Chapter 5 Appropriate Turf Areas

Chapter Contents

Xeriscape Principle

Lawn size and type should fit the specific needs of the site. Reducing the size of lawn areas and replacing thirsty bluegrass with drought-tolerant grasses can significantly reduce outdoor water use.

Key Concepts

Warm-season grass, cool-season grass, bunching grass, creeping grass.

Teacher's Notes

Large, green expanses of turf have been the standard for American landscapes for many years. Now, both homeowners and commercial groundskeepers are rethinking the appropriateness of huge lawns in semi-arid climates. As water conservation becomes more important, turf areas are being evaluated and redesigned so they use less water. Instead of automatically using a lawn to cover large areas, lawn size is being carefully planned to fit the specific needs of the site. Drought-tolerant grass species, such as buffalograss and blue grama grass, are being substituted for water-thirsty bluegrass in many situations. Reducing the size of a lawn and planting waterwise groundcovers and shrubs instead is a smart, water-efficient move.

The purpose of this unit is to teach students to take a critical look at turf areas. It is also a good opportunity to discuss the sources of common assumptions about lawns with the students. We assume, for instance, that we need a lawn at our home. Why? Where did this assumption come from and why is it pervasive in our society? Perhaps a discussion of these questions will encourage the students to think "outside the box" and become better problem solvers in other areas.

Teacher's Notes, continued

Notes on the Activities

The **Problem to Solve** concerns a new lawn area for Mr. Salazar. Mr. Salazar lives in Harding County in northeastern New Mexico. (However, giving him a local address might help the students understand their immediate surroundings better.) In order to choose the best lawn for Mr. Salazar, students must investigate the makeup of the soil and the amount of rainfall where Mr. Salazar resides. Another suggestion is to break the class into groups and place Mr. Salazar in various locations around the state, giving the students an overall picture of the variety of soils and climates in New Mexico. A rainfall chart can be found in Appendix C, and a list of web-based soil maps can be found in Appendix J.

Bunchin' and Creepin' – Students compare and contrast bunch grass[1] and creeping grass[2]. Creeping grasses spread the fastest, since they can put out roots and stems at each growth node[3]. Bunch grasses reproduce by seeds. The students may not see the grass' flowers (or recognize them) since they can be tiny and short-lived. Bunch grasses are wind-pollinated, which means the wind and animals disperse the seeds. Since wind can be a very fickle dispersal agent, grasses produce copious amounts of pollen to make sure some of it hits their mark. The growth node of grasses is close to the ground, which allows grasses to be grazed and cut without being destroyed.

Assessment of Problem to Solve

The **Problem to Solve: Barry Salazar's Lawn** asks students to determine the grass species, location, and irrigation needs of a new lawn. Students should be able to recognize that the state has a variety of soils, precipitation rates, and temperature ranges. They should be able to use a map and/or a chart to assess the three key variables (soil, precipitation, and temperature) for Mr. Salazar's landscape. Good soil maps and information are sometimes hard to find, so a soil sample can be substituted for the soil map. Students should be able to identify a type of grass that will work in Mr. Salazar's landscape. They can use the chart provided, or do their own research.

Students are also asked to recommend a lawn location and an irrigation system. In determining location, they should recognize that lawns are in the "oasis zone" — the highest water-use zone of a landscape. Therefore, lawns belong close to the house where they can be both enjoyed and monitored for water needs. Sprinkler systems, either hand-held or automated, are the best irrigation choice for lawns. However, flood and any rainwater supplement may also be appropriate.

There are a variety of other recommendations that the students can include:

- amendments to the soil to increase water-holding capacity and correct any chemical or biological imbalance,
- combinations of grasses for hardiness,
- alternatives to a lawn such as groundcover,
- shading the lawn with trees to create a beneficial microclimate, and
- shaping the lawn to reduce irrigation problems.

Teacher's Notes, continued

Can Roots Create Air? – Students conduct a lab experiment to test for cellular respiration in grass plants. When students blow into the water containing bromthymol blue, the CO^2 they exhale acidifies the solution, causing it to turn a yellow-green color. Plant roots also give off CO^2, which will also turn the solution yellow-green. The CO^2 that the roots give off either combines with other chemicals in the soil (which helps to acidify it), or it is lost to the atmosphere. All plants, animals and fungi undergo aerobic (with oxygen) respiration.

Deep, Deeper, Deepest – Students will observe the relationship between root growth and soil depth by growing grass plants. Plants with the most root room will grow the best. If this experiment continues long enough, it can also test the effect of intraspecies competition. If this lab is completed prior to Can Roots Create Air?, then these grass plants can be used to test for cellular respiration.

School-arly Habitats I See – Students use the school grounds to assess different types of microclimates (habitats) and their water needs. This activity should demonstrate students' understanding of the correlation between water availability and habitat type. Organisms are adapted to the habitat in which they evolved; therefore, these conditions comprise the most "comfortable" habitat for that organism. While humans may find a desert environment harsh and a forested environment more comfortable, a cactus would find a desert comfortable and a forested environment very harsh, perhaps even lethal. Most organisms do not flourish in extreme environments such as thermal vents, glaciers, and wind-swept mountaintops. However, there are some organisms adapted to all of these places.

Elegant Coverings – Students combine art and research to explore groundcover alternatives to grass lawns. Students can be evaluated on meeting the requirements for the research portion of the assignment and for the clarity of the poster presentation.

Shapely Lawns – Students will use information from charts and maps to determine the proper type of grass for a given area. The fictional Orr family in this activity lives in Los Lunas. (Please feel free to change this to the local town if desired.) As long as students have a valid reason, any of the grasses in the included chart **Xeric Grasses for New Mexico** are acceptable. However, the warm-season grasses would probably grow better and use less water in Los Lunas. The lawn should be placed close to the house but not between the house and the river (where the slope is too steep). The best placement would be next to the house and under the cottonwood trees. Placement on the north side would also be acceptable.

Complementary Activities

The following activities complement the **Problem to Solve** for this chapter:

- ✓ **2-2: Holes in the Soil**
- ✓ **3-1: Moving Water Around**
- ✓ **3-3: Too High, Too Low, Just Right**

Background Information: Rethinking the American Lawn

Lawns are a tradition in America. They provide areas for children and pets to play, and they provide a place for picnics and relaxation on a warm summer day. A well-established lawn can reduce noise, air and water pollution, and soil erosion. However, lawns can also be the largest user of irrigated water in the landscape.

The key to having a water-thrifty lawn is to focus on its desired use and choose the appropriate grass for the soil and rainfall of the area. Once these important considerations have been researched, the size, shape, location, and maintenance schedule of the lawn can be selected.

Choosing Appropriate Grasses

When choosing to install turf, it is important to first consider how that turf will be utilized. This will help to determine the size of the turf area. If the desired use is a play area for small children, the area will need to be large enough for a play set and a tumbling area. If the desired use is the occasional barbeque, that same area might include a large porch with a small turf space for aesthetics. In general, turf areas that will not be utilized should not be installed. Instead, these areas can be turned into landscaped beds or areas with groundcovers that will require less water and maintenance than turfgrasses.

Before choosing a grass species, the soil type and local rainfall data of the site should be checked. Some grasses will tolerate any soil type, but most are pickier. Certain grasses are more tolerant of sandy and saline soils, while others do well in soils that are predominantly clay. The pH factor is also important. Is the soil acidic or alkaline? There is a grass that will fit almost every soil condition, and improvements can be made with soil amendments. However, it is wise not to vary too far from the original makeup of the soil. (Check the **Xeric Grasses of New Mexico** chart in this chapter for information about specific types of grasses.)

Background Information: Rethinking the American Lawn (continued)

Water requirements are also an important factor when selecting grass species. Although many grass varieties can tolerate a large range of precipitation rates, a grass whose watering requirements match the precipitation in the area should be chosen. It is important to know how much rain the area receives and what time of year it falls. For example, a typical landscape in central New Mexico receives only 10 inches of rain a year, the majority of which falls during the hottest summer months. Cool season grasses, such as Kentucky bluegrass, go dormant in the heat of the summer. Consequently, most bluegrass is a less-than-perfect choice for most New Mexico lawns. (However, a new, more water-efficient form of bluegrass was recently discovered in West Texas. It is native from West Texas, through the panhandle of Oklahoma, to Arkansas. Check with the local extension service, Appendix B, to see what mixes and variations are available.)

Consideration should also be given to a combination of grasses or a variation of the desired grass that has been adapted to the area. For example, a mixture of fescue, blue grama and bluegrass has proven drought-hardy and will stand up to use as a playing field in central New Mexico conditions. Such a lawn may not be aesthetically appealing to some people because the warm season grass will form brown patches early in the fall and late into the spring, but it can hold up to tough use. For a uniform turfgrass appearance, it is not recommended to mix cool-season grasses with warm-season grasses.

Grass Types: Cool-Season and Warm-Season Grasses

Grasses come in two types: cool-season and warm-season. Cool-season grasses grow best in the cooler seasons of the spring and fall, when daytime temperatures are 60°-75° F. Cool-season grasses can get brown in the heat of the summer but they hold their green color in the winter. Cool season grasses include Kentucky bluegrass, tall fescue, and perennial ryegrass.

Warm-season grasses grow best in the summer. They tend to grow rapidly at temperatures between 80°-95° F and tolerate higher temperatures well. Warm-season grasses turn brown and go dormant when temperatures are under 50° F. Common warm-season grasses include blue grama, buffalograss, and Bermuda grass.

Background Information: Rethinking the American Lawn (continued)

Grass Types: Bunching and Creeping

It is important to know how grasses grow and propagate. Bunch grasses grow as individual plants that spread over time. They have seeds that are disseminated by blowing in the wind and attaching to animal fur. If the seeds are sown thickly enough, the lawn will show nice results within a year; otherwise, a new bunch grass lawn might be spotty for a year or two until it fills in.

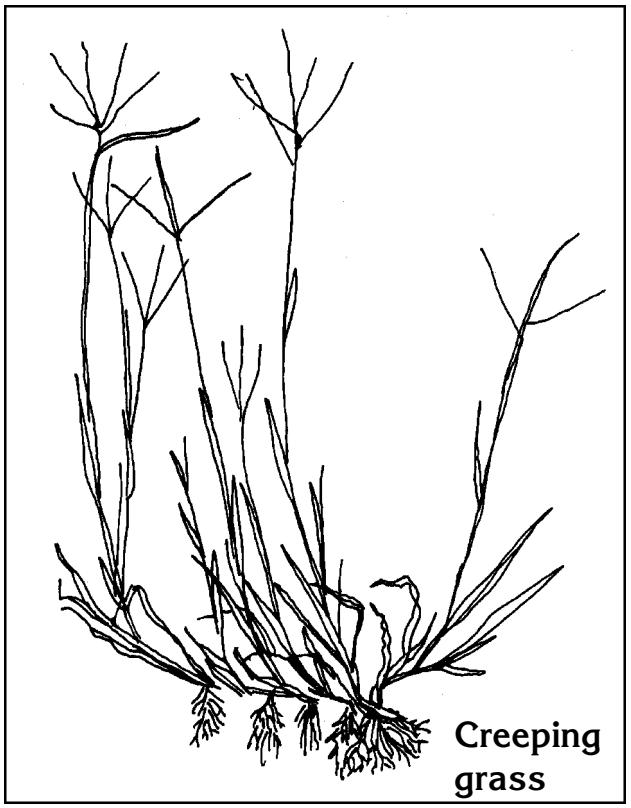
Creeping grasses send out runners[4], both as above-ground stolons[5] and below-ground rhizomes[6]. At each growth node, a new plant will shoot up. This knits the grass together to allow plant growers to cut it into sod squares that can be placed like a puzzle on the lawn. Their ability to spread makes creeping grasses more difficult to weed out of unwanted places such as flowerbeds.

Location and Shape

After deciding the appropriate size of a lawn based on how it will be used, zoning principles should govern its location and shape. Zoning is the practice of placing plants together that have similar water, soil, and sunlight needs. Lawns should be placed in the highest water-use zone. High-water-use plants, like lawns, should be grouped in an "oasis zone" that is visible from the house and can be easily monitored for water use. Slopes or inclines should be avoided, as water will run off rather than soak into the ground.

When designing a lawn's shape, it is important to remember that a sprinkler irrigation system is the most efficient way to water a lawn, and sprinkler systems are designed to work best in an overlapping layout with a circular pattern. Small rectangular strips of

Bunch grass



Creeping grass

Background Information: Rethinking the American Lawn (continued)

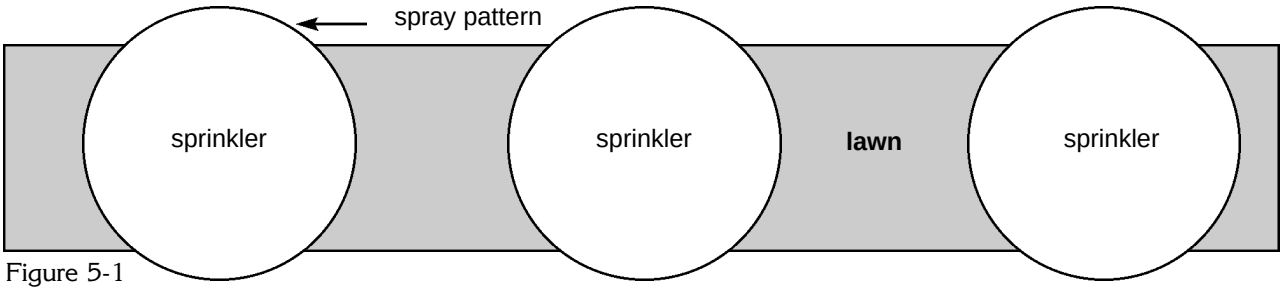


Figure 5-1
Most sprinklers are designed to spray in a circular or semi-circular pattern, which makes it difficult to efficiently water a long, narrow strip of lawn.

lawn and small, oddly shaped areas are harder to irrigate. (See Figure 5-1.) However, technology has improved sprinkler systems to include adjustable sprinkler heads that can accommodate odd shapes and tight spots. Check local suppliers to determine available options. Two websites to consult for information on irrigation supplies are DripWorks at http://www.dripworksusa.com/ and Rain Bird at http://www.rainbird.com/.

Maintenance

Proper watering and mowing techniques promote the development of deeper roots, and deeper roots promote healthier grass that is more drought- and disease-tolerant. Proper watering techniques differ depending on the type of soil. A rich loamy soil or an amended soil that holds water well and provides soil depth will allow grass to develop deep root systems and can be watered deeply and infrequently to encourage the roots to grow down in search of water. Clay soils swell when they become saturated, cutting off any more water penetration, and sandy soils are too porous to hold much water. These soils require frequent watering and short irrigation run times in order to keep the water available in the root zone. In fact, when sod is laid on heavy clay soil and is over-watered, significant water runoff occurs because the ground surface is saturated and impermeable. Finally, grasses are better able to develop deep root systems and require less frequent watering if mower blades are set on high so that the grass is allowed to grow tall. No more than one-third of the leaf blade should be cut at any one mowing.

Researchers are working to develop turf grasses that are drought-tolerant and accept poor soil conditions. For more information on drought-tolerant turf grasses, contact the local county extension service. See Appendix B for area phone numbers.

FOOTNOTES, PAGE 168

[1] Bunch grass – grasses that come up from a single root and propagate through seeds; they can be used as a turf grass or an ornamental grass

[2] Creeping grass – grasses whose roots grow in the form of runners on top of or below the soil; propagated through growth nodes on these roots. Creeping grasses are usually used as turf grass.

[3] Growth node – a knoblike marking on a plant stem or root from which a leaf, bud or stem will grow

FOOTNOTES, PAGE 172

[4] Runners – roots that grow either above ground or below ground; grass runners will grow new grass “leaves” at each growth node

[5] Stolons – a ground-lying or trailing stem that produces roots at the nodes

[6] Rhizomes – a horizontal underground stem which can send out both shoots and roots

FOOTNOTE, PAGE 174

[7] Plugs – also called sprigs; a small core or segment removed from a larger object, in this case a turf grass; plugs are used instead of sod to allow more flexibility in placement and to reduce cost

Background Information: Rethinking the American Lawn (continued)

Planting: Sod or Seed?

Some grasses are available only in seed and others only in sod, but the more popular lawn grasses are available in either form. Both seed and sod need to be started when the temperatures and moisture are the most favorable. Cool-season grasses should be started in the late summer to early fall, while warm-season grasses should be started in the late spring to early summer.

Seed Basics

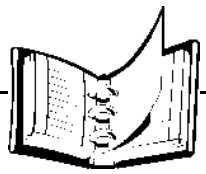
- Seed is usually less expensive than sod.
- It is important to apply enough seed. Seeding a new lawn will require approximately 2.8 pounds of seed per 1,000 square feet of area. Only 80-90 percent of the seed will germinate if it is fresh seed. If the seed is over a year old, approximately 25-50 percent will not germinate.
- When seed is applied, a combination of grass varieties can be sown, allowing the owner to tailor the grass to the needs of the site.
- Care must be taken when sowing grass seed on windy days. Grass seed is light and can easily be blown away.
- Seeding requires more initial water because the ground must be kept moist until the seed germinates. Watering one to four times a day for two to three weeks may be necessary. After germination, the young grass must be kept wet until it is established.
- A newly seeded lawn will almost always contain weeds. The weeds are a natural part of the succession of plants and can be controlled in the first season through mowing. In the second season, the emerging weeds can be controlled through hand weeding or herbicides.

Sod Basics

- Sod should be laid within 24-60 hours after it has been cut from the soil. It is best to use local sod since it will be adapted to the soil of the area.
- Newly placed sod must be watered thoroughly. It should be watered two to three times a week for the first two to three weeks to establish the root base. People should not walk on freshly laid and watered sod for about two weeks.
- Sod can be put on slopes.
- Sod can be installed almost any time in the growing season.
- Sod smothers weed seeds.
- Sprigs or plugs[7] can reduce cost of planting (compared to sod). Plugs can be planted every 12 inches in a grid pattern.

FINAL THOUGHT

Lawns may be an American tradition, but the tradition is changing — especially in the desert Southwest. Warm-season grasses, which use considerably less water than traditional cool-season grass species such as bluegrass and tall fescue, have become a viable lawn alternative. By carefully matching the grass species with soil type and local rainfall — and considering the use, shape, and location of the lawn — a homeowner can have a beautiful lawn that is water efficient.



Problem to Solve: Barry Salazar's Lawn

Harding County Extension Agent
35 Pine St. - County Courthouse
Mosquero, NM 87733

Dear County Extension Agent:

I have just moved into a brand new home and I would like to plant a small lawn — a green oasis where my friends and I can picnic and relax. The rest of my yard will be planted in native shrubs and trees.

The whole backyard measures 50 feet by 75 feet. The homebuilder recommended a sprinkler system, but I have heard that a drip system is more efficient.

My questions are: What is really the best grass choice for this area? What would be a good size and location for my lawn? And which is the best choice for an irrigation system?

Thank you for your assistance.

Sincerely,
Barry Salazar

Barry Salazar's Lawn: Project Cover Sheet

You will be responsible for communicating with Mr. Salazar to advise him on his new lawn. When making your recommendations, think about the conditions in his area — such as average annual rainfall, local soil type, and temperature range. Include information on the type of grass you recommend, the best locations for lawns, and the type of irrigation system that might work best. Make your reasons for your choices very clear. You may wish to include a drawing of your suggested plan.

When appropriate, include what you have learned in the previous chapters: soil, irrigation, and mulch.

Checklist

___ Bunching and Creeping Student Worksheet

___ Can Roots Create Air? journal pages

___ Deep, Deeper, Deepest Student Worksheet

___ School-arly Habits journal pages

___ Letter to Mr. Salazar answering his questions

Barry Salazar's Lawn: Project Cover Sheet

You will be responsible for communicating with Mr. Salazar to advise him on his new lawn. Recommend a grass type for his lawn, including pertinent information such as soil type, rainfall, and temperature ranges that influence your recommendation.

Research cost estimates and availablity from local suppliers for the grass type that you select. If it is not available locally, find the closest available source and shipping costs. Provide a cost estimate for Mr. Salazar.

Provide Mr. Salazar with tips on installing sod or seed and the time of year to plant. If you would like, you can include a drawing of your suggested plan.

Where appropriate, include information from previous chapters: soil, irrigation, and mulch.

Checklist

___ Bunching and Creeping Student Worksheet

___ Can Roots Create Air? journal pages

___ Deep, Deeper, Deepest Student Worksheet

___ School-arly Habits journal pages

___ Letter to Mr. Salazar

___ Cost estimate

___ Optional drawing of Mr. Salazar's backyard

Barry Salazar's Lawn: Tips For Getting Started

Steps

1. Review the rainfall data, soil type, and temperature ranges for Mr. Salazar's new home.

2. Review Mr. Salazar's letter for function of the lawn.

3. Review **Xeric Grasses for New Mexico** chart for grass types that would be appropriate for Mr. Salazar.

4. Select a grass type from the chart and write out your reasons for selecting this grass.

5. Review what you have learned about zoning and irrigation. Suggest a location and irrigation system for Mr. Salazar's lawn. Write out the reasons for your suggestions.

6. Use the information you have gathered from the above steps and write a letter to Mr. Salazar.

What Is It About Lawns?

We all like to have lawns. In fact they are a tradition in America. Lawns provide play areas for children and pets, a nice spot for a picnic, and a place to relax on a warm summer day. A well-established lawn can reduce noise, air and water pollution, and slow the erosion of soil. However, lawns can also be the largest user of irrigated water in the landscape.

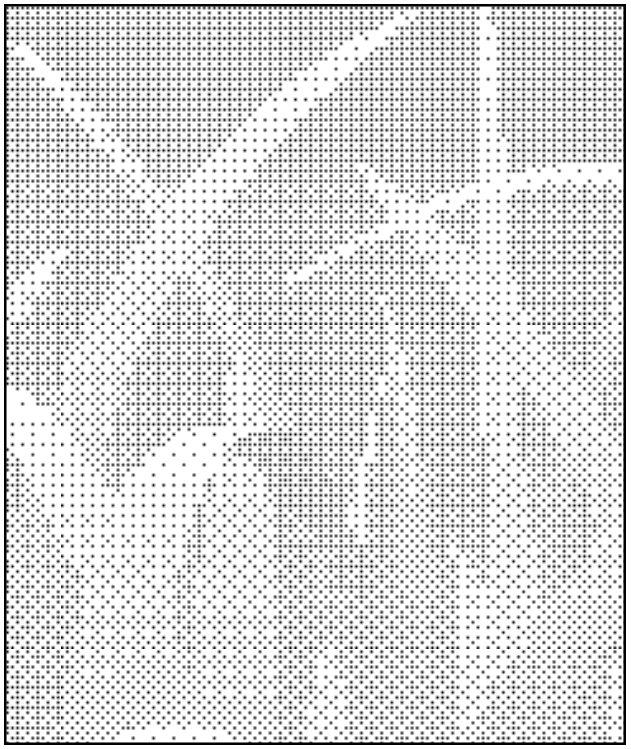
There are two main keys to having a lawn and being water-conscious. The first is to focus on the desired use of the lawn. The second is choosing the appropriate grass for the soil and rainfall of your area. Once these important decisions have been researched, you can select the size, shape, location, and maintenance of the lawn.

Desired Use and Appropriate Grasses

The way in which you are going to use your lawn will determine the size, placement, and grass type. Are there children in your household? What about pets? Do you like to sit on the grass and have a picnic? Consider all the outdoor activities of your family and determine which ones will require a lawn or grassy area. If you are designing a backyard area for a family with small children and no time for maintenance, you may want a small playground area that uses a slow-growing grass that does not need weeding or pesticides. If you need a soccer field, plant a large area with a grass that can take a beating and still keep on growing. Use the function of the lawn to help determine how large the turf area will be and where it will be placed.

When you have determined the function, you will need to research the different types or species of grass. Fortunately for us, a wide variety of grasses work well in New Mexico. To decide which grass will work best with your planned function, check the conditions of your soil and the amount of rainfall in your area. Some grasses will tolerate any soil type or pH; however, most are pickier. For instance, Bermuda grass likes sand or silt and a neutral to acidic pH, while tall fescue likes silt to clay mixtures and tolerates a pH from acidic to alkaline. The trick is to find out what type of soil you have and then pick a grass that will work with the existing soil. You can use soil amendments to improve the soil. However, it is wise not to vary too far from the original makeup of the soil.

It is also important to select a grass whose watering requirements match the precipitation in your area. You need to know not only how much rain the area receives but also what time of year it falls. For example, a typical area in central New Mexico receives only 10 inches of rain a year — and most of it falls in the summer months. If you choose a grass (such as Kentucky bluegrass) that requires 40 inches of water per year, you will have to supplement the rain with at least 30 inches of irrigated water. Plus, the rainy season in New Mexico is when Kentucky bluegrass goes dormant and needs less water!



What Is It About Lawns? (continued)

Grass Type: Cool-Season and Warm-Season Grasses

All of the different species of grasses can be put into two main categories: cool-season grasses and warm-season grasses. Cool-season grasses grow best in the cooler New Mexico environments. They like daytime temperatures to be around 60° to 75° F. This means they grow best in higher elevations or during the spring and fall seasons of lower elevations. Cool-season grasses can get brown in the heat of the summer but they hold their green color in the winter. Cool season grasses include Kentucky bluegrass, tall fescue, and perennial ryegrass.

Warm-season grasses grow best when daylight temperatures reach 80° to 95° F. Most of them will even tolerate higher temperatures. Warm-season grasses grow best in the summer in New Mexico's lower elevations. They will not grow in temperatures under 50° F; in fact, they will turn brown and go dormant. So do not count on green lawns in the winter with a warm-season grass. Warm season grasses include blue grama, buffalograss, and Bermuda grass.

Grass Type: Bunching and Creeping

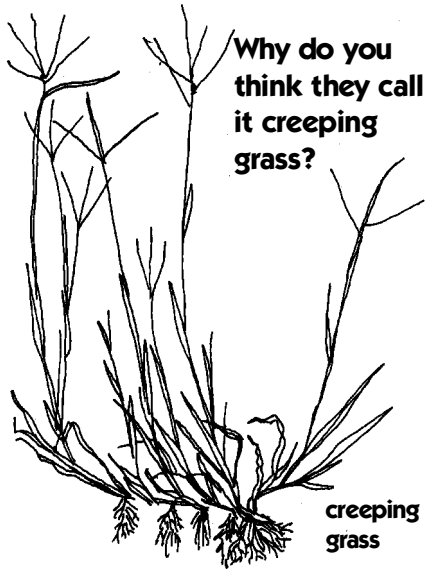
When you are planting or expanding a lawn, it is helpful to know how the grasses propagate or spread. Again, there are two main categories: bunch grass and creeping grass.

The bunch grasses grow as individual plants. They have seeds that grow at the tip or head of the plant and are distributed by the blowing wind and on animal fur. When planting a lawn with bunch grass, you usually plant from seed. The seed should be sown or planted thickly; otherwise, the lawn might be spotty for a year or two until it fills in.

Would a cool-season grass or a warm-season grass work better in your area?

Creeping grasses have multiple growth nodes[1] on a single plant. The parent plant will send out runners[2], like roots, both above ground (stolons) and below ground (rhizomes). At each growth node a new plant will shoot up. This knits the grass together like a fabric and forms what we call a sod. To use as a lawn, plant growers will cut the sod into squares that can be placed like a puzzle on the ground. The cut pieces can be placed side-by-side to form an instant carpet of grass.

bunch grass



Why do you think they call it creeping grass?

creeping grass

[1] Growth node – a knob-like marking on a plant stem or root from which a leaf, bud or stem will grow

[2] Runners – roots that grow either aboveground or below ground; grass runners will grow new grass "leaves" at each growth node

What Is It About Lawns? (continued)

Once you have considered all of the factors (function, soil, rainfall, and temperature ranges) consult the **Xeric Grasses for New Mexico** chart to see if you can find a type of grass that fits your needs.

Location and Shape

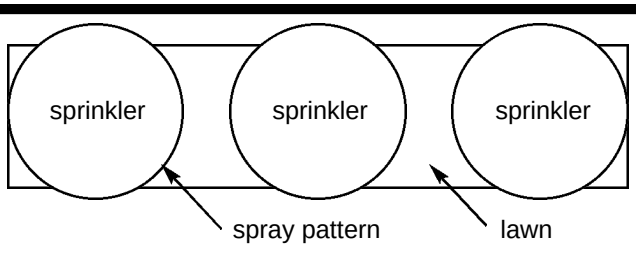
Choosing the location and shape of your lawn should go hand-in-hand with the function of the lawn. Check to see how the lawn will be used and place it appropriately. For example, if you are installing a lawn for small children, you might want to place it in the back, where it can be seen from the kitchen window.

Lawns are considered high-water-users and should be placed in your highest water-use zone[3]. They should be in a highly visible area so they can be easily monitored for their watering needs. You also do not want to put a lawn on a steep slope, because the water will run quickly downhill instead of soaking into the ground. Try to avoid small, oddly shaped areas that will be hard to water. A sprinkler irrigation system is the best way to water a lawn, and sprinkler systems are designed to work best in circles that overlap. It is hard to get overlapping circles to conform to a small rectangular shape. However, technology is improving the sprinkler systems to include adjustable sprinkler heads, so check with the suppliers to see what options you might have.

Maintenance

The best thing that you can do to obtain a healthy lawn is to allow it to grow deep roots. To get deep roots, first make sure that you have a good, deep soil mixture. Then, allow your plants to grow to their optimal height. By allowing plants to grow up, you will help them also grow down. Mow the grass only when needed, rather than on a set schedule. Also, put your mower blade on the highest setting and keep the blade sharp so you stress the plants as little as possible.

The next best thing you can do for a healthy lawn is to practice proper watering. Proper watering techniques will differ depending upon your soil type. If you have an amended soil or a naturally rich loamy soil that holds water well and goes down more than 8 to 10 inches, you can water deeply and infrequently to encourage the roots to grow down in search of water. Clay and sandy soils require more frequent watering and shorter watering times in order to keep the water available in the root zone. This is because clay will swell when it becomes saturated, cutting off any more water access, so you want to stop watering before it becomes saturated. Sandy soils are porous, with large air holes that don't hold much water, so you want to stop watering before the water runs out of the root zone. For all soil types, you can reduce the evaporation losses by watering in the early morning or late evening, and by avoiding over-watering that creates puddles.

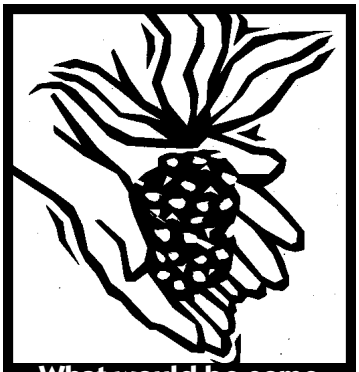


Most sprinklers are designed to spray in a circular or semi-circular pattern, which makes it difficult to efficiently water a long, narrow strip of lawn.

How would adjustable sprinkler heads help with irregularly shaped lawns?

[3] Zoning is the practice of putting plants together that have similar water, soil, and sunlight needs.

What Is It About Lawns? (continued)



What would be some pros and cons of planting seeds versus sod?

Sod or Seed?
While some grasses are available only in seed or only in sod, the more popular lawn grasses are available in either form. You will need to plant either sod or seed according to the category of grass that has been chosen. A cool-season grass should be planted late in the summer or early in the fall. A warm-season grass should be planted in the late spring to early summer. This will provide optimal growing conditions for the chosen grass.

Final Thought

Lawns may be an American tradition, but the tradition is changing - especially in the desert Southwest. Warm-season grasses, which use considerably less water than traditional cool-season grass species such as bluegrass and tall fescue, have become a viable lawn alternative. By carefully matching the grass species with soil type and local rainfall - and considering the use, shape, and location of the lawn, a homeowner can have a beautiful lawn that is water efficient.

Charts & Graphs

Xeric Grasses for New Mexico[1]

Grass Type	Narrative	Season	Water Needed Per Year	Preferred Soil	Preferred pH	Bunch or Creeping
Blue Grama	• blue-green look • mixes well with buffalograss • very drought-tolerant • at higher elevations, where it is mowed, it is a turf grass • at low elevations, it is a bunch grass • adapts well to windy, arid conditions • easily established	Warm	12”-24” optimal; 8”-50” tolerable extremes	Sand to clay	Neutral to alkaline	Bunch
Buffalograss	• soft, light-green foliage • native grass that likes it sunny and hot • needs less water than virtually all other lawns • very wear-tolerant • spreads using surface runners and seeds	Warm	12”-24” optimal; 10”-35” tolerable	Silt to clay optimal; sand to clay possible	6.0-7.5	Creeping
Bermudagrass	• sod-forming • turns brown during its dormant season • very drought-tolerant and heat-tolerant • needs regular fertilization and mowing to maintain an attractive appearance • can be invasive and hard to get rid of once established	Warm	16” or more; 14” minimum	Sand to silt is optimal; sand to clay possible	5.5-7.5	Creeping

1 Xeriscape Gardening: Water Conservation for the American Landscape, Ellefson, Stephens, and Welch, 1992; and Lean & Green: A Simple Guide to Water-wise Lawn Care, City of Albuquerque

Charts & Graphs

Xeric Grasses for New Mexico

Grass Type	Narrative	Season	Water Needed Per Year	Preferred Soil	Preferred pH	Bunch or Creeping
Zoysiagrass	• very wear-tolerant • establishes slowly • drought- and heat-tolerant • needs irrigation because of shallow root system, grows slowly and therefore does not need mowing very often	Warm	30" or more	Well-drained, fine-textured clays	5.0-7.0	Creeping
"Fairway" Crested Wheatgrass	• low-maintenance • drought-tolerant • better meadow grass[2] than lawn grass • needs to be started from seed; forms a deep root system (as deep as 3 feet) and a dense root system near the surface • will thin out if over-irrigated and will not be able to withstand the invasion of sod-forming grasses	Cool	10"-16.5" optimal; 8"-19" possible	Sand to clay; tolerates saline	Adapted to weakly acidic soils	Bunch
"Ephraim" Crested Wheatgrass	• bunch grass • not good for erosion control • best suited for low-maintenance and rarely used areas • will go dormant during drought and recover well when rains return	Cool	10"-14" optimal; 8"-25" possible	Sand to clay	Tolerates wide range of pH	Bunch

[2] Meadow grass – grass used as a lawn but not likely to stand up to regular foot traffic or multiple uses: mainly used for visual effect

Charts & Graphs

Xeric Grasses for New Mexico

Grass Type	Narrative	Season	Water Needed Per Year	Preferred Soil	Preferred pH	Bunch or Creeping
Tall Fescue	• deep-rooted grass with a fine texture • more tolerant of foot traffic and shade than bluegrass • adapts well to dry conditions and poor soils • greens up early in the spring and stays green long into the fall	Cool	18" minimal; 21"-25" for lawn grass	Silt to clay optimal; sandy to heavy clay possible	4.7-8.5	Bunch
Perennial Ryegrass	• fine-textured bunch grass • not very drought-tolerant • somewhat shade-tolerant • excellent wearability • can be used in combination with warm-season grasses • would work well in the cooler climate areas of the state • resists disease	Cool; can be used with warm-season grasses	15" or more	Wide range; fertile	6.0-7.0	Bunch
Kentucky Bluegrass	• fine-bladed grass • able to recover from traffic damage • in New Mexico, should only be used in combination with more drought-tolerant grasses such as fescue or blue grama • will grow better at high elevations that have cooler temperatures and higher precipitation • newer, more water-efficient variety, Texas bluegrass, may provide more options for New Mexican landscapes	Cool	35"-56"	Medium texture	6.0-7.0	Creeping

Bunchin' & Creepin'

Main Question:
How are grasses different?

Objectives:

- To compare the morphology of bunching and creeping grasses
- To examine grass parts in detail

Subjects: science, art

Time: $1\frac{1}{2}$ hours

Vocabulary:
stamen, pistil, xylem, phloem, monocot, dicot, embryonic seed leaf

Advance Preparation:

- Gather different kinds of grasses from around the school or neighborhood. Be sure to collect both bunch and creeping grasses. If time permits, grow samples in the classroom.

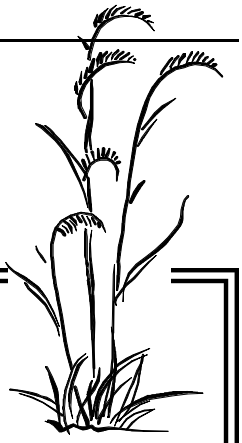
Setting the Stage:

- Review with students the parts of a plant. Review the differences between monocots and dicots. Monocots are plants, such as grass, with a single embryonic seed leaf that appears at germination; dicots have a pair of embryonic seed leafs.

Materials: for each student

4 various collected grasses
4 ethyl alcohol
4 dissecting scopes (optional)
4 magnifying glass
4 methylene blue stain
4 slides
4 cover slips
4 scalpel or razor blade
4 dissecting tray
4 forceps

Bunchin' & Creepin'



A. Plant Form

1. Examine the grass plants and decide which is a bunch grass and which is a creeping grass.

2. Examine the bunch grass. Draw a rough sketch of it on the worksheet and answer the questions.

3. Examine the creeping grass. Draw a rough sketch of it on the worksheet and answer the questions.

B. Root Form

1. With a dissecting microscope or magnifying glass, look at the roots in detail. Does the grass have main roots and secondary roots? Notice how the roots spread out like clumps of threads.

2. Place a thick grass root of either type in the dissecting tray and cut it lengthwise. Examine the two halves (the dissecting scope may be necessary for this). In the center there should be the stele that contains the xylem and phloem. The xylem and phloem transport water and nutrients to the grass. Around this is the food-storing cortex. Draw a diagram of the root and label the parts.

3. With the razor blade, cut a cross section through another thick root. Make a thin cross section by making a second cut as close to the first as possible. Place this on a microscope slide and stain it with methylene blue. Allow the stain to remain on the thin section for one minute, then slowly pour drops of alcohol on the section until no more stain washes away. Look at the section under the dissecting scope or microscope and draw the results.

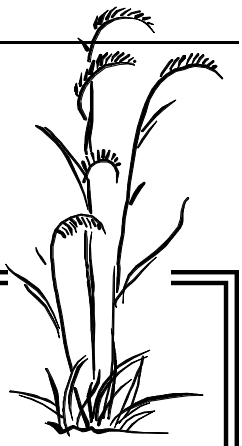
C. Flowers and Seeds

1. Examine a flower head on the bunch grass. Look at it through the dissecting scope or magnifying glass. Draw a rough sketch of it on the worksheet and answer the questions.

2. Examine a flower head on the creeping grass. Look at it through the dissecting scope or magnifying glass. Draw a rough sketch of it on the worksheet and answer the questions.

(continued on next page)

Bunchin' & Creepin'



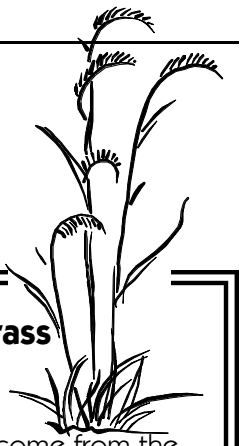
Extension:

- Plant different kinds of grasses in pots in the classroom or around the school and observe them at different seasons.
- Draw sketches of the different kinds of ornamental grasses in the landscapes around the neighborhood.
- Visit the grass demonstration garden at the Rio Grande Nature Center in Albuquerque.
- Research the uses of grasses as forage material for animals and as food crops for humans. Focus on historical as well as current uses.
- Research the "Green Revolution," its purpose, and its results.
- Collect grass seeds, such as wild wheatgrass or Indian ricegrass, grind them up, and make flour. If there is enough, make bread!

Name

Student Worksheet

Bunchin' & Creepin'



Draw Bunch Grass

A. Plant Form: Bunch Grass

1. What do you notice about where the stems start? Do they branch like trees, or do they all come from the base of the plant? Make an observation.

2. Draw a circle around the "base" of the plant. This is the main growth point (node) with stems growing up from it and roots growing down. Why does having a growing point so close to the soil surface make grasses suitable for lawn? What would happen if you tried to cut a bush with the lawnmower? Make a hypothesis.

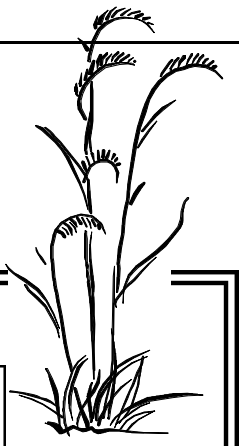
3. How do you think this kind of grass spreads?

(continued on next page)

Name

Student Worksheet

Bunchin' & Creepin'



Plant Form: Creeping Grass

Draw Creeping Grass

4. Describe the leaves. Are the veins on them parallel or branching? What do the leaves feel like? Smooth? Sticky? Are the edges sharp or soft?

5. Draw a circle around the base or bases of this plant in your drawing (above).

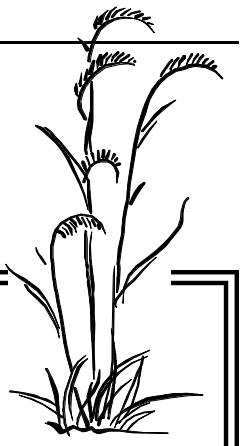
6. What would happen if one of these bases were removed?

(continued on next page)

Name

Student Worksheet

Bunchin' & Creepin'



7. How do you think this kind of grass spreads?

8. Describe the leaves:

9. Which grass do you think would spread better, bunch or creeping? Why?

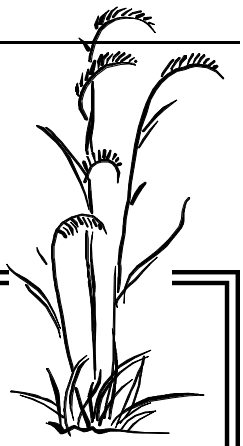
10. Which grass would make a better lawn? Why?

(continued on next page)

Name

Student Worksheet

Bunchin' & Creepin'



B. Root Form

Root Longitudinal Section	Root Cross Section

11. Does the plant have main roots and secondary roots?

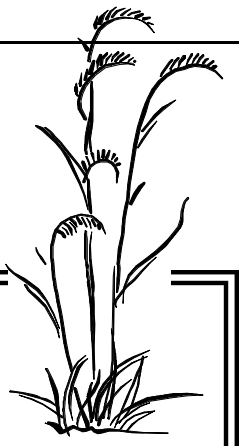
12. Why do you think grass plants are useful for holding soil on steep or windy slopes?

(continued on next page)

Name

Student Worksheet

Bunchin' & Creepin'



C. Flowers and Seeds

Bunch Grass Flower	Creeping Grass Flower

13. Do the flowers look like "typical" flowers? Can you see the separate flower parts?

14. How do you think these flowers are pollinated?

15. Does your grass contain seeds? If so, what kind of grass has seeds?

16. How do you think the seeds are dispersed?

Can Roots Create Air?

Main Question:
How do plants breathe?

Objectives:

- To show that roots are living cells that carry out cellular respiration
- To show that CO^2 is a waste product of cellular respiration

Subjects:
science, math

Time:
30 minutes on Day 1; 10 minutes on Days 2 to 4

Vocabulary:
respiration

Advance Preparation:

- Begin growing grass plants 2 weeks before experiment, or use plants from another experiment such as Deep, Deeper, Deepest
- Note: bromthymol blue solution is blue under neutral conditions. When combined with CO^2, the solution becomes acidic and turns yellow-green.

Setting the Stage:

- Ask students what function roots serve in plants. Are roots living? What are some clues that roots are living?
- What is a good way to test something to see if it is alive?
- Discuss the role of a control in an experiment. How should a control be chosen?

Materials: (one for each group; use a minimum of 3 groups)

- 4 small grass plant
- 4 2 test tubes
- 4 straw
- 4 graduated cylinder
- 4 bromthymol blue solution

TEACHER TIP:
Winter Rye grows very quickly, is easy to find, and does well in grass palettes or pots.

Can Roots Create Air?

A. Testing bromthymol blue solution

1. Put 10-15 ml of water in the test tube.

2. Add 3-4 drops of bromthymol blue solution.

3. Insert a straw into the solution, take a deep breath and exhale gently. Record the color change. What causes this?

4. Try it again, this time blowing instead of exhaling. Was there a difference in the results? Why?

B. Setting up experiment

1. Put 10-15 ml of water in 2 test tubes. Add 3-4 drops of bromthymol blue solution to each test tube.

2. Insert a plant into one test tube so that the roots are submerged in the solution. The other test tube is the control.

3. Observe the test tubes for 2-4 days and record the results.

Discussion

- Based upon this experiment, are roots living or non-living? What is a good way to tell?
- When roots respire into the soil, do they make it more acid or more alkaline?
- What happens to the carbon dioxide given off by roots?
- Humans breathe in oxygen and give off carbon dioxide as a waste product (aerobic respiration). Do other animals do the same thing? Do plants? Fungi? Bacteria? Viruses?
- Why was there a difference between blowing and exhaling into the bromthymol blue solution?

Extension:

- Test other species of plants.
- Use plants with different sizes of root systems to test the rate of CO^2 production.
- Set up an aquarium with beta fish and their plant counterparts so that they are exchanging all of the needed nutrients without outside interference.

Deep, Deeper, Deepest

Main Question:
How does the depth of the soil affect plant growth?

Objectives:
- To observe the relationship between soil depth and root growth

Subjects:
science, language arts, math

Time:
30 minutes to set up; 10 minutes for observation two times a week for 4 to 6 weeks

Vocabulary:
germinate, morphotype

Advance Preparation:
- Obtain several different species or types of grass seeds. All seeds should have a similar morphotype (bunch or creeping).
- The soil type will not vary in this experiment.

Setting the Stage:
- Ask students why plants have roots. Do plants need deep or shallow soil?
- How deep should soil in a lawn be? What would happen to grass grown in soil that is too shallow?
- Is the depth of soil required for plants dependent upon the kind of plant?

Materials:
- 4 grass seeds
- 4 soil
- 4 4 pots per seed type (plastic pots that can be cut away work best)
- 4 metric rulers

TEACHER TIP:
Winter Rye is a fast-growing bunch grass that works well for this experiment.

Deep, Deeper, Deepest

A. Planting the Seeds

1. Label four pots with the soil depth and seed type to be used.
2. Fill one pot with soil 3 cm deep; fill the other 3 pots with 5 cm, 7 cm and 10 cm of soil.
3. Plant 5 - 10 grass seeds just under the soil surface in each pot.
4. Water each pot with the same amount of water.
5. Place all pots in a warm place where they will receive bright light but not direct sunlight.

Pot Number	Soil Depth	Seed Type
1	3 cm	
2	5 cm	
3	7 cm	
4	10 cm	

B. Gathering Data

1. Water pots at set intervals to keep the soil moist. Use the same amount of water in each pot.
2. Twice each week, measure the height of the plants.
3. After the plants have stopped growing, or after four weeks, compare root growth.
4. Carefully cut the cup away from the plant and soil.
5. Observe the direction and conditions of the root growth.
6. Write down the observations on the Student Worksheet.
7. Gently massage the soil away from the roots and pull up each plant away from the group. Try not to break the roots.
8. Measure the length of the roots. Graph the results.

Extension:

- Test different types of soils. Assign each group a different soil type. Groups can then present their results to the class for discussion and comparisons.
- Test different types of grasses of the same morphotype or of different morphotypes.
- Use different watering methods, such as drip versus flood, to determine the influence on root growth.
- Clip grass back as it grows to determine the effect of lawn mowing on grass roots.
- Water plants with a liquid fertilizer to see if this can compensate for lack of soil.

Student Worksheet

NAME

Deep, Deeper, Deepest

Plant Height

1. Record the plant height in each column.
   Seed Type_____

Date	3 cm soil	5 cm soil	7 cm soil	10 cm soil

2. Did soil depth affect the growth of the plant?

3. After cutting away the plastic cup, what observations were made about the directions and conditions of the root growth?

4. Record the <u>average</u> root lengths for each soil depth.

5. Which soil depth allowed the most root growth?

6. Does soil depth affect the length of roots? Explain.

School-arly Habitats I See

Main Question:
What kinds of habitats are on the school's campus?

Objectives:

- To collect information about the types of habitats at a school and transfer this information to a data sheet
- To calculate the area for each habitat
- To correlate habitats with irrigation systems

Subjects:
science, language arts, math

Time:
1 to 1 1/2 hours

Vocabulary:
site plan

Materials:

4 school site plan
4 clipboard
4 tape measure
4 colored pencils
4 calculators (optional)

Advance Preparation:

- Make copies of the school plan drawn in the activity Water Around My School.
- Divide school up into zones that will be surveyed by different groups of students.

Setting the Stage:

- Discuss the concept of habitats. Describe different types of habitats and their water requirements.
- As a group, design a key for how to indicate different habitats.

TEACHER TIP:
Various micro-climates or habitats exist around the school. Allow students plenty of latitude in their identifications.

Examples:
Dumpster – provides moisture and nutrients.
Football field – monoculture grass, plenty of water.
Xeriscape landscape – native plants, controlled environment.

School-arly Habitats I See

Drawing Habitat Locations

1. Divide students into groups of two or three and give each group a site plan, clipboard and colored pencils.
2. Have students walk around the school, observe the different habitats and draw the location of each habitat on their plans.
3. Calculate the area (length x width) of each habitat and correlate it with the type of irrigation in each area and the amount of water the irrigation system dispenses.

Discussion

- How many types of habitats did students find around the school?
- Do some habitats seem more "livable" than others? What qualities make a habitat more comfortable? What qualities make a habitat less comfortable?
- Do all organisms prefer the same kind of habitat? How can one tell?
- What kinds of correlations are there between natural and man-made habitats? Recreate the table below with the habitats you found.

School Habitat	Short Description	Comparable Natural Habitat
Area around a dumpster		
Football field		
Islands in parking lot		
Tennis court		
Planters		
Areas where roof drain spouts hit ground		
Cracks in sidewalk		

Extension:

- Research habitats around New Mexico, the United States, and the rest of the world. Identify the amount of rainfall that they receive.
- Is there a correlation between rainfall amounts and habitats? Research and explain.

Elegant Coverings

Main Questions:
Are there alternatives to grass?

Objectives:

- To examine alternatives to lawn and gravel as a way to cover large areas
- To find appropriate groundcovers for different situations
- To explore using groundcovers as background elements in a landscape

Subjects:
science, language arts, math, art

Time:
1 hour for research; 1 hour for making poster; 10 minutes for each group for presentations

Vocabulary:
soil, mulch, groundcover, meadow grass, habitat

Materials:

- 4 gardening references
- 4 poster board or butcher paper
- 4 magazines/catalogs that can be cut up
- 4 glue or glue sticks
- 4 Internet
- 4 markers or crayons
- 4 scissors
- 4 Desert Blooms CD (online at www.uc.usbr.gov:2525/dblooms)

Advance Preparation:

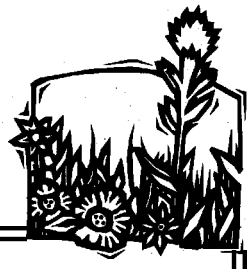
- Arrange library time or computer lab time for research if there are not adequate books available in the classroom.
- This project can be done individually or in pairs.

Setting the Stage:

- Ask students if they can tell how Mother Nature covers large areas of ground. Could any of these ways be used in a yard?
- Discuss with students the design idea of feature/foil, of having one item in a design that stands out (the feature) and the background (the foil) that "sets off" the feature.
- Bring in examples of paintings that show the feature/foil principle.

TEACHER TIP:
This activity can be completed in one period if students prepare posters at home.

Elegant Coverings



A. Exploring the Design Principle

1. Have students go through magazines and cut out examples of a large, solid area of color or texture that serves as a background or foreground for a design element. These can include appliance and fashion advertisements, etc., so students can learn that a basic design principle can have many applications.
2. Once students have cut out several examples, have them make a mini-poster showing their examples and write one or two sentences below each example explaining how the design works, what makes it effective, how it could be improved, etc.
3. Discuss with students the use of groundcovers in filling large spaces and in providing a foreground or background to the landscape "feature" — a flowering tree or shrub, a sculpture, fountain, etc. Show them examples of how groundcovers have been used.
4. Discuss the use of meadows as a design element that changes over time and that gives a natural, restful feel to a landscape. Note that meadows may have some of their own feature/foil dynamics as flowers and grasses bloom and fade.

B. Background Research

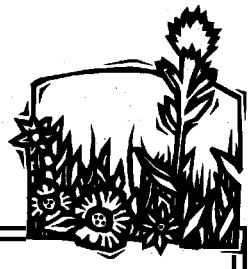
1. Using available materials (books, videos, Internet), research different kinds of groundcovers and wildflower mixes for different habitats.
2. Research one wildflower mix for a selected habitat. Find out what seeds are included in the mix and describe the habitat the mix was designed for.
3. Each student should research, in detail, one groundcover for sun and one for shade. Information to include:
   - Annual or perennial
   - Color of flowers and season of flowering
   - Height and spread
   - Culture conditions (soil type, amount of water, sun/shade)
   - How propagated
   - Landscape use (what to use it with, amount of foot traffic it can take, etc.)
   - Other information (where it originated, wildlife attracted to it, culinary or medicinal uses, etc.)

C. Presentation

1. Using poster board and markers, students should prepare a poster to show the class what they have learned about groundcovers and wildflower meadows. Include pictures of their plants.
2. Sketch a design of how the groundcover or wildflower mix can be used as a feature/foil design element.
3. If a computer is accessible, a Microsoft PowerPoint® presentation could be made.
4. Present research to the class.

(continued next page)

Elegant Coverings

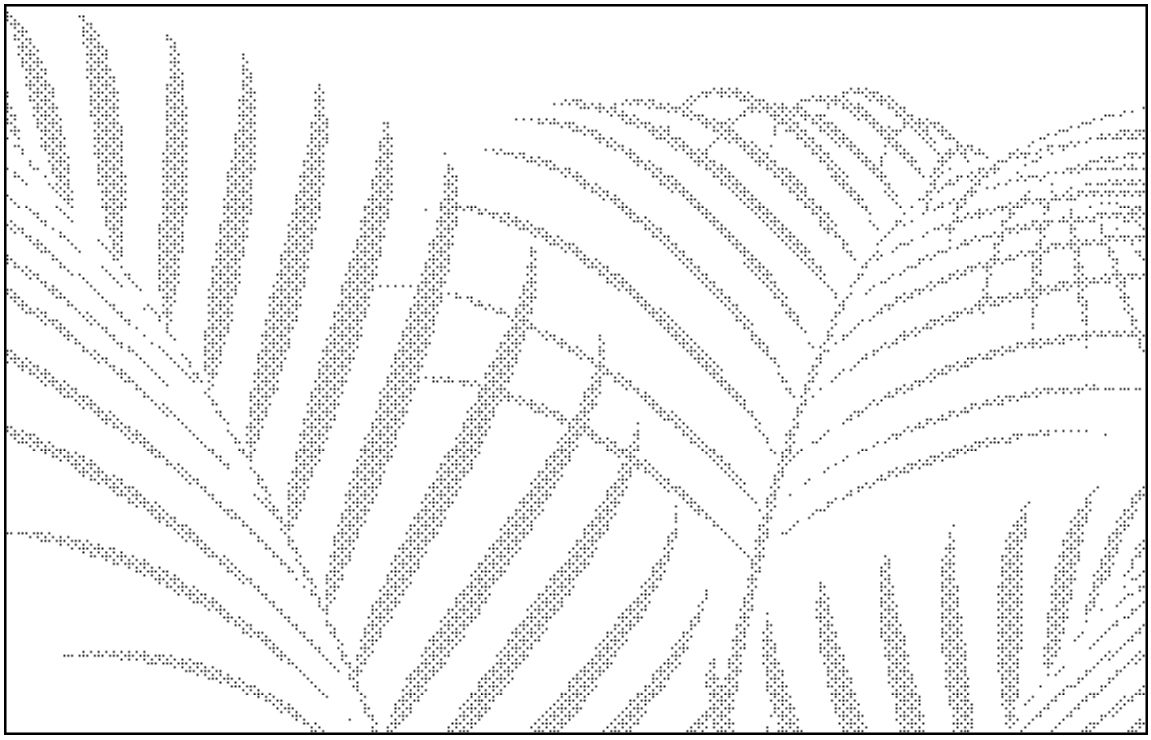


Extension:

- Research how to plant a wildflower meadow.
- Visit wildflower meadows at parks or in the mountains. Identify the plants there.
- Plant a wildflower meadow around the school. How will the watering be handled?
- Get samples of different groundcover plants and study their morphology. Which have fibrous root systems that would help them hold soil on slopes? Are any of them nitrogen fixers (naturally replace nitrogen that is lost to decomposition)?
- Find the recommended spacing for groundcovers and calculate the number of plants needed to fill a particular area. Based upon the plants' average growth rate, how long will it take plants to fill a given area?
- Research "hardscapes" (porches, patios, etc.) as replacements for lawns.

Activity Tip:

To show examples of designs from the entire class, copy pictures onto overhead transparencies. Use markers to highlight key areas of the pictures.



Shapely Lawns

Main Question:
Which grass is right for my situation?

Objectives

- To determine the parameters involved in selecting grass species.
- To determine the parameters involved in lawn site selection.

Subject: math

Time: 1 to $1\frac{1}{2}$ hours

Vocabulary: evaluation, slope

Advance Preparation:

- Provide access to the **Inches of Average Monthly Rainfall for New Mexico Towns** chart in Appendix C
- Provide access to a soil map

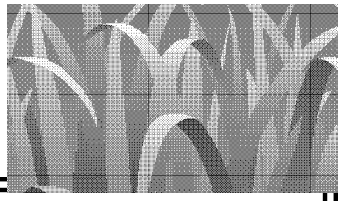
Setting the Stage:

- Ask students what kind of lawn they would like.
- How would they determine what grass type to use?
- Would they base their lawn choice on how it looks and feels, or how well it grows in a particular area?

Materials:

4 calculator
4 **Inches of Average Monthly Rainfall for New Mexico Towns** (Appendix C)
4 graph paper

Shapely Lawns



A. Determining the Needs

1. Read the paragraph at the top of the worksheet to determine the needs of the homeowners.

2. Look up the annual rainfall amount using the **Inches of Average Monthly Rainfall for New Mexico Towns** table in Appendix C.

3. Hypothesize on the type of soil the homeowner will have. Use soil maps, city location, and proximity to river to determine the answer.

4. Use an elevation map to determine temperature ranges that might influence plant choices.

5. Using the information from the **Xeric Grasses for New Mexico** chart provided in the background information, recommend a grass type for the homeowner.

B. Making a Recommendation

On the Student Worksheet provided, use the information that was gathered in Section A, and the information learned from previous readings and activities, to determine the best placement for the Orr's lawn. On the site plan provided, draw both a first choice and second choice for their lawn. Be sure to clearly mark the choices.

Discussion

- What factors influenced your species choice?
- Why is shape so important when planning a lawn?
- What other issues should be considered when putting in a lawn?

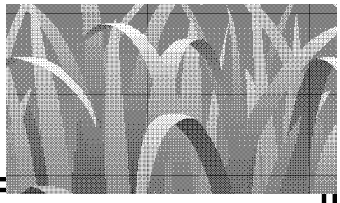
Extension:

- Consider the design for an area that has a slope.
- Design a lawn area for an "island" in a parking lot.
- Design a soccer field.

Student Worksheet

Name

Shapely Lawns



The Household:

The Orr family has two young girls who would like a lawn on which to play. They live in Los Lunas, New Mexico, about 100 yards from the Rio Grande. The property is about one acre, but they plan to fence in a smaller portion and put in a lawn. Help them determine what type of lawn they could have and where they should put it.

Determine the Needs

1. What is the annual rainfall of Los Lunas, New Mexico?

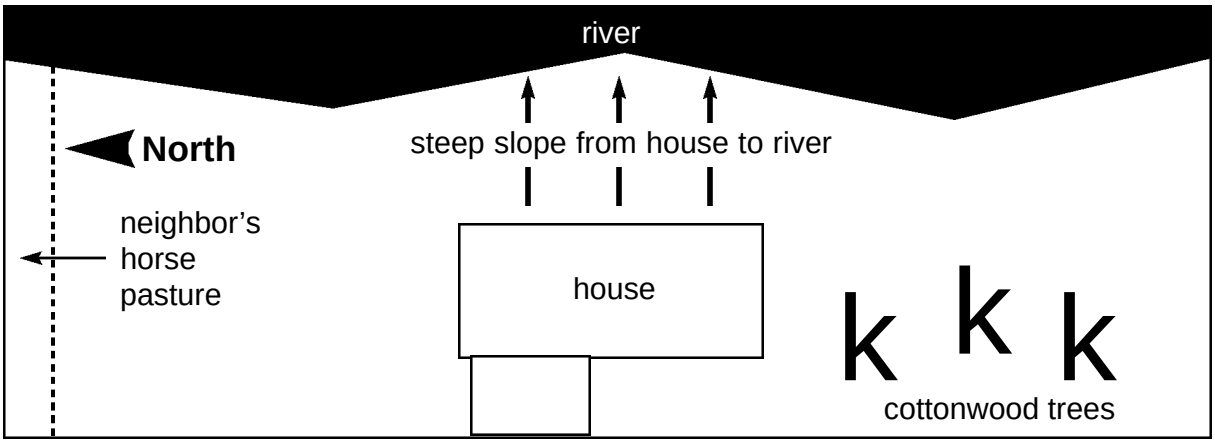
2. What type of soil would you find in Los Lunas, 100 yards from the Rio Grande?

3. What are the temperature ranges in Los Lunas?

4. Using the chart **Xeric Grasses for New Mexico**, what type of grass would you recommend for the Orrs?

5. State why you chose this grass type.

6. Using the following diagram of the Orr's property, make a first and second choice of locations for the Orr's lawn. Draw your choices on the site plan. Explain your choices on the back. j39



RESOURCES:

Lean & Green, A Simple Guide to Water-wise Lawn Care is published by the City of Albuquerque and is free to the public. It contains a short list of xeric grasses for New Mexico. See Appendix F for ordering information.

Manual of the Grasses of the United States, 2nd ed., is a two-volume set published by Dover Publications. It is a reprint of A.S. Hitchcock's 1950 *Manual of the Grasses* and includes descriptions, illustrations, distribution and introductions of exotics. Available from a variety of sources.

Field Guide to the Grasses, Hedges and Rushes of the United States by Knobel Edward includes dichotomous-like key for easy identification, good illustrations and common names as well as scientific names. It is inexpensive and available from a variety of sources.

http://www.santarosagardens.com/html/ornamental_grasses.html – Santa Rosa Gardens in Florida has a web page dedicated to ornamental grasses, including selecting grasses, when to plant, maintenance and growth habits.

http://www.cache.nmsu.edu/ces/yard – New Mexico State University College of Agriculture and Home Economics sponsors *Southwest Yard & Garden*, a weekly column written by an Extension horticulture specialist that answers questions about how to care for your garden and landscape. It includes current columns and searchable database of old columns.

REFERENCES:

Agricultural Research Services of the USDA. 1971. *Common Weeds of the United States*. New York: Dover Publications.

Dunmire, William W., and Tierney, Gail D. 1997. *Wild Plants and Native Peoples of the Four Corners*. Santa Fe: Museum of New Mexico Press.

Ellefson, Connie,et. al., 1992. *Xeriscape Gardening, Water Conservation for the American Landscape*. New York: MacMillan Publishing Company.

Hitchcock, A.S. 1971. *Manual of the Grasses of the United States, 2nd ed.*, Two Volumes. New York: Dover Publications, Inc.

Knoopf, Jim. 1991. *The Xeriscape Flower Gardener*. Boulder: Johnson Books.

Mielke, Judy. 1993. *Native Plants for Southwestern Landscapes*. Austin: University of Texas Press.

Phillips, Judith. 1998. *New Mexico Gardener's Guide*. Franklin: Cool Springs Press.

Whitson, Tom D., et. al. 1999. *Weeds of the West, 5th ed*. Jackson: Western Society of Weed Science in cooperation with the Western United States Land Grant Universities Cooperative Extension Services.