Written Testimony on California Water governance to the Little Hoover Commission

The Importance of Improved Groundwater Management in Sustainable Water Management for California's People and Ecosystems

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INTRODUCTION

Over the past 50 years, The Nature Conservancy has worked in California to protect more than a million acres of natural habitats that support native plant and animal species, including many that depend directly or indirectly on freshwater resources. The Conservancy, recognized as a leader in freshwater conservation, has developed and implemented many innovative freshwater conservation strategies, including protecting the headwaters of streams and rivers, managing forests sustainably, facilitating environmentally beneficial regional water planning, purchasing lands and conservation easements, and acquiring surface water rights to provide environmental flows.

However, our experience in California conservation over the past 50 years has illuminated an Achilles' heel in sustainable water management and the protection of freshwater ecosystems: the overpumping of groundwater, which threatens the long-term sustainability of water supplies for freshwater ecosystems and people across the state. Inadequate groundwater management has already dramatically affected a number of important and iconic California rivers:

- the Santa Clara, the last remaining largely free-flowing major river in highly urbanized southern California and host of a remnant run of southern steelhead.
- the Salinas, lifeblood of the uniquely productive Salinas Valley agricultural region.
- the Shasta River, considered a critical link in sustaining and restoring the Klamath River Salmon runs.

With our testimony, we hope to illuminate three main points:

1) **Groundwater and surface water are intimately connected, and it is impossible to effectively manage our water supplies, whether for people or wildlife, without thorough consideration of groundwater use and behavior.**
2) **Inappropriate management of groundwater has already had dramatic impacts on ecosystems throughout the state, and these impacts will continue without changes in how we manage grounwater.**
3) **Groundwater behavior is not a mystery. We know how it behaves and we have the capabilities to manage it.**

Our perspective is oriented toward the ecosystem needs for water, but we recognize that in California, perhaps more than in most locations, sustainable water supplies for ecosystems must be achieved in balance with sustainable water supplies for the people of California. **Accordingly, while our testimony emphasizes our observations and perspectives grounded in wildlife and habitat conservation, the points are just as relevant in discussions and actions regarding water supplies for agriculture and cities.**

THE GROUNDWATER SITUATION IN CALIFORNIA

Practically all the rivers and streams in California, and the freshwater ecosystems that depend upon them, rely on groundwater for a significant portion of their water. Groundwater pumping for agricultural, urban, and residential use draws on the same water supplies that maintain these surface water ecosystems, and therefore, poor management of groundwater has serious implications for the health of our ecosystems.

Of course, California's natural aquatic systems are stressed by many factors, including surface water diversions, floodplain encroachment, chemical contamination, altered hydrology as a result of dams, and many other stressors that represent serious challenges to the sustainability of freshwater ecosystems. The Nature Conservancy is working diligently with many partners to address these problems at priority sites across California.

What makes groundwater withdrawals unique among the threats is the invisible nature of the connection between groundwater and surface waters. It is fairly easy to understand, observe, and measure how direct diversion of a stream's surface flow results in reduced flow downstream. Groundwater withdrawals, on the other hand, may occur many miles from a stream and still reduce flow in that stream, even though there is no visible link between the pumping and the flow reduction in the stream. Further complicating the connection is the fact that groundwater withdrawals made at one time — say during the spring — may not affect flows in an affected stream until the fall or even until subsequent years. This murky temporal and spatial character of the groundwater influence can make it difficult even to recognize the impacts of groundwater withdrawal on surface streams from casual observations. Yet, the impacts from groundwater withdrawals are just as real as the impacts from surface diversions or contamination.

Although masked from direct observation, the geological and hydrological mechanisms of groundwater and surface water connections are now very well understood. In recent decades the tools and methods for analyzing their interactions have developed to the point where, with adequate monitoring and analysis, we can accurately describe the behavior of groundwater-surface water connections in most situations.

However, while we have made considerable progress in the science of groundwater and in our understanding of the groundwater-surface water connection in recent decades, California groundwater policy has not evolved to include a modern understanding of groundwater. Throughout much of California, coherent groundwater management is practically nonexistent despite the overwhelming scientific concurrence that surface water and groundwater are inextricably linked and that, in fact, surface water and groundwater make up one single water supply. While surface water rights and surface water management are closely tracked and managed at a state level, state involvement in groundwater management and policy is limited to requiring that new wells be reported (although not monitored), providing financial support for local or regional management efforts through grants of public funds, and as of November 2009, requiring that local agencies monitor the water levels in their groundwater basins.

Beyond these meager state provisions, regulatory or planning authority concerning groundwater in California is relegated to local entities, and it is only voluntary. Under California law, more than 30 different types of local agencies have authority to institute groundwater management (DWR 2003). Where local entities have voluntarily chosen to adopt groundwater policies, the policies are highly variable and tend to be very protective of local users, generally preserving the status quo at the expense of proactive management and largely ignoring the state's important public trust obligation to protect wildlife.

That said, rigorous and effective groundwater management has been implemented in a number of groundwater basins in California, usually where significant groundwater problems have made it difficult or impossible to ignore the issue. When conflicts arise among groundwater users, the courts can adjudicate a specific groundwater basin. In the adjudication process, a court can designate groundwater allocations for users in the basin and can limit pumping to a given volume to protect the groundwater supply. So far only 22 of the 431 designated groundwater basins in California have been adjudicated, and all but one of those are in southern California (DWR 2004a and verbal communication). (See Figure 1.)

In some areas of the state, highly sophisticated and successful local and regional groundwater management programs have been developed. (See, for example, OCWD 2009; EMWD 1995; MWA 2004; MWH 2006.) These cases, which include many of the adjudicated basins as well as several other basins where a responsible local entity has taken action, demonstrate what can be accomplished with appropriate oversight and good science. However, even in some of the more encouraging of these example cases, by the time organized groundwater management was formulated for the area, severe groundwater overdraft had long since greatly altered the natural connection between groundwater and surface water, leaving drastically compromised freshwater ecosystems.

The Urgent Need for More Effective Groundwater Management

In early California water development, freshwater ecosystems were largely left to survive on the water left over after mining, agriculture, and urban water users had taken what they needed. California's freshwater ecosystems have already suffered dramatic impacts due to this mind-set. More recently, instream flow regulations, endangered species protection measures, and water quality requirements have provided mechanisms for protecting the environment, have been instrumental in curbing further degradation, and in some cases have contributed to notable improvements for freshwater ecosystems.

Many factors, including climate change, population growth, and energy development, are contributing to increasing demands on California's limited water resources. As the pressures on water supplies mount, our water use will have to become more and more efficient. The increasing scrutiny of water use will require even more aggressive "integrated management" and manipulation of both groundwater and surface water to ensure the reliability of our water supply (see DWR 2005).

In this new era of highly efficient and integrated water planning, every water use and value must be carefully considered and accounted for, and ecosystem needs must be included up front. For surface waters, legal and regulatory mechanisms provide for thorough measurement and accounting and even allow for explicit allocation of water for environmental needs (although even these mechanisms need refinement). But for systems dependent on groundwater, which means nearly all streams, springs, riparian areas, and wetlands in the state, water planning and ecosystem conservation efforts are handcuffed and lack even the most basic information on groundwater use and status on which to base decisions.

Within the current regulatory and administrative framework, the ability to assess the impacts of groundwater or to develop and implement responses to groundwater impacts is severely limited. Without improved monitoring and reporting of groundwater use, increased access to the groundwater information that does exist, and the integrated management of groundwater withdrawals, even an adequate characterization of groundwater conditions and impacts is impossible in all but a handful of groundwater basins around the state.

Even under current conditions, wildlife resources throughout the state are being damaged by unmanaged groundwater withdrawals. Unless we begin to manage groundwater in a coherent way as an integral part of a freshwater system, we cannot ensure sustainable aquatic ecosystems, no matter what Herculean efforts might be made to restore and protect the ecosystems and the water supplies on which they rely.

In order to achieve and sustain a healthy and prosperous California, our integrated water management strategies must provide a sustainable water supply for both people and freshwater ecosystems, and the modern scientific understanding of the connection of groundwater and surface water must be ingrained within these strategies.

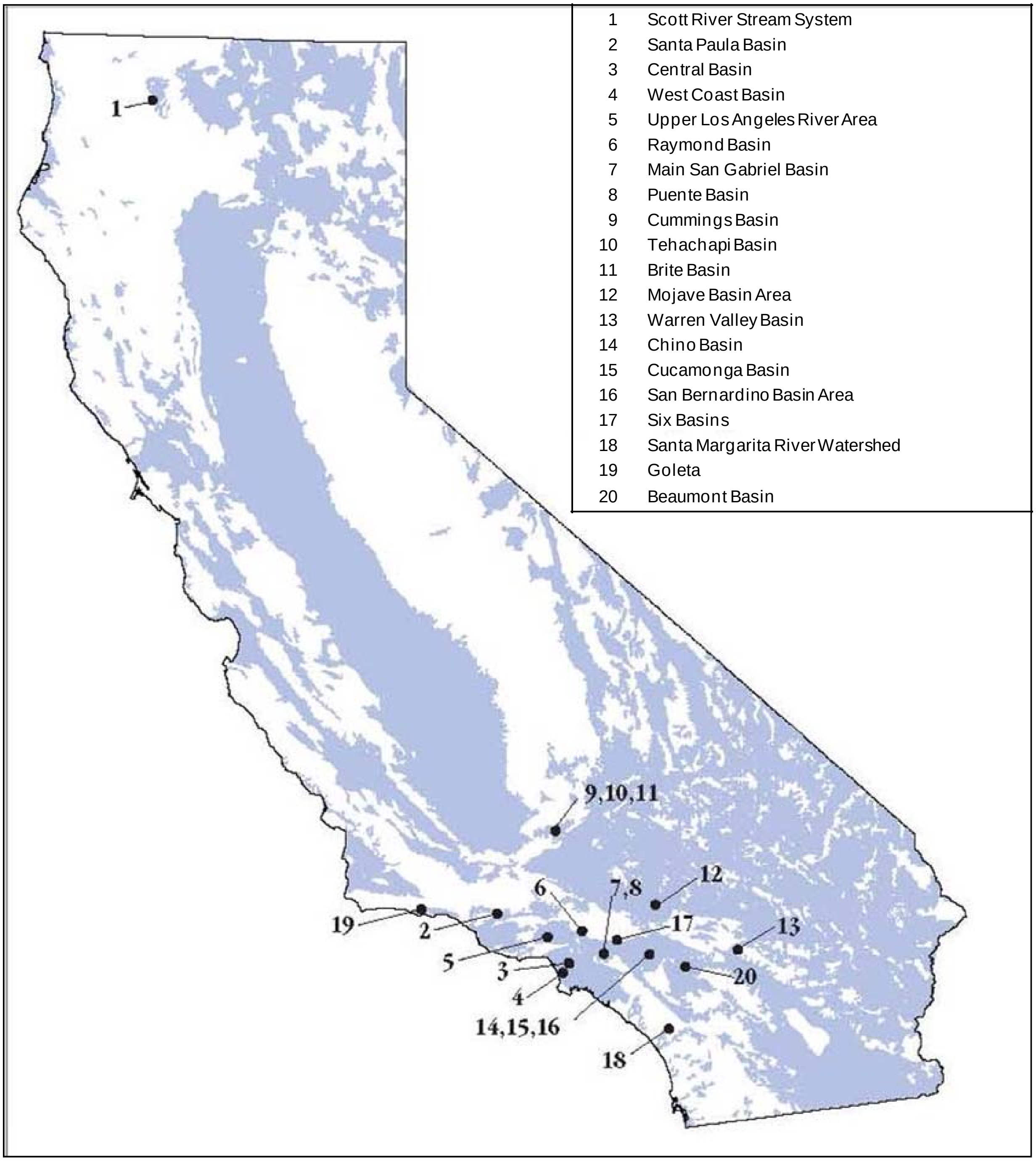


Figure 1. Adjudicated groundwater basins in California. Since production of this graphic, two additional basins have been adjudicated, the Santa Maria Basin and the Seaside Basin. (Adapted from DWR, 2004a)

MAKING THE CASE FOR EFFECTIVE GROUNDWATER MANAGEMENT IN CALIFORNIA

While the science is clear on the connection between surface water and groundwater, in California that scientific understanding has not been transferred consistently into water management, and consequently, our aquatic ecosystems and water supplies for people are at serious risk.

Following are three specific examples from Nature Conservancy conservation sites across California that illustrate how unmanaged groundwater withdrawals have led to ecosystem damage and how change is essential to reverse prior damage and ensure the sustainability of conserved and restored ecosystems. These sites, the Cosumnes River, the Shasta River, and the Santa Clara River (Figure 2), represent the diversity of climate, geology, fresh water-dependent ecosystems, and threats found in California. At each of these sites, The Nature Conservancy and our conservation partners have already invested heavily in the conservation and restoration of freshwater ecosystems or terrestrial ecosystems that depend on fresh water. Some of the affected ecosystems or habitats, such as riparian forests and some wetlands, may depend directly on groundwater while other ecosystems and species are in surface waters that are closely tied to adjacent groundwater. These cases show the stepwise influence of groundwater on surface waters and the resulting harmful effects on ecosystems.

Through presenting these case studies, we want to emphasize the following basic certainties:

- **Groundwater and surface water are inextricably linked in practically all of California's streams, rivers, and wetlands.**
- **The beneficial uses of surface waters have been severely compromised by inadequate management of groundwater withdrawals, and unless changes are made, these negative impacts will continue.**
- **Wildlife that depends on surface water and groundwater, including threatened and endangered species, has been — and without change, will continue to be — injured by groundwater withdrawals.**

Figure 2. Locations and watersheds of three sites presented that demonstrate the interconnections between groundwater and surface water and the impacts of groundwater withdrawals on ecosystems.

CASE STUDY 1

SHASTA RIVER — PUMPING THREATENS COOL FLOWS FOR COHO

The Shasta River is a modest meandering stream in northern California that rises near the base of Mount Shasta and flows north through the Shasta Valley to join the Klamath River near the Oregon border (Figure 3). Although the Shasta provides less than 10 percent of the Klamath's total annual stream flow, it is estimated historically to have produced up to 20 percent of the Klamath's anadromous fish populations, including considerable numbers of fall- and spring-run Chinook salmon, coho salmon, and winter- and summer-run steelhead. It is even thought that in some years, more than half the returning adult salmon in the Klamath system originated in the Shasta River (Wales 1951; Deas et al. 2004).

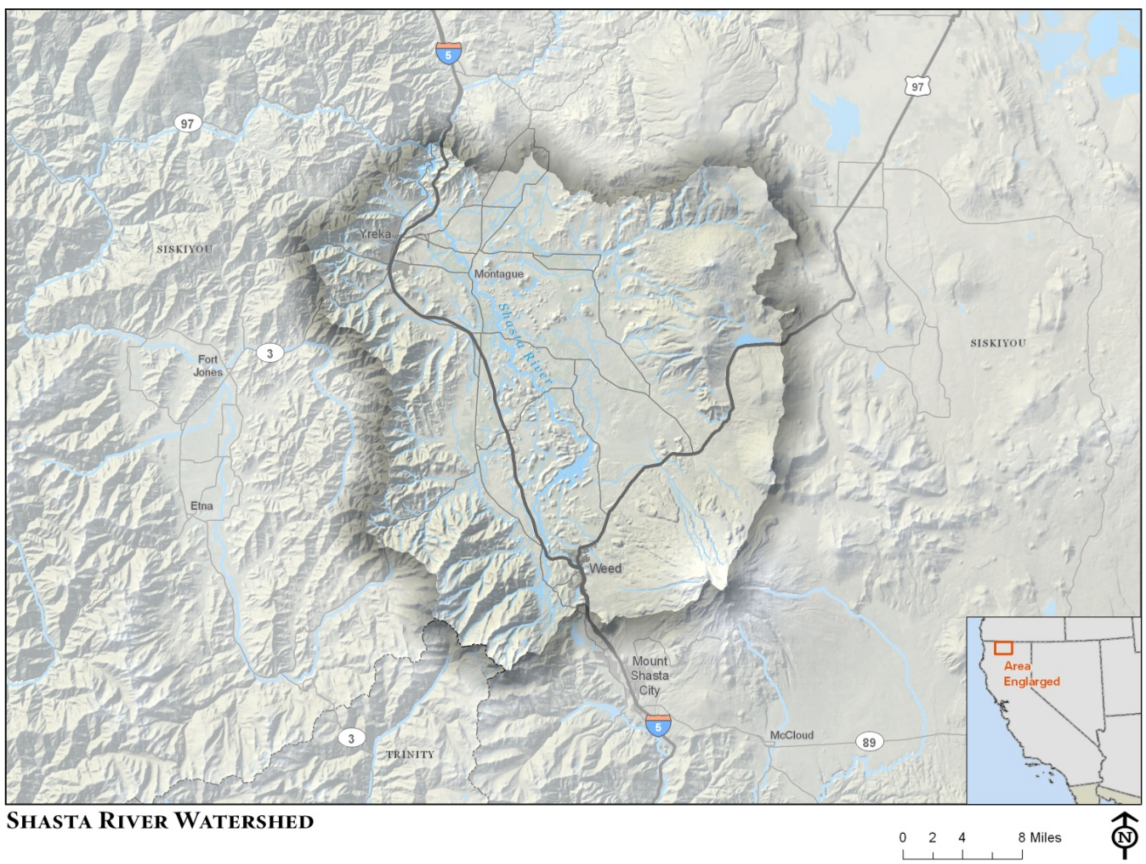


Figure 3. Watershed of the Shasta River, Siskiyou County, California.

A unique characteristic of the Shasta River is the presence of numerous springs that emanate from extensive geological formations formed by successive lava flows that flank Mount Shasta and the volcanic mountains that rim the eastern side of the Shasta Valley. These springs are especially important to the value of the river as a fishery. Under unimpaired conditions, their unvarying flow, constant temperature, and unique nutrient content create nearly optimal conditions for salmonid production year-round (Mount et al. 2009). The abundant nutrients in water flowing out of the springs contribute to an unusually productive food chain, even in the winter, since the spring-fed waters are warm enough to support high rates of biologic production despite the cold Shasta Valley winters.

Today, only around 5,000 Chinook salmon return to spawn in the Shasta annually. Water diversions, dams, agriculture and grazing, as well as conditions outside the river basin (e.g., conditions downstream in the Klamath and in the ocean), have all contributed to the decline of the once productive Shasta River salmon fishery (NRC 2004; NRC 2007).

Cool Water and Adequate Flows — Keys to Shasta River Salmon Survival and Recovery. Although the Shasta River is significantly impaired compared to its historical condition, biologists consider the river crucial to the restoration of the Klamath Basin salmon populations. Fortunately, the cold-water springs that feed the river are still largely intact. If restoration measures and protections are implemented soon, these springs can provide the critical base flows that are the foundation of the Shasta's unique productivity.

One notable group of springs, called "Big Springs," appears to be particularly important to the Shasta in its current impaired state. The groundwater discharge from this spring complex and other springs emerging from the same aquifer appears to be the primary source of cold water flowing into the Shasta River below Dwinnell Dam during summer and fall (DWR 2008, Null 2008). The California Department of Fish and Game (DFG) has determined that the Big Springs area remains the primary destination for adult coho salmon returning to the Shasta River (DFG unpublished data 2007). Big Springs Creek, which is formed by the flows from Big Springs, is identified as a top priority for restoration in the National Marine Fisheries Service's Draft Recovery Plan for Southern Oregon/Northern California Coho Salmon, California Department of Fish and Game's Recovery Strategy for California Coho Salmon, and the State Water Resources Control Board's Shasta River Total Maximum Daily Load (TMDL) Plan.

Recognizing the significance of the Big Springs to salmonid protection and restoration in the Shasta and the corresponding importance of the Shasta in the overall Klamath salmonid recovery efforts, The Nature Conservancy purchased the 4,130-acre Shasta–Big Springs Ranch in March 2009 along with a conservation easement on an adjoining 398-acre property. Between the Shasta Big Springs Ranch and other adjacent protected properties, the entire length of Big Springs Creek (2.2 miles) and more than seven miles of the Shasta River are now protected. The acquisition of the ranch also included most of the rights to divert surface water from Big Springs and two other large springs on the property, providing the opportunity to reallocate water use to benefit stream conditions.

The acquisition of the Shasta–Big Springs Ranch and the impending restoration work represent a giant step toward reviving the Klamath's Chinook, coho, and steelhead runs. Water-temperature modeling indicates that stream restoration on the ranch, along with improved management of the ranch's water rights, can dramatically expand the area of suitable salmonid habitat in the Shasta River (Deas et al. 2004; Mount et al. 2009).

The Groundwater Threat to Shasta River Salmon. Immediate restoration efforts can address many of the acute conditions threatening the survival of the Shasta River fishery, but a closer look has illuminated a potential threat that could limit what can be attained with stream restoration and surface water management. The pumping of groundwater from the same aquifer that supplies the Big Springs Complex and other important springs in the Shasta Valley is reducing flows from the springs. Although the amount of spring flow reduction that results from a given amount of pumping is unclear, the cumulative pumping reduces the quality and extent of the cool-water refuge that is critical to salmon survival in the Shasta River during the hot Shasta Valley summers (Deas et al. 2004; Mount et al. 2009; DWR 2008).

While the flows from the volcanic aquifer continue today, the flows are significantly lower than historical levels and are at risk of declining further because of unmanaged groundwater pumping. The Department of Water Resources (DWR) estimates that approximately 4,300 acres of agricultural land is irrigated with groundwater withdrawn from the volcanic aquifer (DWR 2008). The relatively shallow groundwater levels and the high productivity of the aquifer make groundwater pumping an attractive option for irrigators whose lands overlie the volcanic aquifer.

Flow monitoring conducted by the Conservancy and our science partners has shown that during 2009, the total flow from the Big Springs Complex dropped from approximately 85 cfs in the winter to near 65 cfs during the peak of the irrigation season (Figure 4). So, even before surface water is diverted from Big Springs Creek, a considerable portion of the natural flow of this spring system is being captured by groundwater pumping.

In the Shasta Valley, new wells for domestic and irrigation production continued to be constructed in recent years (DWR 2008), some of them likely tapping the same, already stressed, water source. Each new well drilled into the aquifer translates into some incremental reduction in flows from springs up and down the east side of the Shasta Valley. As with the reduced flows at Big Springs, each additional decline in spring outflow translates into a corresponding reduction in suitable low-temperature aquatic habitat to support Shasta River salmon and steelhead.

The bright side in the case of the Shasta Valley is that there appears to be opportunity to meet the needs of both agriculture and fish with the available water supply. With improved understanding and implementation of the right valley-wide water management strategies, including conjunctive management of groundwater and surface water in a cooperative way, the outlook for salmon and steelhead populations and agricultural land use is promising.

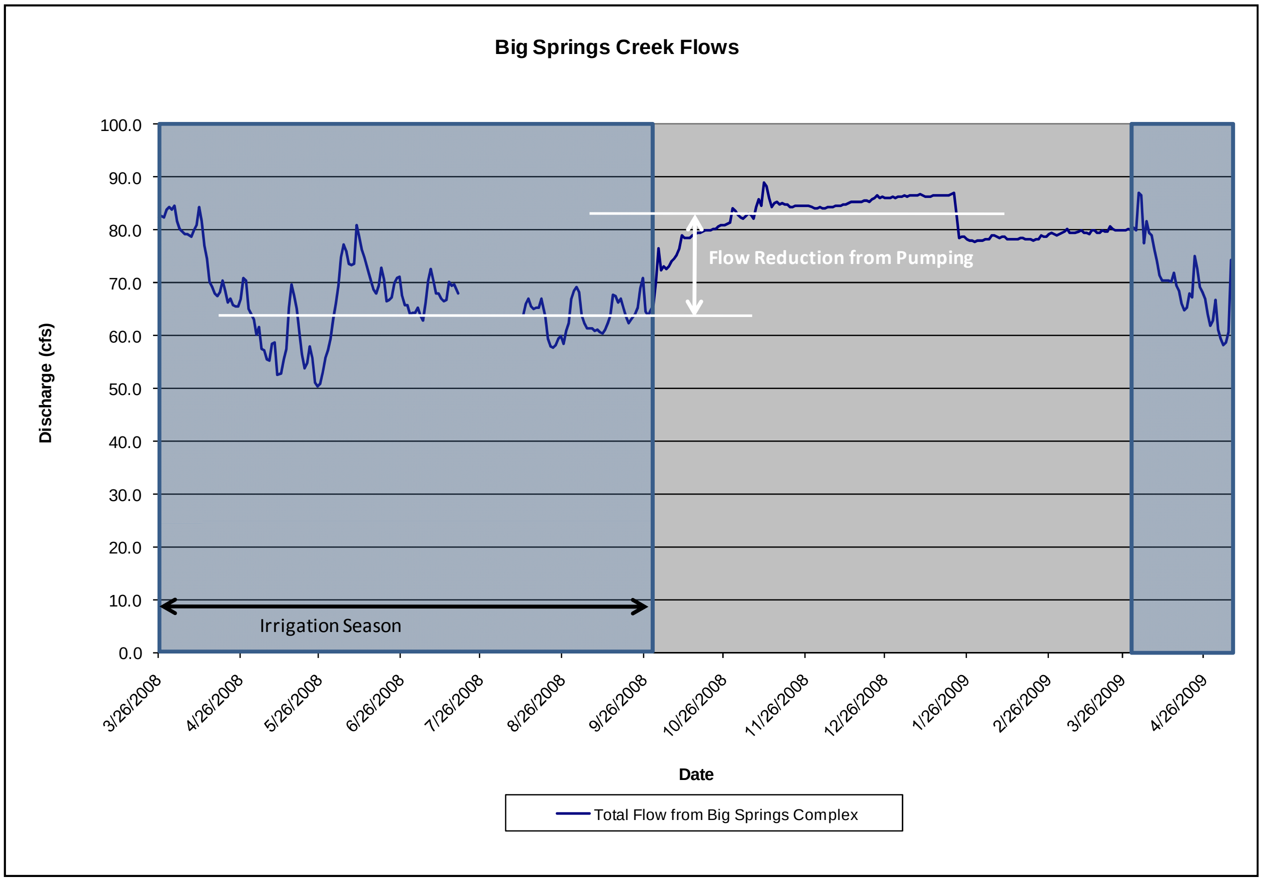


Figure 4. Flow from the Big Springs complex of springs, March 2008–April 2009, Shasta-Big Springs Ranch, Shasta Valley, Siskiyou County, California. Flow from Big Springs is fairly constant during the winter, non-irrigation, season with total outflow from the springs complex forming Big Springs Creek ranging between 80 cfs and 85 cfs. During the irrigation season, outflow from the springs are erratic due to different pumps turning on and off as irrigation needs determine. Flows during the irrigation season vary widely around an average of approximately 65 cfs. (Source: University of California Davis, Center for Watershed Sciences. Unpublished Data.)

<u>Case Study 2</u>

The Cosumnes River — Legacy of Overdraft Leaves Riparian System High and Dry

The Cosumnes River drains approximately 1,300 square miles of the west slope of the Sierra Nevada Mountains and flows into the Mokelumne River on the eastern edge of the Sacramento–San Joaquin Delta in southern Sacramento County (Figure 5). In its lower reaches, the Cosumnes flows across the floor of the Central Valley and is underlain by a highly productive aquifer that is an important water source for municipal and agricultural users in Sacramento County. Extensive pumping of wells in the region has severely lowered groundwater levels, directly affecting flows in the river and compromising the sustainability of the unique aquatic and riparian ecosystems of the river corridor.

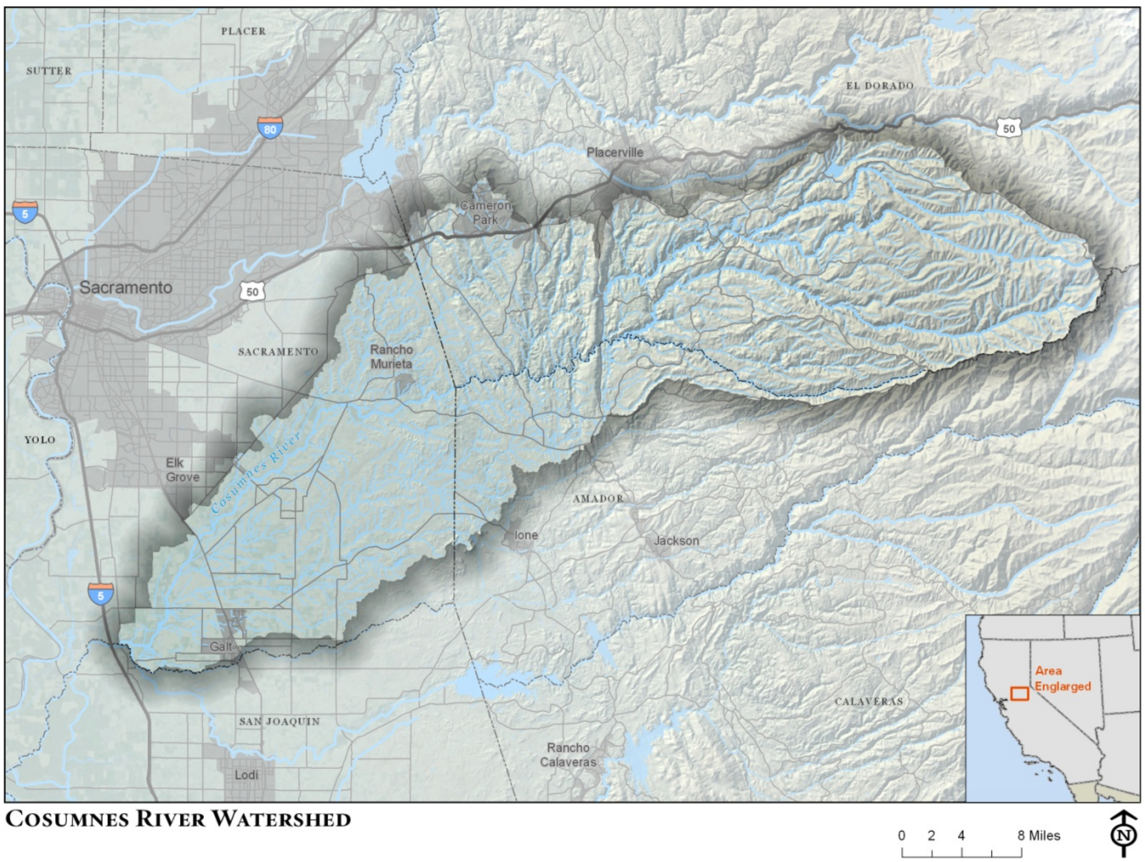


Figure 5. Watershed of the Cosumnes River, Sacramento, El Dorado, and Amador Counties, California.

The Cosumnes is one of few rivers of significant size in California's Central Valley with relatively natural, unregulated stream flows (Booth et al. 2006; Fleckenstein et al. 2004). In its lower reaches, the Cosumnes flows through one of the Valley's biologically richest regions. The lower Cosumnes corridor hosts some of the largest intact stretches of the riparian and floodplain forests that once covered large areas along many rivers in the Central Valley (Figure 6; see also Kleinschmidt 2008). In addition to the critical habitat of the Cosumnes corridor, the Cosumnes river also supports a varied fishery, including a naturally-reproducing population of fall-run Chinook salmon (Moyle 2003; Kleinshmidt 2008).

Figure 6, Cosumnes River and characteristic floodplain riparian forest on the Cosumnes River Preserve, May 2008, showing flow level typical of late spring. *Photo by Maurice Hall.*

To protect the river, the critical stands of valley oak riparian communities and the wetlands that flank the stream and its tributaries, the Conservancy and partners (California Department of Fish and Game, U.S. Bureau of Land Management, Sacramento County, California Department of Water Resources, Ducks Unlimited, Galt Unified School District, and the U.S. Natural Resources Conservation Service) have established the Cosumnes River Preserve, which now consists of approximately 46,000 acres of wildlife habitat and agricultural land managed by the partners (Kleinschmidt 2008).

The preserve partners are working tirelessly to abate multiple threats to the river and its associated floodplain and wetland habitats. Threats include habitat loss and fragmentation from continued urbanization and agricultural conversion, invasive species, and levees, which disrupt the natural floodplain-river connectivity that supports the floodplain forests and wetlands (Kleinschmidt 2008).

In addition to these threats, the current health and long-term sustainability of the ecological treasures of the Cosumnes corridor are severely compromised by a legacy of groundwater depletion.

A Disrupted Connection: Groundwater and the Cosumnes. Because the underlying aquifer is a critically important source of water for cities and farms of southern Sacramento County and because of the conservation importance of the Cosumnes River corridor, the system has been the subject of many investigations conducted by water agencies and researchers (MWH 2006; WRIME 2003; WRIME 2008; SGA 2008; Fleckenstein et al. 2006; Fleckenstein et al. 2001; Niswonger 2006; Booth et al. 2006). Collectively, these investigations show an unfortunate picture that has been repeated many times up and down the east side of the southern Central Valley: Excessive groundwater pumping in the surrounding area has drawn groundwater levels down to levels below the bottom of the river channel. As a result, the Cosumnes, like many rivers to the south, has become what is called a "losing stream," that is, it loses water that percolates downward through the riverbed. In the specific case of the

Figure 7. Riverbed of the Cosumnes in September 2008. Lower groundwater levels, due to many years of pumping in southern Sacramento County, have increased the frequency and extended the duration of periods when the bed of the Cosumnes is dry. *Photo by Maurice Hall.*

Cosumnes, widespread pumping over the past century has lowered the regional groundwater levels in southern Sacramento County so severely that the natural tie between the lower Cosumnes and its alluvial aquifer is severed year-round. As a result, the lower 36 miles of the Cosumnes are now losing water to the underlying aquifer 365 days per year (Fleckenstein et al. 2006). When this percolation rate exceeds the volume of river flow coming from the mountains, all of the river flow percolates downward, leaving the riverbed completely dry. In fact, in recent years flows from the upper watershed are completely lost to the groundwater during much of the summer and fall, leaving many miles of dry riverbed (Figure 7).

The groundwater levels in the Cosumnes River corridor in Spring 2003 are shown in figure 8. The colored contours show the groundwater levels in the uppermost aquifer layer as simulated by the Sacramento Integrated Ground and Surface Water Model (SacIGSM), a calibrated groundwater model developed and maintained by water management agencies across Sacramento County. Large areas on either side of the Cosumnes where groundwater levels in the aquifer are as much as 20 to 60 feet below sea level are indicated by the lighter blue areas in the figure and are commonly called regional “cones of depression.” These cones of depression coincide with areas of extensive pumping for agricultural and urban and/or residential use in the central and southern part of the county. Model simulations estimate that approximately 350,000 acre-feet of water were pumped from the aquifer in the central and southern parts of the county in 2003 (WRIME 2008).

Along the Cosumnes and American Rivers, between the cones of depression are areas with notably higher groundwater levels (indicated in Figure 8 in yellow and darker green). These higher groundwater levels are the result of the rivers’ “recharging” of the groundwater — essentially, water from the river leaks through the porous riverbed materials and into the underlying aquifer. This leakage from river to groundwater occurs wherever groundwater levels are lower than the water level in the river (SCWA 2005; WRIME 2003; SGA 2008).

Under current conditions, with groundwater levels in the aquifer dramatically lowered due to pumping, leakage from the Cosumnes is a significant portion of the overall inflow to the aquifer in the central and southern parts of the county. Simulations by the SacIGSM estimate that in recent years, the Cosumnes and its tributaries contributed approximately 70,000 acre-feet/year to the groundwater basin, or approximately 20 percent of the total groundwater used in the central and south basins (WRIME 2008). **This general situation is repeated along numerous rivers across California – a vivid illustration of why effective management of surface water, separate from groundwater, is a hopeless undertaking**.

Damage Done: Tenuous Water Supply for Groundwater-Dependent Ecosystems. One direct impact of extended periods of very low flows in the lower Cosumnes due to groundwater depletion is on up-migrating salmon. Fall-run Chinook salmon migrate up the Cosumnes from October through December. Analysis of flow records at the two lower Cosumnes gauges between 1941 and 1981 showed an increasing loss of stream flow and a corresponding increase in the number of days during October and November when flows in the lower Cosumnes dropped below a targeted minimum flow for fish passage (Fleckenstein, et al. 2004). This decrease in stream flow corresponds to a period of dramatic drop in regional groundwater levels. In recent years, the Cosumnes channel has commonly remained dry well into the Chinook migration period. This is thought to be a major factor in the decline of the Cosumnes Chinook run. In 1995 the U.S. Fish and Wildlife Service reported that low flows in the fall appear to be the run’s most critical limiting factor (USFWS 1995). In the decade ending in 1990, there were three years when lack of adequate flow during the Chinook migration period precluded perpetuation of a natural Chinook run on the Cosumnes (Reynolds 1990).

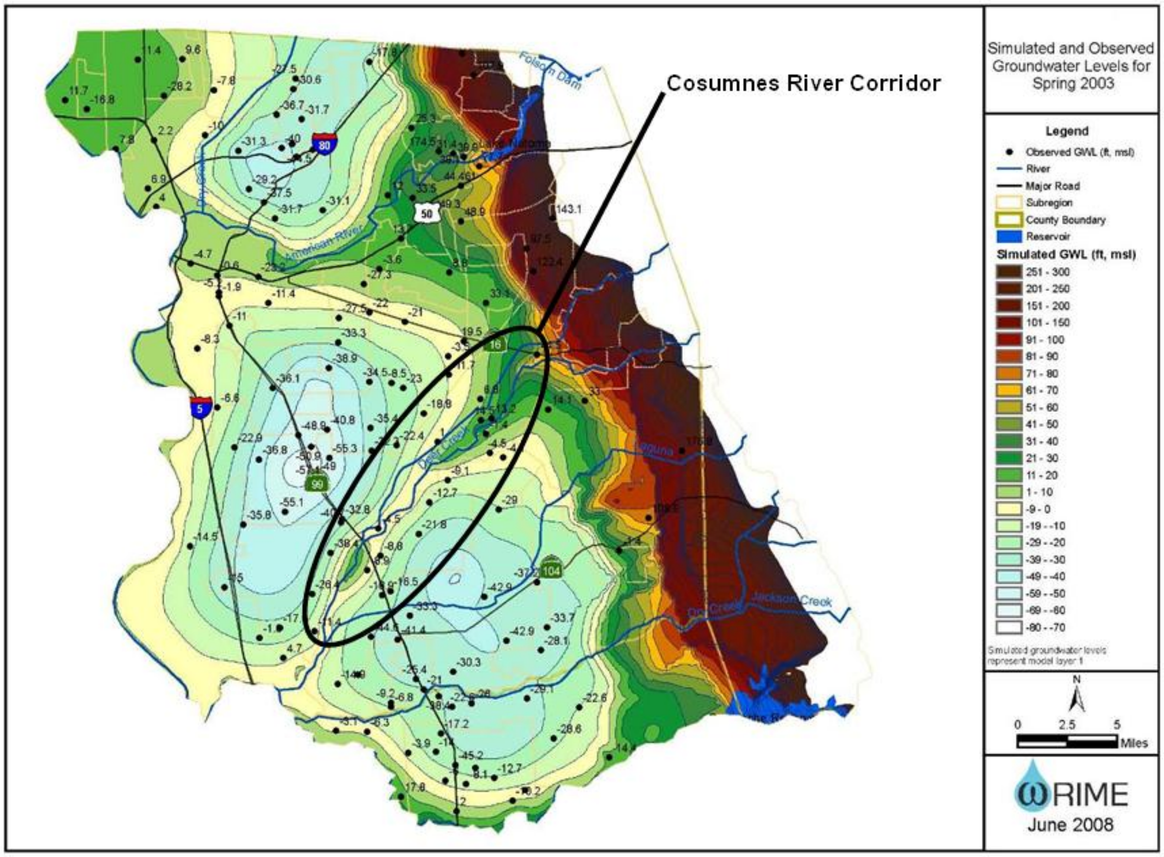


Figure 8. Spring 2003 simulated and observed groundwater levels for Sacramento County. Simulation by the Sacramento Integrated Ground and Surface Water Model (SacIGSM). Color coded contour lines show simulated groundwater levels for spring 2003. Point measurements note actual groundwater levels in monitoring wells for the same period. Values shown are in feet above mean sea level. (WRIME, 2008)

Limited Options for Ecosystem Recovery and Sustainability. In the case of the Cosumnes, much of the damage is already done. Collaborative efforts among water management entities, other water users, and conservation organizations are now developing strategies for improved groundwater management (Water Forum 2000; SGA 2008; SCWA 2005, MWH 2006), but the main emphasis of these efforts is a rear-guard action to halt further lowering of the groundwater levels. Success in halting further overdraft would still leave the ecosystems impaired and at risk.

Options for restoring river flows in the fall to improve salmon migration and for ensuring the sustainability of the floodplain and riparian habitats, if they prove viable at all, will require extensive engineering, water conveyance, and additional energy and infrastructure. And all of these measures would require considerable financial investments. **Instead of protecting the natural water processes necessary to sustain wildlife resources by means of a coherent groundwater management based on sound science, we are now forced to implement expensive patchwork repairs in hope of restoring a damaged system.**

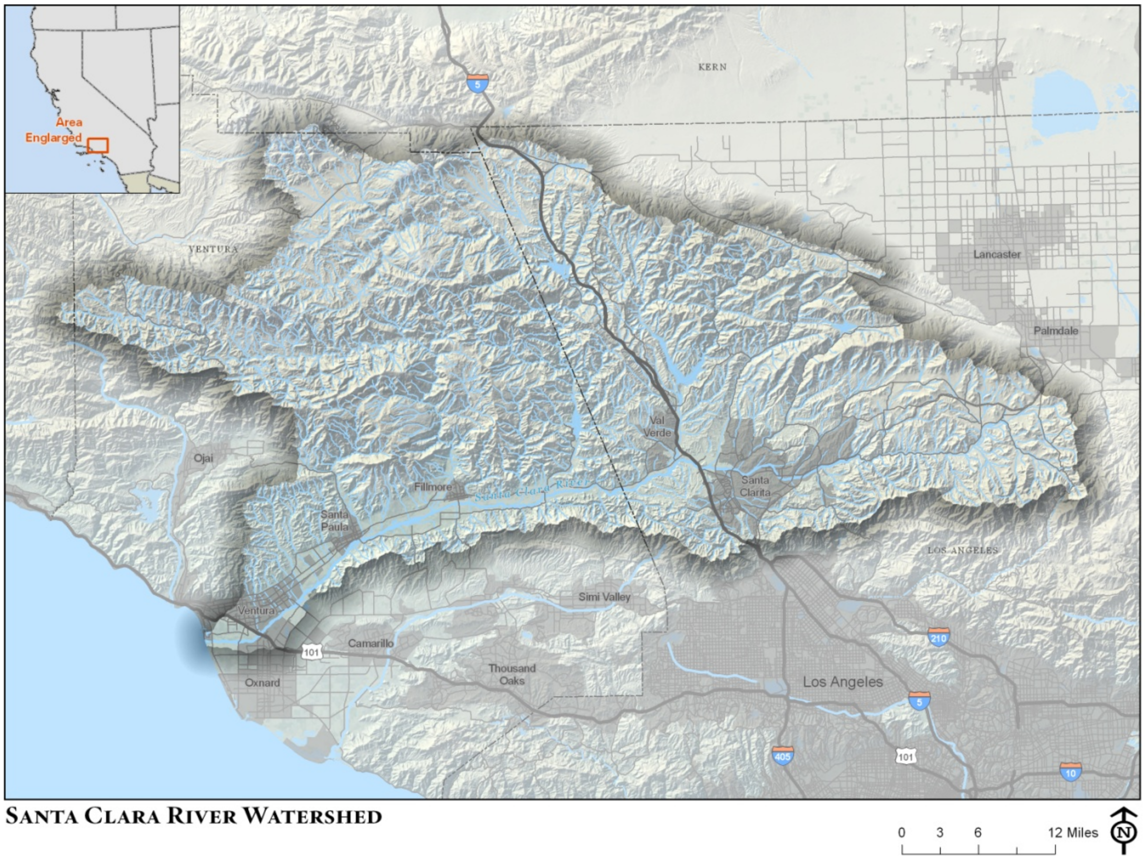


Figure 9. Watershed of the Santa Clara River, Los Angeles and Ventura Counties, California.

<u>Case Study 3</u>

Santa Clara River —Saltwater Intrusion Problem Passed on to Struggling Steelhead

In southern California, a region known for its highly modified river systems, the Santa Clara River stands out as the least altered major river in the region. The Santa Clara runs approximately 90 miles from its headwaters in the San Gabriel Mountains of northern Los Angeles County to the Pacific Ocean near Ventura in Ventura County (Figure 9).

With only 34 percent of its watershed controlled by dams and much of its lower reaches relatively unconstrained by levees, the Santa Clara retains many of it natural attributes (Figure 10), including patches of high-quality aquatic and riparian habitats that help sustain threatened and endangered species, including the least Bell's vireo (an endangered bird) and one of the few remaining runs of southern steelhead (Stillwater 2007; 2008).

Although the numbers of the Santa Clara's southern steelhead have been dramatically reduced from historical levels, the Santa Clara watershed provides one of the top steelhead restoration opportunities in all of southern California (NOAA 2007; Stoecker and Kelley 2005). Largely due to the relatively natural condition of the Santa Clara River and its corridor, The Nature Conservancy has identified the Santa

Clara watershed as a priority conservation area. In partnership with many organizations, the Conservancy is continuing an extensive program to protect the river and the ecosystems that depend on it.

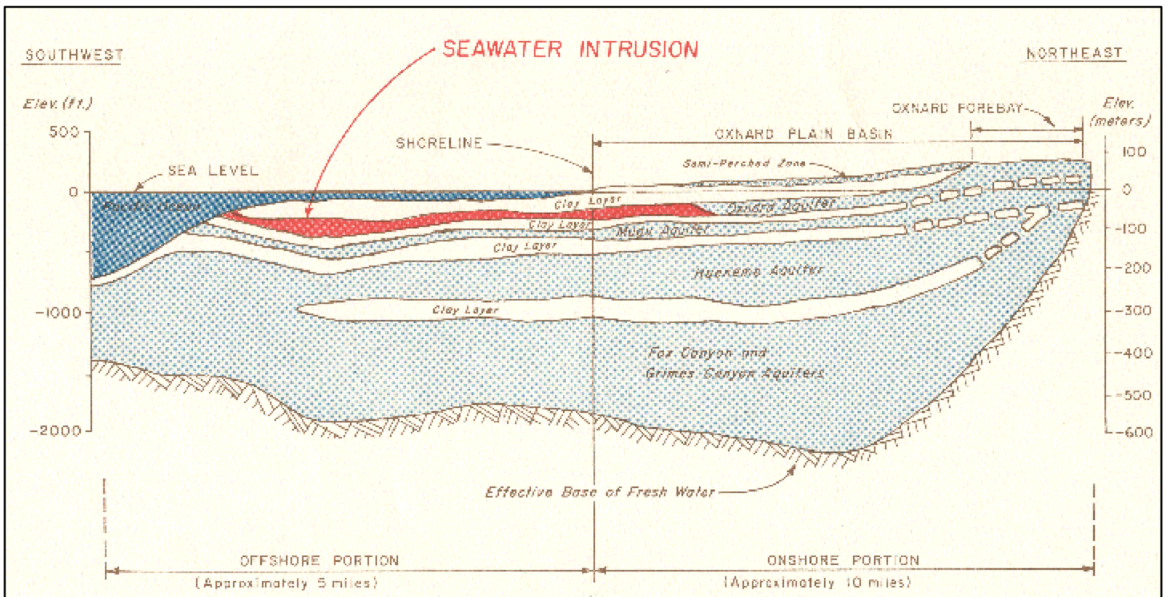
Although groundwater withdrawals from the alluvial aquifer in the immediate vicinity of the lower Santa Clara River have undoubtedly led to impacts on aquatic and riparian habitat in and along the river, the most dramatic groundwater-related impacts on the Santa Clara stem from pumping from another aquifer. This aquifer underlies the Oxnard Plain some distance south of the Santa Clara River, beyond

Figure 10. Santa Clara River just upstream from Santa Paula, Ventura County, California in March 2008. In some locations, the river's surface flow largely disappears into the porous streambed. These flows continue as groundwater flow and re-emerge downstream where geologic constrictions to groundwater flow force more of the flow to the surface. *Photo by Maurice Hall*

the boundaries of the Santa Clara watershed.

Consequences of Uncontrolled Pumping: Saltwater Intrusion Beneath the Oxnard Plain. The Oxnard Plain is a large area (roughly 100 square miles) of relatively level terrain extending along the coast south of the Santa Clara River. On the plain are the urban areas of Oxnard and surrounding communities, and much of the plain outside the cities is highly productive agricultural land. The plain is underlain by the Oxnard Aquifer, which has been the major source of water for the urban and agricultural development of the area (DWR 2006; Hanson, et al. 2003; Bachman and Detmer 2003).

The first wells were drilled in the Oxnard Plain as early as 1870. These were flowing artesian wells, which means that water levels in the aquifer were so high that when wells were drilled, water flowed freely from them without the need for pumps. By around 1900, increased urban and agricultural water use had drawn groundwater levels down to the point that pumps were required to bring water to the surface (Freeman 1968). By the mid-1900s, with continuing urban and agricultural development, groundwater pumping was outpacing natural recharge of the aquifer. In addition to increasing the pump lifts required to extract water, this overdraft caused a general lowering of the groundwater levels to well below sea level. As a result, seawater began intruding into the underground aquifer, contaminating groundwater to the point that in some areas it is no longer suitable for agricultural or residential uses (Figure 11). Along the Pacific Coast, from Point Mugu northward to the Santa Clara River, approximately 23 square miles of the Oxnard Aquifer has been intruded by seawater (Bachman and Detmer 2003; UWCD 2001).



From DWR Bulletin No. 104-8 (1976)

Figure 11. Simplified schematic of sea-water intrusion in the aquifers of the Oxnard Plain. Note: Sea-water intrusion also exists in the lower aquifer layers (Mugu, Hueneme, and Fox Canyon) but is not illustrated. (Modified from DWR Bulletin No. 104-8. Nov. 1976)

Expanding the Problem: Indirect Impacts on the Santa Clara River. To address the problems of overdraft and saltwater intrusion in the Oxnard Aquifer, water has been diverted from the Santa Clara River since the 1950s. The diverted water is either supplied to users that would otherwise use groundwater or is diverted into spreading grounds, which are open pond areas constructed specifically to allow introduced water to infiltrate into and recharge the aquifer (Stillwater 2008).

Despite these early efforts, groundwater overdraft continued, and the seawater intrusion problem in the Oxnard Plain aquifer worsened. In 1991, construction was completed on a permanent diversion structure near Saticoy (Figure 12) to improve capacity to divert water from the river. Under recent operations, the diversion redirects approximately 58,000 acre-feet from the Santa Clara River each year to the recharge basins and water users of the Oxnard Plain.

Ecosystem Costs. Cumulatively, the measures implemented to counteract the damage from unmanaged groundwater withdrawals on the Oxnard Plain have brought about a significant convolution of the Santa Clara River's hydrology. Within the least-disrupted major river system remaining on California's South Coast, dramatic structural and hydrological measures have been taken to respond to groundwater overdraft and accompanying saltwater intrusion in the Oxnard Plain. The ecosystem costs of this cascade of responses are still being assessed.

One prominent ecosystem cost is the impact of the modified flows and of the diversion structure itself on the spawning success of the southern steelhead. The operation of the diversion structure was the subject of a 2008 biological opinion (BO) from the National Marine Fisheries Service (USNMFS, 2008). The BO concluded that proposed operation of the structure (along with the existing fish passage facility) is likely to jeopardize the continued existence of the endangered southern California steelhead and is likely to destroy or adversely modify critical habitat for this species.

The situation highlighted here on the Santa Clara illustrates how poorly planned groundwater management can have impacts well beyond the local boundaries of the specific groundwater issue. **Although it lies miles from the heart of the saltwater intrusion problem, the Santa Clara River is now encumbered by the need to deliver water to replenish an overdrafted aquifer and hold back the advance of the seawater intrusion.** And the nearly extinct steelhead run will have great difficulties in overcoming this additional obstacle.

Figure 12. The Vern Freeman diversion structure near Saticoy on the Santa Clara River, Ventura County, California. The structure diverts surface water flows from the Santa Clara River (1) to provide water for users on the Oxnard Plain who would otherwise pump groundwater and (2) to provide water to recharge the Oxnard Plain aquifer to mitigate for overdraft and reduce or halt further salt-water intrusion. The structure was the subject of a 2008 biological opinion (BO) from the National Marine Fisheries Service (USNMFS, 2008). The BO concluded that proposed operation of the diversion structure (along with the existing fish passage facility) is likely to jeopardize the continued existence of the endangered southern California steelhead and is likely to destroy or adversely modify critical habitat for this species. *Photo by Maurice Hall*

CONCLUSIONS

Multiple threats to the river and riparian ecosystems exist at each of the site-specific cases presented. The Nature Conservancy and a multitude of conservation partners, including public agencies and other non-governmental organizations, are working to address these concerns and using many conservation approaches, including protecting lands through direct acquisition, developing market incentives for ecosystem-friendly practices, acquiring dedicated water rights, educating land and water managers on best management practices, and carrying out active restoration. However, the progress and investment made in all of these conservation efforts are not sustainable if the threat from unmanaged groundwater is not addressed.

The case studies presented demonstrate the direct linkage between groundwater and aquatic ecosystems in three very different geologic, hydrologic, and ecologic settings within California. These happen to be a few sites where the Conservancy is already heavily engaged and where the level of understanding of groundwater conditions is comparatively high. Around the state there are many other places where poorly planned or uncontrolled groundwater withdrawals are currently siphoning too much water from freshwater ecosystems.

Along the Cosumnes River in Sacramento County, collaborative efforts to address the groundwater situation have been launched, but only recently, long after groundwater conditions had been degraded and serious conflicts had developed among different water interests. Many stream-based ecosystems in the Central Valley and elsewhere across the state are in similar or worse condition. We are living with the legacy of decades of overdraft.

Other systems like the Shasta still have reasonably functional groundwater systems. With fairly straightforward and painless precautions, the integrated groundwater and surface water relationships can be protected and maintained — with very powerful outcomes for conservation and sustainable water supplies for cities and farms.

However, with California's current legal and regulatory framework in place, the tools available to address groundwater overdraft and mismanagement are severely limited. **Without access to aquifer information, without improved site-specific understanding of the aquifers, without reporting of pumping rates, and without reasonable limits to ensure that groundwater pumping does not exceed the rate of aquifer recharge, no amount of investment in protection or restoration will be adequate to provide for healthy freshwater ecosystems.**

COMPONENTS OF EFFECTIVE GROUNDWATER MANAGEMENT

The case studies above, along with experiences from closely managed basins in California, policies from other states, and published works on the subject (Bachman et al. 2005; Sax 2002), suggest many of the required components of effective groundwater management. As a starting point for broader discussions, we provide the following preliminary list of possible actions to improve the management of our groundwater resources:

- Provide broader access to existing groundwater information, including
  - Well logs
  - Pumping information
  - Data from groundwater level and quality monitoring
- Improve and expand monitoring of groundwater levels and quality
- Conduct a systematic evaluation of major groundwater basins to determine sustainable groundwater yield and overdraft status.
- Develop effective plans for establishing and meeting sustainable yields of groundwater basins
- Improve information and processes to ensure consideration of the complete water – incorporating groundwater and surface water – balance in integrated water management and planning
- Strengthen mechanisms for encouraging improved conjunctive management of groundwater and surface water

While the investment required to appropriately assess and track the conditions in our groundwater basins is considerable, the costs are very small in comparison to the value of the water resource stored in those basins. And, we cannot implement truly integrated water management without understanding the status and behavior of our largest water reservoirs, the aquifers that underlie vast areas of the state.

A final, critical point that is often missed in the dialogue surrounding groundwater management is the impacts on ecosystems from poor groundwater management. Even in the limited instances where effective management of groundwater basins has been implemented in California, these plans were implemented long after affected ecosystems were severely degraded. In these situations the management objectives that have been established necessarily focus on halting further degradation of groundwater levels and maintaining the groundwater as a water source for human uses, basically as a storage reservoir for drinking water and agricultural supplies – generally after much of the natural ecosystem function of groundwater has already been sacrificed. We must act before the groundwater-dependent species and habitats are similarly sacrificed across more of California. At a minimum, California should **implement a governance mechanism that incorporates the inescapable link between surface waters and groundwater, and establish groundwater management objectives that protect the special species and habitats that depend on groundwater.**

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