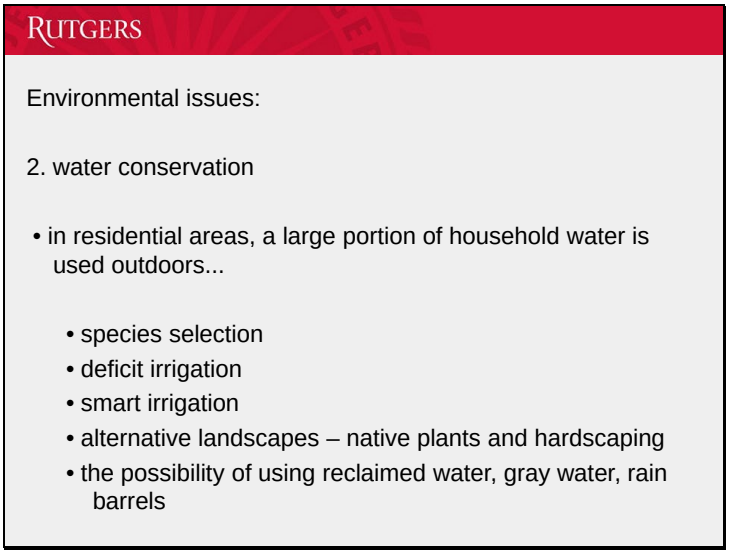
Just a slide of the life cycle of the Japanese beetle.

Slide 46



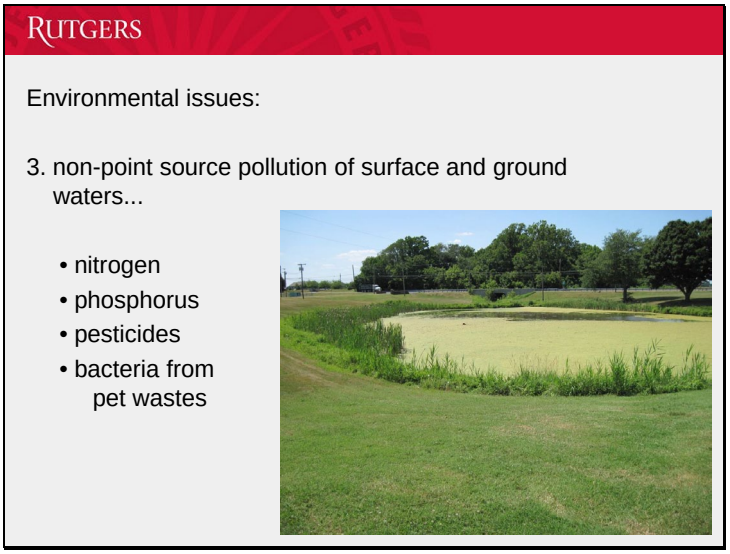
As an example, the threshold for significant damage to a healthy, growing turf from white grubs is sometimes cited as 10 grubs per square foot. If there is an issue with the turf, simply turning over some turf with a shovel and finding a few grubs is not a sufficient indicator that the grubs are causing the problem.

Slide 47



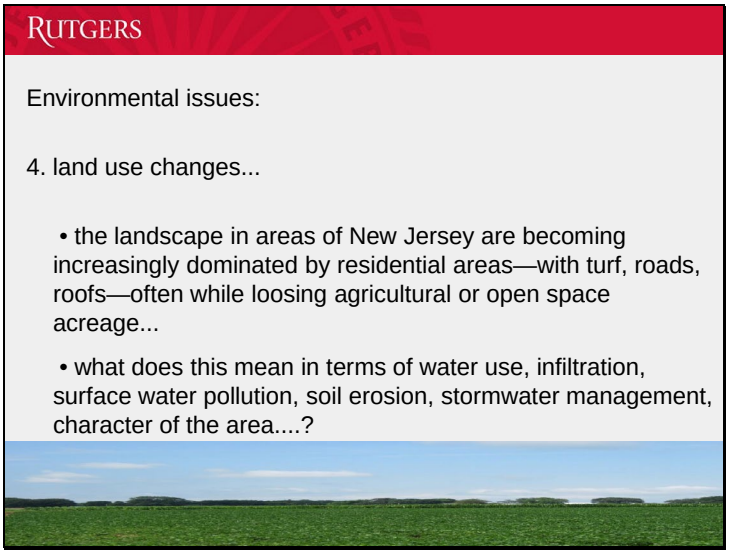
Another potential environmental issue associated with turfgrass is water conservation. This is an issue particularly in residential locations where large areas of the land are devoted to turfgrass and a large percentage of the water use in the summer goes to outdoor irrigation. Several ways to conserve water in these situations include: using drought tolerant turfgrasses; using deficit irrigation—which simply means supplying plants with less water than they could potentially use—; using better irrigation such as smart irrigation controllers; using alternative landscaping materials like native plants or hardscaping; and the possibility of using reclaimed water or gray water for landscape irrigation.

Slide 48



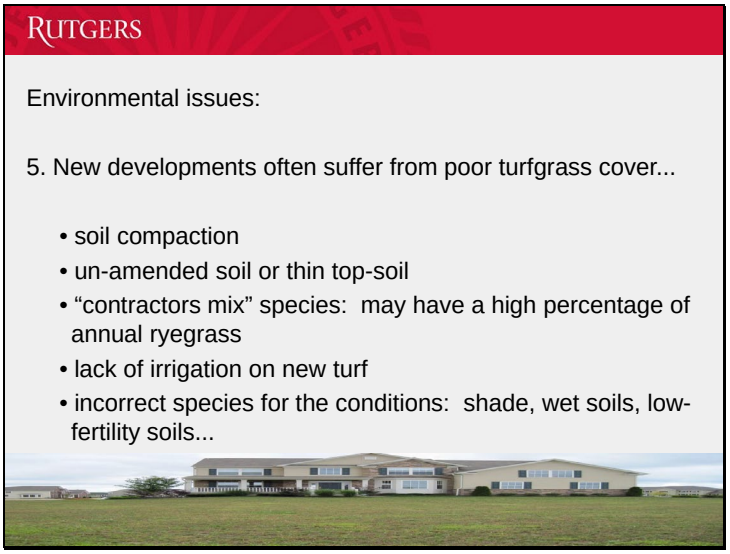
Turf areas can potentially contribute several pollutants to surface waters or ground water, including nitrogen and phosphorus from fertilizers, pesticides, and bacteria from pet wastes. As mentioned earlier, good practices include using good horticulture so that a lawn serves as dense ground cover, protecting streams and ponds with buffers, keeping fertilizers and debris out of storm drains, and using irrigation and fertilizer judiciously.

Slide 49



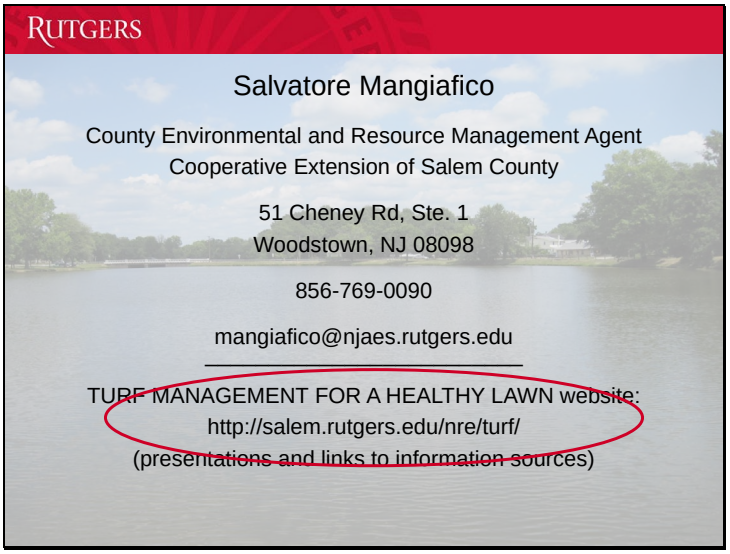
Another potential issue is the changes in the lands use we see on a large scale in some parts of New Jersey, with agricultural or open space lands being converted to residential areas, which may be dominated by turf, trees, roads, and roofs. There is a question as to how these changes will affect water pollution, soil erosion, stormwater management, and of course the character of the landscape.

Slide 50



Finally, there are some issues that are sometimes raised concerning new developments specifically. Often new developments have poor turfgrass stands. Some causes of this may be related to: soil compaction during construction; poor soil, un-amended soil, or a thin topsoil layer; using a "contractor's mix" for seed which may include a high percentage of annual ryegrass or low-quality varieties; lack of irrigation of turf; and issues with poor selection of turfgrass species.

Slide 51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(presentations and links to information sources)