THE NATURAL TENDENCIES OF RIVERS
(PROSPECTING FOR TROUT II[1])

by
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I saw a small dimple tight to the bank. One of the channels in the water weed pushed the flow from the river tight to the bank so that the major portion of the flow skimmed and dragged against the sedges and grasses drooping from the bank. I recognized an ideal lie and had watched it for at least 5 minutes. It was an ideal location for a good trout, at least on similar water back home in Ontario. Sure enough as a Pale Morning Dun drifted along the bank it disappeared in a dimpling rise. I figured I had nothing to lose other than another dry fly amongst the vegetation of the bank..

It was August 1980 and I was fishing with my buddies, Ken Robins and Mike Jeavons on Poindexter Slough, a section of spring creek near Dillon, Montana. Although I had never fished this water before, it seemed familiar. If I ignored the grey and beige side slopes of the mountains in the distance or the sagebrush in the dry fields behind me, the stream could have been the Sydenham River near the village of Chatsworth, Ontario. The similarities were striking! The channels of both streams are quite sinuous, snaking almost tortuously down their valleys. Both streams are substanitally deeper than I would normally assume from their widths. Luxurious vegetation in the form of grasses, sedges, and water-loving forbes and shrubs pack their banks and extend like ribbons of greenery through their valleys. On Poindexter, the remainder of the valley is cured brown grasses and sage, while on the Sydenham, the remainder of the valley is either grazing lands or hay fields. The banks of both streams are vertical with substantial undercuts lining the banks in an almost

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continuous strip. The bed of each channel is composed of gravel and sand with vast areas of waterweed sprouting from the bottom to surface, forcing the flow of water to split, swirl and mix constantly. Fishing that day on Poindexter was like a case of "dejá vue". I suspect that many of you have found a section of new water surprisingly familiar when fishing far from home.

In my previous article, I discussed the role that geology plays in creating the "potential" for coldwater streams and the relative fertility or productivity of the rivers within a specific type of geology. Potential is created on a broad scale by certain types of geology, climate and topography. The elaboration of potential into reality, the reality of productive sections of stream with good habitat for fish, is realized within a particular reach of stream within the watershed. It is a matter of scale. The purpose of this article is to explore the varieties of stream channel that can be formed within a watershed and the implication of varieties to fish habitat.

Rivers and their channels are children of their watersheds. Each watershed, depending upon its mix of geology, topography and valley forms may have a few children or many. We are usually more familiar with the children than with the parent because, unless you are in a airplane or examining topographic maps, it is difficult to "see" or fish a watershed. It is relatively easy to see and fish a section of river. The children I am referring to are the specific reaches of river and their specific structure, shape and features. Over the years that I have fished rivers across North America and in Britain, I have often experienced a sense of "dejá vue". Many portion of new rivers look similar to those I have fished in Ontario or New York: portions of the upper Grand River and Saugeen River remind me of the Beaverkill; portions of the Sydenham River remind me of Poindexter Slough in

Montana; portions of the River Dee in Wales remind me of the Maitland River near Goderich, Ontario.

There are observable, underlying, repeatable patterns in the shape and structure of rivers that flow through valleys of similar form and structure. Dr. Luna Leopold, one of the fathers of modern geomorphology stated that rivers have a natural tendency towards similar shapes and structures given similar topographies, geologies and climate. These similar channel shapes and structures often create similar habitat characteristics as others of similar shape and structure in other parts of the world. In my experience these similarities of channel structure and shape translate into similarities of habitat structure for fish of the same or similar species. I hypothesize that if there are specific, repeatable channel structures and shapes in nature, then an understanding of these similarities can help the angler determine where he or she will find fish when angling on different waters with similar channel structure and shapes.

I have been a keen observer of rivers for 30 years, but it took a cowboy, Dave Rosgen, from Colorado to help me understand the underlying patterns of these rivers. Although Dave is a cowboy at heart, he is also a fly fisherman, hydrologist and geomorphologist with 30 years of experience in river research and restoration. My introduction to Dave was a matter of serendipity. Dave was suggested as a speaker at a conference on trout stream rehabilitation that I chaired in 1990. A mutual friend, Don Duff, from the U.S. Forest Service in Utah said, "You gotta have this guy speak at the conference. He just knows rivers and loves them".

Dave knocked our socks off at the conference. His presentation was like a bombshell for many of us. He presented a way to classifiy streams by form and type, given similar geological characteristics. Dave also presented compelling information on streams, how they function, and how misguided and mis-informed human activities alter rivers.

One year later I organized and participated in a one week course in Ontario taught by Dave. That course was an epiphany to me. During the course, my mind was rocked by revelation after revelation about streams and their characteristics. "It was like flashbulbs constantly going off in my head," I exclaimed to a friend a few weeks later. Those comments were echoed by both biologists and engineers taking that particular course and several others taught by Dave in subsequent years. Dave's course enabled me to understand the physical relationships I had observed about river form, eroding banks, spawning areas in streams and the appropriateness of various stream improvement techniques I had tested over the years. In addition, I gained a new understanding of how to use his classification system as a means to communicate with professionals in other disciplines and as a way to understand how habitat is formed and what stream forms create what types of habitat or lies for fish.

Dave’s classification system defines typical stream forms and patterns that occur under similar physical conditions . The forms range from A to G. The basic stream forms are shown in Figure 1. Once a stream form is determined, it is further refined to “type” based upon the average size of sediment found in its’ channel. So when I speak of form, I am discussing overall shape, sinuosity, channel gradient and generally how entrenched the stream is within its’ valley. When I speak about stream “type” I am further refining it to explain its’ dominant particle sizes found in the bed of the channel. Figure 1 illustrates the variety of channel forms expected in nature given similar characteristics of channel slope, width and depth, entrenchment and sinuosity. These variables are based upon analysis of channel and flow characteristics during the highflow of a river. The classification is based upon research using data from over 450 river systems throughout the United States, Canada and New Zealand. Further information on this approach to classifying and managing rivers can be found in Dave's book entitled: "Applied River Morphology", published by Dave in 1996.

Stream type uses a number system to describe the most common size of the substrate on the bottom of the river. There are six particle sizes: 1 is bedrock; 2 is boulder; 3 is cobble; 4 is gravel; 5 is sand; 6 is silt. The mean size of particles in the bottom of a riffle in a stream indicates the size of substrate moved by the bankfull flow. The sorting of gravels and cobbles in riffles during bank-full discharges is an important process for the "conditioning" of riffles for aquatic bug production and fish spawning. During high flows, the areas of the stream with the greatest erosion is usually in the pools, which is why pools are deep, and the areas of greatest sorting and deposition of substrate are the riffles. Point bars and floodplains are the locations of deposition and storage of finer materials.

Most anglers are familiar with three basic types of streams: pocket water streams, riffle and pool streams, and meadow creeks or spring creeks. These overlap the scientific stream types developed by Dave Rosgen. Pocket water streams fall into the "A", "B", and sometimes "G" stream forms. Riffle:pool streams fall into the "C" and "F" classes and meandering meadow and spring creeks fall in the "E" stream form. I have illustrated the typical planview or top:down view and length-wise side view of pocket water, riffle and pool and meadow streams in Figures 2, 3 and 4. A range of stream types can be found in any particular watershed.

It is a very unusual watershed that will have only one or two stream types. Most of the watersheds I am familiar with across North America have anywhere from 3 to 5 stream forms made up of numerous types due to differences in the geological materials these streams cut through. Stream channels through the processes of erosion over thousands of years will capture the various sizes of particles in the local geological materials and transport them downstream over time. This contributes to the range of particles you would find in a specific section of river. For example, the West Credit River that flows through the Town of Erin in southern Ontario has several stream types (A2, B2, B3, C3, C4, C5, E5, E6) within its small sub-catchment. The stream types reflect the local geological materials that those sections of stream channels flow through. For example, the A2, B2 and B3 stream types are found in the lower section of the river where the bedrock of the Niagara Escarpment is exposed, whereas the C5, E5 and E6 channels are located where the stream flows through sandy moraines (C5 and E5) and clayey tills (E6).

The "A" and "B" stream forms are typical mountain or escarpment topographies, tumbling down a mountain side in a more or less straight line. Given the rocky nature of the valley walls, these streams cannot meander horizontally and therefore must dissipate all their energy through vertical meandering creating high energy pocket water, referred by hydrologists as step:pool sequences (Figure 2). In A and B channels a step:pool sequence repeats itself every 1-3 bankfull channel widths. The A type streams have extremely steep sides, and a bottom of bedrock or boulders. "A" channels also have a fairly narrow profile of width and depth. The "B" channels are also steep although not as steep as "A" streams and have a "bowl shaped" channel when viewed in cross-section rather than steep slopes (Figure 1 and 2). These channels can have boulders and cobble and can range from pocket water to modest pools and riffles (eg. the Credit River from below Cataract downstream to below the Forks; portions of the Taylor River well upstream of Port Alberni). Figure 2 shows the relatively straight form of a "B" channel along with the boulder steps that create the plunge pools and pocket water below them. The length-wise cross-section shows a sharply undulating bed as you move downstream. I believe that meter for meter these streams have more juvenile and adult habitat along the bed than any other stream type. Fish such as rainbow trout and brown trout can be found almost anywhere in these streams. However they often do not have the range of habitat required for all stages of the life cycle of trout or bass and therefore in order to be fully utilized and productive, there also needs to be "C" channel reaches available in the same system in order to provide spawning and early nursery habitat for the trout or bass community. The productivity of “B” streams is therefore ultimately limited by the geology of the watershed, flow stability and the availability of spawning and nursery habitat.

I have found that “A” and “B” channel forms, especially the boulder and cobble type forms (i.e. A2, A3 and B2 and B3) are the easiest rivers to read. Fish the foam lines, and seams beside the boulders and the deeper troughs found in the channel bottom. This holds whether fishing a relatively small “B3” channel like the Credit River between Cataract and the “Meadow” or a larger B3 channels like the Madison River just downstream of Quake Lake or the Crowsnest River downstream of Cowley.

By far the most common river class in southern Ontario and much of North America is the "C" type channel (Figure 3), specifically the C3 (cobble)or C4 (gravel) channels such as the Saugeen River, Ontario, the Miaramichi River, New Brunswick, the Margaree River in Nova Scotia, the Bow River downstream of Calgary, Alberta and the Elk River near

Fernie, British Columbia. These streams are the classic riffle:pool streams common to all areas of the world where you find a modestly wide valley, good soils, and modest valley and stream gradient. The C channel forms along with E and F forms, have riffle and pool sequences which occur every 5-7 bankfull channel widths as you move down the stream. These are the streams that meander in a mild fashion through their landscape. The outside bends have the pools and steepish sides or cut-banks, often with log jams and protruding root wads, the inside bends have point bars with sorted gravels and sands plus a shallow floodplain behind them. The riffles are found half way between the pools. Figure 3 shows the gentle meandering form of the riffle:pool stream along with the characteristic logjams and wood debris at the bends and at the edges of the channel. The bed of these streams undulates in a more gentle manner with a wider spacing between deep sections (pools) than found in the high energy, high gradient A and B streams. Pools may be wider spaced but they are usually much deeper than in A and B channels. A healthy "C" channel has all the major requirements for trout (as long as temperatures are appropriate). This stream type is also ideal for smallmouth bass as long as the stream is large enough. Research in the USA found that a stream had to be, on the average, at least 10 meters wide before it had sufficient size, depth and complexity to hold bass year-round. Although “C” channels do not have as much "usable" habitat throughout the channel as “B” channels, the pools often make up for it. The depth, size and complexity of habitat within a pool, especially pools with log jams, root wads and undercuts can hold surprising numbers of juvenile and adult fish. For example, studies done on the Credit River have found that every healthy, stable pool on the Credit (with a log-jam) appears to have at least 6 - 10kg of trout in them. This weight of trout often equates to 30 - 50 trout ranging in size from 20 - 50cm in size.

Complexity is often the most common description of “C” channels. Although the larger gamefish will likely concentrate in the pools or runs through most of the day, specific structural characteristics such as log jams, sweepers, undercut banks and boulders can provide additional habitat, often in unlooked for places. Often logs and especially fallen trees such as cedars can create habitat even along the edge of a riffle where you would not expect a larger trout under normal circumstances.

Many of the most common spring creeks in Ontario such as the Sydenham upstream of Chatsworth, as well as the more interesting ones in Montana such as O'Dell Creek, Poindexter Slough and Flat Creek in Wyoming are called "E" channels (see Figures 1 and 4). These streams have extreme meanders that seem to loop back and forth with wild abandon. They are extremely deep for their width, often with a width:depth ratio of less than 5. For example, upper Willow Creek, north of Barrie is only approximately 5 - 6m wide but is 3-10m deep! I am certain that many of us know of these creeks. They are the ones that look so small but are so deep that we often go over our hip-waders when we step into them! “E” streams have very low gradients and occur in wide, shallow valleys often called "water meadows". The sinuosity and character of these streams are controlled completely by the herbaceous and shrub vegetation along the banks. This control also creates the incredible undercut banks found in these streams. These streams have almost as much usable linear habitat for fish as the "B" channel and they have more volume of habitat because of their greater depth. In one structurally healthy section of "E" channel on the Sydenham River, Ontario biologists sampled 84 brown trout of 30-45cm in 50 meters of stream! The stream averaged only 5 meters wide but contained 1,680 good size trout per kilometer or over 2,700 per mile! Times change, but this was an enormous number of good size trout for such a small stream.

A few of the other channel forms are less common in Ontario, although some are present. The Colorado River flowing through the Grand Canyon is classified as an "F" channel. These are streams with a low gradient, mild sinuosity and relatively flat channel cross-section. Ontario has a few "F" type channels, the most famous being the Grand River through Elora Gorge. Habitat in these channels is similar to “C” channels although the confined nature of these streams and the rock walls creates more variable riffle and pool structures. These can be more difficult to read when fishing.

Any particular watershed anywhere in the world will likely have a variety of stream types found within it, depending upon its topography, geology, soils, climate and vegetation. For example, the main Credit River has portions of "B", "C", "E", and "G" type reaches, although the most common type is a "C" channel. Anglers fishing the Trout Unlimited water down by Caledon 1 Con. are fishing a C4 stream: the typical gravel bed, riffle:pool stream. Anglers fishing above the Meadow section in the Forks Provincial Park are fishing a B3 channel: the typical step:pool, pocket water cobble bed stream.

Anglers armed with an understanding of the “natural tendencies of rivers” will be more successful. Recognizing and relating the repeating forms and types that occur in nature can improve their ability to “read the water” and locate fish when fishing new waters. Experience gained on home rivers does count, especially if home waters have a good range of stream forms and types. Learning to be observant and using a classification system for streams can markedly improve your ability to find fish and to learn from experiences on new water. This knowledge along with an understanding of the role of geology, climate and topography in creating the potential for coldwater streams will make you a more successful angler a more effective stream conservationist.

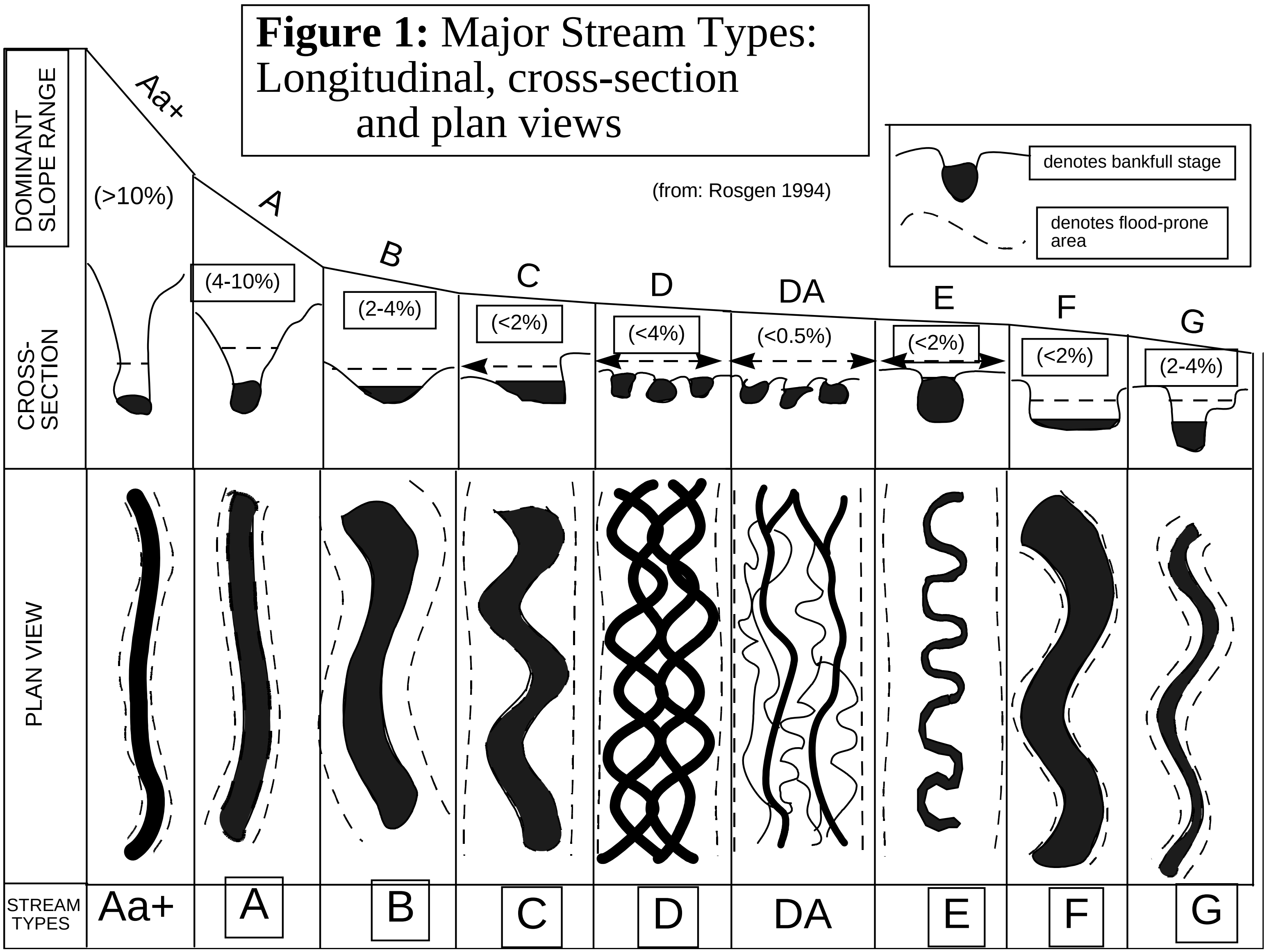


Figure 1: Major Stream Types: Longitudinal, cross-section and plan views
(from: Rosgen 1994)
denotes bankfull stage
denotes flood-prone area
DOMINANT SLOPE RANGE
CROSS-SECTION
PLAN VIEW
STREAM TYPES
Aa+
(>10%)
A
(4-10%)
B
(2-4%)
C
(<2%)
D
(<4%)
DA
(<0.5%)
E
(<2%)
F
(<2%)
G
(2-4%)
Aa+
A
B
C
D
DA
E
F
G

Figure 2:
Form and Characteristics of Typical "B" channels

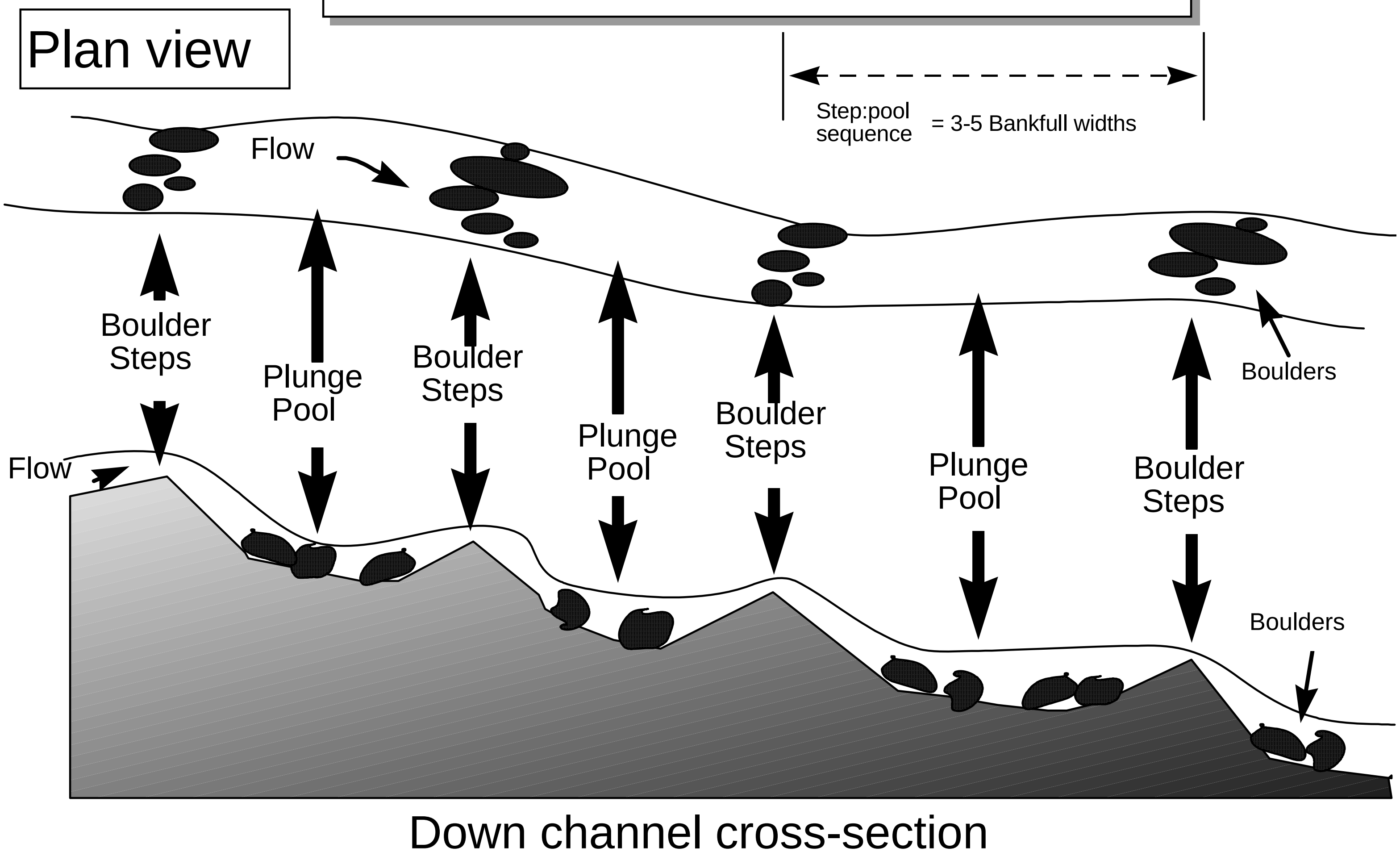
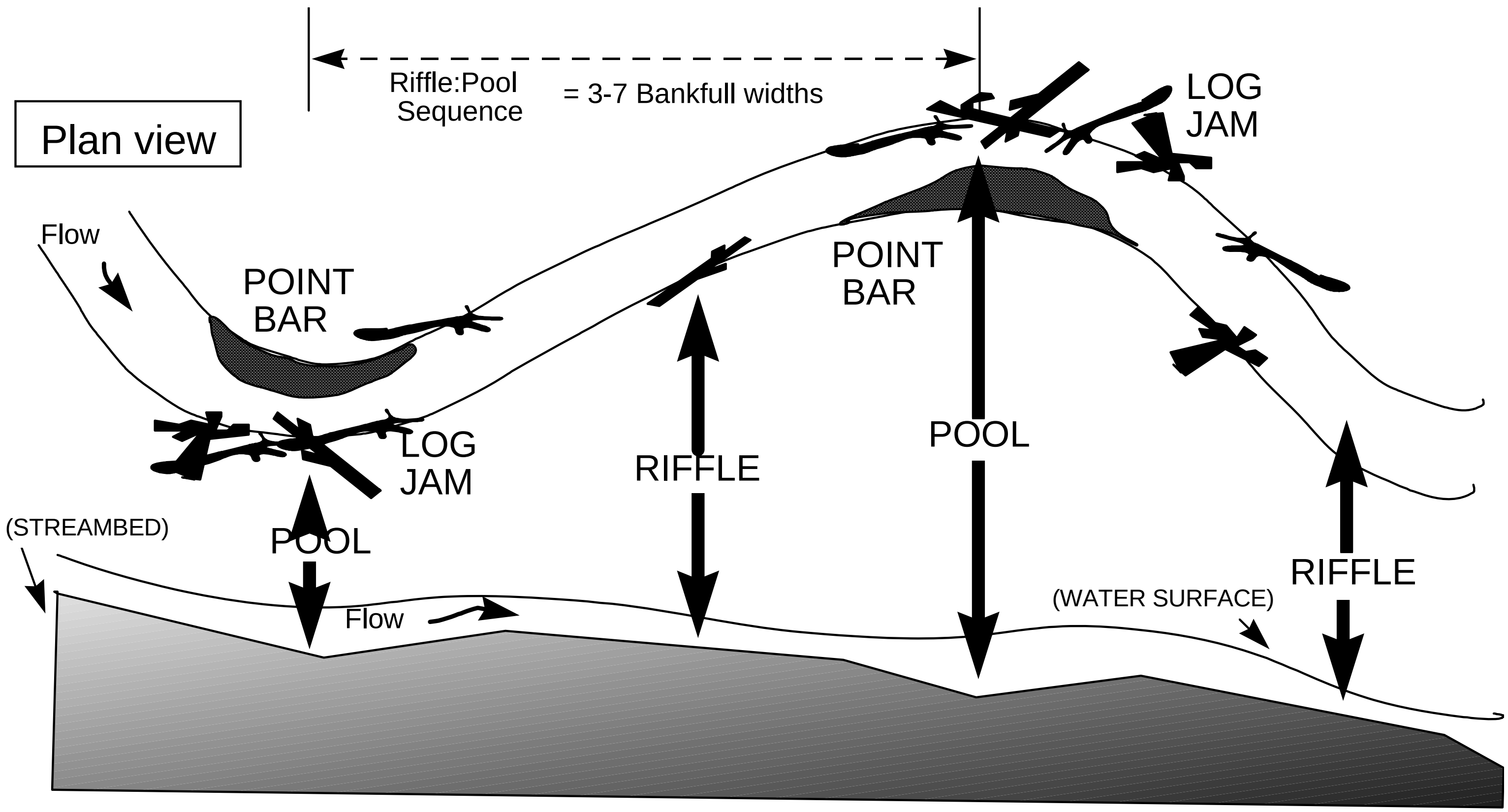


Figure 3:
Form and Characteristics of Typical "C" Channels



Down channel cross-section

Figure 4:
Form and Characteristics of Typical "E" Channels