Cycles of Change: Part I

The Ventura River – 2001 to 2003

Boom or bust cycles don't just affect the California economy, they dominate the vegetation of streams and rivers in our area. Major winter storms, such as occur during severe El Niño years, begin the cycle by completely scouring the stream channel of vegetation and fine sediment. This happens, on average, once every 10 to 12 years (the interval has varied from 3 to 30 years within the last century). With the removal of riparian vegetation by a major winter flood, the channel provides a perfect environment for the growth of algae. Absence of shade increases the amount of sunlight and warms the water. And with high nutrient concentrations – nitrogen and phosphorus – from urban and agricultural runoff, it's an open invitation for filamentous algae (the kind that looks like long, green hair in the water). Even in pristine streams, high phosphorus concentrations from eroding mountain bedrock provide a hospitable environment because some algae can even produce their own nitrogen.

As long as winter rains continue to be severe enough to keep the channel clean and sediment moving to the ocean, algae will thrive. But sooner or later there comes a low runoff year – mostly sooner, since two out of three years have less than half the average runoff. In the absence of severe winter floods, sediment is deposited in the channel and seedlings, having gained a toe-hold the previous summer, become more deeply rooted. It's time for vascular plants to rule. Perennial aquatic plants become established (ludwigia, speedwell, water cress), over-shadowing the water surface and narrowing the channel by trapping fine sediment. The algae are confined to open, deeper water. Where rapid growth of riparian vegetation, like willows and giant reed, provide increased shade to a narrowed waterway, algae may disappear entirely.

Rooted aquatic plants and riparian trees increasingly stabilize the channel and its banks, and as the years go by the size of the storm needed to scour the stream increases. The big storm of March 2003, following the 2002 drought, produced less drastic changes than a similar-sized storm in March 2001. We have cycles within cycles: years of high rainfall and years of low, algae growing and algae disappearing, and the plants that come and go. The following photos document the changes we've seen on the lower river since 2001. The presentation has two sections: the first is a photo essay of changes seen over the years; the second is a technical presentation of what happened to nutrient chemistry during these changes, and what it might all mean.

The Ventura River upstream from Shell Bridge in July 2001, August 2002 and July 2003 (from left to right) . In 2001 the river, still recovering from the scouring of the river bed during the El Niño storms of 1998, was open and relatively free of vegetation. Algae were abundant in the open water with little competition from plants. However, plants began to supersede algae in the fall of 2001. By the summer of 2002, after a winter of low flows (the lowest flows since 1990) and no storms large enough to uproot them, plants came to dominate the entire river channel. Winter storms in 2003 scoured the center of the channel and re-established deeper flows, allowing algae to reappear. But plants still dominated the river edge, poised for a comeback.

Highly variable annual runoff engenders cycles of sediment deposition and removal, algal growth, and the advance and retreat of riparian and aquatic vegetation. Major El Niño winter storms (every 10 to 12 years on average) begin a transformational cycle by completely scouring the channel of vegetation and fine sediment. The photos show the Ventura River upstream of sampling site VR03 in July 2001, August 2002, March 2003 and September 2003 (left to right). In 2001 the river, still recovering from the scouring of the river bed during the El Niño of 1998, was open and relatively free of vegetation. Algae were abundant in the open water with little competition from plants. Aquatic plants began to supersede algae by the end of summer 2001. By 2002, after a winter of low flows and no storms large enough to uproot them, plants came to dominate the entire river channel. Winter storms in 2003 scoured the center of the channel and re-established deeper flows, allowing algae to briefly reappear, but plants, surviving along the channel edge, soon recovered.

The river downstream of Shell Bridge (VR03) in (clockwise from the upper left) June 2001, June 2002, June 2003 and February 2003. The winter storms of 2003 were not able to completely open the channel. Vegetation was not only relatively undisturbed, but taller and deeper rooted species (willows and arundo, shown just beginning to be re-established in 2001) have replaced aquatic vegetation, increasing the threshold size of a channel-scouring storm. Complete plant removal will require another El Niño year such as 1995 or 1998. Absent such a storm, vegetation will continue to dominate and fill in the river channel.

Riparian Vegetation (downstream of VR03) in June 2001, June 2002, March 2003 and September 2003 (clockwise from the upper left): Winter storms of 2003 removed aquatic plants and sediment from the center of the channel, but taller and deeper rooted riparian species (willows and arundo, visible in early stages of establishment in 2001) were relatively undisturbed. The replacement of aquatic by riparian vegetation increases the threshold size of a channel-scouring storm. Ending the riparian growth cycle will require another El Niño year such as 1995 or 1998.

Channel Transformation (VR02) in October 2002, and March, May, June, September and November 2003 (left to right, top to bottom): The plant is water primrose (*Ludwigia hexapetala*) and it dominates the lower river from VR03 to the estuary. By the fall of 2002, the river was essentially a slow-moving current through a sea of Ludwigia. Storms in the winter of 2003 partially opened up the channel, but also deposited sediment among the roots of the remaining plants, creating confining banks in what had been an open waterway (the May photo shows this process during a small storm). Deeper, faster flows in the now confined stream slowed, but didn't stop, plant expansion during the summer of 2003. In the last photo, the process begins anew with November rains. Channel narrowing, aquatic plants and the shading of the waterway by growing riparian vegetation end the cycle of dry-season algal dominance.

Algal growth and senescence at Foster Park (VR06): May 14, June 18, July 24 and July 9, 2003 (from top to bottom, left to right) . The dark blue-green color of the water in the left-hand photos indicate extensive algal growth, so thick that water levels rose 6-8 inches in July due to retarded stream velocities. By July, the bottom-growing algae had largely decayed and disappeared downstream. When a shallow river channel is open to sunlight, algae can grow and die three to four times over the course of the dry season.