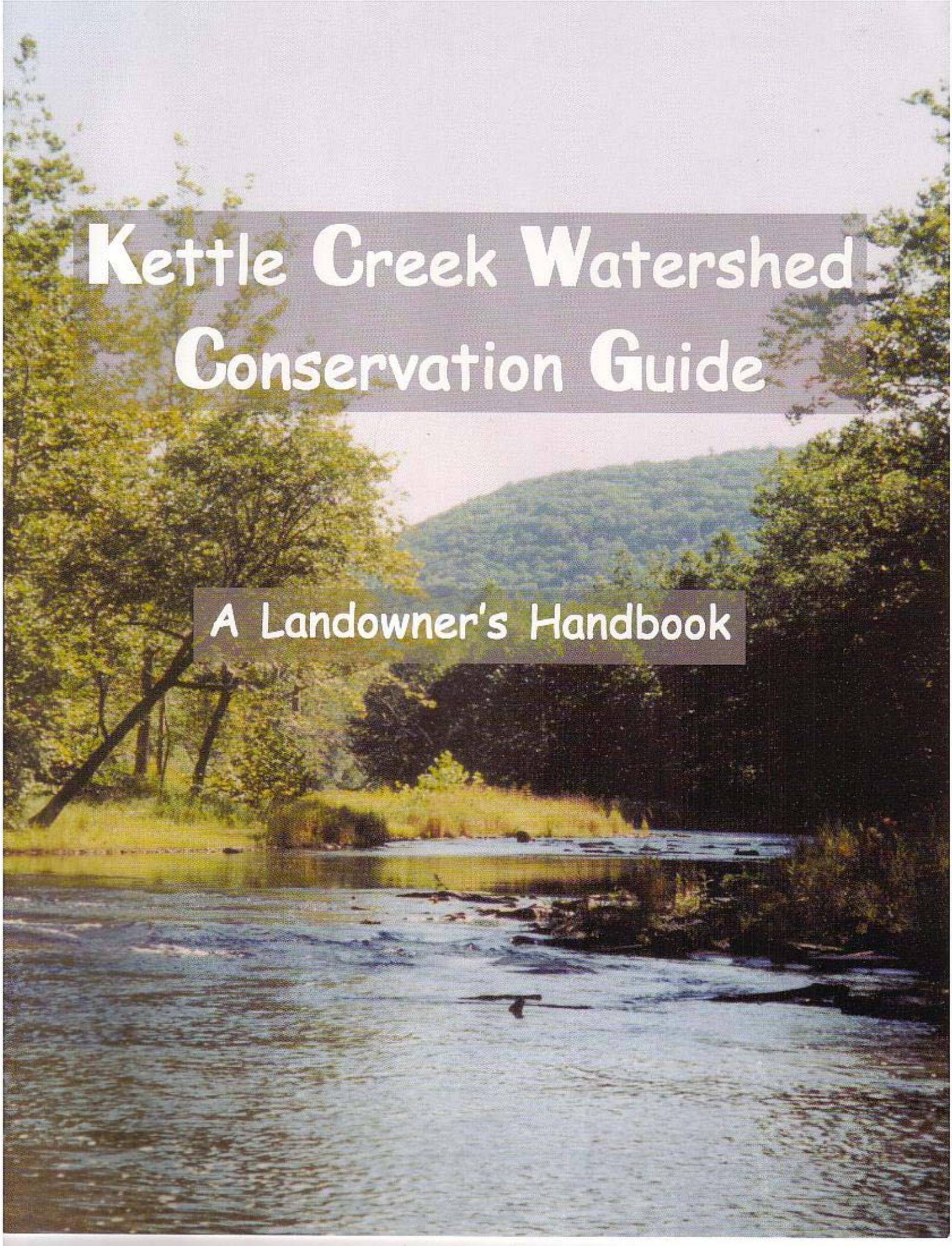

Kettle Creek Watershed Conservation Guide

A Landowner's Handbook

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Compiled and Written by
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Kettle Creek Watershed Director

Contents

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Kettle Creek Watershed Association

The Kettle Creek Watershed Association (KCWA) was established in 1997 by citizens concerned about the protection and improvement of the Kettle Creek watershed. The KCWA has since developed many partnerships and accomplished a number of stream habitat improvement projects, worked hard on acid mine drainage remediation efforts, and involved many people through their various educational programs.

The KCWA's watershed program focuses on four main goals:

Develop a watershed management and conservation plan

Reclaim the lower watershed through treatment of acid mine drainage

Improve aquatic habitat throughout the watershed

Implement a community environmental education program

A Special Partnership: KCWA and Trout Unlimited

The KCWA has joined with Trout Unlimited (TU) through TU's Home Rivers Initiative and together, the KCWA and TU work on the above goals. This special partnership was created in 1998 when TU accepted the Kettle Creek watershed as its 3rd Home Rivers Project. TU's Home Rivers Projects are multi-year efforts that integrate scientific research, community outreach, on-the-ground restoration, and the development of long-term conservation management strategies and tools.

Introduction

Do you fish in Kettle Creek?

Do you hunt around Kettle Creek?

Do you hike or birdwatch in the Kettle Creek area?

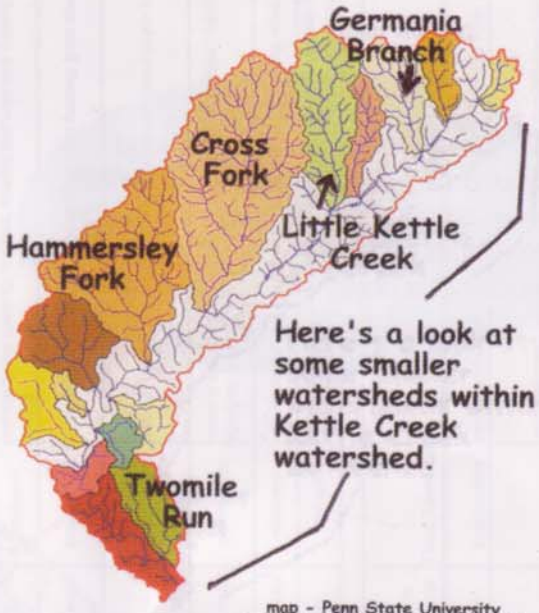
Do you live in or around the Kettle Creek valley?

If your answer if yes to any of these, then you are already a user of the Kettle Creek watershed and appreciate what it has to offer.

We all need clean water and natural resources to exist. This is why it is so important for us to understand our watersheds and how they function. It is the only way we can all work together to protect water quality, natural resources, and the overall health of our watersheds.

So where do we begin in trying to understand how our watersheds function? What can we do to protect them and better manage them?

Believe it or not, there are many things that can be done in as small a place as your own backyard that can make a difference in the overall conservation of the Kettle Creek watershed.



map - Penn State University
Center for Watershed Stewardship

No matter how far you live from a creek, river, lake, or the ocean, you will always live in a watershed.

This watershed handbook for landowners is designed to:

- Familiarize you with basic watershed principles
- Give you an overview of the Kettle Creek watershed
- Introduce you to easy-to-use backyard conservation practices
- Provide you with additional resources and contacts you may wish to pursue as you become more involved in your conservation efforts

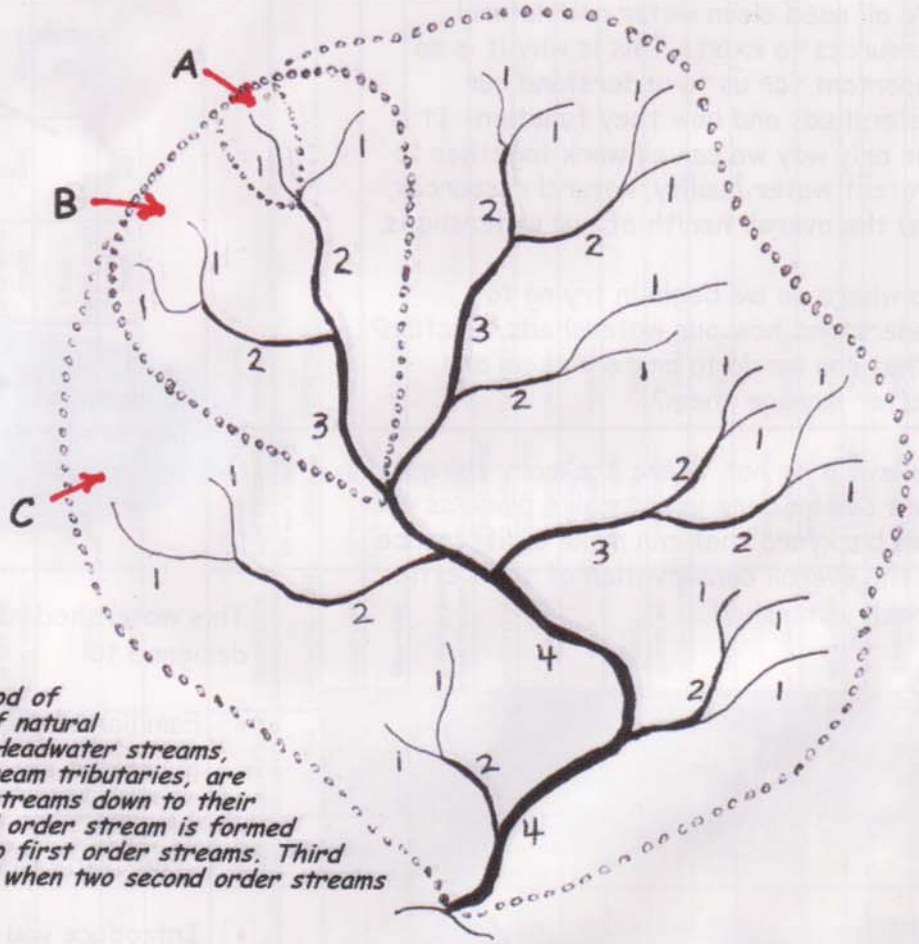
Watershed Basics

So what is a watershed and what does it do?

A watershed is an area of land that drains all water running downhill from ridge tops, over hillsides, through lowlands, towns, and anything else it encounters on its way to a creek, river, lake, or ocean.

Watersheds occur on a wide range of scales. They may be as large as the Mississippi or Chesapeake Bay watersheds, or as small as the watershed belonging to the creek that runs through your backyard. Watershed boundaries are defined by topography.

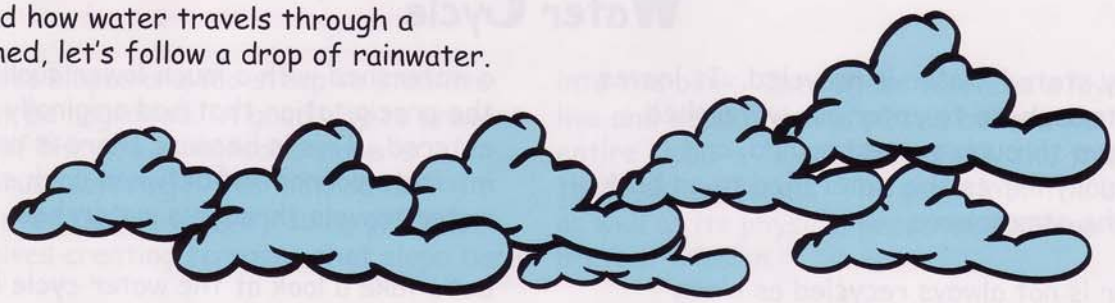
Every watershed can be considered part of a larger watershed. Take a look at the diagram below:



Stream ordering is a method of classifying the hierarchy of natural channels in a watershed. Headwater streams, streams that have no upstream tributaries, are designated as first order streams down to their first confluence. A second order stream is formed below the confluence of two first order streams. Third order streams are created when two second order streams join, and so forth.

Area A designates a small-scale watershed of a headwater tributary, also known as a first order stream. Area B is a somewhat larger watershed that includes watershed A, first and second order streams, and a third order stream. Both A and B watersheds are part of the entire C watershed that is shown above. This example demonstrates how each stream has its own watershed, while at the same time it is part of a larger watershed.

To better understand what a watershed does and how water travels through a watershed, let's follow a drop of rainwater.



1. Water is captured

A watershed naturally collects precipitation that reaches the earth as it soaks or infiltrates through soil, root systems and vegetation, and even animal burrows. However, buildings, pavement, and other hard surfaces may hinder this natural rate of infiltration.

2. Water is stored

Some of the precipitation that has soaked into the ground becomes part of the local aquifer and is temporarily stored. Vegetation also temporarily stores water.

An aquifer is a geologic unit, such as bedrock or sand, which is capable of storing and transmitting water. Depending upon the type of aquifer, it may store water for only a short period of several hours, but storage times of over a hundred years are not uncommon.

3. Water is released

Groundwater temporarily stored in a watershed is eventually released through springs, wetlands, and floodplains into creeks, rivers, lakes, and wells for drinking water. Water is also released through evaporation of surface water and through transpiration, the loss of water by vegetation.

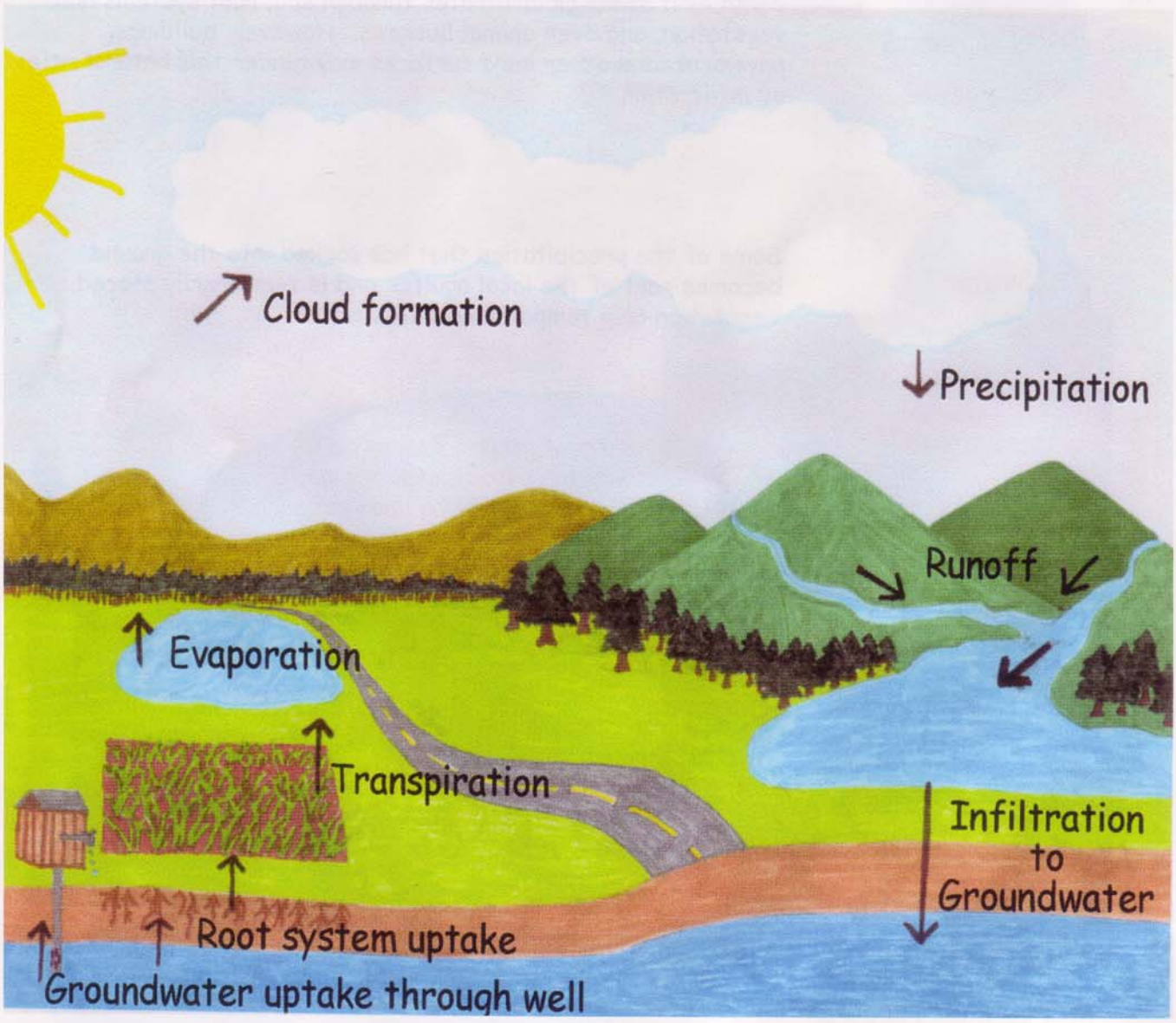
Groundwater is the water stored in an aquifer. It saturates tiny spaces between clay, sand, or fractures in rock. Surface water includes the water of lakes, streams, wetlands, etc.

Water Cycle

Simply stated, water is recycled. It leaves the atmosphere to enter our watershed, journeys through our watershed, and eventually leaves the watershed to go back into the atmosphere.

Water is not always recycled as clean water. In fact, quite often water will leave a watershed with a much lower quality than the precipitation that had originally entered. This is because there is an intricate connection between each step as water travels through a watershed.

Let's take a look at the water cycle below.



The water cycle is continuous as it travels between the earth and the atmosphere through precipitation, runoff, infiltration, transpiration, evaporation, and back into precipitation.

Let's break these processes down into 3 main categories of water: atmospheric water, surface water, and groundwater. Although we have virtually no control over the weather and therefore atmospheric water, we do have control over what happens to the water when it travels through our watershed as surface water and groundwater. So it is very important for us to pay close attention to activities that may directly or indirectly affect the quality and quantity of our water resources.

For example, we can make sure that when maintaining our vehicles we properly dispose of the oil and other automotive fluids. We can also do things as simple as turning off a light when we are not in the room because chances are, our electricity is generated by coal-burning power plants which contribute to acid rain.

How Does a Watershed Become Polluted?

As water travels through a watershed, it can pick up many toxic agents from the air. For instance, the emissions from the burning of fossil fuels by automobiles and industry release nitrogen oxide (NO_x) and sulfur dioxide (SO_2) that mix with precipitation to create acid rain.

The average pH of Pennsylvania's rain is 4.0. Because fish and other aquatic organisms are sensitive to low pH, many acid rain impacted streams and lakes cannot support healthy populations of aquatic life.

Water also becomes contaminated by point source and nonpoint source pollution. Point source pollution is easily defined as pollution emitted from a distinct "point" or pipe, such as a sewer outfall from a municipal or industrial wastewater source. Since the passing of the Clean Water Act in 1972, significant progress has been made in reducing point source pollution.

Nevertheless, serious water quality problems still exist as a result of nonpoint source pollution. Nonpoint source pollution comes from a wide array of everyday activities such as agriculture, timber harvest, abandoned mine drainage, construction, and development. There are 3 major nonpoint source pollutants: sediment, nutrients, and toxins.

Sediment: Sediments are small particles of soil that may be carried to a stream or lake through surface runoff or erosion. Excess sediment significantly decreases habitat quality for all stream-dwelling critters, decreases the amount of sunlight that penetrates through the water, and carries other toxins.

Nutrients: These include primarily nitrogen and phosphorus that come from fertilizers, sewage, and unmaintained septic systems.

Toxins: Toxic metals such as aluminum, iron, and manganese may come from acid mine drainage pollution. Other toxins include chemicals from pesticides, herbicides, winter road treatments, and oil from roads and other paved surfaces.

Let us acknowledge that we are making continual progress in increasing water quality through successful implementation of what is called "best management practices", commonly referred to as BMPs. BMPs include methods of managing the use of land that reduce the 3 main causes for nonpoint source pollution – erosion, sedimentation, and stormwater runoff.

Here are some examples of BMPs that can be found in the Kettle Creek watershed:

A riparian buffer zone filters sediments and nutrients from surface runoff before the water flows into the stream. (More on riparian buffer zones beginning on page 13.)

Periodic maintenance of septic systems reduces high levels of nutrients, bacteria, and organic material that can leak into groundwater or drinking water supplies and runoff into streams.

Instream rock vanes, combined with regraded and revegetated streambanks improve bank stability and reduce erosion.

Water polluted with toxic metals and high acidity from acid mine drainage is treated through a passive treatment system.

Getting to Know Your Watershed

The Kettle Creek watershed drains an area of approximately 244 square miles in the Deep Valleys section of the Appalachian Plateau in northcentral Pennsylvania. The present topography of narrow valleys and flat-topped mountains is primarily a result of streams downcutting into the plateau over millions of years. This process is continuing to this very day.

Wildlife is abundant in the Kettle Creek watershed. Mammals range from black bear and bobcats to smaller mammals such as the star-nosed mole and little brown myotis bat. Bird watchers can be on the lookout for saw-whet owls, pileated woodpeckers, cerulean warblers, and many more. And moist woodland and wetland areas are home to numerous species of frogs, salamanders, toads, and skinks. A more comprehensive list of wildlife and plant species can be found in Resource Management Plans at the state park offices or district forestry offices (contact information listed in the back of this handbook).

The main stem of Kettle Creek is a freestone stream that stretches 42.5 miles from its headwaters in southwestern Tioga County, through Potter County, to its mouth where it empties into the West Branch Susquehanna River in northwestern Clinton County.

There are over 65 miles of Class A streams within the watershed. Class A is a designation given by the PA Fish and Boat Commission which means that the particular section of stream has a healthy population of reproducing native brook trout and/or wild brown trout. Class A streams do not receive stocking of hatchery fish. Management of stream sections rated Class B through Class D is based upon wild trout reproduction (if any), recreational fishing pressure and potential, and available habitat, among other factors, and may or may not be stocked with hatchery trout.

Freestone streams are typically fed by surface water runoff and small feeder streams. The bedrock of these streams is generally sandstone, thus offering little buffering capacity to the stream from the effects of acid rain. In comparison, limestone streams have an excellent buffering capacity against acid deposition because of the calcium-rich rock (limestone) that adds alkalinity to the stream. Freestone streams originate from water that has traveled within that particular watershed, but limestone streams are fed through a network of underground channels that may contain water from several distant watersheds.

Several streams and/or reaches of streams have additional special classifications that imply certain fishing regulations and management objectives. For instance, Cross Fork is managed under the Heritage Trout Angling program and Hammersley Fork is managed under the Wilderness Trout Streams program. Hertitage Trout Streams are areas that have been managed for wild trout and have an historical significance as a

fly-fishing only stream. Designation of a Wild Trout stream is based upon stream habitat that supports wild trout and promotes "wild trout fishing in a remote, natural, and unspoiled environment where man's disruptive activities are minimized." The PA Fish and Boat Commission provides more details on these programs and the fishing regulations enforced for each.

Kettle Creek watershed also boasts as having the largest portion of any watershed in the state designated as "Exceptional Value (EV)" by the PA Department of Environmental Protection in its Chapter 93 Water Quality Standards. Kettle Creek watershed is EV from its source in southwestern Tioga County downstream to the reservoir at Kettle Creek State Park.

The reservoir itself is listed as "High Quality Trout-Stocking Fisheries" and the rest of the watershed from the outlet of the Alvin R. Bush Dam to its mouth at the West Branch Susquehanna River is listed as "Trout-Stocking Fisheries".

An EV stream has excellent water quality and healthy aquatic insect populations and species diversities. EV streams are protected from any possible type of pollution that could degrade the stream(s) from its current state.

In the Kettle Creek watershed, certain tracts of land that belong to the PA Bureau of Forestry are designated as Wild or Natural areas. Wild Areas (i.e. Hammersley Wild Area) are managed to preserve their wild or undeveloped character. No development of a permanent nature is allowed and land use is restricted to uses that will not have a permanent or long-range effect.

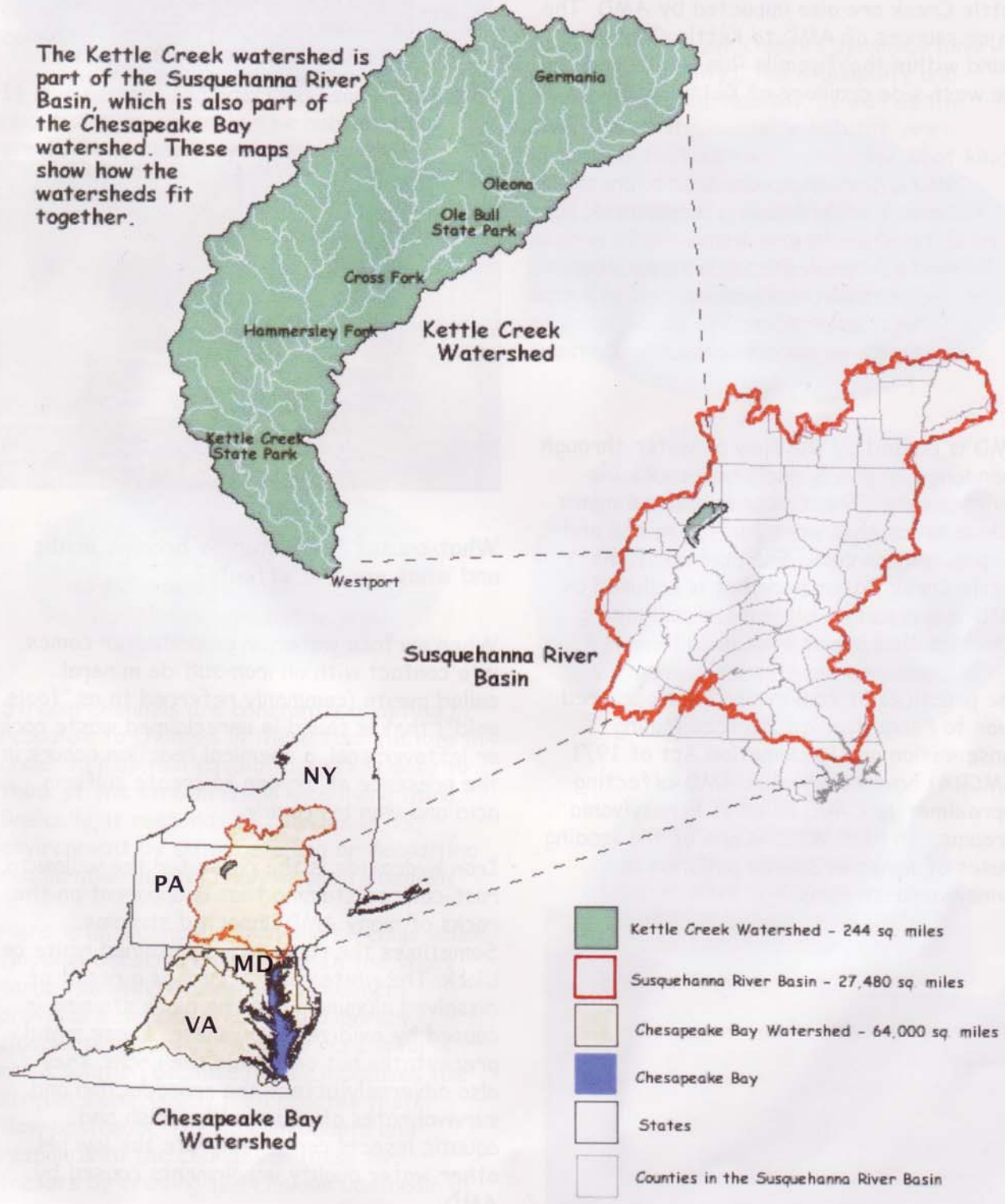
Natural Areas are typically managed to protect a specific botanical or geological area or feature(s) such as the F.H. Dutlinger Natural Area that protects a remaining stand of old growth hemlocks. Management of Natural Areas is much more restrictive than that for Wild Areas. For instance, timber harvesting is permitted on Wild Areas, but it is not allowed in Natural Areas.

Over 85% of the Kettle Creek watershed is contained within the state forest lands of Susquehannock, Sproul, and Tioga. Two state parks, Kettle Creek State Park and Ole Bull State Park are also found within the watershed. Ole Bull State Park, located in the middle of the watershed, was established in 1925. The park owns 125 acres and is utilized for camping, hiking, fishing, swimming, and other recreational pursuits.

The Civilian Conservation Corps (CCC) first established Kettle Creek State Park in 1935 with the development of a campground, beach area, and water system. Construction of the Alvin R. Bush Dam for flood control purposes by the U.S. Army Corps of Engineers was completed in 1962. This dam created a 160-acre lake that is popular for fishing, swimming, and boating.

Additionally, there are literally hundreds of miles of hiking trails in the watershed, many of them created by the CCC back in the 1930s. In the back of this book, contact information is listed for the state parks and district forestry offices that can provide you with more detail.

The Kettle Creek Watershed - Part of the Chesapeake Bay Watershed



Acid Mine Drainage in the Kettle Creek Watershed

Approximately the last six miles of Kettle Creek, before it empties into the West Branch of the Susquehanna River, are polluted with acid mine drainage (AMD). Many more miles of tributaries to lower Kettle Creek are also impacted by AMD. The major sources of AMD to Kettle Creek are found within the Twomile Run watershed and the west-side drainage of Kettle Creek.

Above their AMD impacted reaches, Kettle Creek and its tributaries support healthy populations of aquatic life. Several of the upper reaches of the tributaries are even designated as Class A wild trout waters.

AMD is typically characterized by one or more of the following conditions:
- *High acidity (low pH)*
- *High metal concentrations (i.e. iron, aluminum, manganese)*
- *High sulfate levels*
- *Excessive amounts of sediment*

AMD is caused by the flow of water through abandoned or poorly reclaimed coal mine environments. These abandoned coal mines include areas that were surface mined and deep mined for coal. The portion of the Kettle Creek watershed that is polluted by AMD is a result of bituminous coal mining activities that began back in 1886.

The practices of coal mining that occurred prior to Pennsylvania's Surface Mining Conservation and Reclamation Act of 1971 (SMCRA) have resulted in AMD affecting approximately 2,400 miles of Pennsylvania streams. In fact, AMD is one of the leading causes of nonpoint source pollution in Pennsylvania streams.

What causes the water to become acidic and what are the effects?

When surface water or groundwater comes into contact with an iron-sulfide mineral called pyrite (commonly referred to as "fools gold") that is found in unreclaimed waste rock or leftover coal, a chemical reaction occurs in the presence of oxygen to create sulfuric acid and iron hydroxide.

Iron hydroxide is the cause for the yellow to rust-colored staining that is apparent on the rocks of many AMD impacted streams. Sometimes the rocks may be stained white or black. The white color occurs as a result of dissolved aluminum and the black staining is caused by oxidized manganese. These metal precipitates not only stain the rocks, they also adversely affect the reproduction and survival rates of aquatic life. Fish and aquatic insects cannot tolerate the low pH other water quality impairments caused by AMD.

Stream Habitat and Channel Basics

Stream corridors are used by wildlife more than any other habitat type. Why? Streams provide an important source of water to wildlife populations and the vegetation adjacent to the stream channel in what is called the riparian zone provides food and cover for all types of wildlife.

It is important to understand some basics about stream channels, the habitat they provide, and how they function within a watershed. For instance, stream channels are formed, maintained, and altered by the water and sediment they carry. They are greatly influenced by the surrounding geology, topography, riparian vegetation, floodplains, and land uses within the watershed. Each of these influences channel geometry through four basic factors: sediment discharge, sediment particle size, streamflow, and stream slope.

Fluvial geomorphology is the study of stream channel processes related to sediment discharge and particle size, streamflow, and stream slope.

Stream channels are constantly adapting in response to changes in these four factors in order to maintain equilibrium. It is easy to think of the stream itself as a living thing. Basically, it responds to changes in its environment by either eroding or depositing sediment within its channel and floodplain.

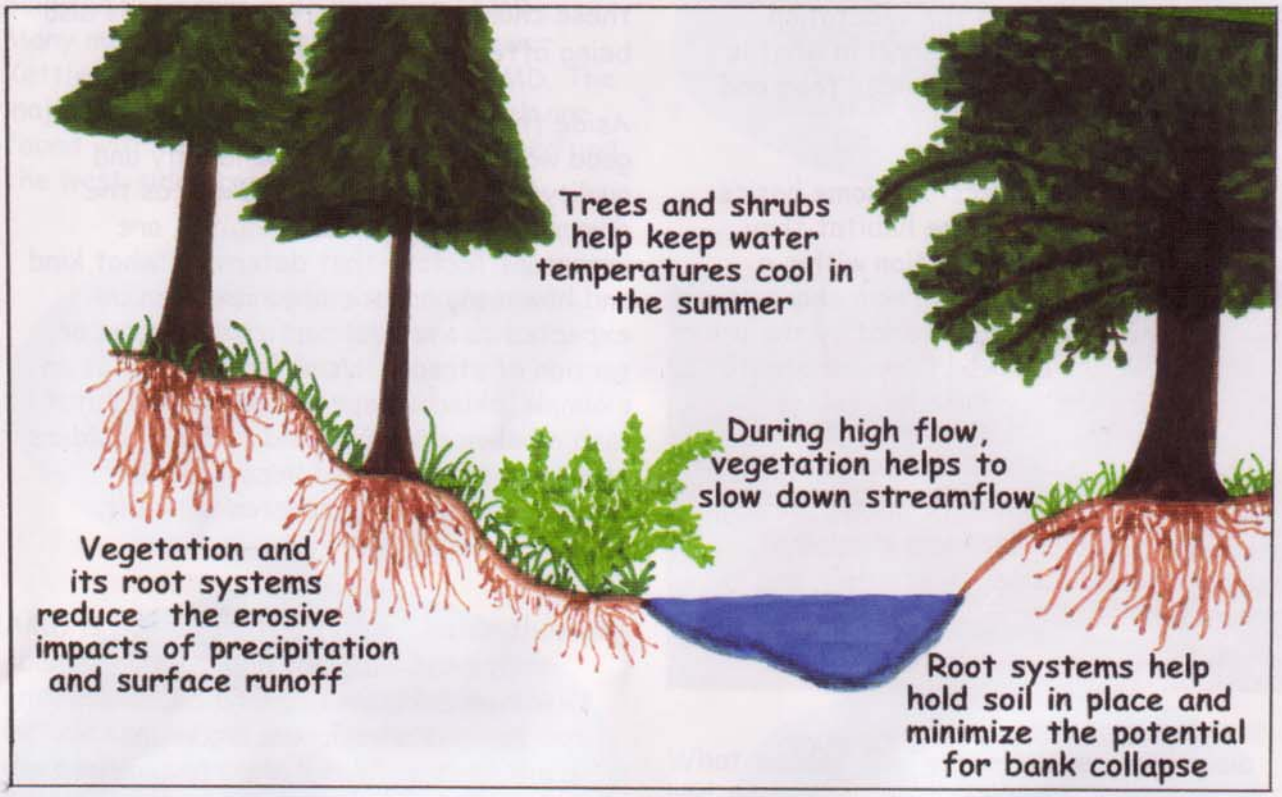
Here is an example - dredging streams when flooding becomes a problem. In the short term, removing accumulated sediment provides a deeper area for temporary floodwater storage. However, dredging is not a solution because it only increases the stream slope, which then creates faster flow upstream. The stream adapts and responds to the changes in these two factors by eroding the channel upstream of the dredged area and in no time, the dredged part of the stream fills in with sediment. And as the stream channel itself is adjusting to these changes, the instream habitat is also being affected.

Aside from stream channel dynamics (and good water quality), the availability and quality of stream habitat, as well as the diversity of the available habitat, are important factors that determine what kind and how many aquatic organisms can be expected to live in a particular stream or section of stream. Using brook trout as an example, this fish species requires habitat with a balance of pools and riffles, boulders or large woody debris for cover, and substrate that is not covered with silt.

Habitat Availability and Quality:
Is there adequate habitat available for fish and other aquatic organisms?
Is the substrate "clean" or is it covered with silt or mud?
Are the fish able to travel and access tributaries and a variety of habitats (are the different habitat types connected)?

Habitat Diversity:
How many different types of habitat are available?
Are there reaches of fast-moving shallow water and slow-moving deeper water?
Are there fallen logs, branches, large rocks, and undercut banks?
Is there a variety of substrate (i.e. gravel, cobble, boulders) present?

In addition to providing habitat and food for wildlife, riparian vegetation has a critical role in helping to maintain bank stability. Riparian vegetation also serves as a buffer zone to reduce the amount of silt and pollution that reaches a stream through runoff. The illustration below demonstrates some of the important roles of a riparian buffer zone:



Water temperature is greatly affected by the presence or absence of riparian vegetation. A lack of cover allows direct sunlight to significantly warm streams, particularly during summer periods of low flow.

Water temperature is also very important in determining the different types and abundances of aquatic organisms found in streams. In fact, water temperature alone may govern what species of fish are able to live and where. For example, brook trout and slimy sculpins dominate coldwater streams (no higher than 75 degrees Fahrenheit), whereas smallmouth bass, suckers, and various minnows are not as sensitive to water temperature and may be present in warmer streams.

Why is water temperature so important to aquatic organisms? Fish and aquatic insects maintain a body temperature that is the same as the surrounding water; therefore, the growth rates, development, and behavioral patterns of these aquatic organisms are largely determined by the water temperature. Additionally, aquatic organisms require an abundant supply of dissolved oxygen and high water temperature, among other factors, contributes to the depletion of dissolved oxygen.

Stream Habitat Improvement Techniques

Many landowners are concerned about losing streambank property during high water events or know of a certain reach of stream where erosion problems persist. A quick glance at a muddy stream bottom can show just how detrimental eroding streambanks are to life in the stream. There are things that you can do to improve bank stabilization, while at the same time providing better habitat that can be enjoyed by you and your wildlife neighbors.

The next several pages will describe some simple and effective streambank stabilization techniques and tips for planning riparian buffer zone projects that any landowner can easily implement themselves. But, there are some important considerations and steps to take before planning such project.

Since the following methods all utilize live trees, shrubs, and/or cuttings of these plants such as willows, timing of your installation is vital to your success. Typically the best time for these projects is in the early spring or late fall when most plants are in or nearing dormancy. You should doublecheck with your county conservation district depending on what types of plants you will be using. A list of additional resources and contacts is found on pages 23-24 of this handbook.

The following list highlights some tips to keep in mind when planning your planting project:

- Always contact your county conservation district to find out if permits will be necessary, particularly if your project plan includes regrading of the streambank.
- Never disturb a site more than absolutely necessary.
- Know your project site, in all seasons.
- Prepare the site from top to bottom and plant the site from the bottom up.
- Do not underestimate the power of mother nature to take your project down stream!
- Be aware that your project may undergo changes by your wildlife neighbors (deer, beaver, birds) and consider fencing in newly planted trees or using tree tubes.
- Be sure to plan for the maintenance (such as watering) and monitoring of your project.
- Do your research. Be sure to determine the slope, soil suitability, moisture, and sunlight availability for your project site and choose plants suited for those conditions.
- Don't plant only trees. Incorporate shrubs into your project plans. Many shrubs reach full size in just a few years and will provide wildlife and habitat benefits while you wait for the trees to mature.
- A list of trees, shrubs, and wildflowers that are native to the Kettle Creek watershed is provided on pages 21-22 of this handbook.

A popular method for improving streambank stability and creating fish habitat is installing instream devices such as log deflectors or rock vanes. However, these instream devices are designed using a series of measurements and equations.
***Do not** attempt to construct or design any such project. Seek the consultation of trained professionals. Your local county conservation district can offer direction and assistance if you are considering this type of project.*

What is the recommended size for a riparian buffer zone?

An ideal buffer is at least 35 feet wide, however just make yours as wide as possible. After all, a little riparian vegetation to serve as a buffer strip is better than none at all! Work with neighbors and adjacent landowners to plant and maintain riparian vegetation along the entire length of the stream or where possible. You'll be amazed at the benefits!

Tip:
Where you do maintain a lawn, set the mower blades to at least 3 inches. Taller grass slows runoff, resists drought, and needs less fertilizer. Try it!

Why the big deal about native plants?

Native plants are adapted to local soil and growing conditions, so they are much easier to maintain and need less watering and fertilizer. In addition, native plants attract wildlife and provide numerous benefits in the form of habitat and food to the critters.

Native plants are also more likely to have developed defenses against insects and diseases.

Leaf litter and other organic material from native vegetation provide more nutrients to aquatic organisms than non-native (exotic) plants. In fact, some exotic plants may even be toxic to wildlife.

What exactly is a non-native or exotic plant? Are they bad to have?

Plants that have not originated in a particular region but instead may have been brought to the area either intentionally such as for ornamental purposes, or unintentionally, are called non-native, exotic, alien, or introduced. In some cases non-native plants can also be invasive and this is a serious problem.

Invasive (also called noxious) plants will aggressively invade streamside areas and completely take over the riparian zone. In fact these species can be so successful that they will significantly reduce the number or even eliminate native plants and wildlife on the site that it invades.

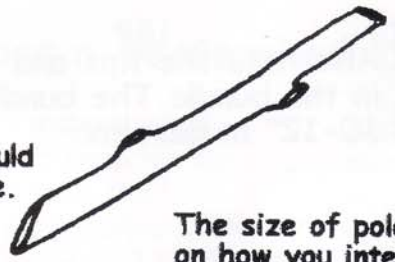
Controlling invasive plants is not an easy task because many of them reproduce from ground root systems and seeds. It is recommended that invasive plants be removed as much as possible before implementing any riparian buffer zone project. Many of the resources listed in the back of this handbook offer helpful suggestions on how to handle this problem.

Some invasive plants to be on the lookout for:
Multiflora rose
Autumn olive
Japanese knotweed
Canada thistle
Purple loosestrife
Japanese barberry
Bush honeysuckles
Norway maple
....and many more

POLE CUTTING

The most basic technique for bank stabilization takes advantage of the ability of certain plants to grow from branches cut from a live plant. This method of revegetation is known as pole cutting.

Pole cutting is basically cutting a section of a plant that roots easily (commonly willow), trimming off twigs to form a stake, and then driving the stake into the ground where it will take root and grow. The stakes are placed about a foot and a half apart with 1/3 of the stake left above the ground surface. Since some of the stake is left exposed above the ground level, it can be used as an anchor for more elaborate bioengineering efforts. Placing the stakes in a random fashion helps to prevent gullying.



Cut the tip so that it has a flat surface. This will make it easier to pound into the ground and prevent it from splitting.

The butt end should be cut at an angle. This is the end you will plant in the soil.

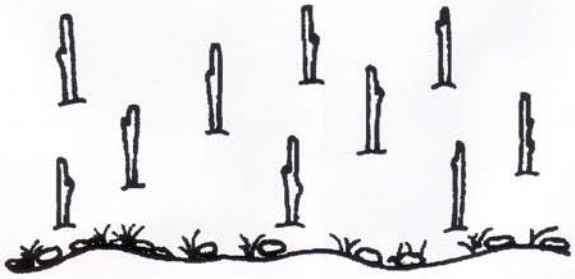
The size of pole cuttings will vary depending on how you intend to use them. Remember that 2/3 of the pole should be in the ground with the upper 1/3 exposed.

Stakes: Length=18" max
Diameter=1/2"-1 1/2"

Posts: Length=18"-4 ft
Diameter=6"-10"

1. **You may use a construction stake (metal pole with a point) and a sledge hammer to help make your hole. Wiggle the stake back and forth after every few strikes so it can be easily removed after making the hole as deep as possible.**

2. **Place the live pole cutting into hole with angled end (butt end) on bottom. Using a board to prevent the pole from splitting (if pole splits, it must be discarded) and a sledge hammer, pound 2/3 of pole into ground. Fill hole with with soil and compact it so the pole cutting is firmly in ground.**

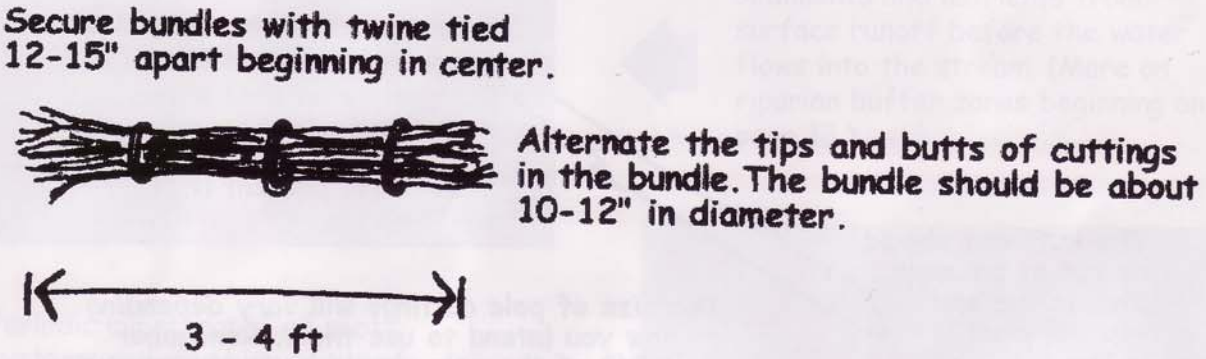


Placing live pole cuttings in a random pattern helps to prevent gullying. It is best to start at the toe of the bank and work your way up.
***A good rule of thumb is to plant 2-4 stakes per square yard.**

FASCINE BUNDLES

A fascine bundle is simply a bundle of live and dead material tied with twine. Willow or alder branch cuttings are good to use. These bundles are placed in long, shallow trenches dug along the topographic contours. The fascines are secured with pole cuttings and the trenches are filled with topsoil.

Eventually the poles and the fascines themselves will grow and add further stability to the bank. This method is often used at the top and toe of the slope and in conjunction with other methods to provide additional stability.



Push the ends of each fascine bundle into the end of another bundle to create one long, continuous fascine bundle. It should be the same length as the trench that has been dug. You can secure the ends together with twine. See the pictures below.

Each individual fascine bundle has been connected to another to create one long fascine bundle.

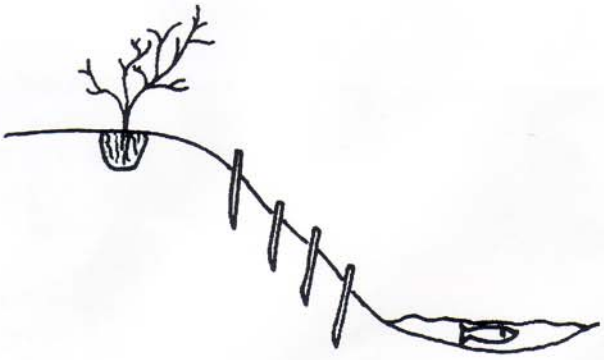
The entire fascine bundle is placed into the trench that has been dug along the contour of the regraded streambank.

BRUSH LAYERING AND REGRADING

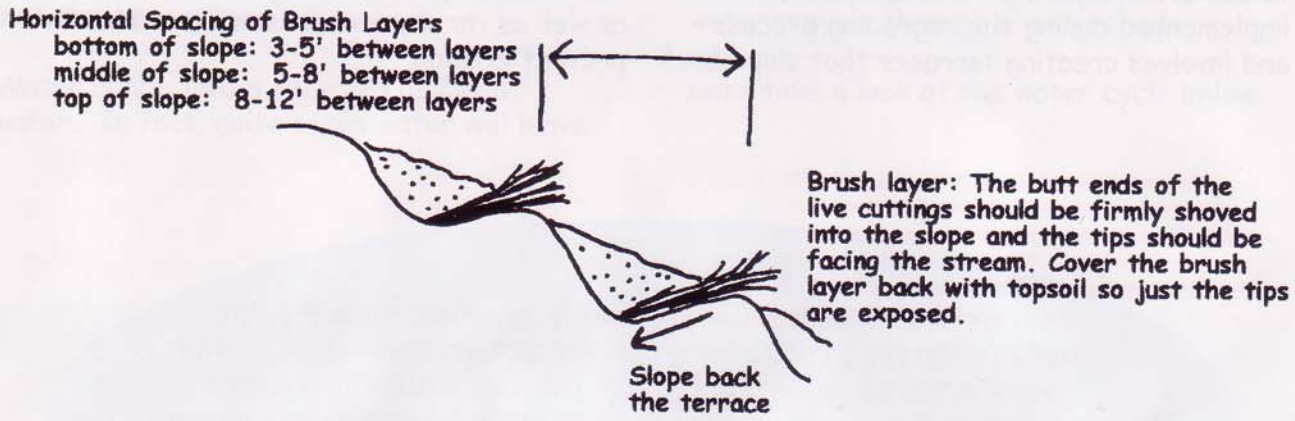
Sometimes slopes are too steep to stabilize and must be regraded. A good way to prevent erosion of the newly regraded slope is to use brush layering. This method is implemented during the regrading process and involves creating terraces that slope back into the bank. Into these terraces a layer of live and dead brush is placed before the entire slope is filled, leaving only the tips of the brush exposed. The growth of the brush, as well as its physical presence combine to prevent erosion.

It is important to consult with your county conservation district before implementing any ground-moving activities such as regrading. A general permit is typically required before such projects. In addition, your local conservation agency can provide assistance to you in planning your stream enhancement project and in choosing the best native plant species for your site. Pages 23 and 24 in this handbook provide names and contact information for agencies and organizations that may offer assistance and/or grant programs for riparian buffer projects.

Severely eroded and undercut banks like this may need to be regraded prior to any planting.
***Make sure to obtain the permits necessary for ground-moving activities before implementing any such project.**



Regrading the bank to a gentler slope (3:1 is good, 5:1 is ideal if you have enough ground and/or fill to work with) will create an area more suitable for successful plant growth. Using pole cuttings on the regraded streambank and container or bareroot plants on the top of the bank is one possible plan for establishing vegetation.



A terrace is dug on the regraded streambank for brush layering.

The brush layers are installed with the butt ends shoved into the bank and the tips pointing toward the stream.

Medium to Large Trees

COMMON NAME	SCIENTIFIC NAME	Growth Height (ft.)	Bloom Period	Bloom Color	Fall Color	Wildlife Value	Light Preference	Moisture Preference	Flood Tolerance	Miscellaneous
American Basswood (or Linden)	*Tilia americana*	75	May-Jun	pale yellow	yellow/green	high	full sun to shade	moist	intolerant	flowers aromatic, with herbal uses; multiple trunks; wood to make boxes, venetian blinds, sashes, doors, picture frames and furniture
American Beech	*Fagus grandifolia*	100	Apr-May	yellow	yellow	very high	partial sun to shade	moist	v. intolerant	timber - used in some furniture; potential food item (nuts..)
Bigtooth Aspen	*Populus grandidentata*	70	Apr-May	yellow	yellow	high	full sun	wet to moist	tolerant	timber - used in some furniture; wood is used chiefly for making paper;
Black Ash (or Swamp Ash)	*Fraxinus nigra*	70	Mar-Apr	white	vivid red	moderate	full to partial sun	wet to moist	v. tolerant	wood is used for sporting goods (especially baseball bats), handles, agricultural tools, and furniture; potential herbal or medicinal uses; baskets can be woven from slats
Black Gum (or Black Tupelo)	*Nyssa sylvatica*	75	May-Jun	green	brilliant red	moderate	full sun to shade	moist	intermediate	wood is difficult to split and is used for boxes, fuel and railroad ties; ornamental; abundant blue fruit
Black Willow	*Salix nigra*	50	Mar-Apr	green	yellow	high	full sun	wet to moist	v. tolerant	wood is used in wickerwork and the bark contains medicinal compounds
Eastern Hemlock	*Tsuga canadensis*	100	May-Jun	yellow/greenish	evergreen	very high	partial sun to shade	moist	intolerant	evergreen conifer; construction timber; PA State tree; tolerates acid soils; potential food item/ herbal use; source of tannic acid for tanning leather
Eastern White Pine	*Pinus strobus*	75	Jun-Jul	yellow/pink	evergreen	very high	full sun to shade	moist to dry	intolerant	most valuable timber trees; evergreen conifer; tolerate acid soils; often planted as an ornamental
Flowering Dogwood	*Cornus florida*	50	Mar-Apr	white (sometimes pink or red)	bright red to reddish	high	partial sun to shade	moist	v. intolerant	ornamental, attractive berrylike, elliptical, shiny red fruits; wood used primarily for textile weaving shuttles is also made into spools, small pulleys, mallet heads, and jeweler's blocks
Northern Red Oak	*Quercus rubra*	80	Apr-May	yellowish green	russet-red	very high	full to partial sun	moist to dry	intermediate	wood is used for furniture, flooring, millwork, railroad ties and veneer; hardy and long lived; tolerate acid soils; potential food item; often planted as a shade tree
Pin Oak	*Quercus palustris*	75	Apr-May	yellow	red	very high	full sun	wet to moist	tolerant	ornamental - beautiful form; wood tends to warp and split during drying good for fuel
Red Maple	*Acer rubrum*	50	Mar-Apr	brilliant red or orange	crimson	very high	full sun to shade	wet to dry	tolerant	ornamental; adaptable; wood sometimes used for furniture; potential food item (maple syrup); grows best in wet soils
Sassafras	*Sassafras albidum*	50	May-Jun	yellow	yellow/crimson	high	full sun to shade	moist to dry	v. intolerant	used in making perfumes; potential food item (tea, candy..); potential herbal or medicinal uses; has dark blue, shiny berries; leaves aromatic when crushed; wood used chiefly for fuel and fence posts
Shagbark Hickory	*Carya ovata*	80	May-Jun	yellow		very high	full sun to shade	moist		wood of all the hickories is heavy, hard, and strong and used principally for tool handles; a valuable fuel wood; is used to give a smoked flavor to meats; potential food item (nuts..)
Silver Maple	*Acer saccharinum*	100	Mar-Apr	yellow	greenish-yellow	high	full sun to shade	moist	tolerant	ornamental - lacey green and silvery leaves
Sugar Maple	*Acer saccharum*	70	Apr-May	yellow	bright yellow, orange or red	very high	partial sun to shade	moist	intolerant	valuble timber (used for furniture, musical instruments & flooring); potential food item (maple syrup)
Sycamore (or Buttonwood or American Planetree)	*Platanus occidentalis*	100	Apr-May	red	yellow	low	partial sun to shade	wet to moist	intermediate	wood is used for furniture, butcher blocks and flooring; good shade tree
Tuliptree (or Yellow poplar, Tulip poplar, White poplar and Whitewood)	*Liriodendron tulipifera*	100	Apr-May	yellow	yellow	moderate	full sun	moist	intermediate	wood is valuable for veneer and many other uses; good shade tree
White Ash	*Fraxinus americana*	100	Apr-May	yellow	brilliant yellow, orange, purple to dark maroon	very high	full to partial sun	wet to moist	intermediate	wood is used for sporting goods (especially baseball bats), handles, agricultural tools, and furniture; potential herbal or medicinal uses
White Oak	*Quercus alba*	100	Apr-May	yellow	purplish-red to violet-purple	very high	full to partial sun	dry to moist	intolerant	valuble timber - traditional uses include hardwood flooring, whiskey barrels and boat building
Yellow Birch	*Betula alleghaniensis*	80	Apr-May	yellow	yellow	very high	partial sun to shade	moist	tolerant	catkins in winter; wood used for distilling wood alcohol, acetate of lime, tar, and oils; potential food item (oil of wintergreen occurs in sap); prefers north facing slopes

Small Trees & Shrubs

COMMON NAME	SCIENTIFIC NAME	Growth Height (ft.)	Bloom Period	Bloom Color	Fall Color	Wildlife Value	Light Preference	Moisture Preference	Flood Tolerance	Miscellaneous
Alternate-Leaved Dogwood	*Cornus alternifolia*	20	May-Jun	white	yellow or red	very high	partial sun to shade	moist	intermediate	multi-stemmed; pinkish fruit stalk with blue-black berrylike fruits; understory
American Elder (or Common Elderberry)	*Sambucus canadensis*	12	Apr-May	white	yellow/green	very high	full sun to shade	moist to wet	v. tolerant	multi-stemmed; produces many small black or purplish-black berries " Elderberries"; potential food item - edible flowers & berries (berries are inedible when fresh and raw but are used for making jelly, preserves, pies, and wine); open areas near water at forest edges.
American Witchhazel	*Hamamelis virginiana*	25	Sept-Nov	yellow	yellow	low	partial sun to shade	moist	intolerant	multi-stemmed; fragrant; medicinal; branches used as divining rods; understory
Common Buttonbush	*Cephalanthus ocidentalis*	12	Apr-May	white	******	high	full sun to shade	wet	v. tolerant	foliage is poisonous and unpalatable to livestock; ornamental - spreading, many-branched; buttonlike balls of fruit; is also a honey plant; grows in wet areas

Small Trees & Shrubs Continued

COMMON NAME	SCIENTIFIC NAME	Growth Height (ft.)	Bloom Period	Bloom Color	Fall Color	Wildlife Value	Light Preference	Moisture Preference	Flood Tolerance	Miscellaneous
Common Winterberry	*Ilex verticillata*	12	May-Jun	greenish to yellowish white	yellow	very high	full sun to shade	wet to moist	v. tolerant	Scarlet red to orange berries; ornamental; Swamps, damp thickets, pond margins; grows in both wet and dry sites.
Mapleleaf Viburnum	*Viburnum acerifolium*	6	May-Jun	yellowish white	reddish purple, purplish pink	very high	full sun to shade	wet to moist	intermediate	ornamental; multi-stemmed; potential food item - edible berries
Mountain Laurel	*Kalmia latifolia*	20	Apr-May	white, pink, purple	evergreen	low	full sun to shade	moist to dry	intolerant	thicket-forming ; beautiful flowers - ornamental uses; acid soils; understory; wood has been used for tool handles and turnery, and the burls, or hard knotlike growths, for briar tobacco pipes.
Northern Spicebush	*Lindera benzoin*	12	Apr-May	white, pale yellow	bright yellow	very high	full sun to partial shade	moist	intermediate	Swamps and wet woods; leaves produce an aromatic, spicy fragrance when crushed; shiny red berries; potential food and herbal uses.
Red-Osier Dogwood	*Cornus sericea*	12	Jun-Aug	white to cream	reddish	very high	full sun to partial shade	wet to moist	v. tolerant	Large, spreading, thicket-forming shrub; purplish-red stems; small whitish fruit; ornamental; potential food and herbal uses.; crafts; spreads readily
Rosebay Rhododendron	*Rhododendron maximum*	20	Apr-May	waxy white or light pink (rarely reddish)	evergreen	low	partial sun to shade	moist	tolerant	forms dense thickets; understory; beautiful flowers, ornamental uses; wood is occasionally used for tool handles; potential medicinal uses.
Downy Serviceberry (or Shadbush, or Shadblow)	*Amelanchier arborea*	20	Mar-May	yellow	yellow to red	high	full sun to partial shade	moist to dry	tolerant	ornamental - showy clusters of flowers; red-purple fruits - like a small apple, edible, nearly dry or juicy and sweet; potential food item; pulp wood uses
Silky Willow	*Salix sericea*	12	mid Jun	green	yellow	imtermed	full sun to shade	wet	v. tolerant	catkins; needs wet conditions; multi-stemmed

Wildflowers

COMMON NAME	SCIENTIFIC NAME	Growth Height (ft.)	Bloom Period	Bloom Color	Light Preference	Moisture Preference	Miscellaneous
Allegheny Monkeyflower	*Mimulus ringens*	3	Jun-Sept	blue-purple, violet	full sun to partial shade	wet to moist	grows in moist places - wet meadows and streambanks; interesting flowers - look like a monkey's face
Blackeyed Susan	*Rudbeckia hirta*	3	May-Sept	orange-yellow	full sun to shade	moist to dry	bright daisy-like flowers; long bloom time; many cultivars; fields, prairies, and open woods
Blue Vervain	*Verbena hastata*	5	Jun-Sept	blue-violet	full sun to partial shade	wet to moist	bright flowers; potential herbal uses; damp thickets, shores, roadsides
Canadian Wildginger	*Chelone glabra*	1	Apr-May	red-brown to green-brown, maroon	full shade	moist	rich woods; potential food and herbal uses
Common Milkweed	*Asclepias syriaca*	6	Jun-Aug	purplish to pink	full sun to partial shade	moist to dry	old fields, roadsides, and waste places; interesting seed pods; butterflies; potential food item
Cutleaf Coneflower	*Rudbeckia laciniata*	6	Jun-Sept	yellow	full sun to partial shade	moist to dry	Moist meadows, slopes, and valleys in the mountains; tall daisy; tolerates wet soil; herbal
False Solomon's Seal	*Smilacina racemosa*	2	May-Jul	white	partial sun to shade	moist to dry	plumelike flower; red berries; herbal uses
Heartleaf Foamflower	*Tiarella cordifolia*	1	Apr-Jul	white	partial sun to shade	moist	attractive, long blooming flower; many cultivars
Jack in the Pulpit	*Arisaema triphyllum*	3	Apr-Jun	green or purplish-brown	partial sun to shade	wet to moist	Damp woods and swamps; unusual flower; bright red berries; potential food item.
Little Evening-Primrose (sundrops)	*Oenothera perennis*	2	Jun-Aug	yellow	full sun	moist to dry	bright flowers; long bloom time
Partridge-Berry	*Mitchella repens*	1	Jun-Jul	white	partial sun to shade	moist to dry	evergreen; highly ornamental foliage; it can be used as a groundcover under acid-loving shrubs; fragrant, tubular, paired flowers; scarlet berry-like fruits; potential food item - berries edible; potential herbal uses
Red Columbine	*Aquilegia canadensis*	3	May-Jun	red & yellow	partial sun to shade	moist to dry	Rocky, wooded or open slopes; showy, drooping, bell-like flowers; spreads by seeds; attracts hummingbirds
Scarlet Bee-Balm	*Monarda didyma*	5	Jul-Aug	red	full sun to shade	moist	showy flowers; aromatic; herbal uses; attracts butterflies
Spotted Geranium (or Wood Geranium)	*Geranium maculatum*	2	Apr-Jun	Lavender	full sun to shade	moist	woods, thickets, and meadows; adaptable; long bloom time; spreads well; herbal uses
Tall Meadow-Rue	*Thalictrum pubescens*	8	May-Jun	white	full sun to shade	wet to moist	tall plant; delicate, clusters of plumy flowers; swamps, meadows, streamsides; attracts bees and butterflies
White Baneberry (doll's eyes)	*Actaea pachypoda*	3	Apr-Jun	white	full shade	moist	interesting white berries; poisonous
White Turtlehead	*Chelone glabra*	3	Jul-Sept	whitish	full sun to shade	wet to moist	wet thickets, streambanks, low ground; interesting flowers - resemble a turtle's head; strong grower; herbal uses; attracts hummingbirds
Wrinkleleaf Goldenrod	*Solidago rugosa*	6	Jul-Nov	yellow	full sun to shade	moist	aggressive; tough plant; attracts butterflies