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# Ventura Stream Team
# 2001 - 2005

*Protecting and restoring the Santa Barbara Channel and its watersheds*

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# Ventura Stream Team
# 2001 - 2005

**A review of the findings of**
**Santa Barbara Channelkeeper's**
**Ventura Stream Team**
**January 2001 - January 2006**

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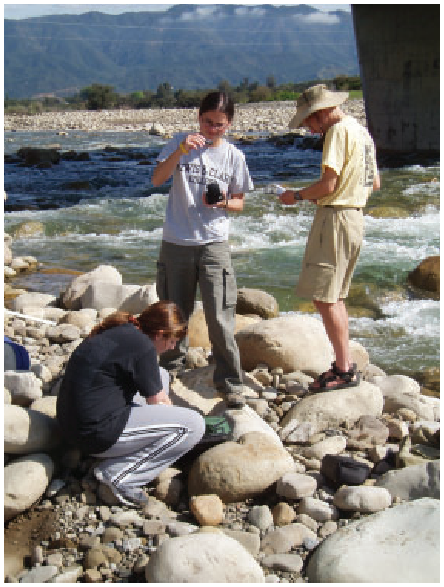
**January 2006**



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## About Santa Barbara Channelkeeper

Santa Barbara Channelkeeper is a local non-profit organization whose mission is to protect and restore the Santa Barbara Channel and its watersheds through citizen action, education and enforcement. We are a member of the international Waterkeeper Alliance, and like the other 153 Waterkeepers across the globe, we work on the water and in our community to monitor local waterways, restore aquatic ecosystems, advocate for clean water, enforce environmental laws, and educate and engage citizens in identifying and devising solutions to local pollution problems. Our efforts are focused on cleaning up the leading sources of pollution that threaten the health of our local beaches, waterways and wetlands, including storm water and urban runoff, sewage, agricultural operations, offshore oil drilling, and large municipal and industrial dischargers.

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# EXECUTIVE SUMMARY

Santa Barbara Channelkeeper, along with the Ventura Chapter of the Surfrider Foundation, launched the Ventura Stream Team water quality monitoring program in January 2001. The program has three goals: to collect baseline data on the health of the Ventura River watershed; to educate and train a force of volunteer watershed stewards; and to identify sources of pollution in the watershed. Over the past five years, more than 350 local citizens have participated as volunteers in the program, contributing in total more than 3,600 hours of their time. Each month, these volunteers collected valuable water quality data at 15 sites on the Ventura River and its major tributaries: San Antonio, Stewart, Thacher, Canada Larga, and Matilija creeks. At each site, volunteers took in-stream measurements on temperature, dissolved oxygen, pH , turbidity, conductivity, and flow, and collected samples that were later analyzed in the laboratory for bacteria and nutrients. Visual observations, such as algae coverage and weather conditions, were also recorded at every site.

The data collected by Ventura Stream Team serve as an excellent source of information about normal, or baseline, conditions throughout the Ventura River watershed. In the future, these data can be used as a yardstick to compare how water quality conditions change over time. In addition, the data have enabled Channelkeeper to identify problem areas throughout the watershed, which can also be used to guide future clean-up and restoration efforts by environmental groups, regulatory agencies and other stakeholders.

The most egregious problem that Channelkeeper identified through its Ventura Stream Team monitoring efforts was that of nutrient pollution. Throughout the five years of sampling, mean nitrate and phosphate levels exceeded the limits recommended by the US Environmental Protection Agency (EPA) at most sampling sites. With nitrate, the most serious problems were seen in two distinct zones of the watershed: the lower river and the San Antonio Creek tributary. High nitrate levels on the lower river are probably the result of treated sewage effluent that enters the river upstream of the Ventura River at the Shell Road sampling site. On San Antonio Creek, which drains much of the Ojai area, high nitrate levels likely come from multiple sources, including animal waste from horse and cattle facilities, faulty septic systems, general urban nuisance flows, and fertilization and irrigation of golf courses, parks and landscaping. Phosphate presents a more complicated picture, as elevated phosphate levels are due somewhat to natural geologic conditions in the watershed and cannot necessarily be attributed to contamination. However, as with nitrate, the highest levels were seen on the lower river and along San Antonio Creek; treated sewage effluent (in the lower river) and animal waste from horse and cattle facilities are the most likely causes.

Ventura Stream Team sampling revealed a serious problem with bacteria levels in only one distinct watershed zone: the Canada Larga Creek tributary. While the three “indicator bacteria” that Channelkeeper tests for (total coliform, E.coli and enterococcus) are not usually harmful in and of themselves, they do indicate the possible presence of pathogenic bacteria, viruses, and protozoans. Results for all three tests from both the upper and lower Canada Larga sampling sites regularly exceeded public health limits set forth by local and federal regulatory agencies. While these standards are meant to protect public health from contact through recreational use of waterbodies, and these sampling sites are not commonly used for human recreation, it cannot be disputed that they do exhibit problems with bacterial contamination. On Canada Larga Creek, the most obvious cause of this contamination is animal waste, as the major land use in the area is cattle grazing. Although not as serious as the problem on Canada Larga Creek, the two sampling sites on San Antonio Creek also exhibit high enterococcus levels; possible causes include animal waste and faulty septic systems.

Other parameters measured by Ventura Stream Team provide additional information about these, and other water quality problems. One of the largest problems associated with high nutrient levels is over-growth of algae, which lowers dissolved oxygen levels and can subsequently harm or kill oxygen-dependent aquatic life. Evidence of this process (called eutrophication) has been found in Stream Team data. For example, high pH levels and extreme dissolved oxygen levels at many sites are indicative of excessive algal growth. High conductivity levels on Canada Larga Creek may signify other kinds of problems. Eroded soils from pastures, industrial nuisance flows, and a concrete channel above the Lower Canada Larga Creek sampling site may contribute to elevated conductivity there.

In light of the findings from the first five years of Ventura Stream Team's water quality monitoring efforts, Channelkeeper believes there is cause for concern and grounds for action to address the problems described above. Stretches of the Ventura River are already listed by the State of California as impaired, and the watershed is set to undergo major changes with the upcoming removal of the Matilija Dam. To mitigate existing and future water quality impairments in the watershed, Channelkeeper recommends that the following actions be taken:

- Regular monitoring efforts by Channelkeeper and other entities should be continued and expanded to assist regulatory agencies in their land use planning and water quality protection efforts.
- Specific pollution sources should be pinpointed by conducting creek walks, sampling at specific discharge points, and identifying the land uses associated with any contaminated discharges.
- Once specific sources are identified, Channelkeeper and other entities should reach out to the appropriate landowners to educate them about the problems of, and solutions to, the water quality issues associated with runoff and/or discharges from their properties.
- Regulatory agencies should strictly enforce water quality regulations and ordinances, including issuing fines or cease and desist orders when necessary.
- Regulatory agencies should scrutinize the results of monitoring conducted by the Ojai Valley Sanitary District to ensure compliance with its discharge permit.
- Regulatory agencies should continue to implement additional treatment methods, including active treatment systems such as ultraviolet and ozone systems, and best management practices (BMPs) such as vegetated swales, constructed wetlands, and permeable pavement, to remove pollutants before they contaminate waterbodies.
- Regulatory agencies should provide incentives to encourage developers to implement low-impact development BMPs in new residential and commercial developments or re-developments.

While this list of recommendations is by no means exhaustive, the implementation of these and related measures will help to reduce the pollution identified by Santa Barbara Channelkeeper's Ventura Stream Team water quality monitoring efforts.

# INTRODUCTION

Santa Barbara Channelkeeper's Stream Team program is a volunteer-based water quality monitoring program that focuses on two major local watersheds, the Ventura River and the Goleta Slough. The streams and rivers that drain these watersheds transport pollutants such as bacteria and excess nutrients into downstream wetlands and the ocean. The purpose of Stream Team is to provide a comprehensive and long-term effort to monitor conditions on these ecologically important waterways.

Ventura Stream Team was launched in early 2001 as a partnership between Santa Barbara Channelkeeper and the Ventura Chapter of the Surfrider Foundation, and was followed by the Goleta Stream Team program, launched by Channelkeeper in June 2002. Both Stream Team programs share the same three goals: to collect baseline data on the health of the watershed; to educate and train a force of volunteer watershed stewards; and to identify sources of pollution in these ecologically important watersheds.

Ventura Stream Team conducts monthly on-site testing at designated locations on the Ventura River and its major tributaries. Teams of volunteers measure physical and chemical parameters in the field using portable hand-held instruments. Data collected include on-site measurements of dissolved oxygen, turbidity, conductivity, pH, temperature, and flow. Water samples collected at each site are processed in Channelkeeper's laboratory for three Public Health bacterial indicators using approved standard methodology (Colilert-18 and Enterolert-24, manufactured by Idexx Laboratories; US EPA, 2003). Additional samples are analyzed for nutrients (ammonium, nitrite plus nitrate, orthophosphate, total dissolved nitrogen and particulate carbon, nitrogen and phosphorus) through cooperation with the Santa Barbara Channel – Long Term Ecological Research Project (SBC-LTER) at the University of California, Santa Barbara (UCSB). Visual observations such as vegetation and aquatic life are also recorded monthly at each site. To ensure quality control, all meters are checked and calibrated against traceable standards prior to every sampling event (see Appendix for details on methodology).

Citizen volunteers are a critical element in the success of Ventura Stream Team. To date, over 350 volunteers have participated in the program, contributing over 3,600 hours of their time to the monitoring discussed in this report. Volunteers include a wide range of local residents, from high school and college students to environmental scientists. While some volunteers come to earn community service hours for school, most participate to gain experience and knowledge and to make a contribution to their community. Many of our volunteers are users of coastal resources - hikers, surfers and fishermen - who are eager to give back to their community.

*From 2001-2005, over 350 volunteers participated in Ventura Stream Team.*

# BACKGROUND

## The South Coast[1]

### *Climate*

The climate of the South Coast, from Point Conception to Ventura, is considered "Mediterranean," typified by relatively mild winters, hot dry summers, and coastal fog during much of the dry season. Rain generally occurs only between the months of November and March, and temperatures at lower elevations are almost always above freezing. High pressure systems which develop over Utah and Nevada are strong enough to keep the weather warm and sunny for much of the summer and fall. These systems also divert rain, and consequently there is little summer precipitation in the region. Higher watershed elevations may have summer daytime temperatures of 85-100$^{o}$ Fahrenheit (F), while the coastal regions are generally about ten to fifteen degrees cooler. Fall daytime temperatures are generally 70-90$^{o}$ F in inland areas, but are considerably colder at night. In the fall, Santa Ana winds can blow hot and dry from desert regions to the east. These warm winds and the prevalent dry conditions often give rise to severe wildfires, which are a natural part of the ecosystem. Winter is characterized by periodic bouts of heavy rainfall, often delivering several inches of precipitation in each storm. The upper mountainous regions receive more rainfall than the lower coastal areas as Pacific storms are uplifted over the coast range. Higher elevations, on average, experience about 22-29 inches of rain a year, while amounts near the ocean are closer to 15 inches. Snow can fall at high elevations during particularly cold winter storms.

### *Geology*

South Coast drainages lie within the western Transverse Ranges of California, mountain ranges notable for easily eroded sedimentary rocks. These ranges have been produced by clockwise crustal rotations between the Pacific and North American plates (the same plate movements that produced the infamous San Andreas fault). California's largest earthquakes have rotated and uplifted the region's coastal mountains (Jaeger and Smith, 1988; Michaelson, 2004), and they are still being uplifted, at rates of 1-3 mm per year (Keller and Capelli, 1992). Regional tectonics have produced numerous faults and folds, and some of the youngest sedimentary rocks have been deformed until they stand nearly vertical. The rocks near the surface are usually recent sedimentary layers of marine origin (Cenozoic – younger than 65 million years) - hard sandstones alternating with weak shales and mudstones. The surrounding geology is responsible for much of the character of local streams. Steep mountains with easily eroded rocks yield "flashy" creeks (quick to rise as rain begins, quick to fall when it ends) with some of the highest sediment loads in the world (Scott and Williams, 1978; Taylor, 1983; Hill and McConaughy, 1988). In addition, fragile marine sediments cause high background conductivities and total dissolved solids (high in sulfate, calcium, magnesium and chloride).

### *Land Use*

Land use in the region is primarily open space, agriculture and urbanized development. Higher elevations are usually covered in native chaparral with areas of oak woodland and tree-lined riparian corridors. In the foothills, many areas have been converted to exotic grass rangeland and avocado and citrus orchards. The coastal lowlands have been put to numerous uses, including urban, agriculture (row crops and greenhouses) and orchards. Light industry and oil production exist in some areas. Nearly half the coastal watershed – mainly at higher elevations – is within the boundaries of the Los Padres National Forest. A number of coastal margin wetlands can be found at the mouth of streams. Most are small and are completely flushed during winter rains, but the Carpinteria Salt Marsh, Goleta Slough, Devereux Slough and the Gaviota Marsh have appreciably larger associated wetlands.

*Vegetation*

Numerous plant communities are found within South Coast watersheds: non-native annual grasslands, Venturan coastal sage scrub, chaparral, coast live oak woodland, and three types of riparian woodland (south coast live oak, central coast cottonwood-sycamore, and southern willow scrub). Each of these habitats have evolved to the specific conditions of the coastal climate of Southern California, and the plants of all communities show traits adapted to fit their niche. Elevation, aspect (shade or sun), rainfall and water availability are the primary determinants of where each community exists.

Plants play a crucial role in the ecology and hydrology of the watershed. They provide habitat, food and shelter for the dozens of animal species that inhabit the region. Plants help to prevent soil erosion by literally holding the soil together with their root systems. Leaf and branch canopies also reduce the impact of rain, and by absorbing rainfall from the soil, they also minimize runoff.

An ongoing problem in these watersheds is the invasion of non-native species of plants – foreign plants that have been introduced, intentionally or unintentionally, and then thrive in local environments, often because of the absence of natural predators. In the process of replacing native species, they present problems for local animals that are not adapted to living with, and on, these invaders. Invasive, non-native species damage the biodiversity of both plants and animals in the region.

*Riparian Zones*

The riparian zone is the vegetative corridor at the boundary of a body of water. Often unique and different from the surrounding vegetation due to its proximity to water, it acts as the interface between terrestrial and aquatic zones. During the dry season, the riparian zone bordering a stream is usually the only area with green plant growth. Riparian areas are often the only home for deciduous trees, like sycamores and willows, which need year-round water to survive. This growth helps to preserve threatened aquatic species like steelhead trout by providing shade and lower water temperatures. Large trees also contribute coarse organic material to the stream. This provides food for benthic macroinvertebrates that are food for other organisms including steelhead trout. These trees also provide instream structure or habitat when they fall into the stream. By preventing erosion, riparian plants keep water silt-free for trout eggs to hatch, and by providing shade, stream temperatures stay cool enough for spawn to survive. Riparian areas also provide protected habitat and travel corridors for much of the area's terrestrial wildlife, and frequently serve as habitat for endangered and threatened species. Studies have shown that as much as 85% of a region's wildlife inhabit riparian zones at some point in their life cycle. Riparian areas also serve as a buffer between land use and the stream, filtering out pollutants before they reach the water and acting as a bacteriological and chemical factory to cleanse stream water as it moves between channel and stream bank.

*Hydrology*[2]

The dominant hydrologic characteristic of the Ventura River, and indeed of all streams in coastal Southern California, is extreme inter-annual variation in rainfall and watershed runoff. Mean annual flows in the Ventura River have varied from 5-3,400 cubic feet per second (cfs) (e.g., a 700-fold variation) over the last 75 years.

Since 1878, the average winter rainfall in Los Angeles has been 15 inches (NWS-LA).[3] However, "average" in this case does not convey the extreme annual variability (Figure 1, upper panel). Very few years actually have average rainfall;

most are drier, and a relatively few very wet years heavily influence the record (these are usually, but not always, associated with strong El Niño events; Null, 2004; Monteverdi and Null, 1997). If a year of significantly high rainfall is defined as having rainfall at least 150% above the average (greater than 22 inches in downtown Los Angeles), there have been seventeen years of significantly high rainfall since 1878, approximately one every seven and a half years. The 1990s were unusual in that three years of significantly high rainfall (1993, 1995 and 1998) occurred within a relatively short span of time.

However, El Niños are just one of the climate cycles influencing local weather. The region is also impacted by the Pacific Decadal Oscillation (PDO), a roughly 50-year pattern of alternately cold and warm waters that abruptly shift location in the Pacific Ocean (Mantua et al., 1997; Minobe, 1997; Mantua, 2000). The "cold" PDO phase moves the jet stream (and a majority of winter rain) northward, while the "warm" phase pushes it, and rainfall, southward, giving Southern California wetter winters.

Figure 1 (lower panel), a plot of cumulative departure from the mean for Los Angeles rainfall (NWS-LA), attempts to show the influence of this pattern by plotting the cumulative rainfall excess or deficiency. In other words, the graph displays a running summary of how much each year's rainfall affected the long-term departure from the annual 15-inch average. The plot shows a pattern of alternately rising and falling trends, where rainfall was either generally above or generally below average, lasting decades. The 1880s and the 1930s had strong increasing trends, trends generally caused by an increased frequency of years of significantly high rainfall. The general pattern between 1944-1968 was below-average rainfall (a decreasing trend), but from 1968-1998 the trend reversed, except during the California drought of 1987-1992.

Annual flows in the Ventura River mimic this rainfall record (flows measured at Foster Park, USGS-NWIS). Figure 2 (upper panel) shows how much each year's flow differed from the median flow of 21 cfs (half the years had average flows less than the median, half greater). The 1930s, early 1940s and 1990s were years of above average flow,

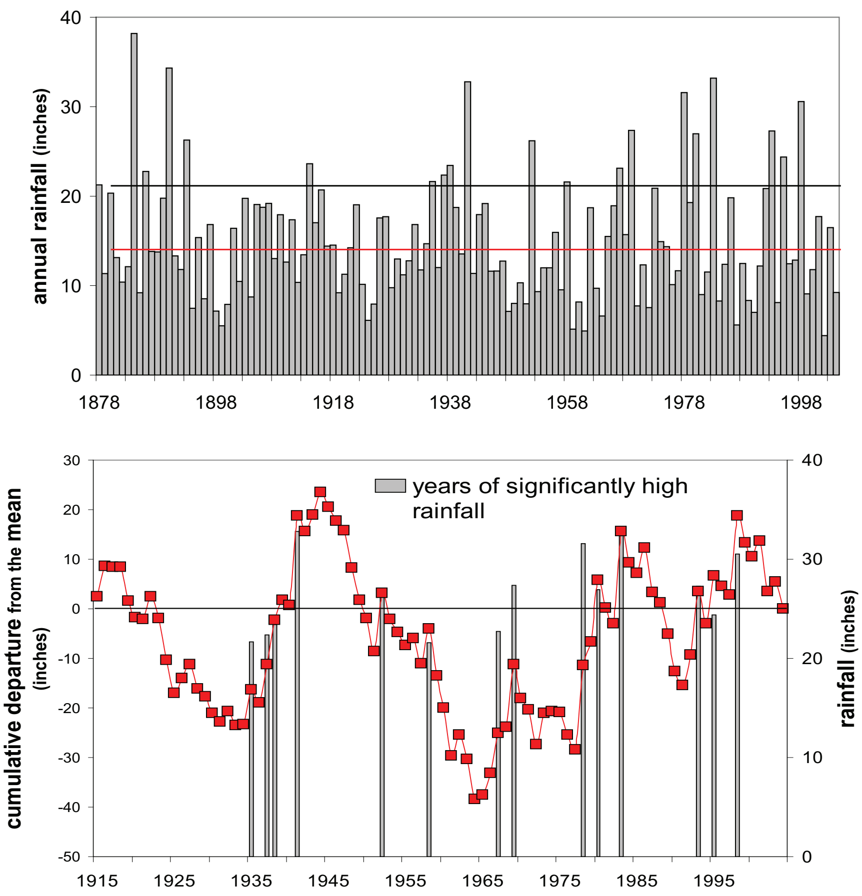



*Figure 1. Annual (water-year) rainfall in downtown Los Angeles: 1878-2004 (upper panel). The lower line represents the annual average of 15 inches, the upper, 150% of average. Lower panel: The cumulative rainfall excess or deficiency – in other words, a running account of how much each year's rainfall varied from the 15-inch average. The plot reveals a pattern of alternately rising and falling trends generally lasting decades. The lower panel also shows years of significantly high rainfall, years when rainfall exceeded 150% of average, e.g., rainfall greater than 22 inches. Years of significantly high rainfall, many of which coincide with major El Niño episodes (but not all), heavily influence the rainfall record; a close grouping of unevenly spaced high rainfall years causes an increasing rainfall trend.*

whereas other decades were below average. The lower panel of Figure 2 displays the cumulative flow excess or deficiency – the running total of how much each water-year's flow (measured in inches of runoff at Foster Park) moved the long-term trend away from the 4.8 inch overall average, and in which direction. The plot shows the same pattern of rising and falling trends, heavily influenced by very wet years, as Los Angeles rainfall. Years of significantly high rainfall, in Figure 2, represent Ojai rainfall greater than 31.5 inches. Note that in the late 1960s it took two years of significantly high rainfall to reverse a 10-year declining trend.

As an aside, the average annual Foster Park runoff is 4.8 inches, while the average Ojai rainfall is 21 inches, indicating that roughly only 20% of the rain is ever discharged into creeks and rivers. As for the rest, most is evaporated or transpired by plants and trees, and a smaller part recharges the groundwater table or is stored as soil moisture.

A new cold phase appears to have begun after 2000. With less rainfall, we can expect conditions similar to those of the 1950s, when lower flows were more common. More wildfires, increased summer fog and extended drought conditions may also be anticipated.

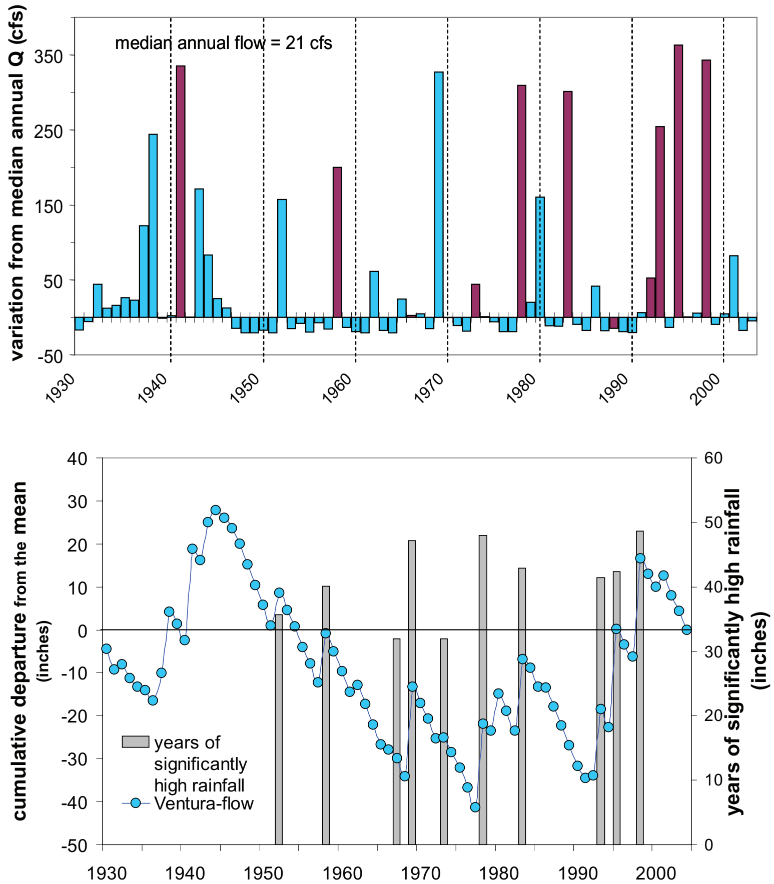



*Figure 2. Upper panel: Median annual flow on the Ventura (at Foster Park) is 21 cubic feet per second (cfs), e.g., half the years on the chart had average flows less than this, the other half had greater. The distribution is skewed – "above the median" years tend to be very wet. Years shown as dark bars were major El Niño episodes. The 1940s, 1950s and 1990s were relatively "wet" decades. Lower panel: The cumulative flow excess or deficiency – a running total of how much each water-year's flow (measured in inches of runoff at Foster Park) moved the long-term trend from the 4.8 inch overall average. The plot shows a pattern of rising and falling trends, heavily influenced by wet years. Wet years, in this chart, represent Ojai rainfall above 31.5 inches. Note that in the late 1960s it took two wet years to reverse a 10-year declining trend.*

## The Ventura River

The Ventura River watershed, with headwaters in the Santa Ynez Mountains north of the City of Buenaventura, has an area of 222 square miles. The river and its catchment can be divided into three zones: (1) the mountainous areas of the basin; (2) the main stem of the river, from the confluence of Matilija and the North Fork of Matilija creeks to the river delta or estuary; and (3) the delta, which is approximately two miles wide at the coast and extends about a mile upstream, almost to the Main Street Bridge.

The mountainous areas produce a majority of the winter runoff and most of the sediment that eventually finds its way to the ocean. The major tributary watersheds that originate in this zone are Matilija Creek (55 sq. miles), the North Fork of Matilija Creek (16 sq. miles) and San Antonio Creek (51 sq. miles). Coyote and Santa Ana creeks (41 sq. miles) were once major tributaries, but almost no runoff or sediment from these drainages has flowed into the Ventura since the creation of Lake Casitas, which lies behind a 285-foot earthen dam storing up to 254,000 acre-feet of water. Matilija Creek also has a dam, built in 1948 and designed to store 7,000 acre-feet. However, sedimentation (principally from the El Niño floods of 1969) has reduced its capacity to 500 acre-feet, and it is now mainly used to enhance diversions to Lake Casitas via the Robles canal. The main stem of the Ventura River is roughly 15 miles long and is characterized by the storage and transport of sediment along a broad flood plain (generally about a half-mile wide). Two major diversion structures on the main stem govern dry-season flow, although their capacity is too low to affect storm flows. Uppermost is the Robles diversion dam, which diverts Ventura River water, two miles below Matilija Dam, into Lake Casitas via the Robles canal. A minimum flow of 20 cfs must be allowed to pass the diversion, but everything above this (up to the canal's maximum capacity of 500 cfs) may be diverted. Given the high infiltration rate of the porous sediments and cobbles that form the Ventura River bottom, this usually ensures that the river goes dry a short distance below the diversion.

Further downstream, a concrete weir extends underground, beneath the river and Coyote Creek, approximately ¼ mile above the Foster Park Bridge. While there is also a surface diversion here, the weir was designed to raise the water table to facilitate pumping from below the river to Ventura's water treatment plant. Since the weir does not fully confine the river, raising the groundwater table usually ensures some river flow past Foster Park. Approximately a mile and a half below Foster Park, effluent from the Ojai wastewater treatment plant (2-3 cfs) helps maintain this year-round flow all the way to the ocean.

The estuary, which covers approximately 30 acres, includes a main lagoon usually separated from the ocean by a sand/cobble bar during the dry season. The sand bar is breached by winter storms and is slowly rebuilt in summer, fed by longshore drift sand. In dry years the bar may not be breached at all, and it may never become established in extremely wet years. With the bar, the lagoon is mainly fresh water, and without it, is mainly salt or brackish water subject to tidal flushing.

The Ventura River watershed is roughly 45% mountains, 40% foothills, and 15% valley; 75% can be considered rangeland (shrub/brush) and 20% forest (half of the catchment is within the Los Padres National Forest). While the basin is mostly undeveloped, urbanization, cattle raising and oil production dominate the coastal plain and adjacent foothills.

The average annual rainfall is 20 inches, and the seasonal and inter-annual variation in river runoff is extreme – as mentioned earlier, mean annual flows vary from 5-3,400 cfs; in other words, a "wet" year can have almost 700 times more flow than a "dry" year. More than 90% of the annual rainfall occurs between November and April, and a majority of the annual runoff usually occurs within a period of three to seven days. The river is hydrologically "flashy" and responds within hours to storms and changes in rainfall.[4]

## Sampling Locations

When Ventura Stream Team was established conceptually in the spring of 2000 as a joint project of Santa Barbara Channelkeeper and the Ventura Chapter of the Surfrider Foundation, 14 sampling sites were selected to exemplify the range of conditions found on the river and its tributaries. These sites extend from just above the estuary at Main Street in Ventura to Matilija Creek and its North Fork. Shortly after sampling began in January 2001, a fifteenth site was added upstream of Matilija Dam. A list of site names and abbreviations is shown in Table 1 and a map of the watershed and sampling locations is shown in Figure 3. Aerial photos of selected watershed zones are also included on the following pages.

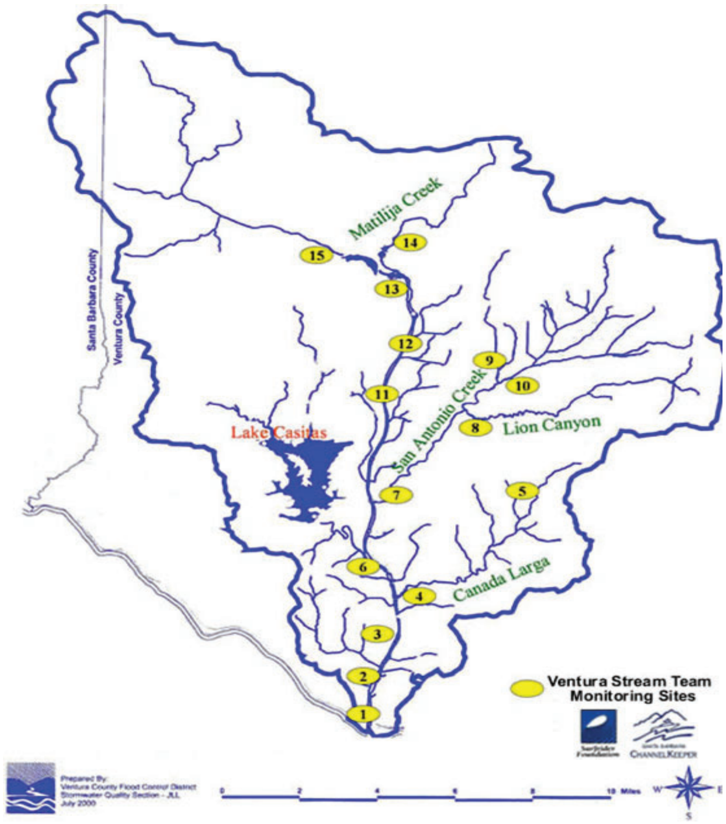



*Figure 3: Map of the Ventura watershed with Ventura Stream Team sampling sites.*

**Table 1. Ventura Stream Team site names and abbreviations.**

| Site Name | Abbreviation |
|---|---|
| Ventura River at Main Street Bridge | VR01 |
| Ventura River near Stanley Drain | VR02 |
| Ventura River at Shell Road | VR03 |
| Lower Canada Larga Creek | VR04 |
| Upper Canada Larga Creek | VR05 |
| Ventura River at Foster Park | VR06 |
| San Antonio Creek at Old Creek Road | VR07 |
| Lion Canyon | VR08 |
| Stewart/Fox Creek | VR09 |
| Thacher Creek | VR10 |
| Ventura River at Santa Ana Road | VR11 |
| Ventura River at Highway 150 | VR12 |
| Matilija Creek | VR13 |
| North Fork Matilija Creek | VR14 |
| Upper Matilija Creek | VR15 |

**Ventura River at the Main Street Bridge (VR01)** is sampled immediately upstream of the bridge. This site is just above marine influence from the nearby estuary and marks the freshwater boundary. The floodplain here is wide and delta-like, a mix of sandy soils with willows and large patches of non-native Arundo donax. During heavy storms, when access becomes difficult and dangerous, sampling is conducted by lowering a bucket from the bridge. The location of the specific sampling site has changed over the course of the program; originally downstream of the bridge, it was moved upstream in late summer of 2002, when prolonged blockage of the estuary by a sand berm inundated the site with brackish backwater.

**Ventura River near Stanley Drain (VR02)** is located just above the confluence with the large Stanley storm drain, which serves semi-industrial and brownfield areas in northern Ventura. Flow is typically confined within a narrow channel on the far side of a wide floodplain.

**Ventura River at Shell Road (VR03)** is slightly downstream of the Shell Road bridge. The bridge serves a major oil field development and is gated on the west side. The main channel (and the sampling location) has moved during the years of sampling, from the oil company side to the center of the floodplain, and then back. The flood plain here is approximately forty yards across and confined within steep rip-rapped slopes. The Ojai wastewater treatment plant is approximately a mile upstream of this location. VR03 allows us to monitor conditions below the sewage treatment plant and, with two sampling locations further downstream (VR02 and VR01), track the sequential changes that occur as this mixture of normal river water and treated effluent flows to the estuary.

**Lower Canada Larga Creek (VR04)** is located off of Ventura Avenue, just downstream of the Canada Larga bridge. Canada Larga flows through extensive ranch lands before passing through industrial development on its way to the river. Upstream concrete channelization of Canada Larga ends at this sampling location. A Ventura County flood gauge is located at the bridge, but the automated gauge does not begin recording until water levels reach one and a half feet. The stream is approximately forty feet in width at this location. During the dry season, there is usually little or no flow here.

**Upper Canada Larga Creek (VR05)** is located 3.5 miles up Canada Larga Road, at a small bridge over the creek. The hills and valley bottom around this location provide extensive grazing lands for local ranches. The stream is typically small and slow-flowing, and is often dry during the dry season. Upstream are pastures and old walnut orchards, and the area is marked with signs of frequent grading and tilling. City sewage sludge was once tilled into the soil here. Evidence of appreciable bank and hillside erosion from overgrazing within the drainage is common. The two Canada Larga sites monitor a major Ventura River tributary as land use changes from ranching to industrial.

**Ventura River at Foster Park (VR06)** is located below the County's Foster Park, slightly downstream of the Casitas Vista Drive bridge. Both a Ventura County flood gauge and a USGS gauging station are located alongside an old fenced and gated bridge abutment. A ladder on the abutment, installed to maintain the gauges, is used to access the sampling site. Thickets of Arundo line the bank and center of the riverbed, and the channel width is approximately 100 yards. A bedrock reef located a quarter mile upstream, in conjunction with the aforementioned underground weir used to enhance withdrawal of domestic water supplies, force groundwater to the surface and ensure year-round flow at this location. Heavily influenced by relatively clean groundwater, VR06 exemplifies relatively natural conditions on the lower river and provides a contrast from which to assess the impacts from the introduction of treated effluent below this point.

**San Antonio Creek at Old Creek Road (VR07)** monitors a major tributary of the Ventura River and represents the combined drainage from various Ojai Valley land uses. This location, and three additional upstream sampling siteson major sub-drainages, track conditions and changes in what is arguably the center of development in the Ventura River watershed and its most important tributary. Sampling takes place at the Old Creek Road low water crossing, just off of Highway 33. Ventura County has a flood gauge approximately 400 meters downstream of this location at the Highway 33 bridge. Surrounding land uses include residential housing and livestock grazing. Horse stables, ranching and grazing, golf courses and the urban area of Ojai lie upstream.

**Lion Canyon (VR08)** is sampled just before it enters San Antonio Creek. A sub-watershed of approximately eight square miles, the entire catchment is mostly under single ownership and is used for cattle grazing and dude ranch activities associated with the Ojai Valley County Club. The lower creek flows over mudstone and shale, and its riparian vegetation is relatively natural. Highway 150 skirts the creek near the top of the drainage.

**Stewart/Fox Creek (VR09)**, adjacent to VR10, samples the combined flow out of Stewart and Fox canyons, both of which flow through western Ojai and are partially channelized through the town (this stream is shown on some maps as Pirie Creek). Dense non-native vegetation includes thick Arundo, Eucalyptus, periwinkle (Vinca), and watercress. Crayfish are seen in the deeper pools, and three species of native fish have been observed at this site: Arroyo chub, Steelhead trout, and Stickleback.

**Thacher Creek (VR10)**, adjacent to VR09, combines flow from the upper San Antonio and Thacher drainages in eastern Ojai. Thick non-native vegetation, such as Arundo and Eucalyptus, are prevalent along its banks.

**Ventura River at Santa Ana Road (VR11)** is sampled below the Santa Ana Road bridge, down a steep rip-rap bank. The channel is approximately 100 yards in width, but flow usually occupies only a small fraction. A large storm drain enters at this location. River flow typically disappears below ground just downstream from the bridge. This site is typically dry during much of the year.

**Ventura River at Highway 150 (VR12)** is upstream of the bridge. As at VR11, a climb down steep rip-rap and a short downstream hike are required to reach the sampling site, which is usually dry. VR11 and VR12 monitor conditions on the upper Ventura River. The Robles Diversion Dam diverts water to Lake Casitas above these sites. These diversions, and the porous sediments that form the river bottom in this reach, typically leave little flow in the channel after the rainy season.

**Matilija Creek (VR13)** is approximately one kilometer downstream of Matilija Dam, at an out-of-use USGS stream gauging station. A small concrete dam at this site creates a large, deep pool that is a popular swimming area, particularly in the summer.

**North Fork Matilija Creek (VR14)** is located below a bridge on Highway 33 used as a Ventura County flood gauging station. Sampling during high flow can be conducted from the bridge. The creek bed is relatively natural with native vegetation and is often visited by sunbathers and kids. VR14 represents the most pristine sampling location in the program, the site least affected by anthropomorphic impacts.

**Upper Matilija Creek (VR15)** is the uppermost sampling location in the watershed. It is in Matilija Canyon, approximately 1.5 miles above Matilija Dam. The three Matilija sites, in relatively pristine environments, serve as a yardstick by which we can measure the effects of human impacts on the lower Ventura and other tributaries. By sampling above and below Matilija Dam, a candidate for removal and restoration, they allow us to monitor the impact of its sediment-filled reservoir.

The 15 sampling sites represent four distinct reaches or sub-watersheds: four on the lower Ventura River, two on Canada Larga, four on San Antonio Creek and its tributaries, and five upper Ventura/Matilija locations. Sampling is accomplished by three teams, with Group I sampling on the lower Ventura and Canada Larga, Group II on San Antonio Creek, and Group III on the upper Ventura/Matilija. Since these groupings divide the watershed into reasonable geographic and ecological units, whenever possible we display and discuss the data that follows using a similar format. When the variation of a measured parameter with time is shown or discussed, four sites, VR04, VR05, VR11 and VR12, will be omitted, as flow in these locations has become increasingly rare with the passage of time.[5] However, we do include these sites in our presentation of the overall results for each parameter.

## Cycles of Change

The extreme rainfall variability experienced in the Ventura watershed engenders cycles of sediment deposition and removal, algal growth, and the advance and retreat of riparian and aquatic vegetation along the river. In turn, these changes dramatically alter the appearance and biological functioning of the river and riparian zone, and regulate the uptake of nutrients.

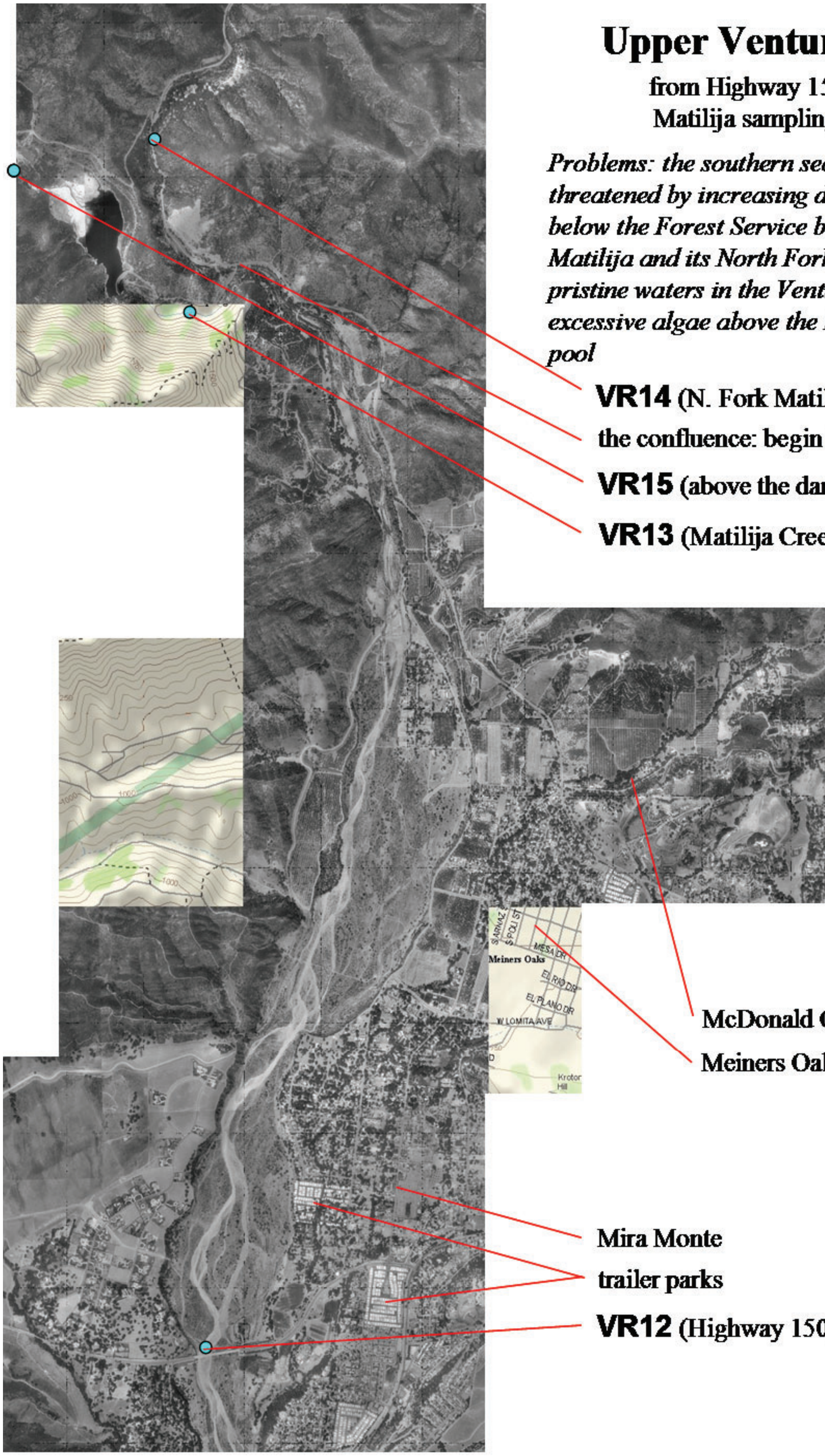
*Following large storms that scour streambeds, filamentous algae often take over. This photo was taken at VR12 in May 2005, following the large January storms.*

Major winter storms, such as occur during severe El Niño years, begin a transformational cycle by completely scouring the channel of vegetation and fine sediment (Figure 4); this occurs, on average, once every 7-10 years (Leydecker et al., 2003). Heavy flows scour streambeds of vegetation and fine sediment, clearing the way for a complete takeover by filamentous algae (principally Cladophora, Rhizoclonium, Enteromorpha and Spirogyra spp.). This is true even in the more pristine, undeveloped upper sections of the Ventura River. However, sooner or later a low runoff year occurs, as two out of three years have less than half the average runoff (Figure 2). In the absence of severe winter floods, sediment accumulates in the channel and exuberant plant growth begins the competitive replacement of algae by aquatic vegetation (Leydecker and Alstatt, 2002). Where the growth of taller riparian vegetation appreciably blocks sunlight, algae may disappear entirely. Over the years these processes increasingly stabilize the channel and elevate the threshold flow of a future scouring storm.

# Upper Ventura River

from Highway 150 to the
Matilija sampling points

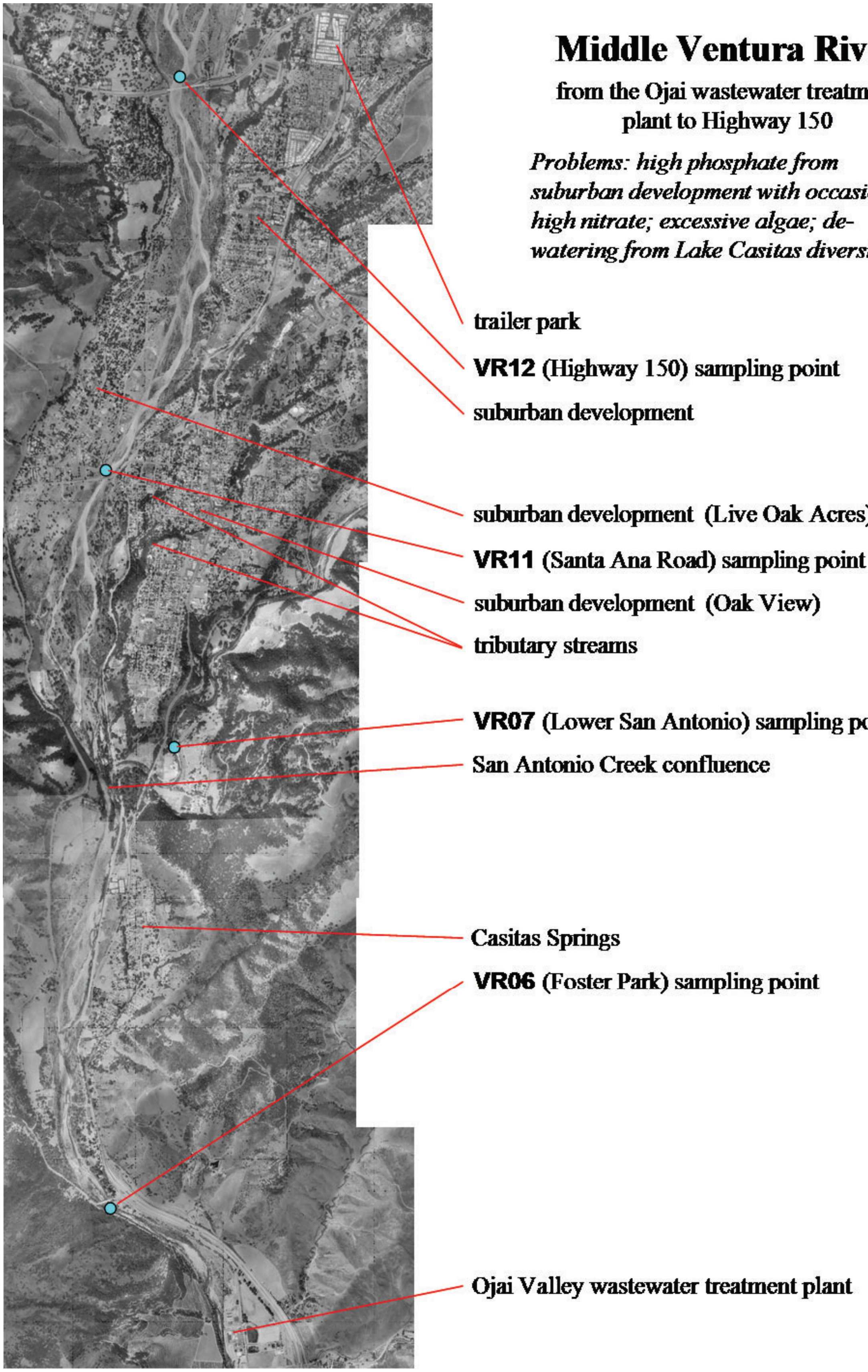
*Problems: the southern section is threatened by increasing development below the Forest Service boundary; the Matilija and its North Fork are the most pristine waters in the Ventura system; excessive algae above the Matilija Dam pool*



# Middle Ventura River

from the Ojai wastewater treatment plant to Highway 150

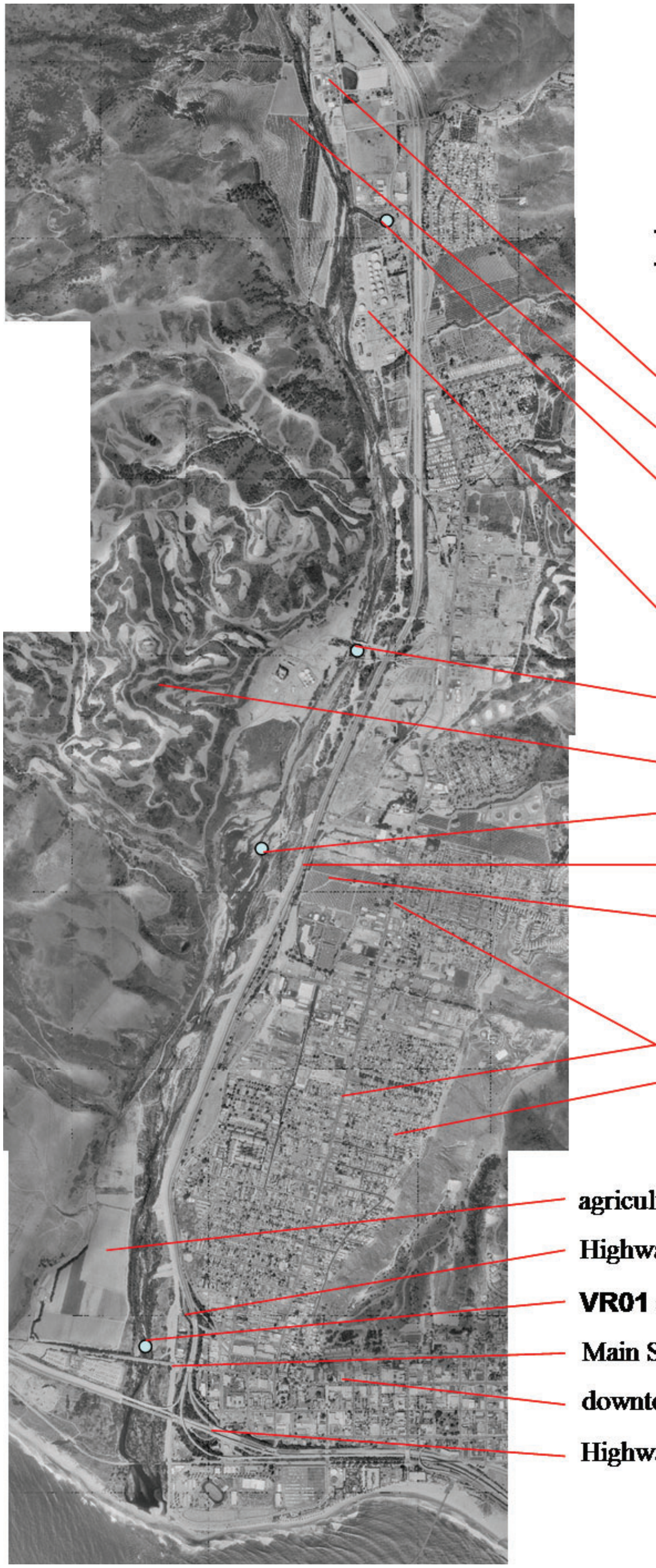
*Problems: high phosphate from suburban development with occasional high nitrate; excessive algae; de-watering from Lake Casitas diversions.*



# Lower Ventura River

from the ocean to the Ojai Valley wastewater treatment plant

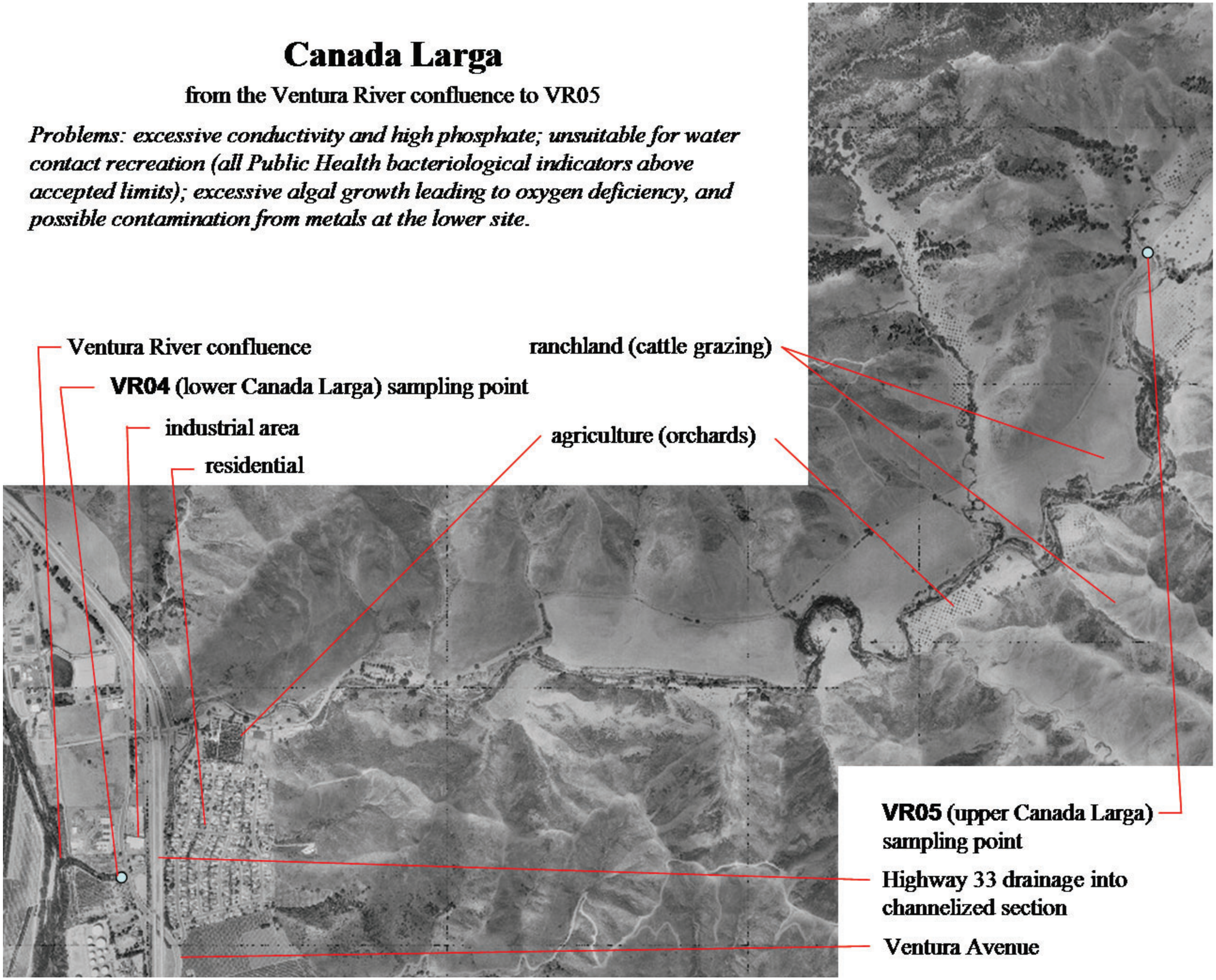
*Problems: high phosphate and nitrate from the sewage treatment plant and from urban and agricultural runoff; excessive algae; contamination from metals remains a possibility.*



# Canada Larga

from the Ventura River confluence to VR05

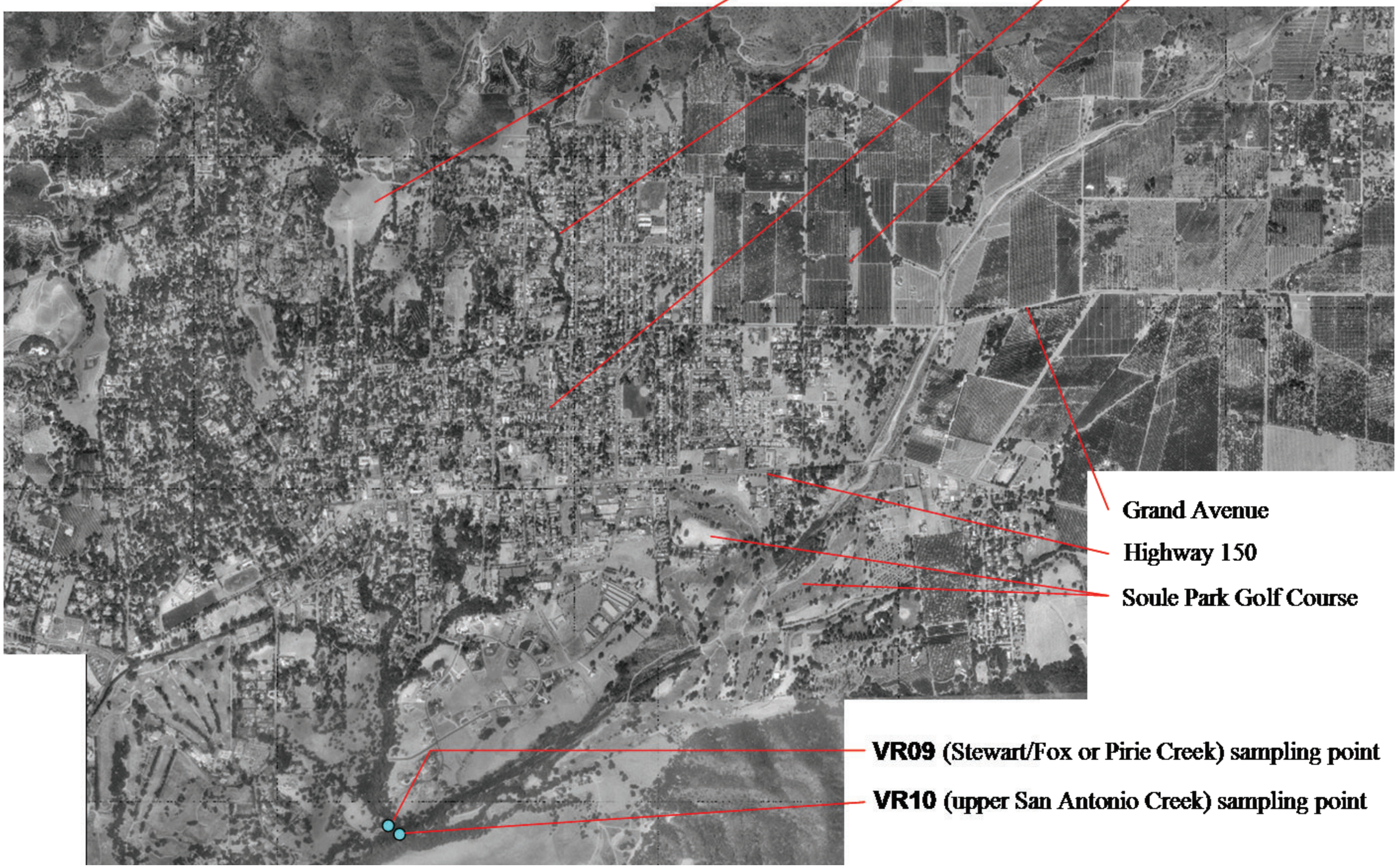
*Problems: excessive conductivity and high phosphate; unsuitable for water contact recreation (all Public Health bacteriological indicators above accepted limits); excessive algal growth leading to oxygen deficiency, and possible contamination from metals at the lower site.*



## Upper San Antonio Creek

from the Pirie Creek confluence to the foothills above Ojai

*Problems: high nitrate (particularly on upper San Antonio Creek) and high phosphate from urban and agricultural land uses; high enterococci concentrations threaten water-contact recreation.*



## Lower San Antonio Creek

from the Ventura confluence to Pirie Creek

*Problems: high nitrate and phosphate from agriculture and suburban development; excessive algal growth leading to oxygen deficiency.*

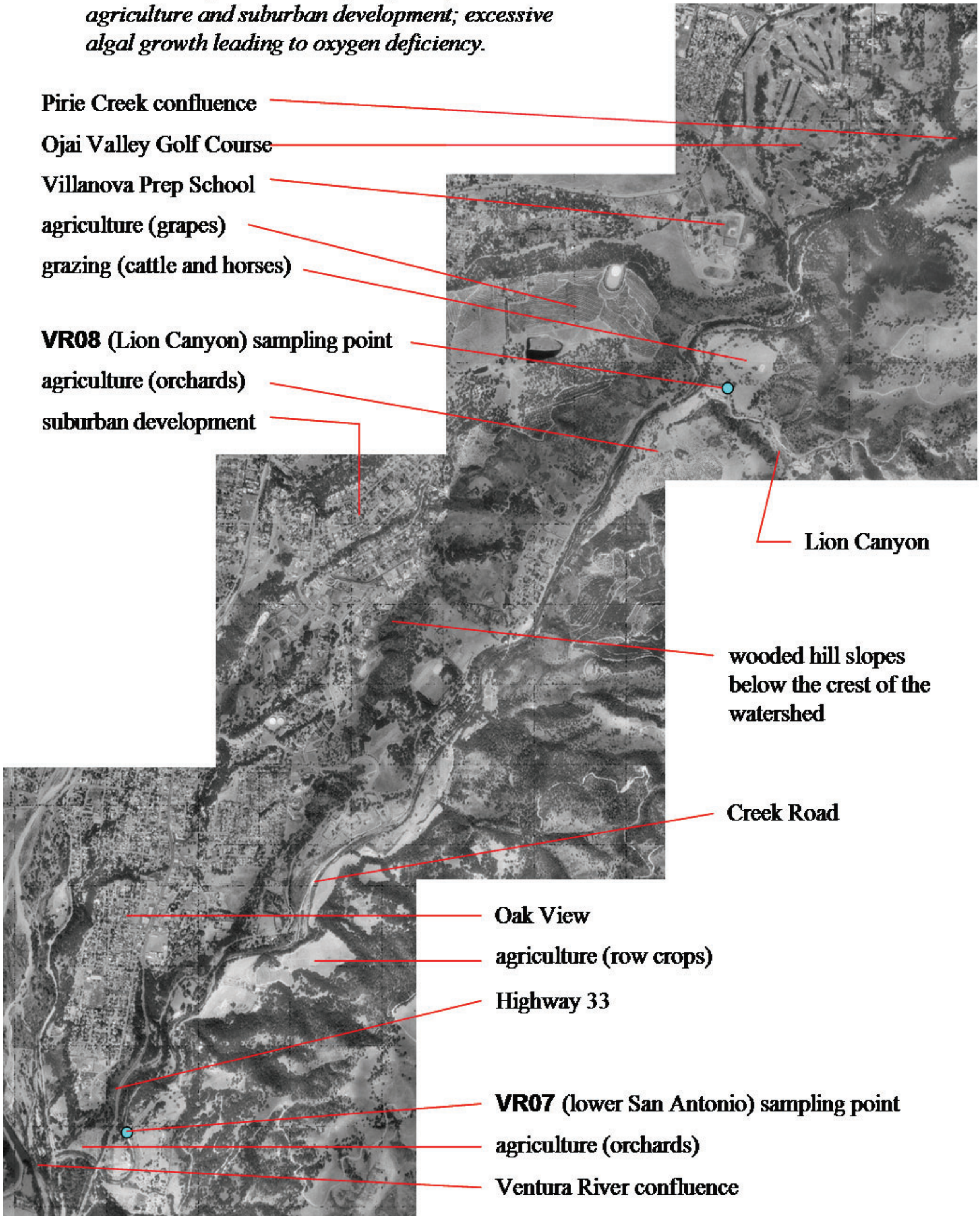


*Figure 4. The view of the Ventura River looking downstream from Shell Bridge (VR03) on October 2, 2004 (upper) and February 2, 2005 (lower).*

From 2001-2005, Channelkeeper's Ventura Stream Team has sampled a wide variety of conditions dictated by the annual variation in rainfall. The previous significant rainfall event, the last big flood that reset the transformational cycle seen over the sampling period and described above, occurred during the severe El Niño winter of 1998. Throughout the 2001-2005 sampling period, Ventura Stream Team has observed and documented these changes (SBCK(b)).

Figure 5 shows the variations in both monthly and annual rainfall that have occurred during the study period. Two of the years were slightly above normal (2001 and 2003) and two were below normal (2002 and 2004), one of which could be characterized as a severe drought year (2002). However, 2005 was a special year.

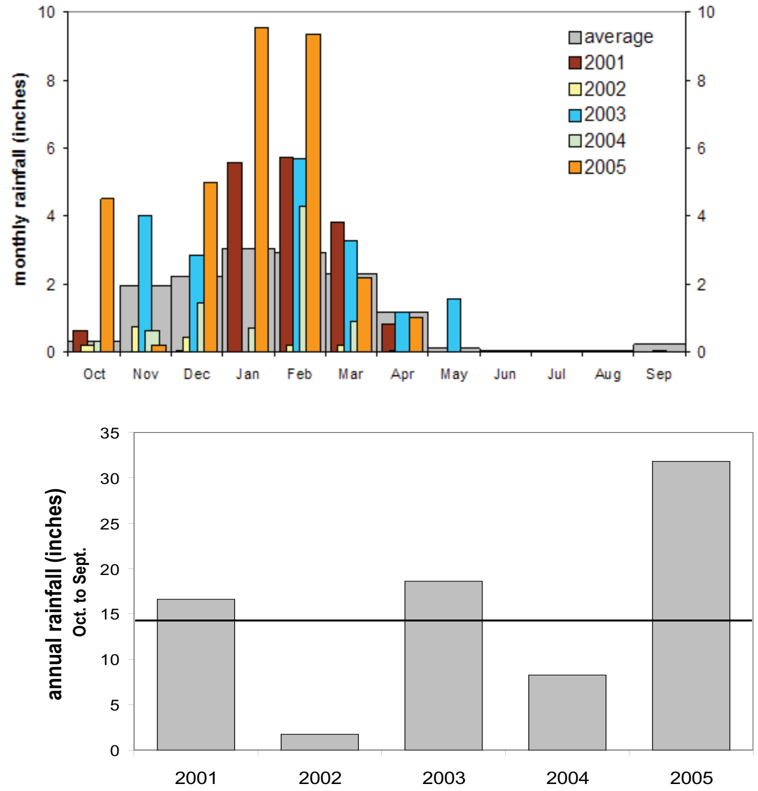



*Figure 5. Monthly (upper panel) and yearly (lower panel, for October to September water-years) rainfall for the years of Channelkeeper's Ventura Stream Team surveys. The data is for Oxnard, and 2005 only includes rainfall through April. 2005 was an extraordinarily wet year, with rainfall throughout the region, as of the end of April 2005, varying from 200-250% of the average annual totals (222% in Oxnard, 268% in Los Angeles, 204% in Santa Barbara and 239% at Lake Cachuma). The heavy line in the lower panel represents the average annual rainfall at Oxnard: 14.3 inches.*

The 2005 water-year, characterized by weak El Niño conditions in the Pacific, began with expectations of another below-normal rainfall winter. However, in the three weeks following Christmas of 2004, the South Coast was hit with a series of major winter storms delivering impressive amounts of rainfall in two distinct pulses: the first from December 26, 2004, through January 4, 2005, and, after a few days of sunshine, the second from January 7-11, 2005. In Ojai, 10.4 inches were recorded during the first phase and 12.6 inches in the second (Figure 6, upper panel). By the end of January, a total of 28.8 inches had fallen since the beginning of the rainy season, compared with the annual average of 20.9 inches. As storms coming out of the Pacific were uplifted over the coastal mountains, even larger amounts of rain were released - San Marcos Pass received 18.2 and 24.6 inches during the first and second storm pulse, and amounts even greater than this were recorded at Old Man Mountain.

However, as shown in the upper panel of Figure 2, not all years with significantly high rainfall are severe El Niño years. At times, some really wet winters are caused by a much shorter weather cycle of 30-60 days called the "Madden-Julian Oscillation." Simplifying the process greatly, atmospheric high pressure off the Pacific Northwest moves west, allowing a low pressure system to develop offshore, which in turn sweeps heavy moisture from Indonesia into Southern California. This type of weather system is often called a "pineapple express," as the moisture plume passes over the Hawaiian Islands en route. This system delivered extraordinary amounts of rainfall in the winter of 2005, rainfall that continued through March and April (Figure 6, lower panel).

The hydrographs in Figure 6 portray how stream flow changed with time. The upper panel represents the variation in height of Ventura River water at Foster Park (VR06) during the storms. Stage is simply the term for how high water levels rose at the USGS gauge downstream of the bridge; when the gauge reads 2.5 feet, the river is flowing at a trickle. The chart also shows hourly Ojai rainfall.

The river reacted rapidly to changes in rainfall. This is what is meant by the term "flashy" – water levels are quick to rise and quick to fall. The Ventura River is relatively short and steep, and thus flashy. The USGS has not as yet formally issued flow data for this gauge, because discharge during the storm rose above previous measurements and re-arranged the channel bottom, but the current estimate for peak flow on January 11, 2005, is 152,000 cfs, equivalent to a wall of water 15 feet high and 400 feet wide, moving at 18 miles per hour.

Figure 6 (upper panel) also shows a greater delay between rainfall and the river's response at the beginning of the storm period than at the end. It also shows a proportional increase in the amount of runoff per inch of rainfall during the latter half of the storm period (noticeably increased runoff from similar amounts of rainfall). The coastal mountains tributary to the Ventura River contain a thin but highly porous layer of soil. This layer acts like a sponge during the first storms of the season, absorbing rainfall and limiting the amount of flow that comes from higher elevations. But when these soils become saturated, they deliver copious amounts of runoff to the valley below, and mountain rainfall becomes the primary cause of flooding on the coastal plain. Twenty-three inches of rain fell during the period shown on the graph, but only about six inches of this rain flowed down the river, most of it during the second storm pulse.

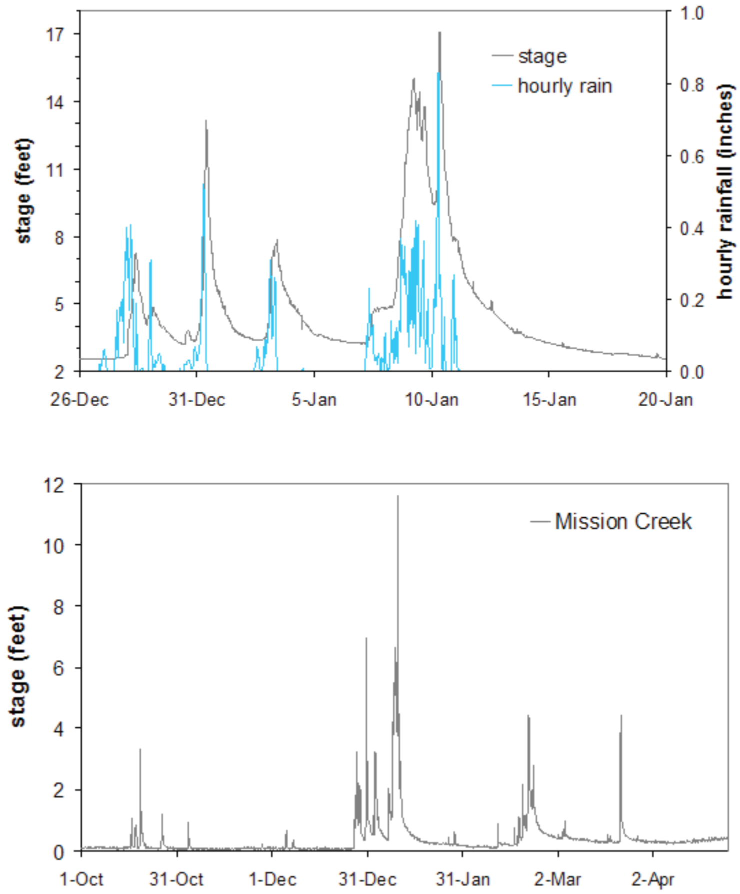



*Figure 6. Upper panel: Stage (river height) on the Ventura River (at Foster Park, VR06) and hourly rainfall (Ojai) during the Christmas 2004 series of winter storms. Lower panel: Stage during the winter of 2005 at Mission Creek (Santa Barbara).*

The lower panel of Figure 6 shows the stage hydrograph for Mission Creek (in downtown Santa Barbara, UCSB-LTER) during the entire 2005 rainy season.[6] It demonstrates that large storms continued throughout February and March (with occasional rainfall as late as May), making 2005 one of the wettest rainfall years on record. Rainfall throughout the region varied between 200-250% of the annual average.[7] The 2005 water-year is now officially the second wettest year in the century and a half record of Los Angeles weather. Thus, 2005 became the new transformational year; the year that begins the cycle anew.

*Foster Park (VR06) during the January 2005 storm.*