A REPORT ON THE QUALITY OF THE ENVIRONMENT IN SONOMA COUNTY, CALIFORNIA

An Investigative Study

by

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ABSTRACT

Purpose of the study:
The natural environment of Sonoma County has been significantly altered in recent decades, coincident with rapid human population growth and major shifts in the economy. Of the ways in which we've changed our environment, which are the most definite? How may they be tracked, and what indication does monitoring give us of current trends? This report attempts to answer these questions.

Procedure:
This researcher began with a review of existing reports on the quality of the environment at the national and international levels. There followed the creation of a wish list of environmental indicators for the local area, culled from a survey of issues receiving coverage in The Press Democrat, the county's daily newspaper, and from suggestions offered by members of groups within the county's Conservation Council. Without narrowing this list, I set out to find what facts were available, collecting reports and soliciting information from local agencies and independent observers. Much of this information was incongruent in terms of its scope, place, and the duration of time covered. The release of Sustainable Seattle's first "Indicators of Sustainable Community" in 1994 finally provided a model for a workable format. As a result, this report consists primarily of established and accessible data series published by state agencies. Topically and geographically specific reports released to the public in recent years by local agencies and researchers have been included in summary form.

Findings:
The environment of Sonoma County does not appear to be managed in a comprehensive manner. No agency is empowered to act as overseer, and because environmental health is an interrelationship of many factors, only some of which are subject to public scrutiny, we can say only that a limited portion of what we do that affects the environment is known. The findings in this report fall into seven basic categories of monitored data, which demonstrated trends as follows:

- **Wild Species**: Worsening. As the number of listed species continues to rise, the condition of most is declining.
- **Land Use**: Improved. New protections for greenbelts and open space lands reduced the amount of total acreage open to development. However, the high rate of land use conversions remains steady.
- **Transportation**: Worsening. Carpooling and mass transit use are down, and congestion is increasing.
- **Energy**: Stable. Gasoline use per capita has dropped, while electric and gas use are up slightly. (This index does not contrast sustainable/nonsustainable sources.)
- **Air Quality**: Improved. Significant strides in air purity are threatened by the continued rise in traffic congestion.
• Solid Waste: Improved. The total amount of waste produced in the county has dropped; recycling rates have increased significantly.
• Water Quality: Improved. Major dischargers are producing purer effluent, but the less controllable sources of pollution--urban and rural runoff, as well as damage resulting from poor logging and industrial practices of earlier decades--still pose problems.

Conclusions:
Some promising trends show themselves: water quality and air quality, long subject to regulation, are relatively good and are likely to improve further with continued effort. Restraint in land development appears to be increasing, but this report does not show trends in land use practices. From the point of view of transportation needs, development has yet to moderate our dependence on the automobile. Although cars have become cleaner burning and more fuel-efficient, they continue to monopolize available energy, and their increased use threatens to offset gains in air quality. Solid waste recycling efforts appear to be on target for waste reduction goals, and more controls are now in place to manage hazardous waste. Finally, immoderate land use and toxics released to the environment continue to affect water purity as well as the integrity of natural communities and the survival of species living within them.

Acknowledgments
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Chapter 1
The State of Wildlife in Sonoma County, California

STATUS OF WILD SPECIES: Worsening

Overview:
One of the most biologically rich areas of the world, California's natural wealth has evolved from a superabundant variety of terrain, microclimates, and soil types. Given the rapid, exponential growth in human numbers that has taken place in recent decades within this setting, state Fish and Game researchers say a major disruption of natural ecosystems has been likely. In fact, human activity has reduced some of California's most productive natural communities--its wetlands--by more than 80 and perhaps as much as 499%. And loss of wetlands is reflected in species counts: in 1993, California was home to more federally-listed threatened and endangered species than any other state in the continental US.

Sonoma County shares many of the same natural features attributed to the state as a whole: coastal zones, mountainous areas, wooded hills, rich alluvial fans and basins, floodplains, wetlands and streams. The county also shares in the state's predicament, with high human population growth rates impacting natural communities. Seventeen native species were in danger of extinction in the county in 1993, primarily as a result of human activity; another eight ranked as rare or threatened. Although the populations of a few locally extant species are stabilizing, in part thanks to human aid, the numbers of most continue to flounder. There remain formidable obstacles to large varieties of wildlife flourishing in Sonoma County--the most prominent among them being, as in the rest of the state, the rapid rate of land conversion.

The foremost cause for species endangerment in Sonoma County is the continued degradation, fragmentation, or reduction in size of wild and natural habitats. Some species have already become extinct locally for this reason, their numbers diminishing with the loss of coastal and interior marshes and seasonal pools; naturally configured streams, creeks, and patterns of drainage; mature forests and individual trees; thickets and trees near water (riparian vegetation); and places where unusual soil types and conditions are present.

These habitats often play an important role in the maintenance of our natural infrastructure. Wetlands, forests, and plants near water are our air and water purifiers, erosion controllers, and flood buffers, as well as places that shelter, feed, and regenerate wildlife. Human impacts on natural water-oriented communities are associated with 12 of the 25 species now listed in the county as rare, threatened or endangered. Another seven listed species--two of them now absent from the county--have depended on trees or...
forests for survival. Eight species are at risk because they evolved under a unique set of conditions present in only one or two places.

**Management:**

Wild species are the concern of the state Department of Fish and Game and the federal Fish and Wildlife Service, while the management of their habitats falls under a broad array of jurisdictions, regulations, and individual concerns.

Biologists at the local level have long maintained that the principal means of protecting wildlife from land use impacts—the project-by-project review of development proposals at the local level, subject to state and federal scrutiny and intervention—has failed to work. Since the passage of the first state and federal species protection acts in the 1970s until recent years, government has relied upon this method to safeguard otherwise unprotected habitat. In 1991, state legislators initiated Natural Communities Conservation Planning, a pro-active approach focused on saving as much of a natural community supporting a species of concern as is possible, taking into account human needs and those of other species.

Recent efforts of this nature in Sonoma County have so far yielded mixed results. A plan to map and manage wetlands, vernal pools, natural wildlife corridors and waterways within the City of Santa Rosa's boundaries elicited a warning from the county's water agency that more streamway would have to be channelized if lowland development was to continue. Controversy over private land ownership rights has stalled county proposals to protect riparian corridors and vernal pools, weakened county Heritage Tree and tree preservation ordinances, and slowed protections for the Laguna de Santa Rosa. A Vernal Pool Task Force formed in 1989 succeeded in creating a voluntary Memoranda of Understanding among vernal pool preservation and development concerns in the central county corridor, but the Santa Rosa Plains Plant Protection Program, a more formal measure to manage the vernal pool ecosystem submitted to county planners in 1990, at the time of this report had not cleared review.

**Assessment:**

The human activities threatening listed species in the county vary, ranging from timber harvesting and land-clearing for fire protection or agriculture, to poisoning or shooting animals. Rural and urban development is the most oft-cited cause leading to endangered status, followed by livestock grazing or overgrazing, other forms of more intensive agriculture, and human disruption of wild places, including off-road vehicle (ORV) recreation. (For a chart of listed species and impacting activities, see Appendix A.)

By these and other means, the county has witnessed the extirpation of at least four species from within its borders in recent years: the marbled murrelet, willow flycatcher,
California brackishwater snail, and Baker's larkspur. The marbled murrelet had occupied old-growth conifer forest along the coast from Monterey to Oregon before timber harvesting over the last 150 years reduced its range down to 3 to 10% of the original. The willow flycatcher, once common throughout the state, has, with the eradication of willow thickets, been reduced to about 200 pairs statewide. Sedimentation and other forms of water pollution drove the brackishwater snail from northern coastal marshlands, including those in Sonoma County; it was last reported seen in the Petaluma River marsh in 1964. Grazing, roadside maintenance, and farmland conversion cleared away all Sonoma County populations of the originally rare Baker's larkspur, leaving one population in Marin.

Three other species have suffered perhaps irreversible losses. A single individual remains to represent the Pitkin Marsh Indian paintbrush, reputedly still growing on private land outside Forestville. The last remaining population of Vine Hill manzanita grows sequestered in a nearby preserve. Many-flowered navaretia, an early casualty of land conversion in the Santa Rosa plains, persists in one known population.

Conservation and restoration efforts have stabilized populations of five other species: the Pitkin Marsh lily, Pennel's bird's beak, Baker's manzanita, bald eagle, and peregrine falcon.

A present-day listing as stable does not ensure the future of a species unless the threats to it can be resolved. In cases of pollution, grazing, ORV recreation and competition from introduced species, public education, restoration and enforcement actions may suffice. But because most listed species are refugees of land use change and the activities associated with it, they won't last long if preserved in isolation. Hence, the state predicts that the number of listed species will continue to mount, and most of those listed will decline further still, as has occurred in Sonoma County, if preservation continues piecemeal.
The number of species within Sonoma County officially listed as nearing extinction rose from one in 1967 to 25 in 1994.

Locally, most of our listed species are in a state of continued decline despite current protections, while the total number of species at risk continues to rise. Four in the county were officially endangered in the early 1970s, the bald eagle among them; another 13 species had received protection by the decade's end, and five more joined government rosters in the 10 years that followed. With the advent of the '90s another three--the northern spotted owl, Clara Hunt's milk vetch, and Sonoma sunshine--have come aboard, while two state-listed vernal pool plants growing in Sonoma County rose to federal endangered status.

**Sources:**
State Department of Fish and Game, Natural Diversity Database; Sonoma County General Plan (Land Use Element); Press Democrat timeline survey; Santa Rosa general plan; county planners Sigrid Swedenborg, Jim Olmsted.

**Special Reports:**
The Laguna Technical Advisory Committee, in *Fish and Wildlife Restoration of the Laguna de Santa Rosa* (1989?), found that the central county's rapid shift from a resource-based to urban economy over the past 30 years has indirectly ravaged the Laguna de Santa Rosa by forcing agriculture off the prime soil of the Santa Rosa Plains into the Laguna's more marginal wetlands. Farmers and ranchers have had to alter this new environment to suit their needs. As a result, "critical habitats ... have been filled and cleared to extend acreage and growing seasons and accommodate livestock," the committee found, "and, with flood control channels, accommodate development" (4).
The valley oak is being lost from the area's oak savannah as trees are cleared and older ones die. Root rot caused by summer wastewater irrigation appears to be a major cause.

The committee noted the Laguna's former status as an important salmon and steelhead nursery in the Russian River watershed, and as a major habitat for mallard and cinnamon teal. It is a popular stopping-place on the Pacific Flyway and remains one of the most significant coastal freshwater wetlands in the state, home to 3,000-5,000 waterfowl.

The committee proposed preservation and restoration of more than 7,000 acres of Laguna wetlands, less than one-eighth of the original acreage occupied by the Laguna earlier in the century.

Ronald Messer and Joe Brumbaugh, in Distribution and Status of the California Freshwater Shrimp (1989): This state- and federally-listed endangered shrimp was found in 10 streams in Napa, Sonoma, and Marin counties during the authors' study period. It was not found in historic habitat in the Laguna and Santa Rosa Creek. Researchers cited low water levels, brought about by drought and water diversion, as well as polluted runoff, intensive agricultural practices, and lack of shady stream cover, as the shrimp's nemeses. Its numbers are limited enough in some creeks that a single event could exterminate them.

Marco Waaland, in Baseline Evaluation (1989): Riparian forest in the Laguna de Santa Rosa has diminished by 73%, leaving 272 acres of the original 950. The riparian forest-dwelling western yellow-billed cuckoo and California freshwater shrimp were last observed there in the 1950s, before channelization eliminated much of their habitat. One of the valley oak's last local strongholds is the Laguna area, Waaland said, but haycropping and cattle grazing have prevented its regeneration there, and irrigation is suspect in the excessive rate of root rot and death among mature members of the species. The valley oak has not reproduced naturally in the area for the last 80 to 100 years.

Peter Connors and John Maron, in Estero Americano Bird Population Study (1989): The partially polluted waters of the estero haven't deterred surprisingly large numbers of birds from flocking there. Researchers witnessed several thousand members of one species collecting at a time, following shifts in the tide. Hordes of western sandpipers, Dunlin and other birds representing more than 62 different species altogether continue to come to the estero for food. The estero is a designated breeding ground for ocean life in the Farallones National Marine Sanctuary.

Waaland and Joan Vilms, in Santa Rosa Plains Plant Protection Program Report (1990): Rare plants in vernal pools lacing the Laguna drainage from Cotati to Windsor are nearing extinction, Waaland's study found. Sonoma sunshine now exists in 30 known locations, or six biological populations; Burke's goldfields in 33 (5); and Sebastopol meadowfoam in 19 (6), most of these on land zoned for development within Santa Rosa's
ultimate urban boundary. Vernal pool mint occurs in six locations (5 pop.) and many-flowered navarretia occurs on one known site. The species, showy Indian clover, specialized to the locale, was not found in this survey.

Vernal pool habitat had at one time covered more than 10,000 acres in the central county. At least 87% of the plant and animal communities native to the Laguna have been altogether eliminated by land grading, stream channelization, vineyards, orchards, imported grass species, and irrigation, Waaland said.

Populations of native species not yet warranting protective measures in the rest of the county or state may already qualify for threatened status within the Laguna, Waaland said. He estimated that one out of every six native species, such as the valley oak, is now locally rare or endangered, compared with one out of every eight statewide. Once a "mosaic" of vernal pools, oak savannah, riparian woodland and freshwater marsh, the Laguna is now scattered oases surrounded by artificial environments, its natural biotic linkages severed, according to Waaland. Roadway improvements and urban expansion threaten what remains.

Waaland said bleak prospects lie ahead for the rare species remaining in the Santa Rosa Plains in the absence of a comprehensive conservation program.

Charles Patterson, in Vernal Pool Creation (1990): Contrary to Waaland's findings, rare plants in the Santa Rosa plains' vernal pools exist in sufficient numbers to be saved, according to Patterson's study. Patterson found significant percentages and numbers of vernal pool species protected and not in imminent danger of extinction, although he said the purchase of natural sites for future preservation appears unlikely. A number of rare plants have grown successfully for several years in transplanted communities on artificially-created pool sites, according to Patterson.

David Smith, et al., in Laguna Characterization Study (1990): In a study area covering 28,000 acres, Smith's group made findings similar to those of Waaland's. The Laguna is the second largest freshwater wetland complex in northwestern California, yet less than one-quarter of its original marshlands remain. Landowners and mosquito abatement workers continue to drain and fill small portions, while parcels in agriculture are now undergoing rural and urban development: urban uses now cover 40 percent of the Laguna drainage basin. Of the 18,000 acres in its west-central agricultural area, more than one-quarter are under Williamson Act (agricultural) protection.

The report charts a rise in human population concurrent with the reduction of agricultural acreage between 1850-1990, and a decline in natural features alongside rising artificial uses.

The most insidious loss of diversity in the Laguna, according to the report, is the displacement of native species by "weed species" such as annual grasses, starlings, bullfrog, and carp, which have acted to genetically isolate native populations already
disturbed by changes in land use. The burrowing owl, a state-listed species of special concern, with one population known to exist in the county, may already be gone from the Laguna, along with the red-legged frog, western rattlesnake, badger, bat, and ringtail.

The highest concentration of rare and endangered species in the county occurs here, and includes white sedge, Hoover's semaphore grass, bald eagle, and peregrine falcon.

Numbers of returning steelhead trout have been low in recent years in the Laguna, the report says. The authors cite water quality degradation, with high levels of ammonia and low amounts of dissolved oxygen, likely caused by urban and agricultural runoff.

Wildlife Center Reports: Operators of the four wildlife rescue and rehabilitation centers in the county each year submit intake tallies to the state Department of Fish and Game. Residents brought in 2,254 animals to the centers in 1989. Many of them had been picked up and separated from their kin unnecessarily, operators said, and a large proportion had been injured in car accidents or mauled by pets. Other causes of injury included trapping in residential areas abutting open space, loss of food, water, and cover to development, and fencing, poisoning, entanglement, and shooting.

"People want wildlife, but they don't want it near them," Sonoma Wildlife Rehabilitation Center director Barbara Elliott said in a telephone interview. "The biggest problems wildlife in Sonoma County faces are intolerance and loss of habitat."

John Berger, ed., in Ecological Restoration (1990): More than 20 individual sites in the county were the focus of restoration efforts reported between 1978 and 1990, including shrimp habitat in Huichica Creek in the east county, the Adobe Creek steelhead and striped bass fishery outside Petaluma (a highschool club project); Petaluma marsh, and San Antonio Creek at the site of a former drive-in theater. In addition, landowners and agencies teamed up to help restore five coastal watersheds in agricultural zones, four channelized creeks around Healdsburg, Windsor, and Santa Rosa, a marshland and two vernal pools. Volunteers and agencies helped transplant oak seedlings in Annadel State Park and the Laguna, and revitalized two wetlands in the Laguna, one of which now draws "vastly increased numbers of waterfowl, shorebirds, upland game birds, raccoons, river otters, fish, and deer" (166).

Ted Wooster, in "Memorandum on the Northern Spotted Owl" (1990): The endangered spotted owl appears to be "much more common than previously thought" (4) with more than 40 individual roosts or nests within the county in 1992, according to Fish and Game biologist Wooster, who provided the updated count in a telephone interview. Virtually all the roosts or nest occurred in groups of trees at least 70 years old in second-growth forest on steep slopes, including one site on recently logged land in the newly-designated Willow Creek Park near Jenner.
Wooster's study disputes contentions that the Northern spotted owl depends on stands of forest at least 200 years old for its survival, and it more than doubles the number of spotted owls known to exist in the region since observations began in 1986.
Chapter 2

Land Use in Sonoma County, California

LAND USE: Improving

Overview:
A strong push for development in the county has come packing its own counterforce--a mushrooming urban population growing increasingly aware of its receding open spaces and of the need for balance in land use.

Management:
Land uses are subject to a host of limitations spelled out in the land use elements of county and city general plans, and specifically by zoning based on those plans, applied through planning departments and commissions. Local governments and landowners are also subject to regional, state, and national agency directives. This report combines information released by monitoring and advisory groups: the Bay Area Greenbelt Alliance, the Association of Bay Area Governments, and the state Department of Conservation.

Recently-instated greenbelt protections and other land-use constraints have reduced the amount of land open to development.
Assessment:

Sonoma County has made a "dramatic turnaround" since 1989, when it topped all other Bay Area counties for the highest proportion of land open to development, according to reports released by the Bay Area Greenbelt Alliance. In intervening years, several local growth-control and land conservation measures have worked to slow the pace of urbanization and set aside more open space.

Prior to these measures, development appeared likely on more than one quarter of Sonoma County's total land area within the next 10 to 30 years, according to Alliance estimates. The watchgroup credits a conscientious general plan, which protects agricultural zoning, in combination with a trend towards enforcing urban boundaries, as well as the creation of a county public land trust, for reducing by half the amount of land most likely to be developed. Urbanization is now considered imminent--likely within ten years' time--on 4.2% of the county's land area (42,200 acres).

The largest of the eight Bay Area counties surveyed by the alliance, Sonoma County still tops the others for having the highest number of acres (126,100) open to urbanization. It also ranks first for having the smallest proportion of land--7.6%--set aside as greenbelt.

Residential and commercial growth into greenbelt surrounding Windsor and Cloverdale caused both cities to be placed on the Alliance's most recent Hot Spots list, along with continuing ranchette subdivision activity outside Petaluma and Sebastopol.

Urban acreage now accounts for 6% of the county's total land area.
Sonoma County has been urbanizing its land at the rate of about 1,100 acres annually, with 83% of newly-urbanized land, or more than 900 acres per year, coming out of agriculture. According to the state Department of Conservation, more than 4,500 acres of land undergo some form of conversion each year in Sonoma County. Urban built-up land has increased by 7.4% in the last ten years.

More than 36,000 acres have undergone land-use changes (shown in two-year increments) since 1984.

Surveys conducted by the Association of Bay Area Governments show that almost three-quarters (72.4%) of the urbanized land in Sonoma County is residential, while nearly one-sixth (11.9%) is devoted to commercial and service uses. Open land in urban areas, including parks and undeveloped lots, accounted for 6.4% in the most recent of ABAG’s periodic reports on existing land uses.

**Sources:**

Bay Area Greenbelt Alliance, California Department of Conservation, Association of Bay Area Governments.
Researcher Carolyn Dixon, writing in *An Inventory of Protected Lands in Sonoma County* (1990), lauded progress in land preservation but said losses of high-quality wildlife habitat and other valuable natural resources still occur far too quickly for state and local conservation organizations to determine their value and move to acquire them prior to development.

Preservationists have overlooked unique places and habitat while focusing on those areas where development appears most imminent, Dixon said. She suggested that an inventory of lands critical to the county's environmental well-being be used as a guide for future preservation plans, and that these lands might include coastal, river, marsh and wetland preserves, springs, agricultural soils, and scenic and historic assets.

More than 20,000 acres, or about 2% of the county's total land area, have been specifically set aside for their value as habitat or other special resources, and protected from human intrusion. This biotically sensitive acreage is contained in more than 50 separate parcels, about 14 of them in parcels of 200 acres or more, the minimal amount of area believed necessary to support a species.

Sonoma County Planning Director Ken Milam, in a "Supplemental Report and Draft Growth Ordinance" submitted to supervisors in 1990, noted that development in unincorporated areas of the county had been proceeding at a rate faster than anticipated in the general plan and, in the vicinity of Sebastopol and Sonoma, had already overtaken 2005 projections during the mid-'80s. In recent years, builders had been adding approximately 1,000 to 1,500 new units annually to housing stock in unincorporated areas, generating a growth crisis which amounted to "an immediate threat to the preservation of the public health, safety, or welfare," Milam said (2).

An ad hoc committee reviewing county growth projections, in its "Report and Executive Summary on the General Plan Database and Growth Rates" (1990), concluded in its findings that the means traditionally used by planners to control the pace of development—such as sewage treatment, road capacity, and other infrastructure—had, in fact, "not been effective" as controls (4). Growth "must occur within a framework of service availability and considerations of quality of life," the committee said in its summary (2).

The Association of Bay Area Governments (ABAG), in *Projections94*, claimed county planners underestimated both the demand and potential for growth by 3,700-6,000 units between 1990 and 2010. The association expects most communities will build out to their official boundaries within this time, assuming that constraints in water supply, roads, schools, or sewage and storm drainage management are overcome.

Urban and rural areas throughout the county have "severe and/or critical infrastructure problems" that currently constrain development or are likely to restrict it in the near future, ABAG holds (314).

ABAG sets "fair share" growth quotas among participating counties in the Bay Area.
The Sonoma County Grand Jury, in its 1990 final report, concluded its investigation of county planning practices by noting that "insufficient resources" in the planning department had prevented planners from doing their jobs effectively. Its investigation was prompted by complaints of seemingly arbitrary and inconsistent land-use decisions, unprocessed zoning violations, and an "inability to reach anyone in the Planning Department via telephone."

"From a cursory review," jurors suggested, "a case might be made that those with the sophistication and funds to engage professional assistance often fare the best" in county planning transactions.

Katie Scarborough and The Sonoma County Farmlands Group, in Farmland Worth Saving (1989?), estimated that agriculture has ceded more than 5,000 acres annually to other uses over the last 40 years, shrinking by more than 130,000 acres between 1959 and 1987, while the size of the average farm has dropped by more than 25%. Farming has become less a way of life and more of a business enterprise in Sonoma County, and is especially vulnerable to changing economic conditions in the surrounding landscape, the group said. It praised the creation of a new agricultural element in the county general plan, which offers more measures to ensure economic stability for farming.
Chapter 3
Transportation in Sonoma County, California

TRANSPORTATION: Worsening

Overview:

Today's transportation picture is dimmer than it was a decade ago, when carpooling was on the rise, along with transit use and walking to work. In a word, it consists of more: more roadway, more cars on the road, more mileage traveled, more congestion, longer travel time to more jobs outside the county, and more accidents. The bright side: vehicle registration per capita is slowing; a greater proportion of commuters now work at home, and fatal accidents have decreased significantly.

The ratio of residents to vehicles (overlay) leveled off in the early '90s.

Assessment:

While Sonoma County's population has grown over the last 50 years by more than 500%, vehicle registrations accelerated even faster, from .5 to .91 vehicles per person between 1940 and 1990, a 992% gain. (In the meantime, the loss of customers cost the county its passenger rail service, which had once spanned its length.) Vehicle registrations during
the last decade continued to rise faster than the population (by 18%), but growth estimates for population in the early '90s outpaced registrations. At the turn of the decade, there were 1.05 residents for every vehicle; in 1994, there were slightly more: 1.08.

To accommodate our chosen mode of transportation, more roadway is built in the county each year. Since 1962, the length of publicly-maintained roadway increased from 2,040 miles to 2,596, an addition of 556 miles in 30 years. The rate of roadway building is mounting as well, from 6.5 miles per year during the '60s to 23 miles added annually during the late '80s and early '90s--enough to connect Guerneville to Cotati once over again each year. Today, if all the publicly-maintained roadway criss-crossing the county were laid end-to-end, the result would span the county's length, measured along Highway 101, 46 times.

Vehicles travel a total of 8.8 million miles daily within the county. The current rate of roadbuilding adds enough roadway to connect Guerneville to Cotati once over again annually.

Vehicle travel within the county increased steadily during the last five years by 13.8%, now amounting to 8,822,000 total miles traveled daily. Population levels have climbed at a faster clip (17.2%), but the per capita rate of vehicle miles traveled continues to average a little over 21 miles per person per day.
Bicentennial Way is now the busiest interchange in the county along Highway 101.

Highway congestion increased by 221% during the last 25 years at the interchange of Highway 101 and 4th Street in Santa Rosa, consistently the busiest section of highway in the county between 1968 and 1993. More than 9,800 vehicles now pass through this location at peak hour on weekdays, up from 3,050 vehicles a quarter-century earlier.

Traffic loads on Highway 101 at peak hour vary considerably from one interchange to another; in the early '80s, the highest traffic count shifted from 4th Street to Baker Ave. Top readings now register at Bicentennial Way, with 11,200 vehicles passing in either direction during peak hour in 1993.
In 1990, a little over 15,000 commuters traveled to Marin, while nearly 156,000 stayed within the county (overlay). The difference between total commuters and the number remaining within the county has widened from 1960 and 1990, with 8% more now traveling to work outside.

Commute traffic today reflects the growth of the county's workforce, now 47.7% of the total population, up from 33% in 1960. Most resident commuters remain within county borders; however, a greater portion today travels to destinations outside. In 1960, residents working within the county comprised 90% of the commuter total; in 1990, they accounted for 82%. The greatest proportion of out-of-county commuters continues to travel to jobs in Marin (44%) and San Francisco (24%). Nearly 7% now head for destinations outside the nine-county Bay Area.

During the last decade, commuters reaffirmed their preference for private conveyance as the favored mode of travel, with more than 87% of the 190,431 commuters in the county using a car or truck to get to work in 1990, 11.3% more than in 1960. Gains made in carpooling around 1980 have since lost ground throughout the Bay Area, with more car-bound commuters reverting to driving alone. In Sonoma County, carpooling dropping down from 16.3% participating commuters in 1980 to 13% in 1990. Slightly more than one in eight resident commuters now chooses to carpool, bringing the average commute vehicle occupancy rate to 1.08 people per car.
During the last decade, the number of commuters choosing to drive alone increased by 5%. Interest in other modes of travel lessened.

Alternative modes of travel have also dropped off: 9% fewer commuters chose to take transit to work in 1990 than a decade earlier, when transit commuting peaked at 3.2%. Walking, the preferred mode of travel for 8.6% of commuters in 1960, is now favored by 3.3%. For all commuters, the average travel time (now 24 minutes) increased over the last decade by 6%. However, the 1990 census saw a resurgence in the number of salaried people who don't commute, but work at home--now 4.9% of the worker total.

Accidents and injuries on Sonoma County roads appear to be rising despite annual fluctuations, with five-year averages over the last 15 years reaching their highest in the late '80s and early '90s. The number of injury accidents now averages around 3,000 per year, the number of injuries, around 4,400. In 1990, 4,759 people were injured in local highway mishaps.

Fatal accidents and fatalities, on the other hand, have dropped by 30% in recent years, from an average of 85 lives lost annually on Sonoma County roads in the early '80s, to 59.5 people killed each year during the early '90s. In 1993, the most recent data year, 49 people lost their lives in 43 accidents, the lowest count since the early 1970s.

In their 1992 annual accident report, CHP researchers attribute higher accident survival rates in California to several factors, including seat belt and helmet laws, and anti-drinking and driving campaigns. Drinking and driving

had been responsible for more than half of all traffic injuries and fatalities in the state.
Overall, traffic accidents increased in recent years. Fatalities (overlay) have fallen off significantly.

**Sources:**
State Department of Motor Vehicles Forecasting Unit;

US Bureau of the Census; state Employment Development Department; state Department of Transportation; Metropolitan Transportation Commission, Planning Section; and Department of California Highway Patrol.

**Special Reports:**
The Sonoma County Transportation Authority, in its annual Sonoma County Unmet Transit Needs Plan: FY 1995/96 Update, concluded that, based on testimony at its annual hearing (reportedly scant), "while all transit needs in all cases are not being met," no significant changes in service in Sonoma County were warranted, "particularly given the already high level of public transportation services available" (i).

The jurisdictions of Rohnert Park, Cotati, and Cloverdale were permitted to use transit funds for road and street improvements, according to rules applying to rural counties (those with populations of 500,000 or less), because their transit services are considered adequate, with no unmet needs existing.

The 10 public transit services operating within the county during 1994 reported a total average of 381,919 monthly riders.
Chapter 4

Energy Use in Sonoma County, California

ENERGY: Maintained

Overview:
Mainstream energy use in Sonoma County eased slightly as the county population grew over the last ten years, increasing by 30% as human numbers climbed 31%. Gains in the conservation of gasoline per capita were offset by increased uses of electricity, while natural gas use per capita remained constant. The bulk of stationary power uses, traditionally in the residential sector, has shifted somewhat to accommodate more energy use for commercial and other applications.

Management:
Use rates for the most common forms of energy are tracked by the California Energy Commission. Sonoma County's main provider of electricity, Pacific Gas and Electric, draws on a variety of sources, some of them local, to feed its regional power grids—including geothermal, natural gas, hydropower, nuclear, oil, and coal resources. Propane, solar, wind, wood heat, cogeneration, other energy alternatives and gains in conservation are not currently monitored by public agencies.

Gasoline, natural gas, and electricity use climbed moderately over the last ten years. (Shown in thousands of gallons, therms, and kilowatthours.)
Assessment:

Total consumption of gasoline, electricity, and natural gas (the three categories measured) amounted to 274,746 Btu's (British thermal units) per capita per day in 1994, the equivalent of 25 pounds of coal or two gallons of crude oil burned per person. Consumption of gasoline accounts for slightly more than half of total mainstream energy use in Sonoma County, down by 4% from 1983 levels. Electric use now takes up more of the pie, having climbed from 16% to 19%. Reliance upon natural gas, the second most favored energy form, moved from 28% to 29% of the total.

Of itself, gasoline consumption rose 25% during this period, falling off from a per capita rate of 1.24 gallons daily in 1983 to 1.17 gallons in 1994, in part reflecting increased fuel efficiency in motor vehicles.

Electricity use in the county rose by 47.6%, from 13.4 kilowatthours (kWh) to 14.8 kWh per capita per day between 1983 and 1994--at its current level, enough to power five refrigerators per person daily. Because energy is lost in the production of usable power, particularly electricity, the total amount of energy consumed by electric users is about 2.75 times more than the amount received for end-use.

Residential and commercial uses place the highest demands on electric power.
Stationary energy use in the county shifted slightly between 1983 and 1994, with more power going to commercial, agricultural, water pumping, miscellaneous, and assembly purposes. Residential use, now 44%, dropped by 8%. Transportation, communication, and utilities (TCU) dropped by 1% in relative usage.

Natural gas use increased 32.6% during this period, remaining at about 286 therms per capita yearly, enough to run one hot water heater for each resident. Residential uses of natural gas have dropped by 2% relatively, yielding to an equivalent rise in commercial use.

A slightly larger portion of the commercial sector now relies on natural gas.

Sources:

Special reports:
The Community Network for Appropriate Technologies, a local group concerned with energy conservation, in Sonoma County Energy End Use Study (1980), found the greatest and costliest user of power in Sonoma County to be transportation (49%) and,
more specifically, the automobile (40%). Among stationary uses of power, a significant portion (35-39%) went into low-temperature tasks--space heating and cooling, water heating, and clothes drying--which are prime candidates for savings through conservation techniques and technologies. The group said energy savings made in these areas in residential, commercial, and institutional sectors, combined with a full review of related policies--and community-based energy planning--could "ensure a successful integration of the conservation ethic" and "reduce by scores of millions the amount of money which now leaves our county annually for energy purposes" (21). Authors also noted that the US was dependent on imports for 50% of its petroleum-based energy uses at that time.

In An Assessment of Energy Use and Resource Potential in Sonoma County (1982), consultant Jennifer Barrett found petroleum fuel provided the largest single portion of energy used in the county, accounting for 46% of the energy pie. Of petroleum used in the state at that time, nearly half was produced along the coast, another significant portion in Alaska, and 18% overseas.

Electric use in primary BTUs accounted for 31% of the total; natural gas, 23%. Sources for electricity passing into the Pacific Gas and Electric energy grid in 1982 included oil, natural gas, hydropower, nuclear, and coal. Most of the natural gas in use had its source in the southwest US and Canada; 12% originated within the state and offshore.

In the county, the transportation sector used more than 45% of all energy consumed, primarily to fuel private trucks and automobiles. Residential uses accounted for 32%; commercial, less than 15%; and industrial (mostly food processing) under 10%.

Agricultural uses--including livestock and poultry production, transportation and application of petroleum-based fertilizers, pesticides, and herbicides--amounted to 1%.

Barrett estimated that the county could save 19% of its total energy consumption through conservation and greater reliance on alternative resources, including solar, wind, biomass, geothermal, and hydropower. Up to 9% of the transportation energy outlay could be cut through use of alternative transportation systems, changes in land use patterns, and alternative fuels, she said. Residents could reduce power consumption by 30% in their homes through conservation and changes in technologies for heating, cooling, and other applications, while the commercial sector could cut back 33% by changing operating procedures, retrofitting for conservation, and through new design. Street lighting costs could be cut by 50%, and industrial by 20% through cogeneration, use of solar energy, and energy efficiency, Barrett said. The same report concluded that agriculture could cut back by 35% with more efficient pumps, solar heating, and agricultural, wind, and biomass energy production.
Chapter 5

Air Quality in Sonoma County, California

AIR QUALITY: Improved

Overview:
Air pollution levels have declined considerably since air quality monitoring began in Sonoma County in the early '70s, largely because some of our strongest sources of emissions have come under conscious control via state and local regulation. Efforts are now turning to new and less tractable sources for further pollution reductions, including stationary sources of toxics and particulates, and home-based and recreational activities. Meanwhile, some pollutant readings appear to have stalled at their new low levels, indicating that the continued growth of our population, paired with our dependence on polluting technologies, particularly cars, could overtake clean air advances. Still more restraint is called for if we're to achieve federal and state clean air objectives in the coming years.

Management:
Sonoma County encompasses portions of two air basins, divided along the line of coastal and inland hills running west and north of Santa Rosa. Around Santa Rosa and to the south and east, Bay Area air circulates, and pollution levels in the southern county are closely related to those of nine other jurisdictions, including Napa, Solano, Contra Costa, Alameda, Santa Clara, San Mateo, San Francisco, and Marin counties. This air basin is monitored and managed by the Bay Area Air Quality Management District, which has two stations for common pollutants in Santa Rosa and Sonoma (a third in Petaluma closed in 1979). To the north, Sonoma County air quality regulation falls in with that of other coastal counties up to the stateline, including Mendocino, Humbolt, Trinity and Del Norte counties. North Sonoma County air quality is monitored and managed by the Northern Sonoma Air Quality Management District, with monitoring stations in Cloverdale, Healdsburg, and Guerneville, and in locations downwind of the Geysers.
Residents in Sonoma County released slightly fewer common pollutants in overall estimated tons per day and pounds per capita daily (overlay) between 1989 and 1991.

Assessment:

For each day of 1991, Sonoma County residents released an estimated 539.4 tons of common pollutants into the air--about 2.64 pounds per person. From its southern air basin, the county contributed about 5.5% of the Bay Area's total estimated air pollutants, roughly equivalent to our relative population. In the north county, which holds one-fifth of the north state's air basin population, residents contributed one-eighth of that basin's estimated pollutants.

These emissions are considerably less than what they've been in the recent past. In fact, the air pollution story is one of the most successful of our attempts to clean up the environment: over the last 20 years, we've seen a 20 to 60% drop in the five-year average measurements for ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, and particulates.

Pollutant Reports: Ozone (O3)

Photochemical smog, of which ozone is a major component, is one of the most visible indicators of warm-season air pollution, although visibility is also affected by weather, wind erosion, pollen, and airborne salt-water and sand particles. In high concentrations, photochemical smog appears as a brown haze, formed from a chemical reaction between nitrogen oxides (NOx) and reactive organic gases (ROG) in the presence of ultraviolet sunlight. These
reactive organic gases arise from the evaporation of aerosol sprays, paints, inks, solvents, and gasoline; both they and nitrogen oxides also have their source in the combustion of various fuels, including wood. Together, they form a mix of air pollutants, including peroxycetyl nitrate, formaldehyde, hydrogen peroxide, and acrolein.

Initially measured along with other oxides, ozone has been an object of regulatory concern since the early 1960s. It is known to harden and crack rubber and affect paint and other synthetics, irritate the eyes, damage lung tissue and cause premature aging of the lungs, and to severely impact the health of those with compromised respiratory systems. Children and seniors are most susceptible to its effects, but even athletic performers can be adversely affected by ozone pollution. It is also known to stunt growth and reduce the yield of crops and affect many varieties of landscaping plants.

In 1991, activities in Sonoma County yielded an estimated 111 tons of reactive organic gases daily; of this, 60% came from natural sources; another 22% from mobile sources, and a little more than 8% from solvents.

Ozone levels, still measured in the cities of Santa Rosa and Sonoma, now hover near state standard (9 parts per hundred million/1-hr.; federal, less than 12 pphm; Alert Level, 20 pphm.)

Ozone levels have dropped steadily in Sonoma County since monitoring began in Santa Rosa in 1969 and in Sonoma in the early ‘70s. Readings at that time exceeded state and federal standards as many as 14 days out of the year. Traditionally the less polluted of the two because of its relatively open surroundings, Santa Rosa last exceeded the more stringent state limit for ozone highs in 1987, while the city of Sonoma, sheltered from wind, continued to experience days of ozone pollution above the state standard--three in
1989 and again in 1991. Current readings for both locations have remained around or just under the state standard since the late 1980s.

For the Bay Area as a whole, days in which ozone levels exceed state standards have dropped 85% since the 1960s. Health Advisory Alerts--when children and seniors were advised to stay indoors--were posted an average of seven days a year during the late '60s, triggered by readings in excess of 20 parts per hundred million. In the latter part of the '80s, air was considered safe to breathe in all Bay Area locations year-round, and "ozone season," when readings tend to exceed clean air standards, retreated from ten down to seven months of the year. Residents of Livermore, where Bay Area air pollution collects, have experienced an average of 11 high-ozone days above federal standards in recent years, down from 40 in 1969. Bay Area pollutants, including ozone precursors and other emissions from Sonoma County, are known to accumulate in air basins around Livermore, the San Joaquin Valley, and Sacramento.

In the relatively less-polluted north Sonoma County, ozone concentrations are mounting, reaching their highest levels on hot summer afternoons during ozone season when winds are from the south. The north county air pollution control district speculates that the elevated readings are a combination of local traffic pollution and emissions from southern Sonoma County and adjacent Bay Area counties. The district's Healdsburg Airport monitors show a steady rise since measurement there began in mid-1991; peak days coincide with Bay Area smog alert forecasts. Although ozone is currently not a problem pollutant for the north district, the district's status is likely to change within a few years should the trend persist, bringing upon it new regulations and controls like those now imposed on the Bay Area.

**Carbon monoxide (CO)**

Odorless and invisible, carbon monoxide is another prevalent pollutant emitted from heated and burning petrochemicals, wood, and other fuels. Carbon monoxide acts to displace oxygen in the blood, reducing the function of heart, brain, lungs, and other tissues.

In Sonoma County, passenger car and light truck emissions accounted for 59% of an estimated 227 tons of CO emitted daily during 1991 (more than a pound per person). Mobile sources in general accounted for 82%.
Local carbon monoxide pollution levels are within limits (state standard, 9 parts per million/8-hr.; federal, 9 ppm/8-hr.)

The average for the highest eight hours of carbon monoxide readings measured per day in Santa Rosa has dropped to half its previous levels, from 8.9 ppm in the early and mid-'70s to 4.5 ppm in recent years; and the trend continues downward. Days in violation of standards numbered as high as three a year in 1973. No CO violations have occurred in Santa Rosa since the '70s.

Nitrogen dioxide (NO2)

A product of combustion, nitrogen dioxide pollution appears "whiskey-brown" in concentration, and can cause airway constriction in asthmatic individuals and bring about sore throat, breathing difficulties and respiratory infections in others. At high concentrations it will damage beans, tomatoes, and other sensitive crops. It is one of the two oxides of nitrogen (NOx)—which also includes nitric oxide—that interact with reactive organic gases to form ozone.

In 1991, the state Air Resources Board estimates that a total of 27 tons of oxides of nitrogen were emitted from Sonoma County sources daily; of that, 90% came from mobile sources on land and from airplanes.
NOX pollution levels averaged a little over 9 parts per hundred million/1-hr. in recent years (state standard, 25 pphm/1-hr.; federal 5.3 pphm/annual av.)

The average for the highest hour readings of the day for nitrogen dioxide has dropped by 40% from the early '70s in Santa Rosa, from a previous average of 15.2 parts per hundred million to 9.2 pphm in recent years. Readings continue to fluctuate a little above this level.

Nitrogen oxide readings in the north county district have remained within state parameters since monitoring began there in 1992, rising and falling with local commute traffic levels. Though within acceptable bounds, the NOx pollution appears to be a contributor to the district's ozone problem.

Mobile sources account for more than 50% of our carbon monoxide air pollution in Sonoma County.
Chapter 6

Solid Waste Generation and Management in Sonoma County, California

SOLID WASTE: Improving

Overview:
Prompted by shrinking landfill space and legislative mandate, county officials and residents successfully reduced landfilled waste and raised recycling rates significantly in recent years.

Management:
The county Public Works department oversees public landfills in the county, while independent companies manage waste collection and recycling concessions and operate private landfills. With the passage of the Integrated Waste Management Act of 1989, counties and cities throughout the state are required to create waste management plans, review them every three years, and to meet landfilled waste reduction deadlines of 25% by 1995 and 50% by 2000.

Assessment:

Landfilled waste decreased as recycling rates rose (overlay) between 1988 and 1991. Hazardous waste, metals, cardboard and newspaper are recycled in greatest quantity.
Sonoma County residents reduced the total amount of waste produced in the county by 6.75% and landfilled waste by nearly 15% between 1988 and 1991, while the amount of material recycled rose by 80% during the same period. In 1991, residents and businesses sent 1,360 tons of waste, or 6.84 pounds per capita, to the landfill daily (compared to 8.5 pounds in 1988), over a year's time landfilling 496,647 tons.

The most recent waste composition study indicates the substance being discarded in greatest quantity is paper, at 35%, followed by garden waste at 14%, and food at 12%. Sludge extracted from waste water amounted to 5% of landfilled waste at the time.

The material showing the greatest gain in recycling was plastic, up by 119%. Glass, newspaper and computer paper recycling rates also rose significantly. The rate of oil recycling dropped during the study period by 16%.

The Sonoma County Public Works department reports that reclamation is now at 25% or greater countywide.

Sources:
Sonoma County Department of Public Works, staff contact Darlene Comingore; Sonoma County Public Health Department, staff contact Jeff Lewin; Sonoma County Solid Waste Management Plan of 1990.

Special Reports:
Waste disposal operators hope to attain a constant 60% diversion of solid waste from landfilling by the year 2000 through reduction, recycling, or composting programs, according to the Sonoma County Source Reduction and Recycling Element draft of July 1991, prepared by Brown, Vence and Associates. Even at this rate, a new landfill site will be needed by 2002, when currently operating sites are likely to reach capacity.

An agency network created to manage a "growing problem of illegal disposal of hazardous waste" in the county was found unequal to the task in the Sonoma County Grand Jury Final Report of 1990.

While several county and state agencies are authorized to handle public reports of illegal disposal, the jury found weak points throughout the system--inadequate budgeting, staffing and training, public education, and number of legal disposal sites--contributing to delays and public frustration. In the case prompting the investigation, workers attending to other emergency duties arrived to clean up crankcase oil dumped onto the shoulder of a road three months after it had been reported.
Investigators said toxic waste is being dumped illegally into local sewers, landfills, and streams, and recommended, in part, that the county create a central toxics hotline to make hazardous waste management agencies more accessible.

![Hazardous Waste Collected in Sonoma County, in Tons](chart)

The amount of hazardous waste produced and collected in the county appears to be lessening.

The Sonoma County Hazardous Waste Management Plan reported that significant amounts of toxics were moving outside legal waste disposal channels in the county during 1986. Smaller businesses that individually produce less than 1,000 kilograms of hazardous waste a month, and therefore until recently were not required by law to track its disposal, collectively produced an estimated 11,950 tons in the study year. More than three-quarters of the small-generator waste was used oil, most of it collected in automotive repair; used lead-acid batteries accounted for a little under 15%. Other dangerous substances generated in small quantities in the county included (in 1986) 540 tons of solvents, 80 tons of PCBs and dioxins, and 50 tons of pesticides. Some portion of this waste, researchers say, was dumped into local landfills, storm drains, and sewers. Recyclers say that, statewide, they receive less than half the amount of waste oil actually generated. The data suggest that the remainder--in Sonoma County, more than 2,700 gallons per day in 1986--has been disposed of illegally.
The average household in Sonoma County produced between six and eight pounds of hazardous waste in 1987, according to estimates, discarding up to about 560 tons of toxic cleaners, pesticides, batteries, paint products, automotive products, pool acids, chorine, photo chemicals, and smoke detector elements, most into local landfills.

Researchers estimate that, altogether, about 49,960 tons of hazardous waste was generated during the study year. Geothermal power production was the single largest generator, accounting for two-thirds of the total. Large generators of hazardous waste in the county shipped waste legally to hazardous waste landfills or incinerators within the state in Kings County, and to Illinois and Idaho.

Hazardous materials and hazardous waste spilled 23 times while in transit along Highway 101 or the geysers road between the years 1985 and 1987, according to Caltrans and California Highway Patrol officials. The Regional Water Quality Control Board in 1985 estimated that 29 percent of transportation-related spills of hazardous substances occurring within the Russian River drainage basin found their way into the river directly or through tributaries and storm drains.
Chapter 7
Water Use and Management in Sonoma County, California

WATER QUALITY: Improved

Overview:

Water in Sonoma County today is considerably less polluted by wastewater discharges than in the past, but contamination from a variety of uncontrolled sources persists, according to recent state and local reports.

The mass fish kills witnessed in the Petaluma River and Laguna de Santa Rosa as late as the mid-1980s are no longer common occurrence, according to accounts from Regional Water Quality Control Board staff. Those crises--caused by summertime releases of sewage and excessive amounts of chlorine in effluent--have abated with seasonal limits for discharge and better wastewater treatment. But the volume of municipal wastewater releases is growing, and the cumulative effects of nonpoint pollution sources still adversely affect water quality, fish and wildlife.

Types of water pollution in Sonoma County vary with land use. In rural areas, leaking septic systems and piled animal wastes have leached bacteria and nitrates into groundwater. Common farming practices have a cumulative impact on streamways: water diversions cause low water levels and intensify pollution; animal wastes feed aquatic plants, algae, and bacteria, which in turn consume dissolved oxygen needed by fish. Decaying wastes also produce ammonia, toxic to fish; and eroded soils muddy the water. Both agricultural and urban activities contribute pesticides and herbicides. Urban centers add large quantities of wastewater and street and storm drain runoff. And in areas of commerce and industry scattered throughout the county, toxic spills and leaks have seeped underground.

Management:

Water quality and water rights management is based on state and federal legislative acts passed during the late 1960s and early ’70s, directing regional boards to identify and enforce the beneficial uses of water within their jurisdictions. In Sonoma County, two water board regions adjoin one another: the North Coast Regional Water Quality Control Board holds jurisdiction over the Gualala, Russian River, and lesser coastal drainage basins; the San Francisco Bay Regional Water Quality Control Board has guardianship of the Petaluma River and Sonoma Creek watersheds feeding into San Pablo Bay.
As part of their job, water quality control boards grant discharge permits, monitor dischargers—both those releasing as point sources (via pipe) and nonpoint sources (via runoff)—and track water quality trends. Between 1976 and 1994, the number of waterbodies routinely monitored for water quality in the county rose from four to 52.

Water rights are granted by the state Water Resources Control Board.

The extent of water quality monitoring in Sonoma County has expanded since the early 1970s. A significant portion of our streamways is known to be polluted to some degree.

Assessment:

In the state's 1994 biennial water quality report, regional staff monitored and reported on 413 miles of streamway in Sonoma County, as well as 13,998 acres of open water and 277 square miles of underground water stores. Of these, the greatest portion meets clean water standards. Serious but localized contamination of open water bodies and groundwater exists, but most known degradation occurred in streamways.

Of total streamway mileage monitored in Sonoma County, one-third (142 miles) was considered of good quality—supporting or enhancing its designated beneficial uses—in the state's most recent biennial water quality report. Thirty-nine percent (161 miles) of streamway received intermediate ranking: either maintaining beneficial uses with occasional degradation, or showing inconclusive evidence of impairment. One-fifth (84 miles) of the county's streamway was rated as impaired, falling short of standards for beneficial use.

Individual streamways rated as follows:
• In the southwest county, sediment- and waste-laden runoff from pasture land and feedlots drains into Americano and Stemple creeks and their esteros, the Americano and San Antonio (the latter in Marin County), producing conditions inimical to fish and wildlife. All seven miles of the Americano Creek, more than half of its estero, and all 17 miles of Stemple Creek are rated impaired.
• Similar conditions, compounded by urban runoff and rural and urban wastewater disposal problems, afflict the Laguna de Santa Rosa and, potentially, water quality downstream in the Russian River. All 26 miles of the Laguna are considered impaired.
• Numerous activities spanning the length of the Russian River threaten to compromise its quality, but current ratings are good, reflecting improvements made to discharges over recent decades.
• To the south and east, both the Petaluma River and Sonoma Creek are subject to eutrophication, becoming progressively more conducive to plant growth than to fish. In the Petaluma River, fish populations are declining in part because of filling and dredging of wetlands and diversions upstream. Twenty miles of the river are rated impaired; the remaining five, rated intermediate.

Bacteria counts exceed standards in Sonoma Creek, indicating the presence of other nutrient-related pollutants, such as ammonia and nitrates. The condition of lesser streams in the south county is unknown. Fourteen miles of the 23-mile Sonoma Creek are rated impaired; the remainder, intermediate.

At the county's northwest edge, sediment generated by poor logging practices of earlier decades continues to wash into the Gualala River, reducing steelhead counts and affecting water supplies for residents of Gualala and Sea Ranch.

All large waterbodies with the exception of the impaired portion of the Estero Americano received a "good" rating from water quality staff. Bodega Bay and Bodega Harbor, also rated as good, are threatened by the poor water quality of their tributaries, by fishing industry discharges, and by offshore spills. Sedimentation in the Russian River Delta threatens fish populations.

Perhaps the most pernicious water quality problems in the county affect portions of its groundwater. Staff estimates that about 4.7% (13 square miles) out of 277 square miles of monitored groundwater rank as impaired. This includes an area beneath the Santa Rosa plains:

• Groundwater and a number of domestic and municipal wells in Santa Rosa, Sebastopol, and Rohnert Park are contaminated with gasoline and diesel from leaking underground tanks and fuel spills, solvents from electronics manufacturing, and bacteria from failing septic systems. Cleanup efforts include an EPA Superfund site in the Roseland district.
• Nitrates from intensive agriculture in the southern central plain pollute groundwater.
• Leaking underground fuel tanks and, frequently, solvent handling problems as well, have tainted portions of the groundwater supply in sites scattered throughout the county, fouling domestic wells and threatening potential municipal water.
supplies in the Alexander Valley, Annapolis, Gualala, the lower Russian River, Bodega Bay, Healdsburg, Cloverdale, Windsor, the Santa Rosa plains, Petaluma, and Sonoma.

- In Cloverdale and Windsor, wood treatment chemicals have entered groundwater; waste oil appears in places under Windsor, as well as beneath Healdsburg.

Sources:

State Water Resources Control Board; North Coast Regional Water Quality Control Board; San Francisco Bay Regional Water Quality Control Board.

Special Reports:

The North Coast Regional Water Quality Control Board staff, writing in its 1993 interim report on Russian River water quality monitoring, said that river water quality has improved significantly since monitoring began in the early 1970s, particularly in terms of nutrient concentrations and bacterial counts. The NCRWQCB credited the improvement to reduced periods of discharge and higher levels of treatment for municipal and industrial wastewater, and better dairy waste management practices. However, pollutant levels still exceed standards at times, especially for bacteria measured at recreational spots during recreational use. (Evidence suggests that bathers are the chief contributors to this problem, according to staff.)

Nutrient pollution still reaches unacceptable levels on occasion in the Laguna de Santa Rosa, a tributary, and in the river just downstream of their confluence.

In other studies, researchers found that excessive plant growth in the river is more likely caused by nutrients in bottom material rather than waterborne nutrients. Concerning gravel mining, staff said that excavations along the river may indeed affect water and groundwater quality and flow patterns--but that it was "difficult to substantiate" to what extent.

In its study of the City of Santa Rosa's regional wastewater system discharges to the Russian River between 1987 to mid-1990 (Analysis of Compliance), the NCRWQCB concluded that releases were of safe quality, with the exception of a high trihalomethanes count in March 1989 that was more than double the state health regulation of 100 parts per billion for drinking water supplies. (Trihalomethanes, a product of conventional wastewater disinfection procedures, are carcinogenic.) Trihalomethanes were detected in the wastewater consistently, usually at levels of around 30 ppb. Six other toxic organic chemicals appeared in the sampling on single occasions in low concentrations. Only copper appeared routinely in concentrations above recommended toxicity levels for freshwater aquatic life, apparently drawn into water supplies from residential copper.
piping. Brief exceedances of limits for bacteria and solids did not constitute a threat to public health, researchers said.

A research group led by Charles V. Logie, writing in Comparison of Wastewater Discharge Rates for River Flows For California Dischargers in 1989 found the Santa Rosa regional system to be among the few of its kind limited to discharges of less than one percent of average annual river flow. While it is currently the largest discharger in the Russian River basin, growth estimates for the communities of Windsor, Healdsburg, and Larkfield-Wikiup indicate that the cumulative releases from these and other river dischargers will match or exceed the volume of Santa Rosa's effluent releases in the near future.

Poor water quality persists in the Laguna de Santa Rosa despite heightened clean up efforts that succeeded in reducing nutrient levels by half in recent decades. In its final report on the "Investigation for Nonpoint Source Pollutants in the Laguna de Santa Rosa, Sonoma County" (1992), the North Coast Regional Water Quality Control Board staff found that non-point sources are still a major contributor of pollutants in the Laguna, and cited three sources: urban runoff; rural septic system failure; and agricultural runoff from livestock and dairy farms, newly-fertilized fields, and irrigation using urban effluent.

Monitoring revealed levels of un-ionized ammonia (a product of waste decomposition) at times exceeding EPA criteria for the protection of aquatic life, as well as water temperatures too high at times for cold-water fish (possibly due to loss of riparian forest), and sediments overladen with nutrients. In the Laguna's urban tributaries, heavy metal pollution, including lead, zinc, copper, and chromium (some from natural sources), exceeded protection standards for aquatic life during the first hours of heavy storms. The presence of motor oil, diesel fuel, and some pesticides was also detected on occasion in "relatively low concentrations."

The Laguna has been frequented by steelhead and other cold-water fish, and Santa Rosans are working to restore the status of Santa Rosa Creek, a Laguna tributary, as a steelhead stream. Additional remedies include a program of voluntary compliance for dairies and new local urban runoff control programs, including a demonstration project operated with the help of high-school students.

Large-scale land-clearing, grazing, and timber harvesting have had "severe environmental and economic effects" on four coastal watersheds in Sonoma County, according to the Draft Sonoma County Coastal Wetlands Enhancement Plan, produced by the state Coastal Conservancy and Circuit Riders in 1987. Researchers found that extreme soil losses had reduced tidal, freshwater, and riparian habitat, and diminished productive agricultural acreage throughout the Americano Creek, Salmon Creek, Willow Creek, and Cheney Gulch basins. A single gully in the Americano Creek area disgorged 4,000 tons of sediment annually, contributing to flooding around Bloomfield and Valley Ford. Because of sedimentation and low water levels, the creek is no longer navigable.
Sedimentation in the Salmon Creek estuary has reduced its capacity by 25%. Past logging and heavy storms have partially filled the Willow Creek channel and surrounding wetlands. In Cheney Gulch, erosion over the years has generated enough sediment to close the gulch to navigation and fill 35 acres of subtidal habitat in Bodega Harbor, requiring costly dredging to keep the channel open.

Roughly 133,791 acres of county flatland were subject to excessive erosion in the early 1980s, according to the Sonoma County Soil Resources Inventory, the Soil Conservation Service's most recent soil inventory. Another 41,000 acres were subject to deep gully erosion, according to the report; about 5000 acres were prone to flooding and sedimentation caused by upstream erosion. Soil conservationists attribute local soil losses largely to land-clearing, including vineyard development on steep hillsides (which shed 20-250 tons of soil per acre per year), overgrazing, ranchette and road development, timberland access roads and timber harvesting.

USDA officials observe that urban uses now cover much of the county's prime agricultural land, and that agricultural production has dropped as a result of this, as well as in response to inflated property values in areas adjacent to cities. Urban expansion is expected to cover 18,000 acres by the year 2000.

Researchers led by David W. Smith, writing in History, Land Uses and Natural Resources of the Laguna de Santa Rosa, (a.k.a. Laguna Characterization Study) of 1990, reported that urban acreage in the Santa Rosa area is roughly equivalent to the amount of land that was under agriculture in the same area around the years 1910-20. Pesticide and chemical use in modern urban areas often far exceeds agricultural use on a per-acre basis, they noted; herbicide uses include private landscaping and county flood control channel maintenance.

Sedimentation is occurring more rapidly than anticipated in Santa Rosa area flood detention basins, possibly as a result, in part, of rapid development, according to the city's 1990 general plan EIR. The increased amount of pavement has accelerated and increased runoff from storms, further eroding natural stream channels. Private owners are losing property and stream banks are slowly collapsing along Spring and Matanzas creeks. Downstream, sedimentation has reduced the Laguna's capacity to hold Russian River floodwater.

Although the plan calls for more natural stream restoration, the cumulative effects of added development may induce the construction of more artificial drainage and flood control channels instead. More development will also increase water pollution and reduce groundwater recharge rates in the city by a total of roughly 31% in urban zones and 11% in outlying areas, according to planners.

A total of 53 public water supply wells in Sonoma County were known to be contaminated with toxic organic chemicals in 1990, according the state's annual Well Investigations Program report of that year. Most of the wells (36), were within Santa Rosa, seven of them listed as state superfund sites. Among the most frequently-occurring of the 37 chemical compounds found in the wells, trichloroethylene (TCE) and 1,1,1-trichloroethane (TCA) led the list, followed by chloroform, freon, and benzene. Some of
the highest concentrations occurred in Bodega Bay (chloroform at 110 parts per billion),
and at a building supply store in Santa Rosa (benzene, 1300 ppb).

At least 697 underground tanks containing hazardous substances are known to have
leaked in Sonoma County, according to the State Water Resources Control Board's 1992
Report on Releases of Hazardous Substances from Underground Storage Tanks, an
annual report. Leaks of gasoline, waste oil, solvents, or other substances from one or
more tanks have contaminated groundwater on 310 sites in the county, affecting drinking
water supplies in 15 instances. Remedial action has been in progress.

State researchers monitoring toxics bioaccumulating in the Russian River watershed
found three heavy metals present at levels in excess of international standards, while
some other toxins appeared in amounts higher than average, according to data published
by the State Water Resources Control Board in its Toxic Substances Monitoring
Program: Ten Year Summary Report; 1978-87 (1990) and annual data reports from 1991,

Toxics are unlikely to appear in detectable amounts in surface water "grab samples," but
do show up over time in some aquatic organisms.

In tests for substances in fish and shellfish tissue taken over 13 years' time, mercury
levels exceeded standards in fish taken from Lake Pillsbury in 1981, and again among
Pillsbury, Mendocino, and Sonoma lakes and Russian River samples between 1989 and
1993. Elevated levels of mercury not above standards in fish tissue have also been found
in Mark West Creek and the lower river. Selenium in excess of international standards
appeared in tissue samples taken from the Russian River, Laguna de Santa Rosa, and
Santa Rosa Creek in 1987. And sampling conducted in the lower Russian River had also
revealed chromium above standards in 1978; elevated levels of chromium not above
standards were again found in samples from the Russian River at Oddfellows, Mark West
Creek, and, in later testing, Sonoma Creek.

Mercury and chromium naturally occur at high levels in the local environment.

The central county river was the only Sonoma County location to be included in the
testing conducted by the state Water Resources Control Board until the early 1990s.

Other toxic substances found to be bioaccumulating in the river watershed include:
aromatic, lindane, nickel, DDT, and lead at occasionally elevated levels; chlordane,
dieldrin, cadmium, DDE, chlorpyrifos, silver and zinc; and copper in concentrations
above those known to bring on chronic poisoning in freshwater organisms. Recent
sampling, expanded to include stations in the southern county, revealed elevated levels of
nickel, zinc, chromium, arsenic, and copper from among samples taken from the
Petaluma River, Sonoma Creek, and the Estero Americano. (Please see Appendix C for
more information on waterborne toxics.)

International standards for toxins in fish and shellfish tissue are levels deemed to be
dangerous by several nations, but not by the US. In the case of mercury and some other
contaminants, federal action levels for edible portions of fish and shellfish have not been
exceeded in Russian River watershed samples, but mercury concentrations have exceeded
more protective alert levels established by the state of California in 1992. For the protection of aquatic organisms themselves, the federal EPA and the National Academy of Sciences have issued advisory guidelines.

A toxics monitoring program for coastal waters found consistently high levels of cadmium in shellfish collected along most of the state's length, including coastal Sonoma County, between 1977 and 1986, according to the California State Mussel Watch: Ten Year Data Summary of 1988. Researchers for the State Water Resources Control Board found cadmium in excess of international standards in mussels or clams taken from stations at Gerstle Cove, the mouth of the Russian River, Duncan's Mills, Bodega Head, and Bodega Bay. Arsenic levels above the standard appeared in samples taken from Bodega Head in the early 1980s.

Trace metals and organic chemicals found on occasion off the local coast at levels greater than most in the rest of the state included aluminum, lindane, and dacthal. Most of the 13 metals tested for were detected in trace amounts, along with the toxic organic chemicals DDT and DDE, dieldrin, hexachlorobenzene, endosulfan, phenol, chlordane, and nonachlor. However, most of the more than 45 organic chemical compounds and derivatives tested for in Sonoma County did not appear in samples.

(Data reports or annual reports with more detailed comments specific to the Sonoma County coastal watch stations may be available.)

A massive set of studies produced during Santa Rosa's survey of wastewater disposal alternatives in the late 1980s (the Long-Term Detailed Wastewater Reclamation Studies) included the following on the Laguna and southwest county watersheds:

The presence of un-ionized ammonia caused primarily by non-point sources of pollution may hamper steelhead migration in winter and spring in the Laguna, according to researchers led by David W. Smith, writing in Preliminary Laguna de Santa Rosa Discharge Criteria, 1989. They said a change in wastewater discharge from the regional plant could help reduce ammonia levels during these seasons by 15 to 60%. Dissolved oxygen in the Laguna was judged adequate for most species, but possibly too low for salmon-like fish.

The entire Americano Creek watershed appears to be contaminated with fecal bacteria, probably from livestock, said Smith in Preliminary Estero Americano Water Quality Evaluation, 1988. Researchers noted widespread trampling of vegetation in the creek and its estero, causing enough sedimentation to alter the estero wetlands and reduce its tidal capacity, probably affecting the types of plants and animals found there.

Some areas of the watershed appeared to be productive fish nurseries, researchers said.

Barren land in the Estero Americano expanded from one to about 35 acres between 1977 and 1989, both because of trampling and because of high soil salinity brought about by the lack of freshwater inflows during summertime, according to H.T. Harvey, et al, in Wetlands in the Estero Americano and Estero de San Antonio. Researchers said that they looked for, but did not find the endangered California Clapper Rail, typically a resident of natural estero habitat.
The EPA criteria for the protection of aquatic life was at times exceeded by un-ionized ammonia, copper, and zinc pollutants in the waste-loaded runoff of Americano and Stemple creek watersheds, with copper concentrations topping the standard as much as 67% percent of the time during sampling in the Americano, reported Marcie L. Commins, et al., in Estero Americano and Estero de San Antonio Monitoring Program: 1988-1989 Results. The copper found in the watersheds may have its source in copper sulfate hoof baths used to control fungus on dairy cattle, or in applications of copper used to kill mollusks in farm ponds.

The tidewater goby, normally found in coastal esteros, appeared only rarely in the upper reaches of the Estero Americano. Due to habitat loss and degradation, the goby has nearly disappeared from California, and is now a candidate for state listing. Researchers said the diversity of organisms in the estero decreased with distance from the ocean as ammonia concentrations in the water rose. Spawning populations of steelhead and coho salmon apparently no longer frequent the two streams.

In his Draft Water Quality Results from Quarterly Groundwater Sampling, researcher Gerald Vogt said levels of indicator bacteria, dissolved solids, and nitrate were higher in groundwater samples from the areas of Stemple and Americano Creeks and Two Rock than in groundwater around Valley Ford and Bloomfield in 1988 and 1989. Vogt's team suggested that runoff or infiltration from agricultural feedlots and dairies might be the cause of the higher readings. Well tests yielded detectable but safe levels of arsenic, barium, iron, lead, and zinc, manganese, copper, silver, and selenium.
Chapter 8

AFTERWORD: On Creating an Index

During the second part of this century, the human population of Sonoma County has more than tripled, growing by 29.5% in the last decade alone. Both population and economic growth, although slowing, have been proceeding at rates higher than the state average. Population density in Sonoma County currently stands at about 268 people per square mile. Planners estimate the county will officially become "urban" by transit standards, with a population topping 500,000, before 2010. Although multi-family home construction is on the upswing, single-family residences continue to dominate the home building market. At the same time, the number of people per household is shrinking. Most job growth continues to concentrate in the service, retail, construction, and government sectors, whereas, prior to World War II, tourism, lumber and agriculture employed the most workers.

Our land uses reflect our priorities, and what this report tells us is that during this surge of growth and economic transformation, the human concerns of the moment have in many cases taken precedence over the care of our common heritage--usurping prime soil, compromising air and water quality, driving some species to local extinction and threatening the survival of others. Although controls on environmental impacts are now stronger, the carelessness of earlier decades has left as its legacy plumes of contaminated ground water and fouled land, areas of massive erosion, wetlands and riparian forests obliterated, and portions of the landscape in fragments:

In 1993, 17 species resident to the county were officially endangered, eight of them on federal lists. Most are still in decline.

Urbanized land has expanded at the rate of 1,100 acres annually, with more than 900 acres converted from agriculture each year.

We've been building roads at the rate of 23 miles a year, driving 8.8 million miles per day, and carpooling less.

Our energy use, of which gasoline consumption accounts for more than half, is equivalent to burning 25 pounds of coal per person daily.

The county casts an estimated 539 tons of pollutants into the air every day--2.64 pounds per person--as well as emitting a hefty 716,713 pounds of airborne toxics per year, including, in 1990, about 125,000 pounds of chlorofluorocarbons.

In 1991, we landfilled nearly a half million tons of garbage, produced at a rate of 6.84 pounds per person daily. Each household generated nearly seven pounds of hazardous
waste per year, and much of it has been disposed of illegally. Illegal disposal of small quantities of hazardous waste appears to be widespread; for each day of 1986, an estimated 2,700 gallons of waste oil found its way onto the ground or into streets and storm drains.

Waste oil, diesel, heavy metals, pesticides, or agricultural runoff have polluted an estimated 245 miles of streamway to some degree, along with 13 square miles of groundwater around the county, affecting numerous wells and some publicly-owned water supplies.

Despite the damage, Sonoma County remains for many a beautiful and desirable place to live. The question before us now is, What will we leave our children? In the present moment, do we find ourselves working to somehow better our world? Or are we asking, What's left in it for me?

This choice is at the root of every decision we make that affects the environment. In that respect, it shows us what we are making of ourselves together, for our impacts are cumulative. Are we acting in harmony with one another? Do material goods figure prominently in our thoughts? Protected hillsides, some innovative development, and big box stores answer back.

By its nature, the environmental dilemma calls for a cooperative solution. Towards that end, we need to know two things: what our current condition is, and what we hope to make it. This report responds to the first concern. The second is up to all of us. A document cannot form a vision nor act in faith on it; for that, we need one another.

How do we attain a brighter future?

The members of Sustainable Seattle, a community-based quality-of-life index project, set before themselves the image of their own children, grand- or great-grandchildren (or the descendants of someone they’ve loved) "being well, happy, fulfilled...and living in a healthy world." They then asked themselves, What would best inform the decisions we must make on their behalf? The result was a list of 40 indicators, pared to 20 for the first year's report, arrived at by consensus among more than 150 participants.

The piece of work they produced is itself an inspiration. But, just as we've seen in our own planning process, documents don't induce intentional living. The only real template we have for our future is the current configuration of our desires. Those who have mastered the lower impulses to live out the higher are those who can affect the future for the common good. When the hearings close, the public process follows us into our private lives.

In offering solutions to environmental problems, government and technology have a place. But it is human interaction that holds the key to what a community can achieve.
When someone personally affects us in a positive manner, we're able to align our attention more with the forward-looking and less with the sideways-glancing. The potency of this renewed perspective can inspire us to act in ways that cumulatively will produce a better place to live. In this way, an environmental index can serve as a meeting ground for dedicated people to refresh one another's vision of a future for us all.
## APPENDICES A

### A Report on the Quality of the Environment

<table>
<thead>
<tr>
<th>Natural Community Impacted</th>
<th>Species Affected</th>
<th>Current Numbers</th>
<th>State, Federal Status</th>
<th>Reasons Cited for Decline</th>
<th>Current Preservation Activity</th>
<th>What the State Thinks Would Help</th>
<th>Species Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>old-growth forest</td>
<td>Northern spotted owl</td>
<td></td>
<td>F:T 1990</td>
<td>timber harvesting</td>
<td></td>
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<tr>
<td>coastal, inland marshes, swamps</td>
<td>California black rail</td>
<td>unknown</td>
<td>S:T 1971 F:C1</td>
<td>Devel., agric., flood control</td>
<td>no active mgt.</td>
<td>Protection and restoration of marshes, management plan, studies, surveys.</td>
<td>Declining (43)</td>
</tr>
<tr>
<td>Same</td>
<td>California Clapper rail</td>
<td>less than 1000 individuals</td>
<td>S:E 1971 F:E 1970</td>
<td>devel., agric., pestic., intro'd cordgrass, red fox, sewage effluent, urban runoff, industrial discharge; flood control</td>
<td>habitat protection, restoration, monitoring, red fox control, &quot;Recovery Team&quot;</td>
<td>Marsh restoration, studies, regular fox control rec'd, possibly captive breeding</td>
<td>Stable/declining</td>
</tr>
<tr>
<td>Natural Community Impacted</td>
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<td>Current Numbers</td>
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<td>What the State Thinks Would Help</td>
<td>Species Trend</td>
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<td>Salt marshes around Suisun, San Pablo, and San Francisco bays, including marsh preserve</td>
<td>Salt-marsh harvest mouse</td>
<td>985 habitat lost in last two decades</td>
<td>S:E 1971 F:E 1970</td>
<td>bay filling and discing -- devel., agric., intro'd plants, flood control possibly intro'd</td>
<td>Habitat preserves, surveys, law enforcement, recovery team. Poss. inclusion in multi-species bay marsh recovery</td>
<td>More marsh habitat protection; law enforcement, surveys.</td>
<td>Declining (27)</td>
</tr>
<tr>
<td>Natural Community Impacted</td>
<td>Species Affected</td>
<td>Current Numbers</td>
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<td>What the State Thinks Would Help</td>
<td>Species Trend</td>
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<tr>
<td>outside Petaluma</td>
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<td></td>
<td></td>
<td>plan,</td>
<td></td>
</tr>
<tr>
<td>low-gradient streams in Marin, Sonoma, and Napa counties</td>
<td>California freshwater shrimp</td>
<td>population s in 15 streams</td>
<td>S:E 1980 F:E 1988</td>
<td>loss of streamway, small dam constructio n, stream alteration, channelizati on, flood and erosion controls, intro'd predators, pollution, soil erosion, cattle grazing, removal of riparian vegetation</td>
<td>study underway</td>
<td></td>
<td>Most populations declining (83)</td>
</tr>
<tr>
<td>serpentine soil in chaparral near Occidental in Sonoma County</td>
<td>Baker's manzanita</td>
<td>population s: 11 known</td>
<td>S:R 1979 F:C2</td>
<td>res. devel., grazing, agric. conversion, ORVs, dumping, intro'd species, fire suppression, hybridizatio n</td>
<td>voluntary protection on one private site; two populations in preserves; preserve plans</td>
<td></td>
<td>Declining (89)</td>
</tr>
<tr>
<td>serpentine chaparral near Occidental in Sonoma County</td>
<td>Pennel's bird-beak</td>
<td>five population s</td>
<td>S:R 1978 F:C1</td>
<td>illegal dumping, ORVs, residential developme nt threaten</td>
<td>voluntary protection on one private site; one partially in preserve; management plan exists</td>
<td></td>
<td>Declined; may be stabilizing (117)</td>
</tr>
<tr>
<td>acid marine deposits in west county known as &quot;Sonoma Barren&quot;</td>
<td>Vine Hill manzanita</td>
<td>one population remaining</td>
<td>S:E 1981 F:C1</td>
<td>Agricul., res. devel., roadside weed abatement</td>
<td>remainder in preserve</td>
<td>Suitable habitat acquisition.</td>
<td>Declining to extinction (93-94)</td>
</tr>
<tr>
<td>soil in Napa and Sonoma counties</td>
<td>Clara Hunt's milk</td>
<td>four population s of several</td>
<td>S:T 1990 F:C1</td>
<td>urbanizatio n, viticulture, site restoration</td>
<td>Management plan. Annual</td>
<td></td>
<td>Declining (93-94)</td>
</tr>
<tr>
<td>Natural Community Impacted</td>
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<td>Current Preservation Activity</td>
<td>What the State Thinks Would Help</td>
<td>Species Trend</td>
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<td></td>
<td>vetch</td>
<td>hundred individuals</td>
<td></td>
<td>dumping, human intrusion</td>
<td>plant.</td>
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<tr>
<td>Santa Rosa Plains and</td>
<td></td>
<td>danger of development</td>
<td></td>
<td></td>
<td>studies; no program implementation on as yet;</td>
<td>for vernal pool species.</td>
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<tr>
<td>Sonoma Valley</td>
<td></td>
<td></td>
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<td>some in state's Laguna preserve</td>
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<tr>
<td>adjacent to freshwater</td>
<td>White sedge</td>
<td>one of five known population remains</td>
<td>S:E 1979 F:C1</td>
<td>habitat conversion, development and drainage alteration threaten</td>
<td>on private land; no protection</td>
<td>Federal protection recommended. Protection</td>
<td>Continued decline (102)</td>
</tr>
<tr>
<td>marshes and creeks in</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>of habitat, drainage patterns.</td>
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<tr>
<td>Sonoma County</td>
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<tr>
<td>west Sonoma County</td>
<td>Pitkin Marsh Indian</td>
<td>single plant remains since late 1970s</td>
<td>S:E 1978 F:C1</td>
<td>drainage alteration, grazing, land-clearing</td>
<td>Lab propagation and hybridization efforts. Private</td>
<td>Drainage pattern protection and cutback of other</td>
<td>Continued declining (105)</td>
</tr>
<tr>
<td>marshland</td>
<td>paintbrush</td>
<td></td>
<td></td>
<td></td>
<td>landowner has allowed no further monitoring; last</td>
<td>plants needed.</td>
<td></td>
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<td></td>
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<td>plant may be gone</td>
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<tr>
<td>sandy</td>
<td>Vine Hill</td>
<td>one native</td>
<td></td>
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<tr>
<td>Blucher loam soil in</td>
<td>Clarkia</td>
<td>population on private land;</td>
<td>S:E 1978 F:C1</td>
<td>originally only two known groupings; one extirpated</td>
<td>voluntary protection by private landowners</td>
<td>Protection. May now merit endangered status.</td>
<td>Decline (113)</td>
</tr>
<tr>
<td>west Sonoma County only</td>
<td></td>
<td>transplanted population in preserve</td>
<td></td>
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<tr>
<td>steep, rocky outcrops on</td>
<td>Yellow larkspur</td>
<td>fewer than 12 original, est. two</td>
<td>S:R 1979 F:C1</td>
<td>cattle grazing, residential development</td>
<td>no protective measures</td>
<td>Protection. May now merit endangered status.</td>
<td>Declining (120)</td>
</tr>
<tr>
<td>coast in sage scrub plant</td>
<td></td>
<td>remain near Bodega Bay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>community</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Geyser's panicum</td>
<td>Seven population known</td>
<td>S:E 1978 F:C2</td>
<td>geothermal power development, road construction, soil</td>
<td>cooperative efforts in Little Geysers Natural</td>
<td>Trend unknown</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Area; monitoring</td>
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</tbody>
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<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Geyser only</td>
<td></td>
<td></td>
<td></td>
<td>temperature increasing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>seasonal pools and moist shallows in Santa Rosa Plains, some sites in Lake County</td>
<td>Burke's goldfields</td>
<td>number of population s small but unknown</td>
<td>S:E 1979 F:E 1991</td>
<td>urbanization, row crop conversion, lwy. widening, effluent irrigation, overgrazing</td>
<td>Cooperative efforts with airport mgt., county planners, SSU; seed storage. Vernal Pools Task Force. Some on Todd Road eco preserve; some transferred as mitigation</td>
<td>Many development s recently approved which impact pool species. Regional conservation of vernal pools.</td>
<td>Drastic decline (140)</td>
</tr>
<tr>
<td>Alongside freshwater marshes in portion of west Sonoma County only</td>
<td>Pitkin Marsh lily</td>
<td>three originally known; two population s remain</td>
<td>S:E 1978 F:C1</td>
<td>land clearing and drainage, cattle grazing, bulb collection, intro'd plants</td>
<td>cooperation of private landowners, protective measures, plant tissue storage</td>
<td>Stabilizing (142-43)</td>
<td></td>
</tr>
<tr>
<td>seasonal pools in volcanic ash soil in Lake and Sonoma County only</td>
<td>Many-flowered navarretia</td>
<td>Two known sites in Sonoma County, status of one unknown</td>
<td>S:E 1979 F:C1</td>
<td>trampling, grazing, ORVs</td>
<td>Lake County nature walk preserve, another fenced. Sonoma County program proposed</td>
<td>Regional conservation of vernal pools.</td>
<td>Stabilized in Lake County (152)</td>
</tr>
<tr>
<td>moist places in north coast forest in Marin,</td>
<td>North coast semaphor e grass</td>
<td>about 12 known occurences , many not</td>
<td>S:R 1979 F:C2</td>
<td>road maintenanc e and herbicide</td>
<td>One pop. in Laguna preserve</td>
<td>Need field surveys.</td>
<td>Declining (160)</td>
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<tr>
<td>Natural Community Impacted</td>
<td>Species Affected</td>
<td>Current Numbers</td>
<td>State, Federal Status</td>
<td>Reasons Cited for Decline</td>
<td>Current Preservation Activity</td>
<td>What the State Thinks Would Help</td>
<td>Species Trend</td>
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<tr>
<td>Sonoma and Mendocino counties only</td>
<td>seen recently.</td>
<td></td>
<td></td>
<td>spraying, land conversion, drainage alteration, possible insect predation</td>
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<tr>
<td>Kenwood Marsh and Knights Valley in Sonoma County only</td>
<td>Kenwood Marsh checkerbl oom</td>
<td>Two sites known, both on private land</td>
<td>S:E 1982 F:C1</td>
<td>land conversion for agric. and devel., drainage alteration, cattle grazing</td>
<td>Field surveys.</td>
<td>No protections. Conservatio n easement called for.</td>
<td>Declining (167)</td>
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## APPENDIX B:

### Sonoma County Waterbody Ratings and Characteristics

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<th>reamws</th>
<th>total miles</th>
<th>good</th>
<th>intermediate</th>
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<th>unknown</th>
<th>sedimentation from logging or urban/agr. discharge</th>
<th>low dissolved oxy., high ammonia from agri. ops.</th>
<th>high bacteria counts</th>
<th>other: high nutrient levels, urban runoff, water diversion</th>
<th>pollution abated</th>
<th>pollution remains despite best treatment/controls</th>
<th>pollutants is both toxic and non-toxic, from non-point sources</th>
<th>EPA listed.</th>
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<td>merced</td>
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<td>Heavy grazing, numerous confined animal waste problems impair fish, other wildlife habitat.</td>
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<td>Recents industrial discharge abated.</td>
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<td>gualala river</td>
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<td>Domestic water supplies for Gualala, Sea Ranch threatened. Steelhead</td>
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EPA listed.
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<th>Low dissolved oxygen, high ammonia from agri. ops.</th>
<th>High bacteria counts</th>
<th>Other: high nutrient levels, urban runoff, water diversion</th>
<th>Pollution abated</th>
<th>Pollution remains despite best treatment/controls</th>
<th>Pollution is both toxic and non-toxic, from non-point sources</th>
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<tr>
<td>Laguna, S.R.</td>
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<td>Surface water affected. Fish, other wildlife habitat impaired. Pollution could affect municipal water supplies at confluence of Laguna, Russian River, via Mark West Creek.</td>
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<td>105</td>
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<td>Municipal and domestic supplies, recreational uses and fish and wildlife habitat threatened by municipal, agricultura l and industrial discharges, road and building constructi</td>
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59
### Table: Water Quality

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<th>Low Dissolved Oxy.</th>
<th>High Ammonia from Agr. Ops.</th>
<th>High Bacteria Counts</th>
<th>Other: high nutrient levels, urban runoff, water diversion</th>
<th>Pollution Abated</th>
<th>Pollution Remains Despite Best Treatments/Controls</th>
<th>Pollutant is both toxic and non-toxic from non-point sources</th>
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<tr>
<td>Amolar Cr.</td>
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<td>Extensive grazing has impacted water quality. Fish, other wildlife habitat impaired.</td>
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<td>Antioch Cr.</td>
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<td>Eutrophication, sedimentation. Fish, other wildlife habitat degraded.</td>
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<td>Adobe Creek</td>
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<td>Eutrophication. Bacterial standards exceeded.</td>
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<td>Non-point runoff, spills, fishing industry discharges</td>
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Note: All entries represent data as of the latest available information.
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<th>reamway</th>
<th>total miles</th>
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<th>intermediate</th>
<th>impaired</th>
<th>unknown</th>
<th>sedimentation from logging or urban/agr. discharge</th>
<th>low dissolved oxy., high ammonia from agri. ops.</th>
<th>high bacteria counts</th>
<th>other: high nutrient levels, urban runoff, water diversion</th>
<th>pollution abated</th>
<th>pollution remains despite best treatment/controls</th>
<th>pollution is both toxic and non-toxic, from non-point sources</th>
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<td>5000</td>
<td>5000</td>
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<td>Pollution from American o., Stemple, and Chaney Gulch creeks threatens commercial, recreational uses and habitat.</td>
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<td>Threat of fish population decline; threat of more sedimentation.</td>
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<td>Other: high nutrient levels, urban runoff, water diversion</td>
<td>Pollution abated</td>
<td>Pollution remains despite best treatment/controls</td>
<td>Pollution is both toxic and non-toxic, from non-point sources</td>
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<td>Pollution Remains Despite Best Treatment/Controls</td>
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<td></td>
<td>Domestic wells contaminated; potential municipal suppy threatened</td>
<td>Chromium related to wood treatment.</td>
<td></td>
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</tr>
</tbody>
</table>
| etaluma 
'alley | 41    | 41   |              |          |         | Toxics contamina te domestic drinking water, threaten more |                                                   |                     |                                                   |             |                                                  |                                                  |
| onoma 
'alley | 50    | 50   |              |          |         | Toxics contamina te domestic drinking water, threaten more |                                                   |                     |                                                   |             |                                                  |                                                  |
APPENDIX C: Waterborne Toxics

These toxics were found in amounts above Median International Standards in fish and shellfish tissue taken from the Russian River watershed:

Chromium, a form of which is known to be a mammalian carcinogen, is especially toxic to salmon-like fish. Used in wood preservation and turf disease control, it also appears in agricultural and mine runoff and industrial discharge. It is present in high quantities in the natural environment.

Mercury, acutely toxic to aquatic organisms and hazardous to humans ingesting them, in coastal areas is present in natural cinnabar deposits and in cinnabar mine runoff.

Selenium, an essential trace mineral, becomes toxic to aquatic organisms and their predators as it oxidizes. As a pollutant, it has its source in agricultural runoff from petroleum-based fertilizers.

Also found:

Arsenic, a pesticide and known human carcinogen persistent in the environment, has in most cases been banned from use, but arsenic-based compounds which can convert to the more toxic form were in common use on grapes, landscaping, and right-of-ways, according to a late 1980 report. Arsenic appeared at elevated levels in samples from Lake Sonoma and the Petaluma River in 1992-93.

Chlordane, a pesticide and known carcinogen, was used to control termites until its prohibition in 1988.

Dieldrin, a known carcinogen, was widely used for termites and other insect control. It was severely restricted in 1974.

Nickel, a known human carcinogen, occurred in elevated levels in samples in the Russian River, Big Sulfur Creek, Sonoma Creek, the Estero Americano, and Mark West Creek as late as 1993. It can be found in acid mine waste and wastes from heavy fuel oil combustion and electroplating.

Lead, a human reproductive toxicant and source of two carcinogens, appears in dwindling concentrations; it had been a component of gasoline. It was found at elevated levels in samples from Mark West Creek in 1992-93.

Cadmium, a known human carcinogen, is often present in air pollution and in industrial and municipal wastewater.

DDE and DDT were banned from use in the US in the early 1970s for environmental persistence, adverse effects on wildlife, and potential carcinogenity. Elevated levels of DDT were found in samples in 1991.
Lindane (hexachlorocyclohexane), a known carcinogen, was found at elevated levels in 1989 samples. It is a multi-purpose insecticide used primarily for structural pest control and landscape maintenance.

Chlorpyrifos, extremely toxic to fish, birds, and other wildlife, is widely used to kill insects in households, on ornamental plants, and on cattle; as well as for mosquito abatement.

Silver and zinc, both toxic to freshwater organisms, are widely used in industrial and commercial operations.

Copper, occurring in samples in concentrations above those known to bring about chronic poisoning in freshwater organisms, is found in mine runoff, industrial releases, and pesticides, and is used in algae control. Regional wastewater issuing into the river has carried elevated levels of copper, possibly drawn by acidic water from plumbing, according to wastewater operators.

Mentioned as appearing in contaminated groundwater:

Trihalomethanes include four types of methane compounds; among them, trichloromethane, or chloroform, is a carcinogen in animal studies, and a suspected carcinogen for humans.

TCE is carcinogenic to animals.
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