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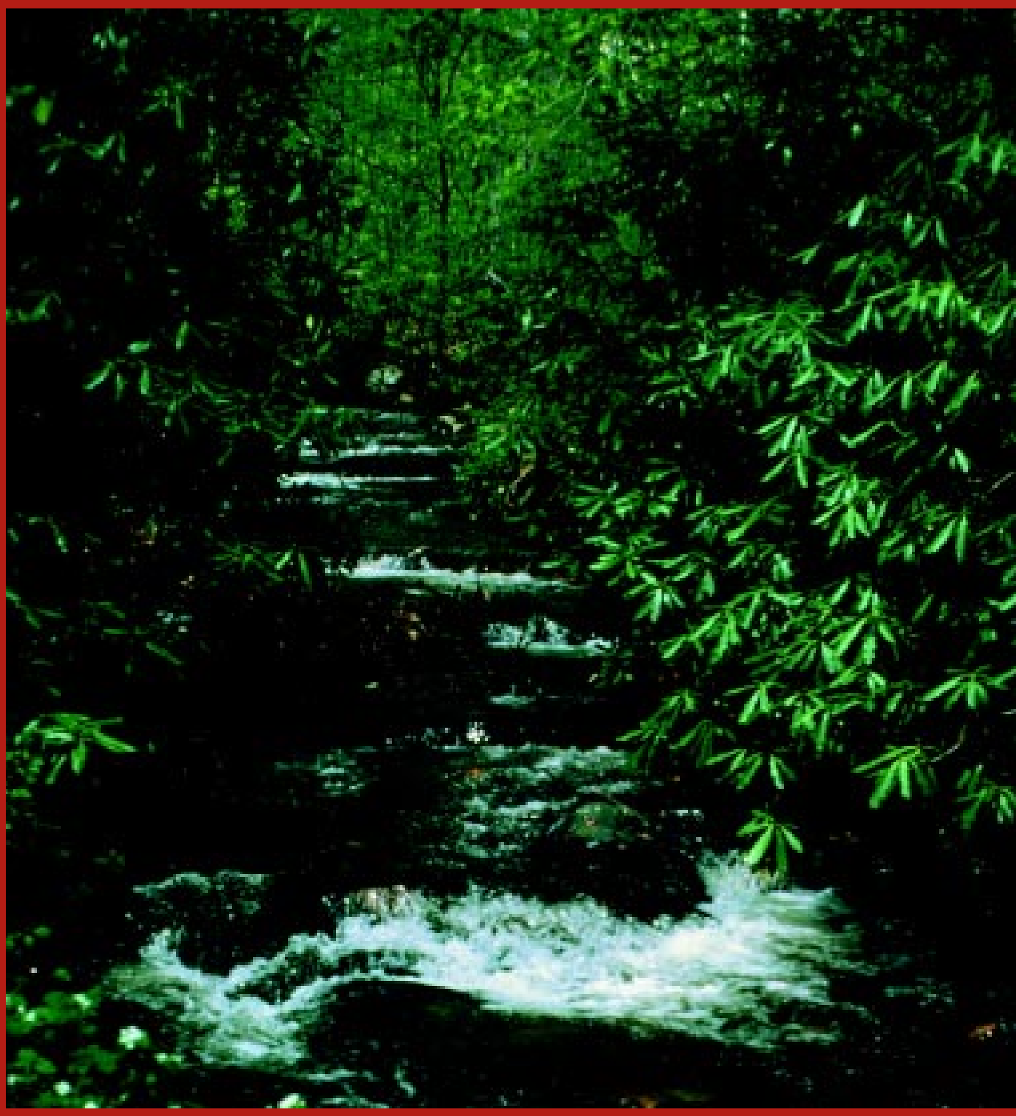
Landowner's Guide to Managing Streams in the Eastern United States



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VIRGINIA STATE UNIVERSITY

Landowner's Guide to Managing Streams in the Eastern United States

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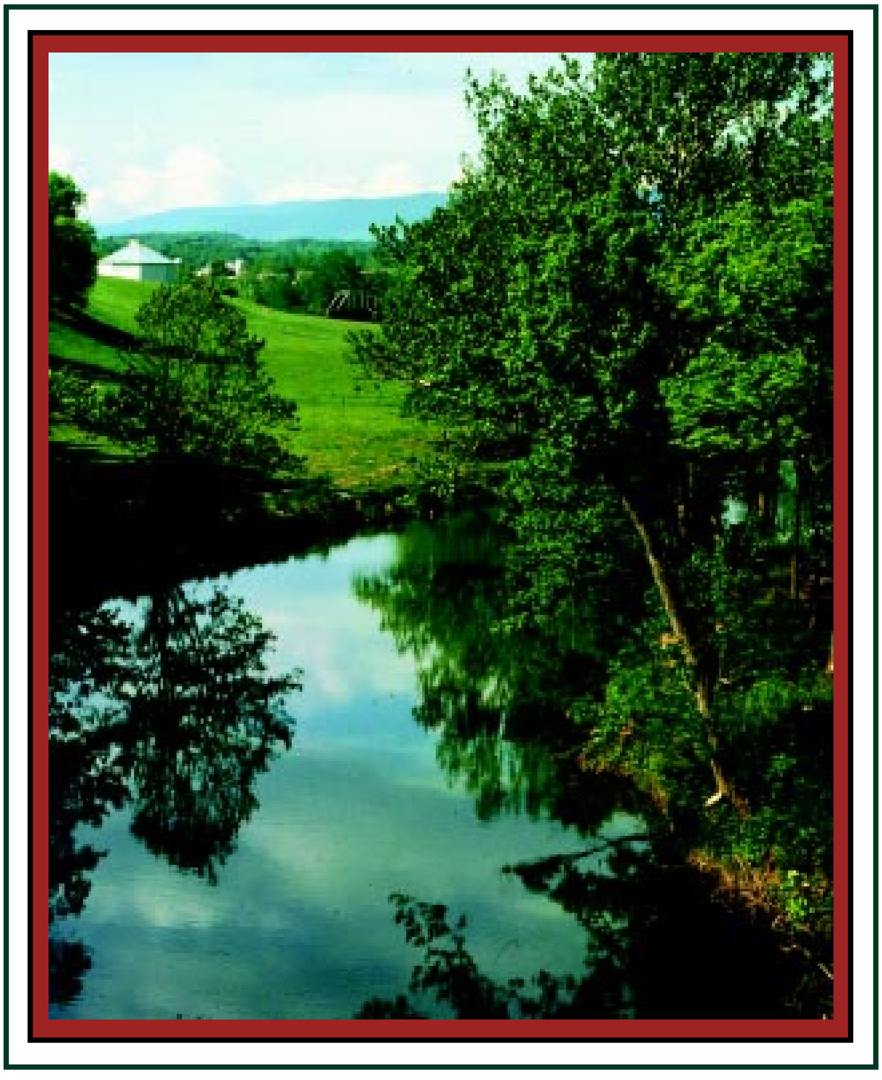

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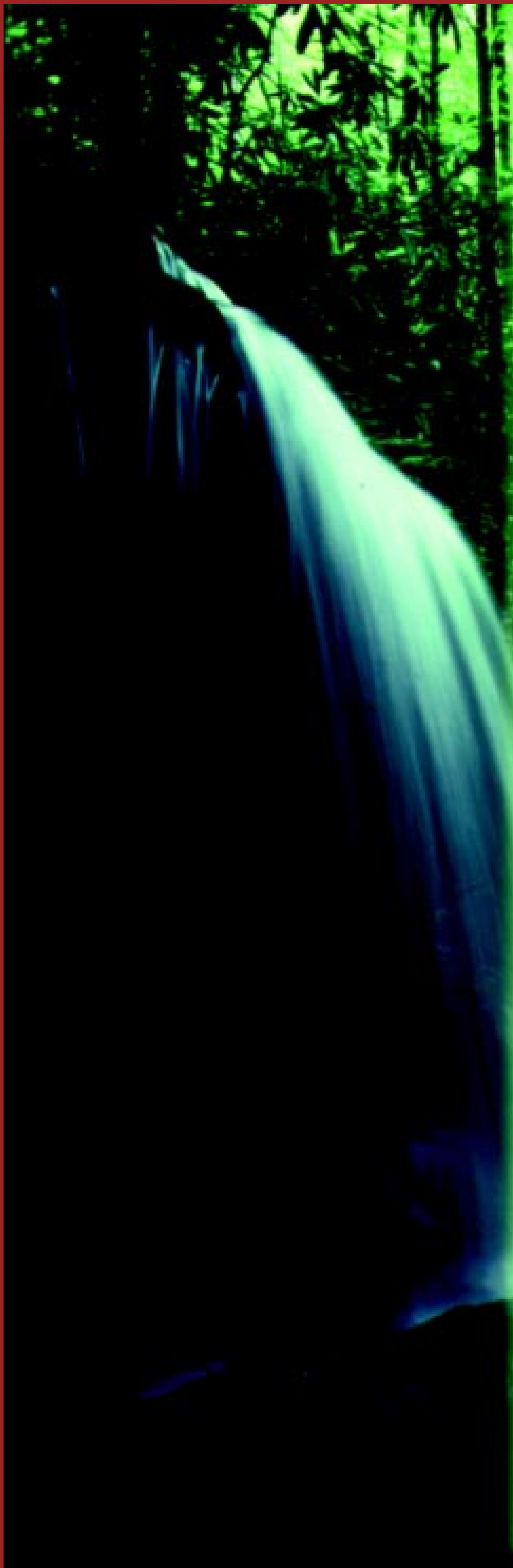


INTRODUCTION

The eastern United States is blessed with an abundance of streams. These flowing waters occur in a variety of settings, shapes, and sizes. They range in character from steep-gradient, swift-flowing, mountain streams to flat-gradient, slow-flowing pasture streams. There are woodland streams, meadow streams, marsh streams, and even urban streams. Some are coldwater trout streams and others are warmwater bass streams. A single stream may support both sportfish, with trout occupying the cold waters and bass inhabiting the warmer waters.

No two streams are alike, but many share certain problems and characteristics. For example, all streams are products of the land they drain, and their waters reflect streamside land management practices, good and poor. Much can be done to protect clean streams and restore damaged ones. Since most streams originate on private lands, their fate depends largely on wise management by streamside landowners. This publication provides general information and management guidelines to help stream property owners and their neighbors protect, improve, and restore these valuable running waters.

Stream water quality largely depends on land use practices such as farming, mining, and forestry in the upstream drainage basin

STREAM SIZE

Streams are called brooks, branches, creeks, cricks, forks, or runs, depending on local custom. In Webster's Dictionary, streams are defined as small rivers. How large is a stream and how small is a river? Apparently, whether a watercourse is termed a stream or a river has depended on the judgment of the person who first discovered and named it. In this publication, streams are defined as flowing waters that are shallow enough to wade across and less than 40 feet wide during normal flow; deeper, larger watercourses are rivers. This distinction is convenient but simplistic, since streams and rivers flow together, forming interconnecting waterways.

The smallest streams are termed headwater or first-order streams. They can be categorized as permanent or intermittent based on their seasonal flow pattern. Permanent streams flow throughout the year. Intermittent streams dry up at certain times of the year. Landowners often assume that tiny streams, particularly intermittent ones, are not important. However, they play significant roles by providing clean, clear water to larger streams and rivers, and by supporting valuable sportfish and wildlife.

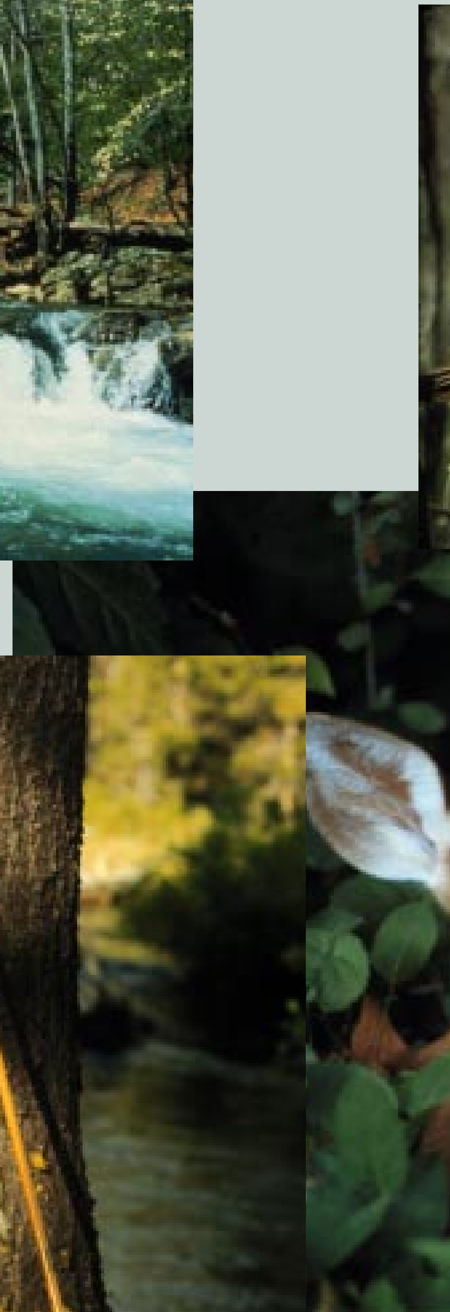
In fact, many tiny feeder streams are essential spawning and nursery areas for trout, bass, and other gamefish. Adult sportfish spawn in tributary streams that have clean gravel and suitable cover to protect their young from predators. Even the smallest tributary, including those narrow enough to step across and those that occasionally dry up, can add value to property and benefit fish and wildlife.

DRAINAGE BASIN

If you look at the shape of a stream on a map or aerial photo, notice that its branching pattern appears tree-shaped (dendritic). Most streams have a main trunk with smaller connecting branches (tributaries). In a single stream system, each stream is a tributary of the larger stream it joins and all streams are tributaries of the main stem.

The land area drained by a stream is called a drainage basin. This is a low area or valley that collects water from a stream. Protecting and improving a stream usually depends on managing activities in the drainage basin. Obviously, upstream landowners influence the amount and quality of water available to those downstream. In other words, your stream is at the mercy of your stream neighbors, so cooperation among adjacent stream property owners is essential for stream protection and management.

Running the rapids on a free-flowing stream is an exciting weekend escape from the hectic workday pressures of modern life.



HOW MUCH IS YOUR STREAM WORTH?

Streams are valuable assets. They offer riparian (streamside) landowners generous, long-term benefits in return for minimal care and expense. Some benefits are financial, providing income either in cash returns or dollar savings. Other benefits are less conspicuous, but equally valuable. Here are some major benefits provided by freshwater streams.

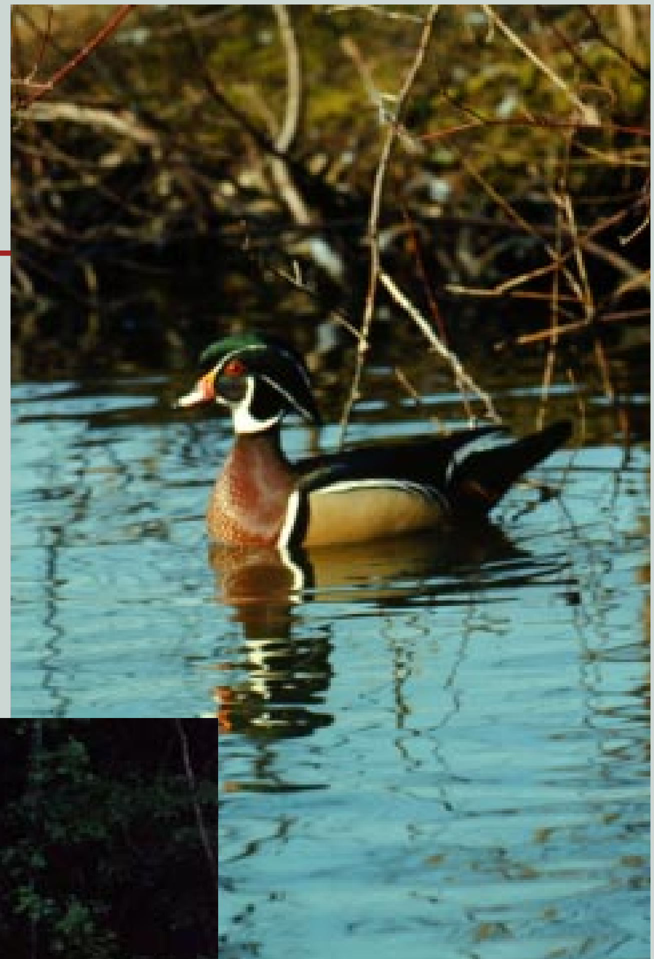
Agricultural and domestic benefits:
Cropland irrigation
Livestock watering
Bottomland timber production
Fire protection
Drinking, bathing, cleaning water
Groundwater supplies
Wastewater processing
Energy production (hydropower)
Streamside real estate
Fish farming
Fish and wildlife benefits:
Sportfish and shellfish habitat
Wildlife habitat
Endangered species habitat
Recreational and scenic benefits:
Fishing, hunting, trapping
Swimming, boating, camping
Tranquillity, scenic beauty
Nature study, education

Small coldwater streams provide ideal sportfish habitat, producing trophy trout such as the "lunker" brown trout harvested here.

Large, secretive animals such as wild turkey, deer, bear, and bobcats find refuge and food along streamside bottomlands.

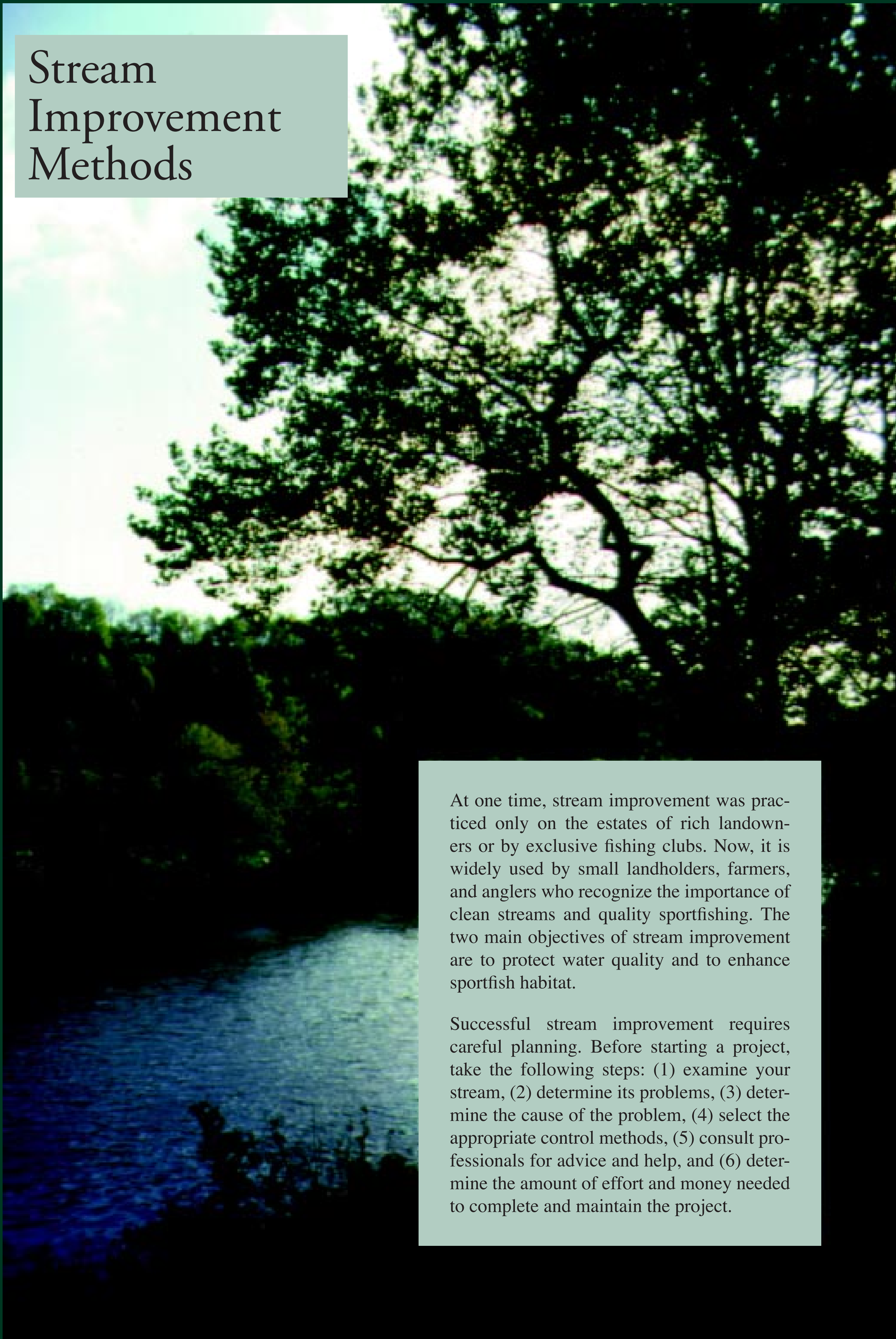
Wood ducks and other waterfowl use streams for nesting and brooding, as well as travel routes during spring and fall migration.

Streamsides are vital breeding, nursing, nesting, and feeding areas for young and adult wild animals.



Stream fishing is a major outdoor delight pursued by millions of anglers in the eastern United States.

Stream Improvement Methods



At one time, stream improvement was practiced only on the estates of rich landowners or by exclusive fishing clubs. Now, it is widely used by small landholders, farmers, and anglers who recognize the importance of clean streams and quality sportfishing. The two main objectives of stream improvement are to protect water quality and to enhance sportfish habitat.

Successful stream improvement requires careful planning. Before starting a project, take the following steps: (1) examine your stream, (2) determine its problems, (3) determine the cause of the problem, (4) select the appropriate control methods, (5) consult professionals for advice and help, and (6) determine the amount of effort and money needed to complete and maintain the project.

PROTECT STREAMBANK PLANTS

The easiest, most effective way to protect your stream is to maintain a strip of plants along the bank. Lush growths of grasses, shrubs, and certain trees are essential to the health of a stream. Some of the valuable benefits to streamside landowners afforded by shoreland plants include streambank support and stabilization, erosion and flood control, water quality protection, scenic beauty, and wildlife habitat.

The roots of native grasses, low shrubs, aquatic plants, and certain trees bind soil to streambanks and reduce erosion. Plant roots deflect the cutting action of swift-flowing stormwater, expanding surface ice, and strong winds. Abundant streamside vegetation slows runoff, catches silt, softens the impact of rain, and helps prevent the undercutting and collapsing of streambanks.

Shoreland plants protect water quality by absorbing and filtering out pollutants such as fertilizers, animal wastes, and toxic chemicals. Plant life along the edges of the stream also provides food and shelter for fish and wildlife. Streamside habitats usually are richer in the number and types of wildlife than upland habitats. Wildlife foods (seeds, buds, fruits, berries, and nuts) are found in abundance along streamsides. Streambank plants preserve scenic beauty and property values. Streams hidden by concrete walls, culverts, and ditches are generally unnoticed, unappreciated, and often neglected.

Try to avoid any activity that will kill or injure streambank plants. It's best to limit activities such as plowing, livestock grazing, housing development, road construction, dumping, filling, and applying herbicides near streambanks.

STREAMBANK PLANTING GUIDELINES

Although any rooted plant growing on the streambank is helpful, some plants give better protection than others. Grasses and low shrubs are preferred because they develop relatively deep, strong, fibrous root systems that bind streambank soils. They also are less costly and become established faster than trees.

The grasses and shrubs listed in Table 1 are the best to use for streamside plantings. They can tolerate a wide range of temperature and moisture conditions; even survive under water for extended periods. They are easy to establish and maintain, and they provide good ground cover. They develop a strong, tough system of roots that tightly binds streambanks, traps silt, and slows erosion.

Of the grasses listed, reed canary grass is widely planted for streambank stabilization. It provides year-round support for banks and a fringe of overhanging streamside cover for sportfish. This fast-growing, early developing grass grows in thick stands that reach heights of 4 to 7 feet. It can be controlled by cutting, but cannot tolerate livestock grazing. Since this grass may block flows on small streams, avoid seeding it on streams that are less than 4 feet wide.

Willows (Salix), unlike other trees and woody shrubs, are water-loving plants that develop relatively deep, strong root systems in wet soil. Many types of willows grow in the U.S., but most are unsuitable for streambank plantings because they grow rapidly and form tall, dense, nearly impenetrable thickets. Thick streamside stands can block stream channels and shade out beneficial plants.

The willows listed in Table 1 are varieties that have proved to be useful streambank protectors. Bankers dwarf willow is a low growing (maximum height of 6 feet), hardy shrub recommended for bank protection on small streams (4 to 20 feet in width). Streamco purpleozier willow (basket willow) is a taller plant (maximum height of 15 feet) used for planting on larger streams (greater than 20 feet in width).

These plants and others are available from nurseries, can be transplanted from existing stands, or started from cuttings. For advice on streambank plantings, landowners should contact their local USDA Natural Resources Conservation Service or Cooperative Extension agents. Survival of streamside vegetation depends on proper planting and care until the plants are firmly established. Bank shaping, weeding, fertilization, mulching, and fencing from livestock may be necessary.

Table 1: Plants for streambanks

Reed canary grass (Phalaris arundinacea)
Fescue Kentucky 31 (Festuca arundinacea)
Redtop grass (Agrostis alba)
Bankers dwarf willow (Salix Cotteti)
Streamco purpleozier willow (Salax purpurea)
Grey stem dogwood (Cornus racemosa)
Silky dogwood (Cornus amomum)
Red stem dogwood (Cornus stolonifera)

FENCE STREAMSIDE

Farm livestock, particularly cattle, sheep, and hogs, are major threats to small streams. Livestock congregate along streams to graze, drink, wallow, and obtain relief from heat and insects. They overgraze and trample streamside plants, leaving bare, muddy banks and silt-choked stream channels. Livestock wastes (liquid and solid) flushed off shorelands or deposited directly into streams contaminate the waters with harmful nutrients and disease-causing fecal bacteria and viruses. These water quality problems can be avoided by fencing farm animals away from streams.

Livestock need drinking water, but they don't need to have unlimited access to the stream just to get a drink of water. Select specific stream watering and crossing sites (fords) for livestock, or develop offstream watering sites such as tanks or small ponds, gravity-fed by piped wells, springs, or stream water.

If stream watering-crossing sites are necessary, carefully choose sites with firm bottom materials (bed-rock if available) and gentle, graded slopes that animals will use. Gravel lined paths or entrance ramps constructed of wood and other materials will minimize streambank damage. Restrict upstream-downstream animal movements by using swinging flood gates suspended from cables or stringing wire high enough across the stream to avoid catching flood debris. Build watering-crossing sites wide enough to accommodate the herd and prevent panic and injury to the animals.

Build fences well back from the streambank, particularly at stream bends. Place the fence at least 15 feet away from the top of the streambank (not the water's edge) to protect streambank plants and prevent flood damage to fencing. Plant fence rows with dogwood, autumn olive, and other wildlife food and cover vegetation.

STREAMBANK PROTECTION STRUCTURES

Artificial structures (terraces, rock riprap, gabions, and tire or sandbag barriers) may be necessary to support and protect streambanks. These structures supplement plants by reinforcing steep banks and banks that are vulnerable to flood and ice damage, swift currents, strong winds, and heavy wave action.

Natural stone is the most durable material for constructing streambank protection structures. If enough stone of the right sizes is not available, use a combination of stone and wire mesh or stone and logs. In areas where stone is scarce and expensive, sandbag barriers anchored with plants will provide good protection.

Temporary structures such as hay bales, mulches, filter fencing, and netting can be used to provide short term protection and allow vegetation to become established. Other materials are not effective. Concrete readily fractures and cracks. Metal structures (steel beams and iron pipes) will rust, pollute stream water, and eventually collapse.

Grading, Terracing, and Berming

Streambanks too steep (slopes greater than 1:1 or 45 degrees) to support plants can be reshaped by grading, bench terracing, or berming. Limit this method to small areas, use erosion control measures, and reseed immediately.

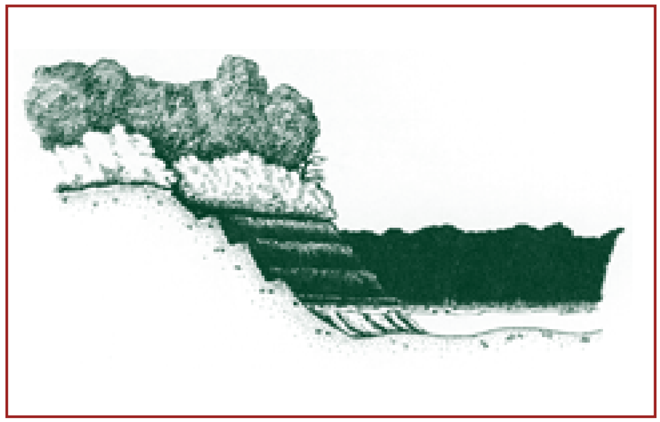
Bench terraces (stair steps), cut across the face of a streambank, break long, steep banks, slow runoff flow, and provide gradual slopes for revegetating. Bench terraces are not flat. Construct them to tilt inward toward the bank to intercept and divert runoff water along the bench rather than downslope. Bench terraces can also be ditched to reroute drainage. The width of each bench and the number of benches necessary depends on site characteristics. Consult professionals for design advice.

Earth berms and diversion ditches built along the top of eroding streambanks intercept and divert runoff water from eroding streambanks. A combination ditch and berm (a low mound of earth excavated from the ditch) provides a simple, effective way to protect streambanks. Locate the ends of the ditch and berm where water can flow into the stream without causing erosion.

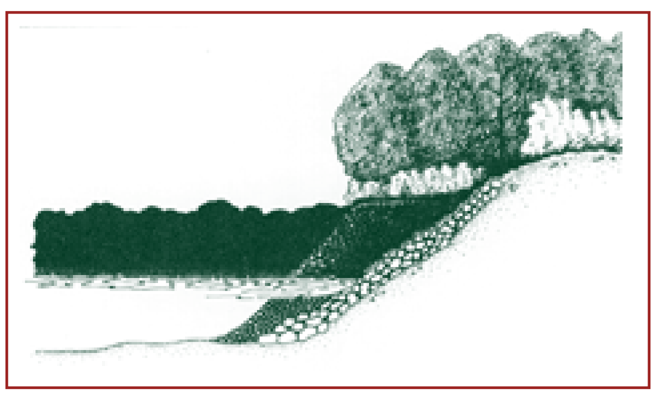
Rock Riprap Barriers

Rock riprap is the most common and effective way to stabilize eroding streambanks, especially at stream bends. Rock riprap is a lining or pile of natural stone placed along streambanks. Construction of riprap barriers is simple. A load of rocks is clumped over the streambank and rearranged by hand. Avoid leaving large rocks jutting out into the stream channel because they create counter currents (eddy currents) that cause washouts. On severely eroding steep streambanks, blanket the

Fence livestock watering and crossing sites to restrict upstream or downstream animal movements. Carefully select sites with a firm bottom and gentle slopes.



Terraces, earth berms, and diversion ditches can be used to stabilize streambanks and reroute silty runoff waters away from streams.

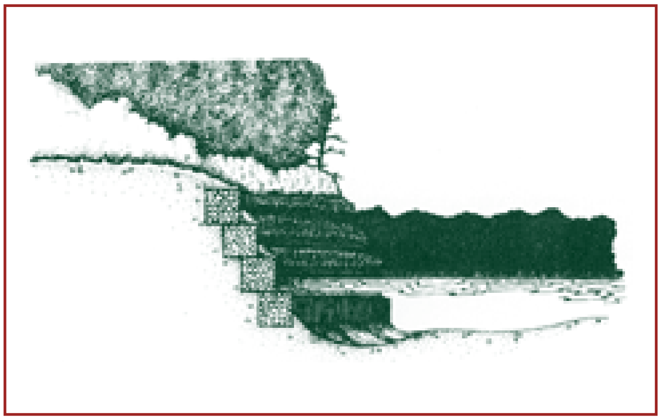


Rock riprap (natural rock) placed on steep streambanks adds support, slows erosion, and protects water quality.

entire face of the slope with rocks. Where erosion is mild, it may be necessary to rock only the bottom of the bank.

On most streambanks, a riprap cover 1 or 2 feet thick should be adequate, but use a thicker layer (2 to 3 feet at the base) to stop rocks from sliding down the bank. Use a mixture of rocks ranging in size from small (10 pounders) to large (100 pounders). This allows for the openings between large stones to fill with smaller ones, providing an interlocking pattern and preventing undercutting.

On banks composed of fine silt and sand, use a fabric filter or plastic mesh sheeting between the rock and the bank to prevent slumpage and the loss of fine materials. Filter sheeting materials that hold fine soils in place, yet still allow for water seepage, are commercially available.

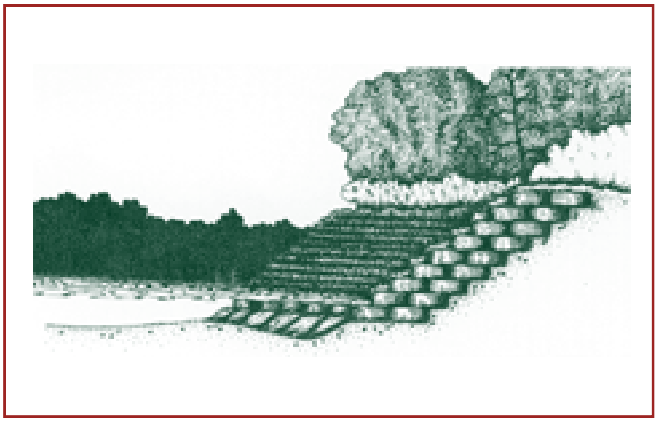


Gabions (rock-filled wire cages) are useful bank protectors on steep slopes.

Gabions (Rock-filled Wire Cages)

A gabion is a rock-filled wire cage, box, or basket. Gabions are used on steep banks to hold rocks in place or at sites where rocks of the right sizes are not available. Gabions can be made easily by using corrosion resistant (galvanized) steel wire. Each cage should be secured to the bank or tied to other cages and filled with rocks that are larger than the wire mesh openings. A less costly method of holding rock riprap in place is to lay wire mesh over the stone. Stake the wire covering into the streambank by driving in bent pipes or bars.

Gabions and wire mesh structures are functional, but not very attractive. To preserve the natural scenic beauty of streamsides, many landowners cover these structures with soil and plant grasses on top.

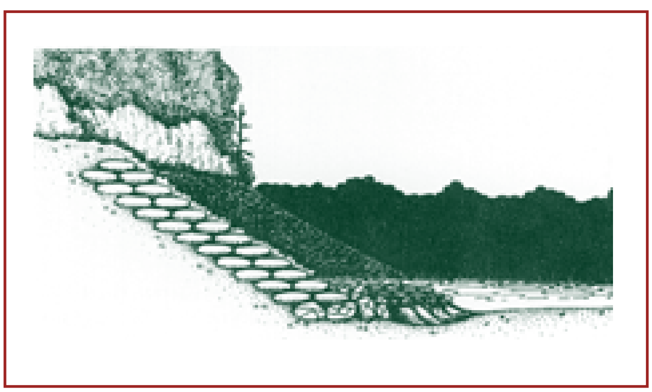


Used-tires, stacked in stair-step fashion, provide good erosion protection in areas where natural rock is not available.

Used-tire Barriers

Old auto and truck tires can serve as streambank protectors. Tires are placed flat on the bank surface to form a blanket or are stacked in stairstep fashion against the bank. To assure that the tire blanket stays in place, tie all tires together by weaving strong cables through them and firmly anchor the cables to the bank.

When constructing the stacked-tire barrier, shape the face of the bank so that the tires can be laid flat, one on top of another, forming a stairstep (not a wall). Each upper tire should overlap two tires under it and each row should be set back about a foot from the row underneath. To reduce flotation and prolong bank protection, holes can be cut, drilled, or burnt into the tires. Packing the tires with stone, sand-cement mixtures (15% cement, 85% sand, by weight), or soil will add stability.



Sand bags similar to those used in flood emergencies provide temporary streambank erosion protection.

Plant grasses or willows inside soil-packed tires to anchor them. Once established, the foliage will hide the tires. A used-tire barrier is a good, inexpensive alternative to rock riprap where natural stone of suitable size and quantity is unavailable.

Junk piles and refuse dumps are worthless as bank protectors. They increase erosion, are unsightly, and pollute stream waters

Sandbag Barriers

Sandbags, widely used during flood control emergencies, may be used to protect eroding streambanks. Bags can be made of burlap, plastic, and other materials. Used bags can be obtained from local feed and seed or hardware stores. Most bags deteriorate rapidly, but filling them with a sand cement mixture can provide lasting protection.

Build sandbag barriers in a stairstep pattern (not a wall) by setting each successive row back about one half of a bag width from the row underneath. Each upper bag should overlap the two bags underneath (like laying bricks). Place rock riprap at the base of the bags to prevent undercutting. On the complete barrier, slope steepness should not exceed 1:1 (1 foot vertical for 1 foot horizontal). Sandbag barriers generally are more costly and less effective than rock riprap.

No Vertical Walls and Bulkheads

Avoid building vertical walls or bulkheads along streambanks. Straight walls (breakwalls, wavewalls, retaining walls) are expensive to construct and maintain; they are unsightly and generally short-lived. Walls tend to divert current energy downward, resulting in undermining and eventual collapse. Water that penetrates cracks in a wall or breaks over a wall frequently erodes the bank behind the wall. A tumbled mass of rock riprap covered with plants provides greater protection, a more natural appearance, and more cover for sportfish.

No Streambank Junk Piles

Streamside junk piles are ugly and ineffective bank protectors. They seldom stay in place during floods and frequently contain substances that cause water pollution. Junk piles shade out beneficial grasses and increase bank erosion. Refuse sliding into streambeds may block the flow and cause flooding.

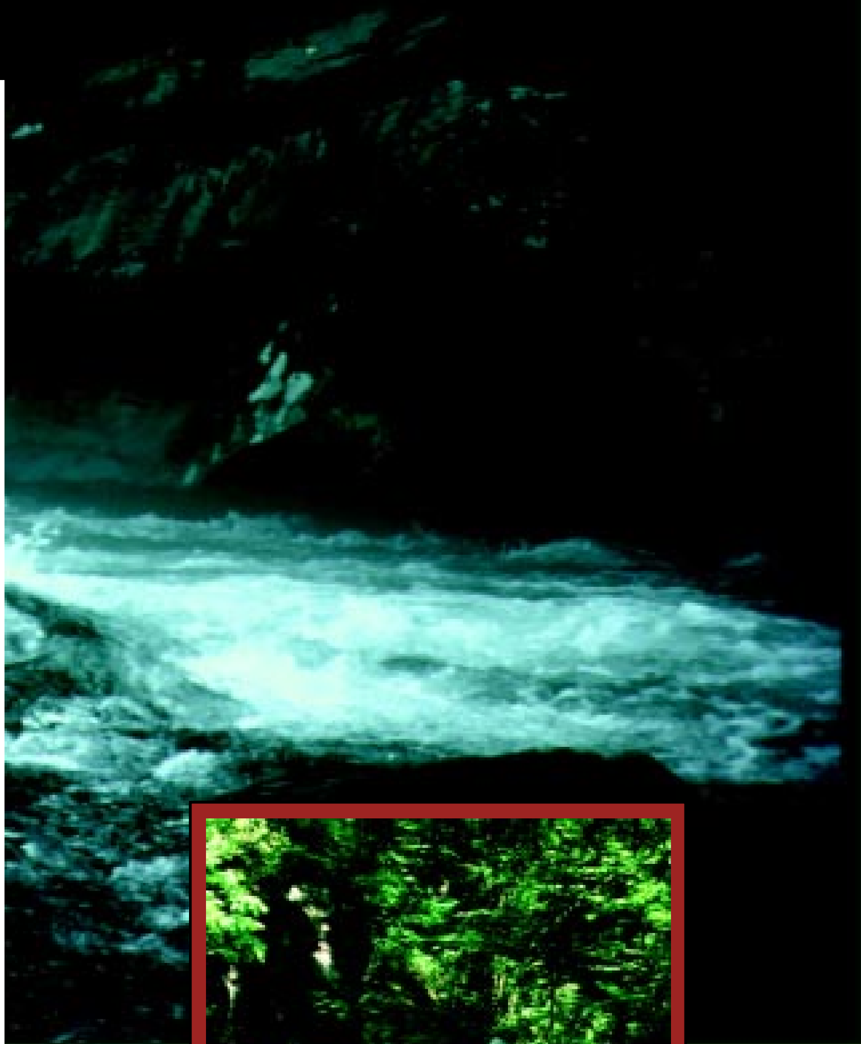
Avoid dumping used construction materials (broken pavement, asphalt slabs, concrete blocks, bricks, rotting lumber, scrap metal), old household appliances (refrigerators, stoves), automobiles, and other types of refuse and garbage on eroding streambanks. It's impractical to sort the types and sizes of these materials cluttering a steep bank and impossible to firmly anchor them to the bank. Garbage dumps on streambanks increase erosion and their unattractiveness depreciates property values.

IN-STREAM HABITAT

Stream Flow

Most of the annual flow in streams is provided by groundwater (natural spring seeps) that, in turn, is replenished by rainwater. Since water seeps slowly through the soil, the surface water flowing in streams can represent rainwater that fell days, weeks, or even months ago. This regular, continuous seepage of groundwater that keeps streams flowing is called base flow, low flow, or minimum flow.

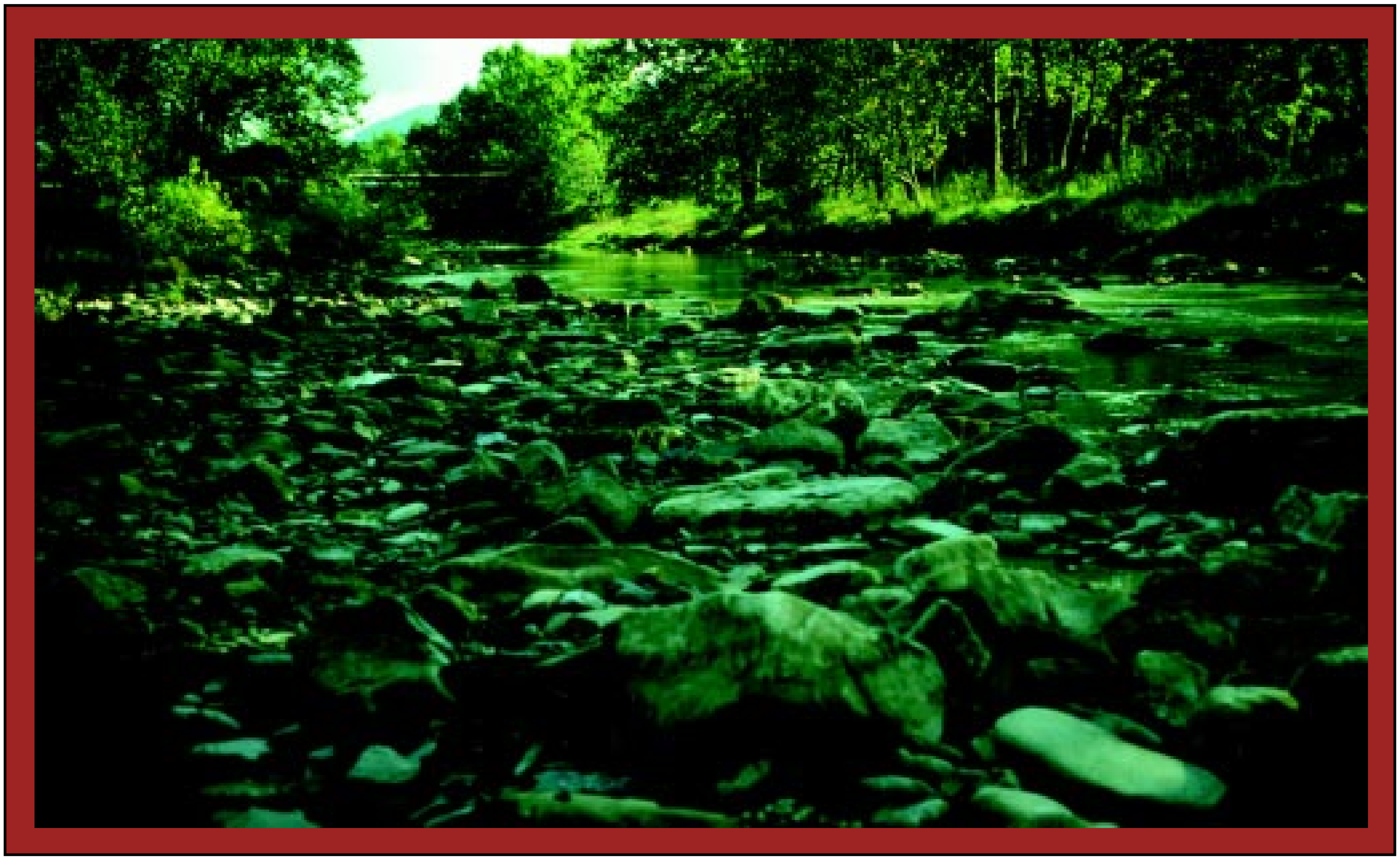
Base flow is critical to stream life and water quality. Sportfish, fish-food animals, and water plants require a stable, continuous flow of water, particularly during dry periods. Stream water quality depends on the amount of water available to dilute and flush out toxic chemicals and other pollutants. During low flows, pollutants are more concentrated and persistent. Streams can clean themselves if they have good base flows and don't receive too much pollution.



Water Velocity

The velocity or speed of water in a stream, commonly expressed in feet per second, is the distance it travels during an interval of time. Water velocity is regulated by gravity (steepness of the slope), friction (roughness of the bottom and banks), and water depth. Although shallow, steep gradient streams appear to be flowing swiftly, a deep river having the same slope and roughness will have the greater velocity. Moreover, speed decreases vertically with depth, so water flows much faster on the surface than the bottom.

Landowners can estimate stream water velocity by tossing an orange into the stream and measuring the time required for it to travel a known distance. For example, if the orange floats 100 feet downstream in 11 seconds the water velocity is about 9 feet per second. Although any object that floats will provide a rough estimate of water velocity, the orange-float works well because oranges have about the same density as water, and float at about the same rate as water moves.



Reduced flows during dry periods can concentrate pollutants and kill fish

Good sportfish streams display an alternating pattern of pools and riffles. Pools and riffles generally occur at a distance of 5 to 7 times the width of a stream. For example, in a stream 10 feet wide, a pool or riffle usually will occur every 50 to 70 feet. An equal amount of both habitats (pool-riffle ratio of 1:1) is considered optimum for sportfish.

STREAMBEDS

The streambed is the foundation of the stream and its banks. Many stream characteristics (channel shape, width, depth, and fish community) will vary markedly depending on streambed materials. Streambeds are formed by two forces: scouring and sedimentation. If the cutting force of running water is directed downward, the bed will be scoured out until a resistant layer (bedrock) is reached. Alternatively, if the gradient (slope) flattens and flow slows, sediment loads are deposited on the bottom.

Streambeds are composed of a variety of materials, collectively called bottom sediments. Bottom sediments range in size from large boulders and rocks, through gravel (1/4 to 3 inches in diameter) to fine sand, silt, and clay particles. Of these, gravel-sized and larger particles are most important to sportfish. Nearly all stream fish require clean gravel to spawn and larger cobbles or boulders for resting and cover. The smaller, fine bottom materials (silt and clay) generally are unsuitable for spawning sites since they smother eggs and young fish.

WATER TEMPERATURE

Water temperature governs most of the physical, chemical, and biological processes that occur in streams. The types of aquatic life inhabiting streams; the timing of fish reproduction, spawning, and migration; animal growth and development rates; concentrations of dissolved gases; and decay rates are directly influenced by water temperature. All aquatic animals have an optimum water temperature range, above and below which they become stressed, and at extreme temperatures, die.

Maximum stream water temperatures usually occur in August when air temperatures are highest and groundwater inflows are reduced. Landowners can improve (cool) stream water temperatures and reduce thermal stress on sportfish by (1) removing dams and log jams, (2) unclogging spring seeps, (3) decreasing channel width and increasing depth, (4) protecting streamsides from livestock, and (5) planting grasses, shrubs, and trees. Free-flowing, deep, narrow streams that receive abundant, regular groundwater inflows typically have stable temperature ranges.

IN-STREAM HABITAT IMPROVEMENT STRUCTURES

In-stream structures are built to extend out into the stream channel. They are intended to protect eroding streambanks and create hiding, resting, and feeding places for sportfish. By modifying the speed and direction of stream flow, these structures can be used to flush out bottom sediments, deepen the channel, form pools or riffles, and provide living space for sportfish.

The design, construction, and placement of in-stream devices require technical expertise. These structures must be built to survive floods, expanding ice, and log jams. Poorly built or placed structures can increase bank erosion and clog streams.

A pair of gabions (rock-filled wire cages), here used as wing deflectors, divert the current away from the banks, narrow and deepen the channel, and increase flow

Before attempting to use in-stream structures, seek expert advice from your district fisheries biologist or soil conservationist. Also, check federal and state legal restrictions. A federal permit available from the U.S. Army Corps of Engineers is required to place material below the ordinary high-water mark on navigable streams with flows greater than 5 cubic feet per second. Other permits are required by state agencies before constructing deflectors, dams, or similar structures across or in streams.

Wing Deflectors

Wing deflectors are triangular shaped wedges of rock built to jut out from the bank into the channel. They point downstream at an angle to direct currents away from eroding banks toward midstream and to increase current speed. Water moving downstream slides off the deflector at an increased velocity. This fast-flowing current cuts and cleans a deep, narrow, center channel that increases sportfish habitat and protection from predators.

Deflectors are built singly to protect an eroding bank, or in pairs to narrow the stream channel. They are placed in a series, positioned alternately, on one bank and then the other to keep the current sweeping swiftly in a natural winding pattern. In nature, pools and riffles normally are repeated every 5 to 7 channel widths; therefore, the distance between deflectors should be at least seven times the average stream width.

Deflectors may be constructed entirely of rock, or rock and wire combinations (gabions), or rock framed with logs. Build deflectors in a triangular shape, with the tip pointing downstream and angling out toward the channel. Adjust the angle (usually about 30 degrees between the bank and the deflector) to guide the current into mid-channel at a suitable speed.

Check the path of the current by throwing a float into the water upstream from the deflector. If the float hits the opposite bank, modify the size or angle of the deflector until the float remains in mid-channel. Deflectors built at an extreme angle (pointed more across than down stream) or too long (more than one half the channel width) may cause erosion on the opposite bank or catch floating debris. Improperly built deflectors receive greater water pressure and may be damaged by floods.

Build deflectors low with only a few inches above the water surface at the offshore tip and tapered upward toward the bank. Design deflector height to allow high flows to pass over the top of the structure. Remember, deflectors should guide the current, not dam it!

Avoid building deflectors in riffles. Preserve natural riffle areas from any type of disturbance or construction. They are important sportfish food production and spawning areas.

Pool Formers

A low waterfall (plunge, or chute) is an in-stream structure built to narrow the channel, increase streamflow, and funnel water over a midstream ledge. Its purpose is to create a plunge pool or hole immediately downstream from the fall. Low waterfalls are used on fast-flowing streams with limited pool habitat to create an alternating series of pools and riffles. Plunge pools are ideal resting and hiding places for sportfish.

A low waterfall is built to form a pool below but not above it. A long pool of slow water above the fall will fill in with silt and destroy fish habitat. Alternatively, a plunge pool or hole below the fall will be flushed with fast, aerated water, providing good sportfish habitat.

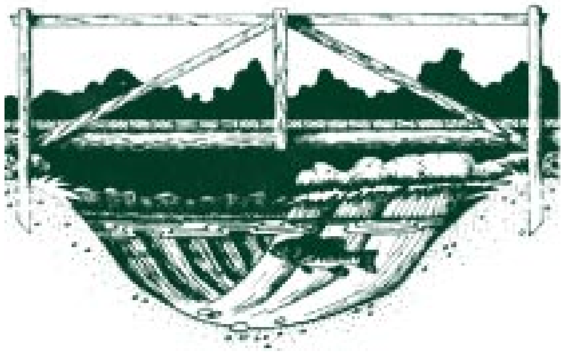
Low waterfalls can be constructed of rock, rock and wire (gabions), or rock and logs (Hewitt ramp). The Hewitt ramp, a ski- jump shaped structure constructed of stone and logs firmly anchored to streambanks, is a good pool former. A pair of wing deflectors can be used to narrow the channel and direct the flow to midstream.

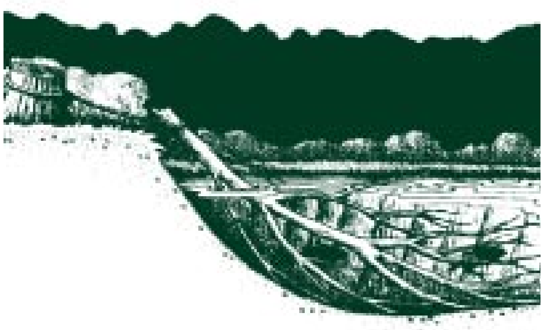
Build these structures low, only about a foot or two above the water surface, to allow for the free movement of fish upstream and downstream. The height of the falls and width of the opening should be adjusted to permit a continuous flow of water over the crest during periods of low flow. As a general rule, the width of the opening should approximate that of the narrowest natural width of the stream.

A pool former (low waterfall) is used to improve sportfish habitat by aerating the water and creating a downstream plunge pool.

Example of a half-log fish cover.

Example of foot and forest road bridges providing overhead cover and access for anglers.





Example of a submerged tree top to provide cover.

An example of a submerged boulder for cover.

Fish covers and shelters are designed to provide resting places for sport fish. Adding boulders, anchoring logs and tree tops, or building streambank platforms can improve sportfish populations that lack fish habitat.

Shelter

In some streams, sportfish populations are limited by the amount of available cover and shelter (submerged boulders, logs, tree roots, undercut banks, and overhanging vegetation). Fish use these protective areas to rest, hide from predators, catch food items drifting in the swirling currents that occur around submerged structures, and avoid territorial conflicts. Large sportfish often select a sheltered site as their territory from which they exclude other adult fish.

Sportfish abundance in streams without sufficient cover can be increased by adding boulders, anchoring logs and trees, and building platforms along the banks. Carefully place these structures to avoid deflecting the current into the bank and damming the flow. In large streams, tree tops, root clumps, and logs can be used, provided they are securely anchored. A half-log cover, as the name implies, is a log cut in half length wise. Completely submerge the half-log, pointing downstream, with the rounded, bark side up and the flat, cut side down. Two stakes driven through the log into the streambed provide firm anchorage.

Artificial platforms, built like small boat docks, are used to supply overhead cover in streams lacking undercut banks and ledges. They can be covered with rocks and sod to add support and a natural appearance. Foot and forest road bridges also provide overhead cover for sportfish and access for anglers.

The Stream Killers

Man has damaged streams in many ways. Dam building, stream channeling, wetland drainage, and water pollution are among the most widespread and destructive threats to small streams. Countless streams have been altered and polluted by (1) poor farm cropland and livestock management practices, (2) careless timber harvesting, (3) improper farm and forest road construction, (4) unwise mining and dredging operations, and (5) unsound streamside property developments.

Dams and Log Jams

Dams, log jams, and other obstructions to flow destroy streams. Small dams once used to hydropower sawmills and grist mills, and those built today to create farm, recreation, and flood control ponds needlessly ruin miles of free-flowing streams.

Dams create a variety of problems. They are costly, short-lived structures easily damaged by floods, winds, and ice. Dams can collapse, threatening downstream life and property. Owners of a dam are responsible for inspecting and maintaining it. They may be held liable for downstream loss of life and property if their dam collapses or malfunctions.

The life expectancy of a dam depends on the amount of upstream erosion, but even those built on streams carrying moderate silt loads eventually silt-in with eroded soil. As silt accumulates in the impounded pools, the water becomes shallow, stagnant, warm, turbid, and weed-choked.

Dams eliminate stream sportfish populations. Stream-dwelling sportfish and the aquatic insects on which they feed require running water. For example, most stream sportfish are gravel-riffle spawners; they deposit their eggs only where the water depth, speed, temperature, clarity, oxygen content, and bottom types are suitable. Dams destroy spawning sites and flowing water conditions essential for stream sportfish. Dams also block the free movement of sportfish to their spawning and nursery grounds. Few small streams have fish ladders (fishways) that provide passage.

Dammed or clogged streams can be restored. Remove old mill-pond dams, log jams, fallen trees, and other impediments to flow. Cut trees that may fall into or across streams, but leave their stumps and roots undisturbed. Use hand labor, chain saws, and winches to avoid killing streambank grasses.

Discourage the damming of streams to create ponds. Ponds needed for cropland irrigation, livestock watering, sportfishing, swimming, and other uses, should be constructed by digging a basin on the flood plain next to the stream and piping water from the stream.

Channeling and Wetland Drainage

Stream channeling (stream-straightening) converts a natural winding stream with riffles, pools, shelter, and abundant fish and wildlife, into a straight, featureless drainage ditch. The resulting ditch contains no protective boulders, ledges, spawning gravel, or stream side cover, and few sportfish or wild animals.

Channeling consists of using a drag line to straighten, deepen, and clear streambeds. When natural streams are ditched, their bottoms containing eggs and young of sportfish, fish-food insects, in-stream cover, and critical spawning gravel are dredged out and piled high on the banks. Streamside vegetation is crushed by machines or buried under the dredge spoils, leaving bare muddy banks.

As storm waters concentrate in the straight, steep trench, they travel at high speed and energy, eroding the banks and stripping off any remaining plant cover. Erosion increases and the waters become too muddy to support life. During dry seasons, channeled streams become mud-choked ditches. They lack the water flow, depth, and oxygen to sustain sportfish. Valuable gamefish are eliminated and replaced by undesirable species such as carp.

So why are streams channeled? Flood protection is the usual excuse given for this wanton destruction. The claim is that ditching speeds storm waters downstream and prevents overflows. This is partly true; storm waters do shoot rapidly through a straight channel and are contained by the high banks (levees) of dredge spoils. But, channeling does not prevent floods, it simply moves them downstream, and at such high velocity that flooding is intensified. The solution to flood control problems is to keep the raindrops where they fall.

Floods are born on the land, not in streams. Floods can be controlled by using good watershed management (contour and no till farming, grassed waterways, streambank filter strips and plantings) and protecting natural wetlands. Streamside wetlands (marshes and swamps) have enormous flood control capacity. They serve as natural sponges, temporarily holding and storing flood waters.

Unfortunately, wetlands are a vanishing resource. Drained by stream channeling, ditching, and water diversion projects to create farmland, tree farms, and urban developments, few natural wetlands remain. Channeling reduces the amount of stream (often to one half of its original length), lowers the water table, and leaves wetlands high and dry.

Marshes and swamps, once considered wastelands, are recognized as important for flood control, water conservation, stream and ground water recharge, outdoor recreation, and as prime fish and wildlife habitat. Streams and their associated wetlands are interrelated. Wetlands supply much of the ground water needed to keep streams flowing. Conserving our valuable wetlands is essential to the protection of stream water quality.

Channeled, ditched streams lack the habitat necessary to support sportfish and wildlife.

Dredging destroys stream habitat and kills sportfish, their eggs, and aquatic insects.

Eroded Soil and Silt

Each year, millions of tons of fertile topsoil, washed from "disturbed" areas (freshly turned fields, overgrazed pasture, logged forest lands, roadways, trails, and construction sites) fill in and clog our streams. Even "undisturbed" forest lands or ungrazed pastures lose about 400 pounds per acre per year of rich topsoil.

No one wins when valuable topsoil is flushed into streams. We all pay higher water, sewage, and electricity bills, as well as higher taxes for bridge construction, road repairs, flood relief, flood control, and water treatment when sediments fill stream channels. Erosion of productive farm and forest lands contributes to the higher cost of food and lumber products. It is a particularly bitter irony to realize that the same soil that produces our food and wood products, when flushed into streams, becomes our worst water pollutant.

As fine soil sediments drop to the stream bottom, they blanket spawning grounds, smother fish eggs, suffocate fish-food insects, bury oxygen producing plants, and clog the gills of sportfish. Muddy waters block sunlight, reducing oxygen production and the ability of gamefish to see and capture prey. Soil sediments pave stream bottoms, filling in pools and riffles, and thereby reduce sportfish habitat.

Keeping soil on the land and out of streams is one of the best ways to protect water quality and sportfish. It's much easier and cheaper to keep soil on the land than to remove it from streams. Important ways to control erosion include: (1) protecting streambank plants; (2) replanting muddy banks; (3) practicing no-till and contour farming; (4) using terraces, grassed waterways, and diversion ditches to reduce edge of field soil loss; (5) preventing overgrazing; (6) fencing livestock from streambanks; and (7) building streambank protection structures.

Soil erosion is the major threat to stream water quality and all aquatic life. Each year, tons of soil washed away from croplands, pastures, roadways, and construction sites clog streams and suffocate aquatic life.

Fertilizers and Animal Wastes

We intentionally apply chemical fertilizers and livestock wastes to our fields, lawns, and gardens to grow healthy plants. Fertilizers and animal wastes, when kept on the land and wisely used, are valuable soil builders that benefit landowners by increasing plant production. However, in streams they cause serious water quality problems.

Fertilizers and animal wastes (manure, urine, rotting feed, and other refuse) from pasturelands, barnyards, feedlots, slaughterhouses, canneries, and septic systems are oxygen-using substances that degrade water quality. In stream waters they decompose, use valuable dissolved oxygen, and produce poisonous methane, ammonia, and sulfur gases that kill sportfish and other water animals.

Stream waters polluted with fertilizers and animal wastes acquire an unpleasant taste and foul odor, and become unfit for drinking, swimming, and sportfishing. Contaminated stream waters carry disease-causing organisms such as fecal bacteria and viruses down stream, infecting healthy herds and flocks, and even humans. They become choked with algae blooms and water weeds that reduce stream flow and water clarity, clog filters and intake pipes, impair scenic beauty, and depreciate property values.

Proper land application of fertilizers and animal wastes will protect stream water quality. Avoid fertilizing or spreading manure near streams or on steep slopes, particularly during rainy weather or when the ground is frozen or covered with ice and snow. Fence livestock from streambanks, and locate or relocate feedlots, barnyards, and winter pasture away from streams and drainage ditches. Avoid overfertilizing and overgrazing. Build waste storage areas (waste ponds, lagoons, pits) where large herds of animals are concentrated in a small area.

Livestock wastes contaminate stream waters with fecal bacteria and disease causing organisms. Fencing livestock away from streams will help protect water quality

Limit the use of pesticides around streams. These toxic chemicals cause fish kills and threaten stream water quality.

Pesticides

Pesticides (insecticides and herbicides) are poisonous chemicals that pose a serious threat to stream water quality, groundwater supplies, and aquatic life. Insecticides are widely used by landowners to kill destructive crop and forest insects, but they also can kill beneficial stream insects and sportfish. Similarly, herbicides used to kill land weeds will also kill oxygen-producing water plants and reduce the food supply of aquatic animals.

Some pesticides remain in the environment for a long time, often accumulating up the food chain and concentrating in animals. For example, if a fish eats dead or dying insects sprayed with an insecticide, the fish and the angler who eats the fish will become contaminated. Low doses of certain pesticides can cripple fish, sterilize them, or increase their susceptibility to diseases and parasites. Moreover, particular pesticides may not be toxic alone, but can become deadly when mixed with other compounds in the environment.

Some basic guidelines for the safe use of pesticides include: (1) apply pesticides only when and where necessary; (2) employ those that are short-lived; (3) avoid applications near streams or drainage ditches; (4) use soil conservation practices to limit runoff; and (5) properly dispose of old or unused pesticides and their containers.

Waste Oil

Many thousands of types of harmful chemicals exist and new ones are being made each day. Among the most familiar contaminants that endanger streams in the eastern United States are pesticides, used motor oil, fuel oil, gasoline, and acids leaching from mined lands.

Used motor oil is a particularly widespread stream pollutant. Each year, millions of gallons are dumped deliberately into streams and poured carelessly in backyards, roadside ditches, and sewers. Motor oil, home heating oil, and gasoline (leaking from buried tanks) eventually end up contaminating surface and ground waters. Removing oil from water is difficult and costly. One quart of oil can contaminate 2 million gallons of water, form a slick covering more than two acres, and cost thousands of dollars to clean up.

The best way to protect stream water quality from oil pollution (and to reclaim valuable energy) is to recycle waste oil. Take your used motor oil to a local oil collection center (certain gas stations and home heating oil companies). Waste oil can be recycled by reprocessing it into heating oil or by refining it into clean lubricating oil.

Coal silt runoff and deadly acids seeping from underground and surface mines pose major threats to stream water quality and aquatic life.

Used motor oil is a widespread water pollutant. Protect surface waters and groundwaters by recycling waste oil products.

COAL MINE SEDIMENTS AND ACID

Coal mining can pollute streams in two ways: siltation and acidification. Coal silt and mined sediments enter streams when coal is washed and sorted. Erosion from strip mined lands and from huge piles of waste materials extracted from deep mines contributes to the silt load of streams, further polluting stream channels, increasing flooding, and suffocating water life.

Acid drainage from coal mining areas results in deadly sulfuric acid being formed when iron and sulfur deposits are exposed to air, rainwater, or ground water. Acid can be formed in the mine itself or leach from spoil banks, slag heaps, and gob piles formed during coal processing. Forgotten waste sites can continue to leak sulfuric acid into streams and ground waters for 100 years or more! Despite current regulations, some streams still run black with coal fines, are stained yellow-orange with "yellow-boy" (ferric hydroxide associated with mine acid drainage), and are devoid of water life.

An important American heritage. Free flowing streams have rewarded countless generations with outdoor adventures.

THE STREAM WATCHER'S GUIDE

THE STREAM WATCHER'S GUIDE

Protecting our stream and water resources can succeed only with the active support of interested landowners and concerned citizens. Too often stream pollution problems are ignored, go unnoticed or unreported and, therefore, continue to occur in the same or other streams.

Police your stream. Be aware of current and changing land-use activities (farming, grazing, irrigation, mining, logging, home construction, business development, dams, bridges, road improvements, sewage disposal, water diversion, power-line spraying, utility crossings). Investigate water laws. Know your community leaders, legislators, county officials, town council and zoning board members.

Be alert and prepared to respond -- know what stream pollution problems to look for and who to contact for help. Report unusual changes in your stream to your county, town, city, or state agency officials. Agencies are listed in your telephone book under U.S. Government, or your state, county, and city governments. Some indicators of stream problems, their possible causes, and some actions to take appear in Table 2.

Table 2. Stream Watchers Guide

Observations	*Causes*	*Things to Do*
Muddy Streams	Flooding & erosion Farming & livestock Logging & dredging Construction activity	Investigate upstream Use fences & filter strips Replant vegetation Use soil erosion barriers Phone soil conservation agency
Fish Kills	Suffocation Decaying water weeds Temperature stress Pesticides & toxins Diseases & parasites	Investigate upstream Estimate number of dead fish Large fish , small, both? Freeze a dying fish for agency Phone fish & game agency
Oil Slicks	Accidental spills Leaking storage tanks Illegal dumping	Investigate upstream Estimate the area covered Take a water sample Phone resource agency
Gravel Dredging	Permits required Illegal dredging	Note vehicle license number Phone water resource agency
Muddy Water	Soil erosion Decaying plants Livestock, mining	Investigate upstream Man or natural causes Phone water resource agency
Odor & Gas	Decaying vegetation Decaying animals Sewage pollution	Follow your nose to source Man or natural causes Report man made pollution Phone water resource agency
Abnormal Flows	Heavy rainfall Drought Dams & log jams Irrigation	Investigate upstream Man or natural causes Remove log jam & old dams Phone water resource agency
Foaming	Decaying plants Detergents & soaps	Check the odor of the foam Man-made soap has a perfume smell
Trash & Litter	Illegal dumping	Erect anti-litter signs Organize a stream clean up day Phone litter control agency
Algae & Weeds	Fertilizer runoff Animal waste Sewage pollution	Investigate upstream Estimate area covered Collect a plant sample Phone soil conservation agency
Green Water	Algae Industrial dye	Investigate upstream Estimate area covered Collect a water sample Phone water resource agency
Milky Water	Sewage pollution Decaying plants	Investigate upstream Collect a water sample Phone water resource agency
Red-yellow Water	Mining waste Industrial waste Algae	Investigate upstream Collect a water sample Phone water resource agency

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