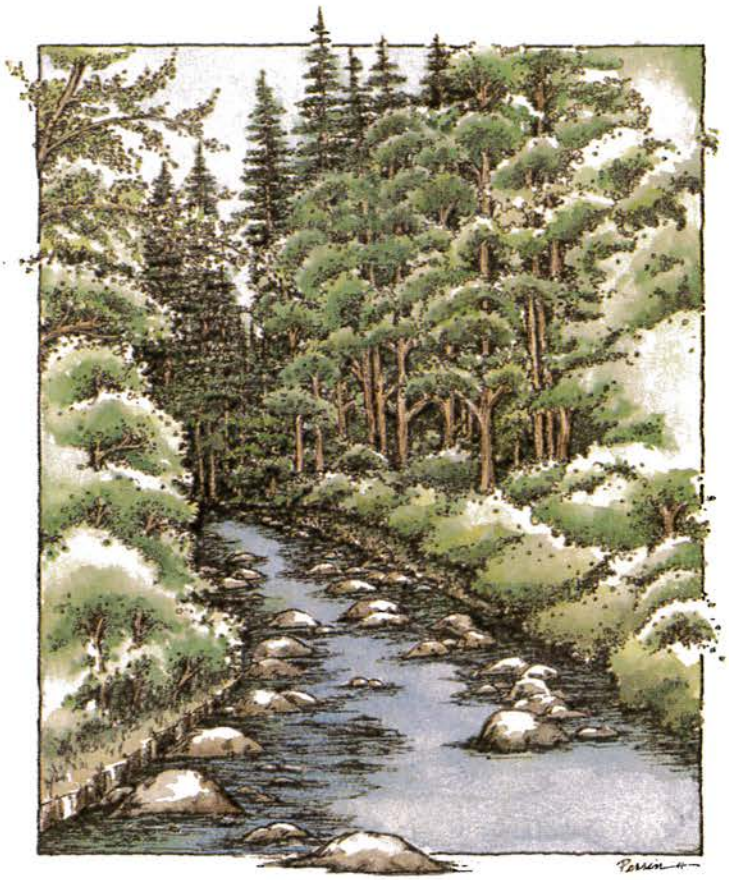

California's Rivers and Streams

Working Toward Solutions

State Water Resources Control Board
California Environmental Protection Agency

STATE OF CALIFORNIA
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Governor

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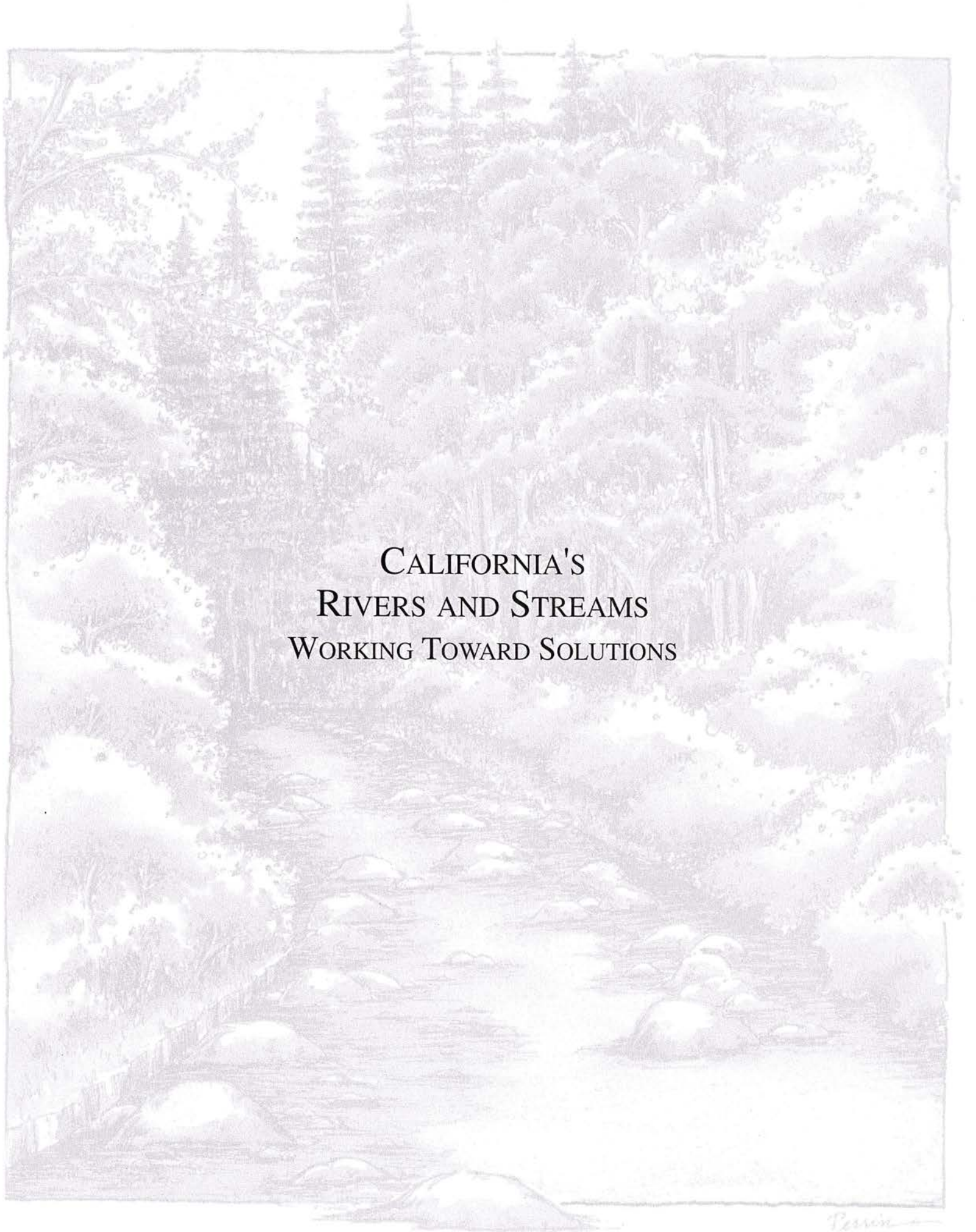

California's Rivers and Streams

Working Toward Solutions

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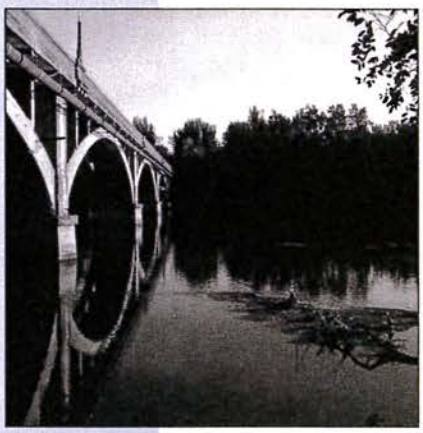
PREFACE

Healthy rivers and streams are essential for a prosperous California. These waters define the treasured California landscape, they supply water for the well being and livelihood of all Californians, and they are the environment for our fisheries and the basis of the food web for wildlife. Yet it is the pursuit of the proverbial "good life" which threatens these waters. Such is the challenge all Californians face in balancing our present needs and uses of water with the long-term prosperity of the State and our quality of life and environment. While various levels of government are called on to protect rivers and streams, the most effective way to do so is through the fullest expression of the public's will. Accordingly, this State Water Resources Control Board (State Water Board) report is dedicated to strengthening public resolve in support of a coherent and comprehensive protection program for the State's rivers and streams.



Sacramento River

This report focuses on how Californians affect water quality through some of our most significant and widespread activities. Such activities can result in the unwitting pollution of our waters. The recent prolonged drought has given us firsthand experience of the difficulties in putting a limited water supply to good and proper use.

While the issues covered in this report are viewed by some as problems and by others as concerns, one thing is certain--they are challenges. In the true California tradition, as challenges are met, new opportunities will emerge. We encourage you to become more familiar with the challenges facing the State's rivers and streams and to join State Water Board and California Regional Water Quality Control Board (Regional Water Board) efforts toward a California resolve to preserve and enhance these waters.

OVERVIEW

This document depicts some of the most common pollution problems which the State and Regional Water Boards deal with today. It also describes recent steps toward the rehabilitation of water quality in our rivers and streams.

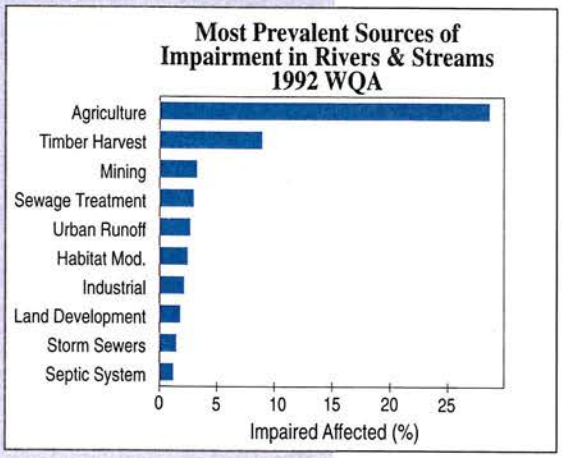
Several themes about water pollution control in California's rivers and streams recur in the ten chapters of this report. First, most of the single-source, well-defined kinds of pollution, including sewage from cities and factories, have been identified and many of them remedied. Our focus is shifting to the diffuse sources--runoff, drainage, seepage, and silt--that may arise over large areas from multiple land uses and political jurisdictions. These "nonpoint" sources represent the accumulation of scores of small contributions. Here the principal technical challenges are to identify the pollutants, trace their sources, and develop new control methods.

Second, this new focus emphasizes pollution prevention--elimination of the problem at the source--rather than "end of the pipe" treatment aimed at removal of pollutants. Most current pollution problems originate over large areas and are complex in their physical and chemical character. Thus it becomes essential to keep pollutants from reaching the water right at the start because treatment to remove them is an expensive and potentially endless task.

The third theme is the need to deal with water quality through a watershed approach. Many of today's pressing problems--whether owing to pesticides, storm water, erosion, livestock, or all of the above--have sources scattered throughout each water basin. This means that the physical unit, the whole river basin, must become the management unit.

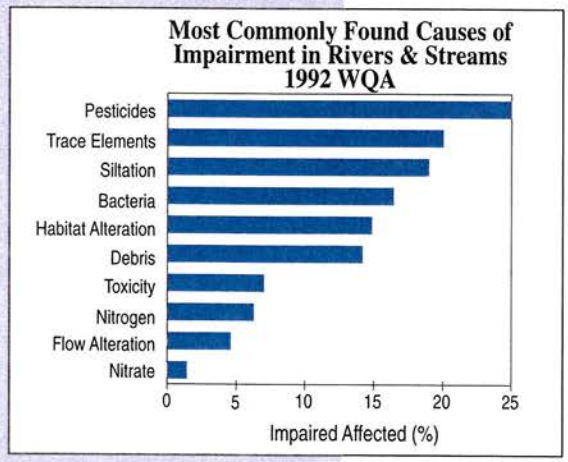
The need for watershed management invites a fourth theme: cooperation among affected interest groups. Since drainage basins support diverse land uses and checkerboards of ownership and administration, the owners have to work together to identify common objectives and the means to attain them. In order to succeed, both priority-setting and specific protective actions must be local matters involving the residents of each water basin.

Those are the broad themes. This report focuses on several specific problems and their sources identified by the State Water Board's Water Quality Assessment (WQA) as the most prevalent sources of impairment to rivers and streams. Most of these problems arise from common and widespread land uses, notably mining (Chapter 1), urbanization (Chapters 3 and 9), logging (Chapter 5), and agriculture--including crop production (Chapters 2 and 9), dairies (Chapter 6), and free-ranging livestock (Chapter 7). Chapters 4 and 6 explore pollution that factories and sewage treatment facilities sometimes create. Chapter 8 describes the unique situation at the border with Mexico where a lack of sewage treatment is a serious problem.



The WQA shows that these pollution sources contribute a wide variety of contaminants that cause impairment. Chief among them are heavy metals (Chapter 1), pesticides (Chapter 2), silt (Chapters 5, 7 and 9), nitrates and ammonia (Chapters 6 and 7), disease microorganisms (Chapters 3 and 8), and other chemicals toxic to aquatic life (Chapters 3 and 4).

The last chapter (10) provides a region-by-region summary of the water quality of selected rivers and streams for each particular Regional Water Board. The chapter highlights each region individually and provides a summary of the general categories of sources or causes of impairment. The information provided is taken from data in the WQA. The data identify the proportion of river and stream miles with good, intermediate, impaired, and unknown (or unassessed) water quality. The WQA database is used in part to report to the U.S. Environmental Protection Agency (USEPA) about the quality of the State's waters and identifies waters not meeting water quality standards. These data represent the best information available, however, they are estimates and do not represent exact figures. The last page is a pictorial index which highlights the rivers mentioned in the report and gives the topics discussed and page numbers for easy referencing.

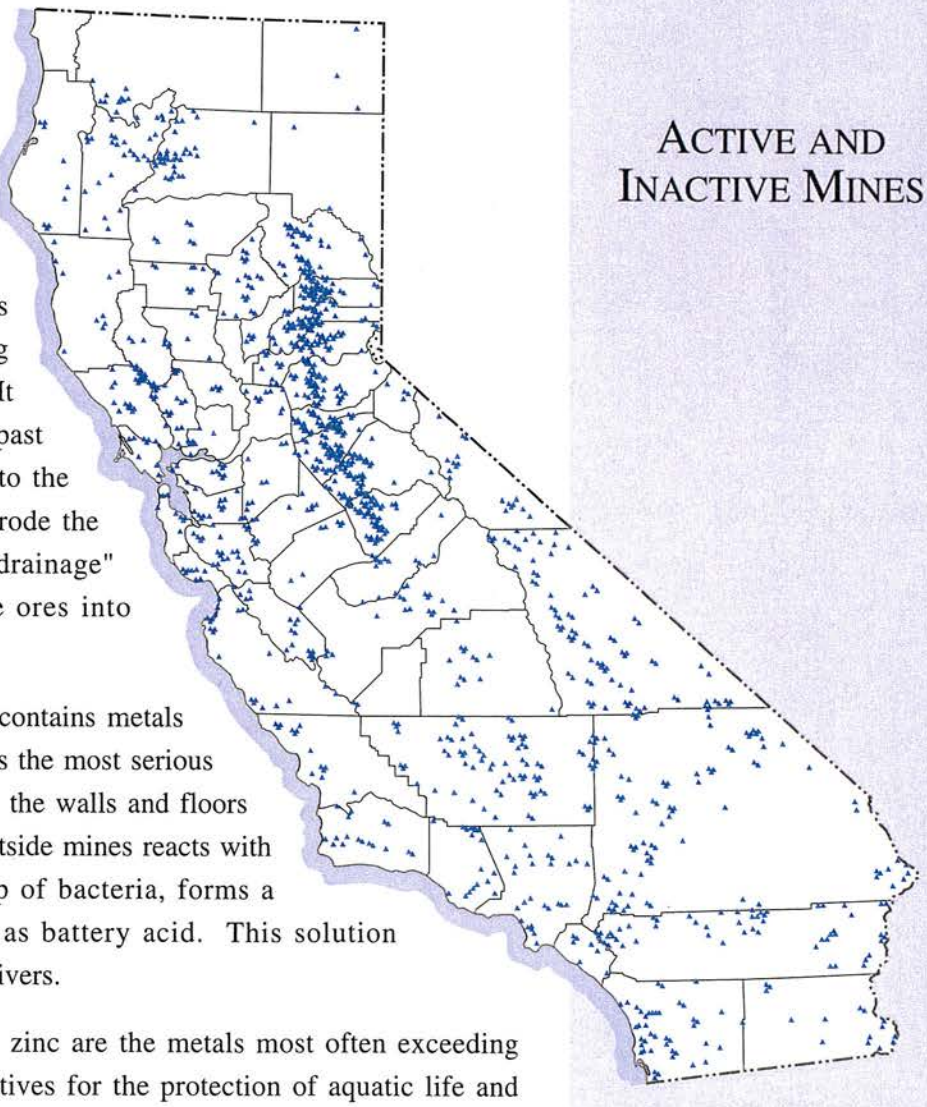


This text is not a stream-by-stream catalog of California's water quality. The pollution issues illustrated in nine examples are not the only ones facing the State and Regional Water Boards. However, they show the direction of our efforts, describing past State Water Board activities and accomplishments, as well as a summary of present challenges, and a glimpse into the future.

CHAPTER 1

MINE DRAINAGE: A LETHAL LEGACY

California has thousands of inactive and abandoned mines. Of these, 20 are known to cause major environmental damage and that may be just the tip of the iceberg. These mines contain gaping holes and fractures through which toxic substances spill into streams and rivers killing aquatic life and threatening human health. How did this happen? It was the hardrock mining of decades past that first exposed the earth's interior to the weather. Air and water began to corrode the mine's interior, forming "acid mine drainage" which leaches pollutants from mine ores into streams.



ACTIVE AND INACTIVE MINES

Approximate location of some of the abandoned and active mines throughout the state

Acid mine drainage which frequently contains metals in toxic concentrations is recognized as the most serious mine pollutant. Pyrite (fool's gold) on the walls and floors of mines and in piles of waste rock outside mines reacts with water and oxygen and, with the help of bacteria, forms a solution which can be as corrosive as battery acid. This solution dissolves metals and carries them into rivers.

Cadmium, copper, lead, mercury, and zinc are the metals most often exceeding water quality criteria. Mercury objectives for the protection of aquatic life and human health are occasionally exceeded in the Sacramento River. About 95 percent of the copper, zinc, and cadmium measured in the Sacramento River is thought to originate from inactive mines. Some of these metals accumulate in fish and in high concentrations these metals halt reproduction or cause death. Fish kills have occurred downstream of leaking mines.

Mine discharge is a statewide problem. Rivers flowing to San Francisco Bay contain mercury and acid drainage from mines in the Coast Range Mountains. The Sierra foothills are dotted with copper and zinc mines that spill metal-laden acidic water.

Iron Mountain Mine

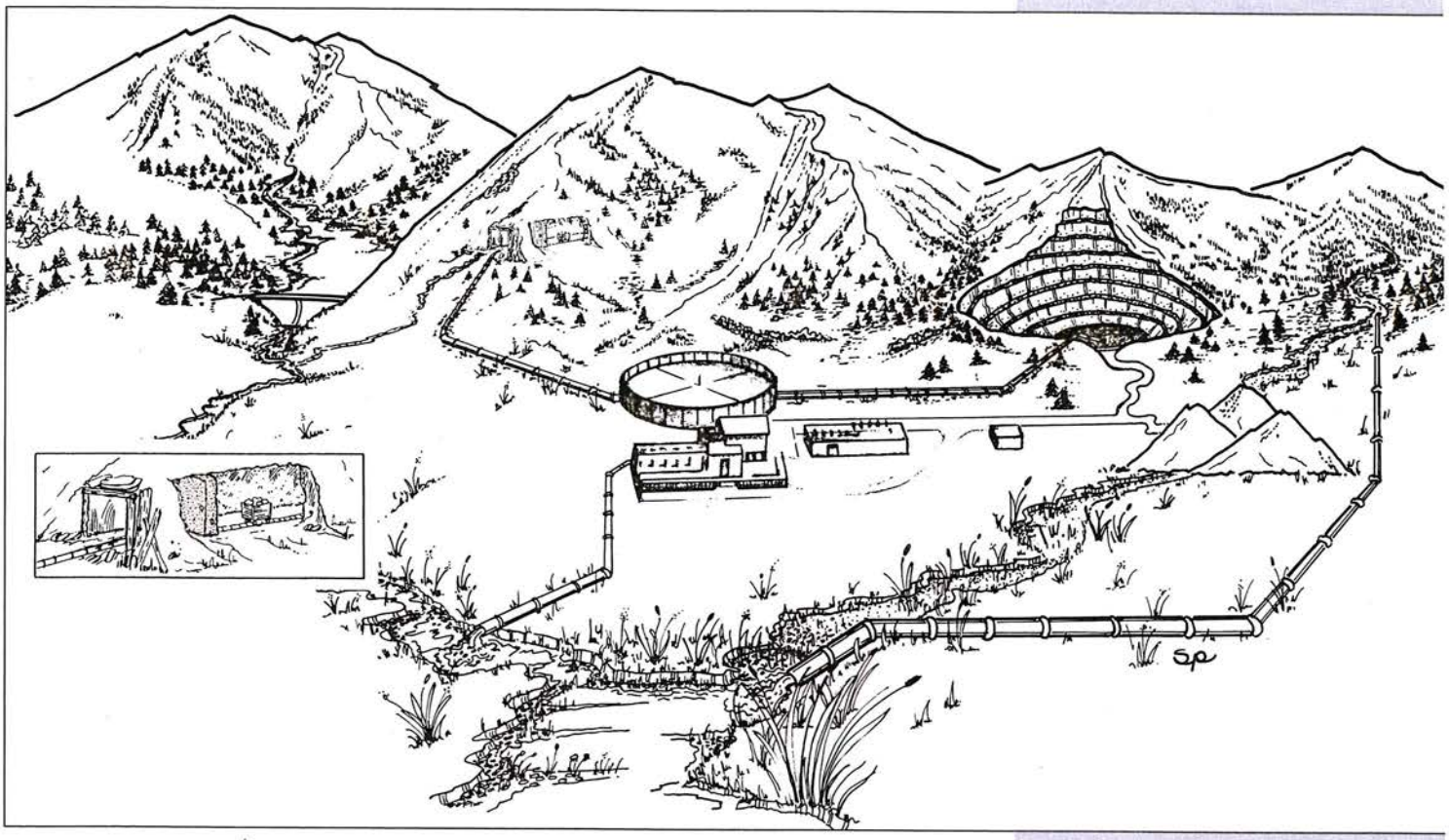
Shasta County has a number of large problem mines including Iron Mountain about four miles northwest of Redding which produces some of the most acidic water in the world. Iron Mountain Mine discharges more metals to surface waters than any other single source in the nation. About a ton of copper and zinc is discharged daily into Spring Creek Reservoir just downstream of Shasta Lake.

Shasta County mine sites discharge acidic and metal-laced runoff directly to Shasta Lake or to the Sacramento River. Drainage from these mines contains enough copper to impair water quality 200 miles downstream in the vicinity of Sacramento and still further downstream in San Francisco Bay. The San Francisco Bay Regional Water Board has identified high levels of copper as a major water quality problem for the Bay and has identified acid mine drainage as one of the principal river sources needing to be controlled. In addition to the copper coming from abandoned and inactive mine sites, copper coming from other sources such as agriculture, storm water, industry, and public sewage plants may have to be reduced further.

Once it begins, acid mine drainage continues to form at rates up to a million times greater than what would naturally occur from weathering, making it extremely difficult to control. Mine clean-up costs are high--in some cases cost estimates exceed $50 million, and there are no guarantees of success. The State and Regional Water Boards recognize the need to correct the problem and wherever possible recover clean-up costs from the mine owners. But often owners cannot be traced or have no money and the taxpayer is faced with the bill.

Clean-up technology does exist, but it is costly, is labor intensive, and must be maintained over a long period. Seldom is one single clean-up method effective. More often several technologies must be used together. Each mine requires an individualized approach. A clean-up strategy might include a combination of concrete plugs, lime injection wells, neutralization ponds, treatment plants, and surface caps.

The surface cap prevents rain from percolating through the ground and into the mine workings. Downstream from a mine, treatment plants are commonly used to



Technologies Used To Control Mine Waste

Technologies to control pollution from inactive mines fall into 2 categories:

- *PREVENTION--preventing the formation of acid mine drainage by diverting local streams away from reactive material, covering reactive mine waste, mixing reactive mine waste with limestone to buffer acid, disposing of reactive mine waste under water to eliminate reaction with air, impounding mine drainage to keep it from entering surface waters, and sealing the mine portal to flood the mine thus suppressing the formation of acid mine drainage.*
- *TREATMENT--treating mine drainage before it enters surface waters including chemical precipitation and ion exchange, construction of wetlands, and evaporating mine discharge in surface impoundments. Note: all these treatment technologies produce sludge which must be disposed of in an environmentally sound manner.*

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treat acid mine drainage. Concrete plugs result in flooding of the underground workings which prevents pyrite exposure to oxygen and theoretically stops acid formation. But plugs frequently leak, making this method unreliable. Another idea is to inject lime through surface-drilled wells to neutralize the acid as a mine is flooded. Revegetation and man-made or natural wetlands are also used to treat acid mine drainage. Trees and shrubs absorb rainwater, reducing moisture seepage. Wetlands fortified with everything from composted vegetation to horse manure have been used to consume metal-laden, acid mine drainage, reducing the acidity and retaining the toxic metals in the wetland.

The known pollution from existing abandoned mines is already one of the largest water quality problems in the State. Additionally, as the many unstudied abandoned mines are investigated, more such problems will undoubtedly surface. As investigative work sheds light on the true magnitude of pollution from abandoned and inactive mines, a mine pollution abatement program is being crafted.

There are, however, major obstacles to overcome before significant progress in controlling pollution from abandoned mines can be realized. In drafting the laws governing pollution control, the situation for abandoned mines where there is no responsible party to hold accountable was not considered. Therefore, laws such as the Clean Water Act or the rules governing superfund site cleanup contain requirements for full attainment of water quality standards. At abandoned mine sites, the obligation to attain standards is often prohibitively expensive. In some cases, there can be no assurance that mitigation has the capacity for full compliance with standards. In most cases, the State would prefer to take corrective actions based on cost effectiveness without a guaranty of attaining standards. In this way, the majority of the pollution from most sites could be controlled.

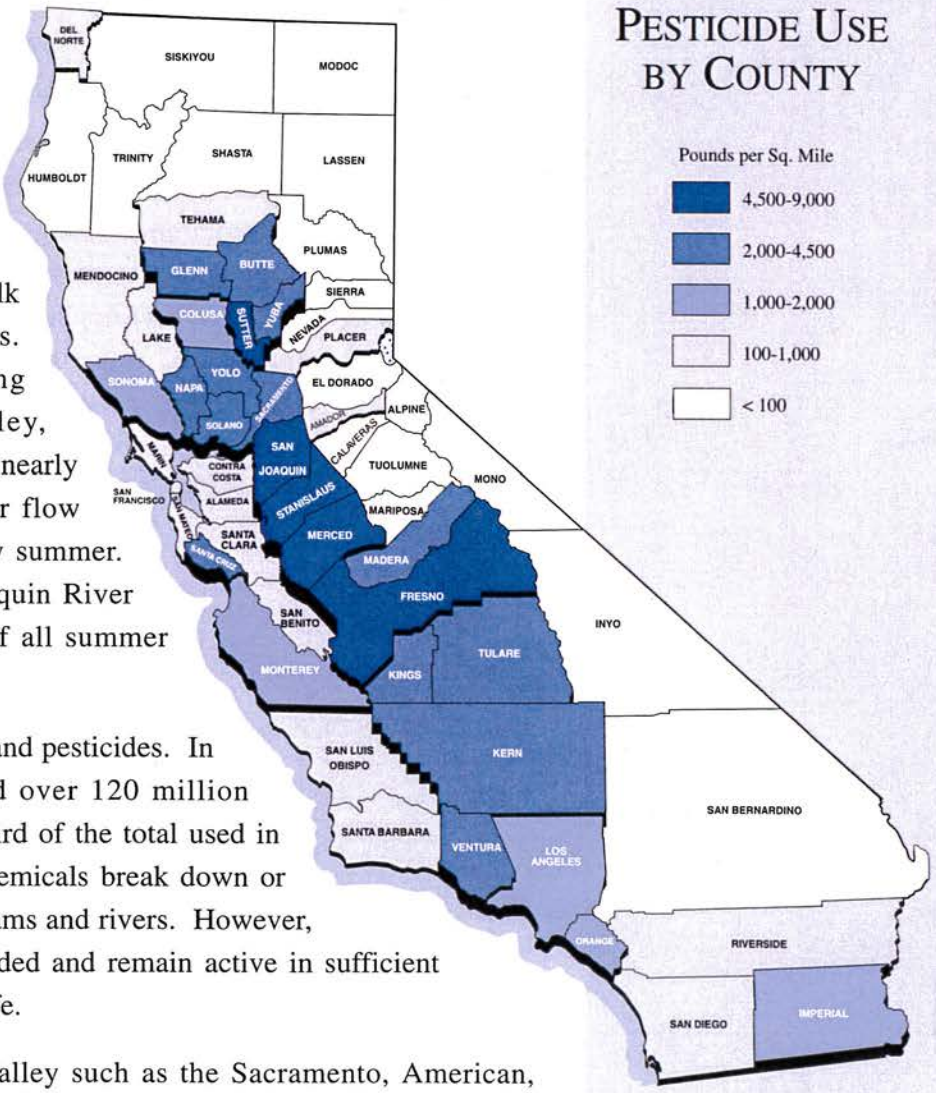
State Water Board is attempting to remove the legal barriers that prevent mine pollution cleanup by changing those state and federal laws which impose liabilities for mine cleanups. By working with USEPA and other federal agencies, a comprehensive mine cleanup strategy is starting to evolve. Strategy elements will include an inventory of all the mines, identifying their location, singling out those causing problems, and then deciding which to fix first. Because mine cleanups are technically complex, staff intends to establish a technical advisory committee to review and approve such proposals. Participation in an international technology exchange provides important information on state-of-the-art technologies used in other parts of the world.

Although the cleanup of abandoned and inactive mines is a massive endeavor, meeting this challenge holds the promise of solving one of California's major surface water quality problems--a problem as old as the State itself.

CHAPTER 2

AGRICULTURAL PESTICIDES: CONTROL IS THE KEY

Because the major growing season in California is also the dry season, most crops require irrigation. Water not used by crops evaporates, seeps underground, or returns to rivers and streams. Runoff from irrigated land usually channeled into drainage canals can make up the bulk of stream flow during dry periods. For example, in the rice-growing areas of the Sacramento Valley, agricultural drain water comprises nearly one-third of the Sacramento River flow during peak rice irrigation in early summer. Similarly, portions of the San Joaquin River consist largely of irrigation runoff all summer long.



Total pesticide use includes agricultural, commercial and residential use.

This runoff often carries fertilizers and pesticides. In 1990, California growers applied over 120 million pounds of pesticides, nearly one-third of the total used in the United States. Some of the chemicals break down or are neutralized before reaching streams and rivers. However, other pesticides are not fully degraded and remain active in sufficient concentrations to threaten aquatic life.

The larger rivers in the Central Valley such as the Sacramento, American, Feather, and lower San Joaquin provide major spawning and rearing habitats for fish such as salmon, steelhead trout, striped bass, shad, and sturgeon. These species' young depend on small invertebrates--mostly insects and tiny shrimp--for food. Certain orchard and field pesticides sometimes occur in streams and rivers at levels that can kill or seriously impair these food sources and the young fish themselves.

The potential adverse effects of agricultural chemicals were realized in the early 1980s when massive numbers of adult fish were killed in the agricultural drainage channels of the Sacramento Valley. The fish kills were linked to two rice herbicides, Ordram and Bolero. A collaborative effort between the Central Valley Regional Water Board, the Department of Pesticide Regulation (at that time a part of the Department of Food and Agriculture), and the rice growers was developed to control the discharge of these chemicals. By instituting restrictions on the timing of the release of the rice field water that had been treated with the chemicals, the fish kills were stopped.

Pesticide spraying in fields.

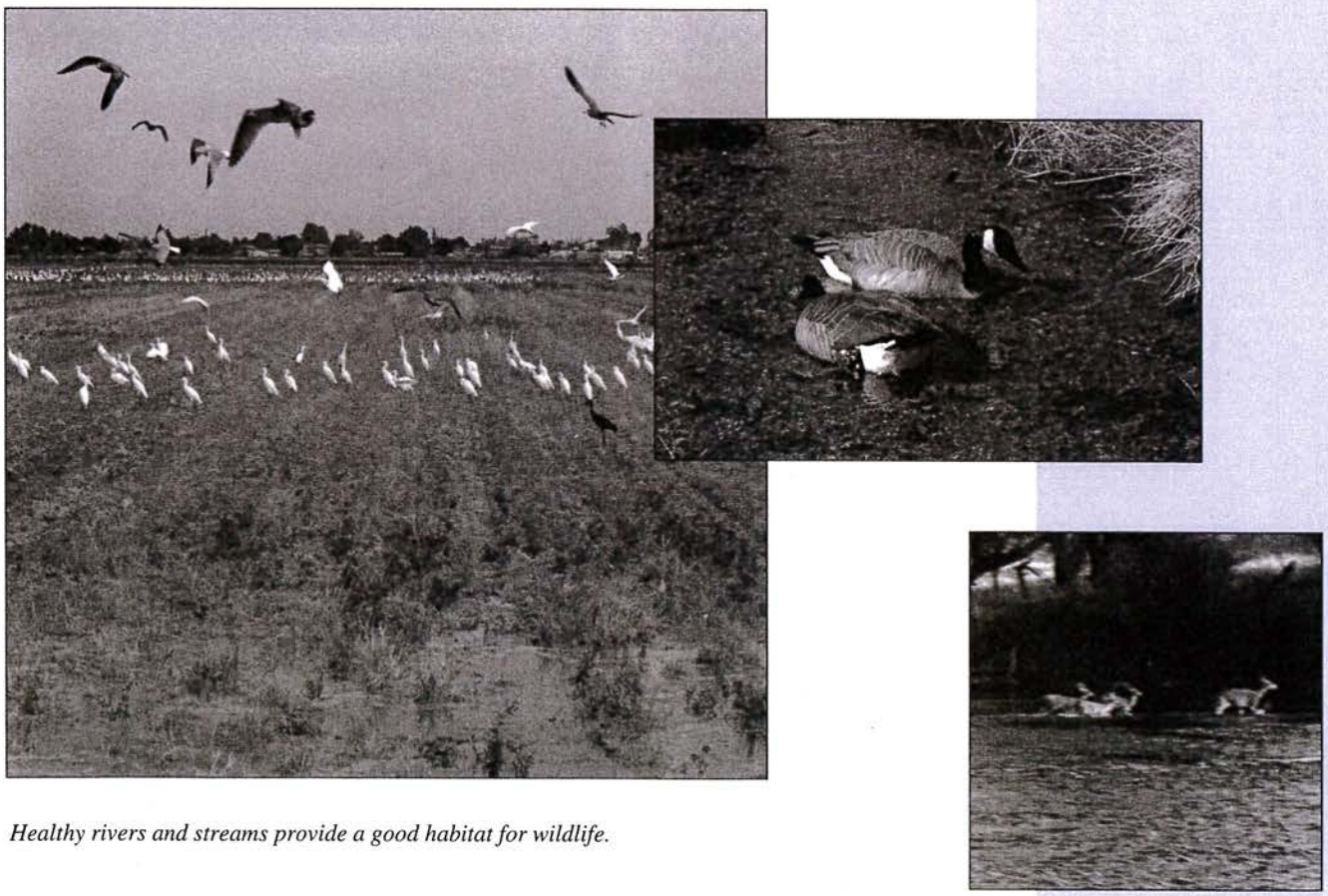
As part of the effort to identify and control these pesticides, an impact on drinking water supplies was identified. Water from the agricultural drains enters the Sacramento River and is carried downstream into the Sacramento River/San Joaquin River Delta. Water taken from the Sacramento River used for drinking water for the citizens of Sacramento was found to contain concentrations of the pesticides that created foul tasting water. Growers agreed to hold the water on their fields for longer periods of time before discharging. This reduced the herbicide levels, eliminating the toxicity to aquatic life and improving the drinking water.

The impacts of pesticides on the aquatic life in the Sacramento River and the agricultural canals remains a concern. Many of the food species for fish are very sensitive to agricultural poisons and even small amounts of agricultural chemicals can severely limit food supplies for fish. Today the Regional Water Boards are using bioassay tests to screen waters for toxic effects. This "early warning" procedure shows whether certain test animals can survive, grow, and reproduce normally in stream water samples carrying irrigation runoff. Since 1986, such tests have examined waters from numerous streams in the San Joaquin, Sacramento, and Imperial Valleys. Streams in other farming areas including the Salinas Valley also will be tested.

These tests show that a number of the State's streams in agricultural areas are frequently toxic to aquatic life. Up to 30 percent of recent measurements in the Feather, Sacramento, and Mokelumne River Basins, and in Imperial Valley channels have revealed toxicity. Portions of the San Joaquin River in Merced and Stanislaus Counties have tested toxic 40 to 50 percent of the time. While the levels of chemicals are generally too low to kill fish outright, they can harm aquatic life by inhibiting reproduction and reducing food supplies.

Such findings present the Regional Water Boards with a new challenge: to identify exactly which ingredients in each stream are toxic and to determine their site of origin. Dozens of pesticides applied to dozens of crops must be screened. Cooperation between the Department of Pesticide Regulation, County Agricultural Commissioners, chemical manufacturers, and growers are essential for accurate information--sites, times, amounts of each chemical applied--which may reveal the source of toxicity.

This cooperative approach should lead to new methods to keep pesticides from harming life in the State's waters. As with the case of rice herbicides, adjusting chemical selection, timing, application method, and release of drain water may help to reduce toxicity from other crops. Alternative approaches must also fit crop cultivation, pest prevalence, water needs, and weather conditions into a practical pest control scheme. Many chemicals are washed from fields along with soil so that ongoing efforts to reduce soil erosion can serve a double purpose.



Healthy rivers and streams provide a good habitat for wildlife.

Prevention of toxicity also may be attained by keeping drain water out of streams, for example, through water conservation, water recycling, and use of evaporation ponds. But withholding water reduces stream flow as well as toxicity. In some cases, irrigation runoff actually creates streams as well as crucial streamside habitat for wildlife. This marsh and streamside vegetation serves as shelter for birds and animals, while the mosaic of surrounding croplands provides them with feeding grounds. The combination of food and shelter can maintain a great diversity of wildlife species.

Pest control practices need to achieve both crop protection and conservation of fish and wildlife. Everyone benefits when chemicals stay on their target crop, soil stays in the field, and clean water runs in the streams.

CHAPTER 3

URBAN RUNOFF: CITY LIFE CAN BE HARMFUL TO A RIVER'S HEALTH

Most cities in California operate a dual system for handling used water. Water from our homes and businesses is carried off by sanitary sewers to wastewater treatment plants, while an entirely separate network of drains diverts storm water quickly off city streets to prevent flooding of streets and sewage treatment plants. It transports runoff directly to the nearest water body--usually rivers--but sometimes lakes or bays. Few realize that storm drains, once known as "storm sewers", do not carry storm water to a treatment facility nor do they remove pollutants before funneling them downstream. Thus they may pose threats to drinking water, aquatic life, and the recreational and economic uses of those waters.

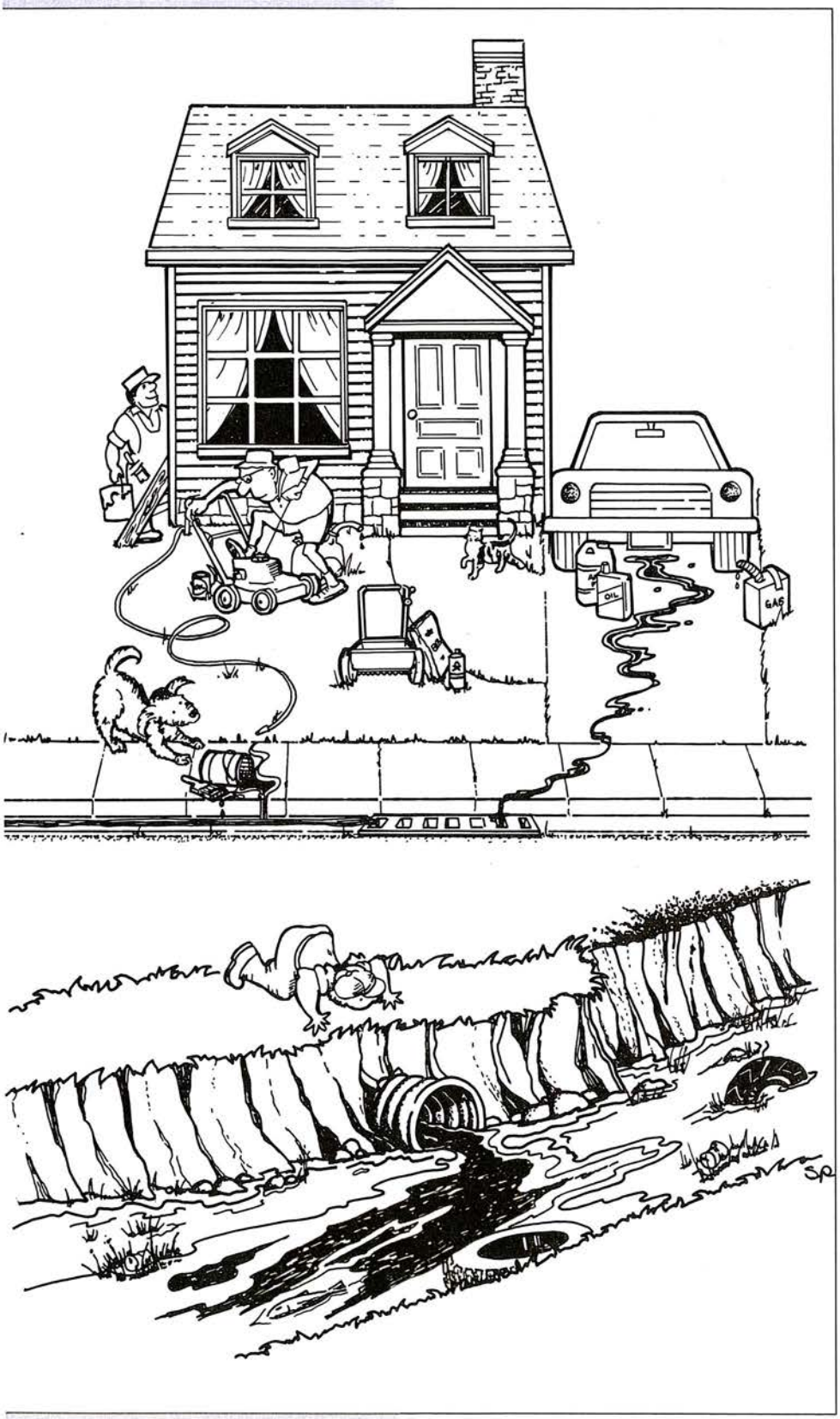
Storm drains are particularly useful in large, steeply sloped basins supporting many cities. Urban areas contain up to 90 percent hard surfaces such as rooftops and pavement where water collects quickly and runs off. Many cities have developed intricate networks of culverts, maintenance holes, catchbasins, and concrete channels to prevent flooding and watercourse changes from disrupting urban development along flood plains.

Rain water washes street pollution into storm drains which carry it to rivers

Though channels tame storm flows through urban areas, the cost is dear. Concrete storm drains prevent percolation for well-water recharge (an important source of drinking water) and deny habitat for plant and animal life and human recreation. These channels also discharge storm water debris directly into rivers, lakes, and bays. Problems occur when storm water picks up harmful amounts of pollutants and delivers them to these waters.

In urban areas, raindrops scavenge dust and pollutants from the air in their journey to the ground. The first rainfalls of the season flush out many kinds of materials accumulated on the ground during dry weather--oil, grease, coolants, garden fertilizers, pesticides, pet droppings, and even traces of hazardous substances stored in containers outside manufacturing plants (see next page).

Storm drains also collect dry weather runoff from lawn overwatering, car washing, construction work, and at times illegal dumping. Additionally, some storm drains convey legally permitted wastewaters, accidental sewer overflows, and other, less



Many household activities release pollutants that are washed into storm drains

common wastewaters. It is not surprising, therefore, that the catacombs hidden beneath city streets serve as major conduits of contaminants to downstream waters.

The Los Angeles/Rio Hondo/San Gabriel River drainage system contains the nation's second largest urban area, and the ninth largest drainage area--414 square miles of watershed. Mazed with hundreds of miles of concrete-lined channels, this massive network accommodates irregular bursts of rainfall across the area and billions of gallons of water and tons of solid materials caught up in the runoff. In Santa Monica Bay alone, 70 storm drains discharge untreated urban runoff into the ocean. Because of the number of drains and the nature and variety of sources of pollutants, identifying and controlling the various types of nonpoint source pollution and urban runoff are not easy tasks.

Although required by the Clean Water Act for years, management of urban runoff and storm water quality has languished over the last decade and a half, in part because of the tremendous complexity of dealing with this multi-faceted pollution source. However, following the 1987 amendments to the Clean Water Act, a regulatory Storm Water Program has emerged and storm water permits are being developed across the nation to address and regulate this problem.

In 1990, the California Regional Water Quality Control Board, Los Angeles Region, Surface Water Regulatory Section, developed one of the nation's first storm

water runoff permits. This permit requires Los Angeles County and its 89 cities and other agencies to control pollution from urban runoff. As measures required under the storm water permit are implemented over the next few years, significant reduction in bacteria along the beaches and near storm drains is expected as well as many other water quality improvements.

A pilot program being tested in the City of Santa Monica involves treatment of urban runoff in storm drains. The City of Santa Monica has been treating the water with varying doses of ozone, a gas used to disinfect drinking water. Initial results have shown that the ozone breaks down many toxic organic compounds and kills most of the harmful bacteria. However, heavy metals (e.g., zinc, copper, and lead) in the runoff are not affected by this process and different methods will be needed if trace metals must be removed.

The positive results from this study have spurred the City of Santa Monica to consider building a full-scale ozone treatment plant, complete with trash removal capability for dry-weather flows and for the initial flush of wet season storm water runoff. Water not routed to reclamation would be screened, disinfected, and released to the ocean. Backwash would be periodically collected and transferred to city sanitary sewers for full treatment.

While Santa Monica has not yet estimated the costs and benefits of building a full-scale plant, tourism continues on the Santa Monica coastline with an average of over 40 million visitor-days a year. This beneficial use alone may justify construction of a storm sewer treatment plant.

Meanwhile, techniques for preventing these compounds from getting into the drains rather than treating the water after it is in the drain are being sought. The reduction of lead in street runoff as a result of the removal of lead from gasoline over the last decade offers a precedent for other materials known to be carried downstream. This approach, pollution prevention, has been the basis for the many grass-roots volunteer efforts to increase public awareness in reducing pollution of urban runoff. Two pollution prevention practices believed to have a potential for dramatic improvement are proper disposal of oil and grease and reduced use of lawn pesticides and fertilizers.

Another major effort by the Regional Water Boards to address urban runoff pollution is to expand their public outreach and education efforts. One of the Regional Water Boards' goals is to educate citizens on impacts to the environment of urban runoff. All 87 of the municipal entities (cities, water districts, and counties) which are co-permittees of the Los Angeles County Storm Water and

Urban Runoff Discharge National Pollutant Discharge Elimination System (NPDES) permit are required to conduct public outreach programs to address proper disposal of household chemicals, pest control chemicals, and general waste disposal. The public outreach requirement of the NPDES Municipal Storm Water Permit is considered one of the most important elements in reducing pollutants to the storm drains. There are hundreds of these programs statewide educating the public about pollution of storm drains. Education and pollution prevention are much more cost effective than treatment of the polluted water. Classroom presentations, public workshops, and the distribution of environmental literature are part of this program. For example, neighborhood campaigns now stress alternatives to pesticide use in lawns and gardens and suggest landscape designs that control erosion.

Everyone needs to take part in reducing water runoff

Managing runoff in a highly urbanized area such as Los Angeles will clearly require a team effort. Residents must become aware of water quality issues in their own communities and get involved. The bottom line is that each of us plays an important role in reducing runoff from our own neighborhoods and cities. Education and participation is the key to bringing about changes.

CHAPTER 4

TOXICITY: SEWAGE COMES CLEAN, ALMOST

The wastewater produced by most of California's homes, businesses, and industries travels through a maze of subterranean pipes to sewage plants, where it is treated, cleaned, and disinfected to a high standard. Indeed, treatment has improved greatly in the last 30 years, essentially eliminating most public health problems, algal blooms, and fish kills. But recently the State and Regional Water Boards have recognized a more subtle set of problems--even after treatment, sewage may still contain chemicals in concentrations that harm aquatic life. These chemicals may not kill fish and shellfish outright but can stunt their growth, reduce fertility, or cause deformities. These effects can ultimately limit populations and communities of aquatic plants and animals.

Toxicity is detected by exposing test plants and animals to the wastewater (see next page). Test species chosen to represent the resident aquatic life are hatched and raised in samples of wastewater that have been mixed with local fresh or salt water simulating conditions near the discharge pipe. Their growth and development is compared to that of like organisms reared in clean laboratory-grade water. The types of organisms commonly used to test the toxicity of freshwater include minnows, shrimp (water fleas), and green algae.

Sewage treatment plant in Orange County

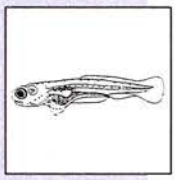
For the past few years, major municipal sewage plants and industrial facilities with their own treatment plants have begun toxicity testing with the wastewater they discharge to streams in California. These tests indicate that the effluent from one-third or more of these facilities can harm aquatic life at least some of the time.

When toxicity is repeatedly detected in a treatment plant's wastewater, the Regional Water Board requires the treatment plant to seek the chemical culprit and take steps to remove or neutralize the offending substance. Initially, the wastewater is separated or partitioned into two groups which are chemically distinct. Each group is evaluated using one or more test

SELENASTRUM
freshwater algae, plant species

CERIODAPHNIA
Cladoceran, invertebrate species

PIMEPHALES
fathead minnow, vertebrate species

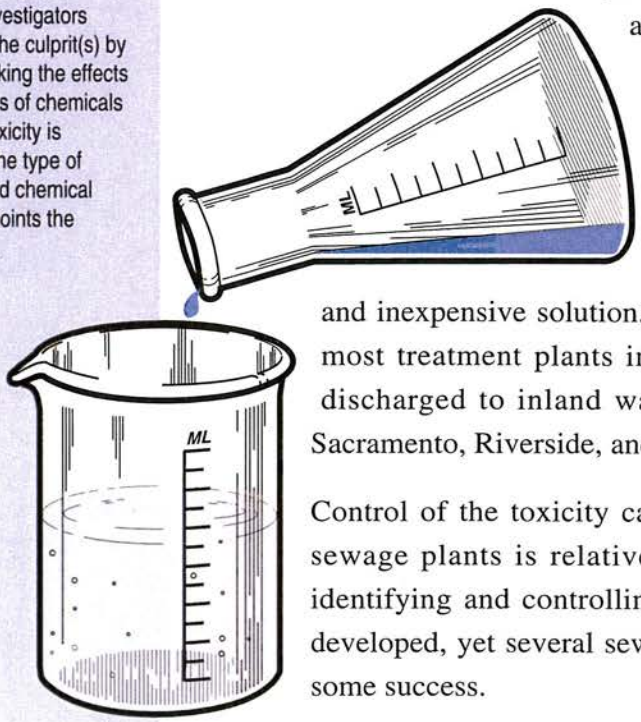


organisms. The portion that shows toxicity is again separated into distinct chemical groups and tested. The scientists follow the toxicity through as many partitioning steps as are needed to identify a specific chemical that is causing the toxicity in the wastewater. One can imagine how difficult this job might be by considering all the different kinds of chemicals that are dumped down the drain.

The next step is to figure out if that substance can be treated either by removing it from the wastewater or by neutralizing it. If treatment is not an option, then the source of the chemical must be identified. In some cases the decision to look for sources is made even if a treatment option is available because control at the source is more effective or cheaper than continuous treatment at the sewage plant. Tracking down sources, particularly in a large municipal sewage system, can be as difficult as identifying the toxic chemical.

Two chemicals found in treatment plant discharges, ammonia and chlorine, have been shown to present toxicity problems, especially those that discharge to small streams or confined bodies of water. Ammonia, a natural byproduct of sewage, can be treated and converted to less harmful chemicals. The sewage treatment plants serving Riverside, Ontario, and Chino have adopted this advanced treatment for ammonia control (see Chapter 6), as have certain plants in the San Francisco Bay, San Diego, and Los Angeles areas, among others.

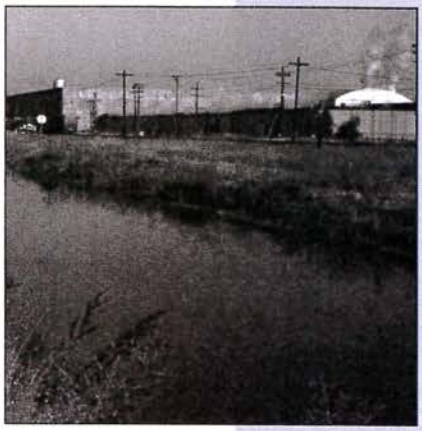
Initially, toxicity tests determine if a discharge is lethal to the test organisms or causes significant changes in their growth or their ability to reproduce. When toxicity is found, investigators attempt to identify the culprit(s) by systematically masking the effects of certain categories of chemicals and seeing if the toxicity is eliminated. Once the type of pollutant is identified chemical detective work pinpoints the specific compound.



Chlorine, routinely added to wastewater for disinfection, can also prove dangerous to aquatic life. But chemicals such as sulfur dioxide neutralize chlorine's toxic properties, and this is a relatively simple and inexpensive solution. This dechlorination step is being used by most treatment plants in California where chlorinated sewage is discharged to inland waters including the cities of Santa Rosa, Sacramento, Riverside, and Central Contra Costa County,

Control of the toxicity caused by ammonia and chlorine at certain sewage plants is relatively straightforward. The techniques for identifying and controlling other sources of toxicity are still being developed, yet several sewage plants and industries already have had some success.

Recently the Central Contra Costa Sanitation District determined through the use of some sophisticated chemical and physical manipulations that toxicity in its wastewater was due to a pesticide commonly used on lawns and gardens. This same pesticide, diazinon, has been implicated in toxicity at municipal sewage plants in other parts of the country as well. Among other steps, the District has undertaken an education program in its service area on the proper use and disposal of home-use pesticides and has instructed dozens of pest control businesses in its service area on the proper disposal of wash water from spray equipment.



Paper mill near Sacramento River in Anderson

In 1987, the Stockton Regional Wastewater Control Facility began toxicity testing on its effluent. After concluding that it posed a threat to invertebrates in the San Joaquin River, the treatment plant operators discovered that the toxicity coincided with pesticide applications to their aeration ponds. These pesticides were used to control chronic gnat infestations.

In order to reduce the threat to the aquatic environment without encouraging a gnat population explosion, the facility switched to a different method of pest control, using bacteria to interrupt part of the gnat growth cycle. Here again a municipal treatment plant took steps toward enhancing the quality of local waterways.

Industries also conduct toxicity testing and search for the chemical culprits. Through such procedures and clever detective work, for example, a San Francisco Bay area steel company discovered that the culprit was the defoamer component in a detergent they used. This company simply and efficiently eliminated the toxicity problem by changing the formulation of the detergent. Similarly, one fraction of a Bay Area oil refinery's wastewater tested toxic but after filtration through activated carbon, toxicity disappeared.

Finally, at a paper mill along the Sacramento River near Red Bluff, operators discovered that the mill wastewater contained dioxin, an extremely toxic chemical. After considerable sleuthing, they found that dioxin was generated when oils used to control foam in the pulp-making process mixed with certain pulp bleaching agents. The company appears to have virtually eliminated dioxin from the paper-making process by switching to a different defoamer.

During the last two years, several groups of toxic substances including ammonia, chlorine, pesticides, metals, surfactants, and defoamers have been clearly identified as the source of toxicity in wastewater discharges. Over the next decade, more wastewater treatment plants will recognize and correct toxicity problems working with the State and Regional Water Boards to better protect California's aquatic life.

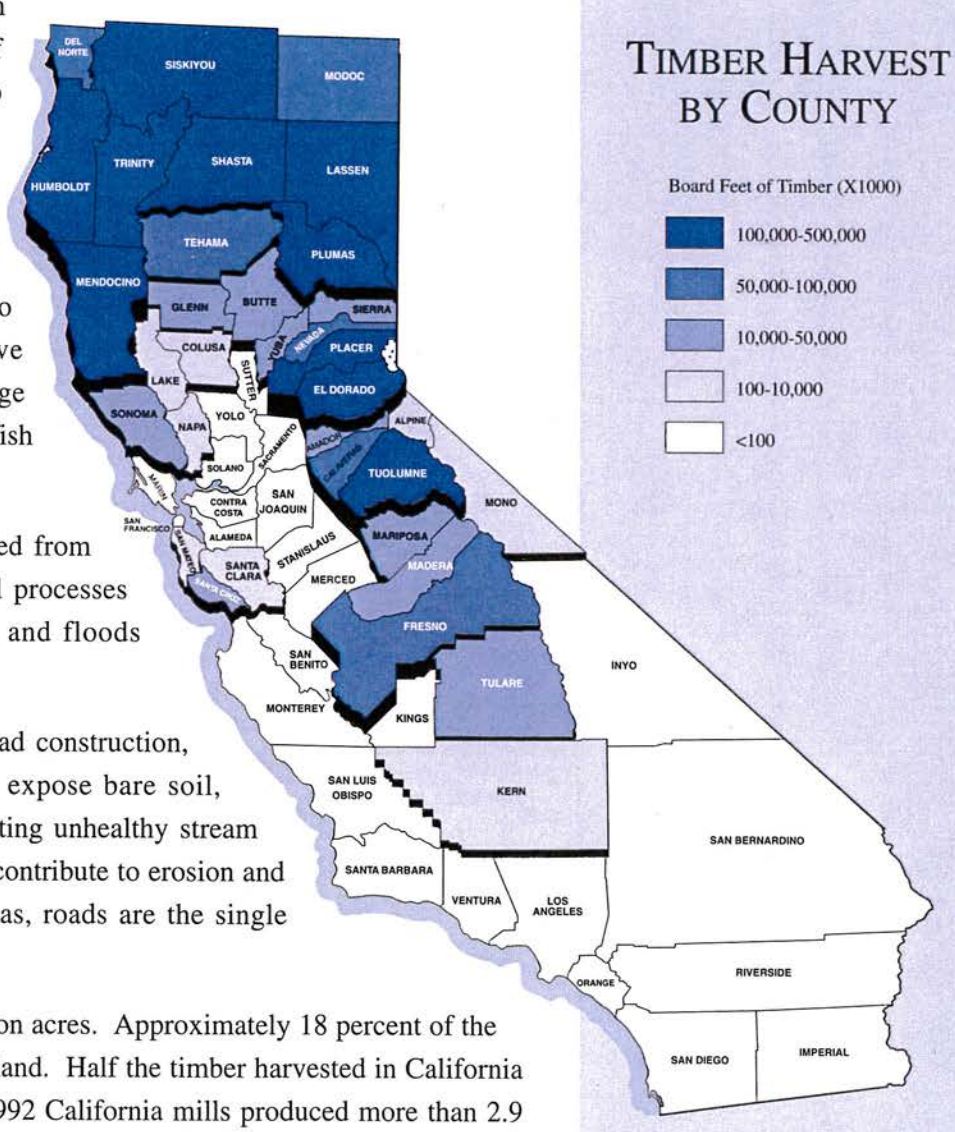
CHAPTER 5

EROSION: IT'S MORE THAN DIRT

On a scenic drive along the North Coast, travelers view the beauty of California's ocean beaches and stop to walk through its favorite forest, the Redwoods. While enjoying sounds of rippling streams and visions of bountiful salmon, the visitor may walk unaware of a major threat to nature's beauty--sediment. Excessive sediment can cause significant damage to rivers and streams and to valuable fish habitat.

Sediment is the soil and debris washed from surrounding land into water. Natural processes such as surface erosion, landslides, and floods contribute to sedimentation.

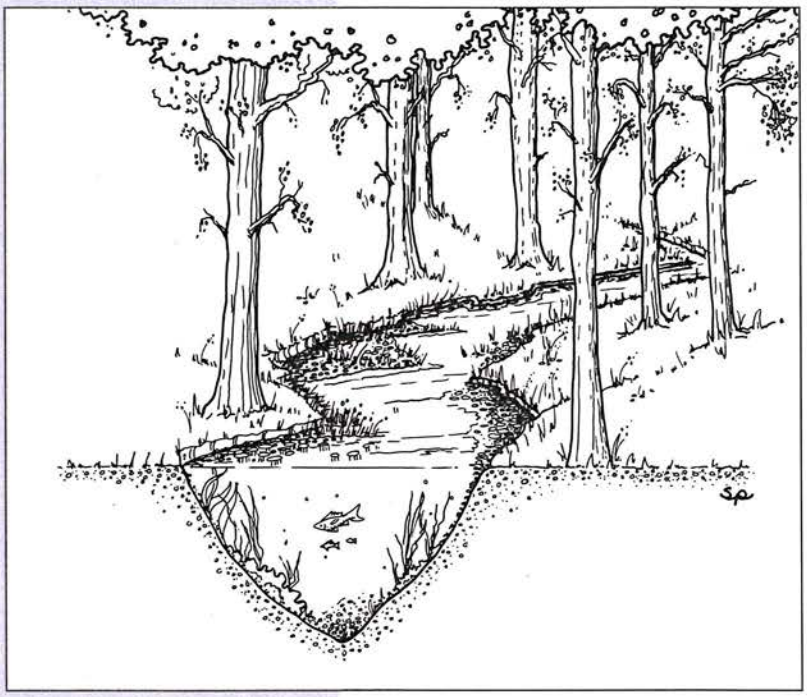
Certain activities, such as logging, road construction, grazing, and surface mining tend to expose bare soil, accelerating sedimentation and promoting unhealthy stream conditions. Other land uses may also contribute to erosion and sedimentation. In many forested areas, roads are the single largest cause of excess sedimentation.



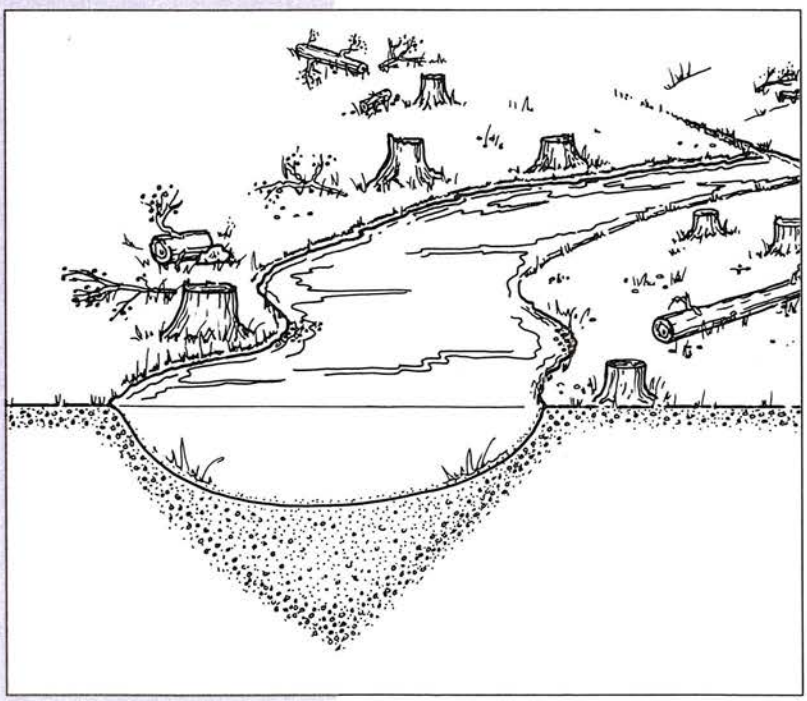
The majority of timber harvest activity is focused in northern California

California's forest land totals 101 million acres. Approximately 18 percent of the land in California is productive forest land. Half the timber harvested in California is from the North Coast Region. In 1992 California mills produced more than 2.9 billion board feet of softwood lumber.

The same area that is home to the rich forests has historically been excellent fish spawning habitat. The rivers contain deep pools which provide areas where fish can rest and remain cool. Filling of these pools limits the amount of resting area as well as the ability of fish to migrate upstream to spawn and the ability of juvenile salmon to escape downstream. The pools are filled when large, heavy sediment



Stream with riparian vegetation



Changes in streambed due to removal of vegetation

particles roll and drag along stream bottoms during high water flows and come to rest in the deeper parts of the stream. Sediment deposits fill streamways forming wider, shallower streams where there once were deep pools.

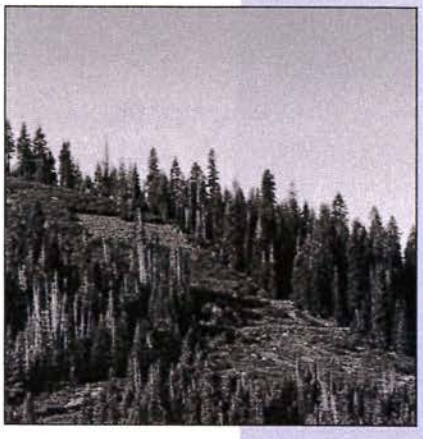
Finer sediment consists of silt and clay particles which remain suspended in water longer before settling out. Suspended sediment may irritate fish gills and cause other physical damage to fish.

Steelhead trout and salmon spawn in rivers and streams, hollowing out nest depressions in the stream gravel, then laying and covering their eggs with layers of gravel. They require clean gravels with adequate water flow, usually just below a deep pool; there cool, oxygen-rich water flows through the gravel and bathes the eggs. Salmon also seek a place with ample food and boulders where young fish can hide from predators. Within a year or less, most young salmonids migrate to ocean waters. If home streams are navigable, in two to five years they will return to spawn and renew the cycle.

Unfortunately, excessive sand, silt, or clay destroys this cycle, filling gravel spaces, eliminating underflow, and discouraging fish from spawning in the area. Eggs already laid may be buried in the sediment and suffocate. Newborn fish and the smaller organisms on which they feed cannot emerge through the sediment layer and die.

From the 1880s through the 1930s, timber harvest operations often left logs in stream bottoms. In many instances logging debris

buried creeks and streams, clogging channels with soil and wood slash. The effects of these past timber practices still remain today, and some streams will take decades to recover. For the most part, recovery depends on a stream's flushing capability. Where stream flushing occurs irregularly, recovery may take centuries.



Soil exposed due to logging

Sediment is not easily collected or removed after being deposited in streambeds. Therefore, approaches to prevent sedimentation have been attempted as a key to protect vulnerable rivers. In 1973, growing concern over California rivers and streams led to legislation requiring the Board of Forestry (BOF) to regulate logging practices. In 1983, the State Water Board certified a Water Quality Management Plan for National Forest System Lands which was developed by the U.S. Department of Agriculture, Forest Service (USFS). In 1986 a BOF and State Water Board Review Team examined timber practices in the State and concluded that noncompliance with timber harvest rules was the major reason for sediment problems related to timber operations. In response, the BOF increased inspections and adopted more rules to protect watercourses and lakes, covering activities such as design, construction, maintenance of logging roads and landings, site preparation, cumulative watershed effects, sensitive watersheds, and harvesting and erosion control. However, putting all of these mitigation measures into practice takes time.

Sediment and logging debris clogs river

Now both the USFS and BOF have adopted forestry practices and regulations to protect fish and drinking water. One regulation provides extra protection for areas especially susceptible to damage from timber operations. Many waterways in the North Coast Region as well as the Sierra-Nevada are recognized through this process as sensitive areas; for example, the Mokelumne watershed, Scott River, and Mattole River. Another practice is to schedule timber harvests at times least likely to cause damage to sensitive streams. Many road systems in forested areas need alteration. Relocating roads which contribute to excessive sedimentation is often feasible, and strategically placing roads to serve several areas can minimize the amount of road in a given area. Closing old decaying roads and minimizing road construction can also reduce degradation.

Addressing each drainage system holistically on a watershed scale, prioritizing vulnerable watersheds and developing methods to lessen the effects of timber

operations in those areas may offer the best solution to this problem. We need to better educate the public on the effects of sedimentation and encourage cooperation between public agencies and private property owners. Public education can achieve understanding and sensitivity to different needs and values.

In Plumas County, for example, Pacific Gas & Electric Company discovered sediment buildup in several hydroelectric reservoirs. The company successfully conducted a broad education campaign aimed at fostering public stewardship of the land. Over 14 public agencies responded and many local citizens became environmentally conscious and economically motivated.

This approach is commonly known as Coordinated Resource Management and Planning (CRMP). This method can produce agreements among diverse entities on natural resource issues including water quality. Through CRMP, private landowners and resource management professionals together identify issues and establish actions to solve problems. In California, cooperation with USFS, California Department of Forestry (CDF), county jurisdictions, and private land owners is essential for desired improvements.

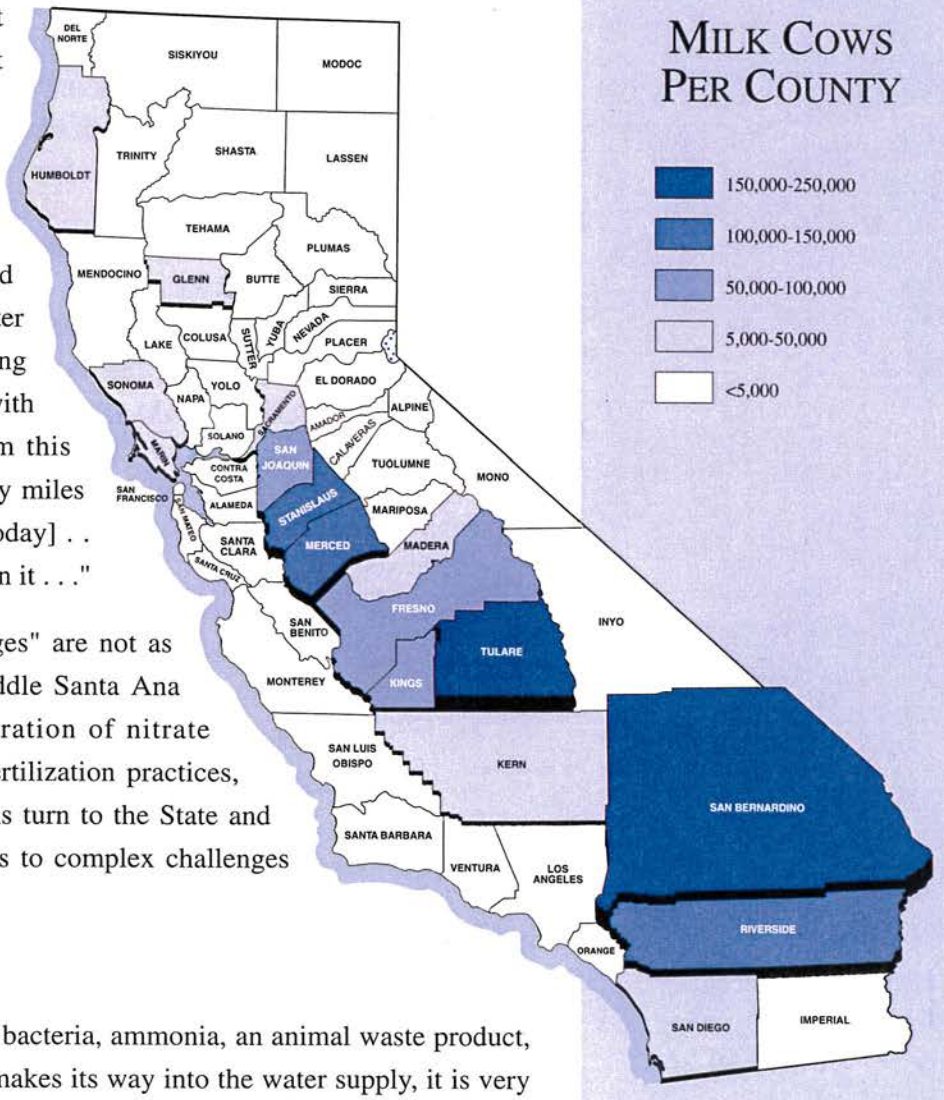
Sedimentation impacts are not limited to forested areas. Naturally high siltation rates occur in areas with combinations of heavy rainfall, steep slopes, and low vegetation cover. This can be made more severe by road building activities. The San Lorenzo River, for example, occupies a broad watershed in the Santa Cruz area. Homebuilding in the 1960s and 1970s produced excessive sediment in the river resulting in a loss of steelhead trout. In response, the County declared a moratorium on homebuilding. Involved citizens organized river restoration projects in an effort to save the fish. Realizing the importance of controlling siltation, the County adopted several erosion and grading ordinances, including prohibitions on grading hillsides during winter months and similar restrictions on slopes of greater than 30 percent.

Today, the area is considered "built out", and home building no longer poses a threat. The reduction in siltation has brought about beneficial changes and a local awareness of what excessive sediment can do. Now emphasis focuses on landslide prevention with less concern over road building and maintenance. The remaining concern is to ensure that erosion control ordinances are vigorously implemented and that local citizens continue the practices necessary to keep their rivers healthy.

CHAPTER 6

NITRATE: FINDING ANSWERS FOR THE SANTA ANA

In southern California, hot, dry summers are offset by mild, wet winters contributing to an excellent environment for agriculture. Recognizing this, a Mormon colony set up residence in San Bernardino in about 1840. Farmers planted wheat, beans, peas, and vineyards, and raised cattle which roamed the valley. A letter to Brigham Young offers the following description: "The rancho connected with the valley is about thirty miles from this place [Los Angeles], and about twenty miles from a good ship landing [Newport today] . . .There are excellent water privileges on it . . ."



Today these "excellent water privileges" are not as pristine as they once were. The middle Santa Ana River suffers from a high concentration of nitrate coming from dairy runoff, historic fertilization practices, and sewage treatment plants. Citizens turn to the State and local water boards to provide answers to complex challenges facing the Santa Ana River.

What is nitrate and why is it harmful?

In the presence of oxygen and certain bacteria, ammonia, an animal waste product, is changed into nitrate. Once nitrate makes its way into the water supply, it is very difficult to remove.

High nitrate levels can upset aquatic life and even threaten human life. Where water high in nitrate and other nutrients is ponded or held for extended periods behind dams, microscopic plants called algae "bloom" grow wildly and die almost as quickly, depleting the oxygen dissolved in the water that fish need to live.

In drinking water supplies, the "blue baby syndrome" can result from high levels of nitrate. Nitrate is altered by metabolism to a compound which affects the oxygen-carrying capacity of the blood; infants with this problem are oxygen-deprived and actually turn blue.

Nitrate enters the river in part from the large dairy industry located in the Chino area about 30 miles east of Los Angeles. But there are other sources too. Since those who have the "excellent water privileges" have taken essentially all the flow from the upper Santa Ana River, the middle river is made up of treated wastewater and rising ground water. That ground water carries high nitrate levels from historically excessive application of nitrogen fertilizers in the first century of agricultural development.

The Santa Ana River's headwaters lie high in the San Bernardino Mountains. In the valley below, river flows naturally percolate into the ground water supplying the wells of all the towns and cities along the way. In Orange County, the local water district actively diverts the river and percolates essentially all of it for eventual extraction and use as drinking water.

Since the river--including dairy runoff and wastewater--is used in this way, nitrogen control is a top priority of the California Regional Water Quality Control Board, (Santa Ana Regional Water Board). Wastewater treatment plants must lower nitrogen levels in the effluent. Four treatment plants (in Riverside, Rialto, Chino, and Ontario) are already practicing some nitrogen control; in November 1991, the Santa Ana Regional Water Board ordered Colton and San Bernardino to upgrade their facilities by 1995. The cost to modify all six treatment plants is between 150 and 200 million dollars which averages three to four dollars per month per customer. River visitors benefit from improved recreational water quality.

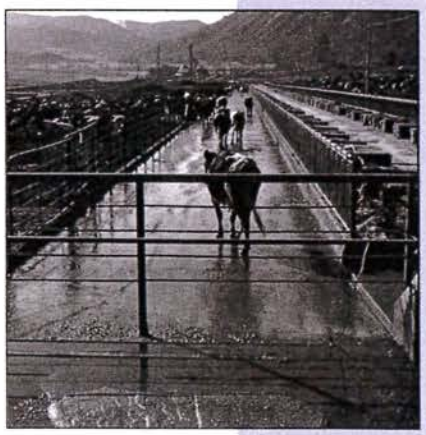
Dairies continue to be a major source of nitrogen and other salts in the Santa Ana River watershed as they are in many parts of the State. Chino Basin, home to over 250 dairies and about 400,000 cows, is west of Riverside. Large amounts of manure with few ways to get rid of it result in piles, large and small, dotting the area. When it rains, chemicals in the manure including salts and nitrate percolate into the ground tainting the underground water supplies. These waters also rise to the surface and add their flows to the river.

How much salt flows from these ground waters into the Santa Ana River? A 1990 Santa Ana Regional Water Board report concluded that "97 percent of the salt load added to the ground water was from agriculture" and "88 percent of that load was

from the dairies alone". Surprising? Not when you realize that last year, over 600,000 tons of manure was produced in this area!

The Santa Ana Regional Water Board recognizes the importance of the dairy industry to the community as a whole, and thus has developed a strong, positive working relationship with two of the major dairy organizations in San Bernardino County. Since the dairies often use their own home-grown manure as fertilizer for the alfalfa and other animal feeds they grow, nitrate can also reach the ground water from this source. Manure typically contains too much salt and not enough nutrients, compared to commercial products; the Santa Ana Regional Water Board therefore limits the use of manure for growing these crops. Where manure is spread on the land simply as a means of getting rid of it, the application rate is strictly controlled to avoid water quality problems.

Dairy cows spend their days in the corrals where they often stand or lie in accumulated manure, so they must be thoroughly washed before each milking. The Santa Ana Regional Water Board insists that this washwater, laden with nitrate and manure, be disposed of on the dairy property using berms to prevent surface runoff. In the dry season, at least, this water is kept away from the river.



Dairy cows

Inspections and voluntary annual reports from the dairies to the appropriate Regional Water Board constitute a reasonable monitoring program for the industry. The best time to inspect dairies is during the rainy season when inadequately sized washwater ponds may spill over and berms are put to the test. The Santa Ana Regional Water Board's goal is to inspect each dairy each year.

In its annual Dairy Management Report, each dairy describes the details of its operation including the number of animals, the amount of manure produced, and the dairy's manure disposal practices. By sending out reminder notices, the Dairy Council aided in collecting these reports last year; every dairy turned in its report on time.

Other steps to lighten the river's salt load include construction of a co-composting facility in the area. This facility will combine sewage sludge with dairy manure creating a soil amendment that is better than either alone. Some will be exported from the region effectively exporting salt as well. Also in the planning stage are

several more ground water desalters funded in part by the Agricultural Drainage Loan Program--a California State program. In these desalters ground water rich in nitrate and other constituents is pumped up through well networks, then treated until suitable for drinking. The salts themselves are discharged to the region's brine line which carries the salts from inland areas to the ocean.

Identification of increasing levels of nitrate in the Santa Ana Region and ways to control the problem means, finally, that corrective steps are at hand. By obtaining cooperation from dairies and local water districts, the Board accomplished much. All those involved--on both sides--who helped build communication and relationships between the organizations are to be applauded.

CHAPTER 7

OPEN RANGE LIVESTOCK: THEY CAN MUDDY THE WATERS

In the lush meadows and pastures that fill the stream valleys of the east side of the Sierra-Nevada, ranches with roaming livestock are an important industry. In the heat of summer, these animals naturally congregate near water to drink, eat, and cool down. But where their access to streams is unrestricted and grazing management is slim, livestock may damage streams in several ways.

First, they can muddy the water, both by walking in streambeds and by trampling the banks. As we have seen (Chapter 5), the resultant erosion and siltation chokes aquatic life. Siltation can kill fish directly, impact fish spawning, or even destroy the insects fish eat for food.

Grazing livestock

Second, increased animal manure in streams raises the nitrogen level and may increase bacteria levels in the stream with the same results seen at poorly managed dairy farms (Chapter 6). Nitrogen stimulates algal growth, and the die-off of algae further robs the stream of oxygen. Plant growth in the streams increases because more sunlight is available than in the original, deeper, uneroded channel. Furthermore, some of the nitrogen occurs as ammonia which is poisonous to aquatic life, and its toxicity is made greater by higher temperatures and lack of oxygen. Increased bacteria pollute the water for drinking.

Third, all of the above effects--siltation, growth of nuisance algae, loss of oxygen--are exacerbated because livestock remove streamside vegetation. With the streamside vegetation removed, the streambanks more readily collapse and erode. As the streambanks erode, the streams become wider and shallower. With this change in stream shape combined with fewer trees, shrubs, and grasses to shade the banks and water, stream temperatures rise. The warmer temperature drives oxygen from the stream water and puts stress on cold-water fish like trout.

Fourth, the loss of streamside foliage has another, more surprising effect on aquatic life: eliminate vegetation and you may put fish on a starvation diet. This is because streambank vegetation is an important place for insects to live, insects that serve as food for fish such as trout. The net result of all these changes can be serious harm to a mountain or meadow trout stream. The damage strikes both in the water and

alongside it for, as noted previously (Chapter 2), streambank vegetation in arid California is a mainstay of biological diversity. Where plant cover is lost, so too is a great variety of animal life lost.

This sort of decline doesn't happen overnight. And it may not be noticeable at the outset. Furthermore, in those parts of California where grazing has long been the chief land use it is hard to visualize the riparian habitat that was once there. In places like the Owens River watershed, public and private owners have used the land for livestock grazing for years.

The U.S. Forest Service, Bureau of Land Management, and the Los Angeles Department of Water and Power (LADWP) are the largest landowners, while many private ranchers own smaller parcels in the Owens Valley and lease additional pasture from the public owners. Recently, the Lahontan Regional Water Board began to stress the need for improved grazing management planning, as few of the large non-federal landowners had formal grazing management plans to protect streams from degradation. As a result, recent fencing projects and improved grazing management by LADWP has resulted in improvements in streamside vegetation.

Several practices can help protect streams, yet sustain adequate food supply for livestock. Some of these are aimed at excluding livestock from large portions of sensitive streams. The techniques include obvious ones like fencing the streambank, and more experimental methods such as the use of electronic ear tags that provide a mild shock when the animal comes too close to the stream. Construction of watering holes away from streams has been successful in Colorado and is being used in parts of California. Pasture rotation systems which allow pastures to be rested and provide a period of recovery from intensive grazing are also an option.

Other practices aim at rehabilitation of the watercourse. These include placement of logs or rocks beneath banks, replanting of native vegetation to restore bank stability and prevent erosion, construction of a deeper, narrower channel in degraded streambeds so stream flows last longer into the summer and stream temperatures do not increase as fast, and where feasible restoration of the original stream contour.

Livestock managers need to include restoration and preservation of water quality, streamside vegetation, and fish habitat in their goals. Currently the State and Regional Water Boards seek voluntary cooperation from ranchers to reduce siltation, overuse of streamside vegetation, and other harmful effects. Other industries have shown that the most effective control strategies originate from the practitioners (i.e., ranchers) themselves. Heightened awareness of those activities that impair streams is but the first step toward necessary improvements.

CHAPTER 8

TIJUANA RIVER: IS A SOLUTION IN SIGHT?

The Tijuana River which flows north from Mexico to San Diego County contains untreated domestic and industrial wastewaters from the Mexican border Cities of Tijuana and Tecate. The health of the citizens of both Mexico and the United States is threatened by this discharge, and water quality in the Tijuana National Estuarine Reserve and at the beaches of south San Diego County is degraded.

The combined populations of Tijuana and Tecate are estimated to exceed one million people. Mexico has not expanded its wastewater system fast enough to keep pace with the population growth. Thus, approximately one-third of Tijuana is currently unsewered. The City of Tecate provides no treatment at all for any of its wastewater. By 1991, 13 million gallons per day of raw sewage flowed in the Tijuana River.

Tijuana River near California border

The need for adequate wastewater collection, treatment, and disposal for Tijuana has long been recognized by officials in both countries. In the fall of 1991, Mexico completed construction of a small dam and collection system designed to divert sewage to the San Diego wastewater treatment plant. During dry weather, when the river's natural flows are low and the wastewater collection facilities are working, no sewage flows in the river. During the rainy season, high flows in the Tijuana River mix with the sewage. When the volume of water is too large to treat, the diversion pipeline is shut down and a mix of sewage and rain water flows into San Diego County. The City of San Diego agreed to provide treatment for up to 13 million gallons per day of Mexican wastewater diversions.

However, because of its own population growth, the City of San Diego cannot long continue to treat and dispose of Mexican wastewater. In the near future, all Mexican wastewater will have to be treated in new facilities constructed either in Mexico or the United States.

The existing treatment capacity is no more than 25 million gallons per day for Tijuana and none exists for Tecate. In the next 20 years, populations of Tijuana and Tecate are expected to nearly double and the wastewater treatment and disposal

needs are anticipated to quadruple. Since 1981, the State and Regional Water Boards have been working with the federal government and local agencies to plan, build, and operate a joint international treatment facility in the United States and a long pipeline for ocean disposal. This team effort is beginning to pay dividends. Planning is nearly complete for a 25 million gallon per day treatment plant to be located in San Diego County which will treat Mexican wastewater. This plant is designed for future expansion to 100 million gallons per day. Treated wastewater from this plant will be discharged approximately three miles out in the Pacific Ocean. Ground breaking for the first phase of the treatment plant occurred July 15, 1994. The entire joint facility is projected to be completed in 1998 and cost $388 million.

There is, however, only so much that facilities on the United States side can do to lessen the impact of Mexican sewage on the United States. It is essential that Mexico upgrade and expand its collection system so that all sewage from Tijuana and Tecate will be routed to the new United States facilities and to existing or future facilities operated by Mexico. In addition, it is imperative that Mexico initiate an industrial waste control program to lessen the toxicity of its wastewater.

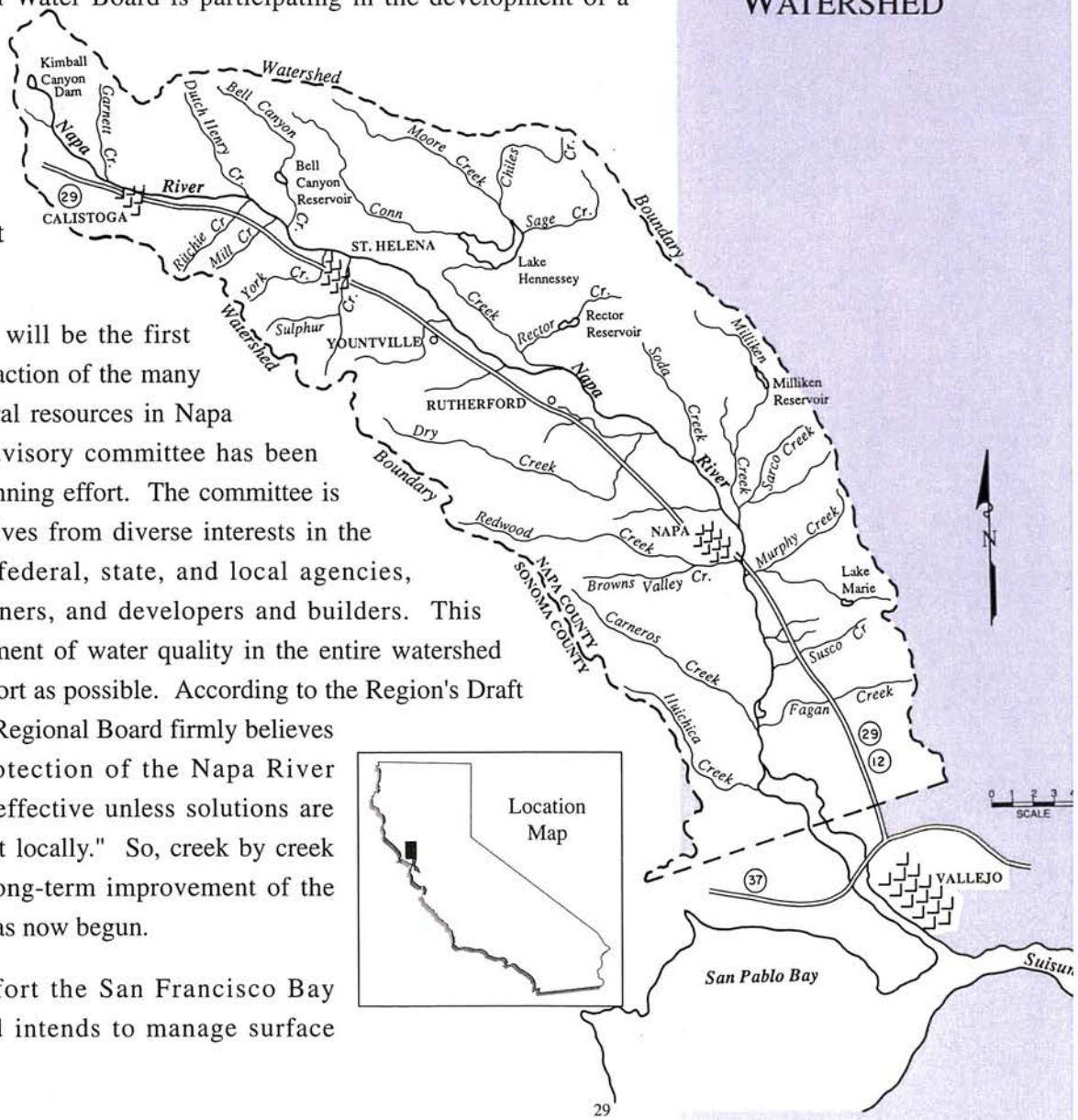
For the long term, the joint international facility can be viewed as the first phase of a much larger facility. The very day the proposed treatment plant begins operation, the sewage flows needing to be treated are expected to exceed the capacity of the plant.

These much-needed facilities, however, provide an important foundation upon which to expand sewage treatment and disposal. Along with the need for more funds in the future, there is the need for continued cooperation from Mexico and the United States governments. The State and Regional Water Boards will continue to work closely with all parties involved to plan and construct Mexican wastewater projects that ensure protection of public health and water quality.

CHAPTER 9

WATERSHED MANAGEMENT: THE ULTIMATE ANSWER?

In August 1992, the California Regional Water Quality Control Board, San Francisco Bay Region (San Francisco Bay Regional Board) pledged to improve the quality of the Napa River with a new and comprehensive approach. Urban and agricultural discharges of pollutants have degraded aquatic habitat in the river, the downstream marsh, and San Pablo Bay estuary. In response, the San Francisco Bay Regional Water Board is participating in the development of a Napa River Watershed Integrated Resource Management Plan, coordinated by the Napa County Resource Conservation District (RCD).



This management plan will be the first examination of the interaction of the many activities affecting natural resources in Napa Valley. A technical advisory committee has been formed to direct the planning effort. The committee is made up of representatives from diverse interests in the watershed, including federal, state, and local agencies, Audubon Society, vintners, and developers and builders. This process allows management of water quality in the entire watershed with as much local support as possible. According to the Region's Draft Watershed Report, "the Regional Board firmly believes that planning and protection of the Napa River watershed will not be effective unless solutions are designed and carried out locally." So, creek by creek and task by task, the long-term improvement of the Napa River watershed has now begun.

In this pioneering effort the San Francisco Bay Regional Water Board intends to manage surface

waters by watershed--the land and surface drainage encompassed within a single basin. Historically, water quality problems have been addressed by program; federal and state agencies have historically funded certain projects ordinarily tied to sewage treatment plants. Now most remaining water quality problems concern runoff from diffuse sources, oftentimes difficult to isolate and sometimes expensive to correct. The cumulative impacts of many small, diffuse contributions from various land use practices are evident but until just recently there was no coordinated attempt to reduce these diverse pollution sources.

Vineyards

Sediment buildup from erosion due to hillside construction of vineyards, homes, and dirt roads, and unstable stream banks affects nearly all segments of the Napa River, endangering sensitive fish and invertebrates downstream. In addition to destroying steelhead spawning grounds, this can cause water quality problems such as high nitrogen concentrations, and buildup of metals and pesticides in downstream sediments. In concert these features lead to poor conditions for aquatic life.

Within the last decade, two vineyard practices have helped considerably to reduce agricultural erosion. Grape growers refrained from tilling in steeply sloped vineyards to control weeds and instead cover crops--usually grasses--now grow between vines. Also, when growers prepare fields for new vines they level the soil with painstaking attention to drainage design. The Napa County Resource Conservation District worked with growers on applying the newest technologies in erosion control.

In the past, certain grazing practices in the Napa Valley also lowered the water quality of the Napa River. Herds of domestic animals muddied creekbeds, stirred up sediments, and disturbed stream bottoms. Manure loaded creeks with its accompanying nutrients, stimulated algal growth and severely strained aquatic life. Increased bacterial contamination of the river also lowered its recreational appeal.

Improved livestock management practices promise lower erosion rates. For example, many ranchers limit their animal numbers while rotating animal pasturage and stream access. On a related problem nearby in Sonoma County, dairymen are reducing their fertilizer applications to minimize nitrogen seepage into Stemple Creek. But these techniques are neither universally known nor practiced. There is still a need to expand efforts to reduce rangeland runoff.

Recently, Napa County citizens recognizing the need to address erosion problems in the watershed convinced local authorities to enact a Conservation Ordinance. This Ordinance confronts a wide array of erosion problems by restricting vegetation removal, requiring setbacks from streams, and promoting use of temporary soil stabilizing measures during construction. The Cities of Calistoga, St. Helena, and Yountville also passed ordinances on property creek set-backs--ranging from 35 to 100 feet--aimed primarily at preventing soil erosion into streams. Additional zoning requirements restrict building on slopes over thirty percent and control temporary soil storage on construction projects. Passage of these ordinances goes beyond community awareness of the problems; it shows genuine commitment to long-term improvements--one vital ingredient for a watershed protection program.

A Napa County ordinance in 1980 established zones along streams in which a permit is required for the removal of any natural vegetation. This sort of ordinance recognizes that vegetation removal can impair water quality in several ways, for example, by speeding the transfer of pollutants such as pesticides, fertilizers, and sediment to streams (see Chapters 5 and 7). The San Francisco Bay Regional Water Board report noted that urbanization, agriculture, and grazing have led to the loss of much streamside vegetation in the Napa River basin, but that there are now several ongoing and proposed projects aimed at reversing the situation through restoration and enhancement of riparian habitat.

In its Watershed Report the San Francisco Bay Regional Water Board outlined four initial tasks: to identify remaining problems and monitoring needs; identify involved agencies and stakeholders in the watershed, including landowners, agricultural groups, industrial groups, and environmental groups; identify potential funding sources; and in conjunction with all stakeholders select criteria for ranking problems and tasks needed to correct them. The proposed restoration and enhancement plan for the Napa River attempts practical solutions to erosion, agricultural runoff, and bacterial contamination through multi-agency, landowner, citizen, and industry cooperation.

One step that local citizens have taken to prevent further pollution has been to project the location, extent, and intensity of population growth and other added burdens to the watershed, such as increased urban runoff. By foreseeing further impacts to the watershed, private and public planners alike can consider actions which will perpetuate good water quality.

For the City of Napa, the formation of a Citizens Advisory Committee on growth direction has been one step toward reconciling land use priorities.

Warning Stencilled on storm drains

Napa County's General Plan also shows residents' involvement in managing Napa Valley growth. And the County boasts numerous policies to protect surface waters throughout the area.

Local volunteer groups have taken action at critical sites in the watershed. A cleanup of Napa Creek took place several years ago. Now citizens provide information on local water quality conditions and local residents take steps to revegetate stream corridors and restore deteriorating wetlands to their natural state. The Napa RCD has begun a pilot project in 3 schools incorporating the Adopt-a-watershed curriculum into the schools. The long-term goal of this project is to tailor the Adopt-a-watershed curriculum specifically to the Napa watershed thus educating youth about their local environment.

The potential for achieving long-term solutions from volunteer support is significant. For example, an all-out sign-posting campaign requires much participation and is an ideal vehicle for expanding local awareness of Napa Valley's water quality problems. The California Department of Fish and Game in Yountville has purchased stencilling equipment with symbols to discourage dumping of oil or other pollutants into storm drains. Many will be watching the Napa watershed restoration and enhancement; its progress may provide a model for others to follow.

CHAPTER 10

REGION-BY-REGION SUMMARY

This chapter provides a summary of the most prominent water quality issues for rivers and streams facing each California Regional Water Quality Control Board (Regional Water Board). Each section includes a brief description of the region, a map identifying a few of the highest priority rivers, and summarized information on the water quality in the form of pie and bar charts.

The first pie chart depicts the water quality of rivers and streams as assessed by the Regional Water Boards in 1991. Each slice represents the percentage of river miles considered good, intermediate, impaired, and those having unknown water quality. The bar chart depicts the relative percent of each source of the pollutants that cause the impairment. The second pie chart below the bar chart names the types of pollutants or other causes responsible for the water bodies being listed as impaired. Only a portion of the rivers and streams in each region have been assessed, chiefly those water bodies that the Regional Water Boards consider high priority. These charts should be considered estimates; however, they represent the best information available.

Although sewage treatment plants, factories, and industrial discharges are sometimes responsible for impairing water quality, few of the sources of impairments come from the end of a pipe. Most result from some type of land use like mining, logging, agriculture, storm and residential water use entering storm drains from urban areas, etc. Some types of pollution are the result of the loss of natural streamside vegetation which increases erosion rates and degrades water quality. In some cases these changes reduce the ability of the water body to support fish and wildlife.

Usually these sources of pollution are the unintentional outcome of the same activities that make or made California a prosperous state. There are no villains, just a lot of work to be done to change practices that have in some cases been done the same way for more than a century.

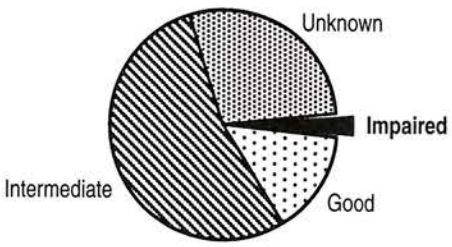
REGION 1

THE NORTH COAST REGION

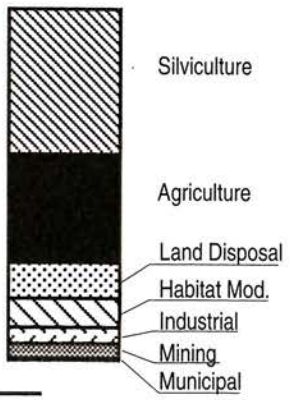
The North Coast Regional Water Board covers approximately 10 percent of the State yet yields about 40 percent of the surface water in the State. The region is characterized by numerous rivers and streams of the highest quality, with vast areas of wilderness and managed forests. Most significant point source discharges are well regulated and significant progress has been made with nonpoint sources. In addition to monitoring point sources and working with resource users to enhance beneficial uses, the primary focus is pollution prevention. While a small fraction of the waters have been assessed, these were generally found to be of good or intermediate quality.

In the North Coast Region only a small portion of the total assessed river and stream miles are impaired (about 84 miles). Due to the large number of smaller tributary streams a large percentage of the total river and stream miles have not been assessed. The economy of the North Coast relies heavily on the timber industry and agriculture. These activities provide jobs, however, they also create changes in the watershed that affect the beneficial uses associated with healthy rivers and streams. Because the area is not densely populated there is relatively small impact from the sources of impairment that are more common to highly populated areas such as storm drains and municipal sources.

RELATIVE PERCENT OF IMPAIRED RIVER AND STREAM MILES AND SOURCES OF IMPAIRMENT

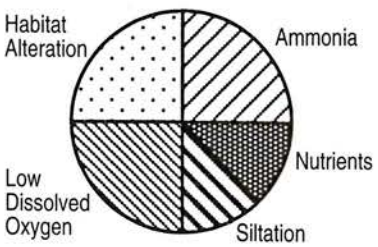


3,085 miles assessed



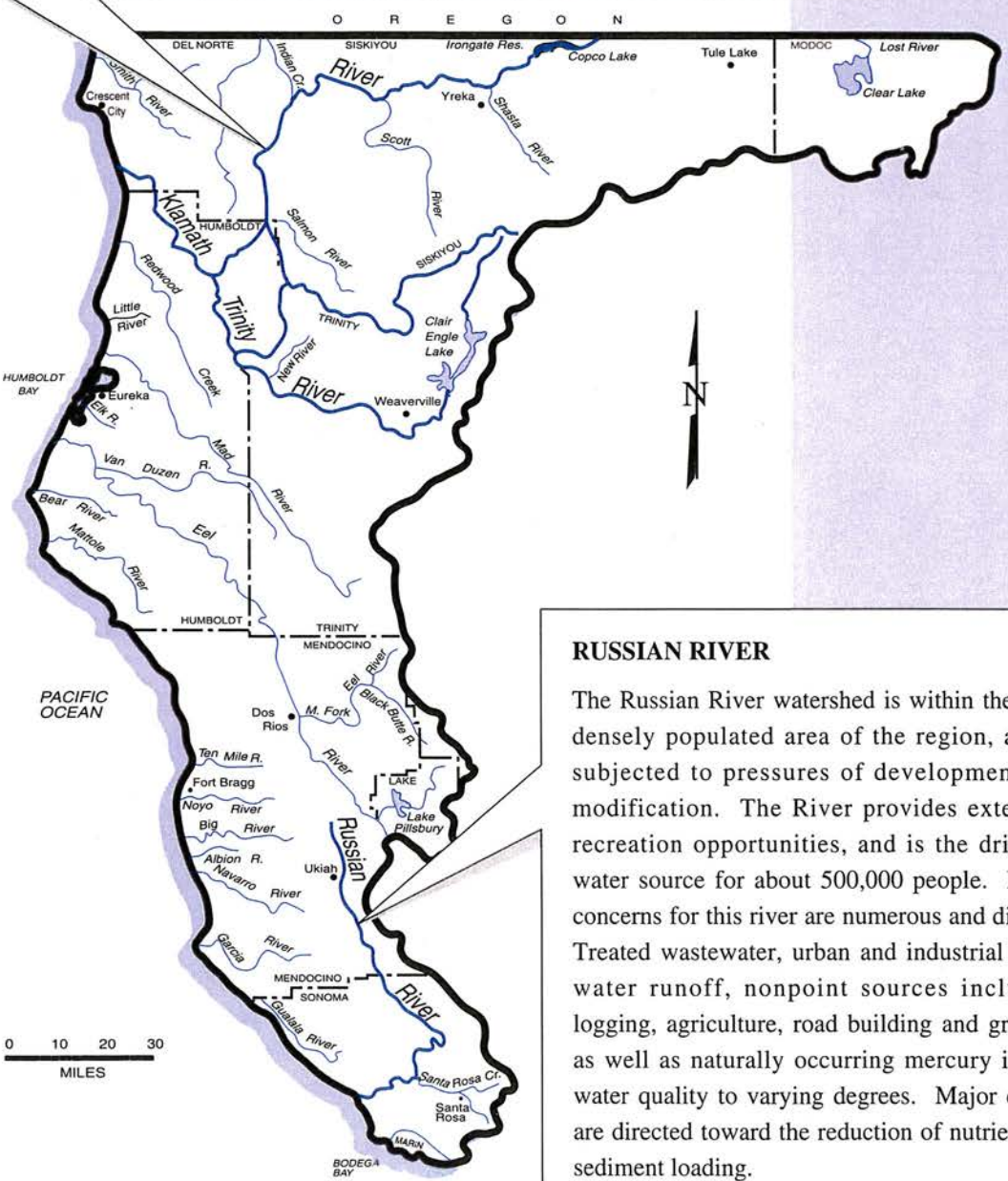
POLLUTANTS AND OTHER CAUSES OF IMPAIRMENT

Pollutants and other causes of impairment which are the result of activities shown in the bar chart.



KLAMATH/TRINITY RIVER SYSTEM

Together, the Klamath and Trinity Rivers support the second largest chinook salmon population in California. While the upper part of the watershed supports extensive agriculture in California and Oregon, the balance of the river, below Iron Gate Dam, is designated Wild and Scenic River status. Current and historic land uses, such as mining, logging, road building, and agriculture have modified the physical and chemical qualities of much of the watershed. Severe and rapid reduction in the salmon populations have prompted the elevation of this watershed to the highest priority.



RUSSIAN RIVER

The Russian River watershed is within the most densely populated area of the region, and is subjected to pressures of development and modification. The River provides extensive recreation opportunities, and is the drinking water source for about 500,000 people. Public concerns for this river are numerous and diverse. Treated wastewater, urban and industrial storm water runoff, nonpoint sources including logging, agriculture, road building and grading, as well as naturally occurring mercury impact water quality to varying degrees. Major efforts are directed toward the reduction of nutrient and sediment loading.

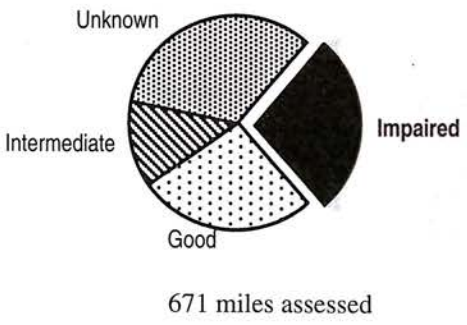
REGION 2

THE SAN FRANCISCO BAY REGION

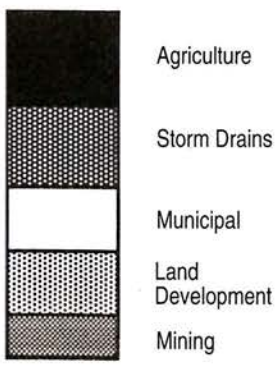
The area encompassed by the San Francisco Bay Regional Water Board is one of the largest urbanized estuaries in the country. Portions of the region also have significant agricultural areas, e.g., the Napa/Sonoma wine region. The rivers and streams of San Francisco Bay Region feed two of California's greatest estuarine assets--the San Francisco Bay Estuary and Tomales Bay. Water quality problems result from the diversion of fresh water inflow from the Sacramento/San Joaquin Delta. Other impacts come from the pollutants generated by the six to seven million people living in the region. This includes point and nonpoint, industrial and agricultural, and urban and rural sources of pollutants.

About one quarter of the assessed river and stream miles are considered impaired. More than half the river miles are considered good or are unassessed. The types of water quality problems facing the Regional Water Board are fairly well balanced between those that are typically considered rural (agriculture and mining) and urban (storm drains, municipal, and land development).

RELATIVE PERCENT OF IMPAIRED RIVER AND STREAM MILES AND SOURCES OF IMPAIRMENT

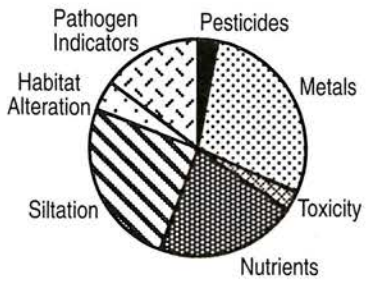


671 miles assessed



POLLUTANTS AND OTHER CAUSES OF IMPAIRMENT

Pollutants and other causes of impairment which are the result of activities shown in the bar chart.

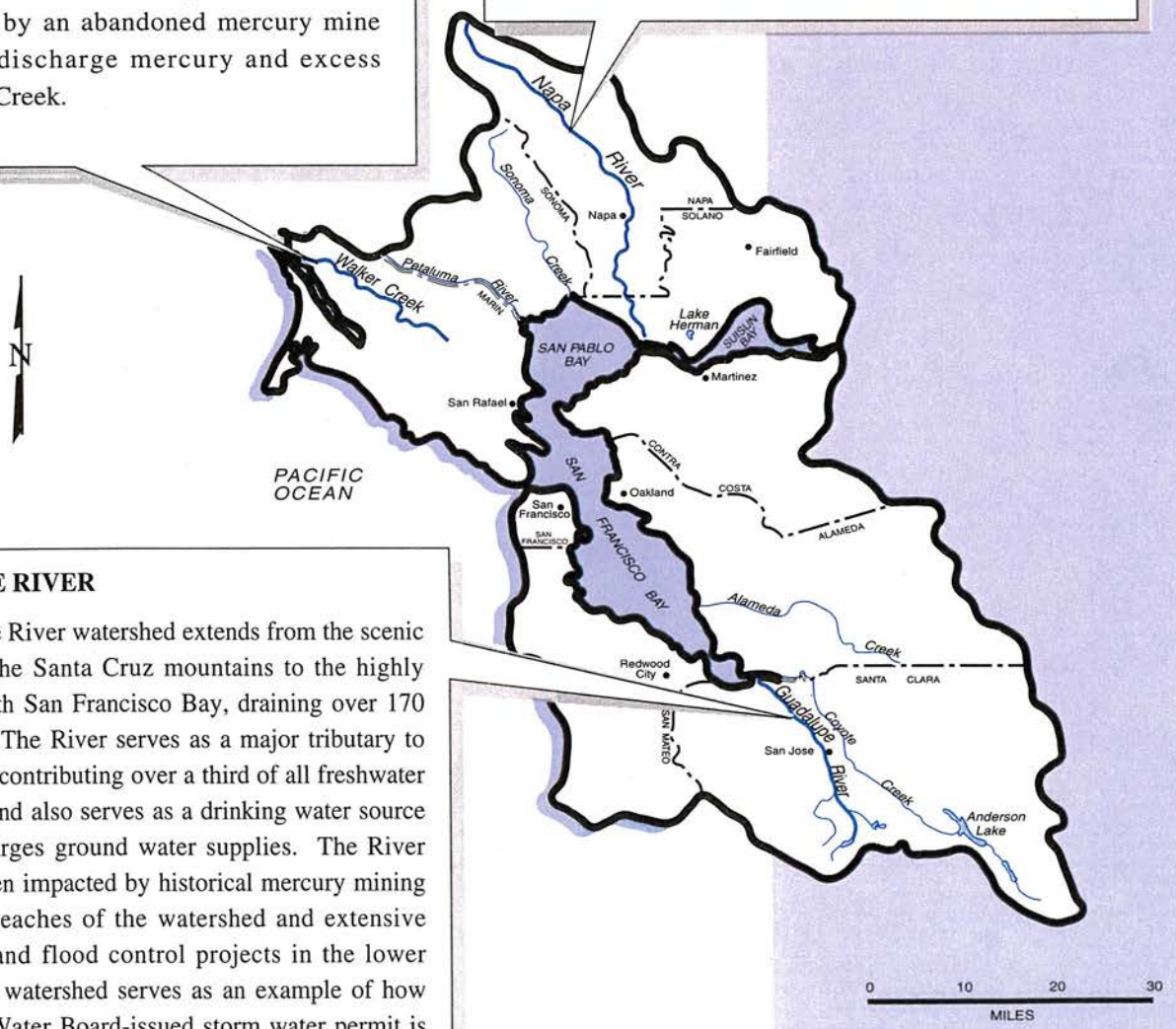


WALKER CREEK

Walker Creek is a major tributary to Tomales Bay--one of the most pristine estuaries remaining in the United States. The Walker Creek watershed supports a remnant run of steelhead trout and salmon. Early on the land was used extensively for logging and farming. Historic grazing and farming practices have lead to excessive erosion and sedimentation throughout the watershed. Today the land is used to support dairies, sheep, and cattle grazing. Dairy waste discharges increase nutrient and coliform bacteria levels, and subsequently reduce the oxygen levels in the streams. The Regional Water Board is working to remediate the impairment caused by an abandoned mercury mine that continues to discharge mercury and excess sediment to Walker Creek.

NAPA RIVER

The Napa River watershed is recognized worldwide for its scenic beauty, premium wineries, hot spring resorts, and rich diversity of fish and wildlife. The Napa River watershed supports a remnant run of steelhead trout and chinook salmon, and is the home for several endangered and threatened species. Erosion from new residential development, vineyards, and agricultural activities have impaired spawning grounds in the watershed and affected water quality. The Regional Water Board has been working closely with local agencies and the community in developing a comprehensive watershed protection management plan which includes developing erosion control strategies associated with residential development and vineyards. The Regional Water Board is also working with local agencies to develop an urban runoff control program.



GUADALUPE RIVER

The Guadalupe River watershed extends from the scenic reservoirs in the Santa Cruz mountains to the highly urbanized South San Francisco Bay, draining over 170 square miles. The River serves as a major tributary to the South Bay contributing over a third of all freshwater stream flows and also serves as a drinking water source where it recharges ground water supplies. The River system has been impacted by historical mercury mining in the upper reaches of the watershed and extensive urbanization and flood control projects in the lower reaches. This watershed serves as an example of how the Regional Water Board-issued storm water permit is facilitating local protection and restoration efforts. In addition, the Regional Water Board through its abandoned mine program has been requiring remediation of mines in this watershed.

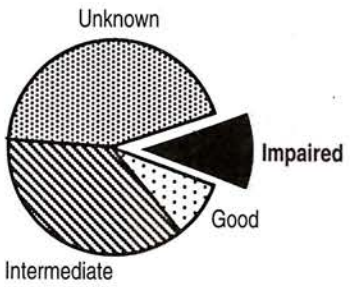
REGION 3

THE CENTRAL COAST REGION

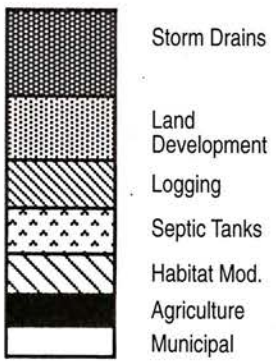
The Central Coast Regional Water Board includes a rugged seacoast, coastal mountain ranges, wide river valleys of prime agricultural land, a high rainfall redwood forest, and extremely arid inland plains. Many of the rivers and streams of the Central Coast have been harnessed by storage reservoirs for municipal and agricultural purposes. Surface water use has been overextended which has resulted in water quality degradation for aquatic habitat, ground water recharge, and other beneficial uses. Competition for adequate quality water will become more intense in the future.

About one eighth of the total river miles assessed are considered impaired. About the same amount of miles are considered good with the majority of river miles assessed as intermediate or unknown. The types of water quality problems associated with the impaired waters are more weighted toward urban (storm drains, land development, municipal) than rural (logging, agriculture).

RELATIVE PERCENT OF IMPAIRED RIVER AND STREAM MILES AND SOURCES OF IMPAIRMENT

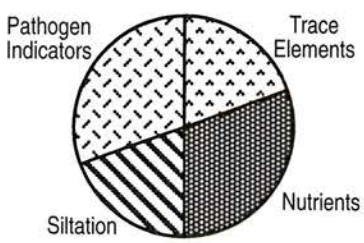


1,976 miles assessed



POLLUTANTS AND OTHER CAUSES OF IMPAIRMENT

Pollutants and other causes of impairment which are the result of activities shown in the bar chart.



SAN LORENZO RIVER

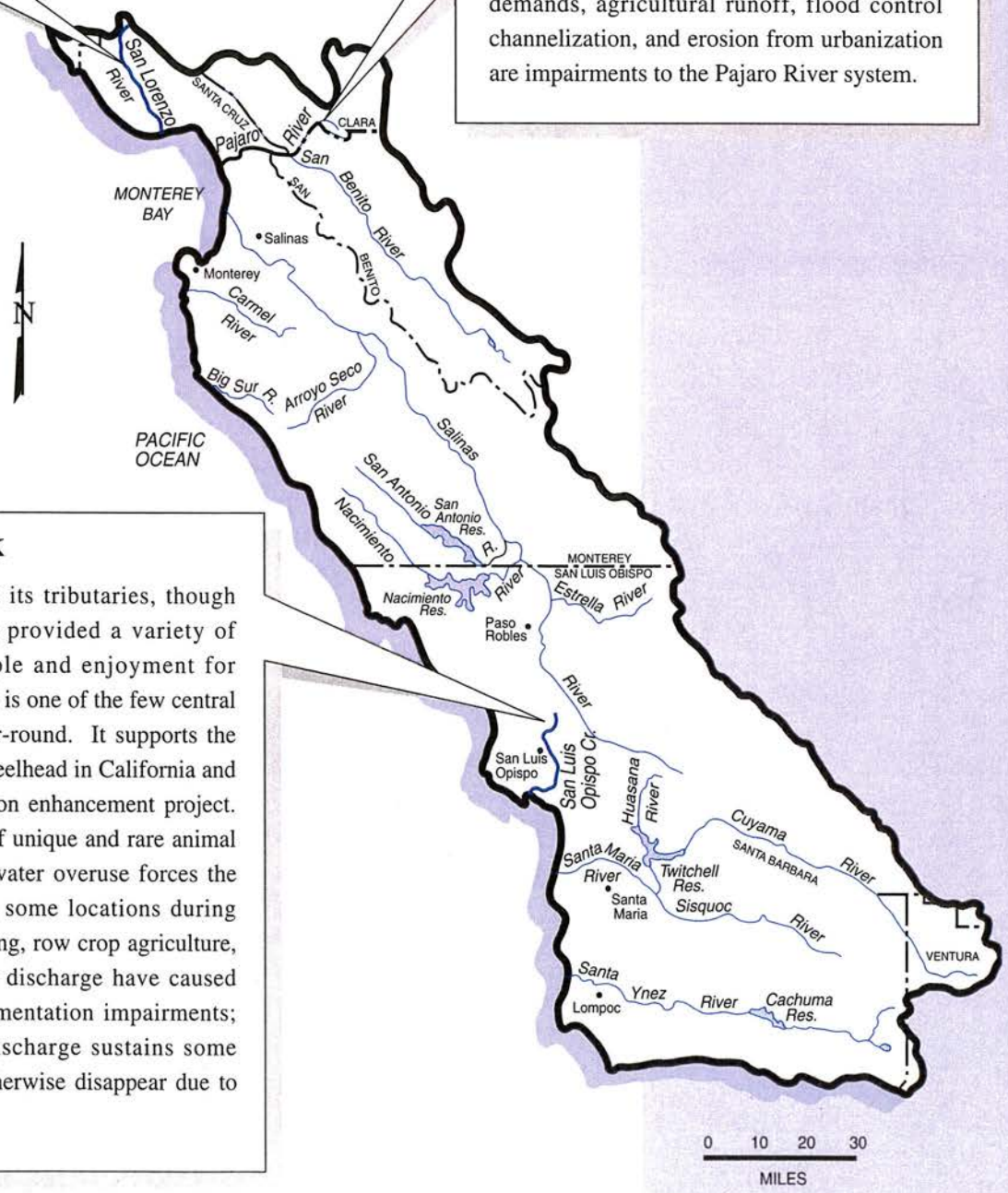
The San Lorenzo River is a highly used recreational water that supports a popular steelhead fishery. It enhances three State parks and at least two city parks and provides municipal water supply for about 100,000 people. Historic logging and land development have resulted in widespread sediment impacts to the River and many of its tributaries. Failing septic systems have long been a source of nitrate and bacterial impairment to the River.

PAJARO RIVER

The Pajaro River is one of California's major coastal streams. The Pajaro River, with its tributaries, provides habitat, migration routes, and spawning for steelhead, silver salmon, and other native and non-native species. When the River mouth is open, marine species such as striped bass and starry flounder travel into the estuary and adjacent sloughs for spawning. Increased water demands, agricultural runoff, flood control channelization, and erosion from urbanization are impairments to the Pajaro River system.

SAN LUIS OBISPO CREEK

San Luis Obispo Creek and its tributaries, though relatively small, have long provided a variety of benefits for the local people and enjoyment for numerous visitors. The Creek is one of the few central coast streams that flows year-round. It supports the southernmost population of steelhead in California and is home to a successful salmon enhancement project. It is also home to a number of unique and rare animal and plant species. Ground water overuse forces the creek to flow subsurface at some locations during summer months. Cattle grazing, row crop agriculture, and a municipal wastewater discharge have caused bacterial, nutrient, and sedimentation impairments; however, the wastewater discharge sustains some beneficial uses that might otherwise disappear due to lack of adequate water.



REGION 4

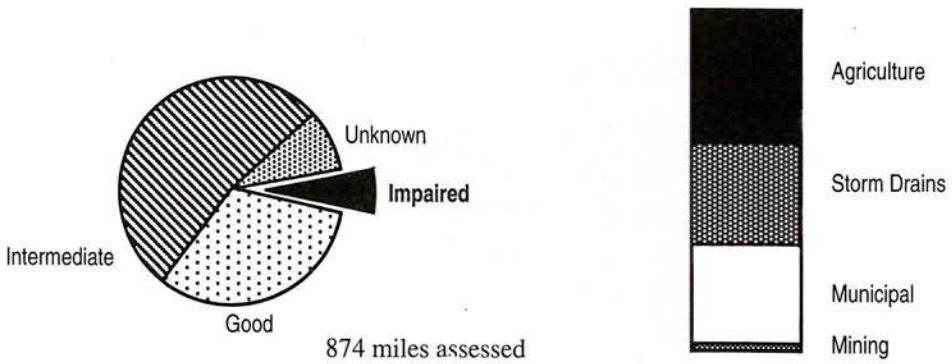
THE LOS ANGELES REGION

The Los Angeles Regional Water Board is characterized by a mix of pristine mountain streams, highly urbanized foothill and valley areas, and heavy residential and industrial coastal areas with highly used recreational beaches and harbors. All of these different land uses present actual or potential threats to water quality from either point or nonpoint sources of pollution.

In 1991, the Regional Water Board assessed 874 miles of rivers and streams, of which, 55 miles (<10%) were considered impaired and 464 miles intermediate (threatened). About a third of the river miles are considered good, and a small amount unknown.

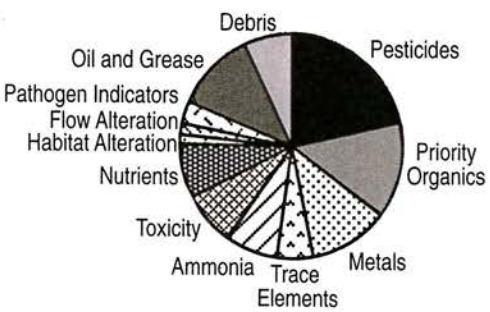
Although the Los Angeles region is densely populated with the characteristic water quality problems associated with storm drains and municipal discharges, there are also rich agricultural land within the region and these have significant influences on water quality.

RELATIVE PERCENT OF IMPAIRED RIVER AND STREAM MILES AND SOURCES OF IMPAIRMENT



POLLUTANTS AND OTHER CAUSES OF IMPAIRMENT

Pollutants and other causes of impairment which are the result of activities shown in the bar chart.

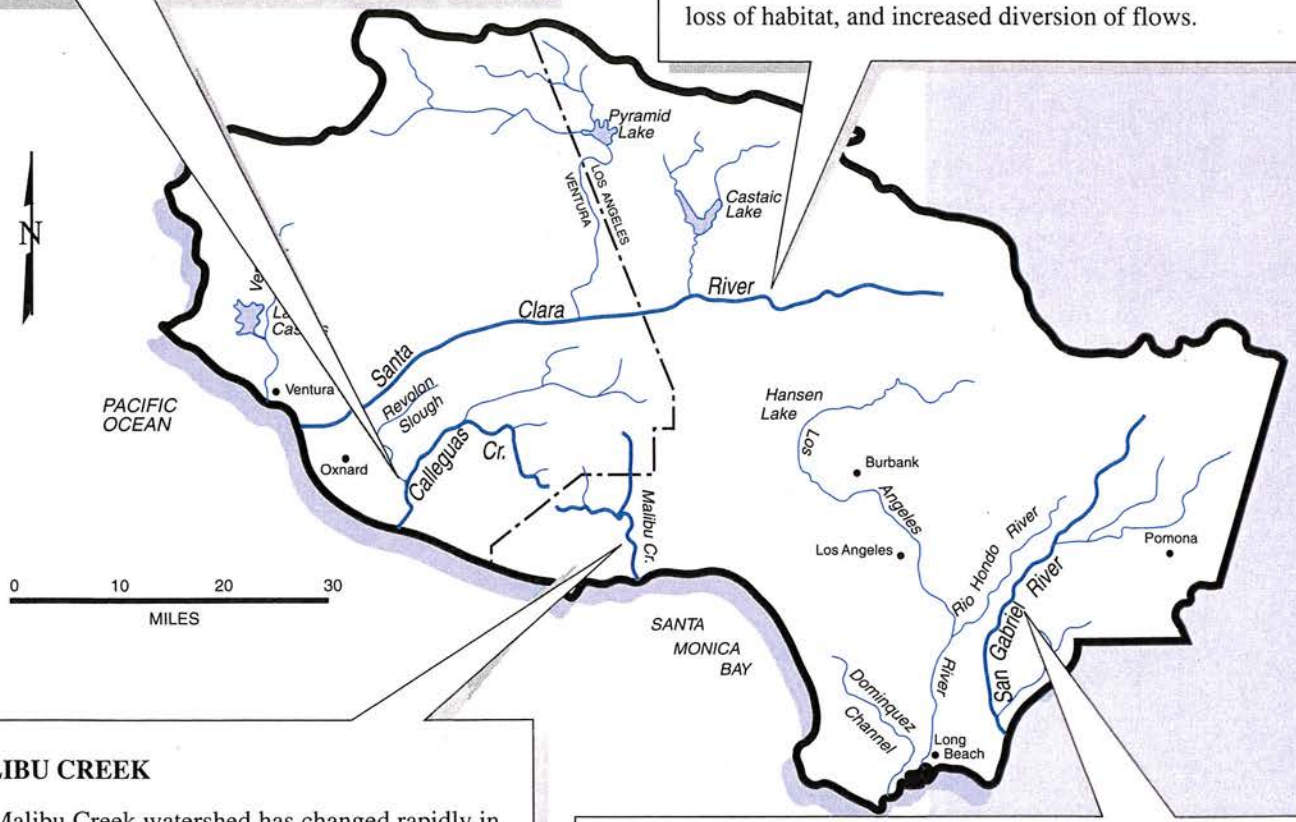


CALLEGUAS CREEK

Calleguas Creek drains a predominantly agricultural area in the Oxnard Plain. Increasing development in the watershed has increased slope instability causing severe erosion and sedimentation. Discharges from sewage treatment plants contribute ammonia, excess nutrients, and other dissolved constituents. Irrigation return flows carry suspended sediment, nutrients, and pesticides. Pesticides have accumulated in aquatic life and sediments.

SANTA CLARA RIVER

The Santa Clara River is the largest river system in southern California and is one of the last major rivers in the region that remains in a relatively natural state. Extensive patches of high quality riparian habitat are present along the length of the Santa Clara River and its tributaries. Because of its size and location, the River serves as an important stopover for migratory birds. This River provides habitat for several endangered and threatened species. Threats to water quality include increasing encroachment by development--resulting in channelization of tributaries, loss of habitat, and increased diversion of flows.



MALIBU CREEK

The Malibu Creek watershed has changed rapidly in the last 20 years from a predominantly rural area to a steadily developing area that has doubled in population to nearly 80,000 residents. Increased flows due to the use of imported water to support the growing population base as well as channelization and urbanization, have caused an imbalance in the natural flow regime in the watershed. Pollutants of concern, many of which are contributed by nonpoint sources, include excess nutrients, sediment, and disease-causing organisms.

SAN GABRIEL RIVER

The headwaters of the San Gabriel River originate along the southern slopes of the San Gabriel Mountains and carry vast amounts of sediment into the San Gabriel Valley and Coastal Plain. While the River and associated habitat in and along the headwaters of the San Gabriel River remain relatively pristine, these areas are heavily used for recreation (picnicking, fishing, and hiking), and some areas are threatened by this intensive use. The middle reaches of the River have been extensively modified to control flood and debris flows and to recharge ground water. Extensive sand and gravel operations are also found along the middle reaches of the River. The lower River is lined with concrete; flow in this stretch is dominated by wastewaters discharged from several municipal treatment plants and urban runoff.

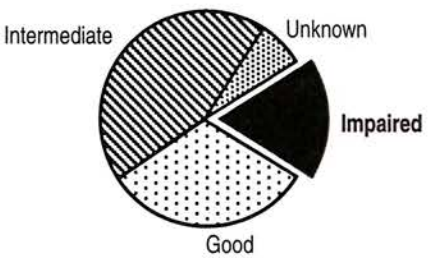
REGION 5

THE CENTRAL VALLEY REGION

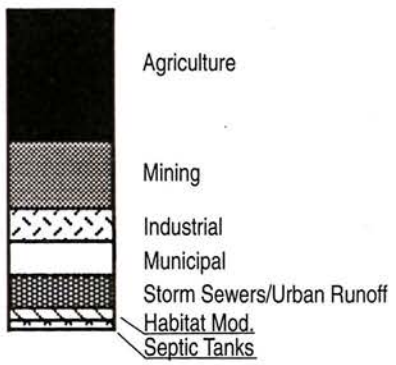
The Central Valley Regional Water Board is the largest of the nine Regional Water Boards, covering about 40 percent of the State. It stretches almost two-thirds the length of California from the Oregon border to the northern tip of Los Angeles County and includes all or part of 38 of the State's 58 counties. Its diversity is exemplified by extensive timber lands, active and abandoned mines, world renowned agricultural productivity from the Sacramento and San Joaquin Valleys and growing metropolitan areas. The main stems of the rivers and streams in the Region have been estimated to be approximately 5,800 miles. Of these, about 5,600 miles have been assessed by the Regional Water Board. Approximately one sixth of the rivers and streams (988 miles) are considered impaired, nearly one third are good, over one third are intermediate and a small fraction are unknown.

Slightly more than half of the impairments are the result of rural activities associated with agriculture and mining. The remaining river miles are impaired by activities that are the result of urbanization including industrial sources, municipal sources and storm drains.

RELATIVE PERCENT OF IMPAIRED RIVER AND STREAM MILES AND SOURCES OF IMPAIRMENT

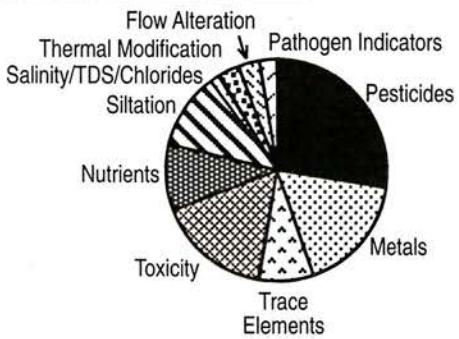


5,594 miles assessed



POLLUTANTS AND OTHER CAUSES OF IMPAIRMENT

Pollutants and other causes of impairment which are the result of activities shown in the bar chart.

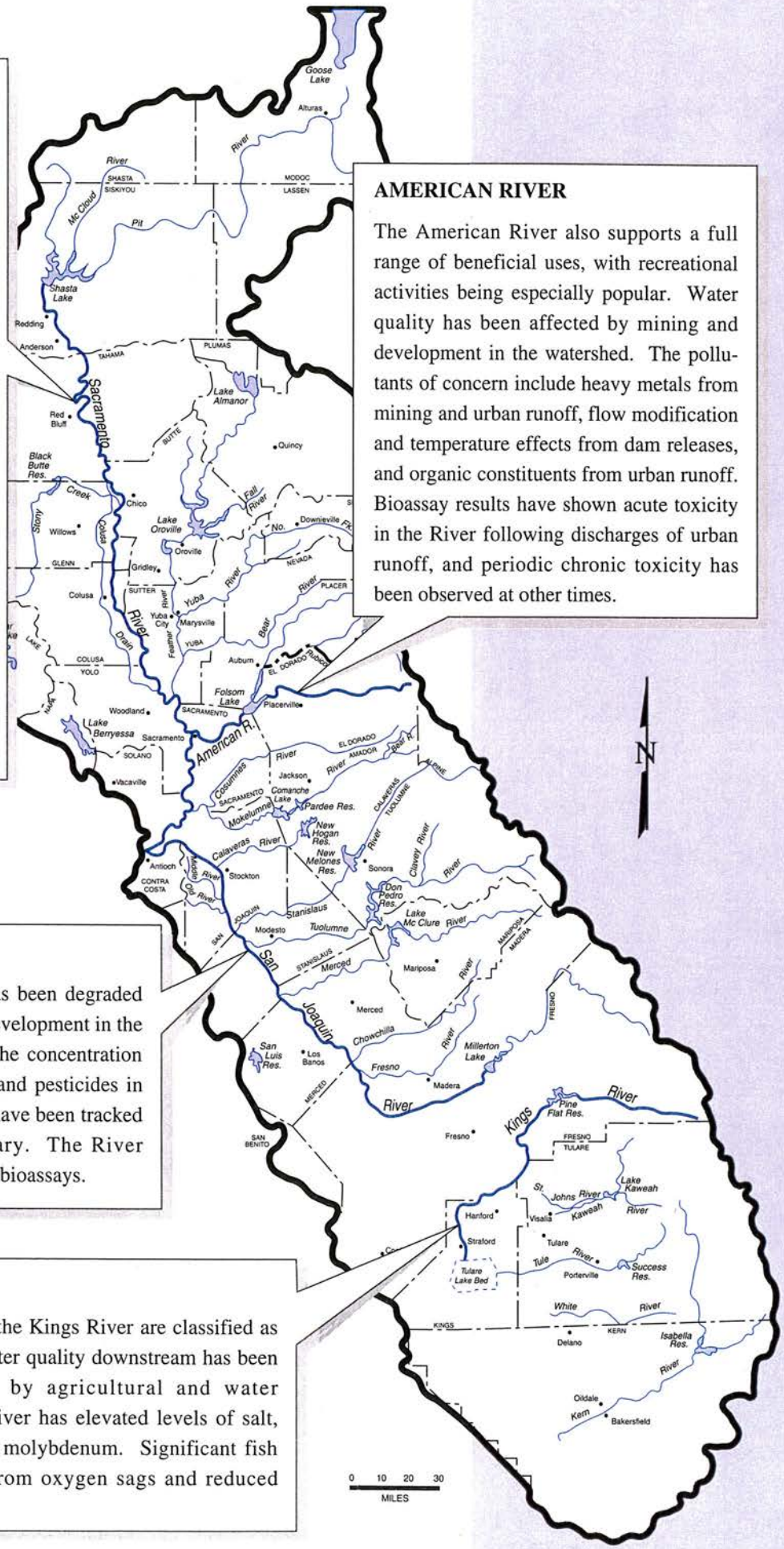


SACRAMENTO RIVER

The Sacramento River and its tributaries supply the majority of the surface water used in the State and supports a full range of beneficial uses, including a rare and endangered species of salmon. The River has been affected by seasonal discharges from mines, agriculture, urban runoff, and water development projects. The pollutants of concern include heavy metals from mines and urban runoff, pesticides from agriculture, flow modification and temperature effects from dam releases, and various organics from urban runoff. Heavy metals in the River cause reductions in the fish and invertebrate populations and have resulted in massive fish kills in the past. Pesticides from the Colusa Basin Drain have been shown to be toxic to striped bass and neomysis.

AMERICAN RIVER

The American River also supports a full range of beneficial uses, with recreational activities being especially popular. Water quality has been affected by mining and development in the watershed. The pollutants of concern include heavy metals from mining and urban runoff, flow modification and temperature effects from dam releases, and organic constituents from urban runoff. Bioassay results have shown acute toxicity in the River following discharges of urban runoff, and periodic chronic toxicity has been observed at other times.



SAN JOAQUIN RIVER

The San Joaquin River water quality has been degraded considerably by agricultural and water development in the watershed. This has greatly increased the concentration of salt, selenium, boron, molybdenum, and pesticides in the River. Elevated levels of pesticides have been tracked down the River and across the estuary. The River periodically tests acutely toxic in routine bioassays.

KINGS RIVER

The upper reaches of the Kings River are classified as Wild and Scenic. Water quality downstream has been heavily influenced by agricultural and water development. The River has elevated levels of salt, selenium, boron, and molybdenum. Significant fish kills have resulted from oxygen sags and reduced flows.

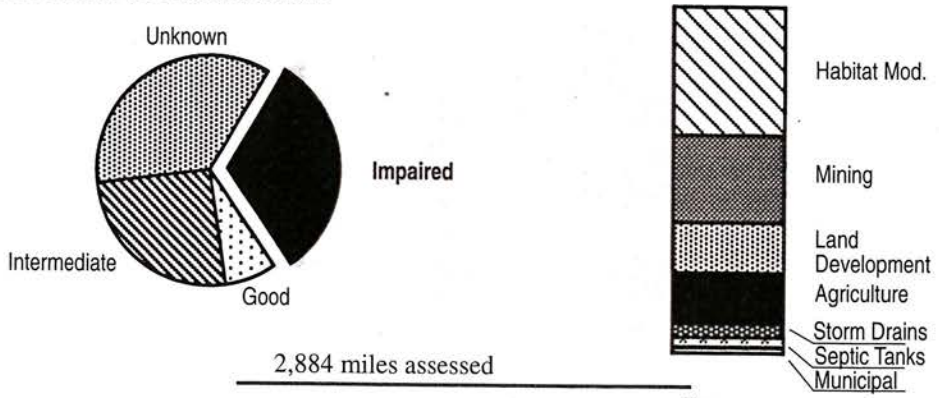
REGION 6

THE LAHONTAN REGION

The Lahontan Region, larger than the State of Maine, includes hundreds of streams. Many mountain streams have naturally excellent water quality; desert streams provide important aquatic and wildlife habitat. Both stream types historically supported rare fish species and subspecies. Many streams in the Lahontan Region receive heavy recreational use. Two streams are State wild and scenic rivers; many others are under study for federal wild/scenic designation. Very few point source discharges occur; some streams are impaired by water diversions or by nonpoint source problems. Most Lahontan Regional Water Board regulatory activities are related to nonpoint source control, including stream/watershed restoration efforts.

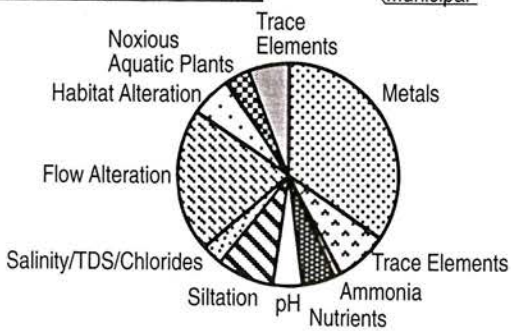
About one third of the river and streams miles are considered impaired and another one third is unknown water quality. Good and intermediate waters make up the remaining third. Water quality problems typical of the region result from using the land for livestock grazing or recreation use (habitat modification). Mining and impairments resulting from agricultural practices are also significant. About a third of the impairment is due to the urban pressures of increased populations (land development, storm drains, septic tanks, and municipal).

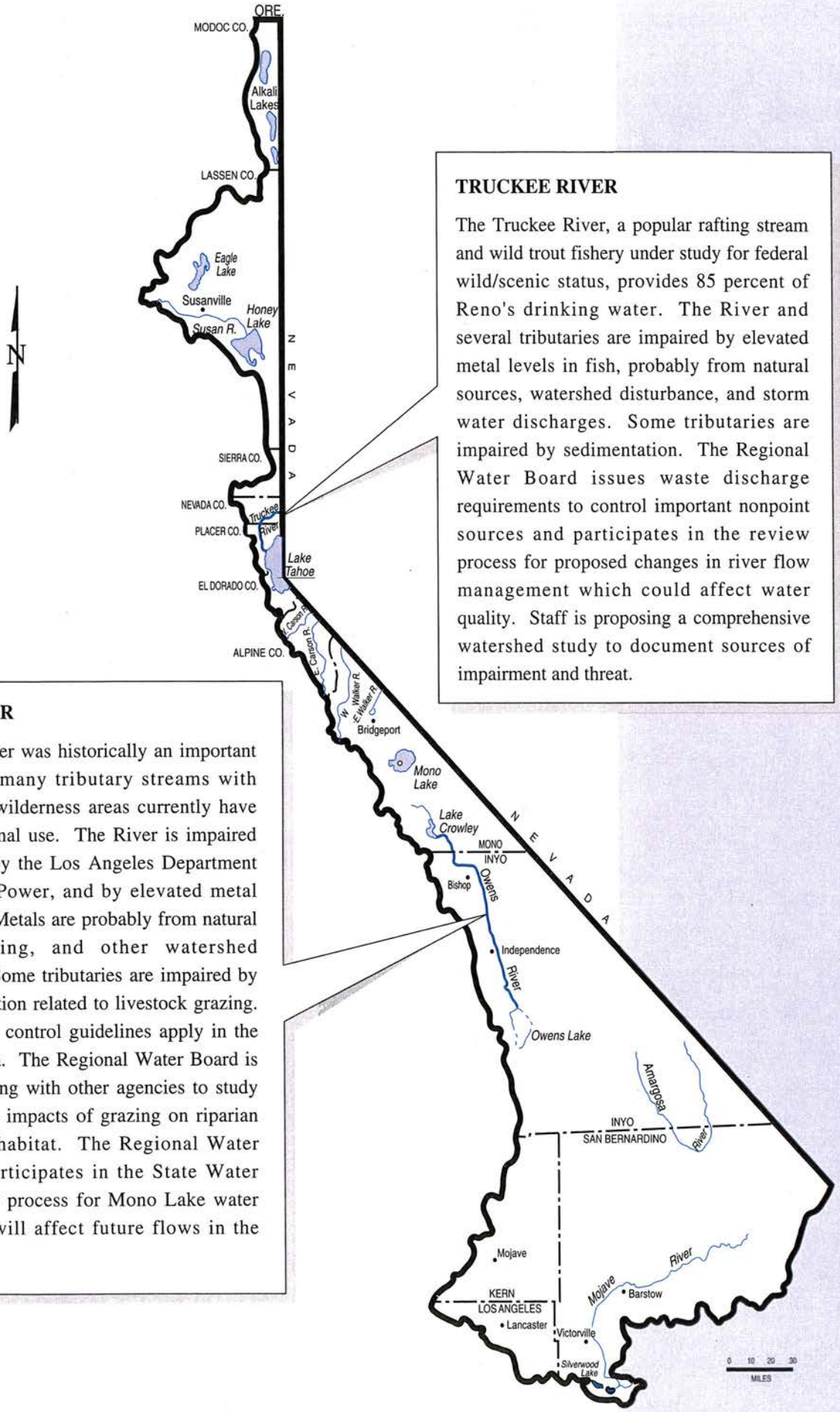
RELATIVE PERCENT OF IMPAIRED RIVER AND STREAM MILES AND SOURCES OF IMPAIRMENT



POLLUTANTS AND OTHER CAUSES OF IMPAIRMENT

Pollutants and other causes of impairment which are the result of activities shown in the bar chart.





TRUCKEE RIVER

The Truckee River, a popular rafting stream and wild trout fishery under study for federal wild/scenic status, provides 85 percent of Reno's drinking water. The River and several tributaries are impaired by elevated metal levels in fish, probably from natural sources, watershed disturbance, and storm water discharges. Some tributaries are impaired by sedimentation. The Regional Water Board issues waste discharge requirements to control important nonpoint sources and participates in the review process for proposed changes in river flow management which could affect water quality. Staff is proposing a comprehensive watershed study to document sources of impairment and threat.

OWENS RIVER

The Owens River was historically an important trout fishery; many tributary streams with headwaters in wilderness areas currently have heavy recreational use. The River is impaired by diversions by the Los Angeles Department of Water and Power, and by elevated metal levels in fish. Metals are probably from natural sources, mining, and other watershed disturbances. Some tributaries are impaired by habitat degradation related to livestock grazing. Special erosion control guidelines apply in the Mammoth Area. The Regional Water Board is currently working with other agencies to study and control the impacts of grazing on riparian and instream habitat. The Regional Water Board also participates in the State Water Board's review process for Mono Lake water rights which will affect future flows in the Owens River.

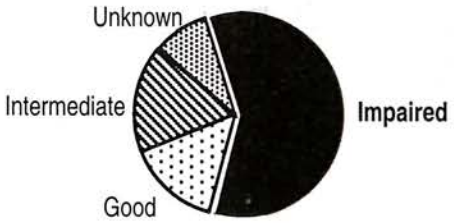
REGION 7

THE COLORADO RIVER BASIN REGION

The Colorado River Basin Regional Water Board covers the most arid area of California. Despite its dry climate, the region contains two substantial surface water bodies, the Colorado River and the Salton Sea. The five rivers that flow into and sustain the Salton Sea are, in order of size, Alamo River, New River, Coachella Valley Storm Water Channel, San Felipe Creek, and Salt Creek. The last two are natural, perennial waterways while the first three exist mainly because of their use as conduits for farm runoff flows from the Imperial and Coachella Valleys. Most of the water used to irrigate farmland in this region comes from the Colorado River via canals.

More than half the river and stream miles are considered impaired. This is due primarily to the fact that the Colorado River Basin has limited river miles and many of those are the result of transporting agricultural runoff. Other river miles consist mainly of sewage overflows from south of the border. Good and intermediate waters make up approximately one third of the total river miles.

RELATIVE PERCENT OF IMPAIRED RIVER AND STREAM MILES AND SOURCES OF IMPAIRMENT



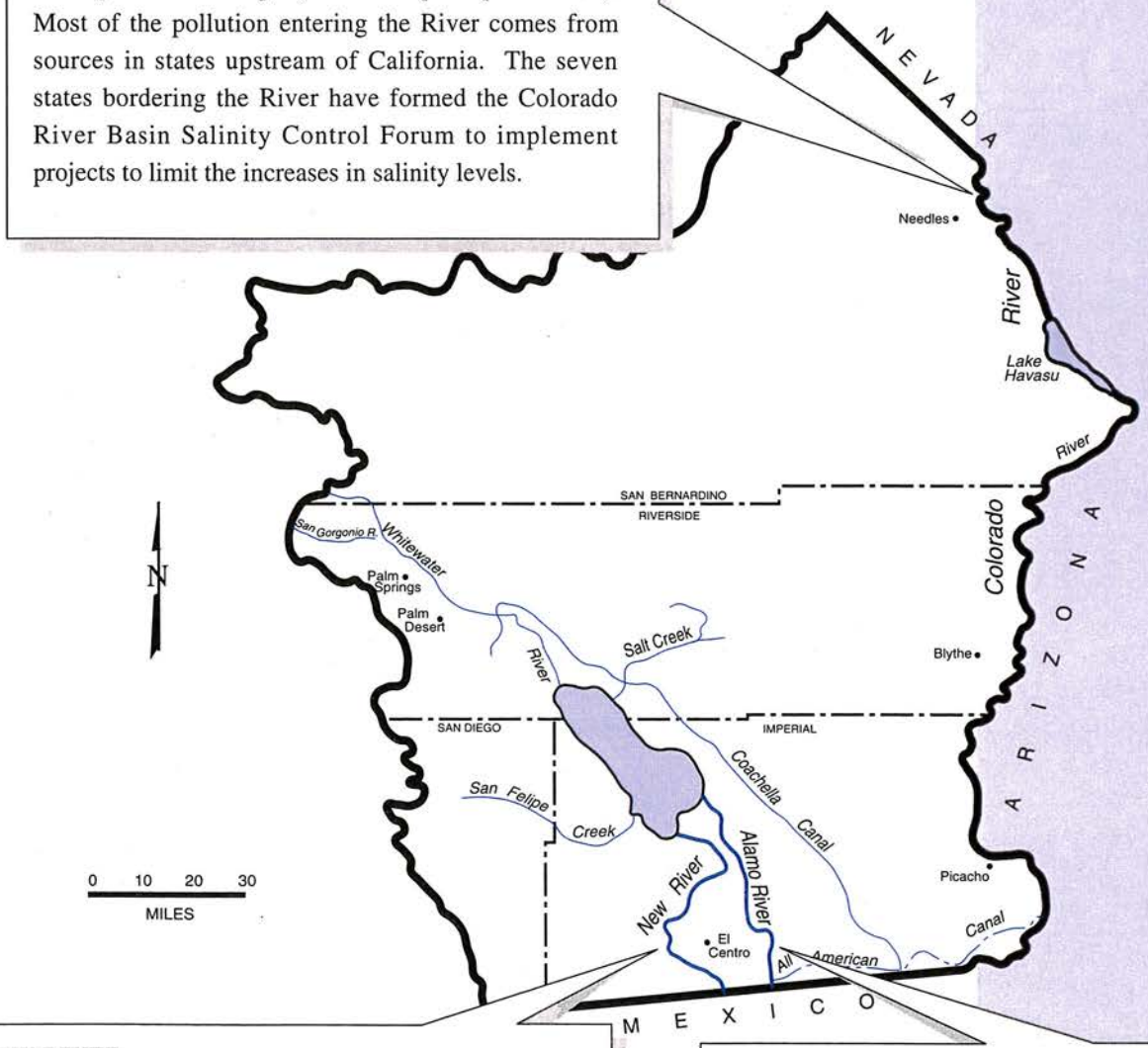
2,442 miles assessed

POLLUTANTS AND OTHER CAUSES OF IMPAIRMENT

Pollutants and other causes of impairment which are the result of activities shown in the bar chart.

COLORADO RIVER

The lower Colorado River forms the 230 mile long border between Arizona and California. Large amounts of River water are diverted through aqueducts and canals to supply southern California. Water quality in the lower Colorado River is generally good although salinity levels are high (about 700 parts per million). Most of the pollution entering the River comes from sources in states upstream of California. The seven states bordering the River have formed the Colorado River Basin Salinity Control Forum to implement projects to limit the increases in salinity levels.



NEW RIVER

The New River is impaired along its entire 60 mile length from the Mexican border to its mouth at the Salton Sea. The flow crossing the border from Mexico (about 200 cfs) is composed of partially treated and untreated sewage from Mexicali, minor industrial flows, and a large volume of farm runoff from the Mexicali Valley. Another 500 cfs of flow enters the River from farmlands in the Imperial Valley of California and contains pesticides, silt, and fertilizers. The Regional Water Board works with the International Boundary and Water Commission and other State, federal, and local agencies to correct the problem of pollution from Mexico. Efforts to control pollution from Imperial Valley farms are directed by the nonpoint source programs.

ALAMO RIVER

The Alamo River flows for 52 miles from Mexico to the Salton Sea although only a small flow (2-3 cfs) currently comes from Mexico. Most of the flow in the River at its mouth (about 800 cfs) is composed of agricultural return flows from farms in the Imperial Valley with minor amounts of sewage treatment plant effluent and storm water flows. The River is impaired due to pesticides, silt, and Selenium. Fertilizers and bacteria also lower the water quality. Efforts to correct this agricultural pollution are directed by the regional, State, and federal nonpoint source programs.

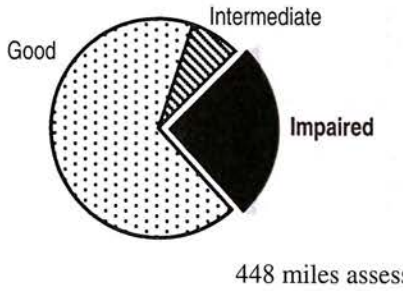
REGION 8

THE SANTA ANA REGION

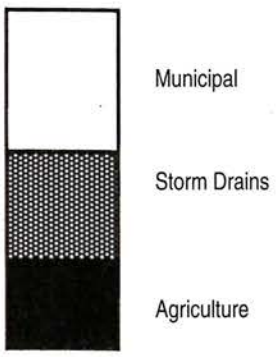
The Santa Ana Region, although the smallest in the State, is one of the most densely populated. The variety of local water resources is impressive: pristine mountain lakes and streams, lowland reservoirs filled with imported water, inland streams made up of reclaimed wastewater or nuisance water and runoff, critically important coastal wetlands, and the Pacific Ocean, with its broad, sandy beaches. Both the reason for development and the source of the problems has been the large population increase. Of the 448 river miles assessed, 109 miles are impaired by nutrients, pesticides, metals and/or pathogens, originating from agriculture, urban areas, and wastewater discharges. The Regional Water Board is focusing its efforts on preventing further degradation where it exists and developing management strategies to improve the quality of the impaired water bodies.

About a quarter of the total river and stream miles are considered impaired. The majority of the river miles are good with a small amount of intermediate river miles. Water quality impairment resulting from municipal and storm drain sources make up approximately two-thirds of the impaired river miles and agricultural type impairments make up the remaining third of the impaired river miles.

RELATIVE PERCENT OF IMPAIRED RIVER AND STREAM MILES AND SOURCES OF IMPAIRMENT

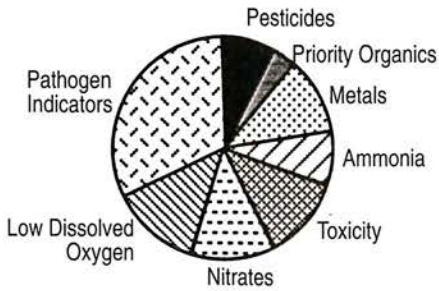


448 miles assessed



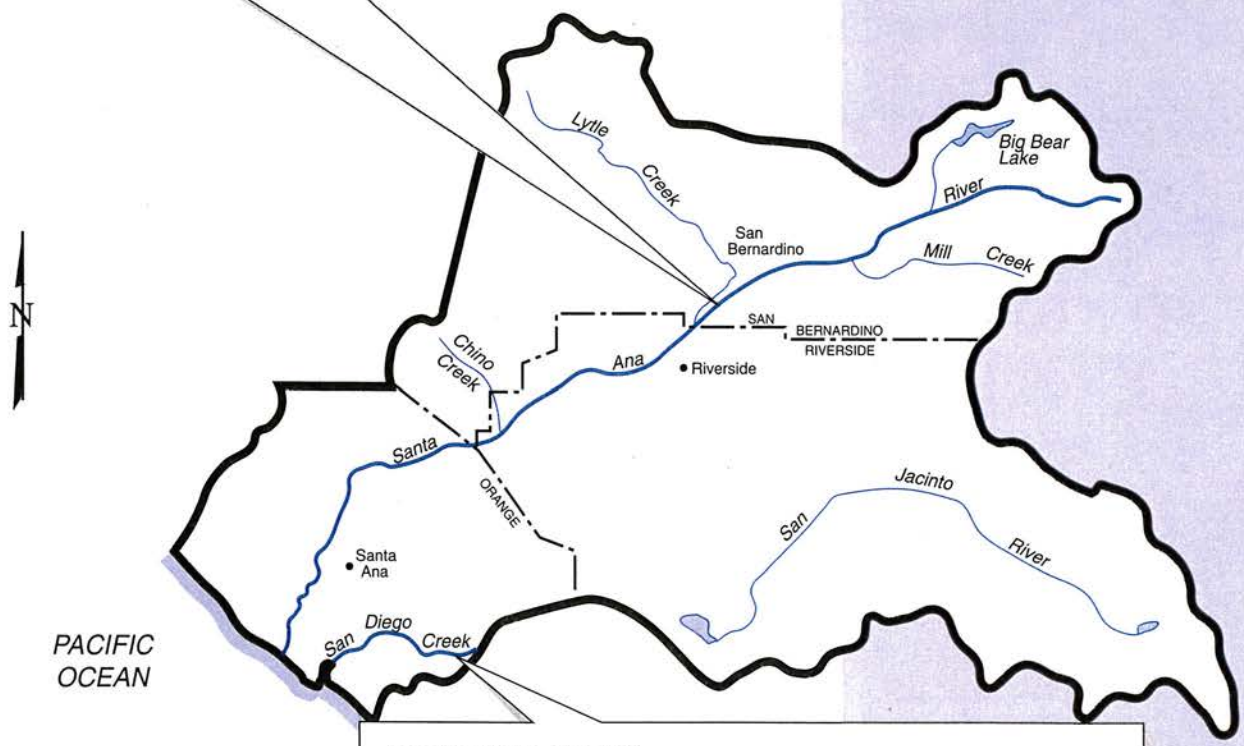
POLLUTANTS AND OTHER CAUSES OF IMPAIRMENT

Pollutants and other causes of impairment which are the result of activities shown in the bar chart.



SANTA ANA RIVER

Flows in the Santa Ana River make up more than 60 percent of the municipal water supply of Orange County, thereby helping support its two million residents. The remaining 40 percent is imported Colorado River or State Water Project water. Between its start in San Bernardino and the Orange County recharge basins, the River is home to two native species of fish--the Santa Ana Sucker, which is thought to be threat-ened, and the Arroyo Chub. In addition, local residents frequently enjoy wading in the warm, shallow water, most unaware that the flow is predominantly reclaimed wastewater. Because (1) public health depends on the river being safe to swim in, (2) the quality of the river directly affects the quality of the ground water, and (3) the quality of the aquatic environment must support the native species, the Regional Water Board recently imposed stricter nitrogen standards on the contributing sewage treatment plants. Lower nitrogen levels in the rivers mean improved ground water quality and also less instream ammonia toxicity. Three major sewage treatment plants are not yet in full compliance and runoff from the dairy area still threatens the River, but efforts continue.



SAN DIEGO CREEK

San Diego Creek provides freshwater flows to one of the Santa Ana region's rare and valuable estuary areas, including San Diego Creek itself, San Joaquin Freshwater Marsh, and the Upper Newport Bay Ecological Reserve. Historic use of pesticides in the watershed continues to affect water quality, as do some other traditional farming practices. Construction-induced erosion has led to siltation problems. Urban runoff carries various toxic materials into the creek system, along with dirt, trash, etc. The implementation of corrective management practices is easing these problems. Urban storm water permits are expected to result in further improvements.

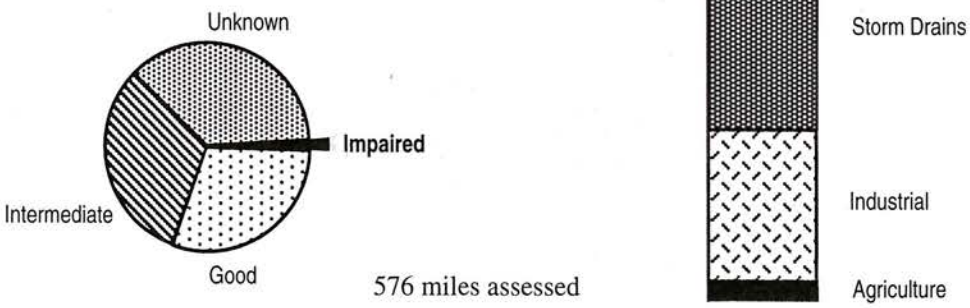
REGION 9

THE SAN DIEGO REGION

The San Diego Region is characterized by a semi-arid climate, with historically ephemeral inland surface waters. Urbanization of this region, coupled with increasing amounts of imported water is leading to changes in the characteristics of many of the region's streams. Increasing water use is producing an increase in dry weather runoff to the streams. Active management programs need to be designed to maximize the water resource benefits of the increased dry weather runoff, while minimizing all potential detrimental effects.

Only a small percentage of the river and stream miles are considered impaired. The remaining river miles are divided roughly equally into good, intermediate and unknown water quality. The sources of impairment are typically urban (storm drains and industrial). A small proportion of impairments are considered to be the result of agricultural practices.

RELATIVE PERCENT OF IMPAIRED RIVER AND STREAM MILES AND SOURCES OF IMPAIRMENT



POLLUTANTS AND OTHER CAUSES OF IMPAIRMENT

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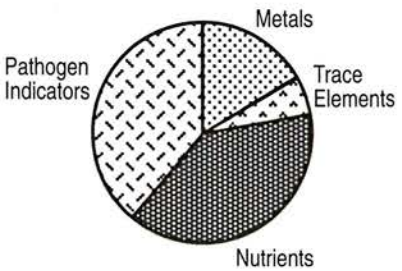
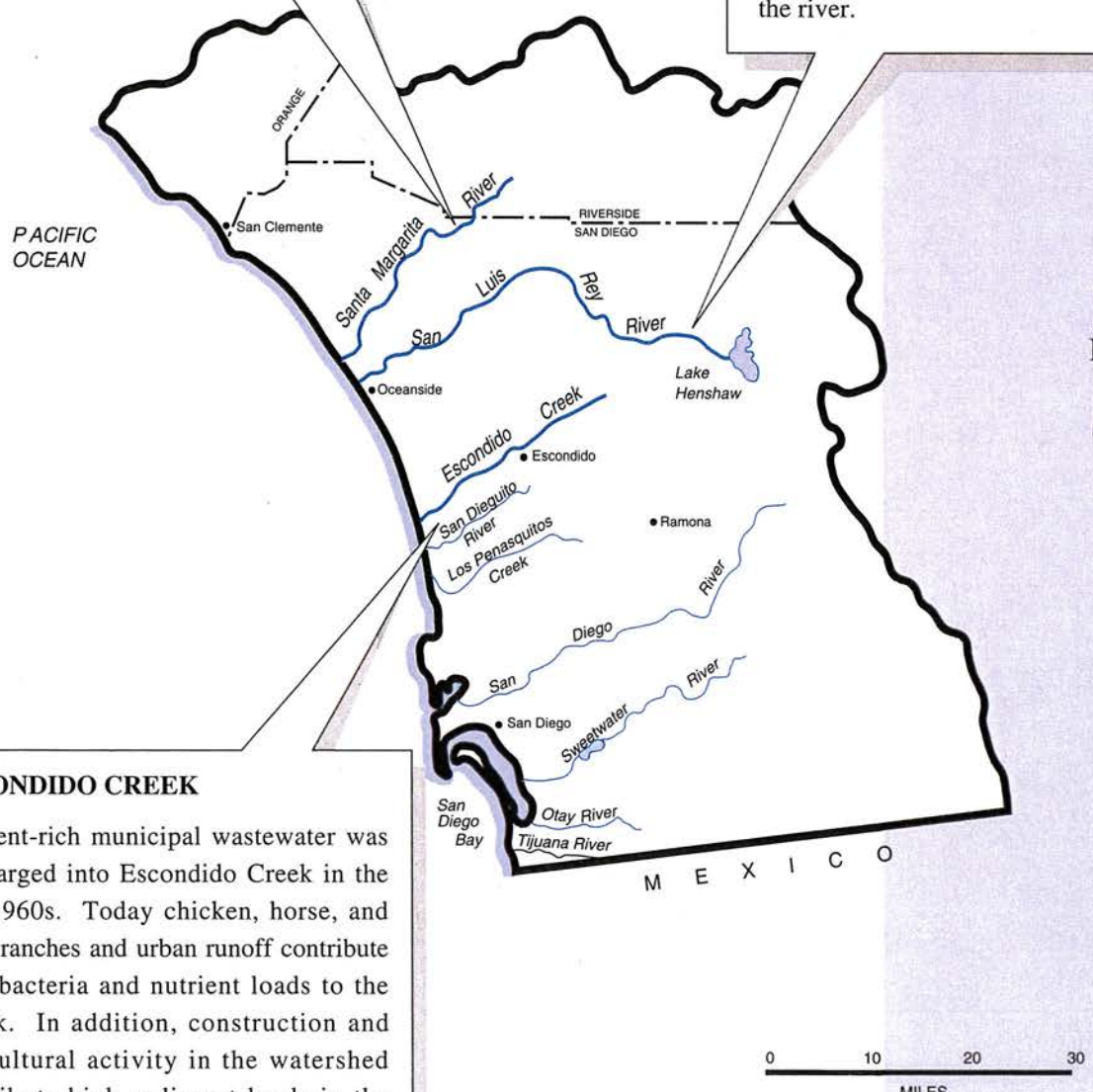


SANTA MARGARITA RIVER

Nurseries of Rainbow Valley have been identified as major contributors to nitrate pollution in Rainbow Creek, and down stream surface and ground waters of the Santa Margarita River Basin. Nursery and stream monitoring is being done to evaluate the impact of irrigation practices at the nurseries. The Santa Margarita River is also severely impacted by sedimentation from upstream construction sites in Riverside County.

SAN LUIS REY RIVER

Plans are underway to inventory existing aquatic and riparian habitat resources, to evaluate water quality, and to determine sources of pollutants. This information will be used to develop a comprehensive aquatic and riparian habitat enhancement and management plan for about 41 miles of the river.



ESCONDIDO CREEK

Nutrient-rich municipal wastewater was discharged into Escondido Creek in the late 1960s. Today chicken, horse, and dairy ranches and urban runoff contribute high bacteria and nutrient loads to the Creek. In addition, construction and agricultural activity in the watershed contribute high sediment loads in the river.

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARDS

NORTH COAST REGION (1)
5550 Skylane Blvd., Ste. A
Santa Rosa, CA 95403
(707) 576-2220

SAN FRANCISCO BAY REGION (2)
2101Webster Street, Ste. 500
Oakland, CA 94612
(510) 286-1255

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SANTA ANA REGION (8)
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(909) 782-4130

SAN DIEGO REGION (9)
9771 Clairemont Mesa Blvd., Ste. B
San Diego, CA 92124
(619) 467-2952

For additional information please contact:
State Water Resources Control Board
Office of Legislative and Public Affairs
P.O. Box 100
Sacramento, CA 95812-0100
(916) 657-1247

PREPARED BY:
Division of Water Quality
Jesse M. Diaz, Chief
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Sharon Perrin

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