Anatomy of a Creek

by Gerhard Epke (2015)

The outstanding scientific discovery of the twentieth century is not television, or radio, but rather the complexity of the land organism. . . If the land mechanism as a whole is good, then every part is good, whether we understand it or not. If the biota, in the course of aeons, has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering. Aldo Leopold 1966

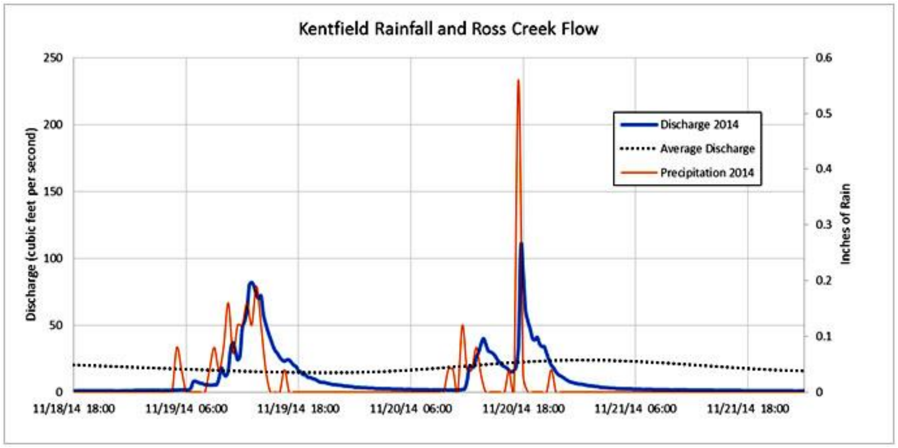
In the words of Aldo Leopold, our watershed is a land organism. Like our own bodies, the watershed's varied components have, over the course of aeons, evolved together and developed very closely connected mechanisms. We delight in the bat rays and river otters, the returning steelhead and olive-sided flycatchers and, as restoration and development projects occur, it is tempting to think that we can preserve these things by preserving the components of their habitats. But as in organisms, the components are not independent of the greater being. Therefore, supporting wildlife requires that we step back and look at the macroscopic mechanisms that support their habitats—the physiology and anatomy of our land organism, as it were.

Large tidal movements are essential to keeping Corte Madera Creek and its sloughs clear of sediment. Photo by Charles Kennard

The anatomy of a natural creek is a function of the environment, influenced primarily by the climate, topography and vegetation. One of the primary mechanisms of this influence is the flow of water, or the hydrology. By looking at small increments of space and time, we can see the individual water-related mechanisms responsible for shaping the landscape. We can measure the physical force of water on its banks below where a log has fallen, the depth of the silt deposited on the floodplain after flooding, the viscosity of the water as it carries sediment and debris through the concrete channel. See, for example, the graph at the top of page 2 illustrating the precipitation and subsequent runoff, or discharge, during two storms this past fall. The graph also illustrates the mean, or average, discharge in the creek based upon 40 years of data collected by the US Geological Survey in Ross.

Notice that because the wintertime flows are so variable, the average flow is far less than what even a small storm delivers. While we can trace individual mechanisms, such as runoff from one event, when viewed over the course of many years, the picture becomes much more complicated. To address this complexity, we talk about a creek's "flow regime", which is something like its character, and a major determinant of a creek's form. As climate is to weather, flow regime is to discharge. If the creek channel's anatomy is a function of its hydrology, which aspects of the flow regime have a greater influence? Is the channel shape dependent upon average annual discharge, small frequent events such as these storms, or the flood events that occur every 20 years and reach 7,000 cfs?

Following in his father's footsteps, Luna Leopold was a river scientist who laid the foundations of the subject we now call fluvial geomorphology. Luna worked for the US Geological Survey and UC Berkeley for over 50 years, studying the shape, size, structure, and evolution of rivers across the western United States. By studying so many rivers at so many scales, he was able to discover emergent mathematical relationships in what he called the hydraulic geometry of stream channels. He showed that these properties exist despite the fact that each channel is a reflection of a specific flow regime. In this way Luna Leopold's contribution to river science was akin to Da Vinci's Vitruvian Man in the field of human anatomy.



Despite being generalized over a broad area, there are still valuable lessons to be learned from the relationships that Luna identified. He showed, for instance, that before agricultural and urban development, when creeks of the San Francisco Bay Area were at equilibrium with the landscape, they were probably about the same width but shallower, making flooding a more common occurrence. Also a channel would occasionally jump banks and find an entirely different way down the valley.

Today the channel is artificially fixed in the landscape, and we try to discourage any flooding of the surrounding landscape. Consequently the channel has cut deeper than it needs to be for the typical flows, but is still too small to contain large storm run-offs.

Corte Madera Creek as it appeared running through the College of Marin campus in 1937. Photo by James Schulze, courtesy of Marin History Museum

The range of flows we have is pushed further from equilibrium by the development in the watershed. Our peak flows are higher because of how quickly water flows off of our streets, and our low flows are lower because the ground isn't getting saturated, to release water later.

Tidal portions of the creek offer another great example of how development has changed the equilibrium conditions that defined the anatomy of the natural creek. Tidal wetland once lined the bay's shore and would fill and empty twice a day with the tides. In doing so, a large amount of water, called the tidal prism, would rush in and out of the estuary, scouring a channel. With the elimination of much of the tidal prism, the Army Corps of Engineers and Flood Control District are faced with an exorbitant amount of dredging just to mimic a natural process.

In the 20th century Aldo Leopold and his hydrologist son Luna articulated and described new ways of thinking about our landscapes as living, breathing, interconnected organisms. In the centuries ahead we have even harder challenges to overcome because, unlike a human body which can be propped up and stinted until its final expiration date, Corte Madera Creek and the watershed does not have an expiration date. The organism will endure long after we are gone, it is just a question of how healthy it remains, what diversity of life it nourishes.

Friends of Corte Madera Creek Watershed P.O. Box 415, Larkspur, California 94977
info@friendsofcortemaderacreek.org