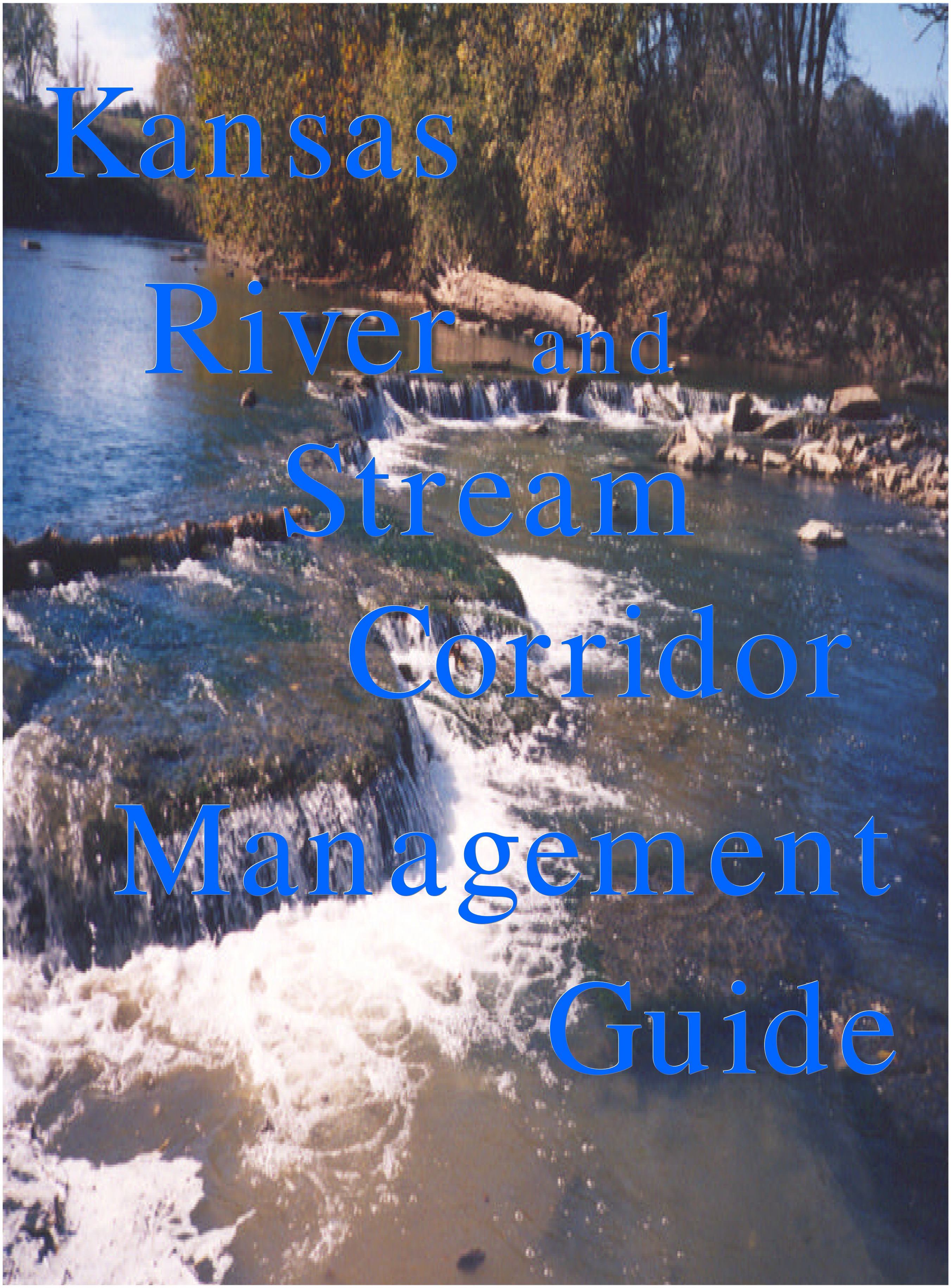
Kansas River and Stream Corridor Management Guide



Contents

Front Cover Photo – Mill Creek, Wabaunsee Co.
Back Cover Photo – Republican River, Clay Co.

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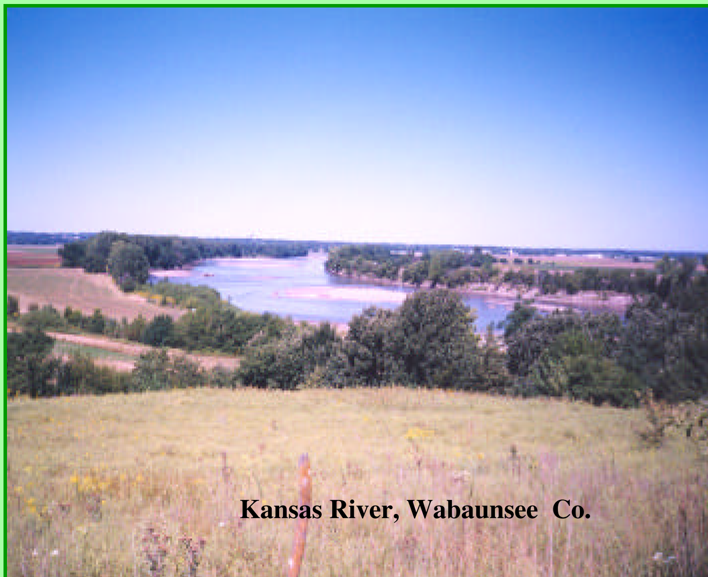
Introduction

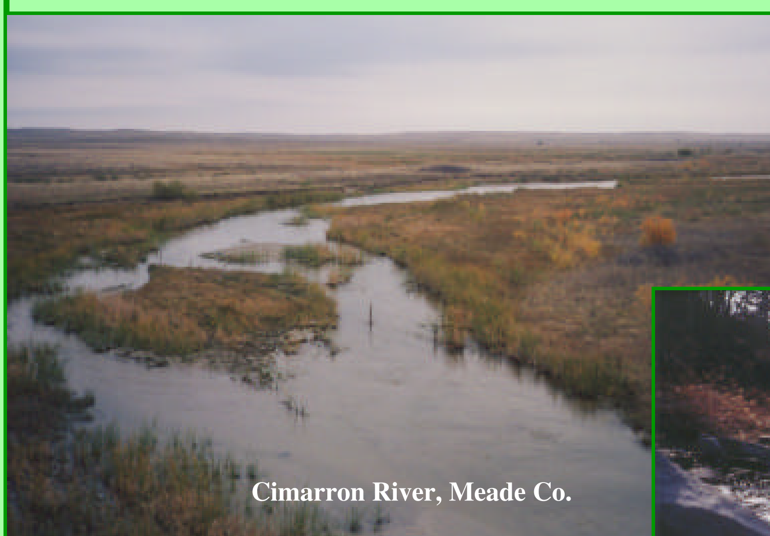


Kansas River, Wabaunsee Co.

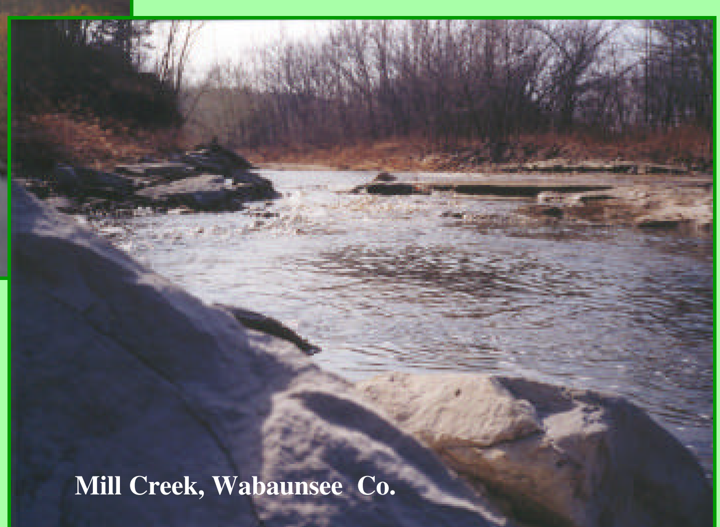
Captain's Creek, Johnson Co.

Kansas rivers, streams, and associated riparian areas are a vital part of our natural resources. Our stream systems are as diverse as the Kansans that enjoy them and just as important to Kansans today as they were to Native Americans and pioneers. Without clean water and healthy stream corridors, we could not survive. Kansas streams and riparian areas provide drinking water for humans and livestock, water for irrigation and industry, aquatic and terrestrial habitat, aesthetic values, and recreational areas. River and stream corridor management affects all citizens of the State. This publication is intended to promote responsible use and management of Kansas stream corridors and watersheds.

Bill Graves, Governor



Cimarron River, Meade Co.



Mill Creek, Wabaunsee Co.

Kansas Stream Fact:

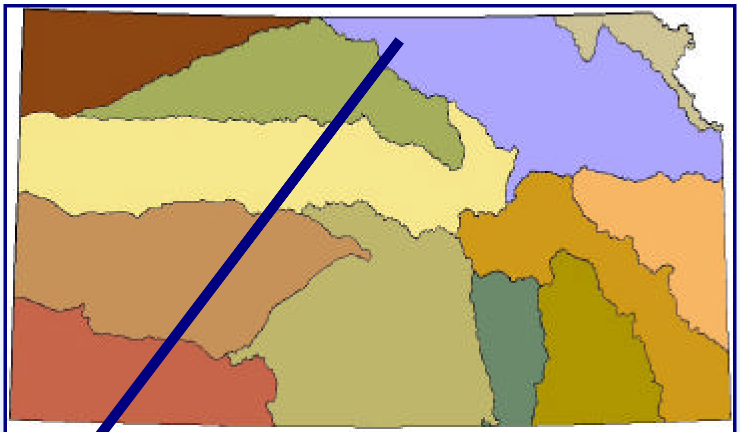
Kansas has 134,338 miles of interior streams
+ 120 miles of border streams
134,458 total stream miles

Watersheds

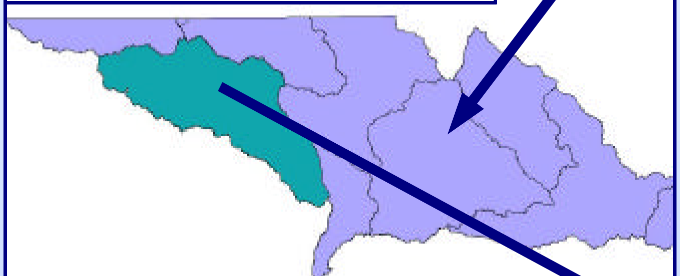
Kansas has 12 major **River Basins**. Each basin is a **watershed**, or a portion of a larger watershed.

A watershed is a land area that drains into a stream, lake, or other body of water. Stream channel size is normally correlated with drainage area, or watershed size. As a rule, the larger the watershed, the larger the stream.

Each river basin is divided into several smaller watersheds based on topography. Watersheds often cross political boundaries such as state or county lines.



Kansas – Lower Republican River Basin



Watersheds are assigned a number called a **Hydrologic Unit Code** or **HUC**.

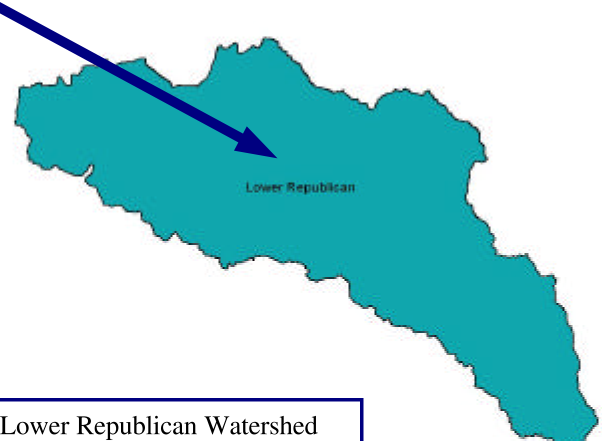
Kansas watersheds are designated as a HUC 8, 11, or 14 which corresponds with the number of digits used to designate the HUC. HUC 8s are the largest watersheds, but are designated with only 8 numbers. HUC 11s are smaller watersheds within HUC 8s and HUC 14s are smaller watersheds within HUC 11s.

Each watershed contains several streams which can be designated as being in one of three categories based on duration of water flow.

Ephemeral streams flow only in response to rainfall or snowmelt. These streams are normally dry and flow only during or shortly after a rainfall or snowmelt event.

Intermittent streams flow most of the year, but are normally dry during one or two months of each year.

Perennial streams flow throughout the year, but may be dry during periods of extended drought.



Lower Republican Watershed

Kansas Watershed Fact:

Kansas has 90 HUC 8s, 355 HUC 11s , and 2020 HUC 14 watersheds.

(Kansas Water Office)

Kansas Stream Fact:

Intermittent Stream Miles	110,225
Perennial Stream Miles	23,731
Canals and Drainage Ditch Miles	382
Border Stream Miles	120
Total Stream Miles	134,458

Approximately 80 percent of Kansas stream miles are intermittent or ephemeral.

Dimension, Pattern and Profile

A stream is a product of its watershed. The watershed's climate, topography, geology, vegetative cover and landuse, all combine to determine the DIMENSION, PATTERN, and PROFILE, or the physical characteristics of a stream.

DIMENSION refers to the cross sectional shape of a stream channel, PATTERN is the configuration of the meanders, and PROFILE is the stream slope or drop in elevation.

Arikaree Breaks, Cheyenne Co.

Republican River, Cheyenne Co.

In Kansas, average annual rainfall varies from 44 inches in Cherokee County, in south-east Kansas, to less than 16 inches in Hamilton and Stanton Counties, in the southwest.

Kansas geology varies from the deep glacial loess soils of Doniphan County to the shallow soils which overlie the limestone of the Flints Hills and the Dakota Sandstone found in central Kansas, to sandy soils found along the Arkansas and Kansas River Valleys.

Kansas landuse and landcover varies from native, warm season grasslands to fertile croplands to concrete and asphalt in urban watersheds. These factors combine to create different water runoff volumes, frequencies and velocities along with varying resistance to erosion.

Many people who have never visited Kansas believe the state is extremely flat. Topography changes dramatically in Kansas, with elevations ranging from 700 to 4,059 feet above sea level.

These differences, in stream variables, have helped develop a wide variety of river and stream corridors across the state.

Mitchell Co.

Stream Fact:

Streams with steeper slopes are normally less sinuous. SINUOSITY is a measurement of the degree of stream meandering. It is calculated by dividing stream length by valley length.

Salt Creek, Mitchell Co.

Dimension, Pattern and Profile

Within any stream there are eight variables that determine the morphology, or form and structure, of the stream.

The variables are channel width, depth, velocity, discharge, slope, roughness of channel materials, sediment load and sediment size.

A change in any one of these variables can begin a series of adjustments which will lead to a change in the other variables. The result is channel erosion, which will change the dimension, pattern or profile of the stream. (Rosgen, 1996)

Gyp Hills, Barber Co.

Elm Creek, Barber Co.

One of the most important factors affecting stream dimension, pattern and profile is a stream discharge volume referred to as BANKFULL FLOW. This flow is the channel forming flow, or the flow volume that determines the width, depth and cross sectional area of a stream channel. The bankfull flow does the bulk of stream work, which is transporting excess water and sediment from the watershed.

Bankfull flow varies from stream to stream, but the recurrence interval, or frequency of occurrence for most streams is similar.

In Kansas, the process of documenting bankfull elevations and determining recurrence intervals for U.S. Geological Survey gaged streams is scheduled to be completed by 2001. Most streams, which have been surveyed, have a recurrence interval between 1.2 and 1.5 years. On average, a discharge of bankfull magnitude SHOULD occur once every 14 – 18 months. This does not mean that a bank full flow WILL occur at this frequency, but rather it is likely. The bankfull flow elevation, for Kansas streams, can normally be located between the top of a point

Stream Fact:

Stream discharge (Q) is a product of width (w), depth (d), and velocity (v). Q = wdv

Stream Fact:

A popular misconception is that sand or gravel bars (point bars) cause streambank erosion by forcing water into the bank. In fact, if streambanks did not erode, gravel bars would remain the same size. Gravel bars are built by various flow volumes, but their size is maintained by the bankfull discharge which, over time, carries the most sediment and water downstream.

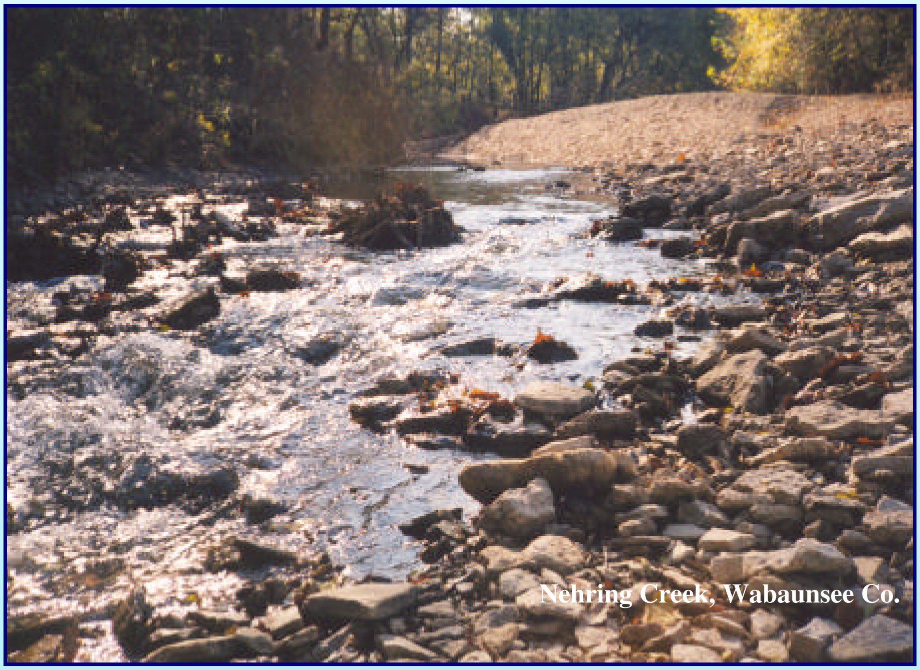
Dimension, Pattern and Profile

Flint Hills watersheds produce more runoff than watersheds of the same size with less, permanent vegetative cover.

This is due to the shallow soil depth which does not allow as much water storage capacity as deeper soils.

Even with greater runoff, the sediment content of Flint Hills runoff is reduced by the permanent native grasslands.

Flint Hills, Wabaunsee Co.



Nehring Creek, Wabaunsee Co.

As a rule, Flint Hills streams move coarse sediment. This material or bedload sediment is usually much larger than the fine grained sands found in the Kansas, Republican or Arkansas River Systems.

Large, coarse materials do not move as far during any single flow as fine sands and silts. Large gravel and cobble, like those shown on the left, may only move a few feet during a high flow event.

Stream Fact:

The cross sectional shape of a stream channel in any given stream reach is a function of the stream flow, the sediment volume, size and shape and the streambed and bank material composition. The bank material composition in an undisturbed system usually includes vegetation.

(Leopold, 1964)

Antelope Creek, Wabaunsee Co.

Channel Evolution Model

The Channel Evolution Model, that follows, provides written and graphic descriptions of five channel cross sections which represent stream channel response to changes in a stream or to major changes in a watershed. These stages range from stable to various forms of DEGRADATION or AGGRADATION and finally back to stable. Pictures of Kansas streams, representative of each stage, are included along with each description.

After Schumm, et al., 1984

Stage I, Stable Channel

A **Stage I** channel is a stable, relatively small channel that carries water and sediment in a manner such that the stream is neither aggrading or degrading. This does not mean that Stage I streams do not change positions in the landscape. Even though a stream is considered stable, it still has the ability to adjust, and is considered to be in a state of DYNAMIC EQUILIBRIUM.

In Stage I channels, flows that occur approximately once every 14 to 18 months (bankfull flows) flow on to the adjacent floodplain where energy can be dissipated by riparian vegetation and sediment deposition occurs. Stage I channels can be very sinuous or meander greatly. These channels have well-vegetated riparian areas, but are extremely fragile and react quickly to detrimental changes in the watershed such as major changes in landuse, landcover, or channelization.

Definition of a stable stream channel:

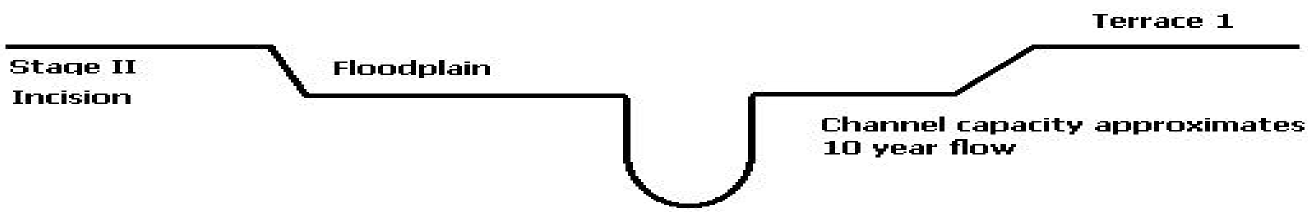
A stream which is able to transport the water and sediment of its watershed in such a manner that the stream's dimension, pattern, and profile is maintained over time without aggrading or degrading.

(Rosgen, 1997)

Channel Evolution Model

Stage II, Incision

After Schumm, et al., 1984



Stage II streams erode the streambed or downcut in response to changes or development in the watershed which result in increased runoff volume and/or velocity. This includes major changes in landuse or landcover such as converting a pasture to a housing development or subdivision. Incision may also result from stream straightening or channelization.

As the channel downcuts, or degrades, runoff that previously spread over the floodplain is now confined to the channel, resulting in further channel incision. This confinement increases energy because flow velocity cannot be reduced by riparian vegetation or by spreading across the floodplain. Signs of sediment deposition, such as point bars, are not present in Stage II stream channels.

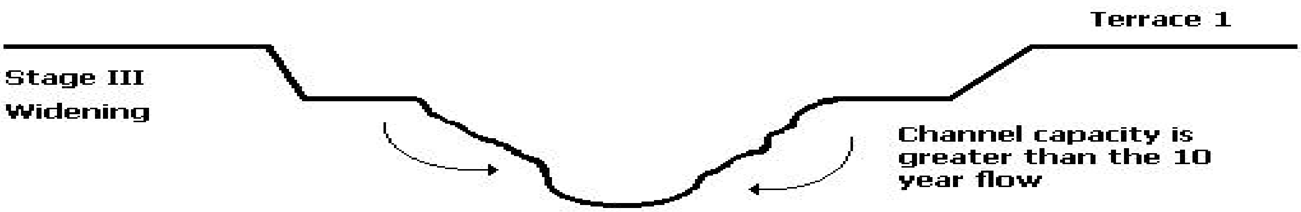
Stage II channels often contain KNICKPOINTS, or abrupt changes in streambed elevation. The knickpoints usually migrate upstream as HEADCUTS. Many Kansas streams are in a Stage II condition.

Knickpoints, or vertical drops in the streambed, move upstream as headcuts unless a rock shelf is encountered. As a headcut moves past a junction of another stream, the second stream will also begin to incise. This process can lead to streambed and streambank instability throughout a watershed.

Channel Evolution Model

Stage III , Widening

After Schumm, et al., 1984



Stage II moving towards Stage III

Stage III channels stop incising because of equalization in slope or because of downcutting to bedrock. (see arrow at right)

The stream channel then typically widens and flow becomes more shallow. Banks fail and collapse into the channel because they are unstable due to the increased height.

As the stream widens, deposition occurs because wide, shallow streams are less efficient in carrying sediment. With lateral erosion and sediment deposition, point bars begin to develop.

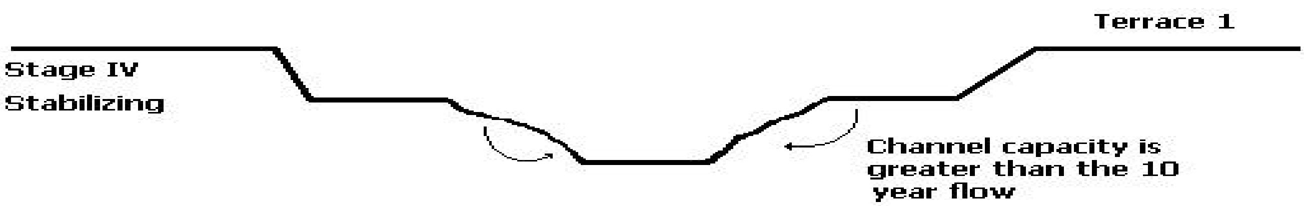
Eroding streambanks in Stage III channels are extremely difficult to stabilize because the channel is adjusting its width to accommodate a larger bankfull flow and is developing a new floodplain.

Stage III Channel

Channel Evolution Model

Stage IV

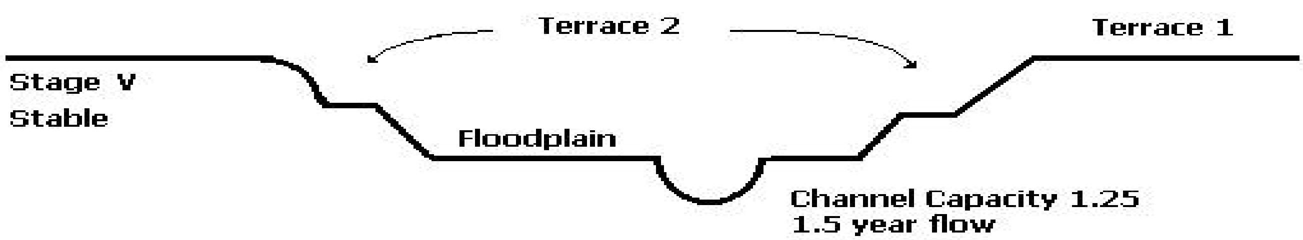
After Schumm, et al., 1984

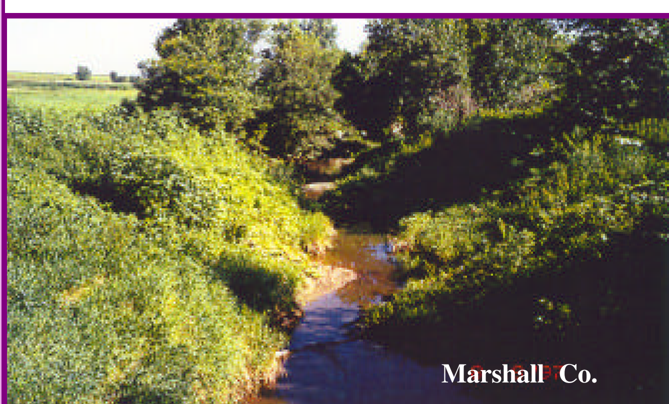


In **Stage IV** channels, some material that sloughed from the high banks remains in the channel and vegetation becomes established on the deposits. As vegetation becomes established, the channel begins to narrow and become more stable. Vegetation reduces surface water velocities while the roots reduce soil erosion.

After Schumm, et al., 1984

Stage V





In **Stage V** channels, the stream has regained the stable characteristics of a Stage I channel, but at a new, lower elevation. The lowest terrace marks the new floodplain boundaries (see diagram).

Urban Corridors

When watersheds become increasingly covered with impervious surfaces such as houses, streets, parking lots, and other forms of urban development, storm water runoff increases along with bankfull flow frequency.

Addition runoff that occurs from rainfall events increases bankfull flow, which often causes an increase in channel width and/or depth.

The results can often look similar to the picture below.

With properly planned development, runoff volume is not increased and stream channels do not make radical adjustments.

When problems occur in urban areas, the solution is often to buy out the homeowners, or construct a traditional solution similar to the picture below. Both solutions are more expensive than proper planning and design in the initial stages of development. Building in a floodplain or too near a stream channel can also be prevented through planning and zoning.

This solution does not provide desirable wildlife habitat or an aesthetic setting.

Water Quality Fact:

Nonpoint source pollution occurs when rainwater or snowmelt flows from fields, city streets or suburban yards carrying various chemicals and compounds. Originating from numerous small sources, nonpoint pollution is widespread and difficult to control or prevent.

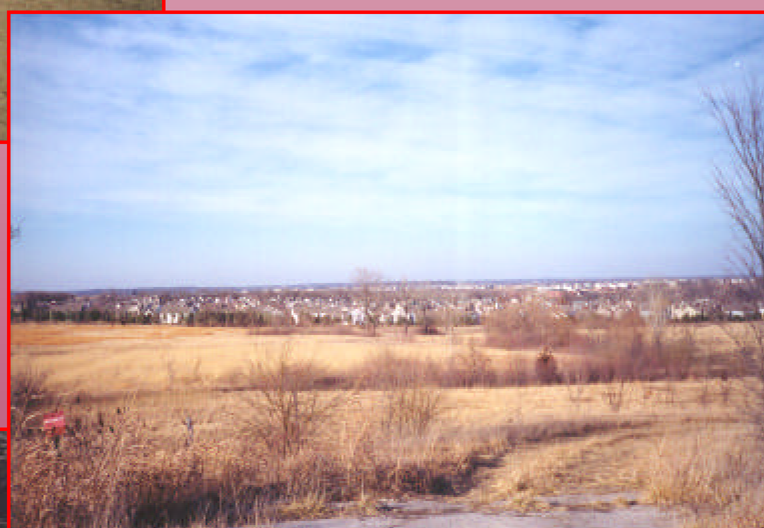
Urban Corridors

For centuries, humans have worked to control rivers and streams rather than attempting to understand and work with a stream's natural tendencies. This is most evident in urban areas.

Replacing natural stream channels with concrete lined ditches or box culverts is required by some Kansas municipal governments. Channels like the one on the right speed storm water runoff and increase downstream flooding.

Urban streams often experience habitat loss, increased water temperatures and loss of fish populations.

Constructed stream channels are often designed for flows greater than bankfull. Normally, this type of channel is too wide to efficiently move sediment during flows at bankfull or less. These channels usually require high construction and maintenance cost.



Between the initial cost and subsequent maintenance, these constructed channels cost thousands of dollars more than proper environmental planning and zoning.

Water Quality Fact:

Urban applications of fertilizers, insecticides and herbicides can exceed agricultural applications, per square foot of application.

Nutrient loading and trash dumping occur in both rural and urban streams.

Rural Corridors

Prior to European settlement, Kansas was mostly rolling prairie with forests in parts of some eastern counties. As the prairie and native forests were converted to cropland, vast quantities of soil eroded from the upper areas of watersheds. The eroded soil was often deposited on the floodplains in lower portions of the watersheds as flood waters spread across

Morris Co.

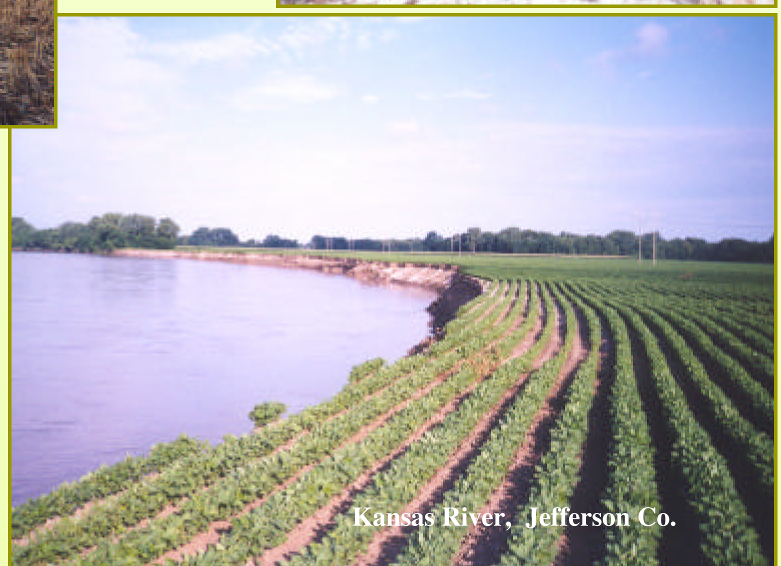
Jackson Co.

Cottonwood tree buried with post –settlement sediment

Modern farmers and ranchers have done a better job of reducing soil erosion on agricultural land in recent years. Millions of dollars have been spent installing conservation practices on agricultural land in Kansas.

Jewell Co. Terraces

Erosion is still a problem along rivers and streams where natural vegetation has been removed, either naturally or by mechanical means.



Kansas River, Jefferson Co.

Stream Fact:

Streambanks with healthy riparian timber erode six times slower than streambanks without trees.

Rural Corridors

Confining livestock in riparian areas allows deposition of waste directly into the stream. Livestock may also damage riparian forests by browsing and trampling young seedlings and trees. This leads to destruction of wildlife habitat and may compromise the effectiveness of natural vegetative buffers. Wintering lots located in areas like those pictured, allow spring rains to carry waste and sediment from lots directly into streams.

Kansas Water Quality Fact:

Small cattle operations (less than 300 animal units) in Kansas consist of approximately 2,000,000 head of cattle on over 32,000 farms. Fecal coliform bacteria from animal waste is a common impairment found in many Kansas streams.

Although tile outlet terraces are very popular in some areas of the state, they provide a direct conduit for transporting agricultural chemicals and nutrients from fields to the stream.

Small wetlands constructed between tile outlets and streams can greatly reduce the amount of pollutants entering a stream. (below)

Water Quality Fact:

Over 90 percent of nitrates in agricultural runoff can be removed when the runoff can be contained in a wetland for a period of seven days. A small portion, 12 percent, is utilized by plants. Most of the nitrates are converted to nitrogen gas through a microbial action called denitrification. The nitrogen is released back into the atmosphere through this process.

Rural Corridors

With prolonged releases of water from major reservoirs, downstream rivers have experienced increased erosion and reduced vegetation. The result is streams that incise and/or widen. Stream channel incision allows stream currents to undercut root systems that would normally help reduce erosion along streambanks.

Measured erosion occurring along these streambanks (left and below left) equaled 3,142 tons per 1,000 feet of streambank in a period of only 22 months. Soil eroded from these and other streambanks eventually becomes deposited in downstream lakes and reservoirs (below). Over time, this deposition decreases flood storage capacity of reservoirs.

Kansas Water Quality Fact:

Sediment is the most prevalent nonpoint source pollutant in Kansas streams.

Components of Healthy Stream Corridors

Healthy Riparian Areas


Marshall Co.

Riparian areas are areas of streamside vegetation along any ephemeral, intermittent or perennial stream including the streambank and adjoining floodplain. Riparian areas are distinguishable from upland areas by vegetation, soils and/or topography.

The width of natural riparian areas, and the riparian plant community, depends on topography, soil type and available moisture. Most moisture supporting riparian vegetation is supplied by the adjacent stream. The water table within the riparian zone is normally maintained at relatively constant and shallow depths during the growing season. In general, natural riparian areas along perennial streams are wider than those along intermittent or ephemeral streams. Plant communities found along streams may also occur along the shoreline of lakes and reservoirs.


Riley Co.

Kansas has four different types of natural riparian areas, RIPARIAN MEADOWS, RIPARIAN SHRUBLANDS, RIPARIAN WOODLANDS and RIPARIAN FORESTS.


Smartweed in riparian area, Marshall Co.


Riparian Meadow, Dickinson Co.

Although RIPARIAN MEADOWS are more common in western Kansas, they can be found throughout the state and are normally found along small, headwater streams in upper portions of watersheds. The riparian meadow vegetative community is composed of grasses which are more water tolerant than other native grass species. Species such as prairie cord grass, switch grass and sedges make up the vegetative community of most riparian meadows. Bulrushes, cattails, smartweed or spikerush may occur if the riparian area is extremely wet.

Components of Healthy Stream Corridors

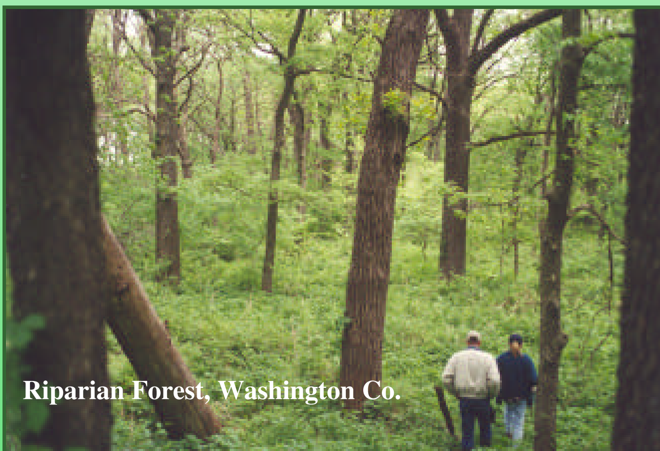
Healthy Riparian Areas

RIPARIAN SHRUB areas are usually associated with intermittent streams. Shrub communities in Kansas typically consists of sandbar willow, false indigo, roughleaf dogwood and/or buttonbush. The picture on the right is mostly tamarisk, or salt cedar, which is neither a native or desirable riparian species.

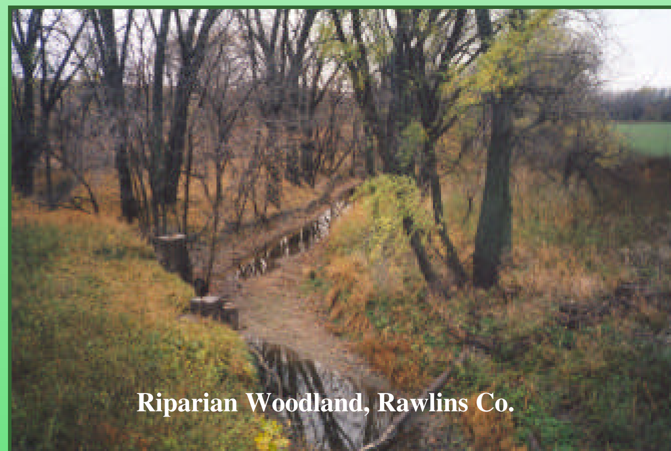
Riparian Shrub

Riparian Shrub – Crooked Creek, Meade Co.

RIPARIAN WOODLANDS are normally composed of cottonwood, black willow, ash, elm and/or box elder. Understory vegetation, in riparian woodlands, consists of grasses and shrubs due to a more open canopy cover. Riparian woodlands can be found throughout the state, but are more common along perennial streams, in central and eastern Kansas.



Riparian Forest, Washington Co.



Riparian Woodland, Rawlins Co.

Riparian Forest, Wyandotte Co.

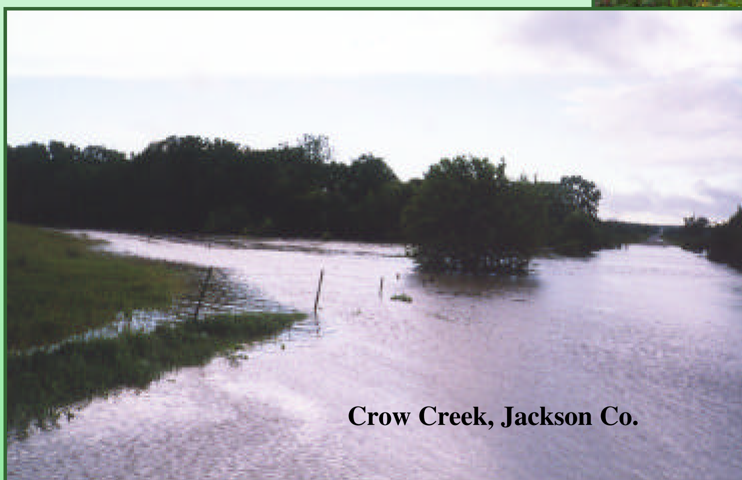
RIPARIAN FORESTS comprise the majority of the 1.5 million acres of Kansas forests with 83 percent occurring in the eastern one third of the state. Riparian forests contain a wide variety of tree species depending on their location in the state. Tree species commonly found in Kansas riparian forests include silver maple, cottonwood, black walnut, green ash, red oak, bur oak, elms, box elder, hickories, hackberry, cottonwood and sycamore. The understory of riparian forests contain small trees, shrubs and vines.

Components of Healthy Stream Corridors

Floodplain

The importance of streams having access to their floodplains cannot be over-emphasized. As water spreads over a floodplain, velocities are reduced. If flood flows are contained within a stream channel, water velocities remain high and cause channel degradation, incision, or excess lateral migration.


Horseshoe Creek, Marshall Co.


Crow Creek, Jackson Co.

Water flowing over floodplains provides a more rapid exchange of gaseous products between soil organisms and the atmosphere. (NRCS, 1996)


Little Blue River, Marshall Co.

Artificial structures such as levees and dikes do not allow streams to access the floodplain during major flow events. When high flows are contained within a channel, the result is often channel degradation.

If levees must be constructed to protect infrastructure, they should be built away from the stream channel. This allows the stream to access the floodplain, even if the access is limited. (see below)

Components of Healthy Stream Corridors

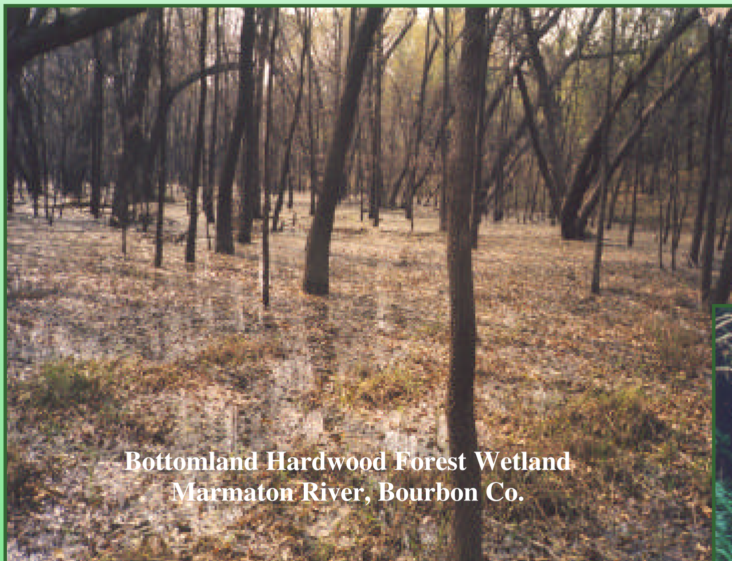
Wetlands

Wetlands were once an integral part of most Kansas stream corridors. Since settlement, a great number of stream corridor wetlands have been converted to other uses, primarily agricultural, residential and industrial.

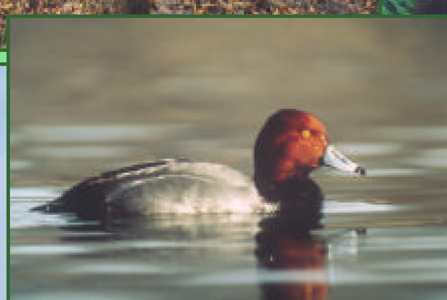
Three major categories of wetlands can be found in Kansas:
PALUSTRINE – commonly called marshes or swamps,
RIVERINE – associated with rivers and streams and

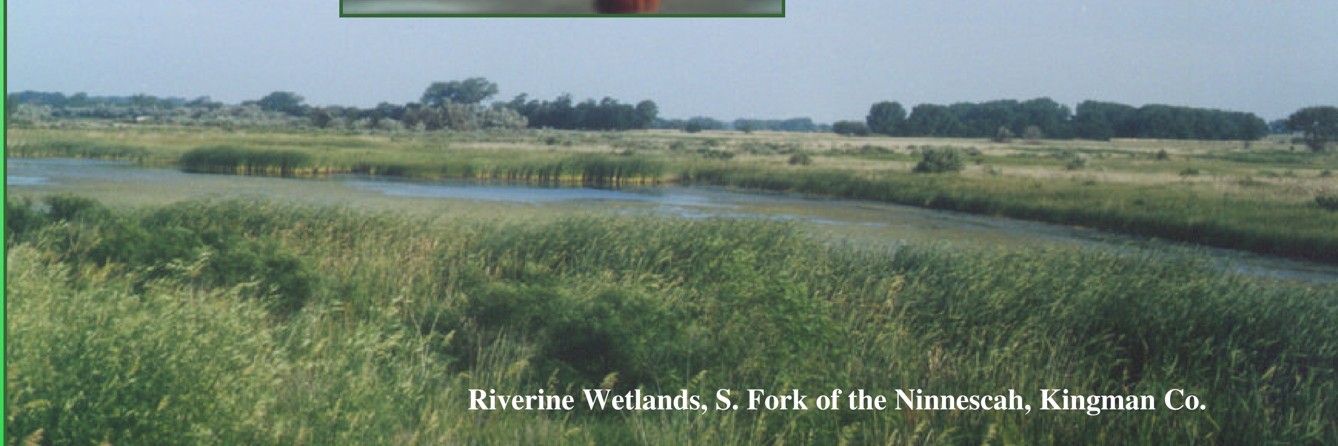
Wet Meadow Wetland
Wakarusa River, Douglas Co.

Wetlands in a floodplain slow water velocities, encourage deposition of excess sediment, and filter pollutants from floodwater. These areas also provide habitat for numerous wildlife species.



Bottomland Hardwood Forest Wetland
Marmaton River, Bourbon Co.





Riverine Wetlands, S. Fork of the Ninnescah, Kingman Co.

Components of Healthy Stream Corridors

Healthy Riparian Areas

Healthy riparian areas are in a dynamic equilibrium with stream flow and riparian and wetland vegetation.

In healthy riparian areas, the stream adjusts its dimension, pattern and profile for increased stream flow, with limited disturbance to the vegetative community.

Marshall Co.

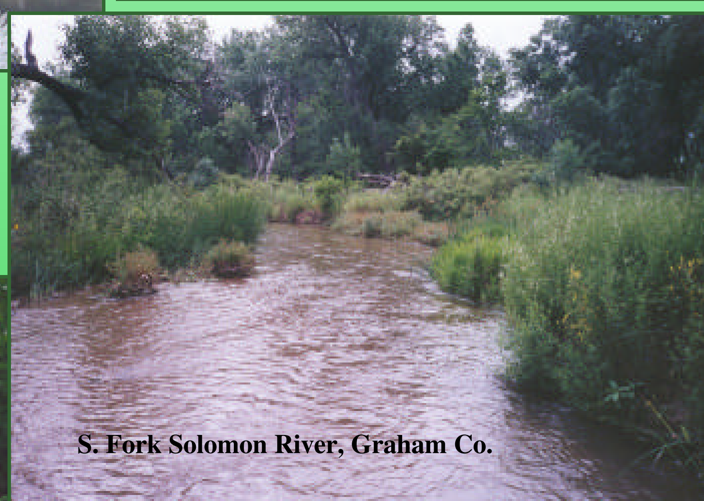
These pictures exhibit characteristics of various types of healthy riparian areas along Kansas streams.

Cimarron River, Meade Co.

West Creek, Greenwood Co.

All of these streams have access to their floodplain. Streambank erosion is limited or non-existent.

Riverine wetlands, present in low lying areas adjacent to the stream channel, are one component of a healthy riparian corridor.



S. Fork Solomon River, Graham Co.

Spring Creek, Chase Co.

The common connection between these examples of healthy riparian areas are healthy, flourishing vegetation, stable hydrology and streambanks, unregulated flows and minimal erosion or deposition.

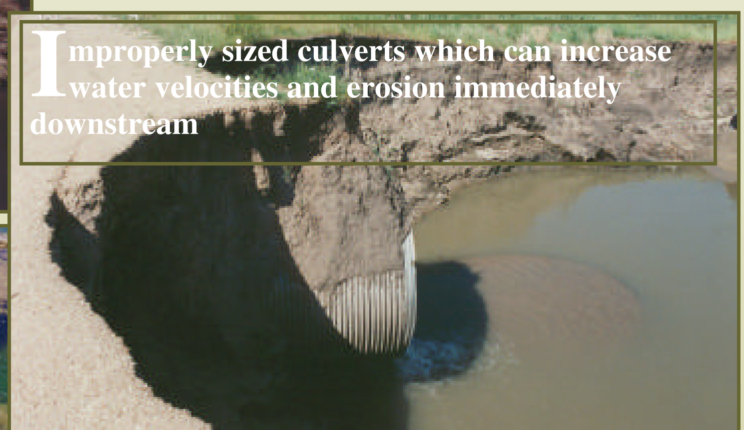
Components of Unhealthy Stream Corridors

Each picture on this page depicts an example of an unhealthy stream corridor or situations which contribute to unhealthy corridors or stream

Riparian areas with little or no riparian vegetation

Straightened or Channelized stream reaches

Bridges or culverts that constrict or widen a stream channel and/or roads that prevent streams from accessing the floodplain



Improperly sized culverts which can increase water velocities and erosion immediately downstream

Areas with high nutrient loads or other pollutants

High, vertical, eroding streambanks

Components of Unhealthy Stream Corridors

Channelization

Channelization, or straightening a stream segment, shortens the natural stream length which increases channel slope. An increase in slope results in increased water velocity.

An increase in water velocity increases erosion, often resulting in a channel that begins to incise or cut deeper.

Incision, Schumm Stage II in the channel evolution process, often begins with a headcut that moves upstream.

As headcuts move upstream, the deepening channel remains narrow with high water velocities. Eroded material is transported downstream where water velocity slows due to a wider or meandering channel with a flatter slope. When water velocities are reduced, excess sediment is deposited, constricting the channel and increasing flood problems.

Excess sediment eroded from straightened stream reaches is deposited downstream as the channel widens and flattens. (left)

Channel incision does not allow point bars to develop because the channel is narrow and deep. (right)

In most cases, streams will not regain a state of dynamic equilibrium, or become stable, until several decades following channelization.

Channelization

Channel incision is often evident at bridges or other structures constructed in stream channels.

The arrows in these pictures indicate stream bed elevations at the time each structure was constructed. The stream channels have since lowered, or incised, due to changes in the stream or watershed.

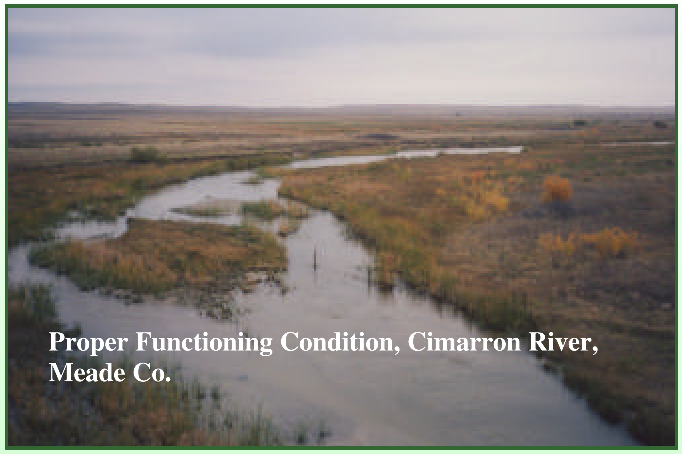
The picture on the right is of an original stream channel. Both pictures below are the same stream and property several years after channelization. The stream bed elevation of the new channel is currently nine feet lower than the original channel and still incising. The stream has not reached an equilibrium more than 30 years after the initial channelization.

Riparian Management

Proper Functioning Condition

It is often helpful to have an idea of the riparian area condition or trend prior to making management decisions. Most natural resource professionals prefer using a uniform method of assessment. For an assessment method to be successful, it must be easy to teach and learn, easy to use and be reproducible by a variety of people.

One method of riparian assessment that fits these criteria is called PROPER FUNCTIONING CONDITION or PFC .



Proper Functioning Condition, Cimarron River, Meade Co.

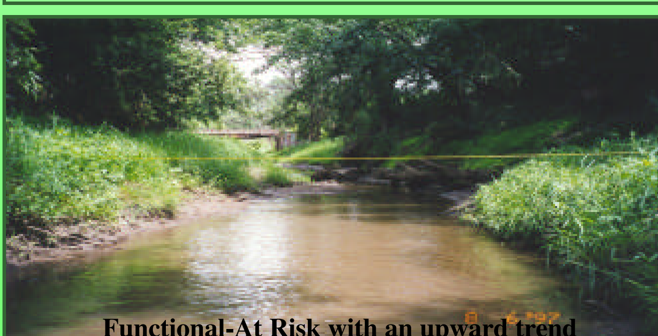
Proper Functioning Condition was developed by the Bureau of Land Management (BLM) and is being used by the U. S. Forest Service (USFS) and the Natural Resources Conservation Service (NRCS). This assessment system places a riparian area into one of three categories based on hydrology, vegetation and erosion or deposition.

The first category is PROPER FUNCTIONING CONDITION. A riparian area in this category is a healthy, desirable area.

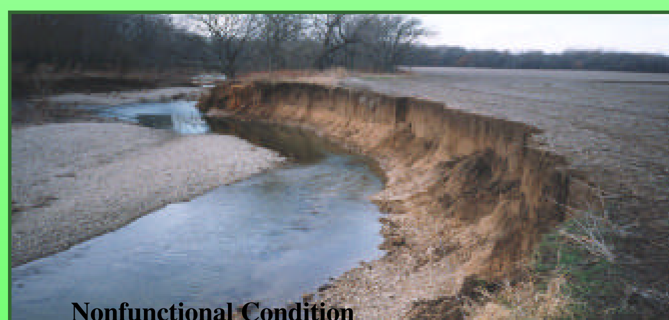
Proper Functioning Condition, Marshall Co.

The second category is FUNCTIONAL–AT RISK. A riparian area in this category can be either in a DOWNWARD or an UPWARD TREND. A downward trend requires changes in riparian management for the riparian area to return to Proper Functioning Condition. An area in an upward trend will return on its own, provided present management practices do not change.

Functional-At Risk with downward trend



Functional-At Risk with an upward trend



Nonfunctional Condition

The third category is NONFUNCTIONAL CONDITION. This category will most often need streambank stabilization, riparian restoration or stream restoration to return to a Proper Functioning Condition.

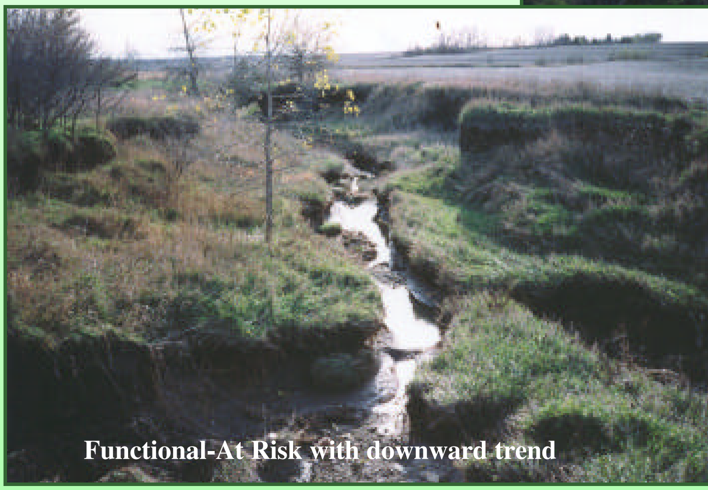
Riparian Management

After the PFC and landowner goals or objectives are determined, appropriate riparian management practices, can be identified to help achieve the objectives. Riparian management practices can be placed into one of three categories.

Protection

If an area is in Proper Functioning Condition, PROTECTION is all that is required to maintain the condition. Protection is the least costly management category.

Proper Functioning Condition



Functional-At Risk with downward trend

Enhancement

Management practices in the ENHANCEMENT category include riparian fencing, alternative livestock water supplies and planting riparian filters or buffers composed of grass and trees. These practices are more expensive than protection. Areas considered Functional–At Risk require management practices that will enhance the area. Enhancement practices will restore an area which is Functional–At Risk with a downward trend or speed recovery of an area that is in an upward trend.

Functional-At Risk with upward trend

Restoration

RESTORATION is the most expensive management option. Riparian areas in Nonfunctional Condition require streambank stabilization and/or riparian restoration to return to Proper Functioning Condition. Some areas may even require stream restoration to achieve a Proper Functioning Condition status.

Not Functioning

Riparian Grazing

Historically, riparian areas have been used by livestock for grazing, shelter, and water. The impact of one animal may seem insignificant, but the cumulative impact of several animals in a stream reach has the potential to degrade riparian areas and streams. Increased nutrients, sediment, bacteria and a reduction of vegetation are common results of livestock grazing and loafing in or next to streams.

Improved grazing management practices have the potential to enhance economic production while protecting riparian areas. One example is livestock loafing away from the stream, on drier ground, are more likely to have increased daily gains. The chance of losing livestock during a flood is also reduced by moving them away from the stream channel.

Several management tools are available to assist landowners in managing livestock use of riparian areas and access to streams. Stabilized in-stream watering points, alternative water supplies and alternative shelters are some examples. Fencing is an option which enables landowners to limit the duration of livestock access as well as the timing of grazing in riparian areas.

<u>Kansas Water Quality Fact</u>:

Fecal coliform bacteria has been determined as a water quality impairment in 70 of the 90 HUC 8 watersheds in Kansas. Livestock waste is one source of bacteria.

Livestock Water Supplies

Strategically placed livestock water supplies can greatly enhance riparian areas as well as range condition. With today's emphasis on water quality, most financial assistance programs require the improvement of a riparian area be one benefit of a water supply installation.

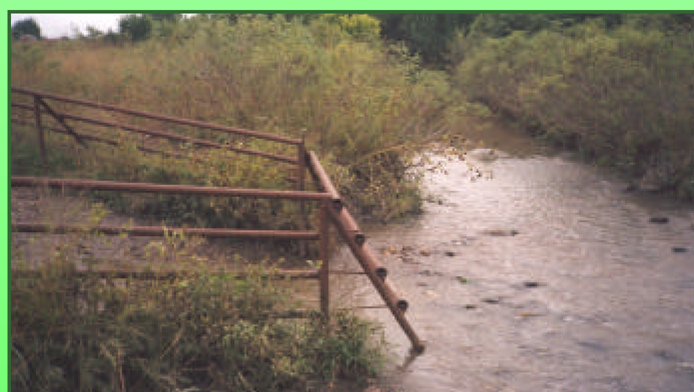
Once the most common water source, or water supply, windmills have been in use in Kansas since the first settlers.

Solar pumps have become more popular for livestock watering, especially in remote areas. Various types of solar pumps are adaptable and require less maintenance than windmills.

The system pictured at left supplies water from the pond to two tanks approximately 300 feet

The systems pictured at right and below, utilize submersible pumps in wells. This type of system is suitable for use throughout the year.

The water access point below was designed by Kansas State Research and Extension.



Freeze proof tanks are gaining popularity in Kansas. These tanks can be connected to wells or gravity lines from springs or ponds.

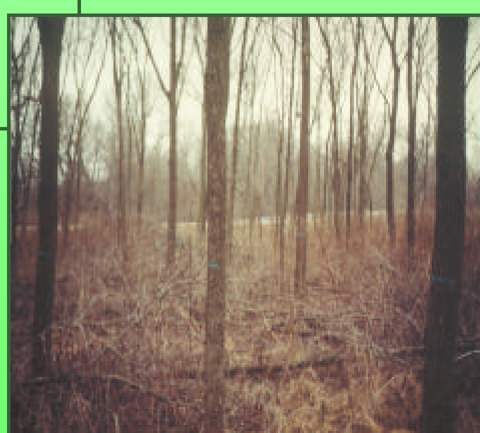
Riparian Forest Management

The majority of forestland in Kansas occurs along riparian areas in the eastern 1/3 of the state. The goal of riparian forest management is to achieve the landowner's objectives while sustaining a healthy forest for future generations. Fortunately, multiple objectives and benefits like water quality, timber products and wildlife habitat for hunting (or threatened and endangered species) can often be attained while properly managing a forest. PROTECTION, REFORESTATION, TIMBER STAND IMPROVEMENT and TIMBER HARVEST are forestry practices that can be implemented individually or collectively to help sustain a healthy riparian forest.

Brush Creek, Jefferson Co.

Riparian forests require PROTECTION from bulldozers that convert ecologically sensitive areas to other landuses, livestock that trample or eat young seedlings which serve to naturally regenerate the forest, fire that can kill and damage trees and damage from off-target herbicide application. Many tools or incentives are available to address these problems, such as conservation easements, alternative livestock water sources, fencing and fire breaks.

TIMBER STAND IMPROVEMENT (TSI) is a method used to increase the growth of high value trees, regulate their number and distribution and to improve trunk quality. Thinning, releasing and pruning trees can increase the growth and quality of a riparian forest by focusing the growth potential of the site on trees of high quality. TSI may also enhance wildlife habitat, recreational use and water quality.



Accelerated growth rate following thinning.

Riparian Forest Management

Harvesting in riparian forests is an important silvicultural practice that can improve the health of the forest while providing economic benefits. Only 33 percent of the annual volume of tree growth in Kansas forests is presently being harvested. When mature trees are not harvested, there is potential for loss in the value of forest products. Growth rates may stagnate, causing younger, pole-sized trees (6 to 11" in diameter) to become more susceptible to insect and disease problems. This size is important because it forms the next forest generation.

Improper harvesting techniques can have negative impacts on water quality, streambank stability, and can damage remaining trees. This can be avoided by planning harvest operations and applying best management practices (BMPs). BMPs are a set of guidelines that reduce impacts to water resources while improving the efficiency of harvesting operations.

Most negative harvesting impacts result from poorly located roads or from removing trees that are serving to stabilize the banks of rivers or streams. Some BMPs that are appropriate for Kansas include: minimizing the number of stream crossings, crossing streams at a 90 degree angle and limiting cutting to no more than 25 percent of the streamside forest when harvesting immediately adjacent to a stream.

Reforestation will be discussed as a tool for riparian restoration on page 32. In addition to tree planting, planting nuts and encouraging natural regeneration are effective methods for restoring riparian areas to a Proper Functioning Condition.

Kansas Riparian Forest Fact:
Riparian timber provides the basis for the aquatic food chain through leaves and woody debris that fall into the stream. Shade provided by trees results in cooler water temperatures which allows a higher water oxygen content for fish. Large woody debris (trees and limbs) that fall into rivers and streams provide aquatic habitat for fish and macroinvertebrates.

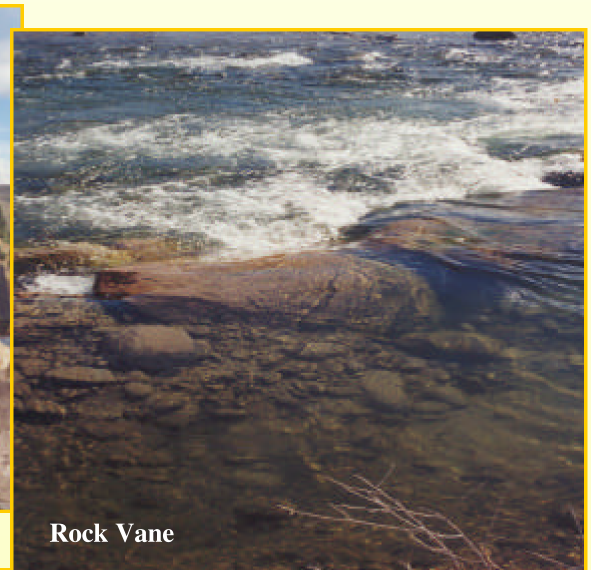
Restoration vs. Stabilization

Restoration and stabilization are two terms often used interchangeably, but their definitions are not the same.

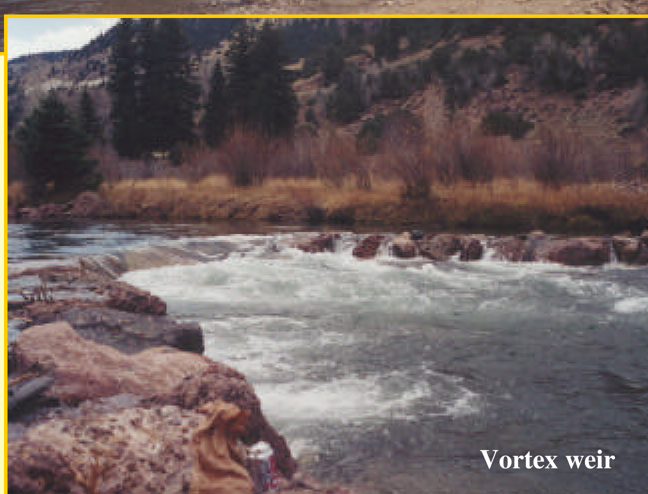
RESTORATION puts something back to an original condition or state.

STABILIZATION keeps something from changing. Stabilization may be considered as a component of restoration.

STREAM RESTORATION is the reconstruction of a stream reach which includes the channel, point bars, and floodplain. One example would be the construction of a meandering stream channel to replace a channel that had been previously channelized or straightened. This type of project has not been implemented in Kansas.



Rock Vane



Vortex weir

STREAMBANK STABILIZATION is not rebuilding a stream channel, but only slowing or stopping the erosion along a stream bank.

The pictures on this page are of stream restoration along a reach of the Gunnison River in Colorado.

Riparian Restoration

The true definition of RIPARIAN RESTORATION is to return a riparian area to its original condition. This is not always possible or even the best option. Most Kansas streams do not have the same dimension, pattern, or profile they had prior to European settlement. Therefore, we must think in terms of the best possible condition that a particular riparian area is capable of achieving under present conditions. In most cases, that means establishing permanent vegetation by planting grass and trees along the riparian area. A particular stream historically may not have had trees along the banks. However, due to channel incision, trees are the better vegetative solution due to their greater rooting depth. The woody nature of tree root systems reinforce the soil similar to rebar in concrete.

Planting bare rooted seedlings by hand, Brown Co.

Republican River, Clay Co.

Along sandy stream systems such as the Republican River, trees are a vital component of healthy riparian vegetation.

Channel width, through reaches of this river that do not have trees, is more than twice that of adjacent reaches with forested riparian areas.

Tree Planter

Planting trees and laying weed – barrier fabric, Jewell Co.

Riparian Planting during 1st year, Jewell Co.

Weed barrier fabric is used on some tree plantings to reduce weed competition and preserve soil moisture in areas of low rainfall or sandy soils. The use of weed barrier fabric adds an additional project expense, but reduces

Riparian Restoration

Riparian filters and buffers slow flood waters; reduce soil erosion; filter pollutants from flood waters, field runoff, and shallow ground water. They also prevent scour erosion and flood debris from reaching crop fields.

Filter and Buffer Planting, Dickinson Co.

Flood erosion in an area without riparian buffer

Flood debris caught by riparian timber

Several state and federal agencies provide technical and financial assistance for various riparian management practices (see page 40).

Grass drills, weed barrier machines, root plows, and tree planters are available from conservation districts and various state agencies.

Native Grass Drill

Grass Filter, Doniphan Co.

Water Quality Fact:

Grass and tree root systems intercept nutrients and chemicals as they move from fields to streams in subsurface water flows.

Filters and buffers can also serve as living snow fences which keep snow from blowing off adjacent crop fields.

Stabilization

Riparian restoration alone is not enough to solve some streambank erosion problems. Banks along many streams are eroding too quickly for riparian plantings to become established. In these areas, the streambank must be stabilized prior to riparian restoration.

Little Blue River, Washington Co.

Smoky Hill River, Russell Co.

Republican River, Clay Co.

Vertical streambanks must be shaped to provide a suitable surface for planting cuttings, seedlings, and grass. On large stream systems, structures such as ROCK BENDWAY WEIRS or ROCK VANES should be installed prior to vegetative planting. **(see page 36)**

After vertical streambanks are sloped, appropriate grass species are seeded on the area. Live stakes and poles are placed on lower portions of the streambank. Grass and trees can be planted adjacent to the bank.

Soil Bioengineering stream bank stabilization project, Mill Creek, Johnson Co.

Republican River, Jewell Co.

Water Quality Fact:

Willow live stakes can produce roots over 6 feet long in 3 to 4 months. Tree roots reinforce the soil and slow bank erosion.

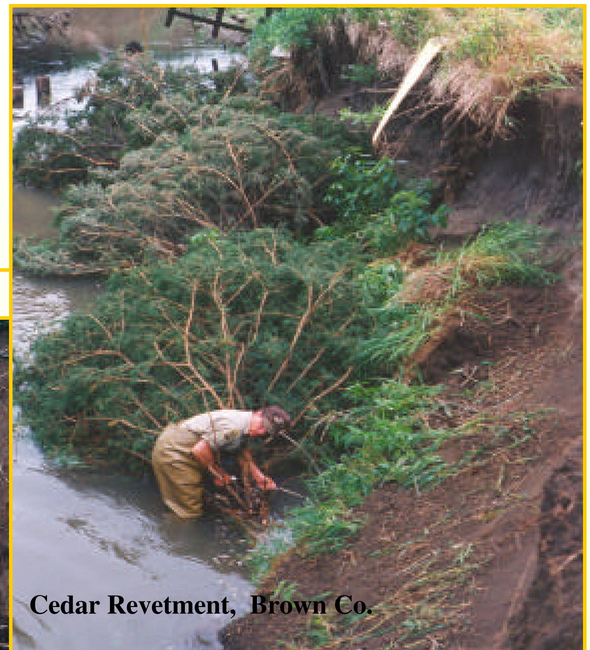
Stabilization

Streambank stabilization can be accomplished through a variety of methods. Some methods have more benefits than others.

Soil Bioengineering

CEDAR TREE REVETMENTS are economical to install, but are labor intensive. Cedar revetments utilize cedar trees to reduce water velocities and induce sediment deposition along the eroding bank. Trees are fastened along the bottom of an eroding streambank with a cable attached to an anchor. The anchor is driven into the stream bed with a jack hammer.

Duckbill anchor

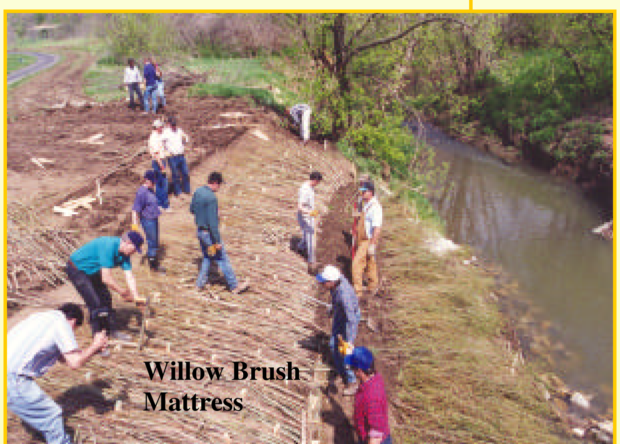


Cedar Revetment, Brown Co.

Ponjoir jack hammer

Cedar revetments work best on small streams with fine soils and high sediment loads. Revetments will eventually decay, but protect the bank long enough for permanent vegetation to become established.

LIVE STAKES AND POLE PLANTINGS are normally used in conjunction with cedar revetments, but may be safely used without revetments on some sites. Unrooted cuttings from willow, cottonwood or sycamore can be used for stakes, poles or several other types of plantings to establish trees while stabilizing streambanks.



Willow Brush Mattress

Willow Live Pole Planting

Some methods of soil bioengineering can be very labor intensive.

Willow cuttings have a higher survival rate than cottonwood or sycamore. Stakes and poles should be cut and planted when dormant.

The willows on the left sprouted from live stakes which were installed 3 months before the picture was taken.

Stabilization

Large streams require more than vegetative solutions to stabilize streambanks and prevent erosion.

Rock bendway weirs were used to stabilize this site. Bendway weirs are low rock structures designed to work under water. The weirs are constructed with an upstream angle which redirects water away from the stream bank as it flows over the weir.

Kansas Water Quality Fact:
Large eroded streambanks like this are common and can easily contribute more than 50,000 tons of sediment to a stream annually. This is equivalent to 38,500 cubic yards or enough soil to fill an area 10 feet high, 20 feet wide, and almost 1 mile long.

Reduced water velocities on the downstream side of bendway weirs result in sediment deposition near the bank.

During high flow, additional sediment will be deposited in the near bank region where vegetation will become established naturally.

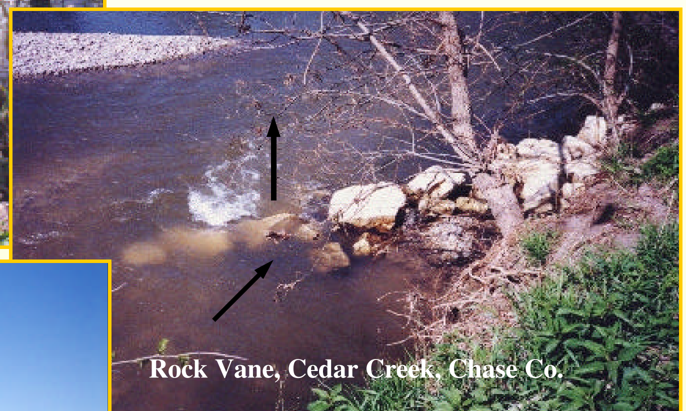
The natural vegetative process can be accelerated by planting live stakes, sedges, reeds and grasses in the depositional area.

The riparian area adjacent to the sloped bank should be planted to a mixture of grass and trees.

Stabilization

Rock Weir, Cedar Creek, Chase Co.

Properly designed and installed rock vanes and bendway weirs work by slowing water velocities near the bank and redirecting flows away from the stream bank (see arrows at left and below). Rock vanes are constructed at a sharper angle and are usually narrower than weirs.

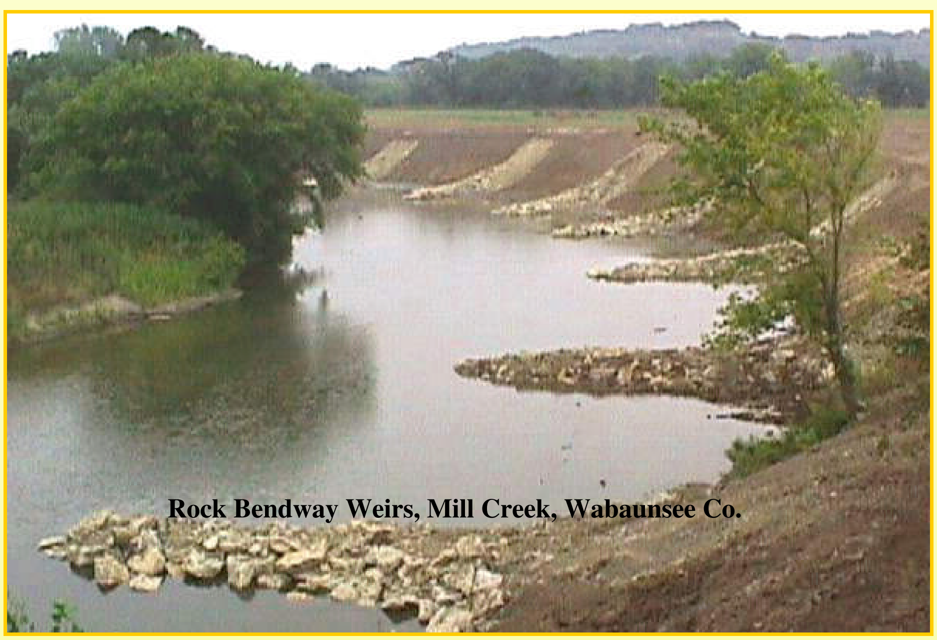


Rock Vane, Cedar Creek, Chase Co.

Bendway Weir Construction, Republican River, Clay Co.

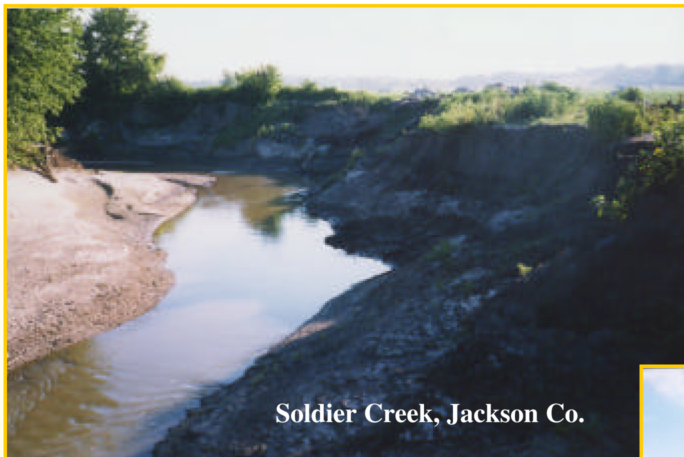
Bendway weirs and rock vanes are constructed as a group extending along the length of an eroding area. Individual weir length, width, upstream angle and spacing between weirs varies from site to site and structure to structure.

Since the entire streambank is not covered with rock, this type of practice is less expensive and also allows room for riparian vegetation to be established between the weirs.



Rock Bendway Weirs, Mill Creek, Wabaunsee Co.

Stabilization


Soldier Creek, Jackson Co.

The picture at left is of an eroding streambank prior to stabilization with rock vanes. The streambanks are approximately 20 feet high and nearly vertical along most of the site. Although the banks are high, floodwater regularly flows over the top. As floodwater overtops the bank, scour erosion occurs and flood debris is often deposited on the adjacent crop field.

The vertical banks are shaped to a 2 feet horizontal to 1 foot vertical slope. A road is excavated down the bank and a trench is excavated, in the road, for the rock vanes. Rock is placed in the trench (or key) and the road and bank are reshaped as the excavator retreats up the bank.

The same site immediately after bank shaping and installation of 4 rock vanes.

Note that the rock vanes extend to just below the top of the bank. (Arrow)

The vanes slow water near the bank by forcing the water to flow up the bank along the row of rock. When water flows over the vane, it will be redirected away from the bank.

The site 8 weeks after installation.

The pale green material along the upper portion of the bank was used to mulch the seeded area.

Live stakes will be placed along the lower portion of the project area the following fall, winter or spring.

A 100 foot wide riparian buffer will be planted adjacent to the site. As the buffer matures, flood flows across the field will be slowed and debris will remain in the channel.

Permits

Although sights like these were once common along many Kansas rivers and streams, car bodies and trash dumping are no longer considered appropriate methods of streambank stabilization.

Before beginning construction of any stream bank stabilization project, you need to receive approval from one or more agencies. Permits may be required for any project that will change the dimension, pattern, or profile of a stream or when a project will be placing any type of fill (rock or soil) in a stream channel.

U. S. Army Corps of Engineers (COE)

The COE is responsible for Section 404 of the Clean Water Act. Therefore, the COE has jurisdiction over any "fills" placed in any "waters of the U. S." For permit applications or other information contact:

U. S. Army Corps of Engineers
Regulatory Branch
700 Federal Building, 601 East 12th St.
Kansas City, Missouri 64106-2896

Phone 816–983–3990

Kansas Department of Agriculture, Division of Water Resources (DWR)

The DWR is required by state law to regulate stream obstructions and floodplain fills of more than one foot in depth. For permit applications or other information contact:

Kansas Department of Agriculture
Division of Water Resources, Water Structures
109 SW 9th St., 2nd Floor
Topeka, Kansas 66612-1283

Phone 785-296-2933 FAX 785-296-1176

Kansas Department of Wildlife and Parks (KDWP)

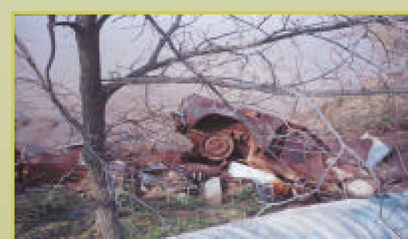
KDWP is one of seven state agencies required to review COE and DWR permit applications prior to a permit being issued. State statutes also require KDWP to protect threatened and endangered species. Many threatened and endangered species utilize streams or riparian areas, so permits from KDWP are sometimes required for projects associated with streams. For more information, contact:

KS Department of Wildlife and Parks
Environmental Services Section
512 SE 25th Ave.
Pratt, Kansas 67124 Phone 316–672–5911

Kansas Department of Health and Environment (KDHE)

Improper installation of streambank stabilization projects or riparian corridor restoration activities could pose a potential threat to water quality. If your project will disturb more that 5 acres, contact KDHE at 785–296–5524. If the project will disturb less than 5 acres, or for further information, contact:

Kansas Department of Health and Environment
Bureau of Water, Nonpoint Source Section
Forbes Field, Building 283
Topeka, KS 66620-0001 Phone 785–296–4195



Assistance

Several state and federal agencies in Kansas have natural resource professionals on staff who can provide information on technical and financial assistance for various stream corridor management practices. Most have agency web pages.


Vassar Creek, Shawnee Co.

Natural Resources Conservation Service
760 S. Broadway
Salina, Kansas 67401-4642
785-823-4556

U. S. Fish and Wildlife Service
315 Houston St., Suite E
Manhattan, Kansas 66502
785-539-3474

Kansas Forest Service
2610 Claflin Road
Manhattan, Kansas 66502-2798
785-532-3300

Ks. Department of Health and Environment
Bureau of Water, Nonpoint Source Section
Forbes Field, Building 283
Topeka, Kansas 66620-0001
785-296-5500

Kansas Department of Wildlife and Parks
512 SE 25th Avenue
Pratt, Kansas 67124
316-672-5911

State Conservation Commission
109 SW 9th, Suite 500
Topeka, Kansas 66612-1299
785-296-3600

Your county conservation district is one source for information on programs, resources and personnel available in your area. Most conservation districts are co-located with U.S. Department of Agriculture Service Centers (Natural Resources Conservation Service Field Offices). You may also wish to contact the Kansas State Research and Extension Office in your county.

Other sources of information and assistance exist with various organizations such as:

Kansas Wetland and Riparian Areas Alliance
433 Elizabeth St.
McPherson, Kansas 67460
316-241-6921

Or your local chapter of:

- Pheasants Forever
- Quail Unlimited
- Ducks Unlimited
- National Wild Turkey Federation

Glossary

Accretion—The process of sediment accumulation due to flowing water.

Aggradation—The geologic process by which stream beds, flood plains and the bottoms of other water bodies raise in elevation. This change in elevation is caused by the deposition of material eroded or transported by water from other areas. (Sediment)

Alluvial Deposit—A deposit of sediment created by the action of running or receding water.

Avulsion – Is the sudden movement of soil from one property to another as a result of flood or a sudden shift in the course of a boundary stream.

Bankfull Discharge---The discharge and corresponding stage found at the incipient point of flooding. It is often associated with an average return period of 1.5 years. Bankfull discharge is the peak of effective discharge and is expressed as a momentary maximum or instantaneous peak flow rather than the mean daily discharge.

Bankfull Width---The water surface width of the stream at the bankfull stage.

Bankfull Mean Depth---The mean flow depth at the bankfull stage. It is determined as the cross sectional area (sum of the products of unit width times depth) divided by the bankfull surface width.

Bankfull Stage---The elevation of the water surface associated with the bankfull discharge.

Belt Width---The width of the full lateral extent of the bankfull channel when measured perpendicular to the fall of the valley (outside of the meander to outside of meander).

Bedload—The material moving on or near the stream bed by rolling and sliding with brief excursions into the flow within three or four grain diameters above the stream bed.

Bedload Discharge—The quantity of bedload that passes a stream cross section in a given unit of time.

Bed Material—The sediment mixture which composes the stream bed.

Braided River---A wide and shallow river channel where flow passes through a number of small interlaced channels separated by bars or shoals. Normally, contains three or more small channels. Under the Rosgen classification system a braided river would be a D or Da.

Canopy Cover – The cover created by branches and leaves of large trees.

Channel---A natural or artificial waterway that periodically or continuously contains moving water. Channels form connecting links between two bodies of water.

Degradation---The geologic process by which streambeds, floodplains and the bottoms of other water bodies are lowered in elevation by the removal of materials by water. (Erosion).

Delta---The sediment deposit formed where moving water is slowed by a body of standing water.

Deposition---The mechanical processes through which sediments settle out and accumulate.

Dissolved Load---The part of a sediment load carried in solution.

Entrenchment Ratio---The quantitative index of vertical containment of rivers. The ratio is determined by dividing the floodprone area width by the bankfull width. (The floodprone area width is measured at twice the maximum bankfull depth, see floodprone area width).

Flood-frequency Analysis---A probability of a given magnitude flood peak that may be expected to occur for a given period expressed in years. The 1 in 100 year flood would have a probability of 0.01 or 1% of being equaled or exceeded in any one year. The reoccurrence interval is determined as 1.00/ probability of exceedance. Correspondingly, probability of exceedance is determined as 1.00 / recurrence interval (years) times 100. The graphical method of flood frequency analysis involves ranking the historical record of flood peaks from the highest to lowest and given a plotting position (m/N+1, where m = rank of the event, N = number of years of record). This calculation gives exceedance probability for their respective peak flows. The resulting data and their respective positions are plotted on probability paper and line drawn between points. The resulting graph is called a probability plot and the fitted line a flood frequency curve.

Glossary

Floodplain---The floodplain of a river or stream is the level land surface found adjacent to the bankfull channel which is constructed by the river in the present climate. It is available to the river to accommodate flows greater than the bankfull discharge (see bankfull stage). The depth of flow over the floodplain is a function of the floodplain width and flood peak magnitude.

Floodprone Area Width---The width associated with an elevation of twice the maximum bankfull depth. It is the area including the floodplain of the river and often the low terrace of alluvial streams. This value when divided by the bankfull width is used to determine entrenchment ratio.

Fluvial Sediment---Is particles derived from rocks or biological materials that are transported by, suspended in or deposited by streams.

Knickpoint – A vertical overfall in a streambed or sharp drop in streambed elevation .

Meander---One of a series of sinuous curves, bends or loops developed in a flood plain by flowing water.

Oxbow Lake---An abandoned stream channel resulting from avulsion. It is the cutoff portion of a meander bend.

Point Bar----One of a series of low ridges, composed of coarse sediment deposited, on the convex side of stream meanders. Commonly called a sand bar.

Runoff---The portion of rainfall than is not infiltrated into the soil or evaporated. It is that part of precipitation that flows on the soil surface to streams.

Scour---The removal of the boundary material by flowing water which results in the enlargement of a stream section.

Sediment---Particles derived from rocks or biological materials that are or have been transported by water.

Sediment Discharge---The mass or volume of sediment passing a particular point during a unit of time.

Sediment Load---The weight of solid matter being moved by a stream through a cross section per unit of time (Bed load plus suspended load).

Sinuosity---The ratio of stream length to valley distance. It is also the ratio of valley slope to channel slope.

Stream Discharge---The volume of flow passing through a cross section in a unit of time. Normally expressed in cubic feet per second (cfs).

Stream Slope---The change in stream bed elevation over a measured length of channel. It is expressed as a ratio of elevation (rise) over distance (run) in ft or as a percent slope.

Stream Stability---A stable stream is one which is able to transport the water and sediment of its watershed in such a manner that the stream's dimension, pattern and profile is maintained over time without aggrading or degrading.

Suspended Sediment Load---The weight of suspended particles continuously supported by the water.

Terrace----A flat area adjacent to a river floodplain in alluvial valleys which is created by the abandonment of a previous floodplain. Other than the low terrace, it is rare that terraces are flooded in the modern climate. Many of the higher terraces are related to elevations associated with the Holocene period. Other terraces are related to changes in local base level adjustments from recent disturbances and associated stream degradation, creating abandoned floodplains (terraces).

Thalweg---The line following the deepest points along a stream bed, valley or reservoir.

Turbidity---An expression of the optical clarity of a water sample. Turbidity results from the presence of suspended and dissolved matter. This can include clay, silt, finely divided organic matter, plankton or other microscopic organisms, organic acids and dyes.

Understory- - The vegetation that grows in areas shaded by taller vegetation. See canopy cover.

Water Pollution---The presence of any harmful or objectionable material in water introduced by anthropogenic means in quantities sufficient to adversely effect its usefulness.

Watershed---The land area enclosed by a continuous hydrologic surface drainage and lying upstream of a specified point.

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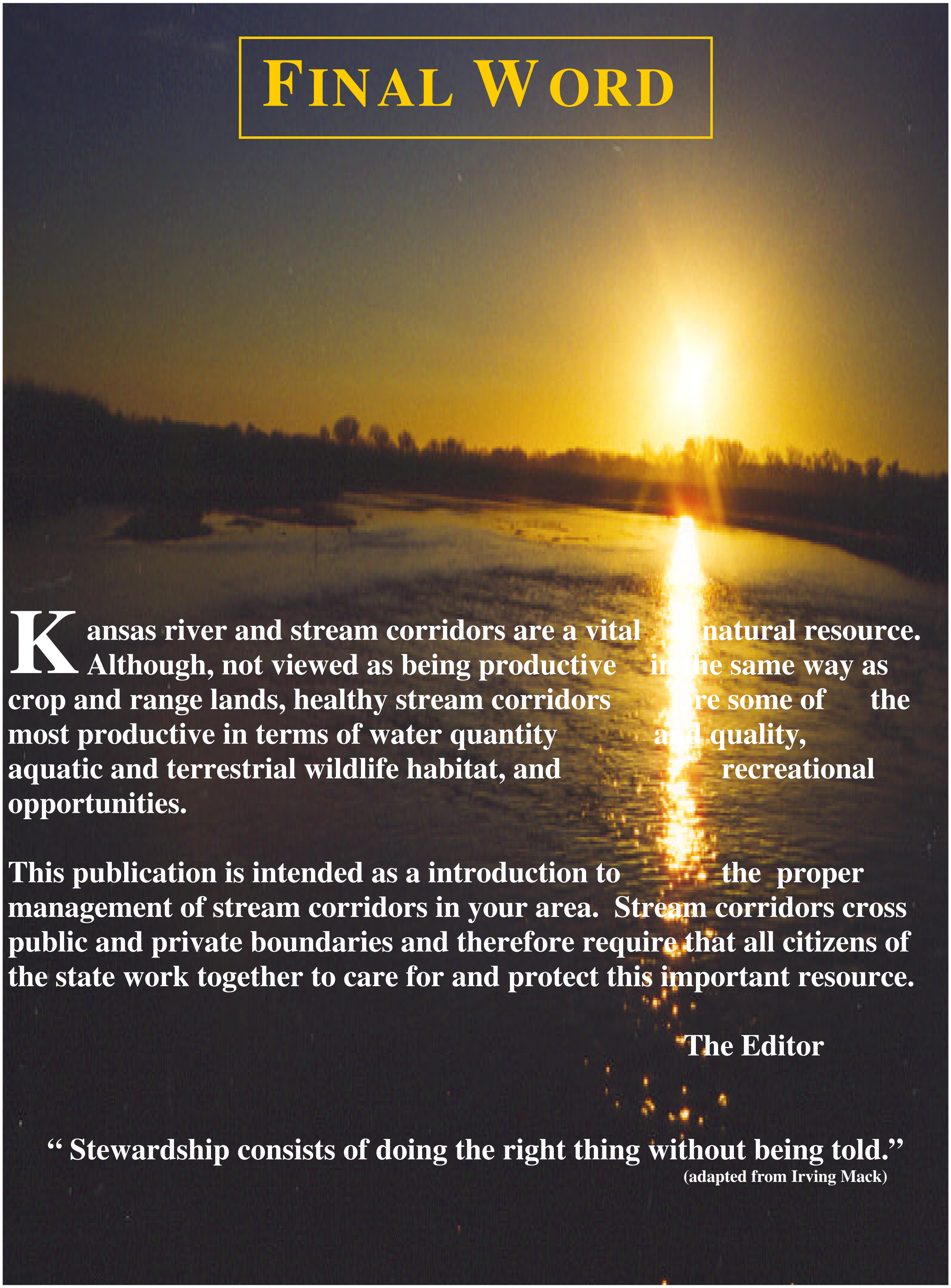

FINAL WORD

Kansas river and stream corridors are a vital natural resource. Although, not viewed as being productive in the same way as crop and range lands, healthy stream corridors are some of the most productive in terms of water quantity and quality, aquatic and terrestrial wildlife habitat, and recreational opportunities.

This publication is intended as a introduction to the proper management of stream corridors in your area. Stream corridors cross public and private boundaries and therefore require that all citizens of the state work together to care for and protect this important resource.

The Editor

" Stewardship consists of doing the right thing without being told."
(adapted from Irving Mack)