Kansas Streams: A Unique Natural Resource

Phil Balch,
Wildhorse Riverworks, Inc.

Kansas river and stream corridors are a vital natural resource. Although, typically not viewed as productive in the same way as crop and range lands, healthy stream corridors are some of our most productive natural areas. Kansas streams and their associated riparian areas provide drinking water for humans and livestock, water for irrigation and industry, aquatic and terrestrial habitat, aesthetic value, and recreational opportunities.

A stream is a product of its watershed (the area of land that supplies water and sediment to the stream). The watershed's climate, topography, geology, vegetative cover and landuse, all combine to determine the stream's **dimension, pattern, and profile**, or its physical characteristics. Dimension refers to the cross sectional shape of a stream channel. Pattern is the configuration of the bends or meanders as seen in an aerial photograph, and profile is the stream slope or drop in elevation over a given distance.

Within any stream system there are eight variables that determine the morphology, or form and structure, of a stream channel. These variables are channel width, depth, water velocity, water volume (discharge), slope, roughness of channel materials, amount of sediment (load), and sediment size. A change in any one of these variables will begin a series of channel adjustments. The result is often channel erosion, which will alter the stream dimension, pattern and/or profile.

If a stream is relatively stable, it is referred to as being in a state of **dynamic equilibrium**. This does not mean that erosion and deposition does not occur but rather this natural cut and fill is balanced enough not to change the general character of the stream. Streams vary over time and also within different reaches, or stretches, of the same stream. The watershed drainage area increases downstream, as tributary channels join the main stem, therefore channel dimensions increase and sediment size usually decreases as does gradient.

One of the most important factors affecting stream dimension, pattern and profile is a specific stream discharge volume referred to as **bankfull flow**. This is the channel forming flow, or the volume of water that determines the width, depth and cross sectional area of a stream channel. The bankfull flow does the bulk of stream work over time, which includes transporting excess water and sediment from the watershed. Bankfull discharge varies from stream to stream, but the recurrence interval, or frequency of occurrence for most Kansas streams is similar. Virtually all Kansas streams have a recurrence interval between 1.2 and 1.5 years. This means that on average, a discharge of bankfull magnitude will occur once every 14 – 18 months. Streams in highly urbanized watersheds have a bankfull frequency of 1 year or less due to their increased impermeable surface area.

Flint Hills watersheds have a shorter bankfull discharge recurrence interval and produce more runoff per unit of drainage area than other Kansas watersheds. This is due to the shallow soil depth which does not allow for as much rainfall to soak in, or infiltrate, as do areas with deeper soils. During the historic flood of 1951, the Neosho River watershed produced almost as much runoff as did the Kansas River watershed. at Topeka; the Kansas River peaked at 469,000 cubic feet per second (cfs) on July 13, 1951. The Neosho River near Iola peaked the same day at 436,000 cfs. This is only 33,000 cfs less than the Kansas River and is pretty amazing when one looks at the large difference in watershed size. The Kansas River flood was created by runoff from 56,720 square miles, while the Neosho River flood was created by excessive runoff from only a 3,818 square mile watershed.

Stream sediment may be placed into one of two categories; bedload or suspended. Bedload sediment ,which is larger, moves along, or bounces within 3 inches, of the streambed. Suspended sediment is fine material that is carried by up lifting currents in the water column. Any sediment from 3 inches above the streambed to the water surface is considered as suspended. Suspended sediment is the fine material seen deposited on surfaces after high stream flows.

As a rule, Flint Hills streams move coarse bedload sediment particles, most of which is gravel size (1/16 inch to 2 1/2 inches). This material or bedload sediment is usually much larger than the fine, uniformly grained sands found in the Kansas, Little Blue, Republican, Ninnescah, or Lower Arkansas River Systems. Large, coarse materials do not move as far during any single flow as do fine sands and silts. In fact, large gravel and cobble may only move a few feet during a high flow event.

Meanders, or bends in the stream channel, reflect the stream pattern while partially regulating channel slope. The degree of stream meandering is measured by dividing stream length by the straight line valley distance; this is called sinuosity. As a general rule, higher gradient streams have less sinuosity. The channel slope becomes flatter as stream length, or meander length increases. The flatter slope reduces water velocity. If a meander is cut off, or channelized, the stream length is shortened and channel slope is increased. This process increases water velocity and therefore also increases channel erosion; both to the streambed and banks.

Pools are the deeper areas of the stream channel, which can normally be found along the outside bend of the meander. On small streams, pools provide fish refuge during drought conditions. They also provide slack water habitats where fish rest and feed.

Riffles are located at the cross over areas between alternating stream meanders. They are the narrowest, most stable reaches of the stream channel and provide vertical control of stream channel slope. Riffles are normally found to be spaced at 5 to 7 channel widths. Riffles increase substrate heterogeneity, providing habitat for benthic invertebrates and small fish. In most shallow streams, riffles are the habitat type supporting the richest community of aquatic organisms that in turn provide a food base for the fish community. Riffles also increase surface turbulence, which enhances dissolved oxygen levels in water downstream of the riffle. The pool - riffle sequence dissipates energy and reduces water velocities.

The Thalweg is the deepest part of the stream channel. This is also the area of higher velocity streamflow. During the rising limb of a high flow, the thalweg can be located by observing the area of foam and/or debris flowing downstream.

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

The width of natural riparian areas, and the riparian plant community, depends on topography, soil type and available moisture. Moisture supporting riparian vegetation is supplied by the adjacent stream via ground or flood water. 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. Over 85 species of birds rely on riparian habitats in Kansas.

The importance of streams having access to their floodplains cannot be over-emphasized. As floodwater spreads over a floodplain, velocities and thus erosive force are reduced. The average water velocity occurring in stream channels may reach 6 feet per second but as the water overflows on to the floodplain, velocities will drop to 3 feet per second or less. If flood flows are contained within a stream channel, water velocities remain high and cause channel degradation in the forms of incision or excess lateral migration (bank erosion).

Healthy riparian areas on the floodplain adjacent to the channel can further reduce flood water velocities by providing increased resistance or roughness. Riparian areas can also prevent flood debris from being deposited on crop fields.

When talking about stream restoration, discussions often turn to pre-settlement stream conditions. Given a thorough understanding of surface water hydrology, fluvial geomorphology, and stream dynamics, it should be understood that the dimension, pattern, and profile of our streams today are much different than those of the mid 1800s. Pre-settlement Kansas streams had adapted to a prairie landscape with little runoff from most rainfall events. Well established prairie ecosystems can infiltrate 5 to 6 inches of rain. Once a prairie is converted to row crop use, the infiltration rate drops to 1 to 1.5 inches of infiltration which greatly increases the amount of water that will flow to stream channels rather than soaking into the soil. Once the prairie is converted to urban landuse, the rate of infiltration is reduced even further. As these changes occurred over the last 150 years, streams have continually adjusted to the changing landuse and conditions. Therefore, when discussing stream restoration, we must look at the watershed and stream conditions in the current time frame and restore the stream to a stable condition that the present landuse and climate will support.

A similar argument applies to riparian restoration. 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 climate and conditions. In most cases, this means establishing permanent vegetation by planting grass and trees along the riparian corridors. A particular stream historically may not have had trees along the banks. However, due to channel incision on most streams, trees are now the better vegetative solution due to their greater rooting depth and the root systems ability to reinforce the soil and maintain bank and channel stability.

Streams are complex systems which react to changes in the factors or variables described above. Stream systems include the stream channel, riparian area, and floodplain. These systems are responsible for providing drinking water, irrigation water, and recreational opportunities in the form of hunting, fishing, wildlife viewing, and canoeing for thousands of Kansans. Stream corridors cross both public and private boundaries and therefore all Kansas citizens need to cooperate in protecting these unique natural resources.