SECTION TWO

CURRENT CONDITIONS

A. Physical Setting, Hydrology, and Geomorphology

Dunne and Leopold (1978) define a watershed as an area of land that drains water, sediment, and dissolved materials to a common outlet at some point along a stream channel. The Santa Ana River watershed, depicted in Figure 2-2, catches stormwater draining a 2,847-square-mile area and channels it into the Pacific Ocean at the City of Huntington Beach. The Santa Ana River, flowing over 100 miles, drains the largest coastal stream system in Southern California including parts of Orange, Riverside, and San Bernardino Counties, as well as a sliver of Los Angeles County. The total length of the River and its major tributaries are about 700 miles.

Much of the movement of materials, energy, and organisms associated with the channel environment and adjoining upland environment depend on the movement of water within the Santa Ana Watershed. To the extent that this movement is altered, so does the potential exist for the system to become "dysfunctional" for species that depend on it for life support. That is, alteration of water movement via damming or channelization can reduce ecosystem functionality. Refer to Figure 2-1, Channel and Floodplain Characteristics Change from Headwaters to Mouth, for an illustration of water and sediment transport throughout a watershed.

Today, only 20 percent of the Santa Ana River is a concrete channel, the majority near the mouth of the River. Discharge from publicly owned treatment works (POTWs) have changed natural surface flows and provides base flow in many parts of the River's drainage network. This treated wastewater has altered the natural system by providing year-round river flow, and, for a number of reasons, many indicators show water quality generally decreases as it travels

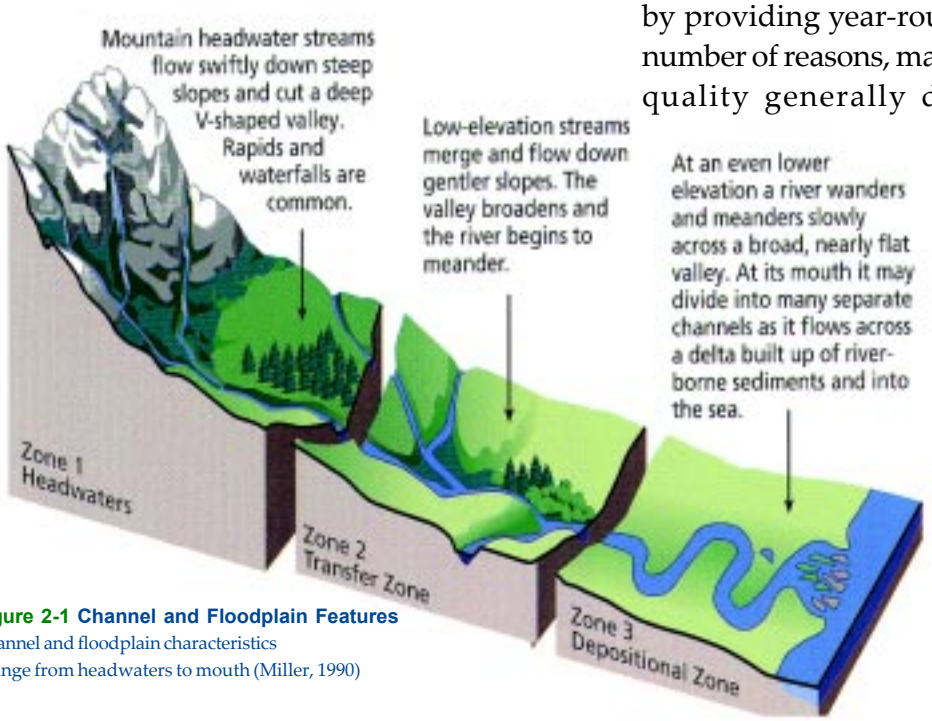


Figure 2-1 Channel and Floodplain Features
Channel and floodplain characteristics change from headwaters to mouth (Miller, 1990)

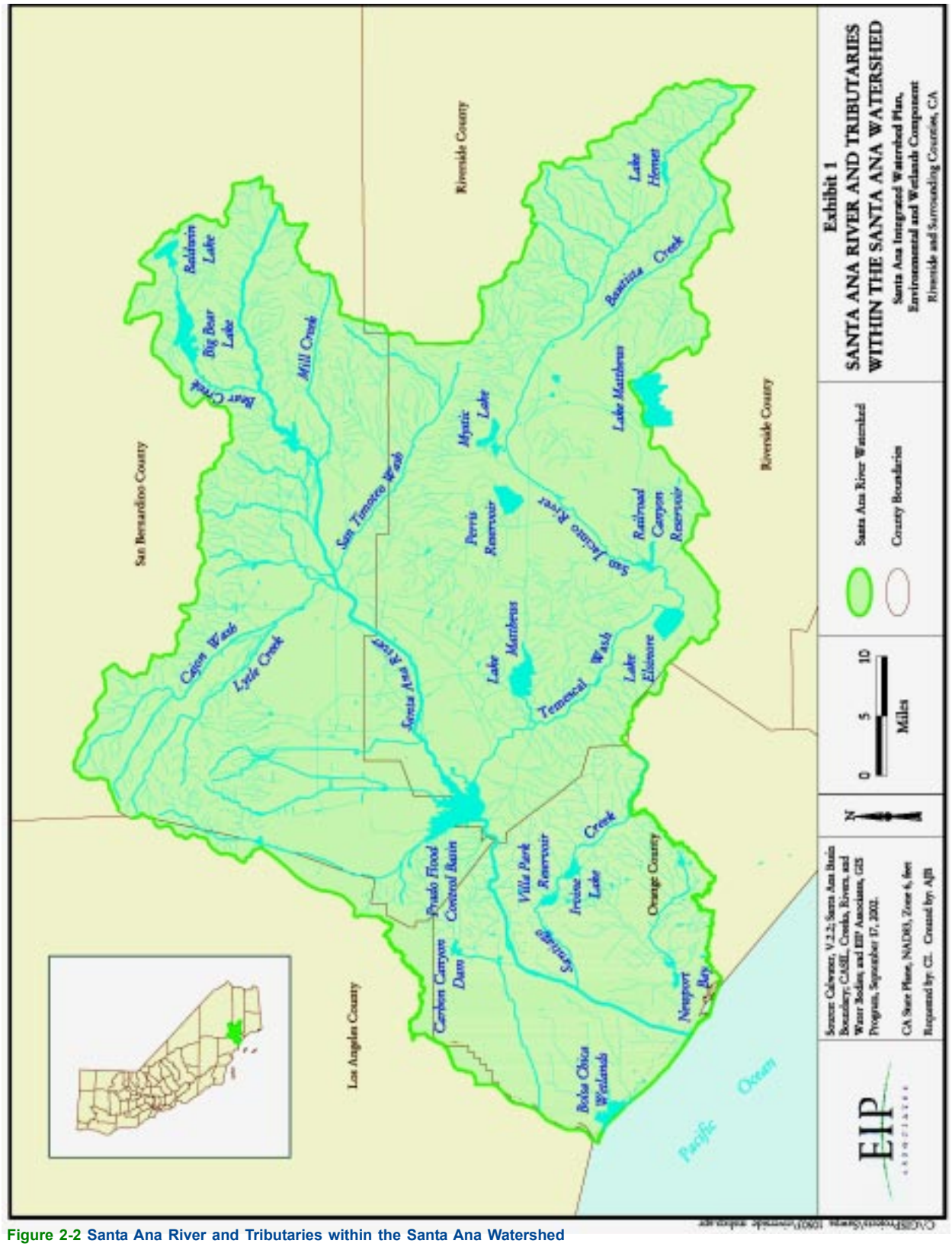


Figure 2-2 Santa Ana River and Tributaries within the Santa Ana Watershed

downstream. As populations have increased, urban runoff and wastewater flows have increased. Between 1970 and 1990, the total average volume rose from less than 50,000 to over 130,000 acre-feet per year, as measured at Prado Dam. Base flow is expected to rise to 230,000 acre-feet per year by 2020, a projected increase of 77 percent since 1990.

Geologic and Hydrologic Features of the Watershed

The upper watershed or headwaters, including the highest point in the drainage system, is delineated by the east-west ridgeline of the San Gabriel and San Bernardino Mountains. Over this ridgeline lies the Mojave Desert, which is part of the Lahontan Basin. This upper "erosion" zone of the watershed has the highest gradient, highest erosion level of new sediment to the system, and fastest stormwater runoff. As flows consist mainly of snowmelt and storm runoff from the undeveloped land in the San Bernardino National Forest, water quality tends to be high, with low concentrations of total dissolved solids, nitrates, and other pollutants. In this zone, the Santa Ana River channel is confined in its lateral movement, contained by the slope of the high, mountainous terrain. Within the upper watershed, the River and its tributaries travel around large boulders and over sand and gravel bars punctuated by pools and riffles reaching depths of about six feet.

Onyx Summit
Photo courtesy of SAWPA

Sedimentary and crystalline materials from the upper watershed move down slope through a process fed by storm pulses; therefore, sediment does not move at a continuous speed. River flow from Seven Oaks Dam to the City of San Bernardino consists mainly of stormflows, flows from the Lower San Timoteo Creek, and groundwater that is rising due to local geological features. From the City of San Bernardino to the City of Riverside, the river flows perennially and much of the reach is operated as a flood control facility. The principal tributary streams in the upper Santa Ana Watershed originate in the San Bernardino and San Gabriel Mountains. These tributaries include San Timoteo, Reche, Mill, Plunge, City, East Twin, Waterman Canyon, Devil Canyon, and Cajon Creeks and University Wash from the San Bernardino Mountains and Lone Pine, Lytle, Day, Cucamonga, Chino, and San Antonio Creeks from the San Gabriel Mountains.

From the City of Riverside to the recharge basins below Imperial Highway, River flow consists of highly treated POTW effluent, urban runoff, irrigation runoff water, imported water applied for groundwater recharge, and groundwater forced to the surface by underground barriers. Near Corona, the River cuts through the Santa Ana Mountains and the Puente-Chino Hills, which together form the northern end of the Peninsular Ranges in Southern California. The River then flows down onto the Orange County coastal plain: the channel lessens in gradient, the valley floor is reached, and the soft features of the channel where sediment has deposited are more prevalent. Floodplains are strewn with boulders and characterized by sand and gravel washes. Within this valley floor, the transport and depositional processes are less confined by higher terrain as water, dissolved material and sediment move toward the sea. Over time, aquatic and terrestrial wildlife have adapted to this dynamic process and channel form (see Figure 2-1). However, rapid urbanization has artificially increased the rate of sedimentation and loss of habitat in this part of the Watershed, negatively affecting water quality and wildlife habitat.

Riverside MWD Crossing
Photo courtesy of SAWPA

In the southern portion of the Watershed, the regional boundary divides the Santa Margarita River drainage area, which is not part of the Santa Ana Watershed, from that of the San Jacinto River. The San Jacinto River, part of the Santa Ana Watershed, starts in the San Jacinto Mountains, runs westerly through Canyon Lake and normally ends in Lake Elsinore. In wet years, the San Jacinto River will overflow the lake and connect with the Santa Ana River. Flood flows produce a broad, shallow wetlands area called Mystic Lake near the northernmost point of the River.

Foreground: Prado Wetlands. Background: Chino Hills State Park.
Photo courtesy of SAWPA.

The Orange County coastal plain is composed of alluvium derived from the mountains. Upstream from the Santa Ana Canyon lay Prado Dam and Prado Wetlands; River flows are passed through the Weltands to improve water quality and remove nitrates before being used for Orange County groundwater basin recharge. Santiago Creek, the only major tributary to the lower Santa Ana River, joins the River in the City of Santa Ana. The lower limit of both the groundwater recharge area and the River's ordinary flows is 17th Street in the City of Santa Ana. Prior to channelization of the lower part of the River, the channel used to meander slowly across broad flood plains. Currently, the River is a concrete channel from 17th Street in the City of Santa Ana to the mouth of the River in Huntington Beach. From 17th Street in Santa Ana to the Victoria Street Bridge, the River is ordinarily dry. The Greenville-Banning Channel, which carries stormwater discharge and urban runoff, is channelized to the Victoria Street Bridge where it joins the Santa Ana River. Discharge from the Greenville-Banning Channel combines with tidal flow from the Pacific Ocean and the River is wet from the Victoria Street Bridge to the mouth of the River.

Groundwater in the watershed is highly controlled by the geology of the area, both the configuration of bedrock and by the extensive faulting. Most groundwater basins are unconfined, much like a bowl full of sand that has water poured in halfway. However, the variable depth to bedrock, and the presence of faults cause pressure zones where water flows towards (or to) the ground surface. In general, groundwater flows the same directions as surface water- from the mountains in the east/north to the Pacific Ocean in the west. There are about 40 groundwater basins in the watershed (depending on how they are defined and boundaries are drawn); many are inter-related.

Some of the largest groundwater basins include the Chino Basin (Chino/Ontario/Fontana area), the Orange County basin, the Bunker Hill Basin (San Bernardino) the San Timoteo Basin (Yucaipa/Banning/Beamont area) and the San Jacinto/Hemet Basins.

The upper Santa Ana River retains much more of its historical character than does the lower part of the River.
Photo courtesy of SAWPA

Four primary faults transverse the watershed, with other minor faults either branching off of, or running parallel to, the major faults. Within the upper watershed, the San Andreas Fault divides the San Bernardino Mountains from the San Gabriel Mountains and branches off into the San Jacinto Fault near San Bernardino. Known as Southern California's most active fault, the San Jacinto Fault affects groundwater in the San Jacinto River and the Santa Ana River, forcing groundwater to the surface at the Bunker Hill Dike. Toward the central watershed, the Elsinore-Whittier Fault passes under the Prado Dam from the northwest to the southeast. Toward the coast, the Newport-Inglewood Fault enters the region from the Los Angeles area and passes offshore near Newport Beach.

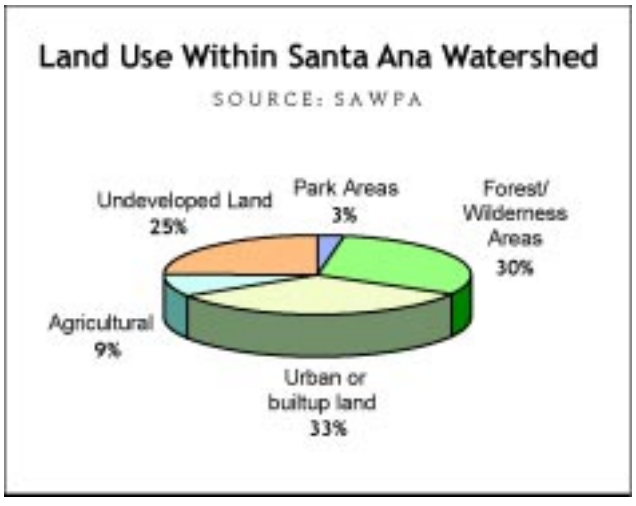
Climate

The climate of the watershed is Mediterranean with hot, dry summers, and cooler, wetter winters. The extent of this climate type is limited worldwide. Other than the central and south coast of California, it only occurs in coastal zones along the Mediterranean Sea, Western and Southern Australia, the Chilean Coast, and the Cape Town region of South Africa. Average annual precipitation ranges from 12 inches per year in the coastal plain, to 18 inches per year in the inland alluvial valleys, reaching 40 inches or more per year in the San Bernardino Mountains. Most of the precipitation occurs between November and March in the form of rain with variable amounts of snow in the higher mountains of the watershed. The climatological cycle of the region results in high surface water flows in the spring and early summer period, followed by typically low flows during the dry season. Winter and spring floods generated by precipitation in the high mountains are not uncommon. Similarly, during the dry season, severe thunderstorms in the high mountains have periodically generated torrential floods in local streams.

Agricultural land, such as the citrus groves shown here, is being replaced by development throughout the watershed.
Photo courtesy of SAWPA

Land Use

The Santa Ana River watershed is substantially urbanized: about 32 percent of the land use is residential, commercial, or industrial. Agricultural land, once accounting for virtually all of the use of the watershed during the days of the *ranchos*, now accounts for a mere 10 percent. Instead of a scattered population of indigenous peoples, the watershed now supports over 5 million people. Refer to Figure 2-3 for a map of Santa Ana Watershed Land Use.



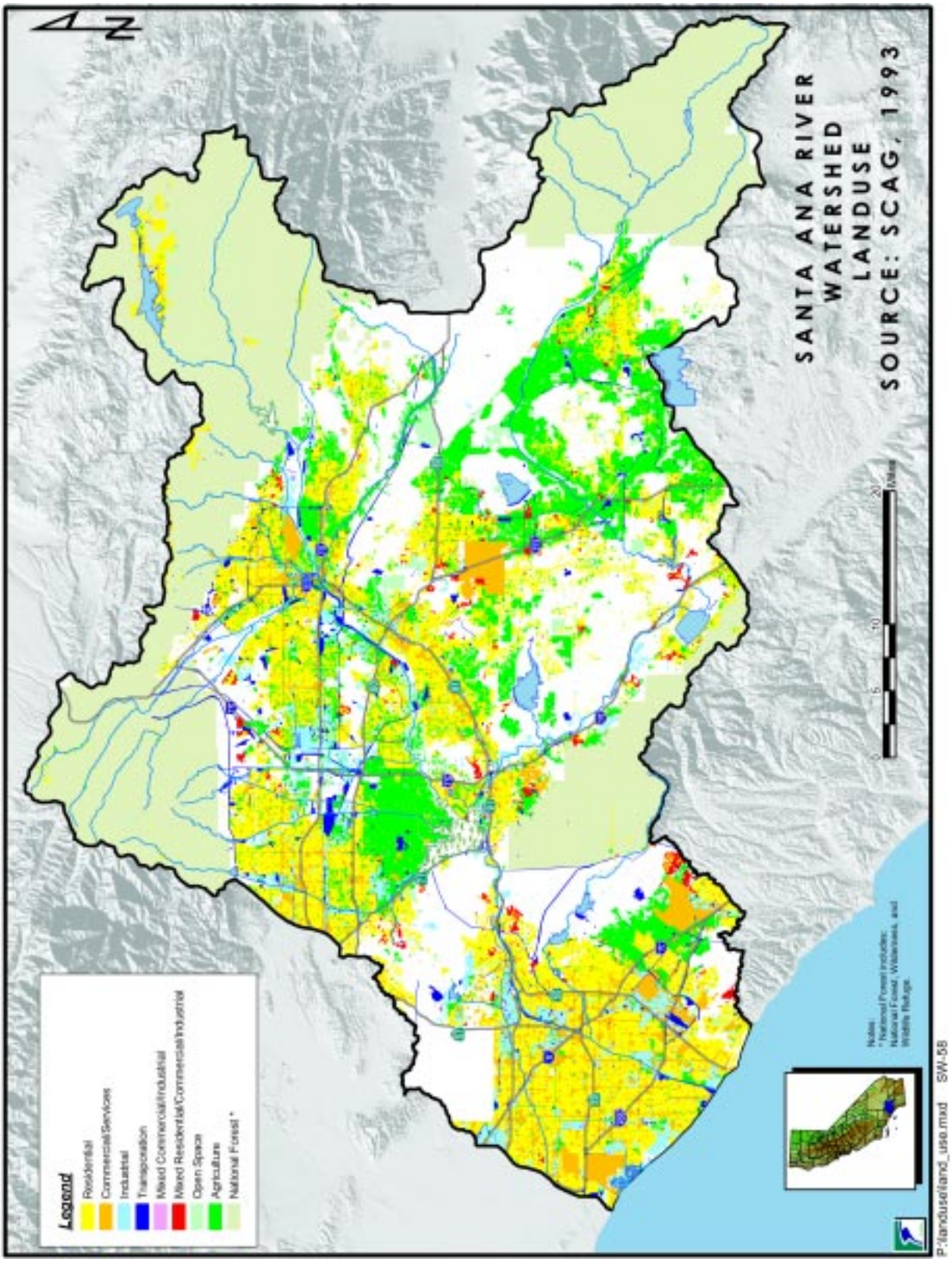


Figure 2-3 Santa Ana River Watershed Landuse

B. Biological Resources

Habitat Modification

As noted by Moyle (2002), most of California's inland waterways today bear little resemblance to the streams and lakes encountered by the first European explorers and settlers. In the Santa Ana River watershed this observation is certainly true. For flood control and channelization activities have left portions of streams channelized and concrete-lined where once riparian forests grew along a meandering stream, although fortunately only 20% of the Santa Ana River is concrete-lined. Dam construction and flood control activities were not the only factors influencing the Santa Ana River watershed in ways that adversely impact habitat critical for aquatic resources. The following factors have also played a role:

- Stream channel alteration
- Draining of streams and lakes, especially adjacent wetlands
- Livestock grazing and the impact on aquatic and riparian vegetation, sedimentation, and water pollution
- Historical logging practices
- Mining, particularly instream aggregate mining
- Watershed changes resulting in cumulative affects to aquatic resources

Historical logging practices have impacted aquatic species habitat. This area is now under the waters of Lake Arrowhead, adjacent to Watershed boundaries in the San Bernardino Mountains.

Special Status Species

Second only to Hawaii, the State of California is home to the highest number of endangered species in the United States. As defined within the Federal Endangered Species Act of 1973, an endangered species is any animal or plant listed by regulation as being in danger of extinction throughout all or a significant portion of its geographical range. A threatened species is any animal or plant that is likely to become endangered within the foreseeable future throughout all or a significant portion of its geographical range. Without a special permit, federal law prohibits the "take" of any individuals or habitat of federally listed species. In addition to federal laws, the State of California has its own California Endangered Species Act, with a separate listing of species and separate laws governing take of listed species. Enforcement of the Federal Endangered Species Act is administered by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service, while the California Department of Fish and Game enforces the California Endangered Species Act. Refer to Figure 2-4 for a map of Critical Habitat within the Watershed.

The Santa Ana Watershed provides habitat for a wide range of biological resources, including the federally endangered Delhi Sands flower-loving fly. *Photo courtesy of the U.S. Fish and Wildlife Service*

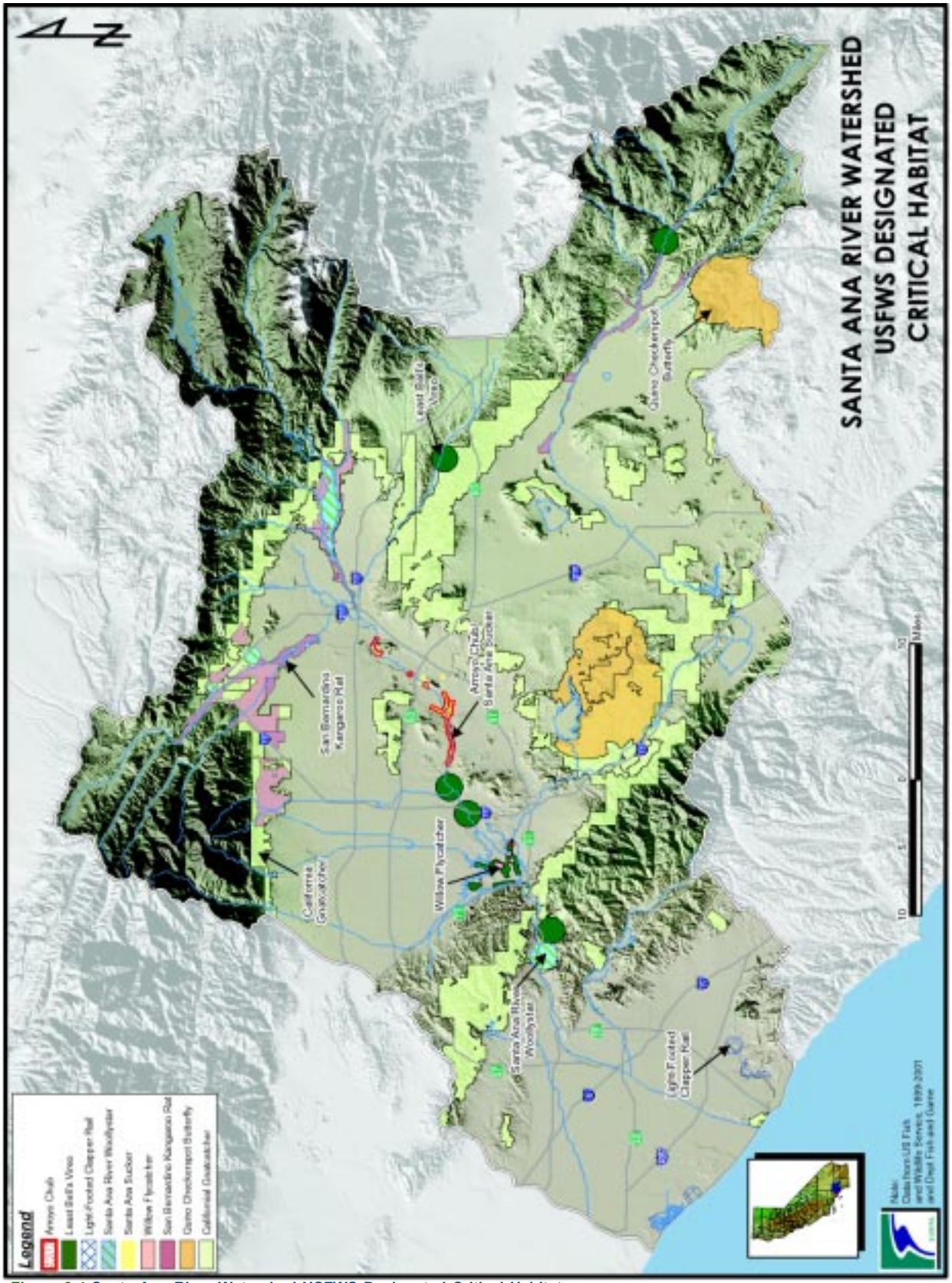


Figure 2-4 Santa Ana River Watershed USFWS Designated Critical Habitat

The varied geography and natural features of the Santa Ana Watershed provide habitat for a number of federally and/or State-listed species. As the Integrated Watershed Plan focuses on the resources in and around the Santa Ana River, listed species of concern herein are those that occupy aquatic, wetland, riparian, or riparian-adjacent areas. Of these, two are plants, the Santa Ana River woolly star (*Eriastrum densifolium*) and slender-horned spine flower (*Dodecahema leptoceras*); one fish, the Santa Ana River sucker (*Catostomus santaanae*); one amphibian, the arroyo toad (*Bufo californicus*); three birds, the least Bell's vireo (*Vireo bellii pusillus*), southwestern willow flycatcher (*Empidonax traillii*), and bald eagle (*Haliaeetus leucocephalus*); two mammals, the San Bernardino kangaroo rat (*Dipodomys merriami parvus*) and Stephen's kangaroo rat (*Dipodomys panamintinus*); and one insect, the Delhi Sands flower-loving fly (*Rhaphiomidas terminatus abdominalis)*. For a full listing of special status species within the Watershed, refer to Appendix F. Any project or policy recommended by the Santa Ana Integrated Watershed Plan will need to assess potential impacts to listed species, and incorporate measures to avoid impacts to these species.

Current Aquatic Resources

Fishes

As described in Section 1B: Historical Context, the Santa Ana River historically provided habitat for eight species of native fish (species have multiple forms). Only four native nongame freshwater fishes are currently found in non-estuarine waters: arroyo chub, Santa Ana speckled dace, Santa Ana sucker, and threespine stickleback. All of these remaining fishes have limited distributions and face possible extirpation. As previously mentioned, the Santa

The Santa Ana sucker is a federally endangered fish native to the Santa Ana River.
Photo courtesy of SAWPA

Ana sucker is listed by the federal government as a "threatened" species pursuant to the Endangered Species Act. Currently, the western brook lamprey, steelhead, and unarmored threespine stickleback are known to be extirpated from the Santa Ana River watershed. The Pacific lamprey has been observed once in the past 47 years and it is likely extirpated as well (refer to Table 1, Appendix G). Introduced forms of the rainbow trout have been extensively stocked in the watershed for sport fishing for over 100 years, and it is unknown if any genetically pure rainbow trout stocks endemic to the watershed remain. The partially armored threespine stickleback was widely planted in the watershed for mosquito control in the early 1900s and is now found out of its natural historical range, e.g., Big Bear Lake.

In contrast, at least 33 fishes have been introduced into the Santa Ana River watershed and are currently present, as shown in Table 2 in Appendix G. Swift *et al*. (1993) notes that many more exotic species of fishes have been introduced, but do not appear to have survived. New species can be expected to be found at any time due to interbasin water transfers, ship ballast water hitchhikers, bait bucket introductions, and hobbyists disposing of unwanted fishes. Many

of the introduced fishes are widespread, while a few are restricted to specific locations or habitats. Of the current inventory of introduced fishes, most were introduced by government agencies to serve as a food resource, for insect control, for sport fishing, or to serve as forage for sport fishes. A smaller number of fish have become established after arriving inadvertently via interbasin water transfers or in ships' ballast water. For a detailed discussion of the introduction of fishes to California, the reader is directed to Dill and Cordone (1997). Additional information about introductions of fishes to Southern California is presented by Swift *et al*. (1993). Supplemental records can be found in Moyle (2002).

Amphibians

During the last 50 years, population growth and urban development in Southern California has displaced many amphibian species, and encroached upon much of former amphibian habitat. Several species are thought to be extinct, and many others have fragmented populations, which are at risk of extirpation. Amphibians are especially sensitive to environmental changes that alter the hydrology, ecology, and geology of a region, because they have evolved highly specialized adaptations that have allowed them to exist in these relatively arid regions. Introduced species have also been a major contributor to the decline in amphibian populations in Southern California. These nonnative species increase competition for food sources, as well as prey upon many of the native amphibians.

Reptiles

The California Department of Fish and Game considers the Southwestern pond turtle *(Clemmys marmorata)* a species of "special concern." Recent reports on *C. marmorata* in Southern California indicate that a few viable populations remain in the regions (see also Brattstrom 1988). Approximately 6–8 viable populations of the turtle remain south of the Santa Clara River system in California. Four years of drought (1986–90) have exacerbated the negative effects of habitat alteration accumulated over many years over much of this region from changes in land and water use, and abusive grazing practices. In particular, most western pond turtle populations examined in this region appear to show an age structure increasingly biased towards adults, indicating little or no recruitment is taking place. Recent surveys indicate that the southwestern pond turtle is also seriously threatened throughout most of its range outside of California.

Birds

Riparian ecosystems harbor the highest number of bird species in the arid and semi-arid parts of the southwestern United States. Riparian habitat provides productive breeding grounds and offers vital overwintering and migration stopover areas for migrating birds. Loss and degradation of riparian habitat have negatively impacted bird populations throughout the watershed. Other factors affecting bird populations are brood parasitism by the brown-headed cowbird and disruption of natural hydrological regimes from dams and levees.

Least Bell's vireo, a federally listed riparian bird species
Photo courtesy of the Inland Empire Chapter of AEP.

Wetland areas, such as the Bolsa Chica Ecological Reserve Park shown here, provide vital habitat for migrating birds.
Photo courtesy of EIP Associates.

The federally endangered least Bell's vireo has experienced recent population growth within the watershed due to aggressive management activities within Prado Basin and on adjacent lands. Within the basin, the population rose from 19 pairs in 1986 to 123 pairs in 1993. By the end of 1996, the count stood at 195 nesting pairs. This stunning recovery is due to the provision of high-quality habitat for the bird species in part due to invasive species removal, a project in place to control populations of the predatory cowbird, and efforts on the part of the U.S. Fish and Wildlife Service, Orange County Water District, a number of Resource Conservation Districts (RCDs), and others.

The federally endangered southwestern willow flycatcher is also affected by cowbird brood parasitism. The implementation of cowbird management programs in addition to preservation and restoration of riparian deciduous shrub habitat is needed to reduce current populations. The bald eagle, listed by the USFWS as endangered in 1978 has experienced population growth over the past two decades. The bald eagle could be considered a USFWS success story: reclassified as "threatened" in 1995 and proposed for delisting in 2000. Delisting of a species is the USFWS's ultimate goal and only happens when specific recovery goals have been met for a species. Unfortunately, delisting is an infrequent occurrence. In the case of the bald eagle, delisting has been delayed while the USFWS determines how the species would be managed once it is no longer classified as threatened.

Factors Affecting Aquatic Resources

Introduced Species

The 33 species of introduced fishes greatly outnumber the four remaining native fish species. The number of species, per se, is not the problem but, rather, the impact that introduced fishes and other aquatic organisms, have on the native fishes of the Santa Ana River watershed. Introduced fishes have dramatically changed the composition of the watershed's fish community and now act as a deterrent to the restoration and enhancement of the native fishes that remain. The manner in which introduced fishes can affect the aquatic resources of the Santa Ana River watershed are

- Competition between native and introduced fishes for food and space
- Predation by introduced species on native fishes
- Habitat interference by introduced fishes that change habitat characteristics
- Introduction of disease that may infect native fish or other aquatic animals
- Hybridization between closely related species

Water Pollution

Fortunately, water quality in the Santa Ana River has improved in recent years due to technological developments and water quality planning. Most of the native fishes of the Santa Ana River watershed are adapted to clear, unpolluted water that can support food resources and provide the various habitat conditions necessary to complete their respective life cycles. While fish kills due to the spill of toxic substances into streams are dramatic examples of the effects of pollution, these instances are acute, or short-term, rather than chronic. More insidious, however, are the chronic effects on aquatic resources of nonlethal forms of pollution that decrease growth, inhibit reproduction, or impair movement. Chronic elevated water temperatures or high sediment loads are an example of this type of pollution, even though toxic chemicals are not involved. Other examples include elevated but nontoxic levels of ammonia, increases in salinity, and low levels of dissolved oxygen. Because most of the remaining native freshwater fishes live, at some time, in treated wastewater, the issue of chronic, low-level pollution is of great concern, although the quality of wastewater has increased markedly in past years.

Fish native to the Santa Ana River are adapted to clear, unpolluted water.
Photo courtesy of EIP Associates

Exploitation

Overexploitation of rainbow trout/steelhead, primarily by angling, was a major factor in driving the native populations to low levels, and perhaps to extinction. Over-fishing, in turn, led to the stocking of hatchery fish and the introduction of various exotic species as angling alternatives to the native trout. The intensity of overexploitation is illustrated by a report in the July 17, 1892, edition of the *Citrograph*, a Redlands newspaper, which reported that three boys fishing in Bear Creek, a tributary to the Santa Ana River in San Bernardino County, had caught 592 trout in three hours. Similar reports are common in the historical press.

It was not until 1872 that the California Legislature banned the use of nets, weirs, baskets, traps, explosives, and poisons as acceptable means of harvesting trout. Unfortunately, there was no one to enforce the statute, nor was there any limit on the number of fish that could be harvested by legal means. The overexploitation of trout became such a problem in the watershed that in 1894 San Bernardino County, on its own authority, finally took action and limited the number of trout a person could catch to 50 per day. The State of California did not take similar action until 1905, when the harvest was limited to 50 trout per day and 25 total pounds. By then, the native stocks had already become depleted in the Santa Ana River watershed.

Each of the aforementioned factors have acted in concert over a long period of time to reduce the native fish community of the Santa Ana River watershed to that which remains today. The Santa Ana River Watershed Plan recognizes that history cannot be undone and the aquatic community cannot be restored to its pre-settlement condition; however, a conservation

strategy can be implemented that will ensure the long-term viability of the watershed's aquatic communities

C. Open Space and Recreation

The Santa Ana Watershed possesses a wealth of natural resources affording numerous outdoor recreational opportunities. On a given day, it is possible to snowboard Big Bear in the morning and surf the "Wedge" in Newport Beach in the afternoon without leaving the Watershed. Varied terrain and a mild climate combine to create the perfect backdrop for outdoor recreation possibilities.

Parkland Ratios

Within the Watershed, parkland totals 75 square miles (48,000 acres) of the Watershed while forest/wilderness areas total 850 square miles. Undeveloped land, while technically open space but not included in open-space calculations, totals 687 square miles. Refer to Figure 2-5 for a map of current open space, based on 1993 Southern California Association of Governments land use information.

The U.S. Department of Housing and Urban Development (HUD) recommends 2.5 acres of parkland for every 1,000 residents, although many consider this ratio to be low. Overall, the Watershed residents experience a ratio of 100 acres of parkland to every 1,000 residents. Two facts make it difficult to compare this number to HUD recommendations. First, HUD recommendations are for urbanized areas, and much of the Watershed is not urbanized. With such a large land area, disparities exist between the ratio of parkland to residents and the accessibility of parkland to residents. That is,

RECREATIONAL OPPORTUNITIES: EXAMPLES

Throughout Watershed

- Parks (active and passive uses)
- Fishing
- Hiking
- Biking
- Horseback Riding
- Bird Watching
- Nature Observation
- Hunting

Big Bear

- Snow Riding
- Snowboarding
- Ice Skating
- Sledding
- Fishing

Pacific Ocean/Coastal Orange County

- Fishing
- Surfing
- Boogie-Boarding
- Sailing
- Boating

Lake Elsinore

- Water-Skiing
- Jet-Skiing
- Boating

Other Lakes and Reservoirs

- Big Bear Lake
- Lake Perris
- Lake Matthews

The upper Santa Ana Watershed provides winter recreational activities, such as sledding (shown here near Crestline).
Photo courtesy of EIP Associates.

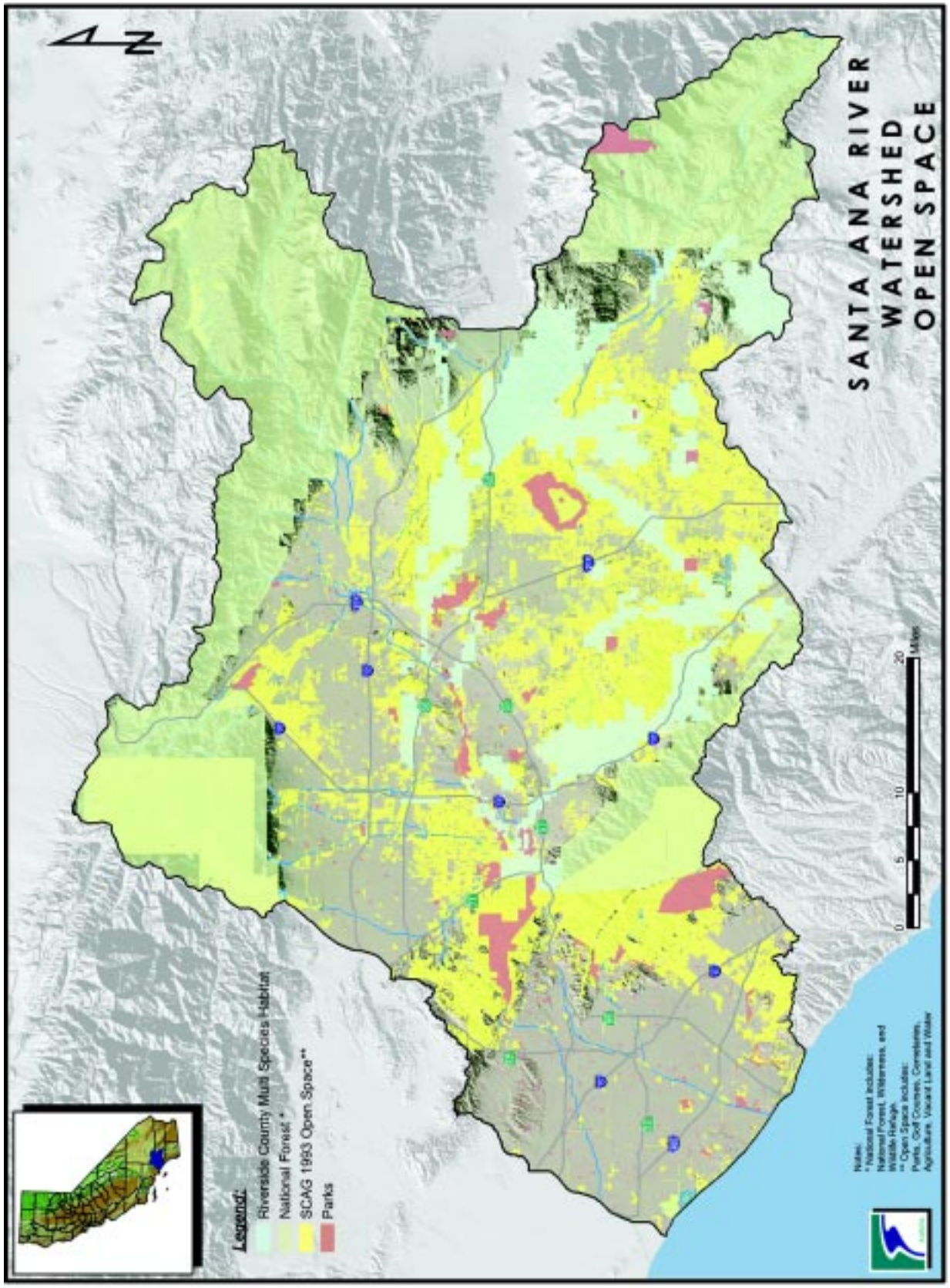


Figure 2-5 Santa Ana River Watershed Open Space

not all watershed residents have access to 0.1 acre of parkland. The second fact that makes comparison difficult is that forest/wilderness lands are not taken into account in this calculation.

Public Access

An important aspect of preserving recreational opportunities is to ensure access to local waterways. The Watershed's rivers, streams, lakes, and beaches are heavily used by watershed residents and visitors. A visit to the Santa Ana River near Van Buren Bridge on a summer afternoon reveals dozens of families picnicking, wading, and swimming in the River, although swimming in the River is not necessarily recommended. Beach access is mandated by the Federal Coastal Zone Management Act, and is a primary mandate of the California Coastal Commission. However, access to lakes and rivers is not given as much attention as beach access, and in some cases, river access is prohibited due to water quality issues. Lake and river access should be monitored as the Watershed continues to urbanize to ensure that homes and commercial development dedicate lateral easements for public access to Watershed resources.

Lake Elsinore provides recreational opportunities, such as swimming, boating, and picnicking.
Photo courtesy of EIP Associates

Forest Land

The Santa Ana Watershed is fortunate to include two national forests: San Bernardino National Forest and Cleveland National Forest. The San Bernardino National Forest includes the wilderness areas of Cucamonga, San Jacinto, San Gorgonio, and Santa Rosa. The National Forests, managed by the U.S. Department of Agriculture, provide recreational opportunities for watershed residents and visitors, such as hiking, camping, and mountain biking. The Santa Ana River headwaters are in the San Bernardino National Forest. Since most of this land is undeveloped, the high water quality at the headwaters of the River provides high-quality habitat for native wildlife.

Santa Ana River Trail

Many recreational efforts are focused on the Santa Ana River Trail, an important regional recreational element. First conceived over a century ago and formally proposed in 1955, the Santa Ana River Trail is a much-anticipated project with watershed-wide support. Within the Santa Ana Watershed, no other issue seems to spark as much enthusiasm or inspire as much collaboration between diverse interests as trail planning. Trails are viewed as valuable resources—providing connectivity, transportation alternatives, scenic relief to urban dwellers, recreational activities, and linear parkways with opportunities for environmental restoration as well as education. Opportunities for multi-benefit projects that incorporate trail planning, open space acquisition, wetlands/habitat enhancement, and educational/interpretive components are desirable.

More equestrian connections to the riverbed are needed, such as this one near Anza Narrows Park in Riverside.
Photo courtesy of EIP Associates

Watershed planning participants agree that the trail should provide access for a wide variety of users, including walkers, hikers, joggers, bicyclists, horseback riders, users in wheelchairs, rollerbladers, and skateboarders. Some of these users require special features, such as wheelchair access or equestrian staging areas.

The Santa Ana River Trail provides a Class I Bikeway along the river for 40 miles, with further segments planned.
Photo courtesy of EIP Associates

While the 110-mile trail is far from complete, several segments totaling approximately 40 miles have been constructed. Plans are almost complete for the remaining 70 miles (as well as a number of feeder trails and connections), and full funding has been secured for some segments. Refer to Figure 3-3 for a map of the current status of the Santa Ana River Trail, including planned segments. One goal of the Santa Ana Integrated Watershed Plan is to assist in securing funds for those trail segments that have not yet received funding. For more information on the Santa Ana River Trail, refer to Section 3A-3.

Proposed site of Santa Ana River Trail in San Bernardino County.
Photo courtesy of EIP Associates.

Challenges and Opportunities

The Santa Ana Watershed is rapidly urbanizing; Lindell Marsh of the Santa Ana River Watershed Group (SARWG) refers to the region as the "urbanizing tier of Los Angeles." As more and more land is developed for homes and commercial enterprises, ratios of parkland to residents become more difficult to maintain. First, there is the direct challenge of maintaining parkland ratios while the number of people increases. Second, planners face an indirect economic challenge: urbanization tends to drive up land prices, making land preservation cost-prohibitive. Watershed wide, cities and counties should consider the issue of retaining the ratio of 100 acres of parkland for every 1,000 residents. This requires a commitment from park planners and other City and County staff, developers, and nonprofit organizations to maintain or improve current open space ratios, even as populations burgeon. In addition, urban and park planners should work to ensure access to waterways including lakes, streams, rivers, and the ocean.

Several opportunities exist within the Santa Ana Watershed to expand recreational opportunities. Many of these are either in project development stage or currently underway. Notable examples of these projects include the following.

San Timoteo State Park—This undertaking of the Riverside Lands Conservancy among others would involve the creation of a new State park centered in San Timoteo Creek Watershed. In addition to other restoration activities in the area will increase water quality in San Timoteo Canyon and subsequently the Bunker Hill Basins, a major source of drinking water. The park will provide a number of linkages with other habitat areas in Riverside County, as well as reestablishing, creating, restoring, and protecting wetlands in the floodplains of the canyon and its major tributaries from Loma Linda to I-10.

Orange Coast River Park—The Friends of Harbors, Beaches, and Parks, with cooperation from many partners, including local cities, Orange County nonprofit organizations, and private entities, have proposed a large park at the mouth of the Santa Ana River. The Orange Coast River Park would link several existing parks, incorporating ponds, boardwalks, and restoration. The project's vision is broadening to include Banning Ranch, which could potentially increase the Park from 1,000 to 1,400 acres. Implementation of this project will involve coordination with many agencies, such as the Orange County Sanitation District.

Santiago Creek Parks—Restoration efforts have been underway in and along Santiago Creek, the Santa Ana River's major tributary in the lower watershed. Local cities and organizations are acquiring land to add new parks along the Creek. These parks would provide recreational and educational benefits, in addition to habitat and water quality benefits. The City of Orange has recently acquired land including eight acres within the Santiago Creek just north of Chapman. This land will be included in the 42-acre Grijalva Park at Santiago Creek. The City also owns Yorba Park that borders the Santiago Creek just south of Chapman Avenue and Hart Park, which includes several acres of unimproved land in the creek. The County of Orange and City of Santa Ana contribute additional park acreage upstream and downstream from the City of Orange. These three agencies, along with the City of Villa Park, are working to connect these parks with a contiguous recreational trail system.

The future site of the Orange Coast River Park is the south side of the Santa Ana River mouth .
Photo courtesy of SAWPA

Chino Creek Park—The Inland Empire Utilities Agency, Orange County Water District, and the Wildlands Conservancy are developing an integrated recreational plan that will link Prado Basin with the Santa Ana River Trail System providing habitat, recreational and educational opportunities. There will be an educational center at Chino Creek Park and a nursery designed specifically to grow native plants for restoration projects. A Prado Basin interpretative

center and youth camp for inner-city children will be developed where currently a gun club is located. This project utilizes a wide-angle integrated planning approach to integrate habitat protection and recreational opportunities for the trail system in the Prado Basin.

D. Water Supply

Groundwater supplies meet most of the direct water demand in the basin, providing 68 percent of the consumptive water needs. Groundwater comes from the inland and coastal aquifers in the region, which range from a few hundred to over one thousand feet in thickness. Inland aquifers, upstream from Prado Dam, underlie about 1,200 square miles of the Watershed, while coastal aquifers downstream from Prado Dam underlie about 400 square miles. Imported water from Northern California and the Colorado River provides about 23 percent of consumptive water demand. Other sources of supply include surface water derived from precipitation within the basin (5 percent) and recycled water (4 percent). Future water supply projections indicate a shift from reliance on groundwater and imported water to increases use of recycled and surface water (refer to Figure 2-6). The amount of groundwater recharged to the Watershed's aquifers is only 37 percent of the volume pumped. Given the imbalance between water pumped and water recharged, it should not be surprising that, under such intense settlement pressures and water demands, the native aquatic community of the Watershed has been significantly impacted. Future water supply planning includes increased groundwater recharge and measures to reduce impacts to native aquatic communities, while meeting increased water demands due to regional population growth.

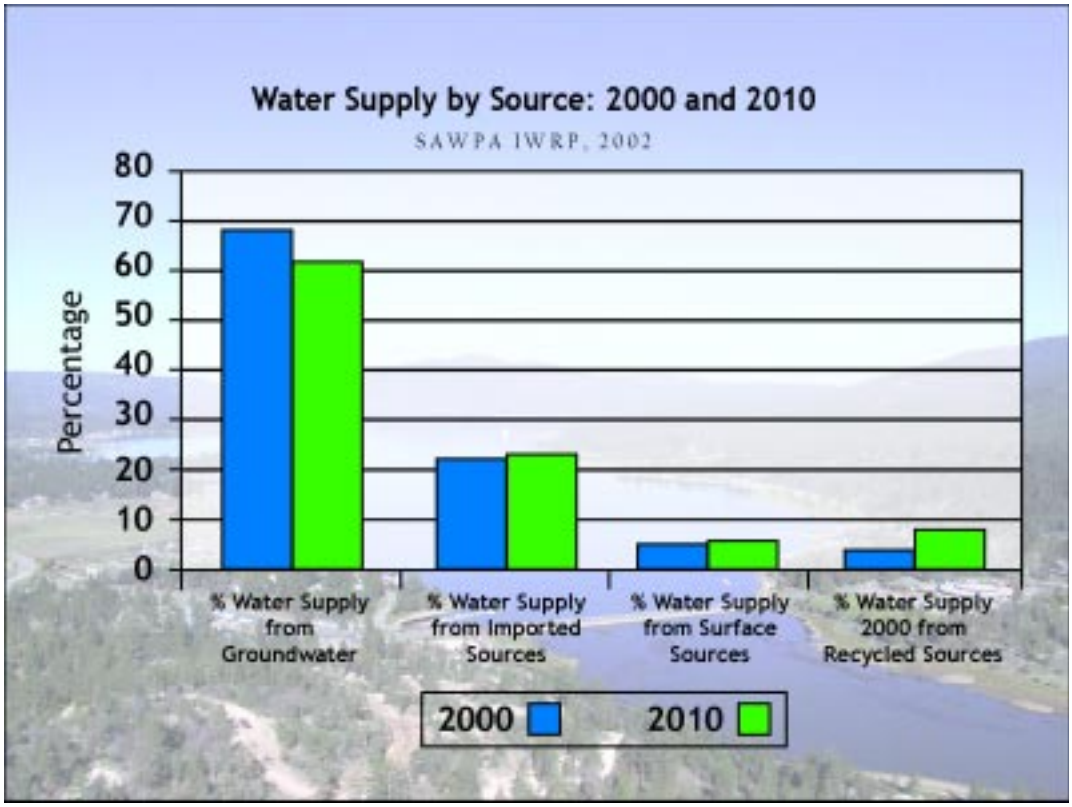


Figure 2-6 Water Supply by Source

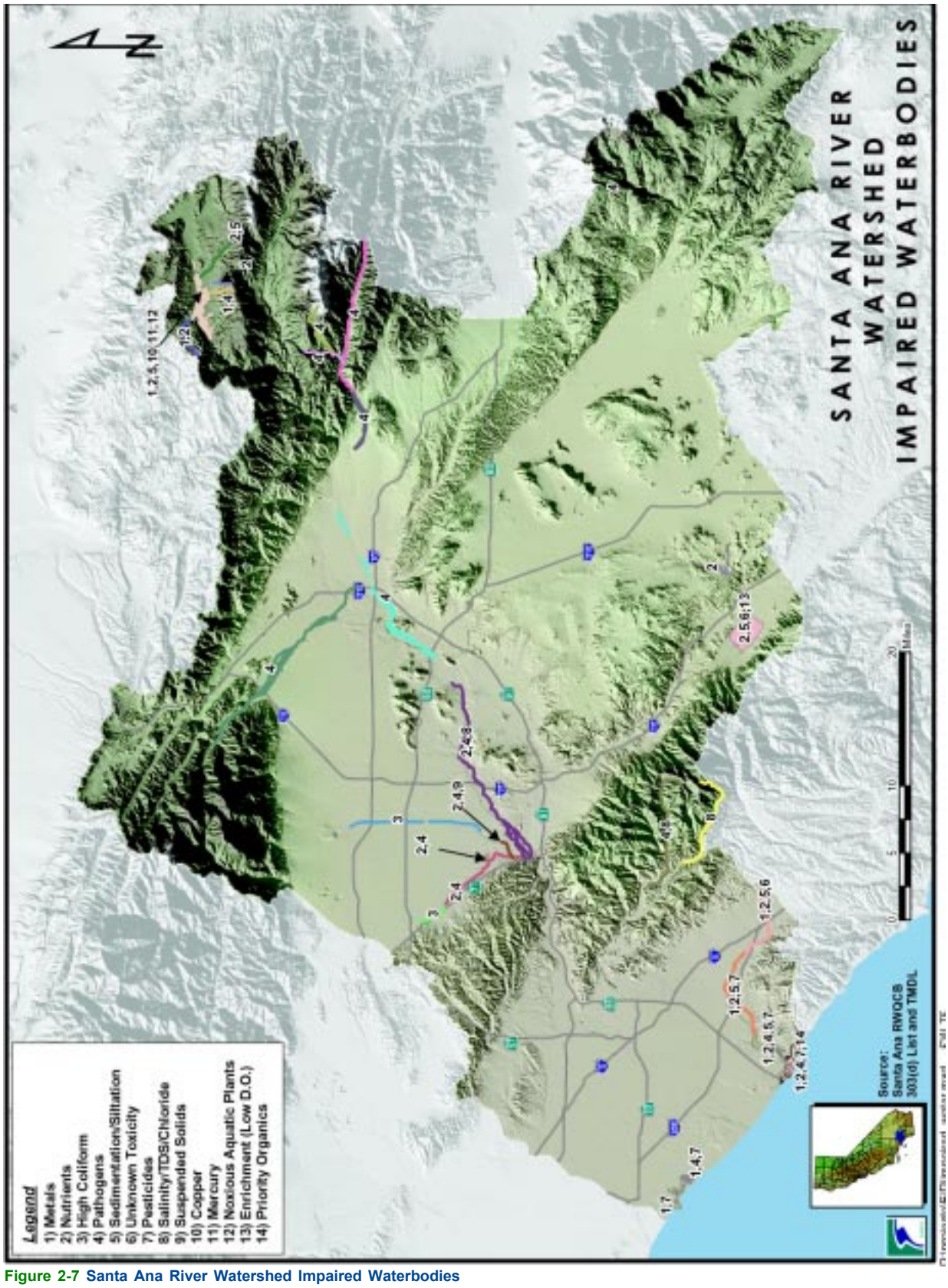


Figure 2-7 Santa Ana River Watershed Impaired Waterbodies

E. Water Quality

Almost a century of agricultural and industrial land use has resulted in salts and other pollutants infiltrating many aquifers and streams within the Santa Ana Watershed. These sources of water quality degradation can be classified into point and nonpoint sources. Point sources are confined to point discharges to the soil, groundwater, or stream systems. Examples include conventional wastewater and industrial discharges to streams or ponds, and leaky underground storage tanks. Nonpoint sources are areawide discharges to soil, groundwater, and surface waters, such as land application of waste and fertilizers, and atmospheric deposition of contaminants to the soil and water bodies. Point sources can be traced back to a single source, such as the end of a pipe, while nonpoint sources can rarely be traced back to an individual origin, and require regional solutions, including regionwide behavioral changes, to reduce pollutants.

Within the Santa Ana Watershed, water quality is generally high in the headwaters and upper watershed, lessening as the distance from the Pacific Ocean decreases. The California Water Resources Control Board and its regional offices (RWQCB) are responsible for enforcing water quality standards within the state. As mandated by Section 303(d) of the Federal Clean Water Act, the RWQCB maintains and updates a list of "impaired waterbodies" that exceed State and federal water quality standards. These impaired waterbodies are shown for the Santa Ana Region in Figure 2-7. Within the upper Santa Ana Watershed, including the Santa Ana River and Lytle Creek, pathogens from unknown nonpoint sources are the primary pollutants. Due to urban development and agricultural operations, pathogens from dairies and other nonpoint sources are joined above Prado Dam by high coliform counts, elevated nutrient levels (especially nitrates), suspended solids, and high salinity. In coastal areas, common pollutants include metals from urban runoff and boatyards, pathogens from urban runoff and storm sewers, nutrients from agriculture and urban runoff, and pesticides from agriculture, contaminated sediments, and other unknown nonpoint sources.

As the Santa Ana Watershed continues to grow, cities encroach ever closer to dairies and other agricultural operations. To counter this added stress to the surface and groundwater supplies, dairy producers and water agencies are working together to develop advanced methods of reducing the dairies' impacts to water quality. Technologically advanced wastewater control techniques have been rigorously employed and negative impacts from agricultural runoff continue to be minimized. In fact, the Santa Ana Watershed is considered to be a world leader with respect to implementation of innovative technology to improve water quality and manage organics from the dairies.

Located in the center of the Santa Ana Watershed, the Chino Basin is home the highest concentration of dairy cows in the world.
Photo courtesy of SAWPA

For example, Orange County Water District and Orange County Sanitation District state-of-the-art Groundwater Replenishment System would purify for reuse 65,000 acre-feet per year of wastewater that is currently discharged into the ocean. Using water treatment methods including microfiltration, reverse osmosis, and UV disinfection, secondarily treated wastewater from the Sanitation District's sewage treatment plant will be purified to levels that far exceed drinking water standards. The water will then be stored in the Orange County Groundwater Basin either by injection along the coast or by percolation in ponds near the Santa Ana River. The underground basin provides 75 percent of the water used by north and central Orange County cities.

The Chino Basin Dairy Program and Organics Management Center is an example of world-class technology where a closed loop waste management system tackles agricultural waste, produces energy, and provides high-quality fertilizer products. Nevertheless, the existing salts and contaminants present in the watershed and adjacent groundwater basins from past practices still need to be removed, as improving water quality is inextricably linked to improving water supplies and implementing a comprehensive groundwater storage program. As regional water leaders seek to develop further groundwater storage in the Santa Ana Watershed, steps must be taken to pump contaminated water from underground, purify the water, and perform groundwater recharge with the purified water.

The Santa Ana Regional Interceptor (SARI) is a waste pipeline designed to convey 30 million gallons daily (MGD) of nonreclaimable wastewater from the upper Santa Ana River basin to the ocean for disposal, after treatment. To date over 55 miles of the SARI line have been completed. The upstream extension, completed in 1995, is to the City of San Bernardino Wastewater Treatment Plant. An extension of the SARI line southerly from Corona through the Temescal Canyon to the Lake Elsinore area was recently completed.

It is estimated that the Santa Ana Watershed will require 59 more desalters, such as the Chino I Desalter shown above, to resolve the region's salt imbalance. *Photo courtesy of SAWPA.*

The Santa Ana Watershed's potential for groundwater banking is substantial, but the volume of clean water that can be stored is commensurate with the amount of salty water that can be removed, and the process of pumping and desalting the old resource will take time. Before the task can be undertaken, the necessary infrastructure must be constructed. Two desalters are already operational in the Arlington and Chino areas and are processing 14 MGD. The current Chino Desalter is undergoing expansion, and a second Chino Desalter will be built soon. In addition, the Temescal Desalter, serving the City of Corona, has a capacity of 10 MGD and will be expanding

to 15 MGD. There are numerous additional desalters that will be installed as part of the SAWPA program and when these are fully operational the basin's cumulative production of purified water from these facilities will be 95 MGD.

SAWPA estimates that the Chino Basin will need many more desalters to solve the salt contamination problem, and will actively seek funding and planning for these additional desalters in the coming years. Some other components relating to the transportation of desalted water, including 22 miles of pipeline and 10 pumping stations will also need to be installed in order to get the usable resources to the entities that can best use them.

Watershed residents cool off in the Santa Ana River on a hot summer afternoon, despite the fact that river flow consists almost entirely of effluent in this area. *Photo courtesy of EIP Associates.*

One of the most challenging problems associated with maximizing the use of local water resources in the basin will continue to be addressing water quality elements that exceed public health or public acceptance standards, such as a high level of pathogens. The water quality problems can be addressed by a variety of strategies including wellhead treatment, blending, dilution or flushing, or even by natural processes such as native or treatment wetlands. Wellhead treatment can include a variety of approaches including desalination, anion exchange, and carbon absorption to name a few. In many cases, multiple contaminants can be addressed through a single-treatment strategy.

F. Flood Control

Many of the Santa Ana's tributaries are what Australians would call billabongs and North Africans and Middle Easterners would call wadis—dry riverbeds that only hold water during the rainy season. These riverbeds are completely parched throughout most of the year, but can quickly become raging torrents. The Santa Ana Basin is an arid environment and even qualifies as a desert in many areas. But the Watershed's close proximity to both the ocean and the mountains at times brings heavy storms, which are problematic from a flood control standpoint. Historically, efforts to deal with flooding in the region focused on damage control to reduce the threat of floodwaters damaging properties. As the area became urbanized, city planners simply channeled the periodic deluges into the ocean. Urban Southern California's concrete-lined creeks and rivers are a legacy to this way of thinking. While effective at preventing flooding, flood control channels that are concrete-lined or absent of riparian vegetation provide little benefit in the way of groundwater recharge, wildlife habitat, or water quality improvements. Additionally, these flood control channels are considered an eyesore and a potential danger by local homeowners. Fortunately, 80 percent of the Santa Ana River is

not a concrete channel. As explained in Section 1C, plans to channelize the entire riverbed were thwarted by forward thinking conservationists in the 1960s and 1970s. In urbanizing Southern California, efforts to control flooding must be balanced by water supply needs, habitat protection, and human enjoyment of wetland and riparian areas.

Historical flooding, as shown here on River Lane in the City of Santa Ana, has caused considerable damage-- costing human lives, property, and agricultural productivity. *Photo courtesy of the Santa Ana Historical Preservation Society (year of photo unknown, but presumed to be 1938 during the great flood).*

Flood protection agencies, including the U.S. Army Corps of Engineers and local flood control districts, are charged with the task of ensuring that floodwaters do not endanger life and property. It is evident that floodwaters can be physically devastating to homes, farms, and wetlands. Although wetlands are frequently inundated under natural conditions, major flooding events can damage wetlands by causing massive sedimentation, substrate disturbance, and periods of inundation that last substantially longer than many wetlands are capable of withstanding. Floods in agricultural and industrial regions also elevate the potential for hazardous discharges into the Santa Ana River and its tributaries. However, given the new era of groundwater storage, it is no longer recognized as advantageous to move floodwaters through an area as quickly as possible. Instead, filtering stormwater runoff through constructed wetlands or native riparian habitat provides both groundwater recharge possibilities and habitat opportunities. See Section 3A-1 for more information on constructed wetlands.

Flood control agencies have adopted a more holistic approach to curbing flooding issues while caring for the environment. In fact, flood control agencies throughout California and North America are undergoing a paradigm shift with respect to structural flood control. Although some areas are still paving their channels, communities such as Berkeley and Santa Barbara are ripping out concrete and restoring streams to their natural flow. The most radical example of this type of restoration is "daylighting," which

Approximately 20 percent of the Santa Ana River is channelized for flood protection. Most of this channelization is in Orange County, as shown here. *Photo courtesy of EIP Assoicates*

involves the deliberate exposure of a previously covered river, creek, or stormwater drainage. The Santa Ana Watershed has not seen any daylighting to date, but several excellent restoration opportunities are in the conceptual stage, including projects in Chino Creek and Santiago Creek. The portion of the Santa Ana River that is a concrete channel is relatively small when compared to other Southern California rivers. However, the channelized portion provides opportunities for the River to improve both flood control and its own aesthetic interest, while providing habitat and recreational benefits to watershed residents.

Major flood control facilities on the Santa Ana River include the Prado Dam and the Seven Oaks Dam. The Prado Dam, located near the intersection of Orange, Riverside, and San Bernardino Counties, was constructed in reaction to the Flood of 1938 and completed in 1941. Prado Dam is a key component for increasing local water supplies in Orange County. In the past, storm flows from the Santa Ana River have been lost to the ocean because flood control took precedence over water conservation. However, a series of agreements among the Orange County Water District, the U.S. Army Corps of Engineers, and the U.S. Fish and Wildlife Service have allowed the District to conserve water behind the dam in a seasonal storage pool. The Seven Oaks Dam, located upstream of the City of San Bernardino, was completed in 1999 against some opposition from environmental groups and with accolades from the engineering community. The Dam, constructed in reaction to both the 1938 flood and the later Santa Ana River flood in 1969, was selected as one of six merit finalists for the American Society of Civil Engineers 2002 Outstanding Civil Engineering Achievement Award due to its flood protection capacity. The Seven Oaks Dam is the largest dam in the country built strictly for flood control, and will save Watershed property owners millions of dollars in flood insurance premiums. For more information on planned and future Santa Ana Watershed flood control projects, please refer to the Integrated Water Resources Plan, published by SAWPA in 2002.

The Seven Oaks Dam, completed in 1999, works in conjunction with Prado Dam to provide flood protection for the Watershed.
Photo courtesy of SAWPA.

G. Watershed Demographics and Growth Pressure Impacts

This section presents population forecasts for the Santa Ana Watershed region with a planning horizon of 2050. In addition, information on per capita income for watershed households and current population density is briefly presented. Refer to Figure 2-8 for a map of watershed income by census tract, based on 1999 incomes as collected by the U.S. Census Bureau in 2000. Figure 2-9 presents a map of population density throughout the Watershed. Currently, watershed residents are concentrated in Orange County, with smaller population centers around the City of Riverside, City of San Bernardino, and San Bernardino–Los Angeles County border.

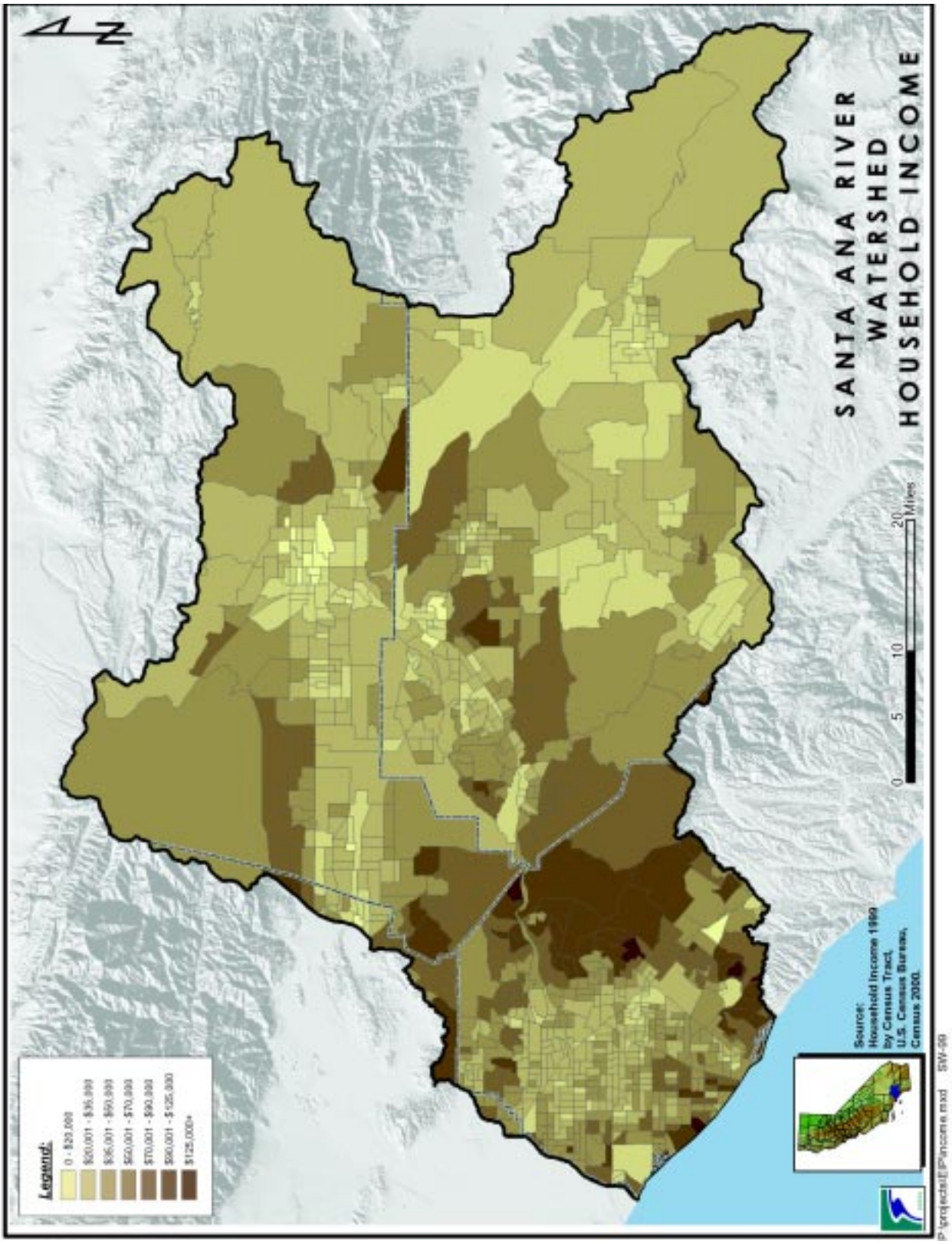


Figure 2-8 Santa Ana River Watershed Household Income

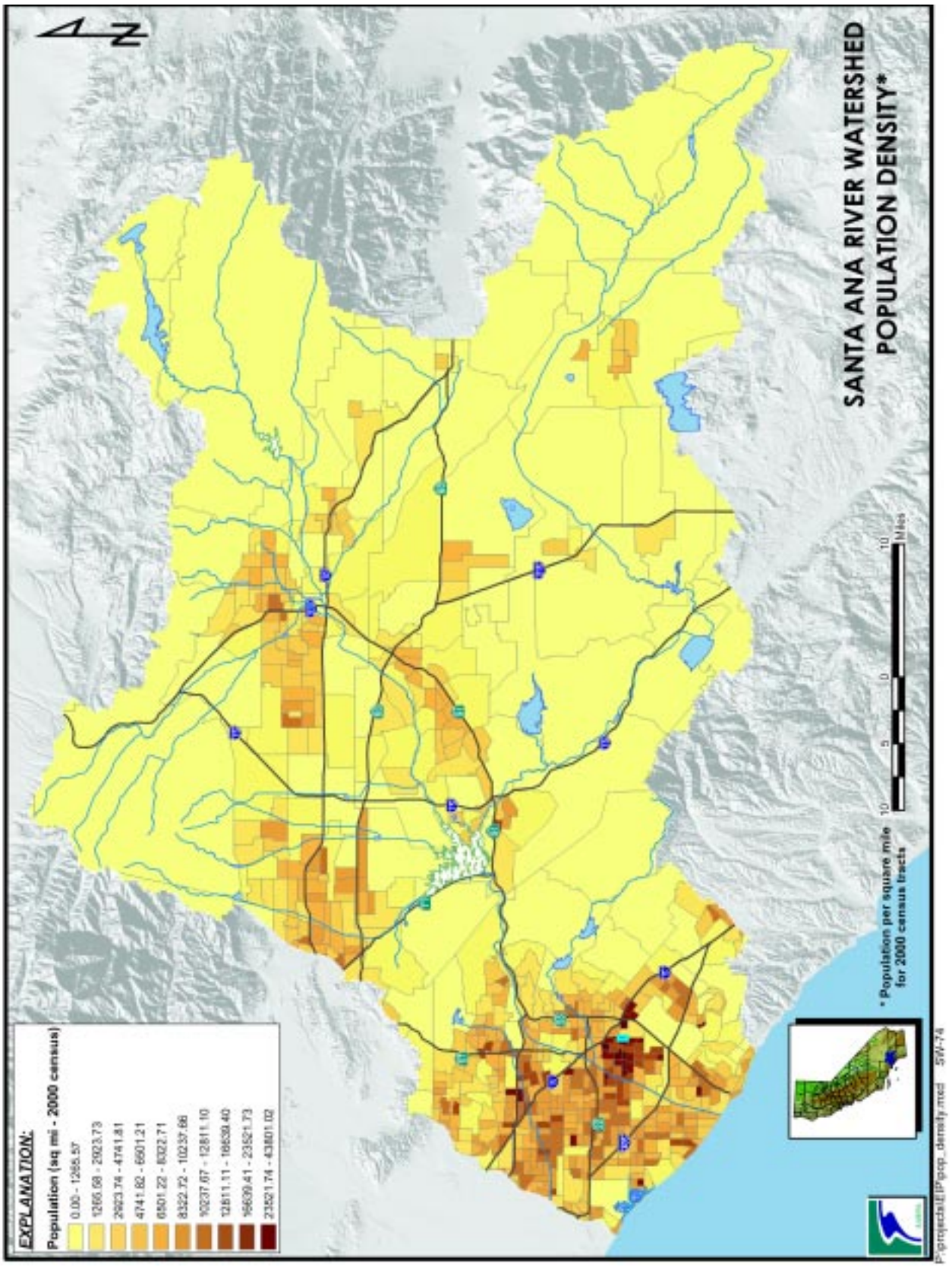


Figure 2-9 Santa Ana River Watershed Population Density

Mountainous areas and National Forest areas are sparsely inhabited, excepting recreational areas such as Lake Arrowhead and Big Bear.

The Watershed has experienced rapid population growth over the past century relative to the rest of the nation, and will continue to grow more rapidly than the rest of the State or nation over the next 50 years. Watershed population, 5.1 million in 2002, is expected to reach 9.9 million by 2050. This population growth will be concentrated mainly in San Bernardino and Riverside Counties, as Orange County is basically "built out" (i.e., most available land has been developed). Unavailable land includes those areas protected as open space or unbuildable due to steep slopes or other geographic constraints. However, redevelopment projects such as one that has been proposed in the City of Anaheim have the potential to increase population in areas that are considered built out. The conversion of agricultural lands to urban areas will fuel population growth, particularly in the Chino and Ontario Spheres of Influence. Without proper planning, rapid population growth can lead to habitat fragmentation, waste disposal issues (i.e., solid waste, biosolids, and wastewater treatment and disposal), water shortages, and increased pollution. However, planners within the Santa Ana Watershed have the opportunity to balance population growth with open space preservation and implementation of green infrastructure to ensure sustainable growth in the region. It is very important to be proactive in combating these future pressures by projecting population growth impacts on existing infrastructure and environmental resources. Integrated watershed planning provides a means by which these impacts can be addressed. One example has been the interest in forming a potential biosolids taskforce (with SAWPA as the administrator) to take a proactive approach to addressing biosolids and their impacts on the Watershed, both now and with projected population growth.

Figure 2-10 demonstrates the overall projected watershed population growth from 1990 to 2050 while Figure 2-11 compares 1990 population by county with 2025 population projections.

In 1990, approximately 4.2 million people resided in the Santa Ana Watershed: approximately 2.08 million in Orange County, 1.1 million in San Bernardino County, 0.9 million in Riverside County, and 0.2 million in Los Angeles County. By 2010, the population of the Watershed is expected to reach 5.9 million. The rate of growth in San Bernardino and Riverside Counties will be much higher than that in Los Angeles and Orange Counties. While in 1990 and 2000 the majority of the population resided in the Los Angeles and Orange Counties portion of the region, by 2010 the population split is expected to even out between Riverside–San Bernardino Counties and Los Angeles–Orange Counties. This balance would be due to a decline in the level of population growth in the two coastal counties while the level of growth remains high in the two inland counties.

From 2010 to 2025, the population is expected to grow by 1.41 million people, reaching 7.3 million. Much of this can be attributed to the availability of land in the eastern portion of the region in relation to the unavailability of land in southern and central Los Angeles County and most of Orange County. By 2025, the majority of the population in the Watershed will be in Riverside and San Bernardino County. Of the total population, 4.2 million will be located in these two counties, while the remaining 2.9 million will be located in Orange and Los Angeles Counties.

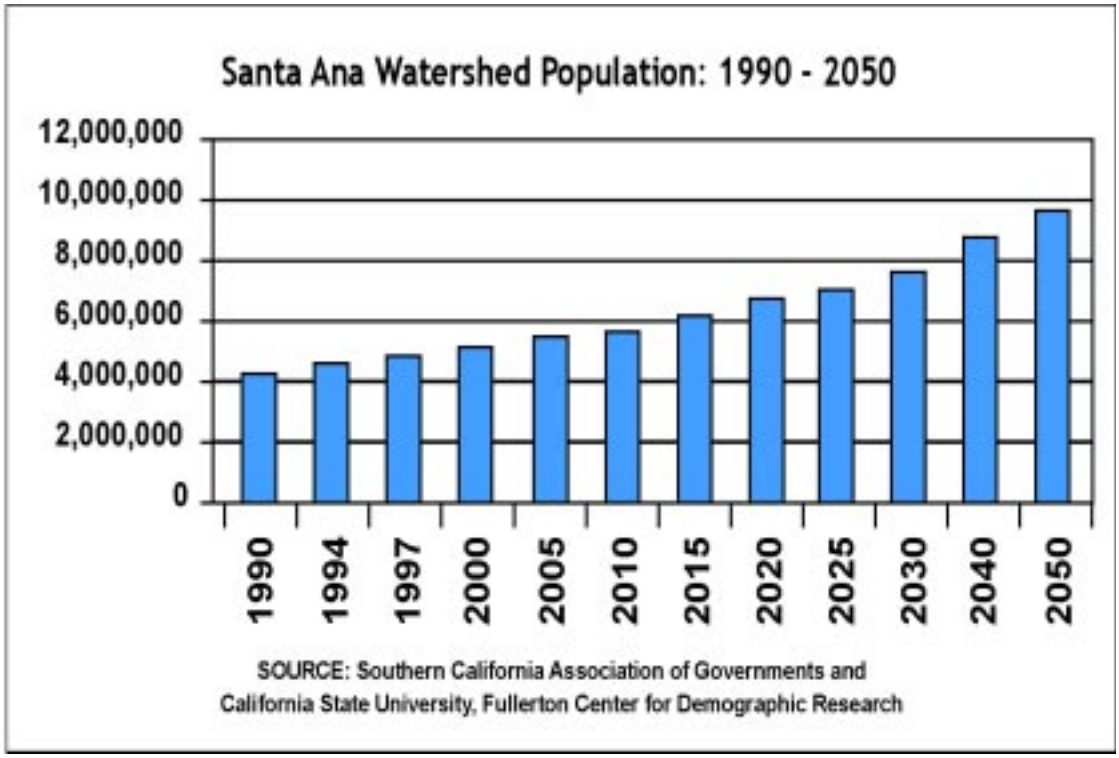


Figure 2-10 Santa Ana Watershed Population, 1990—2050

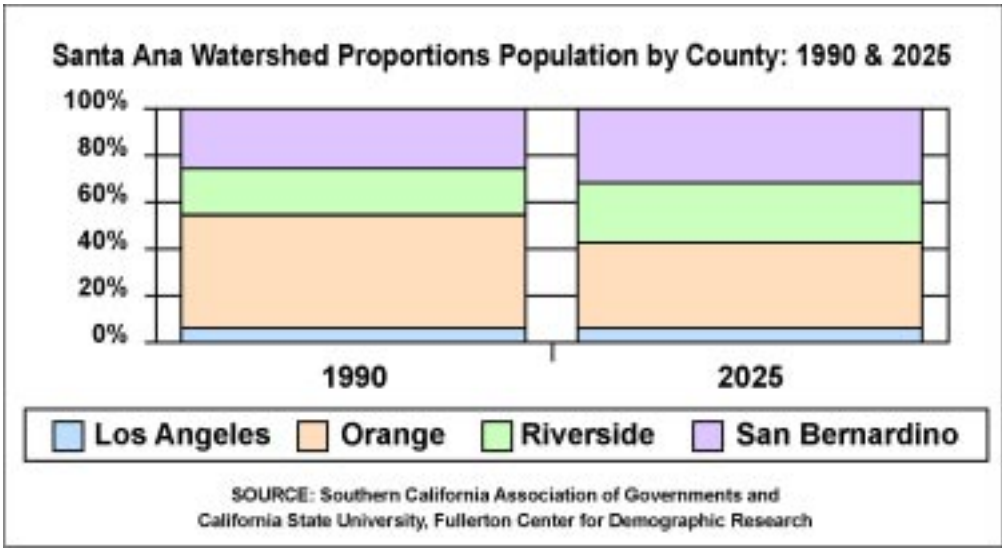


Figure 2-11 Santa Ana Watershed Population by County, 1990 and 2025

The primary source data for population forecasts are the Southern California Association of Governments' (SCAG) socio-economic forecast data sets used in the 1998 and 2001 Regional Transportation Plans, which included 1990 counts and forecasts to 2025. These forecasts were supplemented with data from the California State Department of Finance (DOF) 1998 population projections, DOF projection of population by county to 2040 and Census 2000 information, DOF estimates of population, housing and households, 2000 Census and employment projections developed by the California State University, Fullerton Institute for Economic and Environmental Studies. These data were used to forecast population, housing, households, and employment for 2030–50.

By 2050, the population of the region is projected to reach 9.9 million. This figure appears startling at first, because it would mean that the population will nearly double from what it is today. The California State Department of Finance also projects the populations of both Riverside and San Bernardino to each exceed that of Orange County. (Currently, their combined populations are about equal to that of Orange County.) A significant portion of the growth in Orange and Los Angeles Counties will be outside of the Santa Ana Watershed, while a significant portion of the growth in Riverside and San Bernardino Counties will be within the Watershed region.