

# Exploring the Urban Forest with Your Class

Terrace Town Workshop



Presented by:

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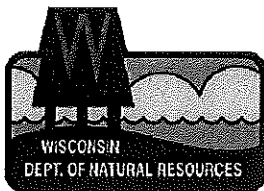
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**Project Learning Tree**  
Secondary Environmental Education Program

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**EXPLORING ENVIRONMENTAL ISSUES:**

**Places We Live**

In this activity, students investigate green infrastructure and native plant communities at the neighborhood, community, and regional scales and then explore the dual needs of accommodating population growth while protecting green space and native plant communities.

### Subjects

Ecology, Environmental Science, Geology

### Concepts

3.4 Ecosystems possess measurable indicators of environmental health.

3.10 In democratic societies, individuals and groups, working through governmental channels, can influence the way public and private lands and resources are managed.

4.6 Human-built environments, if planned, constructed, and landscaped to be compatible with the environment in which they will be located, can conserve resources, enhance environmental quality, and promote the comfort and well-being of those who will live within them.

5.4 Ecosystems change over time through patterns of growth and succession. They are also affected by other phenomena such as disease, insects, fire, weather, climate, and human intervention.

### Skills

Analyzing, Classifying and Categorizing, Comprehending, Identifying Attributes and Components, Interpreting, Observing, Predicting, Problem Solving

### Materials

Copies of student pages, aerial photographs

### Time Constraints

Part A: One 50-minute period

Part B: Two 50-minute periods

Part C: One or two 50-minute periods

### Objectives

- Students will examine and discuss the social, health, ecological, and economic benefits of green space.
- Students will conduct a field inventory to collect data on their community's green infrastructure.
- Students will compare and contrast case studies illustrating a citywide and a statewide initiative to protect green space.
- Students will use maps to evaluate their community's green infrastructure and will design ideas for improving the network.
- Students will study local population growth trends and will explore the balance between protecting and developing community green space.

### Assessments

- Encourage students to draw on the model of "Tall Tree Tales" as they develop their own list of the benefits of trees and open space locally. Each point on the list should be specific to your community (e.g., pro-

tecting the 20-acre swamp near Oak Ridge shopping plaza would provide habitat for the endangered salamander and would help filter drinking water flowing to the Lake Blue reservoir). As a challenge, encourage students to also include drawbacks or costs of preserving local green space.

- Have students imagine that the mayor contracted with them to inventory the local green infrastructure and to write a report summarizing their findings and recommendations. Consider consolidating or integrating the individual reports into one report and then sending or presenting it to your local government.
- Have students develop their own action plans for contributing to the protection of green space. Establish criteria for evaluating the plans using the content of the activity.
- Assign students the task of investigating laws that affect green space development and conservation.

## Background

*A city without trees is like a world without poetry and music. Tree-lined streets are more than shaded passage-ways linking buildings. They give us a chance to bring nature into the heart of our communities, while linking us to our past.*

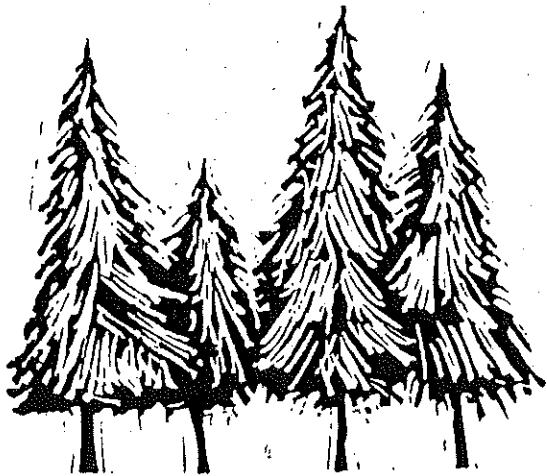
—Henry Arnold, (B)

Where in your community can you relax under green trees and read a great book? Enjoy a summer picnic with family or friends? Teach a child to ride a bike? Listen for the sounds of birds in spring or decode the tracks of local wildlife in winter? Does your community still have **green space** or other natural areas for people to enjoy plus wildlife to inhabit?

## Green Space and Open Space

What do the terms **green space** and **open space** mean? Often those terms are used interchangeably to refer to land that is not covered with concrete or asphalt. Yet not all open space is visibly green or completely undeveloped—a city plaza, a corner playground, a baseball field, or rolling farmland might all be referred

to as open space. Furthermore, not all places that we label "green space" are verdant wildlands and nature preserves. For instance, city parks, wetlands, open desert areas, cemeteries, golf courses, bike paths, vacant lots, and streamside corridors might all be called green space. Some stretches of green space are designed primarily for human activities, others are protected for *biodiversity* and wildlife conservation, and still others might accommodate the needs of both. In this activity, the two terms are used interchangeably.



## The Urban Forest

Remarkably, metropolitan areas collectively support nearly one-fourth of the nation's total tree canopy cover—some 74.4 billion trees. The term *urban forest* refers to the sum of street trees, residential trees, park trees, and greenbelt vegetation found in a city and its outskirts. An urban forest includes trees on unused public and private land, trees in transportation and utility corridors, and forests on *watershed* lands. In some areas of the United States, tree cover may be increasing (such as the Northeast, where trees are re-colonizing abandoned farmland). Yet in other parts of our country, especially in urban and suburban areas where approximately 80 percent of Americans live,<sup>1</sup> our trees are disappearing at disturbing—though sometimes unnoticed—rates to make way for development and for expanding population pressures.<sup>2</sup>

Urban foresters recommend that metropolitan areas strive for an overall tree cover of 40 percent (30 percent in the arid Southwest). However, according to a 2001 national study by American Forests, our nation's urban forests are missing 634,407,719 trees as the result of urban and suburban development.<sup>3</sup> In other words, we would need to plant 634 million trees nationwide to bring urban areas up to the 40 percent target.

Urban forests are a significant national resource. A 1999 study by American Forests found that the tree canopy in Washington, D.C. dropped from 37 percent to 21 percent between 1973 and 1997. As a result, stormwater runoff increased by 34 percent and 354,000 pounds of pollutants remained in the atmosphere (for more information, see "Values of Green Space" in this activity). Urban forests are of special value because they are where the overwhelming majority of the U.S. population lives, works, and plays. Furthermore, urban forests promise to increase in importance in the years ahead. As urbanization spreads into less-developed areas, a growing percentage of the nation's natural resources will become part of urban forest ecosystems. As development proceeds, increasing amounts of forest outside those systems will also be subject to urban influences. For example, surrounding forests may be subject to stress from increased human activities, the introduction of *invasive species*, fire, disease, and insects.<sup>4</sup>

To track changes in the composition of urban forests over time, urban foresters use *geographic information systems* (GIS) and compare satellite images (see Activity 3 "Mapping Your Place Through Time" for more information on GIS). One study, analyzed the 3.9 million-acre Puget Sound watershed surrounding Seattle. Comparison of satellite photographs from 1962 and 1998 revealed that the amount of land with less than 20 percent tree-canopy coverage more than doubled during that time period, from 25 percent to 57 percent.<sup>5</sup> Similarly, the Baltimore and Washington, D.C. area and Atlanta each lost one-third or more of

their heavy tree cover—or the areas that function most like natural forests—by protecting watersheds and providing wildlife habitat.<sup>6</sup> In fact, many cities have seen a decline in natural tree cover by as much as 30 percent over the past several decades.<sup>7</sup>

## Other Green Spaces

Forests and trees are not the only kinds of green space under threat. The preservation of prime farmland and ranch land are also important examples of green space. According to the U.S. Department of Agriculture, from 1992 to 1997 more than 11 million acres of farmland and ranch land were converted to developed use, with agricultural land making up more than half that total. During that period, an average of more than one million agricultural acres were developed each year. And the rate is increasing—up 51 percent from the rate reported in the previous decade.<sup>8</sup> Much of the land under the greatest development pressure is prime farmland—termed “prime” because this farmland has the finest soils, requires the least amount of chemical or irrigation input, or is in greatest proximity to markets and transportation networks.<sup>9</sup>

Conversion of farmland will have economic implications. For instance, in Fresno, California, part of the state’s fertile Central Valley and one of the nation’s most productive farm counties, one million acres of farmland are expected to be converted to suburban and urban areas by the year 2040. Experts predict that this change could reduce the value of the valley’s agricultural production by a cumulative \$49 billion and could take a \$76 billion bite out of various agricultural support businesses.<sup>10</sup>

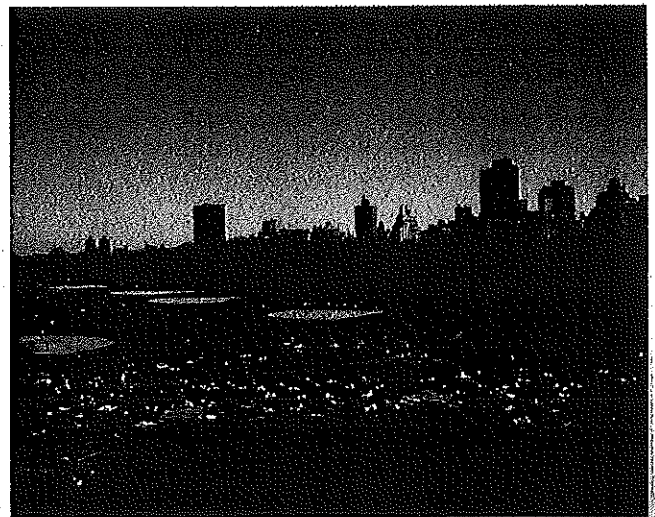
## Reappearing Green

As communities grapple with the challenges associated with growth, we see encouraging initiatives designed to reverse tree loss, to protect open space and *scenic viewsheds*, and to “green” local communities. Increasingly, communities are investing in parks, open space, farmland, forest protection, and other green space elements. Back in 1967, Boulder, Colorado,

pioneered the use of a dedicated sales tax to fund the preservation of open space. Today, Boulder has 41,000 acres of open space, largely in a ring of greenbelts that offer spectacular views of the Rocky Mountains.<sup>11</sup> Some communities have followed Boulder’s lead, while other states and communities have found their own innovative ways to help fund green space conservation. In Minnesota, for example, 40 percent of the proceeds from the state lottery go to the state’s Environment and Natural Resources Trust Fund. This initiative is expected to raise at least \$700 million for land protection in Minnesota during the next 25 years.<sup>12</sup>

Portland, Oregon, initiated another progressive idea: the *urban growth boundary*. In 1980, Portland established a boundary strictly limiting development at the city’s fringe. Critics warned that the boundary would stifle development and damage the region’s economy. Instead, the number of jobs in the metropolitan area has increased by 57 percent.<sup>13</sup>

The Urban Resources Initiative, which is a partnership among a nonprofit organization, Yale University, and the Community Foundation of Greater New Haven, has created the Community Greenspace Program aimed at revitalizing and beautifying common areas across the city. The community forester, landscape architects, and other volunteers offer technical advice and supplies to residents as they work



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together to restore their community's green-spaces. In particular, residents focus their efforts on planting trees, flowers, and shrubs along streetscapes, abandoned lots, neglected front yards, public housing, and parks. Community Greenspace projects have the added benefit of establishing personal ties among participants.<sup>14</sup> None of those initiatives are perfect, and each effort has its critics. Yet, different models represent efforts to protect open space.

## Value of Green Space

*Too many community leaders feel they must choose between economic growth and open space protection. But no such choice is necessary. Open space protection is good for a community's health, stability, beauty, and quality of life. It is also good for the bottom line.*

—Will Rogers in *The Economic Benefits of Parks*  
by S. Lerner and W. Poole (C)

Why should we care about green space? The aesthetic benefits are obvious but that may be difficult to quantify. Strolling along tree-lined streets, playing frisbee in a park, or catching a glimpse of local wildlife can help us stay connected with the natural world, even in a charged urban environment. Frederick Law Olmsted was a visionary 19th-century landscape architect who designed many renowned urban parks. He spoke of the need for parks and of a park's chief purpose as being "its effect on the human organism ... like that of music ... a kind that goes back of thought and cannot be fully given the form of words."<sup>15</sup>

Green space also offers social, economic, health, and ecological benefits that are often overlooked. Green space can bolster local economies, preserve critical environmental areas, provide recreational opportunities, and guide new growth into existing communities. Preservation of green space can have a profound effect on a community's quality of life—and, therefore, a region's economic prosperity.<sup>16</sup>

Social scientists have begun to document and understand the social value that vegetation can play in promoting a safe city environment. For example, research from the University of Illinois suggests that residents living in "greener" surroundings actually reported lower levels of fear, fewer incivilities, and less violent behavior.<sup>17</sup> Homebuyers are more attracted to neighborhoods that offer easy access to parks, playgrounds, trails, greenways, and natural open space. When a community decides which lands to protect, it helps define where development should occur, and it enables growth and protection of the natural environment at the same time. For example, clustered housing and **compact development** are cheaper for a community to service than housing on larger lots, primarily because such development consumes less land and requires less infrastructure, such as shorter roads and utility lines.<sup>18</sup>

Preserving green space is also essential for plant and wildlife populations and for the functioning of ecological processes and ecosystem services, such as providing pure water to drink and clean air to breathe. Wildlife populations and biodiversity decline without green space and the corridors that connect increasingly fragmented green spaces. Actively preserving green space offers the opportunity to promote a richer world for humans and wildlife. For additional examples of the many benefits of open space, please see the student page titled "Tall Tree Tales."

*People need to understand that if you take that big block of green on the outskirts of town or in the heart of the neighborhood, you lose that restoration potential forever.*

—Roger Ulrich

## Can We Afford Green Space?

Does land conservation force a rise in local property taxes by removing land from the tax rolls? A study conducted by the Trust for Public Land in Massachusetts found a mixed answer. In the



conservation project. But in the long term, towns that had protected the most land enjoyed, on average, the lowest property tax rates. Perhaps this consequence is attributed to less development, which required less sewer and water infrastructure, roads, schools, and other services. Other economic benefits of open space conservation include boosting tourism revenues, increasing property values, attracting investment, stimulating commercial growth, revitalizing inner cities, safeguarding the future of farming economies, and preventing flood damage.<sup>19</sup>

## Green Infrastructure

*Green infrastructure offers a smart solution to our land conservation challenges because it seeks to plan land development and land conservation together in a way that is consistent with natural environmental patterns.*

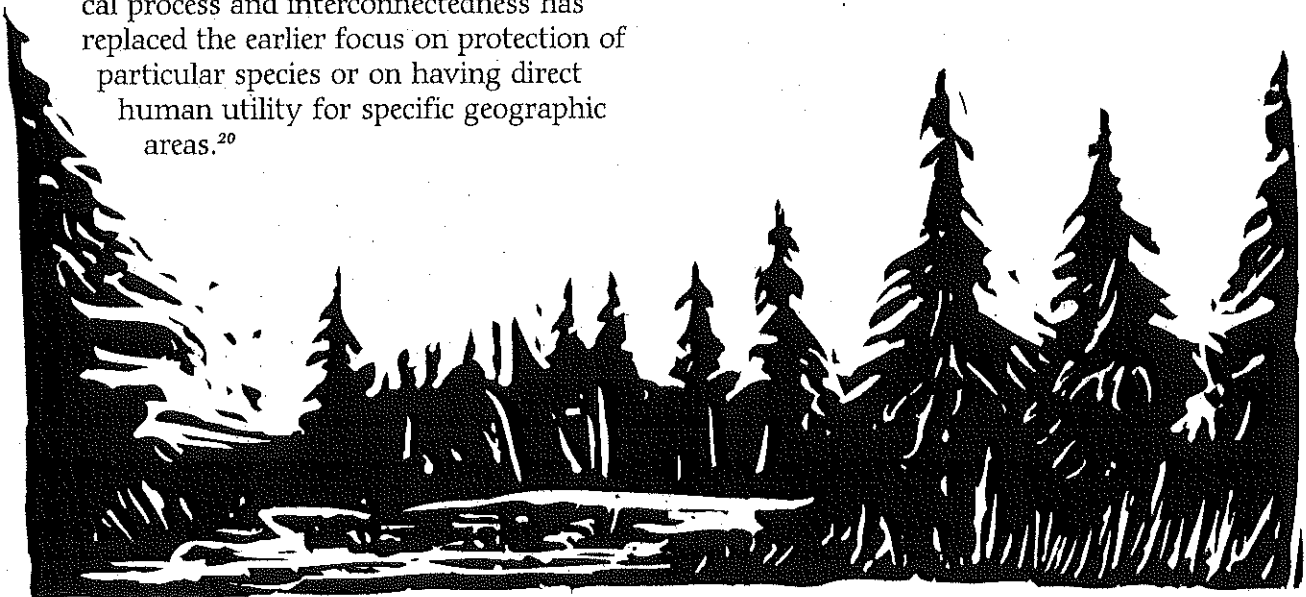
—Mark Benedict and Edward T. McMahon (E)

Where should green space be located in a community? Are all parks, trees, vegetation, and other green spaces equally valuable? What criteria determine the green health of a community? Increasingly, people are emphasizing the importance of not just planting a certain number of trees or vegetation per acre but creating a well-planned, interconnected network of green space. In conservation planning, emphasis on ecological process and interconnectedness has replaced the earlier focus on protection of particular species or on having direct human utility for specific geographic areas.<sup>20</sup>

The term **green infrastructure** can be described as follows (see Activity 3 “Mapping Your Place Through Time”):

“Green infrastructure is the nation’s natural life support system—a strategically planned and managed network of wilderness, parks, greenways, conservation easements, and working lands with conservation value that supports native species, maintains natural ecological processes, sustains air and water resources, and contributes to the health and quality of life for America’s communities and people.”<sup>21</sup>

The green infrastructure concept indicates a planned network of green spaces that benefits wildlife and people, as opposed to just the leftover green bits that escape development. The word “infrastructure” implies that the green areas are critical to the functioning of a community or region and deserving of government funds. Similar to the built, or “gray,” infrastructure, such as sewers and utilities, the green infrastructure also requires maintenance. Green infrastructure is not just about setting aside green space; it also helps frame the most-efficient location for development and growth of traditional gray infrastructure. Green infrastructure planning can happen at a variety of scales (local, regional, and statewide) and within different **land use** patterns (urban, suburban, rural, and wilderness).



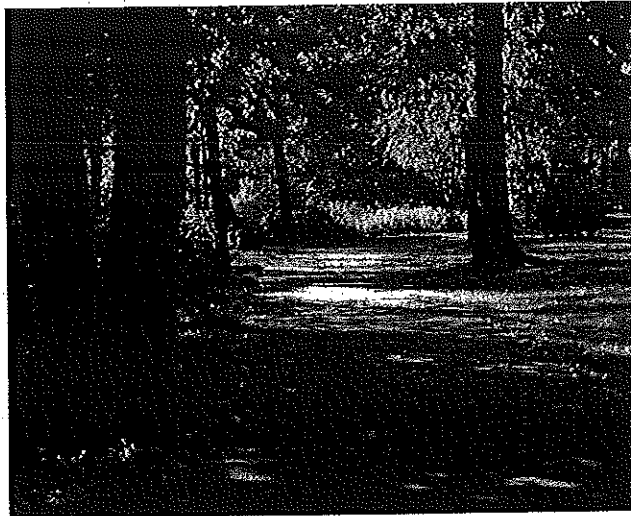
## Green Corridors

Connections and corridors, both for wildlife and humans, hold special significance within the green infrastructure concept. To help link green space, a community might prioritize the protection of a local stream corridor that links two existing green areas over a third discrete and isolated green patch. Corridors greatly expand our recreation possibilities and use of green space. One organization, the Rails-to-Trails Conservancy, seeks to enrich America's communities and countryside by creating a nationwide network of public trails from former rail lines.

A key tenet of conservation biology is preserving and connecting green spaces and corridors to allow wildlife and plant populations to flow, migrate, and find the resources they need to survive and reproduce. As the landscape becomes more and more fragmented, wildlife species that require large areas to roam, such as carnivores and large mammals, are increasingly imperiled. To help conserve biodiversity, at least some of our green spaces need to contain large tracts of undisturbed habitat. By preserving and connecting green spaces such as parks and natural areas with corridors, we can provide richer communities for both our human and our wildlife residents.

## Tough Path Ahead

Despite the numerous benefits of green space and the increasing awareness of its importance, the challenge to conserve such space in light of growing human populations will not be easy. The costs associated with green space conservation require careful planning, dedicated resources, political will, and community support. It is often easier in the short term to move forward with development without considering the long-term implications of diminishing open



space. As discussed throughout this module, growth is a necessary part of our communities' future. The challenge is not to stop growth but to channel it intelligently into the most appropriate areas while considering the needs of future generations of humans and wildlife.

In this activity, students will explore state and local communities that have taken action to protect their valuable green space in the face of development pressures.

## Endnotes

- 1 U.S. Census Bureau Urban and Rural Population by State 2000 (E).
- 2 American Forests 2001 (E).
- 3 Ibid.
- 4 Dwyer et al. 2000 (E).
- 5 Wong 1999 (B).
- 6 Smith 1999 (E).
- 7 American Forests 2002 (E).
- 8 American Farmland Trust 2002 (C).
- 9 Smart Growth Network/ICMA 2002 (C).
- 10 Benfield, Raimi, and Chen 1999 (A).
- 11 City of Boulder 2003 (E).
- 12 Land Trust Alliance 2002 (E).
- 13 Lerner and Poole 1999 (C).
- 14 Urban Resources Initiative 2003 (E).
- 15 Lyman 2002 (E).
- 16 Smart Growth Network/ICMA 2002 (C).
- 17 Kuo and Sullivan 2001 (B).
- 18 Lerner and Poole 1999 (C).
- 19 Lerner and Poole 1999 (C).
- 20 Maryland Department of Natural Resources 2001 (E).
- 21 GreenInfrastructure.Net 2002a (E).

Letters following author and date citations refer to sections in the bibliography (Appendix B) where the reader can find full data about the sources cited.



## Getting Ready

- Make copies of the following student pages: "Tall Tree Tales," "Greening Baltimore One Block at a Time," "Earth & Sky: Up on the Roof," "Green Inventory," and "Green Maryland: Connecting the Dots."
- Locate one or more aerial photographs of your area. See Appendix C for tips on finding aerial photographs. (Note: If you live in an area with deciduous trees, try to find a photo taken when leaves are on the trees.) If possible, make a photocopy or print out the photo for each team.
- To help identify community features, students may find that a local street or community map can be valuable.
- Contact your local government offices to find a current population estimate for your town or city, as well as information on projected growth rates. You can find recent population estimates for your town on the U.S. Census Bureau website. Visit [Factfinder.census.gov](http://Factfinder.census.gov), and enter your town's name in the "Basic Facts" section. Or use an older population estimate, and calculate an estimated growth rate yourself.

## Doing the Activity

### Part A

1. Distribute copies of the student page "Tall Tree Tales" to your students. Give the class a few minutes to complete the quiz.
2. Review the quiz. All the statements are true according to studies investigating the benefits of trees and open space. Discuss how the students categorized the nature of the statements – reflecting aesthetic, economic, ecological, health, and/or social concerns. You may want to point out that some statements apply to more than one category, which helps illustrate multiple reasons to conserve trees and green space. Encourage your students to also think of some of the drawbacks or challenges of preserving trees and green space. Below are possible answers.

1. S, A	2. H, \$	3. H, A, S	4. E, H	5. S
6. E, \$	7. E	8. S, A, \$	9. \$, H, E	10. E, \$, H
11. H, E	12. H, \$	13. \$, A	14. E	15. E, \$
16. \$, A	17. H, S, A	18. H	19. E, \$	20. H, S

A – Aesthetic \$ – Economic S – Social  
E – Ecological H – Health

3. Share a definition of the urban forest with your students (see the "Background" section in this activity). Distribute copies of "Greening Baltimore One Block at a Time." This case study offers an example of a community-based effort to green neighborhoods, plant trees, and give new life to abandoned lots.
4. After students read the case study and answer the questions, review and analyze students' responses as a class.
5. Ask students what they typically find on the roof of a building. Responses may include equipment, decks, etc. Some may respond with plants or gardens. Ask them to list the benefits of growing plants on a roof. Distribute copies of the "Earth & Sky: Up on the Roof" Student Page. The interview describes some of the ecological values of plants in reducing urban environmental problems. Use the Earth & Sky website for further information on the topic. Have the students use this information when completing the inventory in Part B below.

### Part B

6. Ask students these questions: How green is your community? Where can you go to play sports? To bike or run? To watch birds? To relax outside in summer? What sorts of green resources are available in the community? Do community members use these areas? If they don't, why not?
7. Share with your students the definition of green infrastructure (see "Background"). Together, list the types of areas that might form a community's green infrastructure, such as natural areas (e.g., wetlands, woodlands, waterways, and wildlife habitat); public and private conservation

lands (e.g., nature preserves, wildlife corridors, greenways, and parks); public and private working lands that have conservation value (e.g., forests, tree farms, farms, and ranches); and outdoor recreation and trail networks.

**8.** Distribute copies of the student page "Green Inventory." Explain to students that, in teams of two or three, they will inventory the community's green infrastructure and draw a map. (Note: Students might choose to work with or create computer-generated maps.) If possible, encourage students to cover different areas of the community. For example, each team might cover several blocks. (For information on maps, please see Appendix C or the student page titled "Maps and Map Features" in Activity 3.)

**9.** Back in class, review and share "Green Inventory" results. As part of the discussion, encourage teams to share their estimates of the percentage of the survey area that is covered by green infrastructure.

**10.** To gain a different and broader perspective on the green infrastructure in your community, look with your students at an aerial photograph of your area (see Appendix C for tips on finding aerial photos). See if students can locate the areas that they surveyed. Identify the green infrastructure on the map, and discuss students' impressions. Is there more or less green and open space than they expected? Ask students how looking at this type of image helps them identify green infrastructure and gain a big-picture perspective. Note: If your students have completed the "Mapping Your Community through Time" in Activity 3, add the Green Infrastructure team's findings.

**11.** Discuss whether or not the green spaces are well connected in your community. For example, could a squirrel or other local wildlife species make it from one green space to the next? Could a biker or runner travel a green path between areas? Are the areas large enough to meet the needs of a diversity of wildlife?

**12.** Share an estimate of your town's or city's human population with the class. Either pro-

vide an expected rate of growth over the next 10 years, or encourage students to calculate the growth rate using two data points (e.g., current and 10 years previous).

- How many more people will your community need to accommodate during the next 10 years?
- Where will they live? Shop? Work? Play?
- Where will this development likely be concentrated?
- Where should it occur?
- Do you think your community will be able to promote green space conservation in light of development pressures?
- What can be done?

### Part C

**13.** Hand out copies of "Green Maryland: Connecting the Dots." This case study illustrates how Maryland has actively committed to linking green space in the state and to protecting green infrastructure that benefits both people and wildlife. While "Greening Baltimore One Block at a Time" describes a local initiative, this case study takes a broader look at a statewide approach to promoting green health. (For links to other case studies that could be used here, visit [www.plt.org/curriculum/caseStudies.cfm](http://www.plt.org/curriculum/caseStudies.cfm).)

**14.** After students have read the case study, ask them to respond to the accompanying questions in small groups or as a class.

**15.** Encourage students to reexamine the aerial photo of their community in light of the Maryland case study. Are linkages in place? Where are they needed? What is and is not possible? Where might new green spaces be created?

### Enrichment

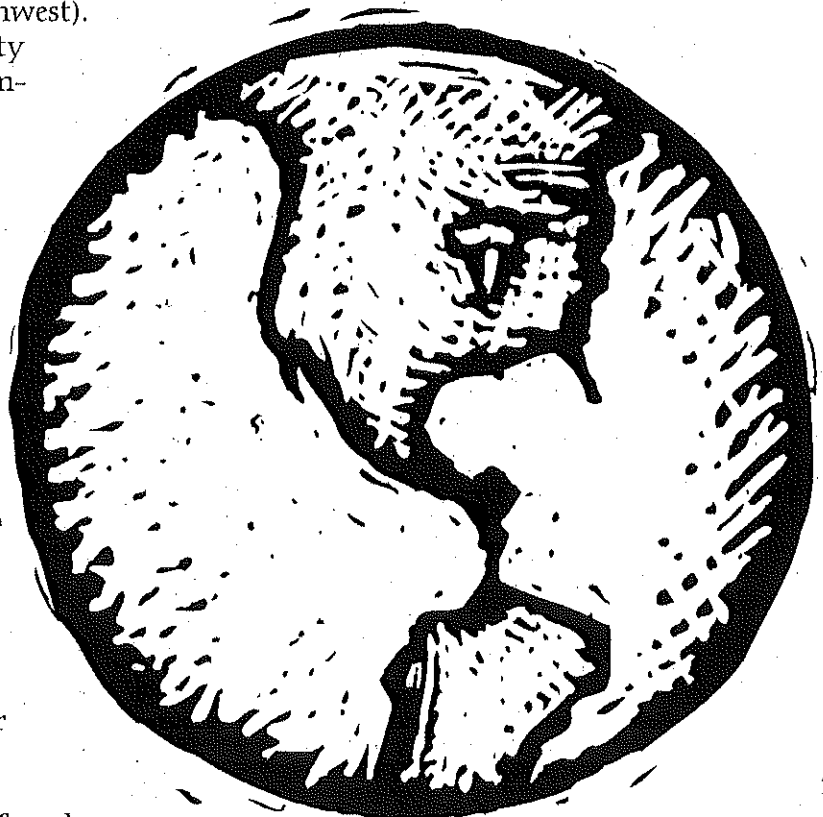
- Plant new trees in your community and help protect existing ones! Helpful resources are: –
  - Envision Utah's publication, *Urban Planning Tools for Quality Growth*: [www.envisionutah.org/implementation\\_toolbox.htm](http://www.envisionutah.org/implementation_toolbox.htm);
  - the National Arbor Day Foundation, [www.arboday.org/arboday](http://www.arboday.org/arboday);

— and American Forests' Global ReLeaf program, [www.americanforests.org/global\\_releaf](http://www.americanforests.org/global_releaf).

- Planting trees might be a GreenWorks! opportunity [www.plt.org/greenworks/index.cfm](http://www.plt.org/greenworks/index.cfm).
- Encourage other members of the community to join (and perhaps help fund) your initiatives. Be sure to seek appropriate guidance from experts about tree selection, placement, and planting. Also, find out if your town has a tree ordinance and requirements. Work with local industry and the Wildlife Habitat Council to establish wildlife habitat in industrial areas.
- Invite a local forester, arborist, landscape architect, or nursery worker into your class to speak with students about trees in the community, plans for the future, and career options. If you plan to plant trees, those experts can be a wonderful resource and can answer students' questions.
- Have students estimate the percentage of your community with tree coverage as they examine an aerial photo or other resources. American Forests recommends that metropolitan areas strive for an overall tree cover of 40 percent (30 percent in the arid Southwest). Although local conditions vary, a city could achieve the recommended number with 15 percent coverage in downtown areas, 25 percent in urban residential and light commercial areas, and 60 percent in suburban residential area ([www.americanforests.org/gray-togreen/treedeficit](http://www.americanforests.org/gray-togreen/treedeficit)).
- Instruct the students to work as a class to create an overall "green map" for their community, noting the different green areas, as well as their recreational and ecological benefits. Tell students to draw on resources from the town and organizations that manage local parks, nature preserves, and other green spaces. Student teams can be responsible for different areas and can engage in a variety of activities, including conducting site visits, interviewing staff, and

writing up short blurbs about their respective areas. The Green Map System's website: [www.greenmap.com](http://www.greenmap.com), is a valuable source of information and offers models of green maps designed by kids.

- Consider purchasing *CITYgreen* as a technology extension. Students can use this innovative GIS software package to map urban ecology and measure the economic benefits of trees, soils, and other natural resources. For more information, visit: [www.americanforests.org](http://www.americanforests.org). Encourage students to survey community residents or schoolmates regarding their use of green space, current views on the intersection of growth and green space, and ideas about future trends and needs.



## Tall Tree Tales

Circle T (true) or F (false) next to each statement below. Then, next to each statement, write the appropriate symbol(s) to indicate the nature of that statement:

A = Aesthetic, \$ = Economic, E = Ecological, H = Health, and S = Social.

T F 1. Trees increase the natural beauty of an area and make cities more livable.

T F 2. The presence of nature and parks helps ensure regular physical activity, which can reduce the risk of coronary heart disease, hypertension, colon cancer, osteoporosis, arthritis, and diabetes.

T F 3. Seeing green prevents people from being mean (i.e., it lowers their levels of aggression). One study found that apartment buildings with high levels of greenery had 56 percent fewer violent crimes than apartment buildings with little or no greenery.

T F 4. The number of rats increases as tree coverage decreases.

T F 5. More trees and grass in the common spaces of neighborhoods lead to better relationships between neighbors.

T F 6. Trees slow and absorb storm water and reduce runoff, thereby reducing flooding and stream degradation. The job done by trees for free in the Seattle area would cost \$2.4 billion if it were part of a storm water management system.

T F 7. Generally speaking, the larger a park, forest, or nature preserve, the more diverse the species of wildlife and plants it will contain.

T F 8. Prisons that incorporate some element of nature—even just a pleasant view—show higher rehabilitation rates.

T F 9. Trees can lower the temperature of a city by 6–10 degrees. They can thus reduce energy use and even save lives during heat waves.

T F 10. Tree leaves filter air pollutants. In large cities, those green filters are worth tens of millions of dollars in air pollution abatements each year.

T F 11. One acre of trees provides enough oxygen to support 18 people.

T F 12. Green settings can help relieve the symptoms of attention deficit disorder (ADD).

T F 13. Trees can add from 7 percent to 20 percent to a home's value.

T F 14. Habitat fragmentation is the greatest worldwide threat to forest wildlife and the primary cause of species extinction.

T F 15. An average tree can absorb 26 pounds of carbon dioxide (the primary greenhouse gas) each year.

T F 16. Across the nation, our parks, protected rivers, scenic lands, wildlife habitat, and recreational open space help support a \$502 billion tourism industry.

T F 17. Green views and access to green spaces can help urban residents cope with the stresses of daily activities.

T F 18. Patients whose hospital rooms overlook trees require less pain medication and recover more quickly than those whose rooms overlook brick walls.

T F 19. New York City avoided spending \$6 billion to \$8 billion for the construction of new water treatment plants by instead spending \$1.5 billion to purchase and protect the upstate watershed that had traditionally accomplished those purification services for free.

T F 20. Tree-lined streets have the effect of reducing driving speeds, thus making neighborhoods safer for bikes and pedestrians.

Sources: American Forests 2005 (E). Carnegie Mellon University 1995 (C). Envision Utah 2003 (E). GreenInfrastructure.Net 2005 (E). Lerner and Poole 1999 (C). Lyman 2002 (E). Maryland Department of Natural Resources 2001 (E). TreeScape 2005 (E). University of Illinois Human-Environment Research Laboratory 2005 (E).

## Case Study—Greening Baltimore One Block at a Time

Did you know that nearly one-quarter of the nation's trees are found in urban forests?

Why are urban forests important? Around the world, the role of urban forestry in creating "healthy" or "livable" cities tends to be underestimated. In addition to bestowing environmental benefits, planting and nurturing community trees can also address a full range of urban social issues, from illegal disposal to education to apathy to crime.

If you canvassed the city of Baltimore, Maryland, you might find as many as 40,000 vacant lots covering approximately 11 percent of the city's land area. About 12,000 of those lots fall under some type of city ownership. The lots represent a social, economic, and visual burden to the city. In many communities, they are dumped on, vandalized, and seen as a social blight rather than as a community benefit.

### What Can Be Done?

Community greening can help turn abandoned land into community-owned property through the adoption (formal or informal) of vacant lands by local residents. The lots can be given new life as parks, community gardens, tree nurseries, or cultural gardens. When urban lands look used and cared for, people usually stop their dumping and curtail their littering. A city might spend between \$2,000 and \$4,000 per year to clean up just one problem lot. Yet greening can keep lots clean for a one-time investment of between \$200 and \$1,000 per lot.

### Parks & People

Since 1984, the nonprofit foundation Parks & People has worked to enhance the health and beauty of Baltimore's communities and parks and to improve the quality of life for residents in Baltimore's neighborhoods. It encourages communities to take advantage of the city's valuable natural assets. Parks & People seeks to

improve the physical, social, and environmental quality of neighborhoods through greening activities and by forming community networks to sustain natural resources.

Parks & People's Community Forestry Program helps Baltimore residents green their neighborhoods by offering educational opportunities and technical assistance to create parks and gardens in community open spaces and schoolyards and along neighborhood streets. The staff supports the planning, organizing, and implementing of greening projects in partnership with residents, city agencies, community associations, and other groups. Since 1993, more than 200 vacant lots have been transformed into community-managed parks or gardens. More than 7,000 promising new trees are growing in 45 Baltimore neighborhoods.

### Enabling Funds

Parks & People's Community Grants Program awards up to \$1,000 to Baltimore community groups that are interested in conducting neighborhood restoration projects such as tree plantings, community gardens, neighborhood cleanups, or environmental education activities. The grants finance tools, plant material, equipment, and other supplies. Since 1996, 403 community greening projects have been funded. Some of the grants support initiatives to build connectors to the Gwynns Falls Trail, a 14-mile hiking and biking trail that is still under development and will connect 24 neighborhoods and more than 2,000 acres of parkland, recreational facilities, and historic and cultural attractions.

### What to Plant Where?

Educational opportunities include hands-on training in tree planting and pruning, soil testing, and streetscaping techniques. Classes are held four times a year on the following topics: developing greening projects and funding

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# Student Page

strategies, plus volunteer recruitment, implementation, and maintenance. Volunteer community activists become Tree Tribers, who work throughout the city while training others to plant trees and to clean and green neighborhoods. The Tree Tribe Training Program provides hours of useful training in plant physiology, urban ecology, community assessment, and vacant lot improvement.

Parks & People also offers an environmental education program called KidsGrow, which is for children who are 7 to 13 years old. The program runs after school and throughout the summer, training kids to become activists in their own neighborhoods.

## Other Successes

Parks & People has also developed green initiatives in housing areas that have been rehabilitated. In one such neighborhood, the community planted small trees in barrels outside doors. This action strengthened neighborhood ties and sparked similar efforts in the five surrounding blocks.

Greening in Baltimore has also been used as a catalyst to help communities fight crime. On one block, a tree planting effort led to a block watch, which led to a group called "pooches on patrol." In another neighborhood, residents organized a tree planting at night to send the message to potential drug dealers that the community cared.

Efforts to green Baltimore have made a difference. Greening improves residents' neighborhoods, health, and quality of life; as trees and gardens grow, so do those benefits. Community greening is more than just an interesting beautification strategy—it can be a vital part of any urban revitalization effort.

*Source:* Adapted from Community Resource 2002 (E) and Parks & People 2002 (E).

## Consider the following questions:

- What are some benefits of greening a city? What are the costs?
- How do you think Baltimore finds enough volunteers to make this program possible?
- If you ran the community greening program, what would you do differently?
- How can a community sustain this type of program?



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## Earth & Sky: Up on the Roof

How can cities become more green? Discover how Washington D.C. and other urban areas are changing their landscaping and designing more sustainable urban ecosystems.

### Cities Ally With Nature to Solve Problems

From: *Earth & Sky Radio Series Program*  
August 21, 2005

JB: This is Earth and Sky. In places like cities, ecologists are looking at ways to maximize the ability of nature to provide us with essential services like clean air and water.

DB: At the moment, paved areas and rooftops of a city often cause real problems with water quality. Water that runs off over pavement gets to rivers and streams very quickly, and this water often carries pollution. Most storm gutter systems only remove water from property, but current systems do little to filter water.

JB: To comply with tougher water quality regulations, some urban areas like those around Washington D.C. are changing their landscaping — and designing more sustainable urban ecosystems. For example, “rain gardens” can be placed near buildings or in parking lots specifically to absorb and filter runoff. “Green roofs” accomplish the same thing with lightweight plants on rooftops. Margaret Palmer is a stream ecologist with the University of Maryland. She talked with us about using nature as an ally in solving environmental problems.

Palmer: Nature can do a lot of things for us if we're clever about thinking about some of those solutions. . . And in general, the rule of thumb is, the less engineered the solution, the more likely it is to cause fewer problems in the environment, and also to be less costly.

DB: With thanks today to the National Fish and Wildlife Foundation, we're Block and Byrd for Earth and Sky.

Author(s): Jorge Salazar

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## Earth & Sky

RADIO SERIES

The Earth & Sky radio series and website can be found at [www.earthsky.org](http://www.earthsky.org). The programs are produced by a non-profit organization committed to describing humans' work to understand themselves and their relationship to the Earth. The information in the Earth & Sky website, and in the daily radio series, is developed from interviews with scientists. This information is supported with additional resources on their website.

Project Learning Tree has worked with Earth & Sky to provide additional resources for many of the radio shows.

See [www.earthsky.org](http://www.earthsky.org) and [www.plt.org](http://www.plt.org)



## Green Inventory

Survey Team Members:

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What kinds of green infrastructure can you find in your survey area? For example, can you find trees, parks, gardens, fields, cemeteries, streams, wetlands, rooftop gardens, and natural woodlands? What else?

Either on the back of this page or on a separate piece of paper, create a map of your survey area, illustrating the green infrastructure. Label the map clearly and create a legend. You don't need to draw every tree, but you might use a tree icon to depict a wooded area. Do your best to draw to scale, which will help show what percentage of the land is developed and what percentage is green space. If you spot any wildlife, mark it on your map.

After you create your map, answer the following questions:

1. What is the location of your survey area?
2. What do you estimate as the percentage of your survey area that is green infrastructure?
3. What do you estimate as the percentage of your survey area that is developed?
4. Do you think your community's green infrastructure is growing or shrinking? Why?
5. How much do you think the habitat has changed for native wildlife over the past 100 years?
6. Does your community's green infrastructure enhance its visual character?
7. In your opinion, does your community have enough green infrastructure?
8. How much of the green infrastructure consists of mostly native species?
9. Are there any noxious weeds or invasive species?
10. How can you use the inventory to implement a greening project?
11. Did this inventory affect your sense of place? If so, how? If not, why not? Do you think your sense of place would change if green space increased or decreased in the future? Why?

## Case Study—Green Maryland: Connecting the Dots

Consider the following:

- Before European colonization, 95 percent of Maryland was carpeted by green forest. By 1993, forest area had decreased to 47 percent of the state's land area.
- Maryland has lost 50 percent of its pre-settlement wetlands.
- Between 1790 and 1990, Maryland's population grew from 320,000 to 4,780,000 people.
- At least 180 plant species and 35 animal species have been eliminated from Maryland, including elk, gray wolves, bison, and mountain lions. Another 310 plant species and 165 animal species are rare, threatened, or endangered.

Is it too late for Maryland to take action to protect its rich ecosystems and wild treasures? Is there hope for maintaining a balance between the needs of humans and the needs of wild species?

Recently, Maryland has been working hard to strike a balance between the natural and built environments and to find innovative methods to accommodate growth while still protecting the best features of Maryland.

### Greenways

In 1990, a Maryland executive order established the Maryland Greenways Commission, with the goal of providing a statewide natural infrastructure by protecting and connecting important natural corridors throughout the state. Since then, Maryland has protected more than 1,500 miles of greenways corridors, including more than 600 miles of land trails and 300 miles of water trails. Consequently, the state is a national leader in efforts to preserve a network of natural corridors that connect areas of open space.

Greenways are natural corridors that have been set aside to connect larger areas of open space and to provide for the conservation of natural resources, including city water supplies, protection of habitats, and movement of plants and

animals. Greenways also offer opportunities for linear recreation like bike trails, alternative transportation, and nature study. The Maryland Greenways program works with local governments, citizen groups, land trusts, businesses, and private organizations.

### What Types of Corridors?

Among the corridors in the greenways system are trails along rivers, streams, ridgelines, abandoned rail lines, and wild vegetated corridors. To be considered part of the statewide greenways network, land must be under some form of permanent protection and serve at least one of several greenways functions:

- Riparian and water quality protection
- Wildlife and ecological corridors
- Linear shaped parks (can be natural areas or developed recreation sites)
- Trails (as long as they include a significant vegetated buffer).

All Maryland greenways provide some ecological benefits, and most serve multiple purposes. For example, parks along stream valleys, especially in urban areas, tend to take on multiple functions such as buffers, flood control, wildlife corridors, and recreation. Most corridors, however, can be classified as primarily ecological or recreational. Most of the current land is publicly owned, but numerous easements are being placed on private properties to enhance the growing network of corridors.

The Baltimore and Annapolis Trail exhibits a green corridor. It is an established recreational greenway following the route of the old Baltimore and Annapolis Railroad. The linear park connects two towns, stretches 13.3 miles, and covers 112 acres. The trail has a 10-foot-wide paved surface within a 66-foot-wide landscaped corridor. Walkers, runners, bicyclists, equestrians, and various forms of wildlife all use the trail.

## Sample Map

As part of the project, an atlas of greenways, water trails, and green infrastructure was created. For each county in the state, the greenways maps show protected lands, including those owned by a conservation or government agency, those owned or under easement to a land trust, and those under agricultural easements. The maps also depict existing, planned, and potential greenways corridors. To see a sample map for Baltimore County, visit this link: [www.dnrweb.dnr.state.md.us/download/greenways/atlas/ba\\_greenway.pdf](http://www.dnrweb.dnr.state.md.us/download/greenways/atlas/ba_greenway.pdf).

## The GreenPrint Program

The sample map of Baltimore County and other maps in the atlas illustrate that Maryland has protected green space. Yet, is it enough? Maryland has only two million acres of ecologically significant land that has not been consumed by development. Of these two million acres of "green infrastructure," almost three-fourths are unprotected. Billions of dollars are spent each year to construct or maintain the state's built infrastructure of roads, bridges, and utilities that residents depend on. By contrast, the state's green infrastructure, which exists naturally, is under tremendous development pressure. Without protection, the remaining green infrastructure is vulnerable and subject to further loss and fragmentation.

So how is Maryland increasing its protection of the state's green infrastructure? Protecting land requires money. In May 2001, the governor signed into law a new \$35 million GreenPrint program as a major expansion to the Greenways program. GreenPrint aims to help protect Maryland's most-valuable remaining ecological lands and the state's long-term ecological health. The program follows a three-step process:

1. Identifying the most important unprotected natural lands in the state by using the most up-to-date computer mapping techniques
2. Linking, or connecting, those lands through a system of corridors or connectors
3. Saving those lands through targeted acquisitions and easements

The program will support efforts to steer growth to appropriate areas while preserving portions of the landscape that make Maryland both bountiful and captivating.

## Green Infrastructure Assessment

A Green Infrastructure Assessment is an essential component of the program to help identify and prioritize areas in need of conservation and restoration. It has focused on two types of important resource lands: "green hubs" and "green links." Green hubs form the heart of Maryland's green infrastructure and typically span hundreds of acres. The hubs serve a vital function in maintaining the state's vibrant and unique ecology. Green hubs are connected by green links—ribbons of land such as stream valleys and mountain ridge lines that function as "habitat highways." The habitat highways allow safe passage for wildlife through their natural domain; facilitate seed and pollen transport, which helps plant life thrive across the state; and keep streams and wetlands healthy by protecting adjacent vegetation. Preserving linkages between the remaining large habitat areas will ensure the long-term survival and continued diversity of Maryland's natural resources and environment.

## Who Gains from the Program?

The GreenPrint program affects all Maryland citizens. For some people, like those who harvest and process timber, it affects their jobs. The

program supports Maryland's economy, especially forest products, seafood, and tourism. For other people, the green infrastructure provides places for hobbies, recreational activities, and learning opportunities. Nature lovers can enjoy hiking, camping, observing, and photographing a wide variety of plants and animals.

Developers, private landowners, and others will benefit from having a clear understanding of where the most ecologically valuable lands are located and where targeted conservation activities will be directed. Local governments will be able to enhance their efforts to provide open space, recreation lands, and natural areas that retain the unique character of their communities and rural landscapes. The GreenPrint program helps preserve and safeguard Maryland's rich quality of life and its special natural landscapes, such as picturesque, rolling mountains; forest lands and wooded wetlands; expansive native marshes; and the Chesapeake Bay. Action taken today will help ensure that future generations have the same opportunities to enjoy Maryland's outstanding natural resources and high quality of life as residents do today.

*Source:* Adapted from [www.dnr.state.md.us/greenways](http://www.dnr.state.md.us/greenways). Check out this site for more information and to view additional maps.

*Additional source:* Smart Growth Network/ICMA 2002 (C).

## Questions to Consider:

- How did Maryland identify high-priority lands to target conservation efforts?
- What do you think are the most important components of Maryland's plans?
- Does this program favor or discourage growth? Explain.
- Do you think the program will succeed? Why or why not? Which criteria would you use to determine success?
- Does your state have a similar program?
- Do you think this program would be funded in a tight budget year? Why or why not?



# *Tall Tree Tales*

Name: \_\_\_\_\_

True or false? Write true or false next to each statement.

1. Trees make a place more beautiful.
2. Trees provide food and shelter for animals.
3. Trees help sick people feel better.
4. Tree roots keep soil from washing away.
5. Trees make shade and help lower temperatures.
6. Trees help clean the air.
7. Trees help reduce energy use.
8. When people see trees, they are nice to each other.
9. Trees produce oxygen that people breathe.
10. Trees make a place more interesting.

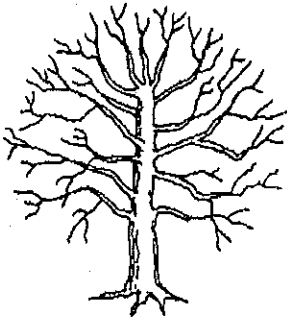


# Explore Tree Shapes

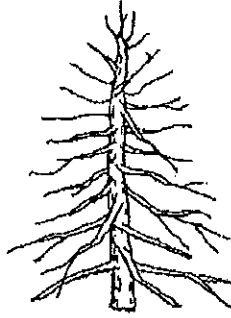


Cut out the shapes below and paste them on a tree that matches each shape.

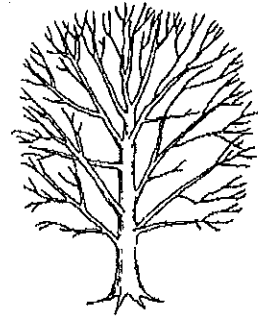
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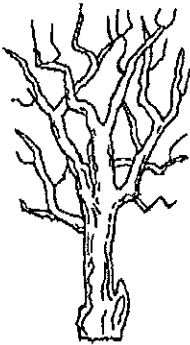
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spruce



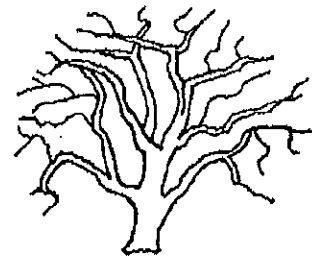
maple



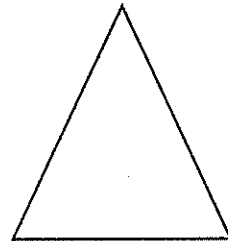
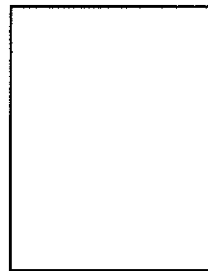
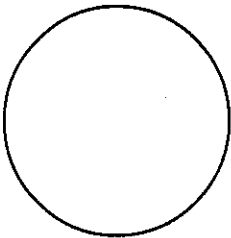
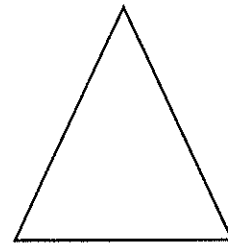
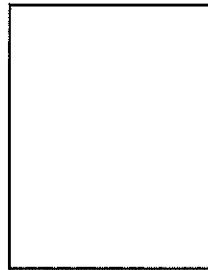
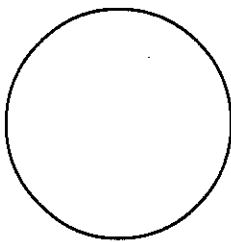
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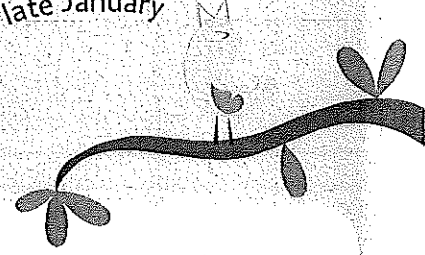
crab apple



**2010**  
**Forest Appreciation**  
**Week Writing Contest**

# Why Plant Trees?

Official contest packets will be mailed in late January



Each year the Department of Natural Resources Forestry Division encourages fourth grade students across Wisconsin to think and write about our tree and forest resources through the Forest Appreciation Week Writing Contest. This year's contest theme, *Why Plant Trees?*, encourages students to write about the importance of tree planting and to become an active steward of the environment.

Planting trees enhances Wisconsin's natural beauty, provides wildlife habitat, prevents soil erosion, improves air quality, provides shade and conserves valuable energy. Tree planting also provides young scholars the opportunity to impact climate change. Students are encouraged to write about a personal experience with tree planting or the general importance of a properly-planted tree.

Learn more by visiting:  
<http://dnr.wi.gov/forestry/uf/awareness/arborwriting.htm>

Inspirational thoughts from 4th grade students at Weyauwega Elementary and singer/songwriter Ken Lonquist:

### Why Plant Trees?

Why plant trees? For magic and for mystery!  
 Why plant trees? For health and wealth and history!

Look around you and the living past is near  
 Rustling voices we can almost hear  
 The planters of the seed who long-since disappeared  
 Did they ask, like me...?

The crunchy nut, the flavorful fruit, the oxygen  
 Wood renewable for every one  
 Sustenance and riches in the golden Sun  
 Far and wide you'll see...

Do they sense our presence when we gather 'round?






Is there meaning in their whispering sound?  
 Are they telling us a secret so profound  
 It's beyond our reach?

Why plant trees?  
 For magic and for mystery!  
 Why plant trees?  
 For health and wealth and history!



First 100 participating teachers will win a copy of the book, *If Trees Could Talk!*

### Contest Requirements

-  Fourth Grade Students Only
-  Submit only one (1) entry per classroom
-  Any written form, including essay, poetry, or other type of creative writing is acceptable. The entry must be 200 words or less and follow the theme: *Why Plant Trees?*
-  Writing must be the original work of a student currently in fourth grade.
-  A participant report form must be attached to your classroom entry.

Entries must be postmarked by March 5, 2010

### Questions? ? ? ? ? ? ? ?

Ken Lonquist  
 WI Dept. of Natural Resources  
 kenlonquist@dnr.wisconsin.gov  
 608/29/3320



**Teaching Green**  
**The Elementary**  
**Years**

**Hands-on Learning**  
**in Grades K-5**

Edited by Tim Grant and Gail Littlejohn



NEW SOCIETY PUBLISHERS

# The Numbered Forest

*Numbering trees in the schoolyard or in a nearby woodland opens the door to a variety of activities*



Charles Pearce

by Emily Kissner

**Grade levels:** 4-5

**Subject areas:** science, language arts, math

**Skills:** writing, reading, mapping, observing

**Location:** outdoors

**Time:** 1 hour or more



Emily Kissner

**A**

lthough it may sound like an exotic locale, the Forest of Fractions is an ordinary stretch of forest. Walking into it, you would likely find your attention drawn, as in any other forest, to the deep shadows of the trees and to the twitter of birds overhead or the crunch of a pine cone underfoot. But venture a little further and you begin to notice what makes this ordinary stretch of forest something extraordinary. Here and there, on this tree and that, are wooden plaques with numbers carved into them.

"Hey, what is that number doing there?" a student asks, pulling at the teacher's sleeve. "Why would someone put numbers on the trees?"

"And strange numbers, too," another student adds. "I think I saw 16.25 back there."

The idea of assigning numbers to trees is not new. Trees along nature trails often display numbers that are keyed to information on interpretative signs or trail guides. But the numbered trees on the grounds of the

environmental learning center at Biglerville Elementary School in Pennsylvania have a wider purpose. They encourage students to look beyond their feet as they walk through the forest, and they open the door to a variety of mapping, mathematics, language arts, and environmental monitoring activities. They also make the schoolyard a more friendly, accessible place.

Whether you have an entire forest in your outdoor classroom or just a few trees scattered in your schoolyard, you can do some pretty neat things with numbered trees. The following are tips on numbering your trees and suggestions for activities and investigations that can be done using the numbered trees as a focal point.

## Numbering the trees

The first step in numbering trees is to make a list of the numbers you want to include. For example, to facilitate math activities, you may wish to select a wide range of prime numbers, factors, fractions, and decimals. If you

teach younger children, limit your list to numbers that the students will recognize.

If you intend to use the numbers for only a few seasonal activities, laminated index cards tied around the trunks of trees with string work well. This method allows your students to help with the work of numbering. (My students take it very seriously!) Cards that are double-laminated should survive a season or two of soaking rains; but for more permanent numbers, use stencils and exterior paint to paint the numbers directly on the trees. Painted numbers will last several years and are resistant to vandalism. Alternatively, permanent placards can be made by using a router to inscribe numbers on 10-centimeter-square (4-inch-square) boards. Drill holes in the corners of the placards and use weather-resistant rope or clothesline wire to attach them to the tree. Affixing the numbers high enough to be out of reach will encourage the children to look up in the trees and will also minimize vandalism.

Which trees do you number? In a schoolyard that has only a few trees, you may want to number them all. If you are fortunate enough to have a wooded area nearby, you can number trees at random throughout the forest, or assign different kinds of numbers to different areas. A deciduous forest, for example, might become a Forest of Integers, while a pine forest might become a deep, dark Forest of Fractions.

### Quick and simple activities

When you have only a short period of time for an outdoor lesson, numbered trees provide a focus for simple activities such as the following. Related concepts and skills are noted for each activity.

#### Number searches

- Challenge students to find as many numbered trees as they can and record the numbers in a journal or keep track orally. (Number recognition, counting, recording)
- Ask students to look for numbers that meet certain criteria. Depending on how you numbered the trees, you can have students look for multiples of three, prime numbers, even numbers, and so forth. Younger students may look for numbers with one, two, or three digits. (Number recognition, mathematical concepts)

### Attribute scavenger hunt

Build vocabulary skills by taking students on attribute scavenger hunts. Create a list of words that signify tree attributes such as "crimson," "enormous," and "gnarled," and ask the students to find numbered trees that have these attributes. (Building vocabulary)

### Tree ID

Have students use field guides to identify numbered trees. Then ask them to defend their identifications to the group, referring both to the details noted in the field guide and to the observable features of the trees. Heated debates can arise over whether a tree is a sugar maple or a red maple! (Observation, language arts, plant studies)



Charles Pearce



Charles Pearce

### Mapping the forest

Give students maps of the area and ask them to find and mark the locations of all of the numbered trees. (Mapping skills)

### Tree food webs

Ask students to sit beside a tree and draw the food chains that they can deduce from their observations. Remind them to look carefully for evidence of decomposers. As a class, discuss factors that might influence the types of wildlife and interactions that students see, such as the species and forms of the trees or their locations. (Observation, drawing, ecological relationships)

### Tree house tales

Have students select a tree to observe every day over a period of time. Ask them to make a list of the various organisms that inhabit or visit the tree, using it for shelter, food, escape from predators, structural support, or for some other purpose. Have students write and illustrate stories or create skits about the creatures that use the tree or call it their home. (Observation, identification, drawing, creative writing, dramatic arts)

### Giving directions

In the outdoor classroom, ask students to choose a point of interest (something other than a numbered tree). Then have them write clear directions for getting to their site, using a nearby numbered tree as a starting point; for example, "From Tree 23, walk four paces



toward the path and then turn left." Have students test the clarity of their directions, as well as their ability to read and follow others' directions, by trading with one another. This activity works well in helping students get acquainted with an outdoor site. (Writing skills)

## Extended investigations

The following are more detailed activities and longer-term projects for those who have more time or are able to take students outdoors frequently through the year.

### Trees in all seasons

Read the book *Sky Tree: Seeing Science Through Art* by Thomas Locker (HarperCollins, 1995) and discuss how trees change through the seasons. Then ask each student to choose a tree to observe, describe, and draw as it changes through the year. (With younger students, you may wish to choose one tree to monitor as a class.) This activity could take the form of an "adopt-a-tree" project in which students complete a tree-adoption form and then make drawings, write poems or songs, and jot down observations and facts about their tree throughout the year. Many students feel an immense sense of ownership for their trees and even return to visit them after they have moved on to other schools. (Observation, drawing, language arts)

### Numbered tree tours

Have students use numbered trees as focal points in creating an illustrated trail guide to the natural features of the outdoor classroom. The guide could be in the form of a pamphlet, booklet, or large map, which members of the school community can use for self-guided tours of the grounds. (Science, writing, drawing)



Charles Pearce



Emily Kissner

### Growing concern

Students can practice the skills of estimation and measurement by tracking the growth of numbered trees. Have students measure the circumference of trees and then calculate the "dbh," or diameter at breast height, a standard height measurement taken at a point 1.37 meters (4 feet) from the ground. This information, recorded in a journal from year to year, will allow

students to track the annual growth of individual trees and to compare the growth rates of different species of trees. (Measurement, math, recordkeeping)

### Signs of discovery

Have students use the numbered trees as reference points in recording where they make observations and discoveries throughout the year. Finding "a rotten stump next to Tree 106" is far easier than finding "a rotten stump halfway down the path, over the ditch, a bit to the left of a big bush." If classes record observations each year, students can monitor changes in many different sites of interest, such as a nesting site, a patch of spring ephemerals around the base

of a tree, the encroachment of invasive species, or the natural succession that occurs after a disruption. (Data collection, environmental monitoring) ✻

*Emily Kissner teaches elementary school in Maryland and lives in Gettysburg, Pennsylvania. She credits the idea of using numbered trees to Charles Pearce, a former Grade 5 teacher at Manchester Elementary School in Manchester, Maryland, and author of Nurturing Inquiry: Real Science for the Elementary Classroom (Heinemann, 1999).*

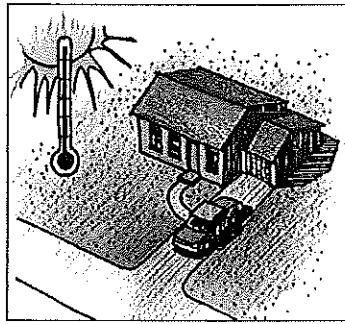


# Tree Planting for Energy Conservation Guidelines - Handout - Page 1

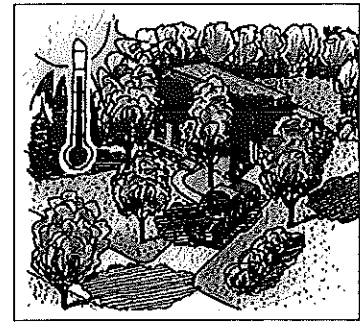
## Guideline #1: Plant Trees to Shade Your Home

**What you should know** – Trees shading a home can reduce the need for air conditioning. Carefully placed trees can save up to 25 percent of an average household's energy needs for cooling - up to 65 percent in the case of mobile homes. According to the U.S. Department of Energy, proper placement of only three trees can save the average household up to \$250 in energy costs each year. Think about what fun things your family could do with that extra money!

**What you can do** – The most energy savings and the best use of shade generally comes from deciduous, broadleaf trees planted about 10 to 20 feet from the walls to the west, east or northwest of the house, depending on the species. These trees shade the house during the summer, reducing the energy needed for air conditioning. When they lose their leaves in the winter, trees correctly planted allow the sun to reach and warm the house, saving energy for heating as well.



A lack of trees around houses means less comfort and higher energy costs.



Carefully planned trees annually save money and add comfort to a home.

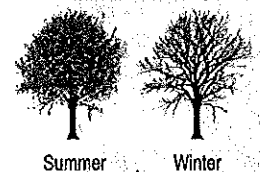
### 2 Main Types of Trees

Different kinds of trees can be part of an energy wise plan.

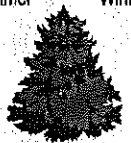
**Broadleaf trees** have leaves that are flat and thin. They are usually deciduous, shedding their leaves annually. Oak, ash, and maple are several examples of broadleaf trees. Broadleaf trees generally provide the best summer shade.

**Conifers** bear cones and have needle-like leaves. Most conifers are evergreen since they do not lose all their leaves at once. Pines, firs, cedars, and spruces are conifers. Conifers generally provide the most effective buffer in windbreaks.

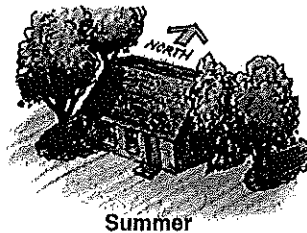
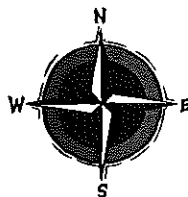
#### Broadleaf



Summer Winter



Conifer



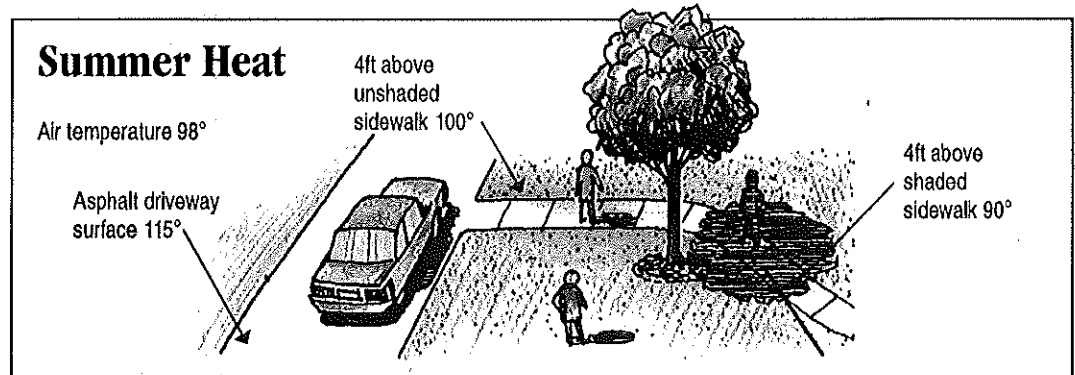
Summer



Winter

## Guideline #2: Plant Trees to Shade Paved Areas

**What you should know** – Trees shading concrete or asphalt driveways and parking lots will greatly decrease surface heat. In the summer, a city area with trees shading paved areas can be 12 degrees cooler than one without trees.



**What you can do** – Plant broadleaf trees near, but not right against, sidewalks and driveways. Create areas in large parking lots or along city streets where trees can be planted for shade. Plant rooftop gardens.

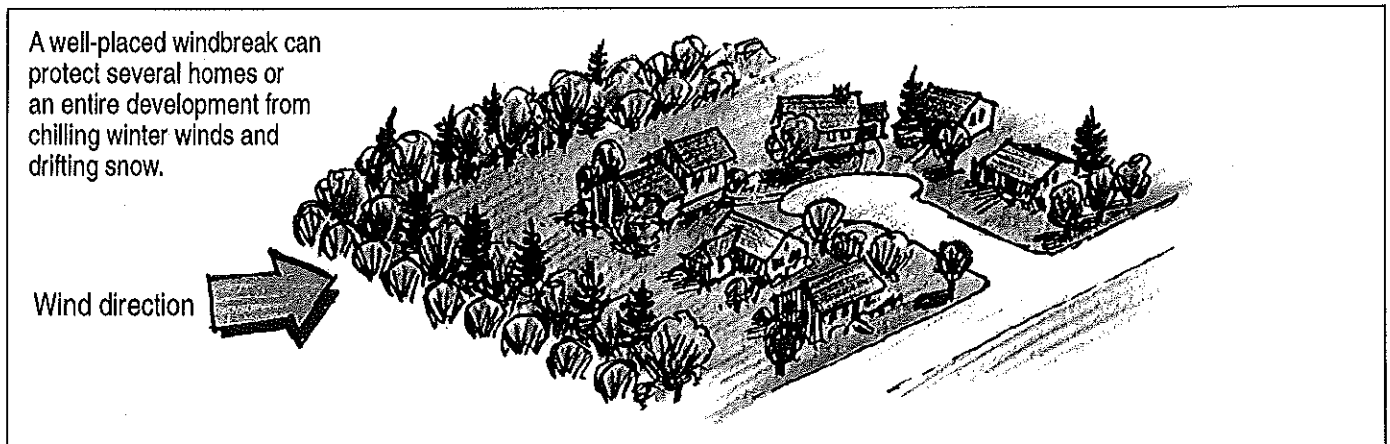
# Tree Planting for Energy Conservation Guidelines - Handout - Page 2

## Guideline #3: Plant Trees to Break the Wind and Reduce Blowing Snow and Dust

**What you should know** - Windbreaks are rows of trees used to reduce the force and direction of the wind. Planting a windbreak around a home or housing development can provide an energy savings of up to 30 percent and reduce blowing snow, noise, and dust.

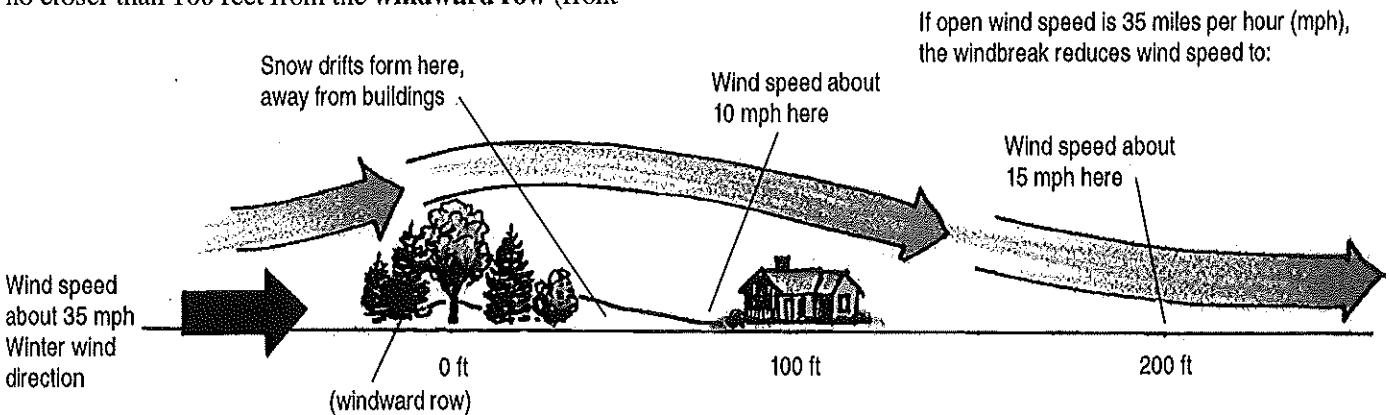
Windbreaks should be planted in an L-shape (right angle) toward the common wind direction. For best protection,



windbreaks may be planted on more than one side of the property. Effectiveness of the windbreak also depends on the density (thickness) of the windbreak and its height. Three or more rows of trees in staggered formation provide the best wind protection. Conifers generally form the best windbreaks but some windbreaks include a few broadleaf trees as well. Windbreaks are effective for a distance of up to 8 to 10 times the height of the mature fully grown trees.

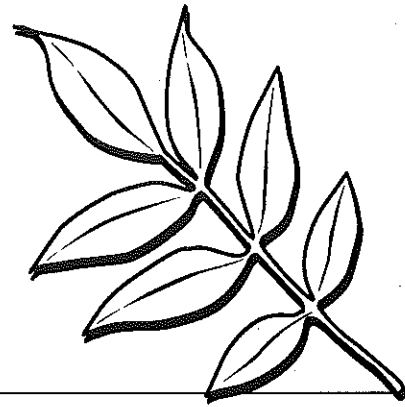


**What you can do** - Plant conifers several rows deep in a continuous line facing **prevailing winds**. Since snow and stale air can collect in the area directly behind a windbreak, buildings to be protected should be located no closer than 100 feet from the **windward row** (front

row facing the wind). The area to be protected should be within a downwind distance of 2 to 5 times the expected height of the tallest windbreak row. (For planning purposes, 20 feet is often used as the height of the tallest trees.)



**DIRECTIONS**- Imagine you are a city planner or landscaper. Using the "Tree Planting for Energy Conservation Guidelines" in this handout, design a new, energy saving neighborhood development plan. Draw in homes and a school. Indicate north, east, south, and west on your plan. Remember to think about what sides of the homes to plant trees on for the best energy savings. Consider carefully where to plant deciduous, broadleaf trees  and where to plant conifers . In your plan, draw in the best kind of trees to shade each home, to shade streets and driveways, and to serve as a neighborhood windbreak. Then describe why you planted trees where you did to be energy wise.



## Tree Enemies

### Objective

Students will:

- identify some of the causes of damage to trees and what they can do to help prevent harm to trees.

### Background Information

Our friends, the trees, have many enemies. Fire, wind, ice, lightning, pollution, disease, insects, machines and vehicles, animals, and abuse from people all hurt trees. Some of these, such as weather damage, we can't always prevent. Others we can do much about. With good care and management, trees can continue to be **renewable resources**.

Trees give us many things. This includes fuel for fires and heating, lumber, wood pulp for paper making, and food for humans and animals in the form of fruits, nuts, bark, and leaves. Trees are an important part of the earth's environment because they absorb **carbon dioxide**, give off **oxygen**, hold water and soil in place, and return nutrients to the soil.

Forests can be resilient, but if they are continually or drastically disturbed, they can be destroyed. It is our job to protect, **conserve**, and manage the forests of the world rather than simply cut them for our uses today. Good management of a forest includes planting, growing, protecting, and reproducing trees in places where we cut them for lumber, fuel, or paper. At the same time, forest managers must control **soil erosion**, guard **watersheds**, protect animals, allow for agriculture, and provide for recreation. Each of us has a responsibility to do what we can to save and protect trees, too.

In these lessons, we will learn about some of the

### Vocabulary Words

renewable resources	elm bark beetles
carbon dioxide	oak wilt disease
oxygen	chemicals
conserve	environment
soil erosion	urban
watersheds	girdling
fungus	humus
Dutch elm disease	kindling

natural causes of damage to trees, as well as damage caused by people and machines.

### Natural Causes of Damage

Did you know that trees, just like people and animals, can get diseases? They can ... and it can be serious.

A **fungus** is an organism that may be deadly to certain trees. Two diseases caused by fungus that have had huge effects on the trees in Minnesota are **Dutch elm disease** and oak wilt.

#### Dutch Elm Disease

Dutch elm disease was first described in the Netherlands in 1919. It spread quickly in Europe and by 1934 was found in most European countries and the British Isles.

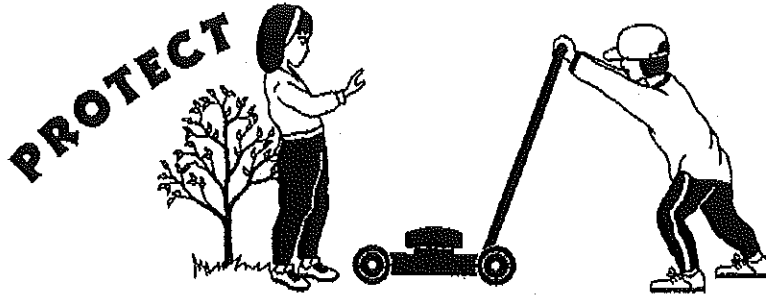
European **elm bark beetles**, which carry the disease, were reported in the United States, in Massachusetts, as early as 1909. The fungus that causes the disease came into this country in logs shipped from Europe. The logs contained both the fungus and the European elm bark beetles. The logs were shipped to factories in New York, Ohio, and



# Trees Have Many Enemies



NAME: \_\_\_\_\_



w d d y m d p d s m a c h i n e s  
 l e e k m j t l g m l h m x v y c  
 n w h g f v a x y v h g n w g q h  
 d e w n k m f m a u c h r o g z e  
 y l x l i m d z m h t x y l o s m  
 r p n n x x p s e x a f l z a r i  
 w o a t a d e m f l e y z e j w c  
 q e y h g l i a h x w i s d u q a  
 r p s g c c w a y e r i f k d t l  
 h x o i a k y l l l d v c o h n s  
 s b h l a w n m o w e r s e s c i  
 f e s p l f q t s k i p o z g n n  
 v u n h k u s l q g x b t u s p s  
 r q h i n g t n u o k j f y g b e  
 d z v j h g n i v r a c y l h h c  
 u h t l k c w k o z v b p w g f t  
 s y x d i u a g b n a c z l h z s

Can you find these words? They go across, up, down, and diagonally. Sometimes they're even backward.

lawn mowers  
people  
drought

machines  
pollution  
fire

disease  
carving  
vehicles

chemicals  
wind  
insects

animals  
lightning  
ice

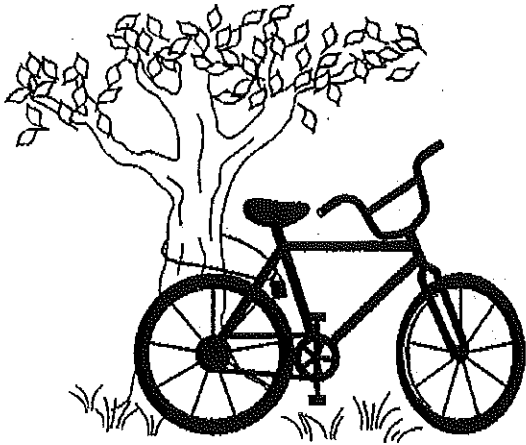


Answers on page 39.

# How Do People Wound Trees?



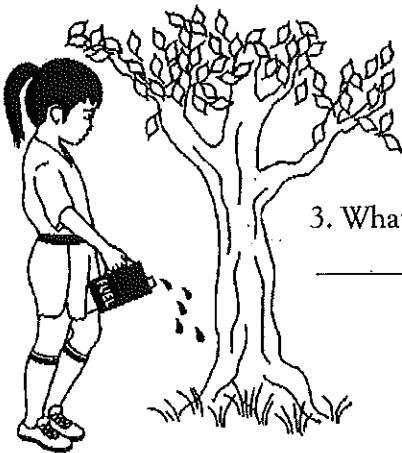
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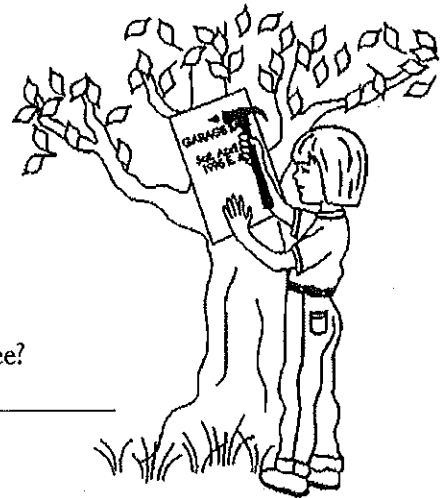
1. What happens to the tree?  
\_\_\_\_\_



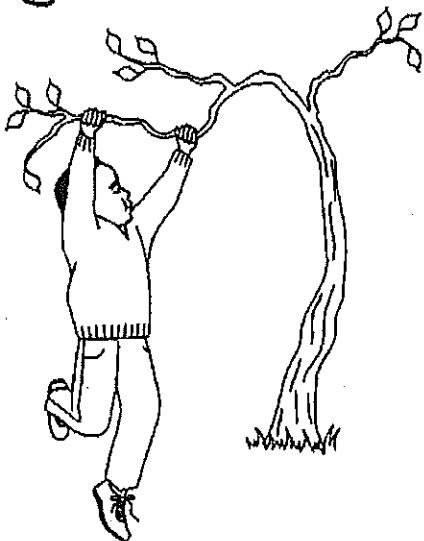
2. What happens to the tree?  
\_\_\_\_\_



3. What happens to the tree?  
\_\_\_\_\_



4. What happens to the tree?  
\_\_\_\_\_



5. What happens to the tree?  
\_\_\_\_\_



6. What happens to the tree?  
\_\_\_\_\_



# Language Arts

## Literature and Folklore

**Book Nook.** See "Book Nook," Resources, page 135, for tree-related books.

**Trees.** Read the familiar tree poem, "Trees," by Joyce Kilmer. What does it mean to students? What other tree stories and poems do you know? Find some to share with the group. For some suggestions, see Resources, page 130.

## How Do People Wound Trees?

*You'll need:* "How Do People Wound Trees?" Activity Sheet, page 45.

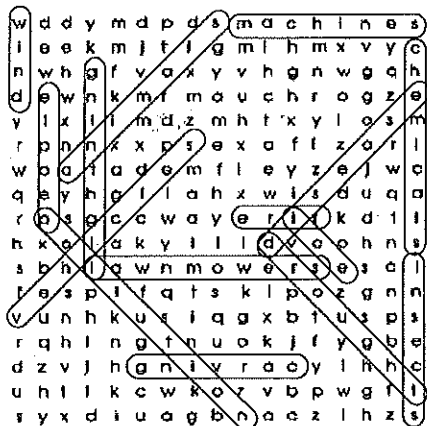
Do the activity sheet and learn more about how trees can be hurt.

## Trees Have Many Enemies (Vocabulary)

*You'll need:* "Trees Have Many Enemies" Activity Sheet, page 46.

Do the activity sheet and discover some enemies of trees.

### Answers:



## Write a Rap

*You'll need:* Writing paper and pencils.

Write raps about saving, protecting, and respecting trees. Brainstorm words that might be used and list them on the white board.

## My Side of the Story

Imagine city life from a tree's point of view. As a group, brainstorm ideas about how a tree might act, or what it might say or feel when it is wounded or hurt in some way. What might it say when it is helped and thoughtfully cared for? Jot down your group's ideas. These discussion-starters may help, too.

What would a tree say or do if:

- a 10-year-old locks his bicycle to it?
- a teenager carelessly rams into it with the lawn mower every week during the summer?
- a person from a lawn service sprays weed killer on the grass around it?
- a parks worker structurally prunes it and places mulch around it?
- cars slap against the branches hanging over the street?
- people having a garage sale nail their signs to it?
- someone gives it water on a hot, dry day?
- children playing in the schoolyard all use the same tree as "base," and the many feet pack down the dirt around it?
- gophers dig tunnels in and around its roots?
- a new curb in the street causes the rain to collect around it in a pool of water?
- junior high kids think it's cool to carve their initials on it?
- the children in the neighborhood climb it, going all the way to the small branches near the top?
- a teenager puts a fence around it when it is small so no rabbits can nibble on it?
- construction crews drive bulldozers and other heavy machines over its roots?
- city workers remove branches broken by strong winds?
- people volunteer to keep watch for insect and disease problems?

## Arbor Month Spelling

For Arbor Day (last Friday in April) or Arbor Month (May), choose tree- and forest-related words in spelling.







## **Tree City USA**

The Tree City USA® program provides direction, assistance, attention, and national recognition for urban and community forestry programs in thousands of towns and cities. More information available online at <http://www.arborday.org/programs/treeCityUSA/index.cfm>.

### ***The Four Standards of a Tree City USA***

To qualify for Tree City USA, a town or city must meet four standards established by The Arbor Day Foundation and the National Association of State Foresters.

These standards were established to ensure that every qualifying community would have a viable tree management plan and program.

It is important to note that they were also designed so that no community would be excluded because of size.

1. A Tree Board or Department
2. A Tree Care Ordinance
3. A Community Forestry Program With an Annual Budget of at Least \$2 Per Capita
4. An Arbor Day Observance and Proclamation

# **Outline for a Community Tree Ordinance**

## **I Contextual Conditions**

- Section 1 Short Title
- Section 2 Purpose, Intent & Definitions

## **II Technical Requirements**

- Section 3 Establishment Of A Tree Commission
- Section 4 Authority Of The Tree Commission
- Section 5 Appointment & Qualifications Of The Town/Parish Arborist
- Section 6 Duties Of The Town/Parish Arborist
- Section 7 Authority Of The Town/Parish Arborist
- Section 8 Community Tree Plan
- Section 9 Permits Required
- Section 10 Trees On Private Property
- Section 11 Abuse Of Public Trees
- Section 12 Interference With The Town/Parish Arborist
- Section 13 Protection of Public Trees
- Section 14 Placing Materials On Public Property

## **III Administrative Components**

- Section 15 Enforcement, Penalty And Appeals
- Section 16 Administrative Guidelines
- Section 17 Conflicts
- Section 18 Severability
- Section 19 Effective Date

Taken from: "Guide to Writing A City Tree Ordinance" model tree ordinances for Louisiana communities, available online at  
<http://www.greenlaws.lsu.edu/modeltree.htm#ordinanceoutline>

Also, see the sample city tree ordinance at:  
<http://www.arborday.org/programs/treeCityUSA/graphics/sample-ordinance.pdf>

An ordinance checklist for Tree Cities, USA is available at  
<http://www.arborday.org/programs/treeCityUSA/graphics/sample-tree-ordinance-checklist.pdf>

## ***Free Tree Education Resources***

*Trees are Terrific... and Energy Wise!* 2010 National Arbor Month poster contest lesson plans and contest rules, available at [http://dnr.wi.gov/forestry/uf/awareness/arbor\\_day\\_pdfs/2010-guide.pdf](http://dnr.wi.gov/forestry/uf/awareness/arbor_day_pdfs/2010-guide.pdf)

*2010 Forest Appreciation Week* writing contest packet, available at [http://dnr.wi.gov/forestry/uf/awareness/arbor\\_day\\_pdfs/20104thGradeWritingContest.pdf](http://dnr.wi.gov/forestry/uf/awareness/arbor_day_pdfs/20104thGradeWritingContest.pdf)

*A Teachers' Guide to Arbor Month*, available at <http://www.dnr.state.mn.us/arbormonth/teachersguide.html>

*Natural Inquirer* middle school science education journal, available at <http://www.naturalinquirer.org/Urban-Forest-Edition-i-9.html>

# Trees Through the Seasons

## Teacher Guide

Most of the activities in this guide are geared toward spring. They're things you can do in connection with your Arbor Day or Arbor Month celebrations.

Yet trees offer fascinating learning opportunities all year long. Don't miss out on the other seasons! The following pages take you "through the year" with trees. Another year, you may want to make trees a whole-year learning adventure. A great ongoing activity is to have students "adopt" trees that they can identify and observe through all the seasons. Each student creates a scrapbook about his or her tree and how it changes through the seasons.

If individual student scrapbooks don't fit your school program, scan and choose other activities as each season arrives. Some activities are interchangeable from season to season. Your students will develop new interests in trees along with better scientific observation skills. You'll probably discover a lot of new things about these intriguing giant plants yourself!

### Trees Throughout the School Year

1. Starting in the fall, encourage each student to choose a special tree and to make a scrapbook called "My Adopted Tree." The scrapbook should have a strong cover so it will last all year. Each time a new drawing or project is completed, it goes into the scrapbook. Display the books for all to enjoy during Arbor Month. Students bring them home at the end of the year.
2. Once each season, ask: How has your tree changed? Each student draws a detailed picture of his or her tree, including all changes and at least six objects found in its environment (flowers, birds, animals, rocks, snow, seeds, grass, etc.).
3. Ask: What animals or insects can be seen near or on your tree during each season?

Look in crevices of the bark, on the leaves, along the bottom of the trunk, and on branches and twigs. Make a picture list of the things you see each season.

4. On nature walks, challenge students:
  - Close your eyes. What sounds do you hear around your tree? What do you smell around your tree? What do you feel on and around your tree? Open your eyes. What do you see around your tree?
  - Choose a dead or nearly dead tree to compare with yours. How are they the same? How are they different?
  - Take seasonal photographs of three or four different kinds of trees. Put them in school-year order and compare them at the end of the school year. Make a bulletin board display of your photographs.

### Autumn Questions and Activities:

1. What words would you use to describe your tree at this time of year?
2. Take a leaf from your tree back to the classroom. Examine it with a magnifying glass. What do you see? Iron it between two pieces of waxed paper and place it in your scrapbook.
3. Are there holes in some of the leaves on your tree? Why? Has something been eating them? What?
4. What is inside leaves to make them green? (Chlorophyll.)
5. Why do leaves change color in fall? (The chlorophyll disappears from the leaf as the days become shorter. The yellow, orange, red, and brown pigments that are also in the leaf now show through.)
6. Why do leaves fall off the trees in autumn? (When the leaves are not producing food, a cork layer grows over their leaf-twig connecting spot. The leaves no longer get water. They dry up and lose their hold on the branches. The wind blows them off.)



7. How much time has passed between the first color changes in the leaves of your tree and the time the tree is left bare?
8. Will a green leaf change color if it is put in a cold place? Put a green leaf in a plastic bag and put it in a refrigerator. Watch the color changes for a few days.
9. What will happen to a green leaf when we boil it? Boil a green leaf for five to 10 minutes. (Use hot burners only with adult supervision.) The water goes through a series of color changes. Collect several tablespoons of water as boiling proceeds. Include a sample of clear water. Keep the samples in order. Compare and discuss the changes. Remove the leaf from the water. What happens to the color?
10. How do the seeds from your tree differ from the seeds on other trees? How are they alike?
11. What is inside a seed from your tree? Cut it in half and look at it with a magnifying glass.
12. How do seeds from trees travel?
13. How did your tree probably begin growing?
14. What protects the buds during fall and winter?
15. Does your tree have any injuries? Who or what might have made them? (If there is a well-formed scar or if the injury is painted black, the wound is probably the result of planned pruning.)
16. Can you find holes that might have been made by woodpeckers?
17. Are there any cocoons on your tree?
18. What happens to a tree when it dies? (It rots or decays and becomes part of the soil again. This is good since it adds food to the soil.)
19. Is there "pollution" around your tree? Which litter is nature-made and which is human-made? (Dispose of all human-made litter.)
20. What geometric shapes do you see on or near your tree?

### Winter Questions and Activities:

1. What words would you use to describe your tree at this time of year?
2. When does a tree stop growing? (Trees "sleep" or "rest" during the winter but never stop growing until they die.)
3. What are your tree's food or water needs during the winter? (Compare this to the hibernation of bears.)
4. Are the needles of pine trees leaves? (Yes.)
5. Do evergreens ever lose their needles? (Yes. When new ones grow, the old ones fall off, but never all at once.)
6. How do evergreen needles stay alive in the winter? Look at some through a magnifying glass. (A covering of thick wax keeps them from losing water. They do not dry out and die in the winter.)
7. Will evergreen branches change color if they are brought inside? Clip a small branch from a spruce or pine tree and bring it to school. Put the branch in a sugar-water solution such as is used for Christmas trees. Watch the changes for several days.
8. Why is the bark of most trees rough and cracked? (The bark is not elastic enough to stretch as the tree grows.)
9. Why do trees have bark? (To protect the insides, like our skin.)
10. Make bark rubbings. Place a piece of paper over the bark and rub the side of a crayon firmly against the paper. Compare your rubbing with other rubbings. Place it in your scrapbook.
11. Measure around the trunk of your tree with a string or a tape measure. Compare your tree with others.
12. How can you tell the age of a tree? (Find a stump or a log and count the age rings in it.)
13. How old is your tree? Borrow an increment borer from a forester to take small cores from the trees. Count the rings.
14. How thick is the bark of your tree?



15. Will some wood from your tree float? Which of your group's trees are made of the heaviest wood? Which of your trees are made of the lightest wood? (Use the core taken with the borer or a small twig from each tree as "floating" samples.)
16. Do the branches show signs of where the leaves used to be? (Look for "leaf scars" with a magnifying glass.)
17. Are there tracks in the snow around your tree? What made them?

### Spring Questions and Activities:

1. If they haven't already done so, invite each child to "adopt" a tree to observe and learn about all year long.
2. What evidence do you see of your tree "waking up"?
3. Cut a twig from your tree in the early spring. Bring it to the classroom and put it in water. Watch the bud scales open and the leaves unfold. Keep a record of when the twigs were put in the water, when the leaves appeared, and when the bud scales dropped off.
4. What makes the buds begin to grow? (Day length is increasing, making more "sun time" available. Warming temperatures allow water movement within the tree.)
5. Take a bud from your tree back to class. Examine it with a magnifying glass. Iron it between two pieces of waxed paper and put it in your scrapbook.
6. What part of the tree makes food? (Leaves make food for the trees. They use air, water, and sunlight to make food. This process is called *photosynthesis*.)
7. When do leaves make food? (During the day. Photosynthesis takes place only in the light.)
8. Why are leaves arranged on the branches the way they are? (So they don't overlap and block sunlight to the ones below.)
9. How does water get to the leaves? (It travels through tubelike cells in the roots, trunk, and branches of the tree.)
10. Where are the roots of your tree?

11. Do some of the roots show above ground?
12. Why do the roots of the trees spread so far in the ground? (To form a strong base and to drink up minerals and moisture from the earth.)
13. Tie a plastic bag around the leaves of a small branch. Look at the branch after a few days. What do you see? (Drops of moisture should appear on the bag. Moisture is released from cells in the leaf. It moderates the air temperature and relative humidity surrounding the leaf. This is called *transpiration*.) Put another plastic bag around a dead twig and compare the two bags. (Remember to remove the bags when done.)
14. Is the whole tree growing? (Trees grow in length only near their tips, but they grow in diameter at their roots, trunk, and branches.)
15. Taste the sap from a maple tree. Is it sweet? (Trees make sugar. We use the sugar sap from maple trees to make syrup.)
16. What movements does your tree make?
17. Look for a "food chain" near your tree. (Birds eat spiders, spiders eat other insects, and insects eat leaves, etc.)
18. Take a picture of each student's tree. Mix up the pictures. Can each student find the picture of his or her own tree?
19. Make a picture list of all the things you think trees are good for. Some possibilities:  
Trees give us:  
moisture in the air  
beauty  
shade  
flowers, fruit, and nuts  
saps and oils  
wood pulp for making paper, plastic, and rayon  
wood for building  
a place to climb  
places for birds' nests  
food and homes for animals and insects  
better soil

(See Resources, page 122 for more ideas.)





### Summer Questions and Activities:

1. If they haven't already done so, ask each child to "adopt" a tree to observe and learn about all year.
2. How is your tree like the others? How is it different?
3. Is your tree dead or alive?
4. Are there any nests in your tree? Why is it a good place for a nest? (The branches hold the nest in place. The nest is hidden and out of reach of many enemies.)
5. Are there many plants growing under your tree?
6. Are there more leaves on one side of the tree than on the other? Why? (The tree may get more sun on one side.)
7. Do you see buds near the leaves of your tree? When are buds for the next season's leaves made? (At the same time as leaves and new shoots, during elongation in spring.) When will these buds grow into leaves?
8. Take two leaves from your tree back to class. Examine them with a magnifying glass. Try to match your leaves to the leaf pictures in a tree identification book. What kind of tree is your tree?
9. Iron one leaf from your tree between two pieces of waxed paper and place it in your "My Adopted Tree" scrapbook.
10. Make a leaf print with the other leaf from your tree. Place the leaf on newspaper. Brush the leaf with ink or paint. Move the leaf to a clean newspaper. Place a porous paper over the leaf and rub gently to transfer the ink or paint from plant to paper. Let the paint dry, and place the print in the scrapbook.
11. Gather a small piece of bark, a twig, a seed from your tree, and a small plastic bag of soil from under your tree (use a large spoon or trowel). Mount all these on a piece of heavy paper and place them in your scrapbook.
12. Take two temperature readings, one under your tree and the other away from its shade. How much do they differ? (Note: When

taking a temperature in the sun, shade the bulb of the thermometer.)

13. Does there seem to be a breeze under your tree when there isn't any away from its shade? Why? (The cool air under the tree is heavy and pushes the warm air away as it sinks to the ground.)

### Evaluation (If a Year-Long Project)

Your evaluation of each student's skills and conceptual developments should be guided by the contents of "My Adopted Tree" scrapbooks, responses to questions, and participation in discussions. The questions listed here are designed to help you make good subjective evaluations. You'll need to adapt the questions to meet your students' age level.

- a. How well did the student follow directions?
- b. How much direction did the student require?
- c. Did the student formulate new questions?
- d. Did the student design new experiments to answer these questions?
- e. Did the student recognize cause and effect relationships?
- f. Could the student state the problem to be solved?
- g. Did the student arrive at conclusions by himself or herself?
- h. How many characteristics of his or her tree did the student identify?
- i. Could the student describe enjoyable and useful ways of using trees?
- j. Did the student compare and contrast the characteristics of his or her tree with those of other trees?
- k. Could the student predict the outcome of his or her investigations?
- l. Could the student predict changes in his or her tree?
- m. How well did the student use his or her five senses?

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